nexperia

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

Part 2: Application Examples

June 2022 •

Agenda

Part 1

Technical Requirements

The need for translators

Types of translators

Product Portfolio

Common Interfaces for translators

Link to recorded session:

Part 2

Applications

Specific applications and translator solutions

- The Translator Toolbox
- Translator solutions from actual designs

Special application information

- Autosense translator with push-pull outputs
- Design flexibility with LSF translators
- LSF pullup-up supply case
- NXB with open drain receiver

More resources

01

The Translator Toolbox

Voltage Translators | Decision tree

How to select the right Translator type

Voltage Level Translation | Basics

Translation Requirements

Translator Type

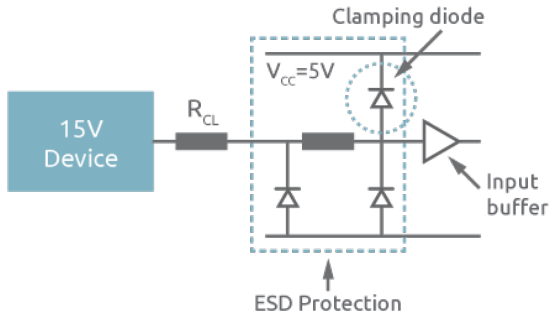
Common Product families

Translation from LOW to HIGH or HIGH to LOW

- Data transmission in **ONE** way → 1 **Uni-Directional** — All logic families
- Data transmission and reception → 2 **Bi-directional | AutoSense** — NXS, NXB, LSF
- Auto direction sensing (no direction control signal needed) → 2 **Bi-directional | AutoSense** — NXS, NXB, LSF
- One or more direction control pin(s) → 3 **Bi-directional | Direction controlled** — AVC, LVC, ALVC, AXP
- Translation combined with gate function → 4 **Translator gate** — LV1T, AUP1T
- Interface between SIM/SD and HOST → **Application specific translators: Sim Card or SD Card Translator** — NXT455xx, NXS0506

Standard Logic Translators

Embedded Translation



Clamp diode inputs

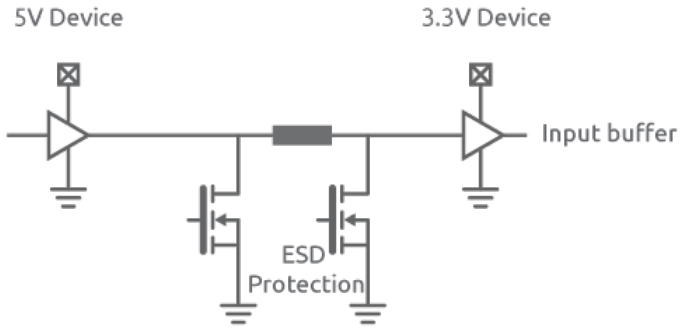
Advantage:
- Can be used to interface any voltage

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}

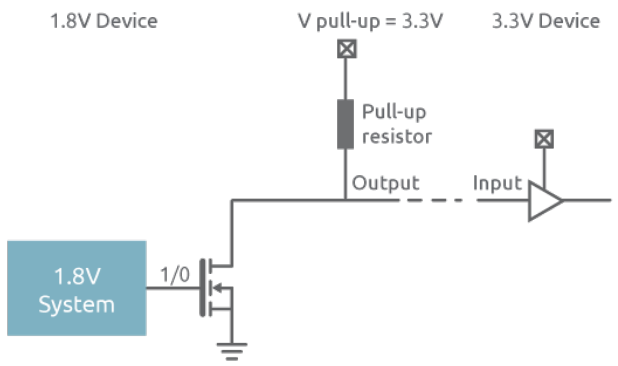
Available Families

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

* Non bus-hold only

Logic Translators Techniques

Embedded Translation (cont.)



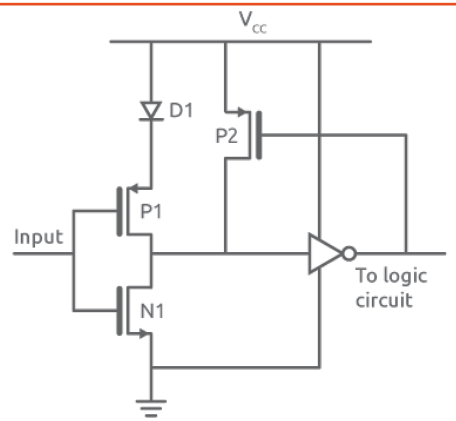
Open-drain outputs

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

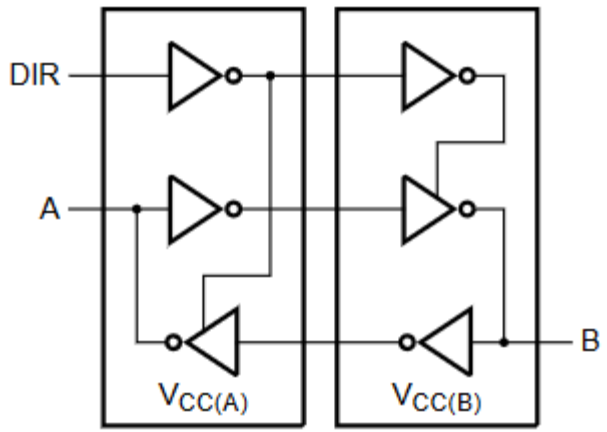
Disadvantage:
- High power dissipation due to ΔI_{CC}

Available Families

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

Logic Translators Techniques

Transceivers



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:

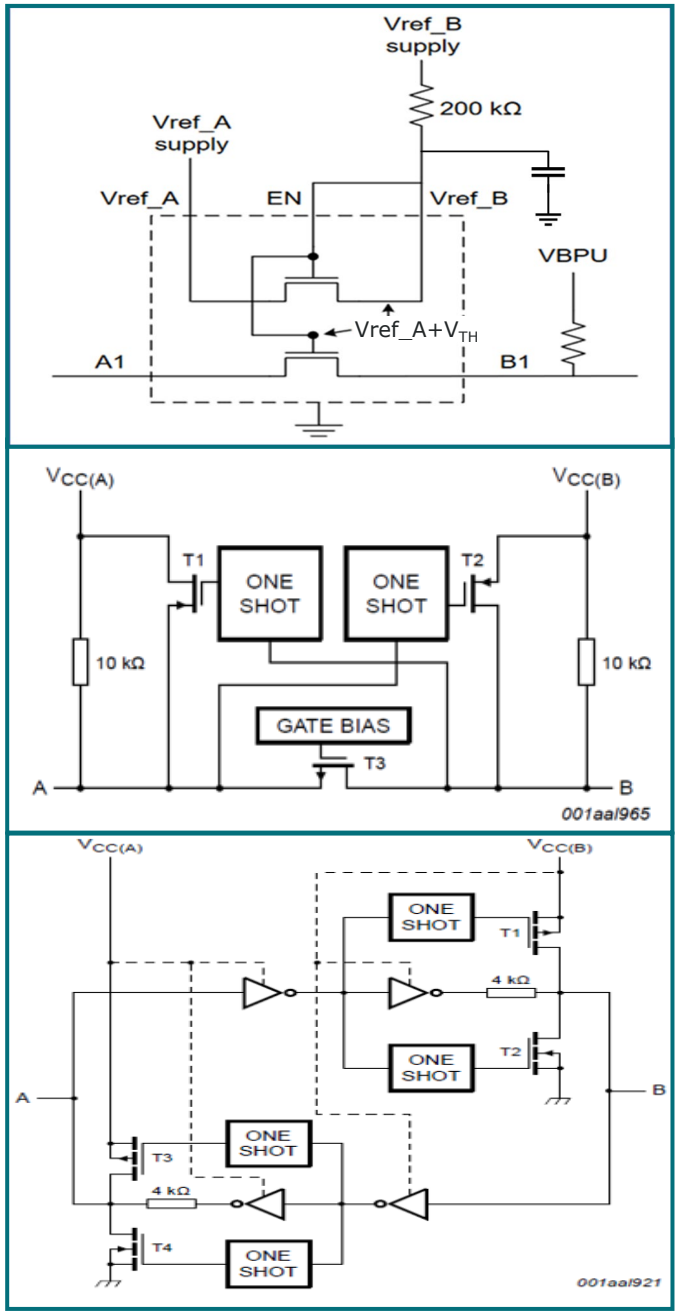
- Requires dual supply
- Requires direction pin

Autosense Translators

3 variants

- LSF:
  - pass transistor per channel
  - external pull-up resistors and voltage supply
- NXS:
  - pass transistor with one-shot accelerator for rising edge only
  - internal pull-up circuit
- NXB:
  - push-pull circuit
  - one-shot accelerators for both rising and falling edges

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



02

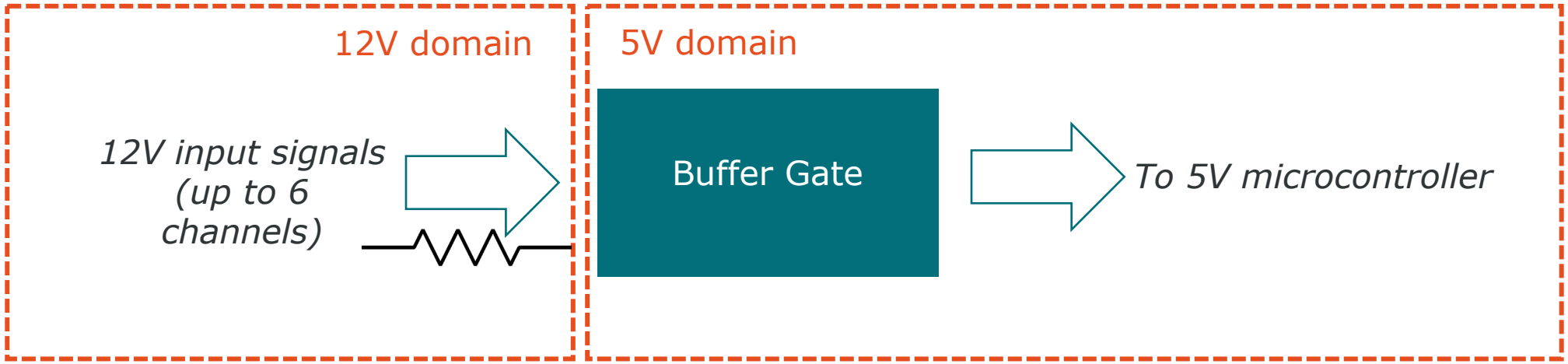
Applications Solutions

- From actual designs

Translator Example 1:

Application: Garden Tractor control panel

Design Issue: 12V status signals from engine to interface to (old) 5V microcontroller



HEF4050 or 74HC4050 (hex buffer) device

0<Vin<15V

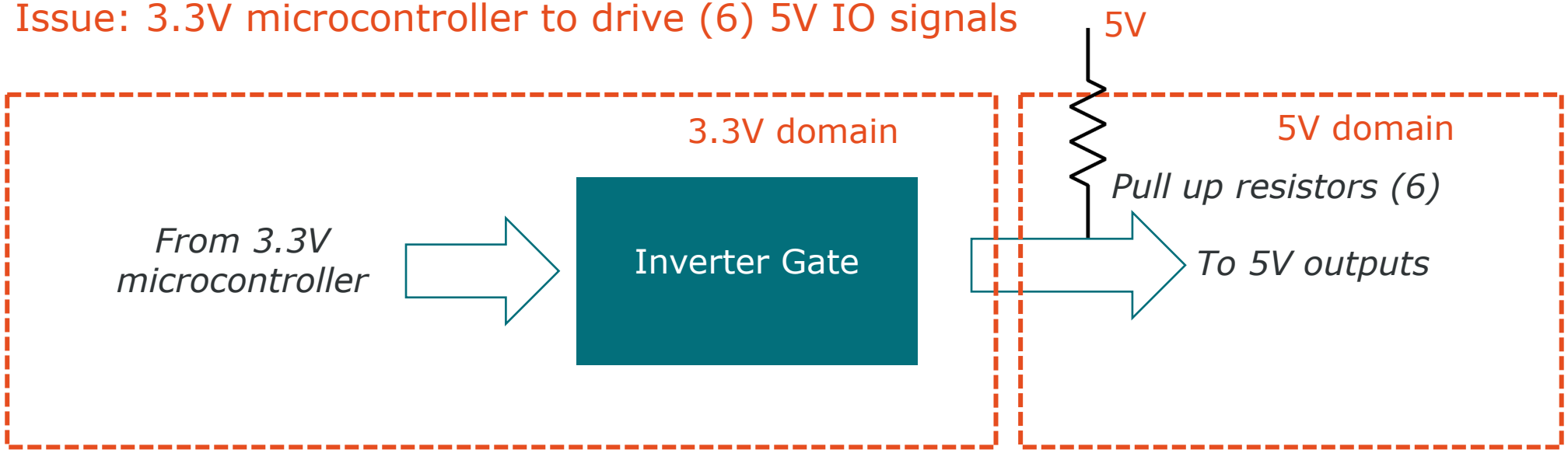
Must limit input current to <10mA

(700 ohm)

Translator Example 2

Application: Industrial controller

Design Issue: 3.3V microcontroller to drive (6) 5V IO signals



74LVC06

(hex inverter open drain)

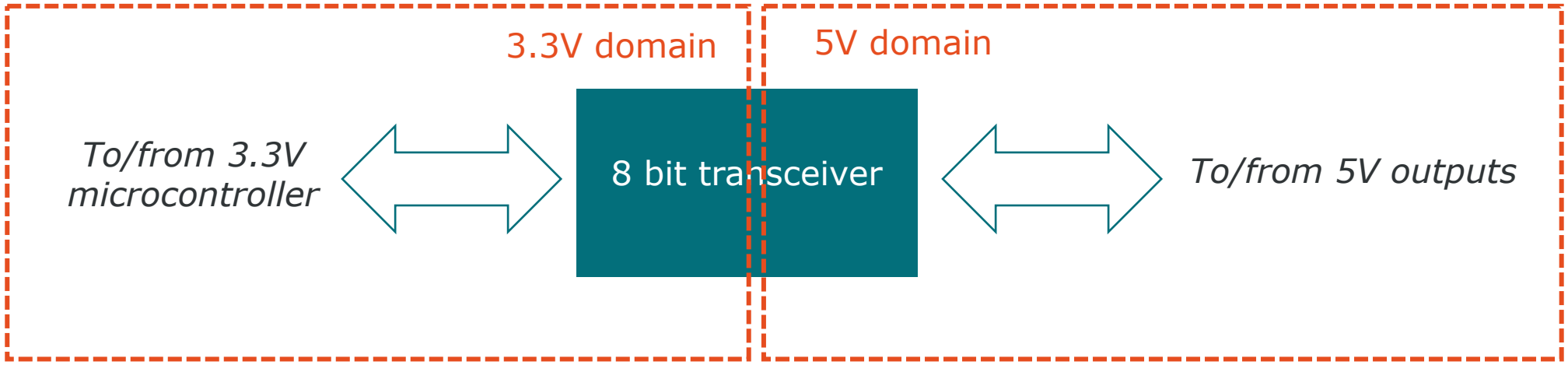
0<Vin<5.5V

0<Vout<5.5V

Translator Example 2 (advanced solution)

Application: Industrial controller

Design Issue: 3.3V microcontroller to drive (6) 5V IO signals *bidirectional*



74LVC8T245

(dual supply transceiver)

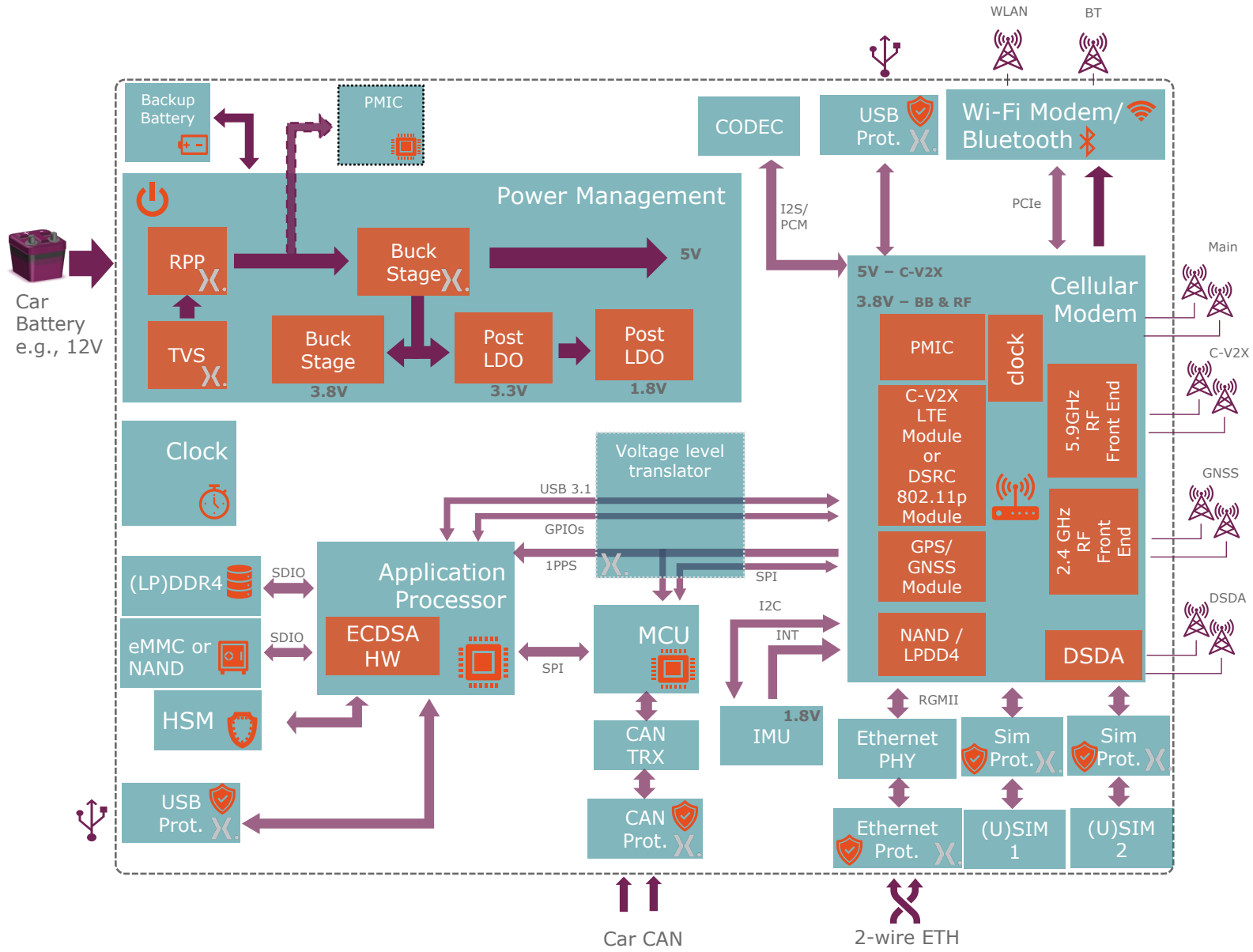
For bidirectional data

Translator Example 3

Application: Automotive Telematics Control Unit

- Central communication hub for automotive applications. Interfaces to car ECU via CA
- SIM card for cellular communications
- SD card for user configuration data
- Cellular modem at 5V, CPU and Applications Processor at 3.3V or lower
- RGMII (Reduced Gigabit Media Independent Interface) at 2.5V or 1.5V

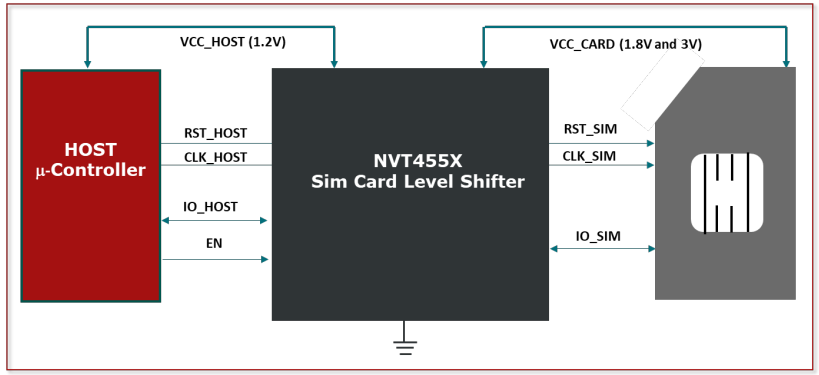
Four translator solutions needed

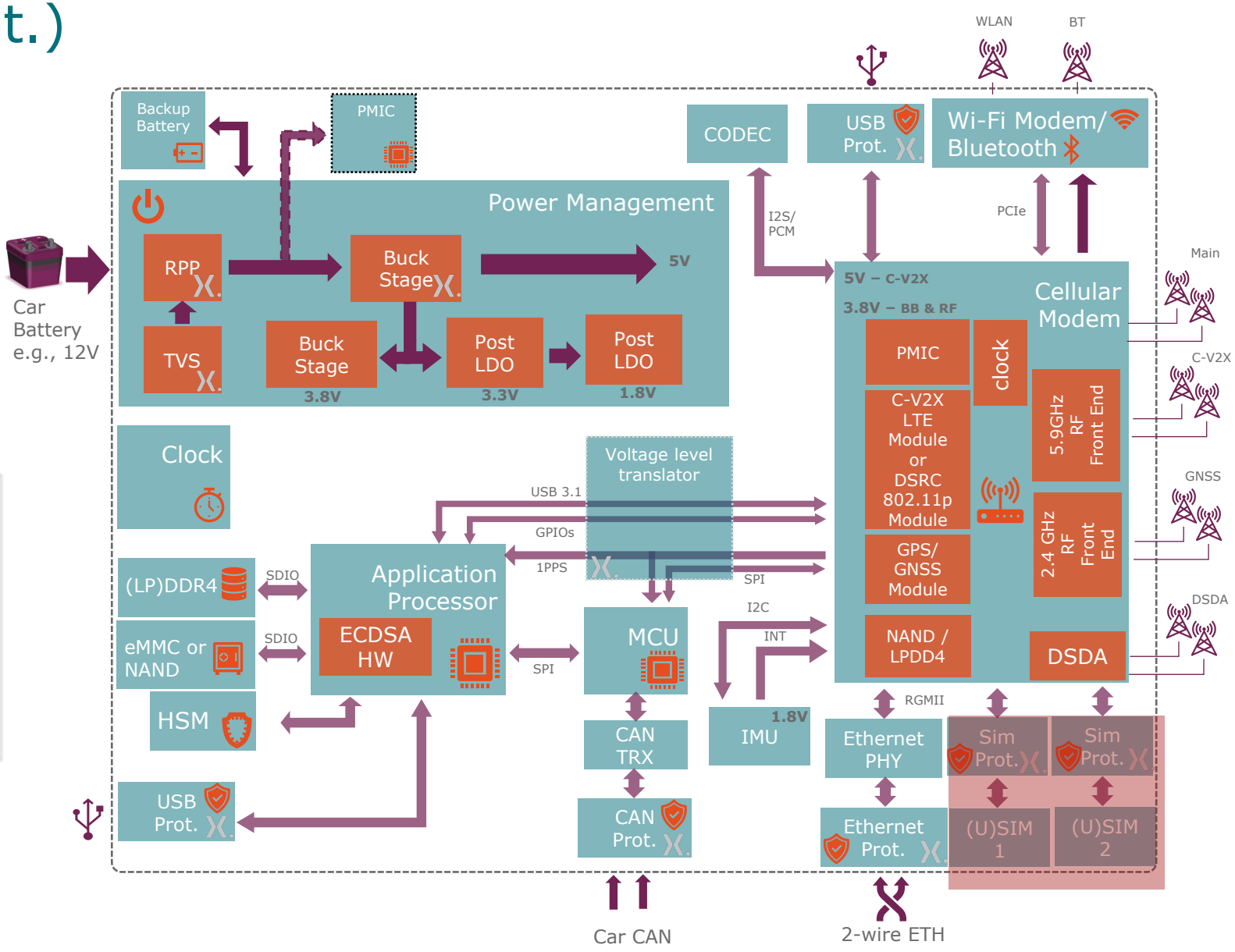


Translator Example 3 (cont.)

Application: Automotive Telematics Control Unit

- **Sim Card Translator**
  - NXT4556 – 10 pin XQFN
  - NXT4557 – 9 ball WLCSP

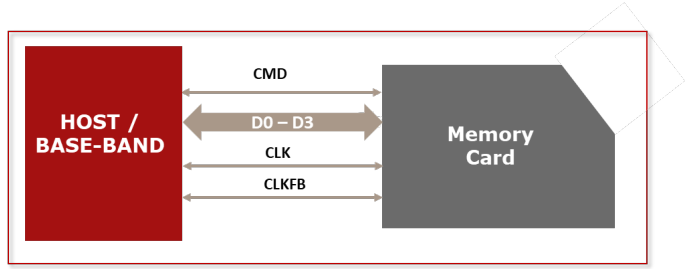


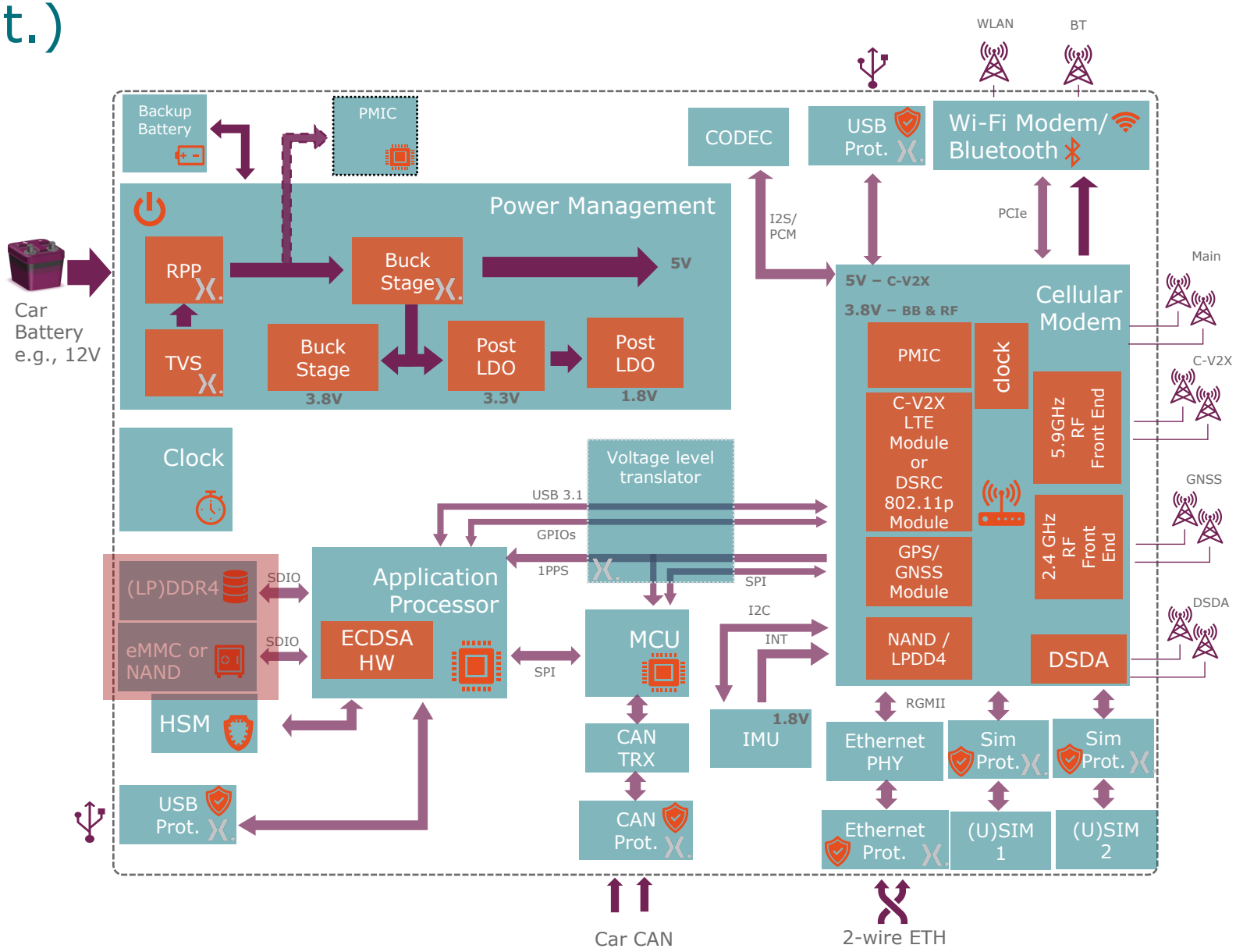


Translator Example 3 (cont.)

Application: Automotive Telematics Control Unit

- **SD Card Translator**
  - NXS0506 – 16 – ball WLCSP

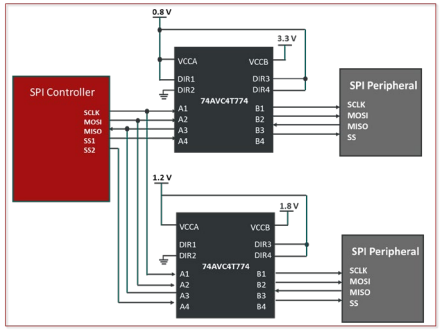


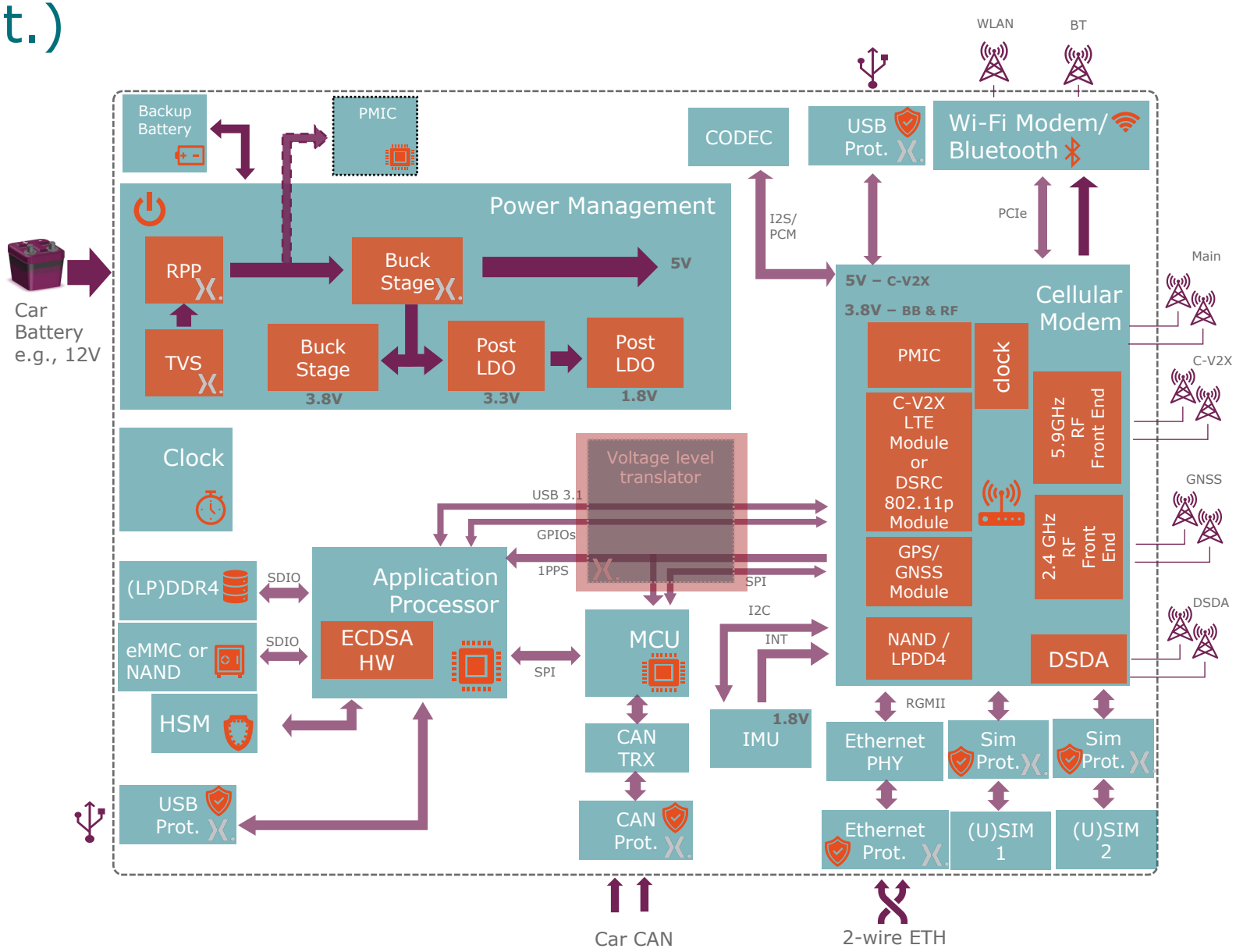


Translator Example 3 (cont.)

Application: Automotive Telematics Control Unit

- **Autosense Translator**
  - NXS010x Family
  - NXB010x Family
  - LSF010x Family
  - 74AVC4T3144
  - 74AVC4T774

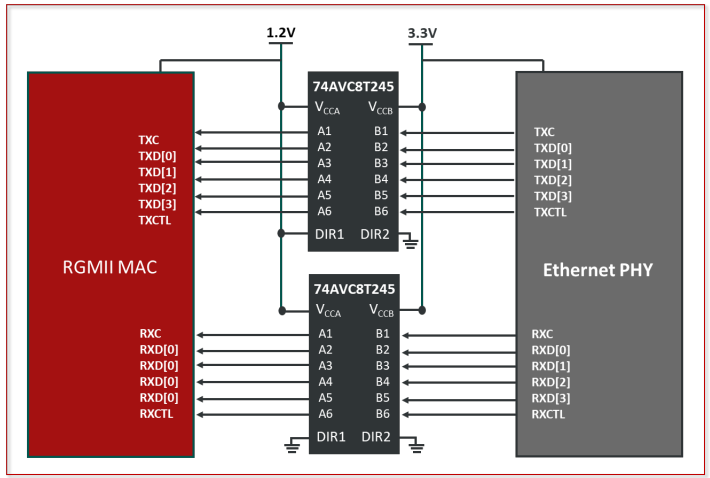




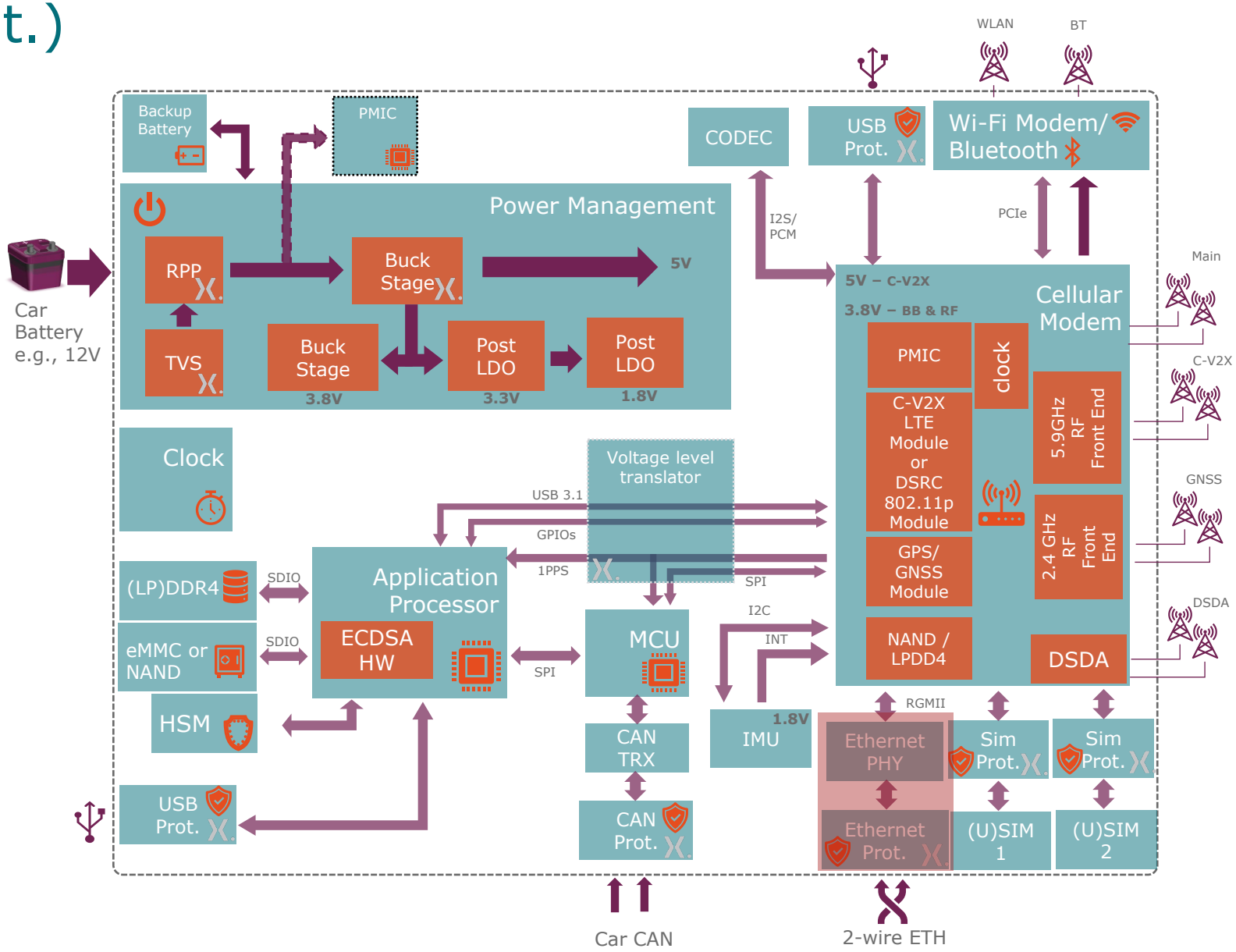
Translator Example 3 (cont.)

Application: Automotive Telematics Control Unit

- **Translator for RGMII protocol**
  - 74AVC8T245 in BQ and PW

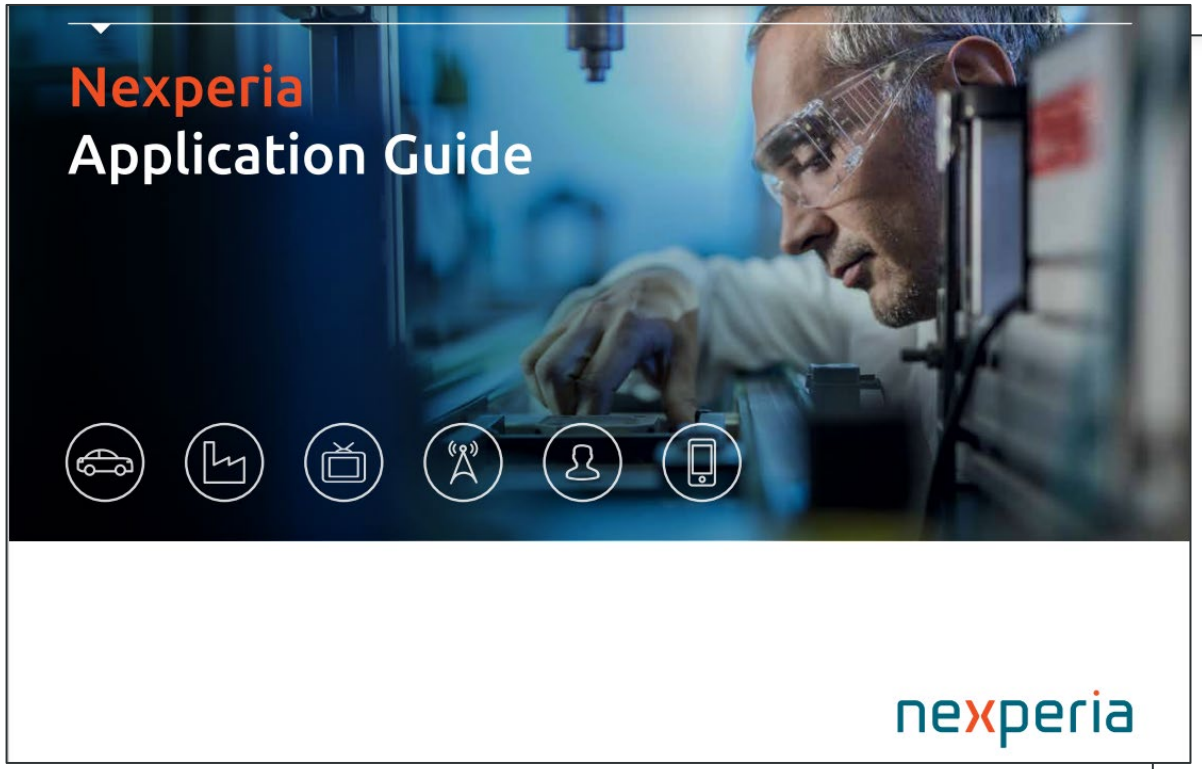


RGMII Voltage Translation Using 74AVC8T245



More Customer Applications/Solutions?

Request a copy of our Nexperia Applications Guide:



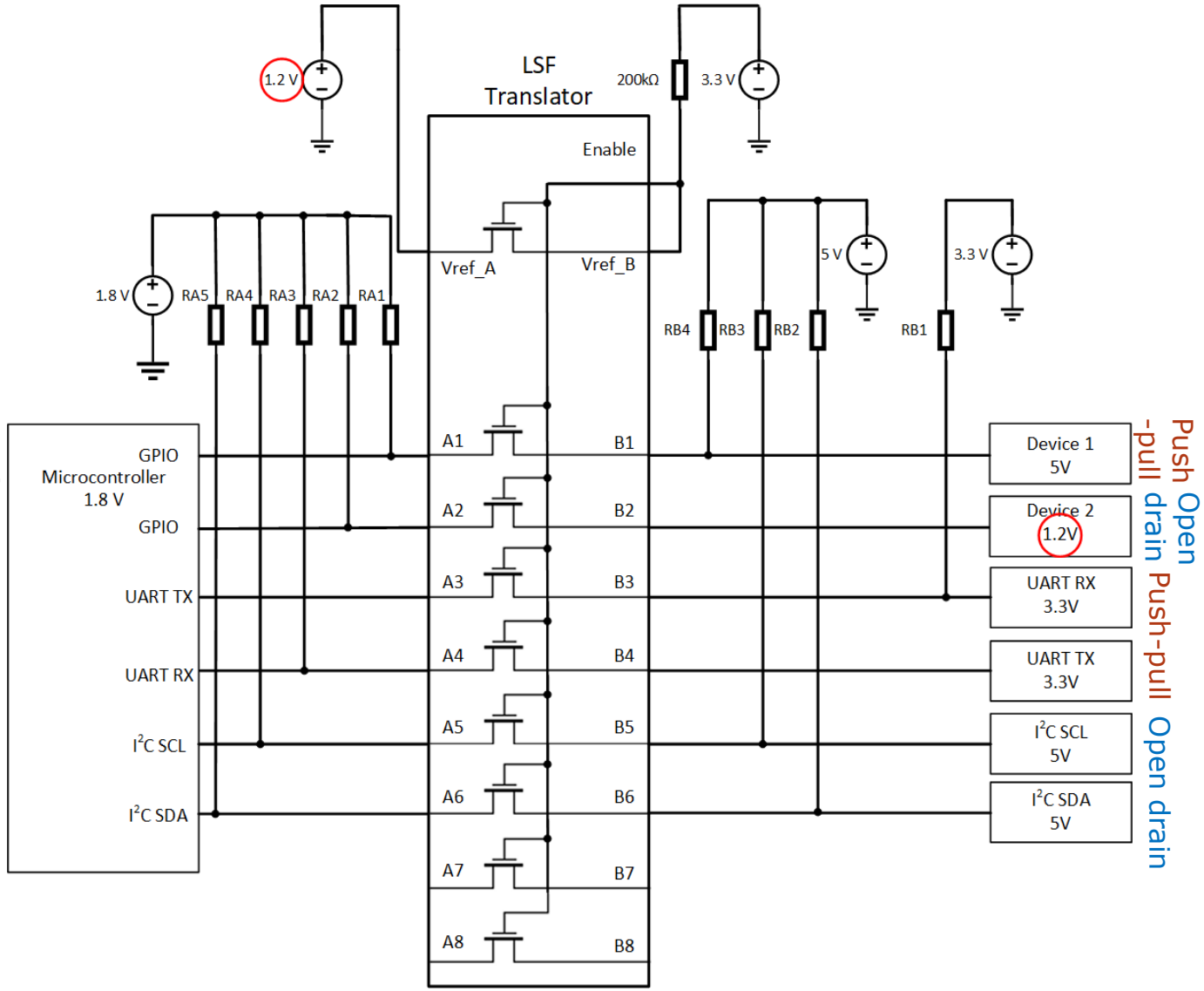
Contents

03

Special Application use cases

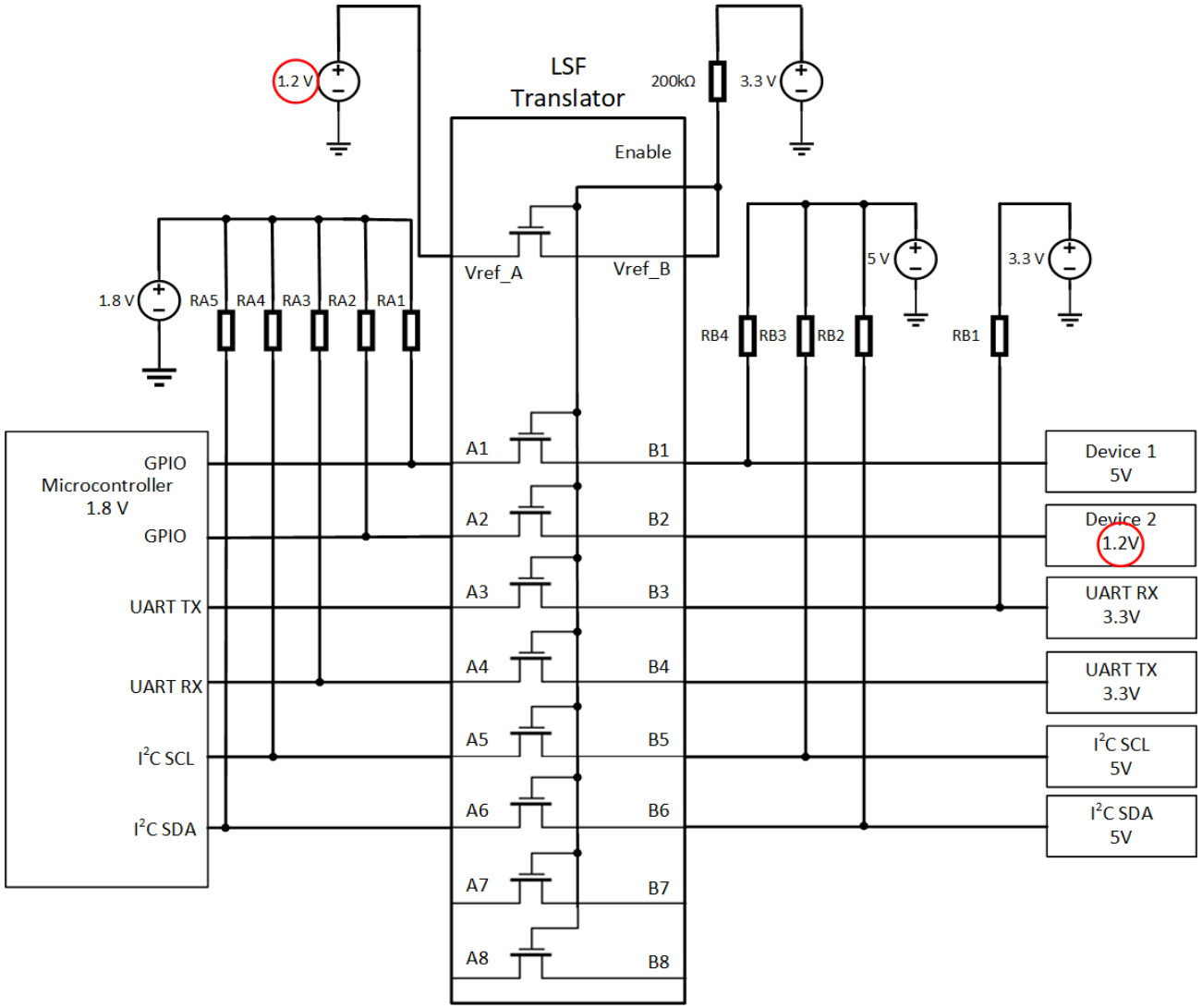
Design flexibility with LSF

- Example case showing an LSF0108 translating between a Microcontroller and various devices
- Interface topologies can be
  - push-pull (UART, Device 1)
    - pull-up needed for the receiver
    - Fix direction or direction control needed to avoid high/low driver conflict, no pull-up for the driver
  - open-drain (I2C, Device 2)
    - Pull-ups needed on both sides
    - No direction control needed, full autosense flexibility



Design flexibility with LSF

- Various voltage levels:
  - Different voltage levels possible
  - Independent pull-up voltage configuration per channel
  - Vref_A must be the lowest voltage in the system
  - Supply of Device 2 is the same as Vref_A, therefore no pull-up needed for the receiver

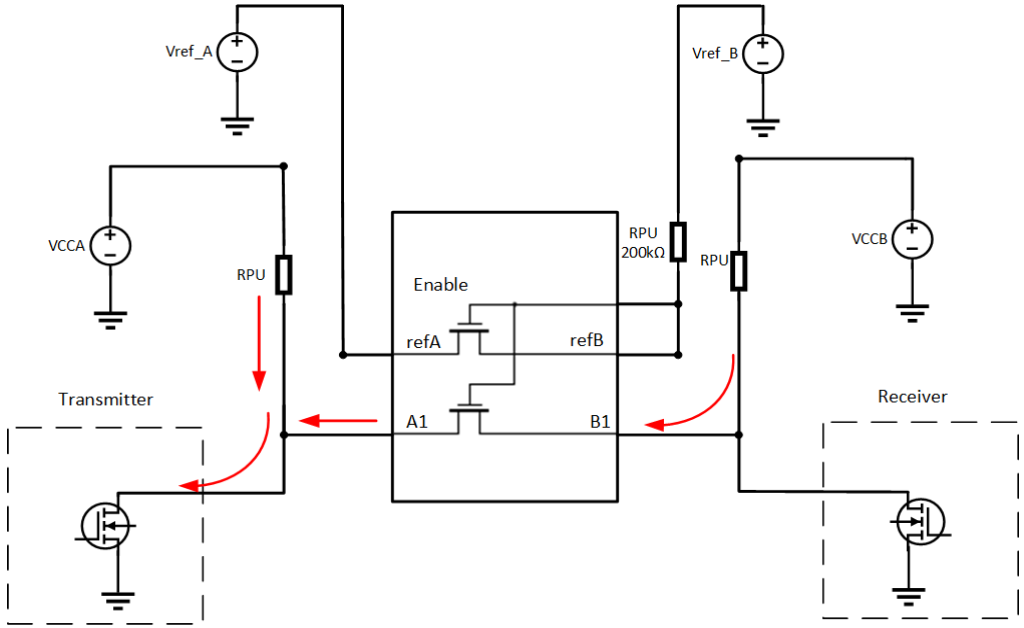


Autosense translator LSF: Open-Drain vs. Push-Pull interfaces

- Scenario of a LSF translator with open-drain devices
- LSF has no driving capability => external pull-up Resistors are needed for transmitter and receiver
- Pull-up resistors can be calculated:

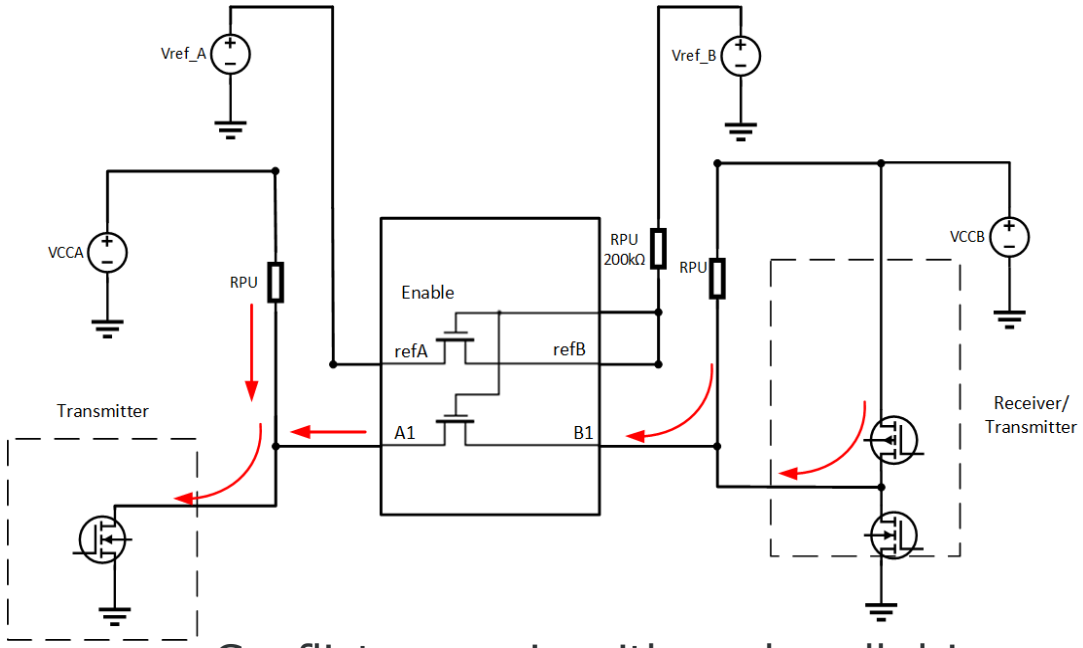
$$\mathrm{RPU} = \frac{VCC_{\mathrm{B}} + VCC_{A} - 2\mathrm{VIL}}{\mathrm{I/O}}$$

- Typical value range is ~0.6 – 4kΩ
- Maximum current scenario:
  - Transmitter is driving a low level
  - continuous current through the pass transistor
  - Current rate ~ 1-8mA



Autosense translator LSF: Push-Pull vs. open-drain interfaces

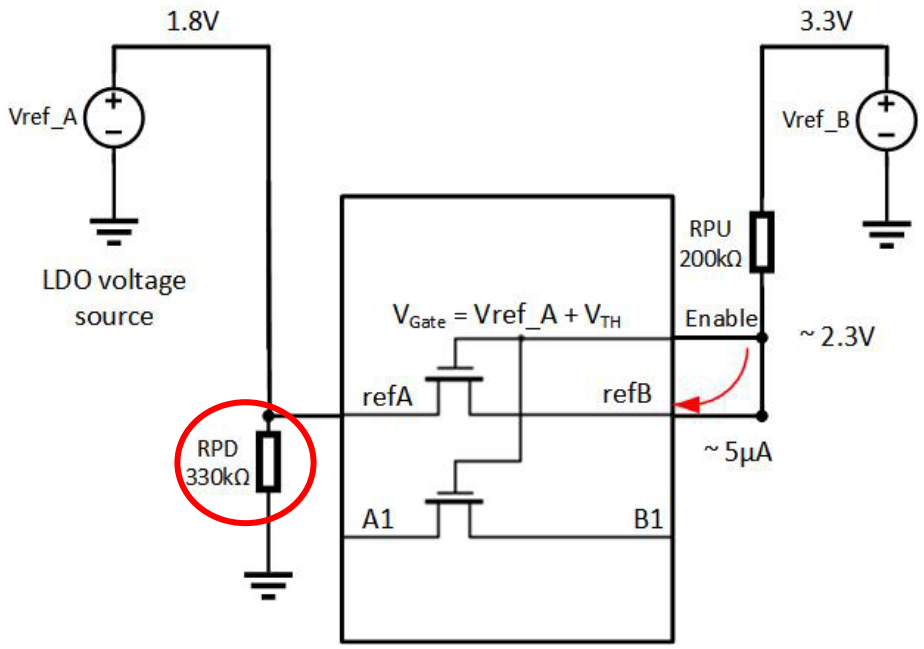
- Scenario of a LSF translator with push-pull participant
- LSF has no driving capability => an extra pull-up Resistor is needed at the input of the receiver
- In case of bidirectional data flow, a conflict can occur: both participants are driving, one is driving high, the other is driving low
  - A push-pull driver is driving with the high-side PMOS transistor, typically with RDSon of ~50-100Ω
  - Resulting in continous current of ~25-50mA per channel (recommended max is 64mA per channel, but the high current is inefficient and not desired)
- Best to have fixed direction when using LSF for push-pull devices



Conflict scenario with push-pull driver

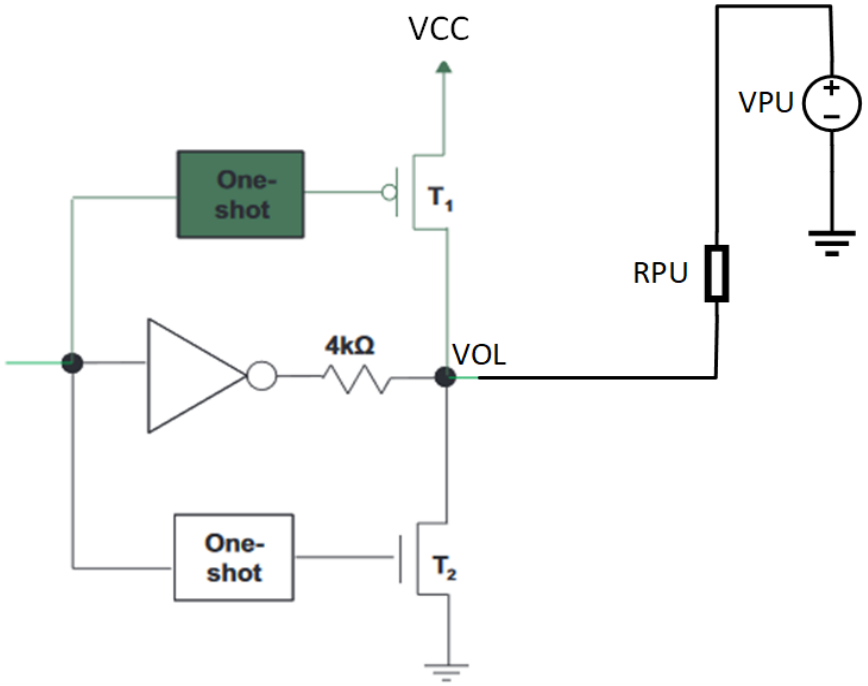
LSF pull-up supply case

- The reference channel is controlling the gate voltages for all translation channels
- Due to 200kΩ resistance between Enable and V_{ref_B}:
  - $V_{Gate} = V_{ref\_A} + V_{TH}$
- Voltage source are assumed to be able to sink current if needed
- Simple voltage regulators (LDO) cannot sink current -> resulting in increased voltage at Vref_A
- The current flow can be estimated to
  - $(V_{ref\_B} - V_{ref\_A} - V_{TH})/R_{pu} = 5\mu A$
- A possible workaround is a pull-down resistor at Vref_A
  - Resistor value = Vref_A/5µA = 360kΩ



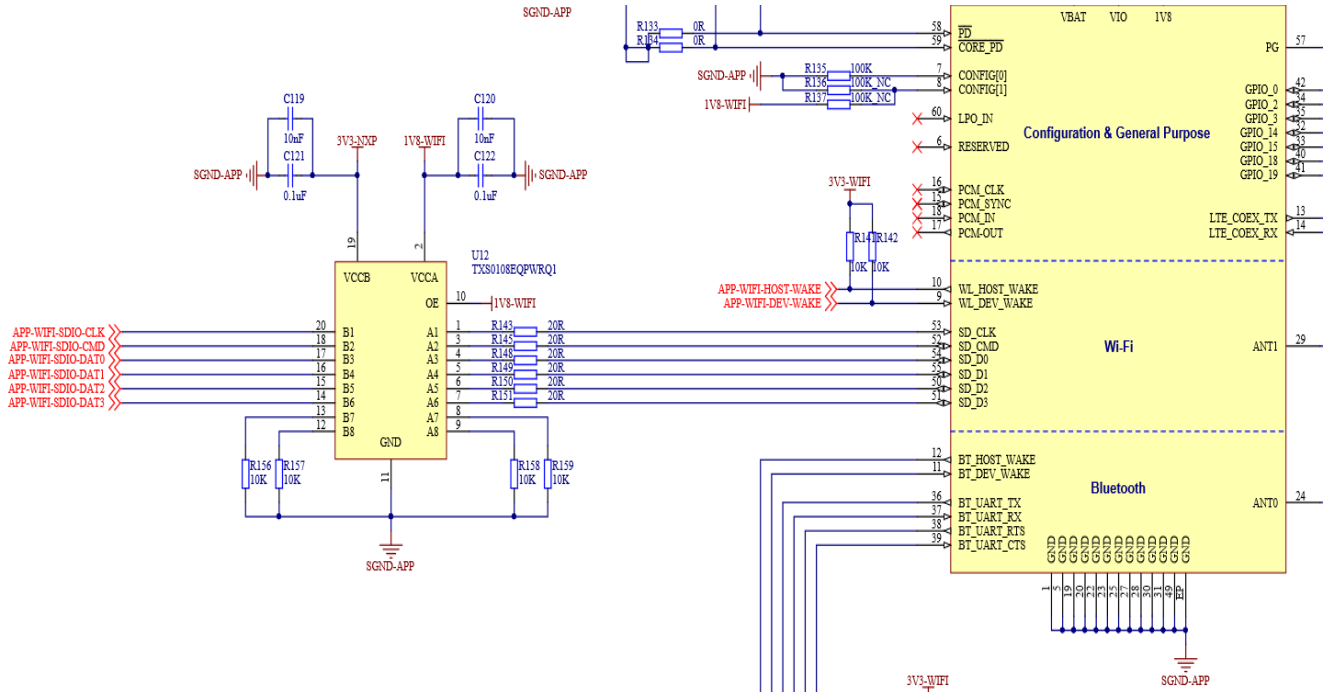
NXB with open drain receiver

- In steady state (high, low), only the buffer via 4KΩ is driving the load, one-shots are off!
- In case of external pull-up or pull-down resistor: Voltage divider network
- Pull-up: $\mathrm{VOL} = \frac{\mathrm{VPU} * 4\mathrm{k}\Omega}{\mathrm{RPU} + 4\mathrm{k}\Omega}$



WIFI module using SD card protocol (SDIO)

- SOCs often use SDIO protocol to interface with WIFI modules
- WIFI speed example 300Mbit/s can be transfered with SD 3.0 mode SDR104 (104 MBytes/s) @208MHz clock
- Translation Solutions:
- SD card translator NXS0506 -> dedicated solution, supports SD3.0 protocol mode
- NXS0108 8-bit translator (the pull-down resistors in the block diagram can be omitted for unused inputs at NXS)

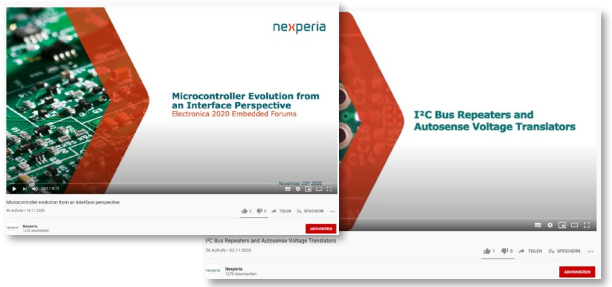


Voltage Translators | Support Material

Extensive information and support available on Nexperia.com

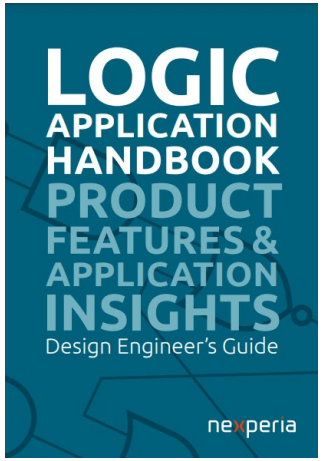
Leaflets

Youtube Videos



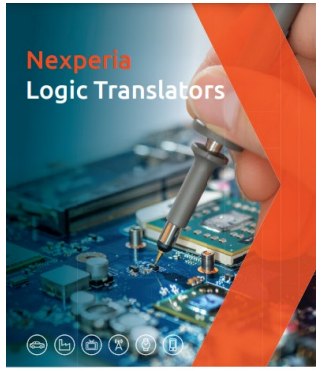
External webinars (recordings are available)

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

Translator Guide



Q&A