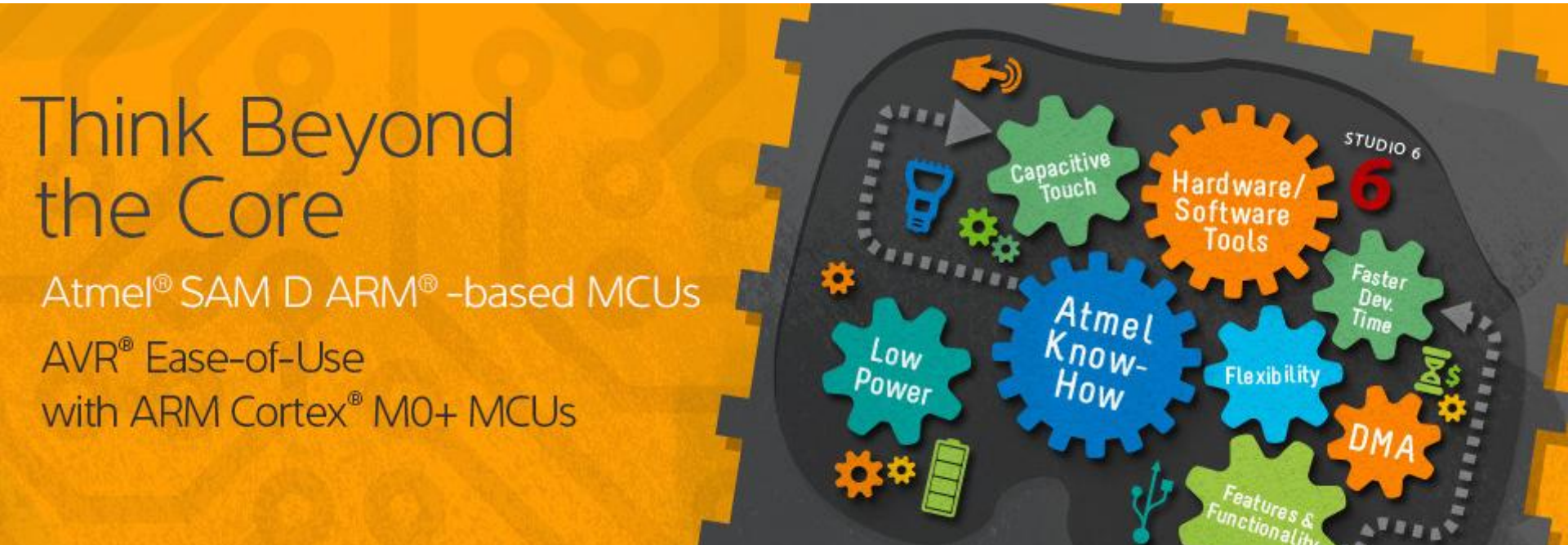
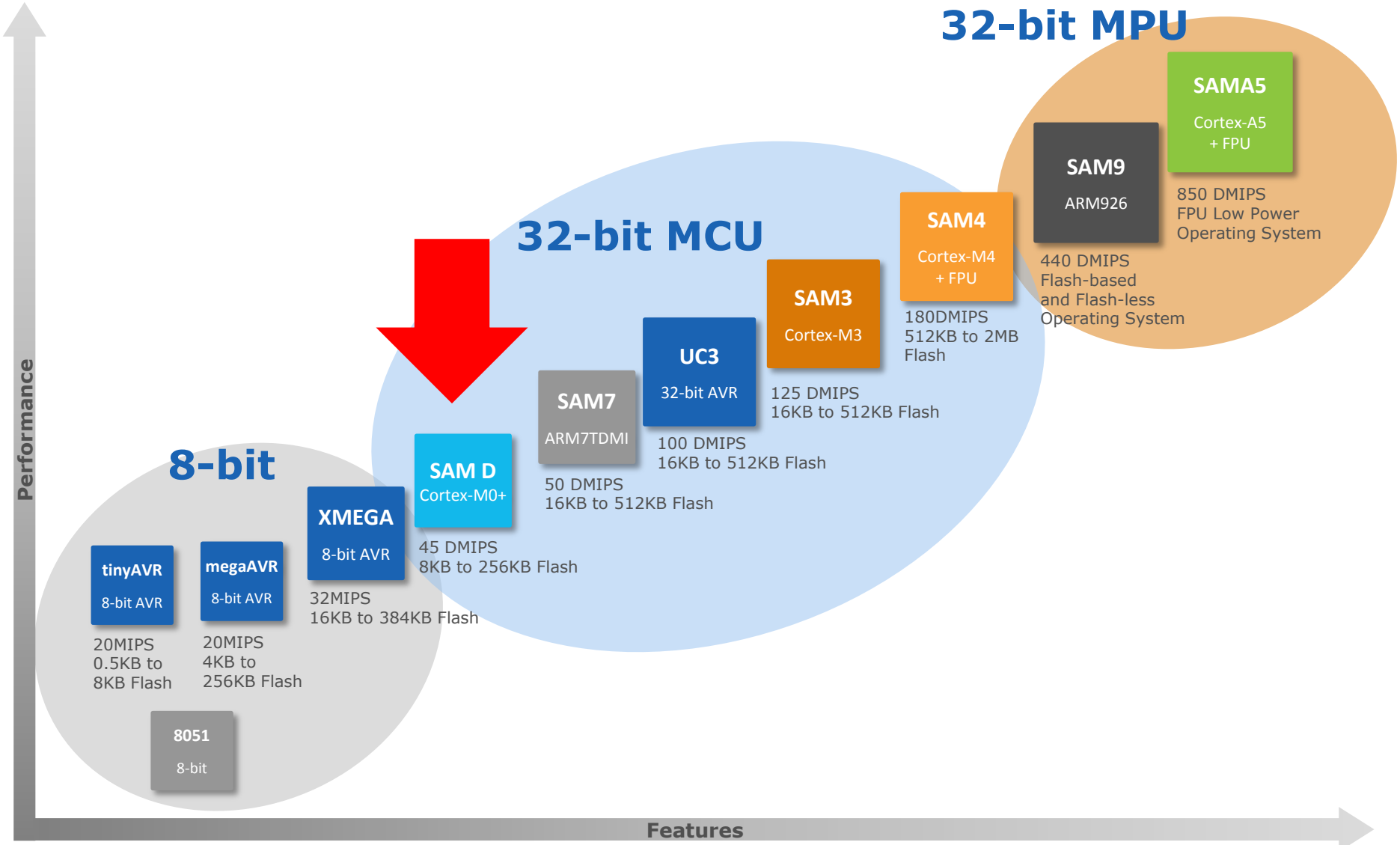
Introduction to SAM D20 based on ARM Cortex-M0+ MCU

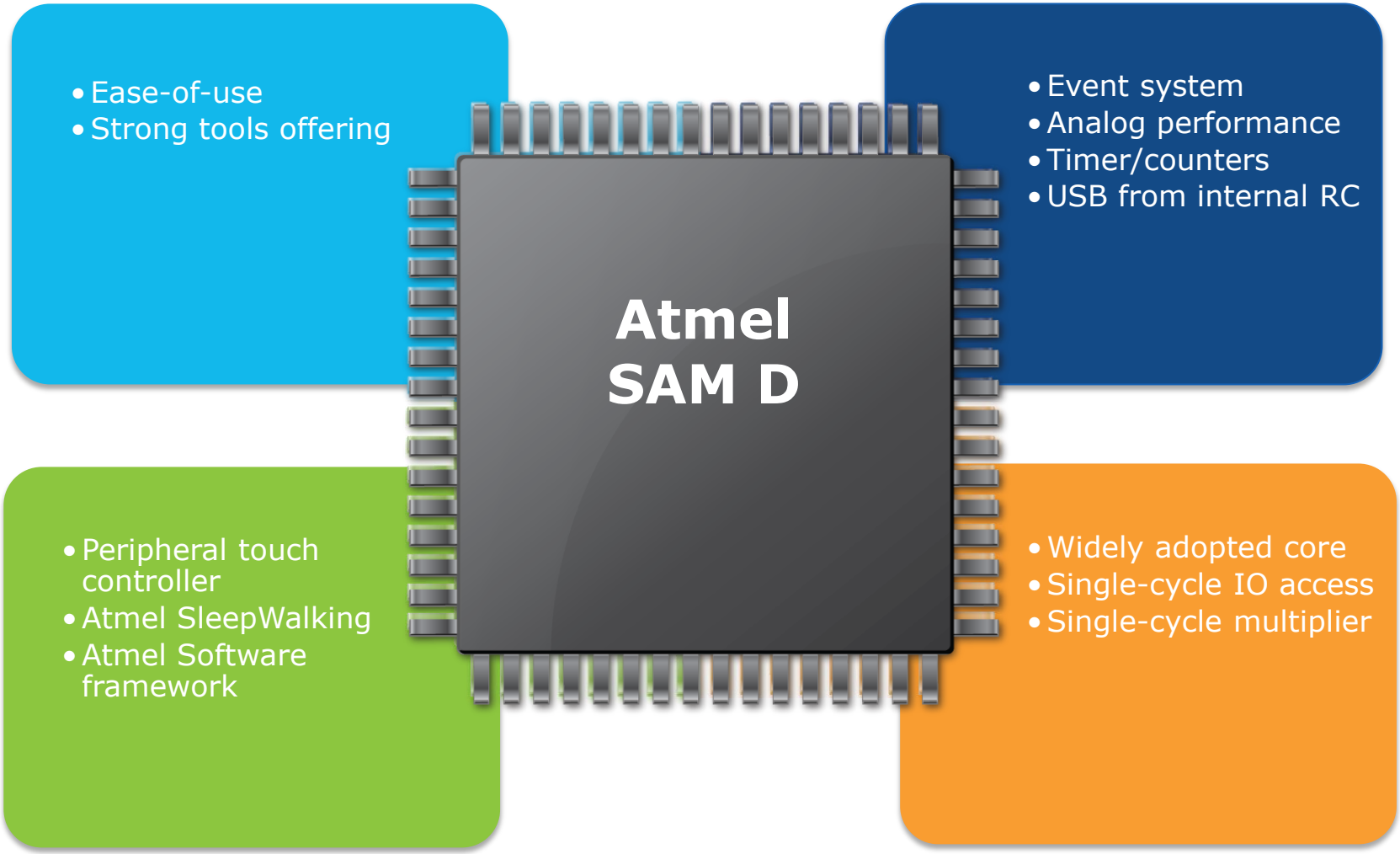


Atmel Product Portfolio



Introduction to Atmel SAM D family

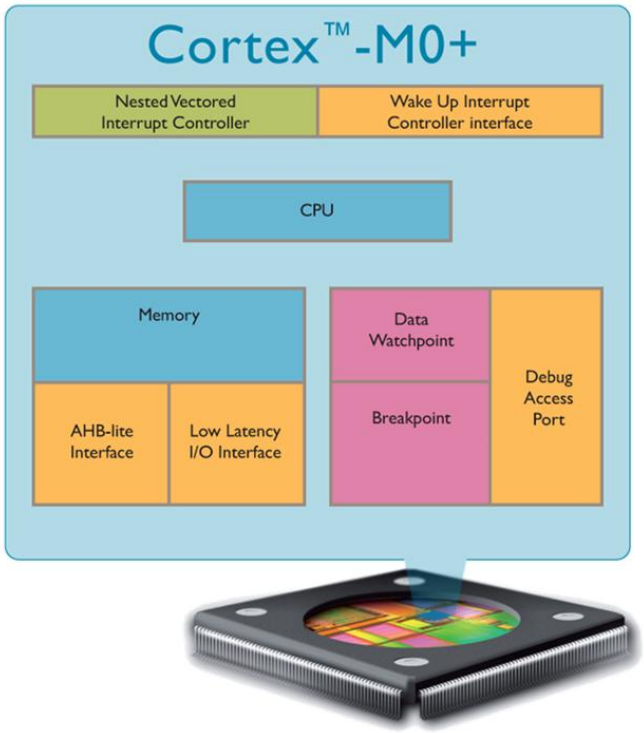
Combining the best of Atmel MCUs with ARM Cortex-M0+



Introducing Atmel SAM D Family

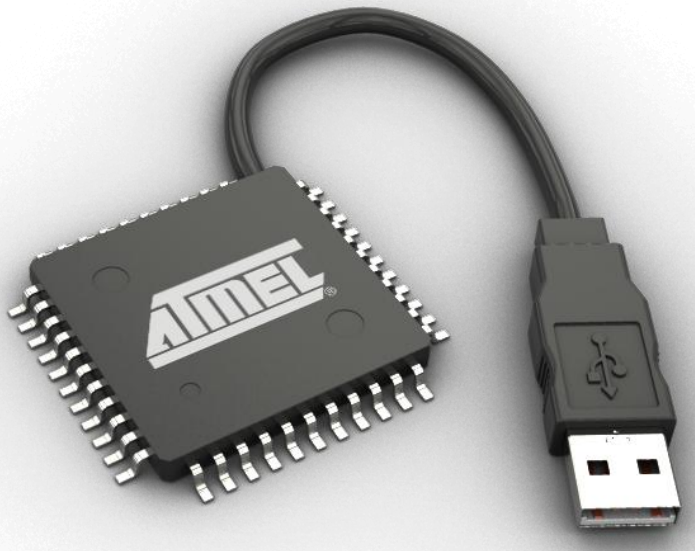
Powerful and Efficient Products

- Atmel SAM D Product Family
  - 48MHz operation
  - Up to 2.14 CoreMark®
  - Down to 70µA/MHz
  - ±2% 8MHz int RC oscillator
  - 1.62V-3.63V
  - 4 product Series
    - 35 pin/memory/feature combinations
    - 8KB to 256KB Flash
    - 14-64 pin packages



Atmel SAM D family

- Event system
- SERCOM modules configurable as I2C, USART or SPI
- Full Speed USB
  - Device from int RC oscillator
  - Embedded host
- Capacitive Touch HW engine
- 12-bit 350ksps ADC with gain stage
- 10-bit 350ksps DAC
- DMA Controller
- I2S
- Fractional PLL
- Timer/Counters

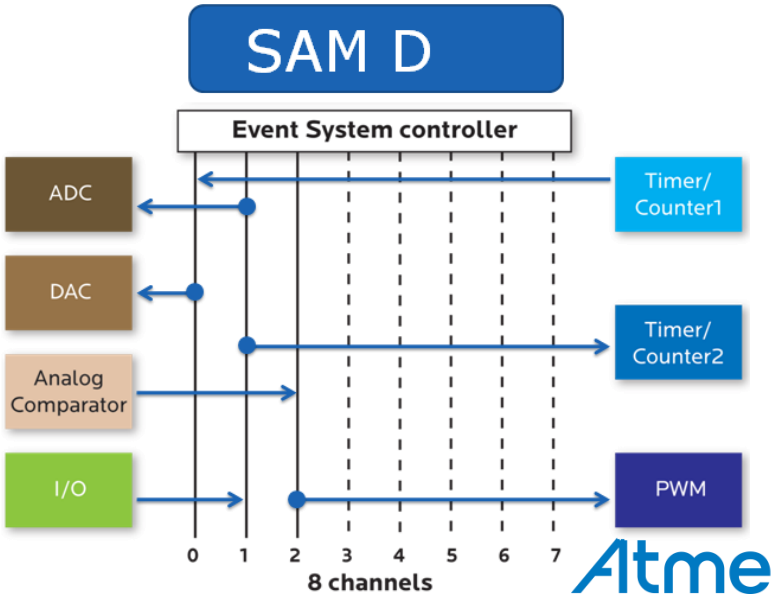


Peripheral Event System

Bringing the Innovation of Atmel AVR XMEGA to the Atmel SAM D Series

- Inter-peripheral Communication
  - CPU independent
  - Eight independent channels
  - Synchronous and Asynchronous
- Latency-free Event Handling
  - Safe fault protection
  - 100% predictable reaction time
- Advantages
  - Accurate timing
  - Efficiently offloading CPU
  - Reduced power consumption

Peripheral Events
GPIO
Timer /Counter
Asynchronous Timer (RTC)
Analog Comparator
ADC
DAC
Peripheral Touch Controller



SleepWalking™ Peripherals

Peripheral Intelligence

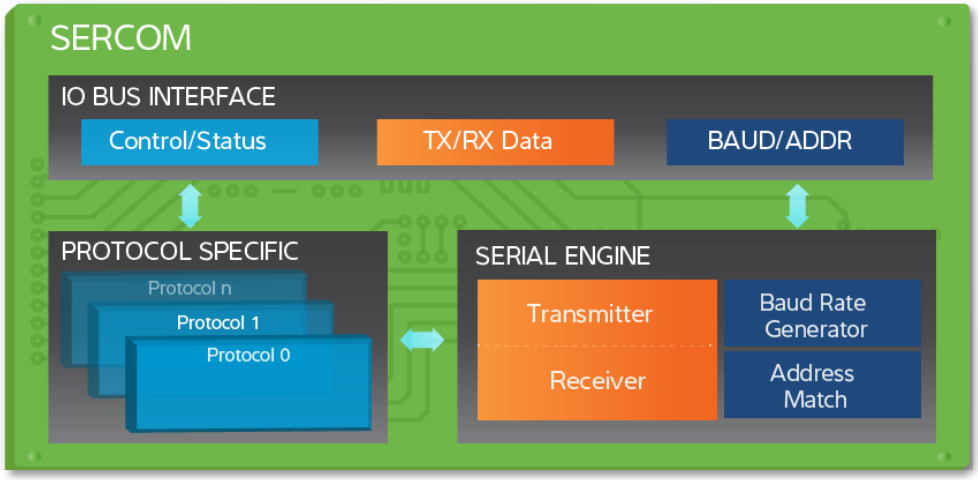
- Main clocks and IO clocks stopped in sleep mode to save power
- SleepWalking peripherals individually request clocks in sleep mode
  - Triggered by Asynchronous or timer events
- Clocks remain active until peripheral operation is complete

- SAM D20 SleepWalking Peripherals:
  - Analog Comparators
  - Peripheral Touch Controller

Serial Communication Module (SERCOM)

Highly Flexible Multi-interface Communication Module

- Configurable as
  - I2C
  - SPI
  - USART
- Double-buffered Reception
- IO Pin multiplexing
- Reconfigurable from software
- Wake-up from All Power Modes
  - I2C address match
  - SPI data reception
  - USART start detection



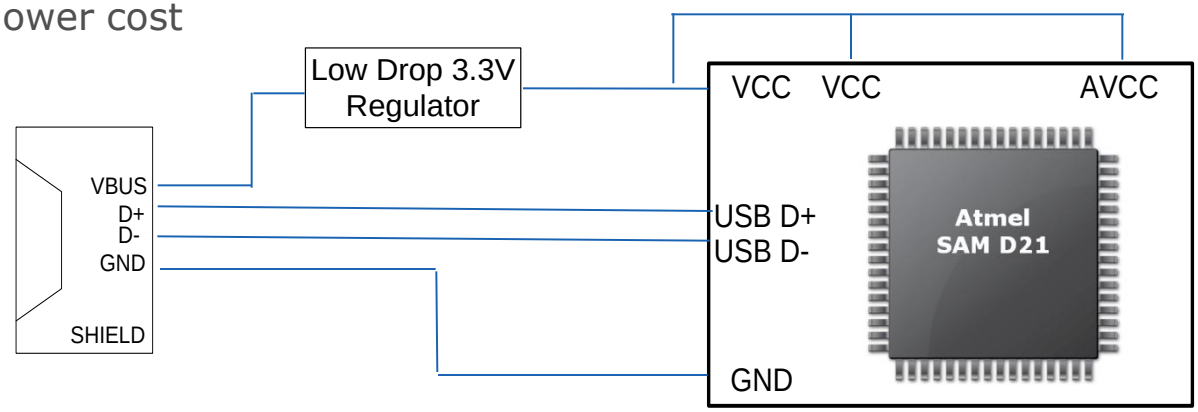
Full Speed USB

USB Device in SAM D11, USB Device and Host in D21

- Supports USB Full (12Mbit/s) and Low speed (1.5Mbit/s)
- No Need for external components
  - On-chip transceivers with built-in pull-ups and pull-downs
  - On-Chip USB serial resistors
- No endpoint/pipe size limitations
  - Uses Device SRAM as communication buffer
- Built-in DMA with multi-packet and double bank
- Supports feedback endpoint
- If USB is not needed, USB pins can be configured to GPIO
- Device Specific features
  - Supports up to 8 IN endpoints and 8 OUT endpoints
  - Can run USB Device from the internal RC oscillator
- Host Specific features
  - Supports up to 8 physical pipes
  - Supports USB 2.0 Phase-locked Start Of Frames feature

USB with Minimal BOM cost

- USB Device operation from internal RC oscillator for both Low and Full speed
- Few external components
  - Smaller PCB area
  - Easier HW design
  - lower cost



Note 1: The MCU must run at 3.3V for USB operation
Note 2: External Clock/Crystal needed for USB Host operation

SAMD21 - USB Software

- Drivers available in Atmel Software Framework (ASF)
- Currently Supported USB classes (Device & Host mode)
  - HID (Human Interface Device) Mouse, Keyboard, Generic…
  - MSC (Mass Storage Class)
  - CDC (Communication Device Class)
  - Vendor (Vendor Device Class)
  - PHDC (Personal Healthcare Device Class)
  - Android Open Accessory Class
  - Composite Device
- Drivers are fully compliant with USB 2.1 specification

- Certified USB - ASF with USB device and embedded host:
  - Using the USB stack available within AS6.2 (fully compliant for all examples)
  - Using the internal RC oscillator in Device mode

Peripheral Touch Controller (PTC)

Built-in Hardware Support for Touch

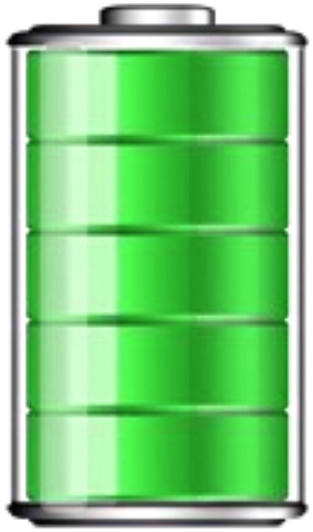
- Supports Buttons, Sliders, Wheels and Proximity
- Superb Sensitivity and Noise Tolerance
- Supports Mutual and Self Capacitive Touch
- Wake-up from Power Down on Touch Detection

Package	PTC channels Mutual Cap	PTC channels Self Cap
64-pin	Up to 256	Up to 16
48-pin	Up to 120	Up to 10
32-pin	Up to 60	Up to 6
24-pin	Up to 72	Up to 16
20-pin	Up to 42	Up to 13
14-pin	Up to 12	Up to 7

Low Power

- Atmel is a Market Leader in Low Power
  - Industry leading 8-bit picoPower devices
  - Worlds lowest power Cortex-M with picoPower SAM4L

- Low-power Atmel SAM D Series
  - Down to 70µA/MHz in active
  - 3.4µA with RTC and Full RAM retention
  - Down to 8µA running Capacitive Touch
  - Ultra-low power oscillators
  - SleepWalking peripherals
  - Wake-up from low-power sleep modes on
    - Pin change
    - SPI data reception
    - I2C address match
    - UART start condition
    - PTC touch detection



Analog to Digital Converter (ADC)

Selectable resolution

8-, 10-, 12-bit

- 2.0µs conversion time

@ 12-bit

- 1.4µs conversion time

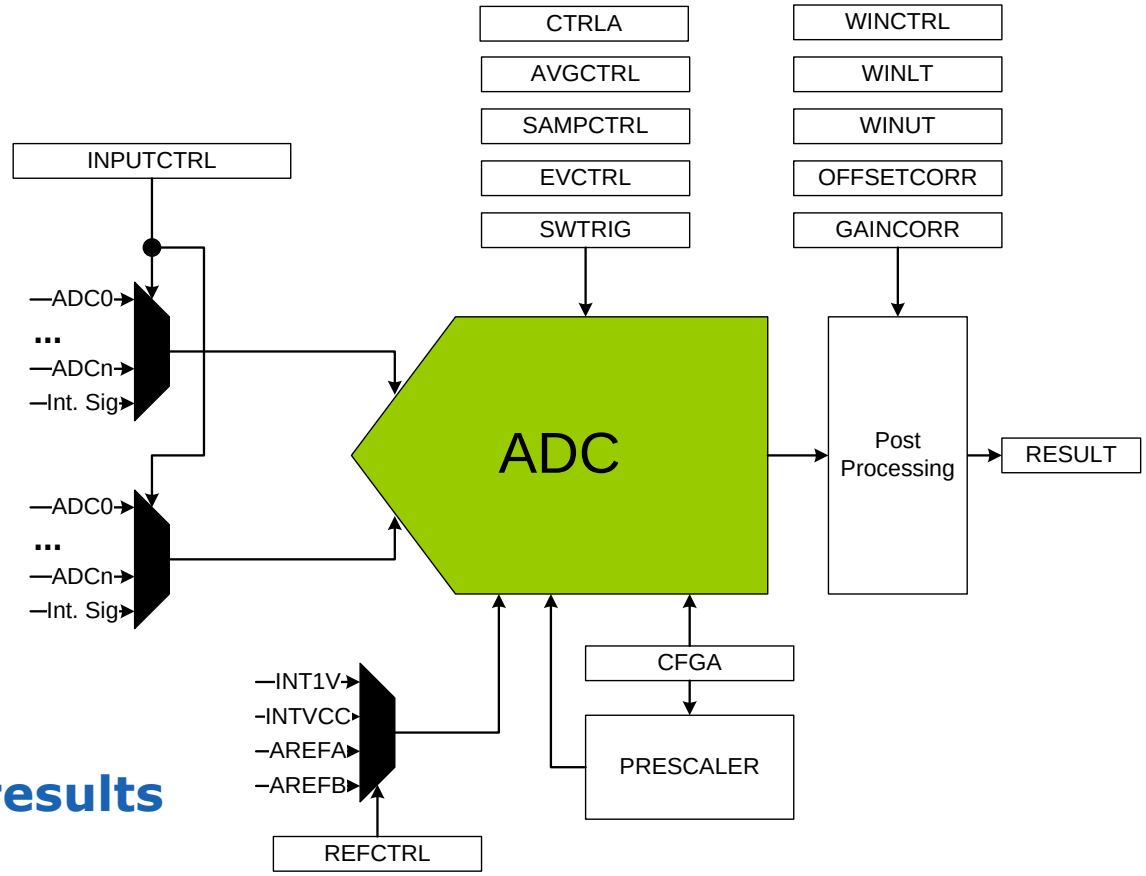
@ 8-bit

HW oversampling

- 13-, 14-, 15- and **16-bit** resolution using HW oversampling

Left or right adjusted results

350 ksps



Digital to Analog Converter (DAC)

350ksps, 10 bit resolution

Resolution:

10-bit resolution

Conversion rate:

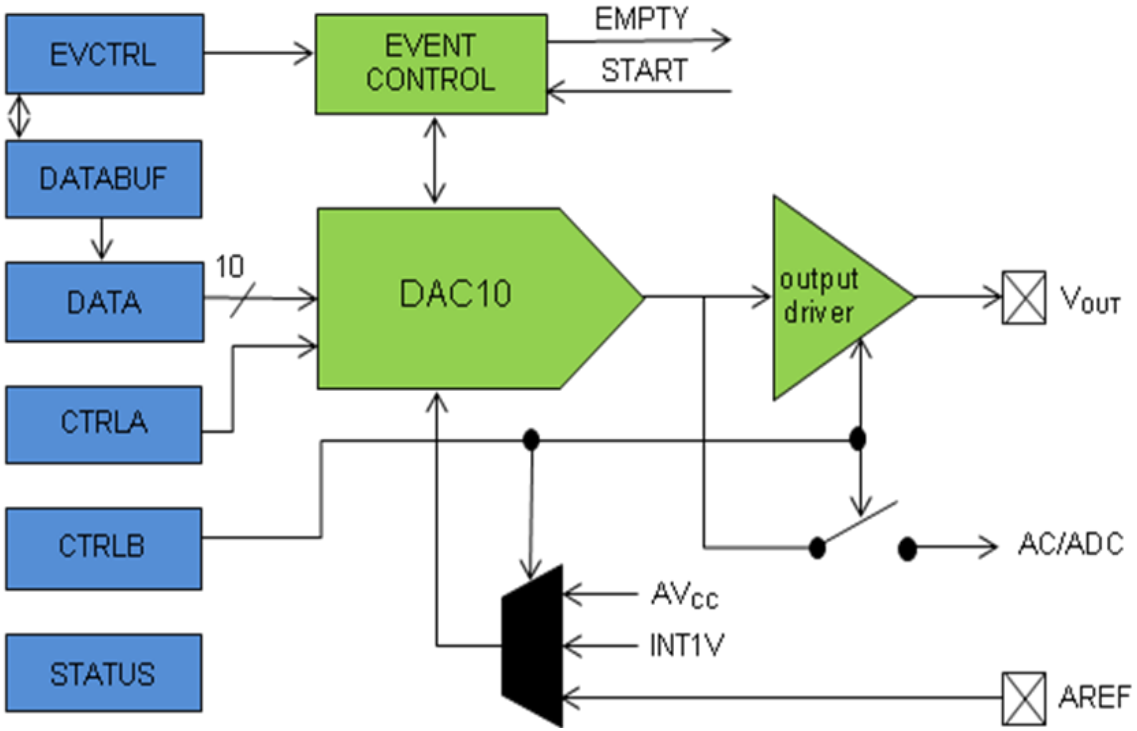
Up to 350ksps

Connected to:

- Event system
- Interrupt systems

High-drive capabilities

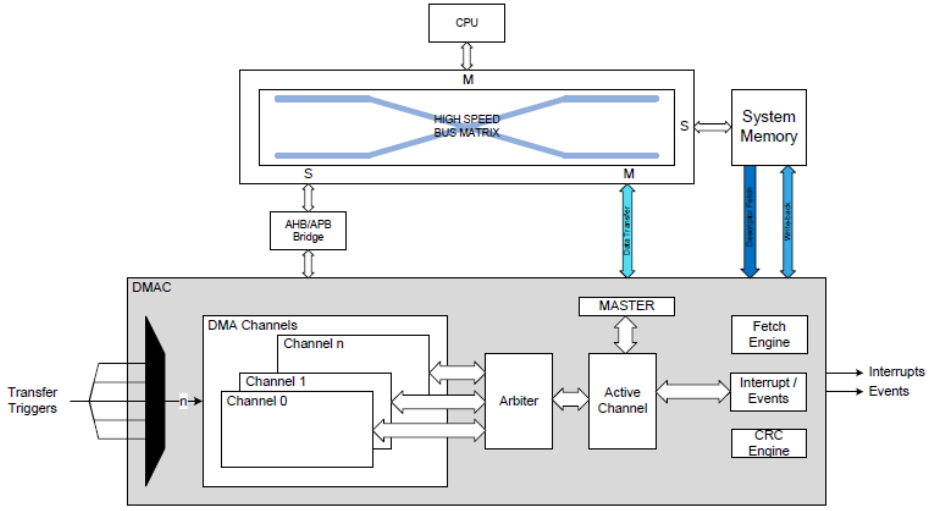
- Resistive loads
- Capacitive loads
- Resistive & capacitive loads



Direct Memory Access - DMA

Available in SAM D10,D11 and D21

- Supports Data Transfers
  - Peripheral to Peripheral
  - Peripheral to Memory
  - Memory to Peripheral
  - Memory to Memory
- Transfer triggers
  - Software
  - Event System
  - Peripherals
- 12 Channels
  - Suspend/resume support for each channel
  - PingPong Operation with Event System
- 3 priority levels
- Flexible Adressing modes
  - Static
  - Programmable increment
- 1- 64KB data transfers
- Connected to
  - ADC,DAC,I2S,SERCOM,T/C,T/CC
- CRC support on transfers
  - CRC-16 (CRC-CCITT)
  - CRC-32 (IEEE 802.3)



Inter IC Sound Controller - I2S with FPLL

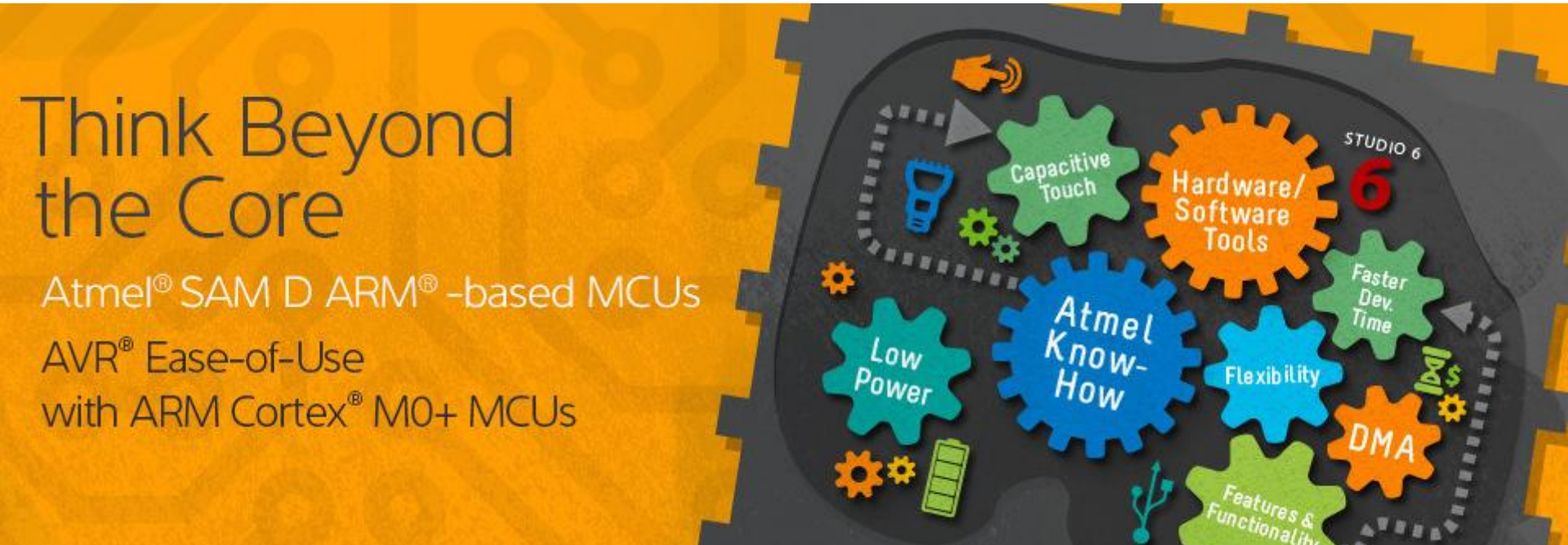
Available in SAM D21

Bidirectional, synchronous, digital Audio link to external audio devices

- 2 independent Serializers configurable as receiver or transmitter
- 32-, 24-, 20-, 18-, 16-, and 8-bit mono or stereo format
- 16- and 8-bit compact stereo format
  - left and right samples packed in the same word to reduce data transfers
- Peripheral DMA channels, separate for each Serializer, allow a continuous high bit rate data transfer without processor intervention
  - Audio CODECs in Master, Slave, or Controller mode
  - Stereo DAC or ADC through dedicated I2S serial interface
  - Multi-slot or multiple stereo DACs or ADCs, using the TDM format
  - Mono or stereo MEMS microphones, using the PDM interface

- Fractional Digital Phase locked loop enables synchronization of data for USB to I2S streaming without audio glitches from a single crystal

Device and Tools Overview



SAM D10 and D11 Series Overview

Development

Low Pin-Count General Purpose Cortex-M0+ based MCU series

Flash / SRAM	Sub-Series			
32KB / 4KB	SAM D10C 2x SERCOM 2x 16b T/C 6-ch ADC 1-ch DAC 2x An.Comp	SAM D11C USB device 2x SERCOM 2x 16b T/C 6-ch ADC 1-ch DAC 2x An.Comp	SAM D10D 3x SERCOM 3x 16b T/C 8-ch ADC 1-ch DAC 2x An.Comp	SAM D11D USB device 3x SERCOM 3x 16b T/C 8-ch ADC 1-ch DAC 2x An.Comp
16KB / 4KB				
8KB / 4KB				
4KB / 4KB				
Package	14-pin SOIC		20-pin SOIC 24-pin QFN	

Spec	NOW
ES	NOW
MP	June, 2015

Main Features and Functions in all devices:

ARM Cortex M0+ CPU at 48 MHz, 1.62-3.6V operation, -40°C – 105°C temp grading
12-bit 350 ksps ADC, 10-bit DAC and analog comparators
Peripheral Touch Controller, 32-bit RTC with calendar mode
4-ch Event system and 6-ch DMA controllerwith SleepWalking, USB Device
SERCOM supports USART/UART with autobaud, SPI, I^2C up to 3.4MHz, PM/SMBus, IrDA
1 Timer/Counter optimized for Control applications

SAM D20 Series Overview

Production

Low Power General Purpose Cortex-M0+ based MCU series

Flash / SRAM	Sub-Series		
256KB / 32KB	SAM D20E 6x 16b T/C 4x SERCOM 12-ch ADC 1-ch DAC 2x An.comp 26 GPIO	SAM D20G 6x 16b T/C 6x SERCOM 14-ch ADC 1-ch DAC 2x An.comp 38 GPIO	SAM D20J 8x 16b T/C 6x SERCOM 20-ch ADC 1-ch DAC 2x An.comp 52 GPIO
128KB / 16KB			
64KB / 8KB			
32KB / 4KB			
16KB / 2KB			
Package	32-pin QFN and QFP	48-pin QFN and QFP	64-pin QFN and QFP

Main Features and Functions in all devices:

ARM Cortex M0+ CPU at 48 MHz, 1.62-3.6V operation, -40°C – 105°C temp grading
12-bit 350 ksps ADC, 10-bit DAC and analog comparators
Peripheral Touch Controller, 32-bit RTC with calendar mode,
8-ch Event system with SleepWalking,
SERCOM supports USART, UART, 400kHz I^2C and SPI

SAM D21 Series Overview

Production

USB Enabled General Purpose Cortex-M0+ based MCU series

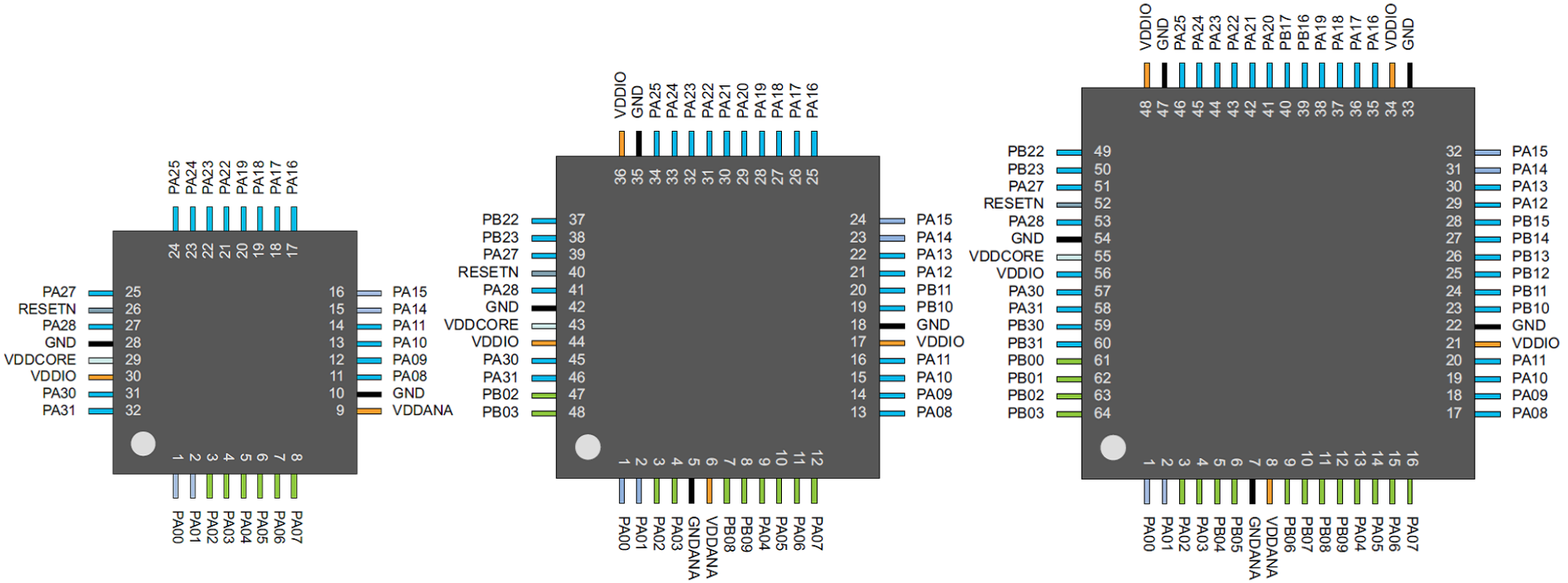
Flash / SRAM	Sub-Series		
256KB / 32KB	SAM D21E 6x 16b T/C 4x SERCOM 10-ch ADC 1-ch DAC 2x An.comp 26 GPIO	SAM D21G 6x 16b T/C 6x SERCOM 14-ch ADC 1-ch DAC 2x An.comp 38 GPIO	SAM D21J 8x 16b T/C 6x SERCOM 20-ch ADC 1-ch DAC 2x An.comp 52 GPIO
128KB / 16KB			
64KB / 8KB			
32KB / 4KB			
16KB / 2KB			
Package	32-pin QFN and QFP	48-pin QFN and QFP	64-pin QFN and QFP

Main Features and Functions in all devices:

ARM Cortex M0+ CPU at 48 MHz, 1.62-3.6V operation, -40°C – 105°C temp grading
12-bit 350 ksps ADC, 10-bit DAC and analog comparators
Peripheral Touch Controller, 32-bit RTC with calendar mode
12-ch Event system and 8-ch **DMA Controller** with SleepWalking, **USB host and device**
2-ch I²S, SERCOM supports USART/**UART with autobaud,** SPI, **I²C up to 3.4MHz, PM/SMBus, IrDA**
96 MHz Fractional PLL, 3 Timer/Counters optimized for Control applications

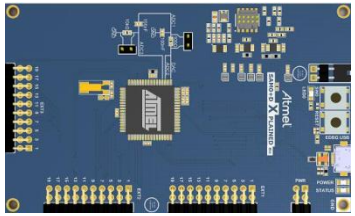
Easy Migration

- Easy Code Migration Within Atmel SAM D Series
- Easy Migration to Atmel SAM4L Family
- Easy Migration Between Pinouts
- Easy Migration to Future SAM devices



Atmel SAM D Tools

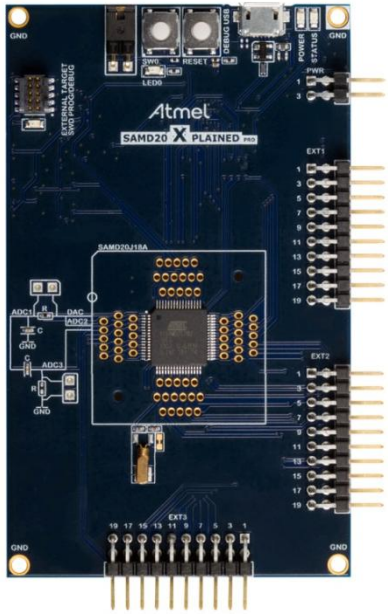
- C/C++ Compilers
  - GCC
  - IAR
  - Keil
- Debuggers/Programmers
  - SAM-ICE/Atmel ICE
  - JTAGICE3
- Development Kits/Programmers
  - STK600
  - SAM D20/D21/D11 Xplained Pro available now!



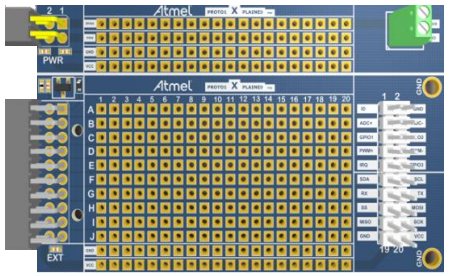
Atmel SAM D Xplained Pros

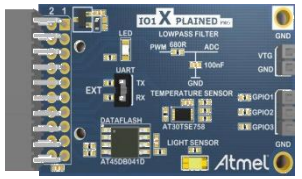
- Atmel SAM D Evaluation Platform
  - Use Largest device in series
  - Powered from USB
  - Optional external power
- Built-in Programmer
  - Programs on-board SAM D
  - Programs external target
- Built-in Debugger
  - Debugs on-board SAM D
  - Debugs external target
- Connectors for Expansion Wings
  - IO Xplained Pro
  - PTC Xplained Pro
  - OLED Xplained Pro
  - PROTO Xplained Pro
  - …

Atmel SAM D20/21 Xplained Pro



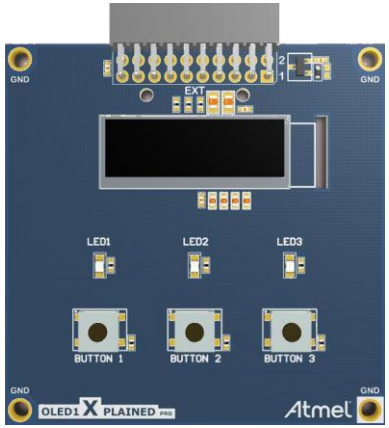
PROTO Xplained Pro





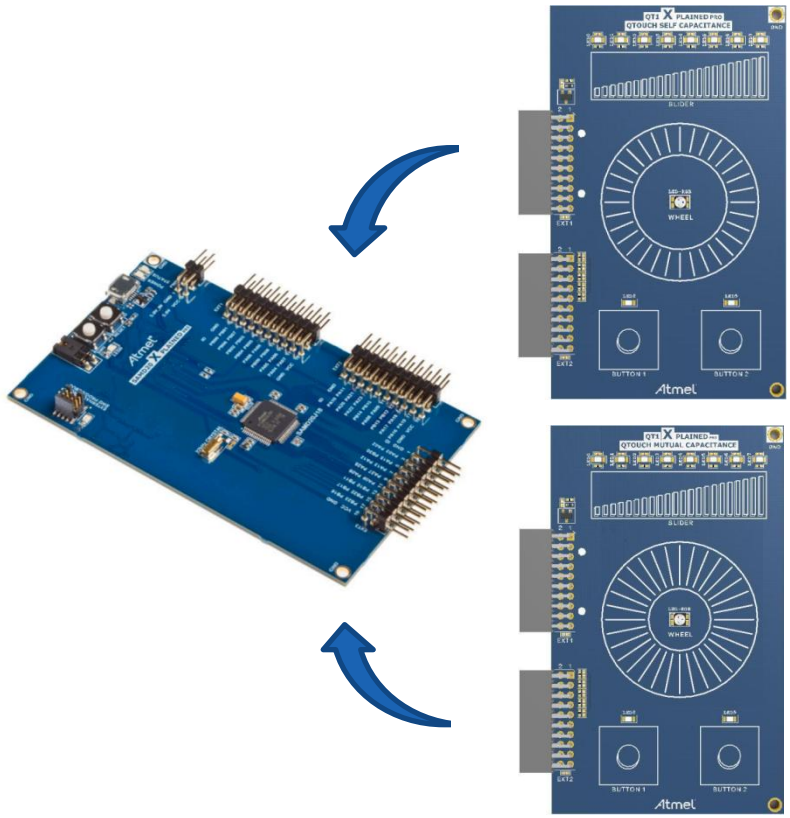
IO Xplained Pro

OLED Xplained Pro



Touch Key Board : QT1 Xplained Pro Extension

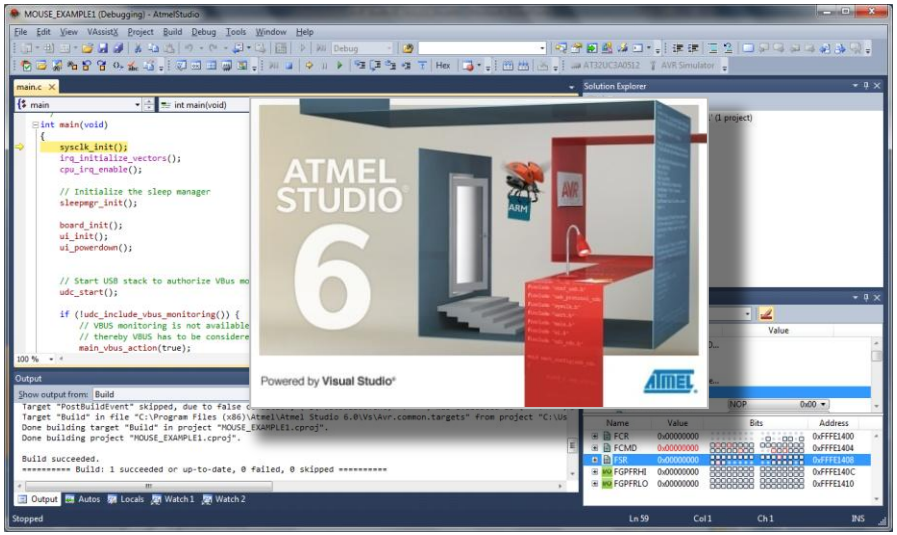
- Interfaces to SAM D20 Xplained Pro
- One kit, two boards
  - Mutual-capacitance board
  - Self-capacitance board
- Different sensing methods, same feature set
  - 2 buttons with yellow LEDs
  - 1 slider with 8 yellow LEDs
  - 1 wheel with RGB LED
- Example projects available in ASF
- Price: $25
- Available in Atmel Store



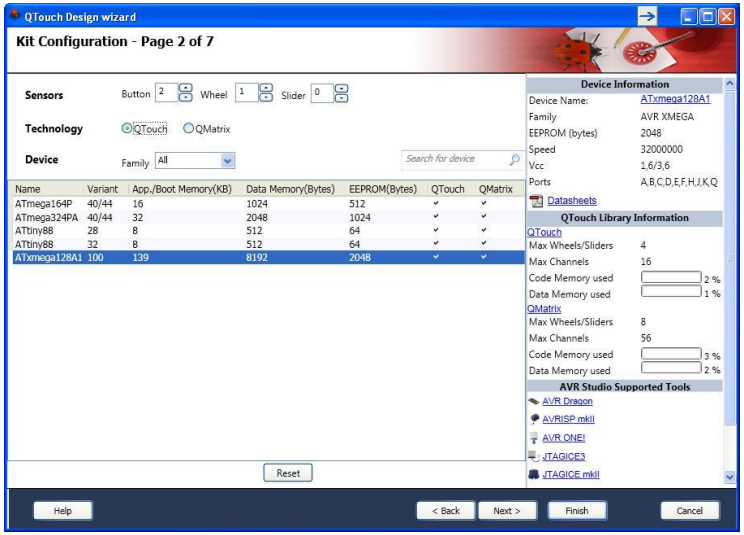
Easy Development

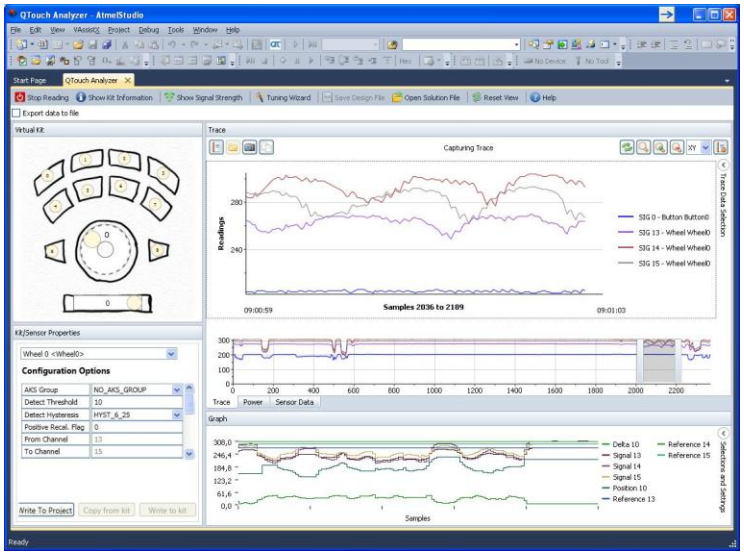
Free Atmel Studio 6 Integrated Development Environment

- Support for All Atmel AVR and SAM Devices
- Intelligent Code Editor
- Integrated GNU C/C++ Compiler
- Seamless Connection to All In-system Debuggers
- Atmel Software Framework (ASF)
  - Project Wizard with more than 2000 ready-to-run project examples
  - Peripheral drivers
  - Hardware abstraction
  - Communication/stacks
- ASF Explorer
  - Manage ASF components
  - Trace driver dependencies
  - Easy access to documentation
- Atmel Gallery – Online Apps Store
- Atmel Spaces – Cloud-based Collaborative Development Workspace



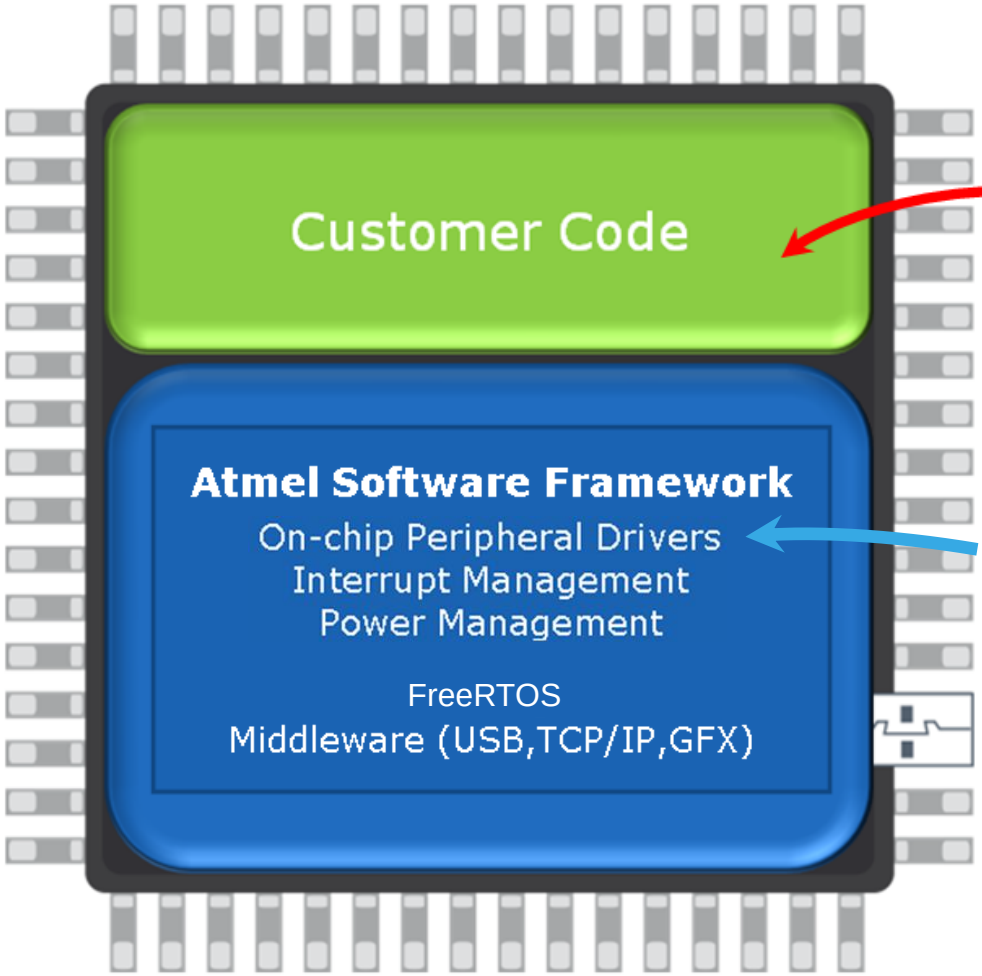
Atmel Studio 6 – QTouch Composer





- QTouch Project Wizard
  - Configure QTouch project
  - Optimized QTouch library code
  - Automatic power management
- Touch Wizard
  - Automatic performance tests
  - Optimal design recommendations
- Power Analyzer
  - Real-time monitoring of MCU power consumption
  - Profiling and visualization
    - Time spent on touch sensing
    - Time spent on user code
    - Time spent in power down

Atmel Studio 6 – Atmel Software Framework



Application Differentiation

Production-ready from Atmel

Ordering information in datasheet: SAM D Family

SAM D 20 E 14 A - M U T

Product Family

SAM D = General Purpose MCU

Product Series

10 = Cortex-M0+ CPU, Basic feature set, TCC,DMA
11 = D10 + USB Device
20 = Cortex-M0+ CPU, Basic feature set
21 = D20 + USB Device and Embedded Host, I2S,DMA, TCC, 3.4 MHz I2C

Pin Count

C = 14 pins
D = 20/24 pins
E = 32 pins
G = 48 pins
J = 64 pins

Memory Density

13 = 8KB
14 = 16KB
15 = 32KB
16 = 64KB
17 = 128KB
18 = 256KB

Package carrier

T = Tape&Reel
No character = Tray/Tube (Default)

Plating material and temp grade

U = -40 – 85°C Matte Sn plating
N = -40 – 105°C Matte Sn plating

Package type

A = TQFP
M = QFN
SS = SOIC
U = WLCSP

Marketing Revision

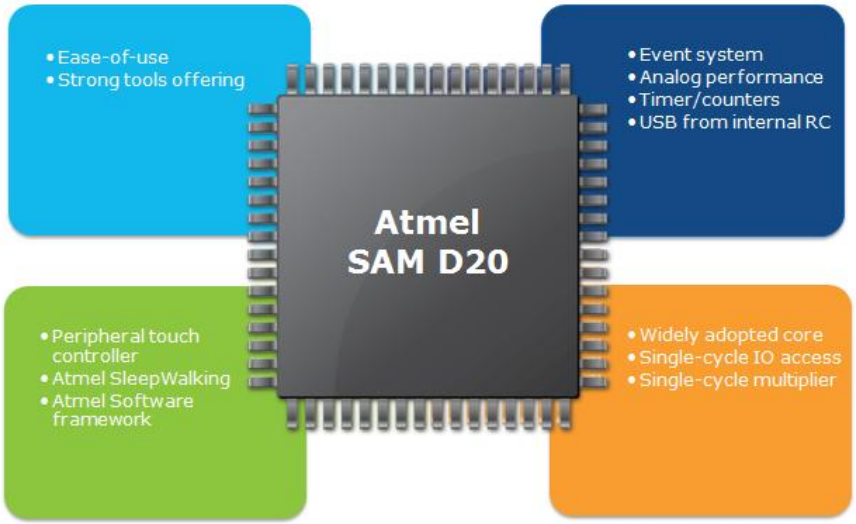
A = Initial revision

Atmel

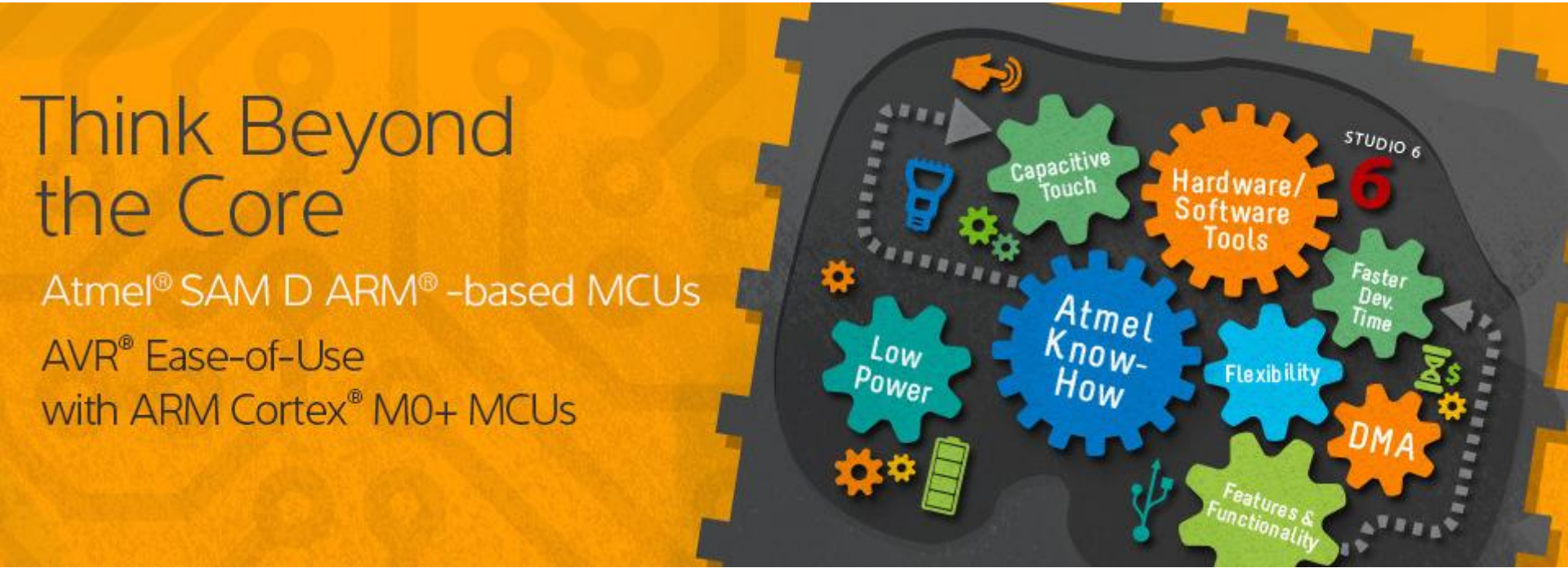
Atmel SAM D summary

- SAM D Combining the best of Atmel AVR® MCUs with ARM CM0+
- Peripheral intelligence
- Event system and DMA
- SERCOM
- Full Speed USB embedded Host and Device
- Peripheral Touch Controller
- Large GPIO count
- Short design time

- Everything is compatible!



Home Sensing Network Demos using SAMD20-XPRO and WINC1500-XPRO Network Controller



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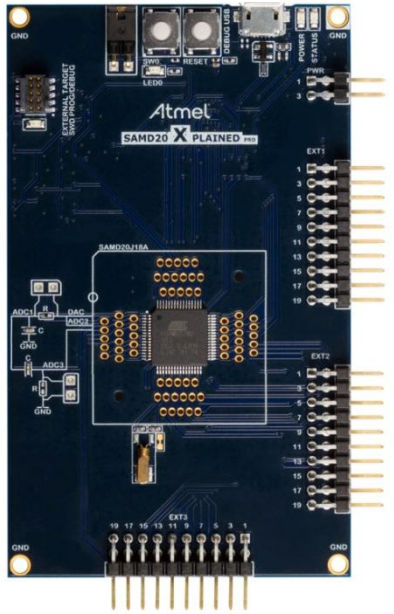
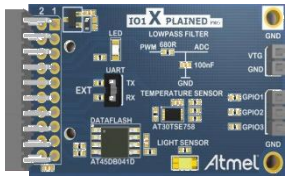
  - PROTO Xplained Pro
  - …

Atmel SAM D20/21 Xplained Pro

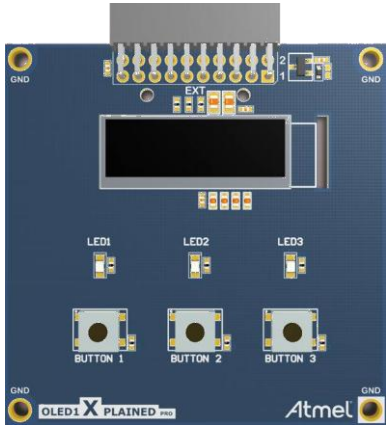


PROTO Xplained Pro



IO Xplained Pro

OLED Xplained Pro



WINC1500 Network Controller Series

WINC is a State of The Art Wi-Fi single-chip Network Controller

Deliverables

- BSD-style Socket Interface MCU SW

-(4K Flash, 1K RAM)

  - Board Support Package Example
  - ASIC Driver (3rd Party MCU)
  - SW Distribution package via Gallery

- Programmer's Guide (Driver API document).
- Software Guides and demo project manual
- Demo project example source code
- PC tools (flashing, efuse … etc).

Network Controller	WINC1500
Standards	802.11 b/g/n 1x1
Max PHY rate	72Mbps
Frequency	2.4GHz
Stacks	TCP/IP, TLS WEP, WPS, WPA2 Wi-Fi STA/AP/Direct
Application	IoT, Audio/Video
Interfaces	SPI, UART
Max throughput (TCP/UDP)	16Mbps/26Mbps (SPI) 1Mbps (UART)
Tx Output Power	+19dBm (DSSS 11Mbps) +17.3dBm (OFDM 54Mbps) +15.8dBm (MCS7)
Rx Sensitivity	-97.3dBm (DSSS 1Mbps) -89.4dBm (OFDM 6Mbps) -74.1dBm (MCS7)

WINC1500 Key Features

5x5 mm QFN40

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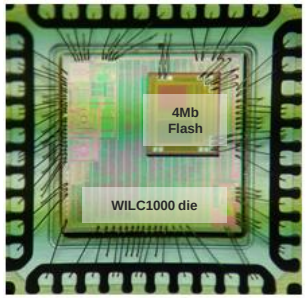


MCU Interfaces

- SPI, UART, and I2C

BOM optimized

- Integrated LNA, PA, and T/R Switch
  - Integrated e-Fuses to store MAC address & calibration data
  - Industry smallest die size

Power Save Modes

- On-chip low power sleep oscillator
- Fast host wake-up by chip pin or clock-less transaction

Fast Boot Options

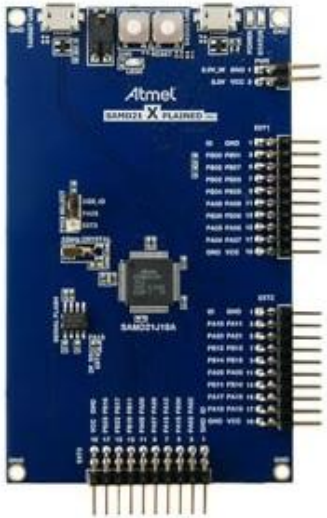
- On-Chip Boot ROM (Firmware instant boot)
- SPI flash boot (firmware patches and state variables)
- Low-leakage on-chip memory for state variables (next chip revision)
- No SPI flash is needed if firmware patches and state variables can be loaded from MCU

On-Chip Network Stack to offload MCU

- Integrated Network IP stack to minimize host CPU requirements
- Network features TCP, UDP, DHCP, ARP, HTTP, SSL, and DNS
- Wi-Fi security WEP, WPA, WPA2 Enterprise and WPS
- No OS small footprint host driver (4KB flash – less than 1KB RAM)

Home IoT(Internet of Things) Demo.

Embedded Module with SAMD21-XPRO and WINC1500-XPRO



SAMD21-XPRO Evaluation kit.
SAMD21 Xplained Pro
SAMD21J18A microcontroller, 8 Mbit Serial Flash,
32.768kHz crystal, Embedded Debugger

WINC1500-XPRO Wi-Fi extension board.
WINC1500 Xplained Pro
Wi-Fi STA, Wi-Fi hotspot., Wi-Fi Direct client (P
2P), IEEE 802.11 b/g/n, Transport Layer Secur
ity, Network protocols.

ATIO1-XPRO Sensor extension board.
IO1 Xplained Pro
ADC: Light Sensor and PWM signal filtered into
ADC
TWI: Temperature sensor w/ EEPROM
SPI: microSD card holder + microSD card

AOLED1-XPRO extension display board.
OLEDIO1 Xplained Pro
128 x 32 Pixels
Controlled by 4-wire SPI interface
Three LEDS, Three Buttons

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Home IoT(Internet of Things) Demo.

Goal

- To Implement Home Sensing Network Service using SAMD21 + WINC1500 Wi-Fi.

Protocol

- MQTT (Message Queue Telemetry Transport) : publish/subscribe model

Server

- IBM IoT Foundation :MQTT Protocol based management server, developed by IBM.
- IBM Bluemix : Development tool for Server and Client based on Cloud service.

Client

- Mobile App. : Client for Mobile application(Smart phone, tablet and etc.)
- Web App. : Client for PC browser(Internet explorer and etc.)

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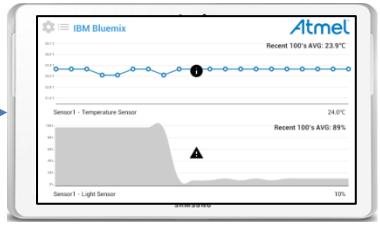
Demo Scenarios

IBM Internet of Things Foundation

IBM Bluemix



Thermostat Sensor

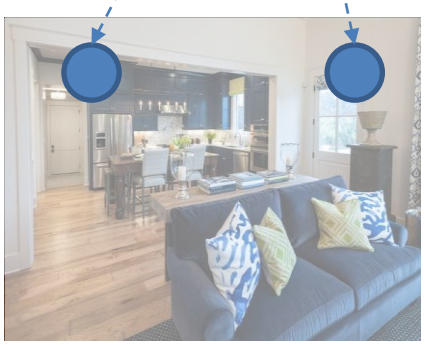
INTERNET

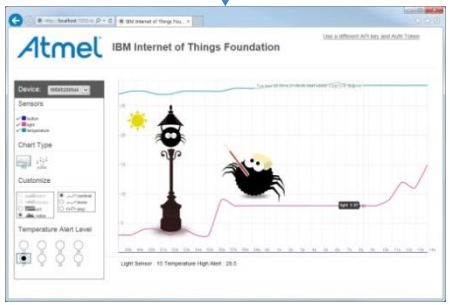
IBM IoT Foundation MQTT Broker Device Manager

IBM Cloud Server

Mobile Application

Light Sensor





Web App

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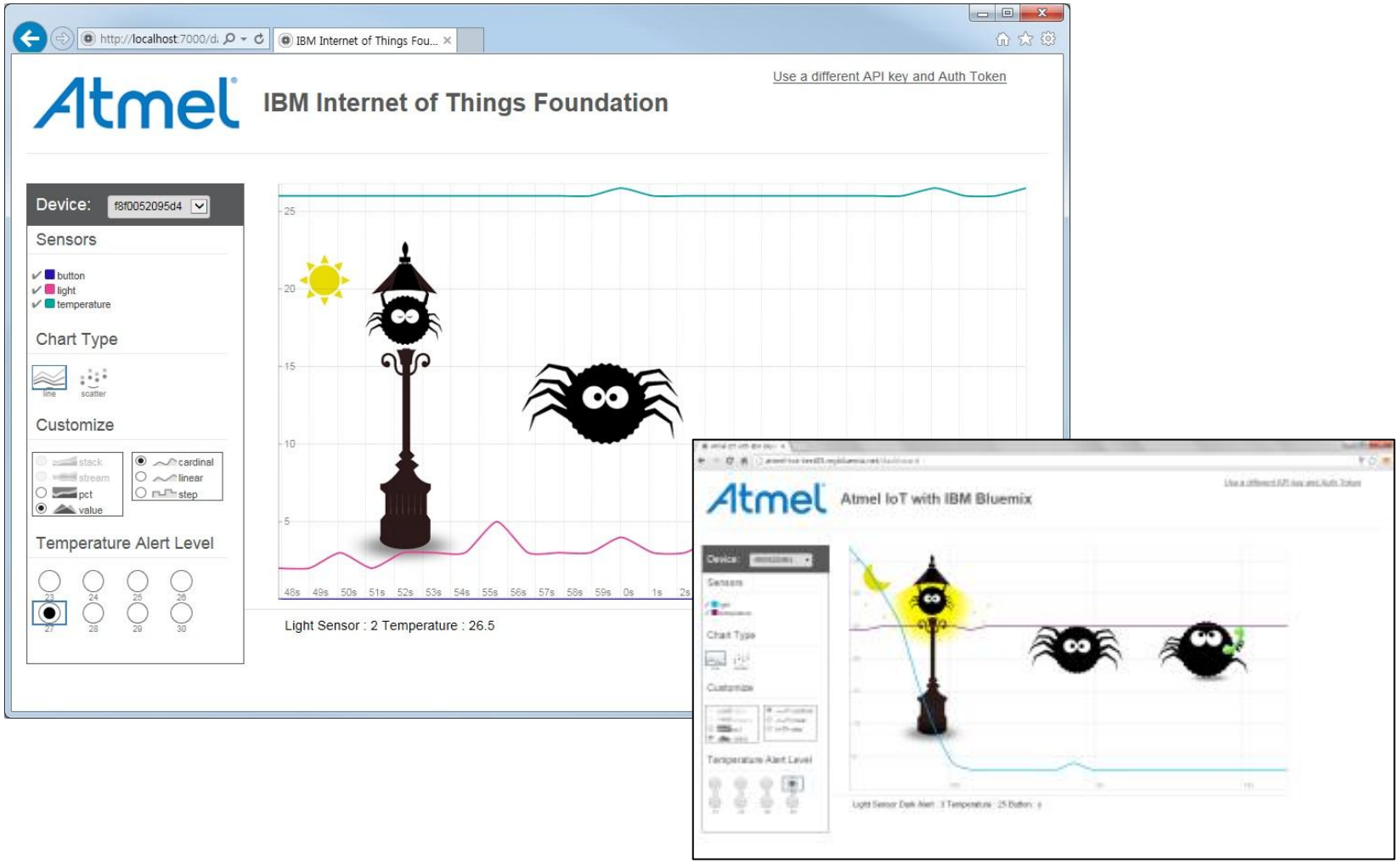
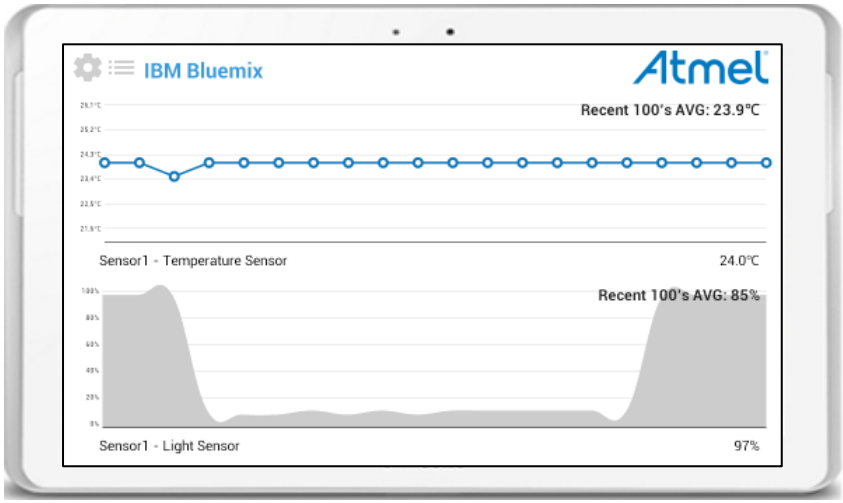
Demo Screen Shots



Demo Screen Shots

Weight

Choose a sensor device



Temp / Light

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Demo Video


atmel-iot-test05.mybluemix.net/login
Atmel IoT with IBM Bluemix
Enter an API Token and authentication token to visualise the data send from registered devices in a single Internet of Things Foundation organization
Go
SAMSUNG