# High Speed Digital to Analog Converter

## DAC1106

**FEATURES**
**High Speed**
**8 Bits in 25ns**
**10 Bits in 50ns**
**Adjustment Free Operation**
**Gain TC: ±10ppm/°C**
**Linearity Error: ±½LSB**
**Small Size: 2" x 2" x 0.4" Module**




### GENERAL DESCRIPTION

The DAC1106 is a high speed, current output digital-to-analog converter which is available in both eight and ten bit versions. The very fast settling times to ½LSB of 25nsec (8 bit models) and 50nsec (10 bit models) make these devices ideally suited for use in high speed applications such as computer driven displays, automatic test equipment and function generators. Accuracy specifications include ±½LSB linearity, 10ppm/°C temperature coefficient, and 0.002%/V power supply rejection.

Everything needed to perform high speed conversions is contained in the compact 2" x 2" x 0.4" package of the DAC1106. Included are a precision temperature compensated reference source, high speed current switches and a carefully trimmed network of weighting resistors. Because of the inherent stability and careful factory adjustment of this device, no external zero or gain adjustment potentiometers are required.

The digital inputs of the DAC1106 are fully DTL/TTL compatible. Binary code is used for unipolar operation and Offset Binary code is used for bipolar operation. The current output of this device can be applied directly to an external resistor to develop a voltage output or it can be applied to the input of a fast settling op amp if amplification or impedance transformation is desired.

### INPUT CONSIDERATIONS

The binary weighted current sources which form the basis of the digital to analog conversion process are directly switched by their associated input bits. A change in the converter's current output will begin to occur approximately 10nsec after a new digital word is applied. Because of this extremely fast response, time skew in the digital input can result in momentary erroneous outputs or "glitches". Consider, for example, the case of a transition from 1000 . . . 0 to 0111 . . . 1, a step of only one LSB. If the MSB turns to a "0" before the rest of the bits have turned to "1"'s, the input will momentarily be 0000 . . . 0 and the converter will start to respond accordingly as shown below in Figure 1.

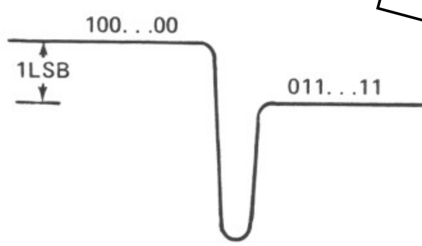


*Figure 1. Switching Transient Caused by Time Skew*

These switching transients will be minimized if the digital input data time skew is held to less than 5nsec.



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In both cases, the output voltage is limited to ±1.2V max. By referring to Figures 3 and 4, the user can readily compute the value of $R_L$ needed to produce the desired full scale voltage. For example, a 300Ω resistor will develop a 0 to +1V F.S. unipolar output and a 2.325kΩ resistor will develop a +1V F.S. bipolar output.

The DAC1106 may be used in conjunction with a high speed external op amp when outputs greater than ±1.2V and 5mA are needed. Because current output converters such as the DAC1106 are not ideal current sources, the op amp does not operate in a unity gain configuration. Figure 7 below shows, in simplified form, a unipolar DAC1106 driving an op amp.

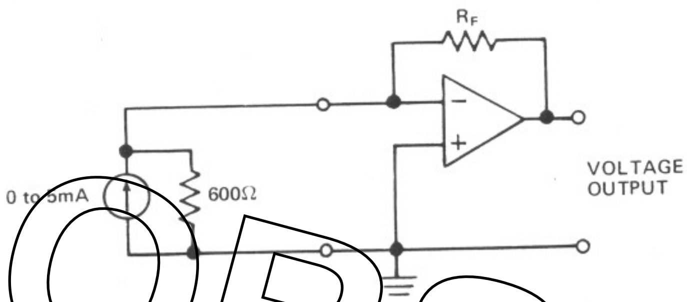


*Figure 7. Voltage Output with an Op Amp Simplified Diagram*

Because of the 600Ω output impedance, the closed loop gain becomes 1 + $R_f$/600 instead of 1. For example with an $R_f$ of 2kΩ the closed loop gain is 4.33.

This can complicate the job of selecting a suitable op amp since most manufacturers specify settling time at unity gain. One extremely fast op amp that performs as well at gains of 2 to 6 as it does at unity gain is the Analog Devices' model 50 differential input, FET amplifier. The model 50 will settle to ten-bit accuracy (0.05%) in a maximum of 200nsec. The high current output of this device (100mA) also makes it ideal for use with the DAC1106 in CRT deflection applications.

Sometimes space or budgetary considerations dictate that an IC rather than a modular op amp be used. In these cases the AD509K fast settling IC op amp is recommended. The AD509K maintains its guaranteed maximum settling time specification (500nsec to 0.1%) even at the closed loop gains encountered with the DAC1106. Furthermore, when the closed loop gain is greater than 3, no external compensating components are required.

Figures 8 and 9 below show the proper means of connecting the converter to an op amp for unipolar and bipolar operation.

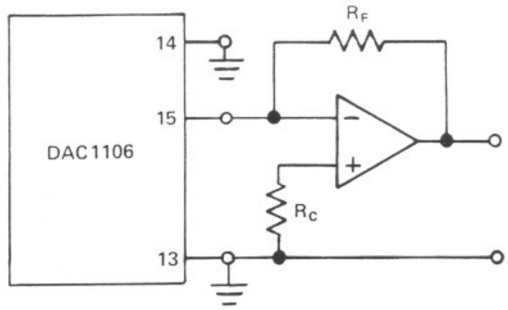


*Figure 8. Connections to an External Op Amp (Unipolar)*

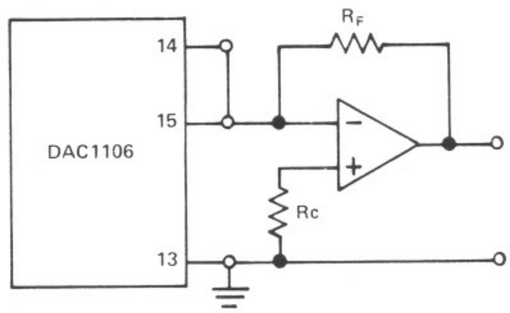


*Figure 9. Connections to an External Op Amp (Bipolar)*

The resistor Rc is used with the AD509K for bias current compensation. Because of the low bias currents inherent with the model 50, Rc is unnecessary and the noninverting input is connected directly to ground.

Great care must be taken in laying out the circuits of Figures 8 and 9 to assure true high speed performance. Several of the most important considerations are listed below:

1. Keep leads, especially those between the converter output and op amp summing junction, as short as possible to prevent the introduction of noise.
2. Orient components to minimize stray capacitance.
3. Carefully bypass power supplies to the op amp.
4. Select suitable components such as metal film resistors with their low capacitance and low stray inductance.
5. Design the signal and power supply ground circuits so as to prevent the introduction of extraneous voltages in ground signal path.
6. Use separate returns for analog and digital grounds. The DAC1106 and op amp power supply returns go to analog ground; any logic circuits that precede the converter go to digital ground.



C191a–10–7/75
PRINTED IN U.S.A.