Application Report
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Optimizing Digital Video Recorder Designs with Common Logic Use Cases

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ABSTRACT

Logic and translation devices can be found in the majority of electronic systems. Digital Video Recorder (DVR) designs integrate numerous subsystems together that often require additional signal interfacing, such as when a shift-register is used to conserve GPIOs when driving multiple LEDs. All of the use cases shown in the *Block Diagram* and *Logic and Translation Use Cases* sections of this document are commonly seen in DVR designs.

Logic gates, voltage translators, and other logic devices are utilized for many purposes throughout modern electronic systems. This document provides example solutions for common design challenges that can be solved using logic and translation. Not all of the solutions here appear in every system, however all solutions shown are commonly used and effective.

There are dozens of logic families available from Texas Instruments, and it can be difficult to select the right one for the application. DVRs can vary in size and in complexity, but the key design parameters remain the same making it easier to identify an appropriate family for this application. Refer to *Section 4* in this document for help finding the right logic family for your use case.

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1 Block Diagram

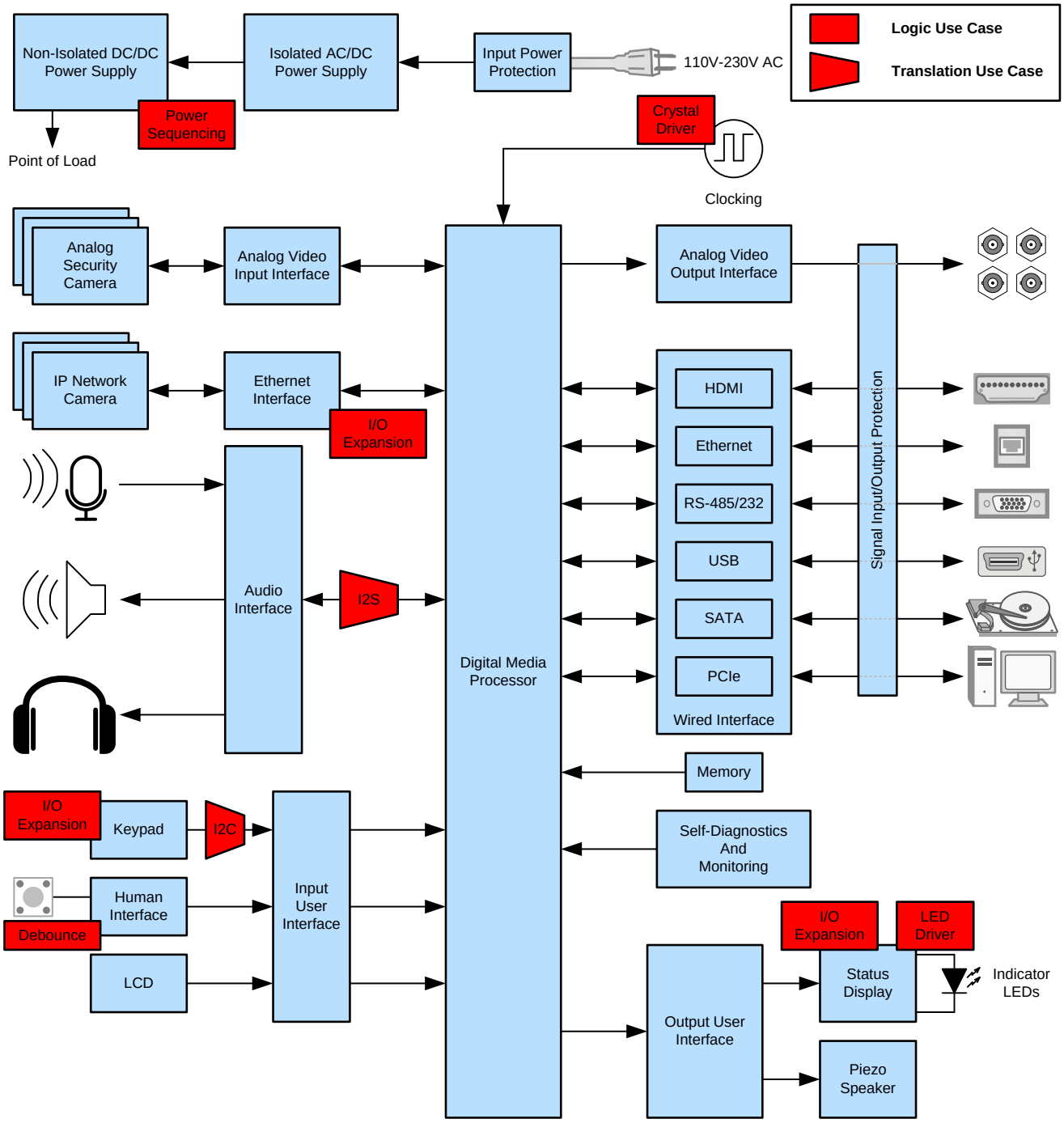

Figure 1. Simplified Block Diagram for Digital Video Recorder

For a more complete view, see the interactive online End Equipment Reference Diagram for *Video Recorder*.

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2 Utilizing Output Expansion to Drive Front Panel Indicators

Digital Video Recorders (DVRs) typically require a variety of indicator LEDs on the front panel to help users with direct feedback during operation. These include power, network connectivity, disk capacity, and other indicators. With a large number of possible LEDs, the number of outputs required for direct driving of each LED is restrictive for controller selection. By adding serial shift registers such as SN74HC595 to the system, these LEDs can be controlled through a simple serial interface only requiring three GPIO pins to handle a practically unlimited number of indicator LEDs. Figure 2 shows an example using the SN74HC595 to drive 16 indicator LEDs.

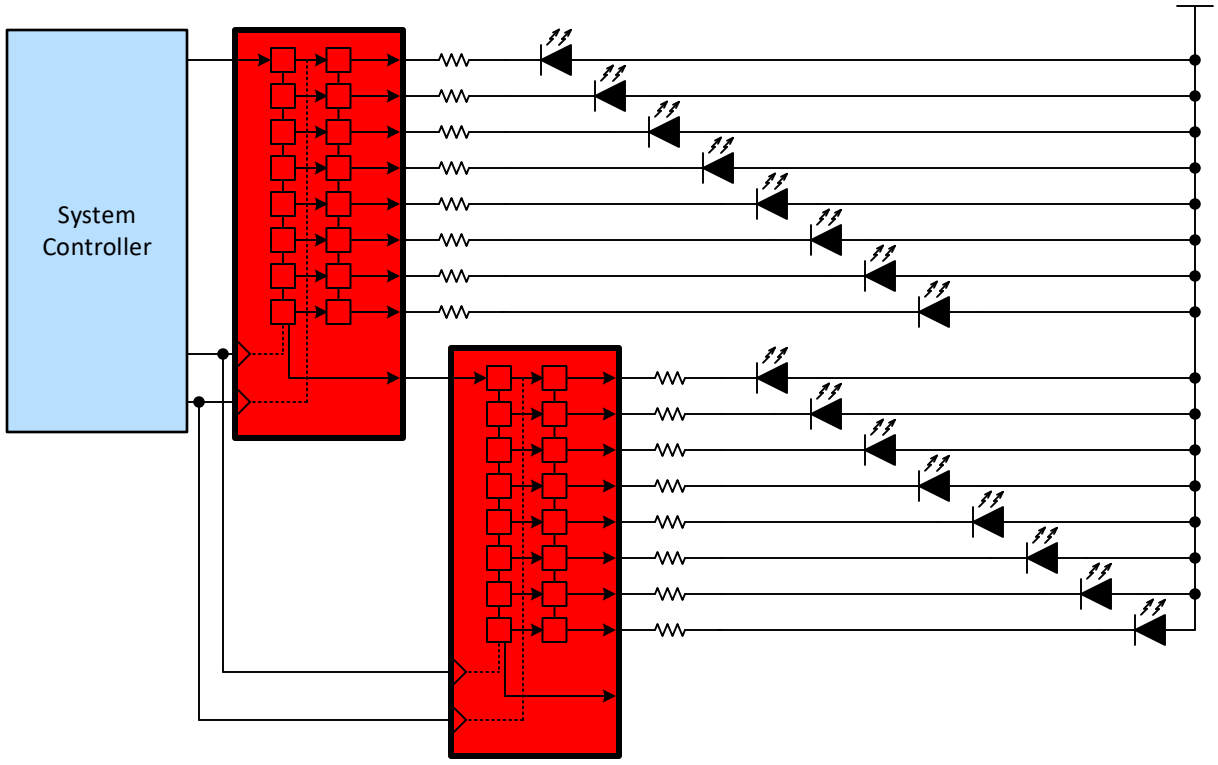

Figure 2. Using Two Shift Registers to Control 16 LEDs with Three Signals (Data, Shift Clock, Output Register Clock)

- Turn as few as two outputs into 8 outputs with one serial-in parallel-out shift register
- Daisy chain shift registers to produce large numbers of outputs
- Drive low-current (< 8 mA) LEDs directly
- Find the right Shift Register through the *online parametric search tool*

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3 Logic and Translation Use Cases

3.1 Logic Use Cases

3.1.1 Drive Indicator LEDs

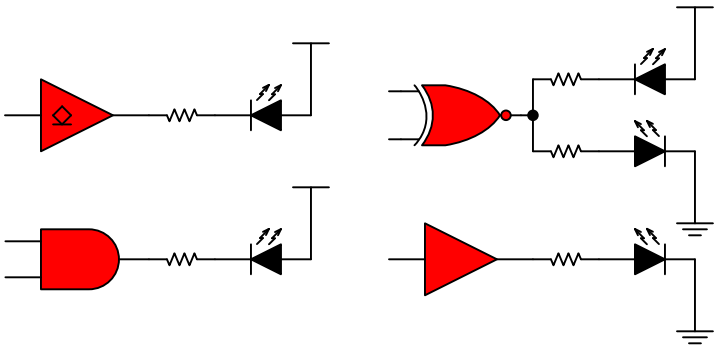

Figure 3. Using Logic as Indicator LED Driver Application Examples.

- Add system indicators without controller interaction required
- Drive low current indicator LEDs (1 to 25 mA) with most logic gates
- Add configurability using logic functions
- Disable indicator LEDs as desired
- Find the right logic or translation device through the *online parametric search tool*

3.1.2 Combine Power Good Signals

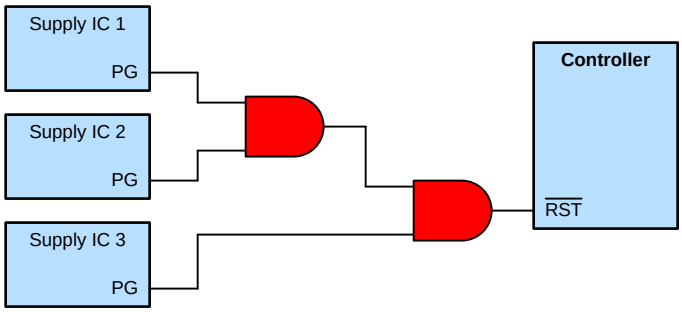

Figure 4. Using Logic to Combine Multiple Power-good Signals.

- Add system indicators without software or system controller interaction
- Drive low current indicator LEDs (1 to 25 mA) with most logic gates
- Add configurability using logic functions
- See more about this use case in the Logic Minute video *Combining Power Good Signals*
- Find the right AND gate through the *online parametric search tool*

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3.1.3 Debounce Switches and Buttons

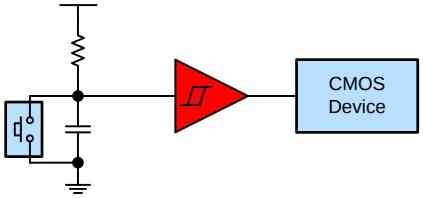

Figure 5. Using Logic to Prevent Multiple Triggers of a CMOS Input Due to Switch Bounce.

- Prevents multiple triggers of CMOS inputs due to switch bounce
- Works when the system controller is asleep
- Works without a system controller
- Reduces controller code complexity, no software debounce required
- See more about this use case in the Logic Minute video *Debounce a Switch*
- Find the right Schmitt-trigger buffer through the *online parametric search tool*

3.1.4 Generate a Clock Signal from a Crystal Oscillator

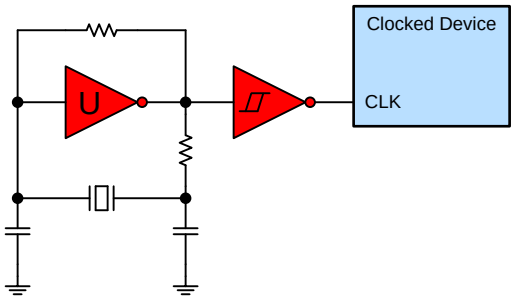

Figure 6. Using an Unbuffered Inverter and Schmitt-trigger Inverter to Generate a Clock Signal From a Crystal Oscillator.

- Drive crystal oscillators directly
- Allows for selectable system clocks with multiple crystals
- Outputs a clean and reliable square wave
- See more about this use case in the application report *Use of the CMOS Unbuffered Inverter in Oscillator Circuits*
- Find the right inverter through the *online parametric search tool*

3.1.5 Increase Number of Controller Inputs

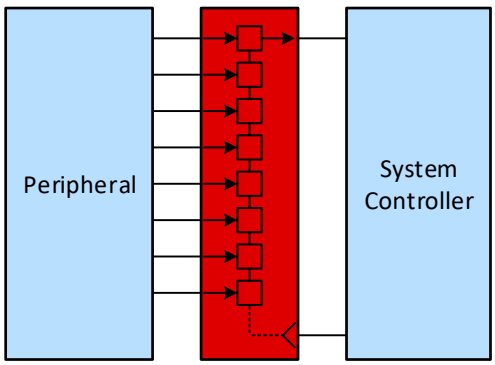

Figure 7. Using Shift-register to Serialize Parallel Data and Conserve Controller I/O's

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- Input 8 bits of parallel data to the System Controller with as few as two I/Os
- Daisy chain shift registers to produce large numbers of inputs
- Input up to 180 Mbps of serial data with a parallel-in serial-out shift register
- Find the right Shift Register through the *online parametric search tool*

3.2 Voltage Translation Use Cases

3.2.1 I²C Communication

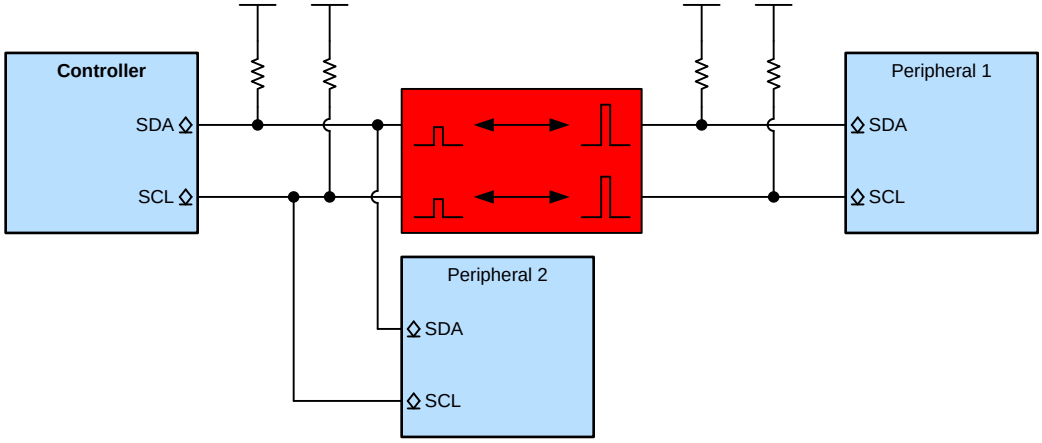

Figure 8. Using Voltage Translation with an I² Communication Bus.

- Enable communication when devices have mismatched logic voltage levels
- Prevent damage to devices that cannot support higher voltage inputs
- Improve data rates over discrete translation solutions
- Find the right voltage level translator through the *online parametric search tool*

3.2.2 I2S Communication

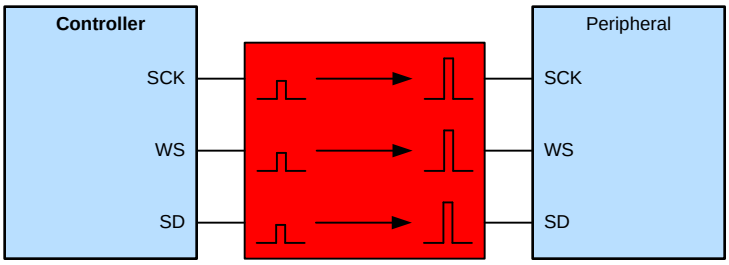

Figure 9. Using Voltage Translation with an I2S Communication Bus.

- Enable communication when devices have mismatched logic voltage levels
- Prevent damage to devices that cannot support higher voltage inputs
- Improve data rates over discrete translation solutions
- Protect controller while peripheral is not connected
- Find the right voltage level translator through the *online parametric search tool*

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4 Recommended Logic and Translation Families for Digital Video Recorders

4.1 TXS010x: Auto-bidirectional Voltage Level Translation

Key features:

- Translates between 1.65-V to 3.6-V and 2.3-V to 5.5-V voltage nodes
- Each channel senses input and output direction automatically
- Ideally suited for open-drain interfaces such as I2C, MDIO, SMBUS, and PMbus; also supports push-pull interfaces
- Each pin has an internal pull-up resistor (values depend on specific device)
- Up to 100-Mbps operation
- I_{off} and V_{CC} isolation supports partial-power-down mode operation
- Packaging Options: TSSOP, SOT-23, VQFN, X2SON, VSSOP

Find the right TXS010x family voltage level translation devices through the *online parametric search tool*

4.2 HC: High-speed CMOS Logic

Key Features:

- Huge portfolio of logic functions
- 4+ channels per package
- Inputs and output include positive and negative clamp diodes
- Wide voltage operating range of 2 V to 6 V
- Up to 140-Mbps operation
- Packaging Options: PDIP, SO, SOIC, SSOP, TSSOP

Find the right HC family voltage level translation devices through the *online parametric search tool*

4.3 LVC: Low-Voltage CMOS Logic and Translation

Key Features (SN74**LVC**xxxx):

- Huge portfolio of logic functions
- LVC: 4+ channels per package
- Over-voltage tolerant inputs allow unidirectional down-translation with any function
- High-drive outputs (up to 32 mA)
- Up to 250-Mbps operation
- I_{off} supports partial-power-down mode operation
- Packaging Options: SOIC, TSSOP, VQFN, SOP, SSOP

Key Features (SN74**LVCxG**xxxx):

- Put 1, 2, or 3 channels of any logic function right where you need them
- Configurable gates available ('57, '58, '97, '98, '99 functions)
- Over-voltage tolerant inputs allow unidirectional down-translation with any gate or buffer
- High-drive outputs (up to 32 mA)
- Up to 250-Mbps operation
- I_{off} supports partial-power-down mode operation
- Packaging Options: SOT-23, SC70, X2SON, SOT-5X3, SON, DSBGA

Key Features (SN74**LVCxT**xxxx):

- LVCxT: Up and Down Translation Across 1.65 V to 5.5 V
- 1, 2, 8, or 16 channels per device
- High-drive outputs (up to 32 mA)

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- Up to 250-Mbps operation
- I_{off} supports partial-power-down mode operation

Find the right LVC family logic and voltage level translation devices through the *online parametric search tool*

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