High Precision 10 Volt Reference

T-58-07

General Description

Maxim's AD581 is a three-terminal, temperature compensated, band-gap voltage reference which provides a precise 10.00V output from an unregulated input of 12.5V to 30V. Laser trimming is used to minimize initial error and temperature drift, to as low as 5mV and 5ppm/°C with the AD581L.

No external components are needed to acheive full accuracy over the operating temperature range. Total supply current to the device, including the internal output buffer amplifier, is typically 750μA.

The AD581 is designed for use with 8 to 14 bit A/D and D/A converters as well as data acquisition systems. The reference is available in a 3 pin TO-5 metal can and 8 lead small outline surface mount package.

Features

- ±5mV Tolerance (AD581L)
- Low Tempco — 5ppm/°C Max. (AD581L)
- No External Components or Trims
- Short Circuit Proof
- Output Sources and Sinks Current
- 10mA Output Current
- Low Supply Current — 1.0mA Max.
- Three-Terminal Package

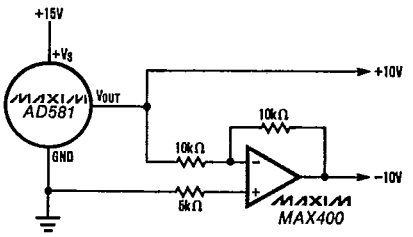
Ordering Information

PART	TEMP. RANGE	PACKAGE	ERROR
AD581JH	0°C to +70°C	TO-39 Can	±30mV
AD581KH	0°C to +70°C	TO-39 Can	±10mV
AD581LH	0°C to +70°C	TO-39 Can	±5mV
AD581JCSA	0°C to +70°C	8 Lead S.O.	±30mV
AD581KCSA	0°C to +70°C	8 Lead S.O.	±10mV
AD581LCSA	0°C to +70°C	8 Lead S.O.	±5mV
AD581SH	-55°C to +125°C	TO-39 Can	±30mV
AD581TH	-55°C to +125°C	TO-39 Can	±10mV
AD581UH	-55°C to +125°C	TO-39 Can	±5mV

Applications

CMOS DAC Reference
A/D Converter Reference
Measurement Instrumentation
Threshold Detectors
Precision Analog Systems

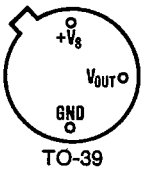
Typical Operating Circuit



±10 Volt Reference

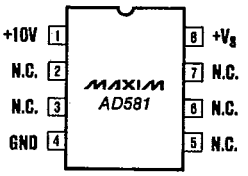
Pin Configurations

Bottom View



TO-39

Top View



8 Lead Small Outline

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ABSOLUTE MAXIMUM RATINGS

Input Voltage V_{IN} to GND ..... -0.3V, +40V
Power Dissipation
  Metal Can (Derate 6.7mW/°C above 60°C) 600mW
  Small Outline (Derate 5.3mW/°C above 75°C) 400mW
Output Short-Circuit Duration (Note 1) ..... Indefinite
Operating Temperature Range
  Commercial (J, K, L) ..... 0°C to +70°C
  Military (S, T, U) ..... -55°C to +125°C

Storage Temperature Range ..... -65°C to +175°C
Lead Temperature (Soldering 10sec) ..... +300°C
Dice Junction Temperature (Tj) ..... -55°C to +150°C
Thermal Resistance, Junction to Ambient
  Metal Can ..... 150°C/W
  Small Outline Package ..... 170°C/W

Stresses above 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 above 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	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage Tolerance			I_L = 0mA, AD581J/S AD581K/T AD581L/U				±30 ±10 ±5	mV
Output Voltage Change with Temperature, (Temperature Coefficient)			AD581J AD581K AD581L AD581S AD581T AD581U				13.5 (30) 6.75 (15) 2.25 (5) 30 (30) 15 (15) 10 (10)	±mV (ppm/°C)
Line Regulation			No Load, +12.5V < V_{IN} < +15V +15V < V_{IN} < +30V				0.005 (1.0) 0.002 (3.0)	%/V (mV) %/V (mV)
Load Regulation			I_L = 0mA to 5mA			20 (200)	50 (500)	ppm/mA (µV/mA)
Quiescent Supply Current		I_Q	I_L = 0mA			750	1000	µA
Turn-on Settling Time to 0.1%		t_{ON}				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
Output Current	Source	I_L	V_{IN} > V_{OUT} + 2.5V	T_A = +25°C T_{MIN} to T_{MAX}	10 5			mA
	Sink			T_{MIN} to T_{MAX}, AD581J/K/L AD581S/T/U -55°C to +85°C, AD581S/T/U	5 0.2 5			

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

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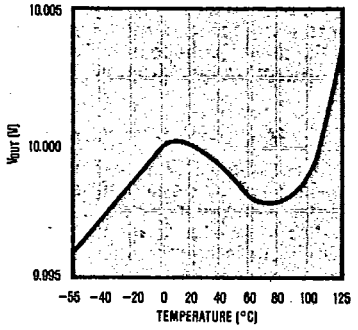
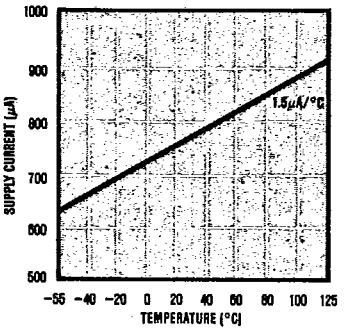
Typical Operating Characteristics

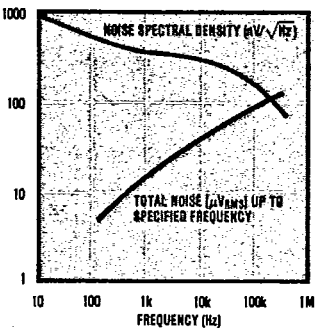
OUTPUT VOLTAGE vs. TEMPERATURE



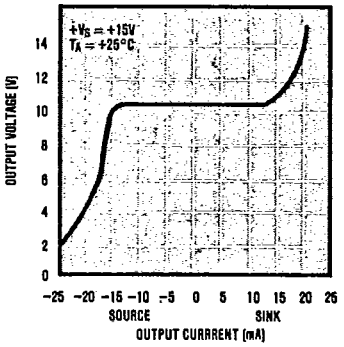
QUIESCENT CURRENT vs. TEMPERATURE



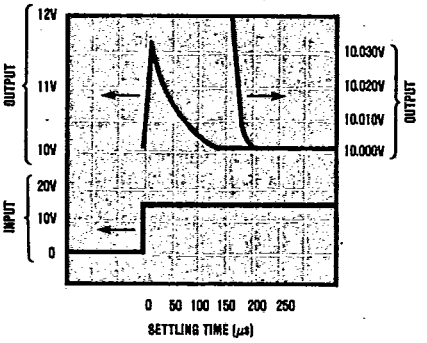
SPECTRAL NOISE DENSITY AND TOTAL RMS NOISE vs. FREQUENCY



AD581 OUTPUT VOLTAGE vs. SINK AND SOURCE CURRENT



OUTPUT SETTLING CHARACTERISTIC



Detailed Description

As shown in Figure 1, most applications of the AD581 require no external components. Connections are $+V_S$, V_{OUT}, and GND (GND is tied to the case in the TO-5 package). Usually the desired accuracy is obtained by selecting the appropriate device grade. However, any part can be adjusted to a tighter tolerance, or to slightly different voltage, using the fine trim circuit in Figure 2. The table in Figure 2 lists the trim range for different values of R in the figure, and also shows the effect on temperature coefficient.

Voltage Temperature Coefficient

The temperature characteristic of the AD581 consistently follows an "S-curve" (see Typical Operating Characteristics). A five-point 100% test guarantees compliance with -55° C to +125° C specifications and a three-point 100% test guarantees 0° C to +70° C specifications.

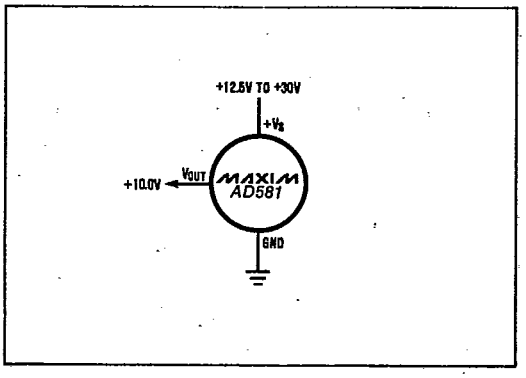


Figure 1. AD581 Basic Connection

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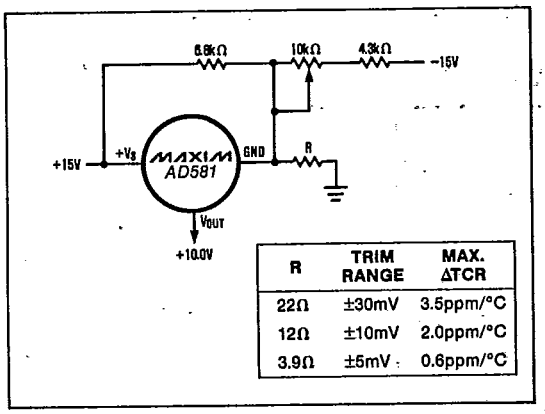

R	TRIM RANGE	MAX. ΔTCR
22Ω	±30mV	3.5ppm/°C
12Ω	±10mV	2.0ppm/°C
3.9Ω	±5mV	0.6ppm/°C

Figure 2. Optional Fine Trim Configuration

The Voltage Change specifications in the Electrical Characteristics table state the maximum deviation over temperature from the reference's initial value at 25°C, as well as drift in ppm/°C. By adding the maximum deviation for a given device to its initial tolerance, the total error is quickly determined.

Output Current

The AD581 is unique in that it can sink as well as source current. The circuit is also protected for output shorts to either $+V_S$ or GND. The output voltage versus current characteristic is shown in the Typical Operating Characteristics section.

Dynamic Performance

The turn-on characteristics and settling performance of the AD581 are shown in the Typical Operating Characteristics. Both coarse and fine transient response is shown. The reference typically settles to 1mV within 180μs after power is applied.

Applications

Precision High Current Reference

A PNP power transistor, or Darlington, is easily connected to the AD581 to greatly increase its output current. The circuit of Figure 3 provides a +10V output at up to 4 Amps. If the load has a significant capacitive component, compensation capacitor, C1, should be added. If the load is purely resistive, high frequency supply rejection is improved without C1.

Low Input Voltage

Although line regulation is specified from 12.5V to 40V, the AD581 can operate with a +12V ±5% input by adding a resistor as shown in Figure 4. The resistor reduces the current that must be supplied from V_{OUT}. Note that the resistor cannot be used at higher input voltages since, as the supply increases, it sources more current than V_{OUT} can sink.

Current Limiter

By adding a single resistor as shown in Figure 5, the AD581 is turned into a precision current limiter for applications where the driving voltage is 12.5V to 40V. The programmed current ranges from 0.75mA to 5mA.

Negative 10V Reference

Where a -10V reference is required, the AD581 can be connected as a two-terminal device and biased like a zener diode. The circuit is shown in Figure 6. $+V_S$ and V_{OUT} are connected to the system's analog ground, and the AD581's GND pin is connected, through a resistor, to the negative supply. With 1mA flowing in the reference, the output voltage is typically 2mV greater than what is obtained with the conventional, positive, hook-up.

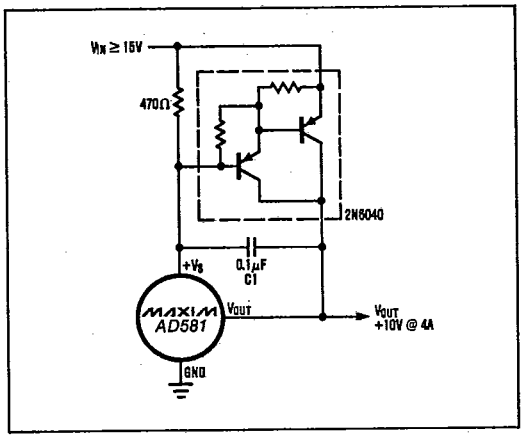

Figure 3. High Current Precision Supply

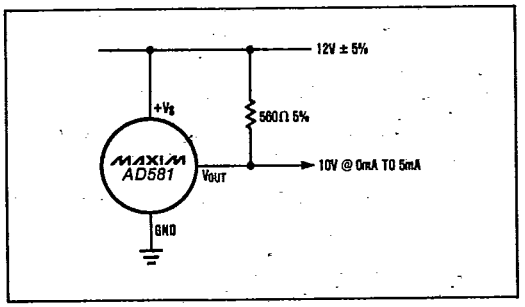

Figure 4. 12-Volt Supply Connection

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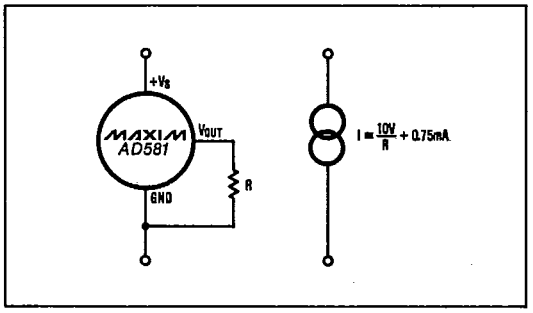

Figure 5. A Two-Component Precision Current Limiter

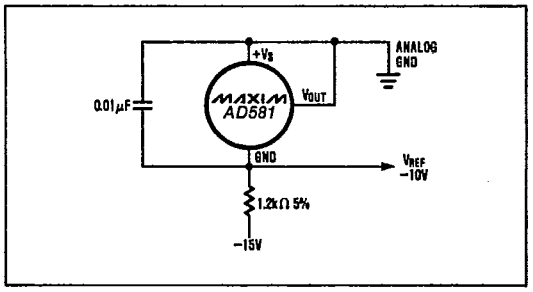

Figure 6. Two-Terminal -10 Volt Reference

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.

Reference for CMOS DACs and ADCs

The AD581 is well suited for use with a wide variety of D-to-A converters, especially CMOS DACs. Figure 7 shows a circuit in which an AD7533 10 bit DAC outputs 0 to -10V when using a +10V reference. For a positive DAC output, the AD581 is configured as a 2-terminal -10V reference (Figure 6) and connected to the DAC's V_{REF} input.

In Figure 8, an AD7574 CMOS A/D converter uses an AD581 for its -10V reference input. The input range for the A/D converter is 0V to +10V.

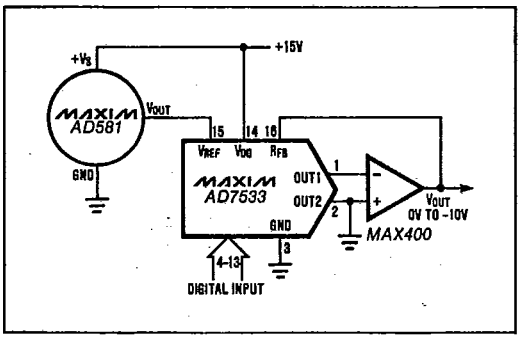

Figure 7. Low Power 10 Bit CMOS DAC Connection

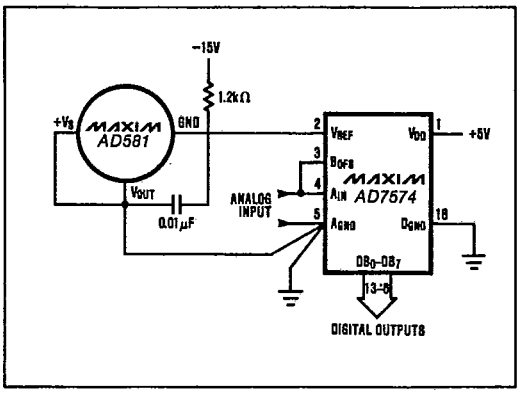

Figure 8. Negative 10V Reference for CMOS A/D Converter

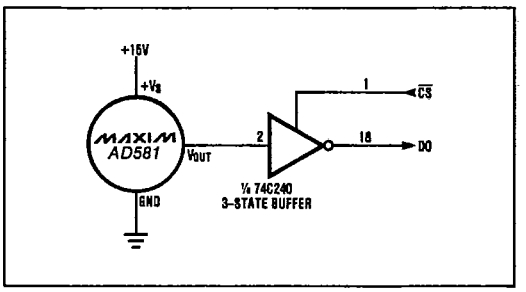

Figure 9. AD581 Microprocessor Interface

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Chip Topography