# ISO164x Hot-Swappable Bidirectional I2C Isolators with Enhanced EMC and GPIOs

## 1 Features

- Robust Isolated Bidirectional, $I^2C$ Compatible, Communication
  - ISO1640: Bidirectional SDA and SCL communication
  - ISO1641: Bidirectional SDA and unidirectional SCL communication
  - ISO1642/3/4: Bidirectional SDA and SCL communication with either 2 or 3 unidirectional GPIO channels
  - Hot-Swappable SDA and SCL
- Bidirectional data transfer up to 1.7 MHz Operation
- Up to 3 additional unidirectional isolated GPIO channels supporting 50 Mbps speed
- Robust isolation barrier with enhanced EMC:
  - >100-year projected lifetime at 450 $V_{RMS}$ working voltage (D-8) and 1500 $V_{RMS}$ working voltage (DW-16)
  - Up to 5000 $V_{RMS}$ isolation rating per UL1577
  - Up to 10 kV reinforced surge capability
  - ±100 kV/µs typical CMTI
  - ±8 kV IEC-ESD 61000-4-2 contact discharge protection across isolation barrier
  - Same side ±8 kV IEC-ESD unpowered contact discharge on SCL2 and SDA2 (Side 2)
- Supply range: 3 V to 5.5 V (Side 1) and 2.25 V to 5.5 V (Side 2)
- Open-drain outputs with 3.5-mA (Side 1) and 50-mA (Side 2) current-sink capability
- Max capacitive load: 80 pF (Side 1) and 400 pF (Side 2)
- 16-SOIC (DW-16) and 8-SOIC (D-8) Package Options
- –40°C to +125°C Operating Temperature
- Safety-Related Certifications (planned):
  - UL 1577 Component Recognition Program
  - DIN VDE V 0884-11
  - IEC 62368-1, IEC 61010-1, IEC 60601-1 and GB4943.1-2011 certifications

## 2 Applications

- Isolated $I^2C$ Buses
- Isolated $I^2C$ and SPI Buses
- SMBus and PMBus Interfaces
- Power Over Ethernet (PoE)
- Motor Control Systems
- Battery Management

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## 3 Description

The ISO1640, ISO1641, ISO1642, ISO1643 and ISO1644 (ISO164x) devices are hot swappable, low-power, bidirectional isolators that are compatible with $I^2C$ interfaces. The ISO164x supports UL 1577 isolation ratings of 5000 $V_{RMS}$ in the 16-DW package, and 3000 $V_{RMS}$ in the 8-D package. Each $I^2C$ isolation channel in this low emissions device has a logic input and open drain output separated by a double capacitive silicon dioxide ($SiO_2$) insulation barrier. The ISO1642 and ISO1643 intregrates 2 unidirectional CMOS isolation channels, while the ISO1644 intregrates 3 unidirectional CMOS isolation channels which can be used for static GPIO isolation or to isolate a Serial Peripheral Interface (SPI) bus. This family includes basic and reinforced insulation devices certified by VDE, UL, CSA, TUV and CQC. The ISO1640/2/3/4 have two isolated bidirectional channels for clock and data lines and the ISO1641 has a bidirectional data and a unidirectional clock channel. The ISO164x family integrates logic required to support bidirectional channels, providing a much simpler design and smaller footprint when compared to optocoupler-based solutions.

**Device Information**(1)

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| ISO1640BD<br>ISO1641BD | SOIC (8) | 4.90 mm × 3.91 mm |
| ISO1640DW<br>ISO1641DW<br>ISO1642DW<br>ISO1643DW<br>ISO1644DW | SOIC (16) | 10.30 mm × 7.50 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

**Isolation Options**

| PART NUMBER | ISO164xBD | ISO164xDW |
|---|---|---|
| Protection Level | Basic | Reinforced |
| Surge Test Voltage | 6500 $V_{PK}$ | 10000 $V_{PK}$ |
| Isolation Rating | 3000 $V_{RMS}$ | 5000 $V_{RMS}$ |
| Working Voltage | 450 $V_{RMS}$ / 637 $V_{PK}$ | 1500 $V_{RMS}$ / 2121 $V_{PK}$ |

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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision C (June 2021) to Revision D (September 2021) | Page |
|---|---|
| • Added ISO1641DW, ISO1642DW and ISO1643DW to the datasheet | 1 |

| Changes from Revision B (May 2021) to Revision C (June 2021) | Page |
|---|---|
| • Added ISO1644DW to the datasheet | 1 |

| Changes from Revision A (December 2020) to Revision B (May 2021) | Page |
|---|---|
| • Added ISO1641B to the datasheet | 1 |
| • Changed minimum input threshold low to 480 mV | 14 |
| • Changed $t_{pLH1-2}$, $t_{pLH2-1}$, $t_{LOOP1}$ max to a lower value for all operating voltages | 19 |

## 5 Pin Configuration and Functions

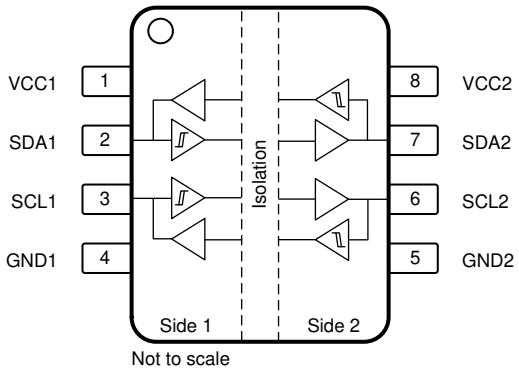



**Figure 5-1. ISO1640B Package 8-Pin SOIC Top View**

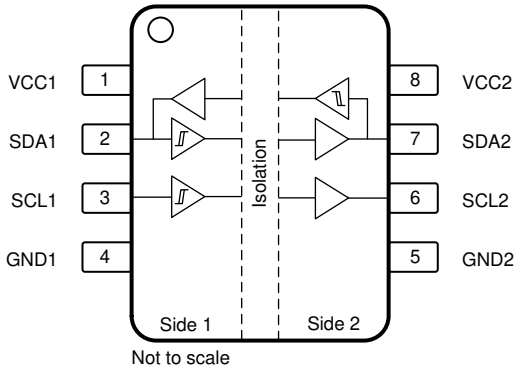



**Figure 5-2. ISO1641B Package 8-Pin SOIC Top View**

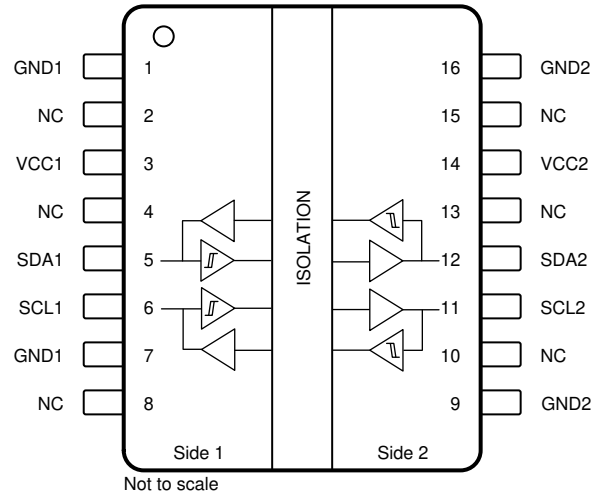



**Figure 5-3. ISO1640 Package 16-Pin SOIC Top View**

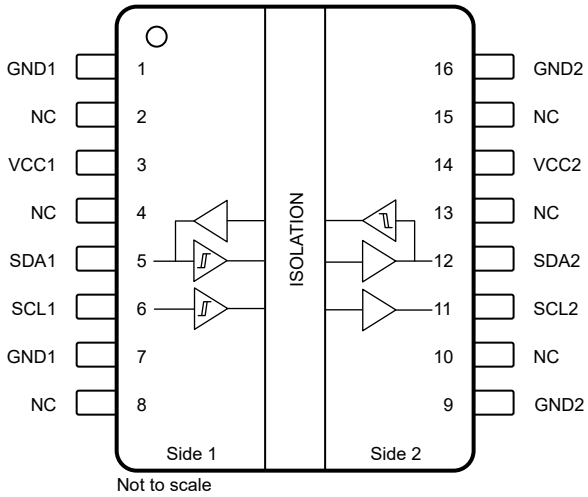



**Figure 5-4. ISO1641 Package 16-Pin SOIC Top View**

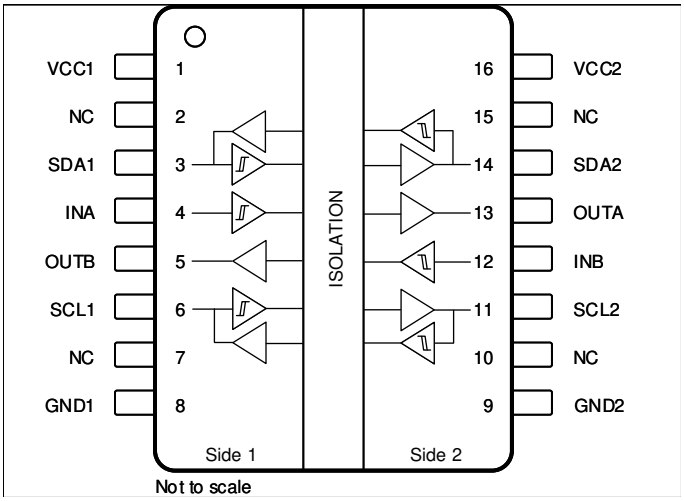



**Figure 5-5. ISO1642 Package 16-Pin SOIC Top View**

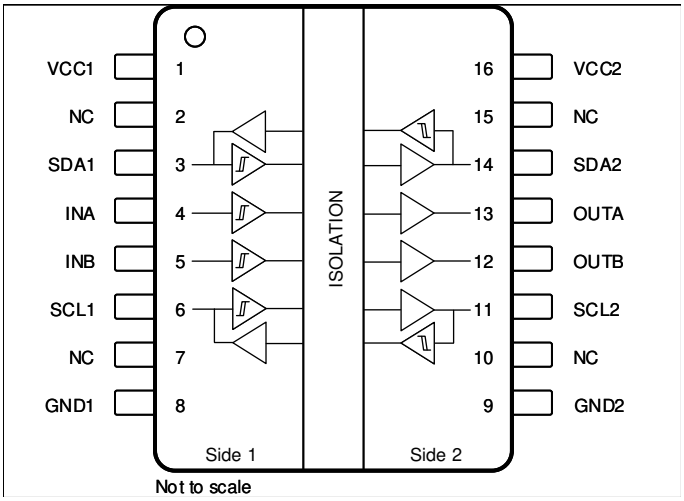



**Figure 5-6. ISO1643 Package 16-Pin SOIC Top View**

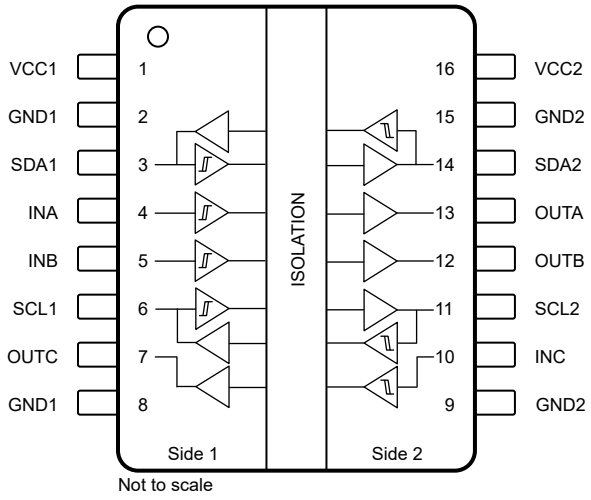



**Figure 5-7. ISO1644 Package 16-Pin SOIC Top View**

**Table 5-1. Pin Functions — ISO1640 and ISO1641**

| PIN | | | I/O | DESCRIPTION |
|---|---|---|---|---|
| | 8-D | 16-DW | | |
| NAME | NO. | NO. | | |
| GND1 | 4 | 1, 7 | — | Ground, side 1 |
| GND2 | 5 | 9, 16 | — | Ground, side 2 |
| NC | — | 2, 4, 8, 10, 13, 15 | — | No Connection |
| SCL1 | 3 | 6 | I/O | Serial clock input / output, side 1 (ISO1640 only)<br>Serial clock input, side 1 (ISO1641 only) |
| SCL2 | 6 | 11 | I/O | Serial clock input / output, side 2 (ISO1640 only)<br>Serial clock output, side 2 (ISO1641 only) |
| SDA1 | 2 | 5 | I/O | Serial data input / output, side 1 |
| SDA2 | 7 | 12 | I/O | Serial data input / output, side 2 |
| VCC1 | 1 | 3 | — | Supply voltage, side 1 |
| VCC2 | 8 | 14 | — | Supply voltage, side 2 |

**Table 5-2. Pin Functions — ISO1642 and ISO1643**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| | 16-DW | | |
| NAME | NO. | | |
| GND1 | 8 | — | Ground, side 1 |
| GND2 | 9 | — | Ground, side 2 |
| INA | 4 | I | Input, channel A |
| INB/OUTB | 12 | — | Input, channel B (ISO1642)<br>Output, channel B (ISO1643) |
| NC | 2, 7, 10, 15 | — | No Connect |
| OUTA | 13 | O | Output, channel A |
| OUTB/INB | 5 | — | Output, channel B (ISO1642)<br>Input, channel B (ISO1643) |
| SCL1 | 6 | I/O | Serial clock input / output, side 1 |
| SCL2 | 11 | I/O | Serial clock input / output, side 2 |
| SDA1 | 3 | I/O | Serial data input / output, side 1 |
| SDA2 | 14 | I/O | Serial data input / output, side 2 |
| VCC1 | 1 | — | Supply voltage, side 1 |
| VCC2 | 16 | — | Supply voltage, side 2 |

**Table 5-3. Pin Functions — ISO1644**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| | 16-DW | | |
| NAME | NO. | | |
| GND1 | 2, 8 | — | Ground, side 1 |
| GND2 | 9, 15 | — | Ground, side 2 |
| INA | 4 | I | Input, channel A |
| INB | 5 | I | Input, channel B |
| INC | 10 | I | Input, channel C |
| OUTA | 13 | O | Output, channel A |
| OUTB | 12 | O | Output, channel B |
| OUTC | 7 | O | Output, channel C |

**Table 5-3. Pin Functions — ISO1644 (continued)**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| | 16-DW | | |
| NAME | NO. | | |
| SCL1 | 6 | I/O | Serial clock input / output, side 1 |
| SCL2 | 11 | I/O | Serial clock input / output, side 2 |
| SDA1 | 3 | I/O | Serial data input / output, side 1 |
| SDA2 | 14 | I/O | Serial data input / output, side 2 |
| VCC1 | 1 | — | Supply voltage, side 1 |
| VCC2 | 16 | — | Supply voltage, side 2 |

# 6 Specifications

## 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1) (2)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply Voltage | $V_{CC1}$, $V_{CC2}$ | –0.5 | 6 | V |
| Input/Output Voltage | SDA1, SCL1 | –0.5 | $V_{CCX}$ + 0.5(3) | V |
| | SDA2, SCL2 | –0.5 | $V_{CCX}$ + 0.5(3) | |
| | INx (ISO1642/3/4 only) | -0.5 | $V_{CCX}$ + 0.5 | |
| Input/Output Current | SDA1, SCL1 | 0 | 20 | mA |
| | SDA2, SCL2 | 0 | 100 | |
| | $I_{IO}$ (ISO1642/3/4 only) | -15 | 15 | |
| Temperature | Maximum junction temperature, $T_J$ | | 150 | °C |
| | Storage temperature, $T_{stg}$ | –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 are with respect to the local ground pin (GND1 or GND2) and are peak voltage values.
(3) During powered off hotswap, the $I^2C$ bus pins can be 0 V < SDAx, SCLx < 6 V.

## 6.2 ESD Ratings

| | | | | VALUE | UNIT |
|---|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | All pins | ±6000 | V |
| | | | ISO1640/1: Bus pins (SDA1, SCL1) | ±10000 | V |
| | | | ISO1640/1: Bus pins (SDA2, SCL2) | ±14000 | V |
| | | | ISO1642/3/4: Bus pins (SDA1, SCL1) | ±8000 | V |
| | | | ISO1642/3/4: Bus pins (SDA2, SCL2) | ±8000 | V |
| | | Charged-device model (CDM), per ANSI/ESDA/JEDEC specification JS-002(2) | | ±1500 | V |
| | | Contact discharge per IEC 61000-4-2; Isolation barrier withstand test(3) (4) | | ±8000 | V |
| | | Same side unpowered IEC ESD contact discharge per IEC 61000-4-2; Side 2 | ISO1640/1: SCL2, SDA2 | ±8000 | 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.
(3) IEC ESD strike is applied across the barrier with all pins on each side tied together creating a two-terminal device.
(4) Testing is carried out in air or oil to determine the intrinsic contact discharge capability of the device.

## 6.3 Recommended Operating Conditions

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC1(UVLO+)}$ | UVLO threshold when supply voltage is rising on Side 1 | | 2.7 | 2.9 | V |
| $V_{CC1(UVLO-)}$ | UVLO threshold when supply voltage is falling on Side 1 | 2.3 | 2.6 | | V |
| $V_{CC2(UVLO+)}$ | UVLO threshold when supply voltage is rising on Side 2 | | 2 | 2.25 | V |
| $V_{CC2(UVLO-)}$ | UVLO threshold when supply voltage is falling on Side 2 | 1.7 | 1.8 | | V |
| $V_{HYS1(UVLO)}$ | Supply voltage UVLO hysteresis, Side 1 | 100 | 150 | | mV |
| $V_{HYS2(UVLO)}$ | Supply voltage UVLO hysteresis, Side 2 | 100 | 150 | | mV |
| $V_{CC1}$ | Supply voltage, Side 1 | 3.0 | | 5.5 | V |
| $V_{CC2}$ | Supply voltage, Side 2 | 2.25 | | 5.5 | V |
| $V_{SDA1}$, $V_{SCL1}$ | I2C Input and output signal voltages, Side 1 | 0 | | $V_{CC1}$ | V |

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{SDA2}$, $V_{SCL2}$ | I2C Input and output signal voltages, Side 2 | 0 | | $V_{CC2}$ | V |
| $V_{IL1}$ | I2C Low-level input voltage, Side 1 | 0 | | 480 | mV |
| $V_{IH1}$ | I2C High-level input voltage, Side 1 | 0.7 × $V_{CC1}$ | | $V_{CC1}$ | V |
| $V_{IL2}$ | I2C Low-level input voltage, Side 2 | 0 | | 0.3 × $V_{CC2}$ | V |
| $V_{IH2}$ | I2C High-level input voltage, Side 2 | 0.5 × $V_{CC2}$ | | $V_{CC2}$ | V |
| $I_{OL1}$ | I2C Output current, Side 1 | 0.5 | | 3.5 | mA |
| $I_{OL2}$ | I2C Output current, Side 2 | 0.5 | | 50 | mA |
| C1 | Capacitive load, Side 1 | | | 80 | pF |
| C2 | Capacitive load, Side 2 | | | 400 | pF |
| $f_{MAX}$ | I2C Operating frequency(1) | | | 1.7 | MHz |
| $V_{ILIO}$ | Low-level input voltage, GPIO pins (ISO1642/3/4 only) | 0 | | 0.3 × $V_{CC2}$ | V |
| $V_{IHIO}$ | High-level input voltage, GPIO pins (ISO1642/3/4 only) | 0.7 × $V_{CC1}$ | | $V_{CC1}$ | V |
| $I_{OHIO}$ | GPIO High-level output current, $V_{CCO}$ = 5 V (ISO1642/3/4 only) | -4 | | | mA |
| | GPIO High-level output current, $V_{CCO}$ = 3.3 V (ISO1642/3/4 only) | -2 | | | mA |
| | GPIO High-level output current, $V_{CCO}$ = 2.5 V (ISO1642/3/4 only) | -1 | | | mA |
| $I_{OLIO}$ | GPIO Low-level output current, $V_{CCO}$ = 5 V (ISO1642/3/4 only) | | | 4 | mA |
| | GPIO Low-level output current, $V_{CCO}$ = 3.3 V (ISO1642/3/4 only) | | | 2 | mA |
| | GPIO Low-level output current, $V_{CCO}$ = 2.5 V (ISO1642/3/4 only) | | | 1 | mA |
| $f_{DR}$ | GPIO maximum data rate frequency (ISO1642/3/4 only) | | | 50 | Mbps |
| $T_A$ | Ambient temperature | –40 | 25 | 125 | °C |

(1) Maximum frequency is a function of the RC time constant on the bus. If the system has less bus capacitance, then higher frequencies can be achieved.

## 6.4 Thermal Information

| THERMAL METRIC(1) | | ISO1640/1 | | ISO1642/3/4 | UNIT |
|---|---|---|---|---|---|
| | | D (SOIC) | DW (SOIC) | DW (SOIC) | |
| | | 8 PINS | 16 PINS | 16 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 106.3 | 62.4 | 58.3 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 38.5 | 29.5 | 25.5 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 52.5 | 33.5 | 29.7 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 8.2 | 11.7 | 8.9 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 51.8 | 32.4 | 28.5 | °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 Semiconductor and IC Package Thermal Metrics application report.

## 6.5 Power Ratings

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **ISO1640** | | | | | | |
| $P_D$ | Maximum power dissipation (both sides) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal | | | 96 | mW |
| $P_{D1}$ | Maximum power dissipation (side-1) | | | | 43 | mW |
| $P_{D2}$ | Maximum power dissipation (side-2) | | | | 53 | mW |
| **ISO1641** | | | | | | |
| $P_D$ | Maximum power dissipation (both sides) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal | | | 87 | mW |
| $P_{D1}$ | Maximum power dissipation (side-1) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal | | | 40 | mW |
| $P_{D2}$ | Maximum power dissipation (side-2) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal | | | 47 | mW |
| **ISO1642** | | | | | | |
| $P_D$ | Maximum power dissipation (both sides) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal INA = INB = Input at 25-MHz 50% duty cycle square wave, CL = 15pF | | | 185 | mW |
| $P_{D1}$ | Maximum power dissipation (side-1) | | | | 83 | mW |
| $P_{D2}$ | Maximum power dissipation (side-2) | | | | 102 | mW |
| **ISO1643** | | | | | | |
| $P_D$ | Maximum power dissipation (both sides) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal INA = INB = Input at 25-MHz 50% duty cycle square wave, CL = 15pF | | | 185 | mW |
| $P_{D1}$ | Maximum power dissipation (side-1) | | | | 67 | mW |
| $P_{D2}$ | Maximum power dissipation (side-2) | | | | 118 | mW |
| **ISO1644** | | | | | | |
| $P_D$ | Maximum power dissipation (both sides) | $V_{CC1}$ = $V_{CC2}$ = 5.5 V, $T_J$ = 150°C, C1 = 20 pF, C2 = 400 pF, R1 = 1.4 kΩ, R2 = 94 Ω, Input a 1.7-MHz 50% duty-cycle clock signal INA = INB = INC = Input at 25-MHz 50% duty cycle square wave, CL = 15pF | | | 210 | mW |
| $P_{D1}$ | Maximum power dissipation (side-1) | | | | 88 | mW |
| $P_{D2}$ | Maximum power dissipation (side-2) | | | | 122 | mW |

## 6.6 Insulation Specifications

| PARAMETER | | TEST CONDITIONS | SPECIFICATIONS | | UNIT |
|---|---|---|---|---|---|
| | | | DW | D | |
| **IEC 60664-1** | | | | | |
| CLR | External clearance(1) | Side 1 to side 2 distance through air | >8 | 4 | mm |
| CPG | External Creepage(1) | Side 1 to side 2 distance across package surface | >8 | 4 | mm |
| DTI | Distance through the insulation | Minimum internal gap (internal clearance) | >17 | >17 | µm |
| CTI | Comparative tracking index | IEC 60112; UL 746A | >600 | >400 | V |
| | Material Group | According to IEC 60664-1 | I | II | |
| | Overvoltage category | Rated mains voltage ≤ 150 $V_{RMS}$ | I-IV | I-IV | |
| | | Rated mains voltage ≤ 300 $V_{RMS}$ | I-IV | I-III | |
| | | Rated mains voltage ≤ 600 $V_{RMS}$ | I-IV | n/a | |
| | | Rated mains voltage ≤ 1000 $V_{RMS}$ | I-III | n/a | |
| **DIN V VDE V 0884-11:2017-01**(2) | | | | | |
| $V_{IORM}$ | Maximum repetitive peak isolation voltage | AC voltage (bipolar) | 2121 | 637 | $V_{PK}$ |
| $V_{IOWM}$ | Maximum isolation working voltage | AC voltage (sine wave); time-dependent dielectric breakdown (TDDB) test; | 1500 | 450 | $V_{RMS}$ |
| | | DC voltage | 2121 | 637 | $V_{DC}$ |
| $V_{IOTM}$ | Maximum transient isolation voltage | $V_{TEST}$ = $V_{IOTM}$ , t = 60 s (qualification); $V_{TEST}$ = 1.2 × $V_{IOTM}$, t = 1 s (100% production) | 7071 | 4242 | $V_{PK}$ |
| $V_{IOSM}$ | Maximum surge isolation voltage(3) | Test method per IEC 62368-1, 1.2/50 µs waveform, $V_{TEST}$ = 1.3 × $V_{IOSM}$ = 6,500 $V_{PK}$ (Basic qualification) Test method per IEC 62368-1, 1.2/50 µs waveform, $V_{TEST}$ = 1.6 × $V_{IOSM}$ = 10,000 $V_{PK}$ (Reinforced qualification) | 6250 | 5000 | $V_{PK}$ |
| $q_{pd}$ | Apparent charge(4) | Method a: After I/O safety test subgroup 2/3, $V_{ini}$ = $V_{IOTM}$, $t_{ini}$ = 60 s; $V_{pd(m)}$ = 1.2 × $V_{IORM}$ , $t_m$ = 10 s | ≤ 5 | ≤ 5 | pC |
| | | Method a: After environmental tests subgroup 1, $V_{ini}$ = $V_{IOTM}$, $t_{ini}$ = 60 s; $V_{pd(m)}$ = 1.6 × $V_{IORM}$ , $t_m$ = 10 s | ≤ 5 | ≤ 5 | |
| | | Method b1: At routine test (100% production) and preconditioning (type test), $V_{ini}$ = $V_{IOTM}$, $t_{ini}$ = 1 s; $V_{pd(m)}$ = 1.875 × $V_{IORM}$ , $t_m$ = 1 s | ≤ 5 | ≤ 5 | |
| $C_{IO}$ | Barrier capacitance, input to output(5) | $V_{IO}$ = 0.4 × sin (2 πft), f = 1 MHz | 1 | 1 | pF |
| $R_{IO}$ | Insulation resistance, input to output(5) | $V_{IO}$ = 500 V, $T_A$ = 25°C | > $10^{12}$ | > $10^{12}$ | Ω |
| | | $V_{IO}$ = 500 V, 100°C ≤ $T_A$ ≤ 150°C | > $10^{11}$ | > $10^{11}$ | |
| | | $V_{IO}$ = 500 V at $T_S$ = 150°C | > $10^9$ | > $10^9$ | |
| | Pollution degree | | 2 | 2 | |
| | Climatic category | | 40/125/21 | 40/125/21 | |
| **UL 1577** | | | | | |
| $V_{ISO}$ | Withstand isolation voltage | $V_{TEST}$ = $V_{ISO}$ , t = 60 s (qualification); $V_{TEST}$ = 1.2 × $V_{ISO}$ , t = 1 s (100% production) | 5000 | 3000 | $V_{RMS}$ |

(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, ribs, or both on a printed circuit board are used to help increase these specifications.

(2) ISO164xDW is suitable for *safe electrical insulation* and ISO164xBD 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) Testing is carried out in air or oil to determine the intrinsic surge immunity of the isolation barrier.

(4) Apparent charge is electrical discharge caused by a partial discharge (pd).
(5) All pins on each side of the barrier tied together creating a two-pin device.

## 6.7 Safety-Related Certifications

| VDE | CSA | UL | CQC | TUV |
|---|---|---|---|---|
| Certified according to DIN VDE V 0884-11:2017-01 | Certified according to IEC 61010-1, IEC 62368-1 and IEC 60601-1 | Recognized under UL 1577 Component Recognition Program | Certified according to GB4943.1-2011 | Certified according to EN 61010-1:2010/A1:2019, and EN 62368-1:2014 |
| Maximum transient isolation voltage, 7071 $V_{PK}$ (DW-16), and 4242 $V_{PK}$ (D-8); Maximum repetitive peak isolation voltage, 1500 $V_{PK}$ (DW-16), and 637 $V_{PK}$ (D-8); Maximum surge isolation voltage, 6250 $V_{PK}$ (DW-16), and 5000 $V_{PK}$ (D-8) | DW-16: 600 $V_{RMS}$ reinforced insulation per CSA 62368-1:19 and IEC 62368-1:2018 , (pollution degree 2, material group I) D-8: 400 $V_{RMS}$ basic insulation per CSA 62368-1:19 and IEC 62368-1:2018, (pollution degree 2, material group III) | DW-16: Single protection, 5000 $V_{RMS}$; D-8: Single protection, 3000 $V_{RMS}$ | DW-16: Reinforced Insulation, Altitude ≤ 5000 m, Tropical Climate,700 $V_{RMS}$ maximum working voltage; D-8: Basic Insulation, Altitude ≤ 5000 m, Tropical Climate, 250 $V_{RMS}$ maximum working voltage | 5000 $V_{RMS}$ (DW-16) and 3000 $V_{RMS}$ (D-8) Reinforced insulation per EN 61010- 1:2010/A1:2019 up to working voltage of 600 $V_{RMS}$ (DW-16) and 300 $V_{RMS}$ (D-8) 5000 $V_{RMS}$ (DW-16) and 3000 $V_{RMS}$ (D-8) Reinforced insulation per EN 62368-1:2014 up to working voltage of 600 $V_{RMS}$ (DW-16) and 400 $V_{RMS}$ (D-8) |
| Certification planned | Master contract number (ISO164xBD): 220991 Certification planned (All others) | File number (ISO164xBD): E181974 Certification planned (All others) | Certification planned | Certification planned |

## 6.8 Safety Limiting Values

Safety limiting intends to minimize potential damage to the isolation barrier upon failure of input or output circuitry.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **ISO1640/1 D-8 PACKAGE** | | | | | | |
| $I_S$ | Safety input, output, or supply current(1) | $R_{\theta JA}$ = 106.3 °C/W, $V_I$ = 5.5 V, $T_J$ = 150°C, $T_A$ = 25°C | | | 214 | mA |
| | | $R_{\theta JA}$ = 106.3 °C/W, $V_I$ = 3.6 V, $T_J$ = 150°C, $T_A$ = 25°C | | | 327 | |
| $P_S$ | Safety input, output, or total power(1) | $R_{\theta JA}$ = 106.3 °C/W, $T_J$ = 150°C, $T_A$ = 25°C | | | 1176 | mW |
| $T_S$ | Safety temperature(1) | | | | 150 | °C |
| **ISO1640/1 DW-16 PACKAGE** | | | | | | |
| $I_S$ | Safety input, output, or supply current(1) | $R_{\theta JA}$ = 62.4 °C/W, $V_I$ = 5.5 V, $T_J$ = 150°C, $T_A$ = 25°C | | | 365 | mA |
| | | $R_{\theta JA}$ = 62.4 °C/W, $V_I$ = 3.6 V, $T_J$ = 150°C, $T_A$ = 25°C | | | 557 | |
| $P_S$ | Safety input, output, or total power(1) | $R_{\theta JA}$ = 62.4 °C/W, $T_J$ = 150°C, $T_A$ = 25°C, | | | 2004 | mW |
| $T_S$ | Safety temperature(1) | | | | 150 | °C |
| **ISO1642/3/4 DW-16 Package** | | | | | | |
| $I_S$ | Safety input, output, or supply current(1) | $R_{\theta JA}$ = 58.3 °C/W, $V_I$ = 5.5 V, $T_J$ = 150°C, $T_A$ = 25°C | | | 390 | mA |
| | | $R_{\theta JA}$ = 58.3 °C/W, $V_I$ = 3.6 V, $T_J$ = 150°C, $T_A$ = 25°C | | | 596 | mA |
| $P_S$ | Safety input, output, or total power(1) | $R_{\theta JA}$ = 58.3 °C/W, $T_J$ = 150°C, $T_A$ = 25°C | | | 2145 | mW |
| $T_S$ | Safety temperature(1) | | | | 150 | °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

over recommended operating conditions, unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **SIDE 1** | | | | | | |
| $V_{ILT1}$ | Voltage input threshold low (SDA1 and SCL1) | | 480 | | 560 | mV |
| $V_{IHT1}$ | Voltage input threshold high (SDA1 and SCL1) | | 520 | | 620 | mV |
| $V_{HYST1}$ | Voltage input hysteresis | $V_{IHT1} – V_{ILT1}$ | 50 | 60 | | mV |
| $V_{OL1}$ | Low-level output voltage(1) (SDA1 and SCL1) | 0.5 mA ≤ ($I_{SDA1}$ and $I_{SCL1}$) ≤ 3.5 mA | 570 | 650 | 710 | mV |
| $\Delta V_{OIT1}$ | Low-level output voltage to high-level input voltage threshold difference, SDA1 and SCL1(2) (3) | 0.5 mA ≤ ($I_{SDA1}$ and $I_{SCL1}$) ≤ 3.5 mA | 50 | | | mV |
| **SIDE 2** | | | | | | |
| $V_{ILT2}$ | Voltage input threshold low (SDA2 and SCL2) | | 0.3 × $V_{CC2}$ | | 0.4 × $V_{CC2}$ | V |
| $V_{IHT2}$ | Voltage input threshold high (SDA2 and SCL2) | | 0.4 × $V_{CC2}$ | | 0.5 × $V_{CC2}$ | V |
| $V_{HYST2}$ | Voltage input hysteresis | $V_{IHT2} – V_{ILT2}$ | 0.05 × $V_{CC2}$ | | | V |
| $V_{OL2}$ | Low-level output voltage (SDA2 and SCL2) | 0.5 mA ≤ ($I_{SDA2}$ and $I_{SCL2}$) ≤ 50 mA | | | 0.4 | V |
| **BOTH SIDES** | | | | | | |
| $\|I_I\|$ | Input leakage currents (SDA1, SCL1, SDA2, and SCL2) | $V_{SDA1}$, $V_{SCL1}$ = $V_{CC1}$, $V_{SDA2}$, $V_{SCL2}$ = $V_{CC2}$ | | 0.01 | 10 | µA |
| $C_I$ | Input capacitance to local ground (SDA1, SCL1, SDA2, and SCL2) | $V_I$ = 0.4 × sin(2e6*πt) + $V_{DD}$x / 2 | | 10 | | pF |
| CMTI | Common-mode transient immunity | $V_{CM}$ = 1000 V, see Common-Mode Transient Immunity Test Circuit | 50 | 100 | | kV/µs |
| **GPIO Channels** | | | | | | |
| $V_{IOOH}$ | High-level output voltage | VCCx = 5 V, $I_{OH}$ = -4 mA; ISO1642/3/4 only | $V_{CCO}$ - 0.4 | | | V |
| | | VCCx = 3.3 V, $I_{OH}$ = -2 mA; ISO1642/3/4 only | $V_{CCO}$ - 0.3 | | | V |
| | | VCC1 = 2.5 V, $I_{OH}$ = -1 mA; ISO1642/3/4 only | $V_{CCO}$ - 0.2 | | | V |
| $V_{IOOL}$ | Low-level output voltage | VCCx = 5 V, $I_{OH}$ = 4 mA; ISO1642/3/4 only | | | 0.4 | V |
| | | VCCx = 3.3 V, $I_{OH}$ = 2 mA; ISO1642/3/4 only | | | 0.3 | V |
| | | VCC1 = 2.5 V, $I_{OH}$ = 1 mA; ISO1642/3/4 only | | | 0.2 | V |
| $V_{IT+(IN)}$ | Rising input switching threshold | ISO1642/3/4 only | | | 0.7 x $V_{CCI}$ (1) | V |
| $V_{IT-(IN)}$ | Falling input switching threshold | ISO1642/3/4 only | 0.3 x $V_{CCI}$ | | | V |
| $V_{I(HYS)}$ | Input threshold voltage hysteresis | ISO1642/3/4 only | 0.1 x $V_{CCI}$ | | | V |
| $I_{IH}$ | High-level input current | $V_{IH}$ = $V_{CCI}$ (1) at INx. ISO1642/3/4 only | | | 10 | µA |
| $I_{IL}$ | Low-level input current | $V_{IL}$ = 0 V at INx. ISO1642/3/4 only | -10 | | | µA |

(1) This parameter does not apply to the SCL1 line of the ISO1641 device because it is unidirectional.
(2) $\Delta V_{OIT1} = V_{OL1} – V_{IHT1}$. This value represents the minimum difference between a threshold for the low-level output voltage and a threshold for the high-level input voltage to prevent a permanent latch condition that would otherwise occur with bidirectional communication.
(3) Any supply voltages on either side that are less than the minimum value make sure that the device does a lockout. Both supply voltages that are greater than the maximum value keep the device from a lockout.

## 6.10 Supply Current Characteristics

over recommended operating conditions, unless otherwise noted. See Test Diagram for more information.

| PARAMETER | | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **2.25 V ≤ $V_{CC2}$ ≤ 2.75 V** | | | | | | | |
| $I_{CC2}$ | Supply current, Side 2 | ISO1640 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 4.9 | 6.6 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.7 | 3.5 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1641 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 3.8 | 5.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.7 | 3.5 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1642 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.3 | 9.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 5.5 | 7.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.3 | 6.0 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 7.5 | 10.5 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1643 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.8 | 9.9 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 4.9 | 7.3 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.8 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6.9 | 9.8 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1644 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.8 | 10 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6 | 8.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.8 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 7.9 | 11.2 | mA |
| **3 V ≤ $V_{CC1}$, $V_{CC2}$ ≤ 3.6 V** | | | | | | | |
| $I_{CC1}$ | Supply current, Side 1 | ISO1640 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 5.2 | 7.1 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 3 | 4 | mA |
| $I_{CC1}$ | Supply current, Side 1 | ISO1641 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 4.6 | 6.1 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.4 | 3.2 | mA |

over recommended operating conditions, unless otherwise noted. See Test Diagram for more information.

| PARAMETER | | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{CC1}$ | Supply current, Side 1 | ISO1642 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 7.3 | 9.6 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 5.8 | 8.3 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.7 | 6.6 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 8.4 | 11.6 | mA |
| $I_{CC1}$ | Supply current, Side 1 | ISO1643 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.9 | 8.9 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6.5 | 8.9 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.3 | 5.9 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 9 | 12.3 | mA |
| $I_{CC1}$ | Supply current, Side 1 | ISO1644 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 7.3 | 10.1 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6.9 | 9.6 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.7 | 6.6 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 9.5 | 13.1 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1640 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 4.9 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.8 | 3.5 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1641 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 3.9 | 5.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.8 | 3.5 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1642 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.4 | 9.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 5.6 | 7.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.4 | 6.0 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 7.6 | 10.5 | mA |

over recommended operating conditions, unless otherwise noted. See Test Diagram for more information.

| PARAMETER | | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{CC2}$ | Supply current, Side 2 | ISO1643 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.8 | 9.9 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 4.9 | 7.3 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.8 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6.9 | 9.8 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1644 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.8 | 10 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6 | 8.4 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.8 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 8 | 11.3 | mA |
| **4.5 V ≤ $V_{CC1}$, $V_{CC2}$ ≤ 5.5 V** | | | | | | | |
| $I_{CC1}$ | Supply current, Side 1 | ISO1640 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 5.3 | 7.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 3 | 4.1 | mA |
| $I_{CC1}$ | Supply current, Side 1 | ISO1641 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 4.7 | 6.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.5 | 3.2 | mA |
| $I_{CC1}$ | Supply current, Side 1 | ISO1642 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 7.6 | 10.4 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 5.9 | 8.2 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.7 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 8.7 | 12 | mA |
| $I_{CC1}$ | Supply current, Side 1 | ISO1643 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 7.2 | 9.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6.5 | 8.9 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.3 | 6 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 9.3 | 12.7 | mA |

over recommended operating conditions, unless otherwise noted. See Test Diagram for more information.

| PARAMETER | | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{CC1}$ | Supply current, Side 1 | ISO1644 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 7.6 | 10.4 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 7 | 9.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.7 | 6.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 9.6 | 13.5 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1640 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 5 | 6.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.8 | 3.6 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1641 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open | | 3.9 | 5.3 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open | | 2.8 | 3.6 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1642 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.5 | 9.1 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 5.6 | 7.7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.5 | 6.1 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 7.7 | 10.7 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1643 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.9 | 9.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 5 | 7 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.9 | 6.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 7 | 10 | mA |
| $I_{CC2}$ | Supply current, Side 2 | ISO1644 | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 6.9 | 9.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 6.1 | 8.5 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = VCC1, $V_{SDA2}$, $V_{SCL2}$ = VCC2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 0 | | 4.9 | 6.8 | mA |
| | | | $V_{SDA1}$, $V_{SCL1}$ = GND1, $V_{SDA2}$, $V_{SCL2}$ = GND2, R1 and R2 = Open, C1 and C2 = Open GPIOs = 1 | | 8.1 | 11.5 | mA |

## 6.11 Timing Requirements

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{UVLO}$ | Time to recover from UVLO | VCC1 > $V_{CC1(UVLO+)}$ or VCC2 > $V_{CC2(UVLO+)}$, I2C bus Idle. see $t_{UVLO}$ Test Circuit and Timing Diagrams | 36 | 95 | 151 | µs |

## 6.12 I2C Switching Characteristics

over recommended operating conditions, unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **2.25 V ≤ $V_{CC2}$ ≤ 2.75 V, 3 V ≤ $V_{CC1}$ ≤ 3.6 V** | | | | | | |
| $t_{f2}$ | Output signal fall time (SDA2 and SCL2) | 0.7 × $V_{CC2}$ ≥ $V_O$ ≥ 0.3 × $V_{CC2}$, R2 = 72 Ω, C2 = 400 pF, see Test Diagram | 16 | 26.5 | 40 | ns |
| | | 0.9 × $V_{CC2}$ ≥ $V_O$ ≥ 400 mV, R2 = 72Ω, C2 = 400 pF, see Test Diagram | 38 | 53.3 | 78 | |
| $t_{pLH1-2}$ | Low-to-high propagation delay, side 1 to side 2 | $V_I$ = 535 mV, $V_O$ = 0.7 × $V_{CC2}$, R1 = 953 Ω, R2 = 72 Ω, C1 and C2 = 10 pF, $V_{CC1}$ = 3.3 V, see Test Diagram | | 20 | 30 | ns |
| $t_{pHL1-2}$ | High-to-low propagation delay, side 1 to side 2 | $V_I$ = 550 mV, $V_O$ = 0.3 × $V_{CC2}$, R1 = 953 Ω, R2 = 72 Ω, C1 and C2 = 10 pF, $V_{CC1}$ = 3.3 V, see Test Diagram | | 80 | 130 | ns |
| $t_{pLH2-1}$ | Low-to-high propagation delay, side 2 to side 1(1) | $V_I$ = 0.4 x $V_{CC2}$, $V_O$ = 0.7 x $V_{CC1}$, R1 = 953 Ω, R2 = 72 Ω, C1 and C2 = 10 pF, $V_{CC1}$ = 3.3 V, see Test Diagram | | 40 | 48 | ns |
| $t_{pHL2-1}$ | High-to-low propagation delay, side 2 to side 1(1) | $V_I$ = 0.4 x $V_{CC2}$, $V_O$ = 0.3 × $V_{CC1}$, R1 = 953 Ω, R2 = 72 Ω, C1 and C2 = 10 pF, $V_{CC1}$ = 3.3 V, see Test Diagram | | 70 | 100 | ns |
| $PWD_{1-2}$ | Pulse width distortion $\lvert t_{pHL1-2} - t_{pLH1-2} \rvert$ | R1 = 953 Ω, R2 = 72 Ω, C1 and C2 = 10 pF, $V_{CC1}$ = 3.3 V see Test Diagram | | 60 | 104 | ns |
| $PWD_{2-1}$ | Pulse width distortion(1) $\lvert t_{pHL2-1} - t_{pLH2-1} \rvert$ | R1 = 953 Ω, R2 = 72 Ω, C1 and C2 = 10 pF, $V_{CC1}$ = 3.3 V see Test Diagram | | 25 | 55 | ns |
| $t_{LOOP1}$ | Round-trip propagation delay on side 1(1) | 0.4 V ≤ $V_I$ ≤ 0.3 × $V_{CC1}$, R1 = 953 Ω, C1 = 40 pF, R2 = 72 Ω, C2 = 400 pF, see Test Diagram | | 62 | 74 | ns |
| **3 V ≤ $V_{CC1}$, $V_{CC2}$ ≤ 3.6 V** | | | | | | |
| $t_{f1}$ | Output signal fall time (SDA1 and SCL1) | 0.7 × $V_{CC1}$ ≥ $V_O$ ≥ 0.3 × $V_{CC1}$, R1 = 953 Ω, C1 = 40 pF, R2 = 95.3 Ω, C2 = 400 pF, see Test Diagram | 8 | 17 | 29 | ns |
| | | 0.9 × $V_{CC1}$ ≥ $V_O$ ≥ 900 mV, R1 = 953 Ω, C1 = 40 pF, see Test Diagram | 15 | 25 | 48 | |
| $t_{f2}$ | Output signal fall time (SDA2 and SCL2) | 0.7 × $V_{CC2}$ ≥ $V_O$ ≥ 0.3 × $V_{CC2}$, R2 = 95.3 Ω, C2 = 400 pF, see Test Diagram | 14 | 23 | 47 | ns |
| | | 0.9 × $V_{CC2}$ ≥ $V_O$ ≥ 400 mV, R2 = 95.3 Ω, C2 = 400 pF, see Test Diagram | 30 | 50 | 100 | |
| $t_{pLH1-2}$ | Low-to-high propagation delay, side 1 to side 2 | $V_I$ = 535 mV, $V_O$ = 0.7 × $V_{CC2}$, R1 = 953 Ω, R2 = 95.3 Ω, C1 and C2 = 10 pF, see Test Diagram | | 21 | 29 | ns |
| $t_{pHL1-2}$ | High-to-low propagation delay, side 1 to side 2 | $V_I$ = 550 mV, $V_O$ = 0.3 × $V_{CC2}$, R1 = 953 Ω, R2 = 95.3 Ω, C1 and C2 = 10 pF, see Test Diagram | | 59 | 88 | ns |
| $t_{pLH2-1}$ | Low-to-high propagation delay, side 2 to side 1(1) | $V_I$ = 0.4 x $V_{CC2}$, $V_O$ = 0.7 x $V_{CC1}$, R1 = 953 Ω, R2 = 95.3 Ω, C1 and C2 = 10 pF, see Test Diagram | | 40 | 47 | ns |
| $t_{pHL2-1}$ | High-to-low propagation delay, side 2 to side 1(1) | $V_I$ = 0.4 x $V_{CC2}$, $V_O$ = 0.3 × $V_{CC1}$, R1 = 953 Ω, R2 = 95.3 Ω, C1 and C2 = 10 pF, see Test Diagram | | 70 | 100 | ns |
| $PWD_{1-2}$ | Pulse width distortion $\lvert t_{pHL1-2} - t_{pLH1-2} \rvert$ | R1 = 953 Ω, R2 = 95.3 Ω, C1 and C2 = 10 pF, see Test Diagram | | 39 | 61 | ns |
| $PWD_{2-1}$ | Pulse width distortion(1) $\lvert t_{pHL2-1} - t_{pLH2-1} \rvert$ | R1 = 953 Ω, R2 = 95.3 Ω, C1 and C2 = 10 pF, see Test Diagram | | 25 | 48 | ns |
| $t_{LOOP1}$ | Round-trip propagation delay on side 1(1) | 0.4 V ≤ $V_I$ ≤ 0.3 × $V_{CC1}$, R1 = 953 Ω, C1 = 40 pF, R2 = 95.3 Ω, C2 = 400 pF, see Test Diagram | | 65 | 78 | ns |

over recommended operating conditions, unless otherwise noted

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **4.5 V ≤ $V_{CC1}$, $V_{CC2}$ ≤ 5.5 V** | | | | | | |
| $t_{f1}$ | Output signal fall time (SDA1 and SCL1) | 0.7 × $V_{CC1}$ ≥ $V_O$ ≥ 0.3 × $V_{CC1}$, R1 = 1430 Ω, C1 = 40 pF, R2 = 95.3 Ω, C2 = 400 pF, see Test Diagram | 6 | 16 | 22 | ns |
| | | 0.9 × $V_{CC1}$ ≥ $V_O$ ≥ 900 mV, R1 = 1430 Ω, C1 = 40 pF, see Test Diagram | 13 | 32 | 48 | |
| $t_{f2}$ | Output signal fall time (SDA2 and SCL2) | 0.7 × $V_{CC2}$ ≥ $V_O$ ≥ 0.3 × $V_{CC2}$, R2 = 143 Ω, C2 = 400 pF, see Test Diagram | 10 | 24 | 30 | ns |
| | | 0.9 × $V_{CC2}$ ≥ $V_O$ ≥ 400 mV, R2 = 143 Ω, C2 = 400 pF, see Test Diagram | 28 | 48 | 76 | |
| $t_{pLH1-2}$ | Low-to-high propagation delay, side 1 to side 2 | $V_I$ = 535 mV, $V_O$ = 0.7 × $V_{CC2}$, R1 = 1430 Ω, R2 = 143 Ω, C1 and C2 = 10 pF, see Test Diagram | | 21 | 28 | ns |
| $t_{pHL1-2}$ | High-to-low propagation delay, side 1 to side 2 | $V_I$ = 550 mV, $V_O$ = 0.3 × $V_{CC2}$, R1 = 1430 Ω, R2 = 143 Ω, C1 and C2 = 10 pF, see Test Diagram | | 51 | 70 | ns |
| $t_{pLH2-1}$ | Low-to-high propagation delay, side 2 to side 1(1) | $V_I$ = 0.4 x $V_{CC2}$, $V_O$ = 0.7 x $V_{CC1}$, R1 = 1430 Ω, R2 = 143 Ω, C1 and C2 = 10 pF, see Test Diagram | | 51 | 57 | ns |
| $t_{pHL2-1}$ | High-to-low propagation delay, side 2 to side 1(1) | $V_I$ = 0.4 x $V_{CC2}$, $V_O$ = 0.3 × $V_{CC1}$, R1 = 1430 Ω, R2 = 143 Ω, C1 and C2 = 10 pF, see Test Diagram | | 60 | 88 | ns |
| $PWD_{1-2}$ | Pulse width distortion $\lvert t_{pHL1-2} - t_{pLH1-2} \rvert$ | R1 = 1430 Ω, R2 = 143 Ω, C1 and C2 = 10 pF, see Test Diagram | | 30 | 45 | ns |
| $PWD_{2-1}$ | Pulse width distortion(1) $\lvert t_{pHL2-1} - t_{pLH2-1} \rvert$ | R1 = 1430 Ω, R2 = 143 Ω, C1 and C2 = 10 pF, see Test Diagram | | 10 | 34 | ns |
| $t_{LOOP1}$ | Round-trip propagation delay on side 1(1) | 0.4 V ≤ $V_I$ ≤ 0.3 × $V_{CCI}$, R1 = 1430 Ω, C1 = 40 pF, R2 = 143 Ω, C2 = 400 pF, see Test Diagram | | 84 | 96 | ns |

(1) This parameter does not apply to the SCL1 line of the ISO1641 device because it is unidirectional.

## 6.13 GPIO Switching Characteristics

over recommended operating conditions, unless otherwise noted. ISO1644 only.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **3 V ≤ $V_{CC1}$, $V_{CC2}$ ≤ 3.6 V** | | | | | | |
| $t_{PLH}$, $t_{PHL}$ | Propagation delay time | See Test Diagram | | 11 | 20 | ns |
| $t_{P(dft)}$ | Propagation delay drift | | | 9.2 | | ps/℃ |
| $t_{UI}$ | Minimum pulse width | | 20 | | | ns |
| PWD | Pulse width distortion | See Test Diagram | | | 7 | ns |
| $t_{sk(o)}$ | Channel to channel output skew time | Same direction channels | | | 6 | ns |
| $t_{sk(p-p)}$ | Part to part skew time | | | | 6 | ns |
| $t_r$ | Output signal rise time | See Test Diagram | | | 6.5 | ns |
| $t_f$ | Output signal fall time | See Test Diagram | | | 6.5 | ns |
| $t_{DO}$ | Default output delay time from input power loss | Measured from the time VCC goes below 1.2V. See Test Diagram | | 0.1 | 0.3 | us |
| tie | Time interval error | | | 0.8 | | ns |
| **4.5 V ≤ $V_{CC1}$, $V_{CC2}$ ≤ 5.5 V** | | | | | | |
| $t_{PLH}$, $t_{PHL}$ | Propagation delay time | See Test Diagram | | 11 | 18 | ns |
| $t_{P(dft)}$ | Propagation delay drift | | | 8 | | ps/℃ |
| $t_{UI}$ | Minimum pulse width | | 20 | | | ns |
| PWD | Pulse width distortion | See Test Diagram | | | 7 | ns |
| $t_{sk(o)}$ | Channel to channel output skew time | Same direction channels | | | 6 | ns |
| $t_{sk(p-p)}$ | Part to part skew time | | | | 6 | ns |
| $t_r$ | Output signal rise time | See Test Diagram | | | 6 | ns |
| $t_f$ | Output signal fall time | See Test Diagram | | | 6 | ns |
| $t_{DO}$ | Default output delay time from input power loss | Measured from the time VCC goes below 1.2V. See Test Diagram | | 0.1 | 0.3 | us |
| tie | Time interval error | | | 0.8 | | ns |

## 6.14 Insulation Characteristics Curves

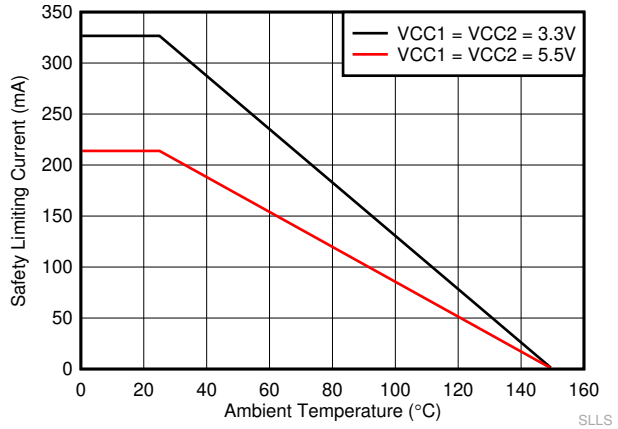



**Figure 6-1. ISO164xB Thermal Derating Curve for Safety Limiting Current for D-8 Package**

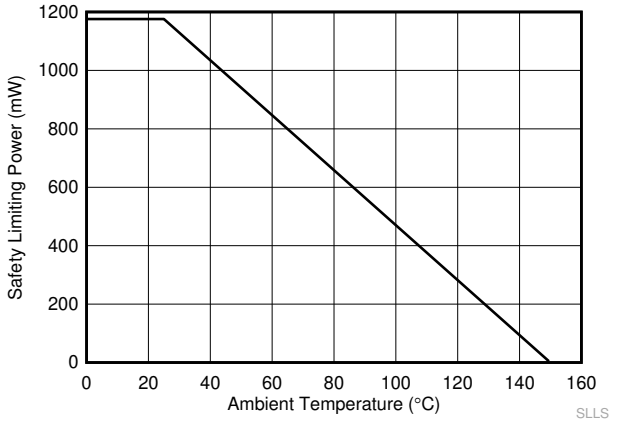



**Figure 6-2. ISO164xB Thermal Derating Curve for Safety Limiting Power for D-8 Package**

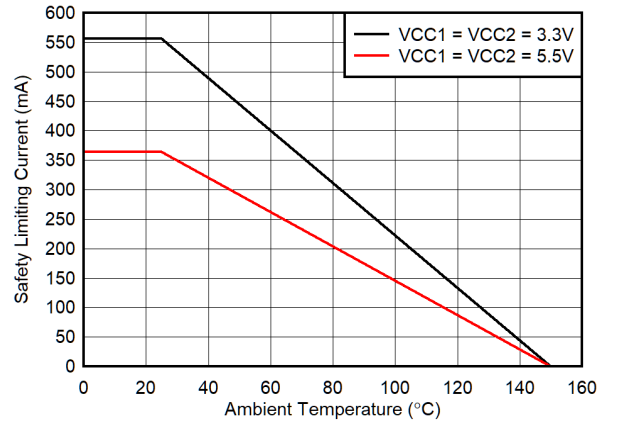



**Figure 6-3. ISO1640/1 Thermal Derating Curve for Safety Limiting Current for DW-16 Package**

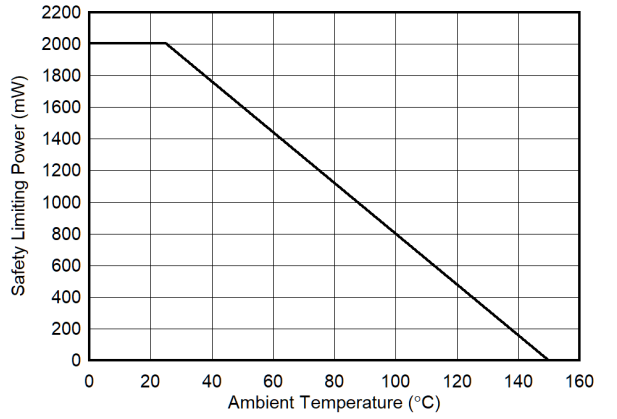



**Figure 6-4. ISO1640/1 Thermal Derating Curve for Safety Limiting Power for DW-16 Package**

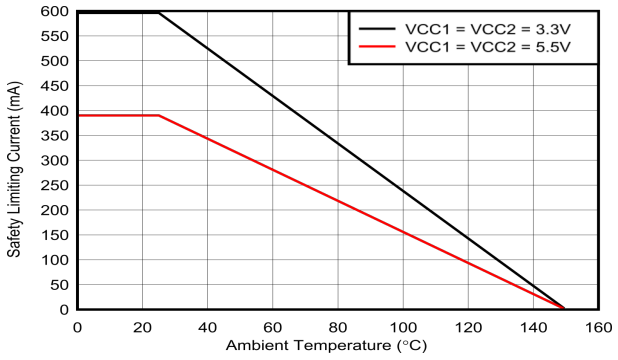



**Figure 6-5. ISO1642/3/4 Thermal Derating Curve for Safety Limiting Current for DW-16 Package**

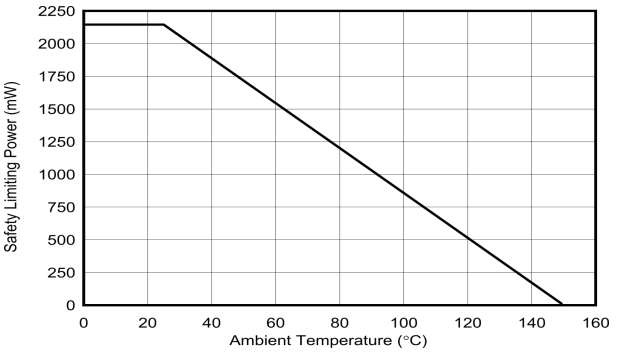
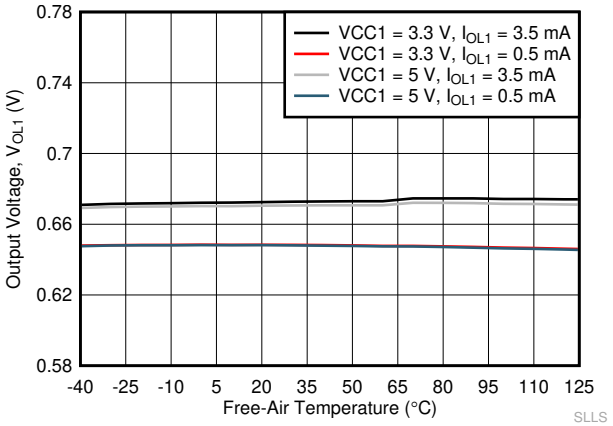


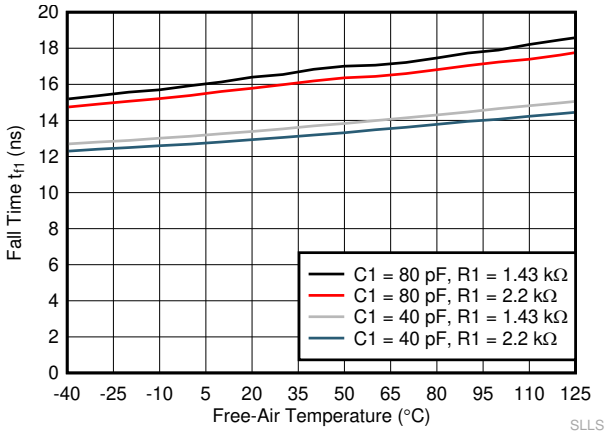

**Figure 6-6. ISO1642/3/4 Thermal Derating Curve for Safety Limiting Power for DW-16 Package**

## 6.15 Typical Characteristics



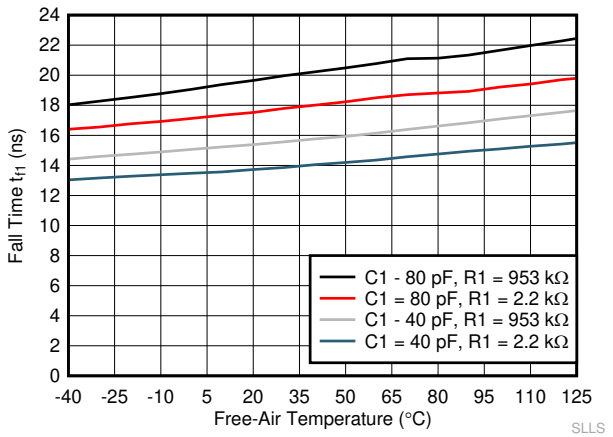

$T_A$ = 25°C

**Figure 6-7. Side 1: Output Low Voltage vs Free-Air Temperature**



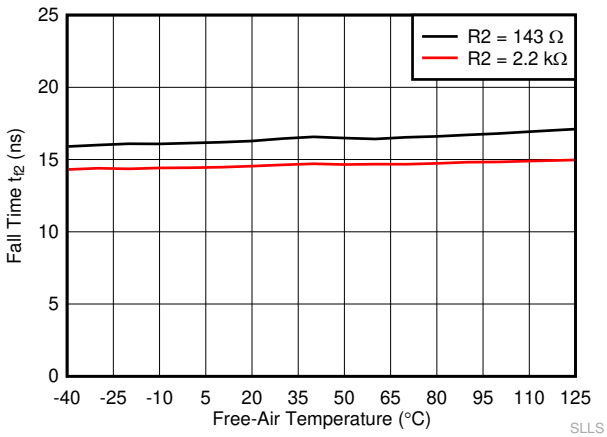

VCC1 = 5 V

**Figure 6-8. Side 1: Output Fall Time vs Free-Air Temperature**



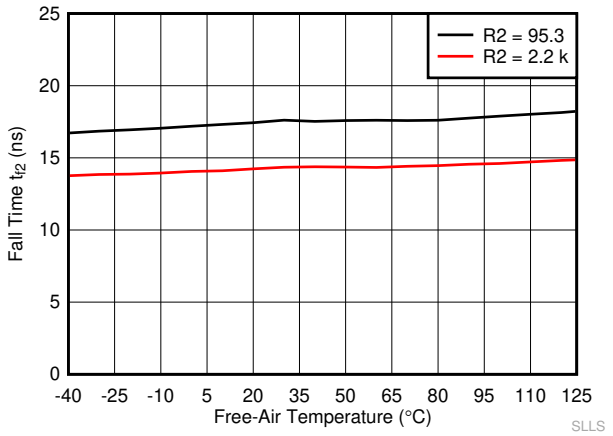

VCC1 = 3.3 V

**Figure 6-9. Side 1: Output Fall Time vs Free-Air Temperature**



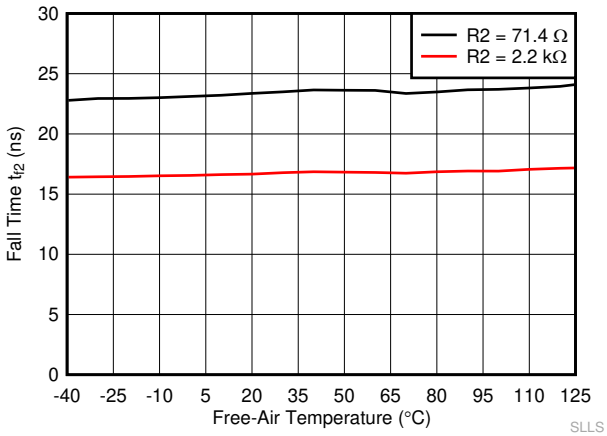

VCC2 = 5 V C2 = 400 pF

**Figure 6-10. Side 2: Output Fall Time vs Free-Air Temperature**



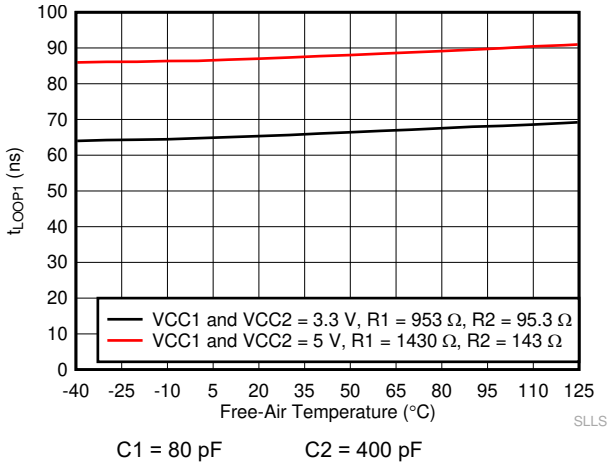

VCC2 = 3.3 V C2 = 400 pF

**Figure 6-11. Side 2: Output Fall Time vs Free-Air Temperature**



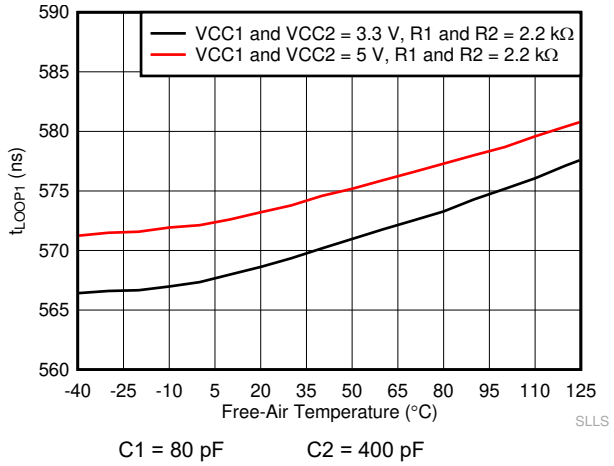

VCC2 = 2.5 V C2 = 400 pF

**Figure 6-12. Side 2: Output Fall Time vs Free-Air Temperature**




C1 = 80 pF C2 = 400 pF

**Figure 6-13. $t_{LOOP1}$ vs Free-Air Temperature**




C1 = 80 pF C2 = 400 pF

**Figure 6-14. $t_{LOOP1}$ vs Free-Air Temperature**

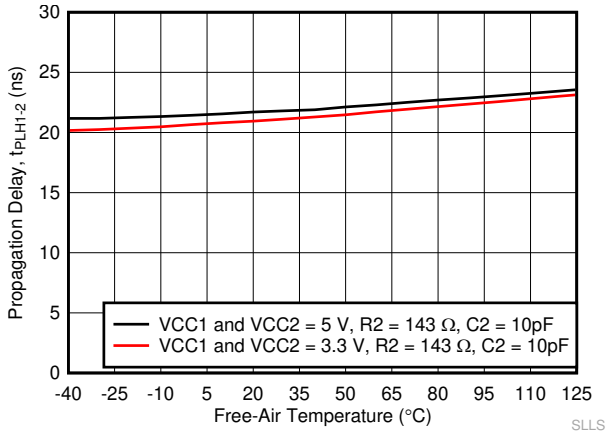



**Figure 6-15. $t_{PLH1-2}$ Propagation Delay vs Free-Air Temperature**

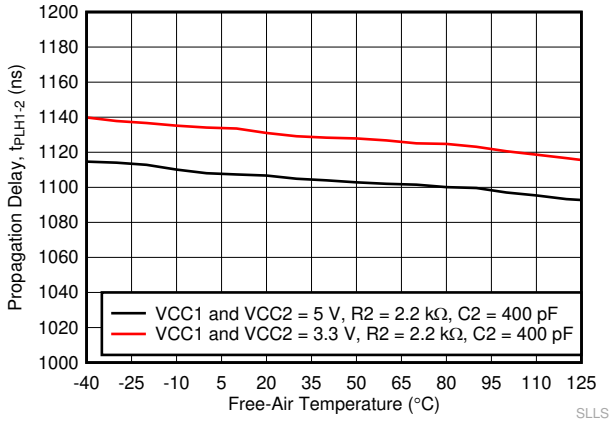



**Figure 6-16. $t_{PLH1-2}$ Propagation Delay vs Free-Air Temperature**

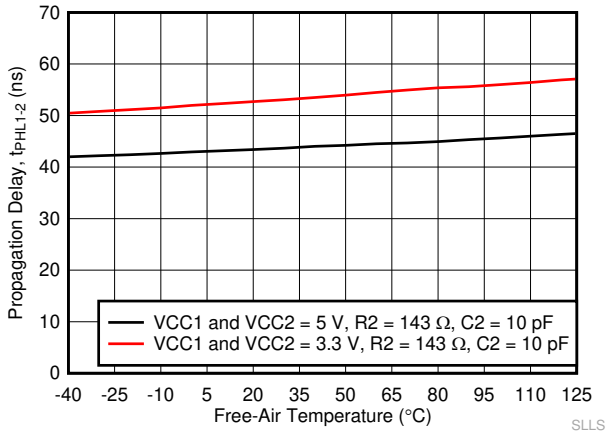



**Figure 6-17. $t_{PHL1-2}$ Propagation Delay vs Free-Air Temperature**

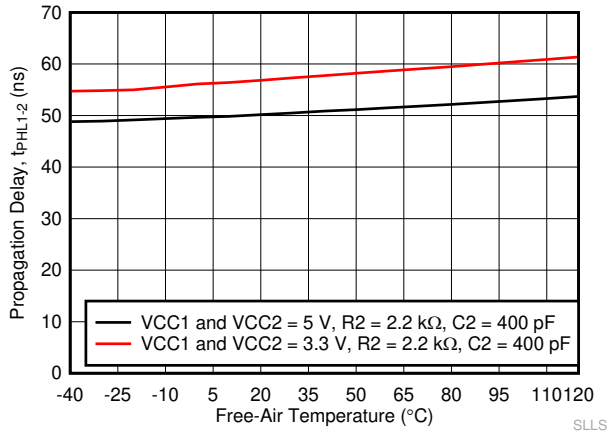



**Figure 6-18. $t_{PHL1-2}$ Propagation Delay vs Free-Air Temperature**

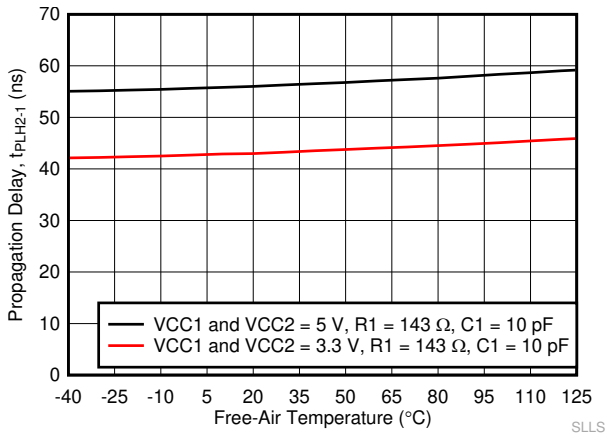



**Figure 6-19. $t_{PLH2-1}$ Propagation Delay vs Free-Air Temperature**

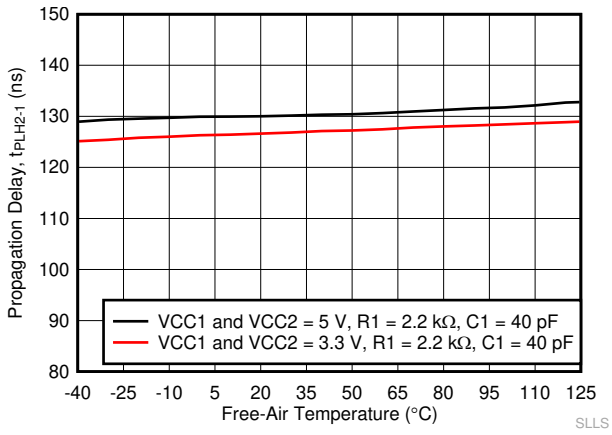



**Figure 6-20. $t_{PLH2-1}$ Propagation Delay vs Free-Air Temperature**

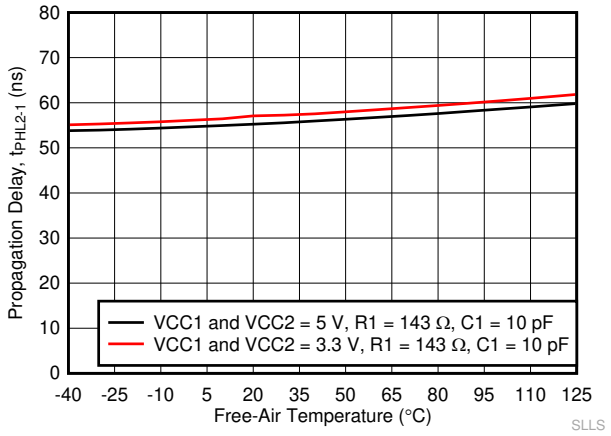



**Figure 6-21. $t_{PHL2-1}$ Propagation Delay vs Free-Air Temperature**

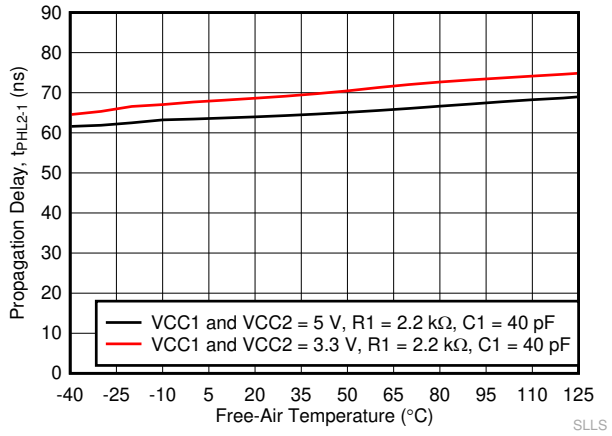



**Figure 6-22. $t_{PHL2-1}$ Propagation Delay vs Free-Air Temperature**

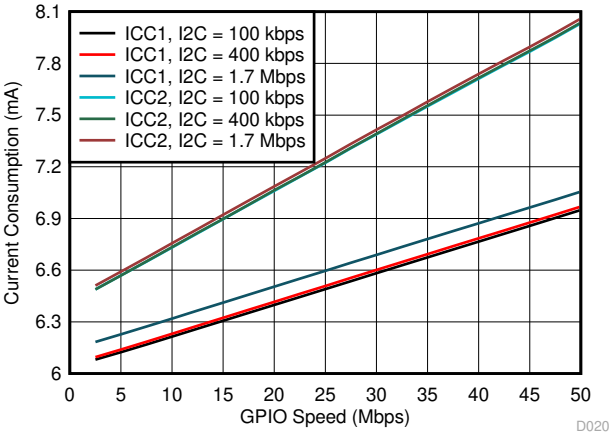



**Figure 6-23. ISO1642: ICC vs GPIO Speed at 3.3V**

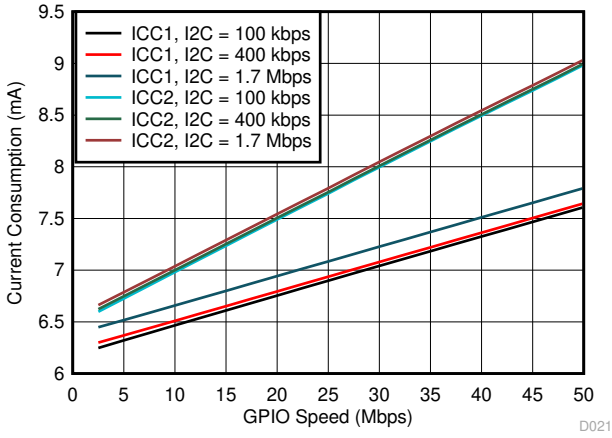



**Figure 6-24. ISO1642: ICC vs GPIO Speed at 5V**

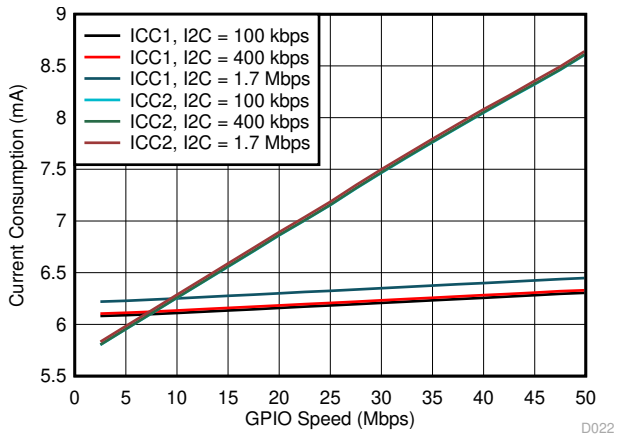



**Figure 6-25. ISO1643: ICC vs GPIO Speed at 3.3V**

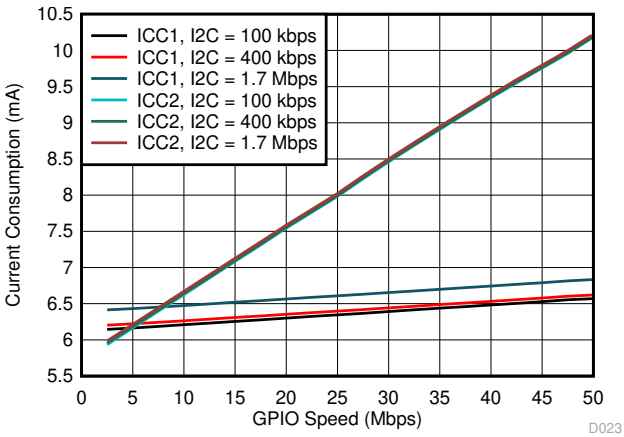



**Figure 6-26. ISO1643: ICC vs GPIO Speed at 5V**

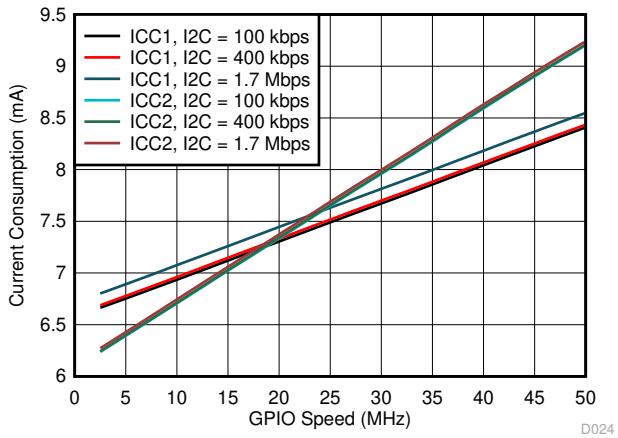



**Figure 6-27. ISO1644: ICC vs GPIO Speed at 3.3V**

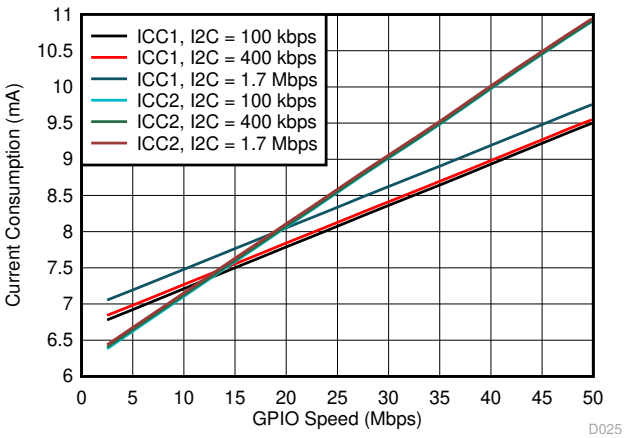



**Figure 6-28. ISO1644: ICC vs GPIO Speed at 5V**

# 7 Parameter Measurement Information

## 7.1 Parameter Measurement Information

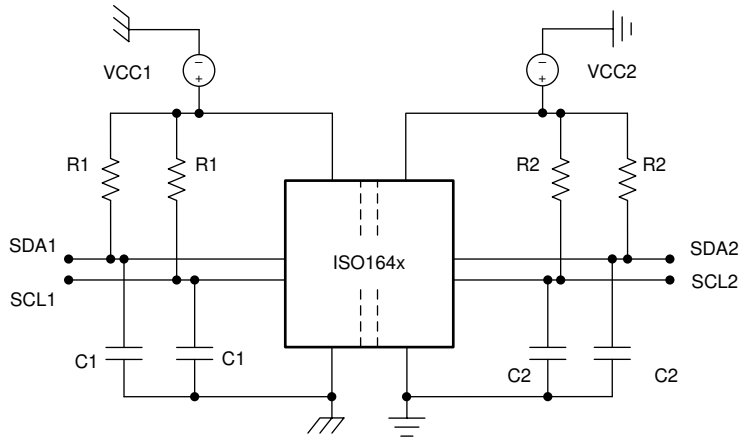



**Figure 7-1. Test Diagram**

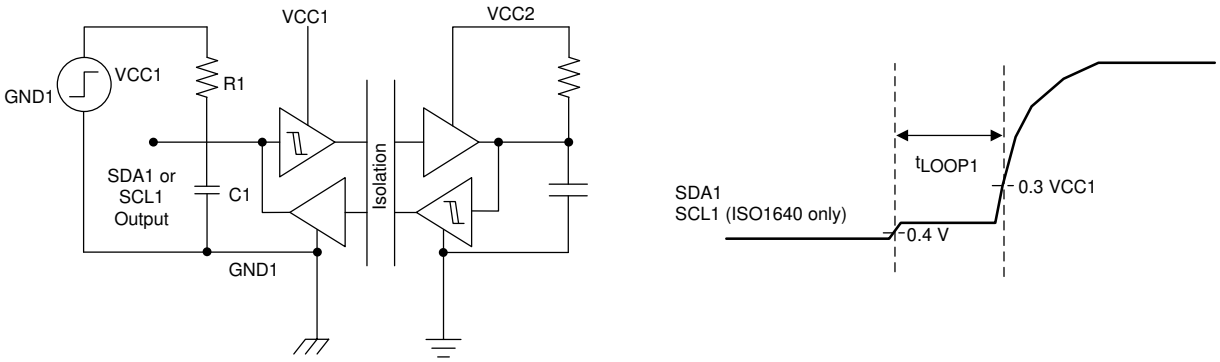



**Figure 7-2. $t_{Loop1}$ Setup and Timing Diagram**

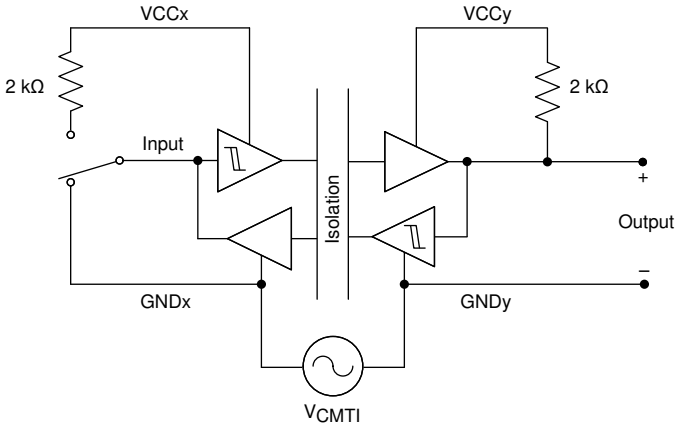
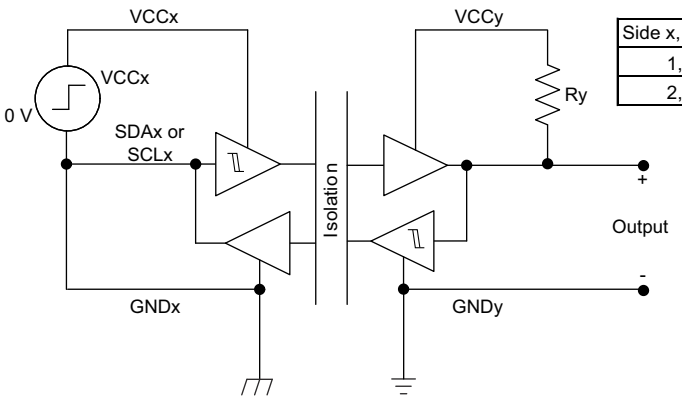
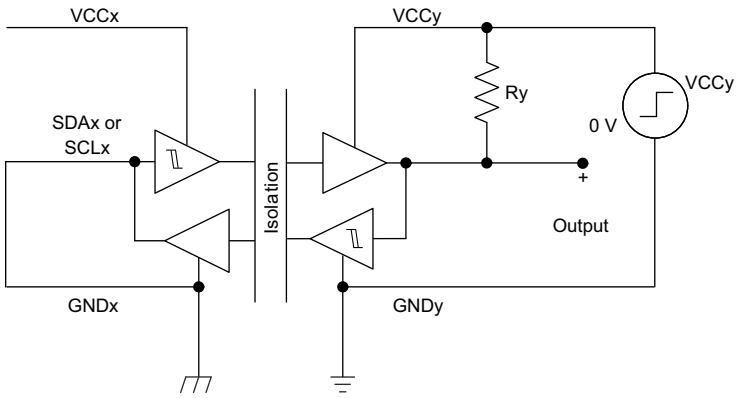


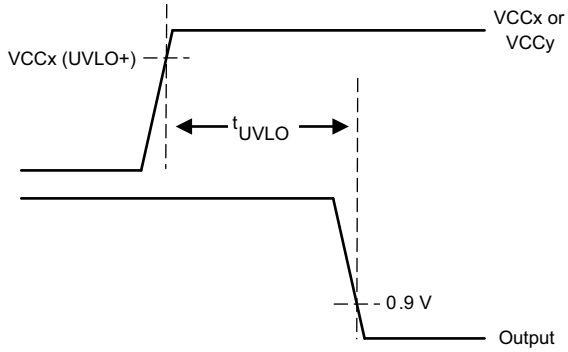

**Figure 7-3. Common-Mode Transient Immunity Test Circuit**

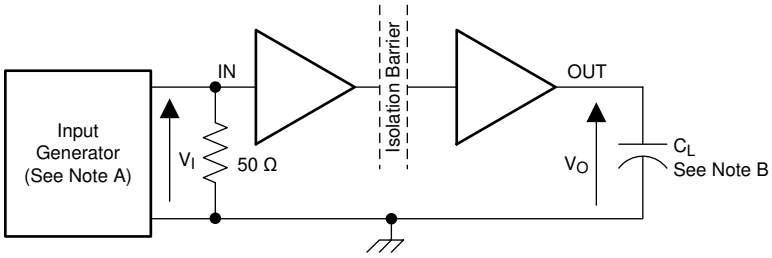


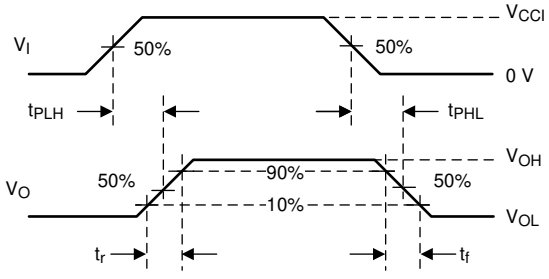

| Side x, Side y | VCCx,VCCy | Ry |
|---|---|---|
| 1, 2 | 3.3 V, 3.3 V | 95.3 Ω |
| 2, 1 | 3.3 V, 3.3 V | 953 Ω |

or



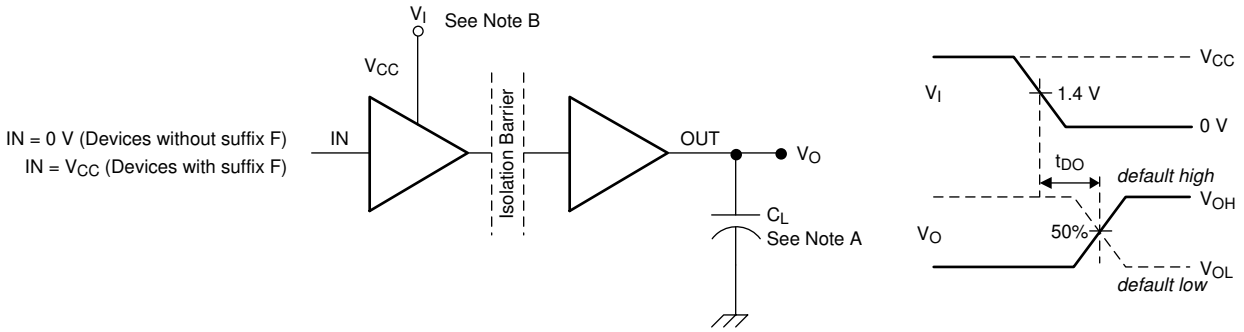






A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 50 kHz, 50% duty cycle, $t_r$ ≤ 3 ns, $t_f$ ≤ 3ns, $Z_O$ = 50 Ω. At the input, 50 Ω resistor is required to terminate Input Generator signal. It is not needed in actual application.

B. $C_L$ = 15 pF and includes instrumentation and fixture capacitance within ±20%.

**Figure 7-4. GPIO Channel Switching Characteristics Test Circuit and Voltage Waveforms**




A. $C_L$ = 15 pF and includes instrumentation and fixture capacitance within ±20%.
B. Power Supply Ramp Rate = 10 mV/ns

**Figure 7-5. GPIO Channel Default Output Delay Time Test Circuit and Voltage Waveforms**

**Figure 7-4. $t_{UVLO}$ Test Circuit and Timing Diagrams**

# 8 Detailed Description

## 8.1 Overview

The $I^2C$ bus consists of a two-wire communication bus that supports bidirectional data transfer between a master device and several slave devices. The master, or processor, controls the bus, specifically the serial clock (SCL) line. Data is transferred between the master and slave through a serial data (SDA) line. This data can be transferred in four speeds: standard mode (0 to 100 kbps), fast mode (0 to 400 kbps), fast-mode plus (0 to 1 Mbps), and high-speed mode (0 to 3.4 Mbps).

The $I^2C$ bus operates in bidirectional, half-duplex mode, using open collector outputs to allow for multiple devices to share the bus. When a specific device is ready to communicate on the bus, it can take control pulling the lines low accordingly in order to transmit data. A standard digital isolator or optocoupler is designed to transfer data in a single direction. In order to support an $I^2C$ bus, external circuitry is required to separate the bidirectional bus into two unidirectional signal paths. The ISO164x devices internally handle the separation and partitioning of the transmit and receive signals, integrating the external circuitry needed and provide the open-collector signals. They provide high electromagnetic immunity and low emissions at low power consumption. Each isolation channel has a logic input and output buffer separated by TI's double capacitive silicon dioxide (SiO2) insulation barrier. When used in conjunction with isolated power supplies, these devices block high voltages, isolate grounds, and prevent noise currents from entering the local ground and interfering with or damaging sensitive circuitry.

## 8.2 Functional Block Diagrams

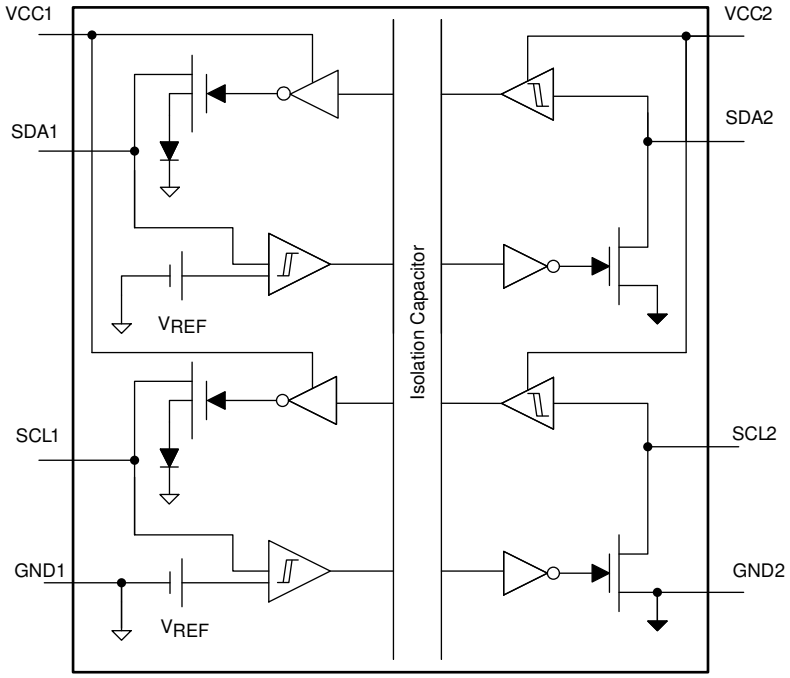



**Figure 8-1. ISO1640 Block Diagram**

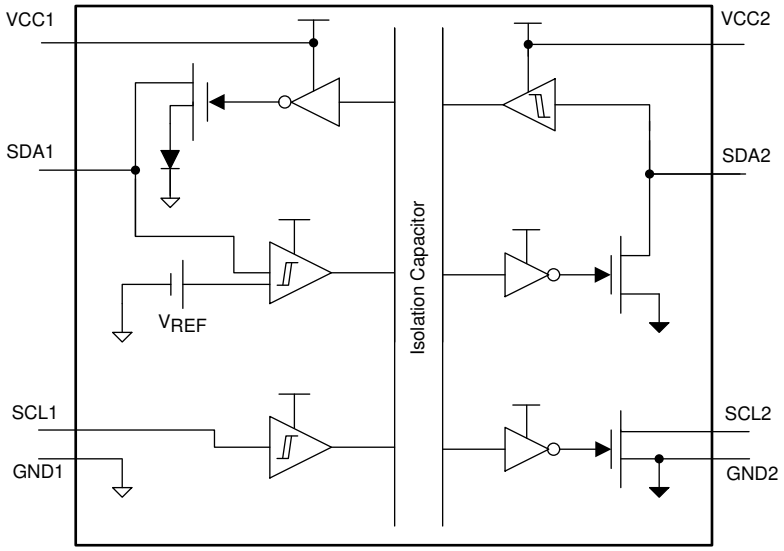



**Figure 8-2. ISO1641 Block Diagram**

## 8.3 Isolation Technology Overview

The ISO164x family of devices has an ON-OFF keying (OOK) modulation scheme to transmit the digital data across a silicon dioxide based isolation barrier. The transmitter sends a high frequency carrier across the barrier to represent one digital state and sends no signal to represent the other digital state. The receiver demodulates the signal after advanced signal conditioning and produces the output through a buffer stage. These devices also incorporate advanced circuit techniques to maximize the CMTI performance and minimize the radiated emissions due the high frequency carrier and switching.

## 8.4 Feature Description

The device enables a complete isolated $I^2C$ interface to be implemented within a small form factor having the features listed in Table 8-1.

**Table 8-1. Features List**

| PART NUMBER | CHANNEL DIRECTION | RATED ISOLATION(1) | $I^2C$ MAXIMUM FREQUENCY | GPIO MAXIMUM FREQUENCY |
|---|---|---|---|---|
| ISO1640 | Bidirectional SCL<br>Bidirectional SDA | 5000 $V_{RMS}$ (16DW) 7071 $V_{PK}$ (16DW) 3000 $V_{RMS}$ (8D) 4242 $V_{PK}$ (8D) | 1.7 MHz | NA |
| ISO1641 | Unidirectional (SCL)<br>Bidirectional (SDA) | 5000 $V_{RMS}$ (16DW) 7071 $V_{PK}$ (16DW) 3000 $V_{RMS}$ (8D) 4242 $V_{PK}$ (8D) | | |
| ISO1642<br>ISO1643<br>ISO1644 | Bidirectional SCL<br>Bidirectional SDA | 5000 $V_{RMS}$ (16DW) 7071 $V_{PK}$ (16DW) | 1.7 MHz | 50 Mbps |

(1) See for detailed Isolation specifications.

### 8.4.1 Hot Swap

The ISO164x includes Hot Swap circuitry on Side 2 of the isolator to prevent loading on the $I^2C$ bus lines while VCC2 is either unpowered or in the process of being powered on. While VCC2 is below the UVLO threshold, the ISO164x bus lines will not load the bus to avoid disrupting or corrupting an active $I^2C$ bus. If the isolator is plugged into a live backplane using a staggered connector, where VCC2 and GND2 make connection first followed by the bus lines, the SDA and SCL lines are pre-charged to VCC2 / 2 to minimize the current required to charge the parasitic capacitance of the device. Once the device is fully powered on, the device bus pins become active providing bidirectional, isolated, SCL and SDA lines.

### 8.4.2 Protection Features

Features are integrated in the ISO164x to help protect the device from high current events. Enhanced ESD protection cells are designed on the $I^2C$ bus pins to support 10 kV HBM ESD on side 1 and 14 kV HBM ESD on side 2. The $I^2C$ bus pins on side 2 are designed to withstand an unpowered IEC-ESD strike of 8 kV, improving robustness and system reliability in hot swap applications. In addition to the improved ESD performance, a short circuit protection circuit is included on side 2 to protect the bus pins (SDA2 and SCL2) against strong short circuits of 5 ohms or less to VCC2.

Thermal shutdown is integrated in the ISO164x to protect the device from high current events. If the junction temperature of the device exceeds the thermal shutdown threshold of 190°C (typical), the device turns off, disabling the $I^2C$ circuits and releasing the bus. The shutdown condition is cleared when the junction temperature drops at least the thermal shutdown hysteresis temperature of 10°C (typical) below the thermal shutdown temperature of the device.

### 8.4.3 GPIO Channels

The ISO1642, ISO1643 and ISO1644 intregrate unidirectional isolation channels, in addition to the bidirectional isolated $I^2C$ lines, to support system signals. The ISO1642 includes two channels in opposing directions (1/1 configuration) and the ISO1643 include two channels in the same direction (2/0 configuration). The ISO1644 includes three GPIO channels, two in one direction and one in the opposite direction (2/1 configuration) making it possible to use with a Serial Peripheral Interface (SPI). The conceptual block diagram of a unidirectional digital capacitive isolator channel is shown in Figure 8-3.

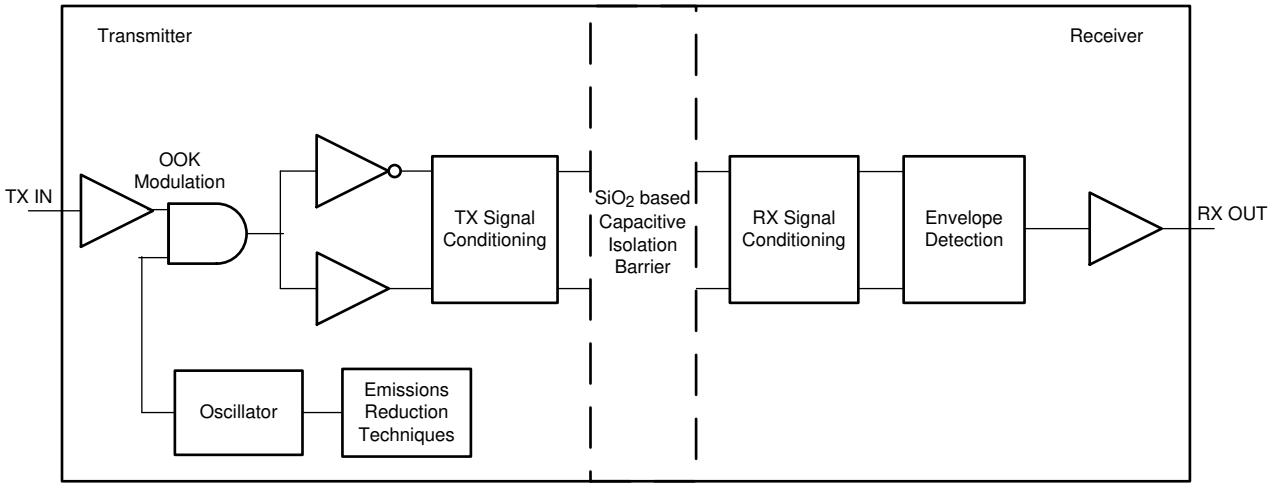



**Figure 8-3. Conceptual Block Diagram of the GPIO Channels**

## 8.5 Isolator Functional Principle

To isolate a bidirectional signal path (SDA or SCL), the ISO1640 internally splits a bidirectional line into two unidirectional signal lines, each of which is isolated through a single-channel digital isolator. Each channel output is made open-drain to comply with the open-drain technology of $I^2C$. Side 1 of the ISO1640 connects to a low-capacitance $I^2C$ node (up to 80 pF), while side 2 is designed for connecting to a fully loaded $I^2C$ bus with up to 400 pF of capacitance.

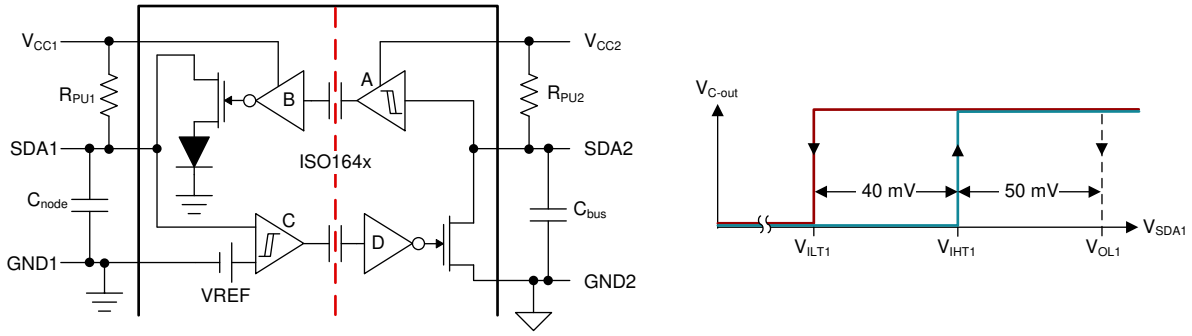



**Figure 8-4. SDA Channel Design and Voltage Levels at SDA1**

At first sight, the arrangement of the internal buffers suggests a closed signal loop that is prone to latch-up. However, this loop is broken by implementing an output buffer (B) whose output low-level is raised by a diode drop to approximately 0.65 V, and the input buffer (C) that consists of a comparator with defined hysteresis. The comparator's upper and lower input thresholds then distinguish between the proper low-potential of 0.4 V (maximum) driven directly by SDA1 and the buffered output low-level of B.

Figure 8-5 demonstrate the switching behavior of the I²C isolator, ISO164x, between a master node at SDA1 and a heavy loaded bus at SDA2.

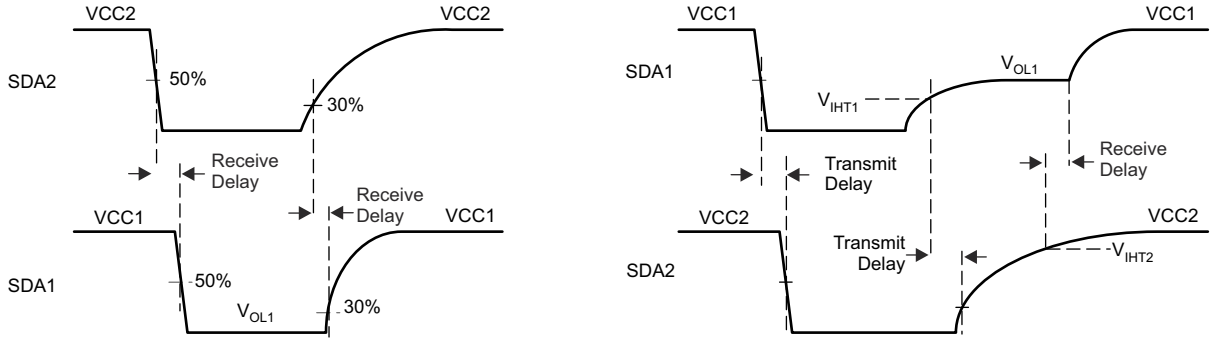



**Figure 8-5. SDA Channel Timing in Receive and Transmit Directions**

### 8.5.1 Receive Direction (Left Diagram of Figure 8-5)

When the I²C bus drives SDA2 low, SDA1 follows after a certain delay in the receive path. The output low is the buffered output of $V_{OL1}$ = 0.65 V, which is sufficiently low to be detected by Schmitt-trigger inputs with a minimum input-low voltage of $V_{IL}$ = 0.9 V at 3 V supply levels.

When SDA2 is released, its voltage potential increases towards VCC2 following the time-constant formed by $R_{PU2}$ and $C_{bus}$. After the receive delay, SDA1 is released and also rises towards VCC1, following the time-constant $R_{PU1} \times C_{node}$. Because of the significant lower time-constant, SDA1 may reach VCC1 before SDA2 reaches VCC2 potential.

### 8.5.2 Transmit Direction (Right Diagram of Figure 8-5)

When a master drives SDA1 low, SDA2 follows after a certain delay in the transmit direction. When SDA2 turns low it also causes the output of buffer B to turn low but at a higher 0.65 V level. This level cannot be observed immediately as it is overwritten by the lower low-level of the master.

However, when the master releases SDA1, the voltage potential increases and first must pass the upper input threshold of the comparator, $V_{IHT1}$, to release SDA2. SDA1 then increases further until it reaches the buffered output level of $V_{OL1}$ = 0.65 V, maintained by the receive path. When comparator C turns high, SDA2 is released after the delay in transmit direction. It takes another receive delay until B's output turns high and fully releases SDA1 to move toward VCC1 potential.

## 8.6 Device Functional Modes

Table 8-2 lists the ISO164x functional modes.

**Table 8-2. I2C Function Table(1)**

| POWER STATE | I2C INPUT | I2C OUTPUT |
|---|---|---|
| $V_{CC1}$ < 2.3 V or $V_{CC2}$ < 1.7 V | X | Z |
| $V_{CC1}$ > 2.9 V and $V_{CC2}$ > 2.25 V | L | L |
| $V_{CC1}$ > 2.9 V and $V_{CC2}$ > 2.25 V | H | Z |
| $V_{CC1}$ > 2.9 V and $V_{CC2}$ > 2.25 V | Z(2) | Undetermined |

(1) H = High Level; L = Low Level; Z = High Impedance or Float; X = Irrelevant
(2) Invalid input condition as an $I^2C$ system requires that a pullup resistor to VCC is connected.

**Table 8-3. GPIO Function Table (ISO1642, ISO1643 and ISO1644 only)(1)**

| $V_{CCI}$ | $V_{CCO}$ | GPIO INPUT (INx) | GPIO OUTPUT (OUTx) | COMMENTS |
|---|---|---|---|---|
| PU | PU | H | H | Normal Operation:<br>A channel output assumes the logic state of the input. |
| | | L | L | |
| | | Open | L | Default mode: When INx is open, the corresponding channel output goes to the default low logic state. |
| PD | PU | X | L | Default mode: When $V_{CCI}$ is unpowered, a channel output assumes the low default logic state.<br>When $V_{CCI}$ transitions from unpowered to powered-up, a channel output assumes the logic state of the input.<br>When $V_{CCI}$ transitions from powered-up to unpowered, channel output assumes the low default state. |
| X | PD | X | Undetermined(2) | When $V_{CCO}$ is unpowered, a channel output is undetermined.<br>When $V_{CCO}$ transitions from unpowered to powered-up, a channel output assumes the logic state of the input |

(1) $V_{CCI}$ = Input-side $V_{CC}$; $V_{CCO}$ = Output-side $V_{CC}$; PU = Powered up ($V_{CC1}$ ≥ 2.9 V or $V_{CC2}$ ≥ 2.25 V); PD = Powered down ($V_{CC1}$ ≤ 2.3 V or $V_{CC2}$ ≤ 1.7 V); X = Irrelevant; H = High level; L = Low level
(2) A strongly driven input signal can weakly power the floating $V_{CC}$ via an internal protection diode and cause undetermined output.

# 9 Application and Implementation

**Note**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 9.1 Application Information

### 9.1.1 I²C Bus Overview

The inter-integrated circuit ($I^2C$) bus is a single-ended, multi-master, 2-wire bus for efficient inter-IC communication in half-duplex mode.

$I^2C$ uses open-drain technology, requiring two lines, serial data (SDA) and serial clock (SCL), to be connected to VDD by resistors (see Figure 9-1). Pulling the line to ground is considered a logic zero while letting the line float is a logic one. This logic is used as a channel access method. Transitions of logic states must occur while the SCL pin is low. Transitions while the SCL pin is high indicate START and STOP conditions. Typical supply voltages are 3.3 V and 5 V, although systems with higher or lower voltages are allowed.

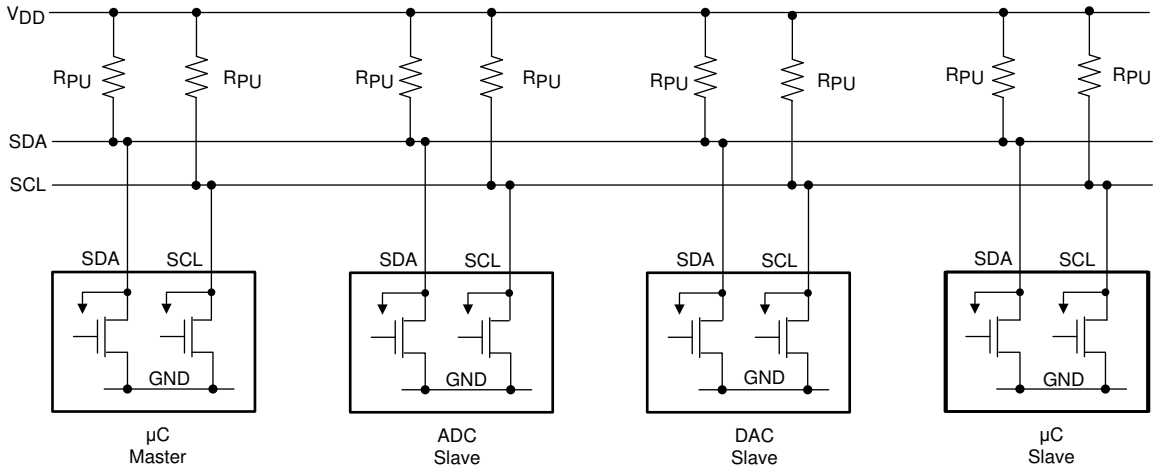



**Figure 9-1. Example $I^2C$ Bus**

$I^2C$ communication uses a 7-bit address space with 16 reserved addresses, so a theoretical maximum of 112 nodes can communicate on the same bus. In practice, however, the number of nodes is limited by the specified, total bus capacitance of 400 pF, which also restricts communication distances to a few meters.

The specified signaling rates for the ISO164x devices are 100 kbps (standard mode), 400 kbps (fast mode), 1.7 Mbps (fast mode plus).

The bus has two roles for nodes: master and slave. A master node issues the clock and slave addresses, and also initiates and ends data transactions. A slave node receives the clock and addresses and responds to requests from the master. Figure 9-2 shows a typical data transfer between master and slave.

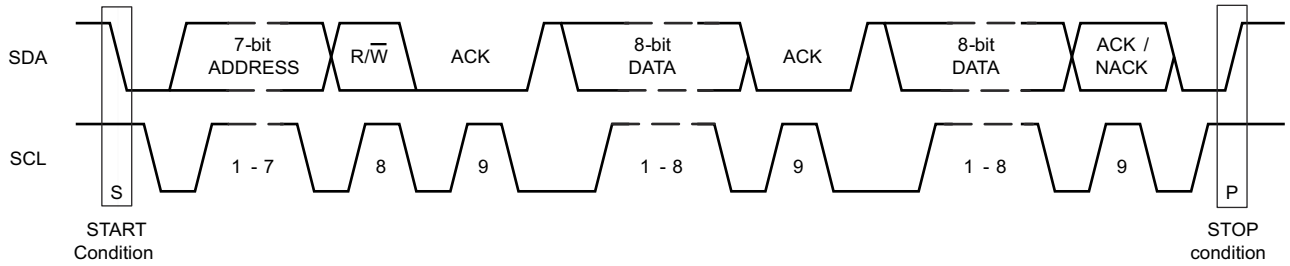



**Figure 9-2. Timing Diagram of a Complete Data Transfer**

The master initiates a transaction by creating a START condition, following by the 7-bit address of the slave it wishes to communicate with. This is followed by a single read and write (R/W) bit, representing whether the master wishes to write to (0), or to read from (1) the slave. The master then releases the SDA line to allow the slave to acknowledge the receipt of data.

The slave responds with an acknowledge bit (ACK) by pulling the SDA pin low during the entire high time of the 9th clock pulse on the SCL signal, after which the master continues in either transmit or receive mode (according to the R/W bit sent), while the slave continues in the complementary mode (receive or transmit, respectively).

The address and the 8-bit data bytes are sent most significant bit (MSB) first. The START bit is indicated by a high-to-low transition of SDA while SCL is high. The STOP condition is created by a low-to-high transition of SDA while SCL is high.

If the master writes to a slave, it repeatedly sends a byte with the slave sending an ACK bit. In this case, the master is in master-transmit mode and the slave is in slave-receive mode.

If the master reads from a slave, it repeatedly receives a byte from the slave, while acknowledging (ACK) the receipt of every byte but the last one (see Figure 9-3). In this situation, the master is in master-receive mode and the slave is in slave-transmit mode.

The master ends the transmission with a STOP bit, or may send another START bit to maintain bus control for further transfers.

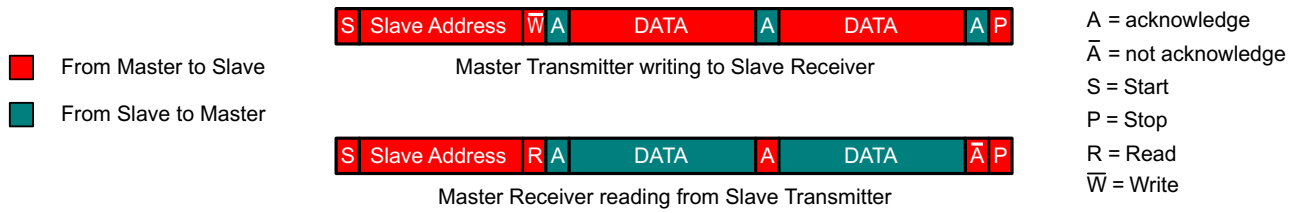



**Figure 9-3. Transmit or Receive Mode Changes During a Data Transfer**

When writing to a slave, a master mainly operates in transmit-mode and only changes to receive-mode when receiving acknowledgment from the slave.

When reading from a slave, the master starts in transmit-mode and then changes to receive-mode after sending a READ request (R/W bit = 1) to the slave. The slave continues in the complementary mode until the end of a transaction.

**Note**

The master ends a reading sequence by not acknowledging (NACK) the last byte received. This procedure resets the slave state machine and allows the master to send the STOP command.

## 9.2 Typical Application

In Figure 9-4, the ultra low-power microcontroller, MSP430G2132, controls the $I^2C$ data traffic of configuration data and conversion results for the analog inputs and outputs. In Figure 9-5, the TMS320F28035 controls both

the I²C interface, for communication to a DAC for analog outputs, and a SPI interface, for communication to an ADC for analog inputs.

Low-power data converters build the analog interface to sensors and actuators. The ISO164x device provides the required isolation between different ground potentials of the system controller, remote sensor, and actuator circuitry to prevent ground loop currents that otherwise may falsify the acquired data.

The entire circuit operates from a single 3.3-V supply. A low-power push-pull converter, SN6501, drives a center-tapped transformer with an output that is rectified and linearly regulated to provide a stable 5-V supply for the data converters.

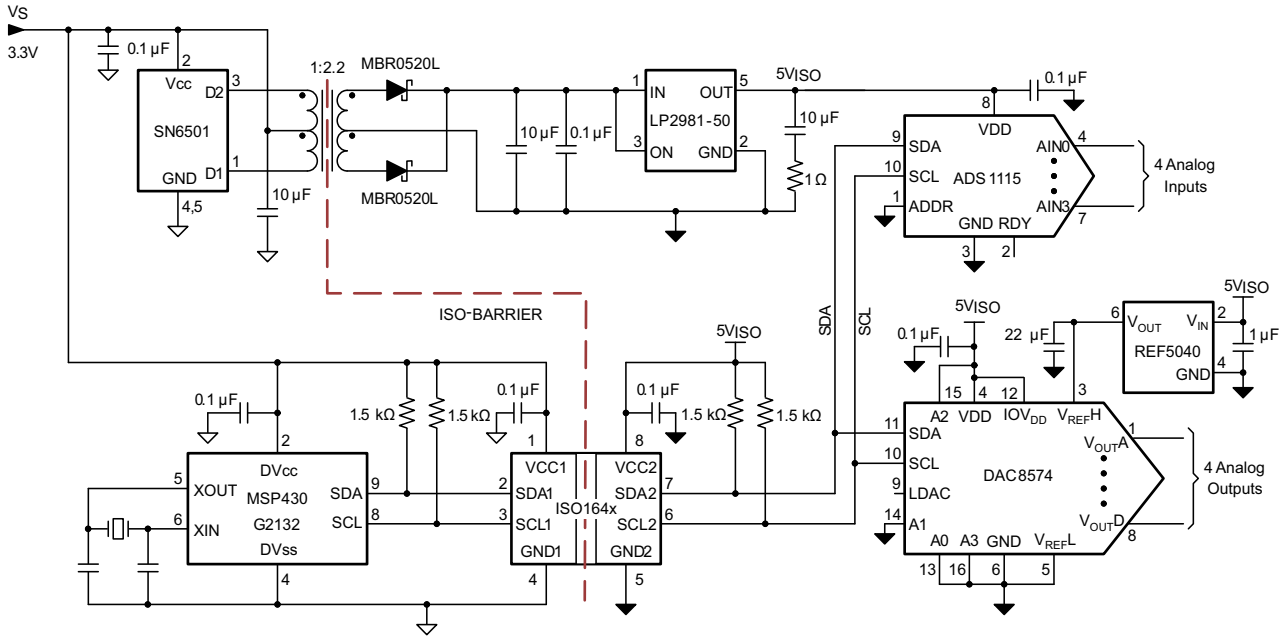



**Figure 9-4. Isolated I²C Data Acquisition System**

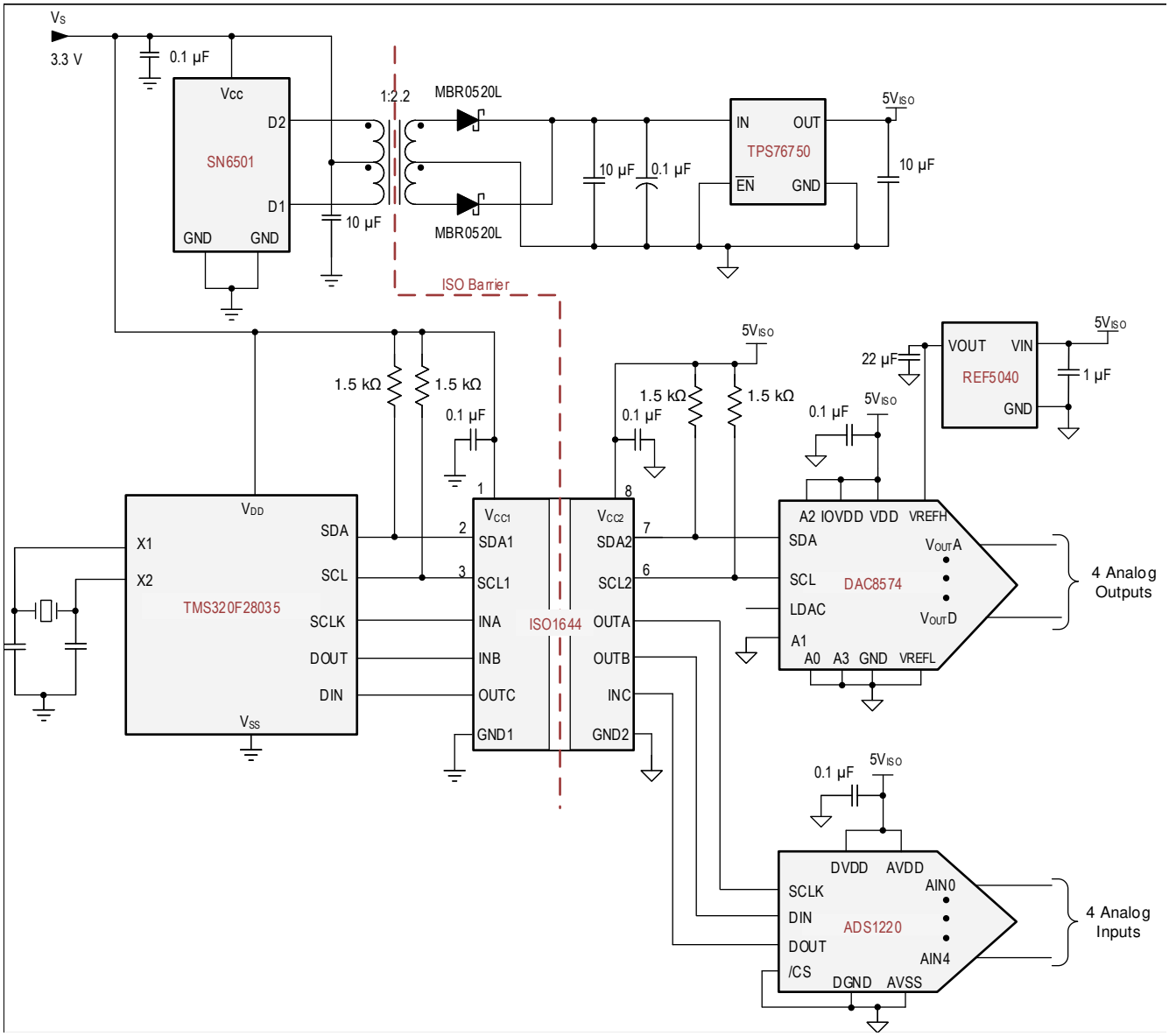



**Figure 9-5. Isolated I²C and SPI Data Acquisition System**

### 9.2.1 Design Requirements

The recommended power supply voltages must be from 3 V to 5.5 V for VCC1 and 2.25 V to 5.5 V for VCC2. A recommended decoupling capacitor with a value of 0.1 µF is required between both the VCC1 and GND1 pins, and the VCC2 and GND2 pins to support of power supply voltage transients and to ensure reliable operation at all data rates.

### 9.2.2 Detailed Design Procedure

Although the ISO1640 features bidirectional data channels, the device performs optimally when side 1 (SDA1 and SCL1) is connected to a single controller or node of an I2C network while side 2 (SDA2 and SCL2) is connected to the I2C bus. The maximum load permissible on the input lines, SDA1 and SCL1, is ≤ 80 pF and on the output lines, SDA2 and SCL2, is ≤ 400 pF. In addition to the bidirectional data and clock channels for the I2C network, the ISO1644 includes 3 GPIOs which can be used for static I/O lines or for a 3 wire SPI interface. These lines are designed to support up to 50 Mbps data transfer rate.

The power-supply capacitor with a value of 0.1-µF must be placed as close to the power supply pins as possible. The recommended placement of the capacitors must be 2-mm maximum from input and output power supply pins (VCC1 and VCC2).

The minimum pullup resistors on the input lines, SDA1 and SCL1 to VCC1 must be selected in such a way that input current drawn is ≤ 3.5 mA. The minimum pullup resistors on the input lines, SDA2 and SCL2, to VCC2 must be selected in such a way that output current drawn is ≤ 50 mA. The maximum pullup resistors on the bus lines (SDA1 and SCL1) to VCC1 and on bus lines (SDA2 and SCL2) to VCC2, depends on the load and rise time requirements on the respective lines to comply with I2C protocols. For more information, see I2C Bus Pullup Resistor Calculation.

The output waveforms for SDA1 and SCL1 are captured on the oscilloscope focusing on the low $V_{OL1}$ voltage offset offered with the ISO164x. This voltage offset is due to the output low level on side 1 designed to prevent a latch-up state mentioned in Section 8.5.

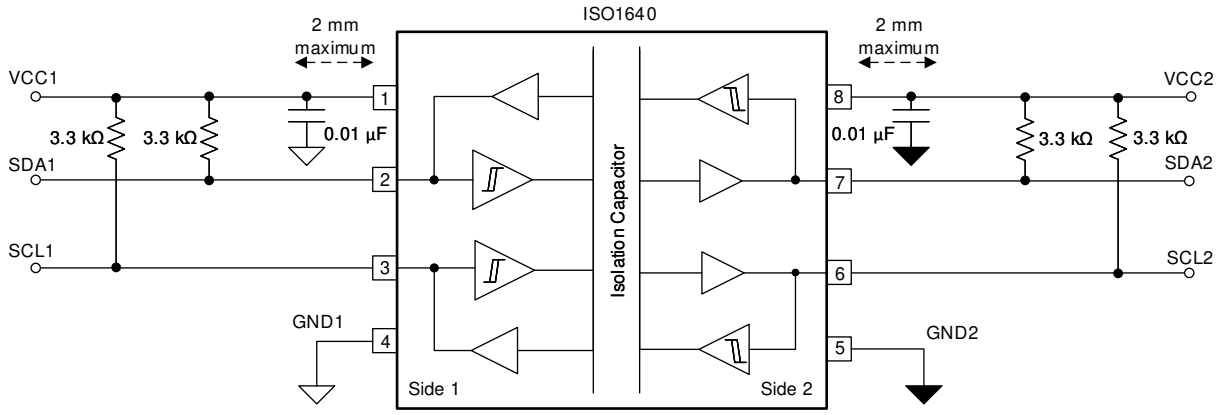



**Figure 9-6. Typical ISO1640 Circuit Hookup**

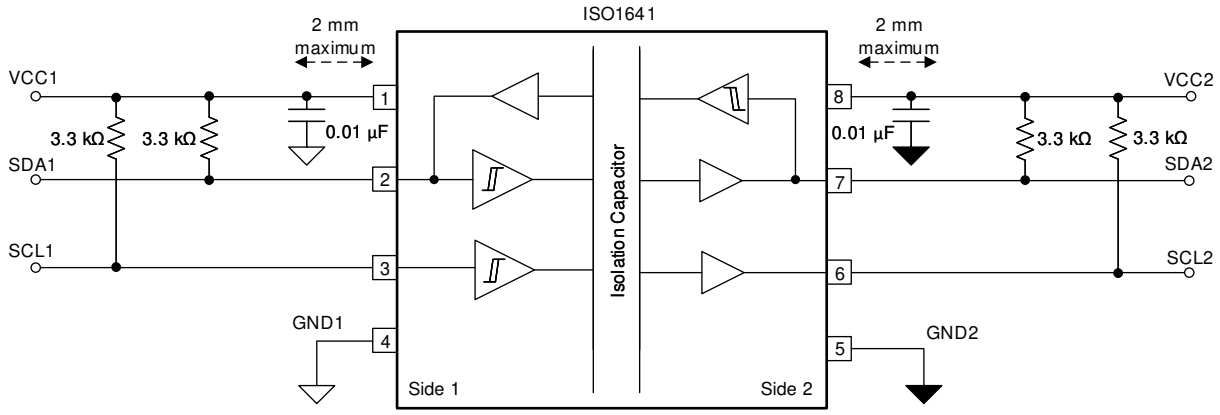



**Figure 9-7. Typical ISO1641 Circuit Hookup**

### 9.2.3 Application Curve

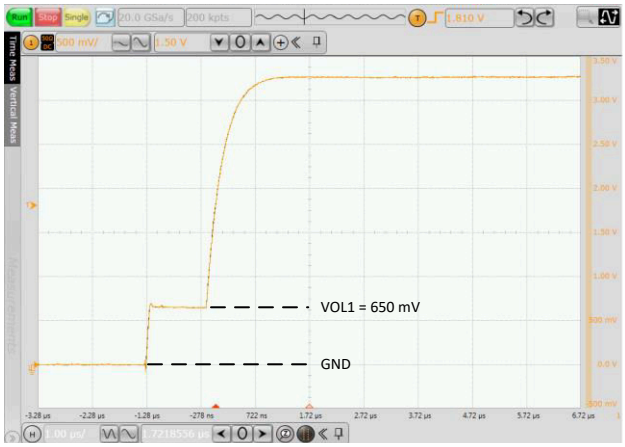



**Figure 9-8. Side 1 ISO1640: Low-to-High Transition**


**Figure 9-9. Side 1 ISO1644: Low-to-High Transition With Toggling GPIO lines**

## 9.3 *Insulation Lifetime*

Insulation lifetime projection data is collected by using the industry-standard Time Dependent Dielectric Breakdown (TDDB) test method. In this test, all pins on each side of the barrier are tied together creating a two-terminal device and high voltage is applied between the two sides; see Figure 9-10 for TDDB test setup. The insulation breakdown data is collected at various high voltages switching at 60 Hz over temperature. For basic insulation, VDE standard requires the use of a TDDB projection line with failure rate of less than 1000 part per million (ppm). For reinforced insulation, VDE standard requires the use of a TDDB projection line with failure rate of less than 1 part per million (ppm).

Even though the expected minimum insulation lifetime is 20 years, at the specified working isolation voltage, VDE basic and reinforced certifications require additional safety margin of 20% for working voltage. For basic certification, device lifetime requires a safety margin of 30% translating to a minimum required insulation lifetime of 26 years at a working voltage that is 20% higher than the specified value. For reinforced insulation, device lifetime requires a safety margin of 87.5% translating to a minimum required insulation lifetime of 37.5 years at a working voltage that is 20% higher than the specified value.

Insulation Lifetime Projection Data for ISO164x in 8-D Package and Insulation Lifetime Projection Data for ISO164x in 16-DW Package show the intrinsic capability of the isolation barrier to withstand high voltage stress over its lifetime. Based on the TDDB data, the intrinsic capability of the insulation is 450 $V_{RMS}$ with a lifetime in excess of 100 years in the 8-D package and 1500 $V_{RMS}$ with a lifetime in excess of 135 years in the 16-DW package. Other factors, such as package size, pollution degree, material group, etc. can further limit the working voltage of the component. At the lower working voltages, the corresponding insulation lifetime is much longer than 100 years in the 8-D package and 135 years in the 16-DW package.

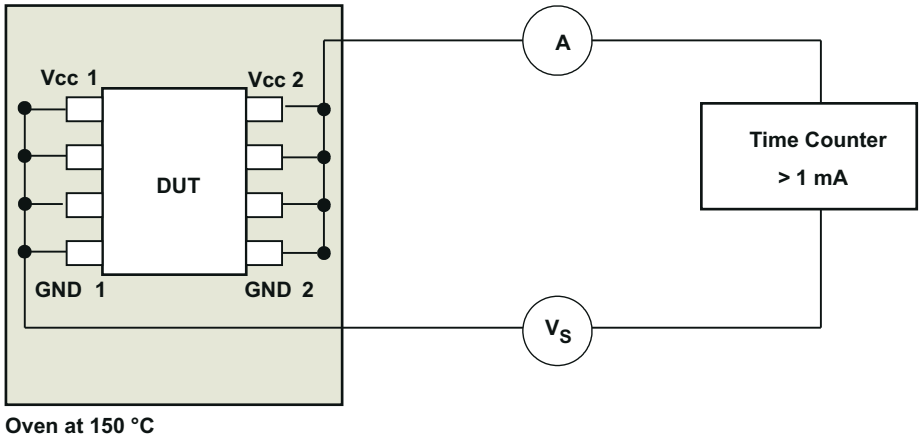



**Figure 9-10. Test Setup for Insulation Lifetime Measurement**

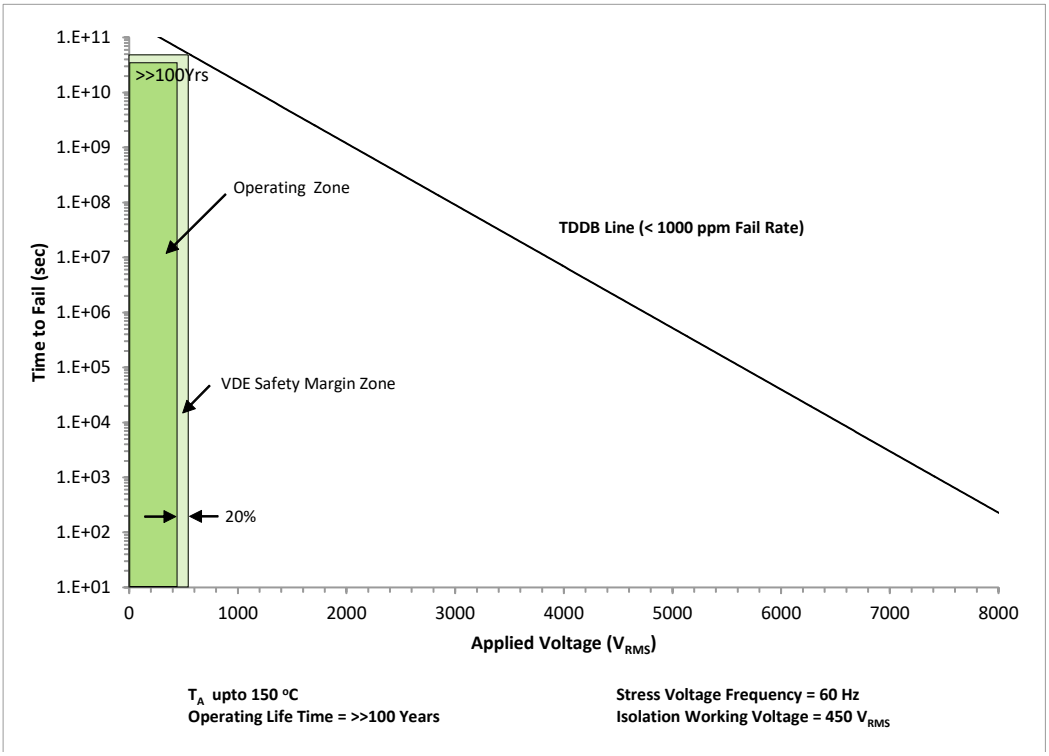



**Figure 9-11. Insulation Lifetime Projection Data for ISO164x in 8-D Package**

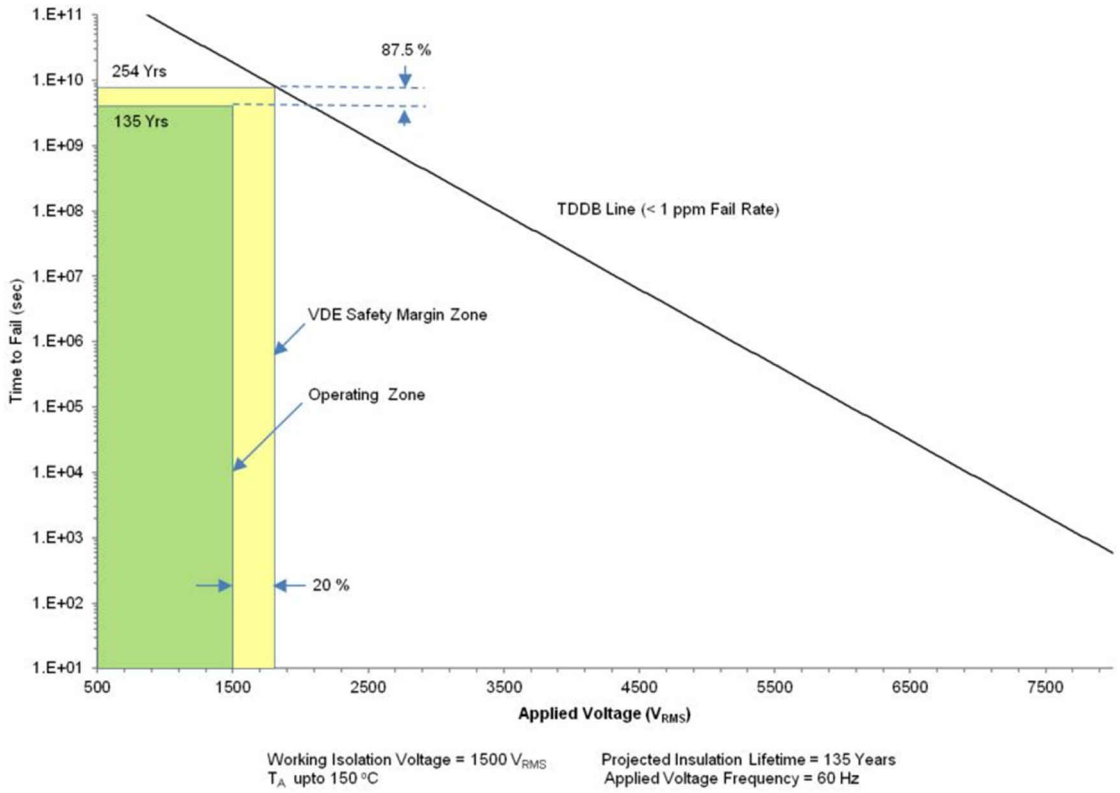



**Figure 9-12. Insulation Lifetime Projection Data for ISO164x in 16-DW Package**

## 10 Power Supply Recommendations

To help ensure reliable operation at data rates and supply voltages, TI recommends connecting a 0.1-µF bypass capacitor at the input and output supply pins (VCC1 and VCC2). The capacitors should be placed as close to the supply pins as possible. If only a single, primary-side power supply is available in an application, isolated power can be generated for the secondary-side with the help of a transformer driver such as TI's SN6501 device. For such applications, detailed power supply design and transformer selection recommendations are available in *SN6501 Transformer Driver for Isolated Power Supplies.* (SLLSEA0).

# 11 Layout

## 11.1 Layout Guidelines

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.

- 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.
- 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$^2$.
- 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.

If an additional supply voltage plane or signal layer is needed, add a second power or 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.

For detailed layout recommendations, see the *Digital Isolator Design Guide* (SLLA284)

### 11.1.1 PCB Material

For digital circuit boards operating at less than 150 Mbps, (or rise and fall times greater than 1 ns), and trace lengths of up to 10 inches, use standard FR-4 UL94V-0 printed circuit board. This PCB is preferred over cheaper alternatives because of lower dielectric losses at high frequencies, less moisture absorption, greater strength and stiffness, and the self-extinguishing flammability-characteristics.

## 11.2 Layout Example

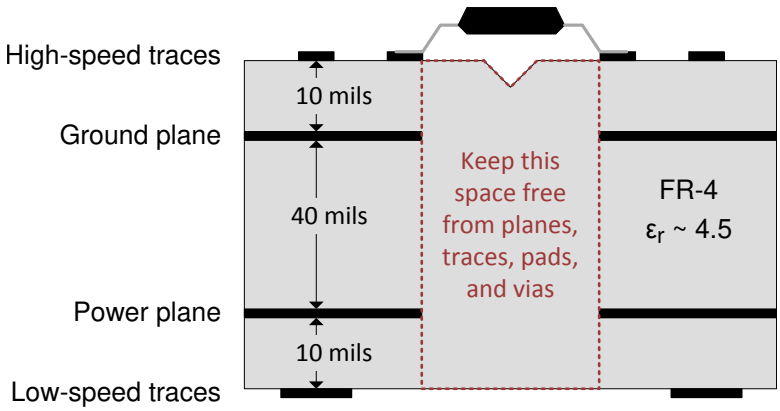



**Figure 11-1. Recommended Layer Stack**

# 12 Device and Documentation Support

## 12.1 Documentation Support

### 12.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, How Do Isolated I2C Buffers with Hot-Swap Capability and IEC ESD Improve Isolated I2C?
- Texas Instruments, *Digital Isolator Design Guide*
- Texas Instruments, *How to use isolation to improve ESD, EFT and Surge immunity in industrial systems* application report
- Texas Instruments, *Isolation Glossary*
- Texas Instruments, *What is EMC? 4 questions about EMI, radiated emissions, ESD and EFT in isolated systems*
- Texas Instruments, *SN6501 Transformer Driver for Isolated Power Supplies* data sheet
- Texas Instruments, *SN6505x Transformer Driver for Isolated Power Supplies* data sheet
- Texas Instruments, *I2C Bus Pullup Resistor Calculation*
- Texas Instruments, *ISO1640DEVM Evaluation Module Users Guide*

## 12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 12.3 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

## 12.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

## 12.5 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 12.6 Glossary

| | |
|---|---|
| TI Glossary | This glossary lists and explains terms, acronyms, and definitions. |

# 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 (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| ISO1640BDR | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1640B |
| ISO1640BDR.A | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1640B |
| ISO1640BDR.B | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1640BDRG4 | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1640B |
| ISO1640BDRG4.A | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1640B |
| ISO1640BDRG4.B | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1640DWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1640 |
| ISO1640DWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1640 |
| ISO1640DWR.B | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1641BDR | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1641B |
| ISO1641BDR.A | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1641B |
| ISO1641BDR.B | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1641BDRG4 | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1641B |
| ISO1641BDRG4.A | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 1641B |
| ISO1641BDRG4.B | Active | Production | SOIC (D) \| 8 | 3000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1641DWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1641 |
| ISO1641DWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1641 |
| ISO1641DWR.B | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1642DWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1642 |
| ISO1642DWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1642 |
| ISO1642DWR.B | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1643DWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1643 |
| ISO1643DWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1643 |
| ISO1643DWR.B | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |
| ISO1644DWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1644 |
| ISO1644DWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | ISO1644 |
| ISO1644DWR.B | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | - | Call TI | Call TI | -40 to 125 | |

(1) **Status:** For more details on status, see our product life cycle.

(2) **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.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **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.

(5) **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.

(6) **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.



**OTHER QUALIFIED VERSIONS OF ISO1640 :**

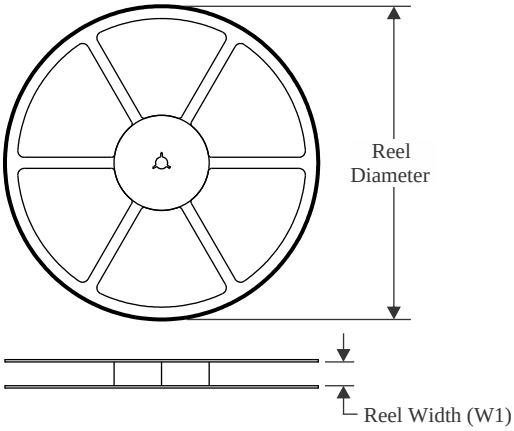
- Automotive : ISO1640-Q1

NOTE: Qualified Version Definitions:

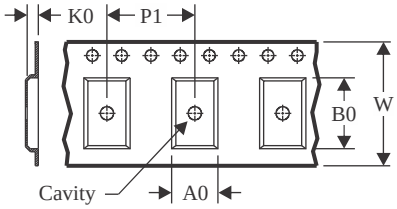
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

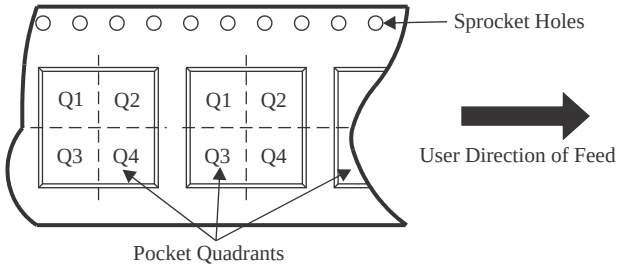



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

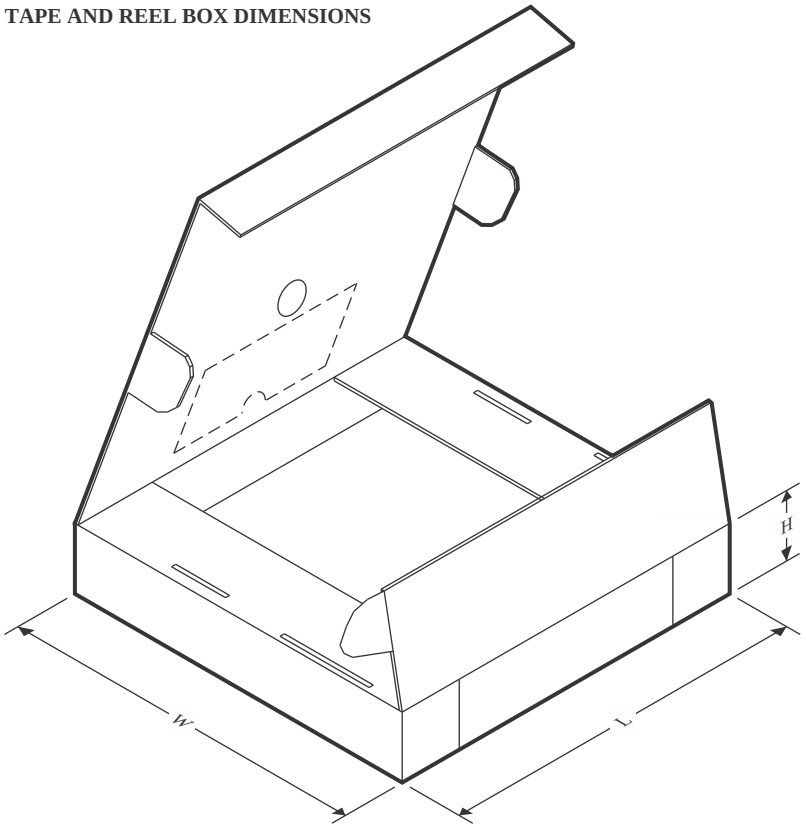
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ISO1640BDR | SOIC | D | 8 | 3000 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| ISO1640BDRG4 | SOIC | D | 8 | 3000 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| ISO1640DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1641BDR | SOIC | D | 8 | 3000 | 330.0 | 12.4 | 6.5 | 5.4 | 2.0 | 8.0 | 12.0 | Q1 |
| ISO1641BDRG4 | SOIC | D | 8 | 3000 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| ISO1641DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1641DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1642DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1642DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1643DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1643DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1644DWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| ISO1644DWR | 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) |
|---|---|---|---|---|---|---|---|
| ISO1640BDR | SOIC | D | 8 | 3000 | 353.0 | 353.0 | 32.0 |
| ISO1640BDRG4 | SOIC | D | 8 | 3000 | 353.0 | 353.0 | 32.0 |
| ISO1640DWR | SOIC | DW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| ISO1641BDR | SOIC | D | 8 | 3000 | 356.0 | 356.0 | 36.0 |
| ISO1641BDRG4 | SOIC | D | 8 | 3000 | 353.0 | 353.0 | 32.0 |
| ISO1641DWR | SOIC | DW | 16 | 2000 | 356.0 | 356.0 | 45.0 |
| ISO1641DWR | SOIC | DW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| ISO1642DWR | SOIC | DW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| ISO1642DWR | SOIC | DW | 16 | 2000 | 356.0 | 356.0 | 45.0 |
| ISO1643DWR | SOIC | DW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| ISO1643DWR | SOIC | DW | 16 | 2000 | 356.0 | 356.0 | 45.0 |
| ISO1644DWR | SOIC | DW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| ISO1644DWR | SOIC | DW | 16 | 2000 | 356.0 | 356.0 | 45.0 |

# GENERIC PACKAGE VIEW

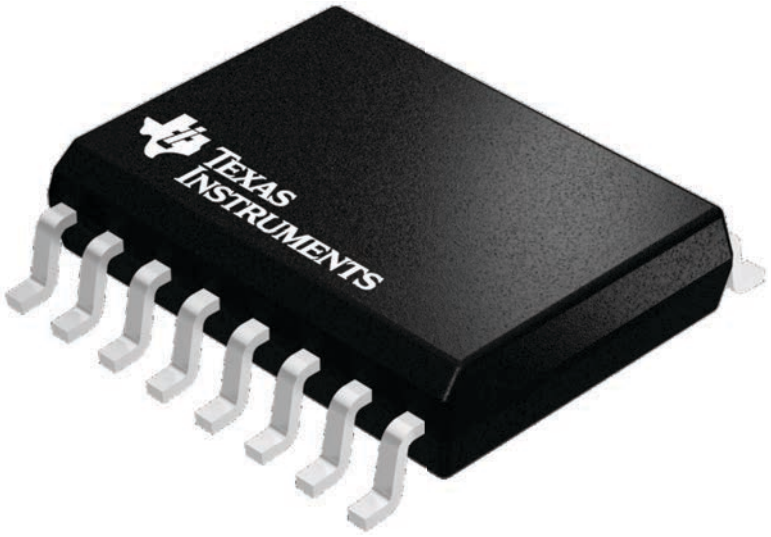
## DW 16

## SOIC - 2.65 mm max height

**7.5 x 10.3, 1.27 mm pitch**

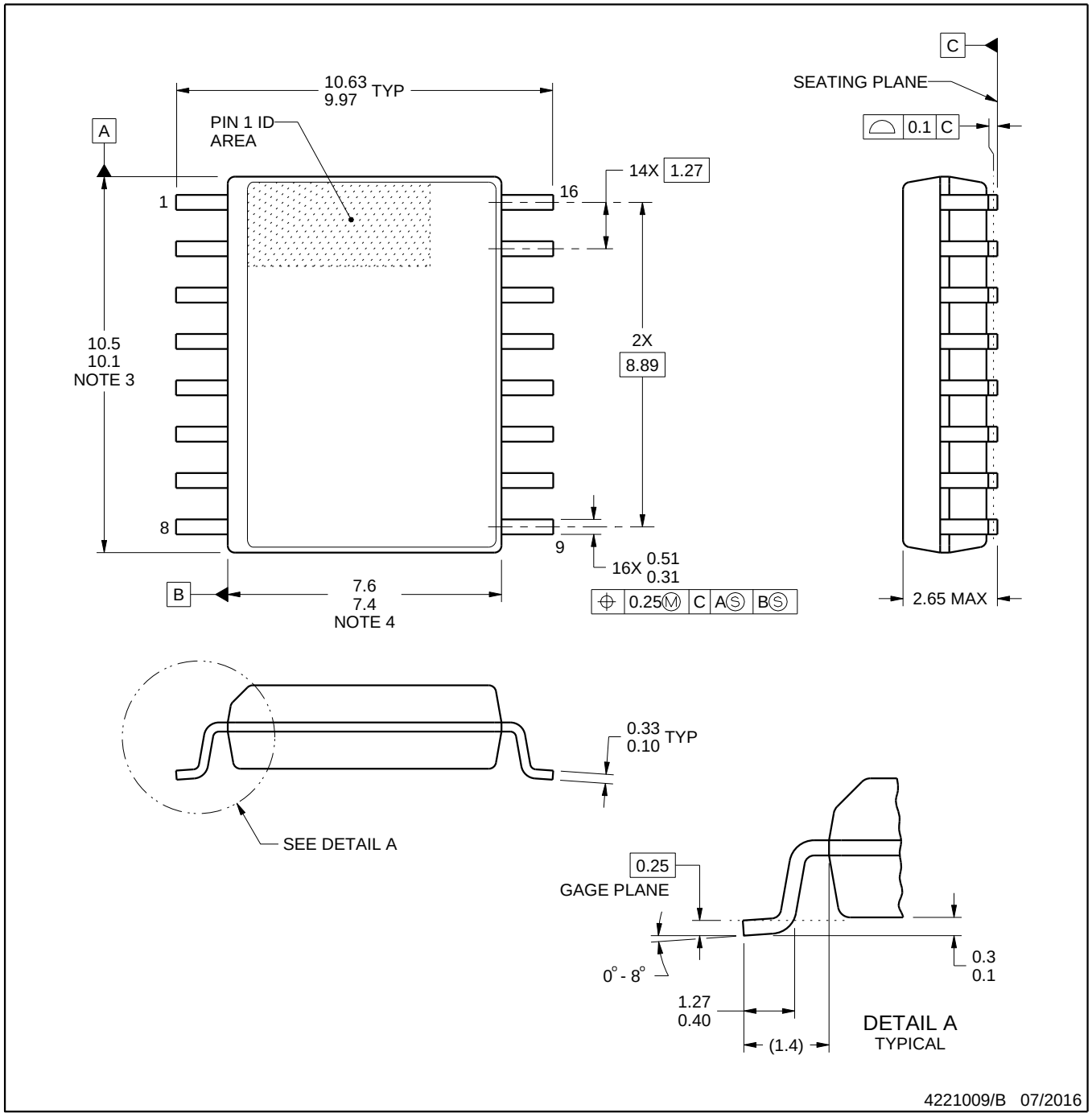
SMALL OUTLINE INTEGRATED CIRCUIT

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



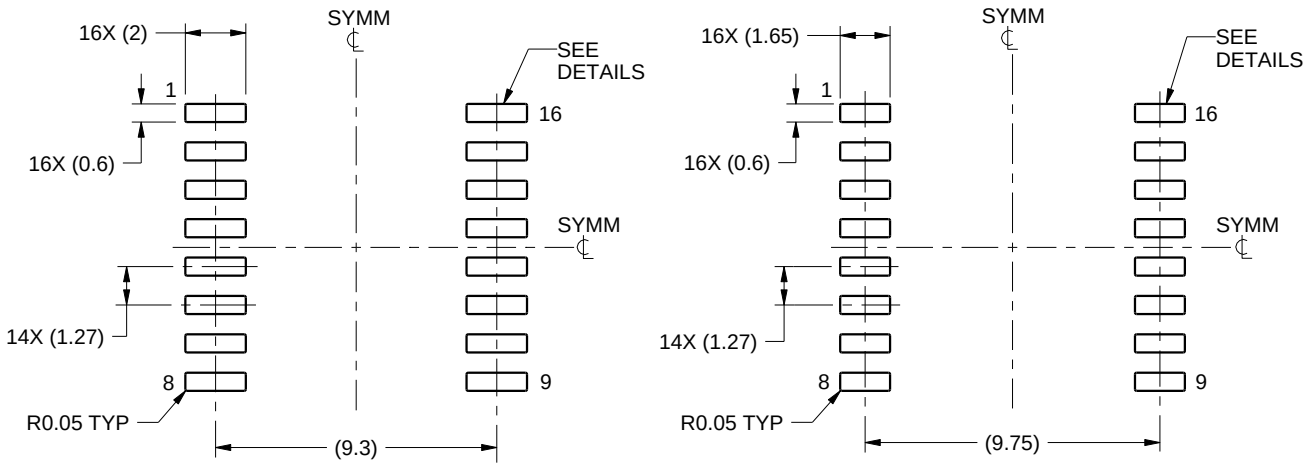

4224780/A

SOIC




NOTES:

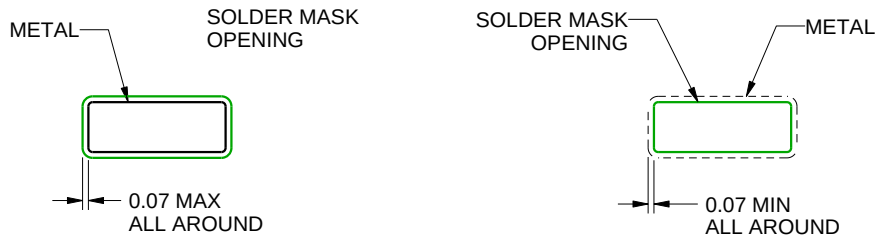
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.




IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

LAND PATTERN EXAMPLE
SCALE:4X




NON SOLDER MASK DEFINED

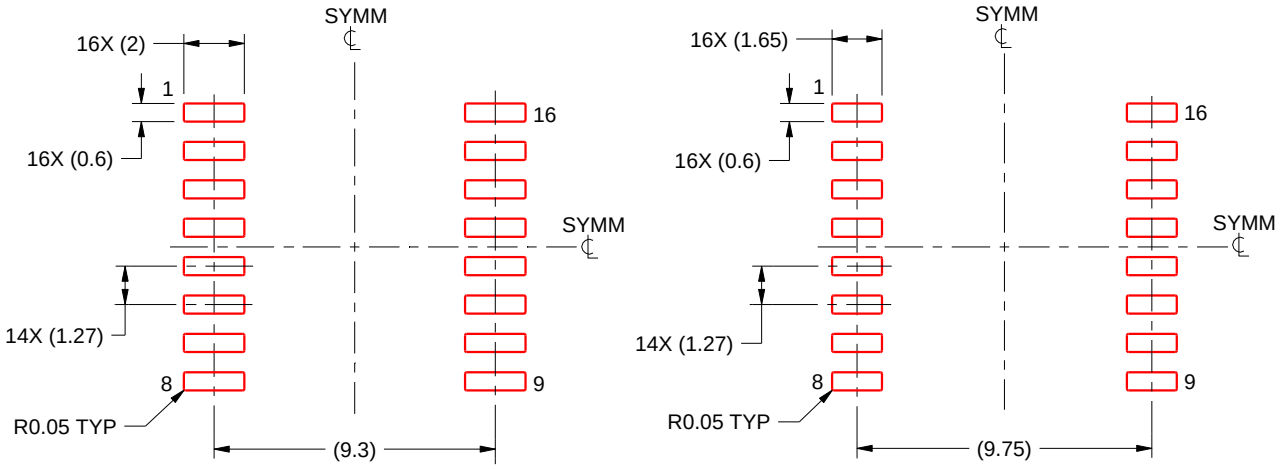
SOLDER MASK DEFINED

SOLDER MASK DETAILS

4221009/B 07/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.




IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

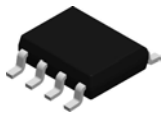
HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:4X

4221009/B 07/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

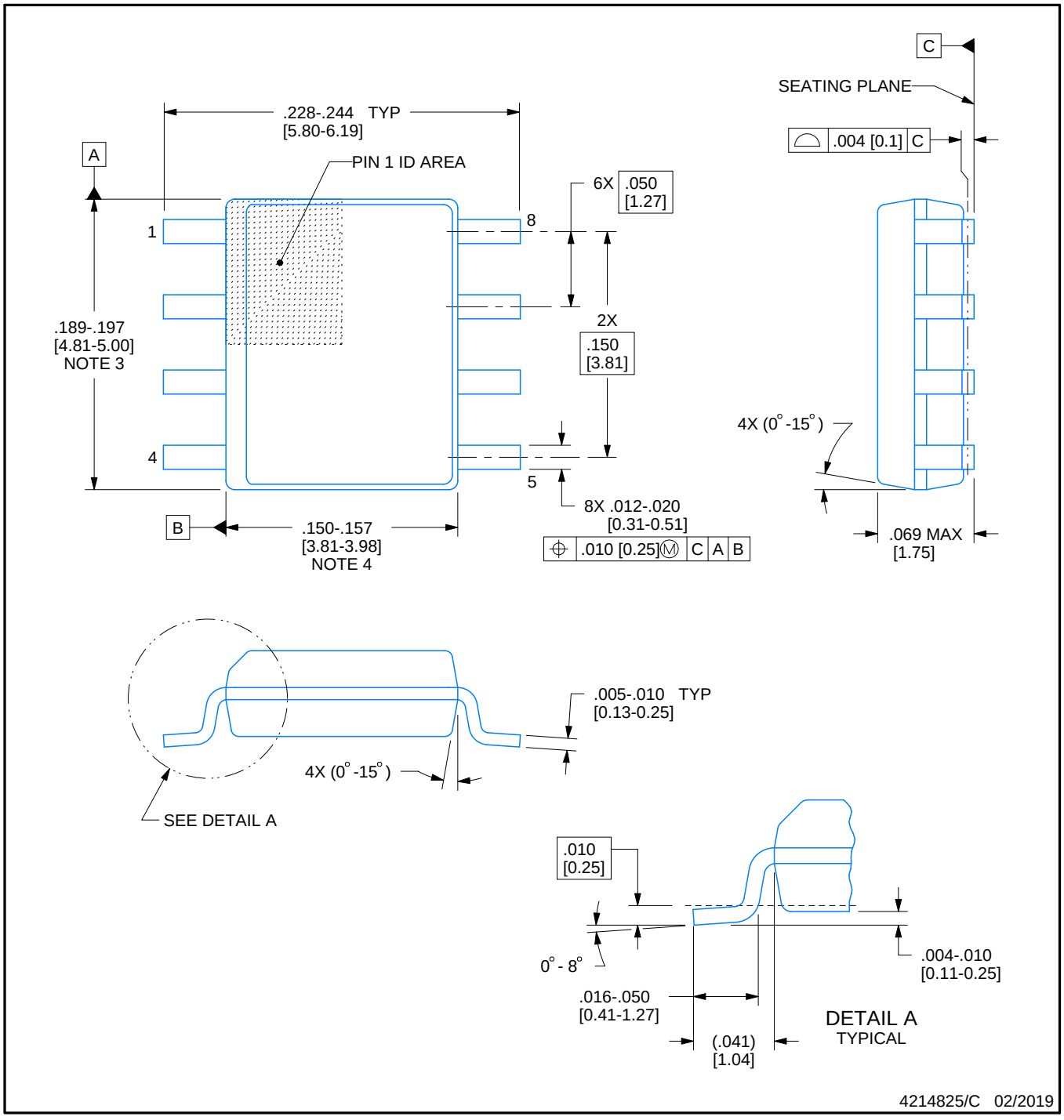


# PACKAGE OUTLINE

## D0008A

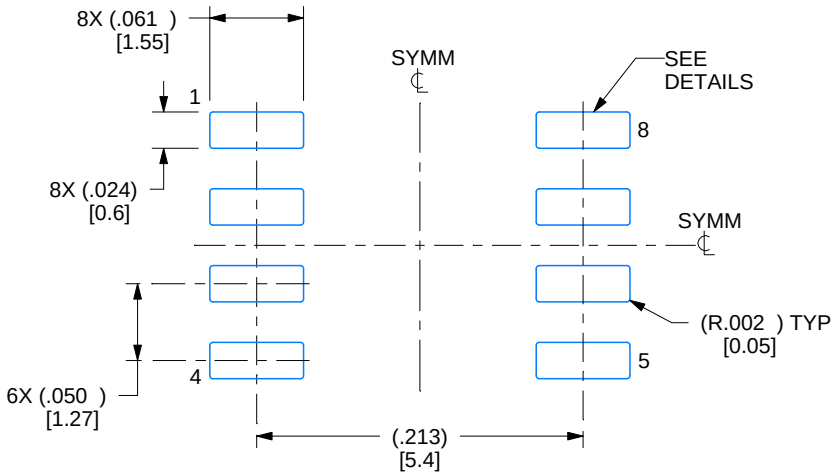
## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

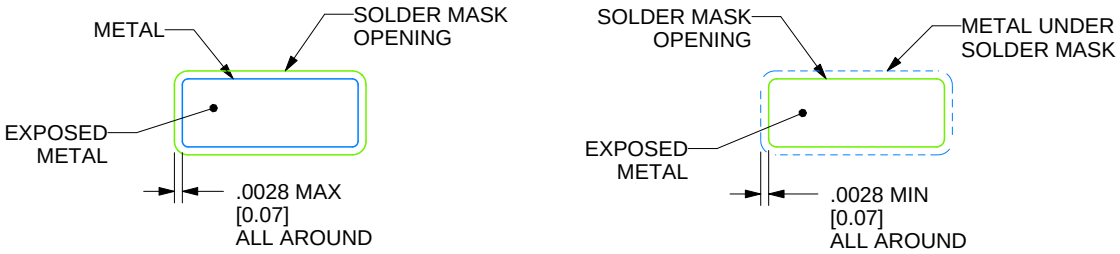



NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X




SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

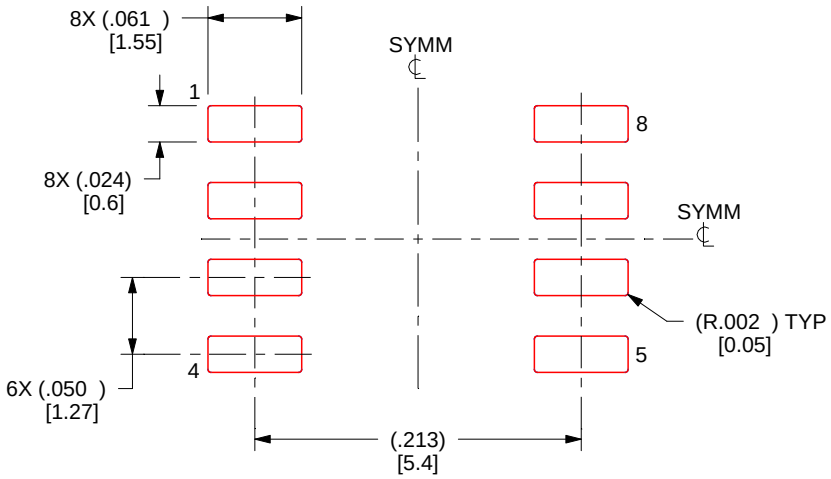
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

## D0008A

## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT




SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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