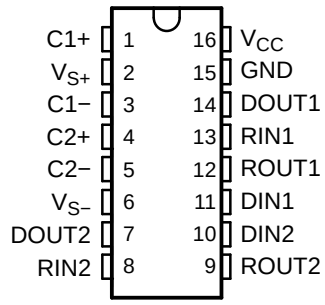
# MAX232E
# DUAL RS-232 DRIVER/RECEIVER WITH IEC61000-4-2 PROTECTION

SLLS723 – APRIL 2006

## FEATURES

- **Meets or Exceeds TIA/RS-232-F and ITU Recommendation V.28**
- **Operates From a Single 5-V Power Supply With 1.0-μF Charge-Pump Capacitors**
- **Operates up to 120 kbit/s**
- **Two Drivers and Two Receivers**
- **±30-V Input Levels**
- **Low Supply Current . . . 8 mA Typical**
- **ESD Protection for RS-232 Bus Pins**
  - **– ±15-kV Human-Body Model (HBM)**
  - **– ±8-kV IEC61000-4-2, Contact Discharge**
  - **– ±15-kV IEC61000-4-2, Air-Gap Discharge**

**D, DW, N, NS, OR PW PACKAGE**
**(TOP VIEW)**




## APPLICATIONS

- **TIA/RS-232-F**
- **Battery-Powered Systems**
- **Terminals**
- **Modems**
- **Computers**

## DESCRIPTION/ORDERING INFORMATION

The MAX232E is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/RS-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/RS-232-F inputs to 5-V TTL/CMOS levels. This receiver has a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/RS-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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## ORDERING INFORMATION

| $T_A$ | PACKAGE(1) | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| 0°C to 70°C | PDIP – N | Tube of 25 | MAX232ECN | MAX232ECN |
| | SOIC – D | Tube of 40 | MAX232ECD | MAX232EC |
| | | Reel of 2500 | MAX232ECDR | |
| | SOIC – DW | Tube of 40 | MAX232ECDW | MAX232EC |
| | | Reel of 2000 | MAX232ECDWR | |
| | SOP – NS | Reel of 2000 | MAX232ECNSR | Preview |
| | TSSOP – PW | Tube of 25 | MAX232ECPW | MAX232EC |
| | | Reel of 2000 | MAX232ECPWR | |
| –40°C to 85°C | PDIP – N | Tube of 25 | MAX232EIN | MAX232EIN |
| | SOIC – D | Tube of 40 | MAX232EID | MAX232EI |
| | | Reel of 2500 | MAX232EIDR | |
| | SOIC – DW | Tube of 40 | MAX232EIDW | MAX232EI |
| | | Reel of 2000 | MAX232EIDWR | |
| | SOP – NS | Reel of 2000 | MAX232EINSR | Preview |
| | TSSOP – PW | Tube of 25 | MAX232EIPW | MB232EI |
| | | Reel of 2000 | MAX232EIPWR | |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

## FUNCTION TABLES

### Each Driver(1)

| INPUT DIN | OUTPUT DOUT |
|---|---|
| L | H |
| H | L |

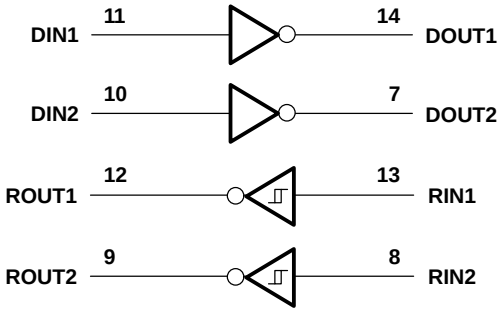
(1) H = high level, L = low level

### Each Receiver(1)

| INPUT RIN | OUTPUT ROUT |
|---|---|
| L | H |
| H | L |

(1) H = high level, L = low level

## LOGIC DIAGRAM (POSITIVE LOGIC)



## Absolute Maximum Ratings(1)

over operating free-air temperature range (unless otherwise noted)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Input supply voltage range(2) | | –0.3 | 6 | V |
| $V_{S+}$ | Positive output supply voltage range | | $V_{CC}$ – 0.3 | 15 | V |
| $V_{S–}$ | Negative output supply voltage range | | –0.3 | –15 | V |
| $V_I$ | Input voltage range | Driver | –0.3 | $V_{CC}$ + 0.3 | V |
| | | Receiver | | ±30 | |
| $V_O$ | Output voltage range | DOUT | $V_{S–}$ – 0.3 | $V_{S+}$ + 0.3 | V |
| | | ROUT | –0.3 | $V_{CC}$ + 0.3 | |
| DOUT | Short-circuit duration | | | Unlimited | |
| $\theta_{JA}$ | Package thermal impedance(3)(4) | D package | | 73 | °C/W |
| | | DW package | | 57 | |
| | | N package | | 67 | |
| | | NS package | | 64 | |
| | | PW package | | 108 | |
| $T_J$ | Operating virtual junction temperature | | | 150 | °C |
| $T_{stg}$ | Storage temperature range | | –65 | 150 | °C |

(1) Stresses beyond 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 beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to network GND.
(3) Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

## Recommended Operating Conditions

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 4.5 | 5 | 5.5 | V |
| $V_{IH}$ | High-level input voltage (DIN1, DIN2) | | 2 | | | V |
| $V_{IL}$ | Low-level input voltage (DIN1, DIN2) | | | | 0.8 | V |
| RIN1, RIN2 | Receiver input voltage | | | | ±30 | V |
| $T_A$ | Operating free-air temperature | MAX232EC | 0 | | 70 | °C |
| | | MAX232EI | –40 | | 85 | |

## Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 4)

| PARAMETER | | TEST CONDITIONS | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{CC}$ | Supply current | $V_{CC}$ = 5.5 V, | All outputs open, $T_A$ = 25°C | | 8 | 10 | mA |

(1) Test conditions are C1–C4 = 1 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 5 V and $T_A$ = 25°C.

## DRIVER SECTION

### Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature range

| PARAMETER | | | TEST CONDITIONS | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | DOUT | $R_L$ = 3 kΩ to GND | | 5 | 7 | | V |
| $V_{OL}$ | Low-level output voltage(3) | DOUT | $R_L$ = 3 kΩ to GND | | | –7 | –5 | V |
| $r_o$ | Output resistance | DOUT | $V_{S+}$ = $V_{S-}$ = 0, | $V_O$ = ±2 V | 300 | | | Ω |
| $I_{OS}$(4) | Short-circuit output current | DOUT | $V_{CC}$ = 5.5 V, | $V_O$ = 0 | | ±10 | | mA |
| $I_{IS}$ | Short-circuit input current | DIN | $V_I$ = 0 | | | | 200 | µA |

(1) Test conditions are C1–C4 = 1 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 5 V and $T_A$ = 25°C.
(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
(4) Not more than one output should be shorted at a time.

### Switching Characteristics(1)

$V_{CC}$ = 5 V, $T_A$ = 25°C (see Note 4)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| SR | Driver slew rate | $R_L$ = 3 kΩ to 7 kΩ, See Figure 2 | | | 30 | V/µs |
| SR(t) | Driver transition region slew rate | See Figure 3 | | 3 | | V/µs |
| | Data rate | One DOUT switching | | 120 | | kbit/s |

(1) Test conditions are C1–C4 = 1 µF at $V_{CC}$ = 5 V ± 0.5 V.

### ESD protection

| PARAMETER | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|
| DOUT, RIN | HBM | ±15 | kV |
| | IEC61000-4-2, Air-Gap Discharge | ±15 | kV |
| | IEC61000-4-2, Contact Discharge | ±8 | kV |

## RECEIVER SECTION

### Electrical Characteristics(1)

over recommended ranges of supply voltage and operating free-air temperature range

| PARAMETER | | | TEST CONDITIONS | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | ROUT | $I_{OH}$ = –1 mA | | 3.5 | | | V |
| $V_{OL}$ | Low-level output voltage(3) | ROUT | $I_{OL}$ = 3.2 mA | | | | 0.4 | V |
| $V_{IT+}$ | Receiver positive-going input threshold voltage | RIN | $V_{CC}$ = 5 V, | $T_A$ = 25°C | | 1.7 | 2.4 | V |
| $VI_{T-}$ | Receiver negative-going input threshold voltage | RIN | $V_{CC}$ = 5 V, | $T_A$ = 25°C | 0.8 | 1.2 | | V |
| $V_{hys}$ | Input hysteresis voltage | RIN | $V_{CC}$ = 5 V | | 0.2 | 0.5 | 1 | V |
| $r_i$ | Receiver input resistance | RIN | $V_{CC}$ = 5 V, | $T_A$ = 25°C | 3 | 5 | 7 | kΩ |

(1) Test conditions are C1–C4 = 1 µF at $V_{CC}$ = 5 V ± 0.5 V.
(2) All typical values are at $V_{CC}$ = 5 V and $T_A$ = 25°C.
(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.

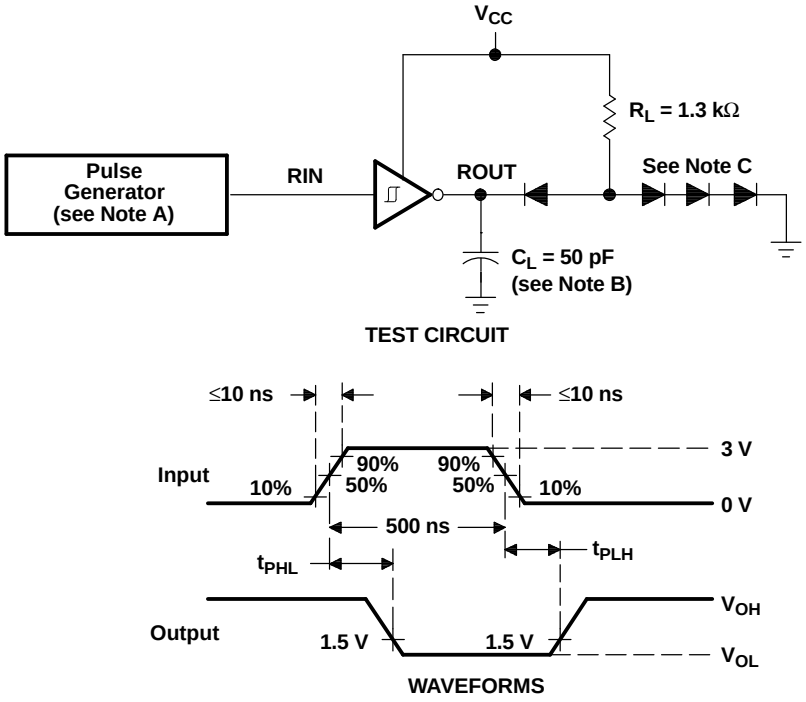
### Switching Characteristics(1)

$V_{CC}$ = 5 V, $T_A$ = 25°C (see Figure 1)

| PARAMETER | | TYP | UNIT |
|---|---|---|---|
| $t_{PLH(R)}$ | Receiver propagation delay time, low- to high-level output | 500 | ns |
| $t_{PHL(R)}$ | Receiver propagation delay time, high- to low-level output | 500 | ns |

(1) Test conditions are C1–C4 = 1 µF at $V_{CC}$ = 5 V ± 0.5 V.

## PARAMETER MEASUREMENT INFORMATION



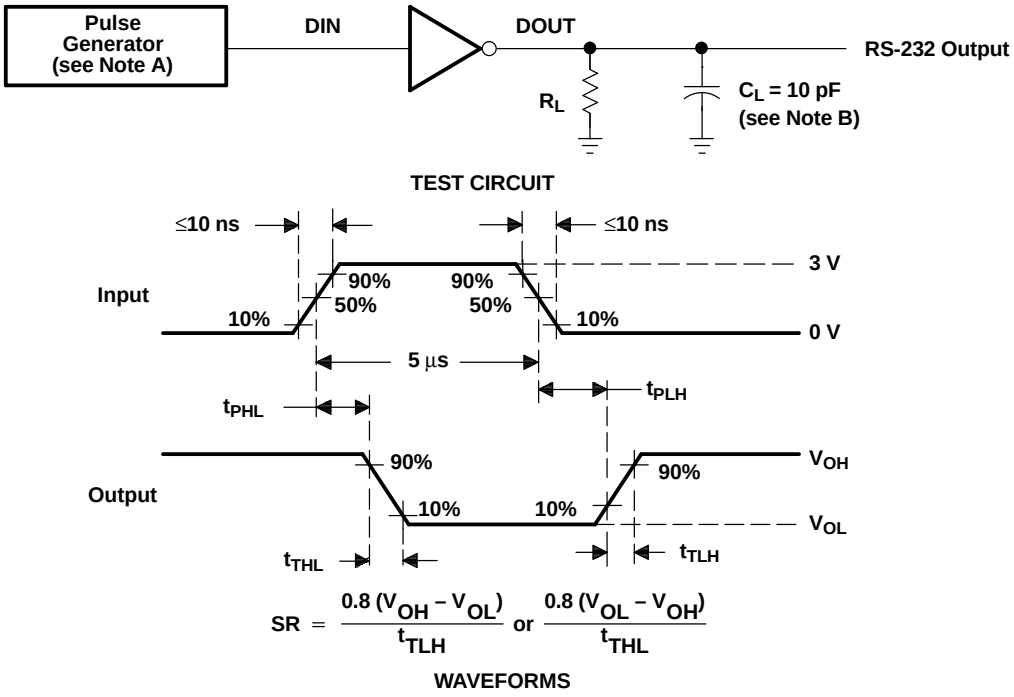

A. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, duty cycle ≤ 50%.

B. $C_L$ includes probe and jig capacitance.

C. All diodes are 1N3064 or equivalent.

**Figure 1. Receiver Test Circuit and Waveforms for $t_{PHL}$ and $t_{PLH}$ Measurements**

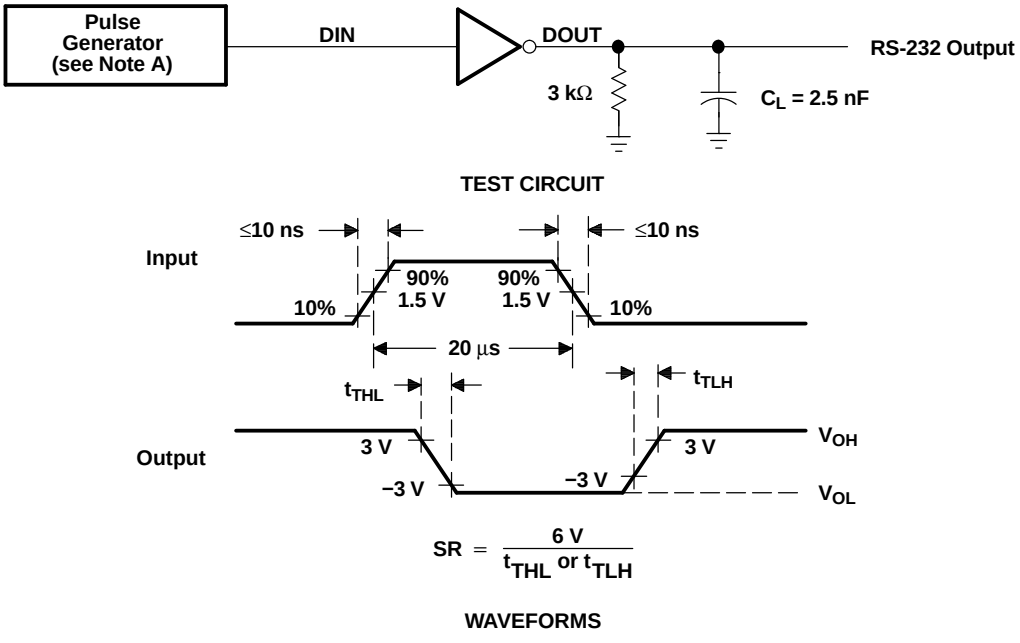
## PARAMETER MEASUREMENT INFORMATION (continued)




A. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, duty cycle ≤ 50%.

B. $C_L$ includes probe and jig capacitance.

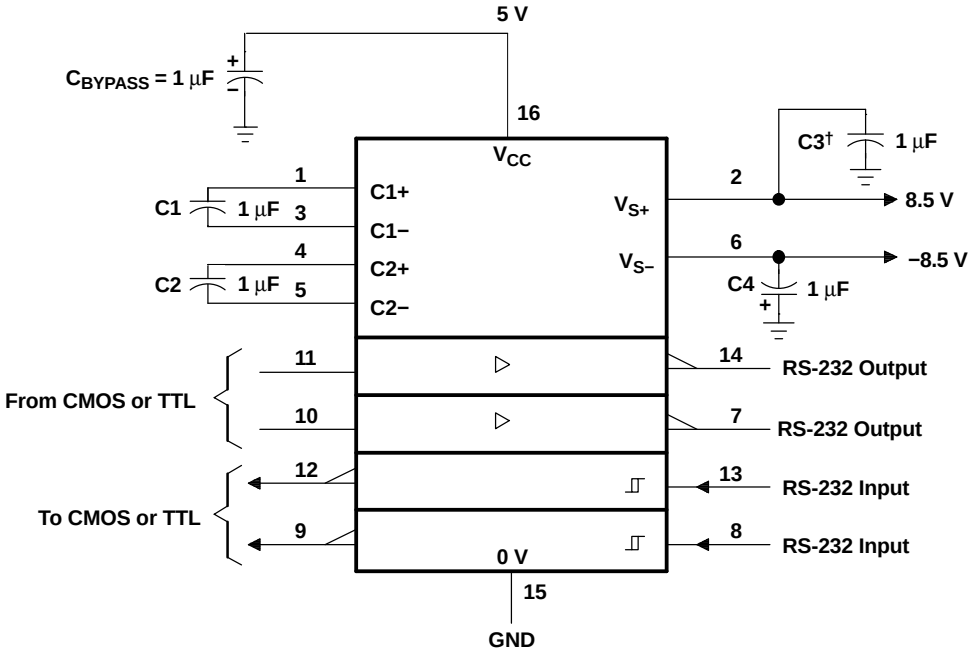
**Figure 2. Driver Test Circuit and Waveforms for $t_{PHL}$ and $t_{PLH}$ Measurements (5-μs Input)**




A. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, duty cycle ≤ 50%.

**Figure 3. Test Circuit and Waveforms for $t_{THL}$ and $t_{TLH}$ Measurements (20-μs Input)**

## APPLICATION INFORMATION




† C3 can be connected to $V_{CC}$ or GND.

A. Resistor values shown are nominal.

B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown. In addition to the 1-µF capacitors shown, the MAX232E can operate with 0.1-µF capacitors.

**Figure 4. Typical Operating Circuit**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| MAX232ECD | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDG4 | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDR | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDRG4 | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDW | ACTIVE | SOIC | DW | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDWG4 | ACTIVE | SOIC | DW | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDWR | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECDWRG4 | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECN | ACTIVE | PDIP | N | 16 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MAX232ECNE4 | ACTIVE | PDIP | N | 16 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MAX232ECPW | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECPWG4 | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECPWR | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232ECPWRG4 | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EID | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDG4 | ACTIVE | SOIC | D | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDR | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDRG4 | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDW | ACTIVE | SOIC | DW | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDWG4 | ACTIVE | SOIC | DW | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDWR | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIDWRG4 | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIN | ACTIVE | PDIP | N | 16 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MAX232EINE4 | ACTIVE | PDIP | N | 16 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MAX232EIPW | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| MAX232EIPWG4 | ACTIVE | TSSOP | PW | 16 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIPWR | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MAX232EIPWRG4 | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

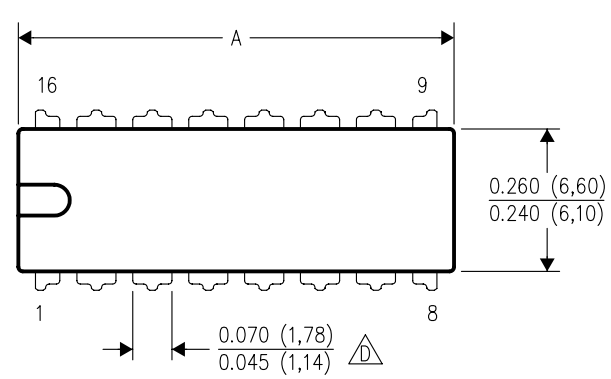
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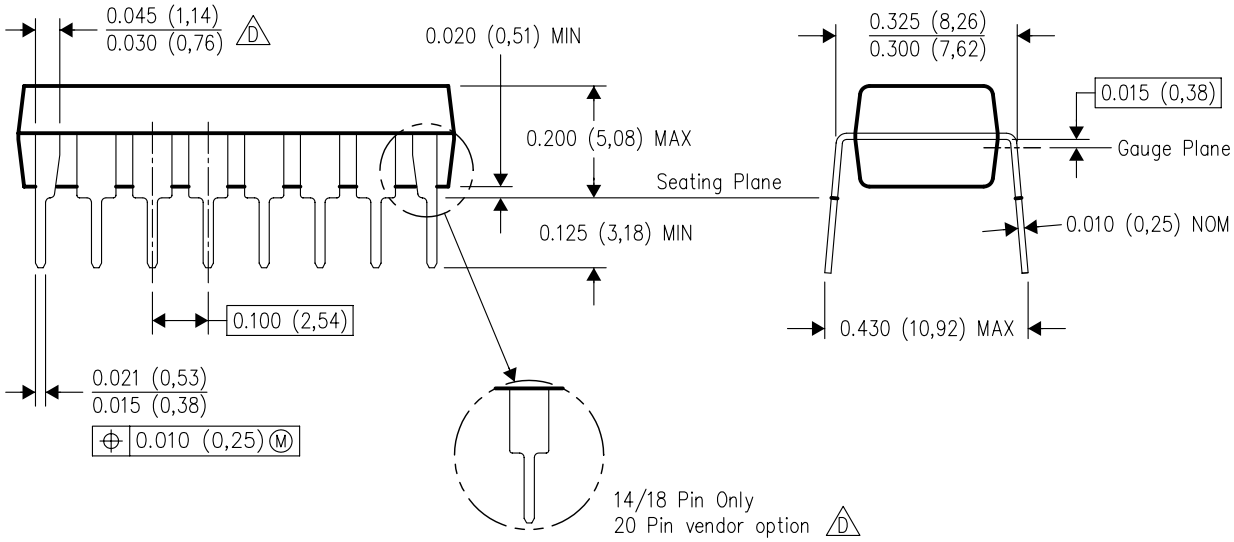
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



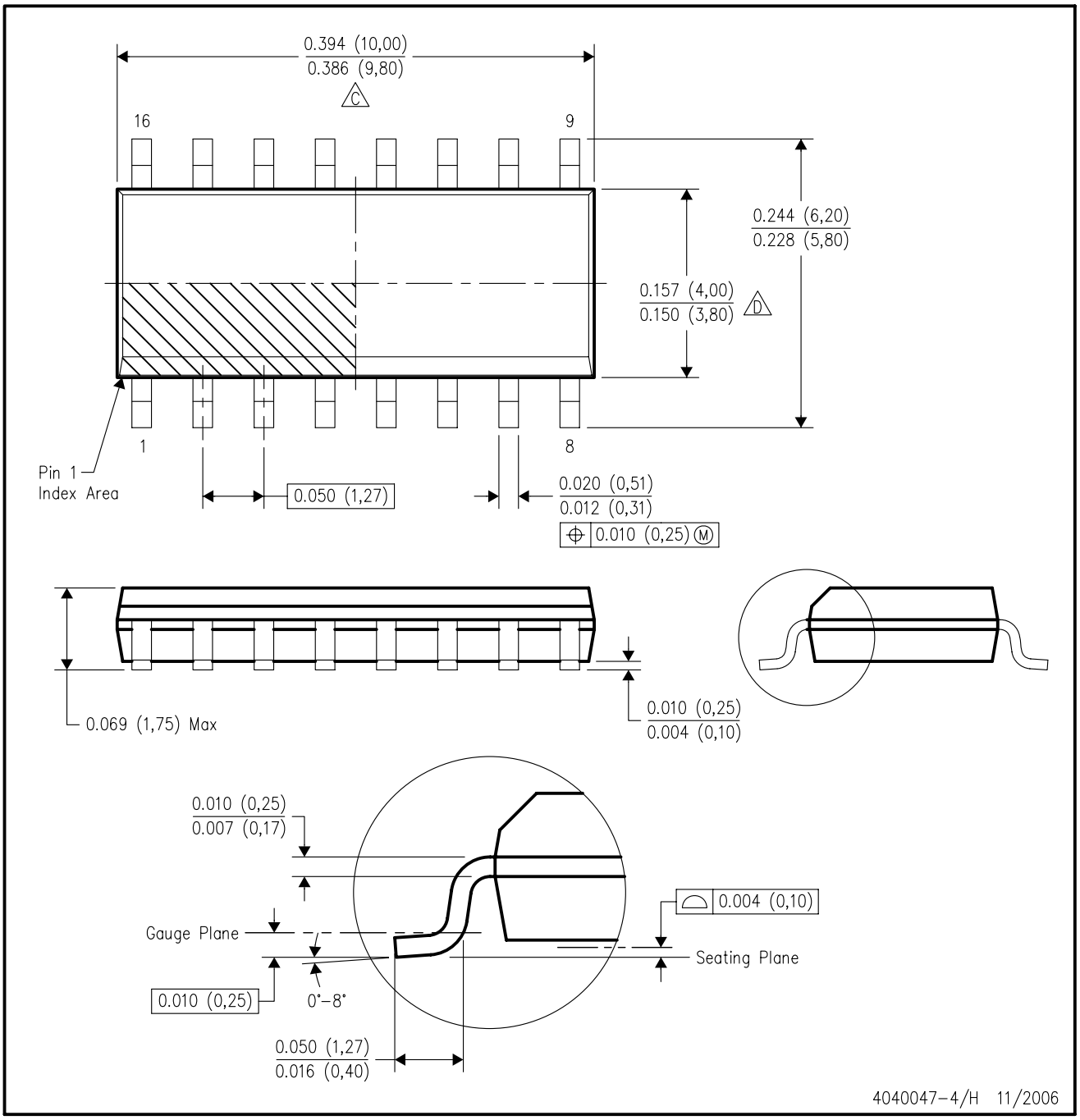

| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| MS–001 VARIATION (C) | AA | BB | AC | AD |




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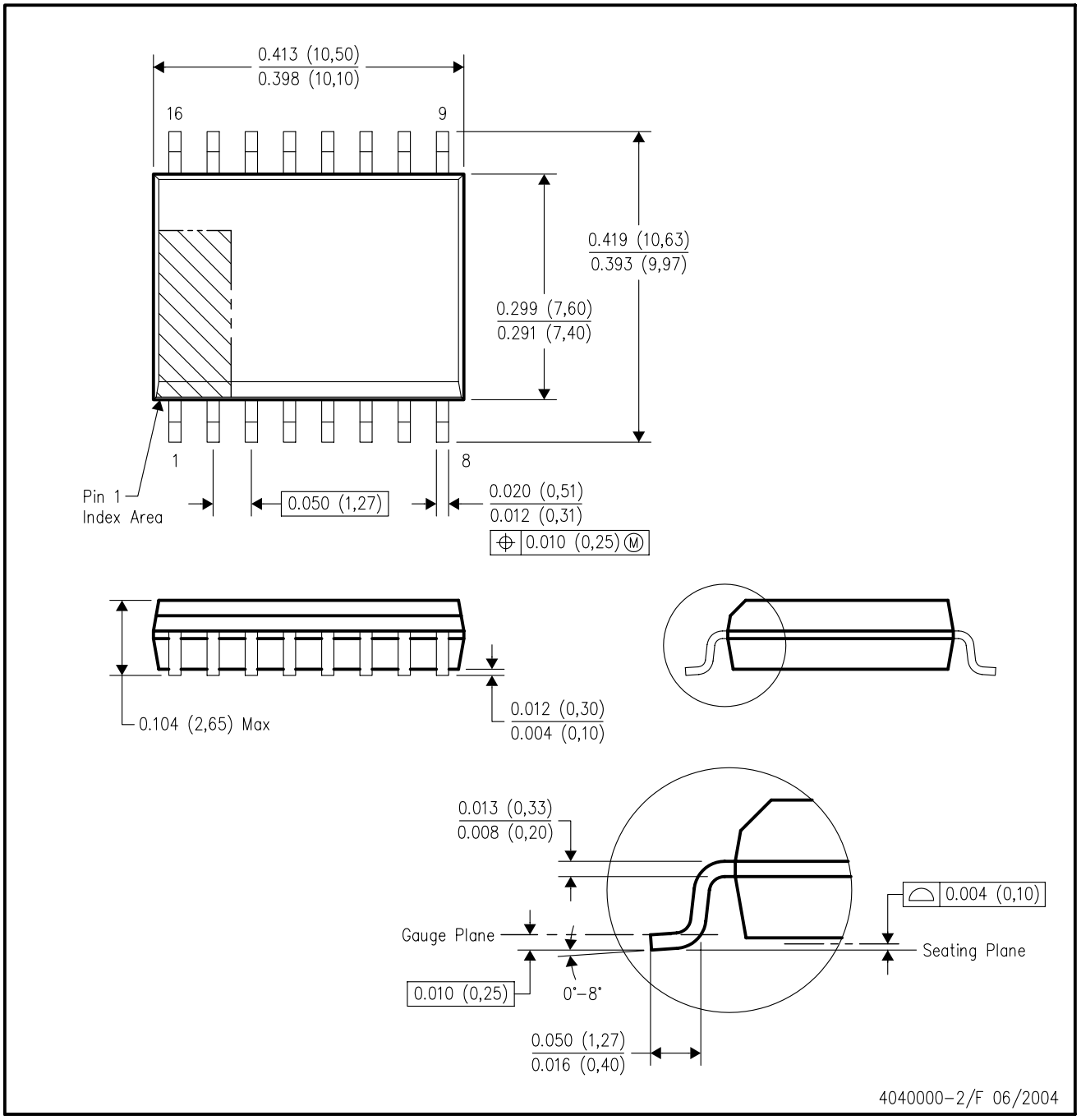
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

## D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE




NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
E. Reference JEDEC MS–012 variation AC.

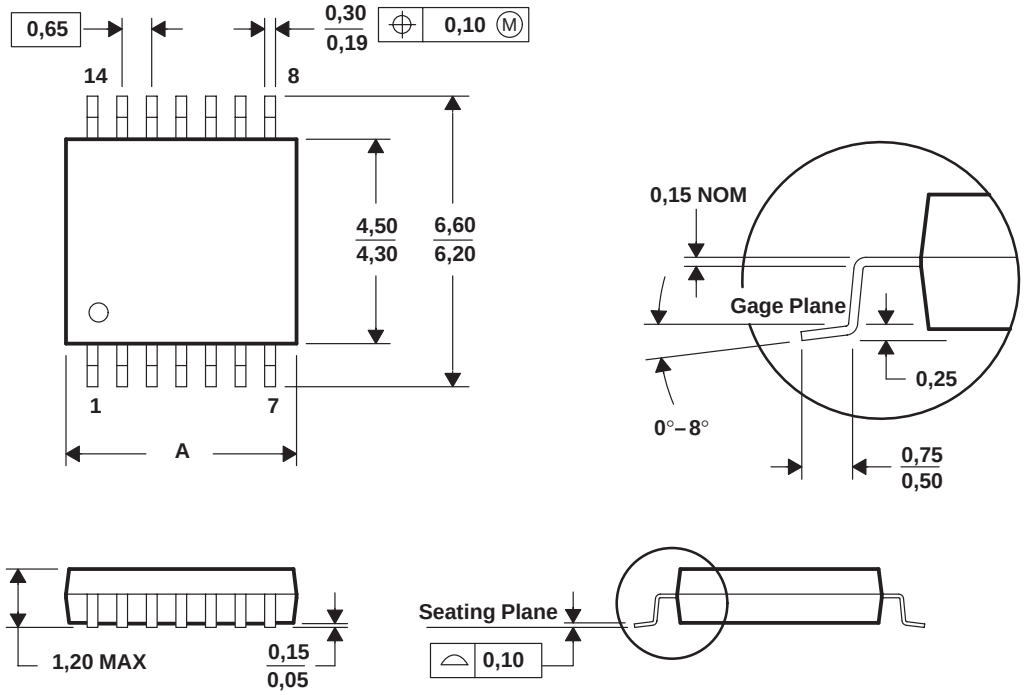
## DW (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE




NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–013 variation AA.

**PW (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14 PINS SHOWN**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**4040064/F 01/97**

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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