What is a PSoC ?

P rogrammable
S ystem
o n
C hip

PSoC combines:

– the familiarity of a microcontroller
– the configurability of an CPLD
– the capabilities of an Mixed –Signal Array

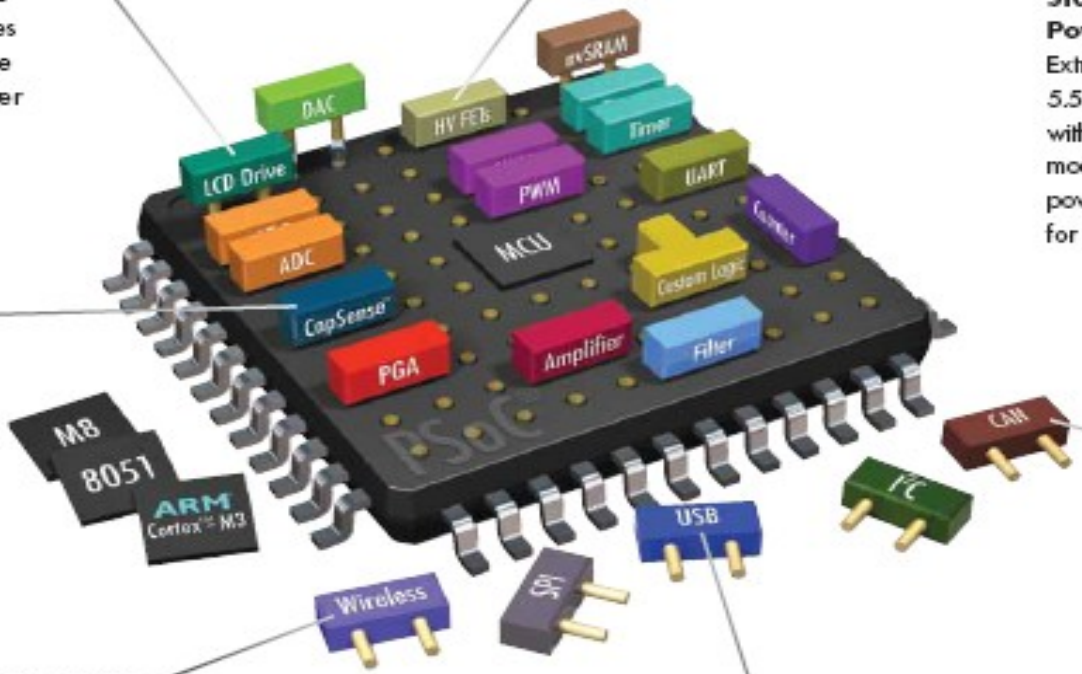
PSoC: Functionalities

High-Precision Programmable Analog. Up to 20-bit precision with reference voltage accuracy better than ±0.1%, ideal for instrumentation and medical signal processing.

HV FETs. Drive up to four integrated FETs at 36v/1amp each for high-voltage applications

Integrated LCD Drive Technology can drive up to 736 LCD segments with no external devices. PSoC's on-board voltage boost technology enables 3V to 5V LCD glass to be driven from a 0.5V power source.

State-of-the-Art Power Management. Extremely wide 0.5V to 5.5V operating range, with several low-power modes. Multiple adjustable power and clock domains for ultimate flexibility.



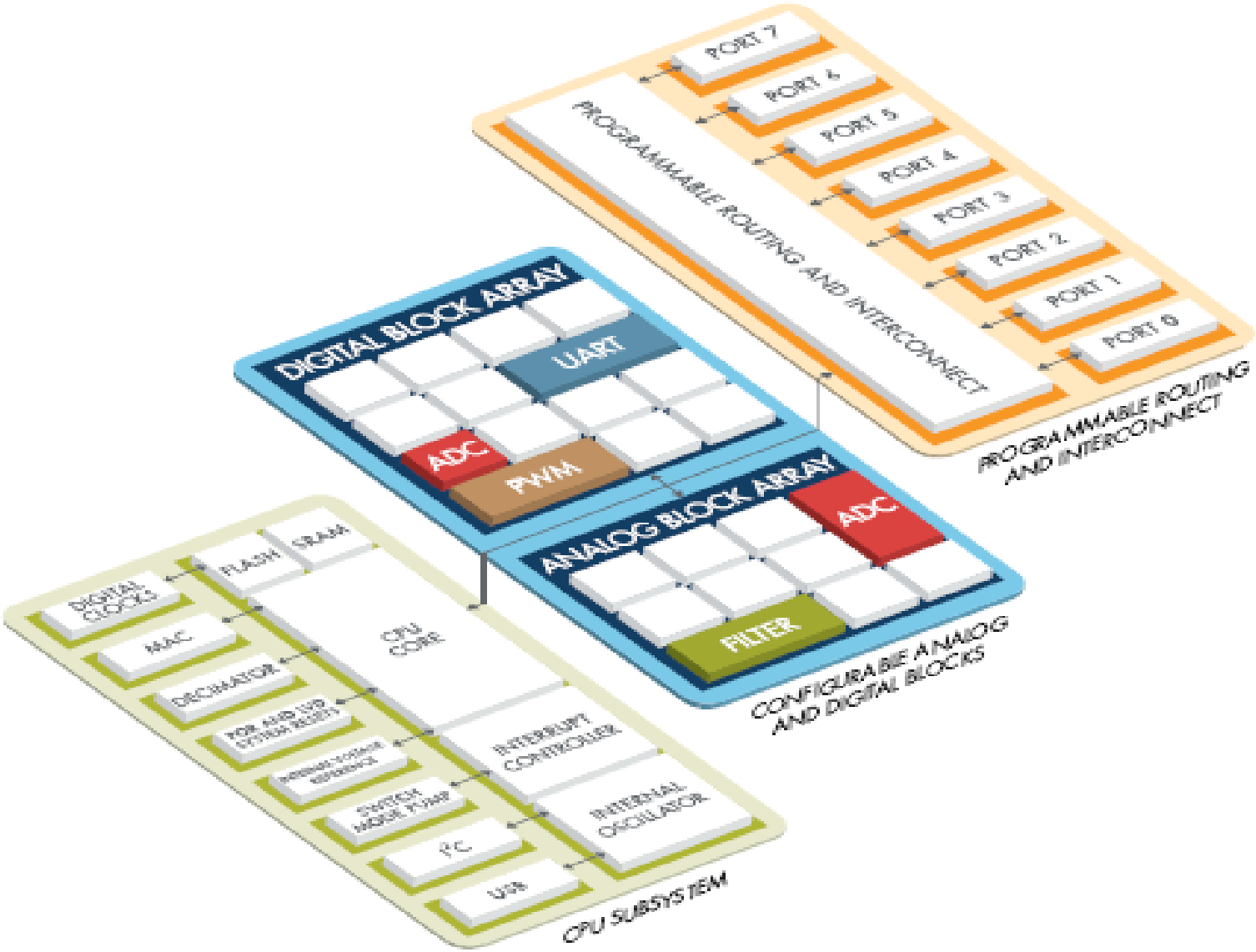
CapSense components enable you to create stylish products with capacitive touch-sensing interfaces.

Controller Area Network (CAN) Support. PSoC supports this interface, which is commonly used in automotive and industrial markets.

CyFi™ 2.4 GHz Low-Power RF is a simple and power-efficient DSSS solution delivering unmatched wireless reliability with 101 dBm of on-chip link budget.

Full-Speed USB 2.0 support enables embedded systems to communicate instantly with USB-enabled devices.

PSoC: Functional Blocks



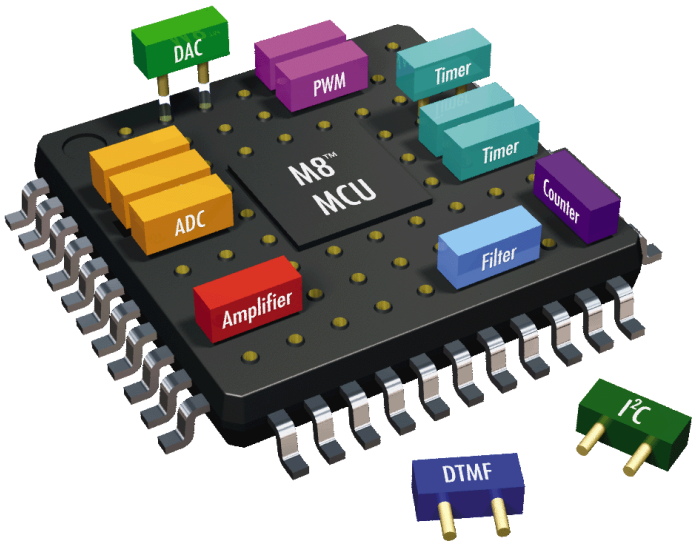
Functions Enabled by PSoC

- Environmental sensing
  - Pressure
  - Humidity
  - Current
  - Airflow
  - Acceleration
  - Tilt
  - Pyroelectric Infrared (PIR)
  - Light
  - Voltage
  - Temperature
  - Inductive
  - Gas
  - Liquid level
- Touch Sensing
  - CapSense capacitive sensing (buttons, sliders)
  - Touchscreens
  - Trackpads
  - Proximity sensing
- Fan/Motor Control
  - AC motor
  - DC motor
  - Fan
  - Fuel pump
  - Instrument gauges

Functions Enabled by PSoC

- Communications interfaces
  - Wireless radio control
  - LIN bus
  - Optical cable conversion
  - Dual Tone Multi-Frequency (DTMF) dialer
  - USB 2.0
- Power Control
  - Battery charging
  - Voltage & current
  - System power
  - AC power metering
  - Lighting
- Other
  - Magnetic cord read/write
  - Mechanical buttons or other inputs
  - LCD display/drive control
  - LED drive

What is PSoC 1?



Inputs

- Each pin can sink 25mA
- Programmable filters
- Flexible sensor interface I/O
- 3 types of ADCs, up to 4

Processing

- Fast M8 Microcontroller Core
- Multiply Accumulate

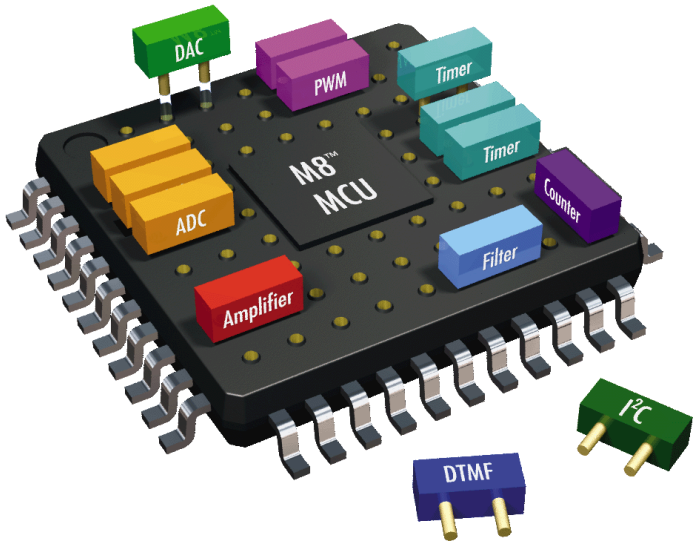
Outputs

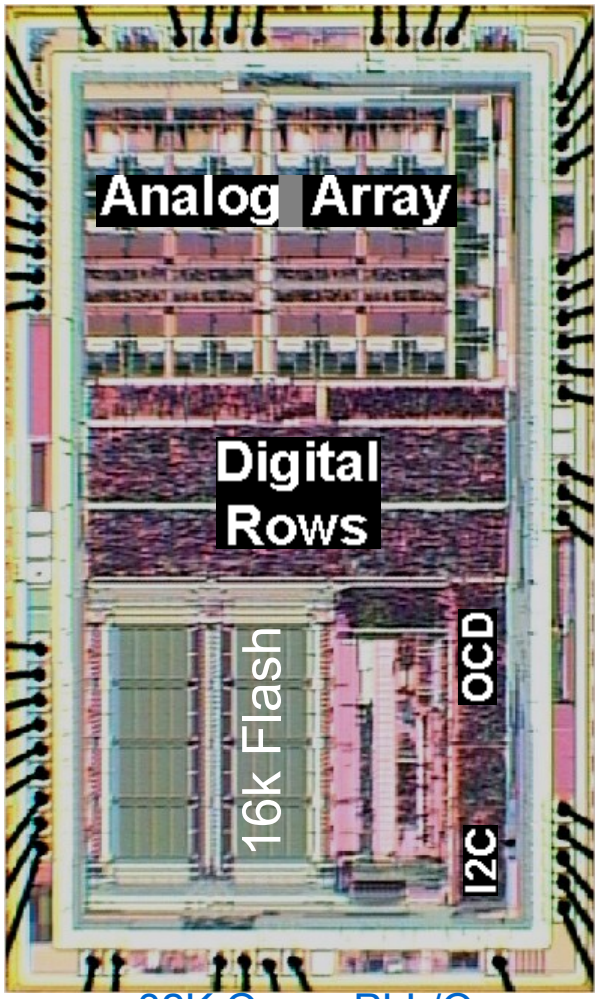
- Each pin can source 10mA
- Up to 16 PWMs, Timers, Counters
- Up to 9-bit DACs, 14-bit ADCs

Support Functions

- EEPROM
- Sleep Options
- Watch Dog Timer
- Low voltage detect

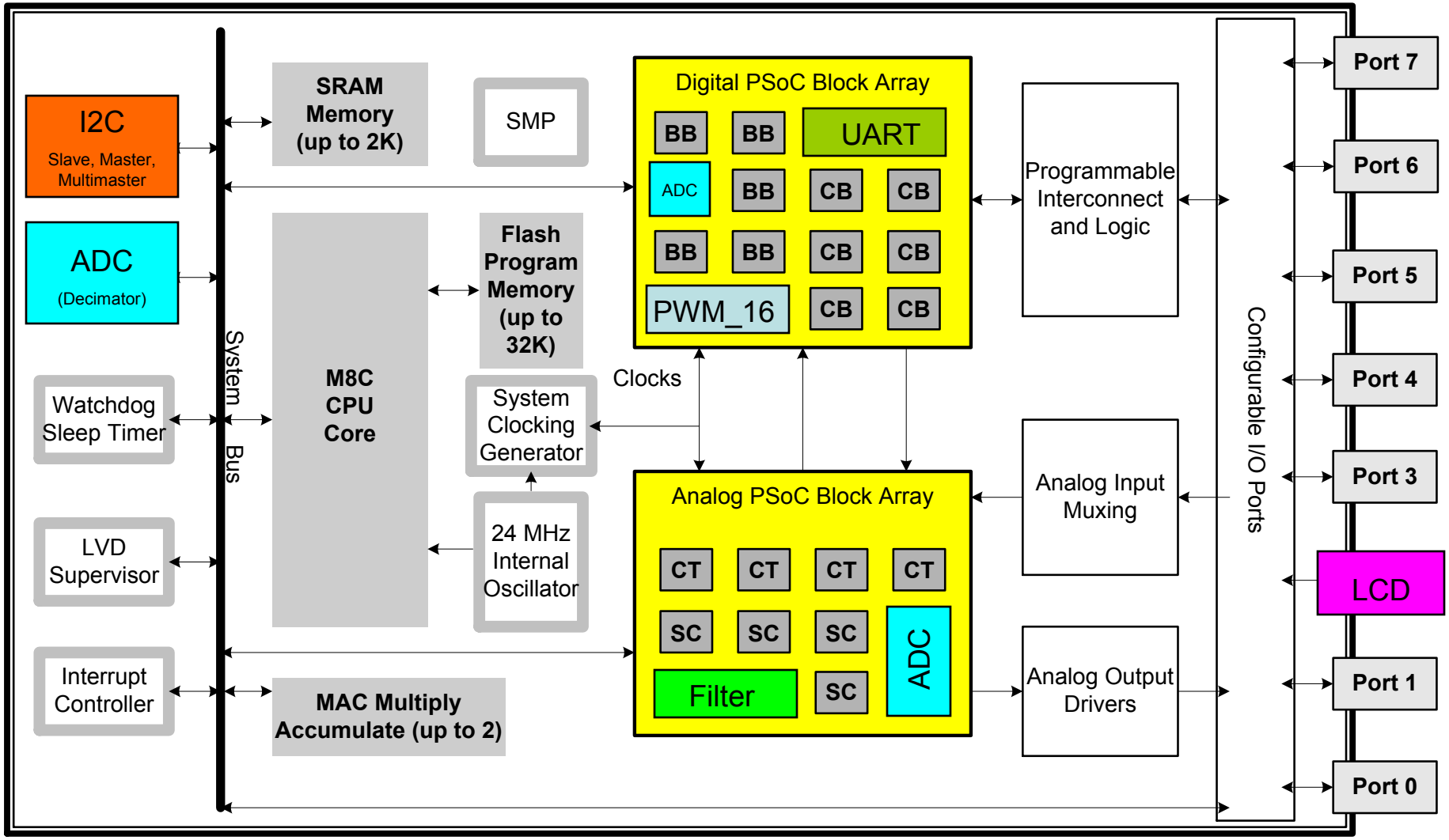
PSoC Die



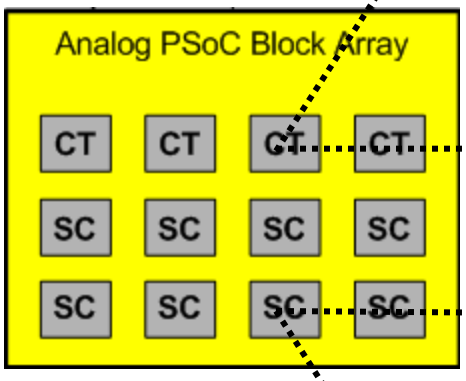


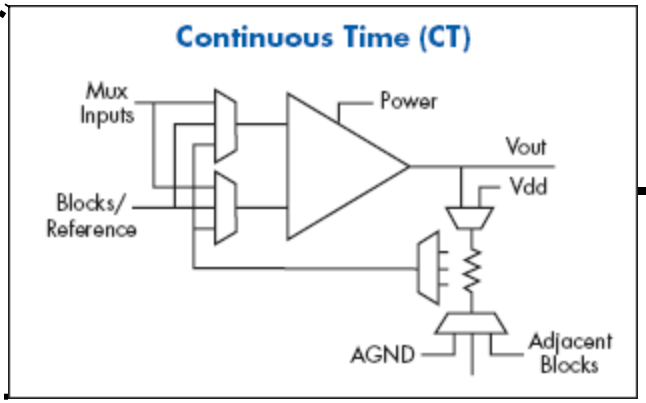
CY8C27XXX – PSoC 1208

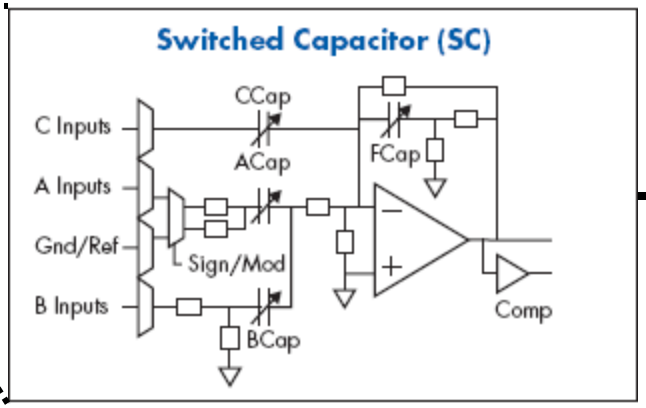
PSoC 1 Architecture



Analog Functions (Subset)

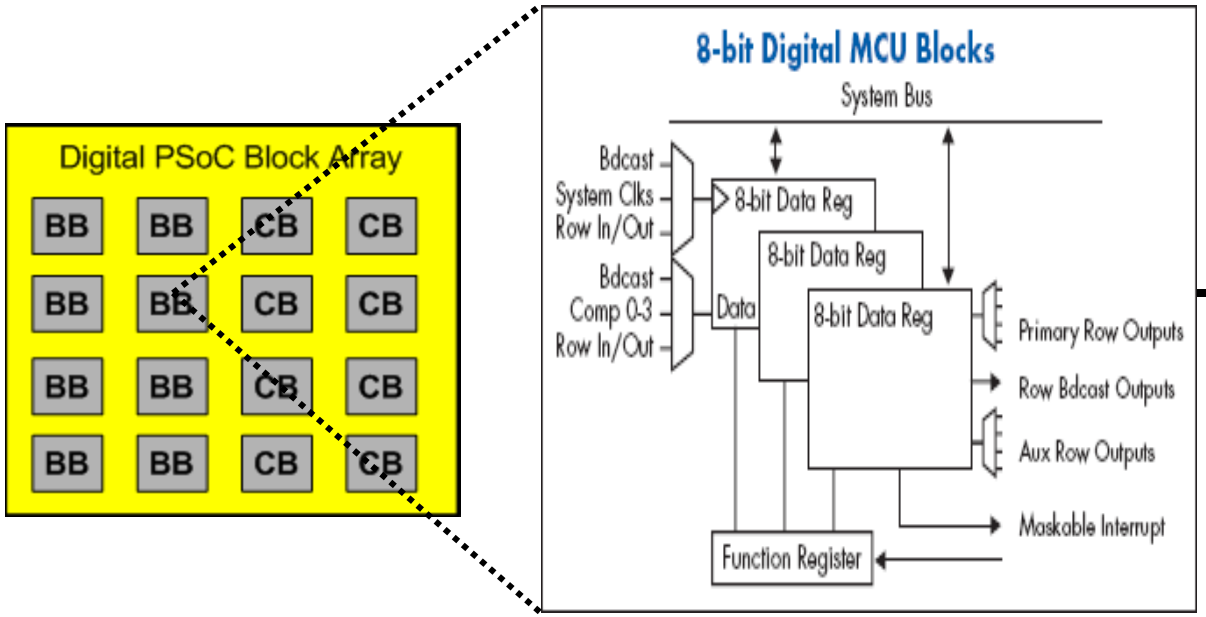






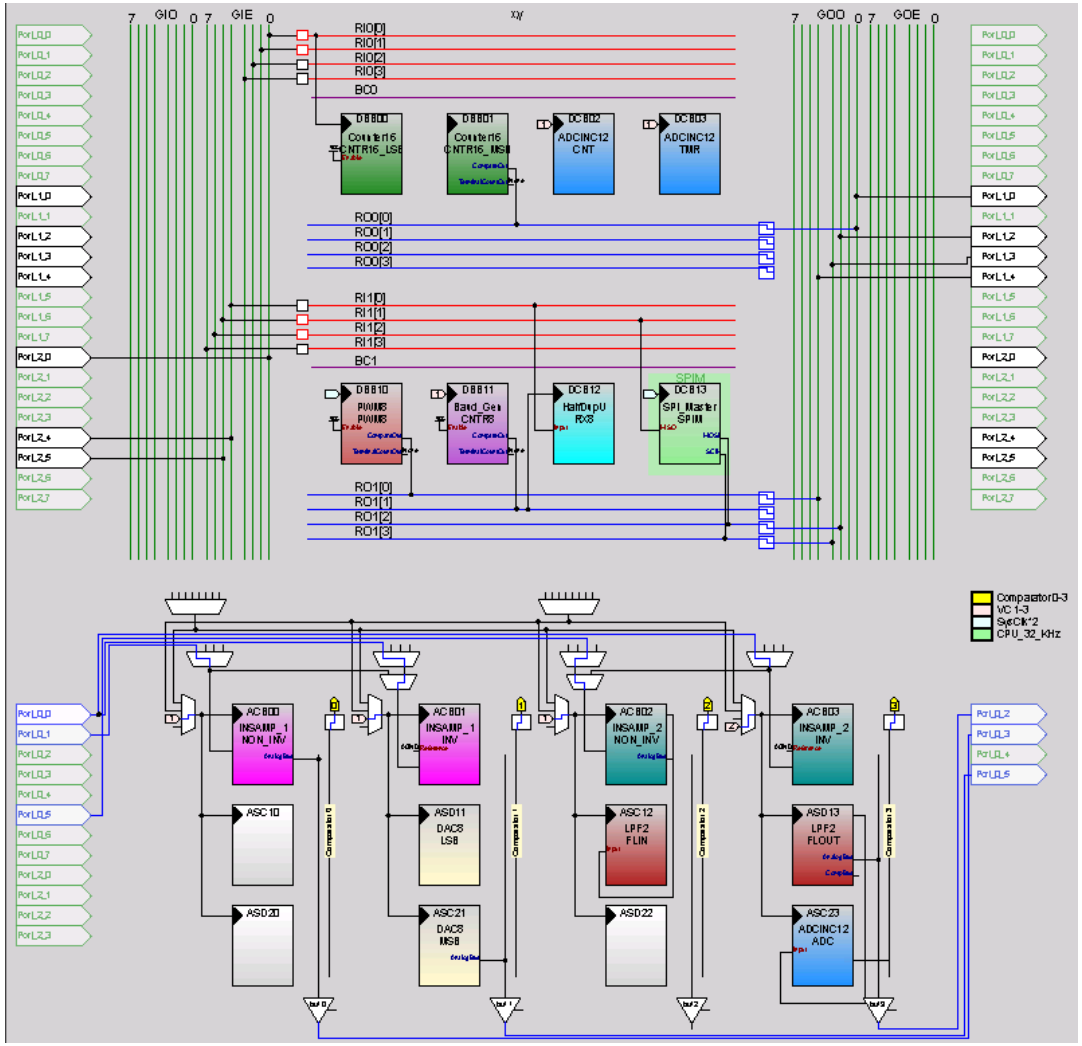
- ADC
  - Incremental 6-14 bits
  - Delta Sigma 6-13 bits
- DAC
  - 6, 8, and 9 bit
  - 6 and 8 bit multiplying
- Filters
  - 2-pole Low-pass
  - 2-pole Band-pass
- DTMF Dialer
- Modulator
- Peak Detector
- V to I Converter
- Amplifiers
  - Programmable Gain
  - Instrumental
  - Inverting
- Comparators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

Digital Functions (subset)



- 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

Interconnection Scheme



- Define connections between pins and function blocks
- Define connections between function blocks
- Define clock paths
- Change connections dynamically too!

User Modules

Pre-configured and Pre-characterized Digital and Analog PSoC Blocks

Greatly simplifies and shortens coding process

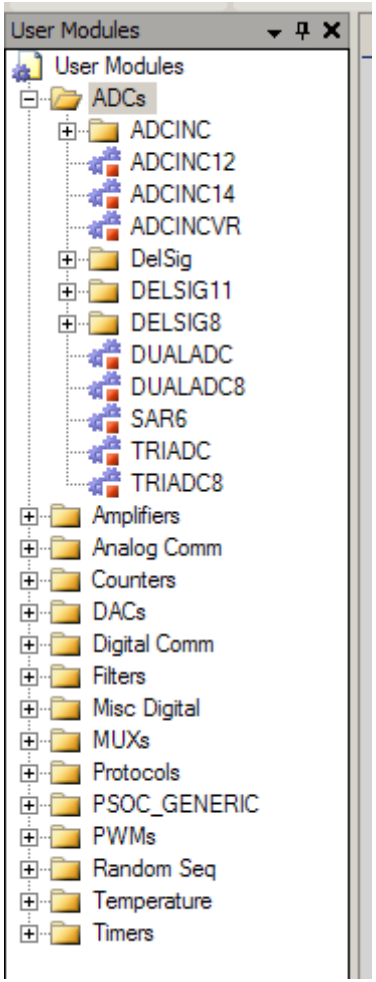
Analogous to On-chip Peripherals

- ADCs, DACs, PGAs, Filters
- Timers, Counters, PWMs
- UART, SPI, I2C

Defines the Register Bits for Initial Configuration
Selected via Double Click in IDE

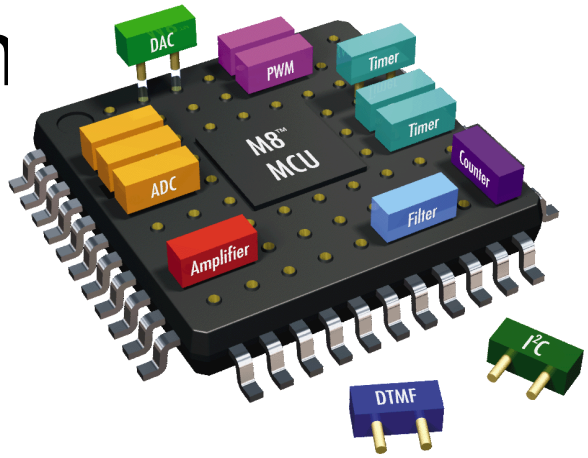
User Modules Include

- Application Programmer Interfaces (APIs)
- Interrupt Service Routines (ISRs)
- Specific UM Data Sheets



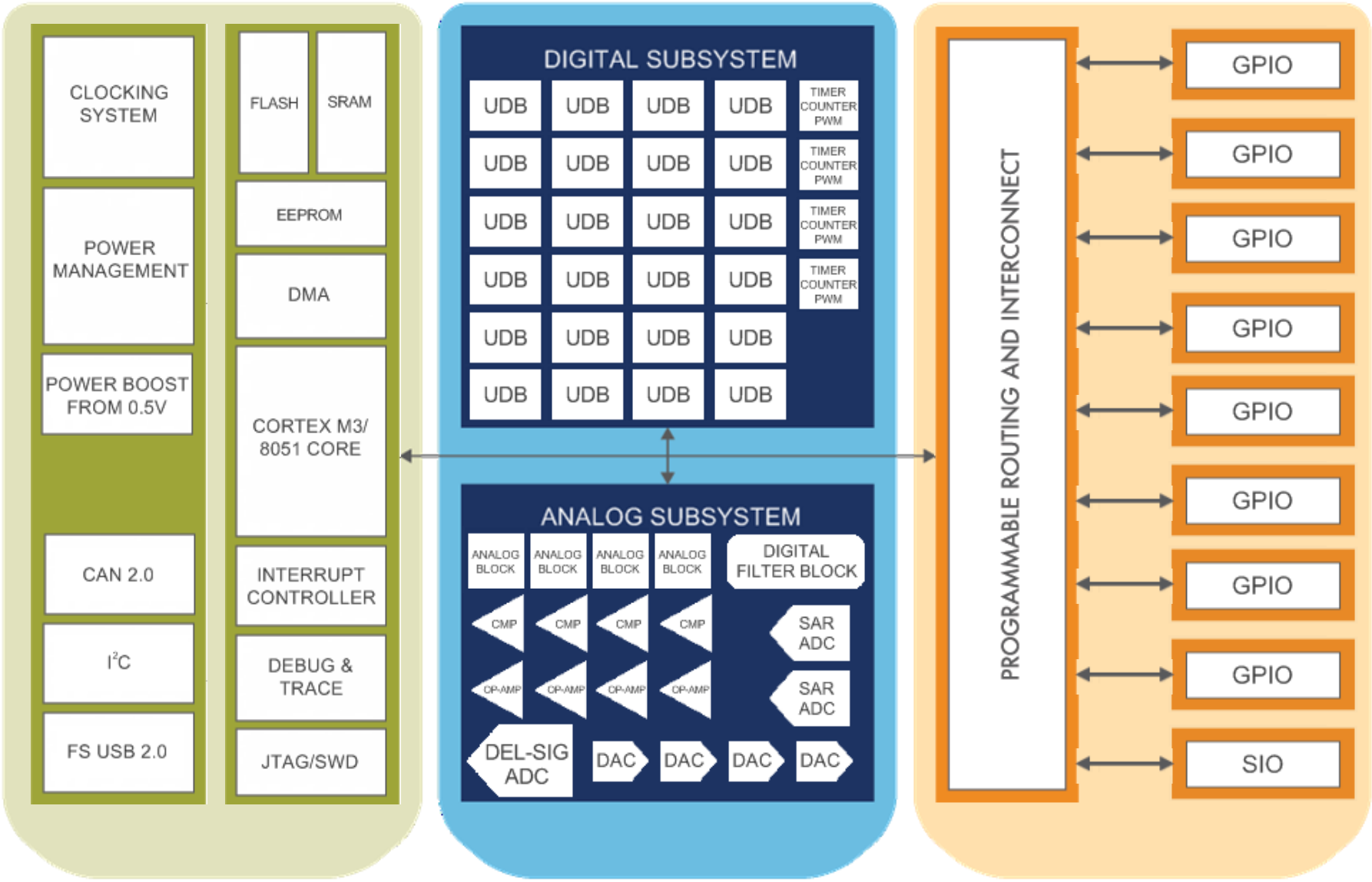
Additional Features

- Comprehensive Design Tools
- Intuitive Resource Placement
- Easy Routing
- Powerful Logic
- Dynamic Reconfiguration

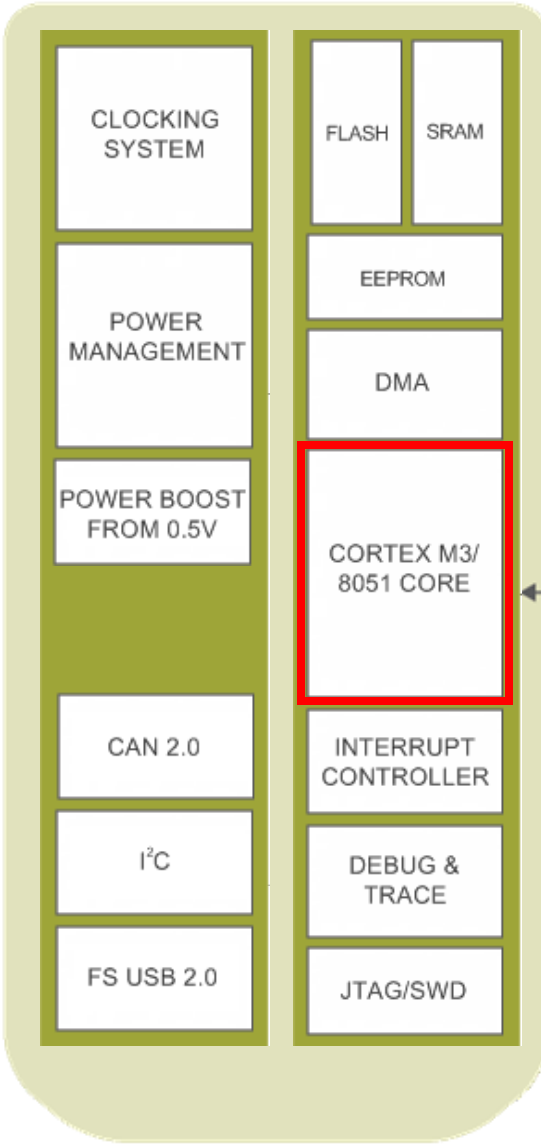


PSoC 3 / PSoC 5 101: Architecture Overview

PSoC 3 / PSoC 5 Platform Architecture



CPU Subsystem



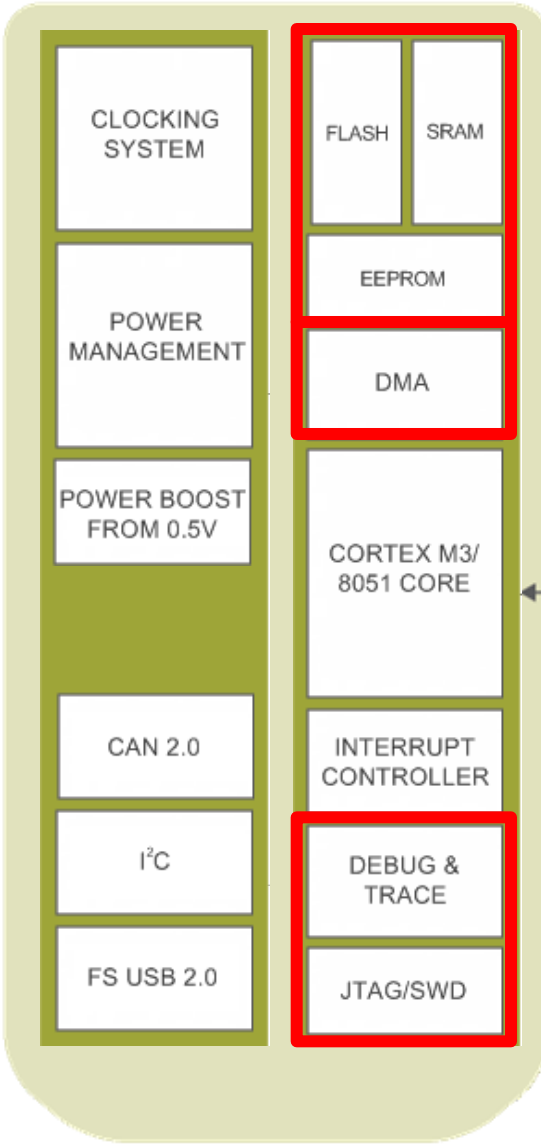
ARM Cortex-M3

- Industry's leading embedded CPU company
- Broad support for middleware and applications
- Up to 80 MHz; 100 DMIPS
- Enhanced v7 ARM architecture:
  - Thumb2 Instruction Set
  - 16- and 32-bit Instructions (no mode switching)
  - 32-bit ALU; Hardware multiply and divide
- Single cycle 3-stage pipeline; Harvard architecture

8051

- Broad base of existing code and support
- Up to 67 MHz; 33 MIPS
- Single cycle instruction execution

CPU Subsystem



High Performance Memory

- Flash memory with ECC
- High ratio of SRAM to flash
- EEPROM

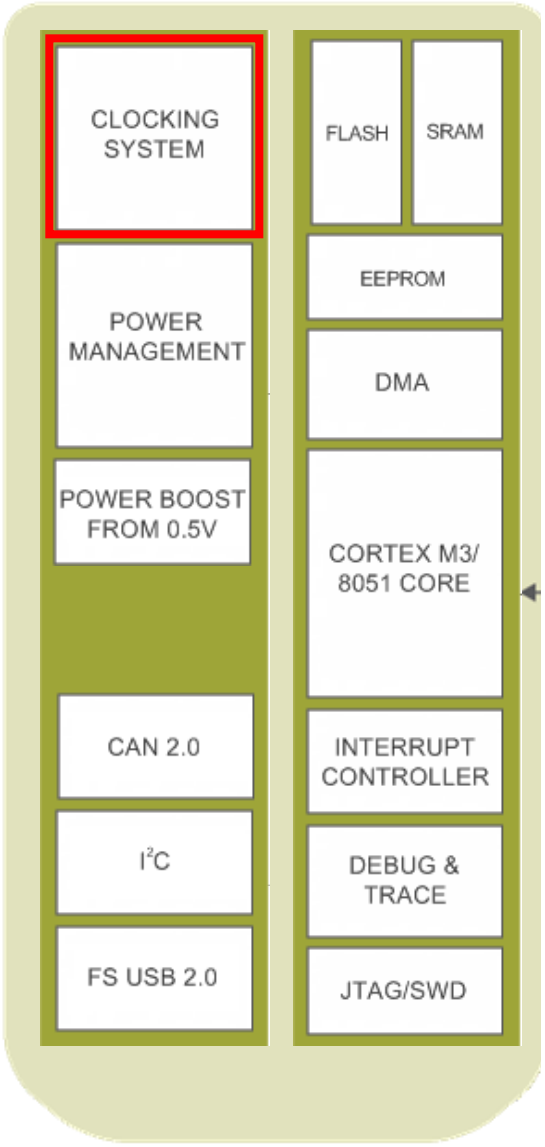
Powerful DMA Engine

- 24-Channel Direct Memory Access
- Access to all Digital and Analog Peripherals
- CPU and DMA simultaneous access to independent SRAM blocks

On-Chip Debug and Trace

- Industry standard JTAG/SWD (Serial Wire Debug)
- On chip trace
- NO MORE ICE

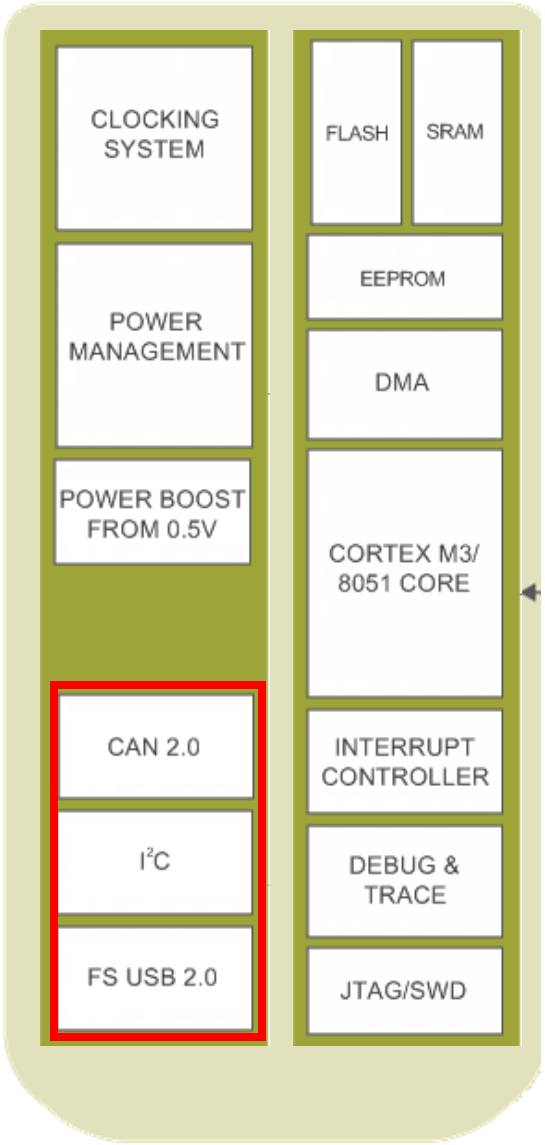
CPU Subsystem



Clocking System

- Many Clock Sources
  - Internal Main Oscillator
  - External clock crystal input
  - External clock oscillator inputs
  - Clock doubler output
  - Internal low speed oscillator
  - External 32 kHZ crystal input
  - Dedicated 48 MHz USB clock
  - PLL output
- 16-bit Clock Dividers
  - 8 Digital
  - 4 Analog
- PSoC Creator Configuration Wizard
- PSoC Creator auto-derive clocking source/dividers

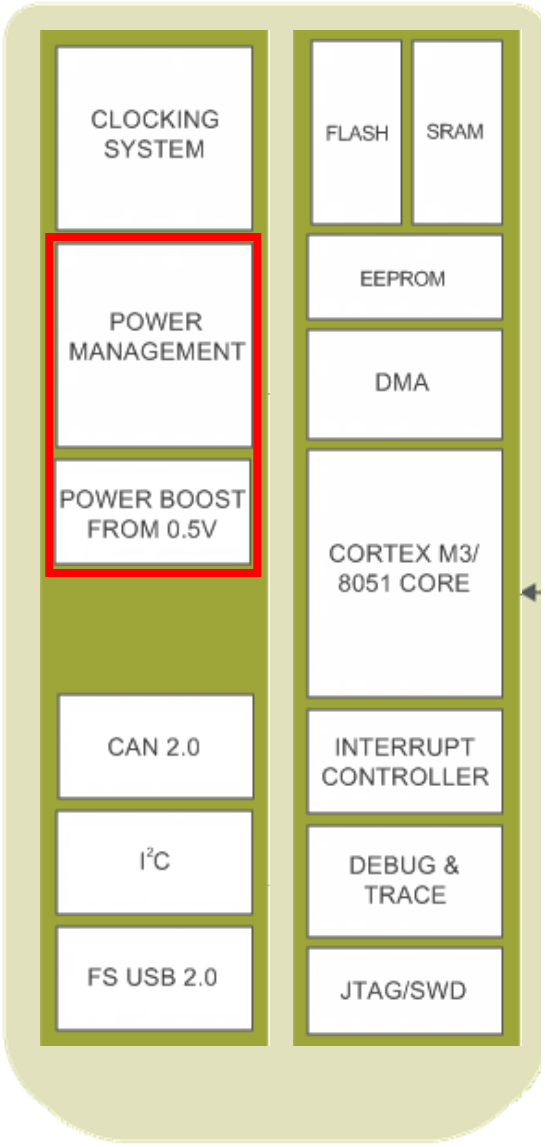
CPU Subsystem



Dedicated Communication Peripherals

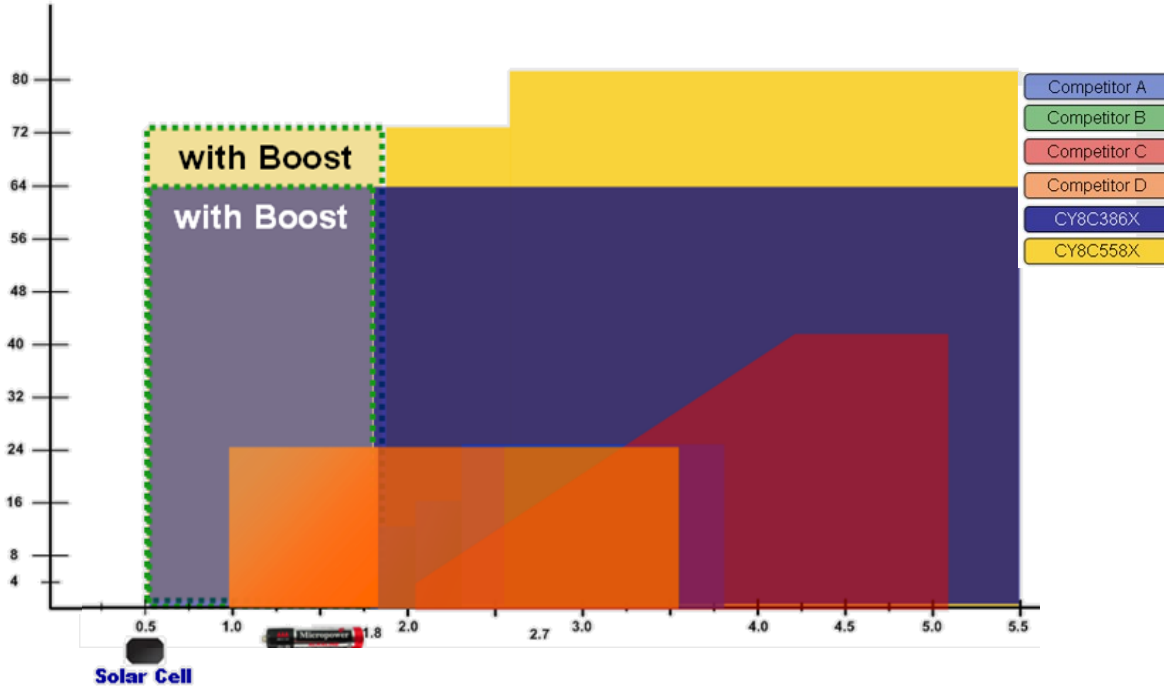
- **Full Speed USB device**
  - 8 bidirectional data end points + 1 control end point
  - No external crystal required
  - Drivers in PSoC Creator for HID class devices
- **Full CAN 2.0b**
  - 16 RX buffers and 8 TX buffers
- **I2C master or slave**
  - Data rate up to 400 kbps
  - Additional I2C slaves may be implemented in UDB array
- New peripherals will be added as family members are added to the platform: Ethernet, HS USB, USB Host…

CPU Subsystem



Power Management

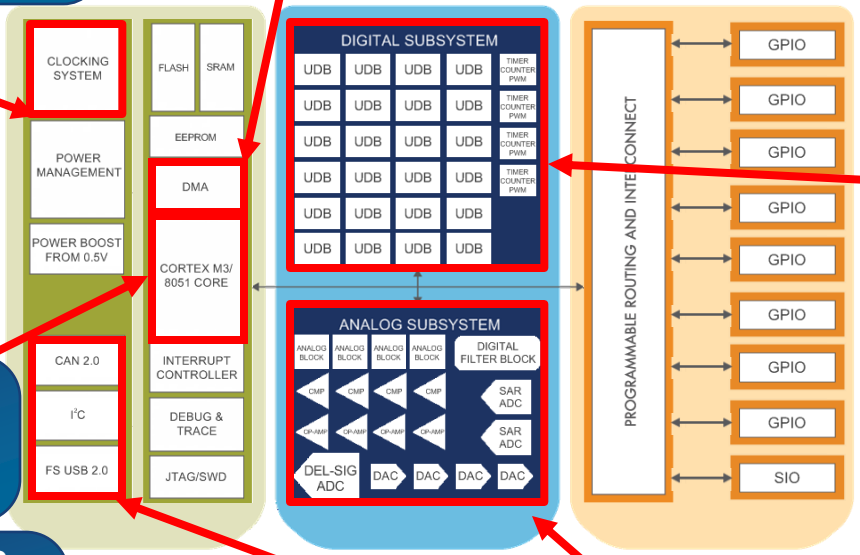
- Industry's Widest Operating Voltage
  - 0.5V to 5.5V with full analog/digital capability
- High Performance at 0.5V
  - PSoC 3 @ 67 MHz; PSoC 5 @ 72 MHz
- 3 Power Modes (Active, Sleep and Hibernate)



Designed for Low Power/Low Voltage

On-board DMA Controller
Direct memory transfer between peripherals offloads CPU operation, lowering power consumption

Highly configurable clock tree
Flexible, automated clock gating.



Universal Digital Blocks
Implement features in hardware that reduce CPU processing requirements, lowering power consumption

Cached Operations
Execution from flash memory is improved by caching instructions (PSoC 5 only)

Precise CPU frequencies
PLL allows 4,032 different frequencies; tunable power consumption

Integrated Analog, Digital and Communication Peripherals
Reduce external component counts and lower overall **system** power consumption

Low Power Modes

Power mode	Current (PSoC 3)	Current (PSoC 5)	Code execution	Digital resources available	Analog resources available	Clock sources available	Wakeup sources	Reset sources
Active	**1.2 mA @ 6MHz**	**2 mA @ 6MHz**	Yes	All	All	All	N/A	All
Sleep	**1 uA**	**2 uA**	No	I2C	Comparator	Low Speed and 32 kHz Osc	IO, I2C, RTC, sleep timer, comparator	XRES, LVD, WDR
Hibernate	**200 nA**	**300 nA**	No	None	None	None	IO	XRES, LVD

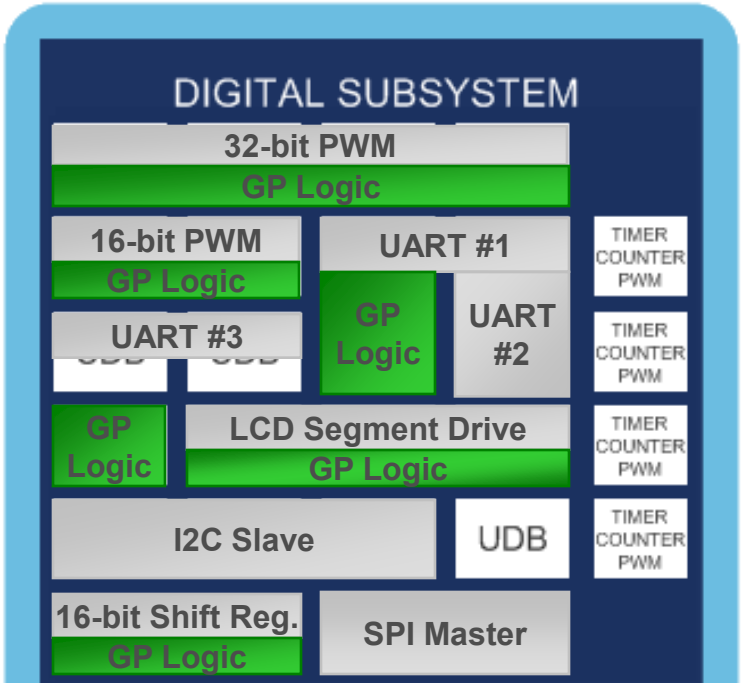
Power Management Enabled in PSoC Creator

- Provides easy to use control APIs for quick power management
- Allows code and register manipulation for in-depth control

Digital Subsystem

Universal Digital Block Array (UDBs)

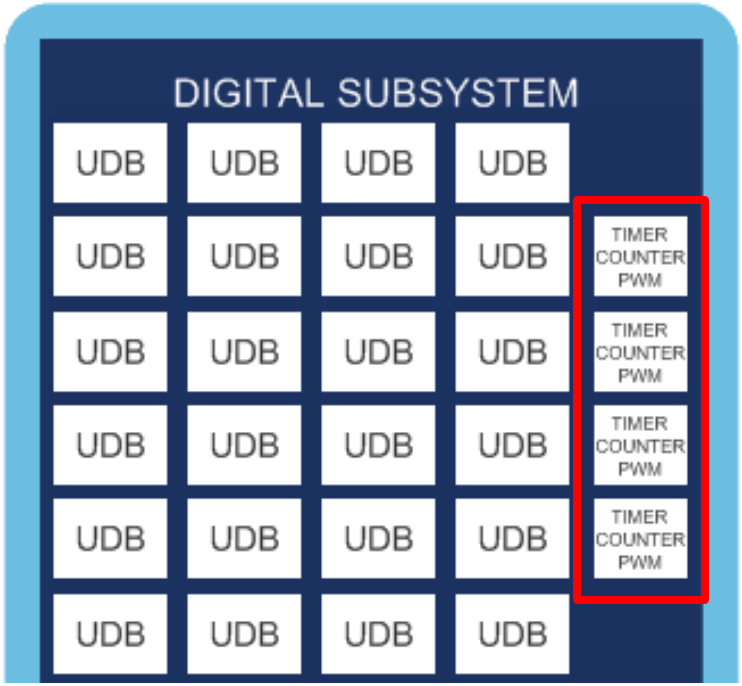
- Flexibility of a PLD integrated with a CPU
- Provides hardware capability to implement components from a rich library of pre-built, documented, and characterized components in PSoC Creator
- PSoC Creator will synthesize, place, and route components automatically.
- Fine configuration granularity enables high silicon utilization
- DSI routing mesh allows any function in the UDBs to communicate with any other on-chip function/GPIO pin with 8- to 32-bit data buses



Digital Subsystem

Optimized 16-bit Timer/Counter/PWM Blocks

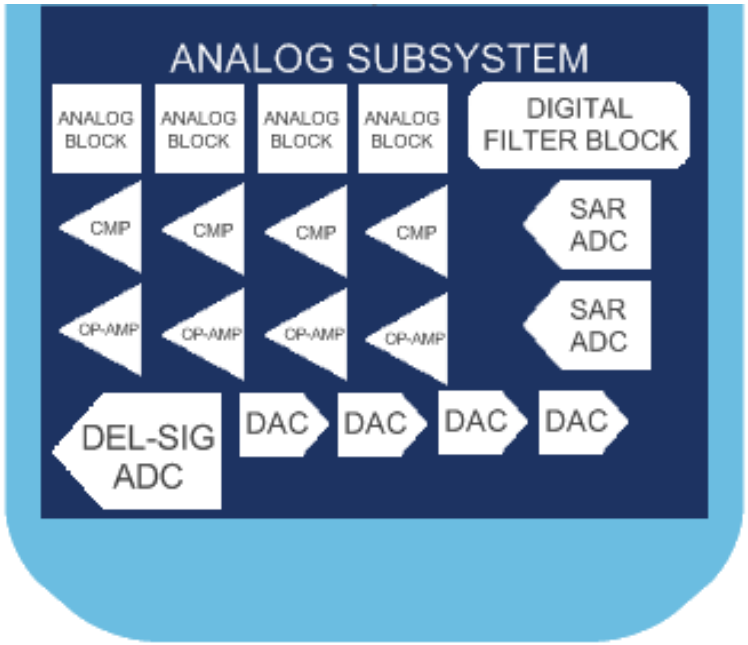
- Provides nearly all of the features of a UDB based timer, counter, or PWM
- PSoC Creator provides easy access to these flexible blocks
- Each block may be configured as either a full featured 16-bit Timer, Counter, or PWM
- Programmable options
  - Clock, enable, reset, capture, kill from any pin or digital signal on chip
  - Independent control of terminal count, interrupt, compare, reset, enable, capture, and kill synchronization
- Plus
  - Configurable to measure pulse widths or periods
  - Buffered PWM with dead band and kill



Analog Subsystem

Configurable Analog System

- Flexible Routing: All GPIO are Analog Input/Output
- +/- 0.1% Internal Reference Voltage
- Delta-Sigma ADC: Up to 20-bit resolution
  - 16-bit at 48 ksps or 12-bit at 192 ksps
- SAR ADC: 12-bit at 1 Msps
- DACs: 8 – 10-bit resolution, current and voltage mode
- Low Power Comparators
- Opamps (25 mA output buffers)
- Programmable Analog Blocks
  - Configurable PGA (up to x50), Mixer, Trans-Impedance Amplifier, Sample and Hold
- Digital Filter Block: Implement HW IIR and FIR filters
- CapSense Touch Sensing enabled



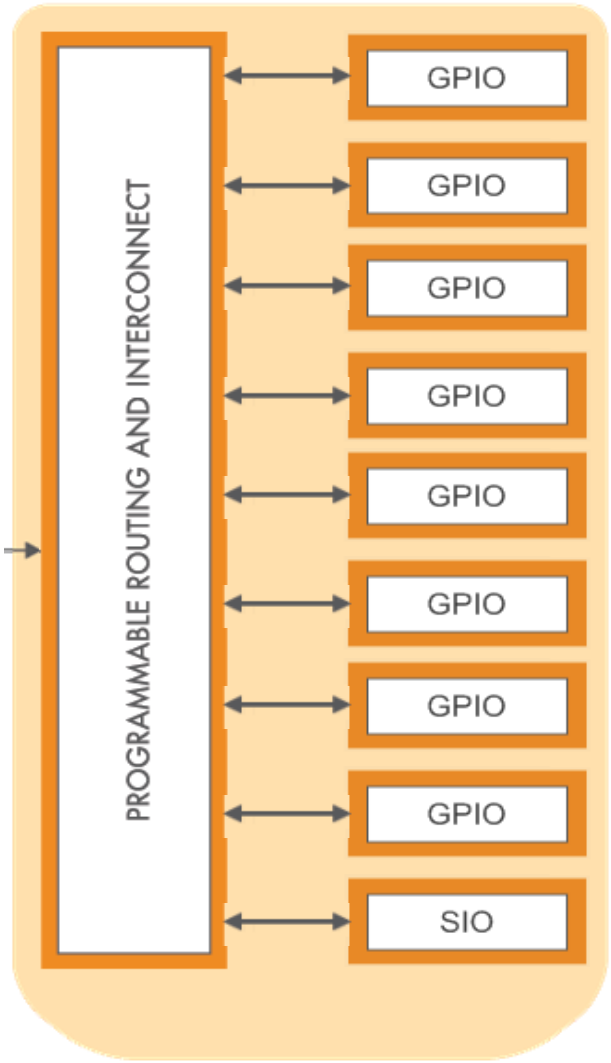
Programmable Routing/Interconnect

Input / Output System

- Three types of I/O
  - GPIO, SIO, USBIO
- Any GPIO to any peripheral routing
- Wakeup on analog, digital or I2C match
- Programmable slew rate reduces power and noise
- 8 different configurable drive modes
- Programmable input threshold capability for SIO
- Auto and custom/lock-able routing in PSoC Creator

Up to 4 separate I/O voltage domains

- Interface with multiple devices using one PSoC 3 / PSoC 5 device



Supported Compilers

- Free Bundled compiler options
  - PSoC 3: Cypress-Edition Keil™ CA51 Compiler Kit
  - PSoC 5: GNU/CodeSourcery Sourcery G++™ Lite
  - No code size restrictions, not board-locked, no time limit
  - Fully integrated including full debugging support

- Upgrade, more optimization/compiler-support options
  - PSoC 3: Keil CA51™ Compiler Kit
  - PSoC 5: Keil RealView® Microcontroller Development Kit
  - Higher levels of optimization
  - Direct support from the compiler vendor

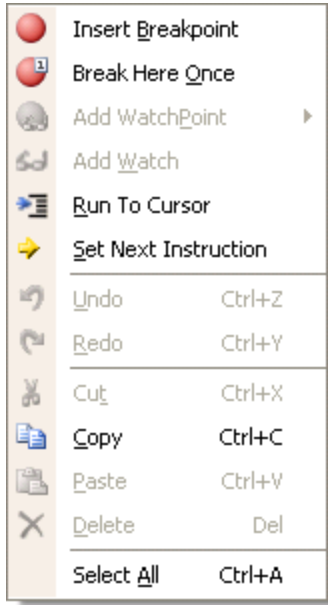
- Upgrade Compiler Pricing
  - Set and managed by our 3rd party partner, Keil
  - Already own these compilers? No need to buy another license!
  - Keil CA51 Compiler Kit ~$2,000
  - Keil RealView MDK ~$3,000-5,000

Integrated Debugger

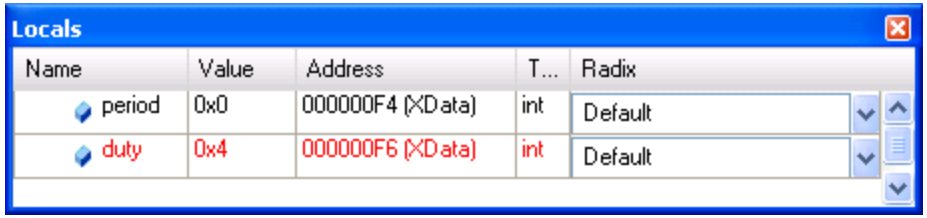
- JTAG and SWD connection
- All devices support debug
- MiniProg3 programmer / debugger

- Control execution with menus, buttons and keys

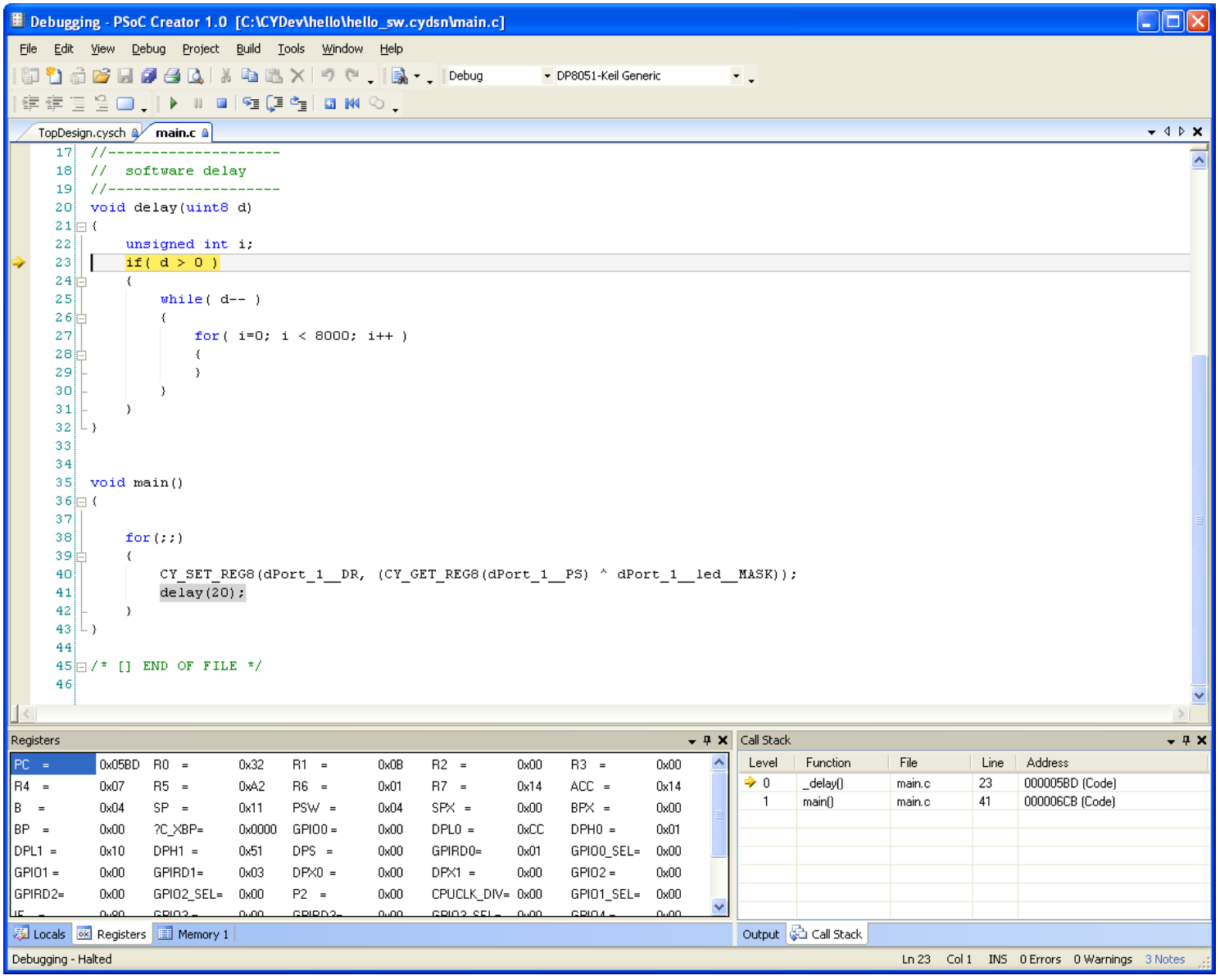
- Full set of debug windows
- Locals, register, call stack, watch (4), memory (4)
- C source and assembler
- Components



- Set breakpoints in Source Editor



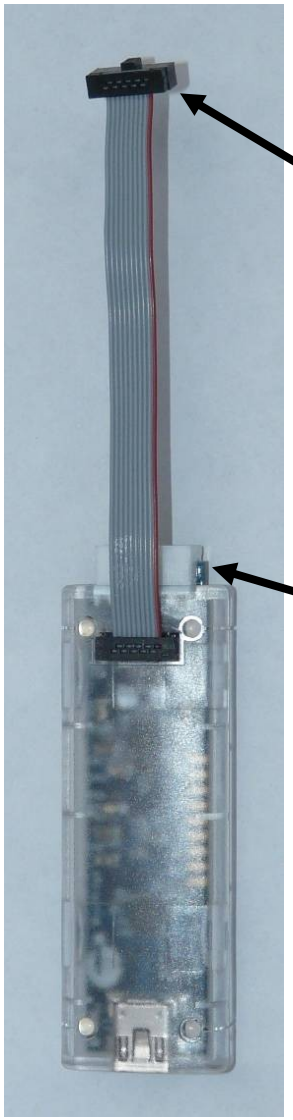
Debugger Windows



MiniProg3

- Program PSoC 1 devices
- Program/Debug PSoC 3 / PSoC 5 devices
- Standard 50mil connector
- nTRST/XRES pin is used as the device reset (XRES) by default
- nTRST is JTAG specific and rarely used

Features	MiniProg	MiniProg3
ISSP connector (5-pin)	Yes	Yes
Issp protocol (PSoC1)	Yes	Yes
JTAG/SWD connector with ribbon cable	No	Yes
JTAG/SWD protocl	No	Yes
SWV protocol	No	Yes
ARM Cortex M3 trace port	No	Yes
Match ISSP, JTAG, SWD voltage to IOs	No	Yes
Target Supply (100ma limit)	5.0V	1.8V-5.0V
USB bus speed	Full	High

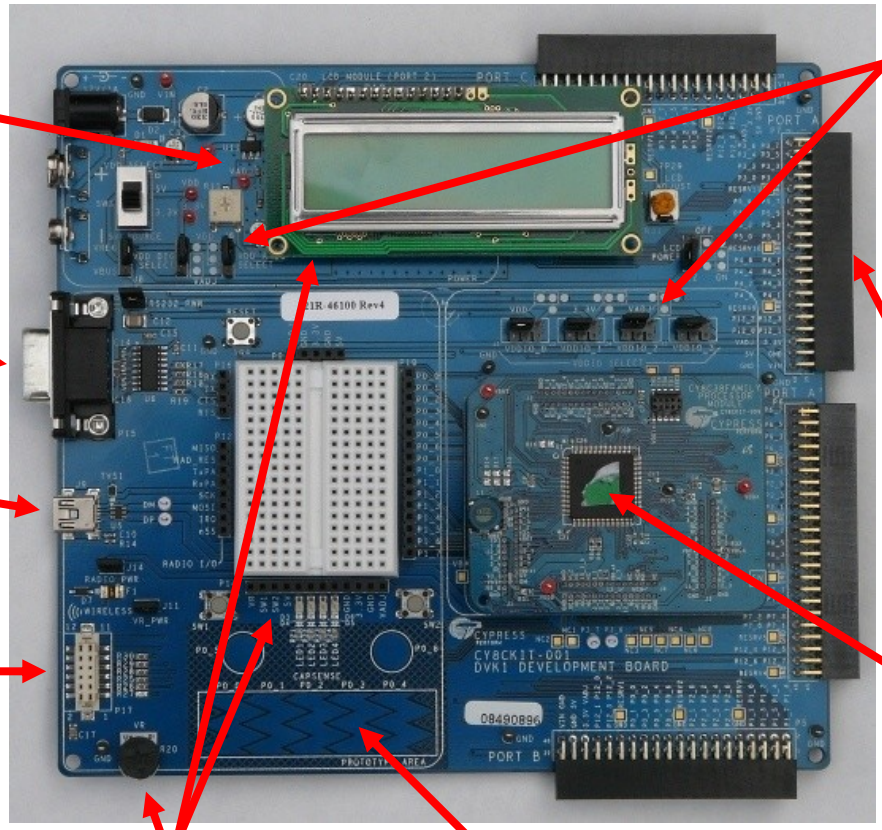


2x5 50mil ISSP/JTAG/SWD/ SWV/TracePort ribbon cable and connector

ISSP connector

PSoC Development Kit (CY8CKIT-001)

- Supports all PSoC architectures via processor modules
- Integrated support of all required and optional chip connections
- MiniProg3 should not supply power to PSoC Development Kit



PSoC Architecture Comparison

Features	PSoC 1	PSoC 3	PSoC 5
Interface	SPI, UART, GPIO, FS-USB, I2C	PSoC1 + CAN, I2S	Same as PSoC 3
Inputs	Sensors, CapSense, Touchscreen, Analog	PSoC1 + Precision Analog	PSoC1 + High speed Analog
Outputs	LED control, Motor control, Analog buffers	PSoC1 + LCD segment drive, LED drive, advanced motor control	PSoC1 + QVGA LCD control
Processing	M8 24 MHz	8051 67 MHz	ARM® Cortex -M3™ 80 MHz

PSoC 1 Architecture

	Features	PSOC 1
Configurable Analog / Digital	ADC	1 Delta-Sigma (6- to 14-bit)
	Sample Rate	Up to 31 KSPS (8-bit)
	Reference Voltage Accuracy	±1.53%
	DACs	Up to 2 (6- to 8-bit)
	PGA	x1 to x48
	LCD Segment Drive	Control
	Integrate Programmable Logic	No
	CapSense & Touchscreen	Up to 44 Buttons and 8 Sliders

PSoC 1 Architecture

	Features	PSOC 1
CPU Subsystem	CPU	M8C
	CPU Performance	24 MHz, 4 MIPS
	Flash	4 KB to 32 KB
	SRAM	256B to 2 KB
	Operating Range	1.7V to 5.25V
	Power Consumption (Active@6MHz)	Active:2mA, Sleep:3uA
	Connectivity Resources	FS USB 2.0, I2C, SPI, UART

PSoC 1 Architecture

	Features	PSOC 1
Programmable Interconnect	Routing & Matrix	Manual Routing, Configurable
	# IO	Up to 64
Tools	Software Development Tools	PSoC Designer and 3rd party compilers
	In-Circuit Emulation and Debug	Requires ICE Cube and FlexPods (Bond Out)

PSoC 3 & 5 Architecture

Features	PSOC 3	PSOC 5
ADC	1 Delta-Sigma (12- to 20-bit)	1 Delta-Sigma (12- to 20-bit); 2-SAR ADC (12-bit)
Sample Rate	192 KSPS (12-bit)	192 KSPS (12-bit) Delta-Sigma; 1 MSPS (12-bit) SAR ADC
Reference Voltage Accuracy	Industrial ±0.1%	Industrial ±0.1%
DACs	Up to 4 (8-bit)	Up to 2 (8-bit) and 1 (12-bit)
PGA	x1 to x50	x1 to x50
LCD Segment Drive	Control + Drive (736 segments)	Control + Drive (736 segments)
Integrate Programmable Logic	Yes	Yes
CapSense & Touchscreen	Up to 62 Buttons and 12 Sliders	Up to 62 Buttons and 12 Sliders

PSoC 3 & 5 Architecture

Features	PSOC 3	PSOC 5
CPU	Advanced 8051 (1CPI)	ARM Cortex-M3
CPU Performance	67 MHz, 33 MIPS	80 MHz, 100 DMIPS
Flash	8 KB to 64 KB	32 KB to 256 KB
SRAM	2 KB to 8 KB	16 KB to 64 KB
Operating Range	0.5V to 5.5V	0.5V to 5.5V
Power Consumption (Active@6MHz)	Active:1mA, Sleep:1uA, Hibernate:200nA)	Active:2mA, Sleep:2uA, Hibernate:300nA
Connectivity Resources	FS USB 2.0, I2C, SPI, UART, CAN, LIN, I2S	FS USB 2.0, I2C, SPI, UART, CAN, LIN, I2S

PSoC 3 & 5 Architecture

Features	PSOC 3	PSOC 5
Routing & Matrix	Automatic; Any pin anywhere	Automatic; Any pin anywhere
# IO	Up to 72	Up to 72
Software Development Tools	PSoC Creator and 3rd party Compilers/IDEs	PSoC Creator and 3rd party Compilers/IDEs
In-Circuit Emulation and Debug	On-chip JTAG, Debug and Trace	On-chip JTAG, Debug and Trace

Bibliography

- Cypress Semiconductor Power Point Slides
- Cypress Semiconductor Product Brochure