

Enabling Next-Generation Processors, FPGAs, and ASSPs with Voltage Level Translation

AND90419/D

Overview

Electronic systems across industrial, communications, enterprise, personal electronics, and automotive segments continue to demand higher integration, lower power, and seamless connectivity. These trends are pushing electronic system architectures toward advanced processors, microcontrollers, FPGAs, and application-specific standard products (ASSPs) fabricated on deep-submicron CMOS nodes. As core geometries shrink, processor core voltages

decline, which in turn constrains the maximum I/O voltage those devices can natively support. Meanwhile, many peripheral devices-sensors, optical modules, human-machine interfaces (HMI), and legacy subsystems-remain tied to common I/O rails such as 3.3 V or 5 V. The result is a growing prevalence of I/O-level mismatches between low-voltage processors and higher-voltage peripherals.

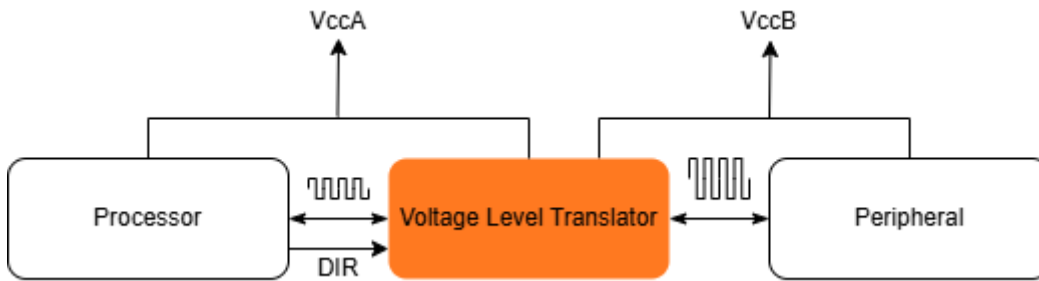


Figure 1. Example Bi-Directional Level Translation

Why Voltage Level Translation Is Now Essential

Modern CMOS process scaling is accompanied by lower core voltage levels as transistor threshold voltages are lower. The corresponding reduction in processor core voltages (and supported I/O levels) creates interoperability challenges across common interfaces-GPIO, I²C, SMBus, MDIO, SPI, UART, I²S, PCM, JTAG, SDIO and many

others. Selecting peripheral devices based on performance criteria such as bandwidth, sensitivity, or drive strength does not guarantee I/O voltage compatibility. Integrated voltage level translators provide an efficient, robust path to bridge these differing domains between processor I/O and peripheral I/O without sacrificing signal integrity, timing, or system reliability.

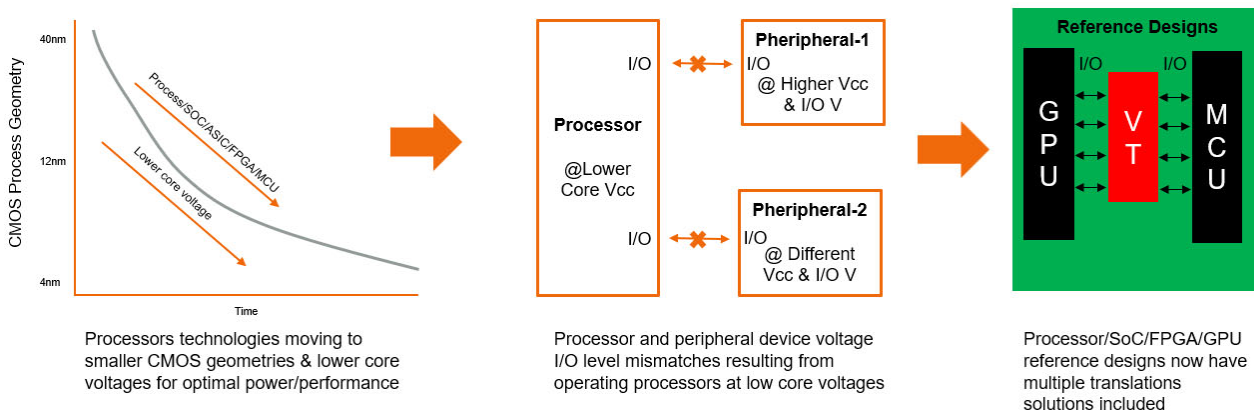


Figure 2. Processor Core Voltage Trend Driven by CMOS Process

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As processors migrate to smaller CMOS process geometries, typical core supplies fall from ~3.3 V toward ~1.0 V, making direct I/O interfacing to 3.3 V or 5 V peripherals impractical without translation. Level translators prevent over-voltage stress and ensure proper VIH/VIL margins across mixed-voltage domains. Integrated level translation devices represent the single best solution for resolving I/O voltage level mismatches. Integrated level translation solutions offer far superior

deterministic signal performance while being power efficient vs discrete solutions of the past. **onsemi**'s portfolio of level translation solutions offers system designers a wide selection of level translation solutions that is capable of resolving almost any I/O level mismatch challenge that a system designer is likely to face. The table below provides a list of **onsemi** level translation devices suited for common interface standards that often need to be level shifted.

Table 1. RECOMMENDED onsemi TRANSLATORS BY INTERFACE

Interface	Up to 3.6 V	Up to 5.5 V
FET Replacement	FXLP34 / NL3V1T244	MC74VHC1G126
1 Bit GPIO / Clock Signal	FXLA101 / NL3V1T244	MC74VHC1G126
2 Bit GPIO	FXL2T245 / NL5X4002	NL5X4002
2-Pin JTAG / UART	FXL2T245	NL5X4002
I ² C / MDIO / SMBus	NLA9306 / FXMA2102 / NL5X4002	NLA9306 / FXMA2102 / NL5X4002
4 Bit GPIO	T30LMXT3V4T245 / FXMAR2104UMX / T30LMXT3V4T244	FXMAR2104
UART	T30LMXT3V4T245 / FXMAR2104	FXMAR2104
SPI	NL3V4T3144/ FXL4TD245 / FXLA0104/NL3X5004	FXMAR2104
JTAG	NL3V4T3144/ FXLA0104 / FXMAR2104	FXMAR2104
I ² S / PCM	NL3V4T3144/ FXMAR2104	FXMAR2104
Quad-SPI	FXL2SD106	NA
SIM	FXLP4555	NA
8 Bit GPIO	FXL4245 / FXLH42245	74LVX4245 / 74LVX3245

onsemi Portfolio Highlights

onsemi offers a broad range of level translators spanning autosensing, bidirectional direction controlled, and fixed direction level translation devices for open-drain buses and push-pull interfaces ranging from 1-bit to 16-bit. Translation devices are available in dual-supply and single supply options. The vast majority of **onsemi** level translation devices are multi-source, meaning that they

follow industry footprint, package and pin-outs making them drop-in compatible with level translation solutions from other vendors. **onsemi**'s level translation portfolio offers industry leading specifications such as low active and quiescent power dissipation, great signal integrity and ease of use. For more information on **onsemi**'s voltage level translators, please visit [onsemi's translation landing page](http://www.onsemi.com) on www.onsemi.com.

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REVISION HISTORY

Revision	Description of Changes	Date
0	Initial document release.	5/12/2026

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