



High Performance Driver/Comparator on a Single Chip

AD53033

FEATURES

250 MHz Operation

Driver/Comparator Included

52-Lead LQFP Package with Built-in Heat Sink

APPLICATIONS

Automatic Test Equipment

Semiconductor Test Systems

Board Test Systems

Instrumentation and Characterization Equipment

PRODUCT DESCRIPTION

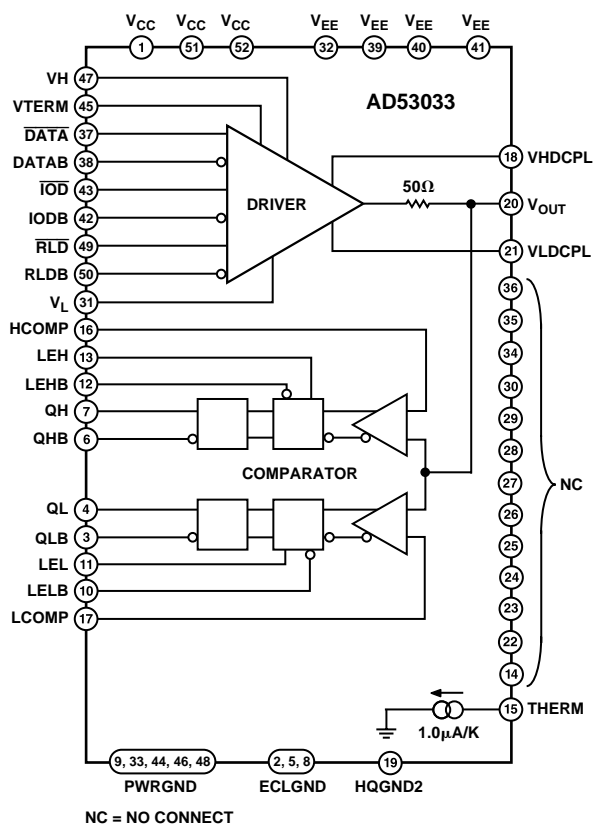
The AD53033 is a single chip that performs the pin electronics functions of driver and comparator (D-C) in ATE VLSI and memory testers.

The driver is a proprietary design that features three active states: Data High Mode, Data Low Mode and Term Mode as well as an Inhibit State. This facilitates the implementation of high speed active termination. The output voltage range is -3 V to $+8\text{ V}$ to accommodate a wide variety of test devices. The output leakage is typically less than 250 nA over the entire signal range.

The dual comparator, with an input range equal to the driver output range, features built-in latches and ECL-compatible outputs. The outputs are capable of driving $50\ \Omega$ signal lines terminated to -2 V . Signal tracking capability is upwards of 5 V/ns .

Also included on the chip is an onboard temperature sensor whose purpose is to give an indication of the surface temperature of the D-C. This information can be used to measure θ_{JC} and θ_{JA} or flag an alarm if proper cooling is lost. Output from the

FUNCTIONAL BLOCK DIAGRAM



sensor is a current sink that is proportional to absolute temperature. The gain is trimmed to a nominal value of $1.0\ \mu\text{A/K}$. As an example, the output current can be sensed by using a $10\text{ k}\Omega$ resistor connected from $+10\text{ V}$ to the THERM (IOUT) pin. A voltage drop across the resistor will be developed that equals: $10\text{K} \times 1\ \mu\text{A/K} = 10\text{ mV/K} = 2.98\text{ V}$ at room temperature.

REV. 0

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AD53033—SPECIFICATIONS

DRIVER SPECIFICATIONS

(All specifications are at $T_J = +85^\circ\text{C} \pm 5^\circ\text{C}$, $+V_S = +12\text{ V} \pm 3\%$, $-V_S = -7\text{ V} \pm 3\%$ unless otherwise noted. All temperature coefficients are measured at $T_J = +75^\circ\text{C}$ to $+95^\circ\text{C}$). $\text{CHDCPL} = \text{CLDCPL} = 39\text{ nF}$.

| Parameter | Min | Typ | Max | Units | Test Conditions |
|--|-----------|---------|-----------|----------------------------|--|
| DIFFERENTIAL INPUT CHARACTERISTICS (DATA to $\overline{\text{DATA}}$, IOD to $\overline{\text{IOD}}$, RLD to $\overline{\text{RLD}}$) | | | | | |
| Input Voltage | -2 | | 0 | V | |
| Differential Input Range | | ECL | | | |
| Bias Current | -250 | | +250 | μA | $V_{\text{IN}} = -2\text{ V}, 0.0\text{ V}$ |
| REFERENCE INPUTS | | | | | |
| Bias Currents | -50 | | +50 | μA | $V_L, V_H, V_T = 5\text{ V}$ |
| OUTPUT CHARACTERISTICS | | | | | |
| Logic High Range | -2 | | 8 | V | DATA = H, $V_H = -2\text{ V}$ to $+8\text{ V}$ $V_L = -3\text{ V}$ ($V_H = -2\text{ V}$ to $+6\text{ V}$) $V_L = -1\text{ V}$ ($V_H = +6\text{ V}$ to $+8\text{ V}$) |
| Logic Low Range | -3 | | 5 | V | DATA = L, $V_L = -3\text{ V}$ to $+5\text{ V}$, $V_H = +6\text{ V}$ |
| Amplitude (V_H and V_L) | 0.1 | | 9 | V | $V_L = 0.0\text{ V}$, $V_H = +0.1\text{ V}$, $V_T = 0\text{ V}$ |
| Absolute Accuracy | | | | | $V_L = -2\text{ V}$, $V_H = +7\text{ V}$, $V_T = 0\text{ V}$ |
| V_H Offset | -50 | | +50 | mV | DATA = H, $V_H = 0\text{ V}$, $V_L = -3\text{ V}$, $V_T = +3\text{ V}$ |
| V_H Gain + Linearity Error | 0.3 – 5 | | +0.3 + 5 | % of V_H + mV | DATA = H, $V_H = -2\text{ V}$ to $+8\text{ V}$, $V_L = -3\text{ V}$, $V_T = +3\text{ V}$ |
| V_L Offset | -50 | | +50 | mV | DATA = L, $V_L = -3\text{ V}$, $V_H = +6\text{ V}$, $V_T = +7.5\text{ V}$ |
| V_L Gain + Linearity Error | -0.3 – 5 | | +0.3 + 5 | % of V_L + mV | DATA = L, $V_L = 0\text{ V}$, $V_H = +6\text{ V}$, $V_T = +7.5\text{ V}$ |
| Offset TC | | 0.5 | | mV/ $^\circ\text{C}$ | $V_L = 0\text{ V}$, $V_H = +5\text{ V}$, $V_T = 0\text{ V}$ |
| Output Resistance | | | | | |
| $V_H = -2\text{ V}$ | 44 | 46 | 48 | Ω | $V_L = -3\text{ V}$, $V_T = 0\text{ V}$, $I_{\text{OUT}} = 0, +1, +30\text{ mA}$ |
| $V_H = +8\text{ V}$ | 44 | 46 | 48 | Ω | $V_L = -1\text{ V}$, $V_T = 0\text{ V}$, $I_{\text{OUT}} = 0, -1, -30\text{ mA}$ |
| $V_L = -3\text{ V}$ | 44 | 46 | 48 | Ω | $V_H = +6\text{ V}$, $V_T = 0\text{ V}$, $I_{\text{OUT}} = 0, +1, +30\text{ mA}$ |
| $V_L = +5\text{ V}$ | 44 | 46 | 48 | Ω | $V_H = +6\text{ V}$, $V_T = 0\text{ V}$, $I_{\text{OUT}} = 0, -1, -30\text{ mA}$ |
| $V_H = +3\text{ V}$ | | 46 | | Ω | $V_L = 0\text{ V}$, $V_T = 0\text{ V}$, $I_{\text{OUT}} = -30\text{ mA}$ (Trim Point) |
| Dynamic Current Limit | 100 | | | mA | $C_{\text{BYP}} = 39\text{ nF}$, $V_H = +7\text{ V}$, $V_L = -2\text{ V}$, $V_T = 0\text{ V}$ |
| Static Current Limit | -85 | | +85 | mA | Output to -3 V , $V_H = +8\text{ V}$, $V_L = -1\text{ V}$, $V_T = 0\text{ V}$ DATA = H and Output to $+8\text{ V}$, $V_H = +6\text{ V}$, $V_L = -3\text{ V}$, $V_T = 0\text{ V}$, DATA = L |
| V_{TERM} | | | | | |
| Voltage Range | -3 | | 8.0 | V | TERM MODE, $V_T = -3\text{ V}$ to $+8\text{ V}$, $V_L = 0\text{ V}$, $V_H = 3\text{ V}$ |
| V_{TERM} Offset | -50 | | +50 | mV | TERM MODE, $V_T = 0\text{ V}$, $V_L = 0\text{ V}$, $V_H = 3\text{ V}$ |
| V_{TERM} Gain + Linearity Error | -0.3 + 5 | | +0.3 + 5 | % of V_{SET} + mV | TERM MODE, $V_T = -3\text{ V}$ to $+8\text{ V}$, $V_L = 0\text{ V}$, $V_H = 3\text{ V}$ |
| Offset TC | | 0.5 | | mV/ $^\circ\text{C}$ | $V_T = 0\text{ V}$, $V_L = 0\text{ V}$, $V_H = 3\text{ V}$ |
| Output Resistance | 44 | 46 | 49 | Ω | $I_{\text{OUT}} = +30\text{ mA}, +1.0\text{ mA}, V_T = -3.0\text{ V}, V_H = 3\text{ V}, V_L = 0\text{ V}$ $I_{\text{OUT}} = -30\text{ mA}, -1.0\text{ mA}, V_T = +8.0\text{ V}, V_H = 3\text{ V}, V_L = 0\text{ V}$ $I_{\text{OUT}} = \pm 30\text{ mA}, \pm 1.0\text{ mA}, V_T = 0\text{ V}, V_H = 3\text{ V}, V_L = 0\text{ V}$ |
| DYNAMIC PERFORMANCE, (V_H AND V_L) | | | | | |
| Propagation Delay Time | 1.1 | 1.6 | 2.1 | ns | Measured at 50%, $V_H = +400\text{ mV}$, $V_L = -400\text{ mV}$ |
| Propagation Delay TC | | 2 | | ps/ $^\circ\text{C}$ | Measured at 50%, $V_H = +400\text{ mV}$, $V_L = -400\text{ mV}$ |
| Delay Matching, Edge to Edge | | <100 | | ps | Measured at 50%, $V_H = +400\text{ mV}$, $V_L = -400\text{ mV}$ |
| Rise and Fall Times | | | | | |
| 1 V Swing | | 0.6 | | ns | Measured 20%–80%, $V_L = 0\text{ V}$, $V_H = 1\text{ V}$ |
| 3 V Swing | | 1.0 | | ns | Measured 20%–80%, $V_L = 0\text{ V}$, $V_H = 3\text{ V}$ |
| 5 V Swing | | 1.7 | | ns | Measured 10%–90%, $V_L = 0\text{ V}$, $V_H = 5\text{ V}$ |
| 9 V Swing | | 3.0 | | ns | Measured 10%–90%, $V_L = -2\text{ V}$, $V_H = 7\text{ V}$ |
| Rise and Fall Time Temperature Coefficient | | | | | |
| 1 V Swing | | ± 1 | | ps/ $^\circ\text{C}$ | Measured 20%–80%, $V_L = 0\text{ V}$, $V_H = 1\text{ V}$ |
| 3 V Swing | | ± 2 | | ps/ $^\circ\text{C}$ | Measured 20%–80%, $V_L = 0\text{ V}$, $V_H = 3\text{ V}$ |
| 5 V Swing | | ± 4 | | ps/ $^\circ\text{C}$ | Measured 10%–90%, $V_L = 0\text{ V}$, $V_H = 5\text{ V}$ |
| Overshoot and Preshoot | -3.0 – 50 | | +3.0 + 50 | % of Step + mV | $V_L, V_H = -0.1\text{ V}, 0.1\text{ V}, V_L, V_H = 0.0\text{ V}, 1.0\text{ V}$ $V_L, V_H = 0.0\text{ V}, 3.0\text{ V}, V_L, V_H = 0.0\text{ V}, 5.0\text{ V}$ $V_L, V_H = -2.0\text{ V}, 7.0\text{ V}$ |
| Settling Time | | | | | |
| to 15 mV | | <50 | | ns | $V_L = 0\text{ V}$, $V_H = 0.5\text{ V}$ |
| to 4 mV | | <10 | | μs | $V_L = 0\text{ V}$, $V_H = 0.5\text{ V}$ |

| Parameter | Min | Typ | Max | Units | Test Conditions |
|---|-----------|------|-----------|----------------|---|
| Delay Change vs. Pulsewidth | | <50 | | ps | $V_L = 0\text{ V}$, $V_H = 2\text{ V}$ |
| Minimum Pulsewidth | | | | | |
| 3 V Swing | | 2 | | ns | $V_L = 0\text{ V}$, $V_H = 3\text{ V}$, 90% Reached, Measure @ 50% |
| 5 V Swing | | 3 | | ns | $V_L = 0\text{ V}$, $V_H = 5\text{ V}$, 90% Reached, Measure @ 50% |
| Toggle Rate | | 250 | | MHz | $V_L = 0\text{ V}$, $V_H = 5\text{ V}$, $VDUT > 3.0\text{ V p-p}$ |
| DYNAMIC PERFORMANCE, INHIBIT | | | | | |
| Delay Time, Active to Inhibit | 1.5 | | 4.0 | ns | Measured at 50%, $V_H = +2\text{ V}$, $V_L = -2\text{ V}$ |
| Delay Time, Inhibit to Active | 1.5 | | 3.5 | ns | Measured at 50%, $V_H = +2\text{ V}$, $V_L = -2\text{ V}$ |
| Delay Time Matching (Z) | | | ± 2.2 | ns | Z = Delay Time Active to Inhibit Test (Above)— Delay Time Inhibit to Active Test (Above) (Of Worst Two Edges) |
| I/O Spike | | <200 | | mV, p-p | $V_H = 0\text{ V}$, $V_L = 0\text{ V}$ |
| Rise, Fall Time, Active to Inhibit | | | 3.5 | ns | $V_H = +2\text{ V}$, $V_L = -2\text{ V}$ (Measured 20%/80% of 1 V Output) |
| Rise, Fall Time, Inhibit to Active | | | 2.2 | ns | $V_H = +2\text{ V}$, $V_L = -2\text{ V}$ (Measured 20%/80% of 1 V Output) |
| DYNAMIC PERFORMANCE, V_{TERM} | | | | | |
| Delay Time, V_H to V_{TERM} | | | 3.0 | ns | Measured at 50%, $V_L = V_H = +0.4\text{ V}$, $V_{TERM} = -0.4\text{ V}$ |
| Delay Time, V_L to V_{TERM} | | | 5.0 | ns | Measured at 50%, $V_L = V_H = +0.4\text{ V}$, $V_{TERM} = -0.4\text{ V}$ |
| Delay Time, V_{TERM} to V_H and V_{TERM} to V_L | | | 4.0 | ns | Measured at 50%, $V_L = V_H = +0.4\text{ V}$, $V_{TERM} = -0.4\text{ V}$ |
| Overshoot and Preshoot | -3.0 + 75 | | +3.0 + 75 | % of Step + mV | V_H/V_L , $V_{TERM} = (+0.4\text{ V}, -0.4\text{ V})$, (0.0 V, -2.0 V), (0.0 V, +7.0 V) |
| V_{TERM} Mode Rise Time | | | 4.0 | ns | V_L , $V_H = 0\text{ V}$, $V_{TERM} = -2\text{ V}$, 20%–80% |
| V_{TERM} Mode Fall Time | | | 5.5 | ns | V_L , $V_H = 0\text{ V}$, $V_{TERM} = -2\text{ V}$, 20%–80% |
| PSRR, DRIVE or TERM Mode | | 35 | | dB | $V_S = V_S \pm 3\%$ |

Specifications subject to change without notice.

COMPARATOR SPECIFICATIONS

(All specifications are at $T_j = +85^\circ\text{C} \pm 5^\circ\text{C}$, $+V_S = +12\text{ V} \pm 3\%$, $-V_S = -7\text{ V} \pm 3\%$ unless otherwise noted. All temperature coefficients are measured at $T_j = +75^\circ\text{C}$ to $+95^\circ\text{C}$).

| Parameter | Min | Typ | Max | Units | Test Conditions |
|---|-------|-------------|------|------------------------------|---|
| DC INPUT CHARACTERISTICS | | | | | |
| Offset Voltage (V_{OS}) | -25 | | 25 | mV | $CMV = 0\text{ V}$ |
| Offset Voltage (Drift) | | 50 | | $\mu\text{V}/^\circ\text{C}$ | $CMV = 0\text{ V}$ |
| HCOMP, LCOMP Bias Current | -50 | | 50 | μA | $V_{IN} = 0\text{ V}$ |
| Voltage Range (V_{CM}) | -3 | | 8.0 | V | |
| Differential Voltage (V_{DIFF}) | | | 9.0 | V | |
| Gain and Linearity | -0.05 | | 0.05 | % FSR | $V_{IN} = -3\text{ V}$ to $+8\text{ V}$ |
| LATCH ENABLE INPUTS | | | | | |
| Logic "1" Current (I_{IH}) | | | 250 | μA | $LE, \overline{LE} = -0.8\text{ V}$ |
| Logic "0" Current (I_{IL}) | -250 | | | μA | $LE, \overline{LE} = -1.8\text{ V}$ |
| DIGITAL OUTPUTS | | | | | |
| Logic "1" Voltage (V_{OH}) | -0.98 | | | V | Q or \overline{Q} , 50 Ω to -2 V |
| Logic "0" Voltage (V_{OL}) | | | -1.5 | V | Q or \overline{Q} , 50 Ω to -2 V |
| Slew Rate | | 1 | | V/ns | |
| SWITCHING PERFORMANCE | | | | | |
| Propagation Delay | | | | | |
| Input to Output | 0.9 | | 2.5 | ns | $V_{IN} = 2\text{ V p-p}$, |
| Latch Enable to Output | | 2 | | ns | HCOMP = +1 V, LCOMP = +1 V |
| Propagation Delay Temperature Coefficient | | 2 | | ps/ $^\circ\text{C}$ | |
| Propagation Delay Change with Respect to | | | | | |
| Slew Rate: 0.5 V, 1.0 V, 3.0 V/ns | | < ± 100 | | ps | $V_{IN} = 0\text{ V}$ to 5 V |
| Slew Rate: 5.0 V/ns | | < ± 350 | | ps | $V_{IN} = 0\text{ V}$ to 5 V |
| Amplitude: 1.0 V, 3.0 V, 5.0 V | | < ± 200 | | ps | $V_{IN} = 1.0\text{ V/ns}$ |
| Equivalent Input Rise Time | | 450 | | ps | $V_{IN} = 0\text{ V}$ to 3 V , 3 V/ns |
| Pulsewidth Linearity | | < ± 200 | | ps | $V_{IN} = 0\text{ V}$ to 3 V , 3 V/ns, PW = 3 ns–8 ns |
| Settling Time | | <25 | | ns | Settling to $\pm 8\text{ mV}$, $V_{IN} = 1\text{ V}$ to 0 V |
| Latch Timing | | | | | |
| Input Pulsewidth | | <1.5 | | ns | |
| Setup Time | | <1.0 | | ns | |
| Hold Time | | <1.0 | | ns | |

Specifications subject to change without notice.

AD53033—SPECIFICATIONS

TOTAL FUNCTION SPECIFICATIONS

(All specifications are at $T_j = +85^{\circ}\text{C} \pm 5^{\circ}\text{C}$, $+V_S = +12\text{ V} \pm 3\%$, $-V_S = -7\text{ V} = \pm 3\%$ unless otherwise noted. All temperature coefficients are measured at $T_j = +75^{\circ}\text{C}$ to $+95^{\circ}\text{C}$).

| Parameter | Min | Typ | Max | Units | Test Conditions |
|---|------|-----|------|-------|---|
| OUTPUT CHARACTERISTICS | | | | | |
| Output Leakage Current, V _{OUT} = −2 V to +7 V | −500 | | +500 | nA | Driver INHIBITED |
| Output Leakage Current, V _{OUT} = −3 V to +8 V | −2 | | +2 | μA | |
| Output Capacitance | | 6 | | pF | |
| POWER SUPPLIES | | | | | |
| Total Supply Range | | 19 | | V | Driver = Active Driver = Active Driver = Active R _{LOAD} = 10 kΩ, V _{SOURCE} = +10 V |
| Positive Supply | | 12 | | V | |
| Negative Supply | | −7 | | V | |
| Positive Supply Current | | | 178 | mA | |
| Negative Supply Current | | | 195 | mA | |
| Total Power Dissipation | | | 3.5 | W | |
| Temperature Sensor Gain Factor | 0.7 | 1 | 1.4 | μA/K | |

NOTES

Connecting or shorting the decoupling pins to ground will result in the destruction of the device.

Specifications subject to change without notice.

Table I. Driver Truth Table

| DATA | $\overline{\text{DATA}}$ | IOD | $\overline{\text{IOD}}$ | RLD | $\overline{\text{RLD}}$ | OUTPUT STATE |
|------|--------------------------|-----|-------------------------|-----|-------------------------|--------------|
| 0 | 1 | 1 | 0 | X | X | VL |
| 1 | 0 | 1 | 0 | X | X | VH |
| X | X | 0 | 1 | 0 | 1 | INH |
| X | X | 0 | 1 | 1 | 0 | VTERM |

Table II. Comparator Truth Table

| V_{OUT} | | LEH | $\overline{\text{LEH}}$ | LEL | $\overline{\text{LEL}}$ | OUTPUT STATES | | | |
|------------------|--------|-----|-------------------------|-----|-------------------------|---------------|------------------------------|----------|------------------------------|
| | | | | | | QH | $\overline{\text{QH}}$ | QL | $\overline{\text{QL}}$ |
| >HCOMP | >LCOMP | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| >HCOMP | <LCOMP | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| <HCOMP | >LCOMP | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| <HCOMP | <LCOMP | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| X | X | 0 | 1 | 0 | 1 | QH (t-1) | $\overline{\text{QH}}$ (t-1) | QL (t-1) | $\overline{\text{QL}}$ (t-1) |

ABSOLUTE MAXIMUM RATINGS¹**Power Supply Voltage**

| | |
|------------------------------------|--------|
| +V _S to GND | +13 V |
| –V _S to GND | –8 V |
| +V _S to –V _S | +20 V |
| PWR GND to ECL GND or HQ GND | ±0.4 V |

Inputs

| | |
|--|------------|
| DATA, $\overline{\text{DATA}}$, IOD, $\overline{\text{IOD}}$, RLD, $\overline{\text{RLD}}$ | +5 V, –3 V |
| DATA to $\overline{\text{DATA}}$, IOD to $\overline{\text{IOD}}$, RLD to $\overline{\text{RLD}}$ | ±3 V |
| LEL, $\overline{\text{LEL}}$, LEH, $\overline{\text{LEH}}$ | +5 V, –3 V |
| LEL to $\overline{\text{LEL}}$, LEH to $\overline{\text{LEH}}$ | ±3 V |
| VH, VL, VTERM to GND | +9 V, –4 V |
| VH to VL | ±11 V |
| (VH – VTERM) and (VTERM – VL) | ±11 V |
| HCOMP | +9 V, –4 V |
| LCOMP | +9 V, –4 V |
| HCOMP, LCOMP to V _{OUT} | ±11 V |

Outputs

| | |
|--|--|
| V _{OUT} Short Circuit Duration | Indefinite ² |
| V _{OUT} Inhibit Mode | +9 V, –4 V |
| VHDCPL | Do Not Connect Except for Cap to V _{CC} |
| VLDCPL | Do Not Connect Except for Cap to V _{EE} |
| QH, $\overline{\text{QH}}$, QL, $\overline{\text{QL}}$ Maximum I _{OUT} | |
| Continuous | 50 mA |
| Surge | 100 mA |
| THERM | +13 V, 0 V |

Environmental

| | |
|---|-----------------|
| Operating Temperature (Junction) | +175°C |
| Storage Temperature | –65°C to +150°C |
| Lead Temperature (Soldering, 10 sec) ³ | +260°C |

NOTES

¹Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Absolute maximum limits apply individually, not in combination. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

²Output short circuit protection to ground is guaranteed as long as proper heat sinking is employed to ensure compliance with the operating temperature limits.

³To ensure lead coplanarity (±0.002 inches) and solderability, handling with bare hands should be avoided and the device should be stored in environments at 24°C ±5°C (75°F ± 10°F) with relative humidity not to exceed 65%.

Table III. Package Thermal Characteristics

| Air Flow, FM | θ _{JA} , °C/W |
|--------------|------------------------|
| 0 | 33 |
| 200 | 25 |
| 400 | 22 |

ORDERING GUIDE

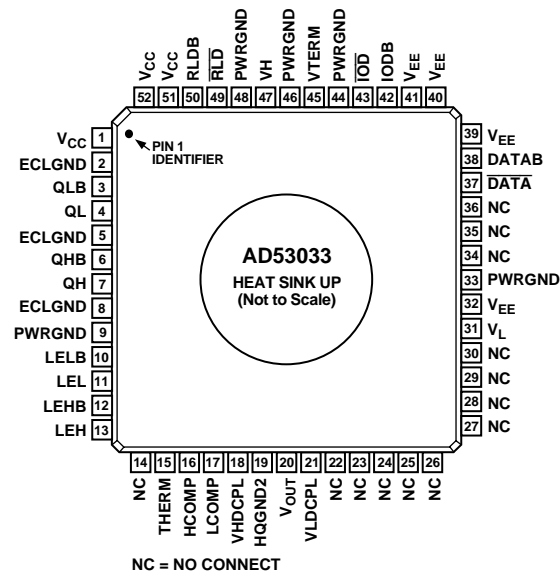
| Model | Package Description | Shipment Method Quantity per Shipping Container | Package Option |
|-------------|---------------------|---|----------------|
| AD53033JSTP | 52-Lead LQFP-EDQUAD | 90 | SQ-52 |

CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD53033 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



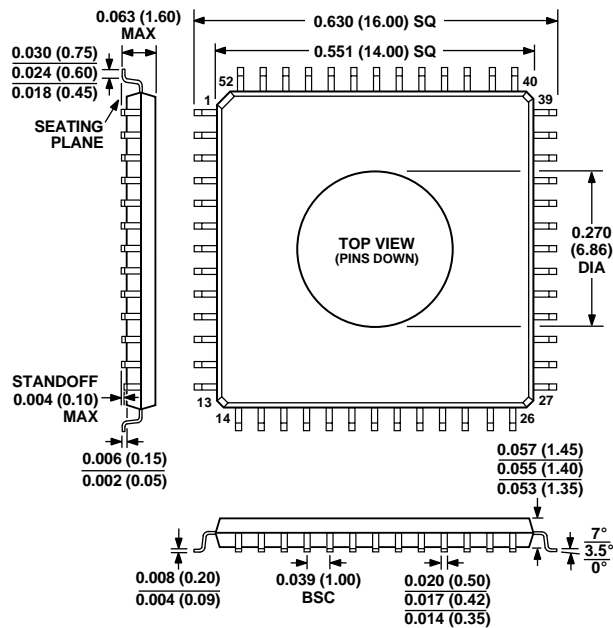
PIN CONFIGURATION



OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

52-Lead LQFP-EDQUAD with Integral Heat Slug
(SQ-52)



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