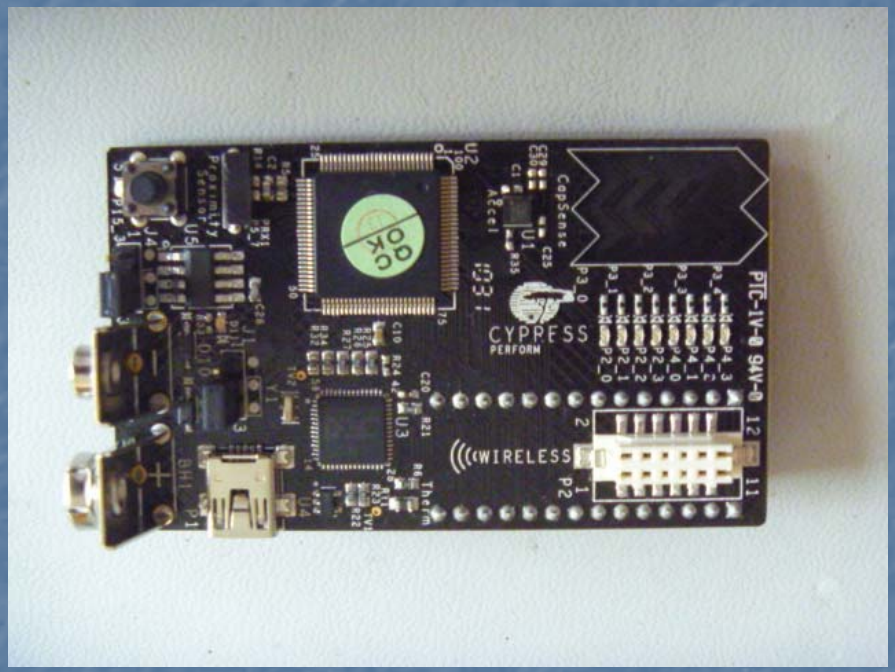
# Using the Cypress PSoC Processor

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# Overview

- Programmable Systems On Chip
- Cypress Family
- PSoC 3/5 Architectural Overview
- Configurable Components
- Development Environment
- Cool Peripherals For Robotics
- Best Practices
- Resources

# Programmable Systems on Chip

- Single chip contains:
  - Traditional processor
  - Traditional peripherals
  - CPLD/FPGA hardware
  - Analog hardware
  - Programmable analog hardware
- Primary advantages are reduced part count, reduced cost, increased flexibility and increased reliability
- Several now on the market
  - Actel SmartFusion
  - Xilinx
  - Cypress PSoC

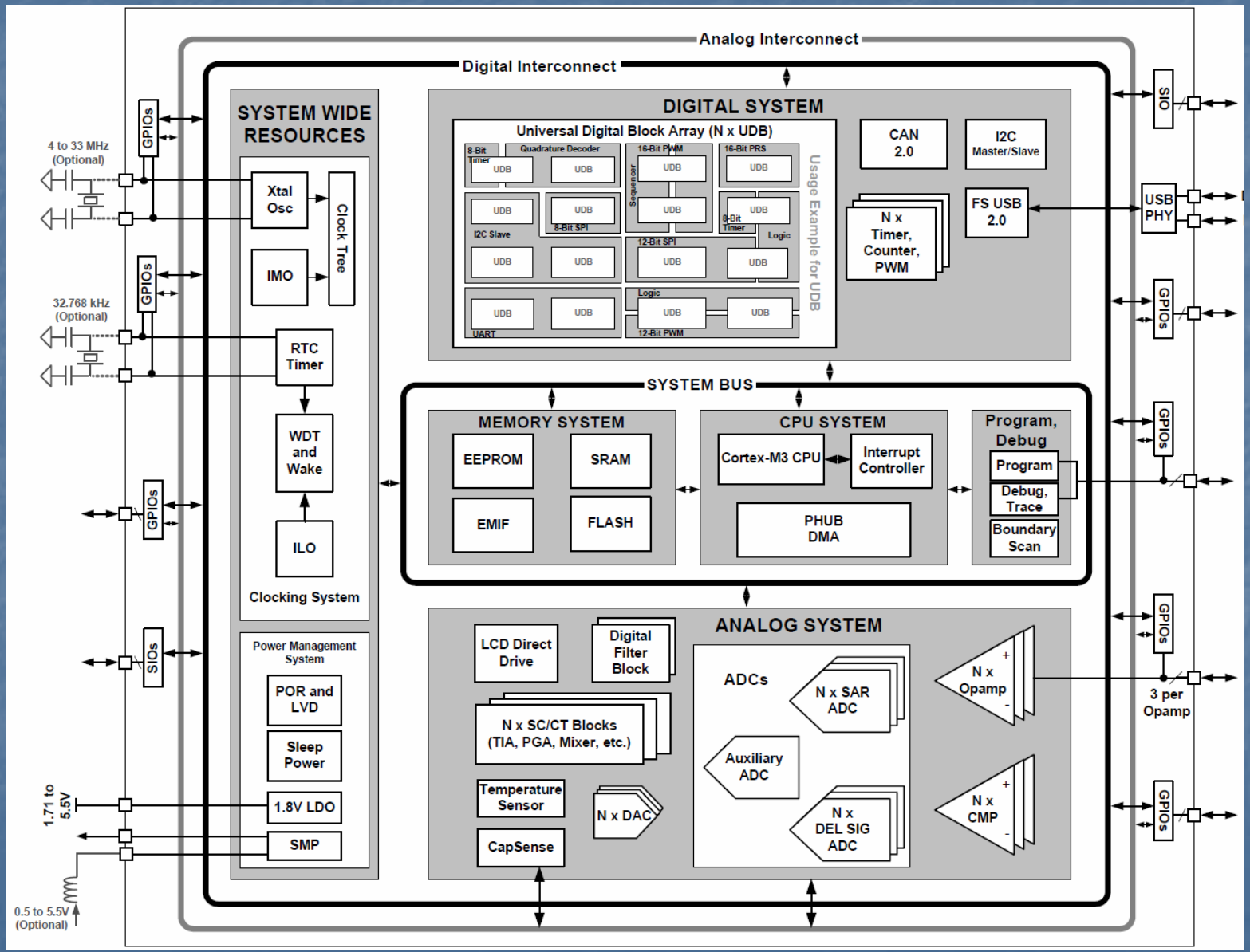
# Cypress PSoC Family

- PSoC 1
  - The original design
  - 8 bit M8C core, 4 MIPS
  - Available since 2001
- Power PSoC
  - Simple devices, for LED lighting and motor control
  - Have high current FETs on board (1A range)
- PSoC 3
  - Redesign of development tool chain
  - Redesign of analog blocks
  - Enhanced 8051 core, 33 MIPS
  - Production parts available December 2010
- PSoC 5
  - Same base architecture as PSoC 3 + 2 additional SAR ADCs
  - 32 bit ARM Cortex M3 core, 100 Dhrystone MIPS
  - Sampling now, production parts Q2 2011
- Will be talking **only** about the PSoC 3 & 5 today

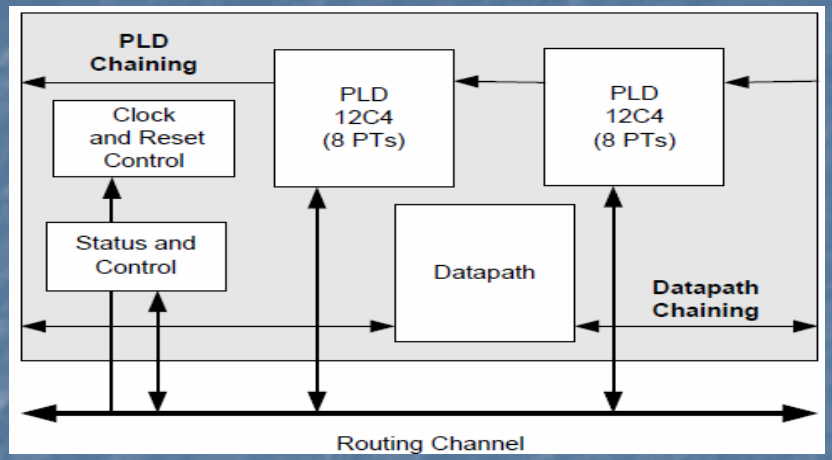
# Cypress PSoC Family

- Programmable in ‘C’ or assembly
  - ‘C’ is the default / recommended language
- Low cost of entry
  - $50 to $250 for development kits
  - Development tools are a free download
    - PSoC Creator
    - PSoC Programmer
    - C – Compiler (Keil for PSoC3, GCC for PSoC5)
- Good balance of processor, analog blocks and digital blocks
- Single chip solution for many designs
- Can start with the PSoC 3 and easily migrate to PSoC 5 when available / needed
  - Plan for this in your design to make it smooth
  - Only a recompile needed in many cases
  - CANNOT migrate to/from PSoC 1

# PSoC 3 & 5 Architecture



# Universal Digital Blocks

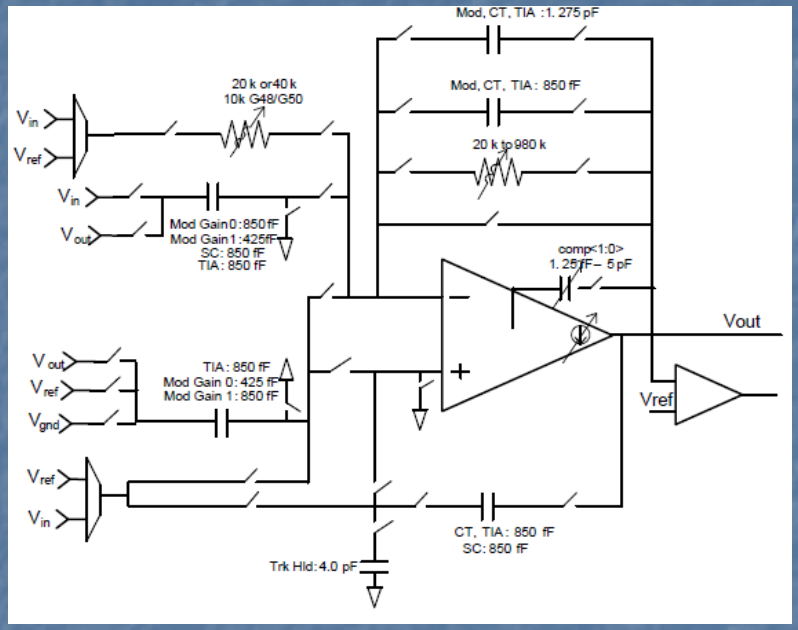



- Each block contains 2 PLD blocks
- The Datapath is a programmable ALU
  - 8 bit single cycle ALU with shift and mask operations
  - 2 Accumulators
  - 2 Data registers
  - 2 FIFO banks (4 bytes deep)
- PLD usage can be decoupled from Datapath
  - Allows for more efficient resource mappings
  - Cross individual block boundaries
- PLD and Datapath blocks can be chained for 16-32 bit operations

# UDB Uses

- Counters
- Timers
- PWM
- UART
- Combinational discrete logic
- Pseudo random number generator
- Quadrature Encoder
- CRC
- Many, many others

# SC/CT Blocks



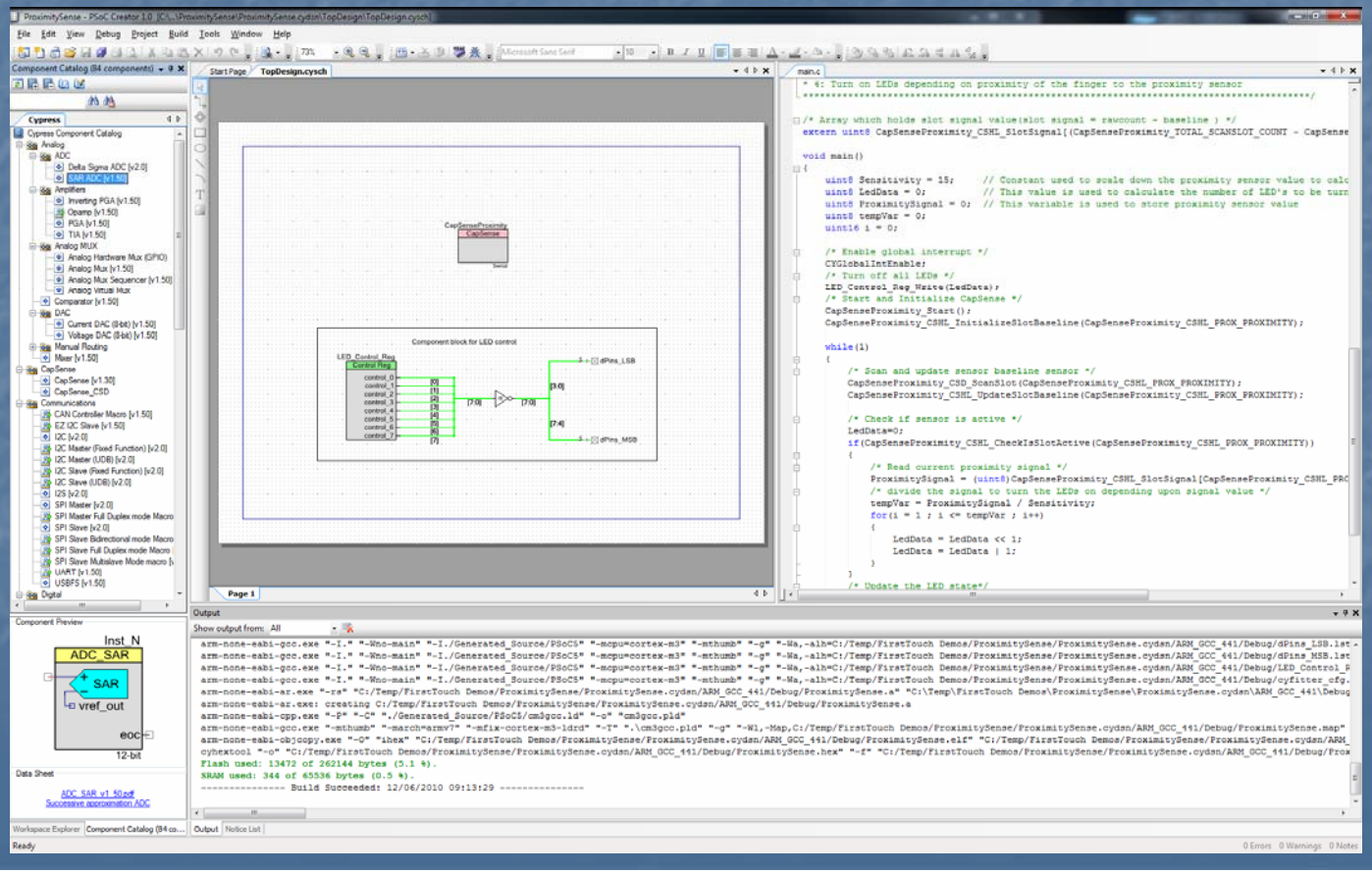

- Basically an op-amp core with programmable resistors and capacitors attached
- Used for building
  - More op-amps!, Programmable gain amplifiers
  - Transimpedance amps, Mixers
  - Sample and hold amplifiers

# Prebuilt Components

- Hardware components normally combined to make what you need for your application
- Large library of prebuilt components available
- Each component consists of
  - Hardware specification (Graphical or VHDL)
  - Schematic symbol for graphical editor
  - ‘C’ API
  - Datasheet
  - Custom configuration dialog
- Extensive abilities to also create your own components
  - VHDL or graphical design for hardware description
  - PDF for the datasheet
  - .NET for configuration dialog
  - Complete SDK in the tool chain for building these

# Development Environment

- PSoC Creator – Full IDE
  - Pretty similar to Visual Studio or Eclipse
  - Hardware aspects programmed with a schematic capture style tool
  - Integrated programmer / debugger



# CapSense Module

- Very flexible architecture
  - Individual buttons, matrix of buttons
  - Linear sliders, radial sliders
  - Full touch pads
  - Proximity sensors
    - Works with most materials, not just fingers!
- Manual and automatic tuning
  - GUI tuning application to assist

# LCD Module

- Modes:
  - Character
  - Graphic
  - Segment
- Character LCD VERY helpful for debugging even if not needed for application
  - Very simple API, base data types supported
  - Can upgrade default LCD in dev kit
    - Lumex family of character displays, 4/8 bit parallel interface

# Boost Converter

- Input from 0.5V to 5.5V
  - Allows for input from a solar cell / energy harvesting
- Requires an external inductor, capacitor and optional diode
- Source up to 30mA with internal diode, 50mA with external diode
- Can also be used to form a regulated power supply not used by the processor

# Best Practices

- Develop the hardware layer first
  - Will automatically generate API for you
- Implement timing critical functions in hardware, complex functions in software
- Use provided APIs and macros
  - Allows for component upgrades automatically
  - Allows for conversion of projects between PSoC3 and PSoC5 with minimal changes
    - Also different processors in the same family

# More Best Practices

- Reserve and use “debug pins” to access internal signals
- Keep digital and analog signals separate
  - Analog domain clocks available
  - Processor die split, orient this with board layout
- Use dedicated pins for internal op-amps
  - Reduced silicon switch resistance
- Buffer analog signals
  - Most internal sources have very minimal drive capability

# And MORE Best Practices

- Watch for hardware race conditions
  - Use a higher frequency clock and “sequencer block” to control complex sequential logic
  - Many resets and presets require a clock cycle to take effect
  - May look like it works, but happening “by chance”
- Read and know the items on the errata sheets!
  - Development tools can also adjust for errata items
- Reserve time for experimentation
  - MANY ways to do things on this processor
  - Power of the processor comes from flexibility
  - Distinction between hardware and software largely gone
  - Combining hardware and software approach often the cleanest and simplest solution

# Summary

- The PSoC processor integrates programmable analog and digital with a traditional processing core
- The PSoC can be a one chip solution for many robotics projects
- Develop the hardware configuration first and then develop the software, leaving time to experiment with different configurations

# Resources

- PSoC Product Web Site:
  - http://www.cypress.com/?id=1353
- PSoC Developer Community:
  - http://www.psocdeveloper.com/forums/
- PSoC Training On Demand:
  - http://www.cypress.com/training
- PSoC 5 FirstTouch Starter Kit: $50
  - http://www.cypress.com/?rID=43674
- PSoC Full Development Kit (1, 3, 5): $249
  - http://www.cypress.com/?rID=37464
- My Contact Info:
  - Lloyd@CyberData-Robotics.com
  - http://www.CyberData-Robotics.com

# Questions????

- IDE demo if time
- Will be around a bit after the meeting for individual questions
- Feel free to e-mail me