19-1115; Rev 1; 8/96

MAXIM

Pin Programmable Precision Voltage Reference

MX584

General Description

Maxim's MX584 is a temperature compensated, bandgap voltage reference which provides pin-programmable output voltages of +10.00V, +7.50V, +5.00V, and +2.50V. External components are not required for these outputs, but if other voltages are desired, they can be programmed with external resistors.

Laser trimming minimizes output error as well as temperature drift, to as low as 10mV and 15ppm/°C with the MX584K.

The input voltage range of the MX584 is 4.5V to 30V. The reference also includes a STROBE input which shuts down the reference output. Typical current drain when ON is 750µA. This drops to about 100µA when the reference is strobed OFF.

The MX584 is designed for use with 8 to 14 bit A/D and D/A converters as well as data acquisition systems. It is available in 8-lead TO-99 metal cans, plastic DIPs, CERDIPs, and small outline packages.

Applications

CMOS DAC Reference

A/D Converter Reference

Measurement Instrumentation

Data Loggers

Precision Analog Systems

Programmable Offset for PGAs

Features

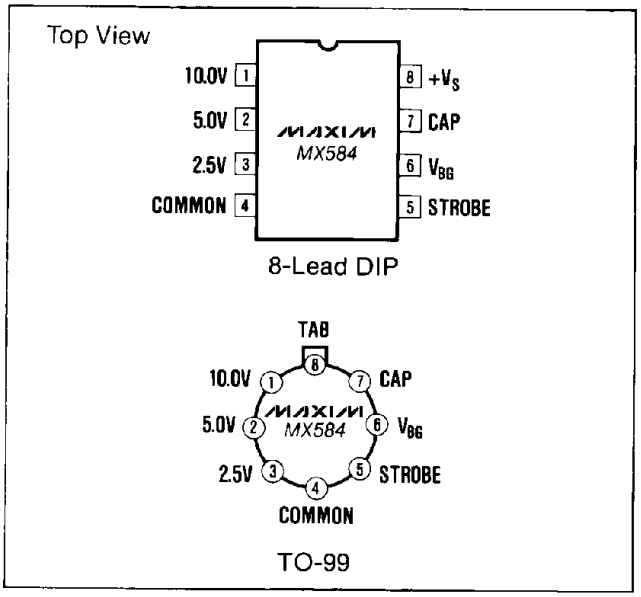
- **Programmable Outputs of: +10.0V, +7.5V, +5.0V, +2.5V**
- **±10mV Tolerance at +10V (MX584K)**
- **Low Tempco: 15ppm/°C Max. (MX584K)**
- **No External Component or Trims**
- **Short Circuit Proof**
- **Output Sources and Sinks Current**
- **10mA Output Current**

Ordering Information

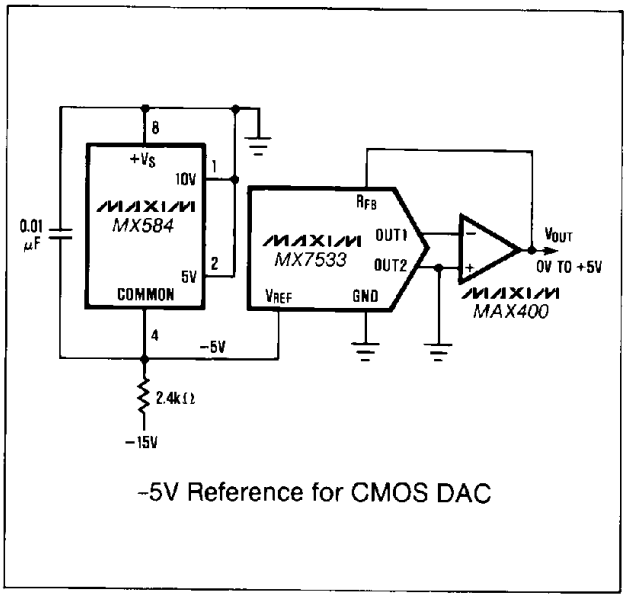
PART	TEMP. RANGE	PACKAGE*	ERROR
MX584JH	0°C to +70°C	TO-99 Can	±30mV
MX584KH	0°C to +70°C	TO-99 Can	±10mV
MX584JN	0°C to +70°C	Plastic DIP	±30mV
MX584KN	0°C to +70°C	Plastic DIP	±10mV
MX584JCSA	0°C to +70°C	Small Outline	±30mV
MX584KCSA	0°C to +70°C	Small Outline	±10mV
MX584JESA	-40°C to +85°C	Small Outline	±30mV
MX584KESA	-40°C to +85°C	Small Outline	±10mV
MX584JC/D	0°C to +70°C	Dice	±30mV
MX584SH	-55°C to +125°C	TO-99 Can	±30mV
MX584TH	-55°C to +125°C	TO-99 Can	±10mV
MX584SQ	-55°C to +125°C	CERDIP	±30mV
MX584TQ	-55°C to +125°C	CERDIP	±10mV

*All devices—8 lead packages

Pin Configuration



Typical Operating Circuit



-5V Reference for CMOS DAC

For free samples & the latest literature: http://www.maxim-ic.com, or phone 1-800-998-8800

Pin Programmable Precision Voltage Reference

ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{IN} to Common . . . . . -0.3, +40V
Power Dissipation
- Metal Can (Derate 6.7mW/°C above +60°C) 600mW
- CERDIP (Derate 8mW/°C above +75°C) 600mW
- Plastic DIP (Derate 6mW/°C above +75°C) 450mW
- Small Outline (Derate 5.3mW/°C above +75°C) 400mW

Output Short-Circuit Duration (Note 1) . . . . . Indefinite
Operating Temperature Range
- Commercial (J, K) . . . . . 0°C to +70°C
- Military (S, T, U) . . . . . -55°C to +125°C
- Extended (J, K) . . . . . -40°C to +85°C

Storage Temperature Range . . . . . -65°C to +150°C
Lead Temperature (Soldering, 10sec) . . . . . +300°C
Dice Junction Temperature (T_J) . . . . . -55°C to +150°C
Thermal Resistance, Junction to Ambient
- Metal Can . . . . . 150°C/W
- CERDIP . . . . . 125°C/W
- Plastic DIP . . . . . 160°C/W
- Small Outline . . . . . 170°C/W

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

(V_{IN} = +15V, T_A = +25°C, unless otherwise noted.)

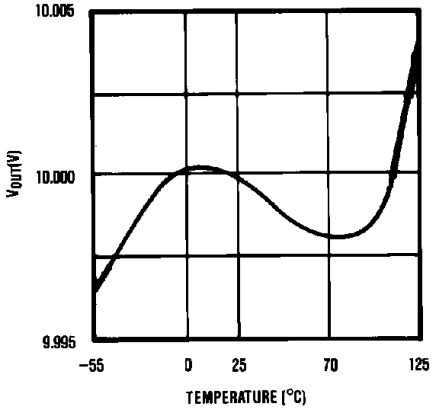
PARAMETER		SYMBOL			MIN	TYP	MAX	UNITS
Output Voltage Tolerance			I_L = 0mA, At Pin 1	V_{OUT} = +10V, MX584J/S			±30	mV
				MX584K/T			±10	
				V_{OUT} = +7.5V, MX584J/S			±22	
				MX584K/T			±8	
				V_{OUT} = +5.0V, MX584J/S			±15	
				MX584K/T			±6	
				V_{OUT} = +2.5V, MX584J/S			±7.5	
				MX584K/T			±3.5	
Output Voltage Temperature Coefficient			MX584J/S, All Outputs				30	ppm/°C
			MX584K, All Outputs				15	
			MX584KE, All Outputs				20	
			MX584JE, All Outputs				30	
			MX584T, +10V, +7.5V, +5V Out				15	
			+2.5V Out				20	
Differential Tempco Between Outputs			MX584K/T			3		ppm/°C
			MX584J/S			5		
Quiescent Supply Current		I_Q	I_L = 0mA			750	1000	µA
Quiescent Current Tempco						1.5		µA/°C
Turn-On Setting Time		t_{ON}	To ±1%			200		µs
Noise		e_{NP-P}	0.1Hz to 10Hz			50		μV_{p-p}
Long-Term Stability			(Non-Cumulative)			25		ppm/kHrs
Short Circuit Current		I_{SC}				30		mA
Line Regulation			No Load, (V_{OUT} + 2.5V) < V_{IN} < +15V			0.005		%/V
			+15V < V_{IN} < +30V			0.002		
Load Regulation			I_L = 0mA to 5mA			30		ppm/mA
Output Current	Source	I_L	V_{IN} > V_{OUT} + 2.5V	T_A = +25°C	10			mA
				T_{MIN} to T_{MAX}	5			
	Sink			T_{MIN} to T_{MAX}, MX581J/K	5			
				MX584S/T	0.2			
				-55°C to +85°C, MX584S/T	5			

Note 1: Absolute maximum power dissipation must not be exceeded.

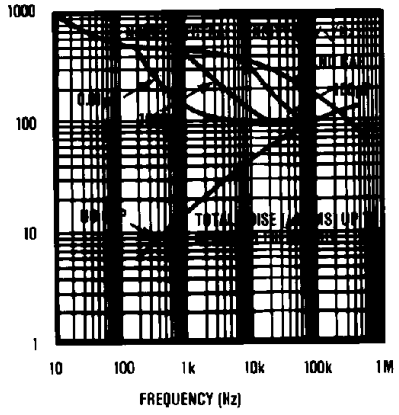
Pin Programmable Precision Voltage Reference

Typical Operating Characteristics

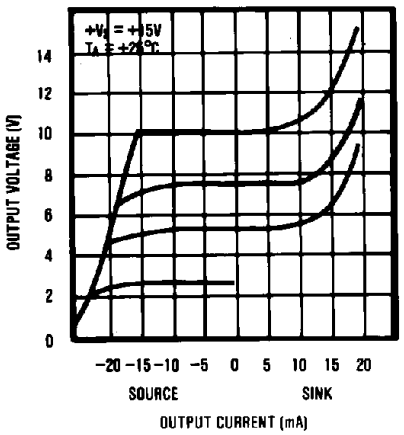
TYPICAL TEMPERATURE CHARACTERISTICS



SPECTRAL NOISE DENSITY AND RMS NOISE vs. FREQUENCY



OUTPUT VOLTAGE vs. SINK AND SOURCE CURRENT



POWER-ON SETTLING CHARACTERISTICS

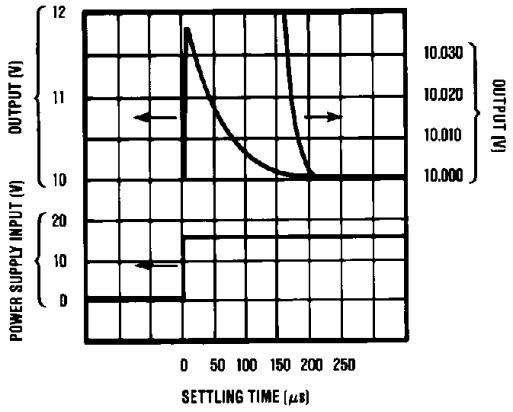


Table 1. Programming Pin Connections

OUTPUT VOLTAGE	PROGRAMMING (OUTPUT ON PIN 1)
10V	Pins 2 and 3 are unconnected.
7.5V	Connect pins 2 and 3 together.
5.0V	Connect pins 2 and 1 together.
2.5V	Connect pins 3 and 1 together.

Detailed Description

As shown in Figure 1, most applications of the MX584 require no external components. Connections to $+V_S$, and COMMON (COMMON is also tied to the case in the TO-99 metal package) with all other pins unconnected result in a buffered +10.00V output at pin 1. The other pretrimmed voltages are obtained by strapping pins as shown in Table 1. If one or more external buffer amplifiers are connected to the programming pins (pin 2,3), multiple outputs can be obtained from one reference.

Other Output Voltages

The MX584 can be adjusted to a different output voltage by adding one or more resistors as in Figure 2. As the diagram shows, the reference can be thought of as a 1.215V band-gap followed by a noninverting amplifier. If R1 and R2 are used alone, the adjustment range is widest but the resolution of the trim may be too coarse, even when a muti-turn trim pot is used.

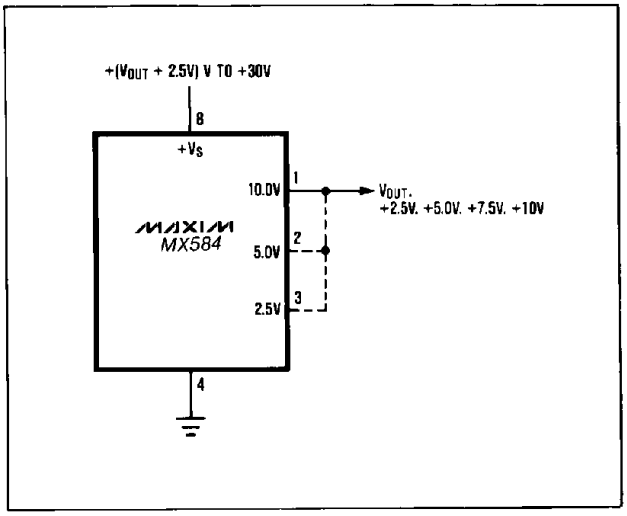


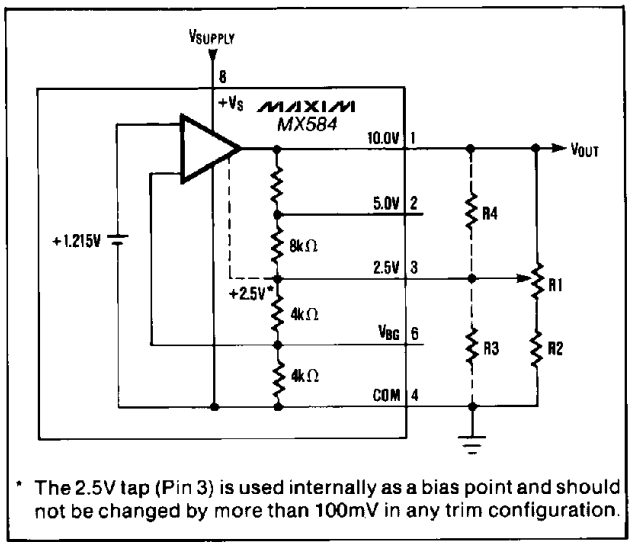
Figure 1. Basic Connection for Positive Outputs

Pin Programmable Precision Voltage Reference

When adding external resistors, output voltages well above 10V can be obtained. R2 should therefore be chosen carefully since it sets the maximum output voltage. R2's resistance should not be so low as to jeopardized other circuits if R1 is misadjusted.

The fixed output voltages can also be varied by connecting only one resistor, as in the dashed lines in Figure 2. Connecting R3 alone raises V_{OUT} while R4 alone lowers it. These resistors (or potentiometers) must have very low temperature coefficients if accuracy over temperature is to be unaffected by the adjustment.

If fine adjustment of the output is all that is required, the circuit of Figure 3 is recommended. It provides good stability and resolution for a trim range of ±200mV. If the 2.5V output is adjusted, R2 should be connected to V_{BG}, pin 6, and the trim range should be limited to ±100mV.



* The 2.5V tap (Pin 3) is used internally as a bias point and should not be changed by more than 100mV in any trim configuration.

Figure 2. Variable Output Options

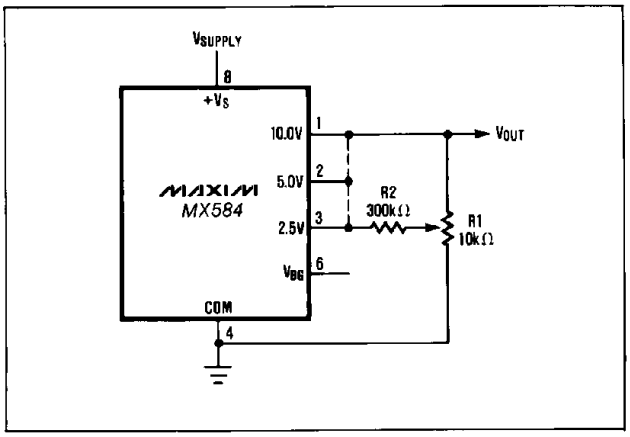


Figure 3. Fine Adjustment of Output Voltage (±200mV)

Voltage Temperature Coefficient

The temperature characteristic of the MX584 consistently follows an "S-curve" as shown in the Typical Charcteristics. A five-point 100% test guarantees compliance with -55°C to +125°C specifications and a three-point 100% test guarantees the 0°C to +70°C specifications.

The tolerance specifications in the Electrical Characteristics table state the maximum deviation from the reference's initial value at 25°C. By adding the maximum deviation for a given device to its initial tolerance, the total possible error is determined.

Output Current

The MX584 is capable of sinking as well as sourcing current. The circuit is also protected for output shorts to either $+V_S$ or ground (COMMON). The output's voltage-versus-current characteristic is shown in the Typical Characteristics section.

Dynamic Performance

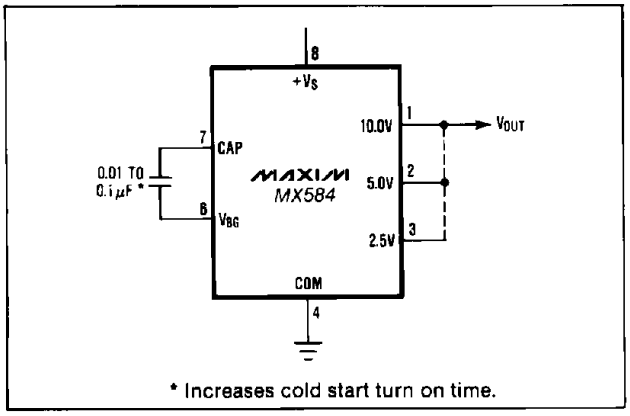
The turn-on settling performance of the MX584 is shown in the Typical Characteristics. Both coarse and fine transient response is shown. The reference typically settles to 1mV (10V output) within 180μs after power is applied.

Noise Filtering

The bandwidth of the MX584's output amplifier can be limited by connecting a capacitor between the CAP and V_{BG} pins (see Figure 4). Typical values range from 0.01μF to 0.1μF. The reduction of wideband and feedthrough noise is plotted in a graph in the Typical Characteristics section.

Strobe Input

The STROBE input, pin 5, zeroes the reference output when it is pulled LOW. If no current is pulled from STROBE, operation is normal. The threshold of the input is 200mV, so an open-drain N-channel FET or open-collector transistor driven from logic is re-



* Increases cold start turn on time.

Figure 4. Additional Noise Filtering with an External Capacitor

commended (see Figure 5). The current sinking ability should be at least 500μA and the leakage current should be 5μA or less. While shut down, the MX584 should not be required to source or sink current unless a 0.7V residual output is acceptable. If the reference is required to sink transient current while shut down, the current flowing out of STROBE should be limited with 100Ω as shown in the dashed connection in Figure 5.

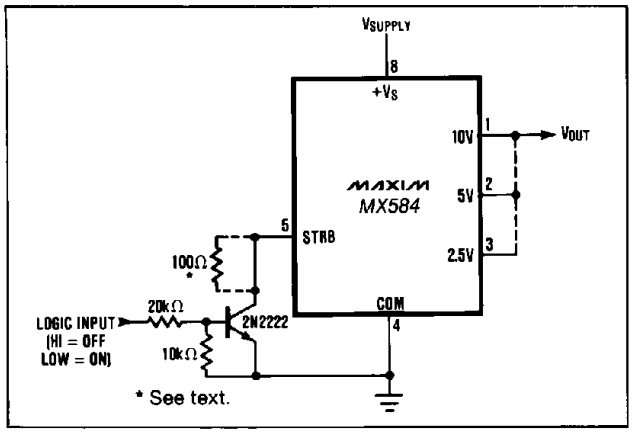


Figure 5. Use of Strobe Terminal

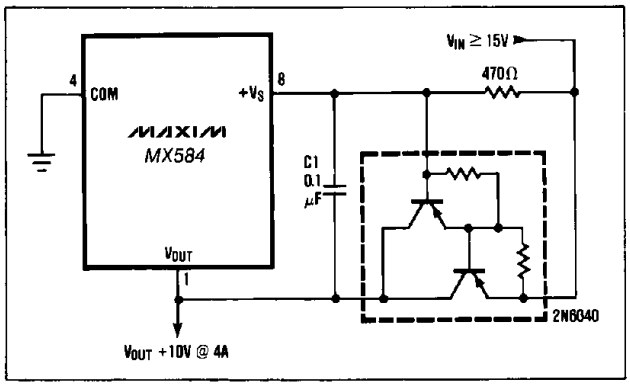


Figure 6. High Current Precision Supply

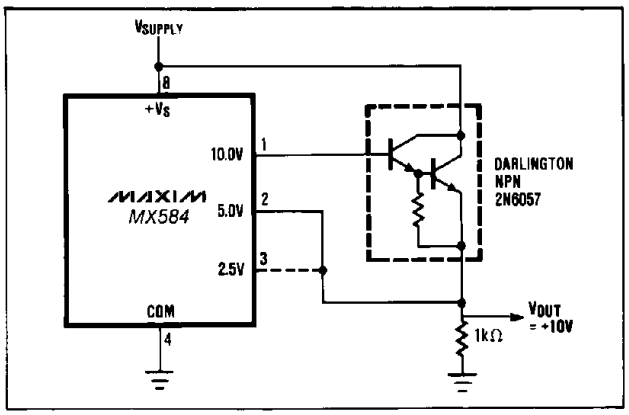


Figure 7. NPN Output Current Booster

Applications

Precision High Current Reference

A PNP power transistor, or Darlington, is easily connected to the MX584 to greatly increase its output current. The circuit in Figure 6 provides a +10V output at up to 4 Amps. If the load has a significant capacitive component, C1 should be added. If the load is purely resistive, high frequency supply rejection is improved without C1. An NPN output transistor or Darlinton can also be used to boost output current as shown in Figure 7.

Current Limiter

By adding a single resistor as shown in Figure 8, the MX584 is turned into a precision current limiter for applications where the driving voltage is 5V to 40V. The programmed current ranges from 0.75mA to 5mA.

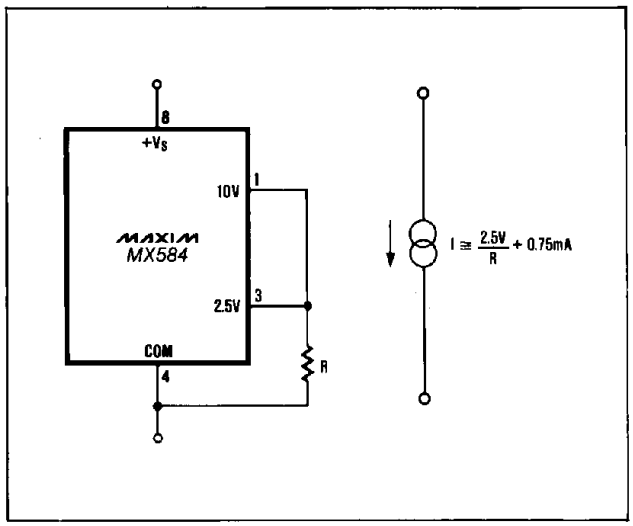


Figure 8. Precision Current Limiter

Negative 10V Reference

In applications which require a -10V, -7.5V, -5.0V, or -2.5V reference, the MX584 can be connected as a two-terminal device and biased like a zener diode. The circuit is shown in Figure 9. $+V_S$ and V_{OUT} are connected to the analog ground bus, and the MX584's COMMON pin is connected, through a resistor, to the negative supply. With 1mA flowing in the reference, the output is typically 2mV greater than what is obtained with a conventional, positive, hook-up.

When using the 2-terminal connection, the load and the bias resistor must be selected so that the current flowing in the reference is maintained between 1mA and 5mA. The operating temperature range for this connection is limited to -55° to +85°C.

Pin Programmable Precision Voltage Reference

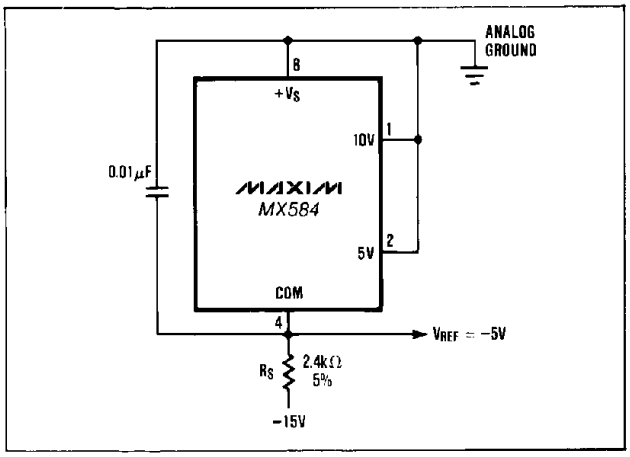


Figure 9. Two-Terminal -5 Volt Reference

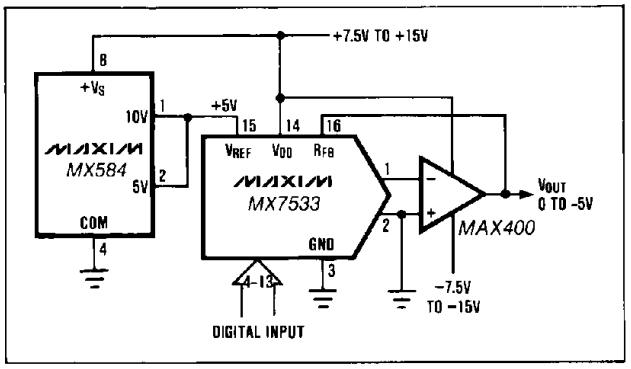


Figure 10. Low Power 10 Bit CMOS DAC Connection

Reference for DACs and ADCs

The MX584 is well suited for use with a wide variety of D-to-A converters, especially CMOS DACs. Figure 10 shows a circuit in which an MX7533 10 bit DAC outputs 0 to -5V when using a +5V reference. For a positive DAC output, the MX584 can be configured as a 2-terminal negative reference as well by using the connection of Figure 9.

In Figure 11, an MX7574 CMOS A/D converter uses an MX584, connected for -2.5V, as its reference input so that the system can operate from ±5V power. The analog input range for the circuit is 0V to +2.5V.

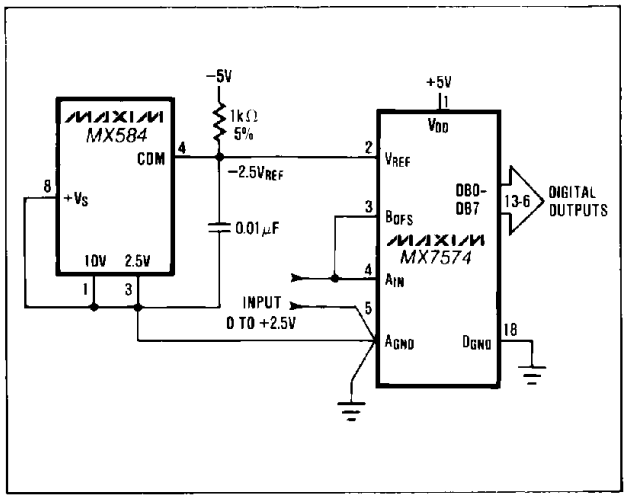
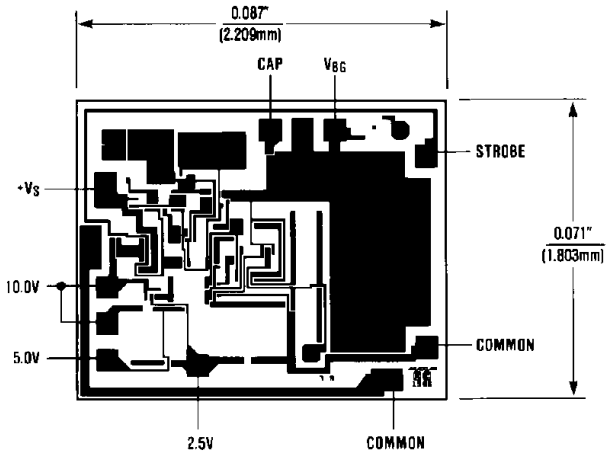


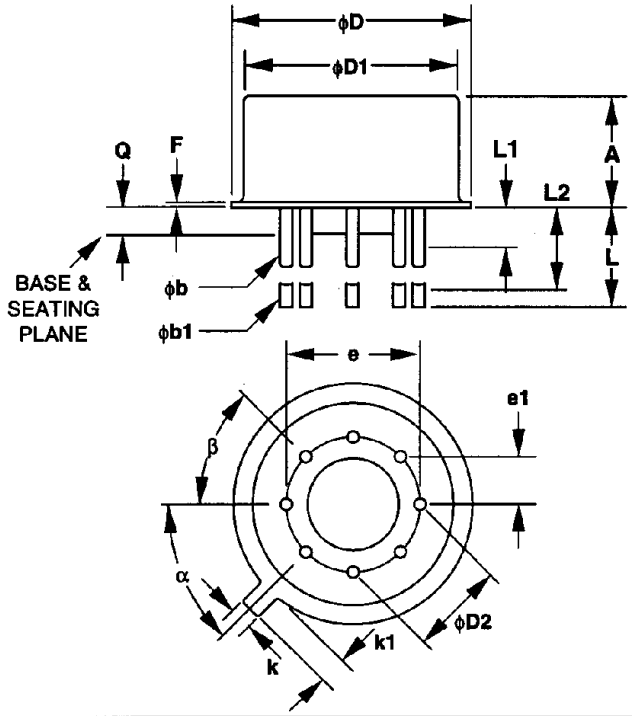
Figure 11. MX584 as Negative 2.5 Volt Reference for a CMOS ADC

Chip Topography



TRANSISTOR COUNT: 72
SUBSTRATE CONNECTED TO GND

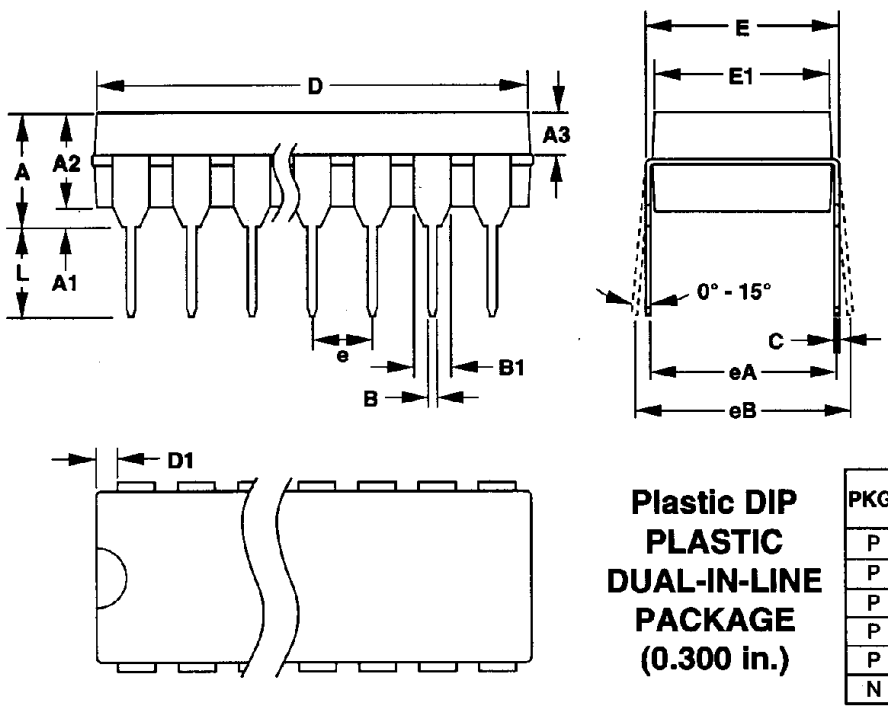
Package Information



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.165	0.185	4.19	4.70
φb	0.016	0.019	0.41	0.48
φb1	0.016	0.021	0.41	0.53
φD	0.335	0.375	8.51	9.40
φD1	0.305	0.335	7.75	8.51
φD2	0.110	0.160	2.79	4.06
e	0.200 BSC		5.08 BSC	
e1	0.100 BSC		2.54 BSC	
F	–	0.040	–	1.02
k	0.027	0.034	0.69	0.86
k1	0.027	0.045	0.69	1.14
L	0.500	0.750	12.70	19.05
L1	–	0.050	–	1.27
L2	0.250	–	6.35	–
Q	0.010	0.045	0.25	1.14
α	45° BSC		45° BSC	
β	45° BSC		45° BSC	

21-0022A

8-PIN TO-99 METAL CAN PACKAGE



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
A1	0.015	–	0.38	–
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	–	2.54	–
eA	0.300	–	7.62	–
eB	–	0.400	–	10.16
L	0.115	0.150	2.92	3.81

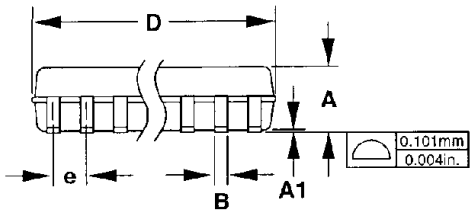
Plastic DIP PLASTIC DUAL-IN-LINE PACKAGE (0.300 in.)

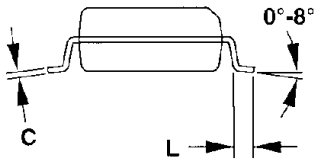
PKG.	DIM	PINS	INCHES		MILLIMETERS	
			MIN	MAX	MIN	MAX
P	D	8	0.348	0.390	8.84	9.91
P	D	14	0.735	0.765	18.67	19.43
P	D	16	0.745	0.765	18.92	19.43
P	D	18	0.885	0.915	22.48	23.24
P	D	20	1.015	1.045	25.78	26.54
N	D	24	1.14	1.265	28.96	32.13

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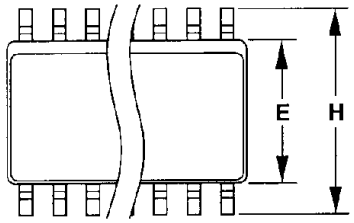
Pin Programmable Precision Voltage Reference

Package Information (continued)





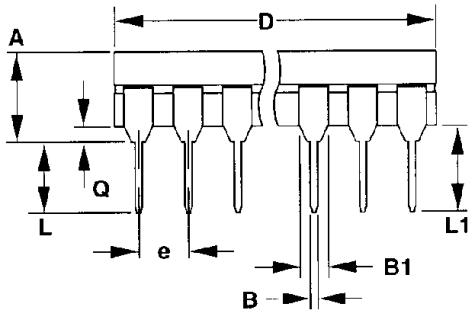
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
E	0.150	0.157	3.80	4.00
e	0.050		1.27	
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

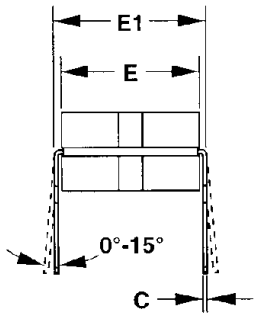


Narrow SO SMALL-OUTLINE PACKAGE (0.150 in.)

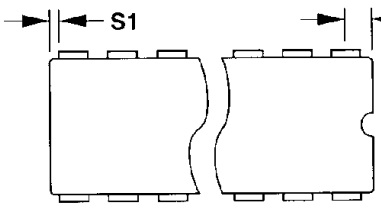
DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	0.189	0.197	4.80	5.00
D	14	0.337	0.344	8.55	8.75
D	16	0.386	0.394	9.80	10.00

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DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
B	0.014	0.023	0.36	0.58
B1	0.038	0.065	0.97	1.65
C	0.008	0.015	0.20	0.38
E	0.220	0.310	5.59	7.87
E1	0.290	0.320	7.37	8.13
e	0.100		2.54	
L	0.125	0.200	3.18	5.08
L1	0.150	–	3.81	–
Q	0.015	0.070	0.38	1.78
S	–	0.098	–	2.49
S1	0.005	–	0.13	–



CERDIP CERAMIC DUAL-IN-LINE PACKAGE (0.300 in.)

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	–	0.405	–	10.29
D	14	–	0.785	–	19.94
D	16	–	0.840	–	21.34
D	18	–	0.960	–	24.38
D	20	–	1.060	–	26.92
D	24	–	1.280	–	32.51

21-0045A

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