



PRESENTED BY



Building Blocks for Enhancing User Interfaces



- How can I design a user interface for my system that is both meaningful and intuitive?

Objective

- Understand the importance of good user interface design
- Explore design considerations and tradeoffs in order to get robust and intuitive interfaces into your system
- Discover how Xilinx Zynq-7000 AP SoC capabilities can be leveraged to glue hardware and software design components together in a system

Agenda

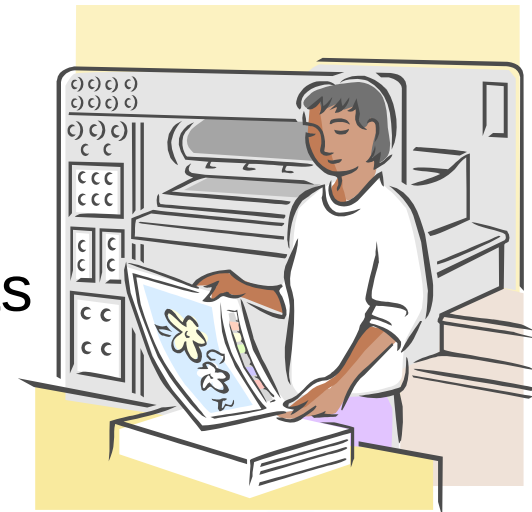
- Engaging and interacting with the user
- Reaching the user with hardware
- Software options for user interfaces
- System level integration using Zynq
- Example design leveraging MicroZed SOM
- Where to find more information

Engaging and Interacting with the User

Information Systems Basics



- Minimize operator frustration
 - System responses need to be timely
- Maximizing operator productivity
 - Accurately interpreted inputs and outputs

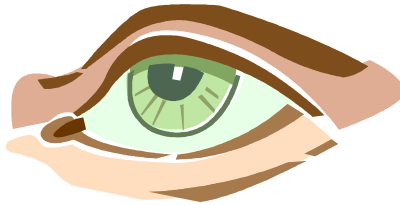


User Engagement – Involve the Human Senses

- Tactioception - Touch sense, haptic feedback



- Ophthalgoception - Visual indicators, display



- Audioception – Hearing of audio

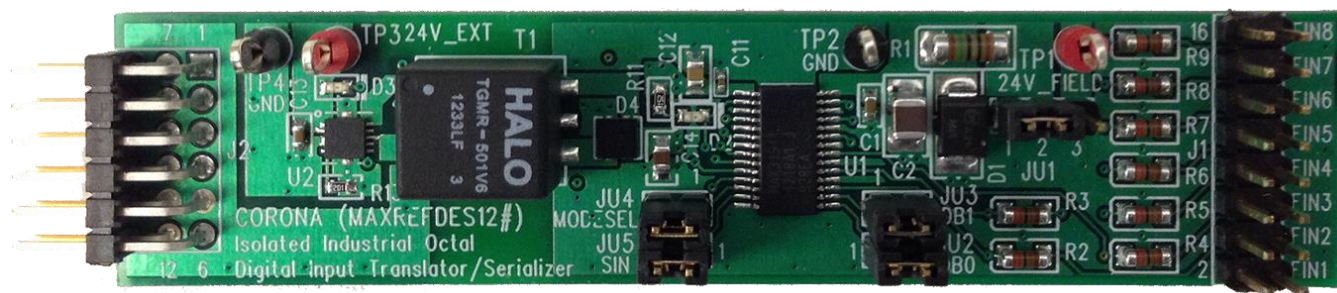


Legacy User Engagement Hardware

- Electromechanical switch



- Design example



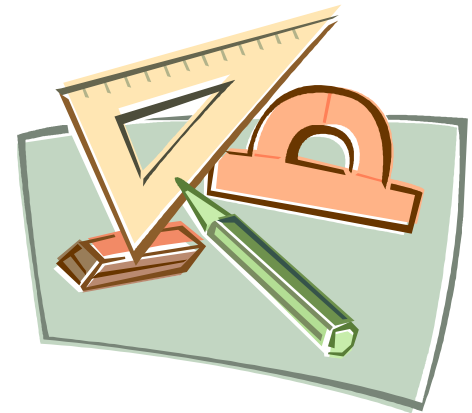
MAXREFDES12#



maxim
integrated™

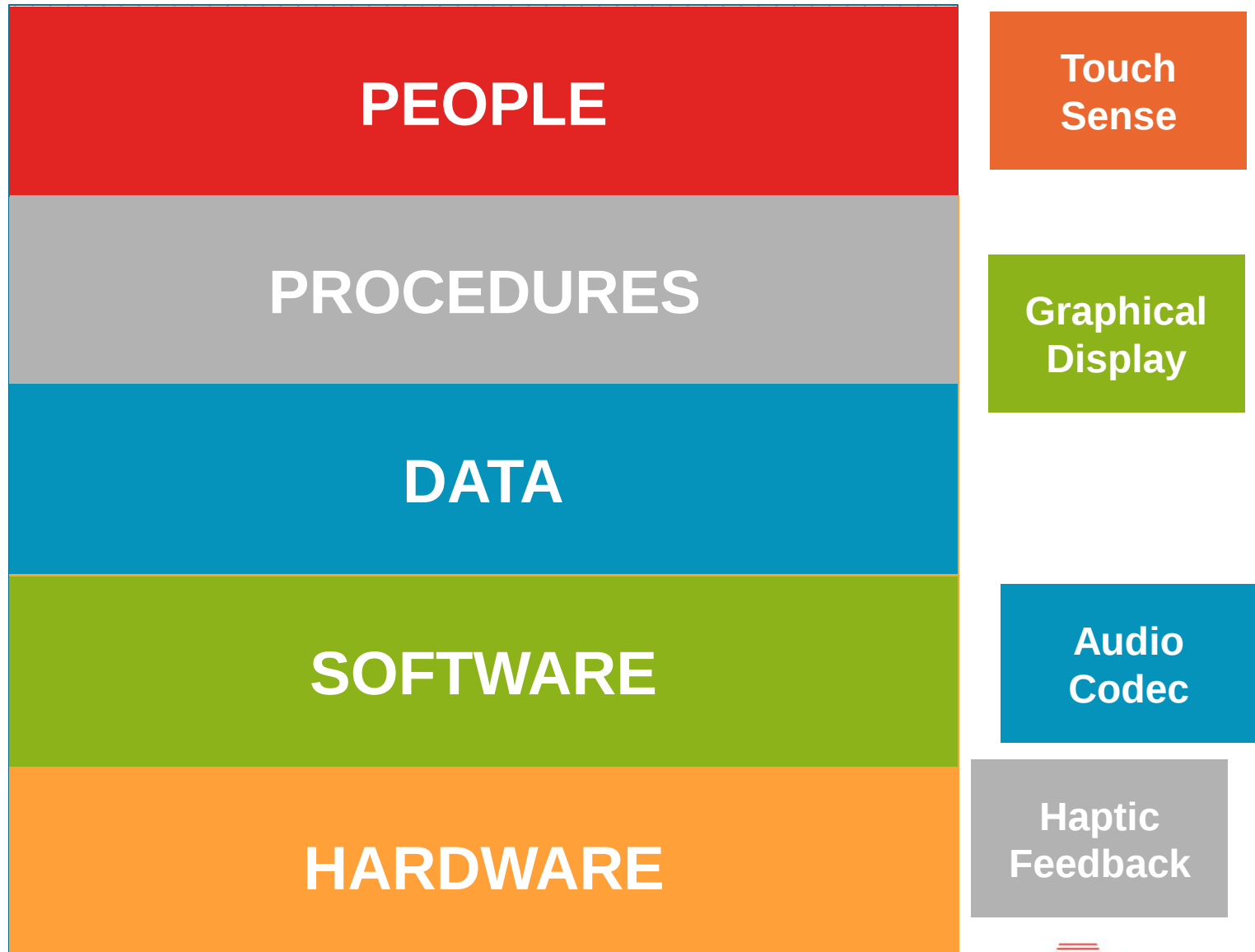
Electromechanical Switch Design Challenges

- Unit cost
- Design flexibility
- Operating environment



Reaching the User with Hardware

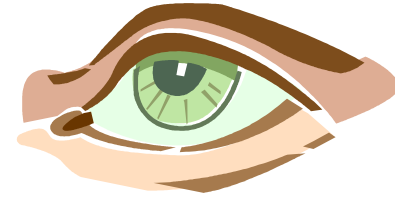
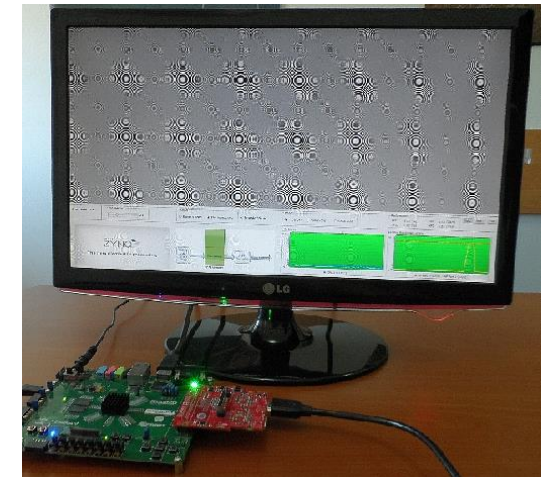
System Level Design



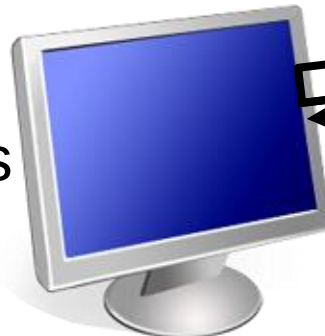
Graphical Display

Graphical
Display

- Range of solutions readily available



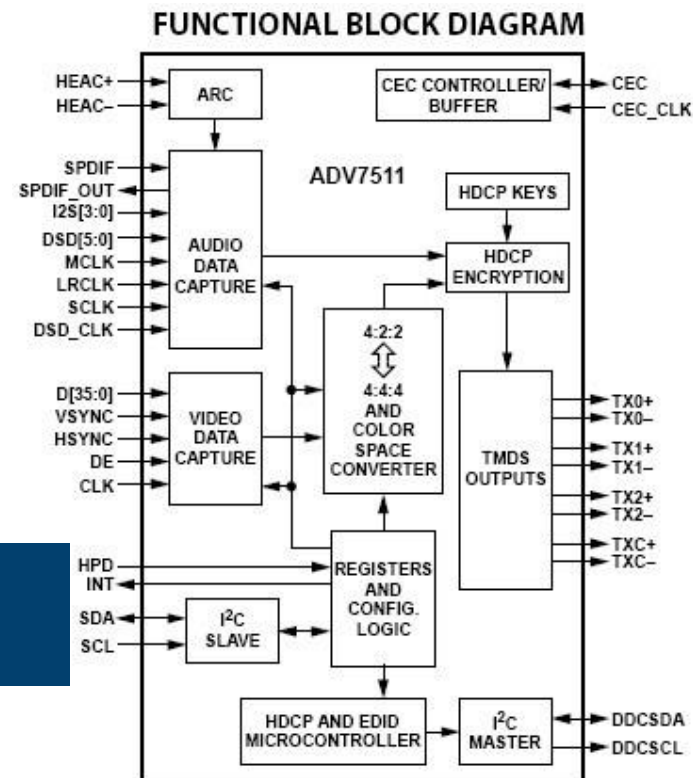
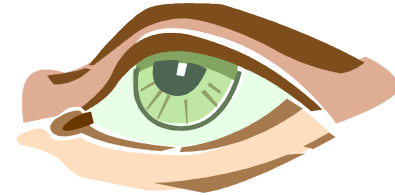
- Factors to consider for operating environment
 - High brightness or contrast
 - Viewing angle
 - Safety requirements



Commercial Off the Shelf HDMI Display

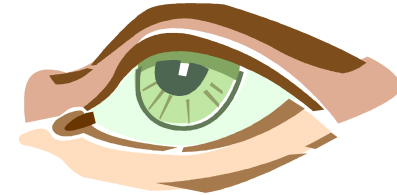
Graphical
Display

- Xilinx Series-7 devices 720p HDMI capable
 - Driven natively through TMDS output setting
- ADI HDMI Transmitter
 - Supports full HDTV formats (1080p, 12-bit Color)
 - Video data requires 19 I/O pins
 - ADI Supported Linux Drivers
 - Reference design implementations
 - ZedBoard
 - Mini-ITX
 - MicroZed Embedded Vision Carrier

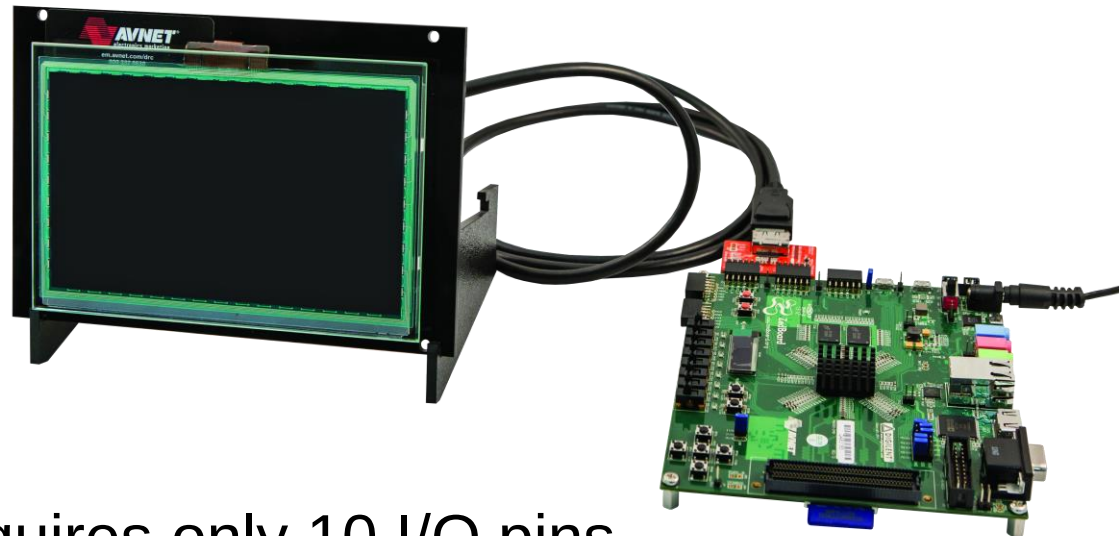


Graphical Display

Graphical
Display



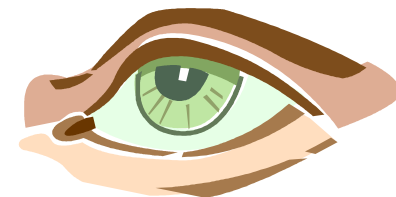
- Industrial grade mid-range display
 - Sharp 7" LVDS TFT panel
 - Low power LED backlight
 - Pmod compatible host adapters



- Customer adoptable
 - LVDS video data requires only 10 I/O pins
 - Low MOQ for production

Graphical Display

Graphical
Display



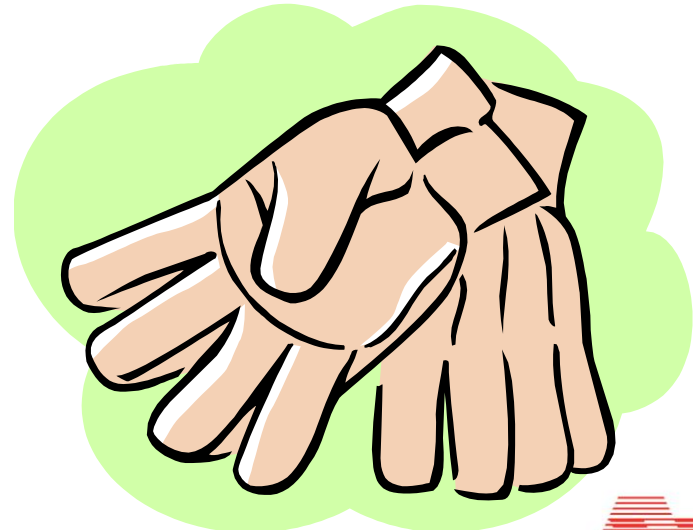
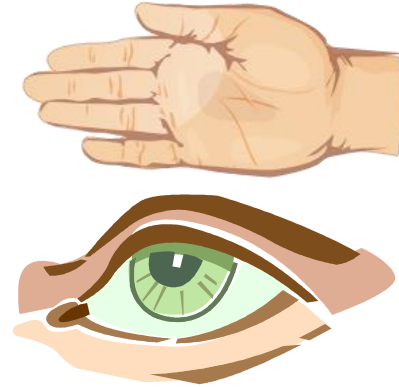
- Avnet Embedded
 - Full color TFTs, 4.3" to 82"
 - Monochrome LCDs
 - Film Enhancements
 - Optical Bonding
 - Custom Solutions
 - Engineering Services



Touch Sense

Touch
Sense

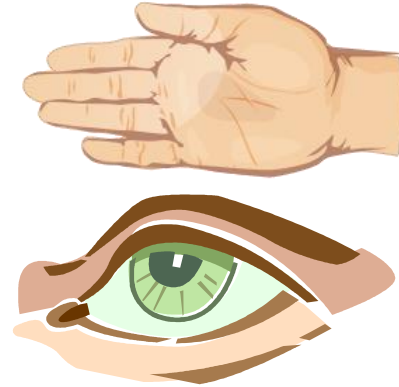
- Wide range of solutions exist
 - Singular touch button elements
 - Circular or linear slide arrays
 - Display panel overlays
- Environmental challenges for overlays
 - High humidity environment
 - Water droplet rejection
 - Glass thickness
 - Thick glove operation



Touch Sense

Touch
Sense

- Touch Technologies
 - Resistive
 - Surface Acoustic Wave
 - Projected Capacitive
- Overlay customization
 - Graphics
 - Specialized glass
 - Buttons



Haptic Feedback

Haptic Feedback

- Range of actuator technologies exist

- Eccentric Rotating Mass (ERM)



Low cost



“Standard Definition” response time

- Linear Resonant Actuator (LRA)



Best performance/cost option



“Standard Definition” response time

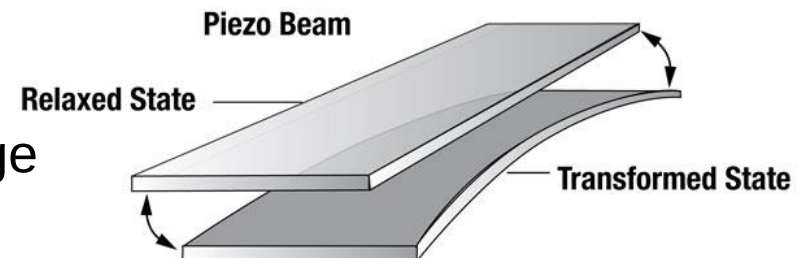
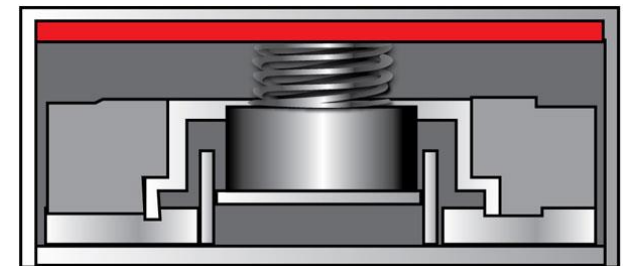
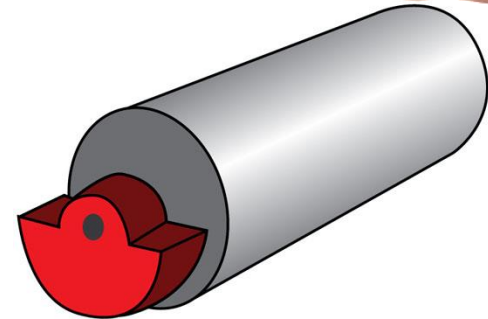
- Piezoelectric



“High Definition” response time



Requires 100-200V_{p-p} drive voltage



Haptic Feedback

Haptic
Feedback



- Design challenges
 - Amplitude of feedback
 - Responsiveness of actuator
 - Mechanical requirements
- Design example for LRA
 - High vibration force
 - Compact size
 - Low power consumption
 - Simple mechanical structure

DMJBRN1030BJ



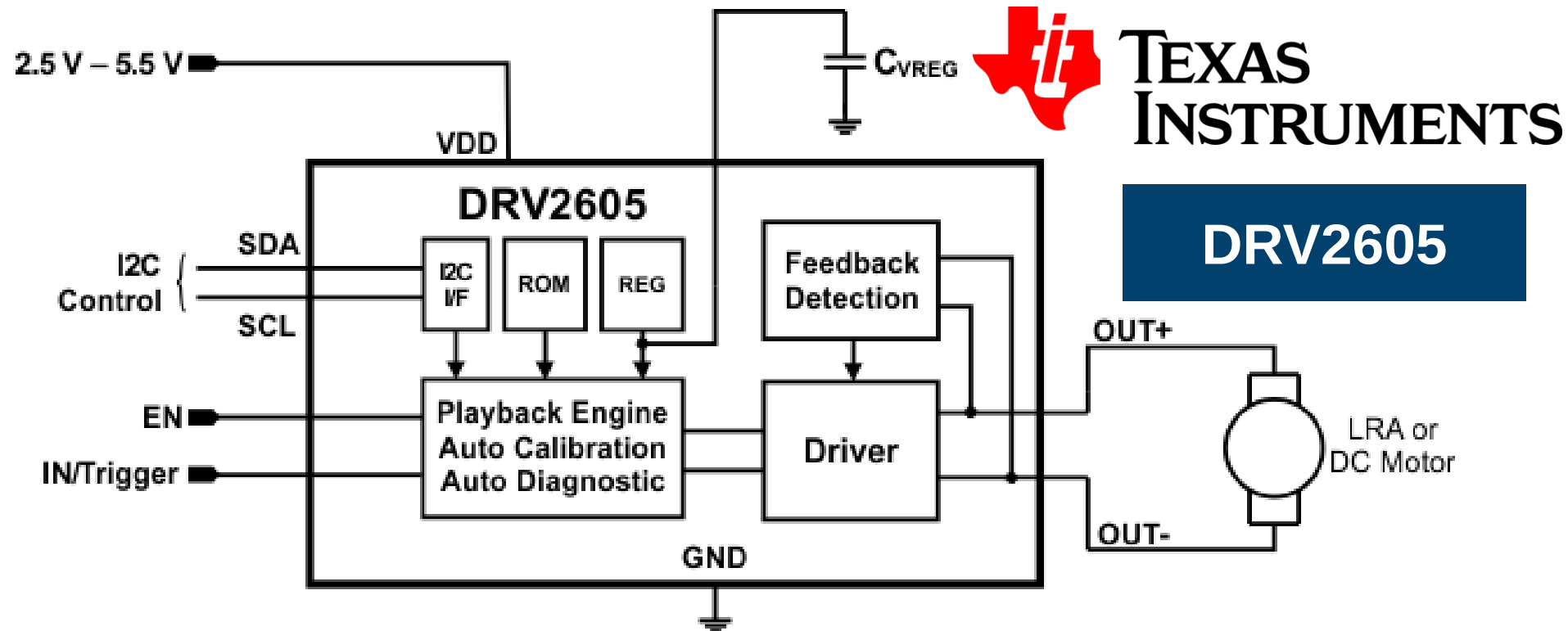
www.em.avnet.com/samsunghaptics

Haptic Feedback

Haptic
Feedback



- Design example for haptic driver
 - Simple I2C host interface
 - Drives ERM or LRA
 - No waveform development needed



- Features to consider for your environment
 - Audio recording
 - Audio playback
 - Audio quality
 - Audio amplitude

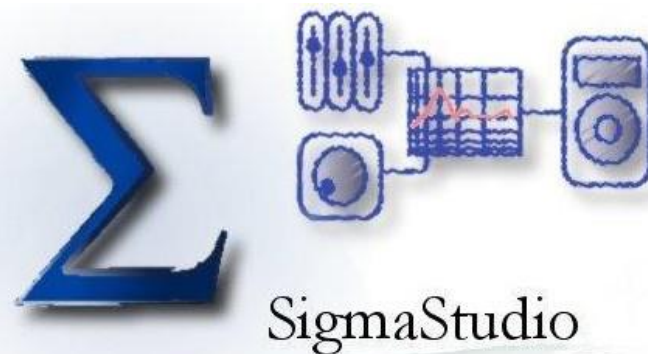
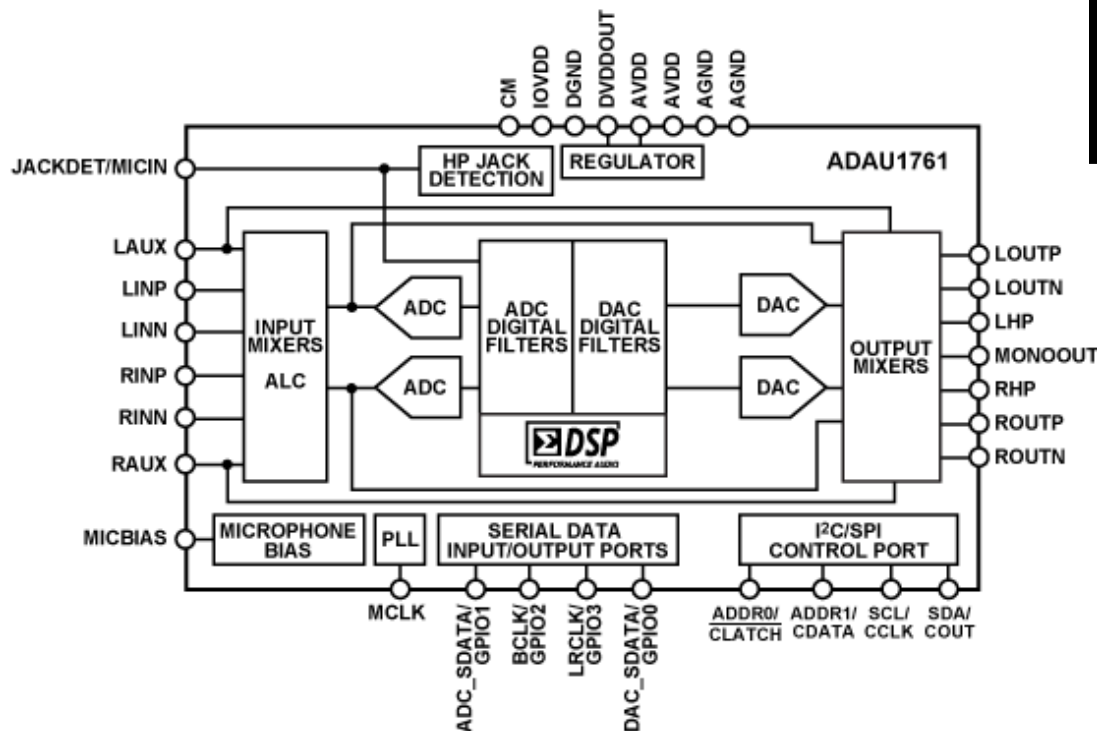


TEXAS
INSTRUMENTS



WiLink™ 8

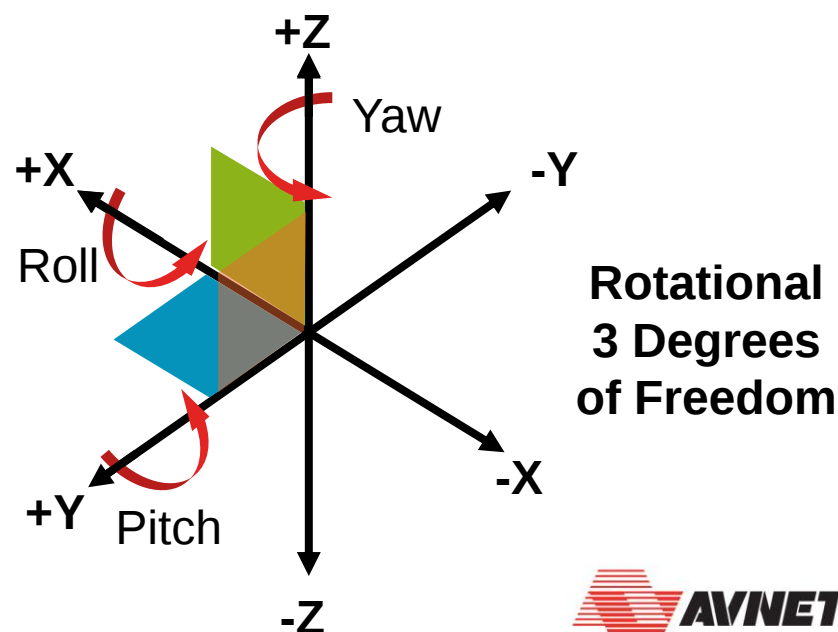
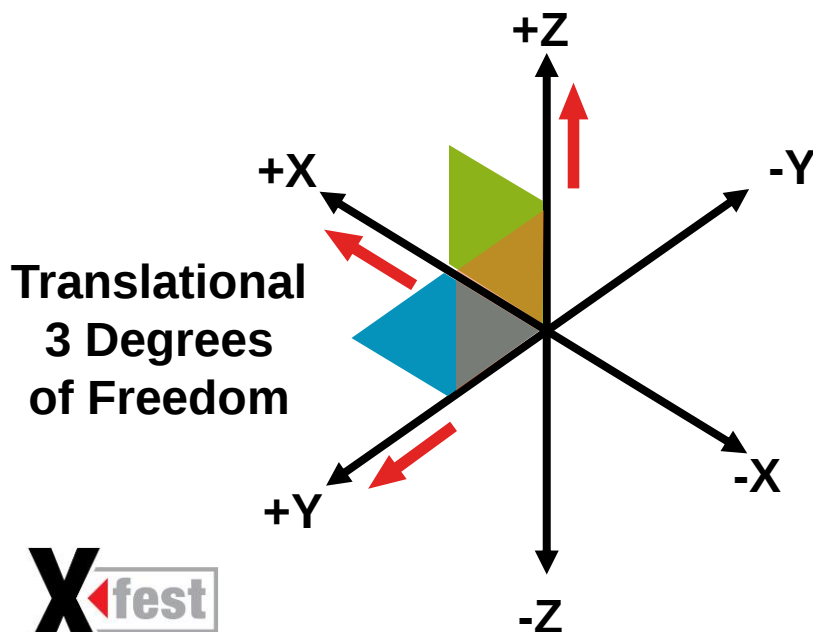
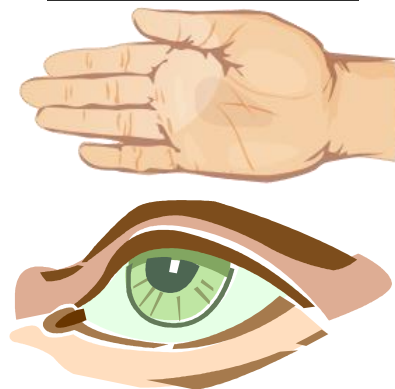
- ADI ADAU1761 Audio Codec
 - ADI Supported Linux Drivers
 - Zynq Mini-ITX Reference Design Available
 - MicroZed Embedded Vision Carrier



Positional Awareness

Positional Awareness

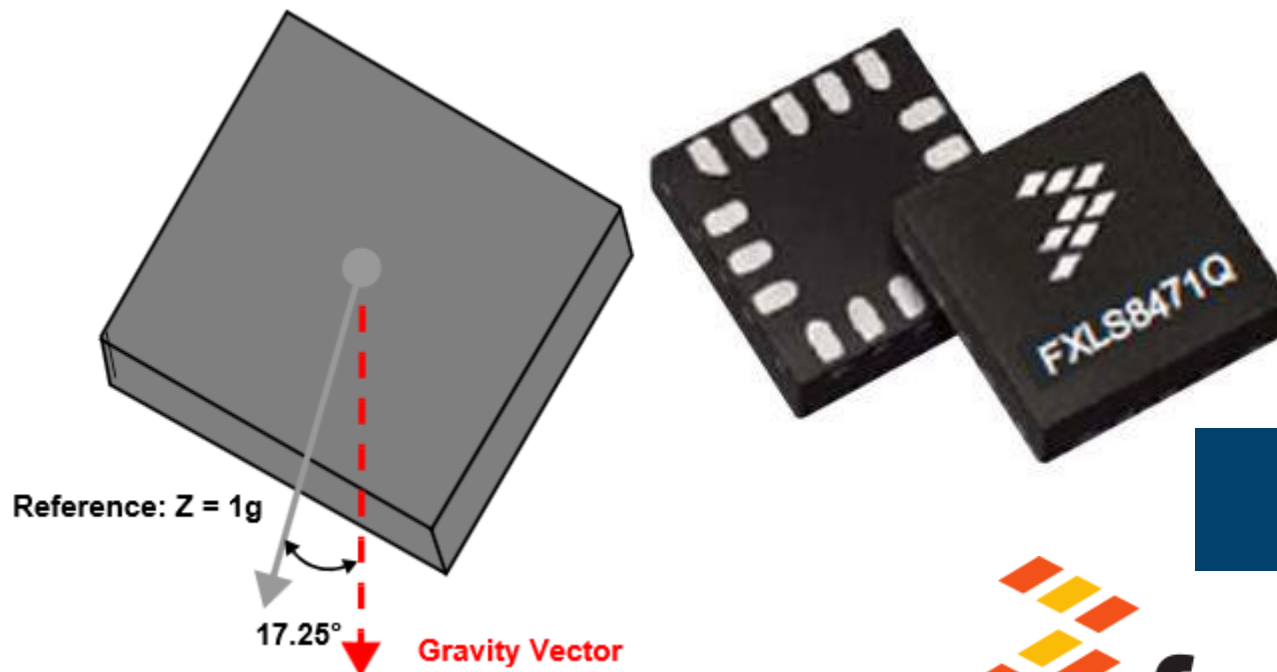
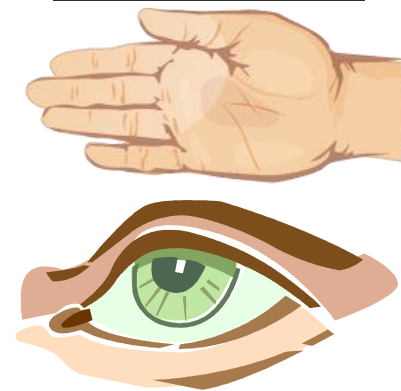
- Features to consider for your environment
 - Tilt, shake, or tap detection
 - Portrait or landscape orientation sense
 - Positional accuracy
 - Number of degrees of freedom



Positional Awareness

Positional Awareness

- Design example for accelerometer
 - Detect change of tilt exceeding a threshold
 - Industrial temperature range -40°C to $+85^{\circ}\text{C}$
 - Simple I2C host interface

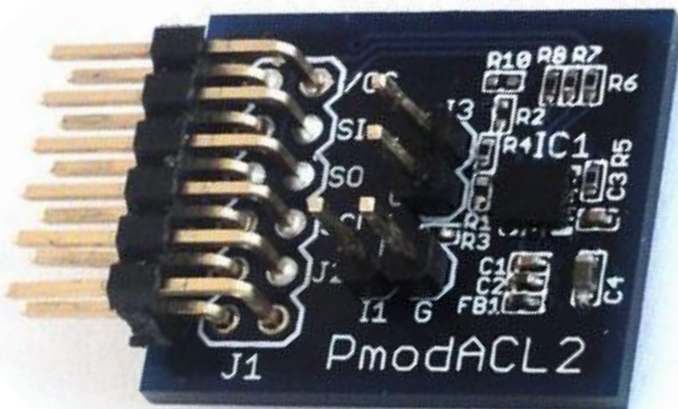
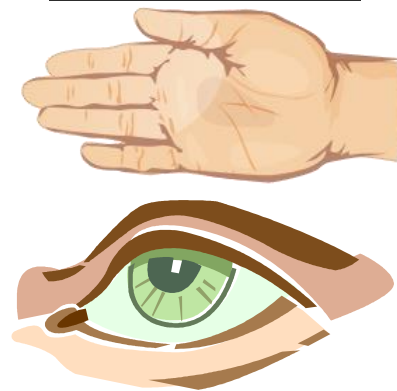


FXLS8471

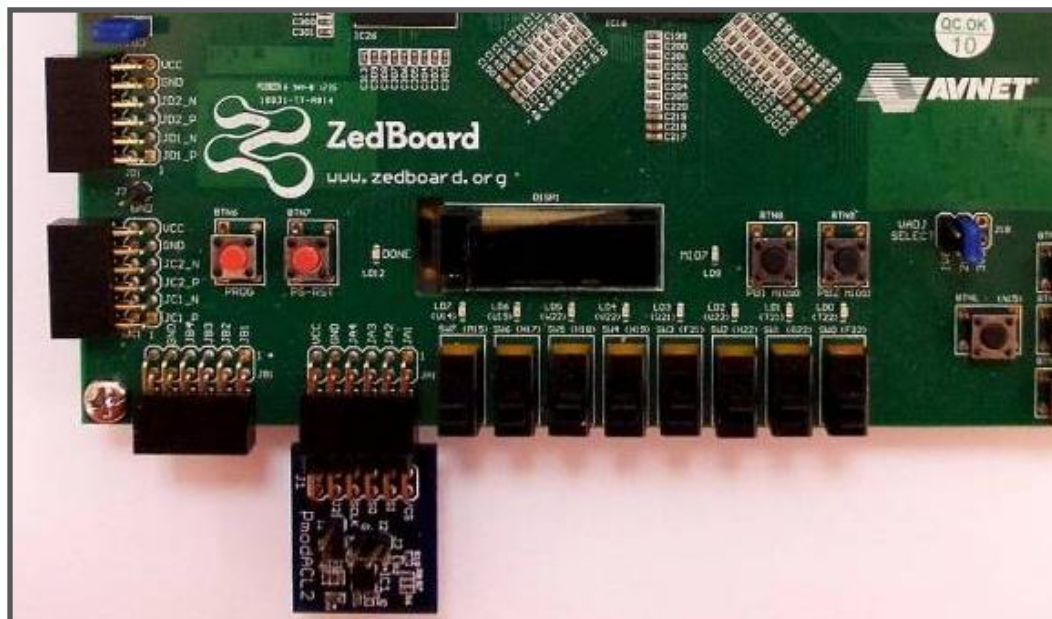
Positional Awareness

Positional Awareness

- Design example for accelerometer
 - ADI Supported Linux Drivers
 - PmodACL2 with SPI host interface



ADXL362



Software Options for User Interfaces

Common Software Options

■ Do It Yourself

- Bare Metal



■ Leverage existing application frameworks

- Qt
- GTK+

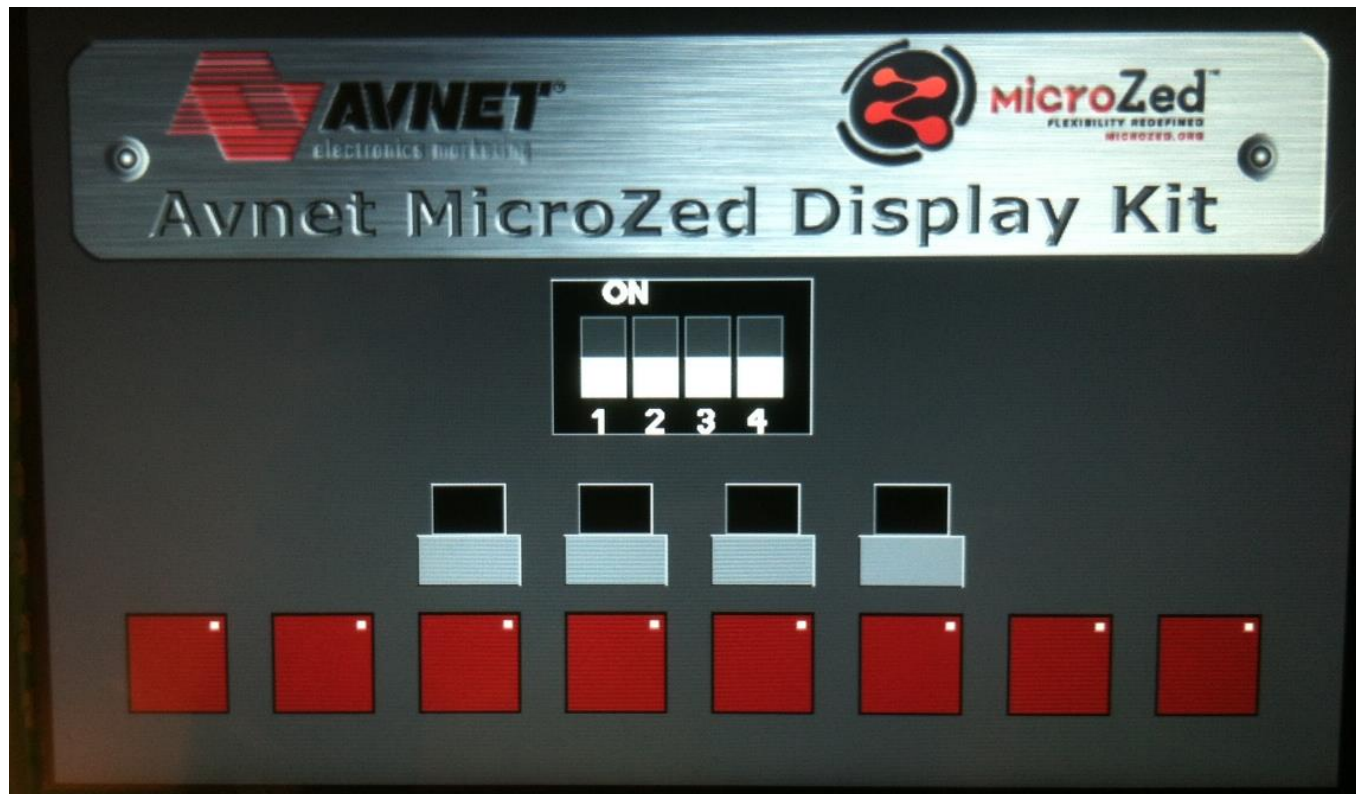


■ Web Enablement

- Remote control via browsers
- Service oriented controls

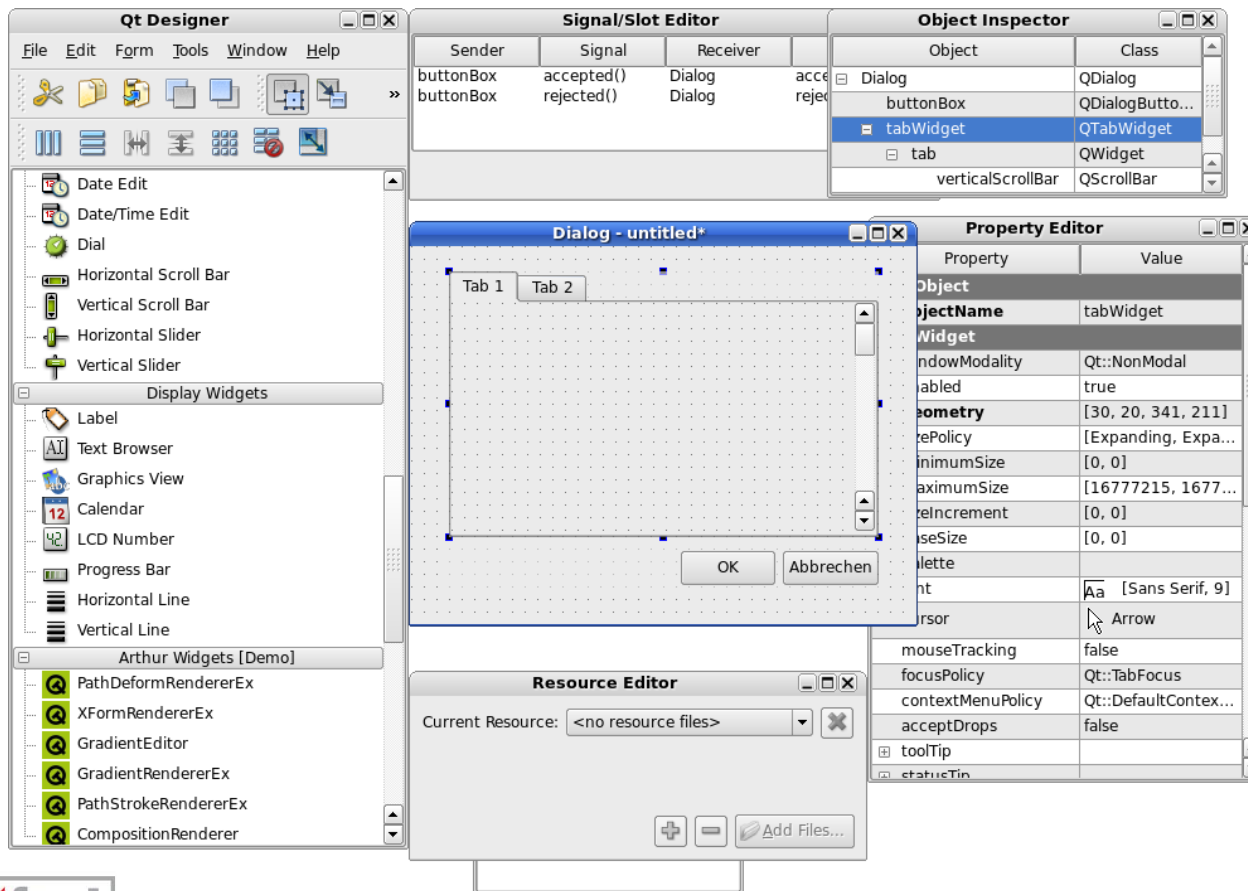


Do It Yourself – Bare Metal



- Straightforward design, but challenge to add functionality
- Example: Display Panel Controller Tutorials
 - <http://www.microzed.org/support/design/1668/13>

- Widely used application framework
- Qt will run on Open Source Linux



Qt Example



- Zynq Base Targeted Reference Design
 - <http://www.wiki.xilinx.com/Zynq+Base+TRD+2014.2>



GTK+

- Widget toolkit for creating GUIs
- Licensed under GNU LGPL

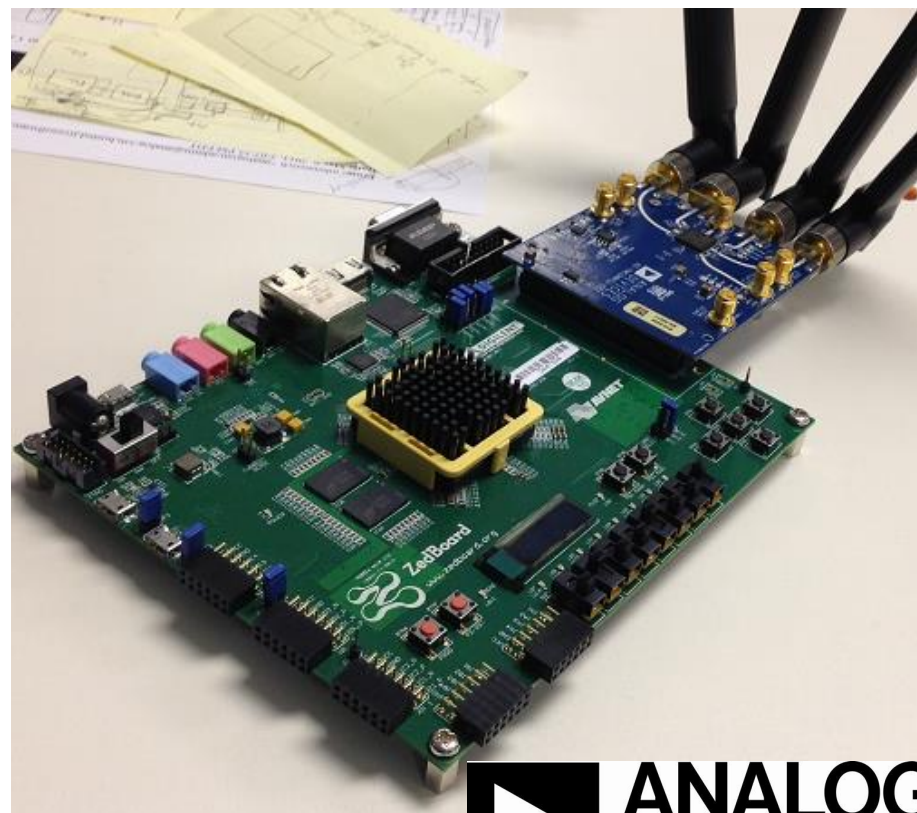


GTK+ Example



- Zynq-7000 AP SoC and AD9361 SDR Evaluation Kit
 - Analog Devices AD-FMCOMMS2-EBZ high-speed analog FMC module with integrated RF agile transceiver
 - RF platform for developers, operates over wide tuning range (70 MHz – 6 GHz)

www.em.avnet.com/adizynqsdr2



- Featured in Avnet “**Integrated Software-Defined Radio on Zynq®-7000 AP SoC**” Training

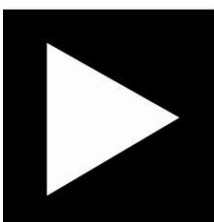
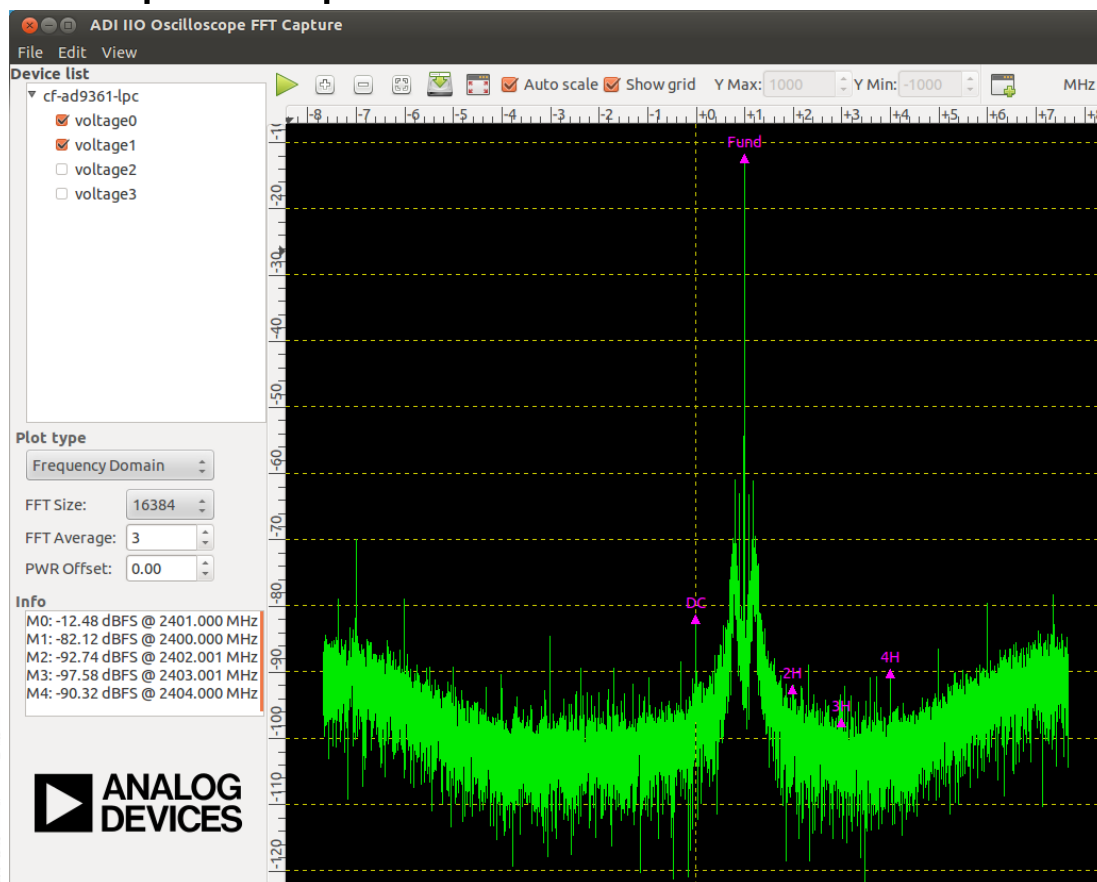
- <http://www.microzed.org/support/trainings-and-videos>



GTK+ Example



- ADI IIO Oscilloscope
 - Runs under Ubuntu Desktop Linux on several Zynq-7000 AP SoC development platforms
 - Designed to use Linux IIO drivers for data access
 - Visualize frequency domain to help make design decisions
 - Example application for ADI components like AD9361



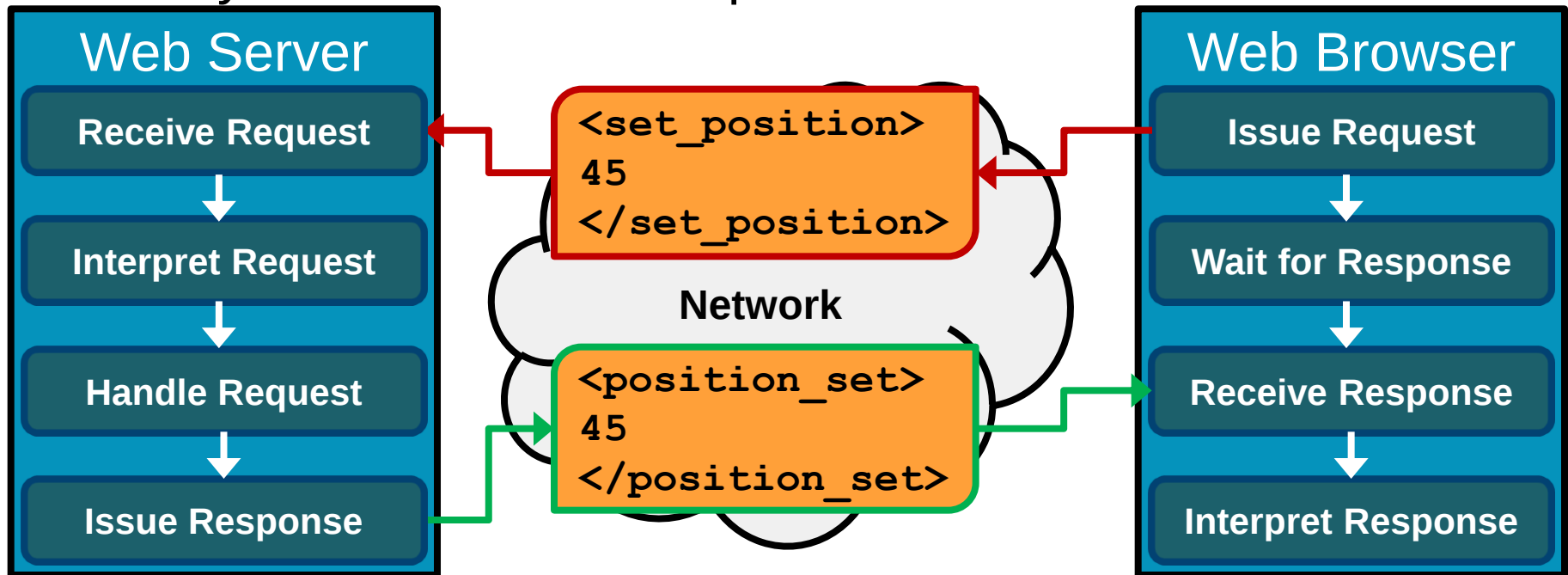
**ANALOG
DEVICES**



Web Enablement



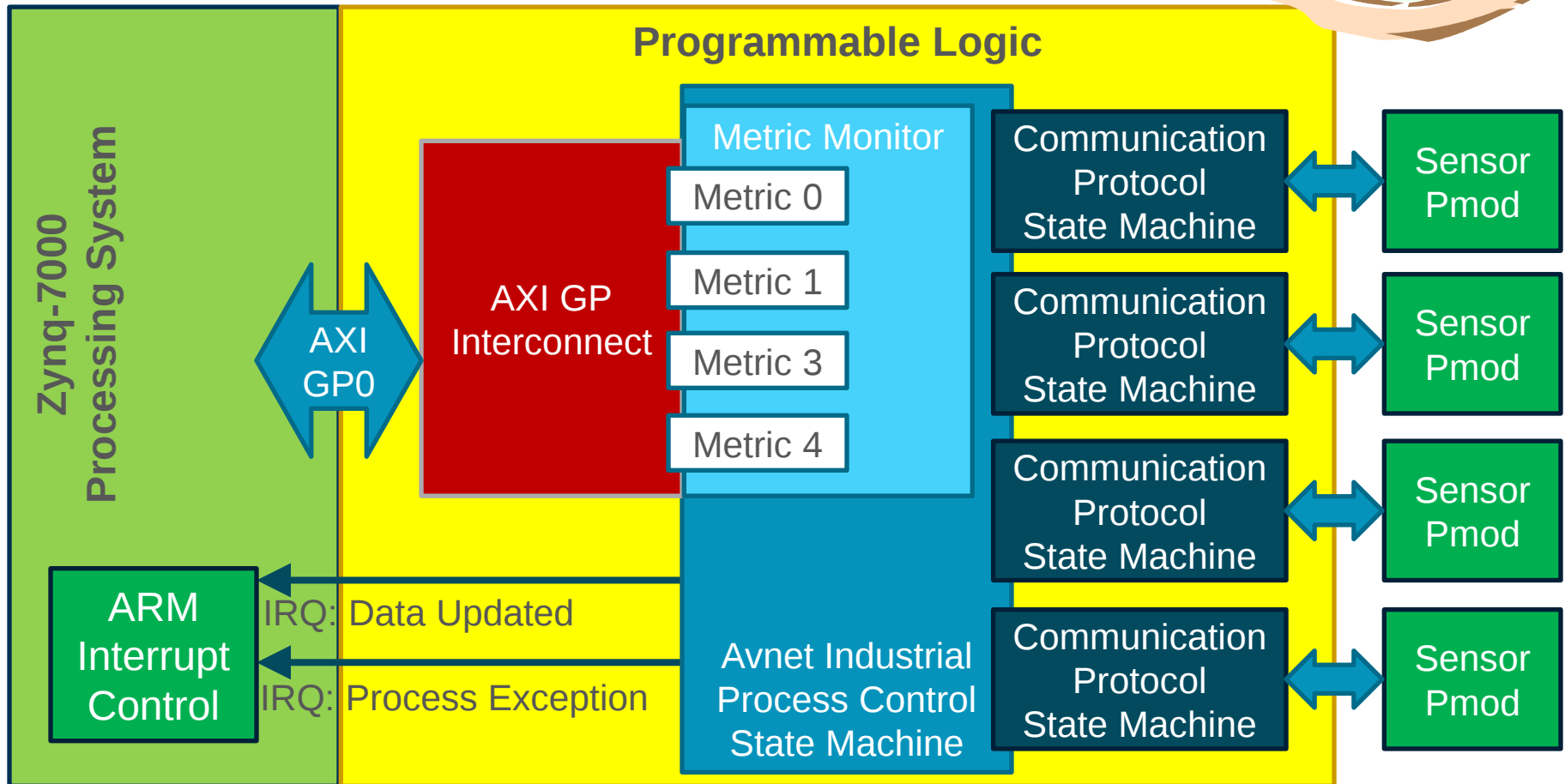
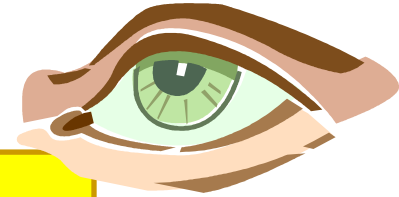
- Machine Interface accessed locally
- Remote control via Ethernet or wireless
- Modern browsers enable web technology
 - Asynchronous JavaScript + XML



System Level Integration Using Zynq

System Level Integration – Existing Design

- Goal: Add a graphical display to system



System Level Integration



Touch
Sense

Graphical
Display

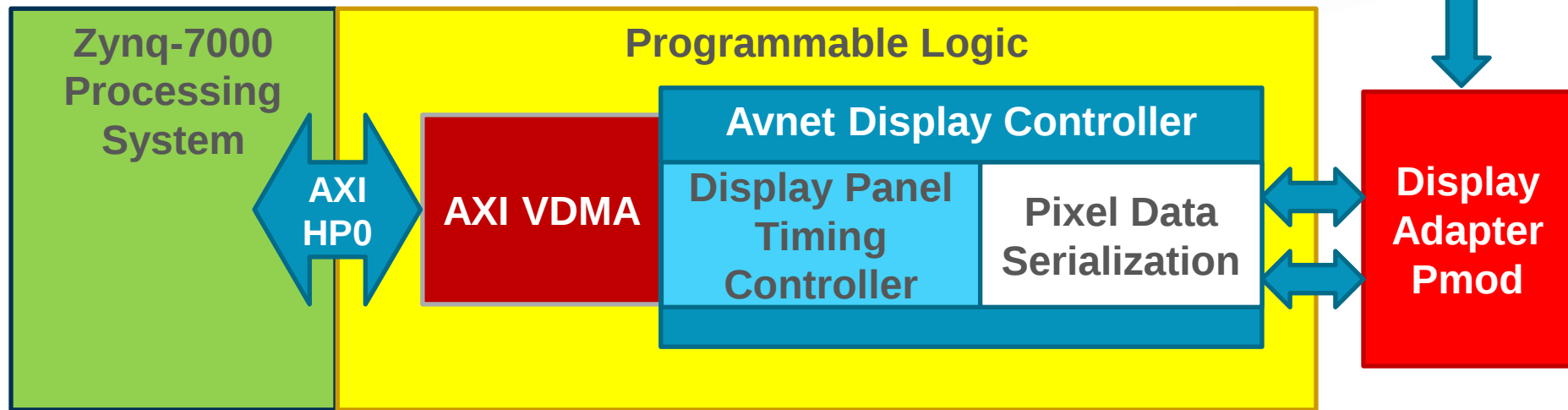
MicroZed SOM

Positional
Awareness

Haptic
Feedback

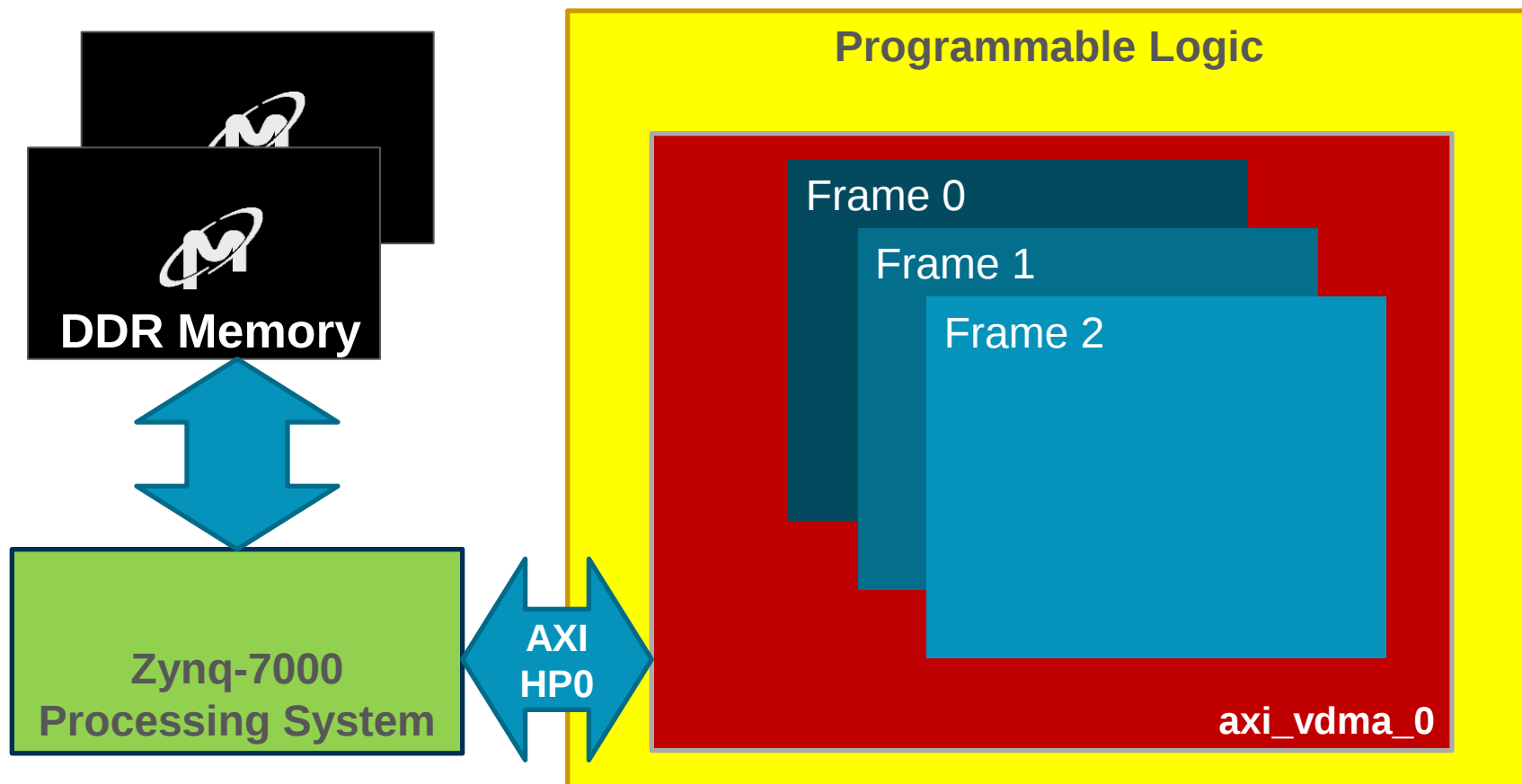
Display Controller System Block Diagram

- Move frame buffer data from the processor to a display panel
 - Move data into Programmable Logic fabric
 - Generate panel timing and serialize pixel data
 - Use differential I/O for transmission to panel



Moving Frame Data to Fabric

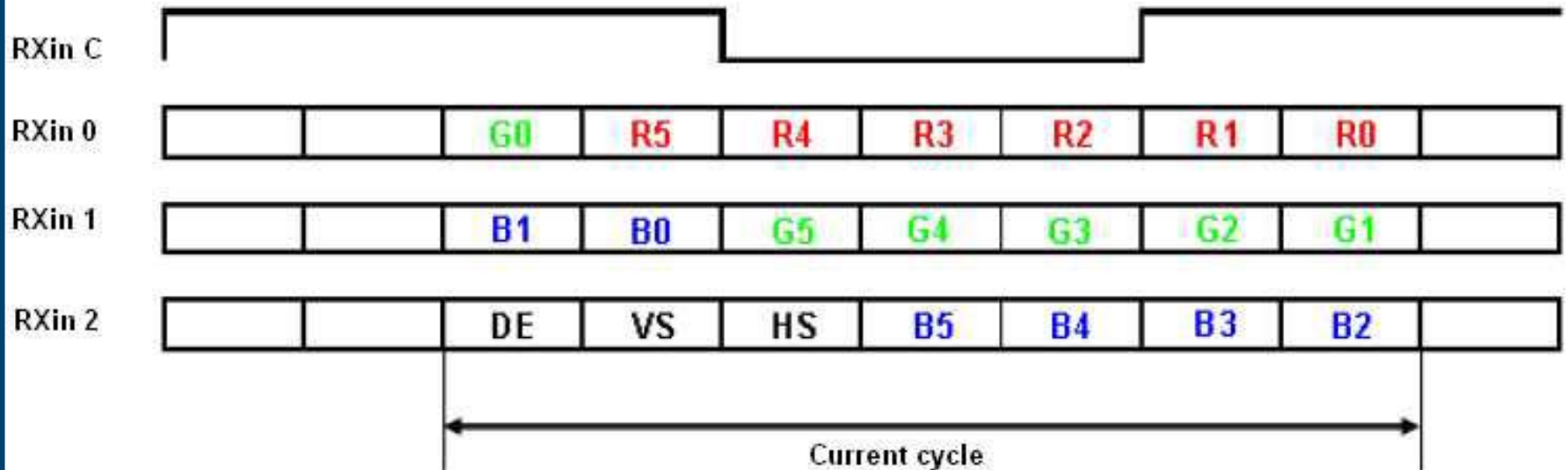
- Triple frame buffer used to pass frames between two distinct clock domains without tearing



Pixel Data Serialization Requirement

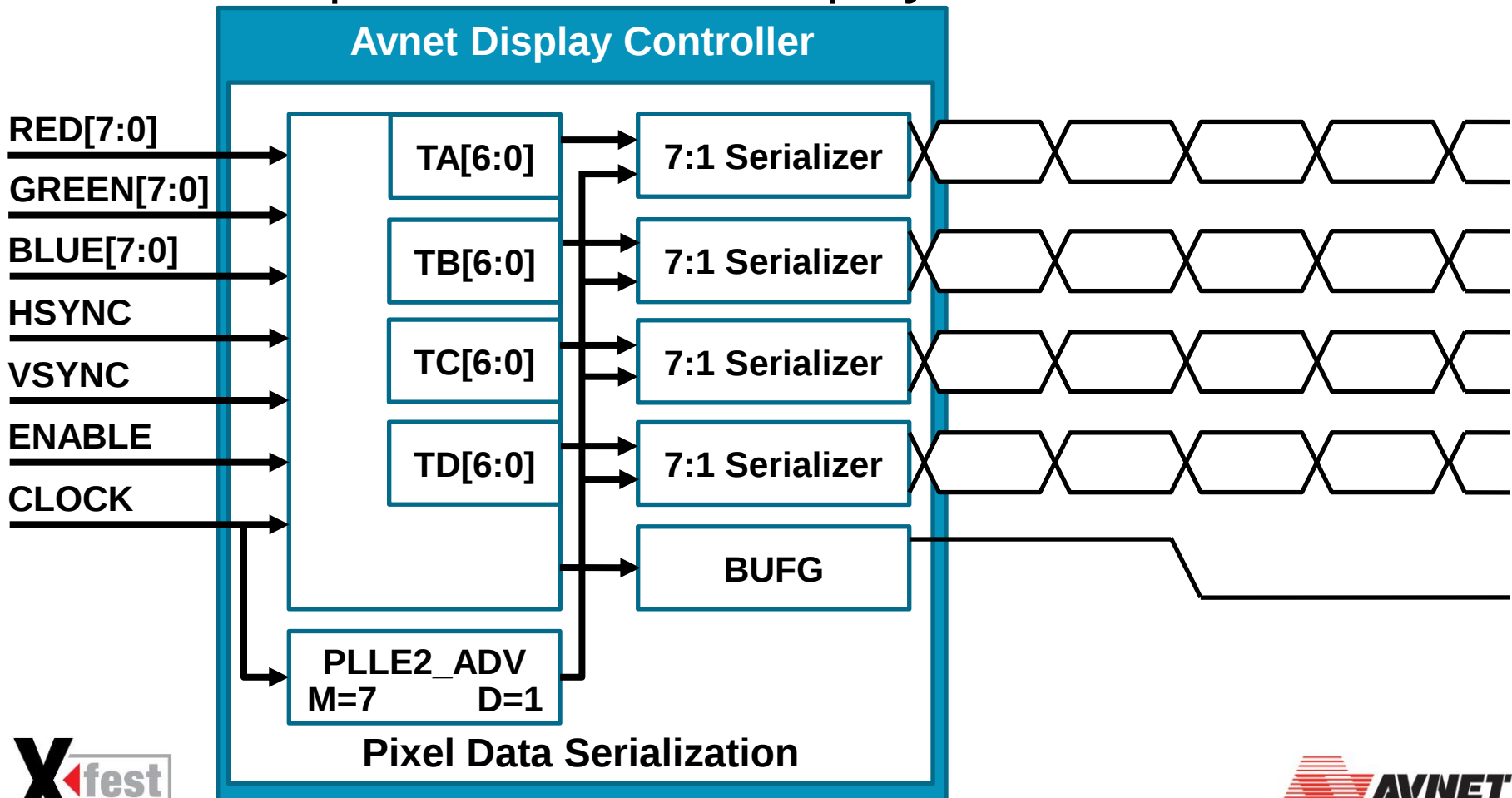
- Video data requires serialization to match data pattern specified by the display manufacturer

Kyocera 10.1 inch TVL-55682D101U-LW-I-AAN LVDS Data Mapping Specification



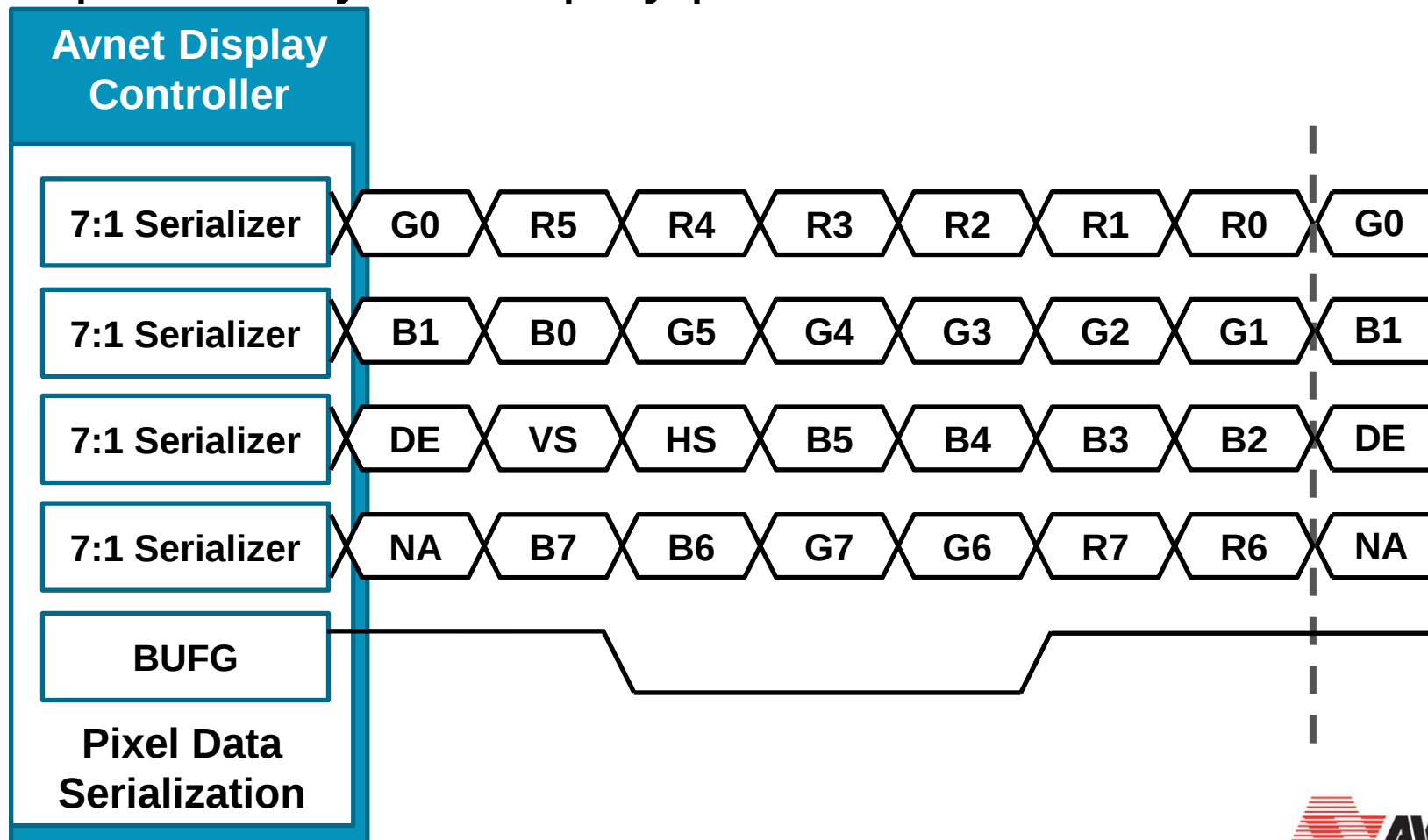
Achieving Pixel Data Serialization

- OSERDES2 primitive of 7-Series™ fabric used to serialize pixel data to the display



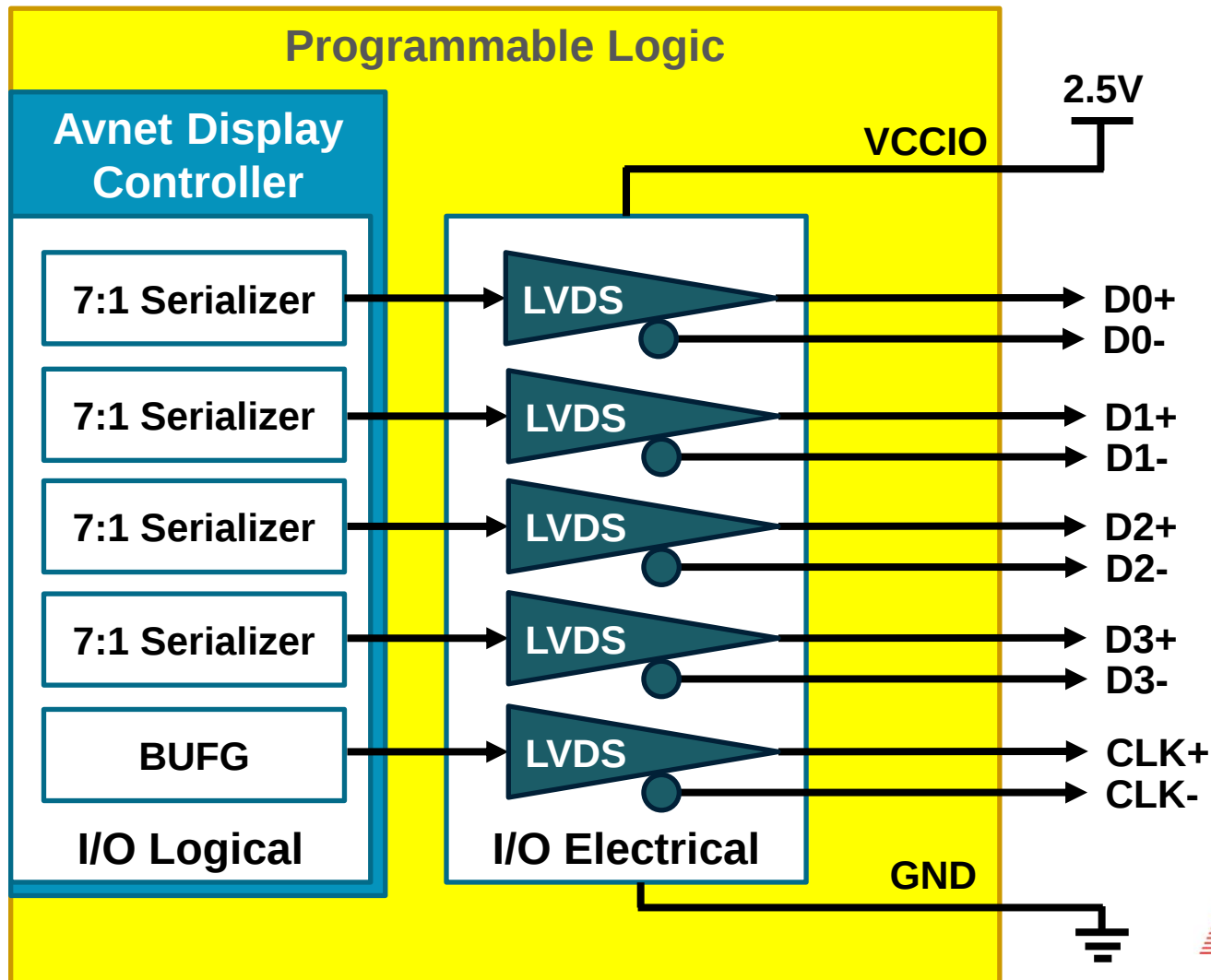
Pixel Data Pattern Formatting

- Resulting data output matches the RGB pattern specified by the display panel manufacturer



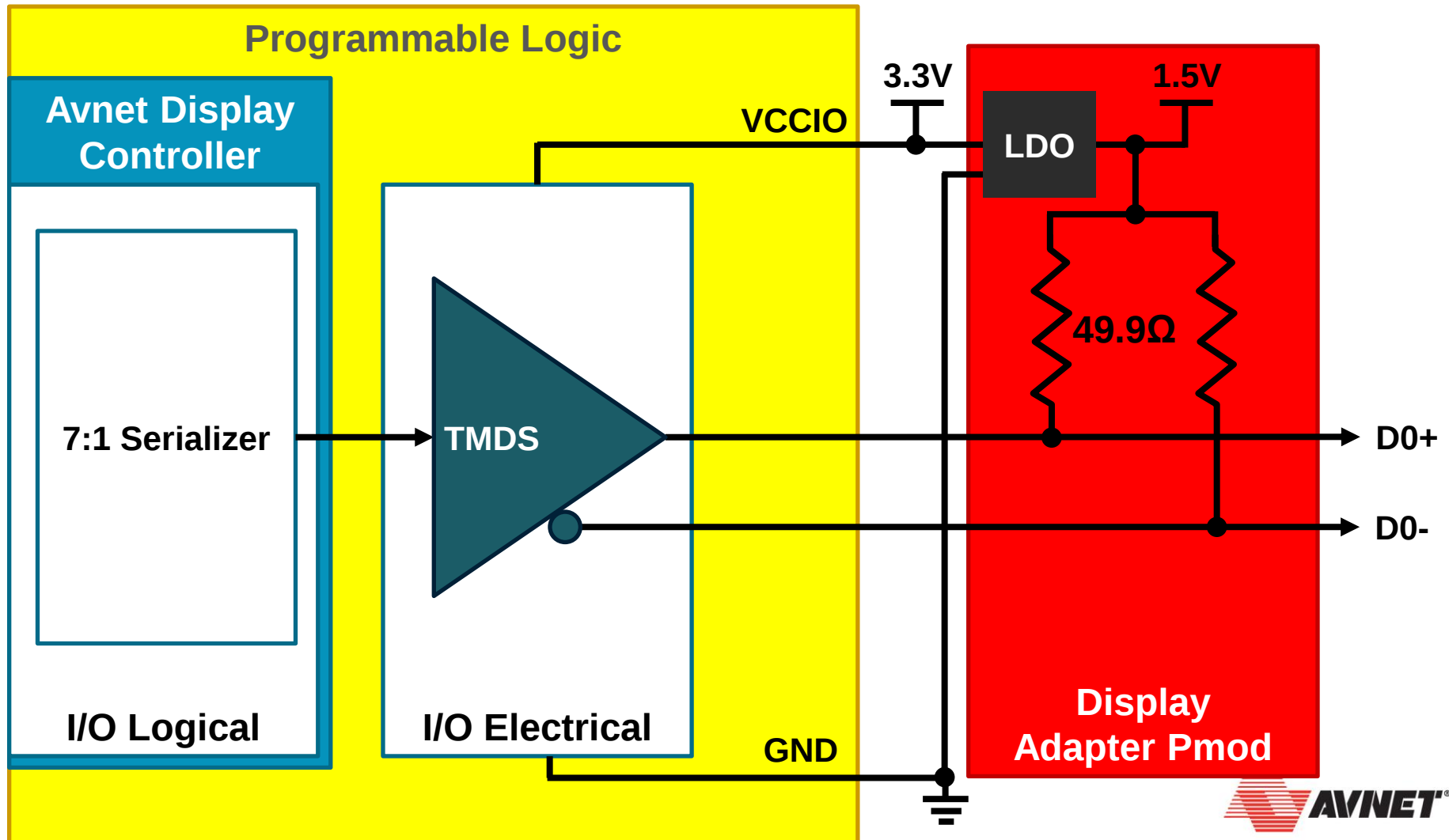
LVDS Output from Programmable Logic

- Driving LVDS output using Series-7 I/O

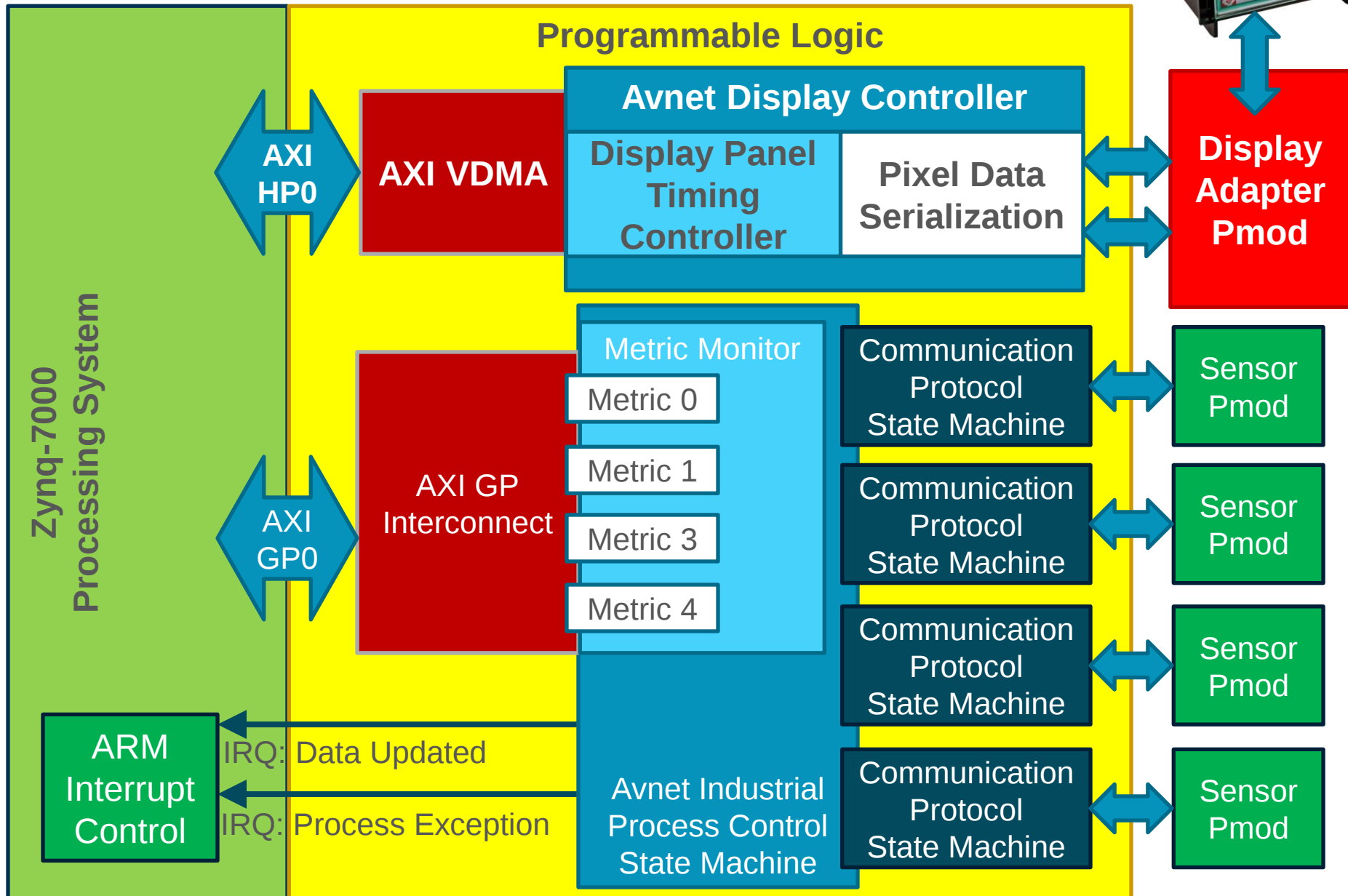


LVDS Output Level Translation

- Synthesizing LVDS output levels using TMD5 drivers



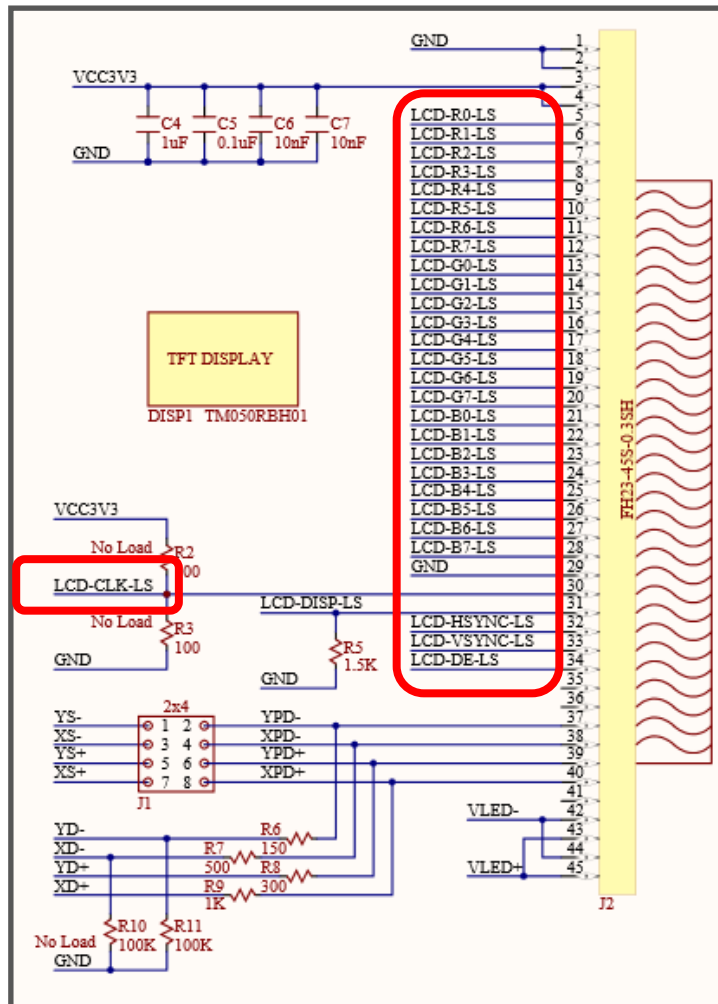
System Level Integration – Display Added



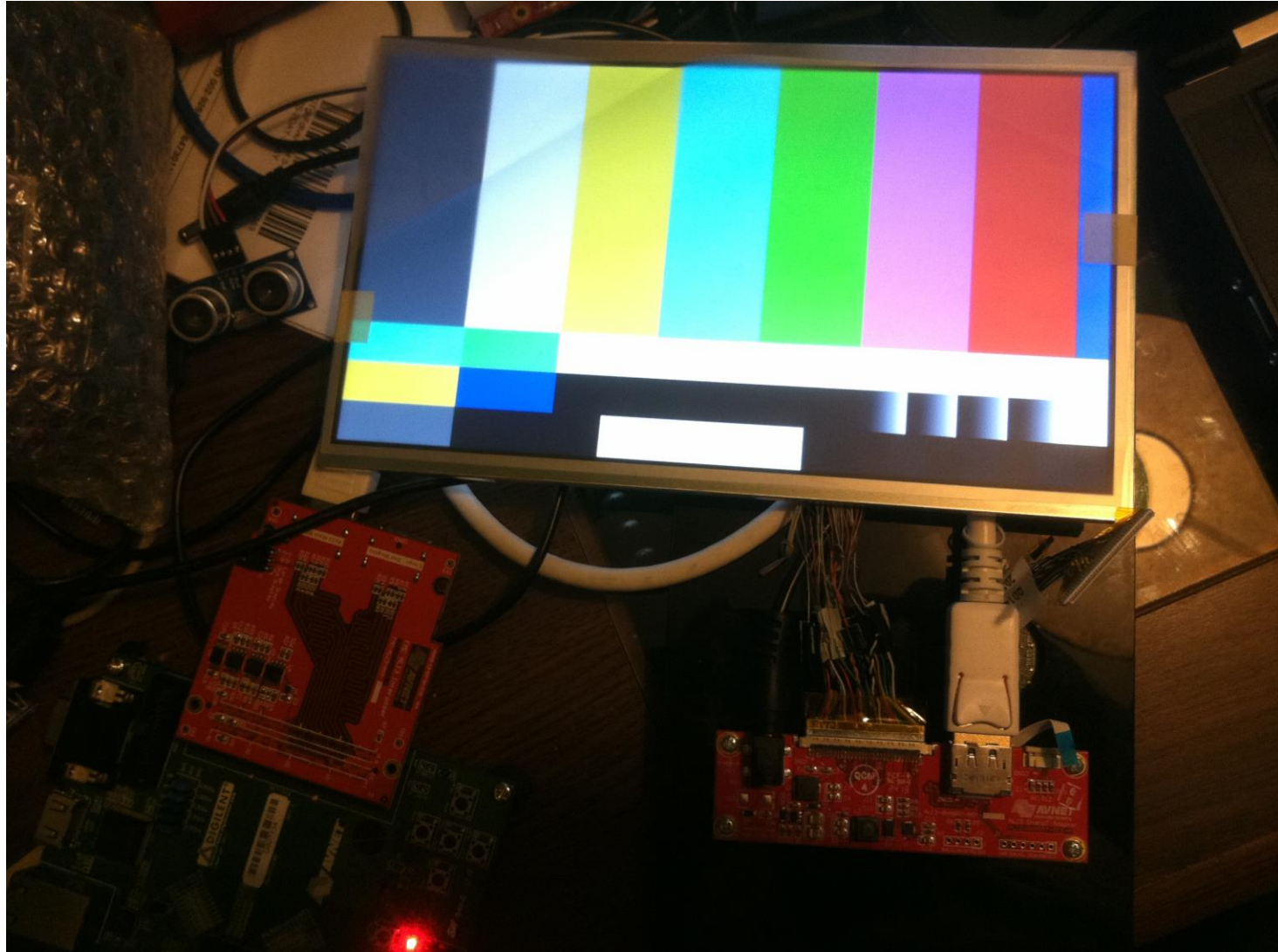
Example Design Leveraging MicroZed SOM

Adding a Touch Display to Your System

- Goal: Provide low cost touch display capability
 - Fits into an LPC FMC slot
 - 29 I/O pins used for parallel RGB
 - Uses XADC for touch

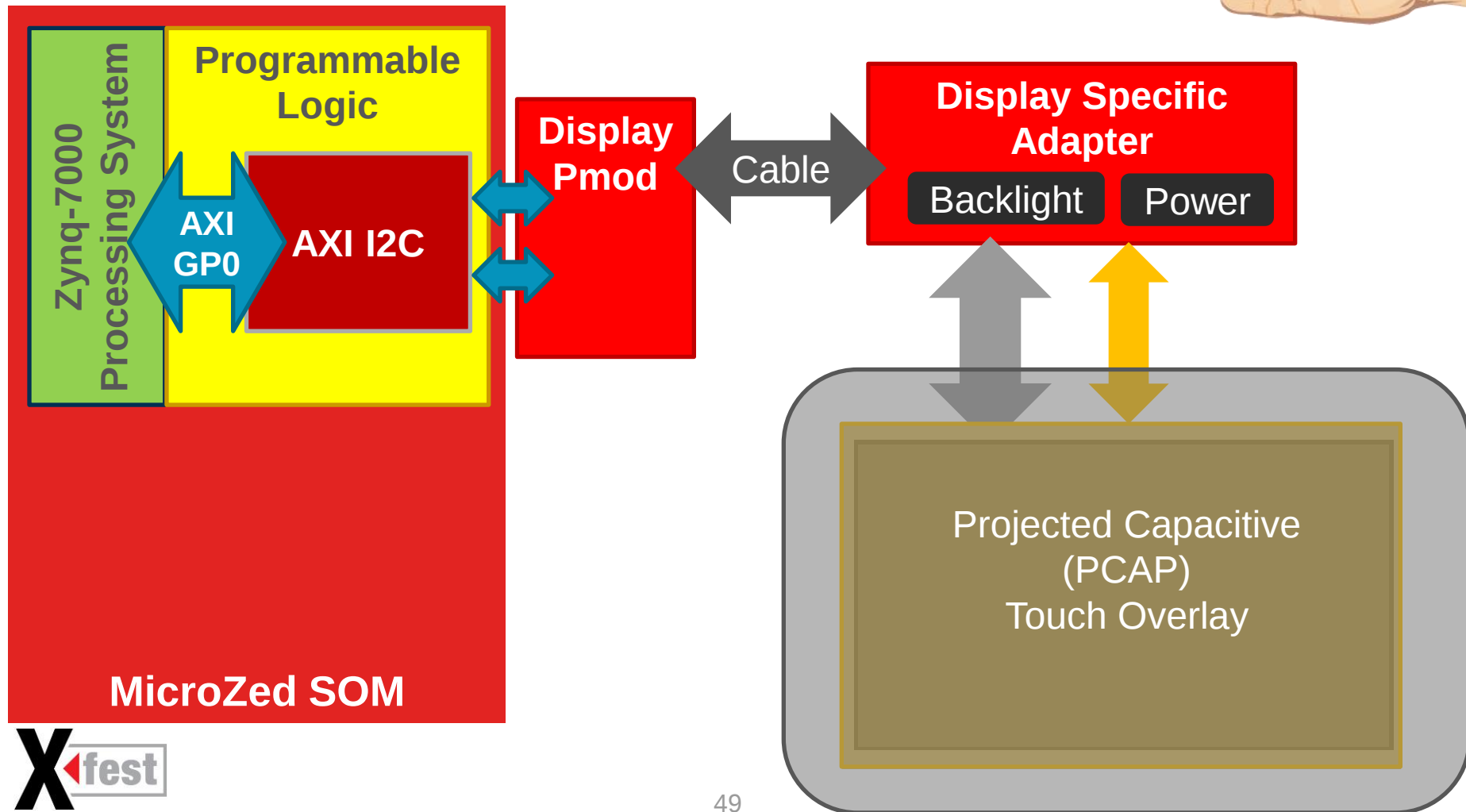


Adding a Better Touch Display to Your System



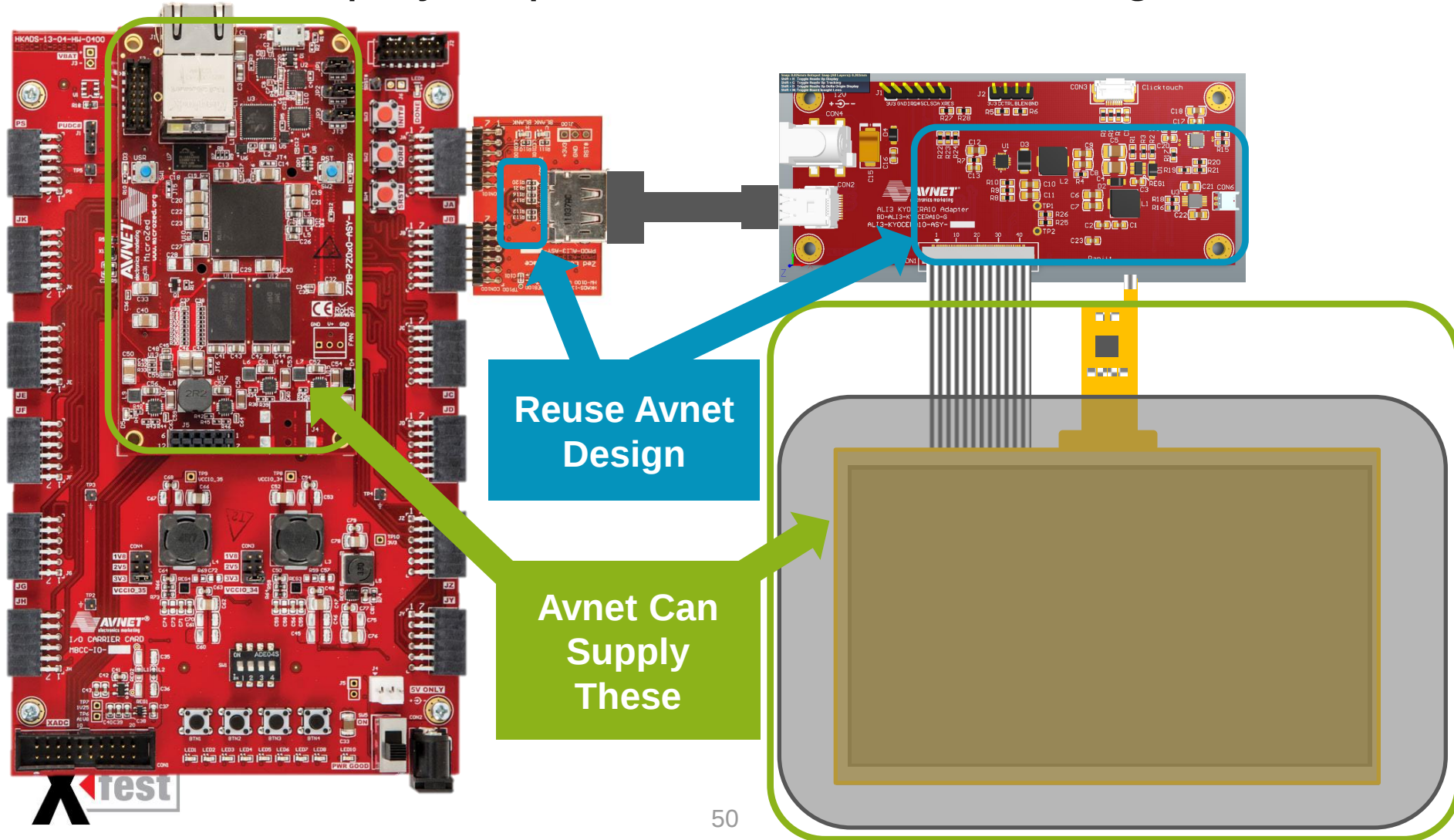
Adding Touch Capability to the Display

- Goal: Provide better touch display capability



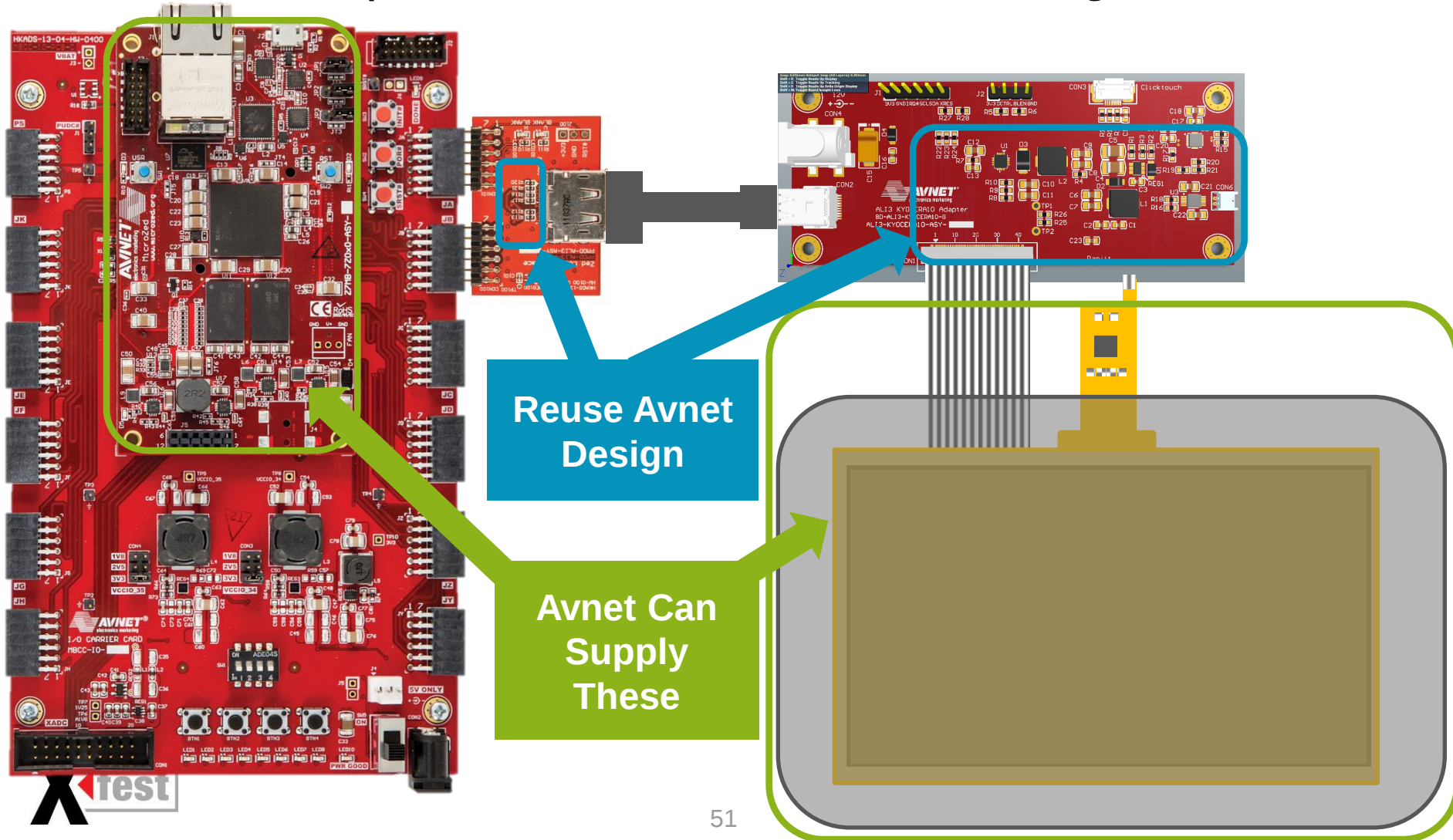
Easy Display Design Adoption Into End Product

- Which display kit pieces are useful for design reuse?



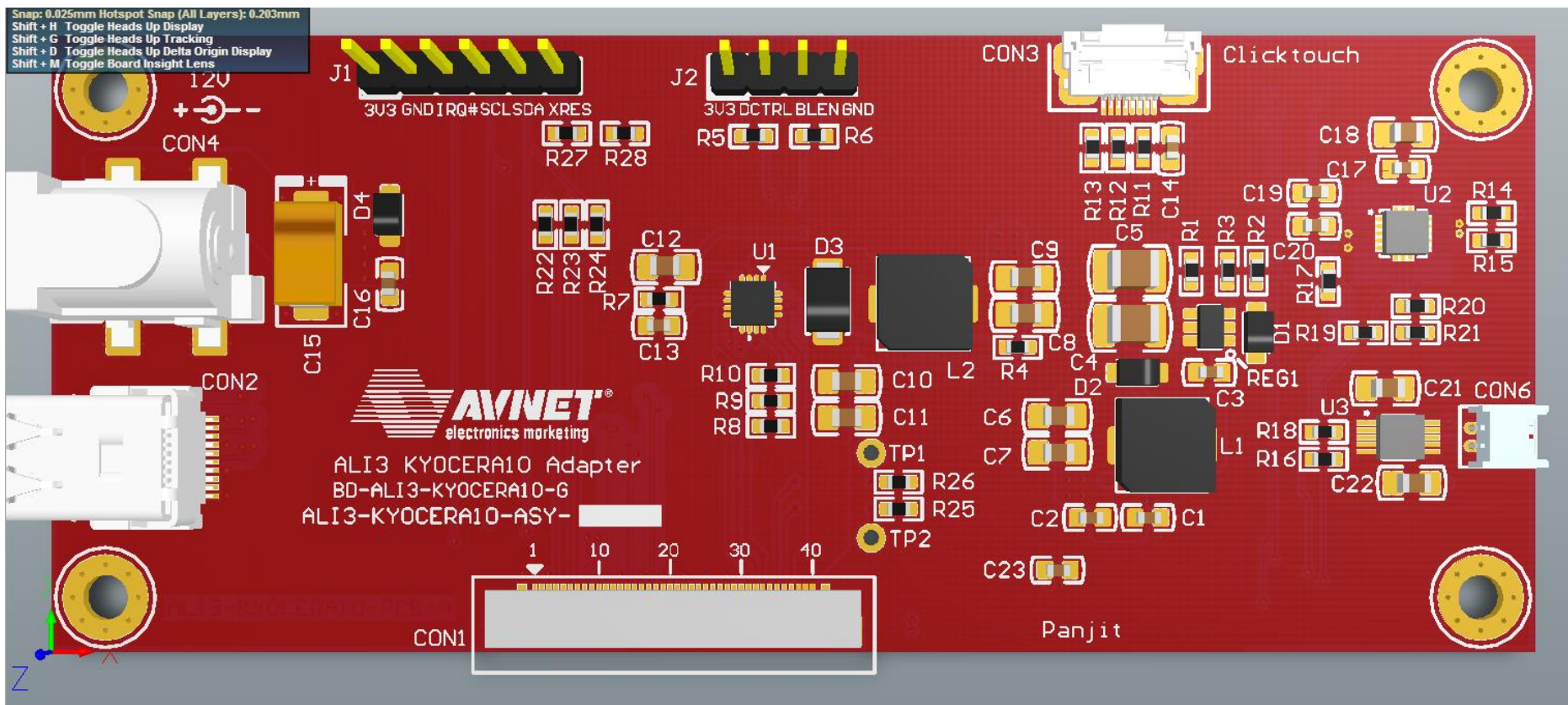
Easy Display Design Adoption Into End Product

- Which adapter circuits are useful for design reuse?



Easy Display Design Adoption Into End Product

- Which adapter circuits are useful for design reuse?

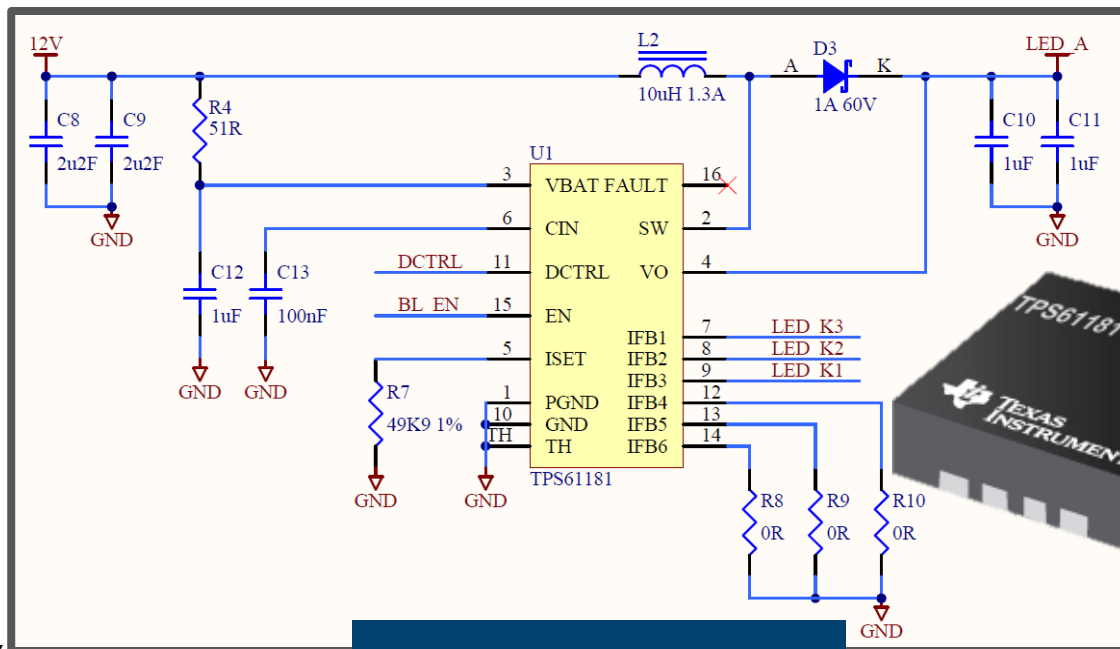


Easy Display Design Adoption Into End Product

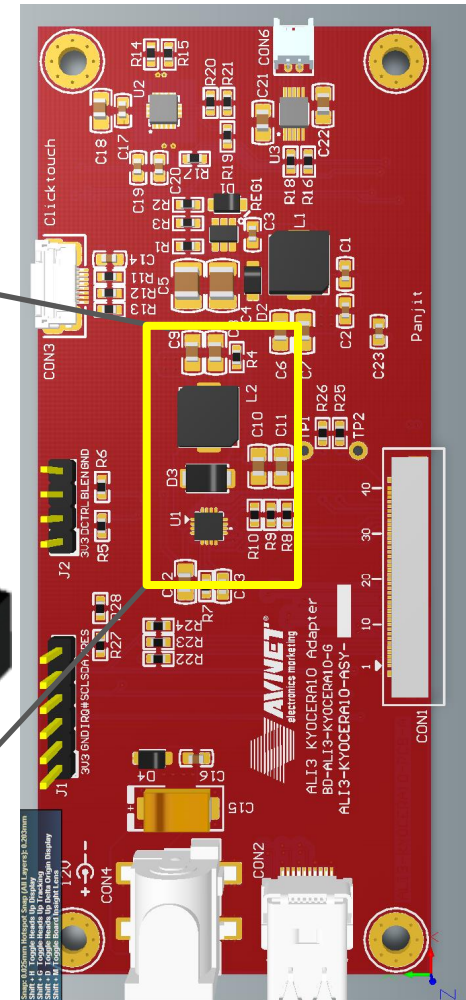
- Display panel LED backlight driver
 - Better than 3% accuracy and current matching between 6 LED strings
 - Up to 10 LEDs per string → 60 LEDs total



TEXAS
INSTRUMENTS



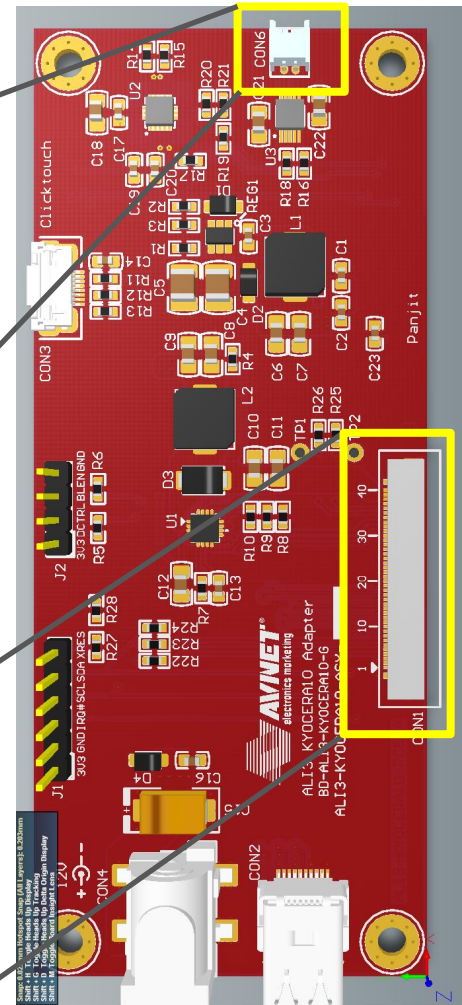
TPS61181



Easy Display Design Adoption Into End Product

- Display panel and actuator connectors
 - High performance and high reliability
 - PCB design files available through FAE

1734829-2



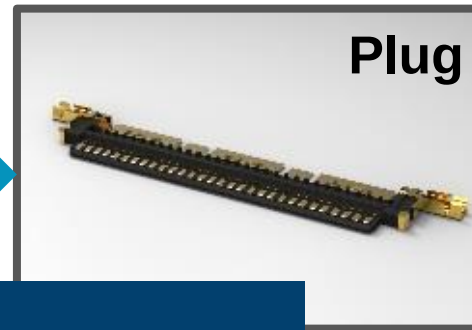
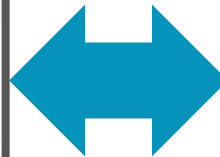
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Easy Display Design Adoption Into End Product

- LCEDI display panel connectors



- LCD Coaxial EMBEDDED DISPLAY Interface
- Compatible and inter-mateable with I-PEX CABLINE-VS
- Full lock mechanism with optional pull bar
- Mixed cable use:
 - Micro coax (Twin coax AWG#40 or smaller)
 - Discrete wire (AWG #32 or smaller)
- Ultra-low profile mating configuration



Easy Display Design Adoption Into End Product

- Sharp 7" Touch Display Assembly
 - Sharp LQ070Y3LG4A 7" LVDS LED Backlight TFT Panel
 - Avnet 7" Projected Capacitive (PCAP) Touch Overlay
- 12V@1A wall power supply
- Zed LCD Interface Board and Cable
- Getting Started Card
- Reference design tutorials

AES-ALI2-ZED-G

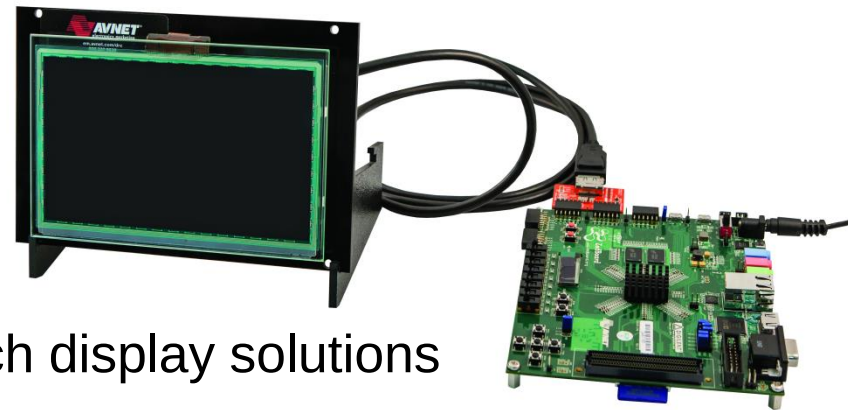
Resale \$499

www.microzed.org/product/7-inch-zed-touch-display-kit



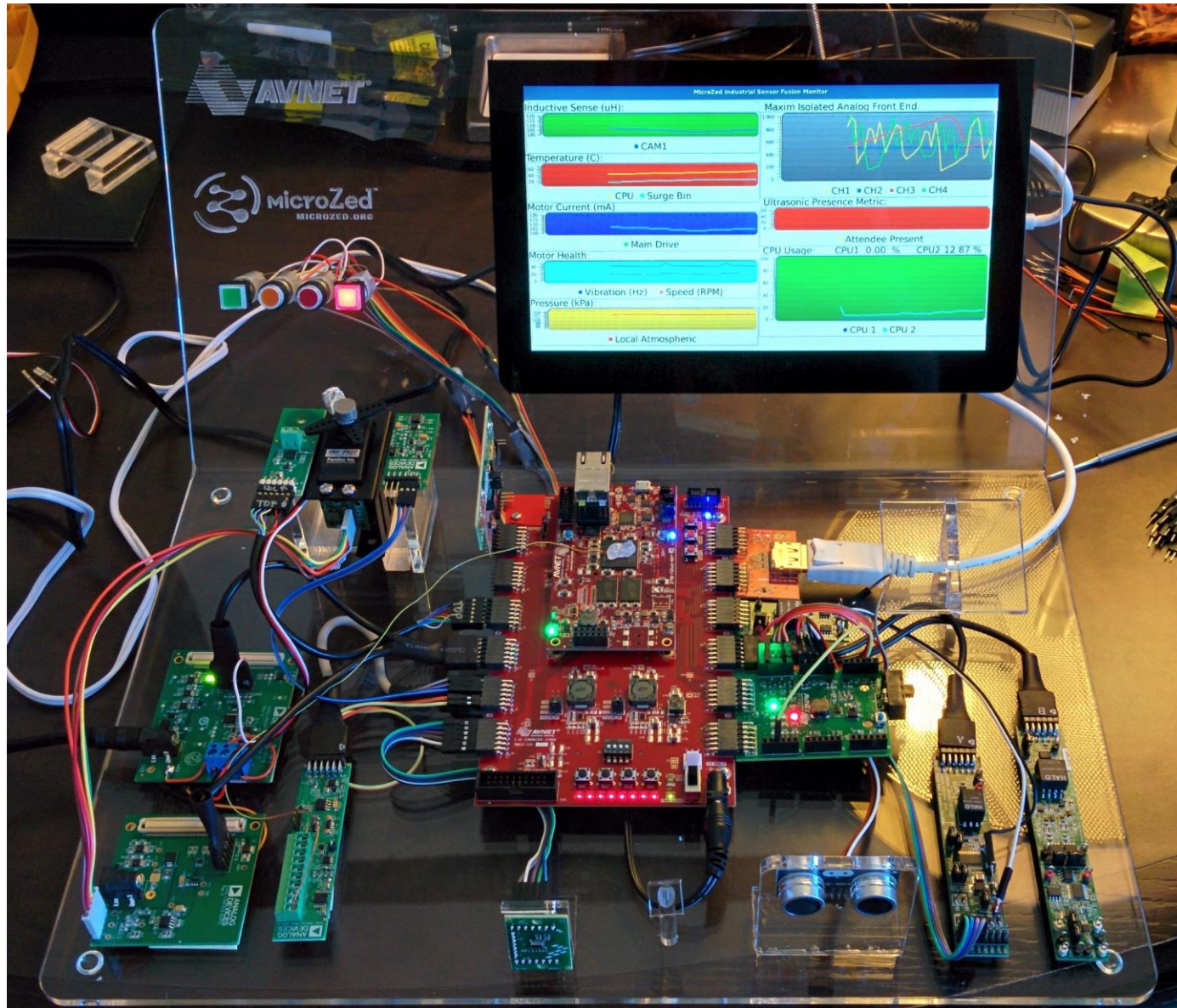
Easy Display Design Adoption Into End Product

- Enhanced Display Ruggedness
 - Outdoor or industrial environments (publicly accessible kiosks)
 - Better long term touch endurance and performance
- Medical and Industrial Product Designs
 - High humidity environment capability
 - Operational temp -20 to +50°C
 - Up to 6mm glass thickness
 - Touch allows for gloved operation
- MicroZed Developers
 - Alternative to existing resistive touch display solutions
 - Connects directly to MicroZed Carriers via Pmod expansion
 - Enables display options without use of sole available FMC slot



Designed for Prototyping, Ready for Production...

MicroZed SOM Based Reference Designs



Where to Find More Information



Training and Reference Design Tutorials

- Introduction to the 7" Zed Touch Display Kit
 - <http://youtu.be/VoiXMn8s0lY>
- Enabling Haptics in Industrial Applications On-Ramp Technical Session™
 - <http://youtu.be/cRof4wyVrDE>
- Display Panel Controller Standalone and Ubuntu Tutorials for MicroZed and ZedBoard
 - <http://www.microzed.org/support/design/1668/13>
- WiLink8 Pmod™ Compatible Adapter and Module
 - www.em.avnet.com/pmodwifi-wilink8
 - <http://www.ti.com/tool/wl1835modcom8b>

Training and Reference Design Tutorials

- Analog Devices ADV7511 HDMI Device Linux Driver
 - <http://wiki.analog.com/resources/tools-software/linux-drivers/drm/adv7511>
- Analog Devices ADAU1761 Audio Device Linux Driver
 - <http://wiki.analog.com/resources/tools-software/linux-drivers/sound/adau1361>
- Analog Devices ADXL362 Accelerometer Pmod Reference Design
 - <http://wiki.analog.com/resources/fpga/xilinx/pmod/adxl362>
- Analog Devices ADV7511 and ADAU1761 Running Under Ubuntu Desktop Linux
 - <http://www.microzed.org/support/design/2056/17>

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Thank You

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