Voltage Level Translation Guide

Voltage Level Translation

TEXAS INSTRUMENTS

Auto-Direction Sensing
Direction Controlled
Application-Specific

Translation Guide

➔ *Table of Contents*

Introduction

In today's complex and high-performance system environment, higher levels of functional integration have led to lower power consumption CMOS process technologies operating at lower supply voltage levels. The ability to mix, match and support the simultaneous use of different operating supply voltage levels on the same circuit board has led to the need for voltage-level translation.

To remedy this problem of logic-threshold incompatibility between the driver output thresholds and receiver input thresholds, a voltage-level translator device from Texas Instruments should be used to accomplish this.

To assist circuit design and system engineers with their operating speed and lower-operating voltage level-translation needs, Texas Instruments (TI) offers a comprehensive voltage translation portfolio including dual-supply level translators; auto-direction sensing translators for both push-pull buffered and open-drain applications; and hybrid application-specific translators optimized for today's constantly emerging signal standards. Translation devices are needed in various markets such as consumer electronic, portable, computing, and networking applications—wherever the need exists to interface lower operating processors with higher operating legacy peripherals.

Portable Electronic Block Diagram

Dual-Supply Translators

→ *Packaging*

Packages

Dimensions are in inches (millimeters)
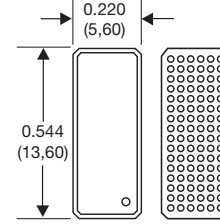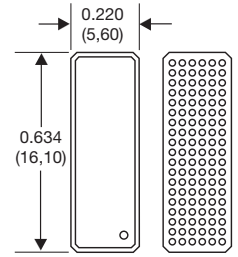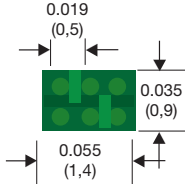
RoHS "GOLD"
ECO-FRIENDLY SOLUTIONS FROM TEXAS INSTRUMENTS
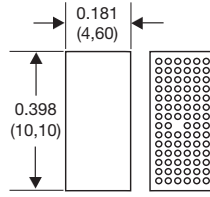
**83-ball
LFBGA (GRG)**

0.181 (4,60)
0.398 (10,10)

**96-ball
LFBGA (GKE)**

0.220 (5,60)
0.544 (13,60)

**114-ball
LFBGA (GKF)**

0.220 (5,60)
0.634 (16,10)

**6-ball NanoStar™ pkg.
(YEP/YZP)**

0.019 (0,5)
0.035 (0,9)
0.055 (1,4)

**8-Pin WCSP
(YZP)**

0.0748 (1,9)
0.0354 (0,9)

**12-pin
(RUT)**

1	2	3	4	5
12				6
11	10	9	8	7

0.0787 (2,0)
0.0669 (1,7)

**20-ball
VFBGA (ZXY)**

0.122 (3,10)
0.102 (2,60)

**12-ball
UFBGA (ZXU)**

0.102 (2,60)
0.083 (2,10)

**56-ball
VFBGA (GQL)**

0.181 (4,60)
0.280 (7,10)

**8-ball NanoStar™ pkg.
(YEP/YZP)**

0.019 (0,5)
0.035 (0,9)
0.075 (1,9)

**8-pin
μQFN (DQM)**

1.2 mm
1.8 mm

1	8
2	7
3	6
4	5

**16-pin
QFN (RSV)**

0.073 (1,85)
0.104 (2,65)

**16-pin
QFN (RGY)**

0.144 (3,65)
0.163 (4,15)

**24-pin
QFN (RHL)**

0.144 (3,65)
0.222 (5,65)
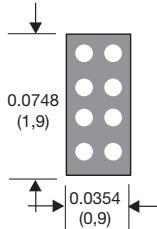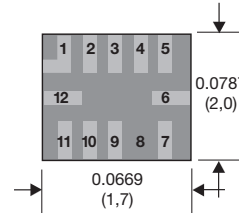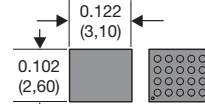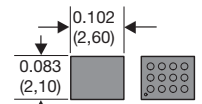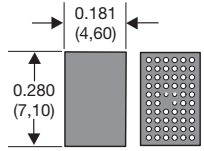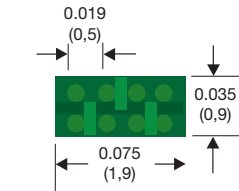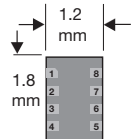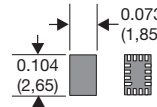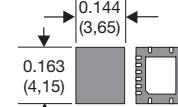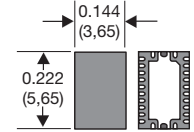
Dual-Supply Translators

➔ Four Classes of Voltage Translators

Auto-direction sensing translators

VccA   VccB

Processor   Peripheral

TXB010x and TXB030x

Application-specific translators
(memory card and SIM card interfaces)

VccA   VccB

Processor   4   DATA_A   DATA_B   4   SD/SDIO Card

CMD_A   CMD_B

CLK_A   CLK_B

TXS02xxx and TXS45xx

Auto-direction sensing translators for open-drain applications

VccA   VccB

Processor   Peripheral

TXS010x/E and TXS030x
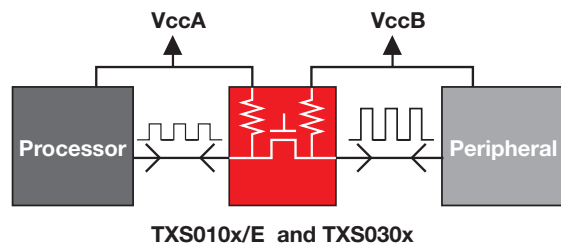
Dual-supply configurable translators

VccA   VccB

Processor   Peripheral

DIR

SN74AVCxT45/245/234/244 and SN74LVCxT45/245

Voltage Translators

Texas Instruments
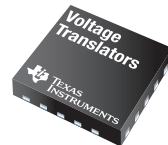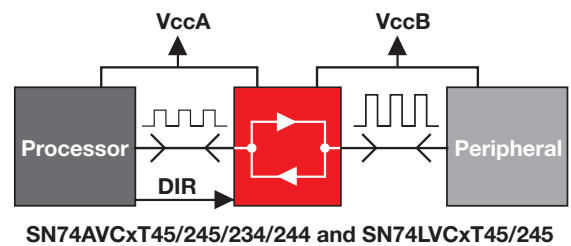
➔ Auto-Direction Sensing Translators Portfolio

Key Features

- Auto-direction sensing — no direction control signal needed
- Automatic reconfigurable I/O buffers — each I/O port is configured as both an input and an output
- Integrated pull-up resistors — provides modest DC-bias and current sourcing capabilities while saving BOM costs
- Output slew-rate control circuitry — edge-rate accelerator circuitry detects and speeds up AC-transitions to maintain fast data rate throughput
- V_{CC} isolation feature — if either V_{CC} input is at GND, all outputs are in the high impedance state
- Highly integrated ESD protection — ±15-kV ESD protection on the B port
- Devices ending in E suffix include integrated IEC 61000-4-2 ESD protection.

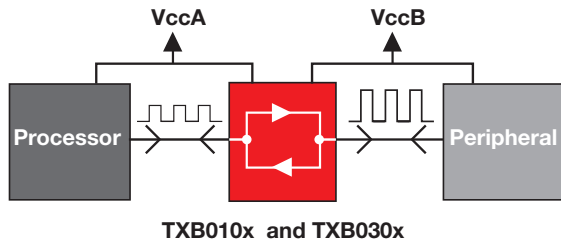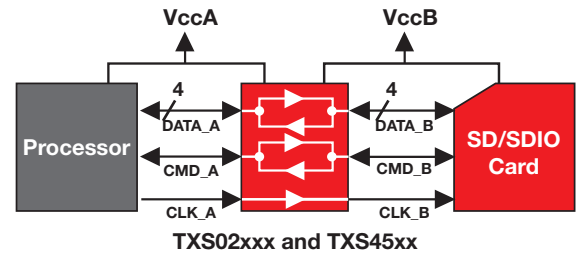TI's auto-direction sensing translation devices are ideal for point-to-point topologies when interfacing devices may be operating at different interface voltage levels. They improve connectivity between next-generation processors and peripheral devices by eliminating the requirement for direction-control signals used by traditional voltage-level translation devices. This decreases the control software complexity while saving valuable GPIO signals on core processors.
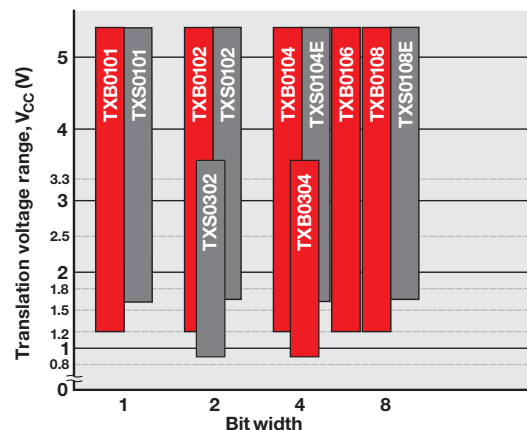
Auto direction-sensing translators.

Dual-Supply Translators

→ *Auto-Direction Sensing Translators*

Bidirectional Auto Direction Sensing Translators with 0.9 V Support
TXB030x

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXB030x**

Key Features
- Optimized for push-pull applications
- Fully symmetric supply voltages: 0.9 V to 3.6 V on both A-port and B-port
- V_{CC} isolation feature – If either V_{CC} input is at GND, all outputs are in the high-impedance state
- OE input circuit referenced to V_{CCA}
- Low power consumption, 5-µA max I_{CC}
- 8-kV Human-Body Model (HBM)

Applications
- Cell phones
- Tablets
- Portable GPS devices
- *Bluetooth*® headsets
- General portable consumer applications

These non-inverting translators use two separate configurable power-supply rails. As voltage signal levels continue to decrease, a new set of low-voltage-level translators are needed. This is the reason why the TXB030x family of low-voltage auto-direction sensing translators were made.

When the output-enable (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver. The TXB030x family is designed so that the OE input circuit is supplied by V_{CCA}. The devices are fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.
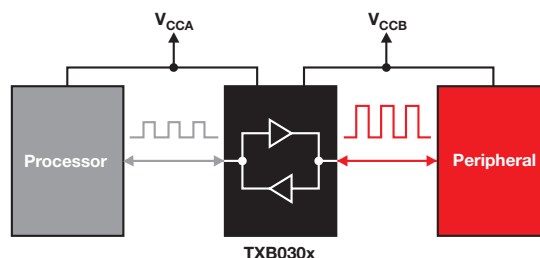
TXB030x functional block diagram.

Bidirectional Auto Direction Sensing Translators
TXB010x

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXB010x**

Key Features
- Optimized for push-pull drivers
- 100 Mbps max data rate transfer
- V_{CC} isolation feature
- OE input circuit referenced to V_{CCA}
- Low power consumption
- I_{OFF} supports operation in partial-power-down mode
- 1.2 V to 3.6 V on A-port and 1.65 V to 5.5 V on B-port ($V_{CCA} \leq V_{CCB}$)

Applications
- Cell phones
- SD/SDIO level translation
- SPI and GPIO level translation

These non-inverting translators use two separate configurable power-supply rails. The A port is designed to track V_{CCA}. V_{CCA} accepts any supply voltage from 1.2 V to 3.6 V. The B port is designed to track V_{CCB}. V_{CCB} accepts any supply voltage from 1.65 V to 5.5 V. This allows for universal low-voltage bidirectional translation between any of the 1.2-V, 1.5-V, 1.8-V, 2.5-V, 3.3-V, and 5-V voltage nodes. V_{CCA} should not exceed V_{CCB}.

When the output-enable (OE) input is low, all outputs are placed in the high-impedance state. This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

TXB010x functional block diagram.

Dual-Supply Translators

➔ *Auto-Direction Sensing Translators for Open Drain Applications*

Bidirectional Auto Direction Sensing Translators for Open Drain Applications with 0.9 V Support
TXS030x

PREVIEW

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXS030x**

Key Features
- Optimized for open-drain applications
- Fully symmetric supply voltages: 0.9 V to 3.6 V on both A-port and B-port
- V_{CC} isolation feature – if either V_{CC} input is at GND, all outputs are in the high-impedance state
- OE input circuit referenced to V_{CCA}
- Low power consumption, 5-μA max I_{CC}
- 8-kV Human-Body Model (HBM)

Applications
- Cell phones
- Tablets
- Portable GPS devices
- *Bluetooth*® headsets
- General portable consumer applications

These two-bit non-inverting translators uses two separate configurable power-supply rails. The A port is designed to track V_{CCA}. V_{CCA} accepts any supply voltage from 0.9 V to 3.6 V. The B port is designed to track V_{CCB}. V_{CCB} accepts any supply voltage from 0.9 V to 3.6 V. This allows for low-voltage bidirectional translation between 1-V, 1.2-V, 1.5-V, 1.8-V, 2.5-V and 3.3-V voltage nodes.

For the TXS0302, when the output-enable (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver. The TXS0302 is designed so that the OE input circuit is supplied by V_{CCA}. This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

TXS030x functional block diagram.

Bidirectional Auto Direction Sensing Translators for Open Drain Applications
TXS010x

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXS010x**

Key Features
- Works with both open-drain and push-pull drivers
- Max data rates:
  - 24 Mbps (push-pull)
  - 2 Mbps (open-drain)
- 1.65 V to 3.6 V on A-port and 2.3 V to 5.5 V on B-port ($V_{CCA} \leq V_{CCB}$)
- No power supply sequencing required
- IEC 61000-4-2 ESD protection on B-port for "E" suffix devices
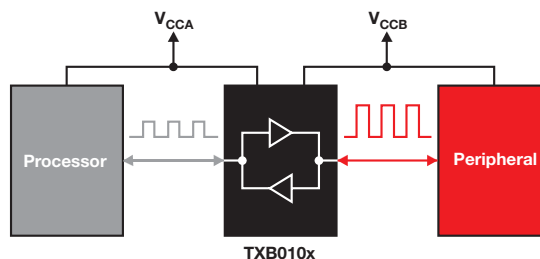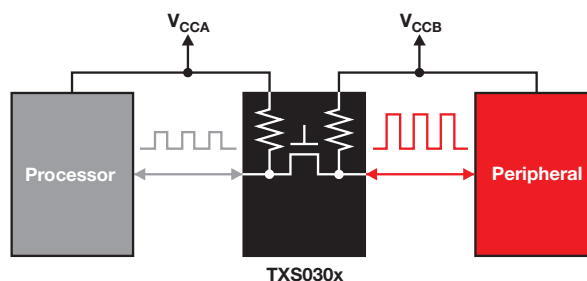
Applications
- Cell phones
- I2C level translation
- MMC and SIM card level translations

These non-inverting translators use two separate configurable power-supply rails. The A port is designed to track V_{CCA}. V_{CCA} accepts any supply voltage from 1.65 V to 3.6 V. The B port is designed to track V_{CCB}. V_{CCA} must be less than or equal to V_{CCB}. V_{CCB} accepts any supply voltage from 2.3 V to 5.5 V. This allows for low-voltage bidirectional translation between any of the 1.8-V, 2.5-V, 3.3-V, and 5-V voltage nodes.

When the output-enable (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.
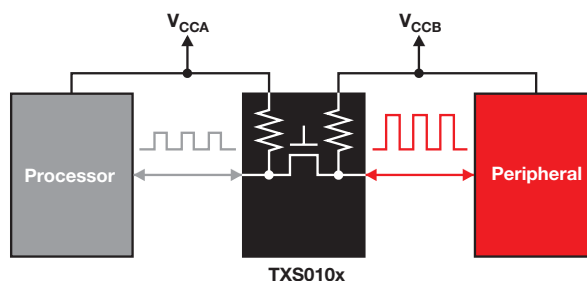


TXS010x functional block diagram.

Dual-Supply Translators

➔ Configurable Translators with Direction Control Portfolio

Key Features

- Fully configurable rails — each V_{CC} rail is fully configurable from 1.2 V to 3.6 V (AVCxT devices) and from 1.65 V to 5.5 V (LVCxT devices)
- No power-up sequencing — either V_{CC} can be powered up first (AVCxT and LVCxT devices only)
- Standby mode — when one V_{CC} is switched off, all I/O ports are placed in the HiZ mode (AVCxT and LVCxT devices only).

TI translators with direction control are designed for asynchronous communication between two buses or devices operating at different supply voltages: V_{CCA} to interface with the A side and V_{CCB} to interface with the B side. These devices are available in a variety of bit widths and cover nearly every supply-voltage node in use today. They are flexible, easy to use and can translate bidirectionally (up-translate and down-translate), which makes them an ideal choice for most level-translation applications.
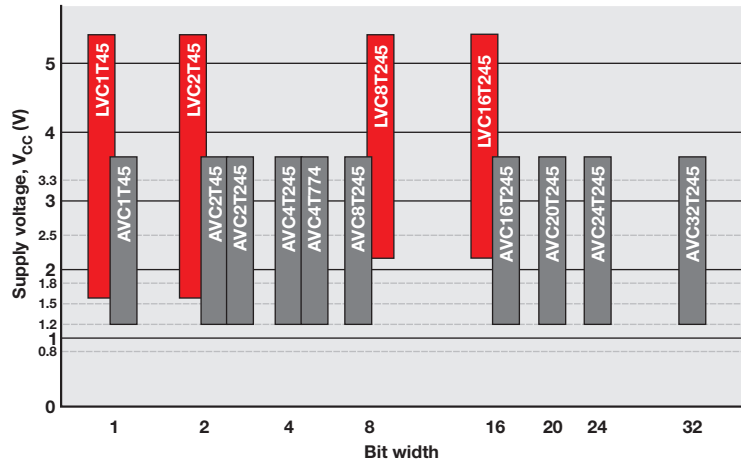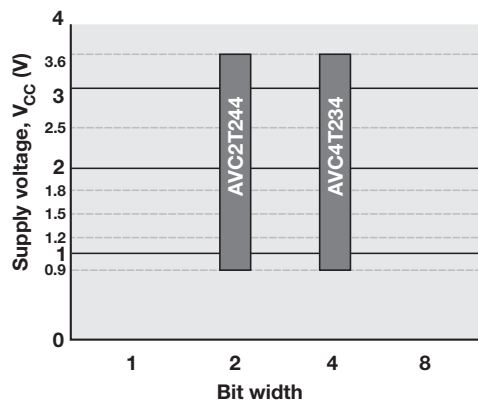

Direction-control translators.

➔ Configurable Unidirectional Translators Portfolio

Key Features

- Unidirectional architecture eliminates the direction control pin saving precious GPIO pins on the processor
- Fully configurable rails from 0.9 V to 3.6 V enable support of 1.0 V nodes used by the most advanced processors
- I_{off} circuitry prevents damaging current backflow in power-down mode

TI unidirectional translators are designed for asynchronous communication between B-port inputs and A-port outputs operating at different supply voltages: V_{CCA} to interface with the A side and V_{CCB} to interface with the B side. These devices cover the most advanced (1.0V and 1.2V) supply-voltage nodes in use today and are fully configurable from 0.9V to 3.6V on both A-port and B-port sides. These devices are fully specified for partial power down applications and use Ioff circuitry that prevents damaging current backflow in power-down mode. These features make these translators an ideal choice for battery powered portable electronics applications.

Dual-Supply Translators

➜ *Configurable Translators with Direction Control*

Dual-Supply Bus Transceiver with Configurable Voltage Translation and 3-State Outputs
SN74AVCxT45/245

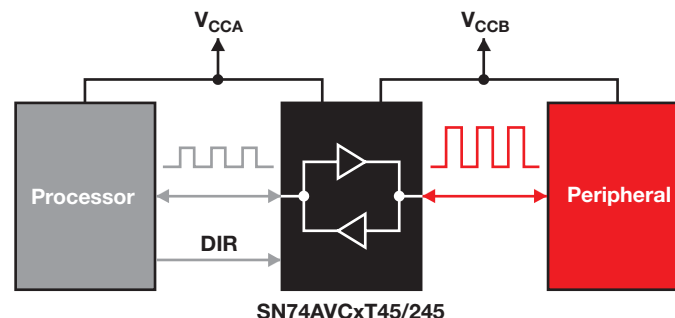Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/SN74AVCxT45/245**

Key Features
- 380 Mbps max data rate
- Control input levels, V_{IH}/V_{IL}, are referenced to V_{CCA} voltage
- Fully configurable dual-rail design allows each port to operate over full 1.2-V to 3.6-V power-supply range
- I_{OFF} supports operation in partial-power-down mode

Applications
- Handsets
- PDAs
- Computing
- Smartphones

These devices are designed for asynchronous communication between data buses. The devices transmit data from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input.

SN74AVCxT45/245 functional block diagram.

Dual-Supply Bus Transceiver with Configurable Voltage Translation and 3-State Outputs
SN74LVCxT45/245

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/SN74LVCxT45/245**

Key Features
- Control input levels, V_{IH}/V_{IL}, are referenced to V_{CCA} voltage
- Fully configurable dual-rail design allows each port to operate over full 1.65-V to 5.5-V power-supply range
- I_{OFF} supports operation in partial-power-down mode

Applications
- Portables
- Telecom
- Computing
- Translation from 3.3 V to 5 V

These devices are fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

The V_{CC} isolation feature ensures that if either V_{CC} input is at GND, then both ports are in the high-impedance state. To ensure the high-impedance state during power up or power down, OE should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.
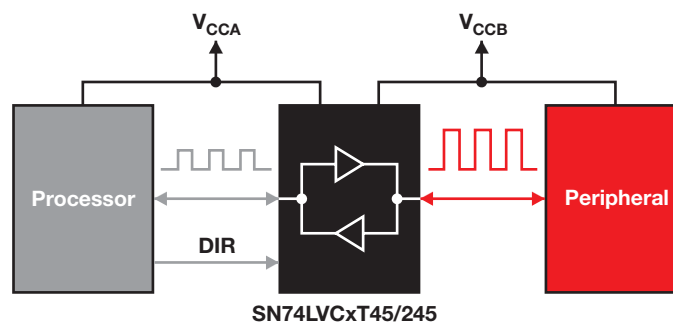
SN74LVCxT45/245 functional block diagram.

Dual-Supply Translators

➜ *Configurable Unidirectional Translators*

4-Bit, Dual-Supply, Non-Inverting Bus Translator
SN74AVC4T234

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/SN74AVC4T234**
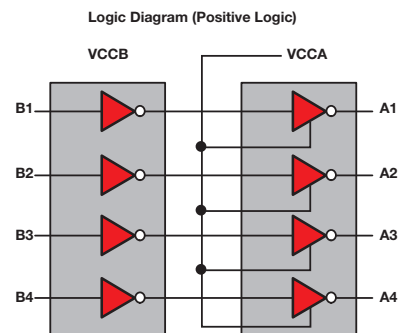
Key Features
- 380 Mbps max data rate
- Wide operating V_{CC} range of 1.2 V to 3.6 V
- 3.6-V I/O tolerant to support mixed-mode signal operation
- Input-disable feature allows floating input conditions
- Input hysteresis allows slow input transition and better switching noise immunity at input

Applications
- Handsets
- PDAs
- Computing
- Smartphones

This 4-bit non-inverting bus transceiver uses two separate configurable power-supply rails to enable asynchronous communication between B-port inputs and A-port outputs. The A port is designed to track V_{CCA} while the B port is designed to track V_{CCB}. Both V_{CCA} and V_{CCB} are configurable from 1.2 V to 3.6 V. The SN74AVC4T234 solution offers the industry's low-power needs in battery-powered portable applications by ensuring both a very low static and dynamic power consumption across the entire V_{CC} range of 1.2 V to 3.6 V, resulting in an increased battery life. This product also maintains excellent signal integrity. This device is fully specified for partial-power-down applications using I_{off}. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The V_{CC} isolation feature ensures that if either V_{CC} input is at GND, then A-side ports are in the high-impedance state.

Logic diagram (positive logic).

2-Bit, Dual-Supply, Unidirectional Translator with Output Enable
SN74AVC2T244

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/SN74AVC2T244**

Key Features
- Wide operating V_{CC} range of 0.9 V to 3.6 V
- Output enable pin allows user to disable outputs to reduce power consumption
- 380 Mbps max data rate
- Input hysteresis allows slow input transition and better switching noise immunity at input
- 4.5 V tolerant I/O to support mixed signal mode operation

Applications
- Handsets
- PDAs
- Computing
- Smartphones

This 2-bit unidirectional translator uses two separate configurable power-supply rails to enable asynchronous communication between B-port inputs and A-port outputs. The A port is designed to track V_{CCA} while the B port is designed to track V_{CCB}. Both V_{CCA} and V_{CCB} are configurable from 0.9 V to 3.6 V. The SN74AVC2T244 offers an output enable pin to disable outputs that reduces power consumption significantly in power down mode. It offers very low static and dynamic power consumption across the entire V_{CC} range of 0.9 V to 3.6 V, making it the ideal translator for battery powered portable electronics applications.
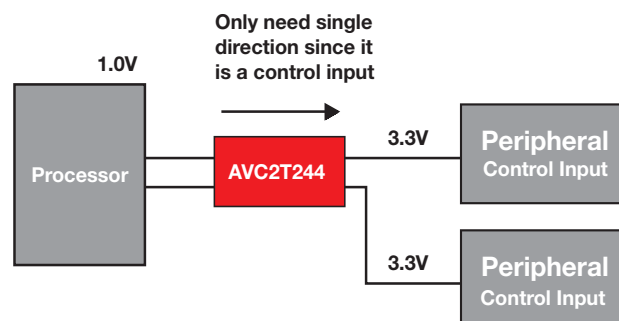
SN74AVC2T244 functional block diagram.

Dual-Supply Translators

➔ *Application Specific Translators*

SD Card, Memory Stick, and MMC Voltage-Translation Transceivers with ESD Protection and EMI Filtering
TXS0206 and TXS0206-29

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXS0206**; **www.ti.com/product/TXS0206-29**

Key Features
- Voltage-translation transceiver for memory card interfaces (SD, Mini SD, MMC)
- Fully configurable dual-voltage supply architecture with both V_{CCA} and V_{CCB} operating range of 1.1 V to 3.6 V
- Six bidirectional channels capable of passing 60 Mbps data rates with 3 ns typical prop-delay
- No direction control needed on data/command paths
- Integrated pull-up resistors on card-side I/Os per SD specification
- SDIO-compliant integrated smart pull-up resistors — enables output drivers to maintain modest DC-bias current sourcing capabilities while maintaining low static power consumption

Memory card standards recommend high-ESD protection for devices that connect directly to the external memory card. To meet this need, these devices incorporate ±8-kV Contact Discharge protection on the card side.
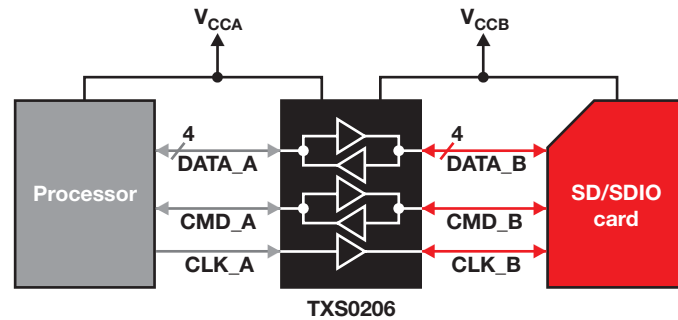
TXS0206 functional block diagram.

Applications
- Mobile phones
- PDAs
- Digital cameras
- Personal media players
- Camcorders
- Set-top boxes

### Interchip USB Voltage Level Translator
TXS0202

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXS0202**

Key Features
- Auto-direction sensing translator
- Voltage range of 1.65-3.6 V
- I_{off} supports partial-power-down mode operation
- Actively detects the status of the host and peripheral and will determine which of the four various modes is desired
- No direction signal control needed
- Works with legacy to next-generation processors and peripherals
- This is done without any need for direction control, external FETs, or external pull up resistors

The TXS0202 is a two-bit voltage level translator optimized for use in Interchip USB (IC-USB) applications. V_{CCA} and V_{CCB} can each operate over the full range of 1.65 V to 3.6 V. The device has been designed to maintain cross-over skew to be less than 1 ns. The device has integrated pull-ups and pull-down resistors to aid in the protocol communication between a host and a peripheral. The translator is a buffered auto-direction sensing type translator. When the output-enable (OE) input is low, all outputs are placed in the high-impedance state.
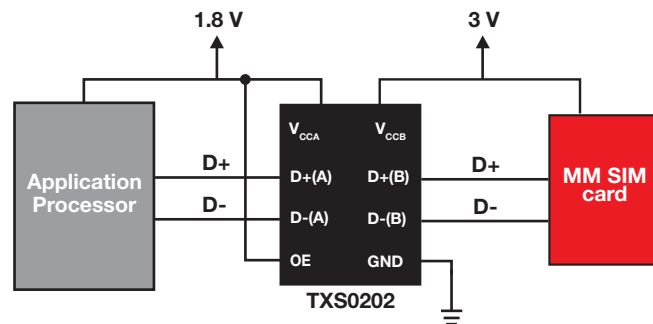
TXS020x functional block diagram.

Applications
- Handsets
  - Smartphone
  - Multimedia
  - Feature
- Tablet
- Portable gaming devices

Translation Guide

Texas Instruments 2011

Dual-Supply Translators

➜ *Application Specific Translators*

Dual-supply SIM Card Translator and 2:1 Multiplexer
TXS02326

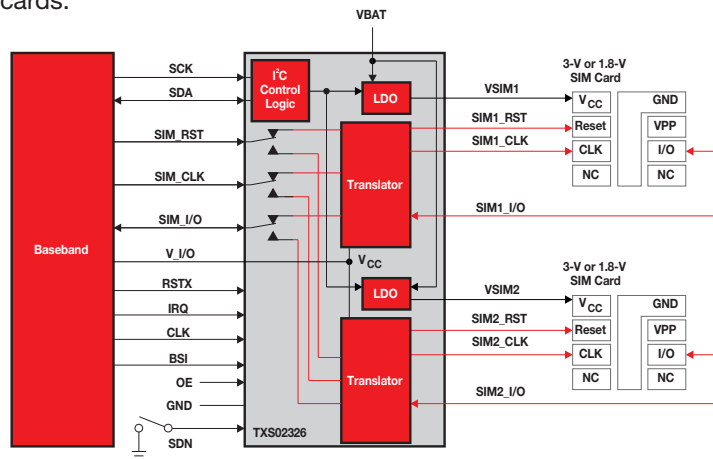Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXS02326**

Key Features

- Dual-supply translator with voltage range of 1.7 V to 3.6 V
- 2:1 multiplexer function enables the use of a single SIM card interface to control two SIM cards
- Integrated dual-LDOs enable support of 1.8 V and 2.95 V SIM card standards
- Available in popular 24-pin QFN package

Applications

- Cell phones

The TXS02326 is a dual-supply SIM card solution for interfacing wireless baseband processors with two SIM cards. The 2:1 multiplexer function extends the single SIM card interface to support two SIM cards. The dual-supply voltage translation function supports 1.7 V to 3.3 V range on the processor side and either 1.8 V or 2.95 V on the SIM card side. The two SIM card interface standards, Class-B (2.95 V) and Class-C (1.8 V) are supported by two integrated low-dropout (LDO) voltage regulators with selectable outputs. An integrated 400 kb/s I^2C interface offers several configuration options, including safe power-down of the two SIM cards.

Interfacing with SIM card.

1.8 V and 3 V SIM Card Power Supply and Voltage Translator
TXS4555

Get samples, data sheets, EVMs and app reports at: **www.ti.com/product/TXS4555**

Key Features

- Dual-supply translator with voltage range of 1.65 V to 3.3 V
- Integrated LDO accepts battery voltage from 2.3 V to 5.5 V and generates 1.8 V or 2.95 V output
- Proper shutdown sequence prevents data corruption in case of accidental phone shutdown
- Available in tiny 16-pin (9mm^2) and 12-pin (3.5mm^2) QFN packages

Applications

- Cell phones

The TXS4555 is a dual-supply SIM card solution for interfacing a wireless baseband processor with any Class-B (2.95 V) or Class-C (1.8 V) SIM card. The dual-supply voltage translation function supports 1.65 V to 3.3 V range on the processor side and accepts any battery voltage between 2.3 V and 5.5 V to generate a constant 1.8 V or 2.95 V output on the SIM card side. A dedicated low-dropout (LDO) voltage regulator with selectable output is used to generate the desired SIM card voltage. Proper shutdown sequence for the SIM card signals helps in prevention of corruption of data during accidental shutdown of the phone.
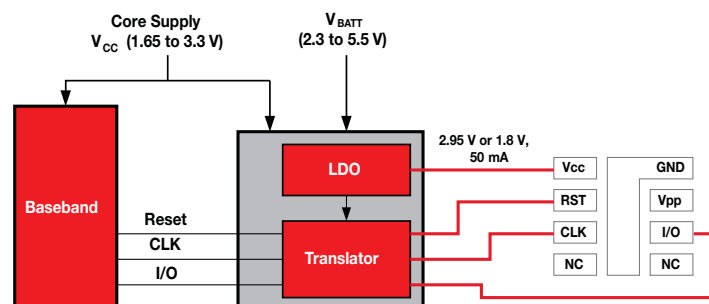
Interfacing with SIM card.

Dual-Supply Translators

➜ Translator Nomenclature

Translator nomenclature					TX	S	01	04	E	RGY	R
Prefix: TX = TI translator											
Device type: S = Switch, B = Buffer											
Grade											
Bit width											
ESD protection: E = IEC Level 4											
TI package designator											
Tape and reel: R or none = Standard reel, T = Small reel											

Translator nomenclature				SN74	AVC	20	T	245	DGV	R
TI prefix:										
Technology family: AHC, AHCT, AVC, AUC, CBT, CBTD, CB3T, HCT, LVC, TVC										
Bit width										
Device type: T = Translation										
Function identifier										
TI package designator										
Tape and reel: R or none = Standard reel, T = Small reel										

➜ Selection Tables

Device	V_{CC} Min. to Max. (V)		V_{CCA} (V)									V_{CCB} (V)									Smallest package
	V_{CCA}	V_{CCB}	0.9	1.2	1.5	1.65	1.8	2.5	2.7	3.3	5	0.9	1.2	1.5	1.65	1.8	2.5	2.7	3.3	5	
Application Specific																					
CF4320H	1.65 to V_{CCB}	3 to 5.5					✔	✔	✔	✔	✔								✔	✔	114-ball LFBGA
SN74AVCA406L	1.2 to 3.6	1.2 to 3.6	✔	✔		✔	✔	✔	✔				✔	✔		✔	✔	✔	✔		20-ball VFBGA
SN74AVC2T872	1.1 to 3.6	1.1 to 3.6	✔	✔		✔	✔	✔	✔				✔	✔		✔	✔	✔	✔		12-ball WCSP
SN74AVC6T622	1.2 to 3.6	1.2 to 3.6	✔	✔		✔	✔	✔	✔				✔	✔		✔	✔	✔	✔		20-ball UFBGA
TWL1200	1.1 to 3.6	1.1 to 3.6	✔			✔	✔	✔	✔	✔						✔	✔	✔	✔	✔	YFF
TXS0202	1.65 to 3.6	1.65 to 3.6				✔	✔	✔	✔	✔						✔	✔	✔	✔	✔	YZP
TXS0206	1.1 to 3.6	1.1 to 3.6	✔	✔		✔	✔	✔	✔				✔	✔		✔	✔	✔	✔		20-ball WCSP
TXS0206-29	1.1 to 3.6	5V Max VBAT	✔			✔	✔	✔	✔												YFP
TXS02612	1.1 to 3.6	1.1 to 3.6	✔	✔		✔	✔	✔	✔				✔	✔		✔	✔	✔	✔		24-ball VFBGA
Application Specific: SIM Card Translators																					
TXS4555	1.65 to 3.3	2.3 to 5.5				✔	✔	✔	✔	✔							✔		2.95			RUT
TXS02326	1.7 to 3.3	2.3 to 5.5				✔	✔	✔									✔		2.95			RGE
TXS02326A	1.7 to 3.3	2.3 to 5.5				✔	✔	✔									✔		2.95			RGE
TXS02324	1.7 to 3.3	2.3 to 5.5				✔	✔	✔									✔		2.95			RUK
TXS4558	1.7 to 3.3	2.3 to 5.5				✔	✔	✔	✔								✔		2.95			RUT

[1] Bus-hold option available

*Preview products are listed in **bold blue.***

Dual-Supply Translators

→ Selection Tables (Continued)

Device	V_CC Min. to Max. (V)		V_CCA (V)									V_CCB (V)									Smallest package
	V_CCA	V_CCB	0.9	1.2	1.5	1.65	1.8	2.5	2.7	3.3	5	0.9	1.2	1.5	1.65	1.8	2.5	2.7	3.3	5	
1-Bit																					
SN74AVC1T45[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		6-ball NanoStar™/NanoFree™
SN74LVC1T45	1.65 to 5.5	1.65 to 5.5					✔	✔	✔	✔	✔					✔	✔	✔	✔	✔	6-ball NanoStar/NanoFree
TXB0101	1.2 to 3.6	1.65 to 5.5		✔	✔		✔	✔	✔	✔						✔	✔	✔	✔	✔	6-ball NanoFree
TXS0101	1.65 to 3.6	2.3 to 5.5					✔	✔	✔	✔							✔	✔	✔	✔	6-ball NanoFree
2-Bit																					
SN74AVC2T45[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		8-ball NanoStar/NanoFree
SN74AVC2T244	0.9 to 3.6	0.9 to 3.6	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔		8-pin µQFN
SN74LVC2T45	1.65 to 5.5	1.65 to 5.5					✔	✔	✔	✔	✔					✔	✔	✔	✔	✔	8-ball NanoStar/NanoFree
SN74LVC2T245	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		10-pin QFN
TXB0102	1.2 to 3.6	1.65 to 5.5		✔	✔		✔	✔	✔	✔						✔	✔	✔	✔	✔	8-ball NanoFree
TXB0302	0.9 to 3.6	0.9 to 3.6	✔	✔		✔	✔	✔	✔	✔		✔	✔		✔	✔	✔	✔	✔		RGE
TXS0102	1.65 to 3.6	2.3 to 5.5					✔	✔	✔	✔							✔	✔	✔	✔	8-ball NanoFree
TXS0302	0.9 to 3.6	0.9 to 3.6		✔	✔		✔	✔		✔			✔	✔		✔	✔		✔		8-pin, YFP, DQE and DQM
4-Bit																					
SN74AVC4T234	1.1 to 3.6	1.1 to 3.6		✔		✔	✔	✔	✔	✔			✔		✔	✔	✔	✔	✔		ZSU
SN74AVC4T245[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		16-pin QFN
SN74AVC4T774	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		16-pin QFN
TXB0104	1.2 to 3.6	1.65 to 5.5		✔	✔		✔	✔	✔	✔						✔	✔	✔	✔	✔	12-ball UFBGA
TXB0304	0.9 to 3.6	0.9 to 3.6	✔	✔		✔	✔	✔	✔	✔		✔	✔		✔	✔	✔	✔	✔		RSV
TXS0104E	1.65 to 3.6	2.3 to 5.5					✔	✔	✔	✔							✔	✔	✔	✔	12-ball UFBGA
6-Bit																					
TXB0106	1.2 to 3.6	1.65 to 5.5		✔	✔		✔	✔	✔	✔						✔	✔	✔	✔	✔	16-pin QFN
8-Bit																					
SN74AVC8T245[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		24-pin QFN
SN74LVC8T245[1]	1.65 to 5.5	1.65 to 5.5					✔	✔	✔	✔	✔					✔	✔	✔	✔	✔	24-pin QFN
TXB0108	1.2 to 3.6	1.65 to 5.5		✔	✔		✔	✔	✔	✔						✔	✔	✔	✔	✔	20-ball VFBGA
TXS0108E	1.65 to 3.6	2.3 to 5.5					✔	✔	✔	✔							✔	✔	✔	✔	20-ball VFBGA
16-Bit																					
SN74AVC16T245[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		56-ball VFBGA
SN74LVC16T245[1]	1.65 to 5.5	1.65 to 5.5					✔	✔	✔	✔	✔					✔	✔	✔	✔	✔	56-ball VFBGA
20-Bit																					
SN74AVC20T245[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		56-ball VFBGA
24-Bit																					
SN74AVC24T245[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		83-ball LFBGA
32-Bit																					
SN74AVC32T245[1]	1.2 to 3.6	1.2 to 3.6		✔	✔		✔	✔	✔	✔			✔	✔		✔	✔	✔	✔		96-ball LFBGA

[1] Bus-hold option available

*Preview products are listed in **bold blue.***

Additional Translators

➔ *FET Switches*

Devices from TI's CBT, CBTD, CB3T and TVC families can be used in level-translation applications. The diagram shows a CB3T bus switch interfacing a 3-V bus with a 5-V (TTL) bus. The CB3T device down-translates the signals from the 5-V bus to 3-V levels.

No translation is necessary to transfer signals from the 3-V bus to the 5-V (TTL) bus, since the V_{OH} level from the CB3T switch is greater than the required V_{IL} of the 5-V (TTL) devices connected to the 5-V bus.
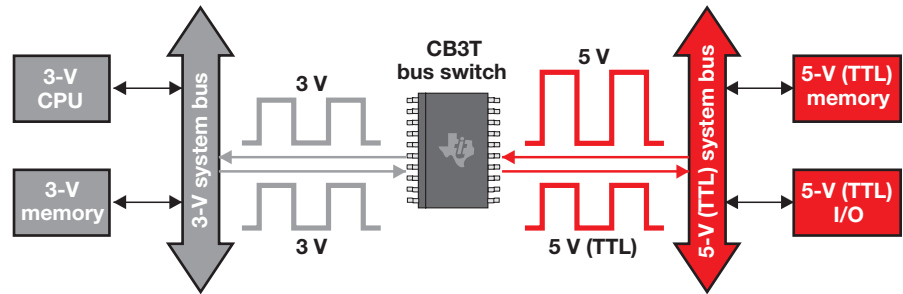
FET switch for translation.

Advantage
• Fast propagation delays

➔ *Overvoltage-Tolerant Devices and TTL-Compatible Inputs and Open-Drain Output Devices*

Overvoltage-Tolerant Devices

Devices with overvoltage-tolerant inputs can be used to perform down-translation as shown in the diagram. Logic families with overvoltage-tolerant inputs include:
• AHC   • LV-A
• AUC   • LVC
• AVC

Advantages
• Only one supply voltage needed
• Broad portfolio of AHC, AUC, AVC, LV-A and LVC devices
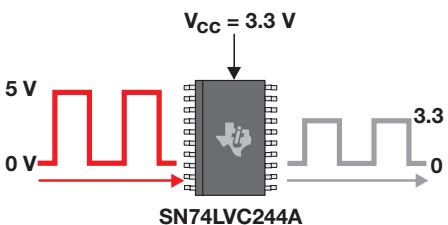
Down-translation.

Devices with TTL-Compatible Inputs

Up-translation from 3.3-V LVCMOS/LVTTL to 5-V CMOS levels can be achieved with logic devices from TI's HCT, AHCT, ACT and AUP families.

Advantages
• Only one supply voltage needed
• Broad portfolio of HCT, AHCT, ACT and AUP devices
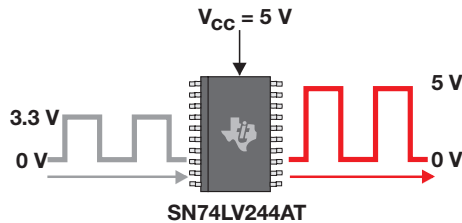
TTL up-translation.

Devices with Open-Drain Outputs

Devices with open-drain outputs can be used to perform both up-translation and down-translation. The output voltage is determined by V_{CCB}. This output level can be higher than V_{CCA} (up-translation) or lower than V_{CCA} (down-translation).

Advantages
• Flexibility in translating to/from a variety of voltage nodes
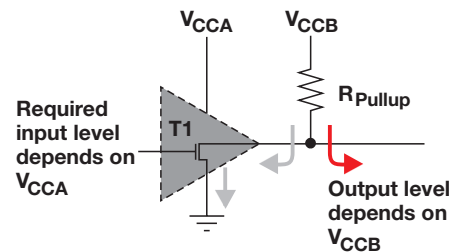
Translation with open-drain buffers.

→ *Sample Requests and Quality Assurance*

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New Zealand	0800-446-934
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