



**THE DATASHEET OF
DS36954MX**



DS36954 Quad Differential Bus Transceiver

 Check for Samples: [DS36954](#)

FEATURES

- Pinout for SCSI Interface
- Compact 20-Pin PLCC or SOIC Package
- Meets EIA-485 Standard for Multipoint Bus Transmission
- Greater than 60 mA Source/Sink Currents
- Thermal Shutdown Protection
- Glitch-Free Driver Outputs on Power Up and Down

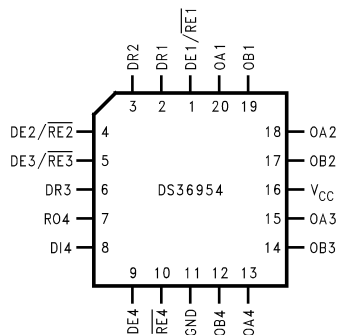
DESCRIPTION

The DS36954 is a low power, quad EIA-485 differential bus transceiver especially suited for high speed, parallel, multipoint, I/O bus applications. A compact 20-pin surface mount PLCC or SOIC package provides high transceiver integration and a very small PC board footprint.

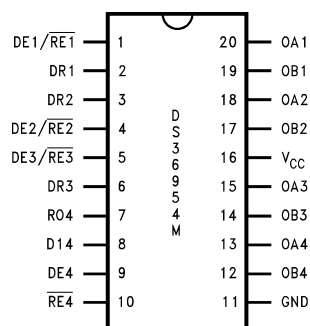
Propagation delay skew between devices is specified to aid in parallel interface designs—limits on maximum and minimum delay times are verified.

Five devices can implement a complete SCSI initiator or target interface. Three transceivers in a package are pinned out for data bus connections. The fourth transceiver, with the flexibility provided by its individual enables, can serve as a control bus transceiver.

Connection Diagram

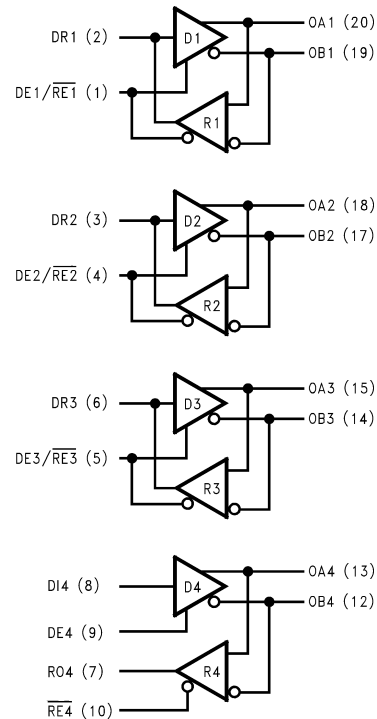


See Package Number FN (S-PQCC-J20)



See Package Number DW (R-PDSO-G20)

Logic Diagram



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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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⁾

| | |
|--|------------------------|
| Supply Voltage | 7V |
| Control Input Voltage | $V_{CC} + 0.5V$ |
| Driver Input Voltage | $V_{CC} + 0.5V$ |
| Driver Output Voltage/Receiver Input Voltage | -10V to +15V |
| Receiver Output Voltage | 5.5V |
| Continuous Power Dissipation @ +25°C | |
| FN Package | 1.73W |
| DW Package | 1.73W |
| Derate FN Package | 13.9 mW/°C above +25°C |
| Derate DW Package | 13.7 mW/°C above +25°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (Soldering 4 Sec.) | 260°C |

- (1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be verified. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" specify conditions for device operation.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instrument Sales Office/ Distributors for availability and specifications.

Recommended Operating Conditions

| | Min | Max | Units |
|--|------|------|-------|
| Supply Voltage, V_{CC} | 4.75 | 5.25 | V |
| Bus Voltage | -7 | +12 | V |
| Operating Free Air Temperature (T_A) | 0 | +70 | °C |

Electrical Characteristics ⁽¹⁾⁽²⁾

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-------------------------------|---|---|------------|-------------|------|-------|
| DRIVER CHARACTERISTICS | | | | | | |
| V_{ODL} | Differential Driver Output Voltage (Full Load) | $I_L = 60 \text{ mA}$ $V_{CM} = 0V$ | 1.5 | 1.9 | | V |
| V_{OD} | Differential Driver Output Voltage (Termination Load) | $R_L = 100\Omega$ (EIA-422) $R_L = 54\Omega$ (EIA-485) | 2.0 1.5 | 2.25 2.0 | | V |
| $\Delta IVODI$ | Change in Magnitude of Driver Differential Output Voltage for Complementary Output States | $R_L = 54$ or 100Ω ⁽³⁾ (Figure 1) (EIA-422/485) | | | 0.2 | V |
| V_{OC} | Driver Common Mode Output Voltage ⁽⁴⁾ | $R_L = 54\Omega$ (Figure 1) (EIA-485) | | | 3.0 | V |
| $\Delta IVOCI$ | Change in Magnitude of Common Mode Output Voltage | ⁽³⁾ (Figure 1) (EIA-422/485) | | | 0.2 | V |
| V_{OH} | Output Voltage High | $I_{OH} = -55 \text{ mA}$ | 2.7 | 3.2 | | V |
| V_{OL} | Output Voltage Low | $I_{OL} = 55 \text{ mA}$ | | 1.4 | 1.7 | V |
| V_{IH} | Input Voltage High | | 2.0 | | | V |
| V_{IL} | Input Voltage Low | | | | 0.8 | V |
| V_{CL} | Input Clamp Voltage | $I_{CL} = -18 \text{ mA}$ | | | -1.5 | V |

- (1) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground unless otherwise specified.
- (2) All typicals are given for $V_{CC} = 5V$ and $T_A = 25^\circ\text{C}$.
- (3) $\Delta IVODI$ and $\Delta IVOCI$ are changes in magnitude of V_{OD} and V_{OC} , respectively, that occur when the input changes state.
- (4) In EIA Standards EIA-422 and EIA-485, V_{OC} , which is the average of the two output voltages with respect to ground, is called output offset voltage, V_{OS} .

Electrical Characteristics ⁽¹⁾⁽²⁾ (continued)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--|---|--|------------------|-------|------|---------|
| I_{IH} | Input High Current | $V_{IN} = 2.4V$ ⁽⁵⁾ | | | 20 | μA |
| I_{IL} | Input Low Current | $V_{IN} = 0.4V$ ⁽⁵⁾ | | | -20 | μA |
| I_{OSC} | Driver Short-Circuit Output Current ⁽⁶⁾ | $V_O = -7V$ (EIA-485) | | -130 | -250 | mA |
| | | $V_O = 0V$ (EIA-422) | | -90 | -150 | mA |
| | | $V_O = +12V$ (EIA-485) | | 130 | 250 | mA |
| RECEIVER CHARACTERISTICS | | | | | | |
| I_{OSR} | Short Circuit Output Current | $V_O = 0V$ ⁽⁶⁾ | -15 | -28 | -75 | mA |
| I_{OZ} | TRI-STATE Output Current | $V_O = 0.4V$ to $2.4V$ | | | 20 | μA |
| V_{OH} | Output Voltage High | $V_{ID} = 0.2V$, $I_{OH} = 0.4$ mA | 2.4 | 3.0 | | V |
| V_{OL} | Output Voltage Low | $V_{ID} = -0.2V$, $I_{OL} = 4$ mA | | 0.35 | 0.5 | V |
| V_{TH} | Differential Input High Threshold Voltage | $V_O = V_{OH}$, $I_O = -0.4$ mA (EIA-422/485) | | 0.03 | 0.2 | V |
| V_{TL} | Differential Input Low Threshold Voltage ⁽⁷⁾ | $V_O = V_{OL}$, $I_O = 4.0$ mA (EIA-422/485) | -0.2 0 | -0.03 | | V |
| V_{HST} | Hysteresis ⁽⁸⁾ | $V_{CM} = 0V$ | 35 | 60 | | mV |
| DRIVER AND RECEIVER CHARACTERISTICS | | | | | | |
| V_{IH} | Enable Input Voltage High | | 2.0 | | | V |
| V_{IL} | Enable Input Voltage Low | | | | 0.8 | V |
| V_{CL} | Enable Input Clamp Voltage | $I_{CL} = -18$ mA | | | -1.5 | V |
| I_{IN} | Line Input Current ⁽⁹⁾ | Other Input = 0V DE/RE = 0.8V DE4 = 0.8V | $V_I = +12V$ | 0.5 | 1.0 | mA |
| | | | $V_I = -7V$ | -0.45 | -0.8 | mA |
| I_{ING} | Line Input Current ⁽⁹⁾ | Other Input = 0V DE/RE and DE4 = 2V $V_{CC} = 3.0V$ $T_A = +25^\circ C$ | $V_I = +12V$ | | 1.0 | mA |
| | | | $V_I = -7V$ | | -0.8 | mA |
| I_{IH} | Enable Input Current High | $V_{IN} = 2.4V$ DE/RE | $V_{CC} = 3.0V$ | 1 | 40 | μA |
| | | | $V_{CC} = 4.75V$ | 1 | | μA |
| | | | $V_{CC} = 5.25V$ | 1 | 40 | μA |
| | | $V_{IN} = 2.4V$ DE4 or RE4 | $V_{CC} = 3.0V$ | 1 | 20 | μA |
| | | | $V_{CC} = 5.25V$ | 1 | 20 | μA |
| I_{IL} | Enable Input Current Low | $V_{IN} = 0.8V$ DE/RE | $V_{CC} = 3.0V$ | -6 | -40 | μA |
| | | | $V_{CC} = 4.75V$ | -12 | | μA |
| | | | $V_{CC} = 5.25V$ | -14 | -40 | μA |
| | | $V_{IN} = 0.8V$ DE4 or RE4 | $V_{CC} = 3.0V$ | -3 | -20 | μA |
| | | | $V_{CC} = 5.25V$ | -7 | -20 | μA |
| I_{CCD} | Supply Current ⁽¹⁰⁾ | No Load, DE/RE and DE4 = 2.0V | | 75 | 90 | mA |
| I_{CCR} | Supply Current ⁽¹⁰⁾ | No Load, DE/RE and RE4 = 0.8V | | 50 | 70 | mA |

(5) I_{IH} and I_{IL} include driver input current and receiver TRI-STATE leakage current on DR(1–3).

(6) Short one output at a time.

(7) Threshold parameter limits specified as an algebraic value rather than by magnitude.

(8) Hysteresis defined as $V_{HST} = V_{TH} - V_{TL}$.

(9) I_{IN} includes the receiver input current and driver TRI-STATE leakage current.

(10) Total package supply current.

Switching Characteristics

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--|---|---|------------|-----|-----|-------|
| DRIVER SINGLE-ENDED CHARACTERISTICS | | | | | | |
| t_{PZH} | Output Enable Time to High Level | $R_L = 110\Omega$ | | 35 | 40 | ns |
| t_{PZL} | Output Enable Time to Low Level | | (Figure 6) | 25 | 40 | ns |
| t_{PHZ} | Output Disable Time to High Level | | (Figure 8) | 15 | 25 | ns |
| t_{PLZ} | Output Disable Time to Low Level | | (Figure 6) | 35 | 40 | ns |
| DRIVER DIFFERENTIAL CHARACTERISTICS | | | | | | |
| t_r, t_f | Rise and Fall Time | $R_L = 54\Omega$ $C_L = 50\text{ pF}$ $C_D = 15\text{ pF}$ (Figure 3 Figure 4 ⁽¹⁾) | | 13 | 16 | ns |
| t_{PLHD} | Differential Propagation | | 9 | 15 | 19 | ns |
| t_{PHLD} | Delays ⁽²⁾ | | 9 | 12 | 19 | ns |
| t_{SKD} | $ t_{PLHD} - t_{PHLD} $ Diff. Skew | | | 3 | 6 | ns |
| RECEIVER CHARACTERISTICS | | | | | | |
| t_{PLHD} | Differential Propagation Delays | $C_L = 15\text{ pF}$ $V_{CM} = 2.0V$ (Figure 10) | 9 | 14 | 19 | ns |
| t_{PHLD} | | | 9 | 13 | 19 | ns |
| t_{SKD} | $ t_{PLHD} - t_{PHLD} $ Diff. Receiver Skew | | | 1 | 3 | ns |
| t_{PZH} | Output Enable Time to High Level | $C_L = 15\text{ pF}$ (Figure 15) | | 15 | 22 | ns |
| t_{PZL} | Output Enable Time to Low Level | | | 20 | 30 | ns |
| t_{PHZ} | Output Disable Time from High Level | | | 20 | 30 | ns |
| t_{PLZ} | Output Disable Time from Low Level | | | 17 | 25 | ns |

(1) Propagation Delay Timing for Calculations of Driver Differential Propagation Delays

(2) Differential propagation delays are calculated from single-ended propagation delays measured from driver input to the 20% and 80% levels on the driver outputs (Figure 16).

PARAMETER MEASUREMENT INFORMATION

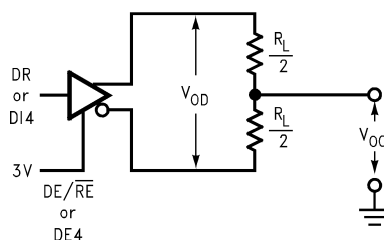


Figure 1. Driver V_{OD} and V_{OC} ⁽³⁾

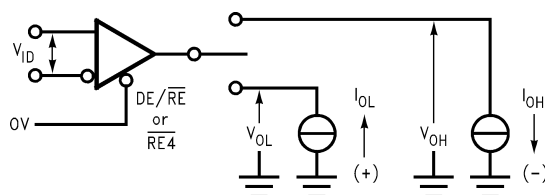
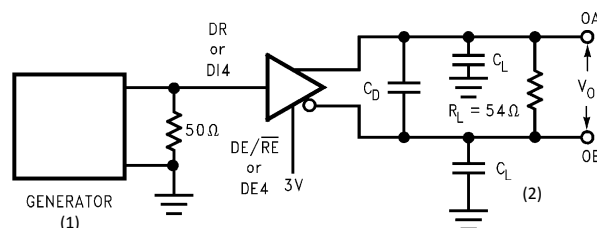
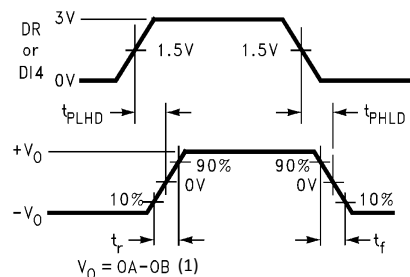


Figure 2. Receiver V_{OH} and V_{OL}



- (1) The input pulse is supplied by a generator having the following characteristics: $f = 1.0$ MHz, 50% duty cycle, $\text{trand} \leq 6.0$ ns, $Z_0 = 50\Omega$
- (2) C_L includes probe and stray capacitance.

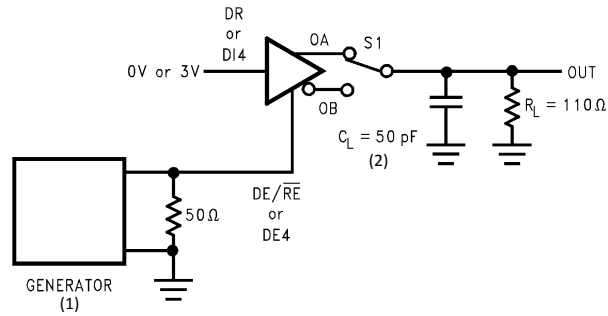
Figure 3. Driver Differential Propagation Delay Load Circuit



- (1) Differential propagation delays are calculated from single-ended propagation delays measured from driver input to the 20% and 80% levels on the driver outputs (Figure 16).

Figure 4. Driver Differential Propagation Delays and Transition Times

(3) C_L includes probe and stray capacitance.



S1 to OA for DI = 3V

S1 to OB for DI = 0V

- (1) The input pulse is supplied by a generator having the following characteristics: $f = 1.0$ MHz, 50% duty cycle, $\text{trand tf} < 6.0$ ns, $Z_O = 50\Omega$.
- (2) C_L includes probe and stray capacitance.

Figure 5.

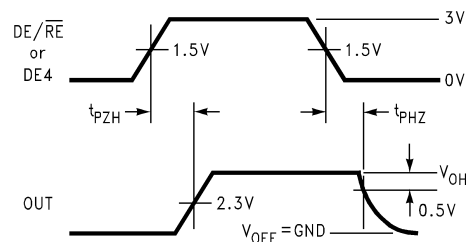
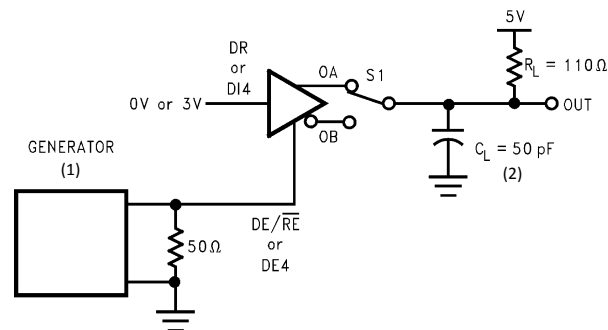


Figure 6. Driver Enable and Disable Timing (t_{PZH} , t_{PHZ})



S1 to OA for DI = 0V

S1 to OB for DI = 3V

- (1) The input pulse is supplied by a generator having the following characteristics: $f = 1.0$ MHz, 50% duty cycle, $\text{trand tf} < 6.0$ ns, $Z_O = 50\Omega$.
- (2) C_L includes probe and stray capacitance.

Figure 7.

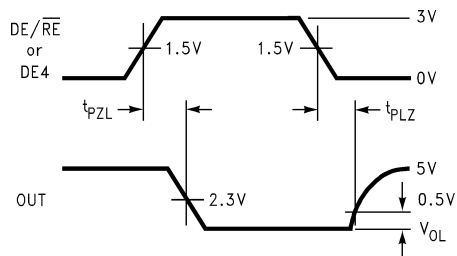
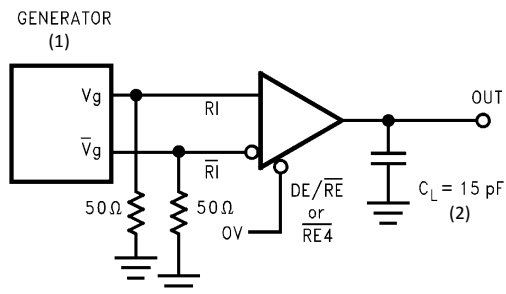


Figure 8. Driver Enable and Disable Timing (t_{PZL} , t_{PLZ})



- (1) The input pulse is supplied by a generator having the following characteristics: $f = 1.0$ MHz, 50% duty cycle, $\text{trand} \leq 6.0$ ns, $Z_0 = 50\Omega$.
- (2) C_L includes probe and stray capacitance.

Figure 9.

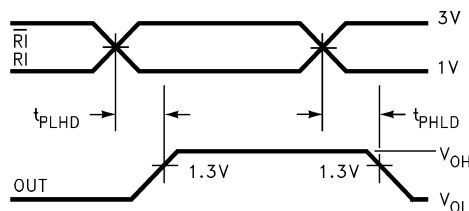
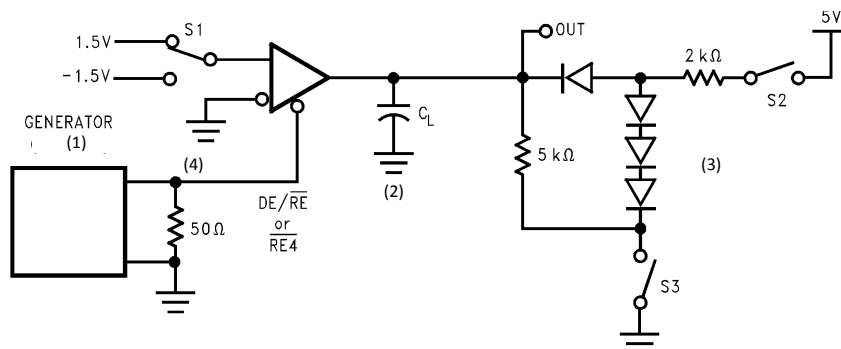
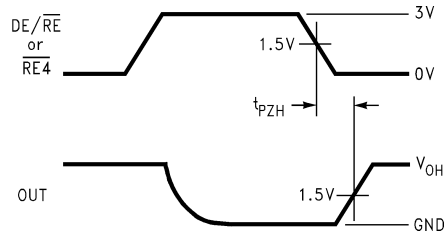


Figure 10. Receiver Differential Propagation Delay Timing



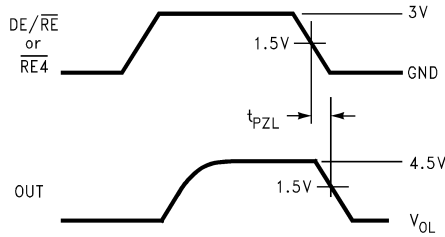
- (1) The input pulse is supplied by a generator having the following characteristics: $f = 1.0$ MHz, 50% duty cycle, $\text{trand} \leq 6.0$ ns, $Z_0 = 50\Omega$.
- (2) C_L includes probe and stray capacitance.
- (3) Diodes are 1N916 or equivalent.
- (4) On transceivers 1–3 the driver is loaded with receiver input conditions when DE/RE is high. Do not exceed the package power dissipation limit when testing.

Figure 11.



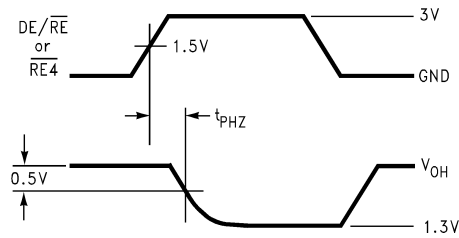
S1 1.5V
S2 Open
S3 Closed

Figure 12.



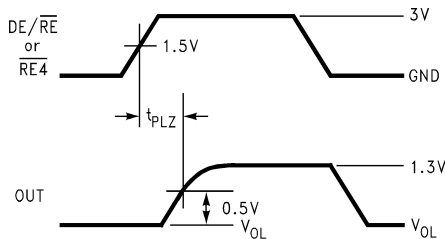
S1 -1.5V
S2 Closed
C3 Open

Figure 13.



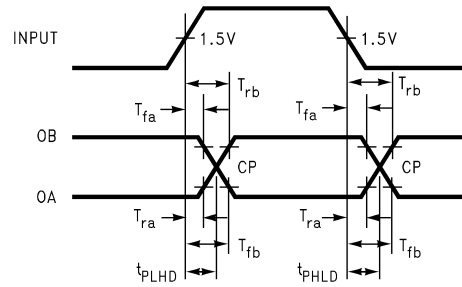
S1 1.5V
S2 Closed
C3 Closed

Figure 14.



S1 -1.5V
S2 Closed
C3 Closed

Figure 15. Receiver Enable and Disable Timing



$$T_{CP} = \frac{(T_{fb} \times T_{rb}) - (T_{ra} \times T_{fa})}{T_{rb} - T_{ra} - T_{fa} + T_{fb}}$$

T_{ra} , T_{rb} , T_{fa} and T_{fb} are propagation delay measurements to the 20% and 80% levels.

T_{CP} = Crossing Point

Figure 16. Propagation Delay Timing for Calculations of Driver Differential Propagation Delays

REVISION HISTORY

| Changes from Revision B (April 2013) to Revision C | Page |
|--|-------------------|
| • Changed layout of National Data Sheet to TI format | 9 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|-------------------------|--------------|-------------------------|-------------------------|
| DS36954M | ACTIVE | SOIC | DW | 20 | 36 | TBD | Call TI | Call TI | 0 to 70 | DS36954 M | Samples |
| DS36954M/NOPB | ACTIVE | SOIC | DW | 20 | 36 | Green (RoHS & no Sb/Br) | CU SN | Level-3-260C-168 HR | 0 to 70 | DS36954 M | Samples |
| DS36954MX | ACTIVE | SOIC | DW | 20 | | TBD | Call TI | Call TI | 0 to 70 | DS36954 M | Samples |
| DS36954MX/NOPB | ACTIVE | SOIC | DW | 20 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-3-260C-168 HR | 0 to 70 | DS36954 M | Samples |
| DS36954VX | ACTIVE | PLCC | FN | 20 | 1000 | TBD | Call TI | Call TI | 0 to 70 | DS36954V | Samples |
| DS36954VX/NOPB | ACTIVE | PLCC | FN | 20 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2A-250C-4 WEEK | 0 to 70 | DS36954V | 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.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS36954MX/NOPB | SOIC | DW | 20 | 1000 | 330.0 | 24.4 | 10.9 | 13.3 | 3.25 | 12.0 | 24.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS36954MX/NOPB | SOIC | DW | 20 | 1000 | 367.0 | 367.0 | 45.0 |

DW (R-PDSO-G20)

PLASTIC SMALL OUTLINE

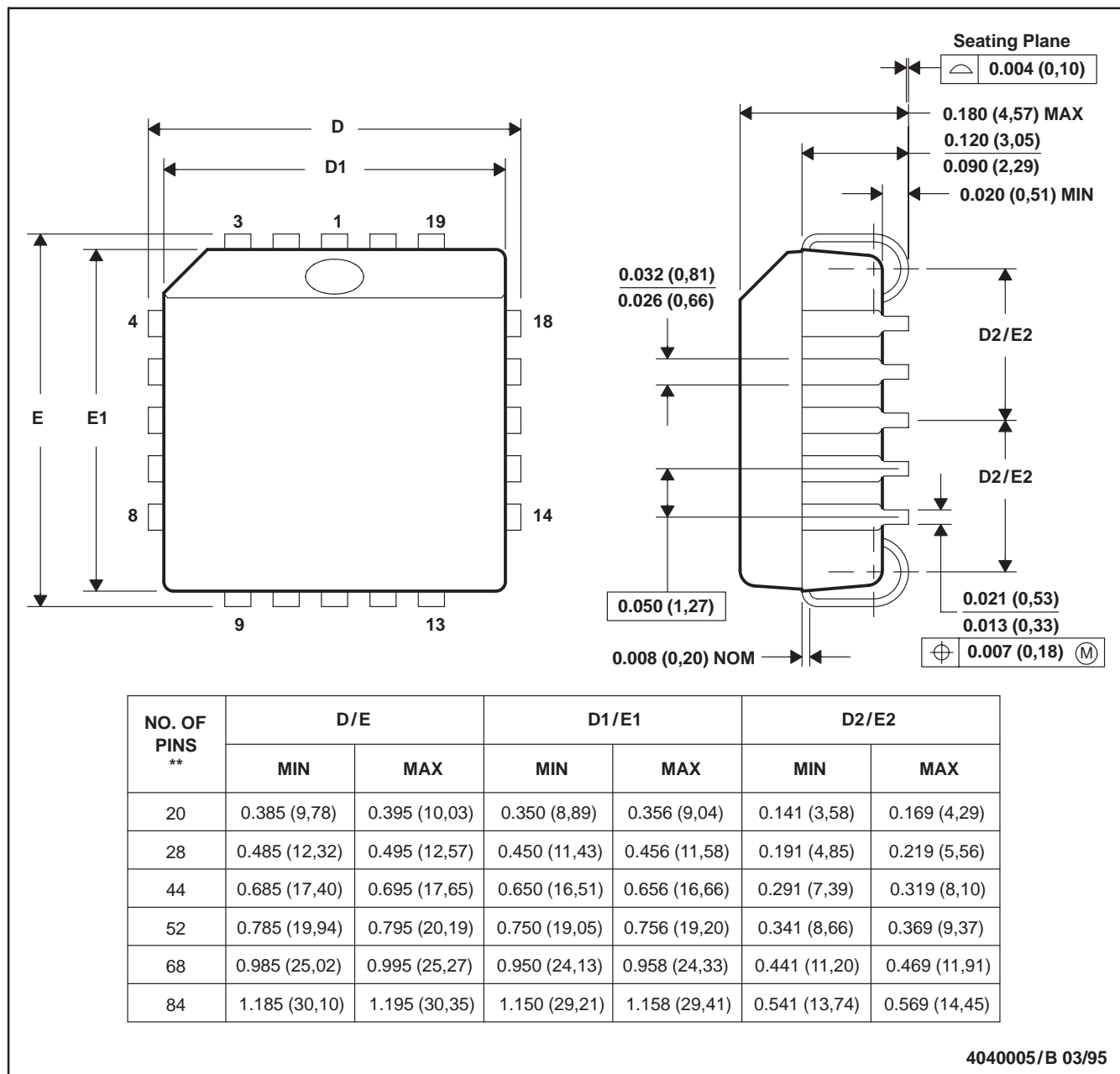


- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MS-013 variation AC.

FN (S-PQCC-J**)

PLASTIC J-LEADED CHIP CARRIER

20 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Falls within JEDEC MS-018

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