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What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "[Embedded - Microcontrollers](#)"

Details

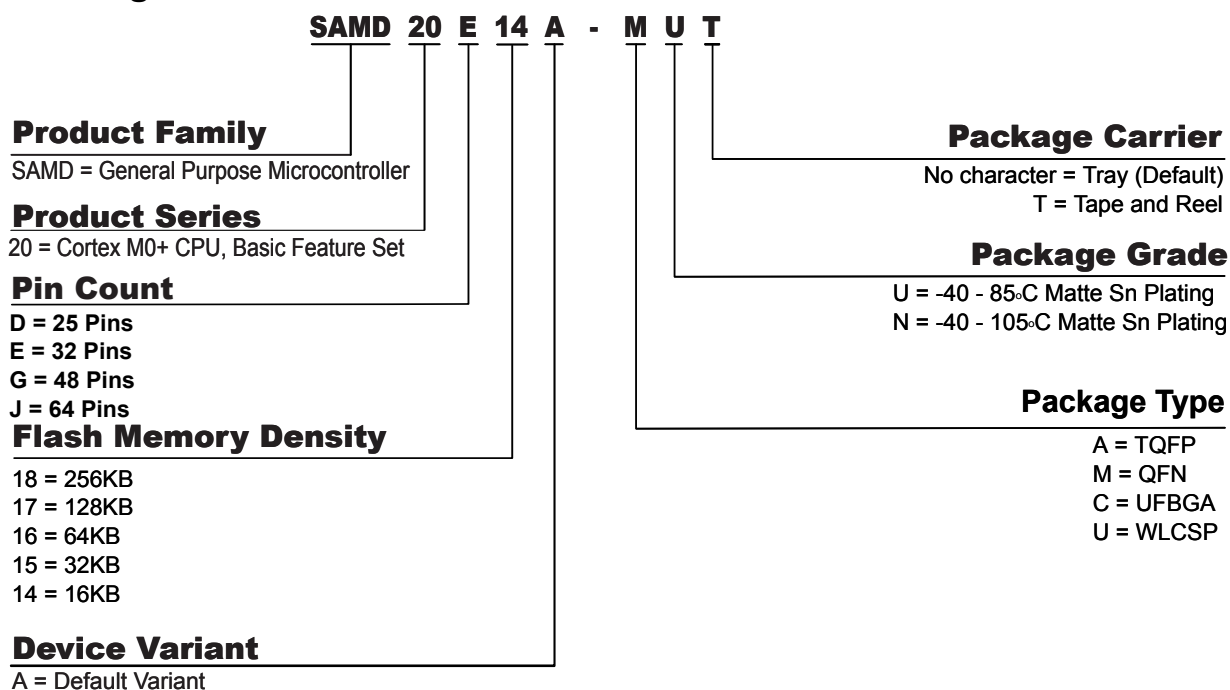
Product Status	Active
Core Processor	ARM® Cortex®-M0+
Core Size	32-Bit Single-Core
Speed	48MHz
Connectivity	I ² C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, WDT
Number of I/O	26
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	1.62V ~ 3.6V
Data Converters	A/D 10x12b; D/A 1x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	32-VFQFN Exposed Pad
Supplier Device Package	32-VQFN (5x5)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atsamd20e18a-mnt

- 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
- 32-bit Real Time Counter (RTC) with clock/calendar function
- Watchdog Timer (WDT)
- CRC-32 generator
- Up to six Serial Communication Interfaces (SERCOM), each configurable to operate as either:
 - USART with full-duplex and single-wire half-duplex configuration
 - Inter-Integrated Circuit (I²C) up to 400kHz
 - Serial Peripheral Interface (SPI)
- 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
- Packages
 - 64-pin TQFP, QFN
 - 64-ball UFBGA
 - 48-pin TQFP, QFN
 - 45-ball WLCSP
 - 32-pin TQFP, QFN
- Operating Voltage
 - 1.62V – 3.63V
- Power Consumption
 - Down to 70µA/MHz in active mode
 - Down to 8µA running the Peripheral Touch Controller

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3. Ordering Information



3.1. SAM D20E

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD20E14A-AU	16K	2K	TQFP32	Tray
ATSAMD20E14A-AUT				Tape & Reel
ATSAMD20E14A-AN				Tray
ATSAMD20E14A-ANT				Tape & Reel
ATSAMD20E14A-MU			QFN32	Tray
ATSAMD20E14A-MUT				Tape & Reel
ATSAMD20E14A-MN				Tray
ATSAMD20E14A-MNT				Tape & Reel

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD20E15A-AU	32K	4K	TQFP32	Tray
ATSAMD20E15A-AUT				Tape & Reel
ATSAMD20E15A-AN				Tray
ATSAMD20E15A-ANT				Tape & Reel
ATSAMD20E15A-MU			QFN32	Tray
ATSAMD20E15A-MUT				Tape & Reel
ATSAMD20E15A-MN				Tray
ATSAMD20E15A-MNT				Tape & Reel
ATSAMD20E16A-AU	64K	8K	TQFP32	Tray
ATSAMD20E16A-AUT				Tape & Reel
ATSAMD20E16A-AN				Tray
ATSAMD20E16A-AFT				Tape & Reel
ATSAMD20E16A-MU			QFN32	Tray
ATSAMD20E16A-MUT				Tape & Reel
ATSAMD20E16A-MN				Tray
ATSAMD20E16A-MNT				Tape & Reel
ATSAMD20E17A-AU	128K	16K	TQFP32	Tray
ATSAMD20E17A-AUT				Tape & Reel
ATSAMD20E17A-AN				Tray
ATSAMD20E17A-ANT				Tape & Reel
ATSAMD20E17A-MU			QFN32	Tray
ATSAMD20E17A-MUT				Tape & Reel
ATSAMD20E17A-MN				Tray
ATSAMD20E17A-MNT				Tape & Reel
ATSAMD20E18A-AU	256K	32K	TQFP32	Tray
ATSAMD20E18A-AUT				Tape & Reel
ATSAMD20E18A-AN				Tray
ATSAMD20E18A-AFT				Tape & Reel
ATSAMD20E18A-MU			QFN32	Tray
ATSAMD20E18A-MUT				Tape & Reel
ATSAMD20E18A-MN				Tray
ATSAMD20E18A-MNT				Tape & Reel

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAMD20J18A-AU	256K	32K	TQFP64	Tray
ATSAMD20J18A-AUT				Tape & Reel
ATSAMD20J18A-AN				Tray
ATSAMD20J18A-ANT				Tape & Reel
ATSAMD20J18A-MU			QFN64	Tray
ATSAMD20J18A-MUT				Tape & Reel
ATSAMD20J18A-MN				Tray
ATSAMD20J18A-MNT				Tape & Reel
ATSAMD20J18A-CU			UFBGA64	Tray
ATSAMD20J18A-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 device 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 3-1. Device Identification Values

Device Variant	DID.DEVSEL	Device ID (DID)
SAMD20J18C	0x00	0x10001300
SAMD20J18A	0x00	0x10001300
SAMD20J17A	0x01	0x10001301
SAMD20J16A	0x02	0x10001302
SAMD20J15A	0x03	0x10001303
SAMD20J14A	0x04	0x10001304
SAMD20G18A	0x05	0x10001305
SAMD20G17A	0x06	0x10001306
SAMD20G16A	0x07	0x10001307
SAMD20G15A	0x08	0x10001308
SAMD20G14A	0x09	0x10001309
SAMD20E18A	0x0A	0x1000130A
SAMD20E17A	0x0B	0x1000130B
SAMD20E16A	0x0C	0x1000130C
SAMD20E15A	0x0D	0x1000130D

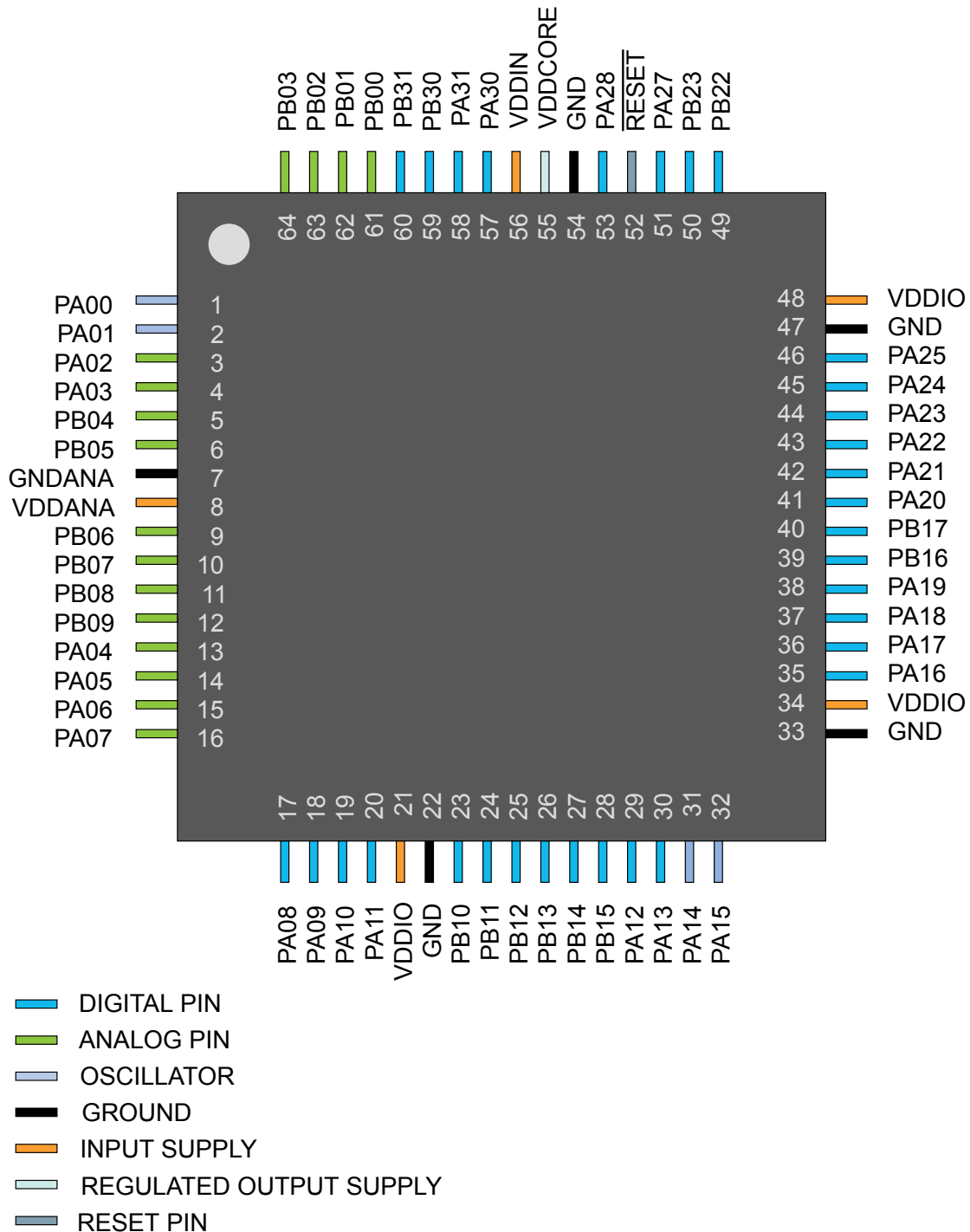
Device Variant	DID.DEVSEL	Device ID (DID)
SAMD20E14A	0x0E	0x1000130E
Reserved	0x0F	
SAMD20G18U	0x10	0x10001310
SAMD20G17U	0x11	0x10001311
Reserved	0x12 - 0xFF	

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.

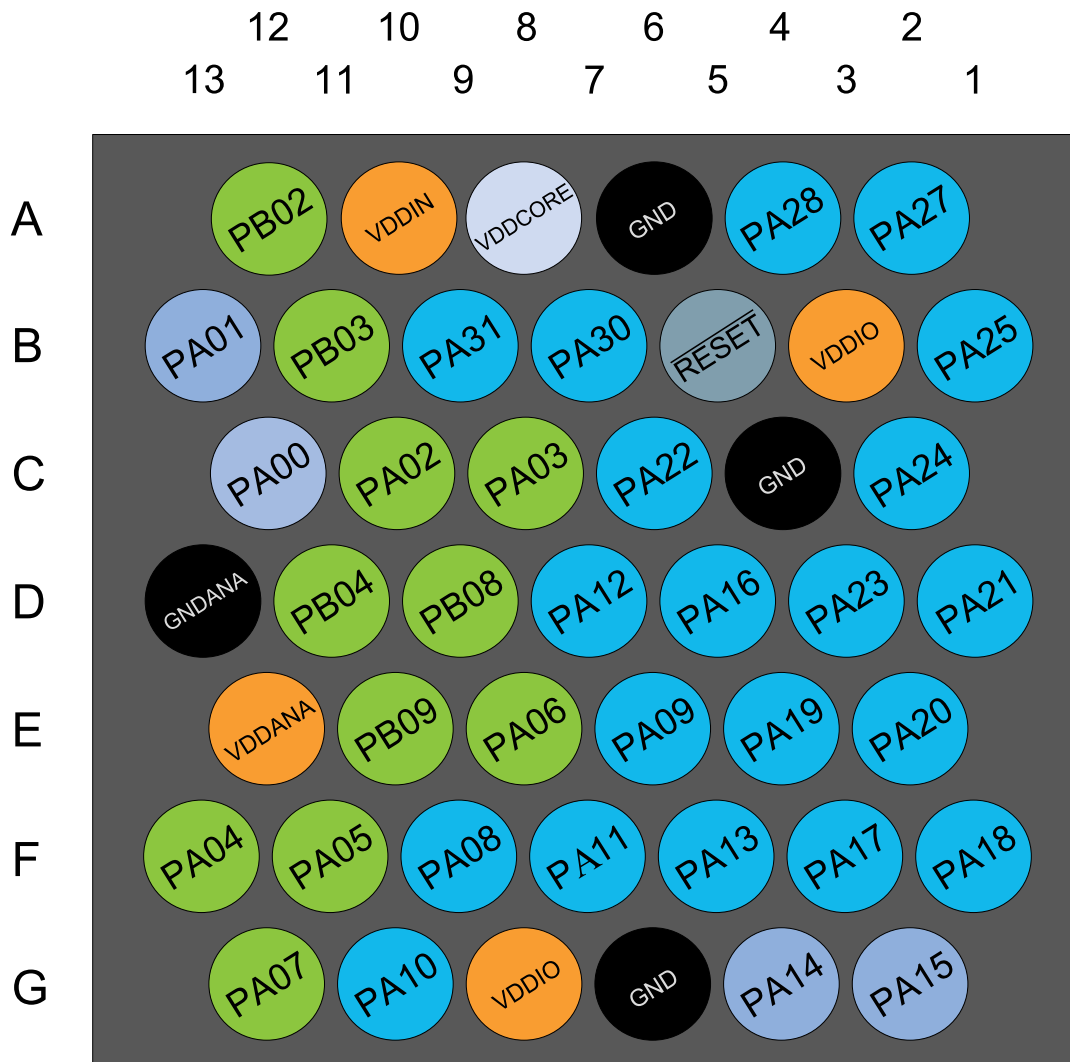
5. Pinout

5.1. SAM D20J

5.1.1. QFN64 / TQFP64



5.2.2. WLCSP45



- DIGITAL PIN
- ANALOG PIN
- OSCILLATOR
- GROUND
- INPUT SUPPLY
- REGULATED OUTPUT SUPPLY
- RESET PIN

7. Processor And Architecture

7.1. Cortex M0+ Processor

The SAM D20 implements the ARM[®] Cortex[®]-M0+ processor, based on the ARMv6 Architecture and Thumb[®]-2 ISA. The Cortex M0+ is 100% instruction set compatible with its predecessor, the Cortex-M0 core, and upward compatible to Cortex-M3 and M4 cores. The ARM Cortex-M0+ implemented is revision r0p1. For more information refer to <http://www.arm.com>.

7.1.1. Cortex M0+ Configuration

Table 7-1. Cortex M0+ Configuration

Features	Configurable option	Device configuration
Interrupts	External interrupts 0-32	28
Data endianness	Little-endian or big-endian	Little-endian
SysTick timer	Present or absent	Present
Number of watchpoint comparators	0, 1, 2	2
Number of breakpoint comparators	0, 1, 2, 3, 4	4
Halting debug support	Present or absent	Present
Multiplier	Fast or small	Fast (single cycle)
Single-cycle I/O port	Present or absent	Present
Wake-up interrupt controller	Supported or not supported	Not supported
Vector Table Offset Register	Present or absent	Present
Unprivileged/Privileged support	Present or absent	Absent ⁽¹⁾
Memory Protection Unit	Not present or 8-region	Not present
Reset all registers	Present or absent	Absent
Instruction fetch width	16-bit only or mostly 32-bit	32-bit

Note:

1. All software run in privileged mode only.

The ARM Cortex-M0+ core has two bus interfaces:

- Single 32-bit AMBA-3 AHB-Lite system interface that provides connections to peripherals and all system memory, which includes flash and RAM.
- Single 32-bit I/O port bus interfacing to the PORT with 1-cycle loads and stores.

7.1.2. Cortex-M0+ Peripherals

- System Control Space (SCS)
 - The processor provides debug through registers in the SCS. Refer to the Cortex-M0+ Technical Reference Manual for details (www.arm.com).
- System Timer (SysTick)

(INTFLAG) register. The interrupt flag is set when the interrupt condition occurs. Each interrupt in the peripheral can be individually enabled by writing a one to the corresponding bit in the peripheral's Interrupt Enable Set (INTENSET) register, and disabled by writing a one to the corresponding bit in the peripheral's Interrupt Enable Clear (INTENCLR) register. An interrupt request is generated from the peripheral when the interrupt flag is set and the corresponding interrupt is enabled. The interrupt requests for one peripheral are ORed together on system level, generating one interrupt request for each peripheral. An interrupt request will set the corresponding interrupt pending bit in the NVIC interrupt pending registers (SETPEND/CLRPEND bits in ISPR/ICPR). For the NVIC to activate the interrupt, it must be enabled in the NVIC interrupt enable register (SETENA/CLRENA bits in ISER/ICER). The NVIC interrupt priority registers IPR0-IPR7 provide a priority field for each interrupt.

Table 7-3. Interrupt Line Mapping

Peripheral Source	NVIC Line
EIC NMI – External Interrupt Controller	NMI
PM – Power Manager	0
SYSCTRL – System Control	1
WDT – Watchdog Timer	2
RTC – Real Time Counter	3
EIC – External Interrupt Controller	4
NVMCTRL – Non-Volatile Memory Controller	5
EVSYS – Event System	6
SERCOM0 – Serial Communication Interface 0	7
SERCOM1 – Serial Communication Interface 1	8
SERCOM2 – Serial Communication Interface 2	9
SERCOM3 – Serial Communication Interface 3	10
SERCOM4 – Serial Communication Interface 4	11
SERCOM5 – Serial Communication Interface 5	12
TC0 – Timer Counter 0	13
TC1 – Timer Counter 1	14
TC2 – Timer Counter 2	15
TC3 – Timer Counter 3	16
TC4 – Timer Counter 4	17
TC5 – Timer Counter 5	18
TC6 – Timer Counter 6	19
TC7 – Timer Counter 7	20
ADC – Analog-to-Digital Converter	21
AC – Analog Comparator	22

Peripheral Source	NVIC Line
DAC – Digital-to-Analog Converter	23
PTC – Peripheral Touch Controller	24

7.3. Micro Trace Buffer

7.3.1. Features

- Program flow tracing for the Cortex-M0+ processor
- MTB SRAM can be used for both trace and general purpose storage by the processor
- The position and size of the trace buffer in SRAM is configurable by software
- CoreSight compliant

7.3.2. Overview

When enabled, the MTB records changes in program flow, reported by the Cortex-M0+ processor over the execution trace interface shared between the Cortex-M0+ processor and the CoreSight MTB-M0+. This information is stored as trace packets in the SRAM by the MTB. An off-chip debugger can extract the trace information using the Debug Access Port to read the trace information from the SRAM. The debugger can then reconstruct the program flow from this information.

The MTB simultaneously stores trace information into the SRAM, and gives the processor access to the SRAM. The MTB ensures that trace write accesses have priority over processor accesses.

The execution trace packet consists of a pair of 32-bit words that the MTB generates when it detects the processor PC value changes non-sequentially. A non-sequential PC change can occur during branch instructions or during exception entry. See the CoreSight MTB-M0+ Technical Reference Manual for more details on the MTB execution trace packet format.

Tracing is enabled when the MASTER.EN bit in the Master Trace Control Register is 1. There are various ways to set the bit to 1 to start tracing, or to 0 to stop tracing. See the CoreSight Cortex-M0+ Technical Reference Manual for more details on the Trace start and stop and for a detailed description of the MTB's MASTER register. The MTB can be programmed to stop tracing automatically when the memory fills to a specified watermark level or to start or stop tracing by writing directly to the MASTER.EN bit. If the watermark mechanism is not being used and the trace buffer overflows, then the buffer wraps around overwriting previous trace packets.

The base address of the MTB registers is 0x41006000; this address is also written in the CoreSight ROM Table. The offset of each register from the base address is fixed and as defined by the CoreSight MTB-M0+ Technical Reference Manual. The MTB has 4 programmable registers to control the behavior of the trace features:

- POSITION: Contains the trace write pointer and the wrap bit,
- MASTER: Contains the main trace enable bit and other trace control fields,
- FLOW: Contains the WATERMARK address and the AUTOSTOP and AUTOHALT control bits,
- BASE: Indicates where the SRAM is located in the processor memory map. This register is provided to enable auto discovery of the MTB SRAM location, by a debug agent.

See the CoreSight MTB-M0+ Technical Reference Manual for a detailed description of these registers.

Write-protect registers allow the user to disable a selected peripheral's write-protection without doing a read-modify-write operation. These registers are mapped into two I/O memory locations, one for clearing and one for setting the register bits. Writing a one to a bit in the Write Protect Clear register (WPCLR) will clear the corresponding bit in both registers (WPCLR and WPSET) and disable the write-protection for the corresponding peripheral, while writing a one to a bit in the Write Protect Set (WPSET) register will set the corresponding bit in both registers (WPCLR and WPSET) and enable the write-protection for the corresponding peripheral. Both registers (WPCLR and WPSET) will return the same value when read.

If a peripheral is write-protected, and if a write access is performed, data will not be written, and the peripheral will return an access error (CPU exception).

The PAC also offers a safety feature for correct program execution, with a CPU exception generated on double write-protection or double unprotection of a peripheral. If a peripheral *n* is write-protected and a write to one in WPSET[*n*] is detected, the PAC returns an error. This can be used to ensure that the application follows the intended program flow by always following a write-protect with an unprotect, and vice versa. However, in applications where a write-protected peripheral is used in several contexts, e.g., interrupts, care should be taken so that either the interrupt can not happen while the main application or other interrupt levels manipulate the write-protection status, or when the interrupt handler needs to unprotect the peripheral, based on the current protection status, by reading WPSET.

7.7. Register Description

Atomic 8-, 16- and 32-bit accesses are supported. In addition, the 8-bit quarters and 16-bit halves of a 32-bit register, and the 8-bit halves of a 16-bit register can be accessed directly. Refer to the Product Mapping for PAC locations.

Related Links

[Product Mapping](#) on page 19

7.7.1. PAC0 Register Description

7.7.2.2. Write Protect Set

Name: WPSET
Offset: 0x04
Reset: 0x000002
Property: –

Bit	31	30	29	28	27	26	25	24
Access								
Reset								
Bit	23	22	21	20	19	18	17	16
Access								
Reset								
Bit	15	14	13	12	11	10	9	8
Access								
Reset								
Bit	7	6	5	4	3	2	1	0
		MTB			PORT	NVMCTRL	DSU	
Access		R/W			R/W	R/W	R/W	
Reset		0			0	0	1	

Bit 6 – MTB

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bit 3 – PORT

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bit 2 – NVMCTRL

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

7.7.3.1. Write Protect Clear

Name: WPCLR
Offset: 0x00
Reset: 0x00800000
Property: –

Bit	31	30	29	28	27	26	25	24
Access								
Reset								
Bit	23	22	21	20	19	18	17	16
					PTC	DAC	AC	ADC
Access					R/W	R/W	R/W	R/W
Reset					0	0	0	0
Bit	15	14	13	12	11	10	9	8
	TC7	TC6	TC5	TC4	TC3	TC2	TC1	TC0
Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Reset	0	0	0	0	0	0	0	0
Bit	7	6	5	4	3	2	1	0
	SERCOM5	SERCOM4	SERCOM3	SERCOM2	SERCOM1	SERCOM0	EVSYS	
Access	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Reset	0	0	0	0	0	0	0	

Bit 19 – PTC

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bit 18 – DAC

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bit 17 – AC

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bit 16 – ADC

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bits 15,14,13,12,11,10,9,8 – TCx

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bits 7,6,5,4,3,2 – SERCOMx

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Bit 1 – EVSYS

Writing a zero to these bits has no effect.

Writing a one to these bits will clear the Write Protect bit for the corresponding peripherals.

Value	Description
0	Write-protection is disabled.
1	Write-protection is enabled.

Table 8-11. Device and Package Maximum Weight

140	mg
-----	----

Table 8-12. Package Characteristics

Moisture Sensitivity Level	MSL3
----------------------------	------

Table 8-13. Package Reference

JEDEC Drawing Reference	MS-026
JESD97 Classification	E3

Table 8-16. Package Reference

JEDEC Drawing Reference	MO-220
JESD97 Classification	E3

8.2.6. 45-ball WLCSP

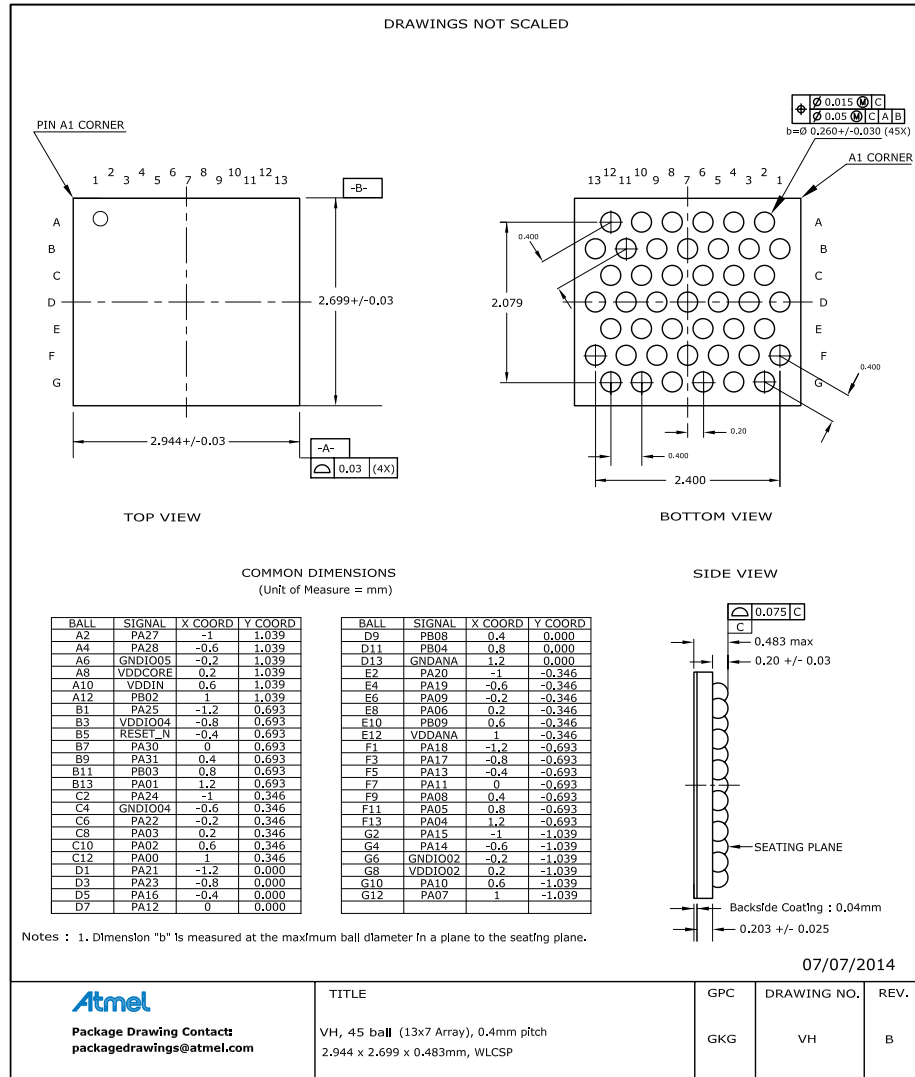


Table 8-17. Device and Package Maximum Weight

7.3	mg
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Table 8-18. Package Characteristics

Moisture Sensitivity Level	MSL1
----------------------------	------

Table 8-19. Package Reference

JEDEC Drawing Reference	MO-220
JESD97 Classification	E1

8.2.7. 32 pin TQFP

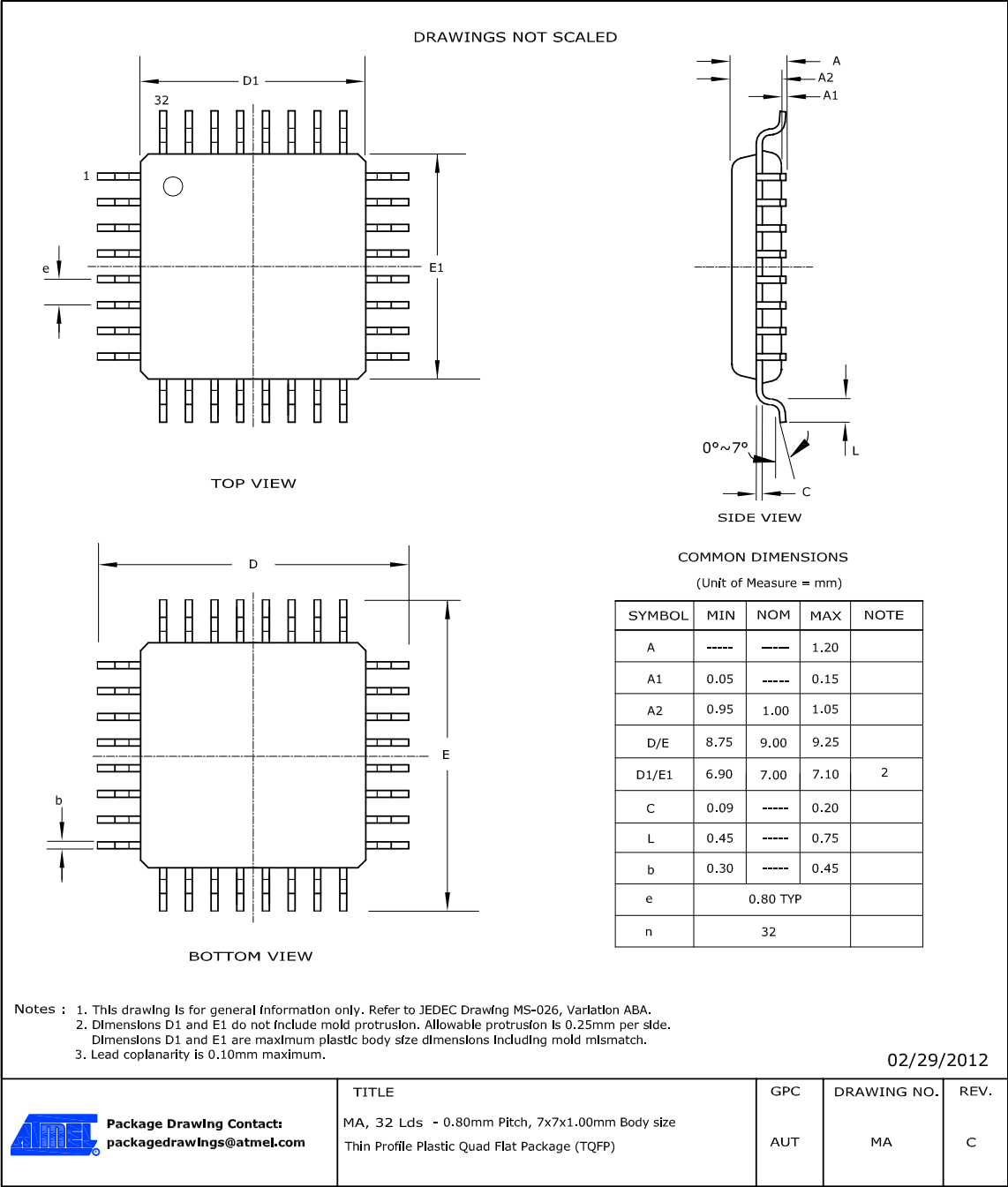


Table 8-20. Device and Package Maximum Weight

100	mg
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Table 8-21. Package Characteristics

Moisture Sensitivity Level	MSL3
----------------------------	------

Table 8-24. Package Characteristics

Moisture Sensitivity Level	MSL3
----------------------------	------

Table 8-25. Package Reference

JEDEC Drawing Reference	MO-220
JESD97 Classification	E3

8.2.9. 35 ball WLCSP

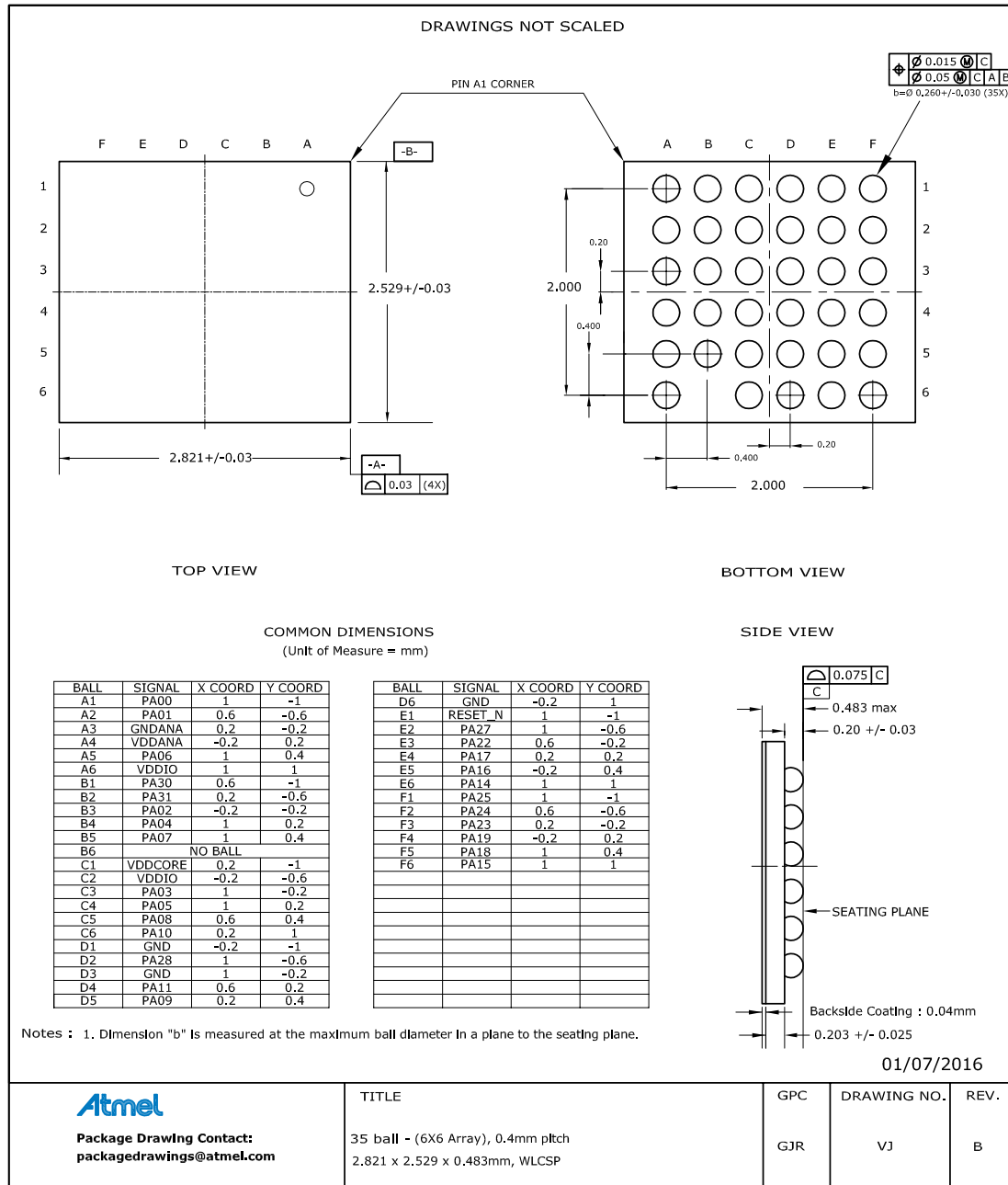


Table 8-26. Device and Package Maximum Weight

6.2	mg
-----	----

Table 8-27. Package Characteristics

Moisture Sensitivity Level	MSL1
----------------------------	------

Table 8-28. Package Reference

JEDEC Drawing Reference	MO-220
JESD97 Classification	E1

8.3. Soldering Profile

The following table gives the recommended soldering profile from J-STD-20.

Table 8-29.

Profile Feature	Green Package
Average Ramp-up Rate (217°C to peak)	3°C/s max.
Preheat Temperature 175°C ±25°C	150-200°C
Time Maintained Above 217°C	60-150s
Time within 5°C of Actual Peak Temperature	30s
Peak Temperature Range	260°C
Ramp-down Rate	6°C/s max.
Time 25°C to Peak Temperature	8 minutes max.

A maximum of three reflow passes is allowed per component.