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19-1930; Rev 0; 4/01

MAXIM

Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

General Description

The MAX6220 is a low-noise, precision voltage reference with extremely low 20ppm/°C temperature coefficient over the automotive temperature range (-40°C to +125°C) and excellent ±0.1% initial accuracy. This device features buried-zener technology for low noise performance. The load-regulation specification is guaranteed for source and sink currents up to 15mA. Excellent line and load regulation and low output impedance at high frequency make the MAX6220 ideal for high-resolution data-conversion systems up to 16 bits. The MAX6220 is set for 2.5V, 4.096V, and 5.0V outputs.

Applications

High-Accuracy Industrial and Process Control

ATE Equipment

Precision Current Sources

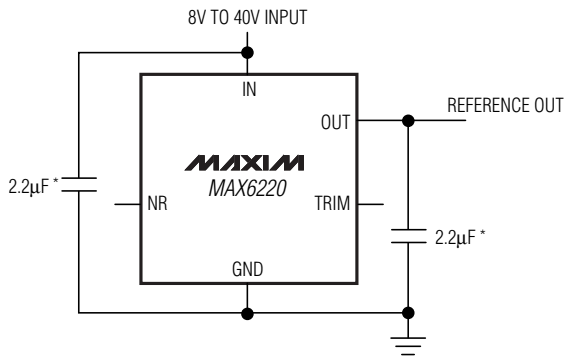
Features

- **Low 20ppm/°C Temperature Coefficient over -40°C to +125°C Range**
- **Very Low 1.5µVp-p Noise (0.1Hz to 10Hz)**
- **±0.1% Initial Accuracy**
- **±15mA Output Source and Sink Current**
- **8V to 40V Input Voltage Range**
- **Optional Noise Reduction and Voltage Trim**
- **Excellent Transient Response**
- **Low 20ppm/1000hr Long-Term Stability**
- **Stable for All Capacitive Loads**

Ordering Information

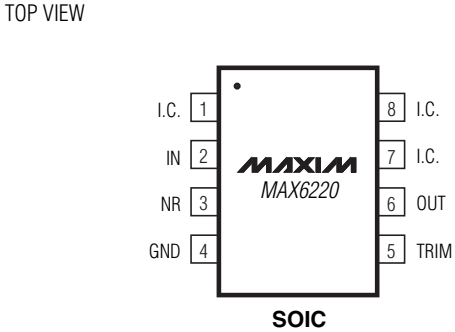
PART	TEMP. RANGE	PIN-PACKAGE	OUPUT VOLTAGE (V)
MAX6220ASA25	-40°C to +125°C	8 SO	2.5
MAX6220ASA41	-40°C to +125°C	8 SO	4.096
MAX6220ASA50	-40°C to +125°C	8 SO	5.0

Typical Operating Circuit



*OPTIONAL (STABLE WITH ALL CAPACITIVE LOADS)

Pin Configuration



SOIC

Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)
IN .....-0.3V to +42V
OUT, TRIM .....-0.3V to +12V
NR .....-0.3V to +6V
OUT Short-Circuit to GND Duration (V_{IN} ≤ 12V).....Continuous
OUT Short-Circuit to GND Duration (V_{IN} ≤ 42V) 5s
OUT Short-Circuit to IN Duration (V_{IN} ≤ 12V) .....Continuous

Continuous Power Dissipation (T_A = +70°C)
8-Pin SO (derate 5.9mW/°C above +70°C).....471mW
Operating Temperature Range.....-40°C to +125°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—(+2.5V)

(V_{IN} = +10V, I_{OUT} = 0mA, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}			8		40	V
Output Voltage	V_{OUT}		+25°C	2.497	2.500	2.503	V
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}				2	20	ppm/°C
Line Regulation (Note 2)	$\Delta V_{OUT}/\Delta V_{IN}$	8V ≤ V_{IN} ≥ 40V	+25°C		2	7	ppm/V
						45	
Load Regulation (Note 2)	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0mA ≤ I_{OUT} ≤ 15mA	+25°C		1	6	ppm/mA
						15	
		Sinking: -15mA ≤ I_{OUT} ≤ 0mA	+25°C		1	6	
						30	
Supply Current	I_{IN}		+25°C		1.8	2.9	mA
						3.3	
Trim-Adjustment Range	ΔV_{OUT}	(Figure 1)		±15	±25		mV
Turn-On Settling Time	t_{ON}	To ±0.01% of final value			5		µs
Output Noise Voltage (Note 3)	e_N	0.1Hz ≤ f ≥ 10Hz			1.5		µVp-p
		10Hz ≤ f ≥ 1kHz			1.3	2.8	μV_{RMS}
Temperature Hysteresis		(Note 4)			20		ppm
Long-Term Stability	ΔV_{OUT}	Δt = 1000hr			20		ppm

ELECTRICAL CHARACTERISTICS—(+4.096V)

(V_{IN} = +10V, I_{OUT} = 0mA, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}			8		40	V
Output Voltage	V_{OUT}		+25°C	4.092	4.096	4.100	V
Output VoltageTemperature Coefficient (Note 1)	TCV_{OUT}				2	20	ppm/°C
Line Regulation (Note 2)	$\Delta V_{OUT}/\Delta V_{IN}$	8V ≤ V_{IN} ≥ 40V	+25°C		2	7	ppm/V
						45	
Load Regulation (Note 2)	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0mA ≤ I_{OUT} ≤ 15mA	+25°C		1	6	ppm/mA
						15	
		Sinking: -15mA ≤ I_{OUT} ≤ 0mA	+25°C		1	6	
						30	
Supply Current	I_{IN}		+25°C		1.9	3.1	mA
						3.5	
Trim-Adjustment Range	ΔV_{OUT}	(Figure 1)		±24	±40		mV
Turn-On Settling Time	t_{ON}	To ±0.01% of final value			5		µs
Output Noise Voltage (Note 3)	e_N	0.1Hz ≤ f ≥ 10Hz			2.4		µVp-p
		10Hz ≤ f ≥ 1kHz			2.0	4.0	μV_{RMS}
Temperature Hysteresis		(Note 4)			20		ppm
Long-Term Stability	ΔV_{OUT}	Δt = 1000hr			20		ppm

Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

ELECTRICAL CHARACTERISTICS—(+5.0V)

(V_{IN} = +10V, I_{OUT} = 0mA, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}			8		40	V
Output Voltage	V_{OUT}		+25°C	4.995	5.000	5.005	V
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}				2	20	ppm/°C
Line Regulation (Note 2)	$\Delta V_{OUT}/\Delta V_{IN}$	8V ≤ V_{IN} ≥ 40V	+25°C		2	7	ppm/V
						45	
Load Regulation (Note 2)	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0mA ≤ I_{OUT} ≤ 15mA	+25°C		1	6	ppm/mA
						15	
		Sinking: -15mA ≤ I_{OUT} ≤ 0mA	+25°C		1	6	
						30	
Supply Current	I_{IN}		+25°C		2.0	3.3	mA
						3.7	
Trim-Adjustment Range	ΔV_{OUT}	(Figure 1)		±30	±50		mV
Turn-On Settling Time	t_{ON}	To ±0.01% of final value			5		µs
Output Noise Voltage (Note 3)	e_N	0.1Hz ≤ f ≥ 10Hz			3.0		µVp-p
		10Hz ≤ f ≥ 1kHz			2.5	5.0	μV_{RMS}
Temperature Hysteresis		(Note 4)			20		ppm
Long-Term Stability	ΔV_{OUT}	Δt = 1000hr			20		ppm

Note 1: Temperature coefficient is measured by the box method; i.e., the maximum ΔV_{OUT} is divided by $\Delta T \times V_{OUT}$.

Note 2: Line regulation ($\Delta V_{OUT} / (V_{OUT} \times \Delta V_{IN})$) and load regulation ($\Delta V_{OUT} / (V_{OUT} \times \Delta I_{OUT})$) are measured with pulses and do not include output voltage changes due to die-temperature changes.

Note 3: Noise specifications are guaranteed by design.

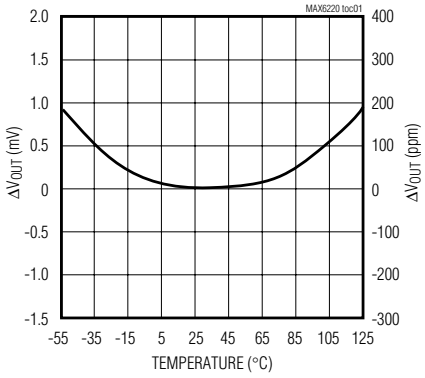
Note 4: Temperature hysteresis is specified at T_A = +25°C by measuring V_{OUT} before and after changing temperature by +25°C.

Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

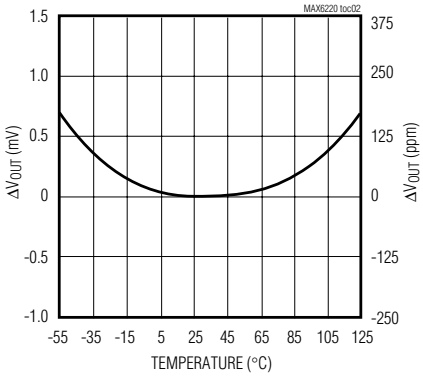
Typical Operating Characteristics

(V_{IN} = +10V, I_{OUT} = 0mA, T_A = +25°C, unless otherwise noted.)

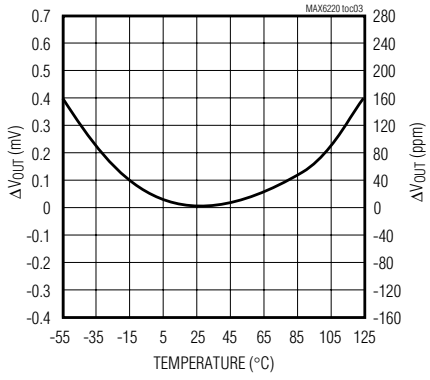
MAX6220_50 NORMALIZED OUTPUT VOLTAGE vs. TEMPERATURE



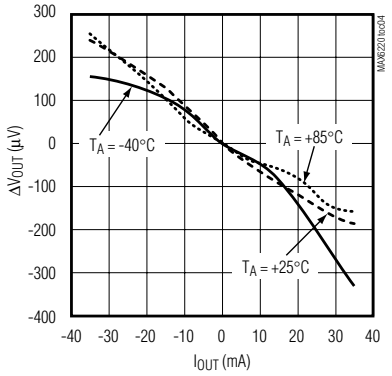
MAX6220_41 NORMALIZED OUTPUT VOLTAGE vs. TEMPERATURE



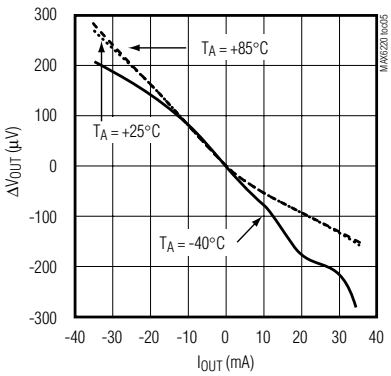
MAX6220_25 NORMALIZED OUTPUT VOLTAGE vs. TEMPERATURE



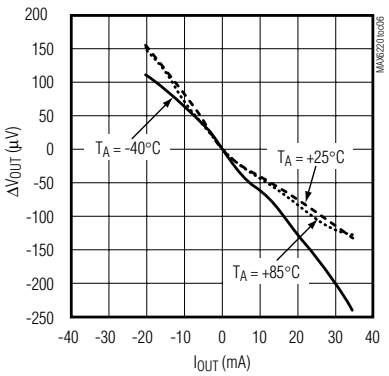
MAX6220_50 CHANGE IN OUTPUT VOLTAGE vs. OUTPUT CURRENT



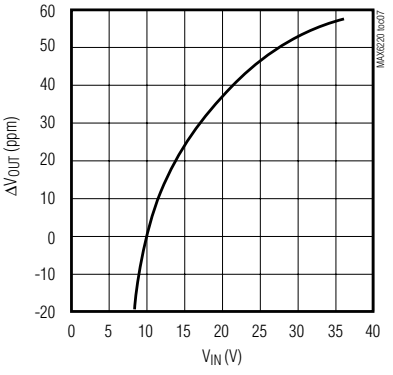
MAX6220_41 CHANGE IN OUTPUT VOLTAGE vs. OUTPUT CURRENT



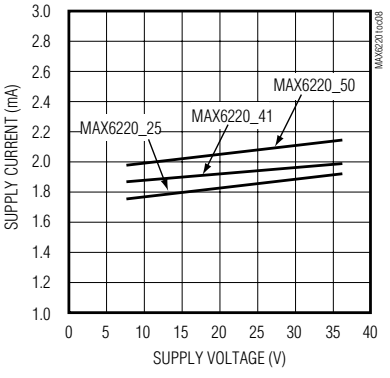
MAX6220_25 CHANGE IN OUTPUT VOLTAGE vs. OUTPUT CURRENT



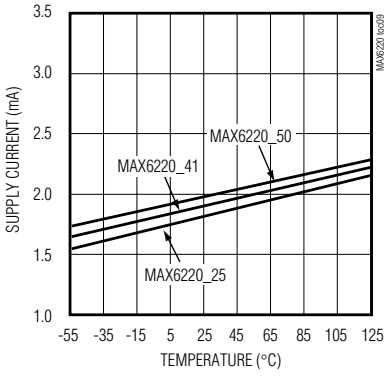
CHANGE IN OUTPUT VOLTAGE vs. INPUT VOLTAGE



SUPPLY CURRENT vs. SUPPLY VOLTAGE



SUPPLY CURRENT vs. TEMPERATURE

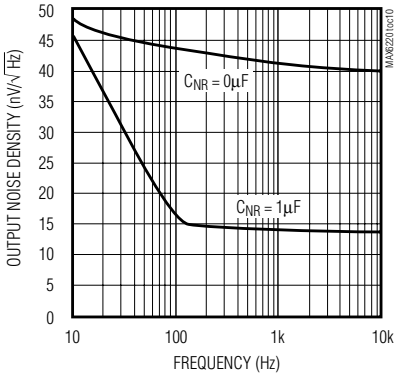


Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

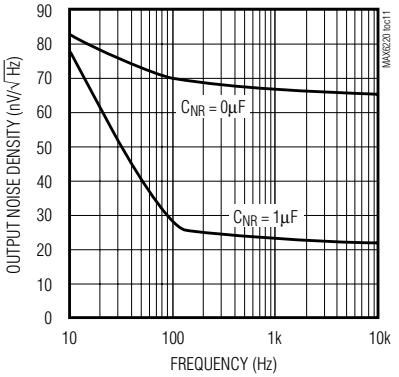
Typical Operating Characteristics (continued)

(V_{IN} = +10V, I_{OUT} = 0mA, T_A = +25°C, unless otherwise noted.)

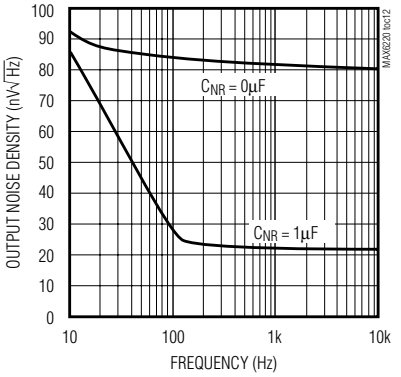
MAX6220_25 OUTPUT NOISE-VOLTAGE DENSITY vs. FREQUENCY



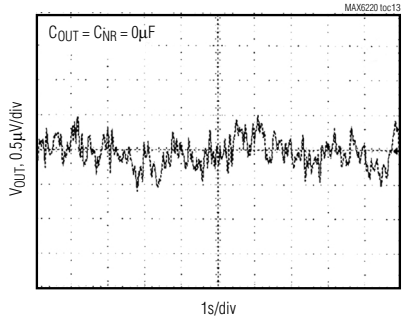
MAX6220_41 OUTPUT NOISE-VOLTAGE DENSITY vs. FREQUENCY



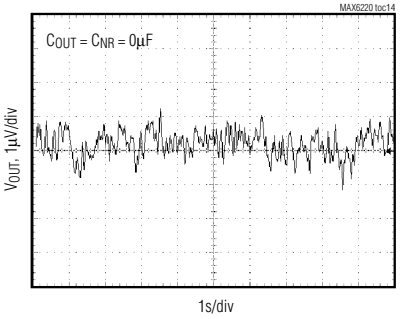
MAX6220_50 OUTPUT NOISE-VOLTAGE DENSITY vs. FREQUENCY



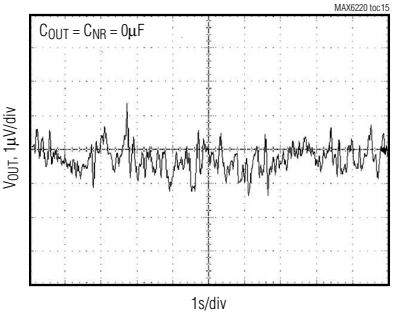
MAX6220_25 0.1Hz TO 10Hz NOISE



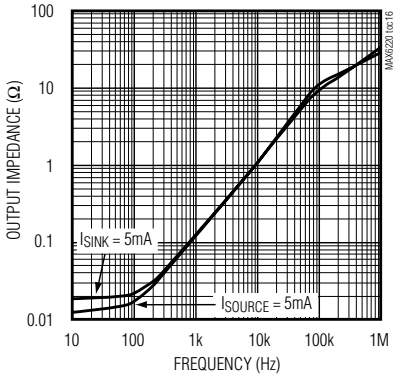
MAX6220_41 0.1Hz TO 10Hz NOISE



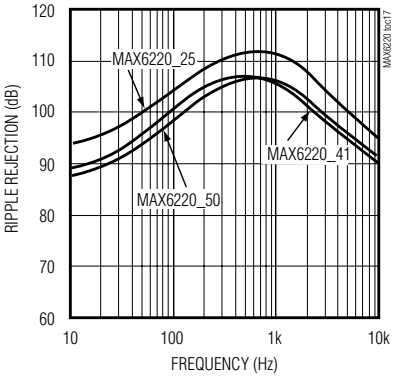
MAX6220_50 0.1Hz TO 10Hz NOISE



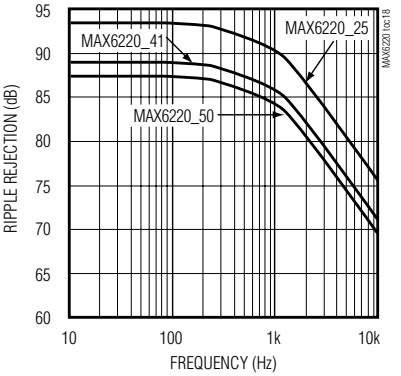
OUTPUT IMPEDANCE vs. FREQUENCY



RIPPLE REJECTION vs. FREQUENCY (C_{NR} = 1µF)



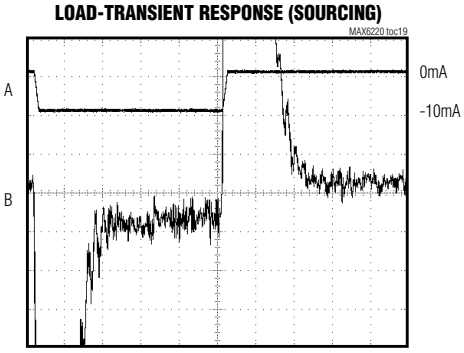
RIPPLE REJECTION vs. FREQUENCY (C_{NR} = 0µF)



Typical Operating Characteristics (continued)

(V_{IN} = +10V, I_{OUT} = 0mA, T_A = +25°C, unless otherwise noted.)

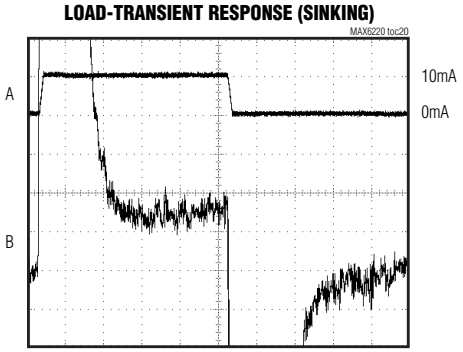
MAX6220_50
LOAD-TRANSIENT RESPONSE (SOURCING)



2µs/div

A: I_{OUT}, 10mA/div (SOURCING)
B: V_{OUT}, 500µV/div

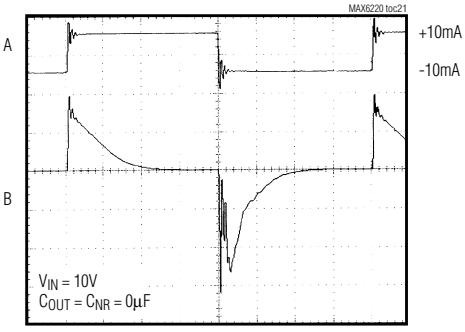
MAX6220_50
LOAD-TRANSIENT RESPONSE (SINKING)



2µs/div

A: I_{OUT}, 10mA/div (SINKING)
B: V_{OUT}, 500µV/div

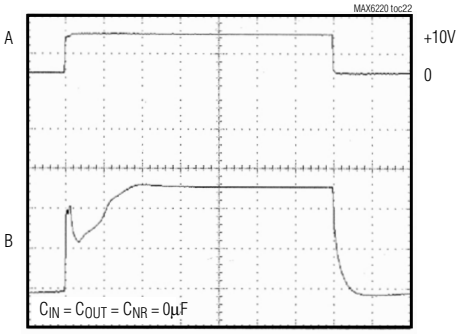
MAX6220_50
LOAD-TRANSIENT RESPONSE



1µs/div

A: I_{OUT} (±10mA SOURCE AND SINK), 20mA/div, AC COUPLED
B: V_{OUT}, 20mV/div, AC COUPLED

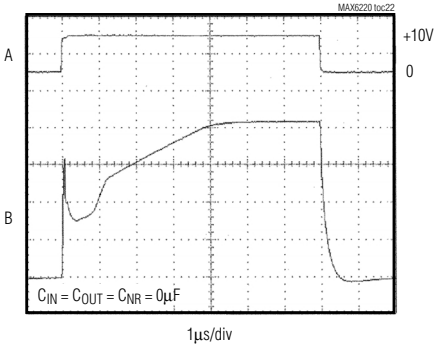
MAX6220_25
TURN-ON AND TURN-OFF TRANSIENT RESPONSE



1µs/div

A: V_{IN}, 10V/div
B: V_{OUT}, 1V/div

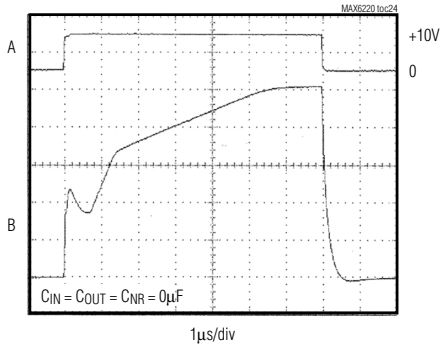
MAX6220_41
TURN-ON AND TURN-OFF TRANSIENT RESPONSE



1µs/div

A: V_{IN}, 10V/div
B: V_{OUT}, 1V/div

MAX6220_50
TURN-ON AND TURN-OFF TRANSIENT RESPONSE



1µs/div

A: V_{IN}, 10V/div
B: V_{OUT}, 1V/div

Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

Pin Description

PIN	NAME	FUNCTION
1, 7, 8	I.C.	Internally Connected. **Do not use**.
2	IN	Positive Power-Supply Input
3	NR	Noise Reduction. Optional capacitor connection for wideband noise reduction. Leave open if not used (Figure 2).
4	GND	Ground
5	TRIM	External Trim Input. Allows ±1% output adjustment (Figure 1). Leave open if not used.
6	OUT	Voltage Reference Output

Detailed Description

Temperature Stability

The MAX6220 is a highly stable, low-noise voltage reference that uses a low-power temperature-compensation scheme to achieve laboratory-standard temperature stability. This produces a nearly flat temperature curve, yet does not require the power associated with heated references.

The output voltage can be trimmed 0.6% (min) by connecting a 10kΩ potentiometer between OUT and GND, and connecting its tap to the TRIM pin (Figure 1). The external trimming does not affect temperature stability.

Noise Reduction

To augment wideband noise reduction, add a 1µF capacitor to the NR pin (Figure 2). Larger values do not improve noise appreciably (*see Typical Operating Characteristics*).

Noise in the power-supply input can affect output noise, but can be reduced by adding an optional bypass capacitor to the IN pin and GND.

Bypassing

The MAX6220 is stable with capacitive load values from 0µF to 100µF, for all values of load current. Adding an output bypass capacitor can help reduce noise and output glitching caused by load transients.

Applications Information

Negative Regulator

Figure 3 shows how both a +5V and -5V precision reference can be obtained from a single unregulated +5V supply. The MAX865 generates approximately ±9V to operate both the MAX6220 reference and the MAX480 inverting amplifier. The +5V is inverted by the MAX480. Resistor R1 is optional, and may be used to trim the ±5V references. R2 and R4 should be matched, both in absolute resistance and temperature coefficient. R3 is optional, and is adjusted to set the -5V reference.

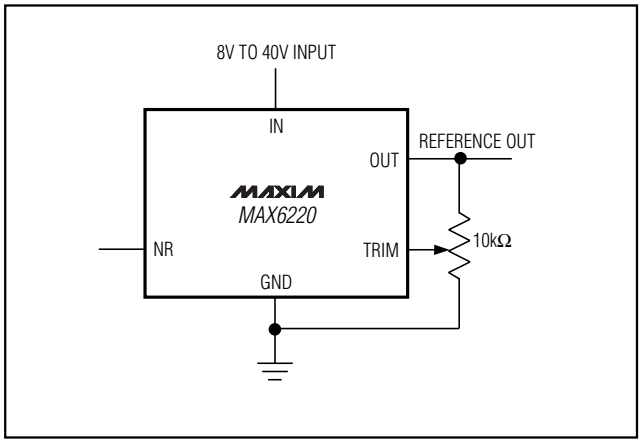


Figure 1. Output Voltage Adjustment

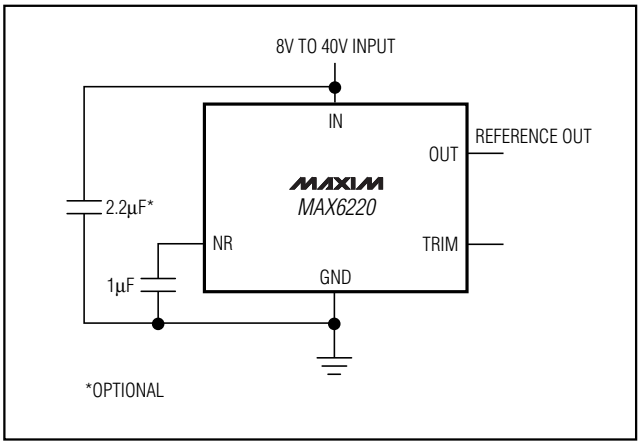


Figure 2. Noise-Reduction Capacitor

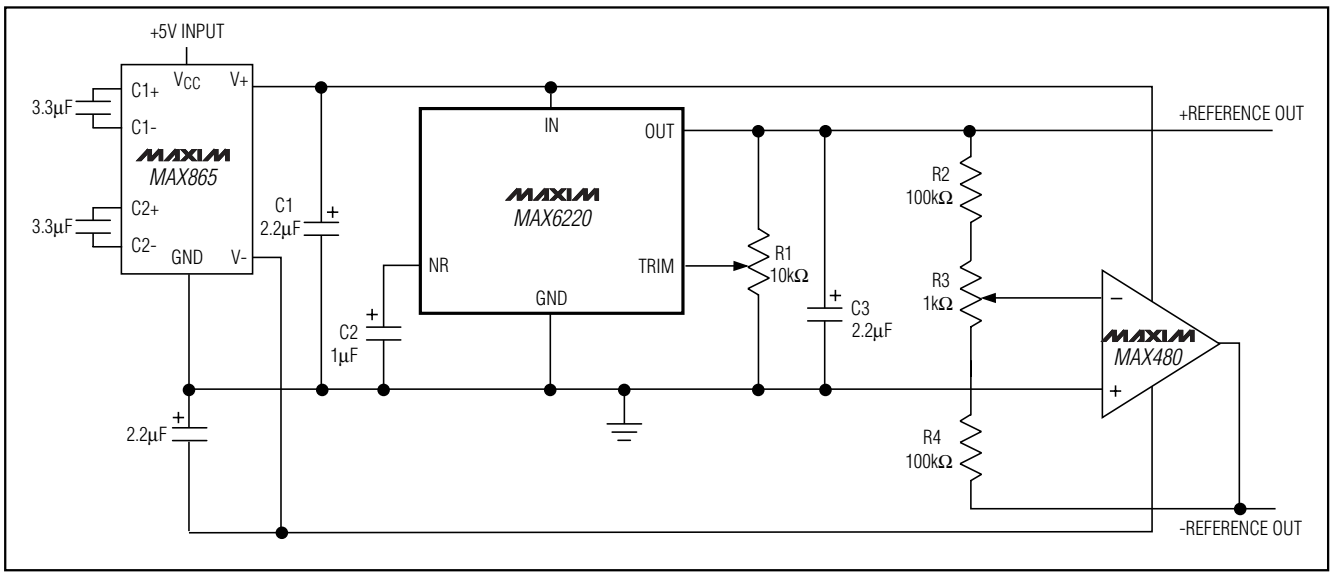


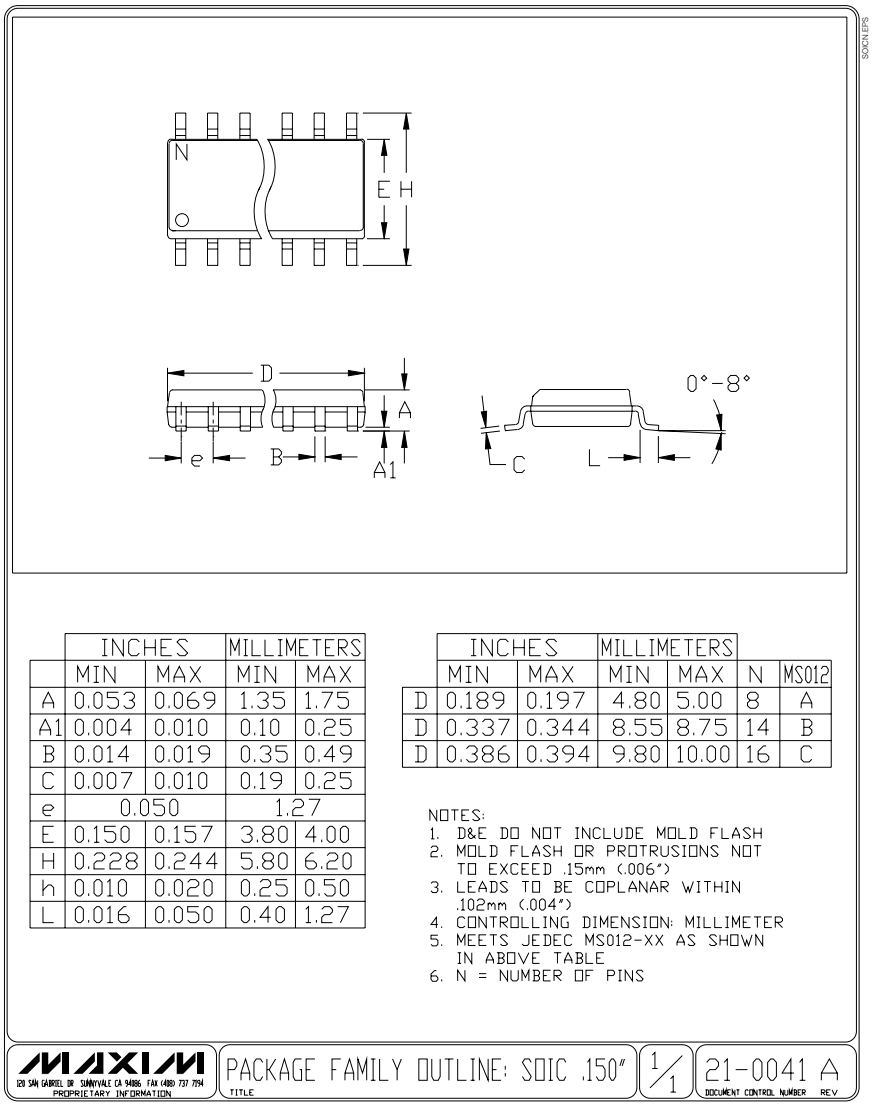
Figure 3. +5V and -5V References from a Single +5V Supply

Chip Information

TRANSISTOR COUNT: 435

Low-Noise, Precision, +2.5V/+4.096V/+5V Voltage Reference

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 | PACKAGE FAMILY OUTLINE: SOIC .150" TITLE | 1/1 | 21-0041 A DOCUMENT CONTROL NUMBER REV