

DS34C87T CMOS Quad TRI-STATE Differential Line Driver

Check for Samples: [DS34C87T](#)

FEATURES

- **TTL Input Compatible**
- **Typical Propagation Delays: 6 ns**
- **Typical Output Skew: 0.5 ns**
- **Outputs Won't Load Line When $V_{CC} = 0V$**
- **Meets the Requirements of EIA Standard RS-422**
- **Operation from Single 5V Supply**
- **TRI-STATE Outputs for Connection to System Buses**
- **Low Quiescent Current**
- **Available in Surface Mount**

DESCRIPTION

The DS34C87T is a quad differential line driver designed for digital data transmission over balanced lines. The DS34C87T meets all the requirements of EIA standard RS-422 while retaining the low power characteristics of CMOS. This enables the construction of serial and terminal interfaces while maintaining minimal power consumption.

The DS34C87T accepts TTL or CMOS input levels and translates these to RS-422 output levels. This part uses special output circuitry that enables the individual drivers to power down without loading down the bus. This device has separate enable circuitry for each pair of the four drivers. The DS34C87T is pin compatible to the DS3487T.

All inputs are protected against damage due to electrostatic discharge by diodes to V_{CC} and ground.

Connection and Logic Diagrams

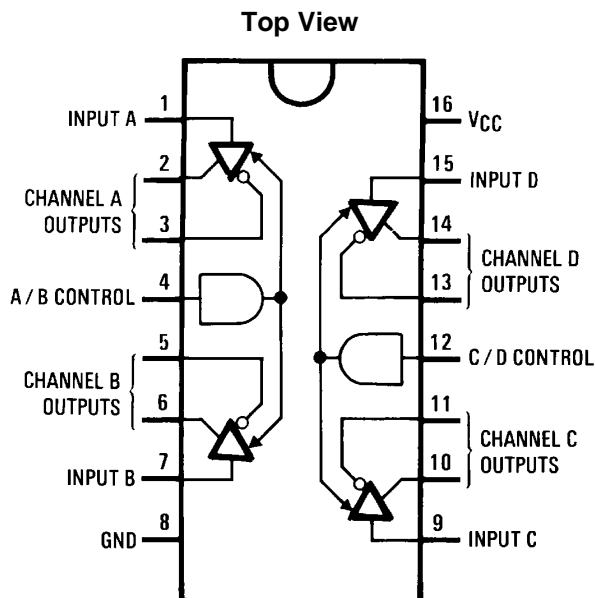

See [PIN DESCRIPTIONS](#) for details.

Figure 1. PDIP Package
See Package Numbers D0016A or NFG0016E

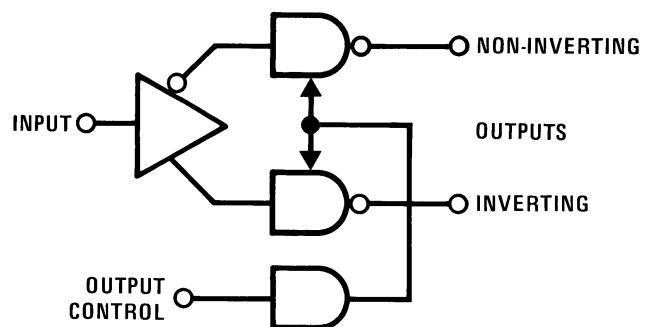


Figure 2. Logic Diagram



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Truth Table⁽¹⁾

| Input | Control | Non-Inverting | Inverting |
|-------|---------|---------------|-----------|
| | Input | Output | Output |
| H | H | H | L |
| L | H | L | H |
| X | L | Z | Z |

- (1) L = Low logic state
H = High logic state
X = Irrelevant
Z = TRI-STATE (high performance)



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾

| | |
|--|-------------------------|
| Supply Voltage (V_{CC}) | -0.5 to 7.0V |
| DC Voltage (V_{IN}) | -1.5 to $V_{CC} + 1.5V$ |
| DC Output Voltage (V_{OUT}) | -0.5 to 7V |
| Clamp Diode Current (I_{IK} , I_{OK}) | ± 20 mA |
| DC Output Current, per pin (I_{OUT}) | ± 150 mA |
| DC V_{CC} or GND Current (I_{CC}) | ± 150 mA |
| Storage Temperature Range (T_{STG}) | -65°C to +150°C |
| Maximum Power Dissipation (P_D) @ 25°C ⁽⁵⁾ | |
| PDIP Package | 1736 mW |
| SOIC Package | 1226 mW |
| Lead Temperature (T_L) | |
| (Soldering 4 sec) | 260°C |
| This device does not meet 2000V ESD rating.⁽⁶⁾ | |

- (1) Unless otherwise specified, all voltages are referenced to ground. All currents into device pins are positive; all currents out of device pins are negative.
- (2) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be specified. They are not meant to imply that the device should be operated at these limits. The table of "Electrical Characteristics" provide conditions for actual device operation.
- (3) ESD Rating: HBM (1.5 k Ω , 100 pF) Inputs $\geq 1500V$ Outputs $\geq 1000V$ EIAJ (0 Ω , 200 pF) All Pins $\geq 350V$
- (4) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (5) Ratings apply to ambient temperature at 25°C. Above this temperature derate NFG0016E Package 13.89 mW/°C, and D0016A Package 9.80 mW/°C.
- (6) ESD Rating: HBM (1.5 k Ω , 100 pF) Inputs $\geq 1500V$ Outputs $\geq 1000V$ EIAJ (0 Ω , 200 pF) All Pins $\geq 350V$

Operating Conditions

| | Min | Max | Units |
|---|------|----------|-------|
| Supply Voltage (V_{CC}) | 4.50 | 5.50 | V |
| DC Input or Output Voltage (V_{IN} , V_{OUT}) | 0 | V_{CC} | V |
| Operating Temperature Range (T_A) DS34C87T | -40 | +85 | °C |
| Input Rise or Fall Times (t_r , t_f) | | 500 | ns |

DC Electrical Characteristics⁽¹⁾

$V_{CC} = 5V \pm 10\%$ (unless otherwise specified)

| Parameter | | Test Conditions | Min | Typ | Max | Units |
|--------------------------------|-----------------------------------|---|-----|------------|-------------|--------------------|
| V_{IH} | High Level Input Voltage | | 2.0 | | | V |
| V_{IL} | Low Level Input Voltage | | | | 0.8 | V |
| V_{OH} | High Level Output Voltage | $V_{IN} = V_{IH}$ or V_{IL} , $I_{OUT} = -20$ mA | 2.5 | 3.4 | | V |
| V_{OL} | Low Level Output Voltage | $V_{IN} = V_{IH}$ or V_{IL} , $I_{OUT} = 48$ mA | | 0.3 | 0.5 | V |
| V_T | Differential Output Voltage | $R_L = 100 \Omega$ See ⁽²⁾ | 2.0 | 3.1 | | V |
| $ V_T - \overline{V_T} $ | Difference In Differential Output | $R_L = 100 \Omega$ See ⁽²⁾ | | | 0.4 | V |
| V_{OS} | Common Mode Output Voltage | $R_L = 100 \Omega$ See ⁽²⁾ | | 2.0 | 3.0 | V |
| $ V_{OS} - \overline{V_{OS}} $ | Difference In Common Mode Output | $R_L = 100 \Omega$ See ⁽²⁾ | | | 0.4 | V |
| I_{IN} | Input Current | $V_{IN} = V_{CC}, GND, V_{IH},$ or V_{IL} | | | ± 1.0 | μA |
| I_{CC} | Quiescent Supply Current | $I_{OUT} = 0 \mu A$, $V_{IN} = V_{CC}$ or GND $V_{IN} = 2.4V$ or $0.5V$ ⁽³⁾ | | 200 0.8 | 500 2.0 | μA mA |
| I_{OZ} | TRI-STATE Output Leakage Current | $V_{OUT} = V_{CC}$ or GND Control = V_{IL} | | ± 0.5 | ± 5.0 | μA |
| I_{SC} | Output Short Circuit Current | $V_{IN} = V_{CC}$ or GND See ⁽²⁾ and ⁽⁴⁾ | -30 | | -150 | mA |
| I_{OFF} | Power Off Output Leakage Current | $V_{CC} = 0V$ $V_{OUT} = 6V$ See ⁽²⁾ $V_{OUT} = -0.25V$ | | | 100 -100 | μA μA |

(1) Unless otherwise specified, min/max limits apply across the $-40^\circ C$ to $85^\circ C$ temperature range. All typicals are given for $V_{CC} = 5V$ and $T_A = 25^\circ C$.

(2) See EIA Specification RS-422 for exact test conditions.

(3) Measured per input. All other inputs at V_{CC} or GND.

(4) This is the current sourced when a high output is shorted to ground. Only one output at a time should be shorted.

Switching Characteristics⁽¹⁾

$V_{CC} = 5V \pm 10\%$, $t_r, t_f \leq 6 \text{ ns}$ (Figure 3, Figure 4, Figure 5, Figure 6)

| Parameter | | Test Conditions | Min | Typ | Max | Units |
|--------------------|--|-----------------|-----|-----|-----|-------|
| t_{PLH}, t_{PHL} | Propagation Delay Input to Output | S1 Open | | 6 | 11 | ns |
| Skew | See ⁽²⁾ | S1 Open | | 0.5 | 3 | ns |
| t_{TLH}, t_{THL} | Differential Output Rise And Fall Times | S1 Open | | 6 | 10 | ns |
| t_{PZH} | Output Enable Time | S1 Closed | | 12 | 25 | ns |
| t_{PZL} | Output Enable Time | S1 Closed | | 13 | 26 | ns |
| t_{PHZ} | Output Disable Time ⁽³⁾ | S1 Closed | | 4 | 8 | ns |
| t_{PLZ} | Output Disable Time ⁽³⁾ | S1 Closed | | 6 | 12 | ns |
| C_{PD} | Power Dissipation Capacitance ⁽⁴⁾ | | | 100 | | pF |
| C_{IN} | Input Capacitance | | | 6 | | pF |

- (1) Unless otherwise specified, min/max limits apply across the -40°C to 85°C temperature range. All typicals are given for $V_{CC} = 5V$ and $T_A = 25^{\circ}\text{C}$.
- (2) Skew is defined as the difference in propagation delays between complementary outputs at the 50% point.
- (3) Output disable time is the delay from the control input being switched to the output transistors turning off. The actual disable times are less than indicated due to the delay added by the RC time constant of the load.
- (4) C_{PD} determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_S = C_{PD} V_{CC} f + I_{CC}$.

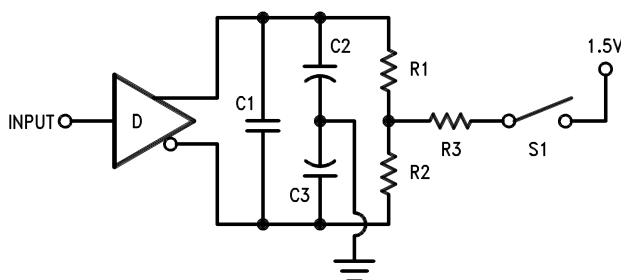
Comparison Table of Switching Characteristics into “LS-Type” Load⁽¹⁾

$V_{CC} = 5V$, $T_A = +25^{\circ}\text{C}$, $t_r \leq 6 \text{ ns}$, $t_f \leq 6 \text{ ns}$ (Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11)

| Parameter | | Test Conditions | DS34C87 | | DS3487 | | Units |
|--------------------|--|---|---------|-----|--------|-----|-------|
| | | | Typ | Max | Typ | Max | |
| t_{PLH}, t_{PHL} | Propagation Delay Input to Output | | 6 | 10 | 10 | 15 | ns |
| Skew | See ⁽²⁾ | | 1.5 | 2.0 | | | ns |
| t_{THL}, t_{TLH} | Differential Output Rise and Fall Times | | 4 | 7 | 10 | 15 | ns |
| t_{PHZ} | Output Disable Time See ⁽³⁾ | $C_L = 50 \text{ pF}$, $R_L = 200\Omega$, S1 Closed, S2 Closed | 8 | 11 | 17 | 25 | ns |
| t_{PLZ} | Output Disable Time See ⁽³⁾ | $C_L = 50 \text{ pF}$, $R_L = 200\Omega$, S1 Closed, S2 Closed | 7 | 10 | 15 | 25 | ns |
| t_{PZH} | Output Enable Time | $C_L = 50 \text{ pF}$, $R_L = \infty$, S1 Open, S2 Closed | 11 | 19 | 11 | 25 | ns |
| t_{PZL} | Output Enable Time | $C_L = 50 \text{ pF}$, $R_L = 200\Omega$, S1 Closed, S2 Open | 14 | 21 | 15 | 25 | ns |

- (1) This table is provided for comparison purposes only. The values in this table for the DS34C87 reflect the performance of the device but are not tested or ensured.
- (2) Skew is defined as the difference in propagation delays between complementary outputs at the 50% point.
- (3) Output disable time is the delay from the control input being switched to the output transistors turning off. The actual disable times are less than indicated due to the delay added by the RC time constant of the load.

AC TEST CIRCUIT AND SWITCHING TIME WAVEFORMS



Note: C1 = C2 = C3 = 40 pF (including Probe and Jig Capacitance), R1 = R2 = 50Ω, R3 = 500Ω

Figure 3. AC Test Circuit

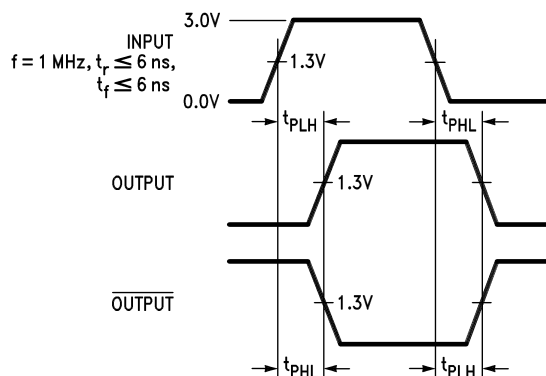


Figure 4. Propagation Delays

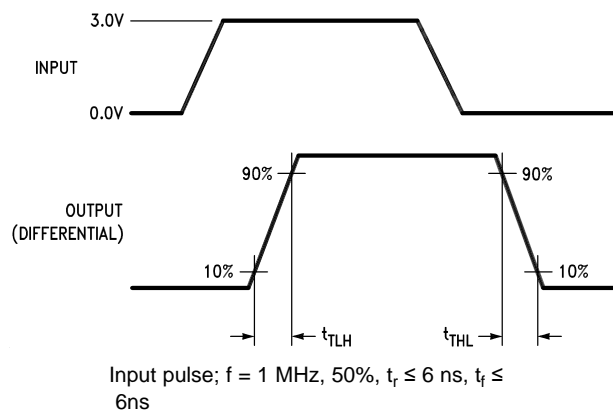


Figure 6. Differential Rise and Fall Times

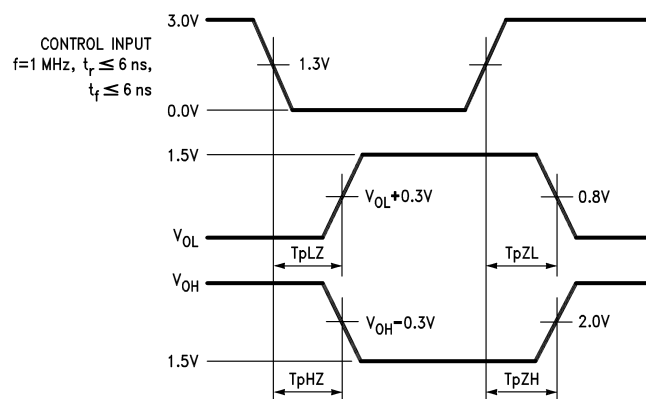


Figure 5. Enable and Disable Times

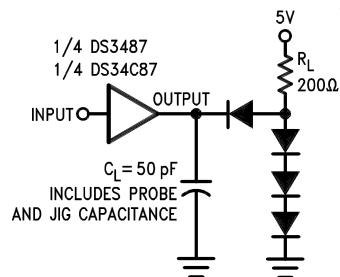


Figure 7. Propagation Delays Test Circuit for "LS-Type" Load

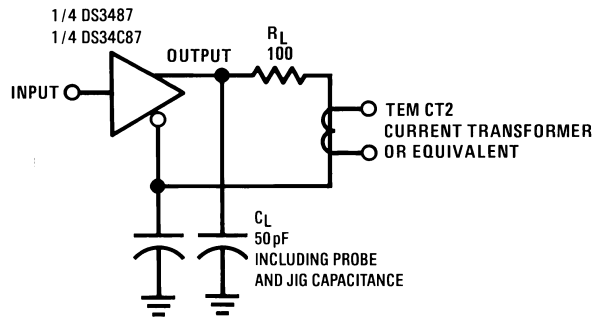


Figure 8. Differential Rise and Fall Times Test Circuit for “LS-Type” Load

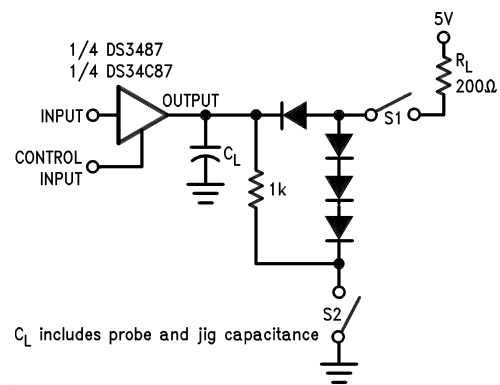


Figure 9. Load Enable and Disable Times Test Circuit for “LS-Type” Load

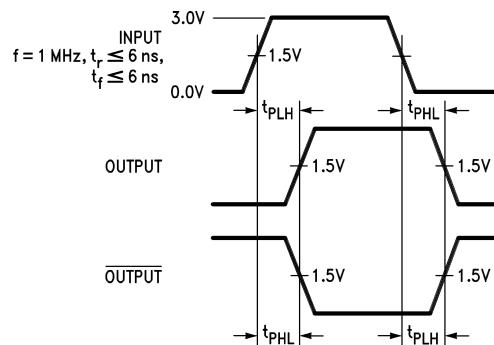


Figure 10. Load Propagation Delays for “LS-Type” Load

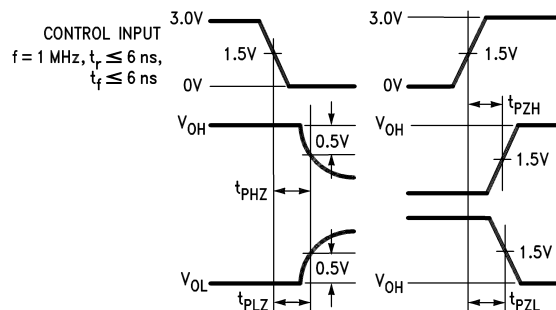
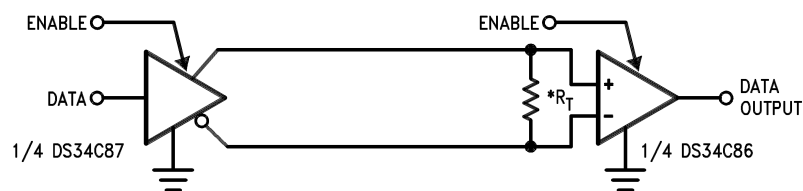


Figure 11. Load Enable and Disable Times for “LS-Type” Load

TYPICAL APPLICATIONS



*R_T is optional although highly recommended to reduce reflection.

PIN DESCRIPTIONS

| Pin Number (PDIP or SOIC package) | Pin Name | Function |
|---|----------------------|--|
| 1 | INPUT A | Channel A - TTL/CMOS input |
| 2 | OUTPUT A - True | True Output for Channel A, RS422 Levels |
| 3 | OUTPUT A - Inverting | Inverting Output for Channel A, RS422 Levels |
| 4 | A/B CONTROL | Enable Pin for Channels A and B, Active High, TTL/CMOS Levels |
| 5 | OUTPUT B - Inverting | Inverting Output for Channel B, RS422 Levels |
| 6 | OUTPUT B - True | True Output for Channel B, RS422 Levels |
| 7 | INPUT B | Channel B - TTL/CMOS input |
| 8 | GND | Ground Pin (0 V) |
| 9 | INPUT C | Channel C - TTL/CMOS input |
| 10 | OUTPUT C - True | True Output for Channel C, RS422 Levels |
| 11 | OUTPUT C - Inverting | Inverting Output for Channel C, RS422 Levels |
| 12 | C/D CONTROL | Enable Pin for Channels C and D, Active High, TTL/CMOS Levels |
| 13 | OUTPUT D - Inverting | Inverting Output for Channel D, RS422 Levels |
| 14 | OUTPUT D - True | True Output for Channel D, RS422 Levels |
| 15 | INPUT D | Channel D - TTL/CMOS input |
| 16 | V _{CC} | Power Supply Pin, 5.0V typical |

REVISION HISTORY

| Changes from Revision A (April 2013) to Revision B | Page |
|--|-------------------|
| • Changed layout of National Data Sheet to TI format | 7 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| DS34C87TM | NRND | SOIC | D | 16 | 48 | TBD | Call TI | Call TI | -40 to 85 | DS34C87TM | |
| DS34C87TM/NOPB | ACTIVE | SOIC | D | 16 | 48 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | DS34C87TM | Samples |
| DS34C87TMX | NRND | SOIC | D | 16 | 2500 | TBD | Call TI | Call TI | -40 to 85 | DS34C87TM | |
| DS34C87TMX/NOPB | ACTIVE | SOIC | D | 16 | 2500 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | DS34C87TM | Samples |

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS34C87TMX | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.3 | 8.0 | 16.0 | Q1 |
| DS34C87TMX/NOPB | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.3 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS34C87TMX | SOIC | D | 16 | 2500 | 367.0 | 367.0 | 35.0 |
| DS34C87TMX/NOPB | SOIC | D | 16 | 2500 | 367.0 | 367.0 | 35.0 |

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - $\triangle D$ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.

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