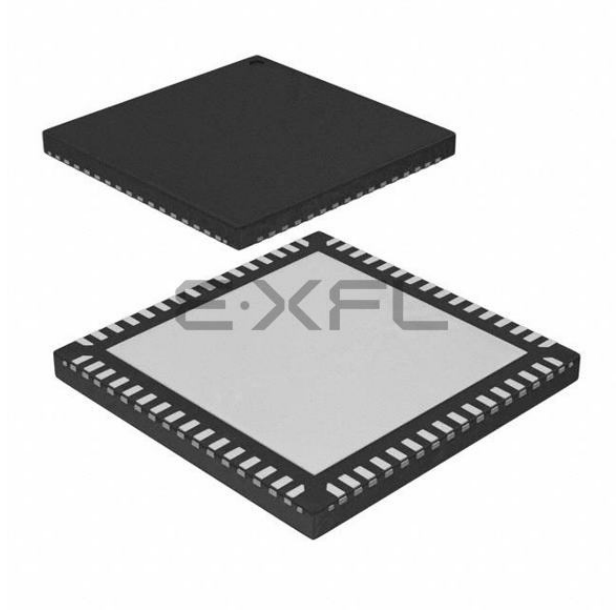

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What is "Embedded - Microcontrollers"?

"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	I²C, LINbus, SCI, SPI, UART/USART, USB
Peripherals	DMA, POR, PWM, WDT
Number of I/O	51
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	1.62V ~ 3.63V
Data Converters	A/D 20x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-VFQFN Exposed Pad
Supplier Device Package	64-QFN (9x9)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atsaml21j18b-mut

  - 0.4-32MHz crystal oscillator (XOSC)
  - 32.768kHz internal oscillator (OSC32K)
  - 32.768kHz ultra-low-power internal oscillator (OSCULP32K)
  - 16/12/8/4MHz high-accuracy internal oscillator (OSC16M)
  - 48MHz Digital Frequency Locked Loop (DFLL48M)
  - 96MHz Fractional Digital Phased Locked Loop (FDPLL96M)
- I/O
  - Up to 51 programmable I/O pins
- Easy migration from SAM D family
- Packages
  - 64-pin TQFP, QFN, WLCSP
  - 48-pin TQFP, QFN
  - 32-pin TQFP, QFN
- Operating Voltage
  - 1.62V – 3.63V

The Atmel SAM L21 devices are supported with a full suite of programs and system development tools, including C compilers, macro assemblers, program debugger/simulators, programmers and evaluation kits.

2. Configuration Summary

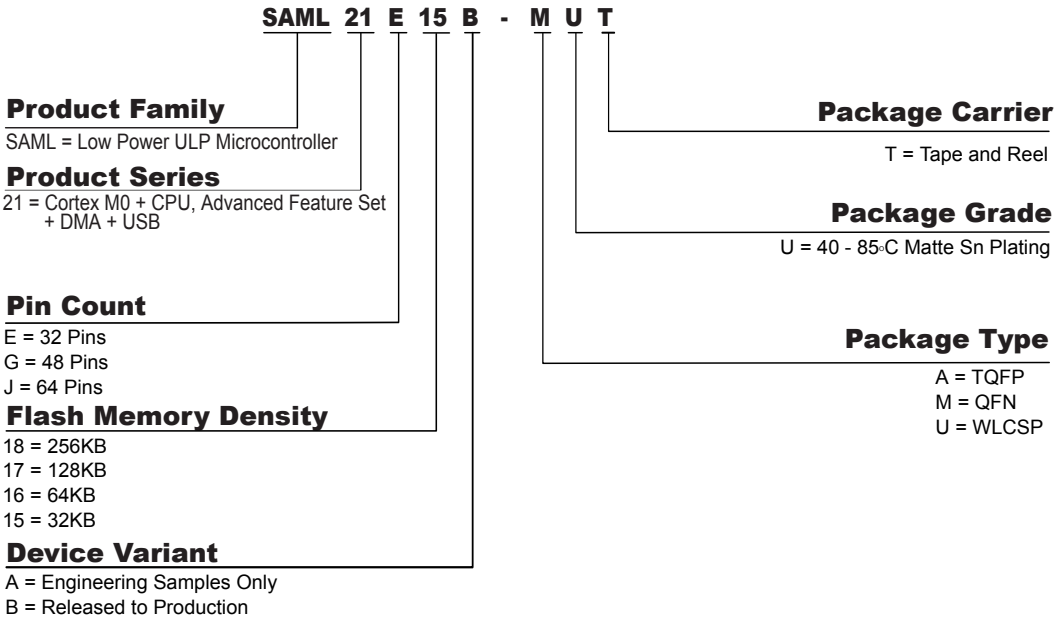
	SAM L21J	SAM L21G	SAM L21E
Pins	64	48	32
General Purpose I/O-pins (GPIOs)	51	37	25
Flash	256/128/64KB	256/128/64KB	256/128/64/32KB
Flash RWW section	8/4/2KB	8/4/2KB	8/4/2/1KB
System SRAM	32/16/8KB	32/16/8KB	32/16/8/4KB
Low Power SRAM	8/8/4KB	8/8/4KB	8/8/4/2KB
Timer Counter (TC) instances(1)	5	3	3
Waveform 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	16	16	16
USB interface	1	1	1
AES engine	1	1	1
Configurable Custom Logic (CCL) (LUTs)	4	4	4
True Random Generator (TRNG)	1	1	1
Serial Communication Interface (SERCOM) instances	6	6	6
Analog-to-Digital Converter (ADC) channels	20	14	10
Analog Comparators (AC)	2	2	2
Digital-to-Analog Converter (DAC) channels	2	2	2
Operational Amplifier (OPAMP)	3	3	3

	SAM L21J	SAM L21G	SAM L21E
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) channels (X- x Y-Lines) for mutual capacitance (2)	169 (13x13)	81 (9x9)	42 (7x6)
Peripheral Touch Controller (PTC) channels for self capacitance (Y-Lines only) (3)	16	10	7
Maximum CPU frequency	48MHz		
Packages	QFN TQFP WLCSP(4)	QFN TQFP	QFN TQFP
Oscillators	32.768kHz crystal oscillator (XOSC32K) 0.4-32MHz crystal oscillator (XOSC) 32.768kHz internal oscillator (OSC32K) 32KHz ultra-low-power internal oscillator (OSCULP32K) 16/12/8/4MHz high-accuracy internal oscillator (OSC16M) 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

Note:

1. For SAM L21E and SAM L21G, only TC0, TC1 and TC4 are available.
2. The number of X- and Y-lines depends on the configuration of the device, as some I/O lines can be configured as either X-lines or Y-lines. Refer to *Multiplexed Signals* for details. The number in the Configuration Summary is the maximum number of channels that can be obtained.

3. Ordering Information



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.

3.1. SAM L21J

Table 3-1. SAM L21J Ordering Codes

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAML21J16B-AUT	64K	8K	TQFP64	Tape & Reel
ATSAML21J16B-MUT			QFN64	
ATSAML21J17B-AUT	128K	16K	TQFP64	Tape & Reel
ATSAML21J17B-MUT			QFN64	
ATSAML21J17B-UUT			WLCSP64	
ATSAML21J18B-AUT	256K	32K	TQFP64	Tape & Reel
ATSAML21J18B-MUT			QFN64	
ATSAML21J18B-UUT			WLCSP64	

3.2. SAM L21G

Table 3-2. SAM L21G Ordering Codes

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAML21G16B-AUT	64K	8K	TQFP48	Tape & Reel
ATSAML21G16B-MUT			QFN48	
ATSAML21G17B-AUT	128K	16K	TQFP48	Tape & Reel
ATSAML21G17B-MUT			QFN48	
ATSAML21G18B-AUT	256K	32K	TQFP48	Tape & Reel
ATSAML21G18B-MUT			QFN48	

3.3. SAM L21E

Table 3-3. SAM L21E

Ordering Code	FLASH (bytes)	SRAM (bytes)	Package	Carrier Type
ATSAML21E15B-AUT	32K	4K	TQFP32	Tape & Reel
ATSAML21E15B-MUT			QFN32	
ATSAML21E16B-AUT	64K	8K	TQFP32	Tape & Reel
ATSAML21E16B-MUT			QFN32	
ATSAML21E17B-AUT	128K	16K	TQFP32	Tape & Reel
ATSAML21E17B-MUT			QFN32	
ATSAML21E18B-AUT	256K	32K	TQFP32	Tape & Reel
ATSAML21E18B-MUT			QFN32	

3.4. Device Identification

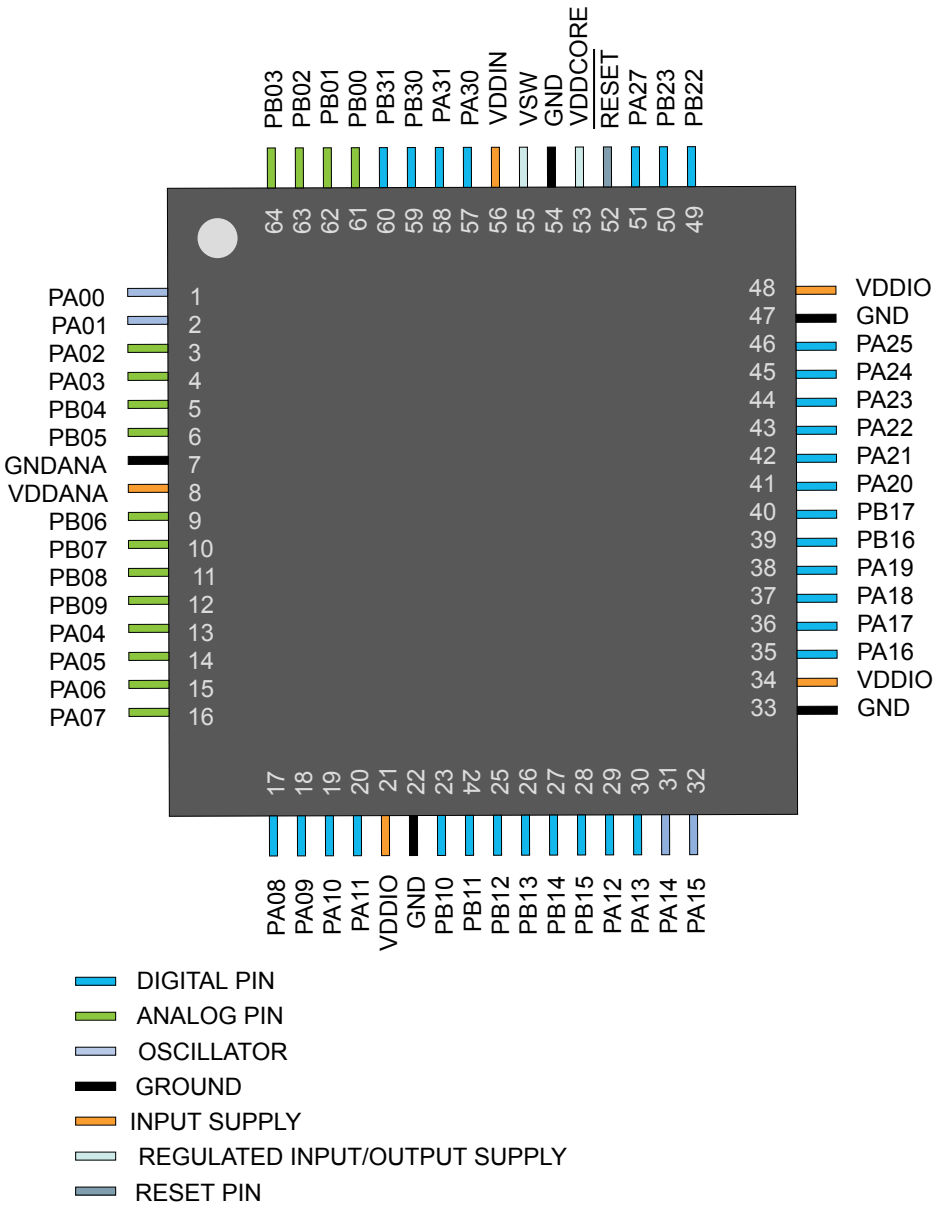
The DSU - Device Service Unit peripheral provides the Device Selection bits in the Device Identification register (DID.DEVSEL) in order to identify the device by software. The SAM L21 variants have a reset value of DID=0x1081drxx, with the LSB identifying the die number ('d'), the die revision ('r') and the device selection ('xx').

Table 3-4. SAM L21 Device Identification Values

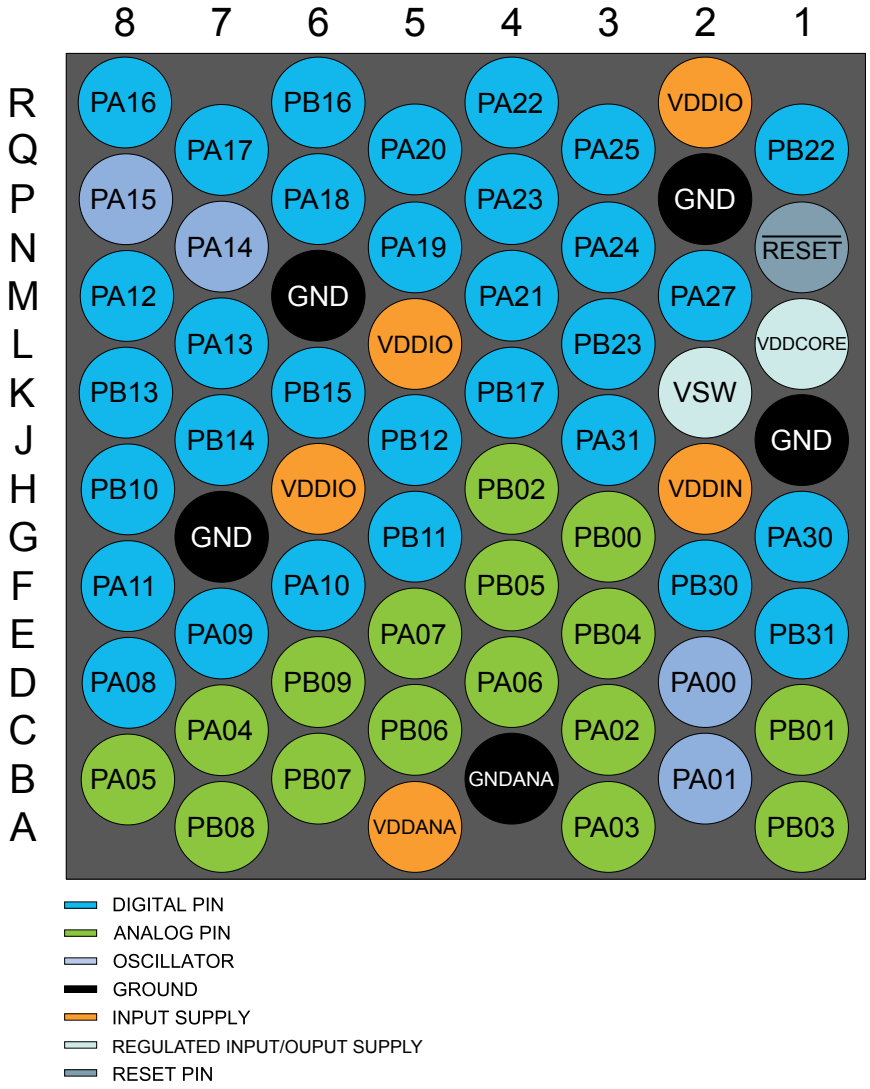
DEVSEL (DID[7:0])	Device
0x00	SAML21J18A
0x01	SAML21J17A
0x02	SAML21J16A
0x03-0x04	Reserved
0x05	SAML21G18A

5. Pinout

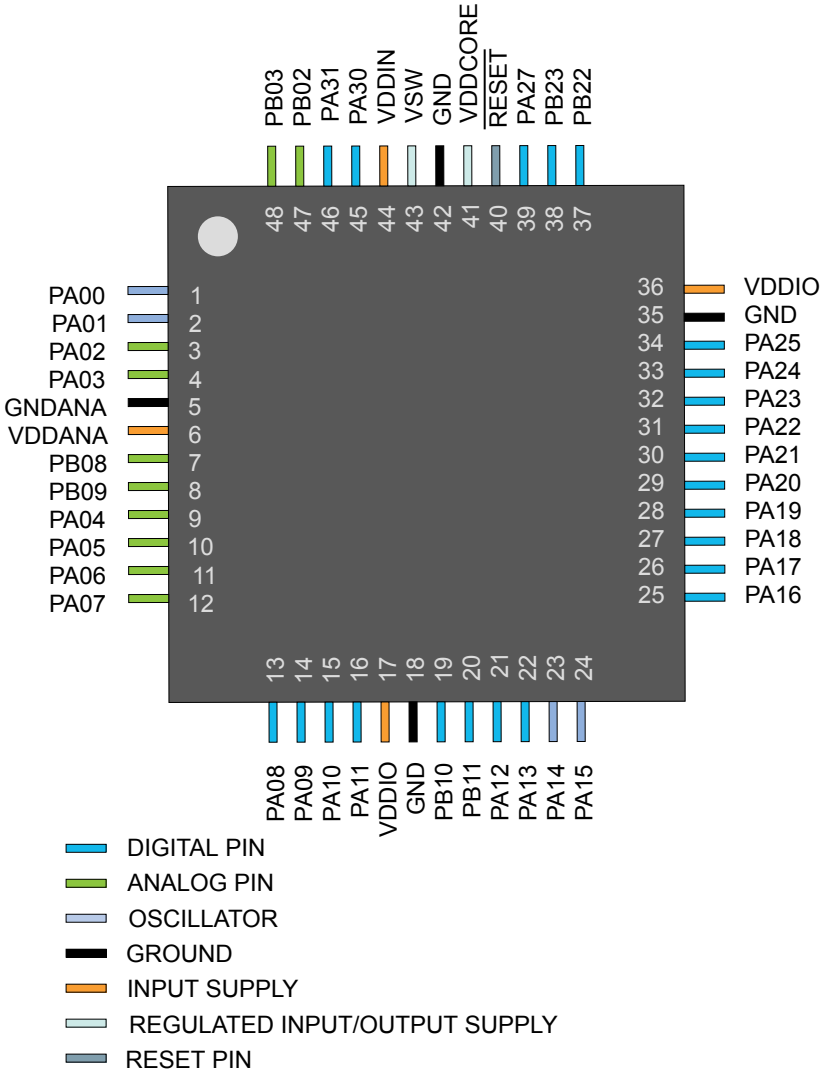
5.1. SAM L21J



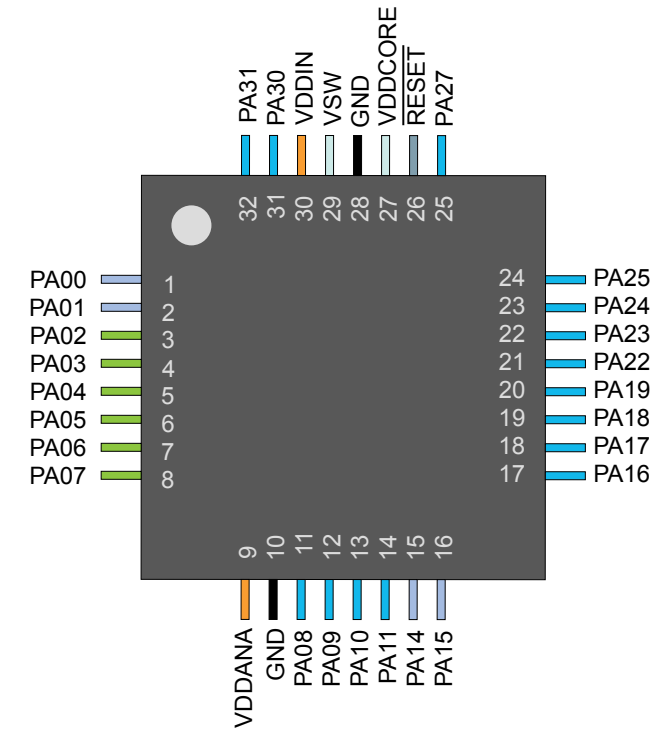
5.2. SAM L21J WLCSP64



5.3. SAM L21G


PB03
PB02
PA31
PA30
VDDIN
VSW
GND
VDDCORE
RESET
PA27
PB23
PB22
48
47
46
45
44
43
42
41
40
39
38
37
PA00
PA01
PA02
PA03
GNDANA
VDDANA
PB08
PB09
PA04
PA05
PA06
PA07
1
2
3
4
5
6
7
8
9
10
11
12
36
35
34
33
32
31
30
29
28
27
26
25
VDDIO
GND
PA25
PA24
PA23
PA22
PA21
PA20
PA19
PA18
PA17
PA16
13
14
15
16
17
18
19
20
21
22
23
24
PA08
PA09
PA10
PA11
VDDIO
GND
PB10
PB11
PA12
PA13
PA14
PA15
DIGITAL PIN
ANALOG PIN
OSCILLATOR
GROUND
INPUT SUPPLY
REGULATED INPUT/OUTPUT SUPPLY
RESET PIN

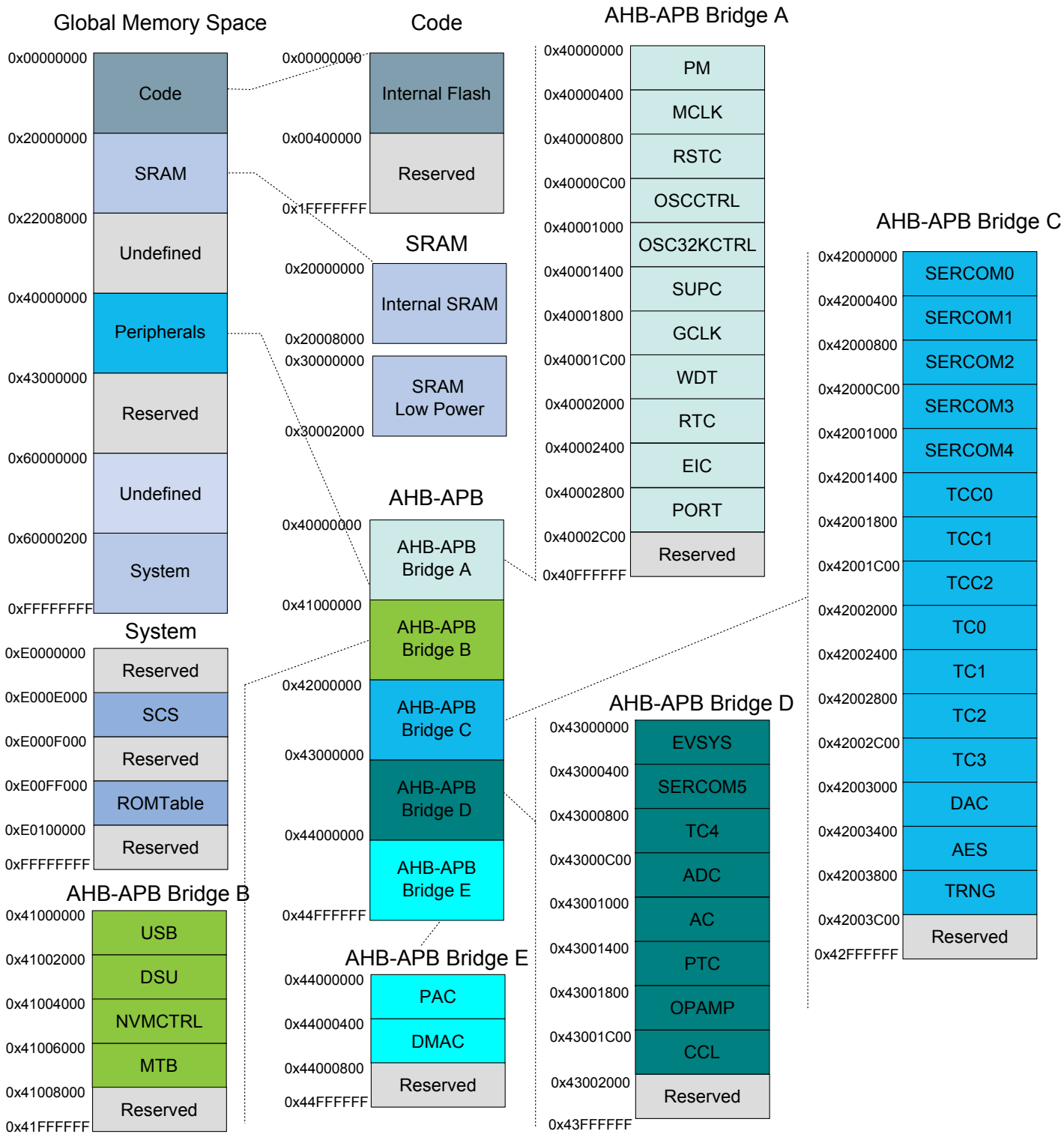
5.4. SAM L21E



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

6. Product Mapping

Figure 6-1. Atmel SAM L21 Product Mapping



7. Processor and Architecture

7.1. Cortex M0+ Processor

The Atmel SAM L21 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 implemented ARM Cortex-M0+ is revision r0p1. For more information refer to http://www.arm.com

7.1.1. Cortex M0+ Configuration

Table 7-1. Cortex M0+ Configuration in Atmel SAM L21

Features	Cortex M0+ options	Atmel SAM L21 configuration
Interrupts	External interrupts 0-32	29
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 - All software run in privileged mode only
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

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 including Flash memory and RAM
- Single 32-bit I/O port bus interfacing to the PORT with 1-cycle loads and stores

7.1.1.1. 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 (http://www.arm.com)
- Nested Vectored Interrupt Controller (NVIC)

- External interrupt signals connect to the NVIC, and the NVIC prioritizes the interrupts. Software can set the priority of each interrupt. The NVIC and the Cortex-M0+ processor core are closely coupled, providing low latency interrupt processing and efficient processing of late arriving interrupts. Refer to the Cortex-M0+ Technical Reference Manual for details (http://www.arm.com).
  Note: When the CPU frequency is much higher than the APB frequency it is recommended to insert a memory read barrier after each CPU write to registers mapped on the APB. Failing to do so in such conditions may lead to unexpected behavior such as e.g. re-entering a peripheral interrupt handler just after leaving it.

- System Timer (SysTick)
  - The System Timer is a 24-bit timer clocked by CLK_CPU that extends the functionality of both the processor and the NVIC. Refer to the Cortex-M0+ Technical Reference Manual for details (http://www.arm.com).
- System Control Block (SCB)
  - The System Control Block provides system implementation information, and system control. This includes configuration, control, and reporting of the system exceptions. Refer to the Cortex-M0+ Devices Generic User Guide for details (http://www.arm.com)
- Micro Trace Buffer (MTB)
  - The CoreSight MTB-M0+ (MTB) provides a simple execution trace capability to the Cortex-M0+ processor. Refer to section MTB-Micro Trace Buffer and the CoreSight MTB-M0+ Technical Reference Manual for details (http://www.arm.com).

Related Links

Nested Vector Interrupt Controller on page 21

7.1.1.2. Cortex M0+ Address Map

Table 7-2. Cortex-M0+ Address Map

Address	Peripheral
0xE000E000	System Control Space (SCS)
0xE000E010	System Timer (SysTick)
0xE000E100	Nested Vectored Interrupt Controller (NVIC)
0xE000ED00	System Control Block (SCB)
0x41006000	Micro Trace Buffer (MTB)

7.1.1.3. I/O Interface

The device allows direct access to PORT registers. Accesses to the AMBA® AHB-Lite™ and the single cycle I/O interface can be made concurrently, so the Cortex M0+ processor can fetch the next instructions while accessing the I/Os. This enables single cycle I/O access to be sustained for as long as necessary.

7.2. Nested Vector Interrupt Controller

7.2.1. Overview

The Nested Vectored Interrupt Controller (NVIC) in the SAM L21 supports 32 interrupt lines with four different priority levels. For more details, refer to the Cortex-M0+ Technical Reference Manual (http://www.arm.com).

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 four 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.

7.4. High-Speed Bus System

7.4.1. Features

High-Speed Bus Matrix has the following features:

- Symmetric crossbar bus switch implementation
- Allows concurrent accesses from different masters to different slaves
- 32-bit data bus
- Operation at a one-to-one clock frequency with the bus masters

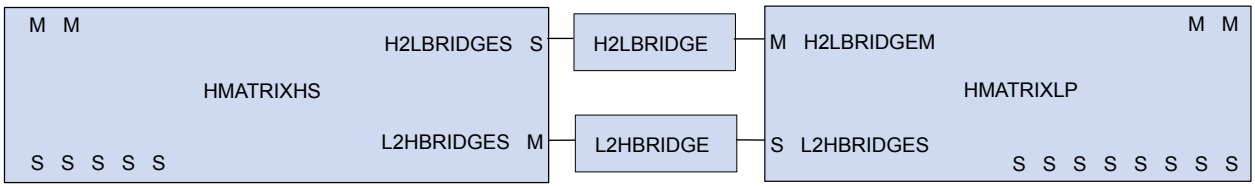
H2LBRIDGE has the following features:

- LP clock division support
- Write: Posted-write FIFO of 3 words, no bus stall until it is full
- Write: 1 cycle bus stall when full when LP clock is not divided
- 2 stall cycles on read when LP clock is not divided
- Ultra low latency mode:
  - Suitable when the HS clock frequency is not above half the maximum device clock frequency
  - Removes all intrinsic bridge stall cycles (except those needed for LP clock ratio adaptation)
  - Enabled by writing a '1' in 0x41008120 using a 32-bit write access

L2HBRIDGE has the following features:

- LP clock division support
- Write: Posted-write FIFO of 1 word, no bus stall until it is full
- Write: 1 cycle bus stall when full when LP clock is not divided
- 2 stall cycles on read when LP clock is not divided
- ultra low latency mode:
  - Suitable when the HS clock frequency is not above half the maximum device clock frequency
  - Removes all intrinsic bridge stall cycles (except those needed for LP clock ratio adaptation)
  - Enabled by writing a '1' in 0x41008120 using a 32-bit write access

Figure 7-1. High-Speed Bus System Components



7.4.2. Configuration

Figure 7-2. Master-Slave Relations High-Speed Bus Matrix

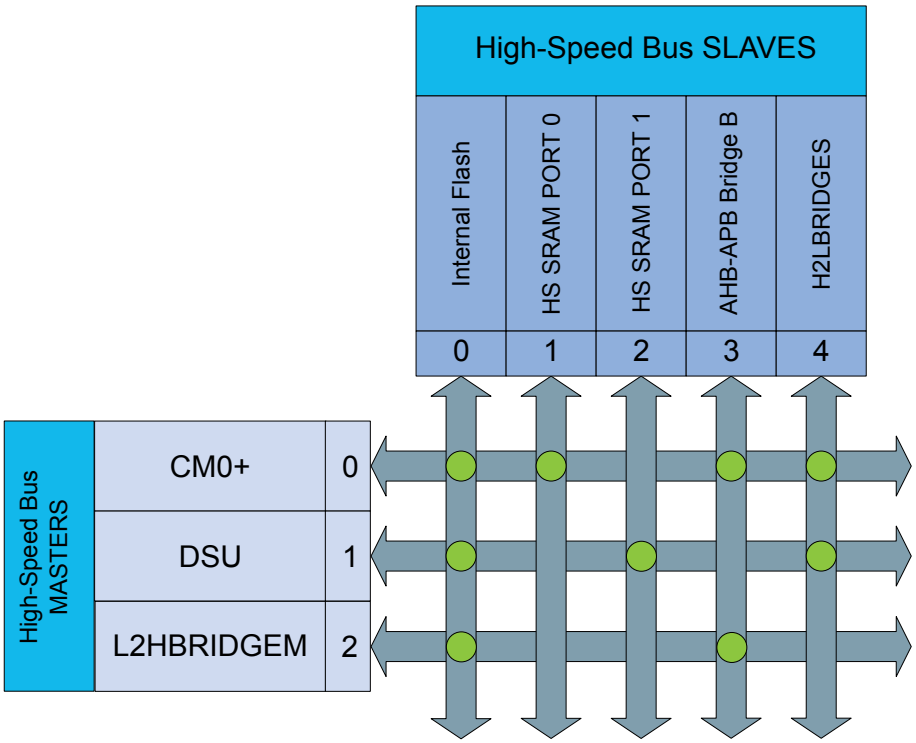


Figure 7-3. Master-Slave Relations Low-Power Bus Matrix

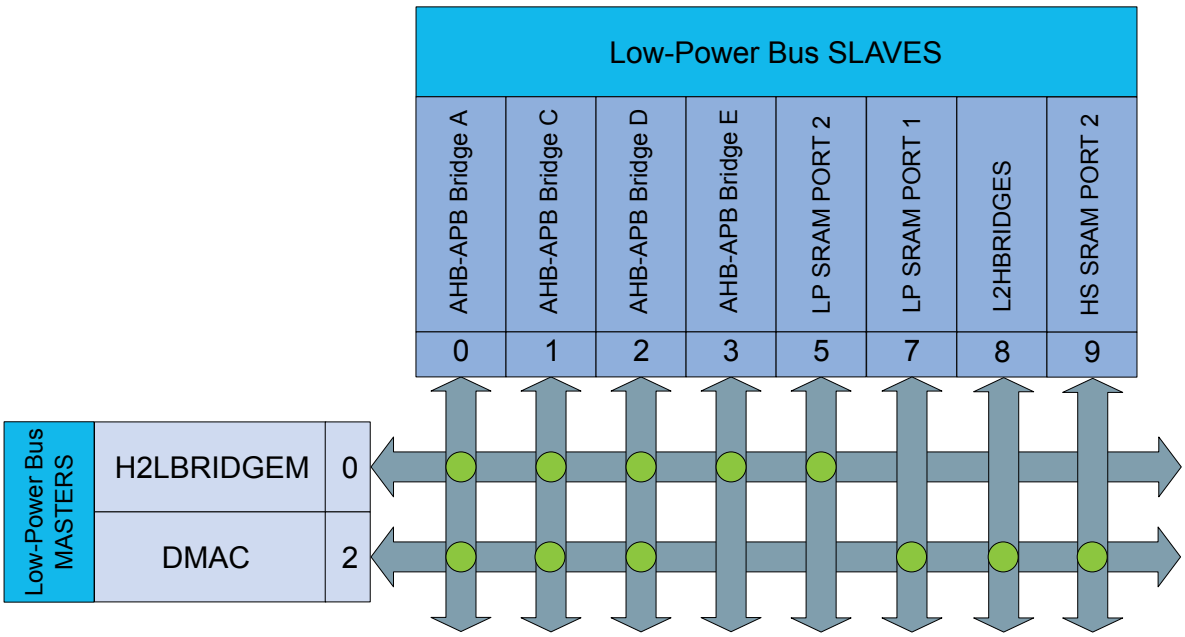


Table 7-4. High-Speed Bus Matrix Masters

High-Speed Bus Matrix Masters	Master ID
CM0+ - Cortex M0+ Processor	0
DSU - Device Service Unit	1
L2HBRIDGEM - Low-Power to High-Speed bus matrix AHB to AHB bridge	2

Table 7-5. High-Speed Bus Matrix Slaves

High-Speed Bus Matrix Slaves	Slave ID
Internal Flash Memory	0
HS SRAM Port 0 - CM0+ Access	1
HS SRAM Port 1 - DSU Access	2
AHB-APB Bridge B	3
H2LBRIDGES - High-Speed to Low-Power bus matrix AHB to AHB bridge	4

Table 7-6. Low-Power Bus Matrix Masters

Low-Power Bus Matrix Masters	Master ID
H2LBRIDGEM - High-Speed to Low-Power bus matrix AHB to AHB bridge	0
DMAC - Direct Memory Access Controller - Data Access	2

Table 7-7. Low-Power Bus Matrix Slaves

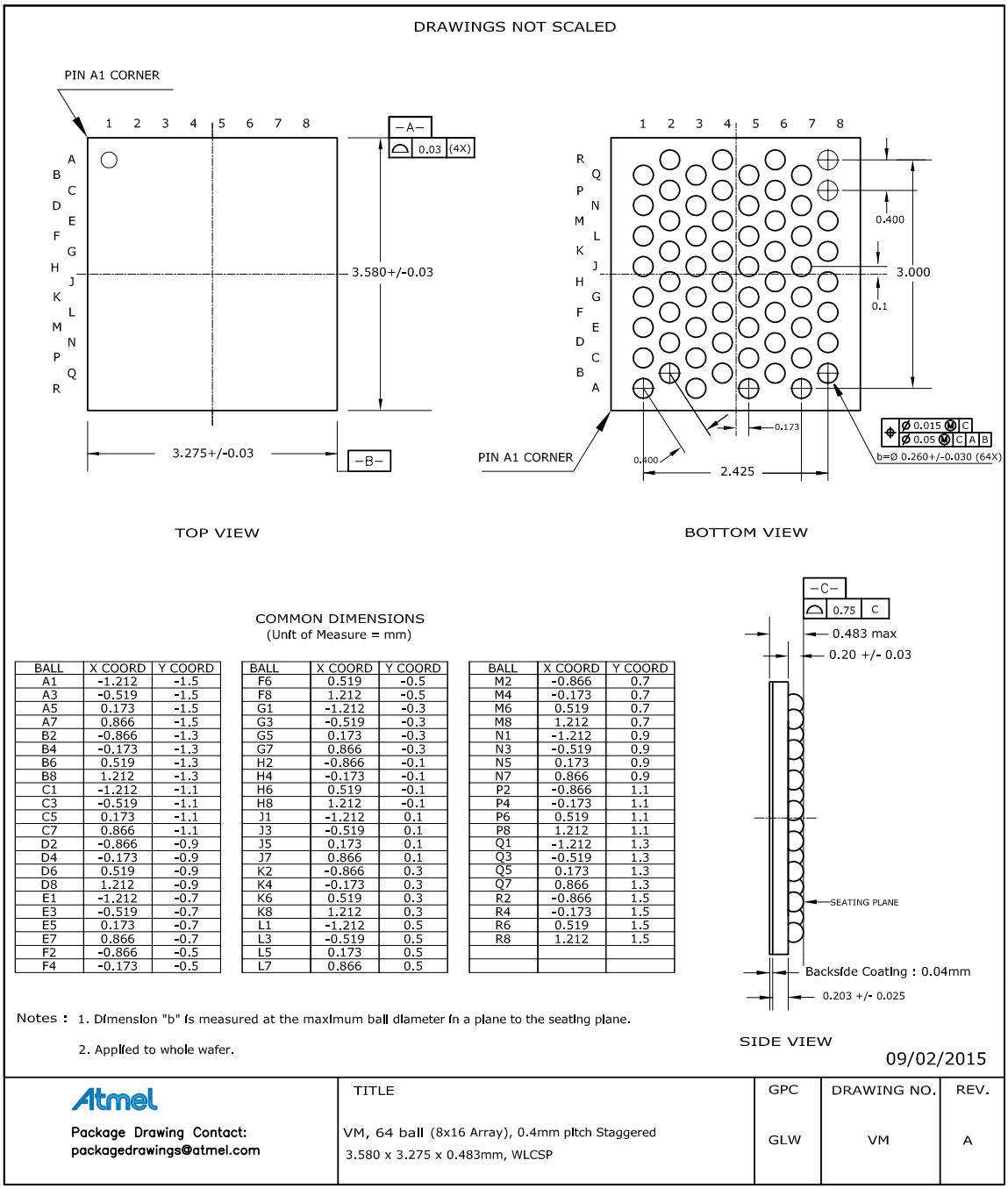
Low-Power Bus Matrix Slaves	Slave ID
AHB-APB Bridge A	0
AHB-APB Bridge C	1
AHB-APB Bridge D	2
AHB-APB Bridge E	3
LP SRAM Port 2- H2LBRIDGEM access	5
LP SRAM Port 1- DMAC access	7
L2HBRIDGES - Low-Power to High-Speed bus matrix AHB to AHB bridge	8
HS SRAM Port 2- HMATRIXLP access	9

7.4.3. SRAM Quality of Service

To ensure that masters with latency requirements get sufficient priority when accessing RAM, priority levels can be assigned to the masters for different types of access.

8.2. Package Drawings

8.2.1. 64-Ball WLCSP



BALL	X COORD	Y COORD
A1	-1.212	-1.5
A3	-0.519	-1.5
A5	0.173	-1.5
A7	0.866	-1.5
B2	-0.866	-1.3
B4	-0.173	-1.3
B6	0.519	-1.3
B8	1.212	-1.3
C1	-1.212	-1.1
C3	-0.519	-1.1
C5	0.173	-1.1
C7	0.866	-1.1
D2	-0.866	-0.9
D4	-0.173	-0.9
D6	0.519	-0.9
D8	1.212	-0.9
E1	-1.212	-0.7
E3	-0.519	-0.7
E5	0.173	-0.7
E7	0.866	-0.7
F2	-0.866	-0.5
F4	-0.173	-0.5

BALL	X COORD	Y COORD
F6	0.519	-0.5
F8	1.212	-0.5
G1	-1.212	-0.3
G3	-0.519	-0.3
G5	0.173	-0.3
G7	0.866	-0.3
H2	-0.866	-0.1
H4	-0.173	-0.1
H6	0.519	-0.1
H8	1.212	-0.1
J1	-1.212	0.1
J3	-0.519	0.1
J5	0.173	0.1
J7	0.866	0.1
K2	-0.866	0.3
K4	-0.173	0.3
K6	0.519	0.3
K8	1.212	0.3
L1	-1.212	0.5
L3	-0.519	0.5
L5	0.173	0.5
L7	0.866	0.5

BALL	X COORD	Y COORD
M2	-0.866	0.7
M4	-0.173	0.7
M6	0.519	0.7
M8	1.212	0.7
N1	-1.212	0.9
N3	-0.519	0.9
N5	0.173	0.9
N7	0.866	0.9
P2	-0.866	1.1
P4	-0.173	1.1
P6	0.519	1.1
P8	1.212	1.1
Q1	-1.212	1.3
Q3	-0.519	1.3
Q5	0.173	1.3
Q7	0.866	1.3
R2	-0.866	1.5
R4	-0.173	1.5
R6	0.519	1.5
R8	1.212	1.5

Table 8-2. Device and Package Maximum Weight

10	mg

Table 8-3. Package Characteristics

Moisture Sensitivity Level	MSL1

8.2.6. 32 pin TQFP

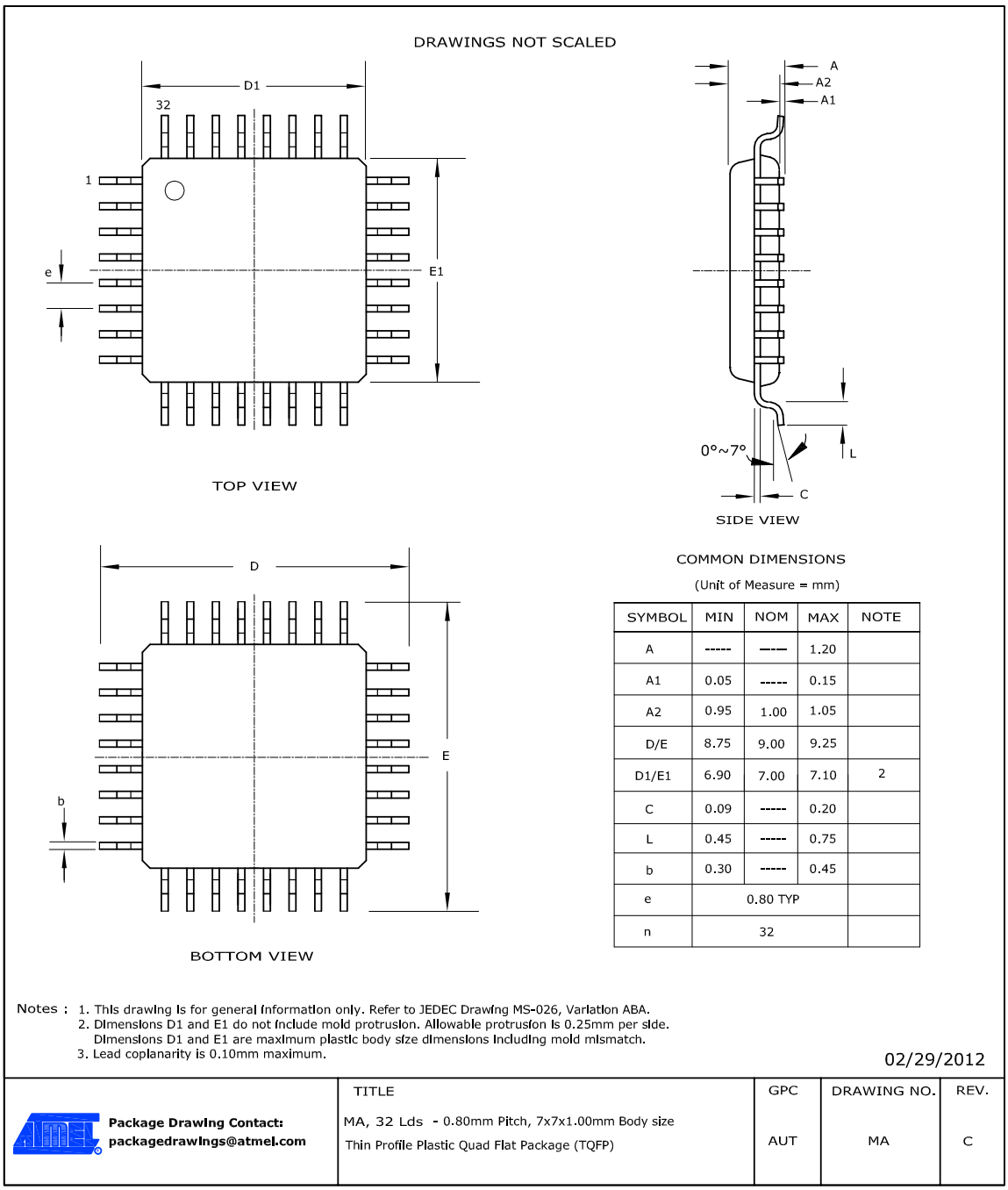


Table 8-17. Device and Package Maximum Weight

100	mg

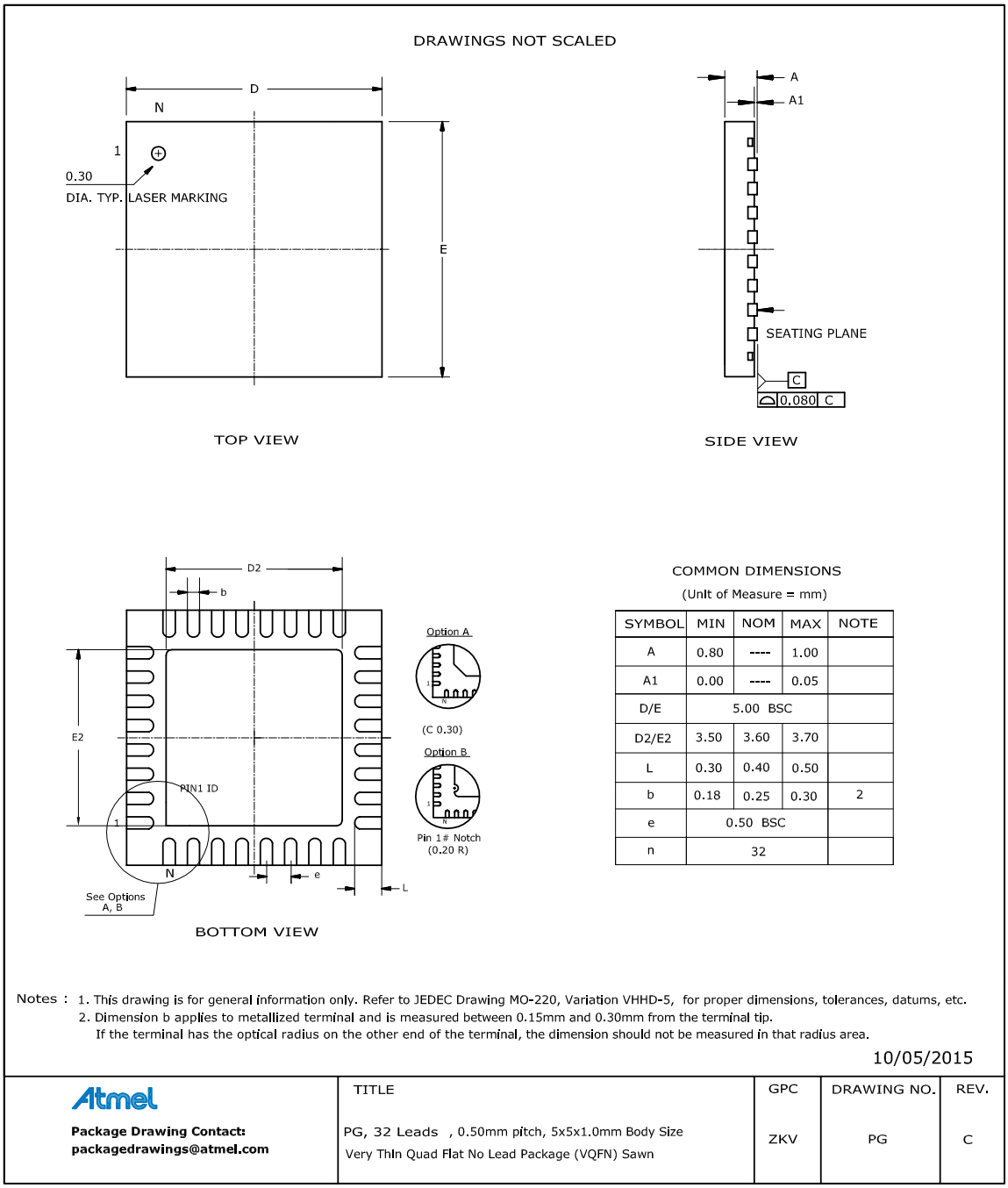
Table 8-18. Package Charateristics

Moisture Sensitivity Level	MSL3

Table 8-19. Package Reference

JEDEC Drawing Reference	MS-026
JESD97 Classification	E3

8.2.7. 32 pin QFN



Note: The exposed die attach pad is connected inside the device to GND and GNDANA.

Table 8-20. Device and Package Maximum Weight

90	mg

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