



## Complete 10 $\mu$ s CMOS 12-Bit ADC

**MAX172**

### General Description

The MAX172 is a complete 12-Bit analog-to-digital converter (ADC) that combines high speed, low power consumption, and an on-chip voltage reference. The conversion time is 10 $\mu$ s. The buried zener reference provides low drift and low noise performance.

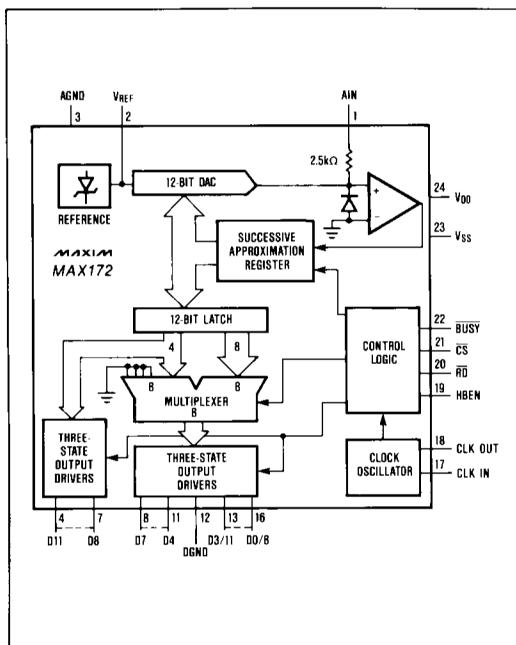
External component requirements are limited to only decoupling capacitors for the power supply and reference voltages. On-chip clock circuitry is also included which can either be driven from an external source, or in stand-alone applications, can be used with a crystal.

The MAX172 uses a standard microprocessor interface architecture. Three-state data outputs are controlled by Read (RD) and Chip Select (CS) inputs. Data access and bus release times of 90 and 75ns respectively ensure compatibility with most popular microprocessors without resorting to wait states.

### Applications

Digital Signal Processing (DSP)  
High Accuracy Process Control  
High Speed Data Acquisition  
Electro-Mechanical Systems

### Functional Diagram



### Features

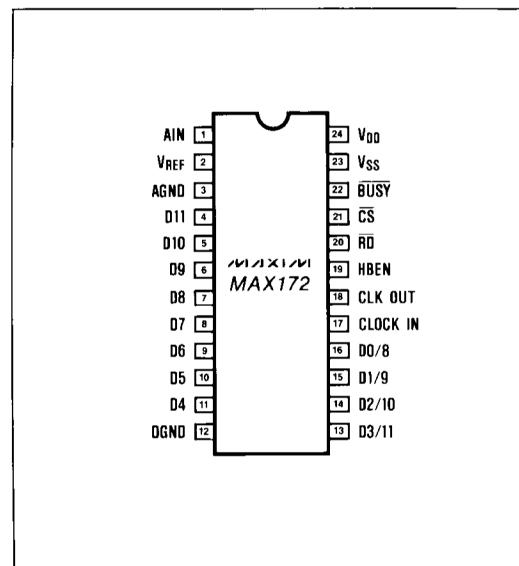
- ◆ 12-Bit Resolution and Linearity
- ◆ 10 $\mu$ s Conversion Time
- ◆ No Missing Codes
- ◆ On-Chip Voltage Reference
- ◆ 90ns Access Time
- ◆ 215mW Max Power Consumption
- ◆ 24-Lead Narrow DIP Package
- ◆ Pin-for-Pin AD7572 Replacement

### Ordering Information

| PART       | TEMP RANGE      | PIN-PACKAGE    | ERROR (LSB) | PKG CODE |
|------------|-----------------|----------------|-------------|----------|
| MAX172ACNG | 0°C to +70°C    | 24 Plastic DIP | $\pm 0.5$   | N24-3    |
| MAX172BCNG | 0°C to +70°C    | 24 Plastic DIP | $\pm 1$     | N24-3    |
| MAX172ACWG | 0°C to +70°C    | 24 Wide SO     | $\pm 0.5$   | W24-1    |
| MAX172BCWG | 0°C to +70°C    | 24 Wide SO     | $\pm 1$     | W24-1    |
| MAX172CC/D | 0°C to +70°C    | Dice*          | $\pm 1$     | —        |
| MAX172AENG | -40°C to +85°C  | 24 Plastic DIP | $\pm 0.5$   | N24-3    |
| MAX172BENG | -40°C to +85°C  | 24 Plastic DIP | $\pm 1$     | N24-3    |
| MAX172AMRG | -55°C to +125°C | 24 CERDIP      | $\pm 0.5$   | R24-4    |
| MAX172BMRG | -55°C to +125°C | 24 CERDIP      | $\pm 1$     | R24-4    |

\* Consult factory for dice specifications

### Pin Configuration


**MAXIM**

Maxim Integrated Products 1

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](http://www.maxim-ic.com).

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### ABSOLUTE MAXIMUM RATINGS

|                                |                                                      |
|--------------------------------|------------------------------------------------------|
| $V_{DD}$ to DGND               | -0.3V to +7V                                         |
| $V_{SS}$ to DGND               | +0.3V to -17V                                        |
| AGND to DGND                   | -0.3V, $V_{DD} + 0.3V$                               |
| AIN to AGND                    | -15V to +15V                                         |
| Digital Input Voltage to DGND  | -0.3V, $V_{DD} + 0.3V$<br>(Pins 17, 19-21)           |
| Digital Output Voltage to DGND | -0.3V, $V_{DD} + 0.3V$<br>(pins 4-11, 13-16, 18, 22) |

#### Operating Temperature Ranges

|                                          |                 |
|------------------------------------------|-----------------|
| MAX172XC                                 | 0°C to +70°C    |
| MAX172XE                                 | -40°C to +85°C  |
| MAX172XM                                 | -55°C to +125°C |
| Storage Temperature Range                | -65°C to +160°C |
| Power Dissipation (any Package) to +75°C | 1000mW          |
| Derates Above +75°C by                   | 10mW/°C         |
| Lead Temperature (Soldering 10 seconds)  | +300°C          |

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 ratings conditions for extended periods may affect device reliability.

### ELECTRICAL CHARACTERISTICS

( $V_{DD} = +5V \pm 5\%$ ,  $V_{SS} = -12V$  or  $-15V \pm 5\%$ ; Slow Memory Mode;  $T_A = T_{MIN}$  to  $T_{MAX}$  unless otherwise noted,  $f_{CLK} = 1.25MHz$ )

| PARAMETER                                  | SYMBOL           | CONDITIONS                                         |                                                                                | MIN | TYP  | MAX          | UNITS  |        |
|--------------------------------------------|------------------|----------------------------------------------------|--------------------------------------------------------------------------------|-----|------|--------------|--------|--------|
| ACCURACY                                   |                  |                                                    |                                                                                |     |      |              |        |        |
| Resolution                                 |                  |                                                    |                                                                                |     | 12   |              | Bits   |        |
| Integral NonLinearity                      | INL              | MAX172A                                            | T <sub>A</sub> = 25°C                                                          |     |      | + 1/2        | LSB    |        |
|                                            |                  | MAX172AC/AE                                        |                                                                                |     |      | + 1/2        |        |        |
|                                            |                  | MAX172AM                                           |                                                                                |     |      | + 3/4        |        |        |
|                                            |                  | MAX172B                                            |                                                                                |     |      | + 1          |        |        |
| Differential NonLinearity                  | DNL              | Guaranteed Monotonic Over Temp.                    |                                                                                |     |      | + 1          | LSB    |        |
| Offset Error (Note 1)                      |                  | MAX172B                                            | T <sub>A</sub> = 25°C<br>T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | + 4<br>+ 6   | LSB    |        |
|                                            |                  | MAX172A                                            | T <sub>A</sub> = 25°C<br>T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | + 3<br>+ 4   |        |        |
| Full Scale Error (Note 2)                  |                  | MAX172B                                            | T <sub>A</sub> = 25°C                                                          |     |      | + 15         | LSB    |        |
|                                            |                  | MAX172A                                            | T <sub>A</sub> = 25°C                                                          |     |      | + 10         |        |        |
| Full Scale Tempco (Notes 3, 4)             |                  |                                                    |                                                                                |     |      | + 45         | ppm/°C |        |
| ANALOG INPUT                               |                  |                                                    |                                                                                |     |      |              |        |        |
| Input Voltage Range                        |                  |                                                    |                                                                                |     | 0    | 5            | V      |        |
| Input Current                              |                  | AIN = 0V to +5V                                    |                                                                                |     |      | 3.5          | mA     |        |
| INTERNAL REFERENCE                         |                  |                                                    |                                                                                |     |      |              |        |        |
| V <sub>REF</sub> Output Voltage            |                  | T <sub>A</sub> = 25°C                              |                                                                                |     | -5.2 | -5.25        | -5.3   | V      |
| V <sub>REF</sub> Output Tempco (Note 5)    |                  |                                                    |                                                                                |     |      | 40           |        | ppm/°C |
| Output Current Sink Capability             |                  | (Note 6)                                           |                                                                                |     |      | 500          |        | μA     |
| LOGIC INPUTS                               |                  |                                                    |                                                                                |     |      |              |        |        |
| Input Low Voltage                          | V <sub>IL</sub>  | CS, RD, HBEN, CLKIN                                |                                                                                |     |      | 0.8          |        | V      |
| Input High Voltage                         | V <sub>IH</sub>  | CS, RD, HBEN, CLKIN                                |                                                                                |     | 2.4  |              |        | V      |
| Input Capacitance (Note 7)                 | C <sub>IN</sub>  | CS, RD, HBEN, CLKIN                                |                                                                                |     |      | 10           |        | pF     |
| Input Current                              | I <sub>IN</sub>  | CS, RD, HBEN<br>CLKIN                              | VIN = 0 to V <sub>DD</sub>                                                     |     |      | + 10<br>+ 20 |        | μA     |
| LOGIC OUTPUTS                              |                  |                                                    |                                                                                |     |      |              |        |        |
| Output Low Voltage                         | V <sub>OL</sub>  | D11-D0/8, BUSY, CLKOUT I <sub>SINK</sub> = 1.6mA   |                                                                                |     |      | 0.4          |        | V      |
| Output High Voltage                        | V <sub>OH</sub>  | D11-D0/8, BUSY, CLKOUT I <sub>SOURCE</sub> = 200μA |                                                                                |     | 4    |              |        | V      |
| Floating State Leakage Current             | I <sub>LKG</sub> | D11-D0/8, V <sub>OUT</sub> = 0V to V <sub>DD</sub> |                                                                                |     |      | + 10         |        | μA     |
| Floating State Output Capacitance (Note 7) | C <sub>OUT</sub> |                                                    |                                                                                |     |      | 15           |        | pF     |

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MAX172

## ELECTRICAL CHARACTERISTICS (Continued)

(V<sub>DD</sub> = +5V  $\pm$  5%, V<sub>SS</sub> = -12V or -15V  $\pm$  5%; Slow Memory Mode; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub> unless otherwise noted, f<sub>CLK</sub> = 1.25MHz.)

| PARAMETER                     | SYMBOL            | CONDITIONS                                                              | MIN | TYP        | MAX        | UNITS   |
|-------------------------------|-------------------|-------------------------------------------------------------------------|-----|------------|------------|---------|
| <b>CONVERSION TIME</b>        |                   |                                                                         |     |            |            |         |
| MAX172                        | t <sub>CONV</sub> | Synchronous (12.5 clock cycles)<br>Asynchronous (12 to 13 clock cycles) | 9.6 |            | 10<br>10.4 | $\mu$ s |
| <b>POWER SUPPLY REJECTION</b> |                   |                                                                         |     |            |            |         |
| V <sub>DD</sub> Only          |                   | FS Change, V <sub>SS</sub> = -15V, V <sub>DD</sub> = 4.75V to 5.25V     |     | $\pm$ 1/2  |            | LSB     |
| V <sub>SS</sub> Only          |                   | FS Change, V <sub>DD</sub> = 5V, V <sub>SS</sub> = -5% to +5%           |     | $\pm$ 1/8  |            | LSB     |
| <b>POWER REQUIREMENTS</b>     |                   |                                                                         |     |            |            |         |
| V <sub>DD</sub>               |                   | $\pm$ 5% for Specified Performance                                      |     | 5          |            | V       |
| V <sub>SS</sub> (Note 8)      |                   | $\pm$ 5% for Specified Performance                                      |     | -12 or -15 |            | V       |
| I <sub>DD</sub>               |                   | CS = RD = V <sub>DD</sub> , AIN = 5V                                    |     | 5          | 7          | mA      |
| I <sub>SS</sub>               |                   | CS = RD = V <sub>DD</sub> , AIN = 5V                                    |     | 8          | 12         | mA      |
| Power Dissipation             |                   | V <sub>DD</sub> = +5V, V <sub>SS</sub> = -15V                           |     | 145        | 215        | mW      |

**Note 1:** Typical change over temp is +1 LSB.

**Note 2:** V<sub>DD</sub> = +5V, V<sub>SS</sub> = -15V, FS = +5.000V, Ideal last code transition = FS - 3/2LSB.

**Note 3:** Full Scale TC =  $\Delta$ FS/ $\Delta$ T, where  $\Delta$ FS is full scale change from T<sub>A</sub> = 25°C to T<sub>MIN</sub> or T<sub>MAX</sub>.

**Note 4:** Includes internal reference drift.

**Note 5:** V<sub>REF</sub> TC =  $\Delta$ V<sub>REF</sub>/ $\Delta$ T, where  $\Delta$ V<sub>REF</sub> is reference voltage change from T<sub>A</sub> = 25°C to T<sub>MIN</sub> or T<sub>MAX</sub>.

**Note 6:** Output current should not change during conversion.

**Note 7:** Guaranteed by design, not subject to test.

**Note 8:** Functional operation at V<sub>SS</sub> = -12V  $\pm$  5% is guaranteed by testing offset error and full scale error.

## TIMING CHARACTERISTICS (Note 9)

(V<sub>DD</sub> = +5V, V<sub>SS</sub> = -12V or -15V; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub> unless otherwise noted.)

| PARAMETER                               | SYMBOL          | CONDITIONS                                      | T <sub>A</sub> = 25°C |                |           | MAX172C/E |                | MAX172M |                | UNITS |
|-----------------------------------------|-----------------|-------------------------------------------------|-----------------------|----------------|-----------|-----------|----------------|---------|----------------|-------|
|                                         |                 |                                                 | MIN                   | TYP            | MAX       | MIN       | MAX            | MIN     | MAX            |       |
| CS to RD Setup Time                     | t <sub>1</sub>  |                                                 | 0                     |                |           | 0         |                | 0       |                | ns    |
| RD to BUSY Delay                        | t <sub>2</sub>  | C <sub>L</sub> = 50pF                           |                       | 90             | 190       |           | 230            |         | 270            | ns    |
| Data Access Time (Note 10)              | t <sub>3</sub>  | C <sub>L</sub> = 20pF<br>C <sub>L</sub> = 100pF |                       | 60<br>70       | 90<br>125 |           | 110<br>150     |         | 120<br>170     | ns    |
| RD Pulse Width                          | t <sub>4</sub>  |                                                 |                       | t <sub>3</sub> |           |           | t <sub>3</sub> |         | t <sub>3</sub> |       |
| CS to RD Hold Time                      | t <sub>5</sub>  |                                                 | 0                     |                |           | 0         |                | 0       |                | ns    |
| Data Setup Time After BUSY<br>Note (10) | t <sub>6</sub>  |                                                 |                       |                | 70        |           | 90             |         | 100            | ns    |
| Bus Relinquish Time (Note 11)           | t <sub>7</sub>  |                                                 | 20                    |                | 75        | 20        | 85             | 20      | 90             | ns    |
| HBEN to RD Setup Time                   | t <sub>8</sub>  |                                                 | 0                     |                |           | 0         |                | 0       |                | ns    |
| HBEN to RD Hold Time                    | t <sub>9</sub>  |                                                 | 0                     |                |           | 0         |                | 0       |                | ns    |
| Delay Between Read Operations           | t <sub>10</sub> |                                                 | 200                   |                |           | 200       |                | 200     |                | ns    |

**Note 9:** Timing specifications are sample tested at 25°C to ensure compliance. All input control signals are specified with t<sub>r</sub> = t<sub>f</sub> = 5ns (10% to 90% of +5V) and timed from a voltage level of +1.6V.

**Note 10:** t<sub>3</sub> and t<sub>6</sub> are measured with the load circuits of Figure 1 and defined as the time required for an output to cross 0.8V or 2.4V.

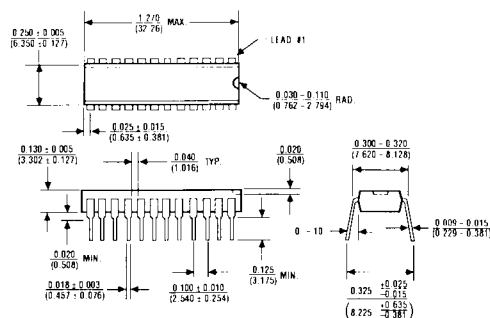
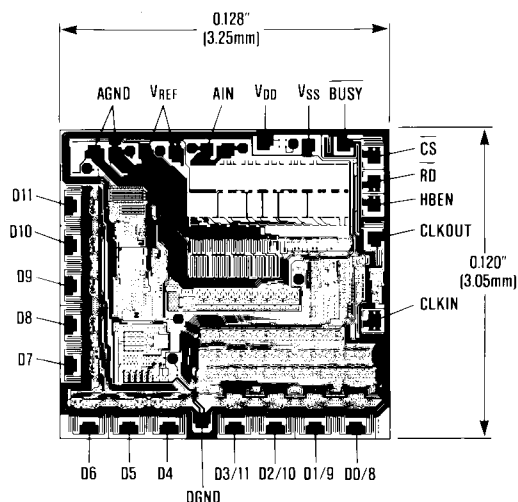
**Note 11:** t<sub>7</sub> is defined as the time required for the data lines to change 0.5V when loaded with the circuits of Figure 2

For additional information on using the MAX172 please refer to MAX162 data sheet.

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## Chip Topography

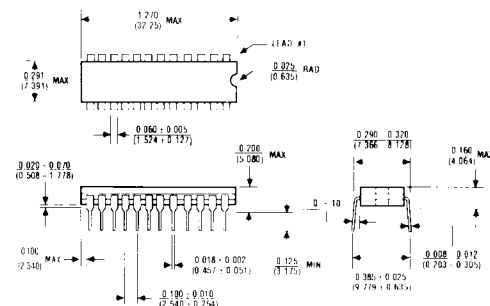
## Package Information



24 Lead Plastic Narrow DIP (NG)

$\theta_{JA} = 120^{\circ}\text{C/W}$

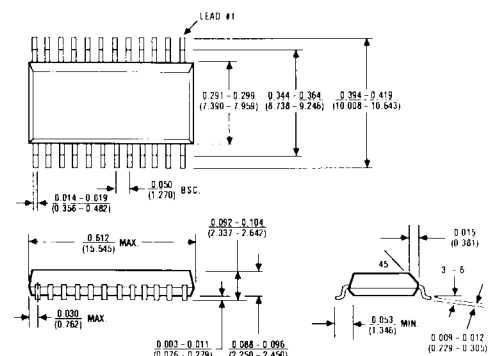
$\theta_{JC} = 60^{\circ}\text{C/W}$



24 Lead Narrow Cerdip (RG)

$\theta_{JA} = 80^{\circ}\text{C/W}$

$\theta_{JC} = 40^{\circ}\text{C/W}$



24 Lead Small Outline, Wide (WG)

$\theta_{JA} = 85^{\circ}\text{C/W}$

$\theta_{JC} = 45^{\circ}\text{C/W}$

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