

English Data Sheet: [SLLSE26](#)

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## 4 Revision History

注：以前版本的页码可能与当前版本的页码不同

### Changes from Revision D (October 2015) to Revision E (August 2023) Page

- Updated Thermal Characteristics, Safety Limiting Values, and Thermal Derating Curves to provide more accurate system-level thermal calculations..... 6
- Updated electrical and switching characteristics to match device performance..... 8

### Changes from Revision C (July 2011) to Revision D (October 2015) Page

- 添加了引脚配置和功能部分、ESD 等级表、特性说明部分、器件功能模式、应用和实施部分、电源相关建议部分、布局部分、器件和文档支持部分以及机械、封装和可订购信息部分..... 1
- 将 VDE 标准更改为 DIN V VDE V 0884-10 (VDE V 0884-10):2006-12..... 1

### Changes from Revision B (June 2011) to Revision C (July 2011) Page

### Changes from Revision A (March 2011) to Revision B (May 2011) Page

- Changed pin 16 From:  $V_{CC1}$  To:  $V_{CC2}$  in the DW Package drawing..... 3

### Changes from Revision \* (November 2010) to Revision A (March 2011) Page

- 将数据表从“产品预发布”更改为量产数据..... 1
- Changed the designator of common mode voltage in Recommended operating condition to  $V_I$  ..... 4

## 5 Pin Configuration and Functions

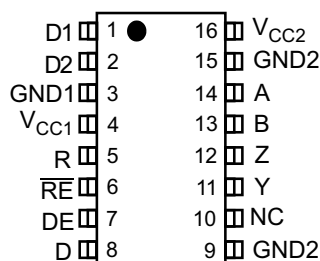


图 5-1. DW Package 16-Pin SOIC Top View

## Pin Functions

| PIN              |       | I/O | DESCRIPTION                                                      |
|------------------|-------|-----|------------------------------------------------------------------|
| NAME             | NO.   |     |                                                                  |
| A                | 14    | I   | Non-inverting Receiver Input                                     |
| B                | 13    | I   | Inverting Receiver Input                                         |
| D                | 8     | I   | Driver Input                                                     |
| D1               | 1     | O   | Transformer Driver Terminal 1, Open-Drain Output                 |
| D2               | 2     | O   | Transformer Driver Terminal 2, Open-Drain Output                 |
| DE               | 7     | I   | Driver Enable Input                                              |
| GND1             | 3     | –   | Logic-side Ground                                                |
| GND2             | 9, 15 | –   | Bus-side Ground. Both pins are internally connected.             |
| NC               | 10    | –   | No Connect. This pin is not connected to any internal circuitry. |
| R                | 5     | O   | Receiver Output                                                  |
| RE               | 6     | I   | Receiver Enable Input. This pin has complementary logic.         |
| V <sub>CC1</sub> | 4     | –   | Logic-side Power Supply                                          |
| V <sub>CC2</sub> | 16    | –   | Bus-side Power Supply                                            |
| Y                | 11    | O   | Non-inverting Driver Output                                      |
| Z                | 12    | O   | Inverting Driver Output                                          |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                               |                                                                                       | MIN  | MAX | UNIT |
|-------------------------------|---------------------------------------------------------------------------------------|------|-----|------|
| $V_{CC}^{(2)}$                | Supply voltage, $V_{CC1}$ , $V_{CC2}$                                                 | -0.3 | 6   | V    |
| $V_A$ , $V_B$ , $V_Y$ , $V_Z$ | Voltage at any bus I/O terminal (A,B,Y,Z)                                             | -9   | 14  | V    |
| $V_{D1}$ , $V_{D2}$           | Voltage at D1, D2                                                                     |      | 14  | V    |
| $V_{(TRANS)}$                 | Voltage input, transient pulse, A, B, Y, and Z (through 100 $\Omega$ , see Figure 27) | -50  | 50  | V    |
| $V_I$                         | Voltage input at any D, DE or RE terminal                                             | -0.5 | 6   | V    |
| $I_O$                         | Receiver output current                                                               | -10  | 10  | mA   |
| $I_{D1}$ , $I_{D2}$           | Transformer Driver Output Current                                                     |      | 450 | mA   |
| $T_J$                         | Junction temperature                                                                  |      | 150 | °C   |
| $T_{STG}$                     | Storage temperature                                                                   | -65  | 150 | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values except differential I/O bus voltages are with respect to network ground terminal and are peak voltage values.

### 6.2 ESD Ratings

|             |                                                                                          |                   | VALUE  | UNIT |
|-------------|------------------------------------------------------------------------------------------|-------------------|--------|------|
| $V_{(ESD)}$ | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>                        | Bus pins and GND1 | ±6000  | V    |
| $V_{(ESD)}$ | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>                        | Bus pins and GND2 | ±16000 | V    |
| $V_{(ESD)}$ | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>                        | All pins          | ±4000  | V    |
| $V_{(ESD)}$ | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> |                   | ±1500  | V    |
| $V_{(ESD)}$ | Machine model (MM), ANSI/ESDS5.2-1996                                                    |                   | ±200   | V    |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

|           |                                                 | MIN | TYP | MAX       | UNIT     |
|-----------|-------------------------------------------------|-----|-----|-----------|----------|
| $V_{CC1}$ | Supply Voltage, Side 1                          | 3   | 3.3 | 3.6       | V        |
| $V_{CC2}$ | Supply Voltage, Side 2                          | 3   | 3.3 | 3.6       | V        |
| $V_I$     | Common Mode voltage at any bus terminal: A or B | -7  |     | 12        | V        |
| $V_{IH}$  | High-level input voltage (D, DE, RE inputs)     | 2   |     | $V_{CC1}$ | V        |
| $V_{IL}$  | Low-level input voltage (D, DE, RE inputs)      | 0   |     | 0.8       | V        |
| $V_{ID}$  | Differential input voltage, A with respect to B | -12 |     | 12        | V        |
| $R_L$     | Differential load resistance                    | 54  | 60  |           | $\Omega$ |
| $I_O$     | Output current, Driver                          | -60 |     | 60        | mA       |
| $I_O$     | Output current, Receiver                        | -8  |     | 8         | mA       |
| $T_A$     | Ambient temperature                             | -40 |     | 85        | °C       |

|            |                | MIN | TYP | MAX | UNIT |
|------------|----------------|-----|-----|-----|------|
| $1/t_{UI}$ | Signaling rate |     |     | 1   | Mbps |

## 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | ISO35T    | UNIT |
|-------------------------------|----------------------------------------------|-----------|------|
|                               |                                              | DW (SOIC) |      |
|                               |                                              | 16 PINS   |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 80.5      | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 43.8      | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 49.7      | °C/W |
| $\psi_{JT}$                   | Junction-to-top characterization parameter   | 13.8      | °C/W |
| $\psi_{JB}$                   | Junction-to-board characterization parameter | 41.4      | °C/W |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | —         | °C/W |

(1) For more information about traditional and new thermal metrics, see the [no](#).

## 6.5 Power Ratings

| PARAMETER | TEST CONDITIONS                                                                                                                                                             | MIN | TYP | MAX | UNIT |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $P_D$     | Maximum power dissipation (both sides)<br>$V_{CC1} = V_{CC2} = 3.6\text{ V}$ , $T_J = 150^\circ\text{C}$ , $CL = 15\text{ pF}$ , Input a 0.5 MHz 50% duty cycle square wave |     |     | 373 | mW   |

## 6.6 Insulation Specifications

| PARAMETER                                        |                                                     | TEST CONDITIONS                                                                                                                                                                            | VALUE             | UNIT            |
|--------------------------------------------------|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------|
|                                                  |                                                     |                                                                                                                                                                                            | DW-16             |                 |
| CLR                                              | External clearance <sup>(1)</sup>                   | Shortest terminal-to-terminal distance through air                                                                                                                                         | 8                 | mm              |
| CPG                                              | External creepage <sup>(1)</sup>                    | Shortest terminal-to-terminal distance across the package surface                                                                                                                          | 8                 | mm              |
| DTI                                              | Distance through the insulation                     | Minimum internal gap (internal clearance)                                                                                                                                                  | 8                 | um              |
| CTI                                              | Comparative tracking index                          | DIN EN 60112 (VDE 0303-11); IEC 60112                                                                                                                                                      | >400              | V               |
|                                                  | Material group                                      | According to IEC 60664-1                                                                                                                                                                   | II                |                 |
|                                                  | Overvoltage category per IEC 60664-1                | Rated mains voltage ≤ 150 V <sub>RMS</sub>                                                                                                                                                 | I-IV              |                 |
|                                                  |                                                     | Rated mains voltage ≤ 300 V <sub>RMS</sub>                                                                                                                                                 | I-III             |                 |
| DIN EN IEC 60747-17 (VDE 0884-17) <sup>(2)</sup> |                                                     |                                                                                                                                                                                            |                   |                 |
| V <sub>IORM</sub>                                | Maximum repetitive peak isolation voltage           | AC voltage (bipolar)                                                                                                                                                                       | 566               | V <sub>PK</sub> |
| V <sub>IOTM</sub>                                | Maximum transient isolation voltage                 | V <sub>TEST</sub> = V <sub>IOTM</sub> ,<br>t = 60 s (qualification);<br>V <sub>TEST</sub> = 1.2 x V <sub>IOTM</sub> ,<br>t= 1 s (100% production)                                          | 4242              | V <sub>PK</sub> |
| q <sub>pd</sub>                                  | Apparent charge <sup>(3)</sup>                      | Method b; At routine test (100% production)<br>V <sub>ini</sub> = 1.2 x V <sub>IOTM</sub> , t <sub>ini</sub> = 1 s;<br>V <sub>pd(m)</sub> = 1.5 x V <sub>IORM</sub> , t <sub>m</sub> = 1 s | ≤5                | pC              |
| C <sub>IO</sub>                                  | Barrier capacitance, input to output <sup>(4)</sup> | V <sub>IO</sub> = 0.4 x sin (2 π ft), f = 1 MHz                                                                                                                                            | 2                 | pF              |
| C <sub>I</sub>                                   | Input capacitance to ground                         | V <sub>I</sub> = V <sub>CC</sub> / 2 + 0.4×sin(2 π ft), f = 1 MHz, V <sub>CC</sub> = 5 V                                                                                                   | 2                 | pF              |
| R <sub>IO</sub>                                  | Isolation resistance <sup>(4)</sup>                 | V <sub>IO</sub> = 500 V, T <sub>A</sub> = 25°C                                                                                                                                             | >10 <sup>12</sup> | Ω               |
|                                                  |                                                     | V <sub>IO</sub> = 500 V, T <sub>S</sub> = 150°C                                                                                                                                            | >10 <sup>9</sup>  |                 |
|                                                  | Pollution degree                                    |                                                                                                                                                                                            | 2                 |                 |
|                                                  | Climatic category                                   |                                                                                                                                                                                            | 40/085/21         |                 |
| UL 1577                                          |                                                     |                                                                                                                                                                                            |                   |                 |

| PARAMETER |                                        | TEST CONDITIONS                                                                                                     | VALUE | UNIT      |
|-----------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------|-------|-----------|
|           |                                        |                                                                                                                     | DW-16 |           |
| $V_{ISO}$ | Maximum withstanding isolation voltage | $V_{TEST} = V_{ISO}$ , $t = 60$ s (qualification),<br>$V_{TEST} = 1.2 \times V_{ISO}$ , $t = 1$ s (100% production) | 2500  | $V_{RMS}$ |

- (1) Creepage and clearance requirements should be applied according to the specific equipment isolation standards of an application. Care should be taken to maintain the creepage and clearance distance of a board design to ensure that the mounting pads of the isolator on the printed-circuit board do not reduce this distance. Creepage and clearance on a printed-circuit board become equal in certain cases. Techniques such as inserting grooves and/or ribs on a printed-circuit board are used to help increase these specifications.
- (2) This coupler is suitable for *basic electrical insulation* only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.
- (3) Apparent charge is electrical discharge caused by a partial discharge (pd).
- (4) All pins on each side of the barrier tied together creating a two-terminal device.

## 6.7 Safety-Related Certifications

| VDE                                                                                                                                                                                  | CSA                                                                                                                                                                                                                                                                                        | UL                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| Certified according to DIN EN IEC 60747-17 (VDE 0884-17)                                                                                                                             | Certified according to IEC 60950-1 and IEC 61010-1                                                                                                                                                                                                                                         | Certified according to UL 1577 Component Recognition Program |
| Basic insulation,<br>Maximum Transient Isolation Voltage, 4242 $V_{PK}$<br>Maximum Surge Isolation Voltage, 4000 $V_{PK}$<br>Maximum repetitive peak Isolation Voltage, 566 $V_{PK}$ | 3000 $V_{RMS}$ Isolation Rating;<br>Reinforced insulation per CSA 61010-1 and IEC 61010-1 150 $V_{RMS}$ working voltage;<br>Basic insulation per CSA 61010-1 and IEC 61010-1 600 $V_{RMS}$ working voltage; Basic insulation per CSA 60950-1 and IEC 60950-1 760 $V_{RMS}$ working voltage | Single protection, 2500 $V_{RMS}$                            |
| Certificate number: 40047657                                                                                                                                                         | Master contract number: 220991                                                                                                                                                                                                                                                             | File number: E181974                                         |

## 6.8 Safety Limiting Values

Safety limiting<sup>(1)</sup> intends to minimize potential damage to the isolation barrier upon failure of input or output circuitry.

| PARAMETER            |                                         | TEST CONDITIONS                                                                                                                              | MIN | TYP | MAX | UNIT             |
|----------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------------------|
| <b>DW-16 PACKAGE</b> |                                         |                                                                                                                                              |     |     |     |                  |
| $I_S$                | Safety input, output, or supply current | $R_{\theta JA} = 80.5^\circ\text{C/W}$ , $V_I = 3.6$ V, $T_J = 150^\circ\text{C}$ ,<br>$T_A = 25^\circ\text{C}$ , see <a href="#">#none#</a> |     |     | 431 | mA               |
| $T_S$                | Maximum safety temperature              |                                                                                                                                              |     |     | 150 | $^\circ\text{C}$ |

- (1) The maximum safety temperature,  $T_S$ , has the same value as the maximum junction temperature,  $T_J$ , specified for the device. The  $I_S$  and  $P_S$  parameters represent the safety current and safety power respectively. The maximum limits of  $I_S$  and  $P_S$  should not be exceeded. These limits vary with the ambient temperature,  $T_A$ .  
The junction-to-air thermal resistance,  $R_{\theta JA}$ , in the table is that of a device installed on a high-K test board for leaded surface-mount packages. Use these equations to calculate the value for each parameter:  
 $T_J = T_A + R_{\theta JA} \times P$ , where  $P$  is the power dissipated in the device.  
 $T_{J(max)} = T_S = T_A + R_{\theta JA} \times P_S$ , where  $T_{J(max)}$  is the maximum allowed junction temperature.  
 $P_S = I_S \times V_I$ , where  $V_I$  is the maximum input voltage.

## 6.9 Electrical Characteristics: Driver

All typical specs are at  $V_{CC1}=3.3V$ ,  $V_{CC2}=5V$ ,  $T_A=27^{\circ}C$ , (Min/Max specs are over recommended operating conditions unless otherwise noted)

| PARAMETER           | TEST CONDITIONS                                                      | MIN                                                                             | TYP | MAX       | UNIT    |
|---------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------|-----|-----------|---------|
| $ V_{OD} $          | Driver differential-output voltage magnitude                         |                                                                                 |     |           |         |
|                     | $I_O = 0$ mA, no load                                                | 2.5                                                                             |     | $V_{CC2}$ | V       |
|                     | $R_L = 54 \Omega$ , See Figure 11                                    | 1.5                                                                             | 2   |           | V       |
|                     | $R_L = 100 \Omega$ (RS-422), See Figure 11                           | 2                                                                               | 2.3 |           | V       |
|                     | $V_{test}$ from $-7$ V to $+12$ V, See Figure 12                     | 1.5                                                                             |     |           | V       |
| $\Delta  V_{OD} $   | Change in differential output voltage between two states             | -200                                                                            |     | 200       | mV      |
| $V_{OC(SS)}$        | Common-mode output voltage                                           | 1                                                                               | 2.6 | 3         | V       |
| $\Delta V_{OC(SS)}$ | change in steady-state common-mode output voltage between two states | -100                                                                            |     | 100       | mV      |
| $V_{OC(PP)}$        | Peak-to-peak common-mode output voltage                              |                                                                                 | 0.5 |           | V       |
| $I_I$               | Input current                                                        | -10                                                                             |     | 10        | $\mu A$ |
| $I_{OZ}$            | High-impedance state output current                                  | $V_Y$ or $V_Z = 12$ V, $V_{CC} = 0V$ or $3V$ , $DE = 0V$ ; other input at $0$ V |     | 90        | $\mu A$ |
|                     |                                                                      | $V_Y$ or $V_Z = -7$ V, $V_{CC} = 0V$ or $3V$ , $DE = 0V$ ; other input at $0$ V |     | -10       | $\mu A$ |
| $I_{OS(P)}^{(1)}$   | Short-circuit output current                                         | $V_Y$ or $V_Z = -7$ V to $+12$ V, Figure 14; Other input at $0$ V               |     | 300       | mA      |
| $I_{OS(SS)}^{(1)}$  | Short-circuit output current                                         | $V_Y$ or $V_Z = -7$ V to $+12$ V, Figure 14; Other input at $0$ V               |     | 250       | mA      |
| $C_{OD}$            | Differential output capacitance                                      | $V_I = 0.4 \sin(4E6 \pi t) + 0.5$ V, $DE$ at $0$ V                              |     | 16        | pF      |

(1) This device has thermal shutdown and output current-limiting features to protect in short-circuit fault condition.

## 6.10 Electrical Characteristics: Receiver

All typical specs are at  $V_{CC1}=3.3V$ ,  $V_{CC2}=5V$ ,  $T_A=27^{\circ}C$ , (Min/Max specs are over recommended operating conditions unless otherwise noted)

| PARAMETER      | TEST CONDITIONS                          | MIN                                                        | TYP | MAX  | UNIT    |
|----------------|------------------------------------------|------------------------------------------------------------|-----|------|---------|
| $V_{IT+}$      | Positive-going input threshold voltage   | $I_O = -8$ mA                                              |     | -20  | mV      |
| $V_{IT-}$      | Negative-going input threshold voltage   | $I_O = 8$ mA                                               |     | -200 | mV      |
| $V_{hys}$      | Input hysteresis ( $V_{IT+} - V_{IT-}$ ) |                                                            | 50  |      | mV      |
| $V_{OH}$       | High-level output voltage                | $V_{ID} = 200$ mV, $I_O = -8$ mA                           |     | 2.4  | V       |
| $V_{OL}$       | Low-level output voltage                 | $V_{ID} = -200$ mV, $I_O = 8$ mA                           |     | 0.4  | V       |
| $I_{O(Z)}$     | Output high-impedance current            | $V_O = 0$ or $V_{CC1}$ , $RE = V_{CC1}$                    |     | 1    | $\mu A$ |
| $I_A$ or $I_B$ | Bus input current                        | $V_A$ or $V_B = 12$ V, Other input at $0$ V                |     | 50   | $\mu A$ |
|                |                                          | $V_A$ or $V_B = 12$ V, $V_{CC} = 0$ , Other input at $0$ V |     | 60   | $\mu A$ |
|                |                                          | $V_A$ or $V_B = -7$ V, Other input at $0$ V                |     | -100 | $\mu A$ |
|                |                                          | $V_A$ or $V_B = -7$ V, $V_{CC} = 0$ , Other input at $0$ V |     | -30  | $\mu A$ |
| $I_{IH}$       | High-level input current, $RE$           | $V_{IH} = 2$ V                                             |     | 10   | $\mu A$ |

All typical specs are at  $V_{CC1}=3.3V$ ,  $V_{CC2}=5V$ ,  $T_A=27^{\circ}C$ , (Min/Max specs are over recommended operating conditions unless otherwise noted)

| PARAMETER |                                | TEST CONDITIONS                     | MIN | TYP | MAX | UNIT    |
|-----------|--------------------------------|-------------------------------------|-----|-----|-----|---------|
| $I_{IL}$  | Low-level input current, RE    | $V_{IL} = 0.8 V$                    | -10 |     | 10  | $\mu A$ |
| $R_{ID}$  | Differential input resistance  | Measured between A & B              | 96  |     |     | kohm    |
| $C_{ID}$  | Differential input capacitance | $V_I = 0.4 \sin(4E6 \pi t) + 0.5 V$ |     | 15  |     | pF      |

## 6.11 Supply Current

Bus loaded or unloaded (over recommended operating conditions unless otherwise noted)

| PARAMETER                                | TEST CONDITIONS                                                                                     | MIN | TYP | MAX | UNIT  |
|------------------------------------------|-----------------------------------------------------------------------------------------------------|-----|-----|-----|-------|
| <b>DRIVER ENABLED, RECEIVER DISABLED</b> |                                                                                                     |     |     |     |       |
| $I_{CC1}$ <sup>(1)</sup>                 | DE & RE = 0V or $V_{CC1}$ (Driver and Receiver Enabled or Disabled), D = 0 V or $V_{CC1}$ , No load |     | 4.5 | 8   | mA    |
| $I_{CC2}$ <sup>(1)</sup>                 | RE = 0 V or $V_{CC1}$ , DE = 0 V (driver disabled), No load                                         |     | 7.5 | 13  | mA    |
| $I_{CC2}$ <sup>(1)</sup>                 | RE = 0 V or $V_{CC1}$ , DE = $V_{CC1}$ (driver enabled), D = 0 V or $V_{CC1}$ , No load             |     | 9   | 16  | mA    |
| CMTI                                     | See Figure 23                                                                                       | 25  | 50  |     | kV/us |

- (1)  $I_{CC1}$  and  $I_{CC2}$  are measured when device is connected to external power supplies,  $V_{CC1}$  &  $V_{CC2}$ . In this case, D1 & D2 are open and disconnected from external transformer.

## 6.12 Transformer Driver Characteristics

| PARAMETER  | TEST CONDITIONS                                                                                                                          | MIN | TYP | MAX | UNIT |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $f_{OSC}$  | Oscillator frequency<br>$V_{CC1} = 3.3 \text{ V} \pm 10\%$ , D1 and D2 connected to transformer                                          | 300 | 400 | 550 | kHz  |
| $R_{ON}$   | Switch on resistance<br>D1 and D2 connected to 50- $\Omega$ pullup resistors                                                             |     | 1   | 2.5 | ohm  |
| $t_{r\_D}$ | D1, D2 output rise time<br>$V_{CC1} = 3.3 \text{ V} \pm 10\%$ , See Figure 28, D1 and D2 connected to 50- $\Omega$ pullup resistors      |     | 70  |     | ns   |
| $t_{f\_D}$ | D1, D2 output fall time<br>$V_{CC1} = 3.3 \text{ V} \pm 10\%$ , See Figure 28, D1 and D2 connected to 50- $\Omega$ pullup resistors      |     | 80  |     | ns   |
| $f_{st}$   | Startup frequency<br>$V_{CC1} = 2.4 \text{ V}$ , D1 and D2 connected to transformer                                                      |     | 350 |     | kHz  |
| $t_{BBM}$  | Break before make time delay<br>$V_{CC1} = 3.3 \text{ V} \pm 10\%$ , See Figure 28, D1 and D2 connected to 50- $\Omega$ pullup resistors |     | 140 |     | ns   |

### 6.13 Switching Characteristics: Driver

All typical specs are at  $V_{CC1}=3.3V$ ,  $V_{CC2}=5V$ ,  $T_A=27^{\circ}C$ , (Min/Max specs are over recommended operating conditions unless otherwise noted)

| PARAMETER               | TEST CONDITIONS                                               | MIN           | TYP | MAX | UNIT |
|-------------------------|---------------------------------------------------------------|---------------|-----|-----|------|
| <b>500-kbps DEVICES</b> |                                                               |               |     |     |      |
| $t_{PHL}$ , $t_{PLH}$   | Propagation delay                                             | See Figure 15 | 205 | 340 | ns   |
| PWD                     | Pulse width distortion <sup>(1)</sup> , $ t_{PHL} - t_{PLH} $ | See Figure 15 | 1.5 |     | ns   |
| $t_r$ , $t_f$           | Differential output rise time and fall time                   | See Figure 15 | 120 | 180 | 300  |
| $t_{PZH}$               | Propagation delay, high-impedance-to-high-level output        | See Figure 16 |     | 530 | ns   |
| $t_{PHZ}$               | Propagation delay, high-level-to-high-impedance output        | See Figure 16 |     | 205 | ns   |
| $t_{PLZ}$               | Propagation delay, low-level to high-impedance output         | See Figure 17 |     | 330 | ns   |
| $t_{PZL}$               | Propagation delay, standby-to-low-level output                | See Figure 17 |     | 530 | ns   |

(1) Also known as pulse skew.

### 6.14 Switching Characteristics: Receiver

All typical specs are at  $V_{CC1}=3.3V$ ,  $V_{CC2}=5V$ ,  $T_A=27^{\circ}C$ , (Min/Max specs are over recommended operating conditions unless otherwise noted)

| PARAMETER               | TEST CONDITIONS                                                                                               | MIN                      | TYP | MAX | UNIT |
|-------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|-----|-----|------|
| <b>500-kbps DEVICES</b> |                                                                                                               |                          |     |     |      |
| $t_{PHL}$ , $t_{PLH}$   | Propagation delay                                                                                             | See Figure 19            | 85  | 115 | ns   |
| PWD                     | Pulse Skew, $ t_{PHL} - t_{PLH} $                                                                             | See Figure 19            |     | 13  | ns   |
| $t_r$ , $t_f$           | Differential output rise time and fall time                                                                   | See Figure 19            | 1   | 4   | ns   |
| $t_{PHZ}$ , $t_{PLZ}$   | Propagation delay, high-impedance-to-high-level output, Propagation delay, high-impedance-to-low-level output | See Figure 20, DE at 0 V | 13  | 25  | ns   |
| $t_{PZH}$ , $t_{PZL}$   | Propagation delay, high-level-to-high-impedance output, Propagation delay, low-level to high-impedance output | See Figure 21, DE at 0 V | 13  | 25  | ns   |

### 6.15 Insulation Characteristics Curves

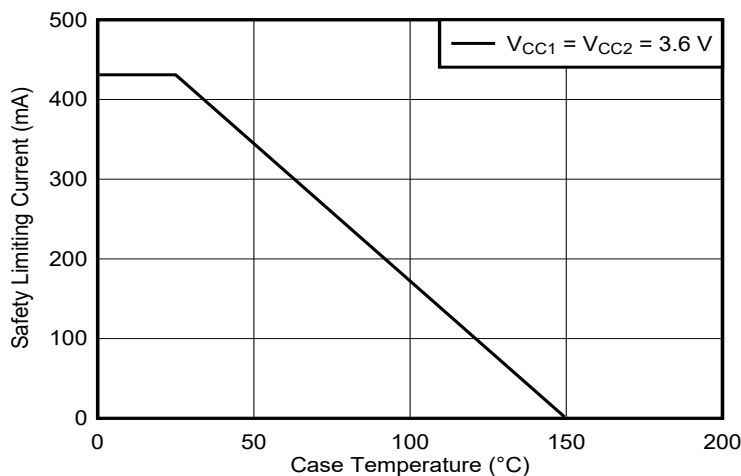


图 6-1. Thermal Derating Curve for Safety Limiting Power for DW-16 Package

## 6.16 Typical Characteristics

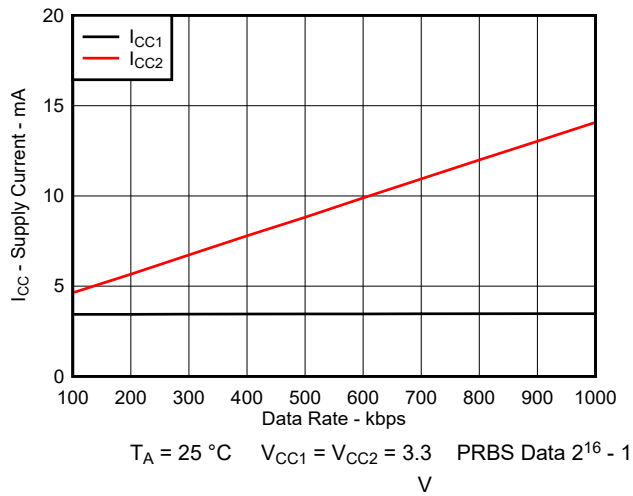


图 6-2. Supply Current vs Data Rate With No Load

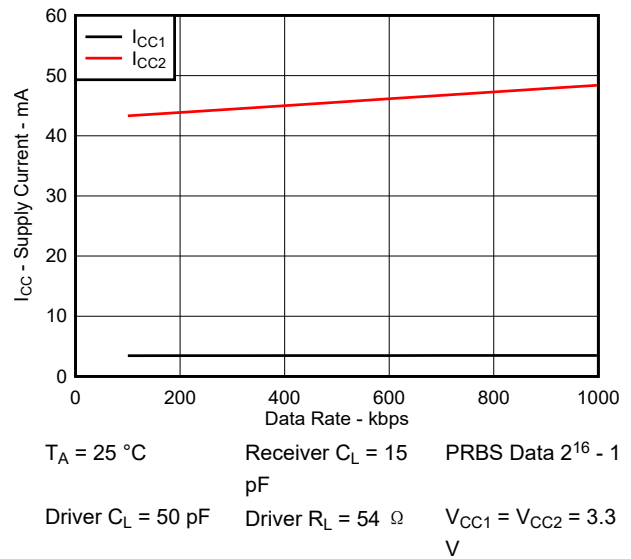


图 6-3. Supply Current vs Data Rate With Load

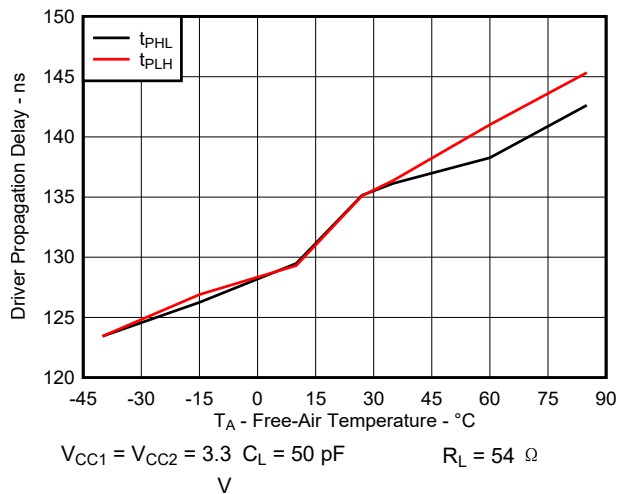


图 6-4. Driver Propagation Delay vs Free-Air Temperature

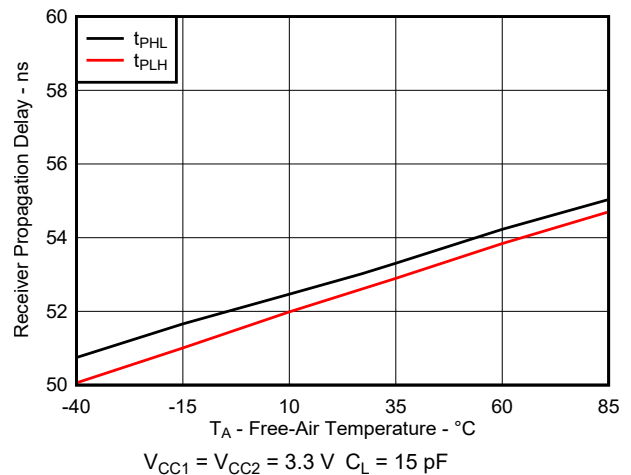


图 6-5. Receiver Propagation Delay vs Free-Air Temperature

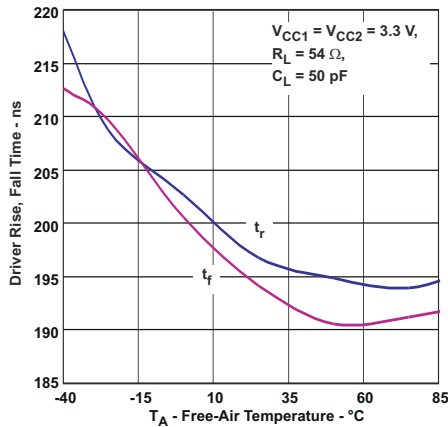


图 6-6. Driver Rise, Fall Time vs Free-Air Temperature

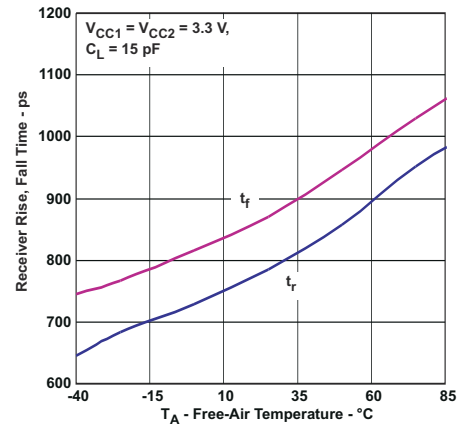


图 6-7. Receiver Rise, Fall Time vs Free-Air Temperature

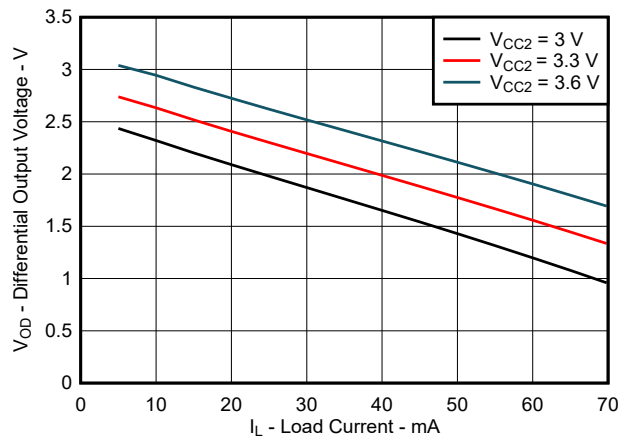


图 6-8. Differential Output Voltage vs Load Current

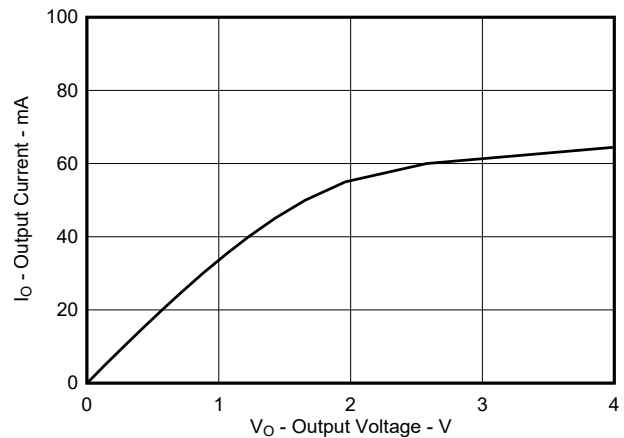


图 6-9. Receiver Low-Level Output Current vs Low-Level Output Voltage

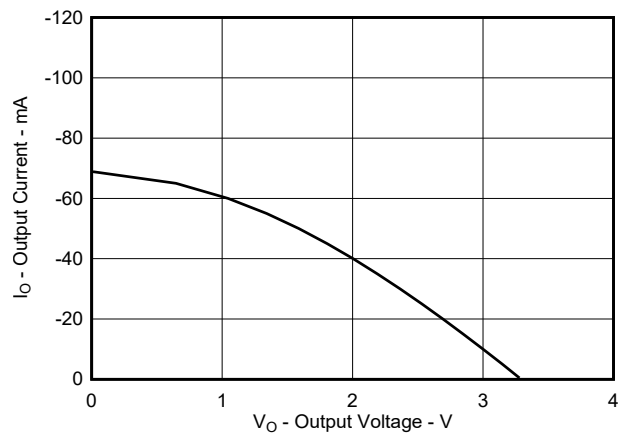


图 6-10. Receiver High-Level Output Current vs High-Level Output Voltage

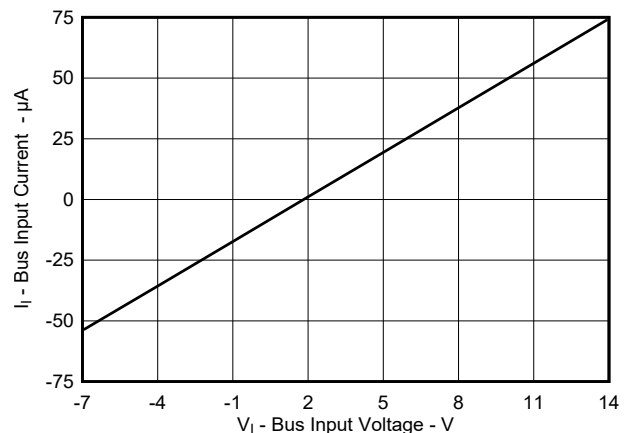


图 6-11. Bus Input Current vs Input Voltage

## 7 Parameter Measurement Information

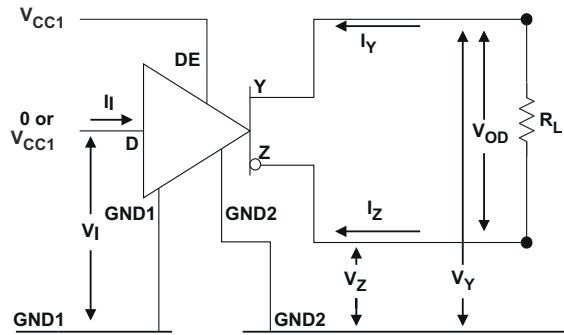


图 7-1. Driver  $V_{OD}$  Test and Current Definitions

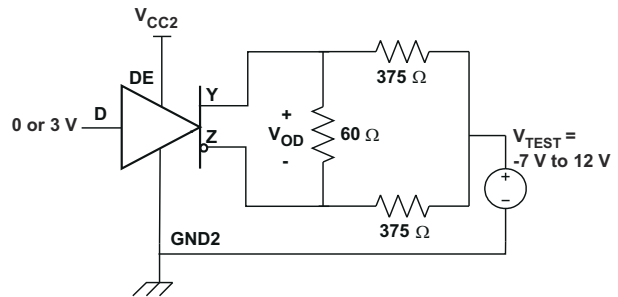


图 7-2. Driver  $V_{OD}$  With Common-Mode Loading Test Circuit

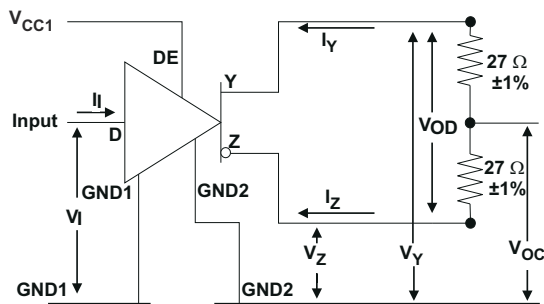


图 7-3. Test Circuit and Waveform Definitions For The Driver Common-Mode Output Voltage

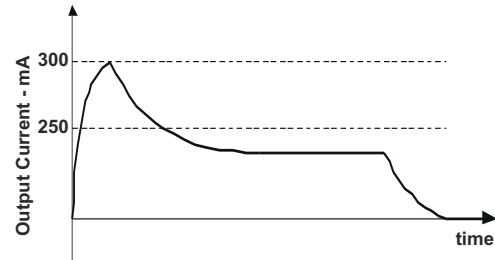
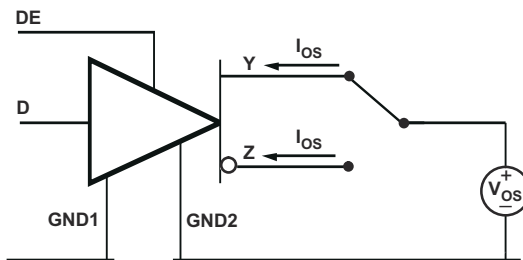


图 7-4. Driver Short-Circuit Test Circuit and Waveforms (Short Circuit applied at Time  $t=0$ )

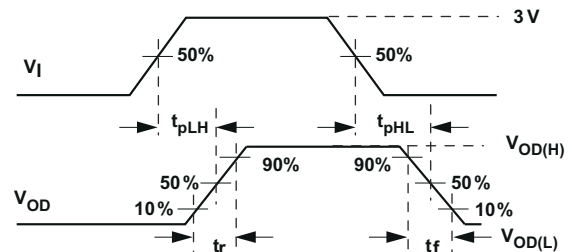
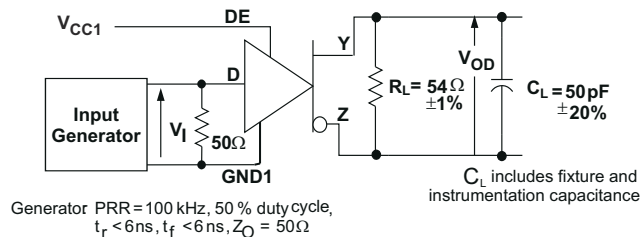


图 7-5. Driver Switching Test Circuit and Voltage Waveforms

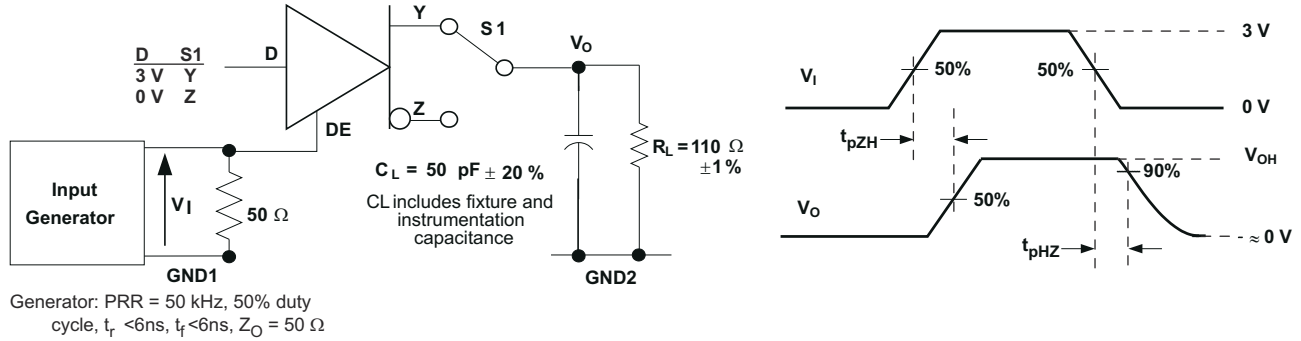


图 7-6. Driver High-Level Output Enable and Disable Time Test Circuit and Voltage Waveforms

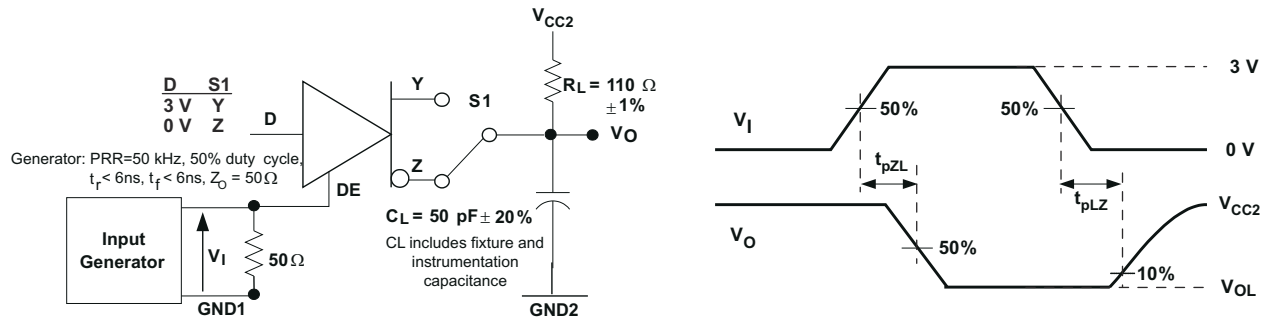


图 7-7. Driver Low-Level Output Enable and Disable Time Test Circuit and Voltage Waveform

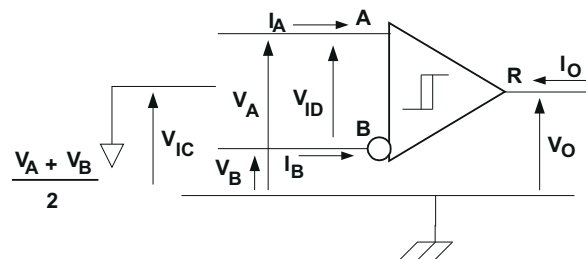


图 7-8. Receiver Voltage and Current Definitions

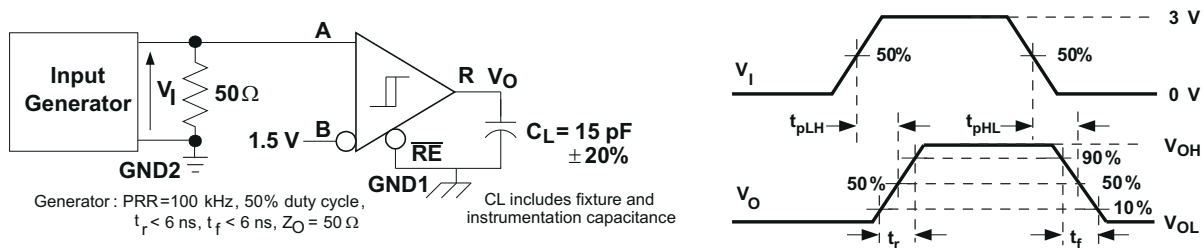


图 7-9. Receiver Switching Test Circuit and Waveforms

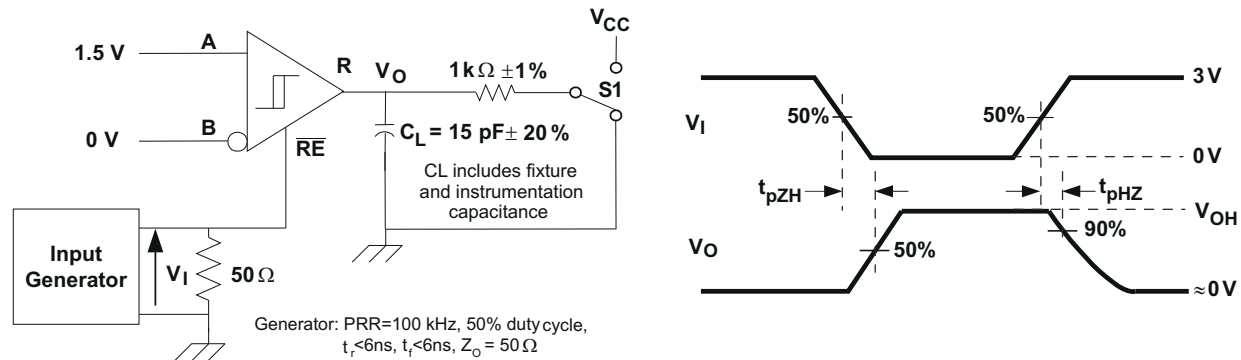


图 7-10. Receiver Enable Test Circuit and Waveforms, Data Output High

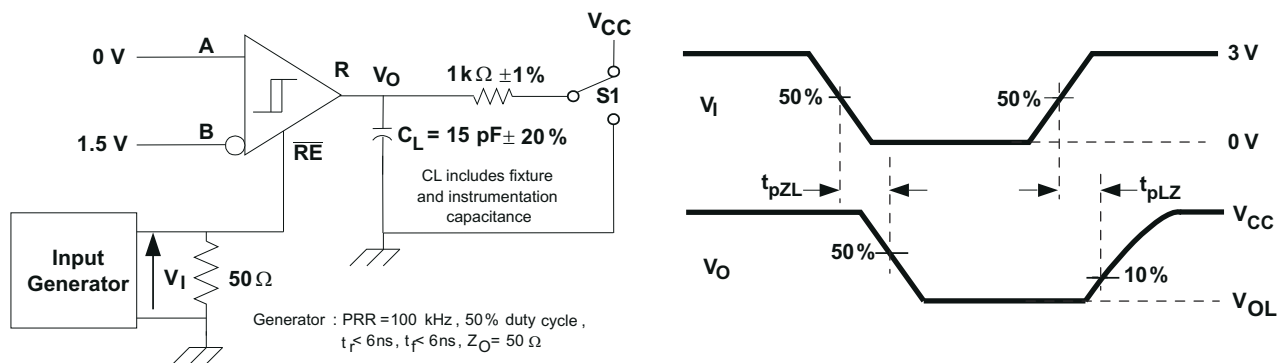


图 7-11. Receiver Enable Test Circuit and Waveforms, Data Output Low

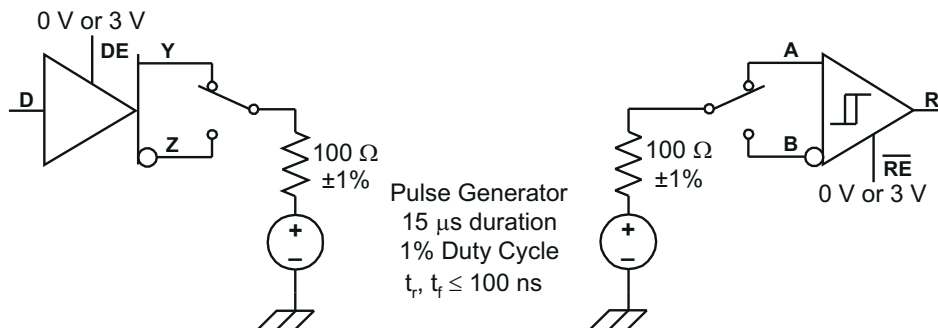


图 7-12. Transient Over-Voltage Test Circuit

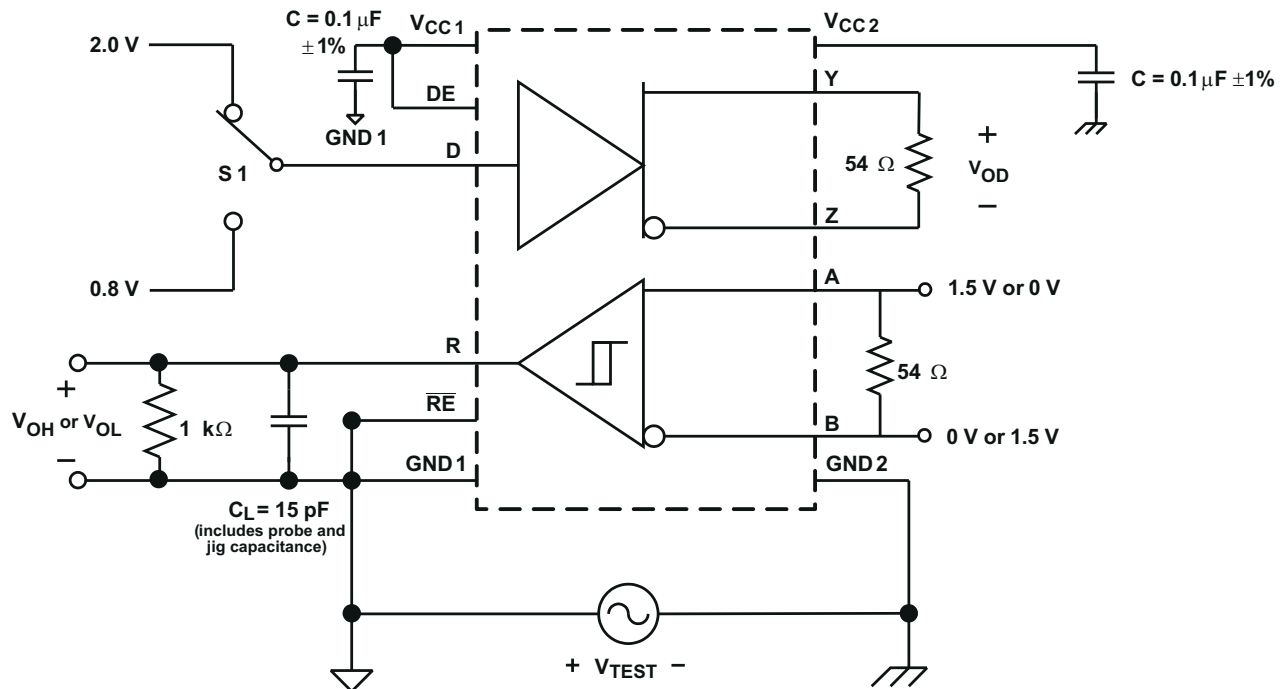


图 7-13. Common-Mode Transient Immunity Test Circuit

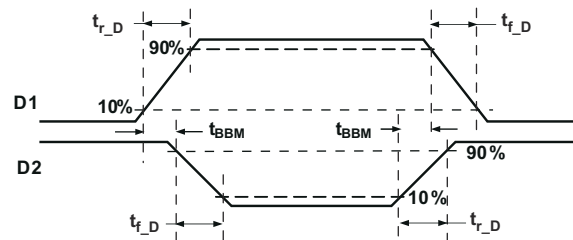


图 7-14. Transition Times and Break-Before-Make Time Delay for D1, D2 Outputs

## 8 Detailed Description

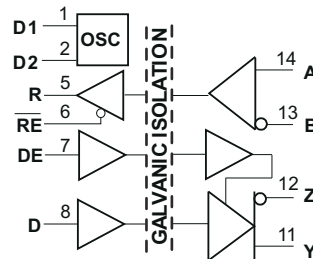
### 8.1 Overview

ISO35T is an isolated full-duplex differential transceiver with integrated transformer driver. The integrated transformer driver supports elegant secondary power supply design. This device is rated to provide galvanic isolation up to 4242 V<sub>PK</sub> per VDE and 2500 V<sub>RMS</sub> per UL. It has active-high driver enable and active-low receiver enable to control the data flow. It is suitable for data transmission up to 1 Mbps.

When the driver enable pin, DE, is logic high, the differential outputs Y and Z follow the logic states at data input D. A logic high at D causes Y to turn high and Z to turn low. In this case the differential output voltage defined as  $V_{OD} = V_{(Y)} - V_{(Z)}$  is positive. When D is low, the output states reverse, Z turns high, Y becomes low, and  $V_{OD}$  is negative. When DE is low, both outputs turn high-impedance. In this condition the logic state at D is irrelevant. The DE pin has an internal pulldown resistor to ground, thus when left open the driver is disabled (high-impedance) by default. The D pin has an internal pullup resistor to V<sub>CC</sub>, thus, when left open while the driver is enabled, output Y turns high and Z turns low.

When the receiver enable pin,  $\overline{RE}$ , is logic low, the receiver is enabled. When the differential input voltage defined as  $V_{ID} = V_{(A)} - V_{(B)}$  is positive and higher than the positive input threshold,  $V_{IT+}$ , the receiver output, R, turns high. When  $V_{ID}$  is negative and lower than the negative input threshold,  $V_{IT-}$ , the receiver output, R, turns low. If  $V_{ID}$  is between  $V_{IT+}$  and  $V_{IT-}$  the output is indeterminate. When  $\overline{RE}$  is logic high or left open, the receiver output is high-impedance and the magnitude and polarity of  $V_{ID}$  are irrelevant. Internal biasing of the receiver inputs causes the output to go failsafe-high when the transceiver is disconnected from the bus (open-circuit), the bus lines are shorted (short-circuit), or the bus is not actively driven (idle bus).

### 8.2 Functional Block Diagram



### 8.3 Device Functional Modes

表 8-1 和 表 8-2 是 ISO35T 驱动器和接收器的功能表。

表 8-1. Driver Function Table<sup>(1)</sup>

| INPUT | ENABLE | OUTPUTS |      |
|-------|--------|---------|------|
| (D)   | (DE)   | Y       | Z    |
| H     | H      | H       | L    |
| L     | H      | L       | H    |
| X     | L      | hi-Z    | hi-Z |
| X     | OPEN   | hi-Z    | hi-Z |
| OPEN  | H      | H       | L    |

(1) H = High Level, L = Low Level, X = Don't Care, hi-Z = High Impedance (Off)

表 8-2. Receiver Function Table<sup>(1)</sup>

| DIFFERENTIAL INPUT<br>$V_{ID} = (V_A - V_B)$ | ENABLE<br>(RE) | OUTPUT<br>(R) |
|----------------------------------------------|----------------|---------------|
| $-0.02\text{ V} \leq V_{ID}$                 | L              | H             |
| $-0.2\text{ V} < V_{ID} < 0.02\text{ V}$     | L              | ?             |
| $V_{ID} \leq -0.2\text{ V}$                  | L              | L             |

表 8-2. Receiver Function Table<sup>(1)</sup> (continued)

| DIFFERENTIAL INPUT<br>$V_{ID} = (V_A - V_B)$ | ENABLE<br>(RE) | OUTPUT<br>(R) |
|----------------------------------------------|----------------|---------------|
| X                                            | H              | hi-Z          |
| X                                            | OPEN           | hi-Z          |
| Open circuit                                 | L              | H             |
| Short Circuit                                | L              | H             |
| Idle (terminated) bus                        | L              | H             |

(1) H = High Level, L = Low Level, X = Don't Care, hi-Z = High Impedance (Off), ? = Indeterminate

### 8.3.1 Device I/O Schematics

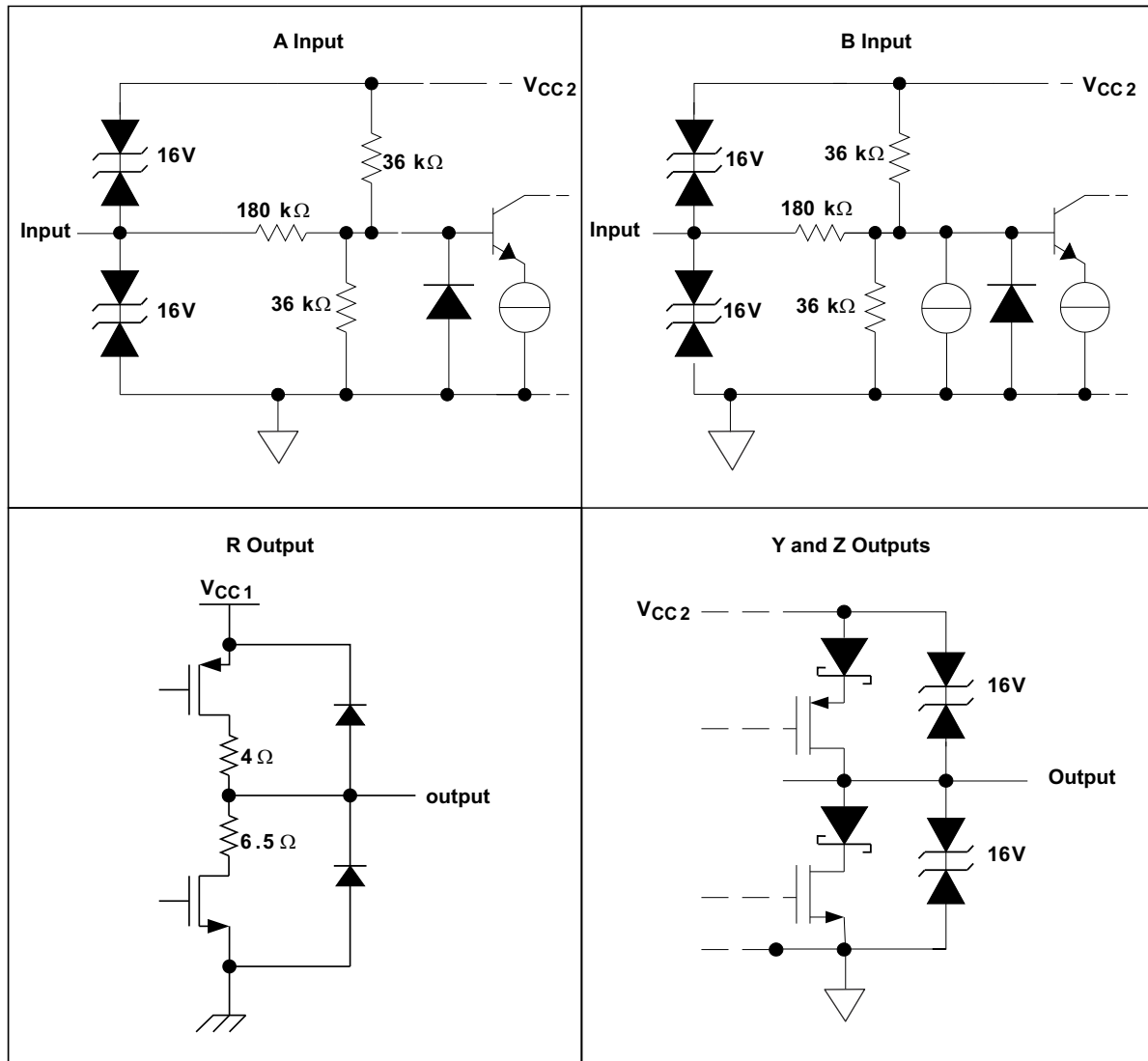


图 8-1. Equivalent Circuit Schematics

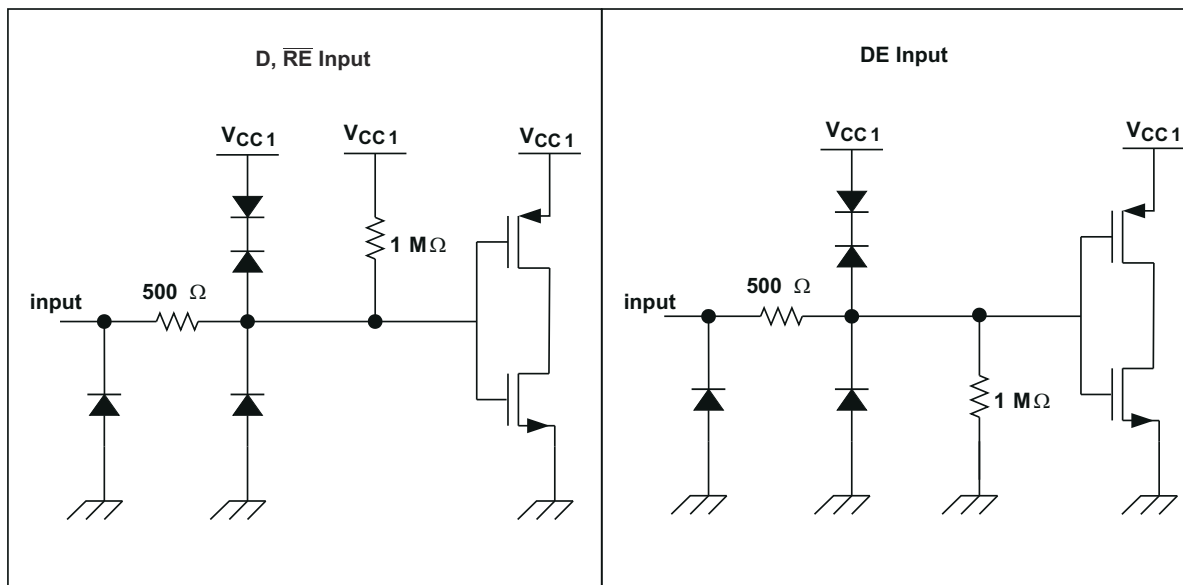


图 8-2. Equivalent Circuit Schematics

## 9 Application and Implementation

### 备注

以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

### 9.1 Application Information

ISO35T is a full-duplex RS-485 transceiver commonly used for asynchronous data transmission. Full-duplex implementation requires two signal pairs (four wires), and allows each node to transmit data on one pair while simultaneously receiving data on the other pair. To eliminate line reflections, each cable end is terminated with a termination resistor,  $R(T)$ , whose value matches the characteristic impedance,  $Z_0$ , of the cable. This method, known as parallel termination, allows for higher data rates over longer cable length.

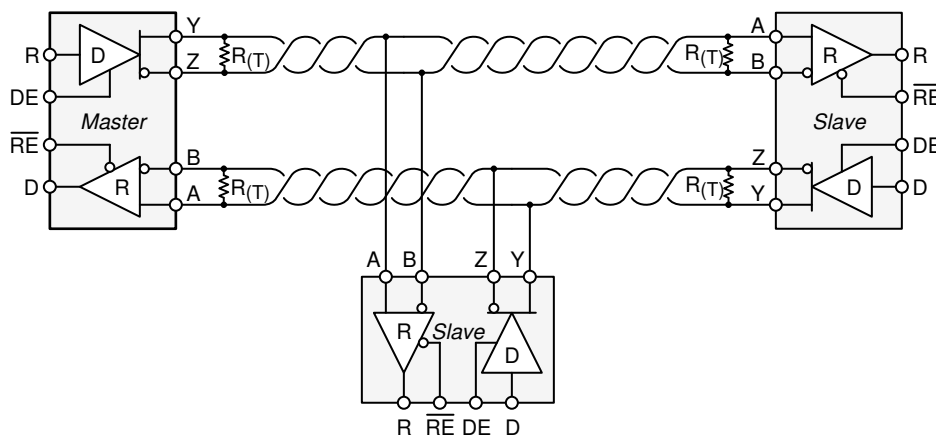


图 9-1. Typical RS-485 Network With Full-Duplex Transceivers

### 9.2 Typical Application

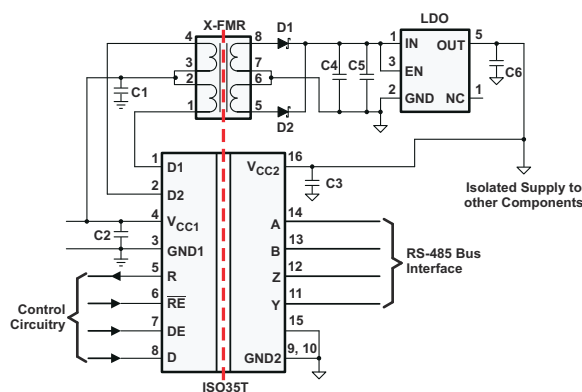


图 9-2. Typical Application Circuit

## 9.2.1 Design Requirements

RS-485 is a robust electrical standard suitable for long-distance networking that may be used in a wide range of applications with varying requirements, such as distance, data rate, and number of nodes.

表 9-1. Design Parameters

| PARAMETER                     | VALUE         |
|-------------------------------|---------------|
| Pullup and Pulldown Resistors | 1 kΩ to 10 kΩ |
| Decoupling Capacitors         | 100 nF        |

## 9.2.2 Detailed Design Procedure

### 9.2.2.1 Transient Voltages

Isolation of a circuit insulates it from other circuits and earth so that noise develops across the insulation rather than circuit components. The most common noise threat to data-line circuits is voltage surges or electrical fast transients that occur after installation and the transient ratings of ISO35T are sufficient for all but the most severe installations. However, some equipment manufacturers use their ESD generators to test transient susceptibility of their equipment and can easily exceed insulation ratings. ESD generators simulate static discharges that may occur during device or equipment handling with low-energy but very high voltage transients.

图 9-3 models the ISO35T bus IO connected to a noise generator.  $C_{IN}$  and  $R_{IN}$  is the device and any other stray or added capacitance or resistance across the A or B pin to GND2,  $C_{ISO}$  and  $R_{ISO}$  is the capacitance and resistance between GND1 and GND2 of ISO35T plus those of any other insulation (transformer, etc.), and we assume stray inductance negligible. From this model, the voltage at the isolated bus return is shown in 方程式 1 and will always be less than 16 V from  $V_N$ .

$$V_{GND2} = V_N \frac{Z_{ISO}}{Z_{ISO} + Z_{IN}} \quad (1)$$

If ISO35T is tested as a stand-alone device,  $R_{IN} = 6 \times 10^4 \Omega$ ,  $C_{IN} = 16 \times 10^{-12} \text{ F}$ ,  $R_{ISO} = 10^9 \Omega$  and  $C_{ISO} = 10^{-12} \text{ F}$ .

In 图 9-3 the resistor ratio determines the voltage ratio at low frequency and it is the inverse capacitance ratio at high frequency. In the stand-alone case and for low frequency, use 方程式 2, or essentially all noise appears across the barrier.

$$\frac{V_{GND2}}{V_N} = \frac{R_{ISO}}{R_{ISO} + R_{IN}} = \frac{10^9}{10^9 + 6 \times 10^4} \quad (2)$$

At very high frequency, 方程式 3 is true and 94% of  $V_N$  appears across the barrier.

$$\frac{V_{GND2}}{V_N} = \frac{\frac{1}{C_{ISO}}}{\frac{1}{C_{ISO}} + \frac{1}{C_{IN}}} = \frac{1}{1 + \frac{C_{ISO}}{C_{IN}}} = \frac{1}{1 + \frac{1}{16}} = 0.94 \quad (3)$$

As long as  $R_{ISO}$  is greater than  $R_{IN}$  and  $C_{ISO}$  is less than  $C_{IN}$ , most of transient noise appears across the isolation barrier, as it should.

We recommend the reader not test equipment transient susceptibility with ESD generators or consider product claims of ESD ratings above the barrier transient ratings of an isolated interface. ESD is best managed through recessing or covering connector pins in a conductive connector shell and installer training.

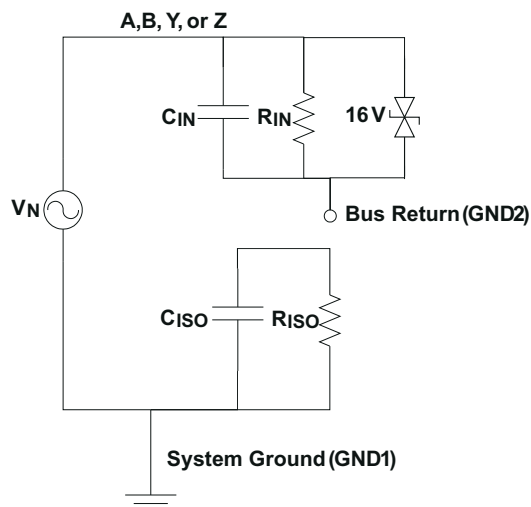


图 9-3. Noise Model

### 9.2.3 Application Curve

At maximum working voltage, ISO3086T isolation barrier has more than 28 years of life.

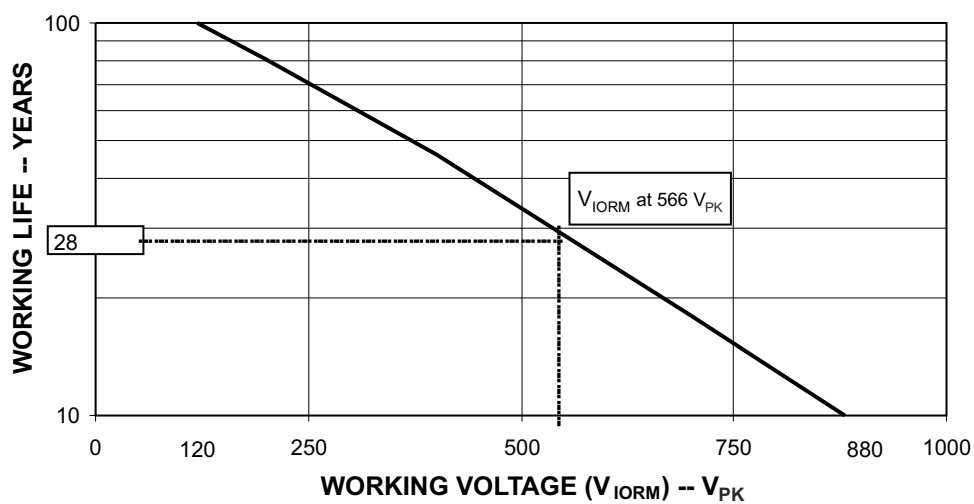


图 9-4. Time-Dependent Dielectric Breakdown Test Results

## 10 Power Supply Recommendations

To ensure reliable operation at all data rates and supply voltages, TI recommends a 0.1- $\mu$ F bypass capacitor at input and output supply pins ( $V_{CC1}$  and  $V_{CC2}$ ). The capacitors should be placed as close to the supply pins as possible. This device is used in applications where only a single primary-side power supply is available. Isolated power can be generated for the secondary-side with the help of integrated transformer driver.

## 11 Layout

### 11.1 Layout Guidelines

ON-chip IEC-ESD protection is good for laboratory and portable equipment but never sufficient for EFT and surge transients occurring in industrial environments. Therefore, robust and reliable bus node design requires the use of external transient protection devices. Because ESD and EFT transients have a wide frequency bandwidth from approximately 3-MHz to 3-GHz, high-frequency layout techniques must be applied during PCB design. A minimum of four layers is required to accomplish a low EMI PCB design (see [Figure 11-1](#)).

- Layer stacking should be in the following order (top-to-bottom): high-speed signal layer, ground plane, power plane, and low-frequency signal layer.
- Placing a solid ground plane next to the high-speed signal layer establishes controlled impedance for transmission line interconnects and provides an excellent low-inductance path for the return current flow.
- Placing the power plane next to the ground plane creates additional high-frequency bypass capacitance of approximately 100 pF/in<sup>2</sup>.
- Routing the slower speed control signals on the bottom layer allows for greater flexibility as these signal links usually have margin to tolerate discontinuities such as vias.
- Place the protection circuitry close to the bus connector to prevent noise transients from penetrating your board.
- Use  $V_{CC}$  and ground planes to provide low-inductance. High-frequency currents might follow the path of least inductance and not necessarily the path of least resistance.
- Design the protection components into the direction of the signal path. Do not force the transient currents to divert from the signal path to reach the protection device.
- Apply 0.1- $\mu$ F bypass capacitors as close as possible to the  $V_{CC}$ -pins of transceiver, UART, and controller ICs on the board.
- Use at least two vias for  $V_{CC}$  and ground connections of bypass capacitors and protection devices to minimize effective via-inductance.
- Use 1-k $\Omega$  to 10-k $\Omega$  pullup and pulldown resistors for enable lines to limit noise currents in these lines during transient events.
- Insert pulse-proof resistors into the A and B bus lines if the TVS clamping voltage is higher than the specified maximum voltage of the transceiver bus pins. These resistors limit the residual clamping current into the transceiver and prevent it from latching up.
- While pure TVS protection is sufficient for surge transients up to 1 kV, higher transients require metal-oxide varistors (MOVs) which reduce the transients to a few hundred volts of clamping voltage, and transient blocking units (TBUs) that limit transient current to less than 1 mA.
- Routing the high-speed traces on the top layer avoids the use of vias (and the introduction of their inductances) and allows for clean interconnects between the isolator and the transmitter and receiver circuits of the data link.

If an additional supply voltage plane or signal layer is needed, add a second power and ground plane system to the stack to keep it symmetrical. This makes the stack mechanically stable and prevents it from warping. Also the power and ground plane of each power system can be placed closer together, thus increasing the high-frequency bypass capacitance significantly.

#### 备注

For detailed layout recommendations, see Application Note *Digital Isolator Design Guide*, [SLLA284](#).

## 11.2 Layout Example

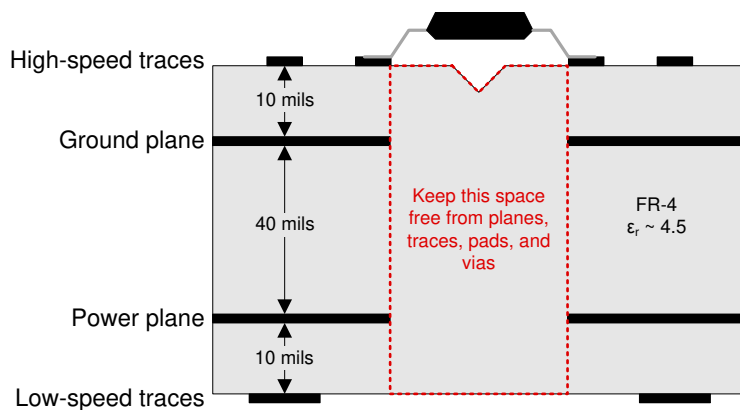


图 11-1. Recommended Layer Stack

## 12 Device and Documentation Support

### 12.1 Documentation Support

#### 12.1.1 Related Documentation

For related documentation see the following:

- *Isolated, Full-Duplex, 1-Mbps, 3.3-V to 3.3-V RS-485 Interface* ([SLUU470](#))
- *Digital Isolator Design Guide* ([SLLA284](#))
- *Isolation Glossary* ([SLLA353](#))

### 12.2 Community Resources

### 12.3 Trademarks

所有商标均为其各自所有者的财产。

### 12.4 静电放电警告



静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

### 12.5 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

| Orderable part number     | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|---------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">ISO35TDW</a>  | Obsolete      | Production           | SOIC (DW)   16 | -                     | -           | Call TI                              | Call TI                           | -40 to 85    | ISO35TDW            |
| <a href="#">ISO35TDWR</a> | Active        | Production           | SOIC (DW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | ISO35TDW            |
| ISO35TDWR.A               | Active        | Production           | SOIC (DW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | ISO35TDW            |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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 |
|-----------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| ISO35TDWR | SOIC         | DW              | 16   | 2000 | 330.0              | 16.4               | 10.75   | 10.7    | 2.7     | 12.0    | 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) |
|-----------|--------------|-----------------|------|------|-------------|------------|-------------|
| ISO35TDWR | SOIC         | DW              | 16   | 2000 | 353.0       | 353.0      | 32.0        |

## GENERIC PACKAGE VIEW

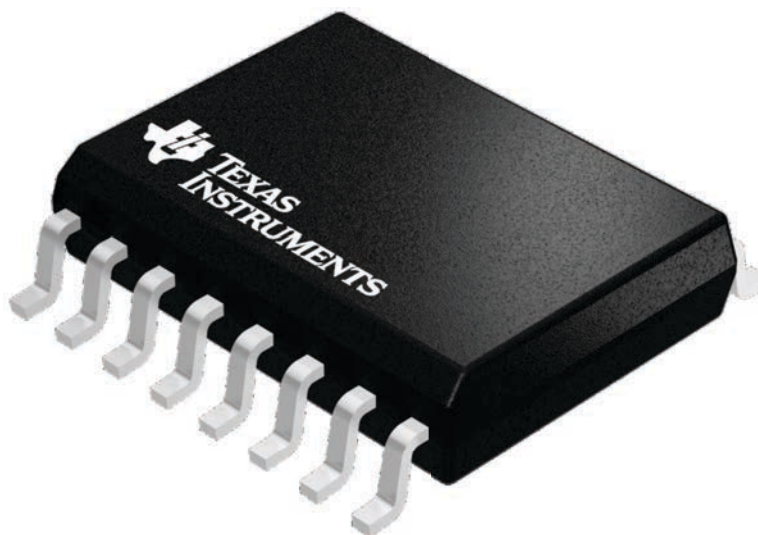
**DW 16**

**SOIC - 2.65 mm max height**

7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4224780/A

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