

SoC Technology/Tools and the CYPros Program

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May 15, 2007



PERFORM

Agenda

- Non-UI applications of embedded SoC
- UI applications of embedded SoC
 - Capacitive sensing
 - Touchscreens
 - Pyroelectric IR proximity detection
- “Make a PSoC design” application demonstration
- CYPros Consultants Program

Agenda

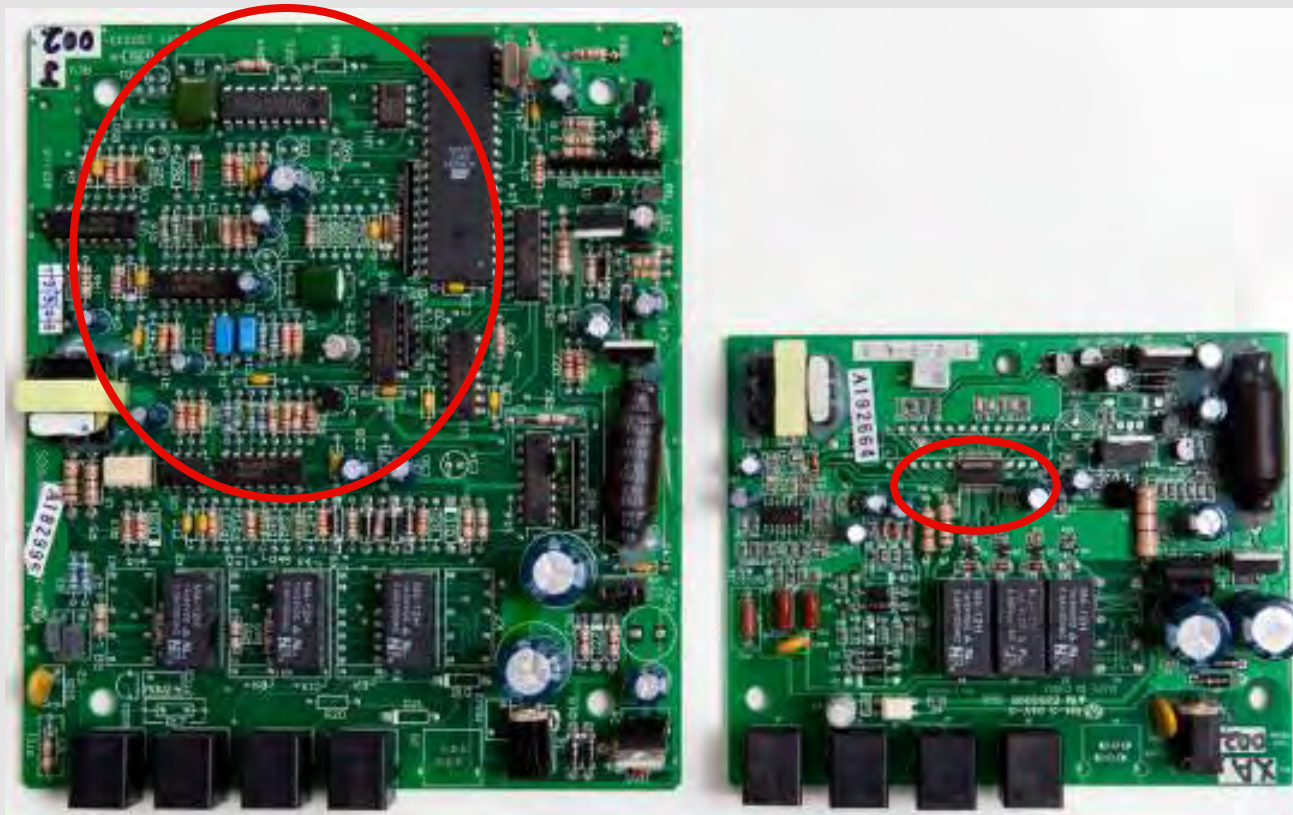
- ***Non-UI applications of embedded SoC***
- UI applications of embedded SoC
 - Capacitive sensing
 - Touchscreens
 - Pyroelectric IR proximity detection
- “Make a PSoC design” application demonstration
- CYPros Consultants Program

What is SoC?

- Wikipedia

System-on-a-chip or **system on chip** (**SoC** or **SOC**) is an idea of integrating all components of a computer or other electronic system into a single integrated circuit (chip). It may contain digital, analog, mixed-signal, and often radio-frequency functions – all on one chip. A typical application is in the area of embedded systems.

SoCs: “Analog IC Replacement”



Before SoC

After SoC

Example: Voltage Monitoring and Sequencing

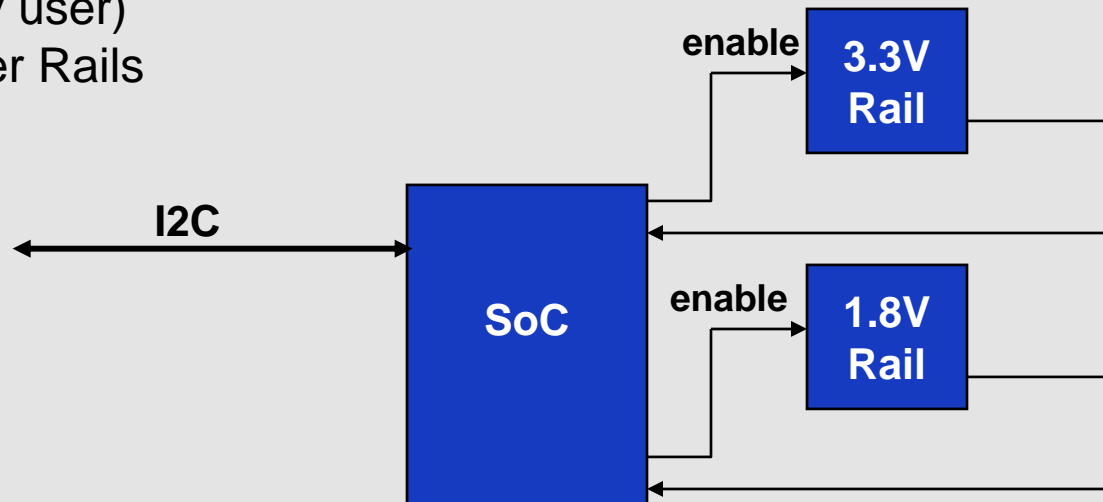
Voltage Monitoring And Sequencing

- Control and Monitoring Of Up To 8 Voltages (values/order selected by user).
- Analog Inputs Muxed into Delta Sig A/D. (compare Values selected by user)
- Sequenced Enable of Power Rails (variable time set by user)

For up to 8 Voltages:

Turn On 3.3V
Wait x ms
Is 3.3V Good?
Wait 'x' ms
Turn on 1.8V
Is 1.8V Good?

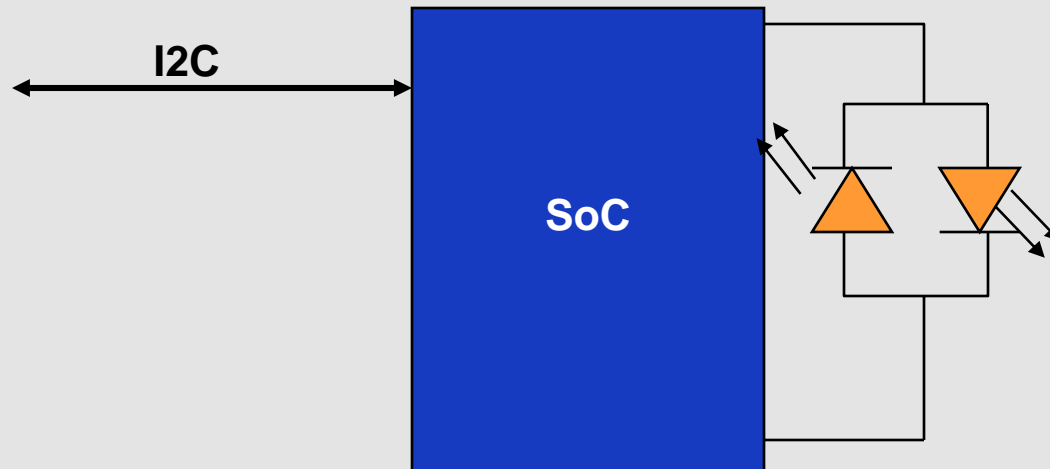
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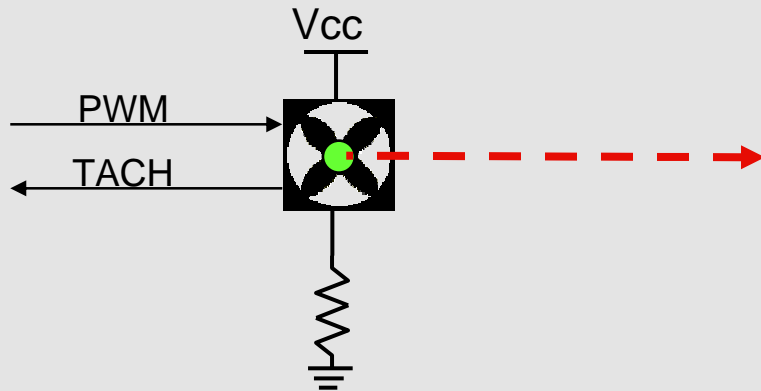
Example: LED Test and Control

I2C Based LED Test and Control

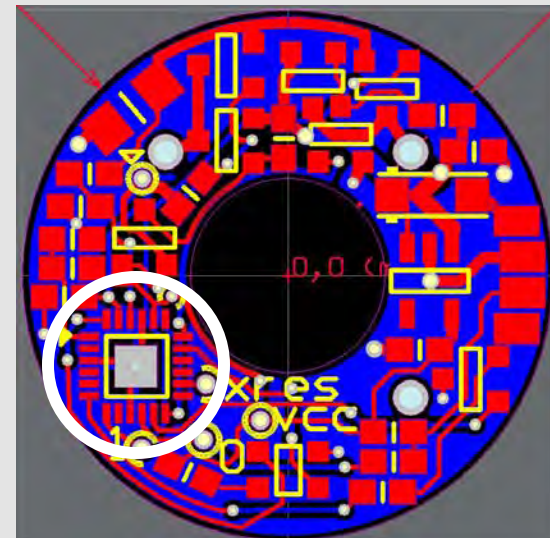
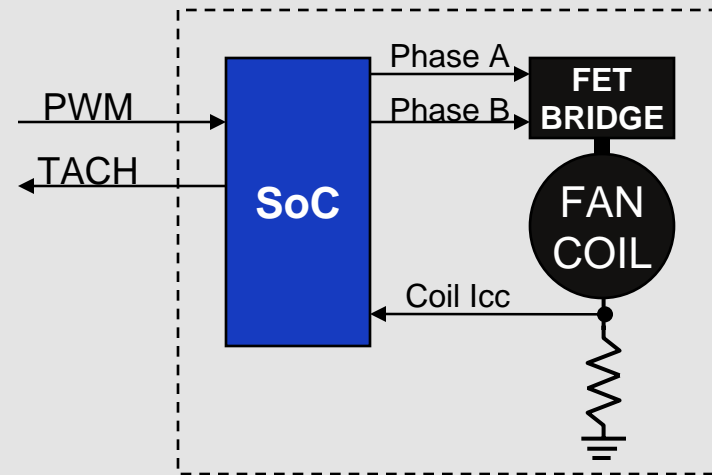
- Enables Test AND Control (e.g., Bi-Color LEDs)
- Interface through I2C
- LED intensity control with blink and dim
- Testing can detect opens, shorts, degraded performance
- tiny pkg: 32-pin MLF (QFN) – drives 12 bicolor LEDs
- eliminates manual visual testing



Example: Fan Control



- SoC Replaces PWM ASIC Inside Fan
- Implements Closed Loop PID Fan Controller
- “Drop-In” replacement for any 4-wire fan
- Increased performance, flexibility and features at a reduced per-unit fan cost



40mm Fan hub layout with SoC

SoCs and Measuring Temperature (using a thermistor)

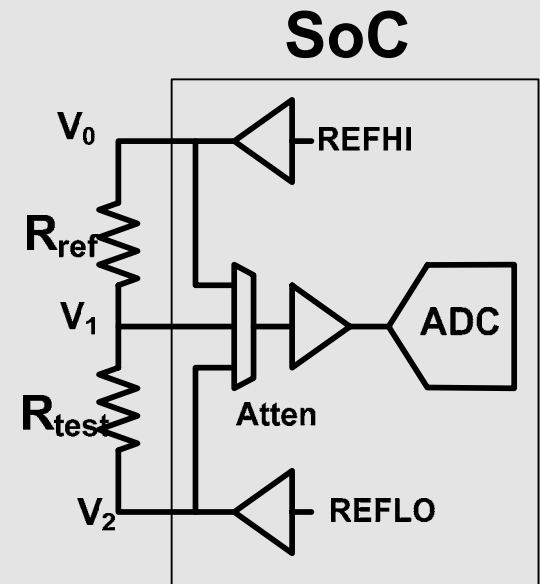
- For this circuit the following equation holds.

$$\frac{V_0 - V_1}{R_{ref}} = \frac{V_1 - V_2}{R_{test}}$$

- Solving for R_{test} results in:

$$R_{test} = R_{ref} \frac{V_1 - V_2}{V_0 - V_1}$$

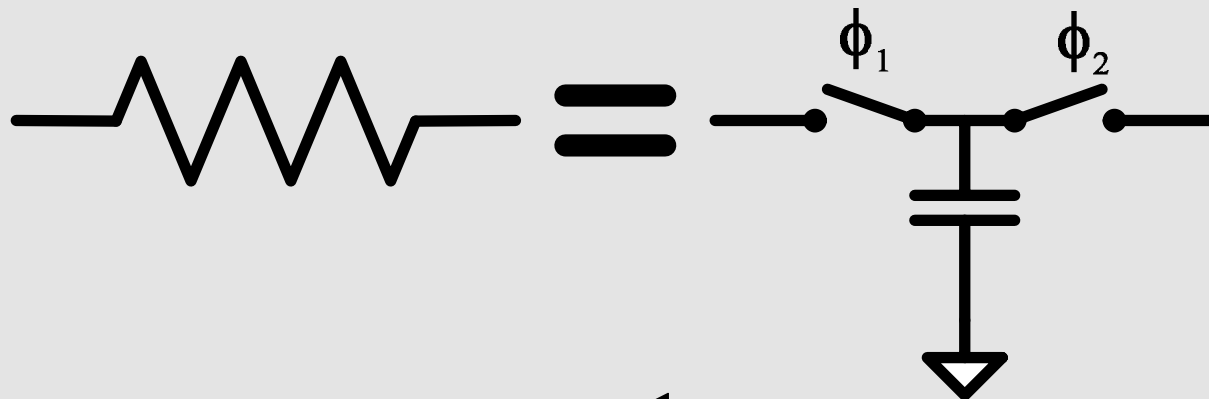
- Offset errors removed by difference
 - Measurement offset voltages subtract out
- Gain errors removed by quotient
 - Measurement path errors divide out
- Accuracy determined by external reference resistor and ADC resolution



SoCs and Fan Control

- Advantages of using SoCs for Fan Control
 - More accurate fan speed control
 - Airpath blockage detection
 - Lower audible noise
 - Lower current demands on system startup
 - Fan failure prediction
- Additional system management capabilities enabled by SoCs
 - CapSense (for buttons, sliders, etc)
 - Power sequencing
 - Power supply monitoring
 - Thermal monitoring
 - Display control (Hitachi HD44780 protocol or I2C)

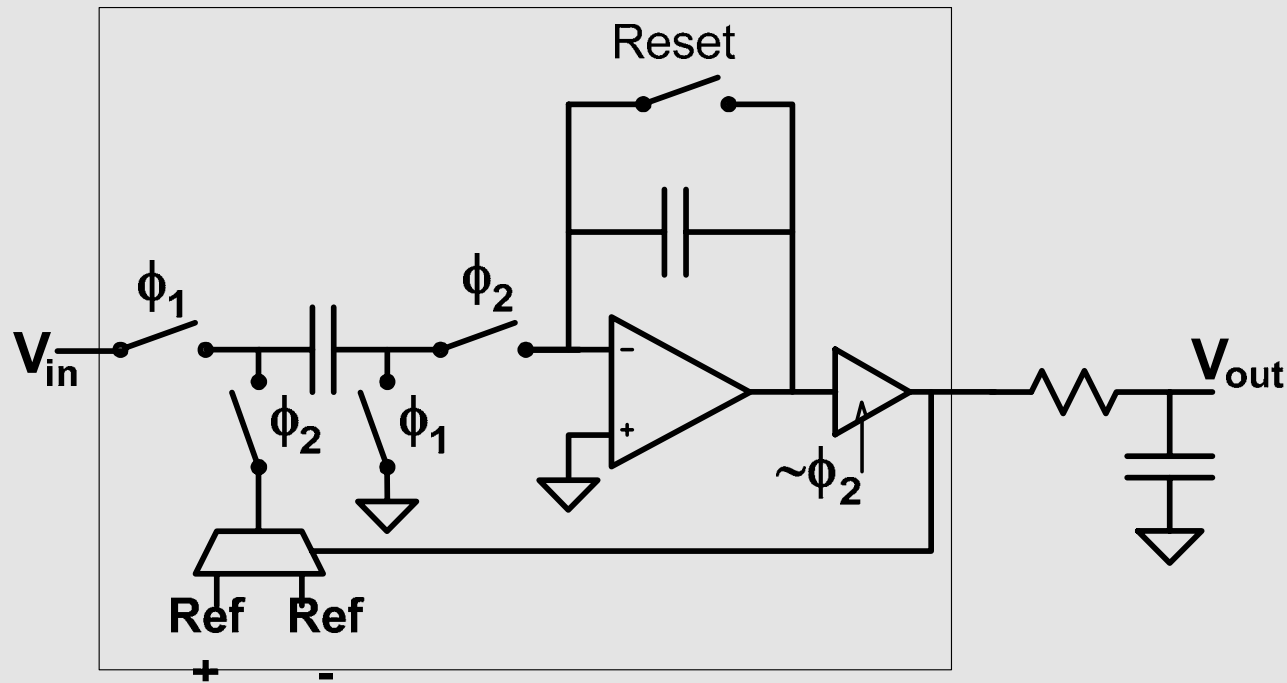
Switched Cap Technology



$$R = \frac{1}{f_s C}$$

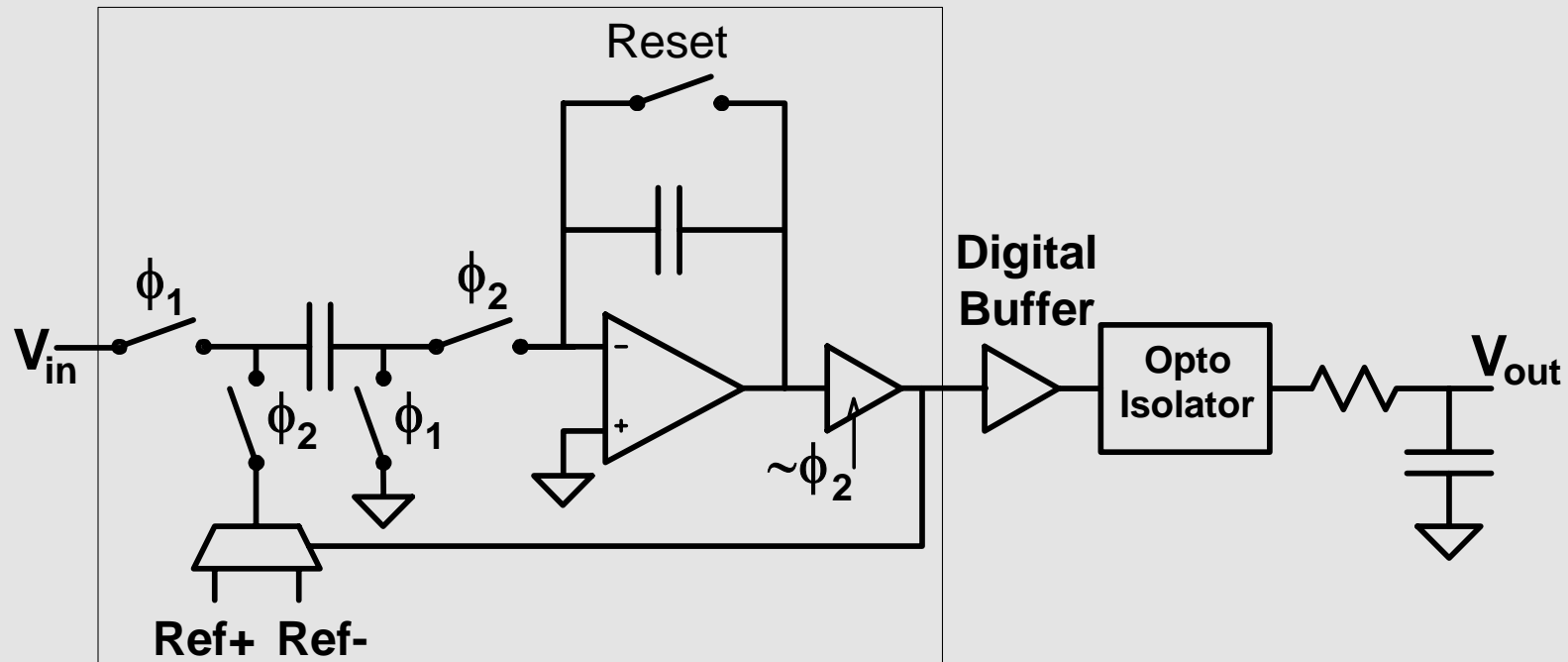
Switched-Cap Technology Applications

Analog-Analog Conversion (AAC)



Switched-Cap Technology Applications

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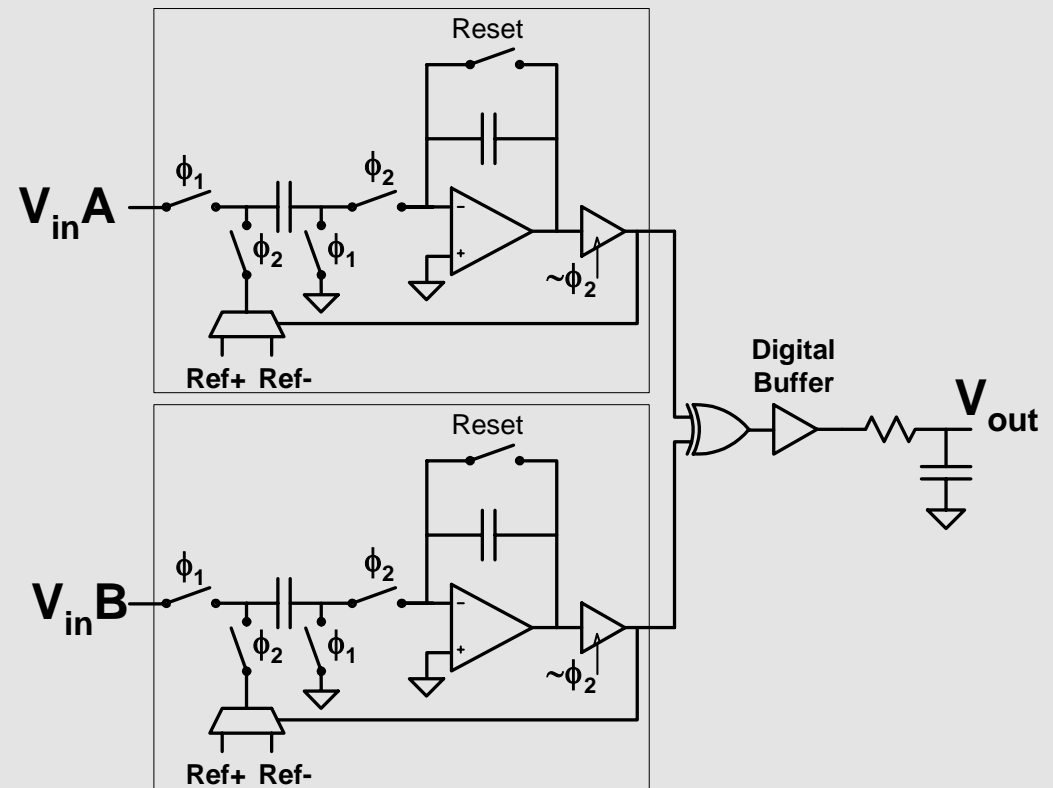


Switched-Cap Technology Applications

Analog Multiplier

- ADC Modulator acts like a one bit ADC that converts an input to a series of positive and negative pulses.
- XOR gate acts like a one bit inverting multiplier.
- When XOR output is filtered the result is:

$$V_{out} = -(V_{inA} \cdot V_{inB})$$



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 - ***Pyroelectric IR proximity detection***
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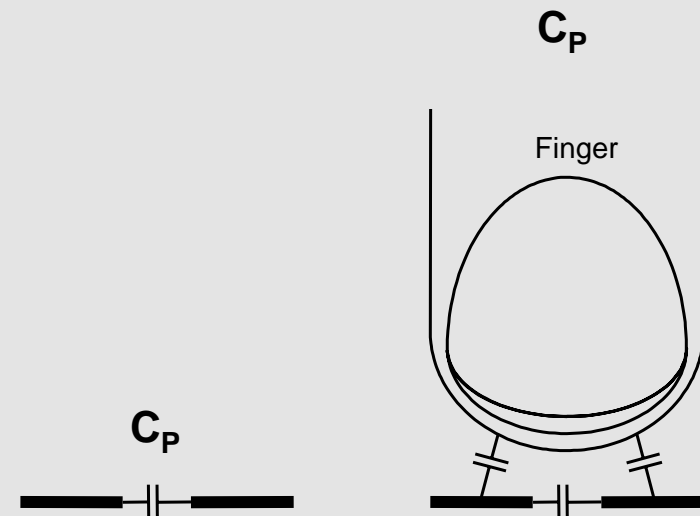
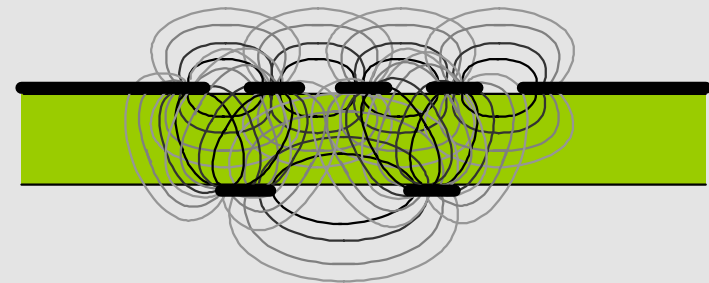
Capacitive Sensing

- **Replaces**
 - Mechanical buttons
 - Thumbwheels
- **Detects presence/absence of an object**
 - No direct contact required



How CapSense Works

- C_P is sum of sensor pad capacitance and parasitics
- C_P is higher when finger is on the sensor pad
- Parasitic Capacitance is generated by coupling from the sensor pad to traces, ground plane, and any surrounding conductive material



Capacitive Sensing Applications

- Buttons
- Sliders
- Touchpads
- Touch Screens
- Proximity Sensors

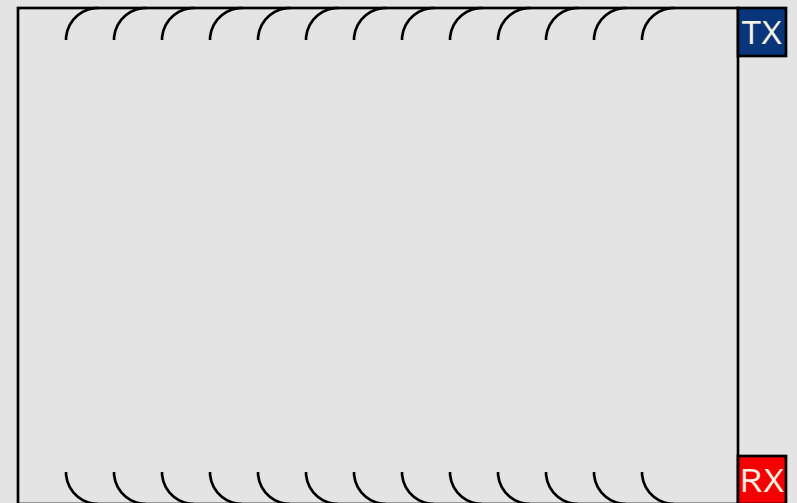


Types of Touch Screens

- Five basic formats
 - Surface Acoustical Wave (SAW)
 - Infrared
 - Resistive (dual-layer)
 - Surface capacitance (single-layer)
 - Projected capacitance
- ITO is primary differentiator
 - Transparent conductor – Indium Tin Oxide

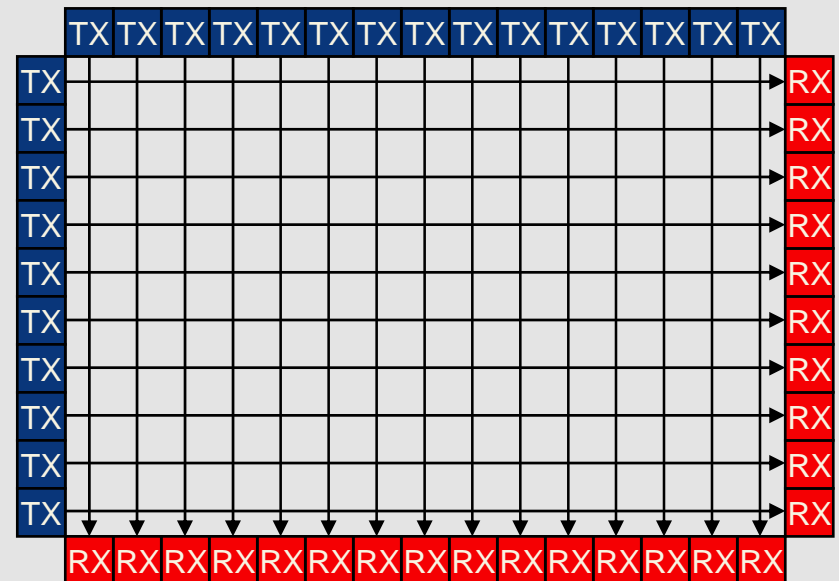
Surface Acoustical Wave (SAW)

- Touch surface separated into multiple zones
- SAW signal
 - Driven into glass
 - Monitored by receiver(s)
 - Other topologies also used
- Requires “soft” touch
 - Damps / terminates acoustic source signal
- Will not work with stylus / fingernail
- Touches between zones may not register



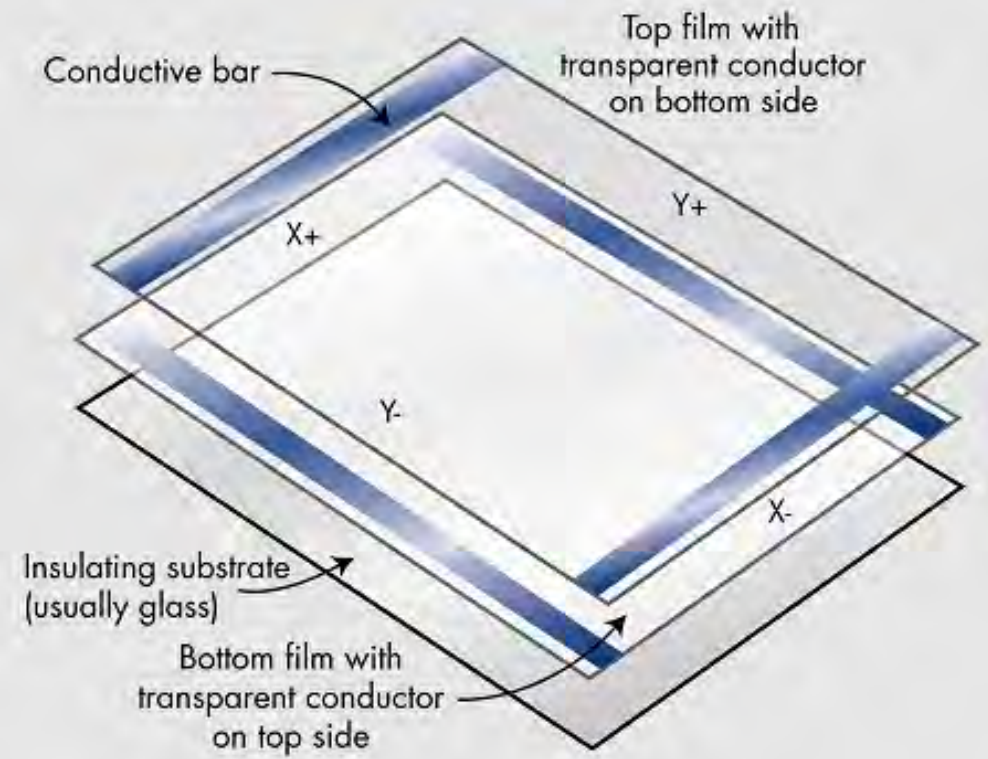
Infrared

- Matrix of infrared emitters and detectors
- Beam broken by finger
 - Used on larger screens
 - Used on test equipment for menus
 - Limited resolution (no interpolation)
- Requires raised bezel
 - Must pass infrared
 - May embed light pipes



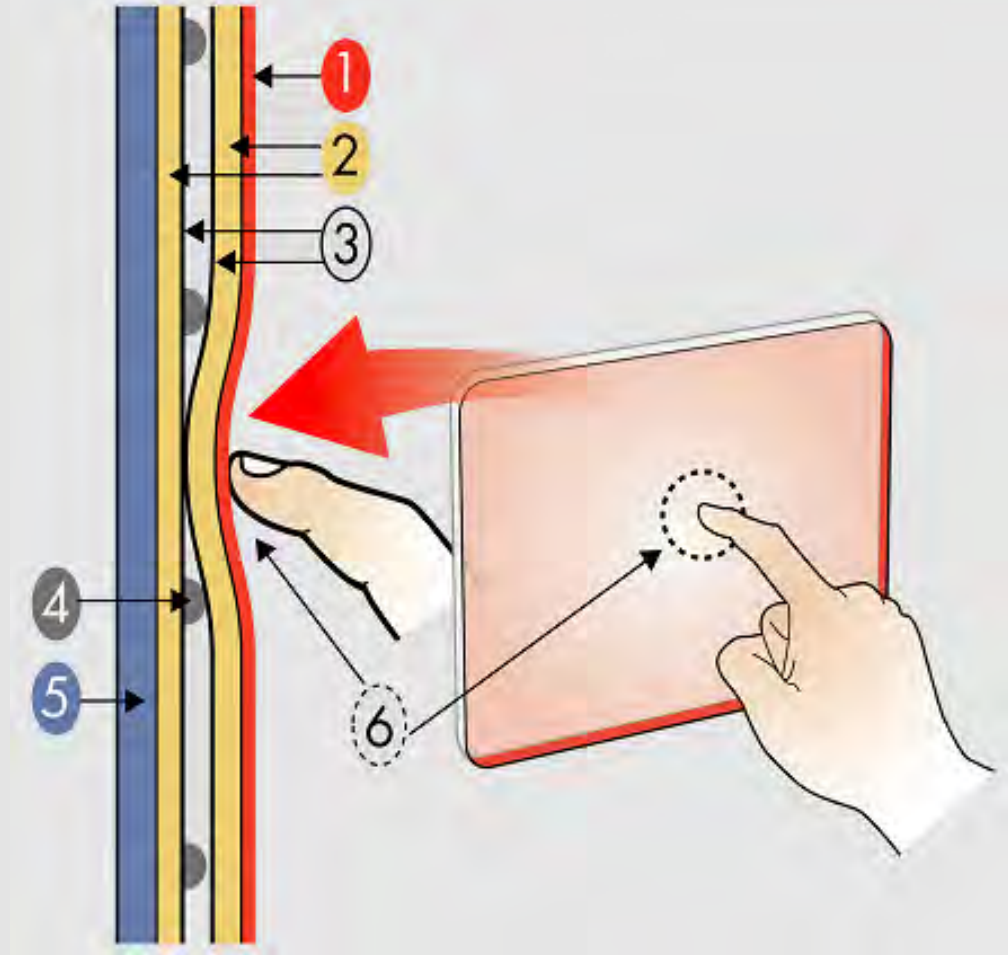
Resistive

- First to use ITO (Indium Tin Oxide)
- 2-layer with air gap
- Many variants exist
 - 4/5/6/8-wire
 - Improves durability and noise rejection



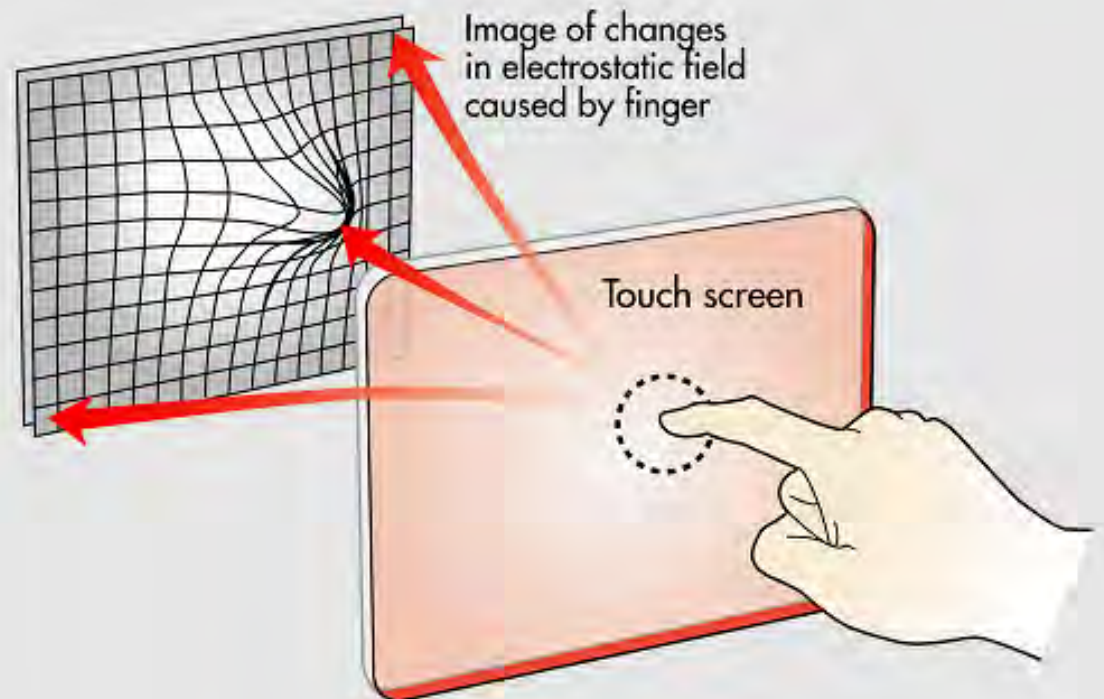
Resistive Construction

1. Hard coat
2. PET film
3. ITO ceramic
4. Spacer dots
5. Glass substrate
6. Pressure element



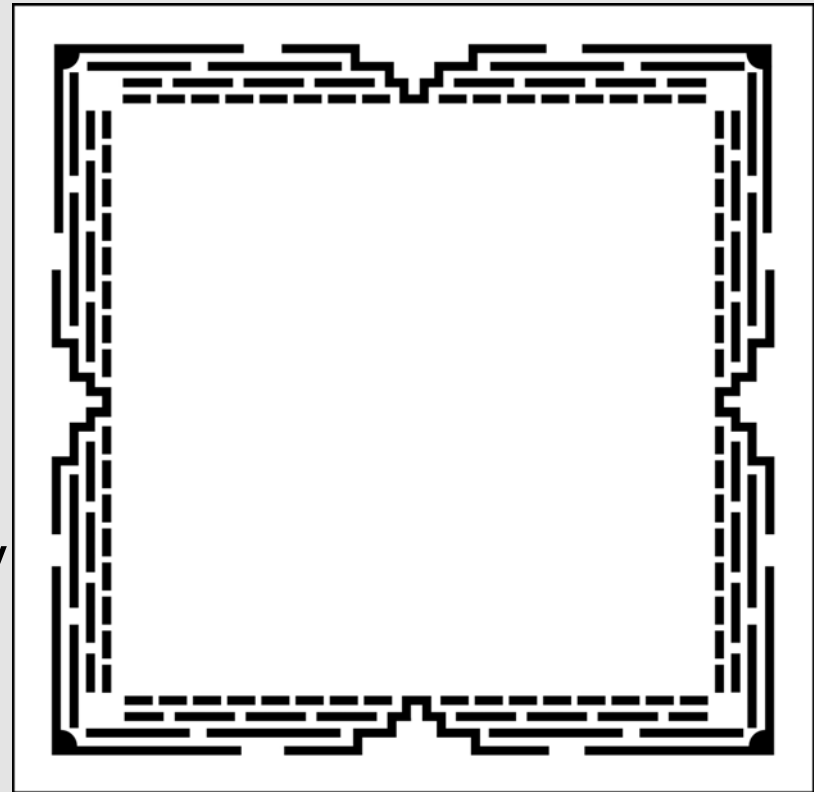
Surface Capacitive

- Sensing from four corners
- Electric field created across surface
- Finger bleeds charge from panel



Surface Capacitive Construction

- Requires metalized border pattern
 - Linearizes electric field across ITO
 - Minimizes corner/edge effects
- Sense lines connect to four corners
- May include a shield layer
 - Blocks noise from display

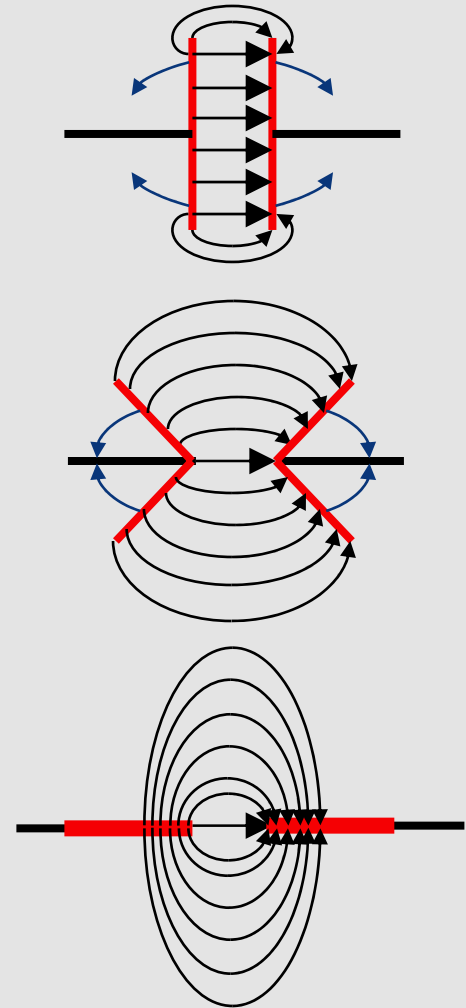


Projected Capacitance

- Ideal for applications requiring
 - Sensing through thick overlays
 - No calibration
 - Multi-touch detection
- E-field forced above sensing surface
- Requires patterned ITO
 - Single or dual-layer
 - Creates multiple sensing elements
- Sense-pads must be small (6-10 mm) for resolution
 - Determined by size of finger

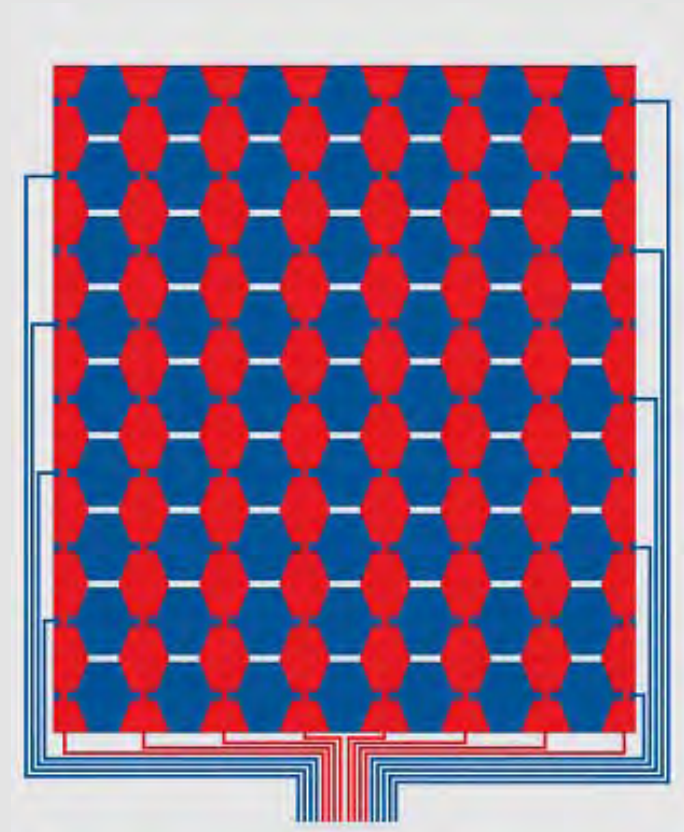
E-field Projection

- Electrostatic field exists between plates of capacitor
- Orientation of plates allows shaping of E-field
- Edge-wise plates cause maximum field projection
 - Projection enhanced by dielectrics



XY Matrix Projected Capacitive

- Typical construction has 2-layers
 - Rows on one
 - Columns on the other
- Alternate construction
 - ITO on both sides of substrate
- Works with multiple sensing methods
 - Each row / column scanned
 - Centroid of finger calculated



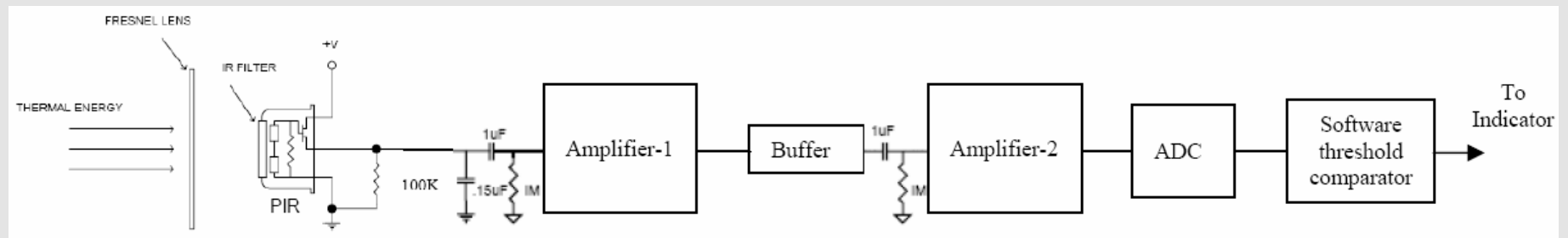
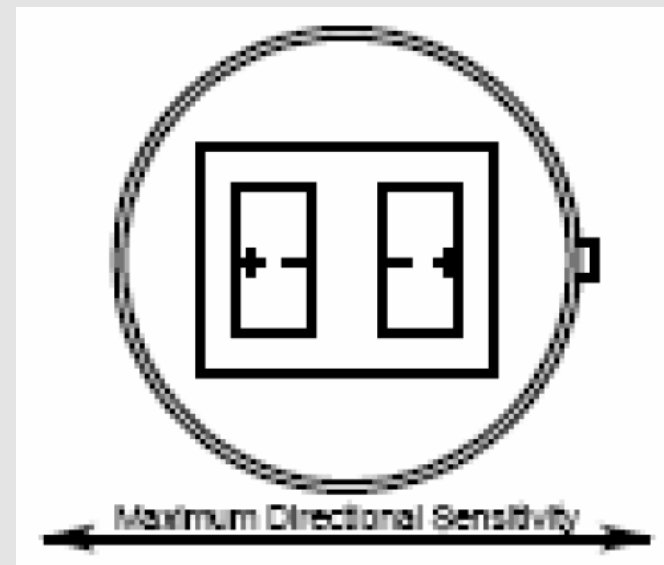
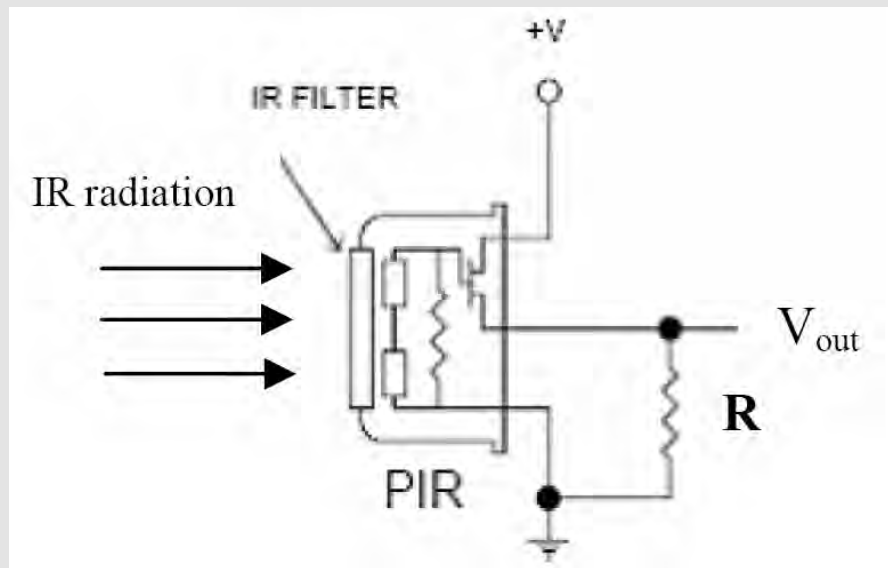
Surface vs. Projected Capacitance

Parameter	Surface Capacitance	Projected Capacitance
ITO Layers	1	1 or 2
Sheet Rho	1k–3k Ω/\square	50–300 Ω/\square
Touch Detection	Single touch	Dual touch
Touch Resolution	Single touch	Single touch
Gloved Hand Detection	Depends	Yes
Linearization Needed	Yes	No

Capacitive vs. Resistive

Capacitive	Resistive
Touch (no pressure needed)	Press (pressure activated)
Single or no calibration required	Calibration required (resistance drift on film)
Better Durability. No significant ageing. Handles high temp.	Display turns white when ageing. Film breaks down at high temp.
Better Transparency, less optical power needed	Shaded Display (Film on Glass with air gap)
Single/dual-layer ITO	Two-layer ITO
Can be vandal-proof (thick glass/plastic)	Easily damaged (thin top layer)
Scratch Resistant (with glass)	Prone to scratch without hardcoat
Requires specialized stylus	Works with any stylus

Pyroelectric Proximity Sensing

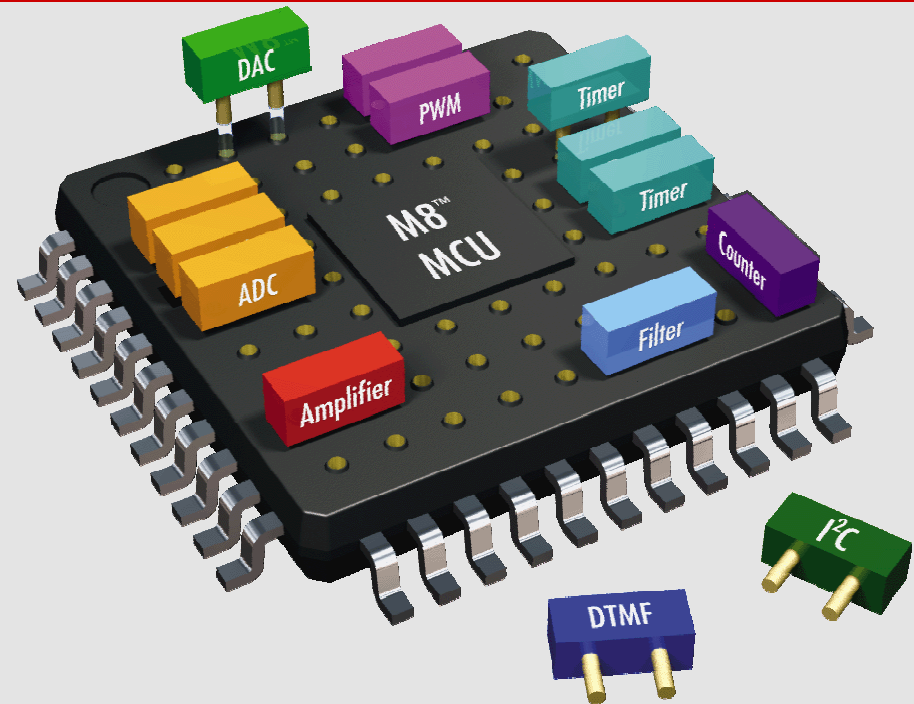


PSoC Mixed Signal Array

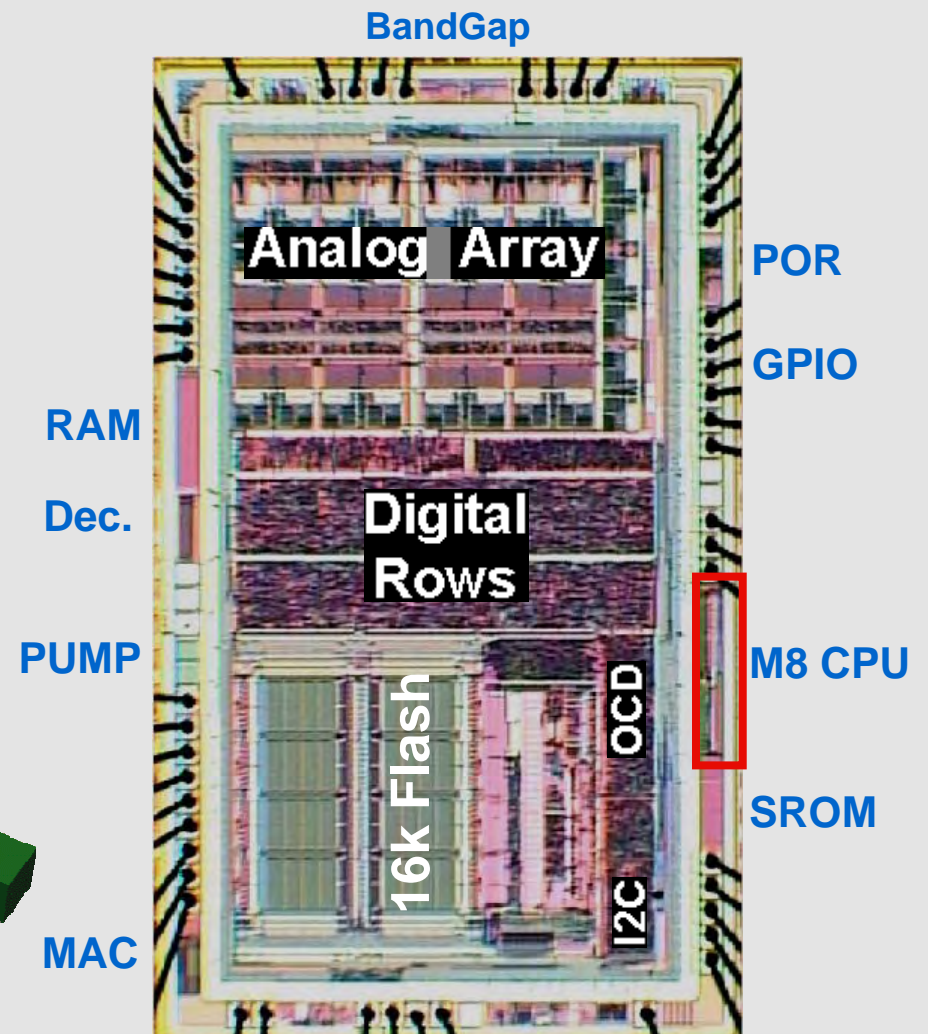
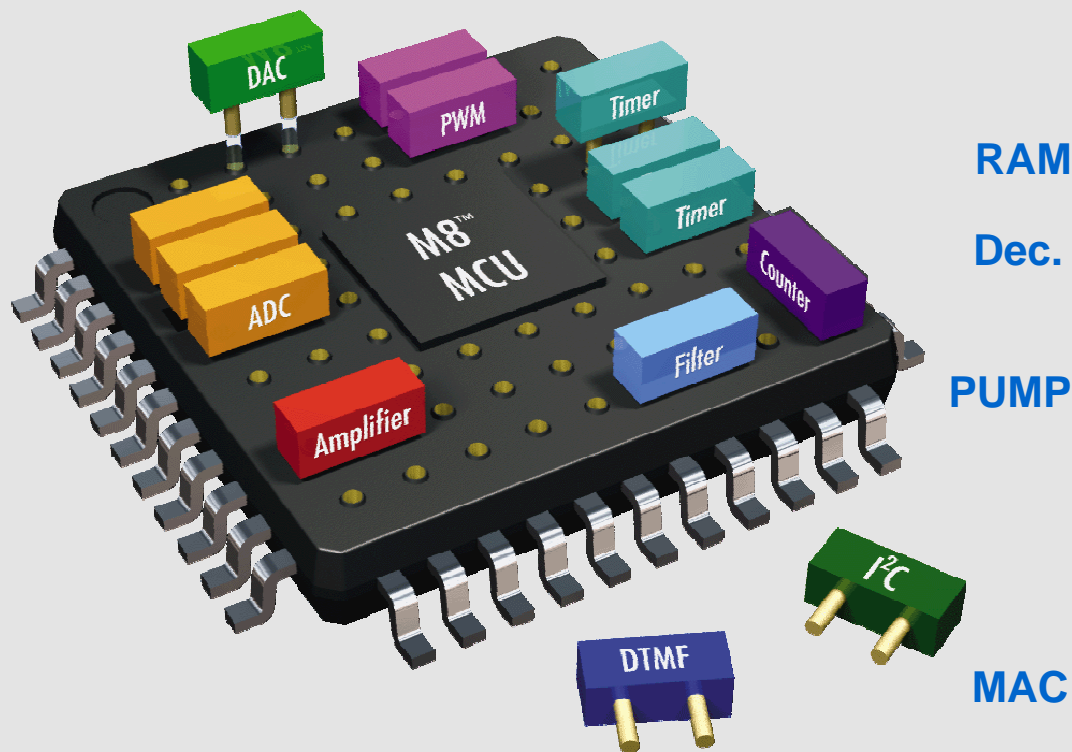
Programmable
System
on
Chip

PSoC provides:

- the familiarity of a microcontroller
- the configurability of an FPGA
- the capabilities of an ASIC

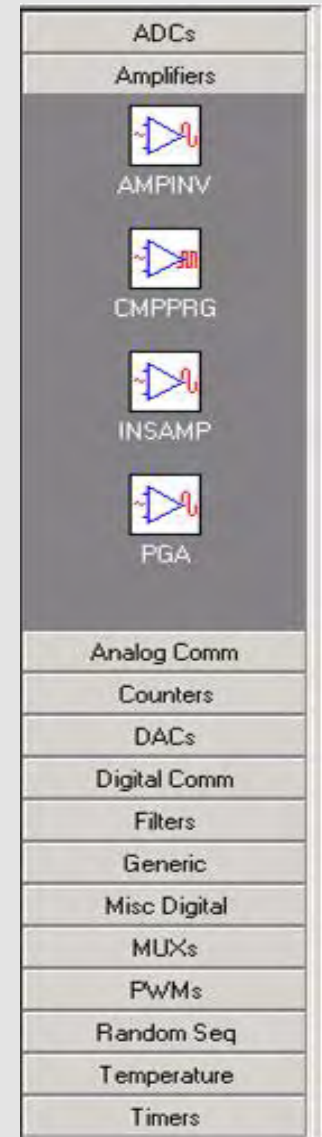


PSoC Architecture



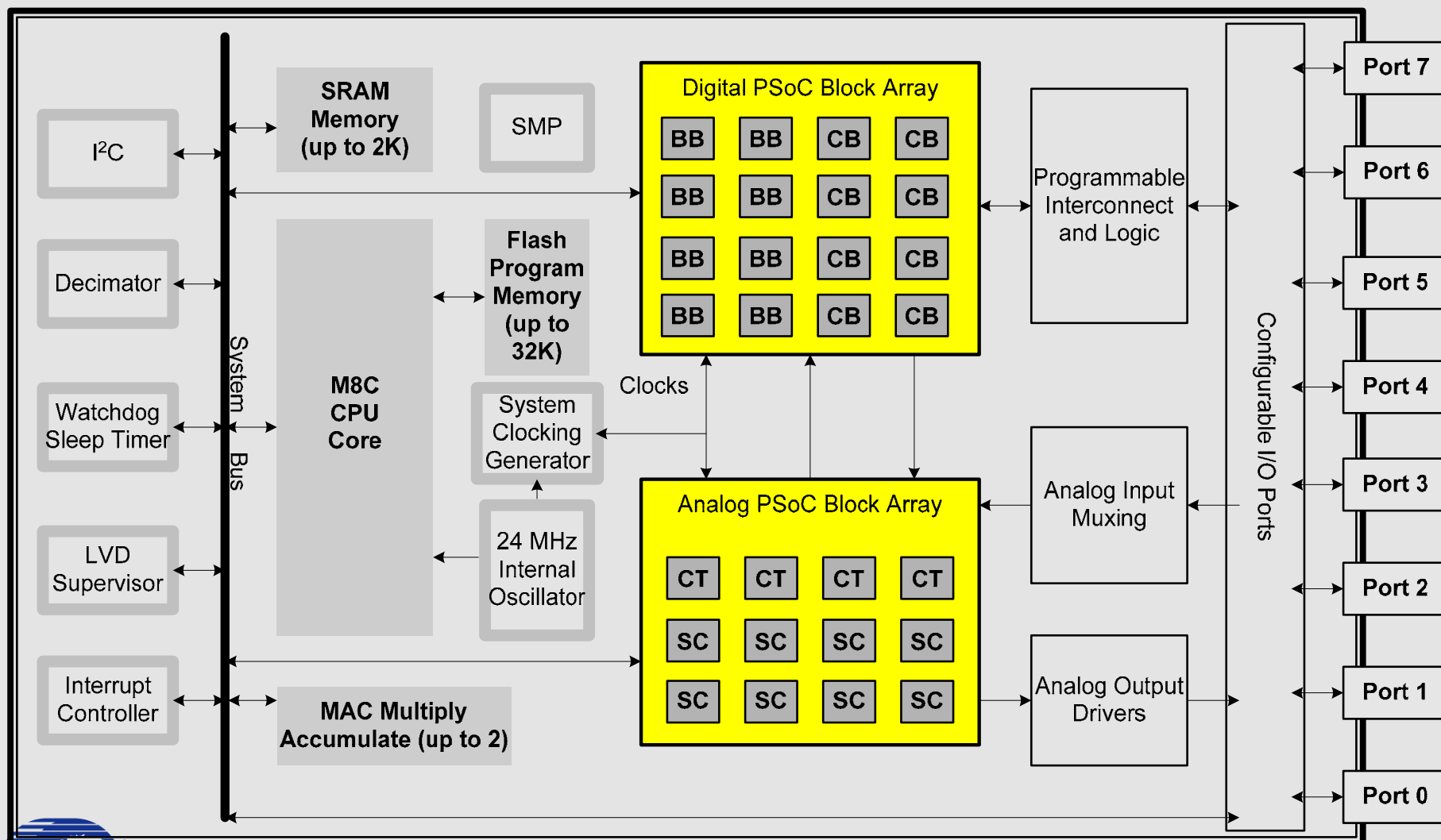
User Modules

- Embedded designs require on-chip peripherals
 - ADC's, DAC's, PGA's, Filters
 - Timers, Counters, PWM's
 - UART, SPI, I2C
- PSoC Implementation:
 - Pre-characterized library modules
- User Modules Include
 - Application Programming Interfaces (APIs)
 - Interrupt Service Routines (ISRs)
 - Specific UM Data Sheets
- CapSense is a PSoC User Module



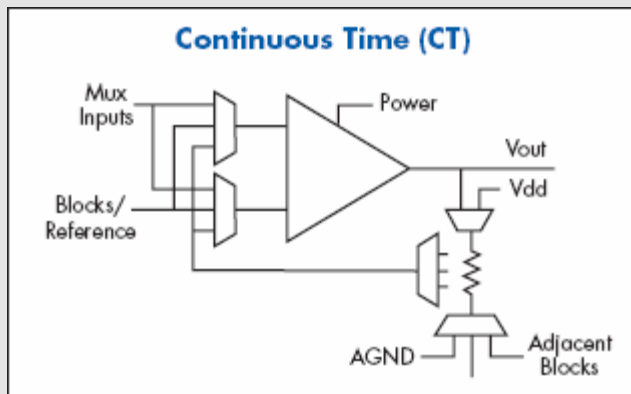
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PSoC Blocks

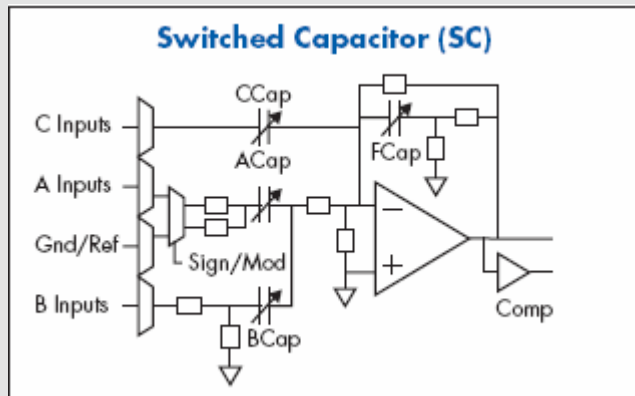


Digital and Analog Functions

Continuous Time (CT)

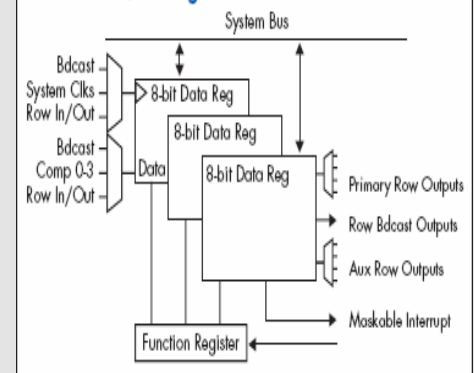


Switched Capacitor (SC)



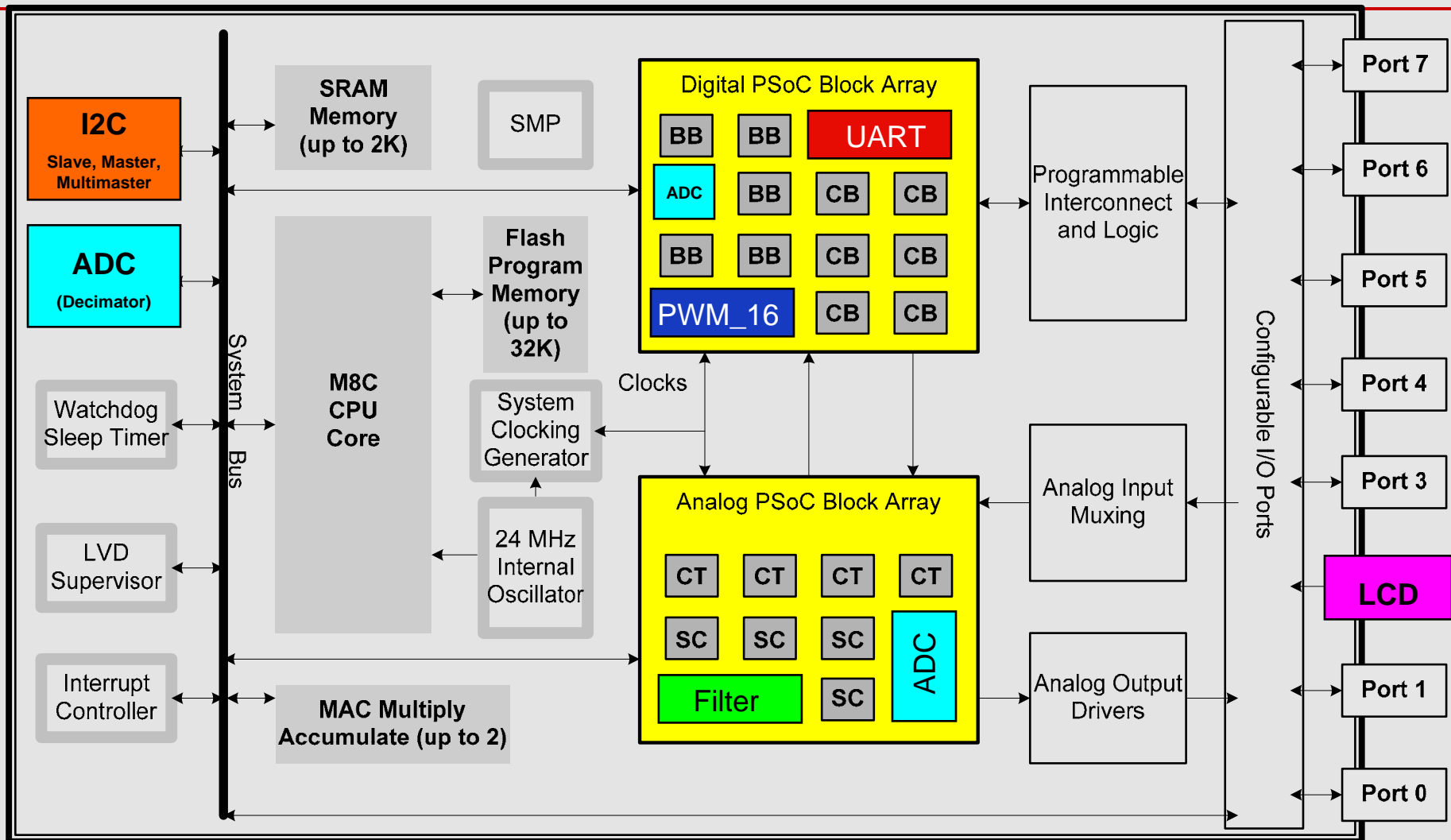
- ADC
Incremental 6-14 bits
Delta Sigma 6-13 bits
- DAC
6, 8, and 9 bit
6 and 8 bit multiplying
- Filters
2-pole Low-pass
2-pole Band-pass
- DTMF Dialer
- Modulator
- Peak Detector
- V to I Converter
- Amplifiers
Programmable Gain
Instrumental
Inverting
- Comparators
Programmable
Hysteresis
Zero-Crossing
- CapSense

8-bit Digital MCU Blocks

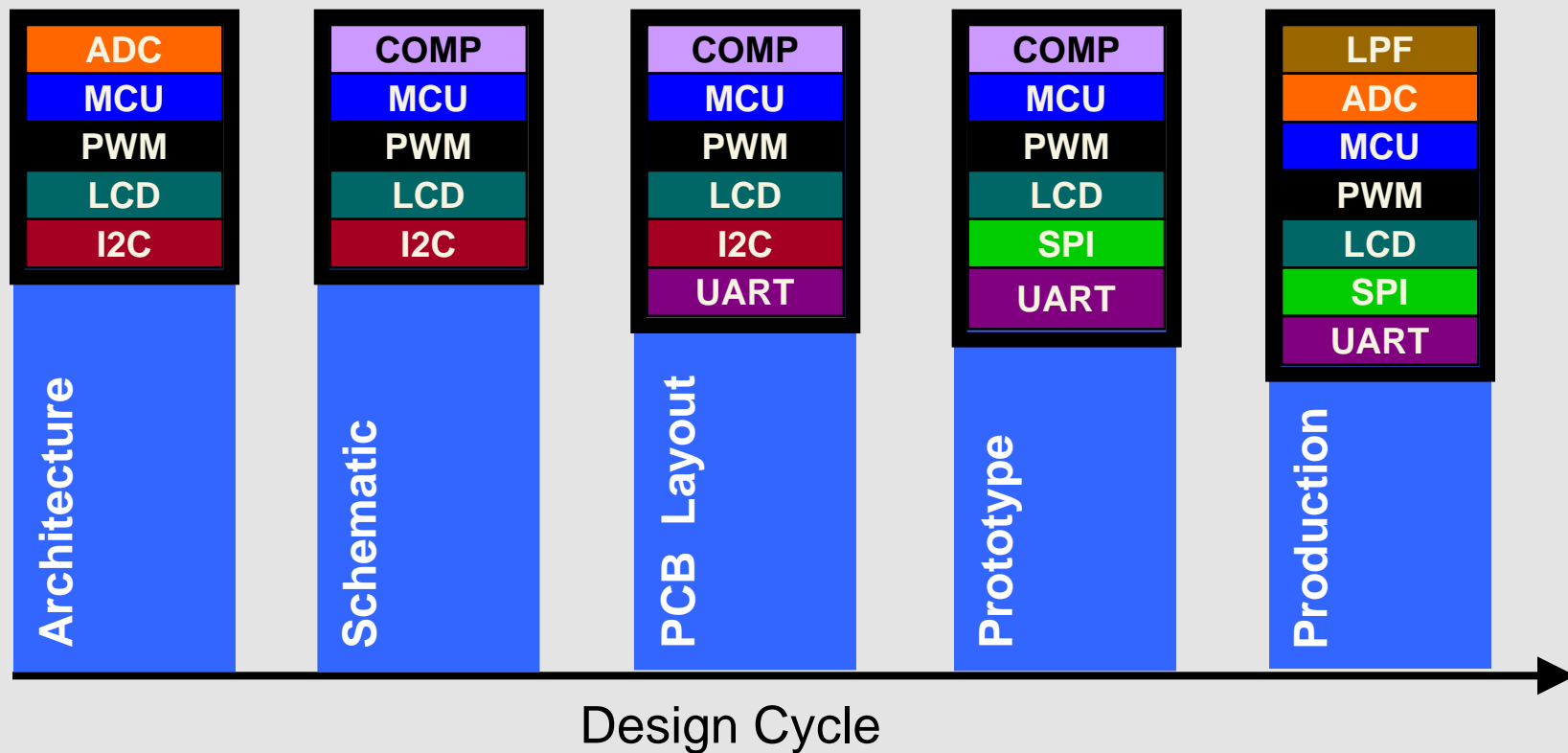


- Timer
8, 16, 24, 32 bit
- Counter
8, 16, 24, 32 bit
- PWM
8, 16, 24, 32 bit
- Dead Band Generator
8, 16, 24, 32 bit
- Pseudo Random Source
- Cyclic Redundancy Check
- Communication Interface
I2C Master
I2C Slave
SPI Master
SPI Slave
Full Duplex UART
Tx, Rx
Full Speed USB v2.0

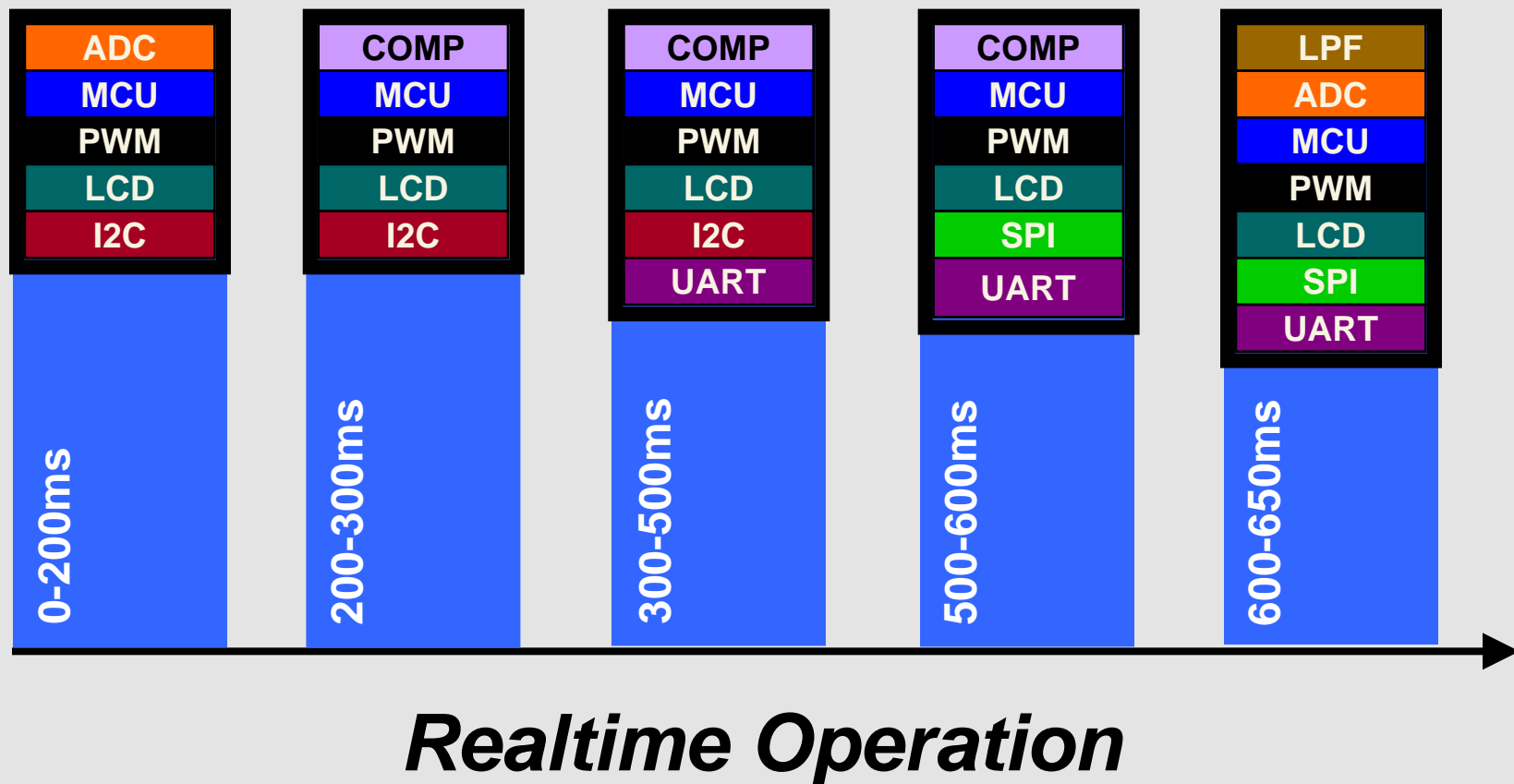
Map User Modules to PSoC



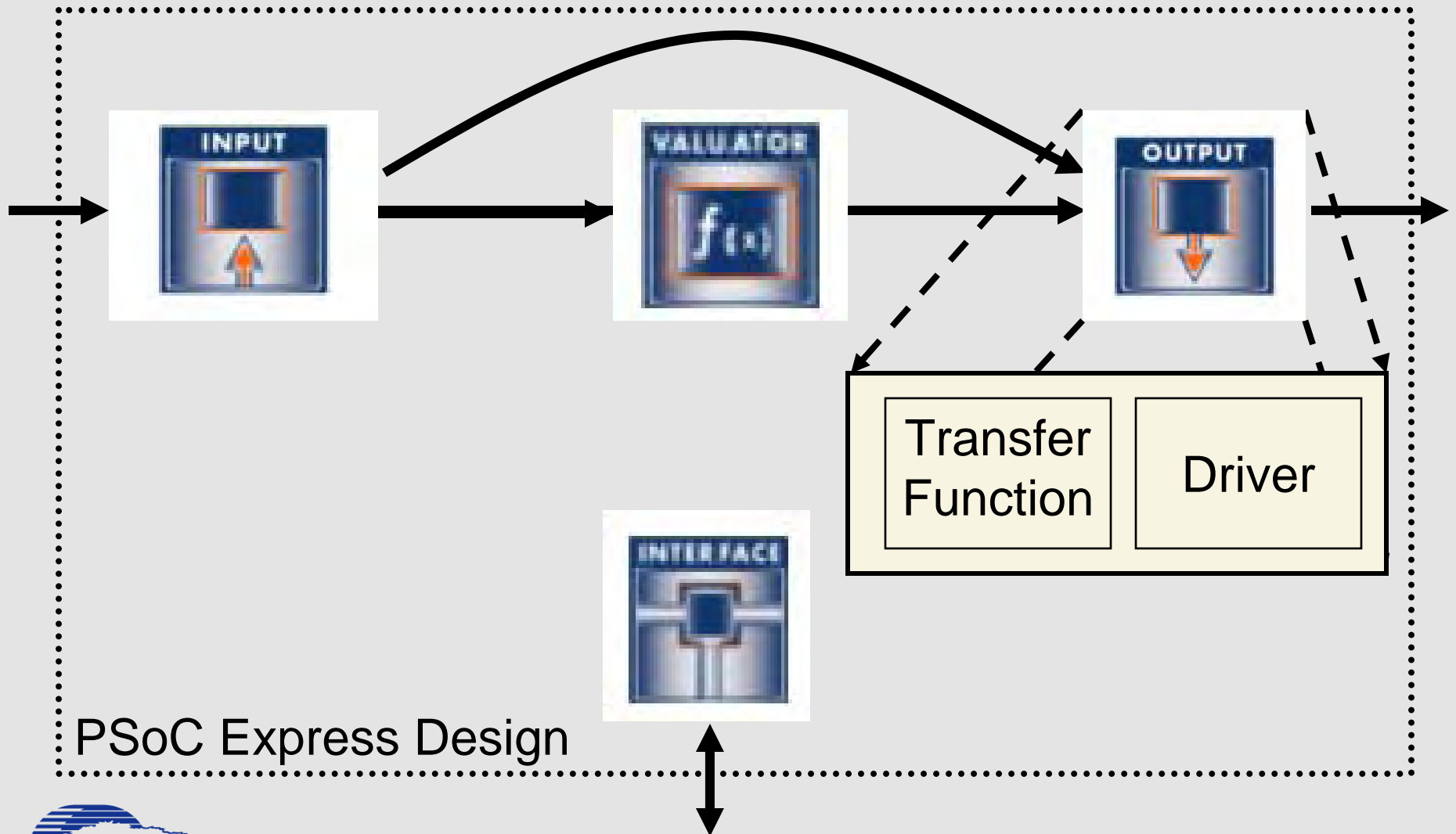
Embedded System Design Cycle



Embedded System Design Cycle

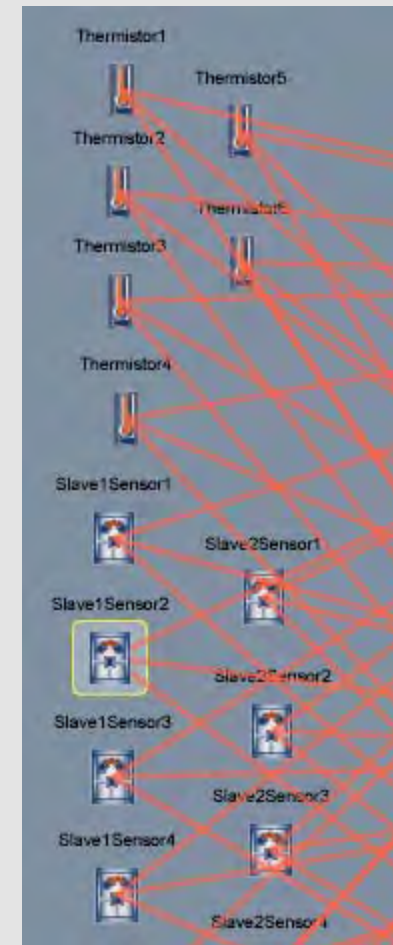
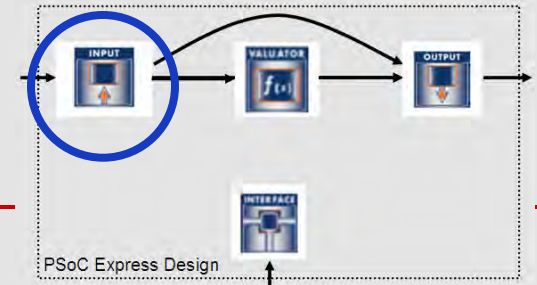


PSoC Express Design Elements



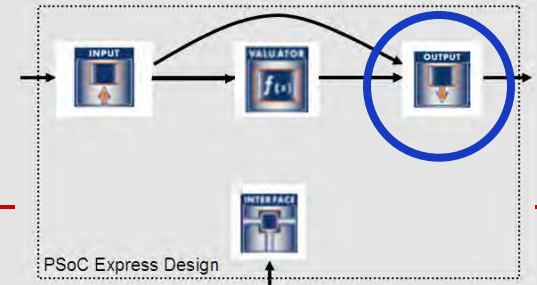
What are Inputs?

- Device-specific input drivers
 - Application-specific units
- Input Types
 - Accelerometers
 - Airflow Sensors
 - CapSense
 - Current sensors
 - Digital Inputs
 - Distance sensors
 - I2C Expanders
 - Humidity sensors
 - Light sensors
 - Pressure sensors
 - Remote I2C devices
 - Remote WUSB devices
 - Resistance sensors
 - Tachometer
 - Potentiometers/buttons/switches
 - Temperature sensors
 - Timing
 - Voltage inputs (use PSoC's integrated ADCs)

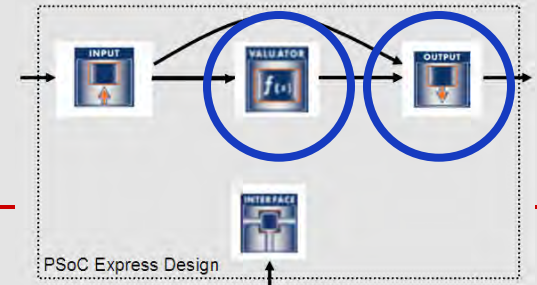


What are Outputs?

- Device-specific output drivers
 - Application-specific units
- Output Types
 - Digital “GPIO-type” output
 - Audio buzzer output
 - Relay outputs
 - Simple LED drivers
 - 7-Segment LED drivers
 - Multi-digit 7-seg drivers
 - LCD drivers (Hitachi i/f)
 - I2C Port expanders
 - Brushless DC fan drivers
 - Speed-controlled fan drivers
 - Variable-frequency PWM outputs
 - Variable-duty cycle PWM outputs
 - External I2C devices
 - CPU Reset
 - Analog voltage outputs (PWM DAC)
 - WirelessUSB interface



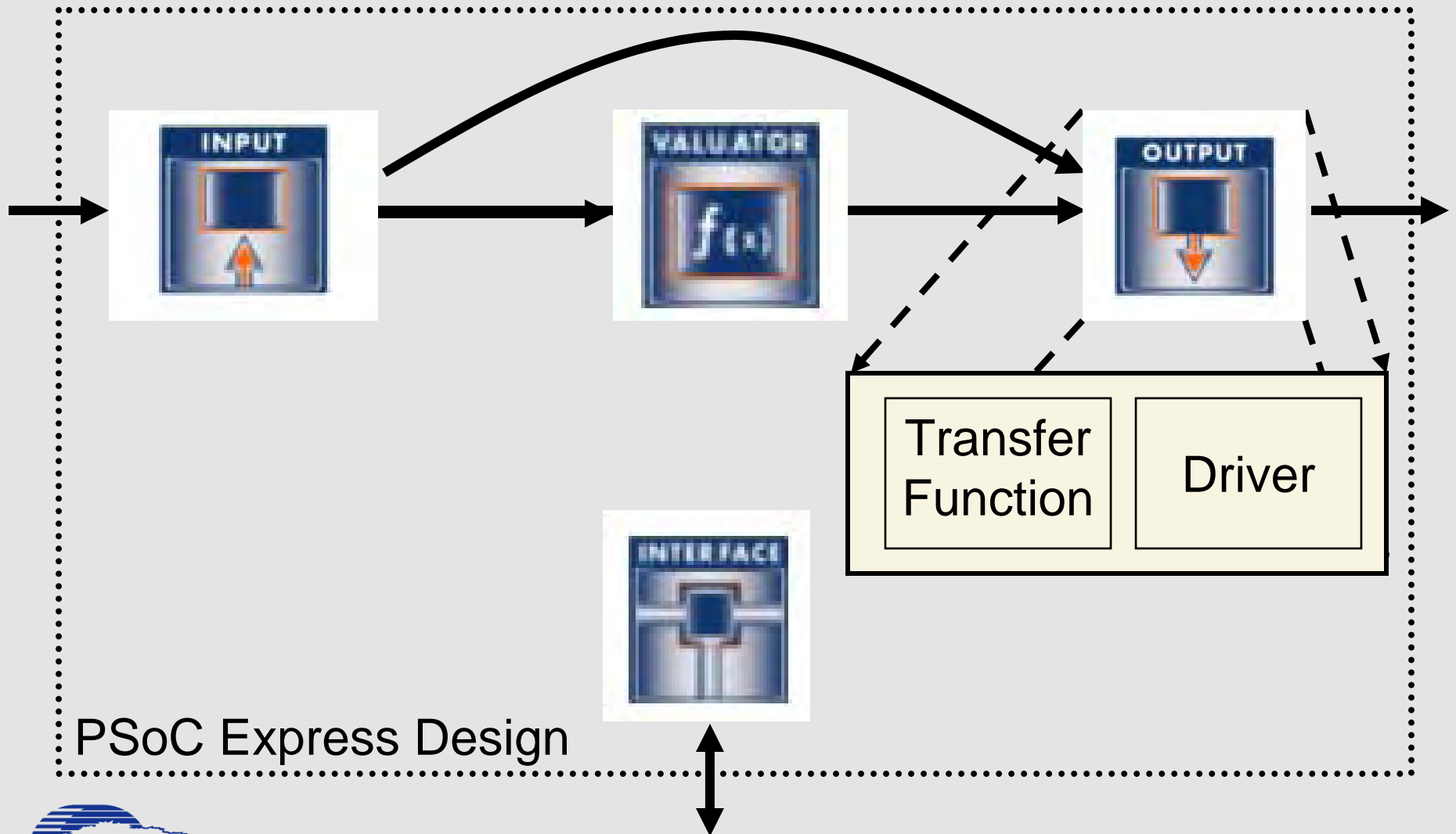
What are Transfer Functions?



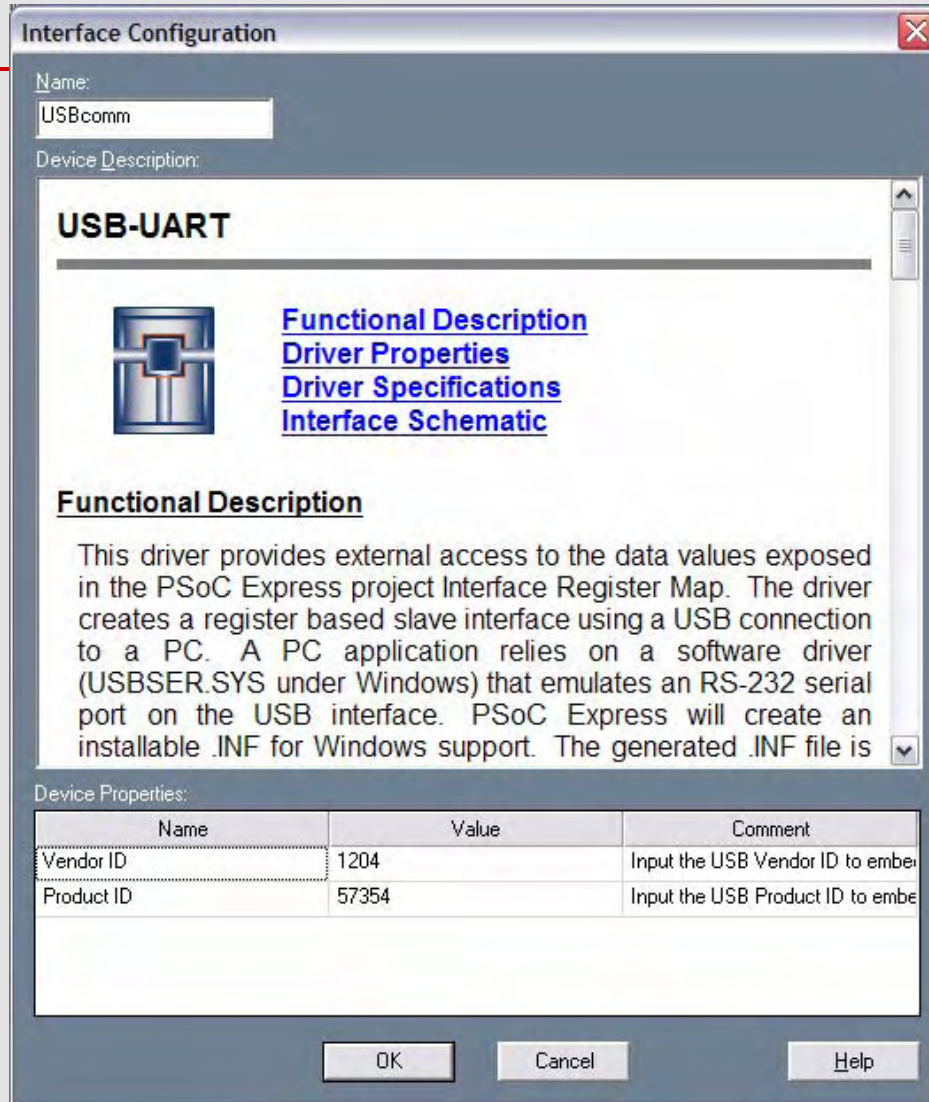
- Operations that define an output or valuator
- Types of Transfer Functions
 - SetPoint Region, Table Lookup, Priority Encoder
 - Status Encoder, State Machine, Loop Delay

Command	OFF	ON	BLINKING
Low	Low		
Medium		Medium	
High			High

PSoC Express Design Elements



USB-UART Interface



- USB virtual comm port
- Uses USBSER.SYS
- Auto-generates USBUART.inf file
- Select VID and PID
 - Enter as decimal now
 - Defaults to World Tour Demo values
 - Change for production

PSoC Express Example

- Let's make a voltmeter...

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Cypress Top Customers

WIRELESS

Handsets
Basestations



NETWORKS

Switches
Routers
Storage

CISCO SYSTEMS



Lucent Technologies
Bell Labs Innovations



CONSUMER & COMPUTATION

PC, HID, Mass Storage
DSC, MP3, Gaming

SONY

Microsoft



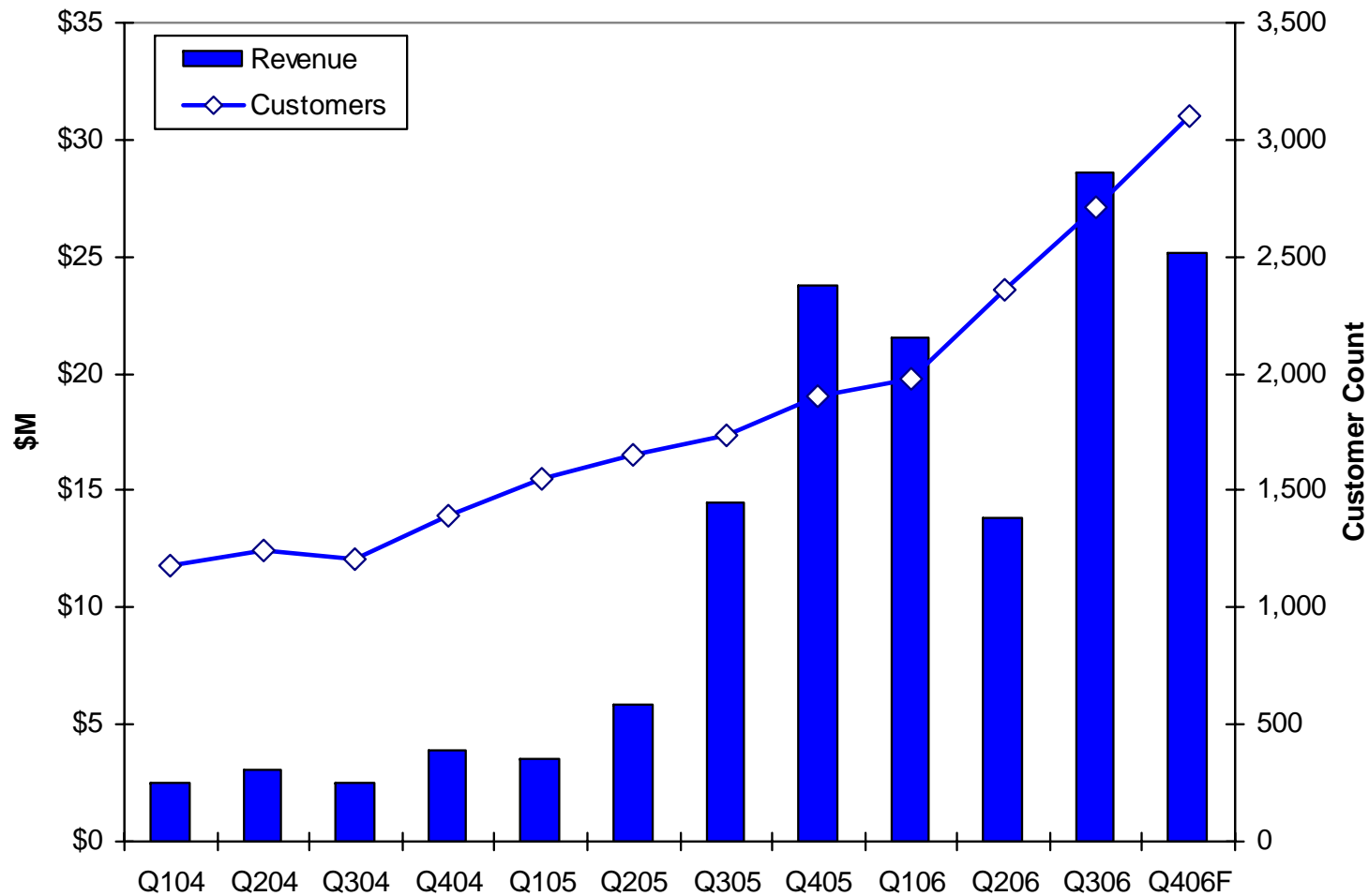
Easy as



FLEXTRONICS



PSoC Growth

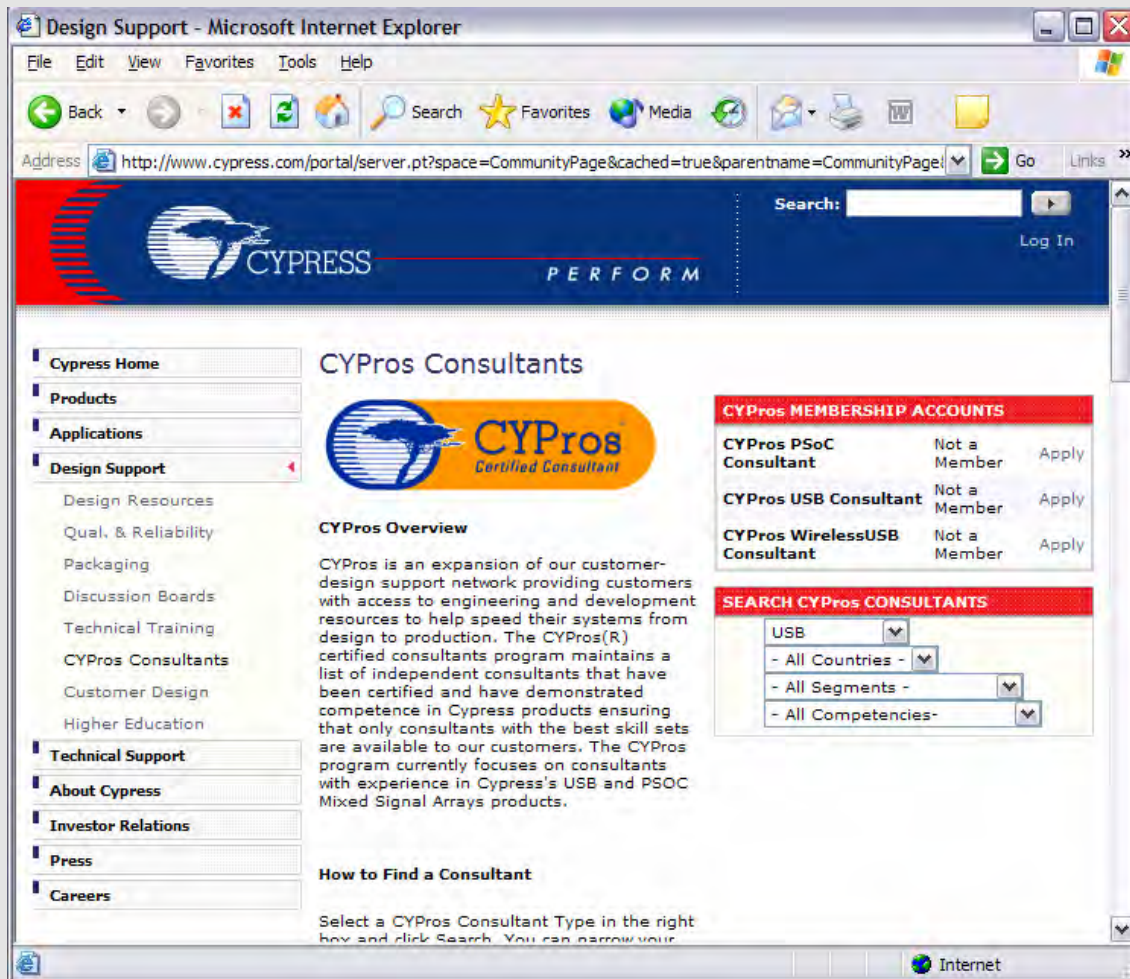


Growing Customer Count is our Strategy

CYPros Program Expectations

- What can Your Customers expect from CYPros?
 - Faster time to market (Programmability & Easy to Use Tools)
 - Product Differentiation (Programmable Digital/Analog/Memory)
 - Lower BOM Cost (Integration of IC's & Passives)
 - Proven Product Solution Understanding (Use of Logo/Web)
- What can CYPros expect of Cypress?
 - Free training (Online & Hands-on), Samples & SW
 - Discounted HW (Order Online)
 - Enhanced Support Structure (Online, Local, & HQ)
 - Newsletters & Advanced Product Solution Information
 - Advertisement on Cypress Website
 - Potentially business (from Cypress)
 - Strong, proven solutions to grow your business
- What does Cypress expect of CYPros?
 - Become & Remained Certified
 - Feedback (on activities, the program, & our solutions)

CYPros Web Page



**Customer
Searchable
Resource**

**Profiles of
Available
Consultants &
Design Houses**

For CYPros: Community

CYPros Program

Welcome to the CYPros Community:

This is the place where you can access the CYPros Consultant Product Pages and learn more about the program. Please make sure you review the CYPros Certification & Program Maintenance Requirements section and other information below.

We've created these pages as a way to provide information to you to help you in your development efforts using Cypress silicon. We also encourage you to make contact with the local Cypress people or Representatives in your market place. These people can be your best resource for finding design work, getting samples, tools, advice and the information you need in real-time to keep your projects on track. To find your local Cypress representative click [here](#).

Program Maintenance Requirements

The CYPros maintenance requirements described in the your CYPros Agreement are discussed in detail at the "Program Maintenance" link on the left hand side of the screen in the CYPros Consultants Community." These requirements will ensure that all CYPros consultants stay current with Cypress product knowledge. Fulfilling these maintenance requirements will require very minimum overhead for consultants actively utilizing Cypress products. New capabilities for CYPros include:

CYPros ACCOUNTS		
CYPros PSoC Consultant	Not a Member	Apply
CYPros USB Consultant	Not a Member	Apply
CYPros WirelessUSB Consultant	Not a Member	Apply

Consultant Type:
 Country:
 Market Segments:
 Competencies:

CYPros News Letters

- ☐ CYPros newsletter Fall 2005

CYPros Learning Management System

- ☐ Cypress University Training

Website, Training, Samples, Material Requests, Newsletters, General Information



Dear CYPros® Consultant,
 This communication is intended to provide you with an update to the CYPros Program and the Cypress Products that are supported by CYPros Consultants. Please look this over to understand some of the benefits and requirements of the program and to keep you aware of the latest developments with the product line.

General CYPros Information:

CYPros Web Community:
 The CYPros Community Web Page is where you will find key information about the CYPros Program. The following image shows the page with descriptions of important link features mentioned below in this newsletter. Go ahead - click and check it out!



CYPros Community Web Page

New CYPros Brochure Available!

To help you sell to your customers...

The new CYPros Brochure is available throughout collateral fulfillment here. These popular pieces have been updated with WirelessUSB program information, PSoC Express and the new Cypress Corporate branding using the tagline "PERFORM".

For CYPros: HW & SW Tools



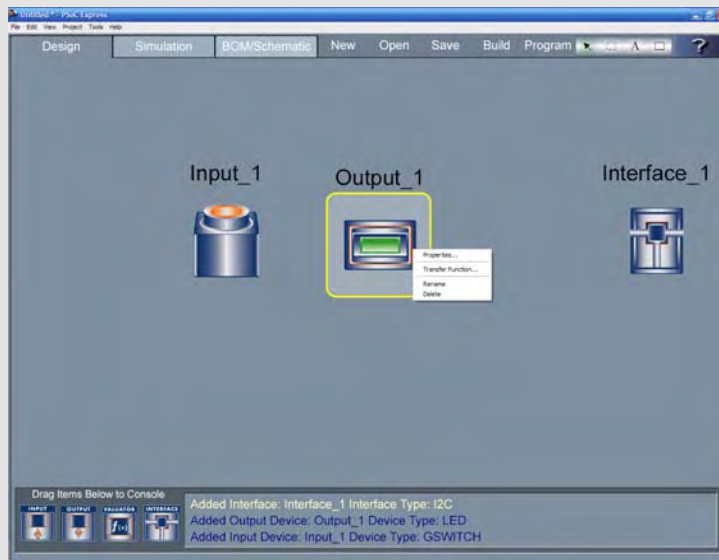
Evaluation Boards



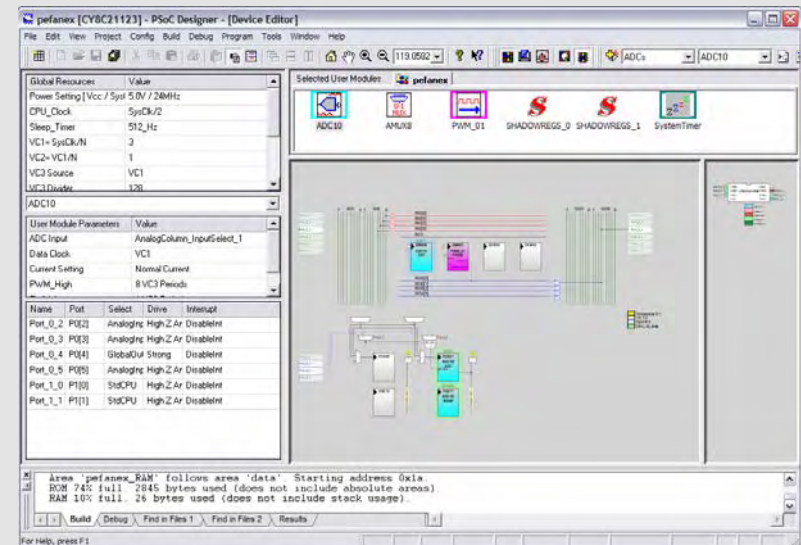
Development Tools



Design Kits



PSoC Express (No Code)



PSoC Designer (Compiler & Assembler)

Certification Process

CYPros Certification Requirements

- Take Certification Training Courses
 - Optional live training available
- Proven Design Experience
- Must own Development Kit & Tools

Yearly Maintenance

- Attend or Take Additional Product Training
- Design Activity – Register Designs with CY Sales

Program Certification (online 1.5 hours per module)

- USB – Take three USB modules
- WUSB – Take six hours Dev Kit (instructor led)
 - Offered at Multiple Times for EU, NA & Asia
- PSoC – Take four PSoC modules

CYPros Approval Process

1. Sign up with user name and password on the Cypress Portal at <http://www.cypress.com/portal/server.pt>
2. Apply to the Consultants program under design support on the left hand side of the site, then CYPros consultants, and finally apply on the upper right hand corner of the screen
3. Cypress grants access to online training modules
4. Sign Agreement Form
5. Fill in Company Information
6. Take four Designer online training modules or three Express training modules
7. Follow-on Hands-on Training