

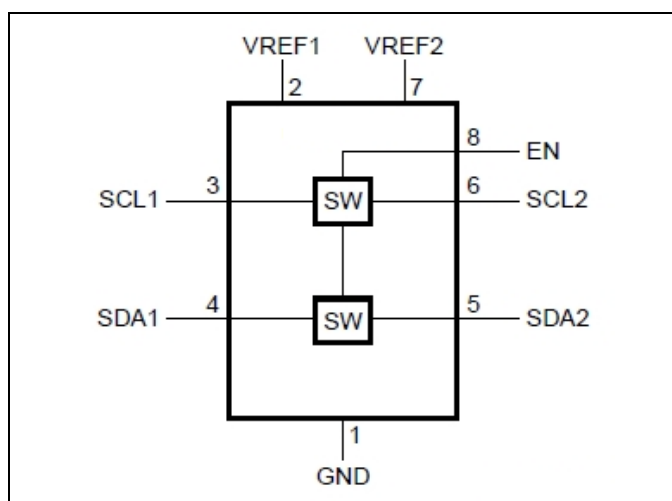
Dual Bidirectional I2C-Bus and SMBus Voltage-Level Translator

Description

The DIODES PI6ULS5V9306 is a dual bidirectional I²C-bus and SMBus voltage-level translator with an enable (EN) input. It is operational from 0.9V to 3.3V (VREF1) and 1.8V to 5V (VREF2).

The PI6ULS5V9306 allows bidirectional voltage translations between 1.0V and 5V without the use of a direction pin. The low ON-state resistance (Ron) of the switch allows connections to be made with minimal propagation delay. When EN is HIGH, the translator switch is on, and the SCL1 and SDA1 I/O are connected to the SCL2 and SDA2 I/O respectively, allowing bidirectional data flow between ports. When EN is LOW, the translator switch is off, and a high-impedance state exists between ports.

Block Diagram



Function Table

| EN | Function |
|----|-----------------------------|
| H | SCL1 = SCL2; SDA1 = SDA2 |
| L | disabled |

Features

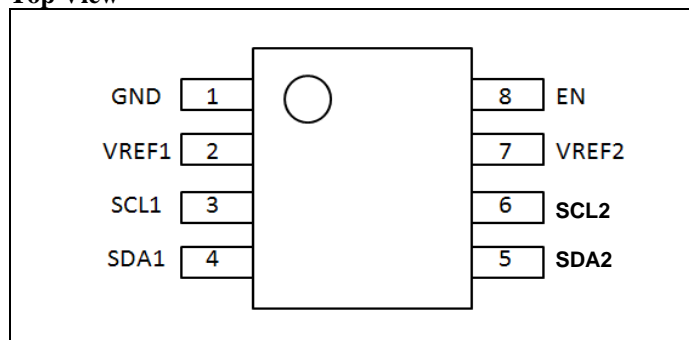
- 2-bit Bidirectional Translator for SDA and SCL Lines in Mixed-Mode I2C-Bus Applications
- Standard-Mode, Fast-Mode, and Fast-Mode Plus I2C-Bus and SMBus Compatible
- Less than 1.5ns Maximum Propagation Delay to Accommodate Standard Mode and Fast Mode I2C-Bus Devices and Multiple Masters
- Allows Voltage Level Translation Between:
 - 0.9V VREF1 and 1.8V, 2.5V, 3.3V, or 5V VREF2
 - 1.2V VREF1 and 1.8V, 2.5V, 3.3V, or 5V VREF2
 - 1.5V VREF1 and 2.5V, 3.3V, or 5V VREF2
 - 1.8V VREF1 and 3.3V or 5V VREF2
 - 2.5V VREF1 and 5V VREF2
 - 3.3V VREF1 and 5V VREF2
- Provides Bidirectional Voltage Translation with no Direction Pin
- Low 3.5Ω ON-State Connection Between Input and Output Ports Provides Less Signal Distortion
- Open-Drain I2C-Bus I/O Ports (SCL1, SDA1, SCL2, and SDA2)
- 5V Tolerant I2C-Bus I/O Ports to Support Mixed-Mode Signal Operation
- High-Impedance SCL1, SDA1, SCL2, and SDA2 Pins for EN = LOW
- Lock-up Free Operation for Isolation when EN = LOW
- Flow-Through Pinout for Ease of Printed-Circuit Board Trace Routing
- ESD Protection Exceeds 4KV HBM per JESD22-A114
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](mailto:contact@diodes.com) or your local Diodes representative. <https://www.diodes.com/quality/product-definitions/>
- Packaging (Pb-free & Green):
 - 8-Pin, TDFN2x3 (ZE) (Not Recommend for New Design)
 - 8-Pin, MSOP (U) (Not Recommend for New Design)
 - 8-Pin, SOIC(W) (Not Recommend for New Design)
 - 8-Pin, MSOP (M)
 - 8-Pin, VSSOP (V)
 - 8-Pin, SSOP (SS)
 - 8-Pin, SOT28 (TA)
 - 8-Pin, X2-DFN (HK)

Notes:

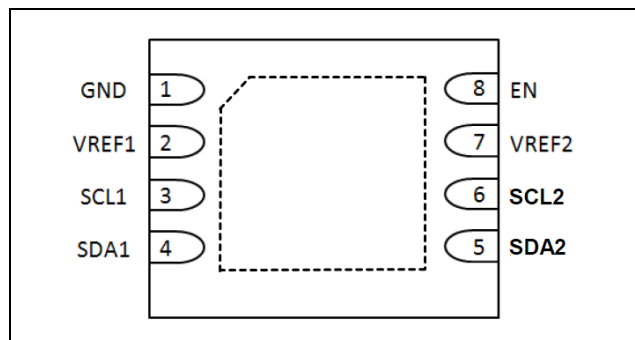
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Configuration

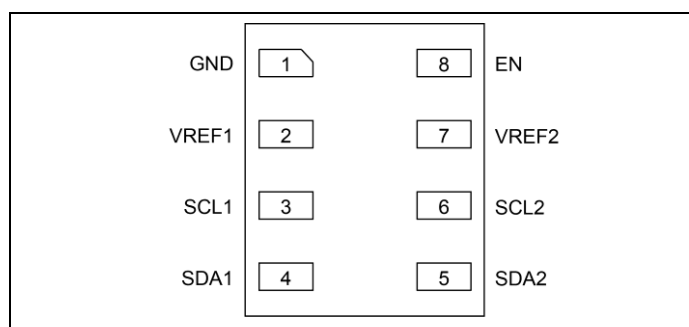
Top View



MSOP-8(U)/SOIC-8(W)/VSSOP-8(V)/SSOP-8(SS)
/SOT28(TA)



TDFN2x3-8(ZE)



X2-DFN-8(HK)

Pin Description

| Pin# | Name | Description |
|------|-------|---|
| 1 | GND | Ground (0V) |
| 2 | VREF1 | Low-voltage side reference supply voltage for SCL1 and SDA1 |
| 3 | SCL1 | Serial clock, low-voltage side; connect to VREF1 through a pullup resistor |
| 4 | SDA1 | Serial data, low-voltage side; connect to VREF1 through a pullup resistor |
| 5 | SDA2 | Serial data, high-voltage side; connect to VREF2 through a pullup resistor |
| 6 | SCL2 | Serial clock, high-voltage side; connect to VREF2 through a pullup resistor |
| 7 | VREF2 | High-voltage side reference supply voltage for SCL2 and SDA2 |
| 8 | EN | Switch enable input; connect to VREF2 and pullup through a high resistor |

Maximum Ratings

| | |
|---|-----------------|
| Storage Temperature..... | -65°C to +150°C |
| Reference Voltage ⁽²⁾ | -0.5V to +6.0V |
| Reference Bias Voltage..... | -0.5V to +6.0V |
| DC Input Voltage | -0.5V to +6.0V |
| Control Input Voltage (EN)..... | -0.5V to +6.0V |
| Channel Current (DC)..... | 128mA |
| Input Clamping Current..... | -50mA |
| ESD: HBM Mode | 4000V |
| Junction Temperature under Bias (T _J) | 125°C |

Note:

Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended Operation Conditions

V_{CC} = 2.7V to 5.5V; GND = 0V; T_A = -40°C to +85°C; unless otherwise specified.

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------------|---------------------------------------|------------------------|------|------|------|------|
| V _{I/O} | Voltage on an Input/Output Pin | SCL1, SDA1, SCL2, SDA2 | 0 | — | 5 | V |
| V _{REF1} | Reference Voltage ⁽¹⁾ | VREF1 | 0.9 | — | 3.3 | V |
| V _{REF2} | Reference Bias Voltage ⁽²⁾ | VREF2 | 1.8 | — | 5 | V |
| V _{I(EN)} | Input Voltage on Pin EN | — | 0 | — | 5 | V |
| I _(pass) | Pass Switch Current | — | — | — | 64 | mA |
| T _A | Ambient Temperature | — | -40 | — | 85 | °C |

DC Electrical Characteristics

T_A = -40°C to +85°C; unless otherwise specified.

| Parameter | Description | Test Conditions ⁽¹⁾ | | Min | Typ. ⁽²⁾ | Max | Unit |
|--------------------------------|---|--|---------------------------|-----|---------------------|------|------|
| Input and Output SDAB and SCLB | | | | | | | |
| V _{IK} | Input Clamping Voltage | I _I = -18mA; V _{I(EN)} = 0V | | — | — | -1.2 | V |
| I _{IH} | HIGH-Level Input Current | V _I = 5V; V _{I(EN)} = 0V | | — | — | 5 | μA |
| C _{i(EN)} | Input Capacitance on pin EN | V _I = 3V or 0V | | — | 11 | — | pF |
| C _{io(off)} | Off-State Input/Output Capacitance (SCLn, SDAn) | V _O = 3V or 0V; V _{I(EN)} = 0V | | — | 4 | — | pF |
| C _{io(on)} | On-State Input/Output Capacitance (SCLn, SDAn) | V _O = 3V or 0V; V _{I(EN)} = 3V | | — | 10.5 | — | pF |
| Ron | ON-State Resistance ⁽²⁾ (SCLn, SDAn) | V _I = 0V; I _O = 64mA | V _{I(EN)} = 4.5V | — | 3.5 | 5.5 | Ω |
| | | | V _{I(EN)} = 3V | — | 4.7 | 7.0 | Ω |
| | | | V _{I(EN)} = 2.3V | — | 6.3 | 9.5 | Ω |
| | | | V _{I(EN)} = 1.5V | — | 60 | 140 | Ω |
| | | V _I = 2.4V; I _O = 15mA | V _{I(EN)} = 4.5V | 1 | 6 | 15 | Ω |
| | | | V _{I(EN)} = 3V | 20 | 60 | 140 | Ω |
| | | V _I = 1.7V; I _O = 15mA | V _{I(EN)} = 2.3V | 20 | 60 | 140 | Ω |

Notes:

- All typical values are at T_A = 25°C.
- Measured by the voltage drop between the SCL1 and SCL2 or SDA1 and SDA2 terminals at the indicated current through the switch. ON-state resistance is determined by the lowest voltage of the two terminals.

Dynamic Characteristics

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$; unless otherwise specified. Values guaranteed by design.

| Symbol | Parameter | Conditions | C _L = 50pF | | C _L = 30pF | | C _L = 15pF | | Unit |
|---|-------------------------------|--|-----------------------|-----|-----------------------|-----|-----------------------|-----|------|
| | | | Min | Max | Min | Max | Min | Max | |
| Dynamic Characteristics (Translating Down) | | | | | | | | | |
| V _{I(EN)} = 3.3V; V _{IH} = 3.3V; V _{IL} = 0V; V _M = 1.15V | | | | | | | | | |
| t _{PLH} | LOW-to-HIGH Propagation Delay | From (Input) SCL2 or SDA2 to (Output) SCL1 or SDA1 | 0 | 0.8 | 0 | 0.6 | 0 | 0.3 | ns |
| t _{PHL} | HIGH-to-LOW Propagation Delay | From (Input) SCL2 or SDA2 to (Output) SCL1 or SDA1 | 0 | 1.2 | 0 | 1 | 0 | 0.5 | ns |
| V _{I(EN)} = 2.5V; V _{IH} = 2.5V; V _{IL} = 0V; V _M = 0.75V | | | | | | | | | |
| t _{PLH} | LOW-to-HIGH Propagation Delay | From (Input) SCL2 or SDA2 to (Output) SCL1 or SDA1 | 0 | 1 | 0 | 0.7 | 0 | 0.4 | ns |
| t _{PHL} | HIGH-to-LOW Propagation Delay | From (Input) SCL2 or SDA2 to (Output) SCL1 or SDA1 | 0 | 1.3 | 0 | 1 | 0 | 0.6 | ns |
| Dynamic Characteristics (Translating up) | | | | | | | | | |
| V _{I(EN)} = 3.3V; V _{IH} = 2.3V; V _{IL} = 0V; V _T = 3.3V; V _M = 1.15V; R _L = 300Ω | | | | | | | | | |
| t _{PLH} | LOW-to-HIGH Propagation Delay | From (Input) SCL1 or SDA1 to (output) SCL2 or SDA2 | 0 | 0.9 | 0 | 0.6 | 0 | 0.4 | ns |
| t _{PHL} | HIGH-to-LOW Propagation Delay | From (Input) SCL1 or SDA1 to (Output) SCL2 or SDA2 | 0 | 1.4 | 0 | 1.1 | 0 | 0.7 | ns |
| V _{I(EN)} = 2.5V; V _{IH} = 1.5V; V _{IL} = 0V; V _T = 2.5V; V _M = 0.75V; R _L = 300Ω | | | | | | | | | |
| t _{PLH} | LOW-to-HIGH Propagation Delay | From (Input) SCL1 or SDA1 to (Output) SCL2 or SDA2 | 0 | 1 | 0 | 0.6 | 0 | 0.4 | ns |
| t _{PHL} | HIGH-to-LOW Propagation Delay | From (Input) SCL1 or SDA1 to (Output) SCL2 or SDA2 | 0 | 1.3 | 0 | 1.3 | 0 | 0.8 | ns |

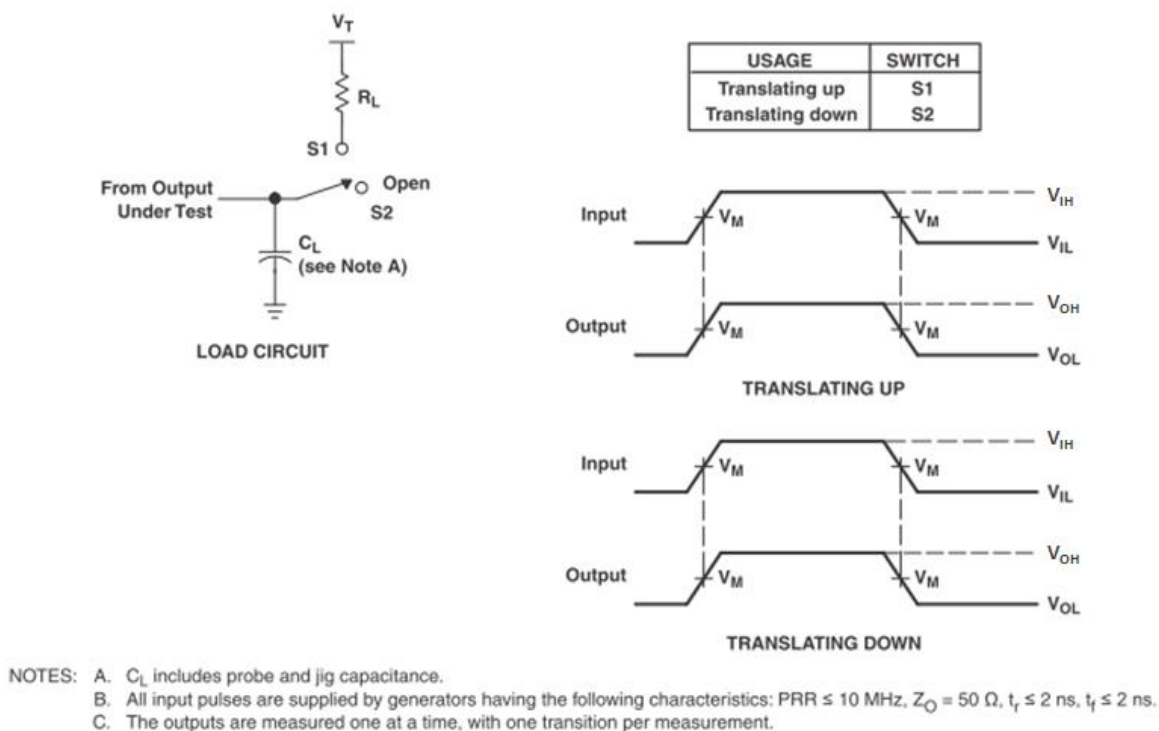


Figure 1. Load Circuit for Outputs

Functional Description

The PI6ULS5V9306 can also be used to run two buses—one at 400kHz operating frequency and the other at 100kHz operating frequency. If the two buses are operating at different frequencies, the 100kHz bus must be isolated when the 400kHz operation of the other bus is required. If the master is running at 400kHz, the maximum system operating frequency may be less than 400kHz because of the delays added by the translator.

As with the standard I²C-bus system, pullup resistors are required to provide the logic HIGH levels on the translator's bus. The PI6ULS5V9306 has a standard open-collector configuration of the I²C-bus. Each side of the translator must have a pullup resistor though the size of these pullup resistors depends on the system. The device is designed to work with standard mode, fast mode, and fast mode plus I²C-bus devices in addition to SMBus devices.

When the SDA1 or SDA2 port is LOW, the clamp is in the ON-state and a low-resistance connection exists between the SDA1 and SDA2 ports. When the higher voltage is on the SDA2 port, and the SDA2 port is HIGH, the voltage on the SDA1 port is limited to the voltage set by VREF1. When the SDA1 port is HIGH, the SDA2 port is pulled to the drain pullup supply voltage (VDPU) by the pullup resistors. This functionality allows a seamless translation between higher and lower voltages selected by the user without requiring directional control. The SCL1/SCL2 channel also functions as the SDA1/SDA2 channel.

All channels have the same electrical characteristics, and there is minimal deviation from one output to another in voltage or propagation delay. This is a benefit over discrete transistor voltage translation solutions because the fabrication of the switch is symmetrical. The translator provides excellent ESD protection to lower voltage devices, and at the same time protects less ESD-resistant devices

Application Information

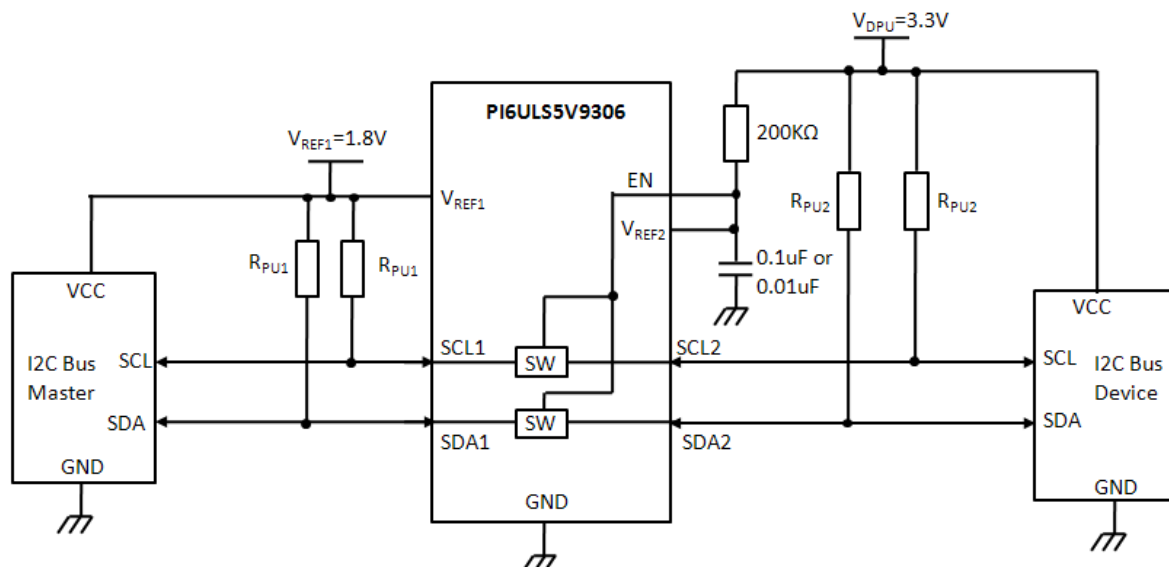


Figure 2. Typical Open-Drain Application Circuit (Switch Always Enabled)

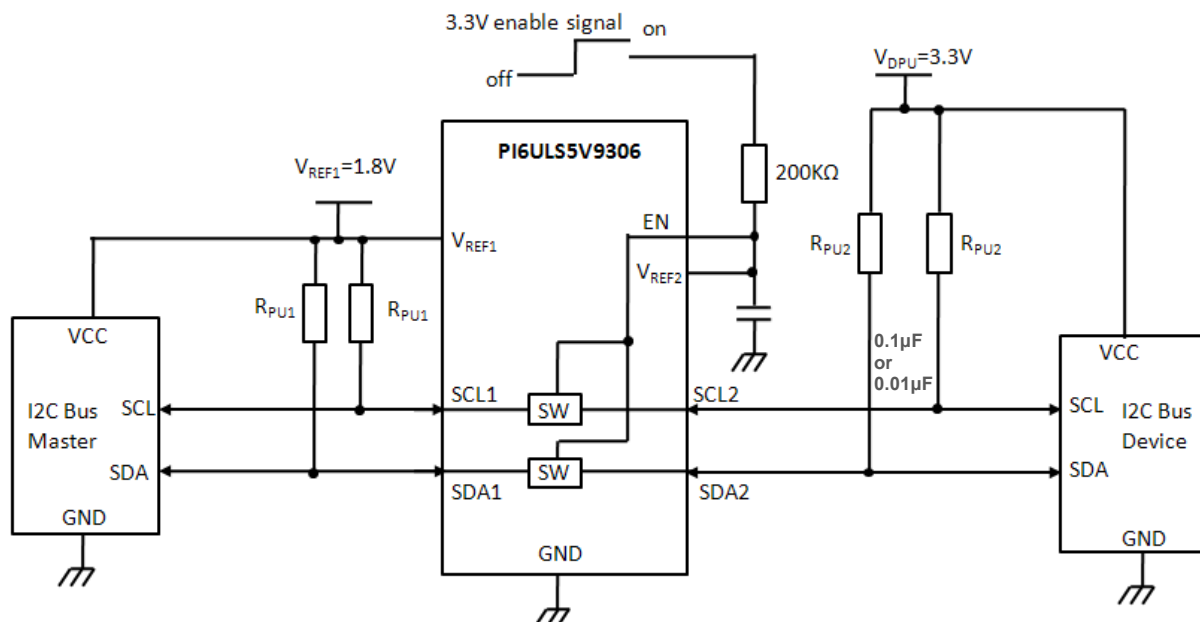


Figure 3. Typical Open-Drain Application Circuit (Switch Enabled Control)

Open-Drain Application

For the bidirectional clamping configuration (higher voltage to lower voltage or lower voltage to higher voltage), the EN input must be connected to VREF2 and both pins pulled to high-side VDDPU through a pullup resistor (typically 200kΩ). This allows VREF2 to regulate the EN input. A filter capacitor on VREF2 is recommended.

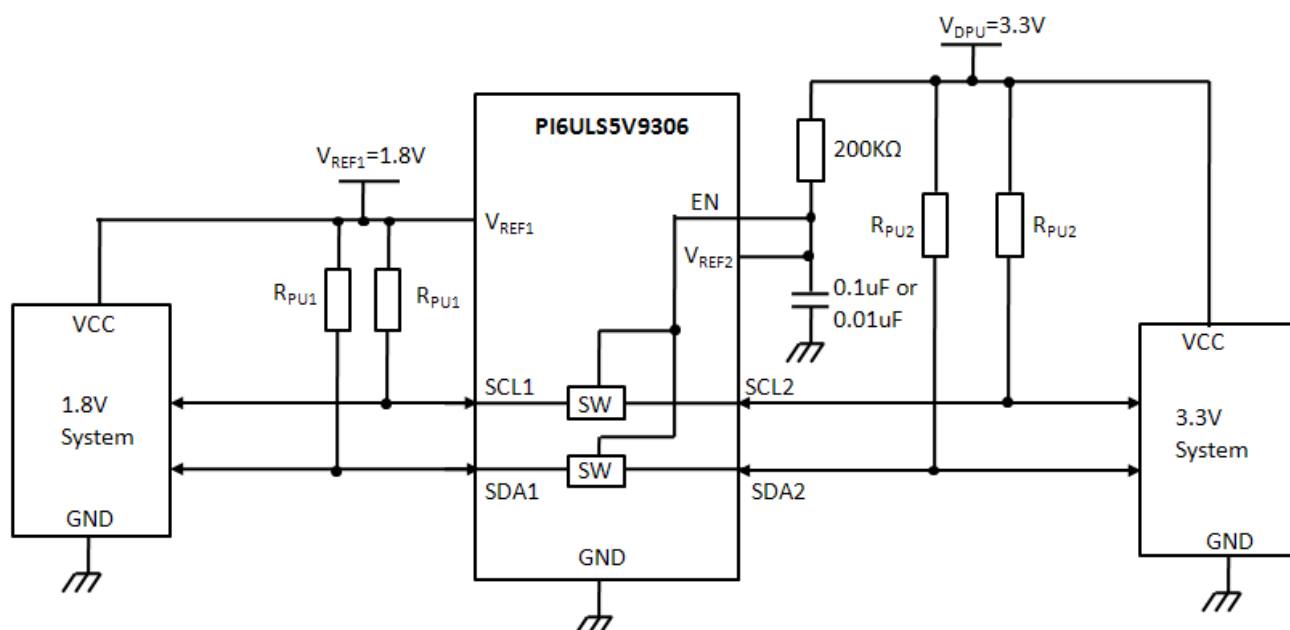


Figure 4. Typical Push-Pull Application Circuit (Switch Enabled Control)

Push-Pull Application

If used in push-pull system, the pullup resistors on REF side are also required. The data must be unidirectional, or the outputs must be 3-stateable and controlled by some direction-control mechanism to prevent high-to-low contentions in either direction.

Operating Voltage

Refer to Figure 2

| Symbol | Description | Min | Typ ⁽¹⁾ | Max | Unit |
|--------|-----------------------------------|------------------|--------------------|-----|------|
| VDPU | Ref2 Side Pullup Voltage on 200kΩ | $V_{REF1} + 0.6$ | 2.1 | 5 | V |
| EN | Enable Input Voltage | $V_{REF1} + 0.6$ | 2.1 | 5 | V |
| VREF1 | Reference Voltage | 0 | 1.5 | 4.4 | V |
| IPASS | Pass Switch Current | 14 | — | — | mA |
| IREF | Reference-Transistor Current | — | — | 5 | μA |
| TA | Operating Free-Air Temperature | -40 | — | 85 | °C |

The Pass-Through Current: I_{pass}

I_{pass} is determined by the pullup and the low voltage added on the PI6LS5V9306.

In Figure 6, I_{pass} equals $(V_{REF1} - V_{OL1_9306})/R_{PU1}$.

When V_{IN} is 0V, the PI6ULS5V9306 can support as large as 64mA pass-through current in theory, but it is recommend to limit the I_{pass} in 15mA.

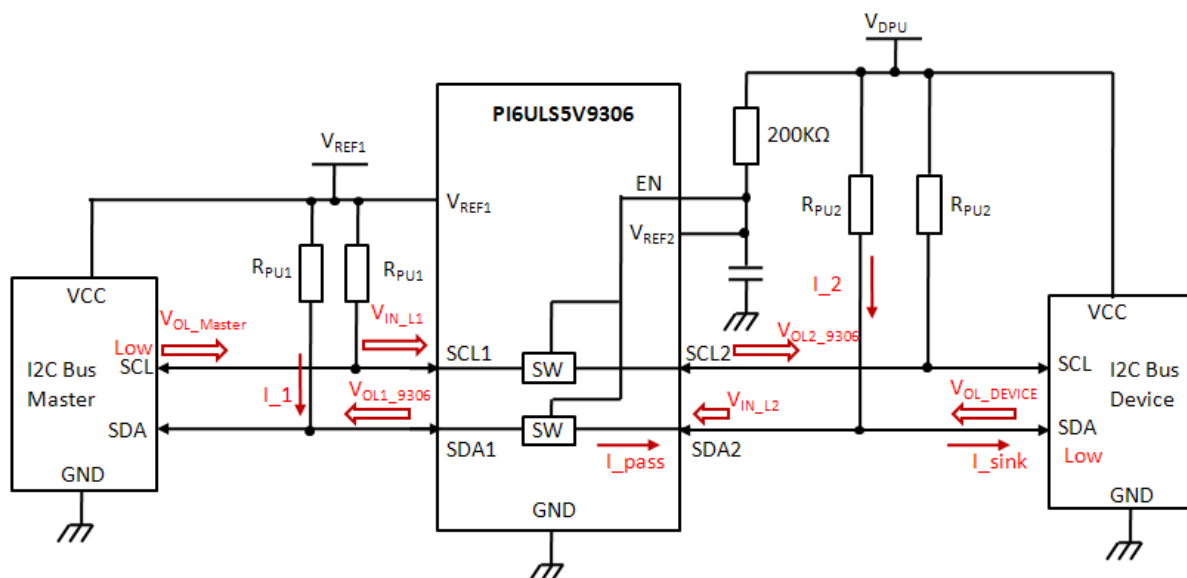


Figure 5. Typical Open-Drain Application Circuit

(1) The Sink Current: I_{sink}

The device sinks the total current from both pullup resistors. For example, in figure below, when the SDA2 is pulled low by the I2C device, the sink current of the I2C device is $I_{\text{sink}} = I_{\text{pass}} + I_2 = I_1 + I_2$. The same thing happens when I2C master pulls low the I2C bus. The I_{sink} should not be larger than the tolerance of the I2C devices.

(2) V_{IL} , V_{OL} of the External Drive and V_{OL} of PI6ULS5V9306

In normal application, the V_{IL} of external devices should always be larger than the V_{OL} of PI6ULS5V9306. The value of PI6ULS5V9306's V_{OL} is determined by the pass-through current and the low voltage added on the SDA, SCL pins. The $V_{\text{OL}_9306} = V_{\text{IN}_L} + V_{\text{UP}}$ (V_{UP} is mainly determined by the I_{pass} , which is always less than 0.35V).

(3) Low VREF Application

The PI6ULS5V9306 can support very-low Vref1 application in theory, but it is recommended no lower than 0.9V. Because when VREF1 is less than 1.8V, the V_{OL} of REF1 side is a concern in system. For example, in Figure 6, if VREF1 = 0.9V, VDPU = 3.3V, the V_{IL} of the REF1 side I2C master is normally $0.3 \times V_{\text{REF1}} = 0.25\text{V}$, but the V_{OL} of REF2 side can up to $0.1 \times V_{\text{DPU}} = 0.36\text{V}$. The system designer must make sure this situation does not happen. A limit for the V_{OL} of REF2 side devices is required then.

The following table shows the requirements for V_{OL} of VREF2 side devices when using PI6ULS5V9306. Figure 6 shows the requirement for $V_{\text{OL}_\text{DEVICE}}$.

| The V_{OL} Requirement of V_{REF2} Side External Devices (Temp = 25°C, Assume the V_{IL} of V_{REF1} Side Devices is $0.3 \times V_{\text{REF1}}$) | | | |
|--|---------------------|---------------------|--------------------|
| $V_{\text{REF1}} \backslash I_{\text{pass}}$ | $\leq 3\text{mA}$ | 10mA | 15mA |
| 0.9V | $\leq 0.15\text{V}$ | $\leq 0.1\text{V}$ | Not Recommended |
| 1.2V | $\leq 0.2\text{V}$ | $\leq 0.15\text{V}$ | Not Recommended |
| 1.5V | $\leq 0.3\text{V}$ | $\leq 0.25\text{V}$ | $\leq 0.2\text{V}$ |
| 1.8V | $\leq 0.4\text{V}$ | $\leq 0.35\text{V}$ | $\leq 0.3\text{V}$ |

Pullup Resistors and Minimum Values

Sizing the pullup resistor on an open-drain bus is specific to the individual application and is dependent on the following driver characteristics:

- The driver sink current
- The V_{OL} of driver
- The V_{OL} of the PI6ULS5V9306
- The V_{IL} of the driver
- Frequency of operation

The following tables can be used to estimate the pullup resistor value in different use cases so that the minimum resistance for the pullup resistor can be found.

The tables below show suggested minimum values of pullup resistors for the PI6ULS5V9306 with typical voltage translation levels and drive currents. The calculated values assume that both drive currents are the same.

$V_{OL} = V_{IL} = 0.1 \times V_{CC}$ and accounts for a 5% V_{CC} tolerance of the supplies, 1 % resistor values. Note that the resistor chosen in the final application should be equal to or larger than the values shown in the table to ensure that the pass voltage is less than 10% of the V_{CC} voltage, and the external driver should be able to sink the total current from both pullup resistors.

Pullup Resistor Minimum Values, 3mA Driver Sink Current for PI6ULS5V9306

| A Side | B Side | | | | |
|--------|--|--|--|--|--|
| | 1.5V | 1.8V | 2.5V | 3.3V | 5.0V |
| 0.9V | $R_{RPU1} = 859\Omega$ $R_{RPU2} = 859\Omega$ | $R_{RPU1} = 970\Omega$ $R_{RPU2} = 970\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 896\Omega$ or both 1.23k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.19k\Omega$ or both 1.53k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.82k\Omega$ or both 2.16k Ω |
| 1.2V | — | $R_{RPU1} = 1.07k\Omega$ $R_{RPU2} = 1.07k\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 886\Omega$ or both 1.33k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.18k\Omega$ or both 1.63k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.81k\Omega$ or both 2.26k Ω |
| 1.5V | — | — | $R_{RPU1} = \text{none}$ $R_{RPU2} = 875\Omega$ or both 1.43k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.17k\Omega$ or both 1.73k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.8k\Omega$ or both 2.36k Ω |
| 1.8V | — | — | $R_{RPU1} = 1.53k\Omega$ $R_{RPU2} = 1.53k\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.16k\Omega$ or both 1.82k Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.79k\Omega$ or both 2.46k Ω |
| 2.5V | — | — | — | $R_{RPU1} = 2.06k\Omega$ $R_{RPU2} = 2.06k\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.77k\Omega$ or both 2.69k Ω |
| 3.3V | — | — | — | — | $R_{RPU1} = \text{none}$ $R_{RPU2} = 1.74k\Omega$ or both 2.96k Ω |

Pullup Resistor Minimum Values, 10mA Driver Sink Current for PI6ULS5V9306

| A Side | B Side | | | | |
|-------------|--|--|---|---|---|
| | 1.5V | 1.8V | 2.5V | 3.3V | 5.0V |
| 0.9V | $R_{RPU1} = 258\Omega$ $R_{RPU2} = 258\Omega$ | $R_{RPU1} = 291\Omega$ $R_{RPU2} = 291\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 269\Omega$ or both 369Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 358\Omega$ or both 458Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 546\Omega$ or both 646Ω |
| 1.2V | — | $R_{RPU1} = 321\Omega$ $R_{RPU2} = 321\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 266\Omega$ or both 399Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 355\Omega$ or both 488Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 543\Omega$ or both 677Ω |
| 1.5V | — | — | $R_{RPU1} = \text{none}$ $R_{RPU2} = 263\Omega$ or both 429Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 352\Omega$ or both 518Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 540\Omega$ or both 707Ω |
| 1.8V | — | — | $R_{RPU1} = 460\Omega$ $R_{RPU2} = 460\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 348\Omega$ or both 548Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 537\Omega$ or both 737Ω |
| 2.5V | — | — | — | $R_{RPU1} = 619\Omega$ $R_{RPU2} = 619\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 521\Omega$ or both 808Ω |
| 3.3V | — | — | — | — | $R_{RPU1} = \text{none}$ $R_{RPU2} = 522\Omega$ or both 889Ω |

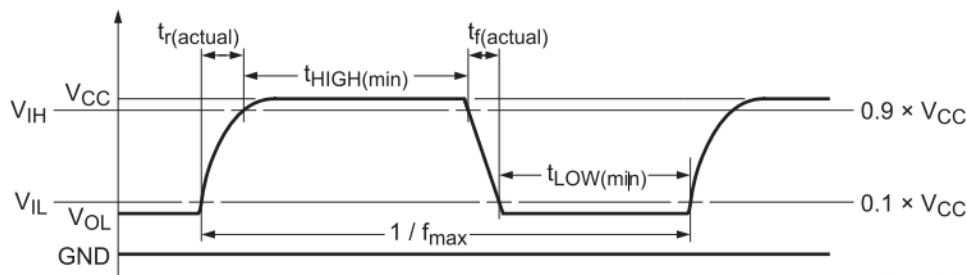
Pullup Resistor Minimum Values, 15mA Driver Sink Current for PI6ULS5V9306

| A Side | B Side | | | | |
|-------------|--|--|---|---|---|
| | 1.5V | 1.8V | 2.5V | 3.3V | 5.0V |
| 0.9V | $R_{RPU1} = 172\Omega$ $R_{RPU2} = 172\Omega$ | $R_{RPU1} = 194\Omega$ $R_{RPU2} = 194\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 179\Omega$ or both 246Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 238\Omega$ or both 305Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 364\Omega$ or both 431Ω |
| 1.2V | — | $R_{RPU1} = 214\Omega$ $R_{RPU2} = 214\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 177\Omega$ or both 266Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 236\Omega$ or both 325Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 362\Omega$ or both 451Ω |
| 1.5V | — | — | $R_{RPU1} = \text{none}$ $R_{RPU2} = 175\Omega$ or both 286Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 234\Omega$ or both 345Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 360\Omega$ or both 471Ω |
| 1.8V | — | — | $R_{RPU1} = 306\Omega$ $R_{RPU2} = 306\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 232\Omega$ or both 366Ω | $R_{RPU1} = \text{none}$ $R_{RPU2} = 358\Omega$ or both 492Ω |
| 2.5V | — | — | — | $R_{RPU1} = 413\Omega$ $R_{RPU2} = 413\Omega$ | $R_{RPU1} = \text{none}$ $R_{RPU2} = 354\Omega$ or both 539Ω |
| 3.3V | — | — | — | — | $R_{RPU1} = \text{none}$ $R_{RPU2} = 348\Omega$ or both 593Ω |

Maximum Frequency Application

The maximum frequency is limited by the minimum pulse width LOW and HIGH as well as rise time and fall time.

$$f(\text{max}) = \frac{1}{t_{\text{LOW}}(\text{min}) + t_{\text{HIGH}}(\text{min}) + t_r(\text{actual}) + t_f(\text{actual})}$$



The rise and fall times are dependent upon translation voltages, the drive strength, the total node capacitance (CL), and the pullup resistors (RPU) that are present on the bus. The node capacitance is the addition of the PCB trace capacitance and the device capacitance that exists on the bus.

Because of the dependency of the external components, PCB layout and the different device operating states the calculation of rise and fall times is complex and has several inflection points along the curve.

The main component of the rise and fall times is the RC time constant of the bus line when the device is in its two primary operating states: when device is in the ON state and it is low-impedance and when the device is OFF isolating the A-side from the B-side.

There are some basic guidelines to follow that will help maximize the performance of the device:

- Keep trace length to a minimum by placing the PI6ULS5V9306 close to the processor.
- The signal round trip time on trace should be shorter than the rise or fall time of signal to reduce reflections.
- The faster the edge of the signal, the higher the chance for ringing.
- The higher drive strength controlled by the pullup resistor (up to 15mA), the higher the frequency the device can use.

The system designer must design the pullup resistor value based on external current drive strength and limit the node capacitance (minimize the wire, stub, connector, and trace length) to get the desired operation frequency result.

Part Marking

W Package Cu (NRND)



Z: Die Rev
Y: Date Code (Year)
W: Date Code (Workweek)
1st X: Assembly Site Code
2nd X: Wafer Fab Site Code
Bar above fab code means Cu wire

W Package Au (NRND)



Z: Die Rev
AB: Date Code (Year & Workweek)
K: Assembly Site Code
G: Wafer Fab Site Code

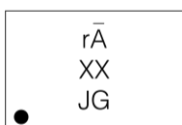
U Package (NRND)



Z: Die Rev
Y: Date Code (Year)
W: Date Code (Workweek)
1st X: Assembly Site Code
2nd X: Wafer Fab Site Code
Bar above fab code means Cu wire

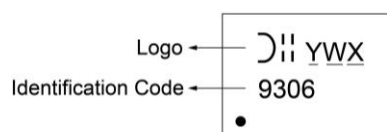
Note: Bar above "I" means Fab3 of MGN

ZE Package (NRND)



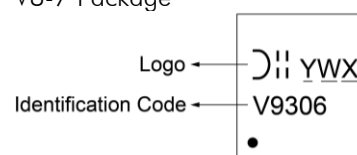
J: Assembly Site Code
G: Fab Site Code
XX: Date Code (Year & Workweek)
Bar above "A" means Fab3 of MGN

M8-13 Package



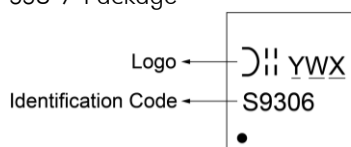
Y: Year: 0~9
W: Week: A-Z: 1~26 week;
a~z: 27~52 week; z represents
52 and 53 week
X: Internal Code

V8-7 Package



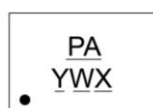
Y: Year: 0~9
W: Week: A-Z: 1~26 week;
a~z: 27~52 week; z represents
52 and 53 week
X: Internal Code

SS8-7 Package



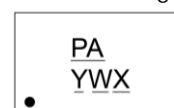
Y: Year: 0~9
W: Week: A-Z: 1~26 week;
a~z: 27~52 week; z represents
52 and 53 week
X: Internal Code

HK3-7 Package



XX: Identification Code
Y: Year: 0~9
W: Week: A-Z: 1~26 week;
a~z: 27~52 week;
z represents 52 and 53 week
X: Internal Code

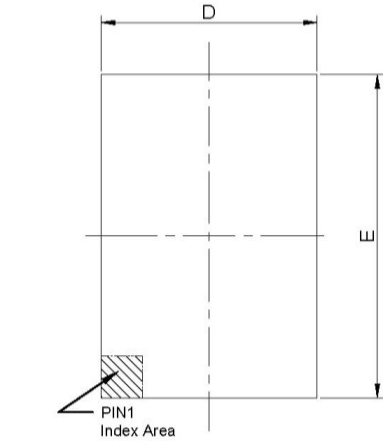
TA8-7 Package



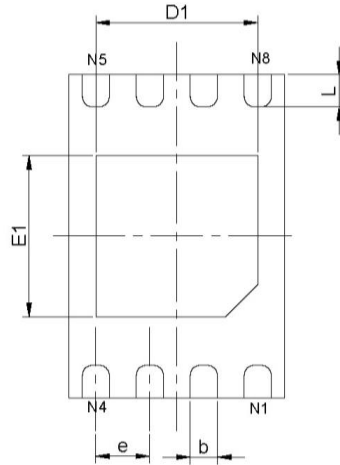
XX: Identification Code
Y: Year: 0~9
W: Week: A-Z: 1~26 week;
a~z: 27~52 week;
z represents 52 and 53 week
X: Internal Code

Packaging Mechanical

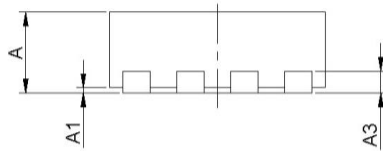
TDFN-8 (ZE) (Not Recommend for New Design)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

| PKG. DIMENSIONS(MM) | | |
|---------------------|----------|------|
| SYMBOL | Min | Max |
| A | 0.70 | 0.80 |
| A1 | 0.00 | 0.05 |
| A3 | 0.20 REF | |
| D | 1.92 | 2.08 |
| E | 2.92 | 3.07 |
| D1 | 1.40 | 1.60 |
| E1 | 1.40 | 1.60 |
| k | 0.20 MIN | |
| b | 0.20 | 0.30 |
| e | 0.50 TYP | |
| L | 0.22 | 0.38 |

Notes:

1. Ref: JEDEC MO-229



DATE: 06/14/13

DESCRIPTION: 8-Pin, TDFN, 2X3

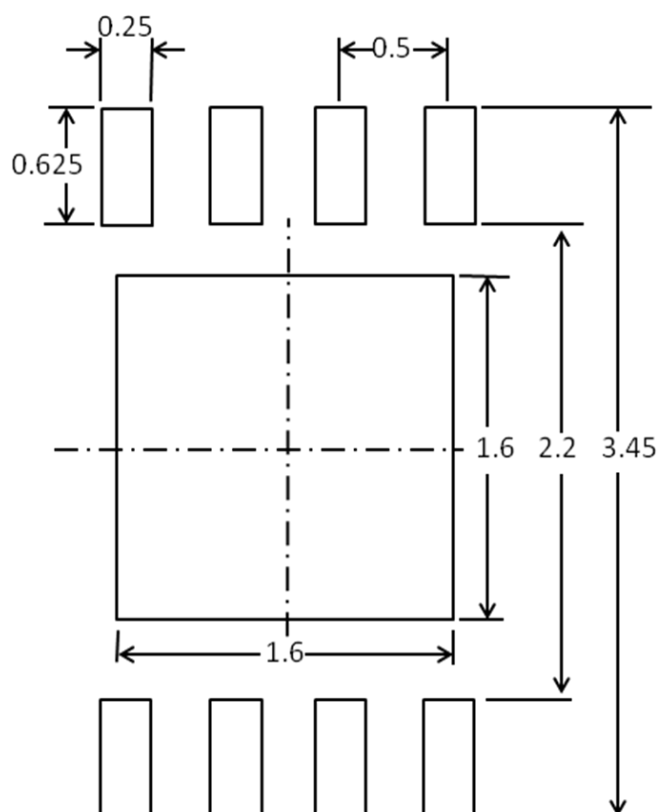
PACKAGE CODE: ZE (ZE8)

DOCUMENT CONTROL#: PD-2116

REVISION: --

13-0155

Recommended Land Pattern for TDFN2x3-8L

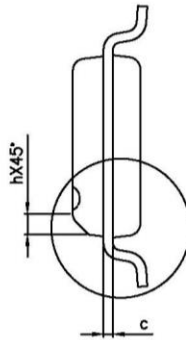
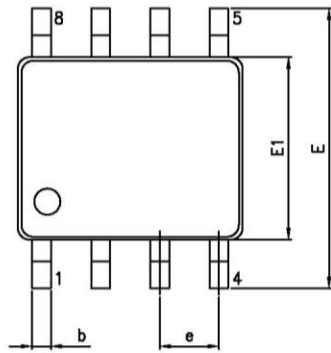


Note:

All linear dimensions are in millimeters.

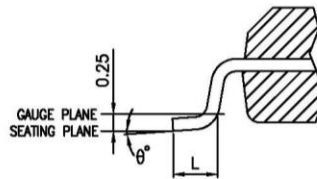
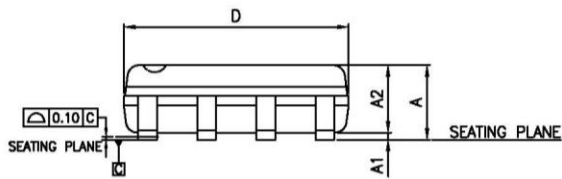
PI6ULS5V9306

SOIC-8 (W) (Not Recommend for New Design)



| SYMBOLS | MIN. | NOM. | MAX. |
|---------|----------|------|------|
| A | — | — | 1.75 |
| A1 | 0.10 | — | 0.25 |
| A2 | 1.25 | — | — |
| b | 0.31 | — | 0.51 |
| c | 0.10 | — | 0.25 |
| D | 4.80 | 4.90 | 5.00 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.80 | 3.90 | 4.00 |
| e | 1.27 BSC | | |
| L | 0.40 | — | 1.27 |
| h | 0.25 | — | 0.50 |
| θ° | 0 | — | 8 |

UNIT : mm



NOTE :
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES
2. DIMENSIONS EXCLUDE BURRS, MOLD FLASH OR PROTRUSIONS
3. REFER JEDEC MS-012



DATE: 02/21/14

DESCRIPTION: 8-Pin, 150mil-Wide, SOIC

PACKAGE CODE: W (W8)

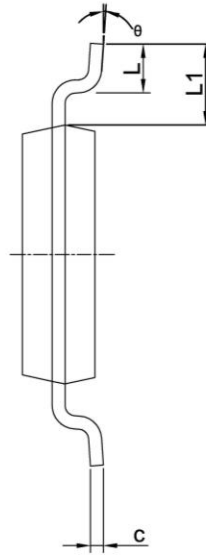
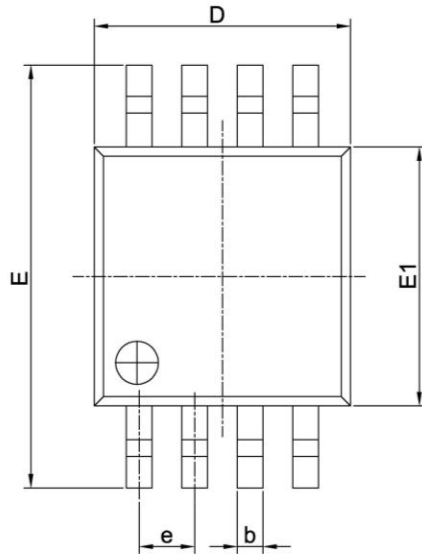
DOCUMENT CONTROL #: PD-1001

REVISION: G

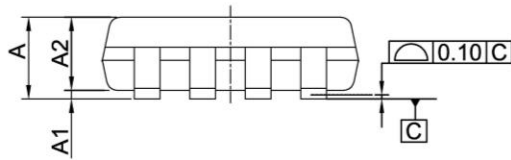
15-0103

PI6ULS5V9306

MSOP-8 (U) (Not Recommend for New Design)



| PKG DIMENSIONS(MM) | | |
|--------------------|----------|------|
| SYMBOL | Min. | Max. |
| A | -- | 1.10 |
| A1 | 0.00 | 0.15 |
| A2 | 0.75 | 0.95 |
| b | 0.22 | 0.38 |
| c | 0.08 | 0.23 |
| D | 2.80 | 3.20 |
| E | 4.65 | 5.15 |
| E1 | 2.80 | 3.20 |
| e | 0.65 BSC | |
| L | 0.40 | 0.80 |
| L1 | 0.95 REF | |
| θ | 0° | 8° |



NOTE:

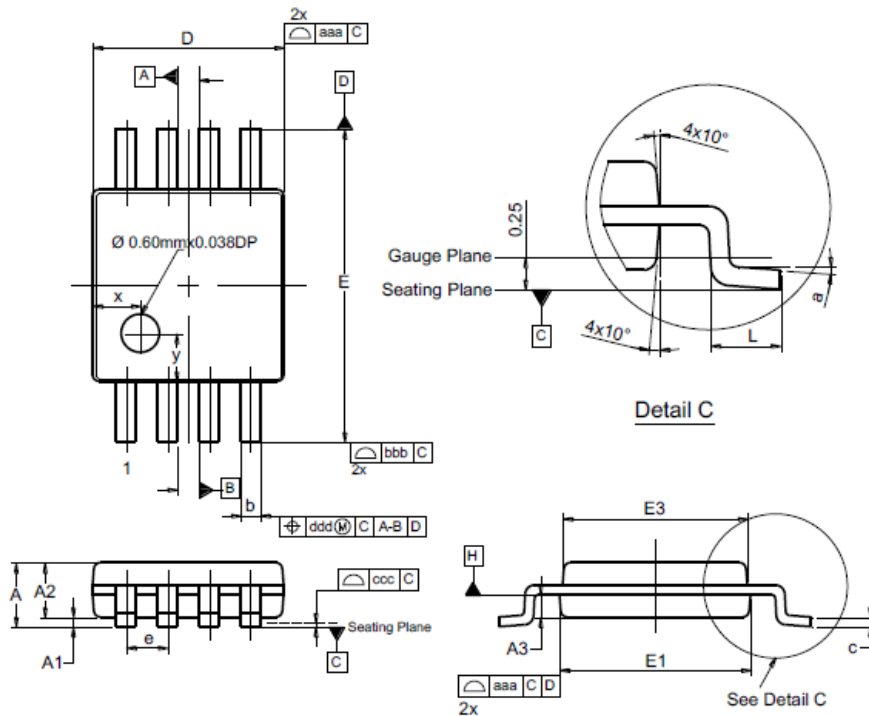
1. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES IN DEGREES.
2. REFER JEDEC MO-187F/AA
3. PACKAGE OUTLINE DIMENSIONS DO NOT INCLUDE MOLD FLASH AND METAL BURR.

16-0242

MSOP-8 (M)

Package Outline Dimensions

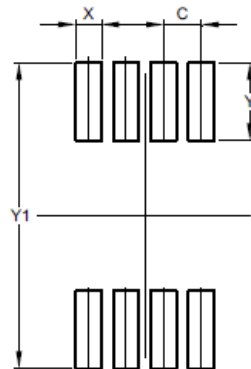
MSOP-8



| MSOP-8 | | | |
|----------------------|------|------|-------|
| Dim | Min | Max | Typ |
| A | -- | 1.10 | -- |
| A1 | 0.05 | 0.15 | 0.10 |
| A2 | 0.75 | 0.95 | 0.86 |
| A3 | 0.29 | 0.49 | 0.39 |
| b | 0.22 | 0.38 | 0.30 |
| c | 0.08 | 0.23 | 0.15 |
| D | 2.90 | 3.10 | 3.00 |
| E | 4.70 | 5.10 | 4.90 |
| E1 | 2.90 | 3.10 | 3.00 |
| E3 | 2.85 | 3.05 | 2.95 |
| e | -- | -- | 0.65 |
| L | 0.40 | 0.80 | 0.60 |
| a | 0° | 8° | 4° |
| x | -- | -- | 0.750 |
| y | -- | -- | 0.750 |
| aaa | 0.20 | | |
| bbb | 0.25 | | |
| ccc | 0.10 | | |
| ddd | 0.13 | | |
| All Dimensions in mm | | | |

Suggested Pad Layout

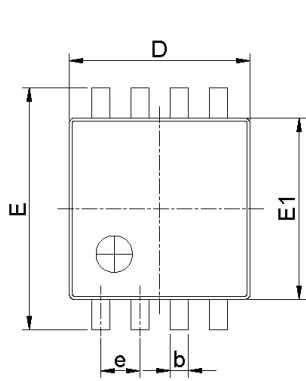
MSOP-8



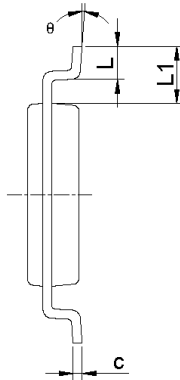
| Dimensions | Value (in mm) |
|------------|---------------|
| C | 0.650 |
| X | 0.450 |
| Y | 1.350 |
| Y1 | 5.300 |

PI6ULS5V9306

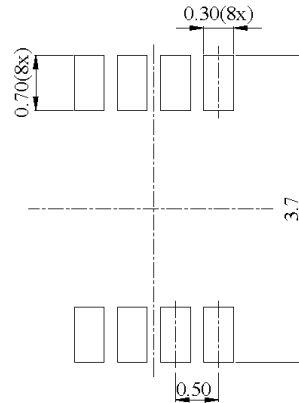
VSSOP-8 (V)



Top View

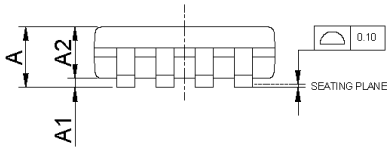


Side View



RECOMMENDED LAND PATTERN(unit:mm)

| PKG DIMENSIONS(MM) | | | |
|--------------------|----------|------|------|
| SYMBOL | Min. | Nom. | Max. |
| A | 0.60 | — | 0.90 |
| A1 | — | — | 0.10 |
| A2 | 0.60 | — | 0.80 |
| b | 0.17 | 0.21 | 0.25 |
| c | 0.08 | — | 0.13 |
| D | 1.90 | 2.00 | 2.10 |
| E | 3.20 | 3.40 | 3.60 |
| E1 | 2.20 | 2.30 | 2.40 |
| e | 0.50 BSC | | |
| L | 0.30 | 0.35 | 0.40 |
| L1 | 0.55 REF | | |
| θ | 0° | 3° | 6° |



Side View

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES IN DEGREES.
2. REFER JEDEC MO-187F/CA
3. PACKAGE OUTLINE DIMENSIONS DO NOT INCLUDE MOLD FLASH AND METAL BURR.
4. LAND PATTERN REFERENCE DIODES MSOP-8 PACKAGE INFORMATION.



DATE: 04/08/21

DESCRIPTION: 8-Pin, VSSOP-8L

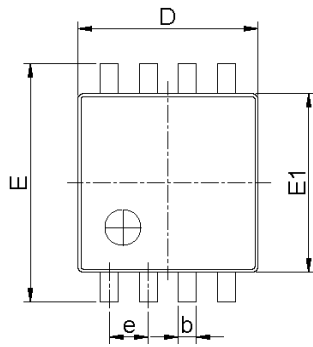
PACKAGE CODE: V (V8)

DOCUMENT CONTROL #: PD-2265

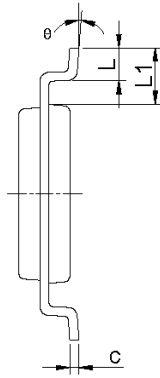
REVISION: A

PI6ULS5V9306

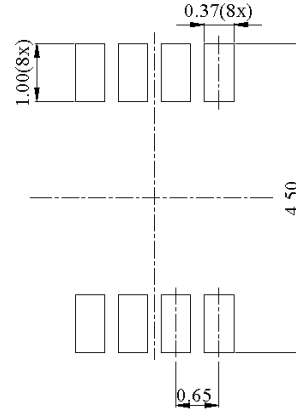
SSOP-8 (SS)



Top View

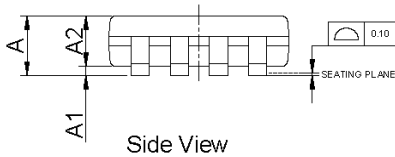


Side View



RECOMMENDED LAND PATTERN(unit:mm)

| PKG DIMENSIONS(MM) | | | |
|--------------------|----------|------|------|
| SYMBOL | Min. | Nom. | Max. |
| A | -- | -- | 1.30 |
| A1 | 0.05 | -- | 0.15 |
| A2 | 0.95 | 1.05 | 1.20 |
| b | 0.15 | 0.23 | 0.30 |
| C | 0.08 | -- | 0.23 |
| D | 2.75 | 2.95 | 3.15 |
| E | 3.75 | 4.00 | 4.25 |
| E1 | 2.70 | 2.80 | 2.90 |
| e | 0.65 BSC | | |
| L | 0.20 | 0.40 | 0.60 |
| L1 | 0.60 REF | | |
| θ | 0° | 4° | 8° |



Side View

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES IN DEGREES.
2. REFER JEDEC MO-187F/DA
3. PACKAGE OUTLINE DIMENSIONS DO NOT INCLUDE MOLD FLASH AND METAL BURR.
4. LAND PATTERN REFERENCE DIODES MSOP-8 PACKAGE INFORMATION.



DATE: 03/02/21

DESCRIPTION: 8-Pin, SSOP-8L

PACKAGE CODE: SS (SS8)

DOCUMENT CONTROL #: PD-2266

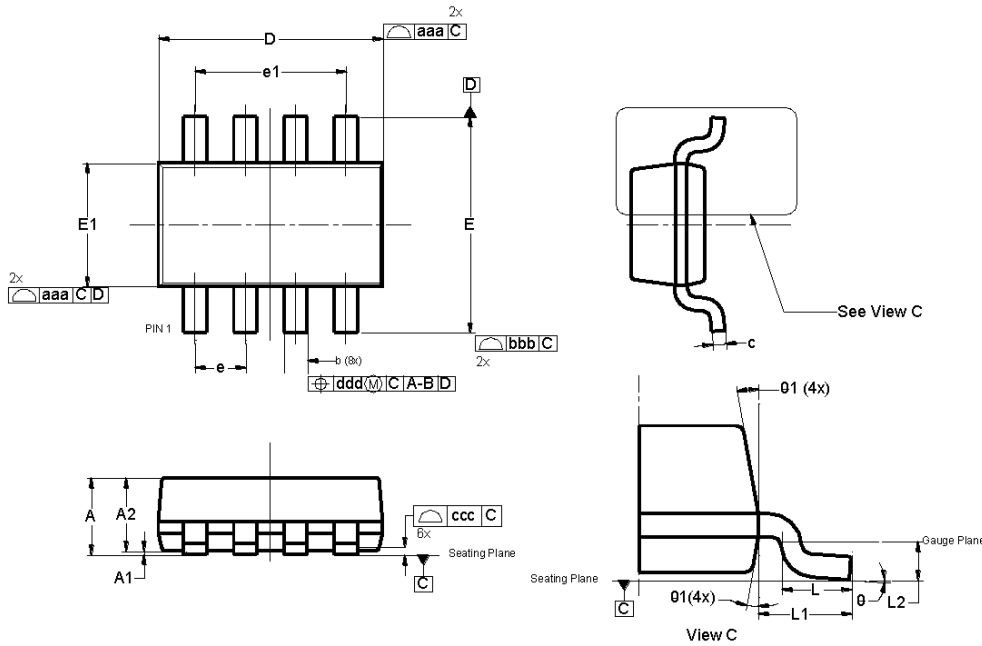
REVISION: A

21-1374

SOT28-8 (TA)

Package Outline Dimensions

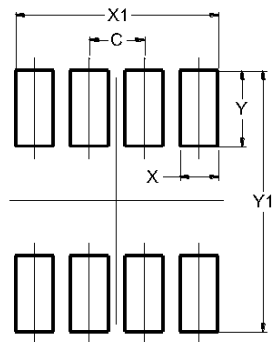
SOT28



| SOT28 | | | |
|----------------------|----------|------|------|
| Dim | Min | Max | Typ |
| A | 0.90 | 1.10 | 1.00 |
| A1 | 0.00 | 0.10 | -- |
| A2 | -- | -- | 0.95 |
| b | 0.20 | 0.40 | 0.30 |
| c | 0.08 | 0.20 | -- |
| D | 2.85 | 2.95 | 2.90 |
| E | 2.65 | 2.95 | 2.80 |
| E1 | 1.55 | 1.65 | 1.60 |
| e | 0.65 BSC | | |
| e1 | 1.95 BSC | | |
| L | 0.30 | 0.60 | 0.45 |
| L1 | 0.60 REF | | |
| L2 | 0.25 BSC | | |
| θ | 0° | 8° | -- |
| θ1 | 9° | 11° | 10° |
| aaa | 0.15 | | |
| bbb | 0.25 | | |
| ccc | 0.10 | | |
| ddd | 0.20 | | |
| All Dimensions in mm | | | |

Suggested Pad Layout

SOT28

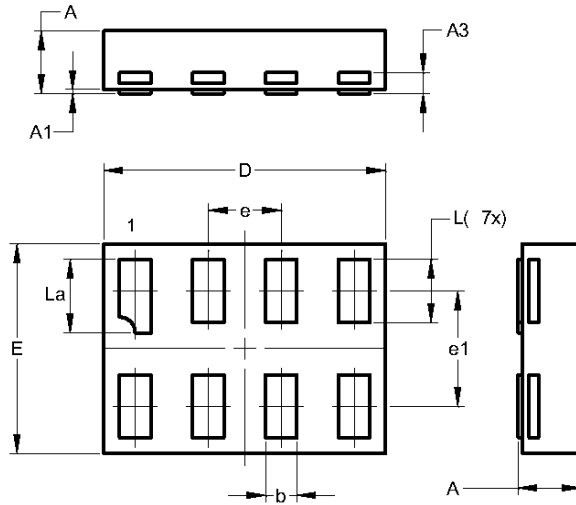


| Dimensions | Value (in mm) |
|------------|---------------|
| C | 0.950 |
| G | 1.600 |
| X | 0.700 |
| Y | 0.900 |
| Y1 | 3.400 |

X2-DFN-8 (HK)

Package Outline Dimensions

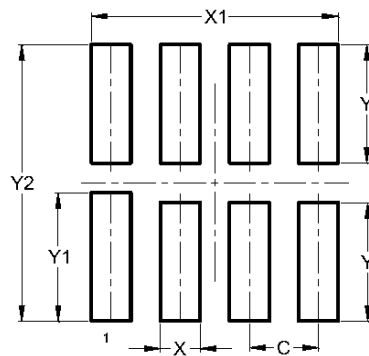
X2-DFN1410-8



| X2-DFN1410-8 | | | |
|----------------------|------|------|------|
| Dim | Min | Max | Typ |
| A | 0.30 | 0.35 | 0.33 |
| A1 | 0.00 | 0.03 | 0.02 |
| A3 | -- | -- | 0.10 |
| b | 0.12 | 0.20 | 0.15 |
| D | 1.30 | 1.40 | 1.35 |
| E | 0.95 | 1.05 | 1.00 |
| e | -- | -- | 0.35 |
| e1 | -- | -- | 0.55 |
| L | 0.27 | 0.35 | 0.30 |
| L1 | 0.32 | 0.40 | 0.35 |
| All Dimensions in mm | | | |

Suggested Pad Layout

X2-DFN1410-8



| Dimensions | Value (in mm) |
|------------|---------------|
| C | 0.350 |
| X | 0.200 |
| X1 | 1.250 |
| Y | 0.600 |
| Y1 | 0.650 |
| Y2 | 1.400 |

For latest package information:

See <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>.

Ordering Information

| Part Number | Package Code | Package Description |
|-------------------|--------------|---|
| PI6ULS5V9306ZEEX | ZE | 8-Pin, 2X3 (TDFN) (Not Recommend for New Design) |
| PI6ULS5V9306WEX | W | 8-Pin, 150 mil Wide (SOIC) (Not Recommend for New Design) |
| PI6ULS5V9306UEX | U | 8-Pin, Mini Small Outline Package (MSOP) (Not Recommend for New Design) |
| PI6ULS5V9306M8-13 | M | 8-Pin, MSOP |
| PI6ULS5V9306V8-7 | V | 8-Pin, VSSOP |
| PI6ULS5V9306SS8-7 | SS | 8-Pin, SSOP |
| PI6ULS5V9306TA8-7 | TA | 8-Pin, SOT28 |
| PI6ULS5V9306HK3-7 | HK | 8-Pin, X2-DFN |

Notes:

- No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
- See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
- Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
- E = Pb-free and Green
- 7 = Tape/Reel size (7"), X suffix = Tape/Reel

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