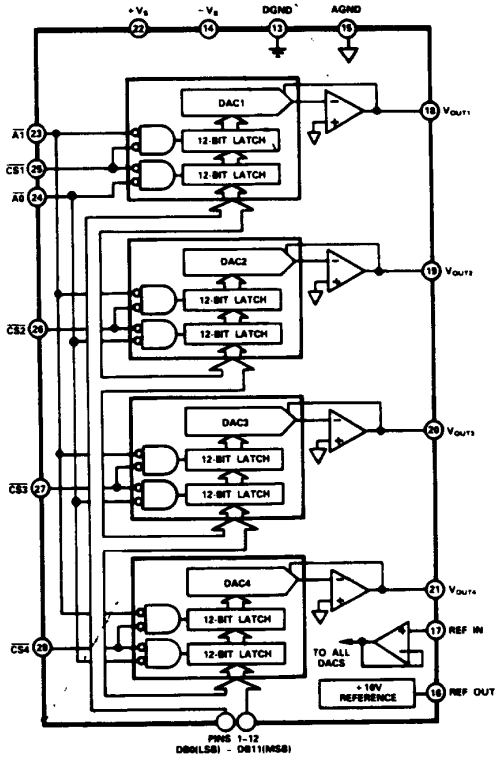
# Quad 12-Bit Microprocessor-Compatible D/A Converter

# AD390*



**FEATURES**
**Four Complete 12-Bit DACs in One IC Package**
**Linearity Error ±1/2LSB $T_{min}$ – $T_{max}$ (AD390K, T)**
**Factory-Trimmed Gain and Offset**
**Buffered Voltage Output**
**Monotonicity Guaranteed Over Full Temperature Range**
**Double-Buffered Data Latches**
**Includes Reference and Buffer**
**Fast Settling: 8μs max to ±1/2LSB**

**FUNCTIONAL BLOCK DIAGRAM**




**PRODUCT DESCRIPTION**

The AD390 contains four 12-bit high speed voltage-output digital-to-analog converters in a compact 28-pin hybrid package. The design is based on a proprietary latched 12-bit DAC chip which reduces chip count and provides high reliability. The AD390 is ideal for systems requiring digital control of many analog voltages where board space is at a premium. Such applications include automatic test equipment, process controllers, and vector-scan displays.

The AD390 is laser-trimmed to ±1/2LSB max nonlinearity (AD390KD, TD) and absolute accuracy of ±0.05 percent of full scale. The high initial accuracy is made possible by the use of thin-film scaling resistors on the monolithic DAC chips. The internal buried Zener voltage reference provides excellent temperature drift characteristics (20ppm/°C) and an initial tolerance of ±0.03% maximum. The internal reference buffer allows a single common reference to be used for multiple AD390 devices in large systems.

The individual DACs are accessed by the $\overline{CS1}$ through $\overline{CS4}$ control inputs and the $\overline{A0}$ and $\overline{A1}$ lines. These control signals permit the registers of the four DACs to be loaded sequentially and the outputs to be simultaneously updated.

The AD390 outputs are calibrated for a ±10V output range with positive-true offset binary input coding. A 0 to +10V version is available on special order.

The AD390 is packaged in a 28-lead ceramic package and is specified for operation over the 0 to +70°C and −55°C to +125°C temperature range.

**PRODUCT HIGHLIGHTS**

1. The AD390 offers a dramatic reduction in printed circuit board space requirements in systems using multiple DACs.
2. Each DAC is independently addressable, providing a versatile control architecture for simple interface to microprocessors. All latch enable signals are level-triggered.
3. The output voltage is trimmed to a full scale accuracy of ±0.05%. Settling time to ±1/2LSB is 8 microseconds maximum.
4. An internal 10 volt reference is available or an external reference can be used. With an external reference, the AD390 gain TC is ±5ppm/°C maximum.
5. The proprietary monolithic DAC chips provide excellent linearity and guaranteed monotonicity over the full operating temperature range.
6. The 28-pin double-width hybrid package provides extremely high functional density. No external components or adjustments are required to provide the complete function.
7. The AD390SD and AD390TD feature guaranteed accuracy and linearity over the −55°C to +125°C temperature range.

# AD390—SPECIFICATIONS ($T_A$ = +25°C, $V_S$ = ±15V unless otherwise indicated, specifications guaranteed after 10 minute warmup)

| Model | AD390JD/SD | | | AD390KD/TD | | | Units |
|---|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max | |
| DATA INPUTS (Pins 1-12 and 23-28)[1] | | | | | | | |
| TTL or 5 Volt CMOS | | | | | | | |
| Input Voltage | | | | | | | |
| Bit ON (Logic "1") | +2.0 | | +5.5 | +2.0 | | +5.5 | V |
| Bit OFF (Logic "0") | | | +0.8 | | | +0.8 | V |
| Input Current (Pin 24 is 3× Larger) | | | | | | | |
| Bit ON (Logic "1") | | 500 | 1200 | | 500 | 1200 | µA |
| Bit OFF (Logic "0") | | 150 | 400 | | 150 | 400 | µA |
| RESOLUTION | | | 12 | | | 12 | Bits |
| OUTPUT[2] | | | | | | | |
| Voltage Range[3] | | | ±10 | | | ±10 | V |
| Current | 5 | | | 5 | | | mA |
| Settling Time (to ±½LSB) | | 4 | 8 | | 4 | 8 | µs |
| ACCURACY | | | | | | | |
| Gain Error (w/ext. 10.000V reference) | | ±0.05 | ±0.1 | | ±0.025 | ±0.05 | % of FSR[4] |
| Offset | | ±0.025 | ±0.05 | | ±0.012 | ±0.025 | % of FSR |
| Linearity Error | | ±1/4 | ±3/4 | | ±1/8 | ±1/2 | LSB |
| Differential Linearity Error | | ±1/2 | ±3/4 | | ±1/4 | ±1/2 | LSB |
| TEMPERATURE DRIFT | | | | | | | |
| Gain (internal reference) | | | ±40 | | | ±20 | ppm/°C |
| (external reference) | | | ±10 | | | ±5 | ppm/°C |
| Zero | | | ±10 | | | ±5 | ppm/°C |
| Linearity Error $T_{min}-T_{max}$ | | ±1/2 | ±3/4 | | ±1/4 | ±1/2 | LSB |
| Differential Linearity | MONOTONICITY GUARANTEED OVER FULL TEMPERATURE RANGE | | | | | | |
| CROSSTALK[5] | | 0.1 | | | 0.1 | | LSB |
| REFERENCE OUTPUT | | | | | | | |
| Voltage (without load) | 9.997 | 10.000 | 10.003 | 9.997 | 10.000 | 10.003 | V |
| Current (available for external use) | 2.5 | 3.5 | | 2.5 | 3.5 | | mA |
| REFERENCE INPUT | | | | | | | |
| Input Resistance | | $10^{10}$ | | | $10^{10}$ | | Ω |
| Voltage Range | 5 | | 11 | 5 | | 11 | V |
| POWER REQUIREMENTS | | | | | | | |
| Voltage[6] | ±13.5 | ±15 | ±16.5 | ±13.5 | ±15 | ±16.5 | V |
| Current | | | | | | | |
| $+V_S$ | | 20 | 35 | | 20 | 35 | mA |
| $-V_S$ | | −85 | −100 | | −85 | −100 | mA |
| POWER SUPPLY GAIN SENSITIVITY | | | | | | | |
| $+V_S$ | | 0.002 | 0.006 | | 0.002 | 0.006 | %FS/% |
| $-V_S$ | | 0.0025 | 0.006 | | 0.0025 | 0.006 | %FS/% |
| TEMPERATURE RANGE | | | | | | | |
| Operating (Full Specifications) J, K | 0 | | +70 | 0 | | +70 | °C |
| S, T | −55 | | +125 | −55 | | +125 | °C |
| Storage | −65 | | +150 | −65 | | +150 | °C |

NOTES

[1]Timing specifications appear in Table 2.

[2]The AD390 outputs are guaranteed stable for load capacitances up to 300pF.

[3]±10V range is standard. A 0 to 10V version is also available. To order, use the following part numbers:

| | |
|---|---|
| AD50207-1 | J Grade |
| AD50207-2 | K Grade |
| AD50207-3 | S Grade |
| AD50207-4 | T Grade |
| AD50207-7 | S/883B Grade |
| AD50207-8 | T/883B Grade |

[4]FSR means Full Scale Range and is equal to 20V for a ±10V range.

[5]Crosstalk is defined as the change in any one output as a result of any other output being driven from −10V to +10V into a 2kΩ load.

[6]The AD390 can be used with supply voltage as low as ±11.4V, Figure 10.

Specifications subject to change without notice.

## ABSOLUTE MAXIMUM RATINGS

$+V_S$ to DGND . . . . . 0 to +18V
$-V_S$ to DGND . . . . . 0 to −18V
Digital Inputs (Pins 1-12, 23-28) to DGND . . . . −1 to +7V
Ref In to DGND . . . . . $\pm V_S$
AGND to DGND . . . . . ±0.6V
Analog Outputs (Pins 16, 18-21)
. . . . . Indefinite Short to AGND or DGND
Momentary Short to $\pm V_S$
Storage Temperature . . . . . −65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) . . . . . +300°C

## ORDERING GUIDE

| Model | Temperature Range | Gain Error 25°C | Linearity Error $T_{min}-T_{max}$ | Package Option* |
|---|---|---|---|---|
| AD390JD | 0 to +70°C | ±4LSB | ±3/4LSB | DH-28 |
| AD390KD | 0 to +70°C | ±2LSB | ±1/2LSB | DH-28 |
| AD390SD | −55°C to +125°C | ±4LSB | ±3/4LSB | DH-28 |
| AD390TD | −55°C to +125°C | ±2LSB | ±1/2LSB | DH-28 |

*DH-28 = Side Brazed Ceramic DIP for Hybrid. For outline information see Package Information section.

## PIN CONFIGURATION