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32-bit ARM-Based Microcontrollers

SAM D21E / SAM D21G / SAM D21J

Introduction

The SAM D21 is a series of low-power microcontrollers using the 32-bit ARM[®] Cortex[®]-M0+ processor, and ranging from 32- to 64-pins with up to 256KB Flash and 32KB of SRAM. The SAM D21 operate at a maximum frequency of 48MHz and reach 2.46 CoreMark[®]/MHz. They are designed for simple and intuitive migration with identical peripheral modules, hex compatible code, identical linear address map and pin compatible migration paths between all devices in the product series. All devices include intelligent and flexible peripherals, Event System for inter-peripheral signaling, and support for capacitive touch button, slider and wheel user interfaces.

Features

- Processor
 - ARM Cortex-M0+ CPU running at up to 48MHz
 - Single-cycle hardware multiplier
 - Micro Trace Buffer (MTB)
- Memories
 - 32/64/128/256KB in-system self-programmable Flash
 - 4/8/16/32KB SRAM Memory
- System
 - Power-on reset (POR) and brown-out detection (BOD)
 - Internal and external clock options with 48MHz Digital Frequency Locked Loop (DFLL48M) and 48MHz to 96MHz Fractional Digital Phase Locked Loop (FDPLL96M)
 - External Interrupt Controller (EIC)
 - 16 external interrupts
 - One non-maskable interrupt
 - Two-pin Serial Wire Debug (SWD) programming, test and debugging interface
- Low Power
 - Idle and standby sleep modes
 - SleepWalking peripherals
- Peripherals
 - 12-channel Direct Memory Access Controller (DMAC)
 - 12-channel Event System
 - Up to five 16-bit Timer/Counters (TC), configurable as either:
 - One 16-bit TC with two compare/capture channels
 - One 8-bit TC with two compare/capture channels
 - One 32-bit TC with two compare/capture channels, by using two TCs
 - Three 24-bit Timer/Counters for Control (TCC), with extended functions:

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- Up to four compare channels with optional complementary output
- Generation of synchronized pulse width modulation (PWM) pattern across port pins
- Deterministic fault protection, fast decay and configurable dead-time between complementary output
- Dithering that increase resolution with up to 5 bit and reduce quantization error
- 32-bit Real Time Counter (RTC) with clock/calendar function
- Watchdog Timer (WDT)
- CRC-32 generator
- One full-speed (12Mbps) Universal Serial Bus (USB) 2.0 interface
 - Embedded host and device function
 - Eight endpoints
- Up to six Serial Communication Interfaces (SERCOM), each configurable to operate as either:
 - USART with full-duplex and single-wire half-duplex configuration
 - I2C up to 3.4MHz
 - SPI
 - LIN slave
- One two-channel Inter-IC Sound (I²S) interface
- One 12-bit, 350ksps Analog-to-Digital Converter (ADC) with up to 20 channels
 - Differential and single-ended input
 - 1/2x to 16x programmable gain stage
 - Automatic offset and gain error compensation
 - Oversampling and decimation in hardware to support 13-, 14-, 15- or 16-bit resolution
- 10-bit, 350ksps Digital-to-Analog Converter (DAC)
- Two Analog Comparators (AC) with window compare function
- Peripheral Touch Controller (PTC)
 - 256-Channel capacitive touch and proximity sensing
- I/O
 - Up to 52 programmable I/O pins
- Drop in compatible with SAM D20
- Packages
 - 64-pin TQFP, QFN, UFBGA
 - 48-pin TQFP, QFN, WLCSP
 - 32-pin TQFP, QFN, WLCSP
- Operating Voltage
 - 1.62V – 3.63V

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1. Description

The SAM D21 is a series of low-power microcontrollers using the 32-bit ARM[®] Cortex[®]-M0+ processor, and ranging from 32- to 64-pins with up to 256KB Flash and 32KB of SRAM. The SAM D21 operate at a maximum frequency of 48MHz and reach 2.46 CoreMark/MHz. They are designed for simple and intuitive migration with identical peripheral modules, hex compatible code, identical linear address map and pin compatible migration paths between all devices in the product series. All devices include intelligent and flexible peripherals, Event System for inter-peripheral signaling, and support for capacitive touch button, slider and wheel user interfaces.

The SAM D21 provide the following features: In-system programmable Flash, twelve-channel direct memory access (DMA) controller, 12 channel Event System, programmable interrupt controller, up to 52 programmable I/O pins, 32-bit real-time clock and calendar, up to five 16-bit Timer/Counters (TC) and three 24-bit Timer/Counters for Control (TCC), where each TC can be configured to perform frequency and waveform generation, accurate program execution timing or input capture with time and frequency measurement of digital signals. The TCs can operate in 8- or 16-bit mode, selected TCs can be cascaded to form a 32-bit TC, and three timer/counters have extended functions optimized for motor, lighting and other control applications. The series provide one full-speed USB 2.0 embedded host and device interface; up to six Serial Communication Modules (SERCOM) that each can be configured to act as an USART, UART, SPI, I²C up to 3.4MHz, SMBus, PMBus, and LIN slave; two-channel I²S interface; up to twenty-channel 350kps 12-bit ADC with programmable gain and optional oversampling and decimation supporting up to 16-bit resolution, one 10-bit 350kps DAC, two analog comparators with window mode, Peripheral Touch Controller supporting up to 256 buttons, sliders, wheels and proximity sensing; programmable Watchdog Timer, brown-out detector and power-on reset and two-pin Serial Wire Debug (SWD) program and debug interface.

All devices have accurate and low-power external and internal oscillators. All oscillators can be used as a source for the system clock. Different clock domains can be independently configured to run at different frequencies, enabling power saving by running each peripheral at its optimal clock frequency, and thus maintaining a high CPU frequency while reducing power consumption.

The SAM D21 have two software-selectable sleep modes, idle and standby. In idle mode the CPU is stopped while all other functions can be kept running. In standby all clocks and functions are stopped except those selected to continue running. The device supports SleepWalking. This feature allows the peripheral to wake up from sleep based on predefined conditions, and thus allows the CPU to wake up only when needed, e.g. when a threshold is crossed or a result is ready. The Event System supports synchronous and asynchronous events, allowing peripherals to receive, react to and send events even in standby mode.

The Flash program memory can be reprogrammed in-system through the SWD interface. The same interface can be used for non-intrusive on-chip debug of application code. A boot loader running in the device can use any communication interface to download and upgrade the application program in the Flash memory.

The SAM D21 microcontrollers are supported with a full suite of program and system development tools, including C compilers, macro assemblers, program debugger/simulators, programmers and evaluation kits.

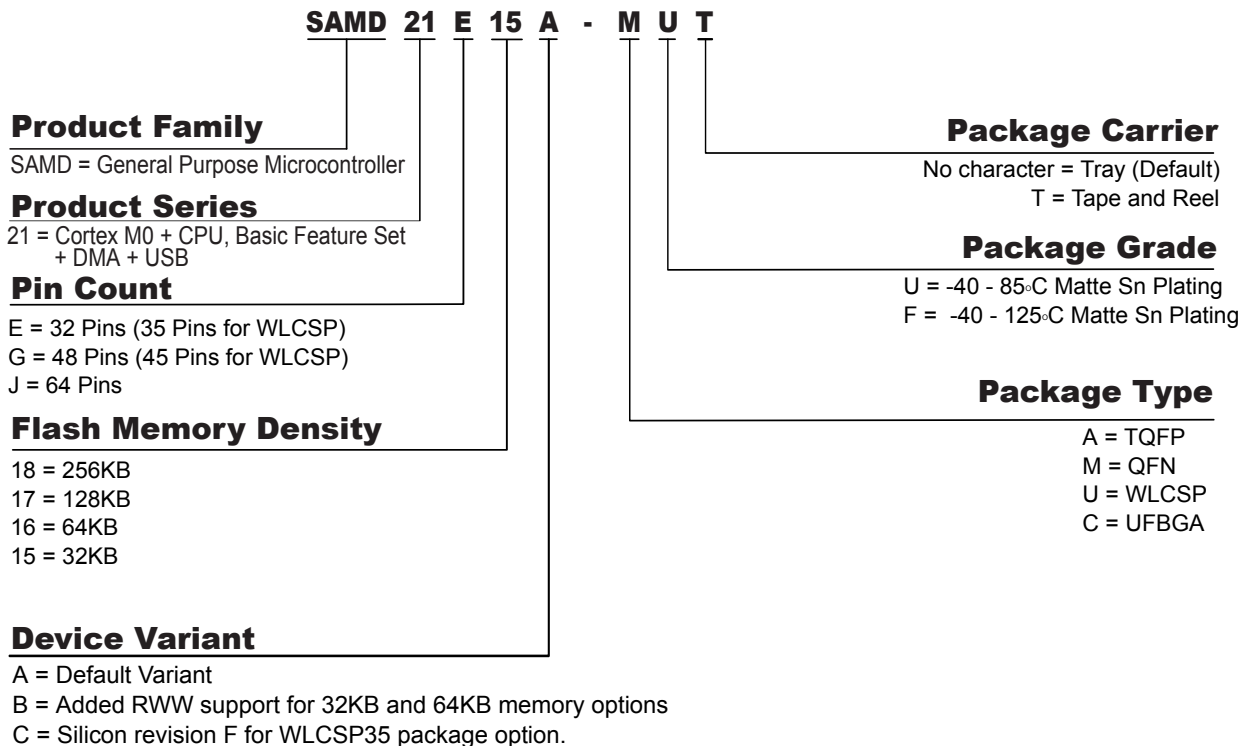
2. Configuration Summary

	SAM D21J	SAM D21G	SAM D21E
Pins	64	48 (45 for WLCSP)	32 (35 for WLCSP)
General Purpose I/O-pins (GPIOs)	52	38	26
Flash	256/128/64/32KB	256/128/64/32KB	256/128/64/32KB
SRAM	32/16/8/4KB	32/16/8/4KB	32/16/8/4KB
Timer Counter (TC) instances	5	3 (5 for WLCSP)	3
Waveform output channels per TC instance	2	2	2
Timer Counter for Control (TCC) instances	3	3	3
Waveform output channels per TCC	8/4/2	8/4/2	6/4/2
DMA channels	12	12	12
USB interface	1	1	1
Serial Communication Interface (SERCOM) instances	6	6	4
Inter-IC Sound (I ² S) interface	1	1	1
Analog-to-Digital Converter (ADC) channels	20	14	10
Analog Comparators (AC)	2	2	2
Digital-to-Analog Converter (DAC) channels	1	1	1
Real-Time Counter (RTC)	Yes	Yes	Yes
RTC alarms	1	1	1
RTC compare values	One 32-bit value or two 16-bit values	One 32-bit value or two 16-bit values	One 32-bit value or two 16-bit values
External Interrupt lines	16	16	16
Peripheral Touch Controller (PTC) X and Y lines	16x16	12x10	10x6
Maximum CPU frequency	48MHz		

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	SAM D21J	SAM D21G	SAM D21E
Packages	QFN TQFP UFBGA	QFN TQFP WLCSP	QFN TQFP WLCSP
Oscillators	32.768kHz crystal oscillator (XOSC32K) 0.4-32MHz crystal oscillator (XOSC) 32.768kHz internal oscillator (OSC32K) 32KHz ultra-low-power internal oscillator (OSCULP32K) 8MHz high-accuracy internal oscillator (OSC8M) 48MHz Digital Frequency Locked Loop (DFLL48M) 96MHz Fractional Digital Phased Locked Loop (FDPLL96M)		
Event System channels	12	12	12
SW Debug Interface	Yes	Yes	Yes
Watchdog Timer (WDT)	Yes	Yes	Yes

3. Ordering Information



3.1 SAM D21E

Table 3-1. Device Variant A

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD21E15A-AU	32K	4K	TQFP32	Tray
ATSAMD21E15A-AUT				Tape & Reel
ATSAMD21E15A-AF				Tray
ATSAMD21E15A-AFT				Tape & Reel
ATSAMD21E15A-MU			QFN32	Tray
ATSAMD21E15A-MUT				Tape & Reel
ATSAMD21E15A-MF				Tray
ATSAMD21E15A-MFT				Tape & Reel

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Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD21E16A-AU	64K	8K	TQFP32	Tray
ATSAMD21E16A-AUT				Tape & Reel
ATSAMD21E16A-AF				Tray
ATSAMD21E16A-AFT				Tape & Reel
ATSAMD21E16A-MU			QFN32	Tray
ATSAMD21E16A-MUT				Tape & Reel
ATSAMD21E16A-MF				Tray
ATSAMD21E16A-MFT				Tape & Reel
ATSAMD21E17A-AU	128K	16K	TQFP32	Tray
ATSAMD21E17A-AUT				Tape & Reel
ATSAMD21E17A-AF				Tray
ATSAMD21E17A-AFT				Tape & Reel
ATSAMD21E17A-MU			QFN32	Tray
ATSAMD21E17A-MUT				Tape & Reel
ATSAMD21E17A-MF				Tray
ATSAMD21E17A-MFT				Tape & Reel
ATSAMD21E18A-AU	256K	32K	TQFP32	Tray
ATSAMD21E18A-AUT				Tape & Reel
ATSAMD21E18A-AF				Tray
ATSAMD21E18A-AFT				Tape & Reel
ATSAMD21E18A-MU			QFN32	Tray
ATSAMD21E18A-MUT				Tape & Reel
ATSAMD21E18A-MF				Tray
ATSAMD21E18A-MFT				Tape & Reel

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Table 3-2. Device Variant B

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type			
ATSAMD21E15B-AU	32K	4K	TQFP32	Tray			
ATSAMD21E15B-AUT				Tape & Reel			
ATSAMD21E15B-AF				Tray			
ATSAMD21E15B-AFT				Tape & Reel			
ATSAMD21E15B-MU			QFN32	Tray			
ATSAMD21E15B-MUT				Tape & Reel			
ATSAMD21E15B-MF				Tray			
ATSAMD21E15B-MFT				Tape & Reel			
ATSAMD21E15B-UUT				WLCSP35 (GJR)	Tape & Reel		
ATSAMD21E16B-AU				64K	8K	TQFP32	Tray
ATSAMD21E16B-AUT	Tape & Reel						
ATSAMD21E16B-AF	Tray						
ATSAMD21E16B-AFT	Tape & Reel						
ATSAMD21E16B-MU	QFN32	Tray					
ATSAMD21E16B-MUT		Tape & Reel					
ATSAMD21E16B-MF		Tray					
ATSAMD21E16B-MFT		Tape & Reel					
ATSAMD21E16B-UUT		64K	8K			WLCSP35 (GJR)	Tape & Reel

Table 3-3. Device Variant C

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD21E15C-UUT	32K	4K	WLCSP35 (GJS)	Tape & Reel
ATSAMD21E16C-UUT	64K	8K	WLCSP35 (GJS)	Tape & Reel

3.2 SAM D21G

Table 3-4. Device Variant A

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD21G15A-AU	32K	4K	TQFP48	Tray
ATSAMD21G15A-AUT				Tape & Reel
ATSAMD21G15A-AF				Tray
ATSAMD21G15A-AFT				Tape & Reel
ATSAMD21G15A-MU			QFN48	Tray
ATSAMD21G15A-MUT				Tape & Reel
ATSAMD21G15A-MF				Tray
ATSAMD21G15A-MFT				Tape & Reel
ATSAMD21G16A-AU	64K	8K	TQFP48	Tray
ATSAMD21G16A-AUT				Tape & Reel
ATSAMD21G16A-AF				Tray
ATSAMD21G16A-AFT				Tape & Reel
ATSAMD21G16A-MU			QFN48	Tray
ATSAMD21G16A-MUT				Tape & Reel
ATSAMD21G16A-MF				Tray
ATSAMD21G16A-MFT				Tape & Reel
ATSAMD21G17A-AU	128K	16K	TQFP48	Tray
ATSAMD21G17A-AUT				Tape & Reel
ATSAMD21G17A-AF				Tray
ATSAMD21G17A-AFT				Tape & Reel
ATSAMD21G17A-MU			QFN48	Tray
ATSAMD21G17A-MUT				Tape & Reel
ATSAMD21G17A-MF				Tray
ATSAMD21G17A-MFT				Tape & Reel
ATSAMD21G17A-UUT				WLCSP45

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Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type	
ATSAMD21G18A-AU	256K	32K	TQFP48	Tray	
ATSAMD21G18A-AUT				Tape & Reel	
ATSAMD21G18A-AF				Tray	
ATSAMD21G18A-AFT				Tape & Reel	
ATSAMD21G18A-MU			QFN48	Tray	
ATSAMD21G18A-MUT				Tape & Reel	
ATSAMD21G18A-MF				Tray	
ATSAMD21G18A-MFT				Tape & Reel	
ATSAMD21G18A-UUT				WLCSP45	Tape & Reel

Table 3-5. Device Variant B

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD21G15B-AU	32K	4K	TQFP48	Tray
ATSAMD21G15B-AUT				Tape & Reel
ATSAMD21G15B-AF				Tray
ATSAMD21G15B-AFT				Tape & Reel
ATSAMD21G15B-MU			QFN48	Tray
ATSAMD21G15B-MUT				Tape & Reel
ATSAMD21G15B-MF				Tray
ATSAMD21G15B-MFT				Tape & Reel
ATSAMD21G16B-AU	64K	8K	TQFP48	Tray
ATSAMD21G16B-AUT				Tape & Reel
ATSAMD21G16B-AF				Tray
ATSAMD21G16B-AFT				Tape & Reel
ATSAMD21G16B-MU			QFN48	Tray
ATSAMD21G16B-MUT				Tape & Reel
ATSAMD21G16B-MF				Tray
ATSAMD21G16B-MFT				Tape & Reel

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Table 3-6. Device Variant A

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type		
ATSAMD21J15A-AU	32K	4K	TQFP64	Tray		
ATSAMD21J15A-AUT				Tape & Reel		
ATSAMD21J15A-AF				Tray		
ATSAMD21J15A-AFT				Tape & Reel		
ATSAMD21J15A-MU			QFN64	Tray		
ATSAMD21J15A-MUT				Tape & Reel		
ATSAMD21J15A-MF				Tray		
ATSAMD21J15A-MFT				Tape & Reel		
ATSAMD21J16A-AU	64K	8K	TQFP64	Tray		
ATSAMD21J16A-AUT				Tape & Reel		
ATSAMD21J16A-AF				Tray		
ATSAMD21J16A-AFT				Tape & Reel		
ATSAMD21J16A-MU			QFN64	Tray		
ATSAMD21J16A-MUT				Tape & Reel		
ATSAMD21J16A-MF				Tray		
ATSAMD21J16A-MFT				Tape & Reel		
ATSAMD21J16A-CU			UFBGA64	Tray		
ATSAMD21J16A-CUT				Tape & Reel		
ATSAMD21J17A-AU			128K	16K	TQFP64	Tray
ATSAMD21J17A-AUT						Tape & Reel
ATSAMD21J17A-AF	Tray					
ATSAMD21J17A-AFT	Tape & Reel					
ATSAMD21J17A-MU	QFN64	Tray				
ATSAMD21J17A-MUT		Tape & Reel				
ATSAMD21J17A-MF		Tray				
ATSAMD21J17A-MFT		Tape & Reel				
ATSAMD21J17A-CU	UFBGA64	Tray				
ATSAMD21J17A-CUT		Tape & Reel				

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Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type	
ATSAMD21J18A-AU	256K	32K	TQFP64	Tray	
ATSAMD21J18A-AUT				Tape & Reel	
ATSAMD21J18A-AF				Tray	
ATSAMD21J18A-AFT				Tape & Reel	
ATSAMD21J18A-MU			QFN64	Tray	
ATSAMD21J18A-MUT				Tape & Reel	
ATSAMD21J18A-MF				Tray	
ATSAMD21J18A-MFT				Tape & Reel	
ATSAMD21J18A-CU				UFBGA64	Tray
ATSAMD21J18A-CUT					Tape & Reel

Table 3-7. Device Variant B

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD21J15B-AU	32K	4K	TQFP64	Tray
ATSAMD21J15B-AUT				Tape & Reel
ATSAMD21J15B-AF				Tray
ATSAMD21J15B-AFT				Tape & Reel
ATSAMD21J15B-MU			QFN64	Tray
ATSAMD21J15B-MUT				Tape & Reel
ATSAMD21J15B-MF				Tray
ATSAMD21J15B-MFT				Tape & Reel
ATSAMD21J16B-AU	64K	8K	TQFP64	Tray
ATSAMD21J16B-AUT				Tape & Reel
ATSAMD21J16B-AF				Tray
ATSAMD21J16B-AFT				Tape & Reel
ATSAMD21J16B-MU			QFN64	Tray
ATSAMD21J16B-MUT				Tape & Reel
ATSAMD21J16B-MF				Tray
ATSAMD21J16B-MFT				Tape & Reel
ATSAMD21J16B-CU			UFBGA64	Tray
ATSAMD21J16B-CUT				Tape & Reel

3.4 Device Identification

The DSU - Device Service Unit peripheral provides the Device Selection bits in the Device Identification register (DID.DEVSEL) in order to identify the device by software. The SAM D21 variants have a reset value of DID=0x1001drxx, with the LSB identifying the die number ('d'), the die revision ('r') and the device selection ('xx').

Table 3-8. SAM D21 Device Identification Values

Device Variant	DID.DEVSEL	Device ID (DID)
SAMD21J18A	0x00	0x10010000
SAMD21J17A	0x01	0x10010001
SAMD21J16A	0x02	0x10010002
SAMD21J15A	0x03	0x10010003
Reserved	0x04	
SAMD21G18A	0x05	0x10010005
SAMD21G17A	0x06	0x10010006
SAMD21G16A	0x07	0x10010007
SAMD21G15A	0x08	0x10010008
Reserved	0x09	
SAMD21E18A	0x0A	0x1001000A
SAMD21E17A	0x0B	0x1001000B
SAMD21E16A	0x0C	0x1001000C
SAMD21E15A	0x0D	0x1001000D
Reserved	0x0E	
SAMD21G18A (WLCSP)	0x0F	0x1001000F
SAMD21G17A (WLCSP)	0x10	0x10010010
Reserved	0x11 - 0x1F	
SAMD21J16B	0x20	0x10011420 (die revision E) 0x10011520 (die revision F)
SAMD21J15B	0x21	0x10011421 (die revision E) 0x10011521 (die revision F)
Reserved	0x22	
SAMD21G16B	0x23	0x10011423 (die revision E) 0x10011523 (die revision F)
SAMD21G15B	0x24	0x10011424 (die revision E) 0x10011524 (die revision F)

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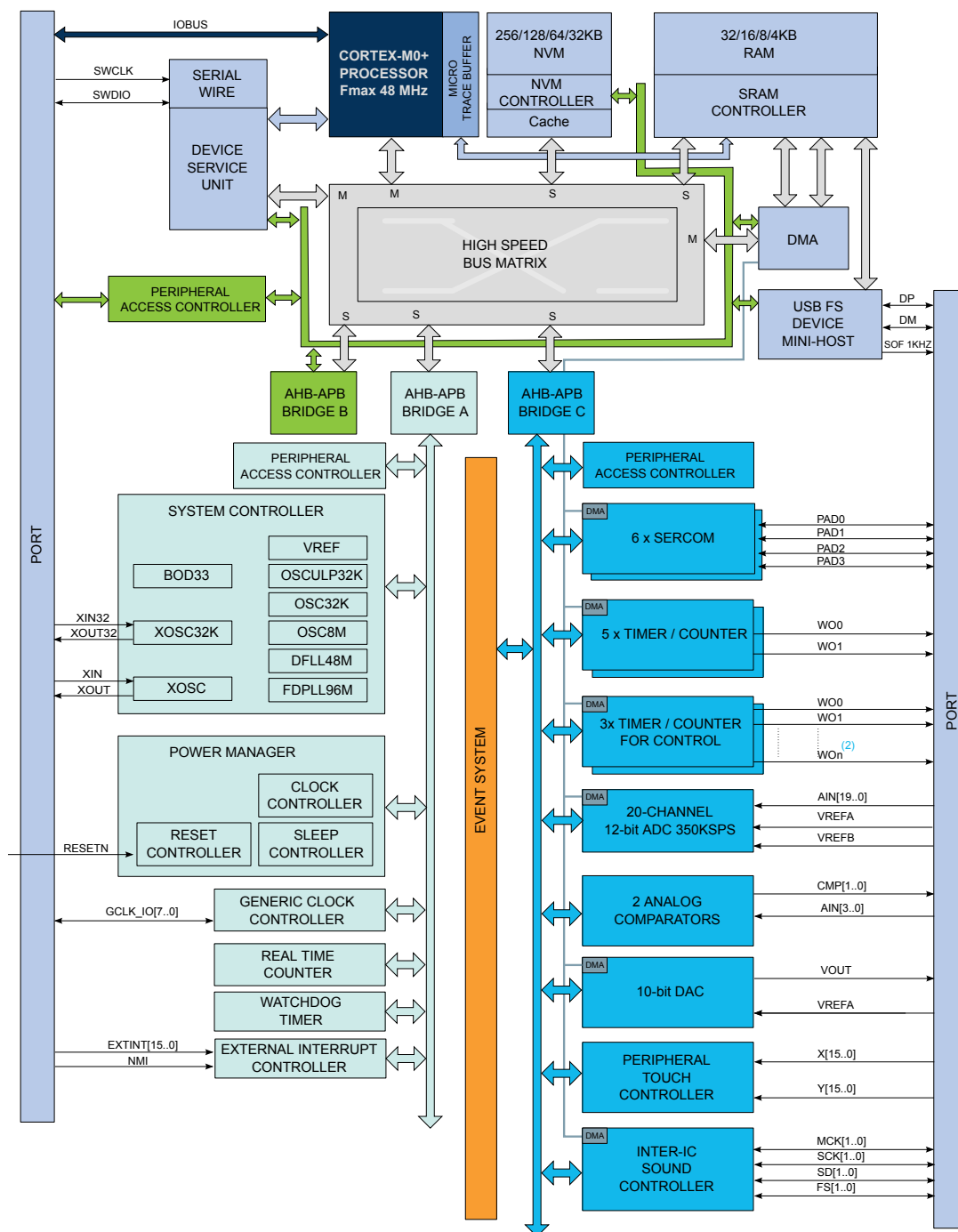
Device Variant	DID.DEVSEL	Device ID (DID)
Reserved	0x25	
SAMD21E16B	0x26	0x10011426 (die revision E) 0x10011526 (die revision F)
SAMD21E15B	0x27	0x10011427 (die revision E) 0x10011527 (die revision F)
Reserved	0x28-0x54	
SAMD21E16B (WLCSP)	0x55	0x10011455 (die revision E)
SAMD21E15B (WLCSP)	0x56	0x10011456 (die revision E)
Reserved	0x57 - 0x61	
SAMD21E16C (WLCSP)	0x62	0x10011562 (die revision F)
SAMD21E15C (WLCSP)	0x63	0x10011563 (die revision F)
Reserved	0x64-0xFF	

Note: The device variant (last letter of the ordering number) is independent of the die revision (DSU.DID.REVISION): The device variant denotes functional differences, whereas the die revision marks evolution of the die. The device variant denotes functional differences, whereas the die revision marks evolution of the die.

Related Links

[DID](#)

4. Block Diagram



1. Some products have different number of SERCOM instances, Timer/Counter instances, PTC signals and ADC signals. Refer to the Configuration Summary for details.
2. The three TCC instances have different configurations, including the number of Waveform Output (WO) lines. Refer to the TCC Configuration for details.

Related Links

[Configuration Summary](#)

[TCC Configurations](#)

5. Pinout

5.1 SAM D21J

5.1.1 QFN64 / TQFP64

