

Optimizing Wearable Electronics with TI's Programmable Logic Devices



Functional Block Diagram

TI's programmable logic devices (TPLD) support designers pushing for smaller and cheaper wearable electronics. The TPLD family allows designers to simplify and reduce the sizes of bill of materials (BOMs) and boards by integrating multiple discrete components into a single, small form factor package. Compared to microcontrollers (MCUs), TPLD have low standby power consumption, like that of logic devices, and can have integrated analog components.

TPLD can perform multiple functions in wearable electronics. Some examples are shown in the block diagram below. Note that rather than replacing the MCU, TPLD can be used to offload functions from one, reducing the necessary MCU size, complexity, and cost.

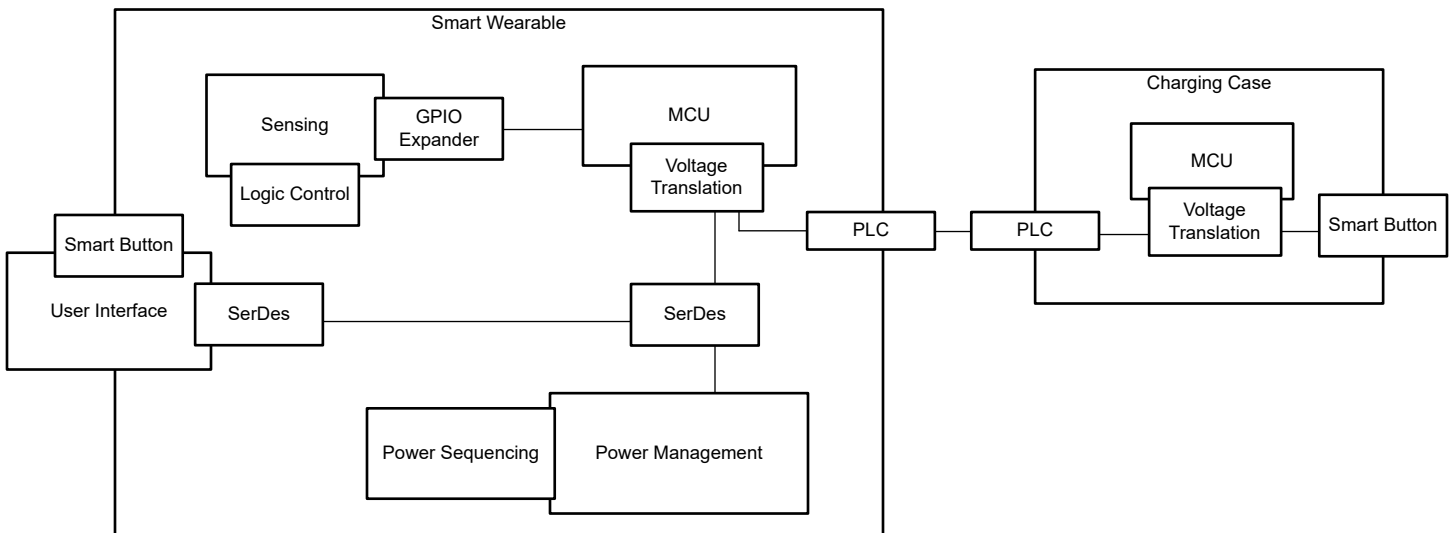


Figure 1. Simplified Block Diagram for Wearable Electronics

TPLD Applications in Wearable Electronics

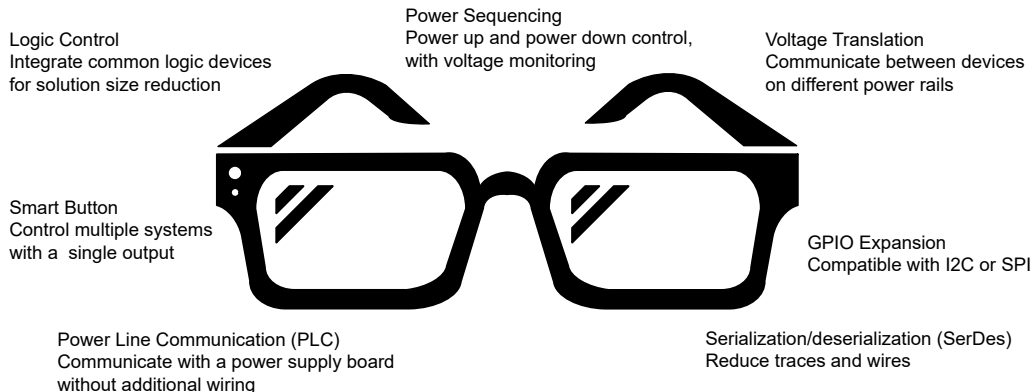


Figure 2. Example TPLD Applications

Power Line Communication (PLC)

Communication between a charging unit and a smart device typically requires separate power and communication lines. PLC with TPLD eliminates the need for the communication line, reducing complexity and size. Compared to existing dedicated PLC integrated circuits (ICs), TPLD offers a configurable design that can integrate into a custom system and does not require an MCU.

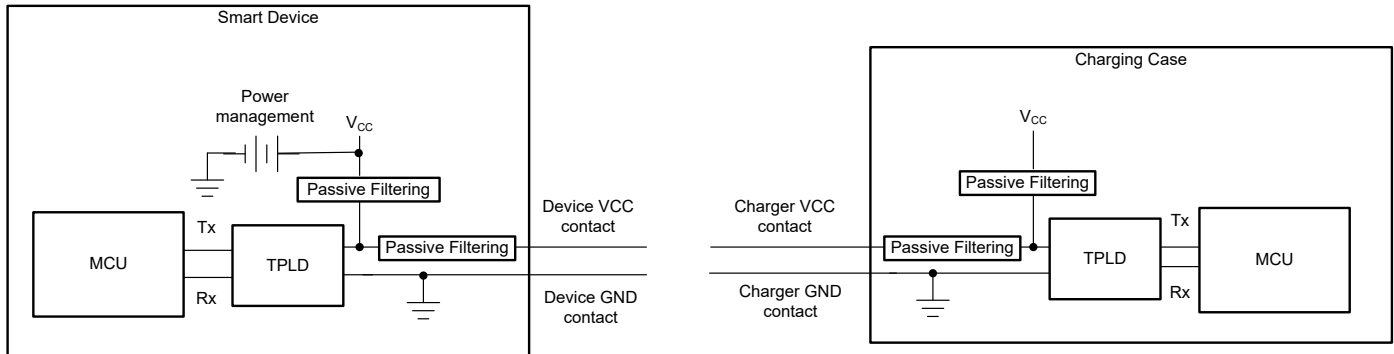


Figure 3. PLC Block Diagram

For more information about PLC using TPLD, see [Half-duplex Power Line Communication in TI's Programmable Logic Devices \(TPLD\)](#).

Serialization/Deserialization (SerDes)

In devices with spread-out boards, such as smart glasses, leading multiple traces from one side of the system to the other increases the total design size. Using TPLD, up to eight parallel input signals can be serialized to a single output, sent across a single trace, and deserialized by another TPLD on the other side of the board. Thus, using TPLD can reduce the design size and routing complexity.

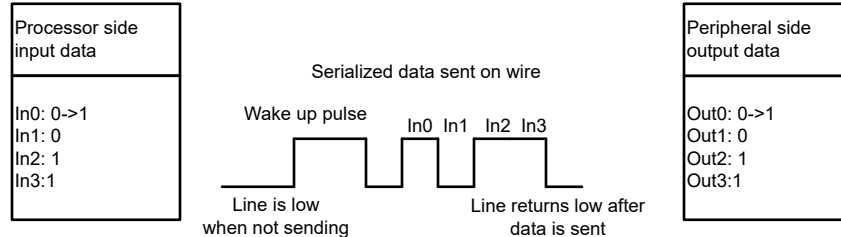


Figure 4. SerDes Function

TPLD allows for customizable input/output (IO) count from zero to eight inputs on either side of the SerDes system and responds automatically to changes of input signals without requiring an MCU or other primary device.

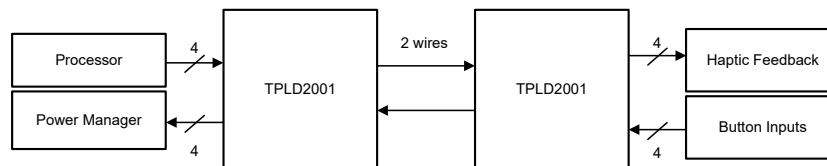


Figure 5. SerDes Block Diagram

Power Sequencing and Voltage Monitoring

Many designs require power sequencing to avoid backpowering or unintended device operation. TPLD offers single chip power-up and power-down control with error detection. TPLD is more consistent and allows more control than a resistor-capacitor (RC) network design, and boots faster and consumes less power than an MCU

design. The internal oscillators of TPLD allow for timing control without external clock signals, and the integrated analog comparators allow for voltage monitoring and gating the power sequence .

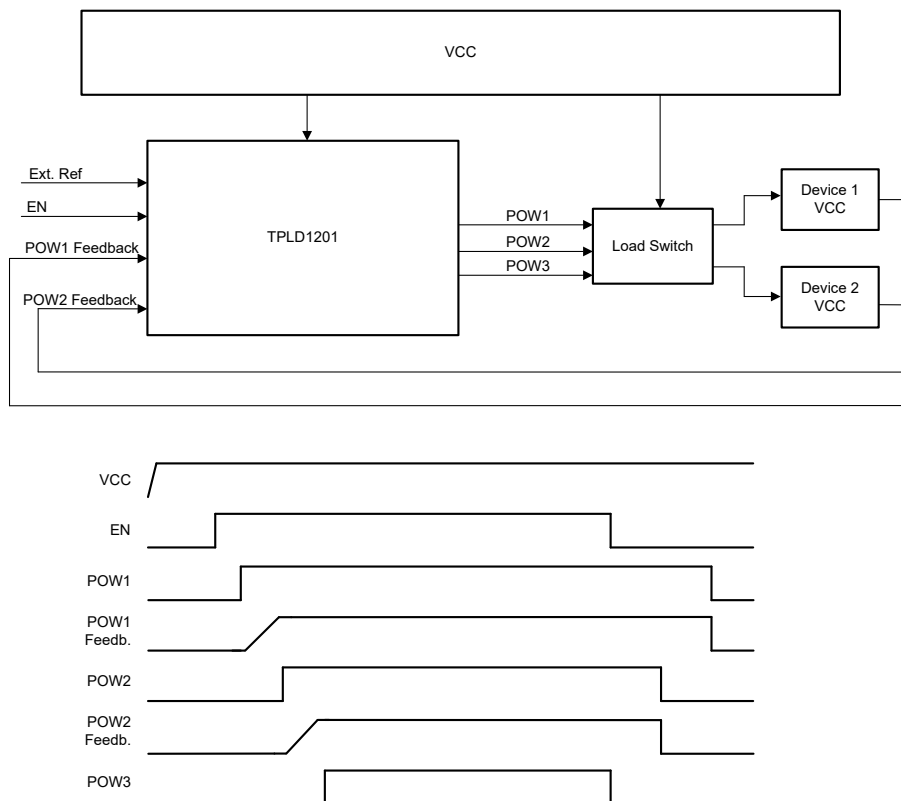


Figure 6. Power Sequencer Function

For more information about power sequencing using TPLD, see [Power Sequencing With Feedback Using TI Programmable Logic Devices](#).

General-Purpose Input/Ouput (GPIO) Expansion

Dedicating multiple pins from an MCU to peripheral control expands necessary MCU cost and complexity. TPLD GPIO expanders can use either a serial peripheral interface (SPI) or an inter-integrated circuit (I2C) from an MCU to control GPIO outputs. Up to eight inputs and eight outputs can be read or written to using an SPI or I2C. An I2C or SPI block can be used completely independently of other resources to read or write to any unused pins, allowing for the combination of GPIO expansion with other functions in the TPLD. This eliminates the need for a dedicated GPIO expander chip, reducing BOM size and design size.

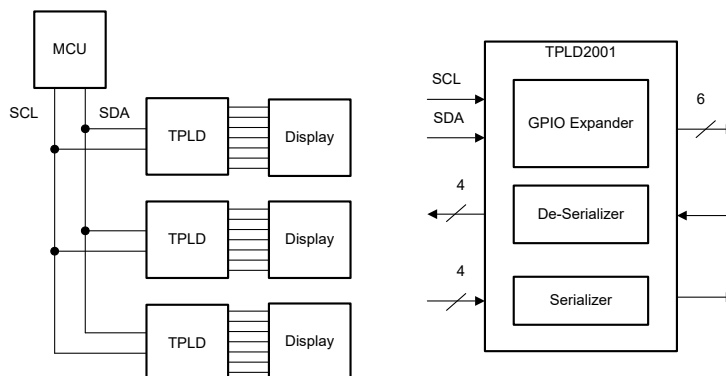


Figure 7. GPIO Expansion Example

For an example of GPIO expansion using TPLD, see [Controlling 7-Segment Displays Using I2C GPIO Expansion and State Machines in TI Programmable Logic Devices..](#)

Smart Buttons

Wearable devices are increasingly pushed to smaller sizes, reducing the available space for user inputs like buttons. TPLD can be used to interpret button press patterns to perform different operations using a single input signal, reducing the number of user-facing inputs needed without reducing device controllability. TPLD can also perform button debouncing, voltage translation, and has a wide configurable array of possible control schemes.

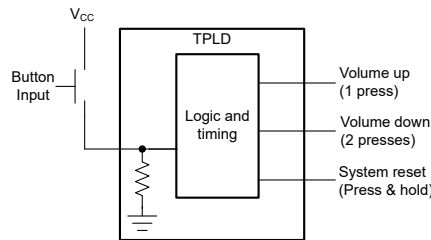


Figure 8. Smart Button Example

An example smart button control scheme is implemented in [Using State Machines in Programmable Logic.](#)

Logic Control

Small, one-off logic elements are often needed for functions like power-good communication or signal redriving. These logic elements can be integrated into a TPLD performing other functions to eliminate the need for multiple different components. All TPLD blocks operate independently from each other, so multiple functions can be performed in parallel. Integrating logic components into a single device reduces total design size and power consumption.

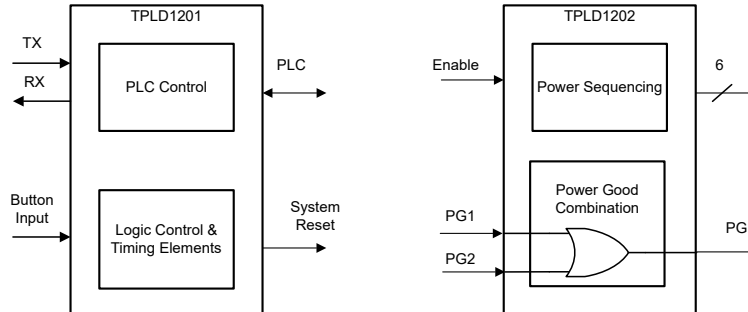


Figure 9. Logic Control Examples

Voltage Translation

MCUs often operate at lower voltage levels than peripheral devices and need other ICs to enable communication. TPLD have optional, low voltage level inputs and open drain outputs that allow for up or down translation. Routing traces from the MCU through the TPLD for another purpose such as GPIO expansion or logic control allows for voltage translation without a dedicated voltage translation IC, reducing design size and power consumption.

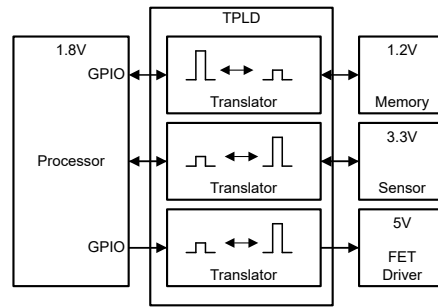


Figure 10. Voltage Translation Example

For more information about using TPLD for up and down voltage translation, see [Up and Down Translation in TI's Programmable Logic Devices \(TPLD\)](#).

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