nexperia

Webinar Series
“Lost in Translation”: Selecting the Right Translator

Part 1: Technical Requirements

May 2022 •

Agenda
Part 1

01 The need for translators

02 Types of translators

03 Product portfolio

04 Common interfaces for translators

05 Q&A

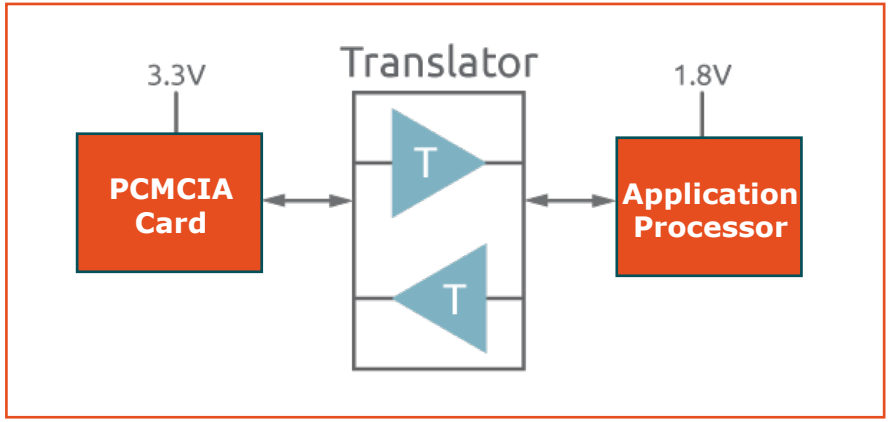
01

The need for translators

Voltage Translation – Why ?

Introduction

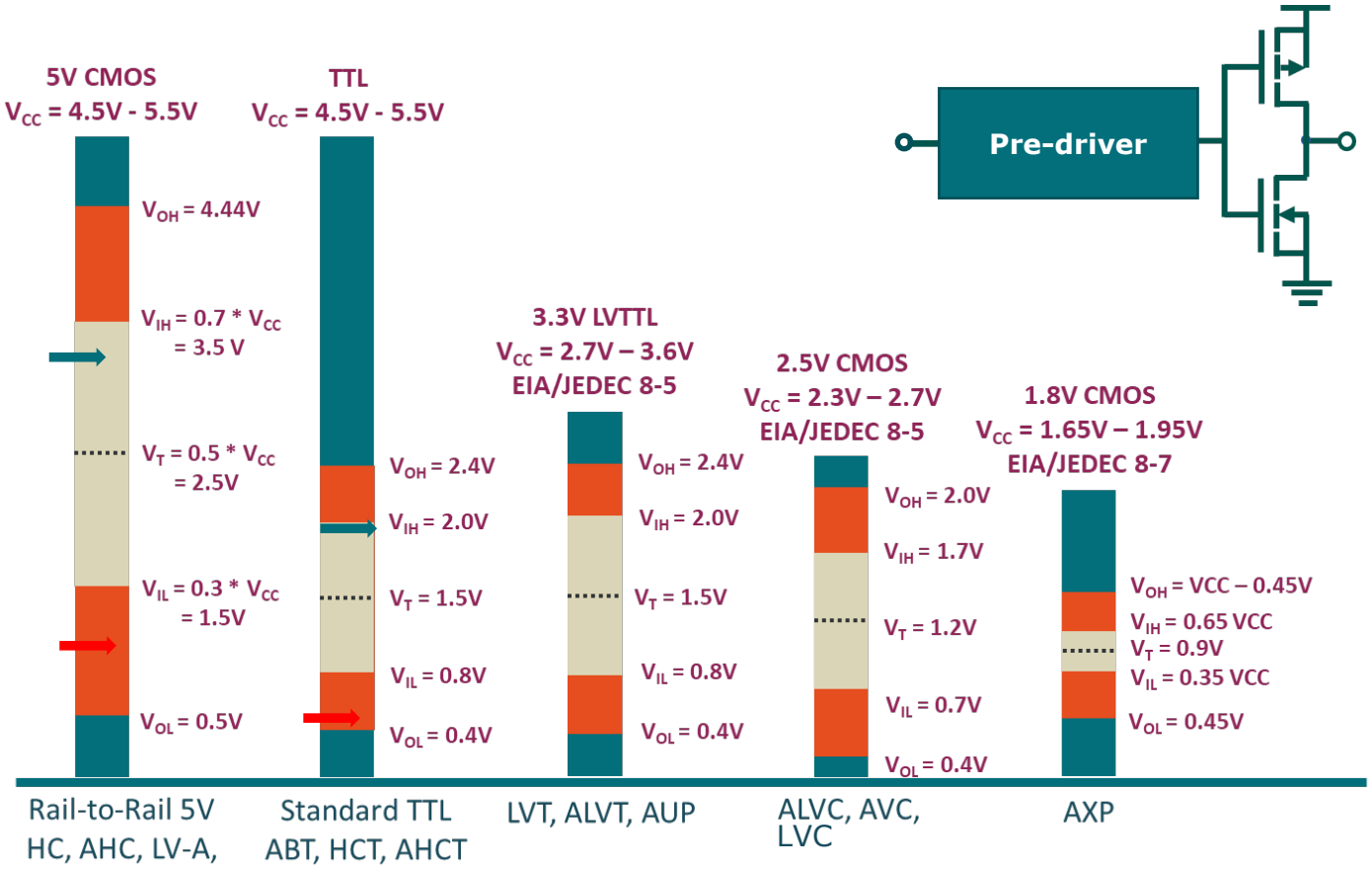
- Bipolar 5V TTL replacing 5V CMOS
- Latest data processors for battery operated applications and legacy peripherals like memories, sensors etc.
- Growth of portable market (1.8V and 1.2V) and trend towards 0.9V and less
- In modular designs devices may be at different supply voltages

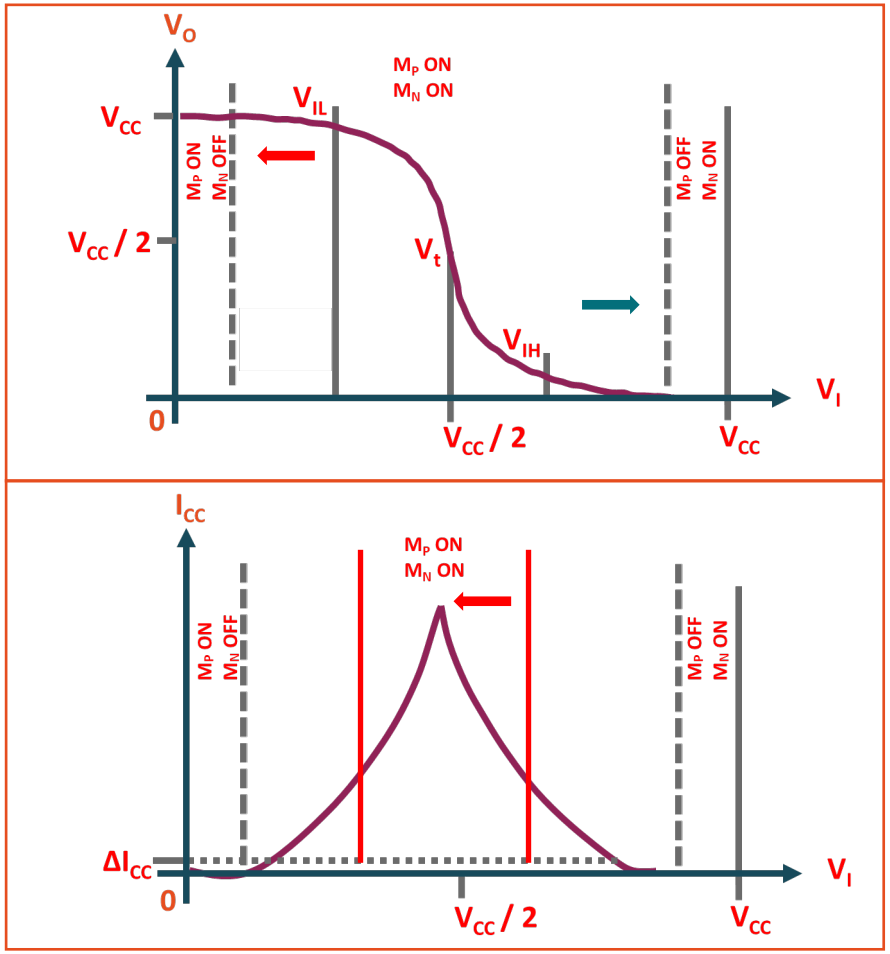


Usage of level Translator

Voltage Translation – Why ?

CMOS Input and Output levels





Voltage Translation – Why ?

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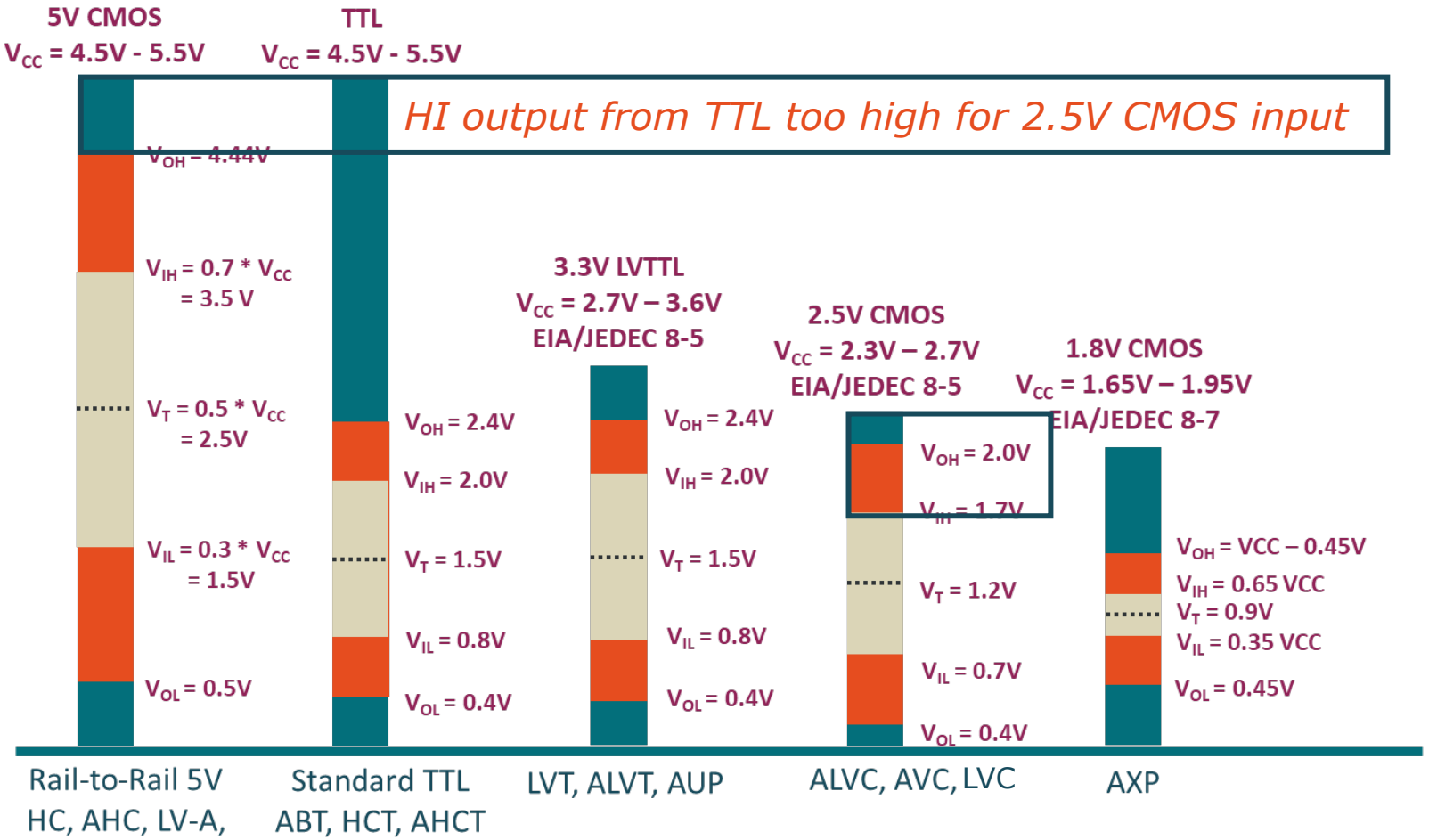
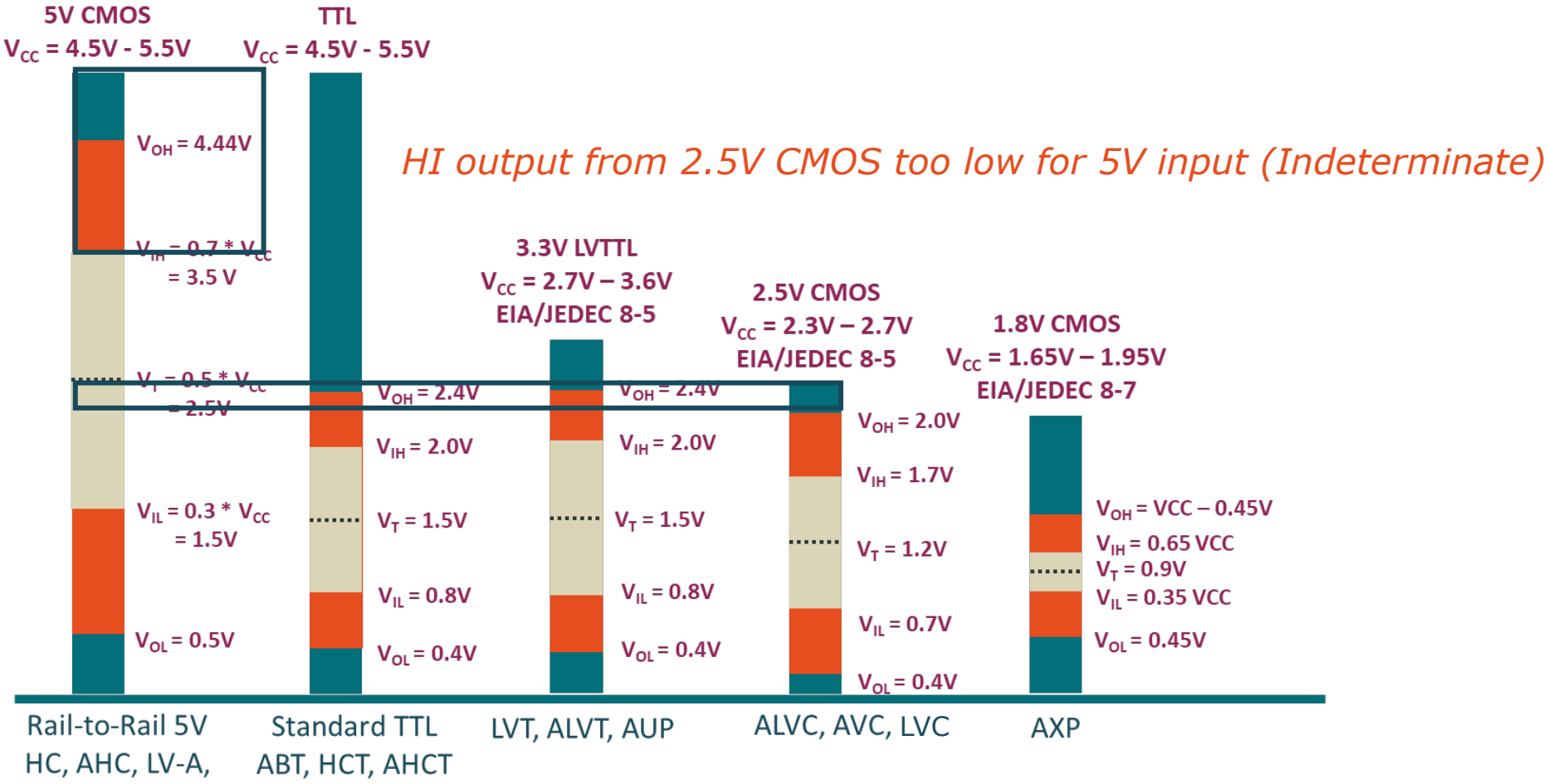


Voltage Translation – Why ?

CMOS Input and Output levels

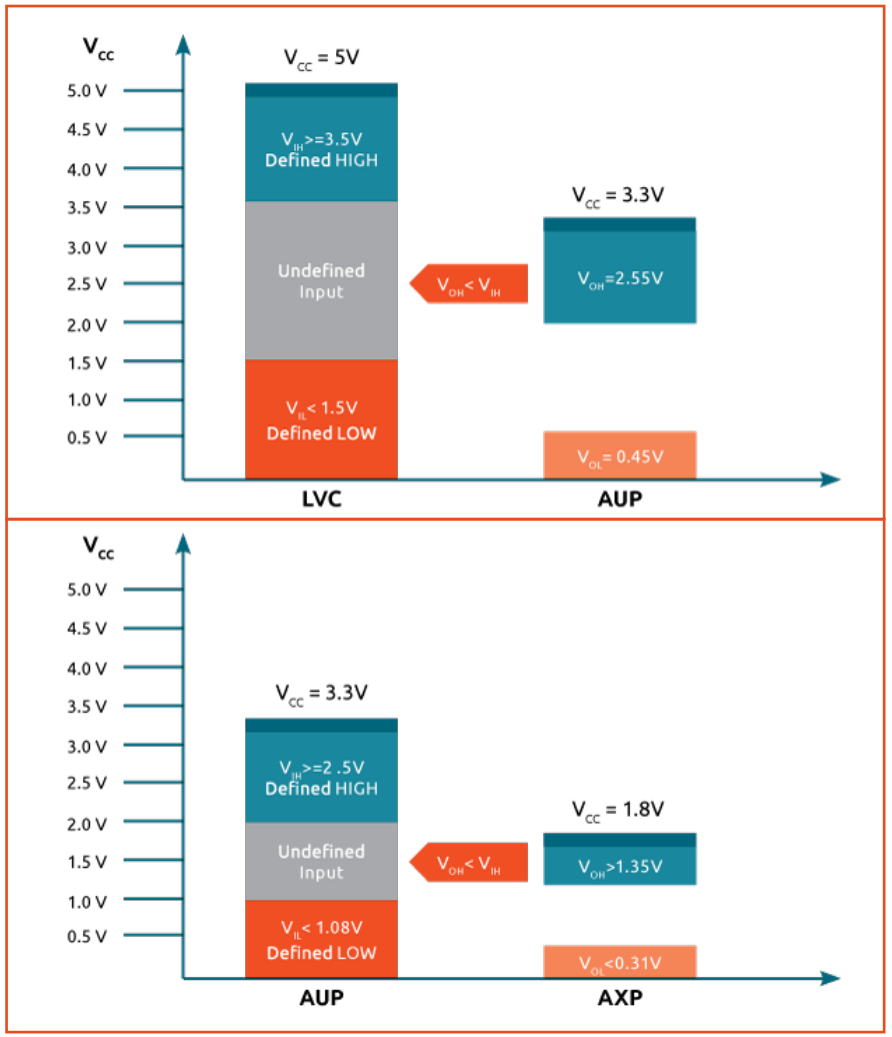


HI output from 2.5V CMOS too low for 5V input (Indeterminate)

Voltage Translation – Why ?

Conditions

Driver		Receiver	Operations
V_{OH} (min)	>	V_{IH} (min)	Function guaranteed
V_{OH} (min)	<	V_{IH} (min)	Function not guaranteed
V_{OL} (max)	>	V_{IL} (max)	Function not guaranteed
V_{OL} (max)	<	V_{IL} (max)	Function guaranteed



02

Translation Techniques

Translation in the logic gate

Autosense translators

Translation Location

Single Supply devices:

Input Side

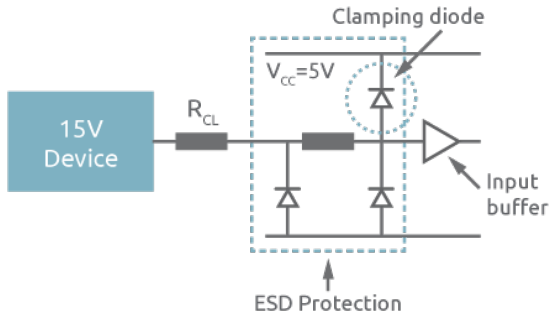
- Clamp diode protection
- Overvoltage tolerant inputs
- Low threshold inputs

Output Side

- Open drain output

Standard Logic Translators

Embedded Translation



Clamp diode inputs

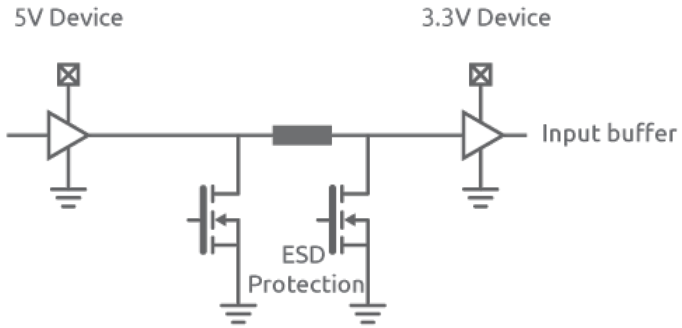
Advantage:
- Can be used to interface any voltage

Disadvantage:
- Requires external component

Available Families

- HEF4000B*
- HC(T)*
- LV

* HEF4104B, HC4049 & HC4050 only



Overvoltage tolerant inputs

Advantage:
- No external components required
- Low system power than the clamp diode solution
- Only one supply voltage needed

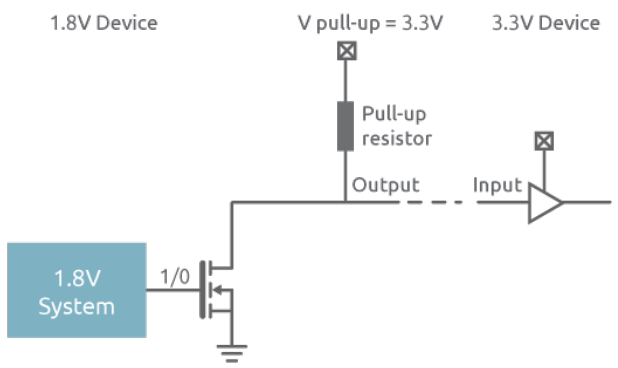
Disadvantage:
- Inputs cannot be driven at voltages greater than the recommended maximum value of V_{CC}

Available Families

- AHC
- ALVC*
- ALVT
- AUP
- AVC, LVC
- AXP
- CBTLV(D)
- LV-A

* Non bus-hold only

Logic Translators Techniques



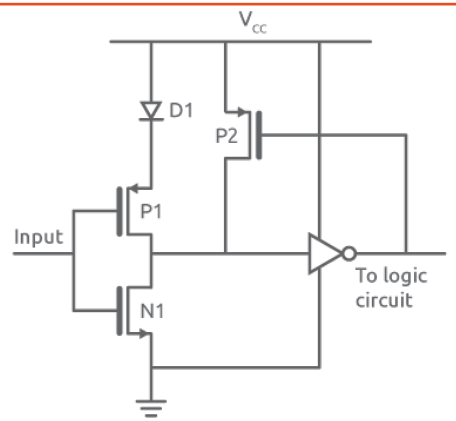
Open-drain outputs

Advantage:
- HIGH to LOW or LOW to HIGH translation
- Can be used in a wired-OR interface

Disadvantage:
- Requires external component
- Additional system power

Available Families

- AHC(T)
- HC(T)
- LVC
- LV
- AUP
- AXP



Low-threshold inputs

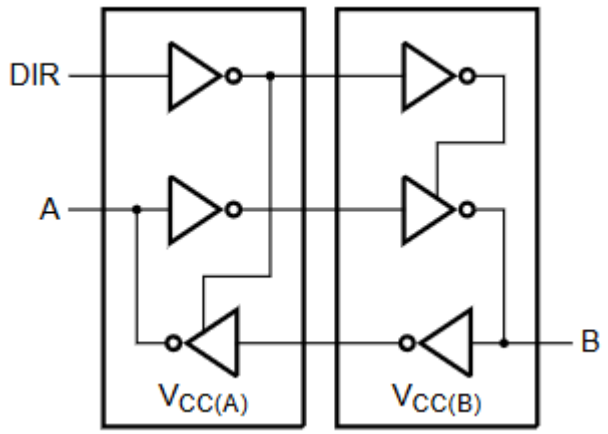
Advantage:
- No external components required
- Same footprint as standard function

Disadvantage:
- High power dissipation due to ΔI_{CC}

Available Families

- HCT
- AHCT
- LV1T
- LVC
- AUP1T
- AXP

Logic Translators Techniques



Transceiver (bidirectional Buffer)

Advantage:
- HIGH to LOW or LOW to HIGH translation
- Bidirectional, supports half duplex communication
- Increased voltage translation range compared to single supply

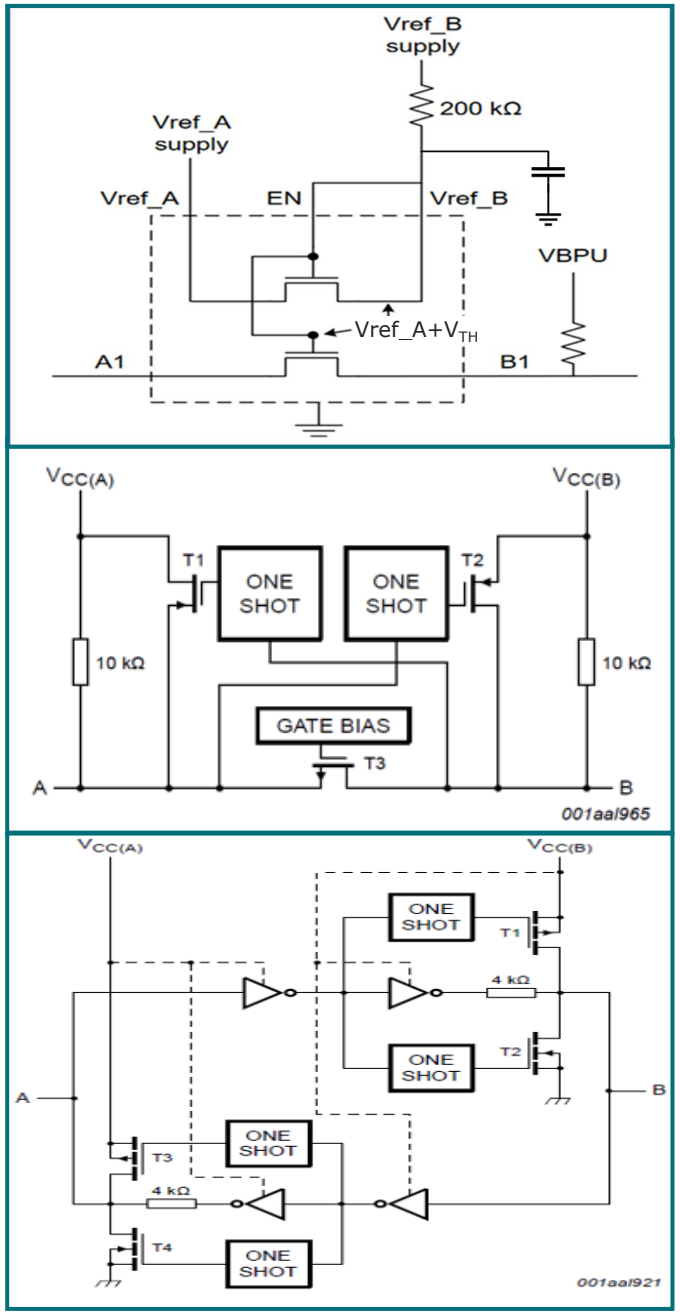
Disadvantage:
- Requires dual supply
- Requires direction pin

Autosense Translators

Overview: 3 variants

- LSF:
  - pass transistor per channel
  - reference channel for switching threshold
  - external pull-up resistors and voltage supply
- NXS:
  - pass transistor with one-shot accelerators for rising edges and
  - internal pull-up circuit
- NXB:
  - push-pull circuit
  - one-shot accelerators for rising and falling edges

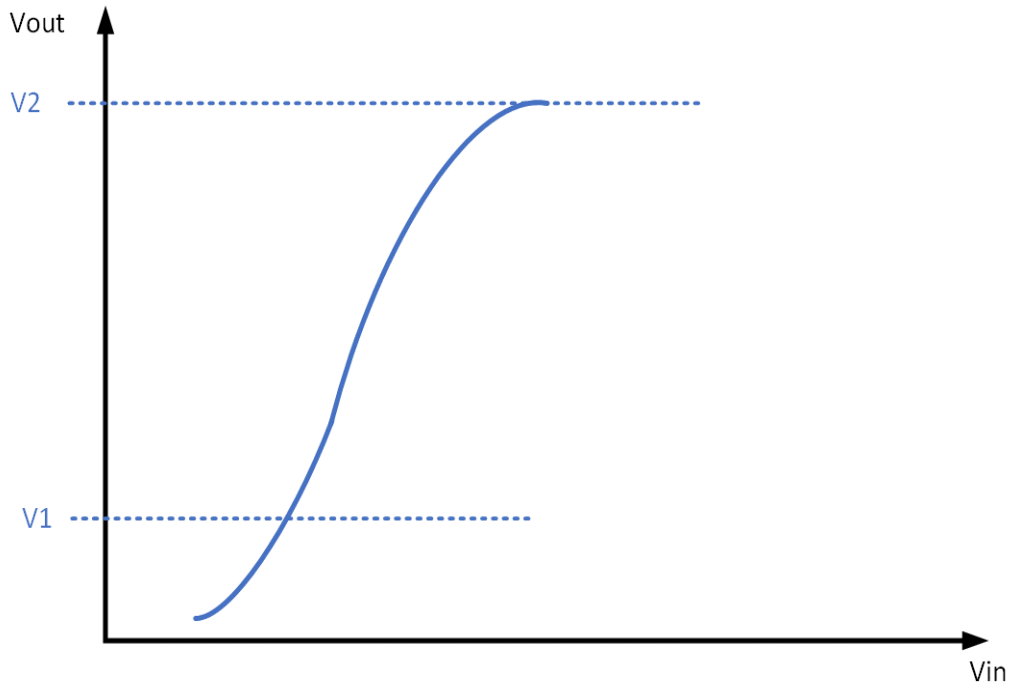
More details on Autosense Translators? See our past Webinar at https://www.nexperia.com/support/on-demand-seminars.html



Autosense Translator Mechanisms

Sender is driving the rising edge

- LSF:
  - begins with pass transistor in conduction mode until Vth is reached (V1)
  - pass transistor disconnects and external pull-up on the receiver side takes over up to V2
- NXS:
  - begins with pass transistor in conduction mode until Vth of the *one shot* is reached (V1)
  - when V2 is reached, one-shot stops and pull-up takes over
- NXB:
  - push-pull drives initial voltage until *one-shot* triggers
  - when high level is reached, *output driver with 4K* series resistor takes over



03

Product Portfolio

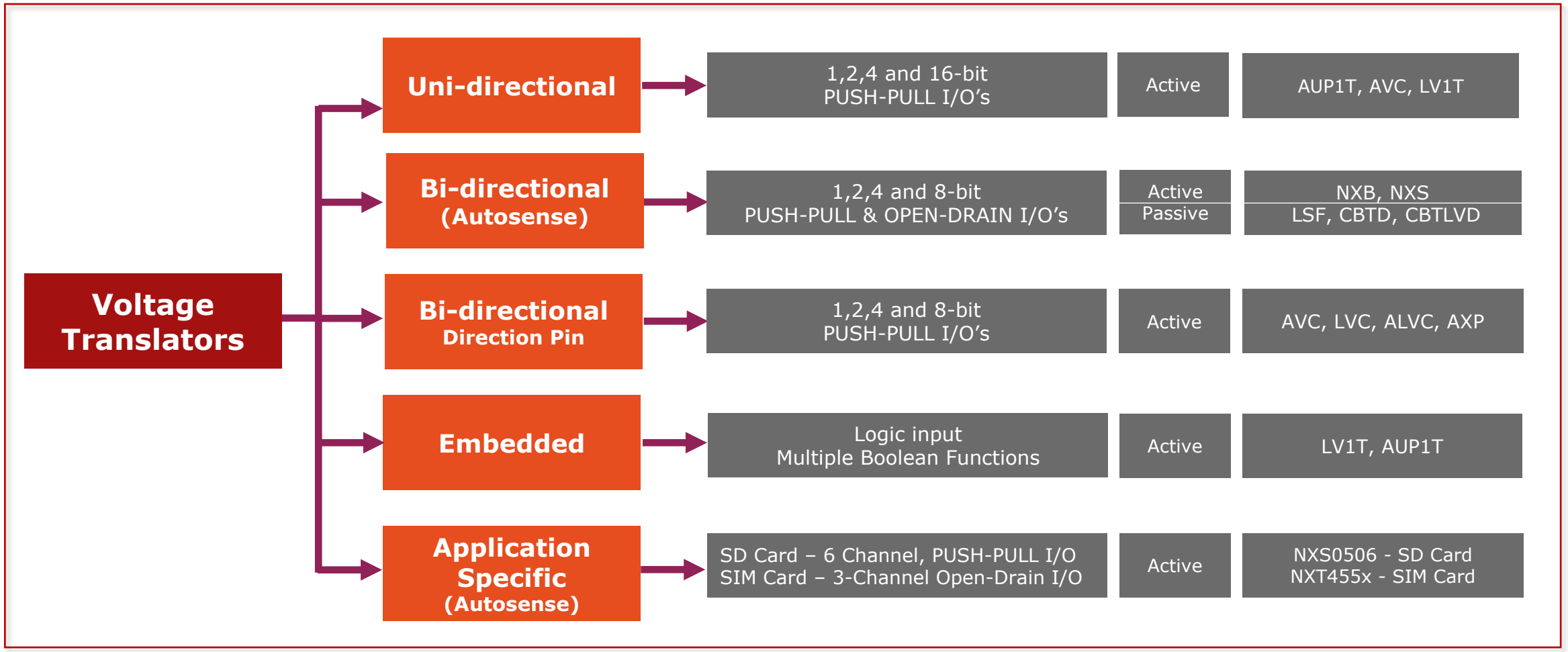
Translator Application Families

A solution for every design

Uni-directional	Bi-directional (Autosense)	Bi-directional Direction Controlled	Embedded
❑ Single supply translators provide simplicity in system design ❑ Dual supply translators provide dynamic operating range for voltage translation ❑ Voltage translating logic gates achieve two functions in one chip ❑ Optimized to translate control inputs	❑ Works with bi-directional signals ❑ Devices available that have been optimized for common interfaces ❑ Works with open-drain and push-pull interfaces ❑ Design flexibility with external pull-up resistors ❑ Direction control pins are eliminated saving space and cost	❑ Buffered output for high driver strength ❑ One or more direction control pins ❑ Devices available that have been optimized for common interfaces ❑ Bus Hold functionality available	❑ No external pull-up or pull-down resistors required ❑ Integration of logic function with translation saves device count and PCB space ❑ Footprint-compatible with existing non-translating devices ❑ Low dynamic power consumption increasing battery

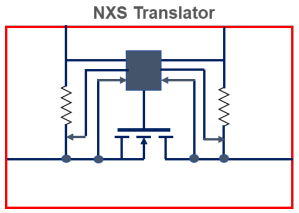
Translator Families

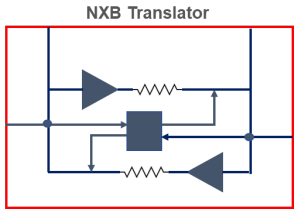
A complete portfolio of solution

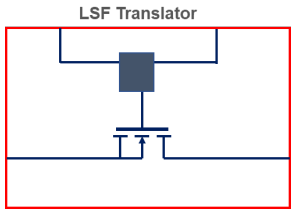


Product Comparison

Autosense Translators: NXS, NXB and LSF Family







Family	NXS	NXB	LSF
Translation	Active	Active	Passive
Benefit	One-Shot improves rise time	One-Shot improves rise time	FET switch-based topology resulting in fast switching speed
Applications	Open Drain and Push-Pull, Control interfaces, I²C-bus, GPIO, I2C, PMBus, SMBus, Display modules, HDMI, 1-wire Bus, GPIO	Push Pull, Control interfaces with active drive, I²C-bus, SPI, UART, HDMI,GPIO, USB Ports	Open Drain and Push-Pull, Control interface, I²C-bus, GPIO, I2C, PMBus, SMBus
Number of Channels	1,2,4,8	1,2,4,8	1,2,4,8
Signal Integrity	Better	Best	Good
Package options	GS, GM, DC, PW, GU12, BQ	GS, GM, DC, PW, GU12, BQ	GM, GX, DP, DC, PW, GU12, BQ
Temperature Range	−40 °C to +125 °C	−40 °C to +125 °C	−40 °C to +125 °C
I_{OFF}	Yes	Yes	-
Over voltage tolerant inputs	Yes	Yes	Yes
Products	• NXS0101GS, NXS0101GM, NXS0102DC, NXS0102DC-Q100, NXS0104PW, NXS0104PW-Q100,NXS0104BQ,NXS0104GU12,NXS0108BQ, NXS0108BQ-Q100, NXS0108PW, NXS0108PW-Q100	• NXB0101GS, NXB0101GM, NXB0102DC, NXB0102DC-Q100, NXB0104PW, NXB0104PW-Q100, NXB0104BQ, NXB0104GU12, NXB0108BQ, NXB0108BQ-Q100, NXB0108PW, NXB0108PW-Q100	• LSF0101GM, LSF0101GX , LSF0102DP, LSF0102GX, LSF0102DC, LSF0102DC-Q100, LSF0204PW, LSF0204GU12, LSF0108PW, LSF0108PW-Q100, LSF0108BQ, LSF0108BQ-Q100

04

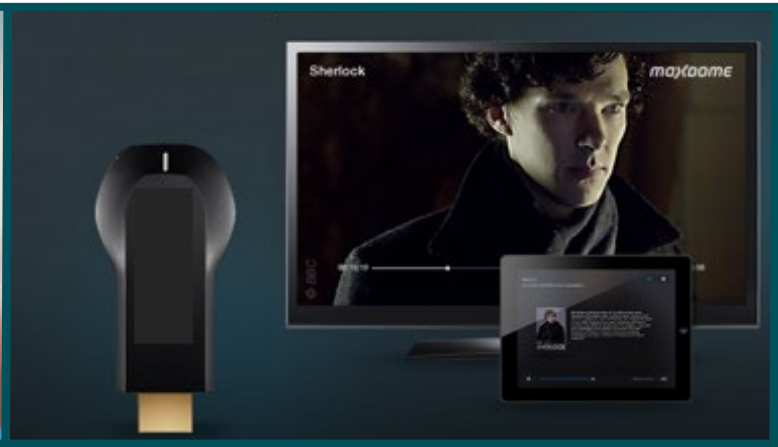
Common interfaces for translators

Level Shifters and Translators

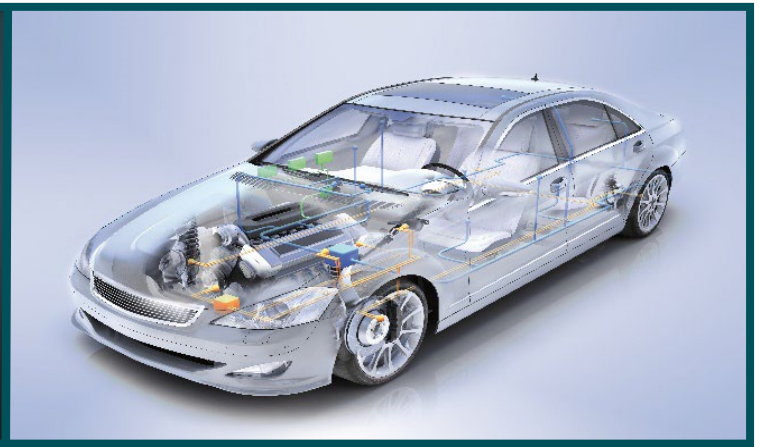
Many Markets

Communications

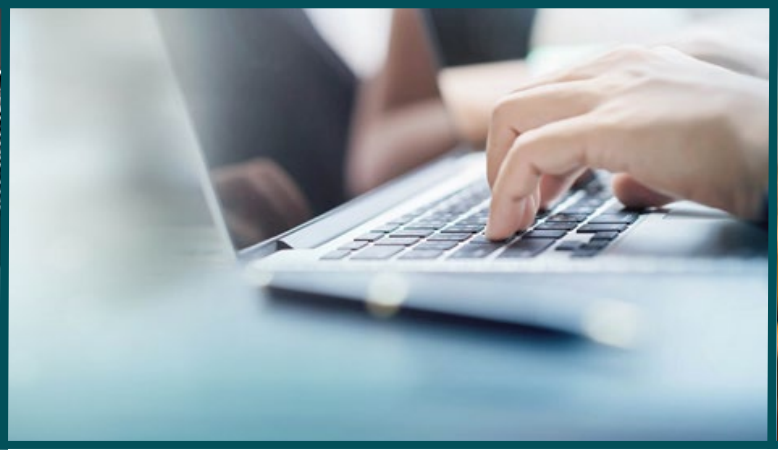
Consumers and Portable



Automotive



Computing

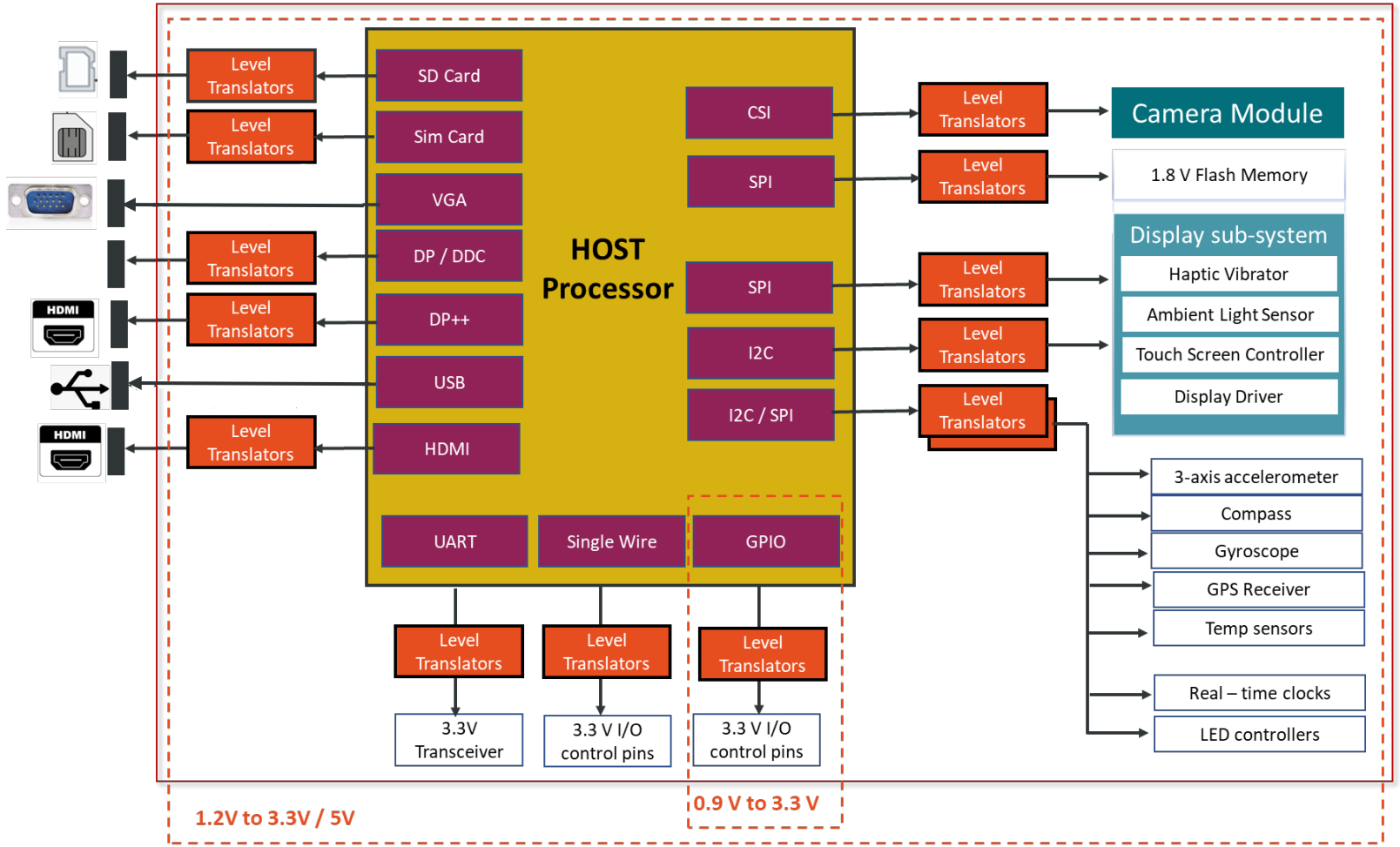


Mobile Computing

Industrial

Translator Interface Examples

Portable electronics Block diagram



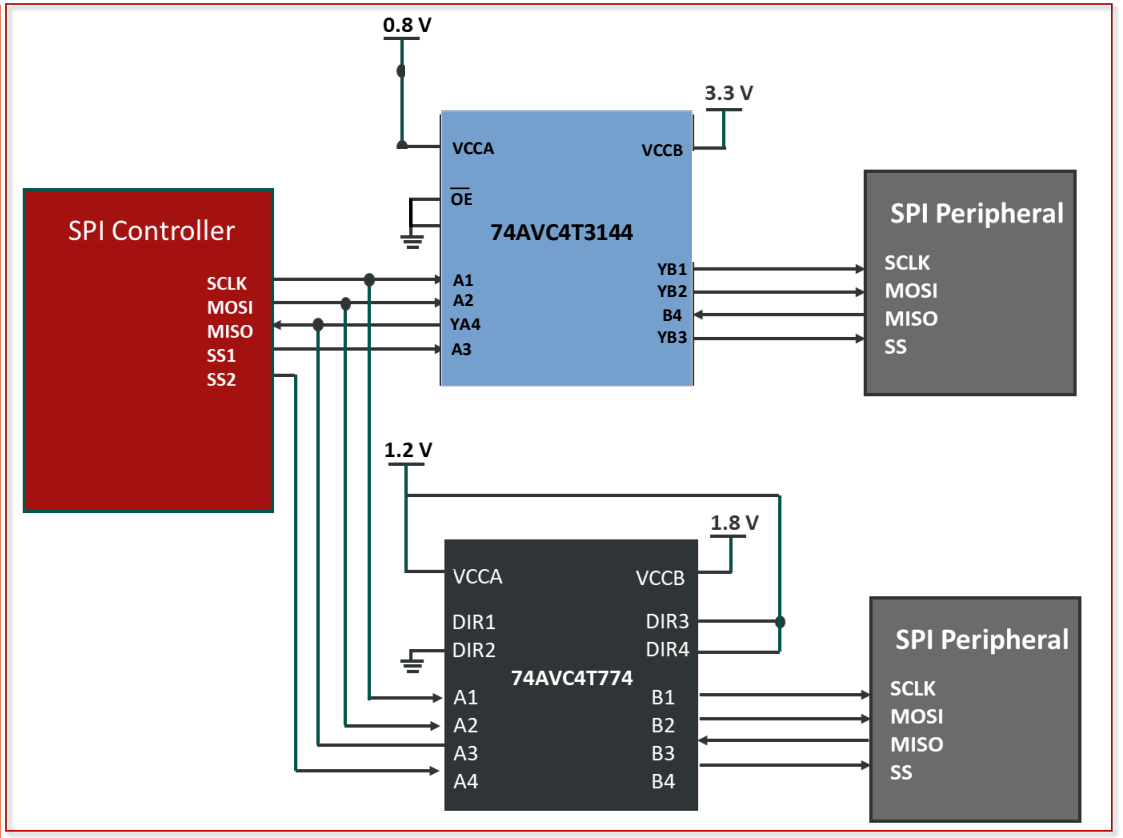
Supply voltage trend

5.0V → 3.3V → 1.8V → 1.2V → 0.9V

Common Interfaces for Voltage Translators

Serial Peripheral interface (SPI)

- Commonly used interface due to its simplicity
- Simple protocol provides synchronous communication between processor and peripherals
- An interface that can accommodate multiple independent peripherals operating under same master
- Applications
  - Control Signals
  - Sensors
  - Memory
  - LCD display
  - Automotive head unit
  - Smart speaker / display

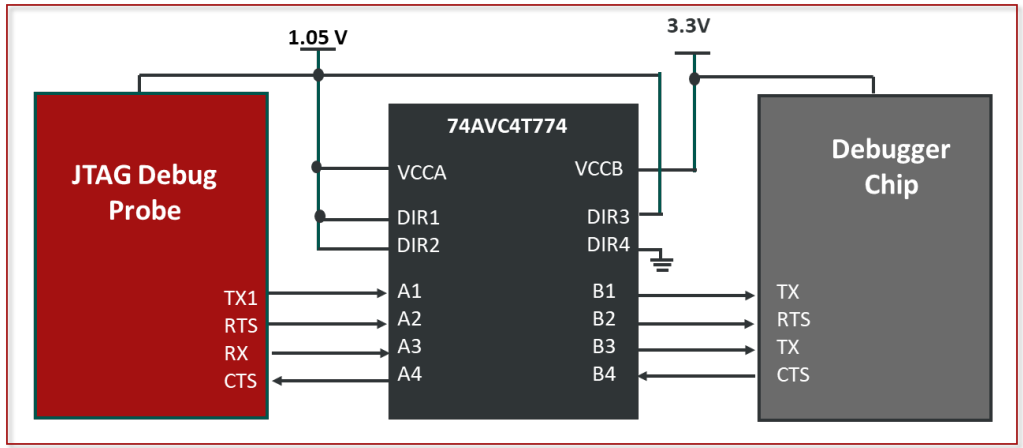


SPI interface using 74AVC4T3144 and 74AVC4T774 translators

Common Interfaces for Voltage Translators

Joint Test Action Group (JTAG)

- Hardware interface allows debugging, testing, verification and programming of embedded designs.
- JTAG is similar to SPI
- Applications:
    - Enterprise computing (JTAG headers are found in RACK servers
    - Microprocessors

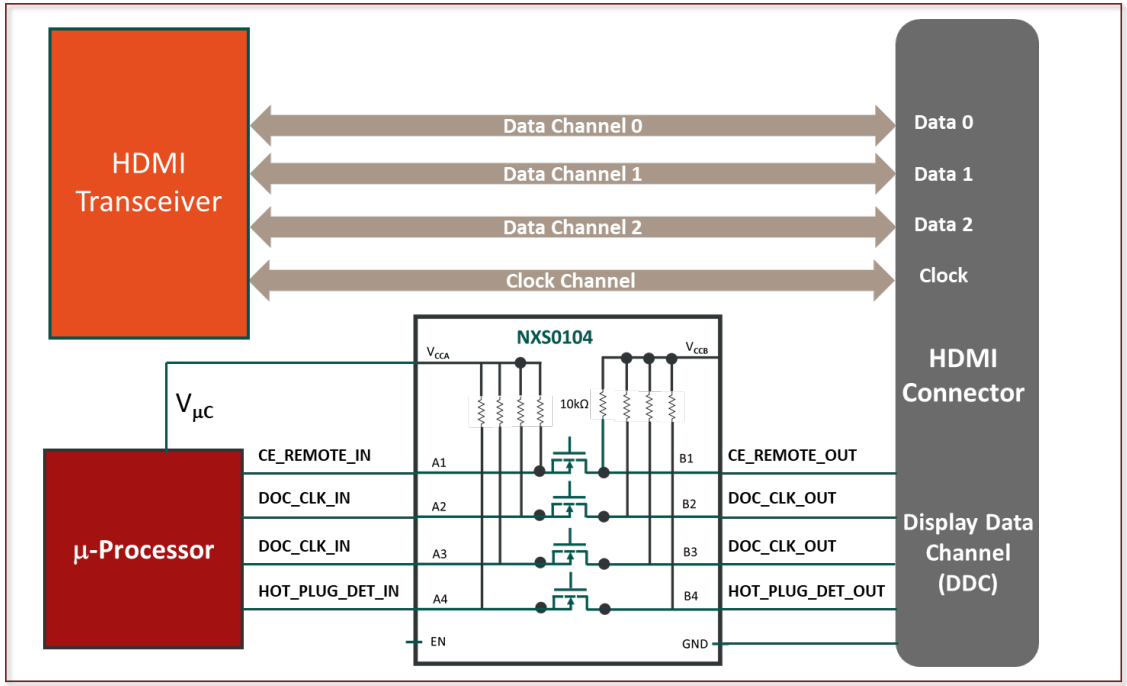


JTAG Voltage Translation Using 74AVC4T774

Common Interfaces for Voltage Translators

High-Definition Multimedia Interface (HDMI)

- Popular communication protocol used to transmit digital audio video signals
- Used to shift voltages of 4 signal line DDC
- Applications:
  - Set top boxes
  - HD televisions
  - Home theaters
  - Audio systems,
  - Display monitors

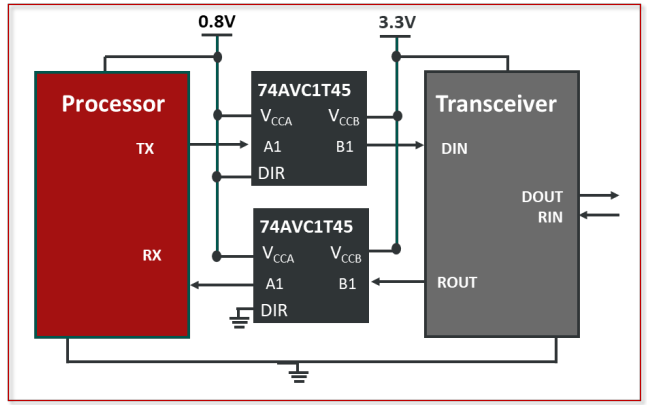


DDC channel uses the I2C protocol to communicate information such as the graphics modes that a monitor can support

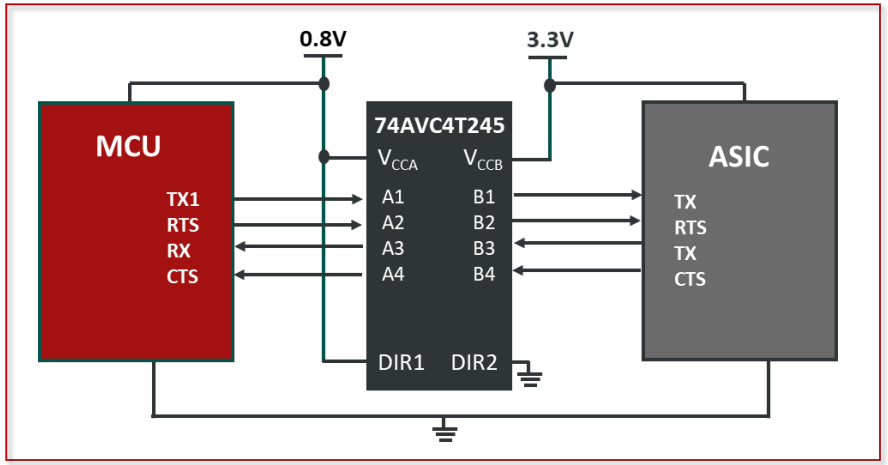
Common Interfaces for Voltage Translators

Universal Asynchronous Receiver / Transmitter (UART)

- UART hardware is found on nearly every processor.
- Hardware device that enables 2 or 4 signal asynchronous full duplex communication interfaces
- Responsible for converting parallel data to serial for transmission and vice-versa for receiving
- Applications
  - ADAS Surround view system ECU
  - ADAS domain controller
  - RRU
  - PLC controller module (UART interface between FPGA and ASIC



2-wire UART interface voltage translation using 74AVC1T45

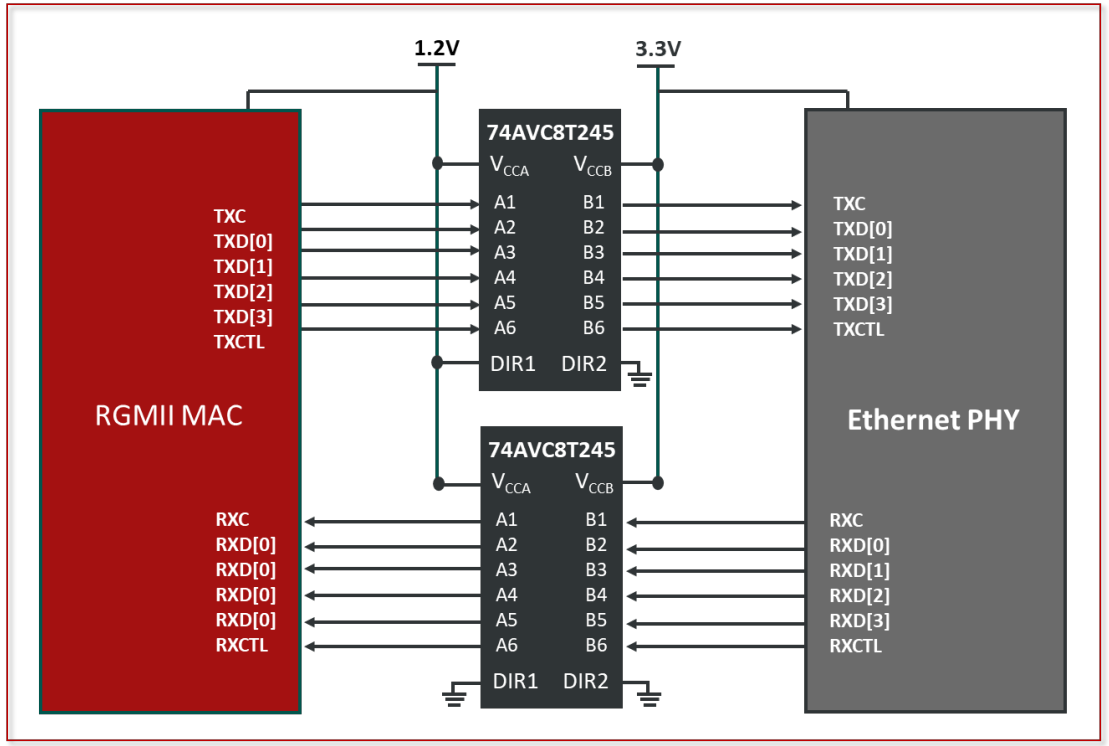


4-wire UART interface voltage translation using 74AVC4T245

Common Interfaces for Voltage Translators

Reduced Gigabit Media Independent Interface (RGMII)

- High speed interface to connect Media access control (MAC) to an Ethernet physical layer chip (PHY)
- Widely used communication protocol in industrial and telecommunication sectors
- Multiple applications that sends large data over ethernet
- Application has large bandwidth due to its very high-speed requirement
- Application examples
  - IP network cameras
  - ADAS / Autopilot

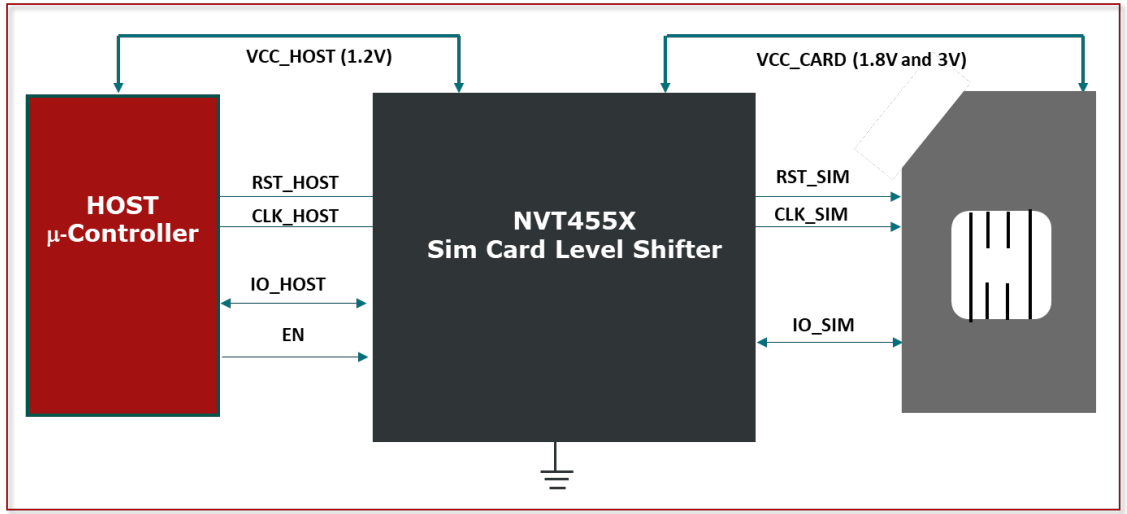


RGMII Voltage Translation Using 74AVC8T245

Common Interfaces for Voltage Translators

SIM Card Interface

- NVT455X used to interface a baseband processor and Sim Cards
- Complies with EMI and ESD requirement
- Shut-down sequence handled according to ISO7816-3
- Very low propagation delays on all channel
- VCC_SIM drop detection mechanism to compensate LDO
- Higher data rates
- Available in a tiny WLCSP package and XQFN package
  - Smartphones and Tablets
  - Car infotainment systems
  - Wireless modems

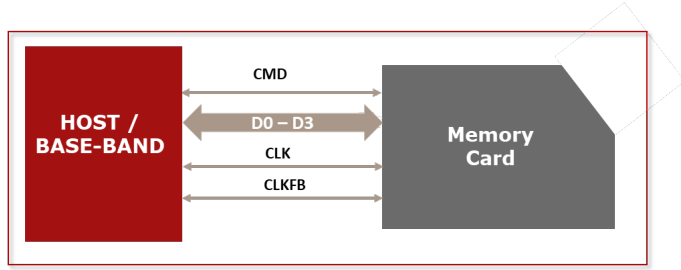


NXS0506 - Translator for the use of Sim Card Level Translator

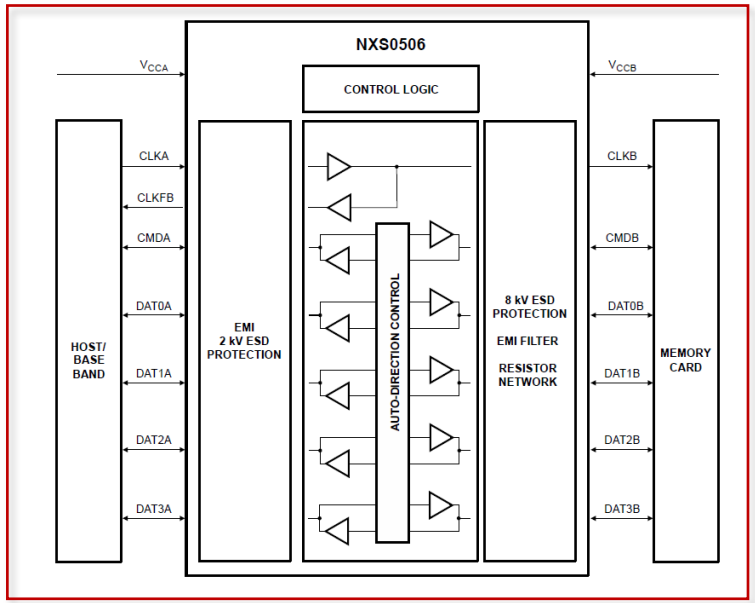
Common Interfaces for Voltage Translators

SD Card Interface

- SDIO cards are commonly used in portable products
- Nexperia's NXS0506 provides SD card interface for faster data storage
  - Supports up to 208MHz clock rate
  - IEC 61000-4-2, level 4 on the card side
  - Eliminated external components
  - No LDO required
- Applications
  - Smartphones, Mobile Handsets
  - Digital Cameras
  - SD, MMC or microSD card readers
  - Car Infotainment Systems
  - Tablet PCs
  - Laptop computers



SD Card Interface



NXS0506 - Translator for the use of SD Card Level Translator

Selection of Voltage Translator

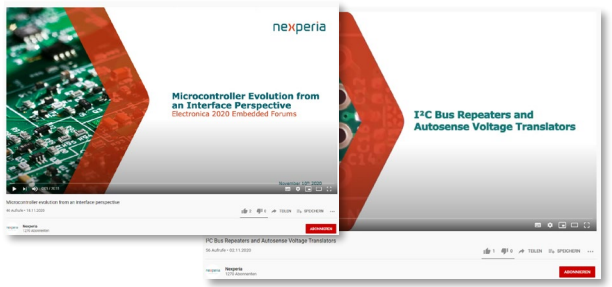
- Understand the need for "**LOW to HIGH**" or "**HIGH to LOW**" voltage translation application
- Determine the number of channels or bits required
- Find out the direction of data flow between driver and receiver, it can also be bidirectional voltage translation
- Determine the required drive capability (sourcing current), V_{OH}, V_{OL}, V_{CCA}, V_{CCB} and propagation delay
- For "**HIGH to LOW**" voltage translation, choose a device with over-voltage tolerant inputs (For interfacing with voltages far in excess of typical logic families (i.e. 5V) choose devices with input clamping diodes and use current limiting resistors)
- For "**LOW to HIGH**" voltage translation, choose a device with low-threshold inputs or open drain outputs
- For Bidirectional or low power Unidirectional data flow with H-L and L-H voltage translation, choose a dual supply translator.
- What kind of signals run between the different devices ?

Voltage Translators | Support Material

Extensive information and support available on Nexperia.com

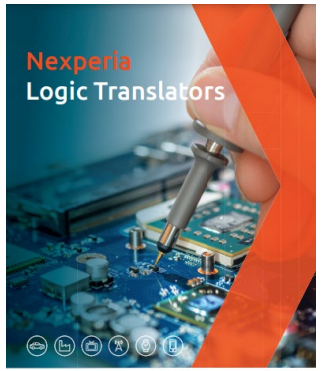
Leaflets

Youtube Videos

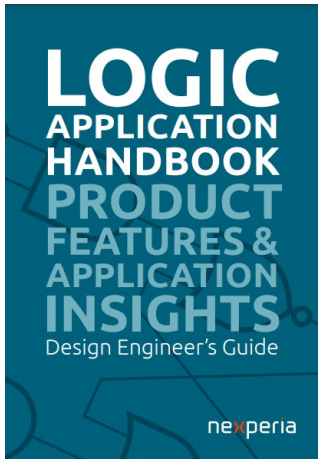


External webinars (recordings are available)

Translator Guide



Logic Applications Handbook



If you'd like to receive a free hardcopy of the Logic Application Handbook, please leave your shipping details in the questionnarie form after this webinar

Summary

- Low to High and High to Low voltage translation is required between driver and receiver devices in mixed supply voltage systems
- Features in standard logic that supports voltage translation are overvoltage tolerant inputs, low-threshold inputs, clamping diodes at inputs and open drain outputs
- In addition to voltage translation feature in standard logic, NEXPERIA also offers dedicated dual supply, uni-directional and bi-directional voltage translators
- Availability of a large portfolio of voltage translators in different families with different electrical specifications, provides greater design flexibility
- Dedicated translators are available in innovative leadless packages such as MicroPak and DQFN for space critical applications
- The complete NEXPERIA voltage level translator portfolio can be found at Nexperia website CLICK ME

June 1st, 2022 – 10am EDT / 4pm CET - Part 2

- Specific applications and discussion of translator selection
- Special autosense translator scenarios

Register via email or here

Q&A