Application Brief

Voltage Level Translation Use Cases for Smart Meters

TEXAS INSTRUMENTS

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The shift from hydrocarbon-based energy sources to renewables is causing an increased dependency on electrification. To support this transition, many infrastructure projects have taken steps to generate more electricity to address the demand. Although this solution can seem rather straightforward, there are also other areas such as energy management that needs improvement as well. The traditional approach is inefficient as it does not allow for proper demand management and conservation. Instead, smart electric meters (SEM) can be implemented to enable more efficient and agile electrical grids.

In the grid infrastructure, SEM allows the supplier companies to manage grids like an intelligent network rather than a set of static meters through the collection of energy data from consumers. The data is used to conduct load profiles at different times, and then establishing those benchmarks/trends for energy usage in the future. SEM also provide benefits to consumers as well by allowing for more insight on energy usage through the use of external peripherals that would not be possible on a traditional electric meter. These insights in-real-time allow the consumer to see energy consumption being used and allows them to make smarter decisions regarding energy usage. Furthermore, SEM systems unlock the potential to allow two-way communication between energy provider and the consumer. With the establishment of this connection with the supplier, the consumer is capable of putting power back into the grid via their own renewable energy sources such as solar panels. For more information regarding solar inverters, see *Enabling Smart Solar Inverter Designs with Level Translation.*

To use smart electric meters to their maximum potential, designers need to make meters more capable by using the latest processor and peripheral circuit technologies. The latest controllers, FPGAs and processors can be used as they operate at low power while still delivering high performance. However, the peripheral devices/sensors remain operating at a higher voltage due to their analog nature, which leads to a mismatch between the two different integrated circuits. This implementation challenge is then faced by system designers as they try to interconnect circuit components that have I/O voltage level mismatches. The control interface cannot simply be connected directly to the data interface due the mis-alignment of logic-levels in voltage. Instead, system designers can turn to level shifters (translators) to match their common voltage levels so that the devices can interpolate as expected. Translators can also be used for power supply isolation and as buffers in applications where increased drive strength is needed.

TI's level-shifting portfolio allows for level translation supporting various interface standards such as SPI, I2C, GPIO, UART and many others while optimizing space, cost and performance. In the smart electric meter reference design shown in Figure 1, the common use cases for level translation are shown. One example shown is between the microcontroller and the wireless interface being used with UART protocol. Wireless connectivity is common among smart meters as they allow for smart meters to communicate with the grid infrastructure as well as enabling the local electricity providers for optimal grid utilization. Level translators can also be used with the MCU and peripherals of the SEM such as in-home-displays (IHD), smart thermostats and many others to further enhance the consumer experience while reducing energy usage. Another common communication protocol, GPIO, allows for the transfer of signals between MCUs and peripherals which is also made possible by level translators. For more information on recommended devices to be used based on interface, please visit *Voltage Translation Application Quick Reference* product overview.

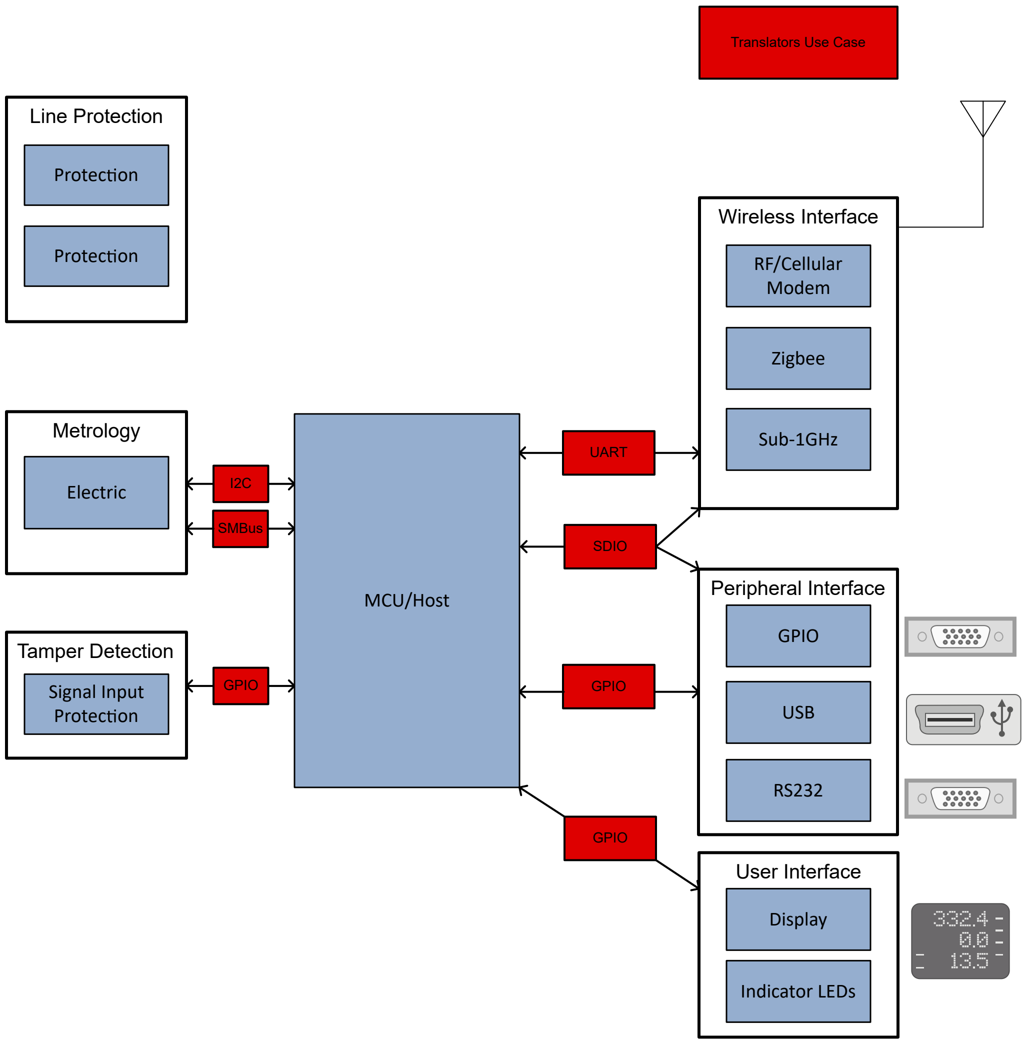

Figure 1. Functional Block Diagram

Table 1. Recommended Translator by Interface

	Translation Level	
Interface	**VCC: Up to 3.6 V**	**VCC: Up to 5.5 V**
FET Replacement	2N7001T	SN74LXC1T45 / TXU0101
1 Bit GPIO/Clock Signal	SN74AXC1T45	SN74LXC1T45 / TXU0101
2 Bit GPIO	SN74AXC2T245	SN74LXC2T45 / TXU0102
2-Pin JTAG/UART	SN74AXC2T45	SN74LXC2T45 / TXU0202
I2C/MDIO/SMBus	TXS0102 / LSF0102	TXS0102 / LSF0102
IC-USB	SN74AVC2T872 / TXS0202	NA
4 Bit GPIO	SN74AXC4T245	TXB0104 / TXU0104
UART	SN74AXC4T245	TXB0104 / TXU0204
SPI	SN74AXC4T774 / TXB0104	TXB0104 / TXU0304
JTAG	SN74AXC4T774 / TXB0104	TXB0104 / TXU0304
I2S/PCM	SN74AXC4T774 / TXB0104	TXB0104 / TXU0204
Quad-SPI	TXB0106	TXB0106
SDIO/SD/MMC	TXS0206 / TWL1200	NA