Not Recommended for New Designs

This product was manufactured for Maxim by an outside wafer foundry using a process that is no longer available. It is not recommended for new designs. The data sheet remains available for existing users.

A Maxim replacement or an industry second-source may be available. Please see the QuickView data sheet for this part or contact technical support for assistance.

For further information, contact Maxim's Applications Tech Support.

19-0038; Rev 1; 10/92

MAXIM

Low-Power, Low-Drift, +2.5V/+5V/+10V Precision Voltage References

General Description

The MAX873/MAX875/MAX876 precision 2.5V, 5V, and 10V references offer excellent accuracy and very low power consumption. Extremely low temperature drift combined with excellent line and load regulation permit stable operation over a wide range of electrical and environmental conditions. Operation for the MAX873 is guaranteed with a +4.5V supply, making the part ideal in systems running from a +5V ±10% supply. Low 10Hz to 1kHz noise – typically 15µVRMS, 30µVRMS, and 60µVRMS, respectively, for the MAX873, MAX875, and MAX876 – make the parts suitable for 12-bit data-acquisition systems.

A TRIM pin facilitates adjustment of the reference voltage over a 4% range, using only a 100kΩ potentiometer. A voltage output proportional to temperature provides a source for temperature compensation circuits, temperature warning circuits, and other applications.

Applications

12-Bit A/D and D/A Converters

Digital Multimeters

Portable Data-Acquisition Systems

Low-Power Test Equipment

Features

- **MAX873/MAX875/MAX876**
  +2.5V/+5V/+10V Outputs
  ±1.5mV/±2.0mV/±3.0mV Max Initial Accuracy
  ±2.5mV/±4mV/±7mV Max Error Over Temperature
- **7ppm/°C (Max) Temperature Coefficient**
- **280µA (Max) Quiescent Current**
- **Sources 10mA, Sinks 2mA**
- **15ppm/mA Load Regulation (Max)**
- **4ppm/V Line Regulation (Max)**
- **Wide Supply Voltage Range, +4.5V to +18V (MAX873)**
- **TEMP Output Proportional to Temperature**

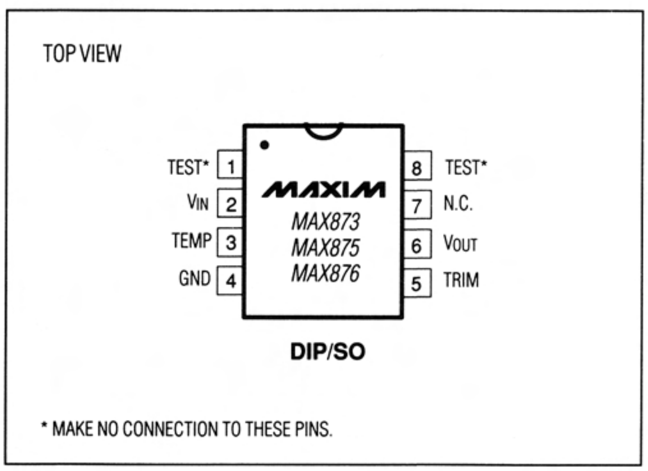
Ordering Information

PART	PIN-PACKAGE	TEMPCO (ppm/°C max)	V_{OUT} AT +25°C
TEMP. RANGE	**0°C to +70°C**		
MAX873ACPA	8 Plastic DIP	7	2.5V ±1.5mV
MAX873BCPA	8 Plastic DIP	20	2.5V ±2.5mV
MAX873ACSA	8 SO	7	2.5V ±1.5mV
MAX873BCSA	8 SO	20	2.5V ±2.5mV
MAX873BC/D	Dice*	20	2.5V ±2.5mV

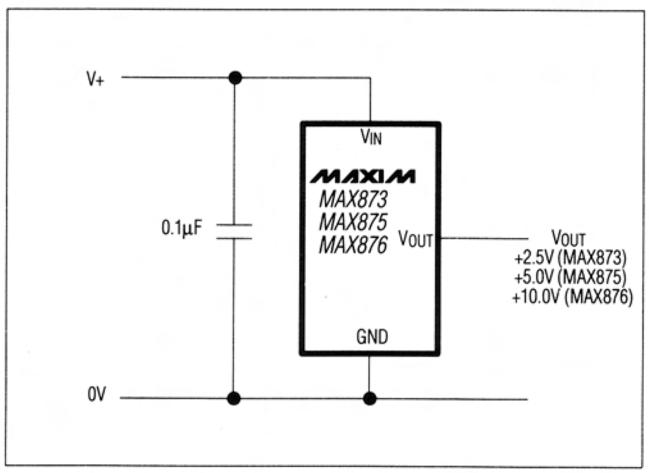
Ordering Information continued on last page.

** Dice are tested at T_A = +25°C only.*

Pin Configuration



Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND 20V
V_{OUT}, TRIM, TEMP, TEST ...... (GND - 0.3V) to (V_{CC} + 0.3V)
Output Short-Circuit Duration (to GND) ....Continuous
Current into Any Pin .... ±50mA
Continuous Power Dissipation (T_A = +70°C)
Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
SO (derate 5.88mW/°C above +70°C) 471mW
CERDIP (derate 8.00mW/°C above +70°C) 640mW

Operating Temperature Ranges:
MAX87_ _C_A ....0°C to +70°C
MAX87_ _E_A .... -40°C to +85°C
MAX87_ _MJA ....-55°C to +125°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10 sec) .... +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 – MAX873

(V_{IN} = +5V, I_L = 0mA, C_{LOAD} < 100pF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		T_A = +25°C	MAX873A	2.4985	2.5000	2.5015	V
				MAX873B	2.4975	2.5000	2.5025	
			0°C ≤ T_A ≤ +70°C	MAX873A	2.4975	2.5000	2.5025	
				MAX873B	2.4950	2.5000	2.5050	
			-40°C ≤ T_A ≤ +85°C	MAX873A	2.4970	2.5000	2.5030	
				MAX873B	2.4940	2.5000	2.5060	
			-55°C ≤ T_A ≤ +125°C	MAX873A	2.4960	2.5000	2.5040	
				MAX873B	2.4925	2.5000	2.5075	
Output-Voltage Drift	TCV_{OUT}	(Note 1)		MAX873A		4	7	ppm/°C
				MAX873B		10	20	
Output-Noise Voltage	e_n		T_A = +25°C	0.1Hz to 10Hz		16		µV_{p-p}
				10Hz to 1kHz		15		µV_{RMS}
Line Regulation		V_{IN} = 4.5V to 18V	T_A = +25°C			1.5	4.0	ppm/V
		MAX873_C/E: V_{IN} = 4.5V to 18V MAX873_MJA: V_{IN} = 4.75V to 18V	T_A = T_{MIN} to T_{MAX}			3	6	
Load Regulation		I_L = 0mA to 10mA (source)	T_A = +25°C			6	15	ppm/mA
			T_A = T_{MIN} to T_{MAX}			10	20	
		I_L = 0mA to -2mA (sink)	T_A = +25°C			6	15	
			T_A = T_{MIN} to T_{MAX}			10	20	
Quiescent Supply Current	I_Q		T_A = +25°C			190	280	µA
			T_A = T_{MIN} to T_{MAX}			190	375	
Short-Circuit Output Current	I_{SC}	Output shorted to GND				35		mA
V_{OUT} Adjust Range						±95		mV
Long-Term Output Drift						20		ppm/kh
TEMP PIN								
Voltage Output	V_{TEMP}		T_A = +25°C			608		mV
Temperature Sensitivity	TCV_{TEMP}					2		mV/°C

ELECTRICAL CHARACTERISTICS – MAX875

(V_{IN} = +15V, I_L = 0mA, C_{LOAD} < 100pF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C, MAX875A	4.998	5.000	5.002	V
		T_A = +25°C, MAX875B	4.997	5.000	5.003	
		0°C ≤ T_A ≤ +70°C, MAX875A	4.996	5.000	5.004	
		0°C ≤ T_A ≤ +70°C, MAX875B	4.992	5.000	5.008	
		-40°C ≤ T_A ≤ +85°C, MAX875A	4.9945	5.000	5.0055	
		-40°C ≤ T_A ≤ +85°C, MAX875B	4.990	5.000	5.010	
		-55°C ≤ T_A ≤ +125°C, MAX875A	4.9935	5.000	5.0065	
		-55°C ≤ T_A ≤ +125°C, MAX875B	4.988	5.000	5.012	
Output-Voltage Drift	TCV_{OUT}	(Note 1), MAX875A		4	7	ppm/°C
		(Note 1), MAX875B		10	20	
Output-Noise Voltage	e_n	T_A = +25°C, 0.1Hz to 10Hz		32		μV_{p-p}
		T_A = +25°C, 10Hz to 1kHz		30		μV_{RMS}
Line Regulation		V_{IN} = 7V to 18V, T_A = +25°C		1.5	4.0	ppm/V
		MAX875_C/E: V_{IN} = 7V to 18V; MAX875_MJA: V_{IN} = 7.2V to 18V; T_A = T_{MIN} to T_{MAX}		3	6	
Load Regulation		I_L = 0mA to 10mA (source), T_A = +25°C		6	15	ppm/mA
		I_L = 0mA to 10mA (source), T_A = T_{MIN} to T_{MAX}		10	20	
		I_L = 0mA to -2mA (sink), T_A = +25°C		6	15	
		I_L = 0mA to -2mA (sink), T_A = T_{MIN} to T_{MAX}		10	20	
Quiescent Supply Current	I_Q	T_A = +25°C		190	280	µA
		T_A = T_{MIN} to T_{MAX}		190	375	
Short-Circuit Output Current	I_{SC}	Output shorted to GND		35		mA
V_{OUT} Adjust Range				±200		mV
Long-Term Output Drift				20		ppm/kh
TEMP PIN						
Voltage Output	V_{TEMP}	T_A = +25°C		608		mV
Temperature Sensitivity	TCV_{TEMP}			2		mV/°C

ELECTRICAL CHARACTERISTICS – MAX876

(V_{IN} = +15V, I_L = 0mA, C_{LOAD} < 100pF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

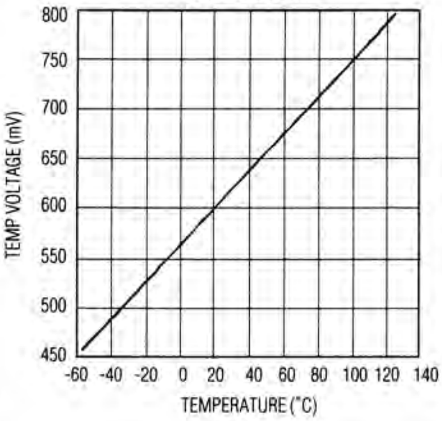
PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		T_A = +25°C	MAX876A	9.997	10.000	10.003	V
				MAX876B	9.995	10.000	10.005	
			0°C ≤ T_A ≤ +70°C	MAX876A	9.993	10.000	10.007	
				MAX876B	9.985	10.000	10.015	
			-40°C ≤ T_A ≤ +85°C	MAX876A	9.990	10.000	10.010	
				MAX876B	9.975	10.000	10.025	
			-55°C ≤ T_A ≤ +125°C	MAX876A	9.990	10.000	10.010	
				MAX876B	9.975	10.000	10.025	
Output-Voltage Drift	TCV_{OUT}	(Note 1)		MAX876A		4	7	ppm/°C
				MAX876B		10	20	
Output-Noise Voltage	e_n		T_A = +25°C	0.1Hz to 10Hz		64		µV_{p-p}
				10Hz to 1kHz		60		µV_{RMS}
Line Regulation		V_{IN} = 12V to 18V	T_A = +25°C			1.5	4.0	ppm/V
		MAX876_C/E: V_{IN} = 12V to 18V	T_A = T_{MIN} to T_{MAX}			3	6	
		MAX876_MJA: V_{IN} = 12.2V to 18V						
Load Regulation		I_L = 0mA to 10mA (source)	T_A = +25°C			6	15	ppm/mA
			T_A = T_{MIN} to T_{MAX}			10	20	
		I_L = 0mA to -2mA (sink)	T_A = +25°C			6	15	
			T_A = T_{MIN} to T_{MAX}			10	20	
Quiescent Supply Current	I_Q		T_A = +25°C			190	280	µA
			T_A = T_{MIN} to T_{MAX}			190	375	
Short-Circuit Output Current	I_{SC}	Output shorted to GND				35		mA
V_{OUT} Adjust Range						±400		mV
Long-Term Output Drift						20		ppm/kh
TEMP PIN								
Voltage Output	V_{TEMP}		T_A = +25°C			608		mV
Temperature Sensitivity	TCV_{TEMP}					2		mV/°C

Note 1: Temperature coefficient is determined by the "box" method in which the maximum ΔV_{OUT} over the temperature range is divided by ΔT.

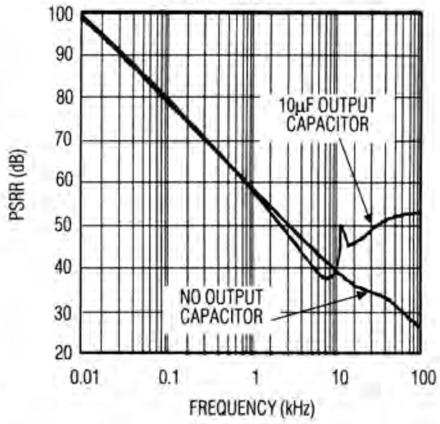
Typical Operating Characteristics

(T_A = +25°C, V_{IN} = +5V(MAX873), V_{IN} = +15V (MAX875/MAX876), I_L = 0mA, C_{LOAD} < 100pF, unless otherwise noted.)

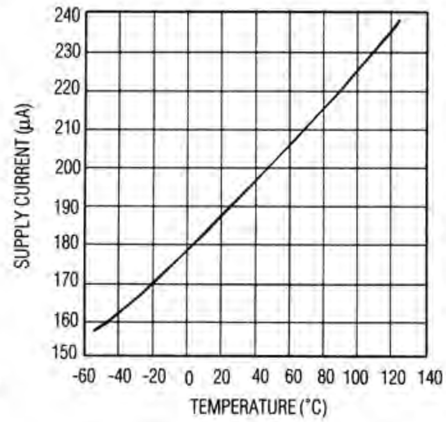
TEMP PIN VOLTAGE vs. TEMPERATURE



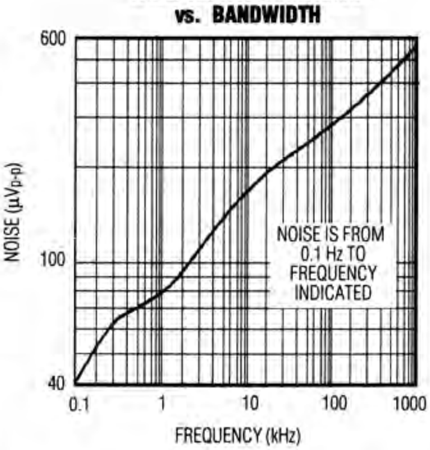
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



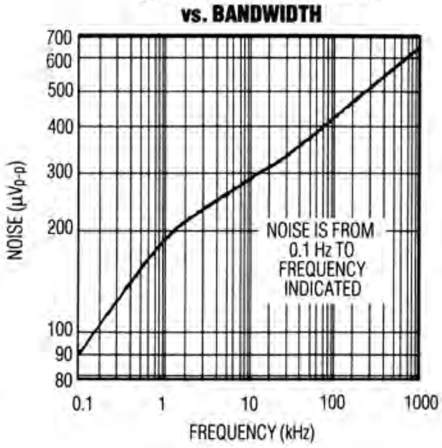
SUPPLY CURRENT vs. TEMPERATURE



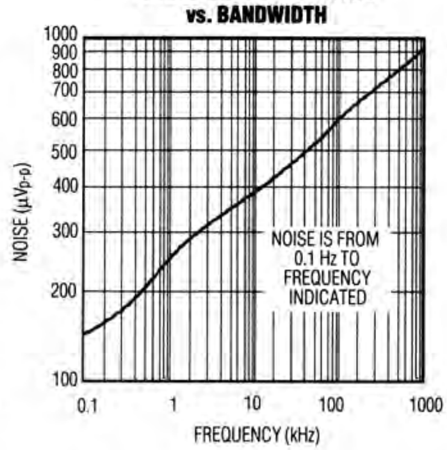
MAX873 WIDEBAND OUTPUT NOISE vs. BANDWIDTH



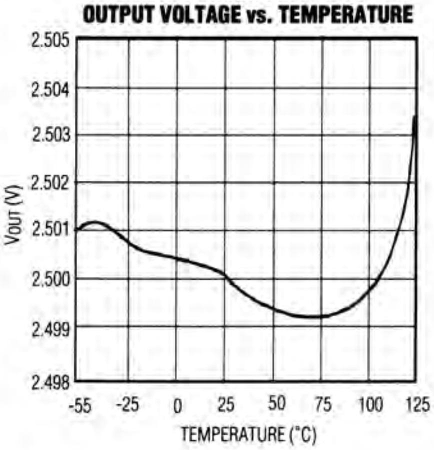
MAX875 WIDEBAND OUTPUT NOISE vs. BANDWIDTH



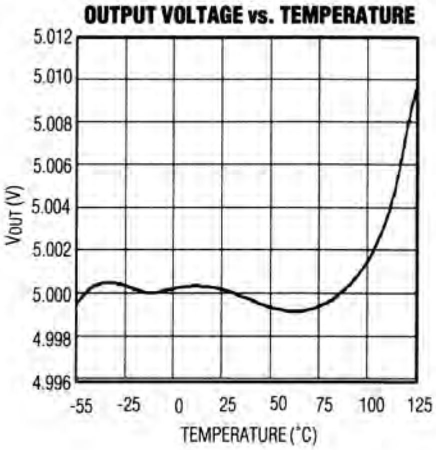
MAX876 WIDEBAND OUTPUT NOISE vs. BANDWIDTH



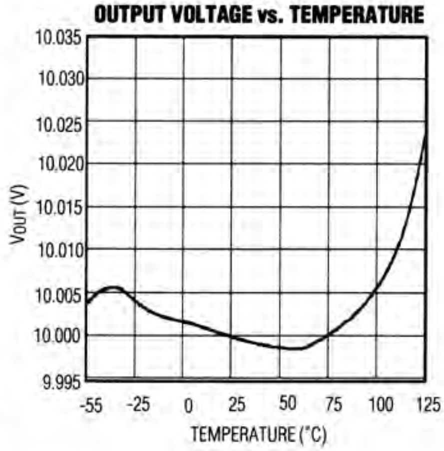
MAX873 OUTPUT VOLTAGE vs. TEMPERATURE



MAX875 OUTPUT VOLTAGE vs. TEMPERATURE



MAX876 OUTPUT VOLTAGE vs. TEMPERATURE



Low-Power, Low-Drift, +2.5V /+5V/+10V Precision Voltage References

Pin Description

PIN	NAME	FUNCTION
1,8	TEST	For factory test use only. Make no connections to these pins.
2	V_{IN}	Supply Voltage
3	TEMP	Temperature Proportional Output Voltage. Generates a voltage proportional to the temperature of the die.
4	GND	Ground
5	TRIM	Output Voltage Trim. Connect to the center of a voltage divider for trimming; otherwise, make no connection.
6	V_{OUT}	Output Voltage
7	N.C.	No Connect - not internally connected.

Detailed Description

The bipolar MAX873, MAX875, and MAX876 are bandgap references, amplified to give an output voltage of 2.500V, 5.000V, and 10.000V, respectively. Laser trimming is used to adjust the output voltage and minimize thermal drift. Post-package trimming allows control of the output to within ±1.5mV, ±2.0mV, and ±3.0mV, respectively.

The MAX873, MAX875, and MAX876 are essentially three-terminal references with a power-supply input, ground, and reference output. Additionally, a TRIM pin facilitates adjustment of the reference voltage over a 4% range using ony a 100kΩ potentiometer. A voltage output proportional to temperature provides a source for temperature compensation circuits, temperature warning circuits, and other applications.

Applications Information

Input Bypassing

For best transient performance, decouple the input with a 10μF electrolytic capacitor in parallel with a 0.01μF to 0.1μF ceramic capacitor as shown in Figure 1. Where transient performance is less important, a single 0.1μF capacitor is sufficient.

Output Bypassing

These devices perform well with no output decoupling capacitance. However, if the capacitive load on the output exceeds 100pF, bypass the output with at least 1μF to ensure stability. A 10μF electrolytic capacitor in parallel with a 0.01μF to 0.1μF ceramic capacitor provides excellent load-transient performance and guarantees stability as shown in Figure 1.

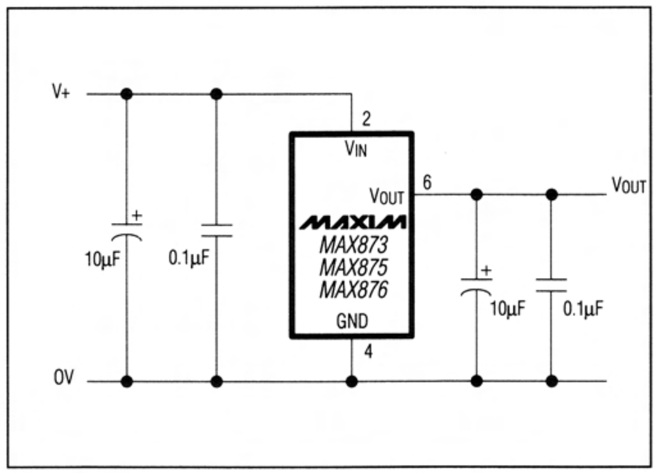


Figure 1. Recommended Bypassing for Good High-Frequency Response

Standard Application

The standard application for the references is shown in the *Typical Operating Circuit*. Additional bypassing, shown in Figure 1, provides superior performance over a range of conditions.

Output-Voltage Trimming

Use a 100kΩ potentiometer as shown in Figure 2 to trim the output voltage to the desired level. A trim range of ±95mV (MAX873), ±200mV (MAX875), or ±400mV (MAX876) is available using this technique. Large adjustments of the output voltage may degrade its temperature coefficient by as much as 5ppm/°C.

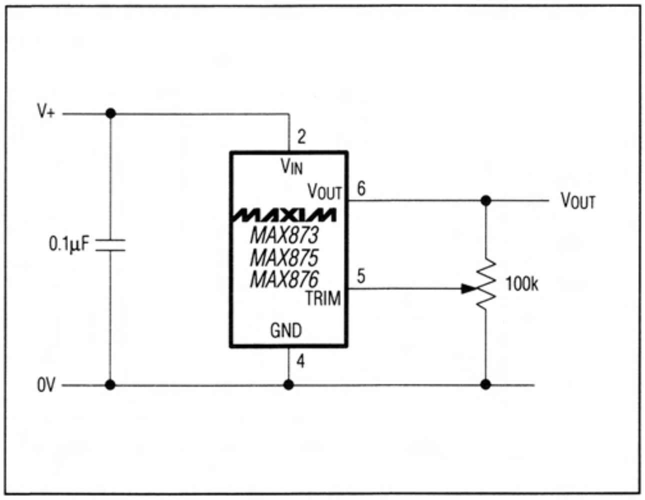


Figure 2. Output-Voltage Trim Circuit

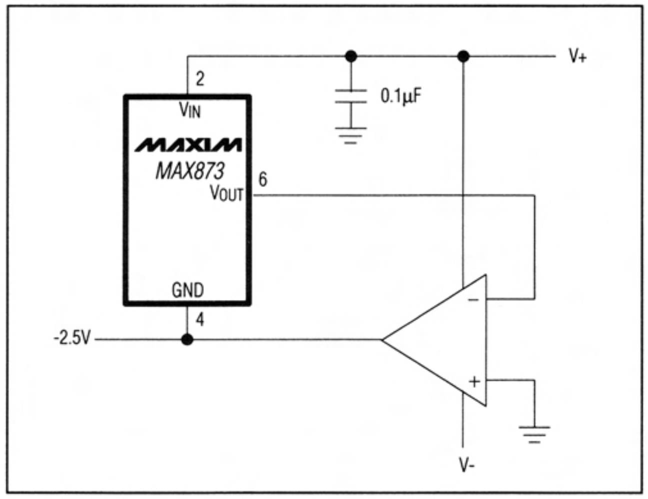


Figure 4. Low-Dropout -2.5V Reference

Inverting Applications

+2.5V and -2.5V reference voltages can be generated using the MAX873 with an op amp in the traditional gain of -1 configuration shown in Figure 3. The accuracy of this circuit depends on the matching of the two resistors R and R′. A similar configuration using the MAX875 and MAX876 can provide ±5V and ±10V references, respectively.

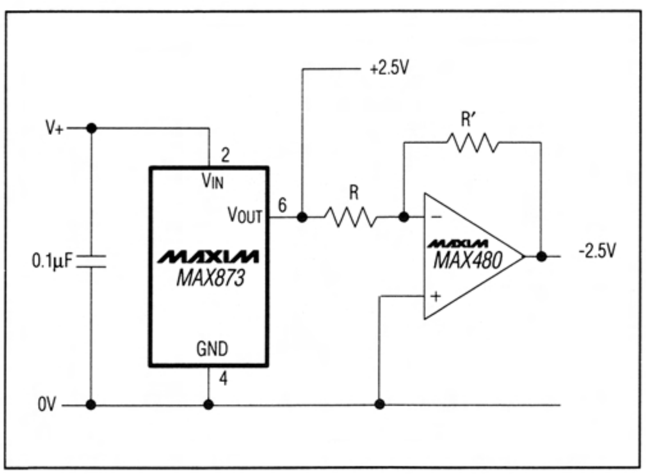


Figure 3. +2.5V and -2.5V Outputs

The circuit in Figure 4 requires no resistors and suffers only from offset and temperature coefficient errors of the op amp itself. The op amp also buffers the reference, so the output capability of this circuit depends on the performance of the op amp selected. In addition, the dropout performance of this circuit is very good: the positive rail can go down to about 1.5V because the MAX873 is unloaded, and the negative rail can decline typically to -3.2V using a MAX480, or to -2.6V using an ICL7611 (I_Q = 100µA mode). A similar configuration using the MAX875 or MAX876 can generate -5.0V or -10.0V references, respectively.

Temperature Measurement

The TEMP output delivers a voltage proportional to the absolute temperature of the die. In packaged parts, this closely approximates the ambient temperature of the device because the power dissipation of the reference itself is very small. The temperature coefficient of this output is typically 2mV/°C, and the nominal voltage at +25°C is 608mV (*Typical Operating Characteristics*).

Low-Power, Low-Drift, +2.5V /+5V/+10V Precision Voltage References

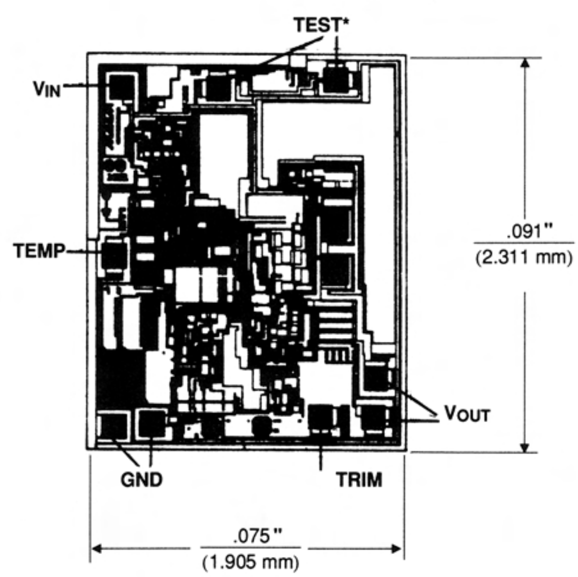
Ordering Information (continued)

PART	PIN-PACKAGE	TEMPCO (ppm/°C max)	V_{OUT} AT +25°C
TEMP. RANGE -40°C TO +85°C			
MAX873AEPA	8 Plastic DIP	7	2.5V ±1.5mV
MAX873BEPA	8 Plastic DIP	20	2.5V ±2.5mV
MAX873AESA	8 SO	7	2.5V ±1.5mV
MAX873BESA	8 SO	20	2.5V ±2.5mV
TEMP. RANGE -55°C TO +125°C			
MAX873AMJA	8 CERDIP**	7	2.5V ±1.5mV
MAX873BMJA	8 CERDIP**	20	2.5V ±2.5mV
TEMP. RANGE 0°C to +70°C			
MAX875ACPA	8 Plastic DIP	7	5V ±2.0mV
MAX875BCPA	8 Plastic DIP	20	5V ±3.0mV
MAX875ACSA	8 SO	7	5V ±2.0mV
MAX875BCSA	8 SO	20	5V ±3.0mV
MAX875BC/D	Dice*	20	5V ±3.0mV
TEMP. RANGE -40°C TO +85°C			
MAX875AEPA	8 Plastic DIP	7	5V ±2.0mV
MAX875BEPA	8 Plastic DIP	20	5V ±3.0mV
MAX875AESA	8 SO	7	5V ±2.0mV
MAX875BESA	8 SO	20	5V ±3.0mV
TEMP. RANGE -55°C TO +125°C			
MAX875AMJA	8 CERDIP**	7	5V ±2.0mV
MAX875BMJA	8 CERDIP**	20	5V ±3.0mV
TEMP. RANGE 0°C to +70°C			
MAX876ACPA	8 Plastic DIP	7	10V ±3.0mV
MAX876BCPA	8 Plastic DIP	20	10V ±5.0mV
MAX876ACSA	8 SO	7	10V ±3.0mV
MAX876BCSA	8 SO	20	10V ±5.0mV
MAX876BC/D	Dice*	20	10V ±5.0mV

PART	PIN-PACKAGE	TEMPCO (ppm/°C max)	V_{OUT} AT +25°C
TEMP. RANGE -40°C TO +85°C			
MAX876AEPA	8 Plastic DIP	7	10V ±3.0mV
MAX876BEPA	8 Plastic DIP	20	10V ±5.0mV
MAX876AESA	8 SO	7	10V ±3.0mV
MAX876BESA	8 SO	20	10V ±5.0mV
TEMP. RANGE -55°C TO +125°C			
MAX876AMJA	8 CERDIP**	7	10V ±3.0mV
MAX876BMJA	8 CERDIP**	20	10V ±5.0mV

* *Dice are tested at T_A = +25°C only.*
** *Contact factory for availability and processing to MIL-STD-883.*

Chip Topography



SUBSTRATE CONNECTED TO GND;
TRANSISTOR COUNT: 76.

* MAKE NO CONNECTION TO THESE PADS

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