32-bit PIC® and SAM Microcontrollers Peripheral Integration

Quick Reference Guide

						ล											Peripheral Function Focus																			
						irade	Intelligent Analog			og	Waveform Control		Timin Measur	ig and ements	Safet Moni	y and toring		Communicatio				tion				User Interface			Security				s	System Flexibility		
Product Family	Core	Max. Operation Freq. (MHz)	Program Flash Memory (KB)	RAM (KB)	Pin Count	Automotive (AEC-Q100 Grade 1 or 0	ADC (channels/bits)	ADC Speed (sps)	DAC (channels/bits)	Analog Comparator (+Op Amp)	Output Compare/Input Capture/ Waveform Output Channels	Motor Control PWM Pairs/Single Ended MC PWM (3)	16-bit/32-bit Timer Channels (TC)	Quadrature Encoder/Decoder for Motor Contorl: QEI/QDEC/PDEC(3)	Functional Safety Ready	Class B Safety Library	USB (FS/HS) + PHY (Transceiver)	CAN (2.0B or FD)	Ethernet (10/100)	UART	Irc SPI (3)	SDIO/SD/eMMC PCC or PIO as CMOS Camera	Interface SQI/QSPI	12S for Audio CODEC ⁽³⁾	Peripheral Bus Interface EBI/ PMP ⁽³⁾	Hardware Peripheral Touch, PTC (channels/Driven Shield +) ⁽³⁾	Segment/Graphics LCD Controller	LCD Controller (External, Low- Cost Controllerless, Integrated) Embedded Hardware Security	Crypto Engine (AES. SHA. ECC.	RSA/ DSA, TRNG)	TrustZone ⁽³⁾	Secure Boot ⁽³⁾	Tamper Detection	Dual Panel/Bank Flash ⁽³⁾ Intelligent Low Power Peripheral Event System (channels) ⁽³⁾	DMA (channels)	Ultra Small Package (WLCSP)
PIC32C Family (Arm® Cortex®-M)																																				
PIC32CM LX	CM23	48	256-512	32-64	48 -100	G1 2	4/12 1	M	2/10	4	16/16/30	4/4	5/2	0			1F+P			66	5 6			1		P256			A,	S,T 🛛 🗸	/*	√ * ·	√*	√*	12	
PIC32CM MC (4)	CM0+	48	64-128	8-16	32-48	1	4/12 1	М	1/10	2	16/16/30	4/4	5/2	1						4 4	4 4					E		_						12	12	
PIC32CM JH (4)	CIVIU+	48	256-512	32-64	32-100	G11	2/12 1	M	1/10	4	16/16/30	4/-	4/-	1	~			2FD*		8 8	8 8	-				P256 P+AE35:		E	(>	-			12	12	_
PIC32CX SG	CIM4F	120	1024	256	100-128	G1 1	6/12 1	M	2/10	4	33/33/39	8/13	8/4	1			1F+b	2FD*		8 8	8 8	~		1		AR35256		E	✓ A,S,	E,R,I		~	~	32	32	
PIC32CK SG / GC	CM33 CM7F	120	512-2048	128-512	64-144	G1 1	2/12 2	2M		2	40/40/40	10	8/4	1			1F+P 2H+P	2FD*	1	8 8	8 8	2	1	1	1	P256		E	✓ A,S,	E,R,T	-	✓ ✓	✓ ✓	✓ 32	12	
PIC32M Family (M	IIPS32®)	300	2048-8192	512-1024	208		0/12 4	FIVI		Z	40/40/40	10				1	2111	OPD		101	01101	2	2	2		P 230		L	• \\,,,,,,,	L, IX, I				• 32	52	
PIC32MM GPL	microAptiv™	25	16-64	4-8	20-36	G1 1	4/12 20	00k	1/5	2	3/3/3		7/3			✓				2	2			2												
PIC32MM GPM	microAptiv	25	64-256	16-32	28-64	G1 2	4/12 20	00k	1/5	3	3/3/3		21/9			~	1F+P			3 3	3 3			3											4	
PIC32MX 1/2*/5+	M4K [®]	50	16-512	4-64	28-100	4	8/10 1	M		3	5/5/5		5/2			✓	1F+P*+	1+		5 2	2 4			4	~			E							8	
PIC32MX 1/2* XLP	M4K	72	128-256	32-64	28-44	1	3/10 1	M		3	5/5/5		5/2			~	1F+P*			2 2	2 2			2	~	E									4	
PIC32MX 3/4*	M4K	120	32-512	8-128	64-100	2	8/10 1	M		2	5/5/5		5/2			~	1F+P*			5 2	2 2			2	~			E/L							4	
PIC32MX 5×/6*/7+	M4K	80	64-512	16-128	64-100	1	6/10 1	M		2	5/5/5		5/2			~	1F+P	1×/2+	1*+	6 5	5 4				~	E/L									8	
PIC32MK GP/MC	microAptiv	120	128-1024	64-256	28-100	4	2/12 2	5M 🗌	3/12	5/4	16/16/16	12/12	9/8	6		~	2F+P	4FD		6 4	4 6			6	~			E/L						✓	8	
PIC32MZ EF	M-Class	252	512-2048	128-512	64-144	G1 4	8/12 1	8M		2	9/9/9		9/4			✓	1H+P	2	1	6 5	5 6		 ✓ 	6	~	E/L			Α,	S,T				✓	8	
PIC32MZ DA (2)	microAptiv	200	1024-2048	256-640	169-288	G2 4	5/12 1	8M		2	9/9/9		9/4			✓	1H+P	2	1	6 5	56	1	 ✓ 	6	✓		G	1	Α,	S,T				✓	8	
SAM Family (Arm	Cortex-M)																																			
SAM D09	CM0+	48	8-16	4	14-24	1	0/12 35	50k			2/2/2		2/1							2 2	2 2													6	6	
SAM D10/D11*	CM0+	48	8-16	4	14-24	1	0/12 35	50k	1/10	2	6/6/10	4*/-	2/1				1F+P*			3 3	3 3					P72					_		_	6	6	~
SAM D20/D21*	CM0+	48	16-256	2-32	32-64	G1 2	20/12 35	50k	1/10	2	22/22/32	8*/-	5/2		√*	✓	1F+P*			6 6	5 6			1*		P256		E	_					12	12*	~
SAM D21L	CM0+	48	32-128	4-16	32-48	G1 1	8/12 35	50k	1/10	4	22/22/32	8/-	5/2		✓	V				66	5 6				_	E		-	_		_			12	12	
SAM DAT	CM0+	48	16-64	4-8	32-64	G2 2	0/12 35	50K	1/10	2	18/18/24	8/-	5/2		~	✓ ✓	TF+P			66	5 6			1	_	P256		E	A -4-	C+ T	(*	<u>/+</u>	_	12	12	
SAM L10/L11*	CM23	32	16-64	4-16	24-32	GTT	0/12 1	M	1/10	203	6/6/6	A.(3/1		1	~	15.0			3 :	3 3	_	_		_	P100, D+		E	A*,	5*,I ¥	· · ·	✓ *	~	8	8	✓
SAIVI LZ I	CM0+	48	32-256	4-32	32-64	2	0/12 1	IVI .	2/12	203	12/12/12	4/-	5/2		V		1F+P			6 6						P169	5220	E	A	, I	-	-		12	16	×
SAM C20/C21* (4)	CM0+	12	22 256	1 22	22 100	G1 1	2/12 1	M 1	1/10*	2	16/16/20	4/-	9/4		√*	1	IFTF	250*		000						P256	3520	E		,1	-	_	-	12	12	v -
SAMANI	CMA	100	512 1024	64.80	48 100	1	6/10 5		1/10	4	6/6/10	4/4	6/	2	•			ZFD		7 3					_	F 200	_	L			-	-	-	12	22	-
SAMAS	CM4	120	128 20/18	64 160	48-100	1	6/12 1	M	2/12	1	6/6/10		6/	2			1 E+D			1 -	2 2	1 .	/	1	1						-	-	-	111	23	1
SAM/F	CM/F	120	512-102/	128	100-144	2	0/12 1		2/12	1	9/9/13		_/9	2			1E+P	2	1	4 2	2 3	1 4	/	-	· ·		_			Δ	-	-		• 14	22	-
SAM4I	CM4	48	128-512	32-64	48-100	1	6/12 30)0k	1/12	4	6/6/6		3/-	5			1F+P	2	-	4 4	4 1		1	1		P32	\$160		Δ	т	-	-	·	4	16	~
SAM G	CM4F	120	256-512	64-176	49-100		8/12 50	00k			6/6/6		6/-				1F+P			8 8	8 8			2	_					,.			~	6	30	~
SAM D5x+/E5x*	CM4F	120	256-1024	128-256	48-128	G1 3	2/12 1	M	2/12	2	33/33/39	8/13	8/4	1		~	1F+P	2FD*	1*	8 8	8 8	2 •	/ /	1		P+AE35:		E	A,S,	E,R,T			\checkmark	√ 32	32	√+
SAM S7x (2)/F7x	CM7	300	512-2048	256-384	64-144	1 2	4/12 1	7M	2/12	1	12/12/16	8	12/-	4			1H+P	2FD*	1*	8 :	3 5	1 .	/ /	2	~	F/I			Δ	ST	+		-	12	24	
SAM V7x	CM7	300	512-2048	256-384	64-144	G2 2	4/12 1	7M	2/12	1	12/12/16	8	12/-	4			1H+P	2FD	1	8 :	3 5	1 1	/ /	2	·	E/I			Α,	S.T			✓	12	24	
	0.007	330	512 2040	200 004	0.144	22/2			_,		,, 10	5	/					1 -1 0		1915		1		-		L/ L			, , ,	-/-				12		

1: USARTs with SPI mode are taken into account 2: DRAM Memory Support: PIC32MZ DA with DDR2 (32 MByte embedded or 128 MB external) 3: Terminology in the back 4: SAM C20/C21, PIC32CM MC / JH are true 5V devices; SAM C21 & PIC32CM MC also come with 16-bit Sigma Delta ADC and integrated temp sensor



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Terminology

WAVEFORM CONTROL: PWM	Drive and Waveform Generation
Motor Control PWM Channel Pairs 24-bit TCC with Dead Time Insertion	In some datasheet, look for 24-bit TCC with Dead-Time Insertion (DTI) or PWM with Dead-Time Generator (also know as Dead-Band or Non- Overlapping Time). TCC (Timer/Counter for Control): Selected SAM products have TCCs for applications like Switch Mode Power Supplies (SMPS), lighting and motor control. The TCCs support up to 96 MHz and 24-bit resolution. 24-bit TTC channels with Dead Time Insertion are considered as Motor Control PWM channel.
TIMING AND MEASUREMENT	TS: Signal Measurement with Timing and Counter Control
QEI: Quadrature Encoder Interface QDEC: Quadrature Decoder PDEC: Position Decoder	QEI to increment encoders for obtaining mechanical position data typical for automation or motor control applictions. QDEC performs the input lines filtering, decoding of quadrature signals and connects to the timers/counters in order to read the position and speed of the motor through the user interface. The PDEC consists of a Quadrature/Hall decoder, following by a counter, with two compare channels. The counter can be split into two parts to report the angular position and the number of revolutions.
COMMUNICATIONS: Genera	l, Industrial, Lighting and Automotive
SERCOM: Serial Communication Module	A SERCOM is a configurable peripheral that may be used to operate as I ² C, SPI or USART, giving you extended flexibility to mix serial interfaces and greater freedom in PCB layout. Each SERCOM instance can be assigned to different I/O pins through I/O multiplexing, further increasing versatility.
CMOS Camera Interface PCC: Parallel Capture Controller PIO: Parallel Input/Output	PCC: The Parallel Capture Controller can be used to interface an external system, such as a CMOS digital image sensor, ADC, or DSP, and capture its parallel data. PIO: The Parallel Input/Output Controller (PIO) manages up to 32 fully programmable input/output lines. An 8-bit Parallel Capture mode is also available which can be used to interface a CMOS digital image sensor, an ADC, a DSP synchronous port in Synchronous mode, etc.
I2S: Inter-IC Sound Controller	The Inter-IC Sound Controller provides a bidirectional, synchronous digital audio link with external audio devices.
EBI: External Bus Interface PMP: Parallel Master Port	EBI: The External Bus Interface (EBI) is designed to ensure the successful data transfer between several external devices and the embedded Memory Controller of an Arm-based device. Data transfers are performed through a 16-bit or 32-bit data bus. PMP: The PMP (mostly seen in PIC32M) is a parallel 8-bit/16-bit input/output module specifically designed to communicate with a wide variety of parallel devices, such as communications peripherals, LCDs, external memory devices and microcontrollers.
SAFETY AND MONITORING: I	Hardware Monitoring and Fault Detection
Functional Safety Ready	Complete collateral ready, including FMEDA, Safety Manual, Diagnostic Software (in development) and third Party Tools.
USER INTERFACE: Capacitive	Touch Sensing and LCD Control
PTC: Peripheral Touch Controller	An embedded peripheral touch controller makes it easy to add capacitive touch buttons, sliders, wheels and proximity. By offering superb sensitivity and noise tolerance as well as self-calibration, the PTC eliminates the need for external components and minimizes CPU overhead. PTC with Driven Shield + can achieve better noise immunity and moisture tolerance.

SYSTEM FLEXIBILITY: System Peripherals and Interconnects The CCL is a programmable logic peripheral which can be connected to CLC/CCL: Configurable the device pins, events or to other internal peripherals. This allows you to **Custom Logic** eliminate logic gates for simple glue logic function on the PCB. Dual Bank Flash allows live field firmware/program update on one bank while **Dual Panel/Bank Flash** CPU can continue executing code from another Flash bank. The Event System allows autonomous, low-latency and configurable communication between peripherals. Several peripherals can be configured to generate and/or respond to signals known as events. Communication is EVSYS /PEVC: Event System made without CPU intervention and without consuming system resources such as Bus or RAM bandwidth. This reduces the load on the CPU and power consumption, compared to a traditional interrupt-based system. SECURITY: Chip-Level Security, Crypto Acceleration, Secure Key Provisioning & Storage, and Tamper Detection Secure Enclave with cryptographic hardware acceleration, True Random **Embedded Hardware** Number Generator, dedicated memory, dedicated processor, with factory Security Module (HSM) provisioning. TrustZone[®] for ARMv8-M provides hardware-enforced security isolation TrustZone between trusted and the untrusted resources on a Cortex[™]-M23 based device, while maintaining the efficient exception handling. Secure Boot authenticates the Flash content at startup and ensures the Secure Boot desired code is executed.

Development Tools

Tools	Description
MPLAB [®] X Integrated Development Environment (IDE)	MPLAB X IDE is an expandable, highly configurable software program that incorporates powerful tools to help you discover, configure, develop, debug and qualify embedded designs for most of Microchip's microcontrollers and digital signal controllers. MPLAB X IDE works seamlessly with the MPLAB development ecosystem of software and tools, many of which are completely free.
MPLAB Harmony v3	 MPLAB Harmony v3 is a fully integrated embedded software development framework that provides flexible and interoperable software modules to simplify the development of value-added features and reduce your product's time to market. Key benefits: Core agnostic supporting both MIPS* and Arm* Cortex* core architectures Code portability with consistent APIs that can be used across different device families Easily configurable using MPLAB Harmony Configurator's (MHC's) Graphical User Interface (GUI) Optimized peripheral libraries to simplify device setup and peripheral usage Supports multiple development models with application examples and demos
MPLAB Code Configurator (MCC)	MPLAB Code Configurator (MCC) is a free graphical programming environment that generates seamless, easy-to-understand C code that can be used in your 32-bit application development, replcing the MPLAB Harmony code configurator. Key features like the content manager and project graph have now been integrated into MCC to provide a unified code configuration tool that spans all Microchip MCU platforms.
MPLAB Harmony Graphics Suite (MHGS)	MPLAB Harmony Graphics Suite (MHGS) is Microchip's industry leading embedded GUI (Graphical User Interface) development tool for 32-bit MCUs and MPUs. Available within the MPLAB Harmony embedded software development framework, this tightly integrated system of tools and software allows you to quickly and easily add GUIs, animation and imagery to a graphical display.

Note: Existing Arm^{*} Cortex^{*}-M based SAM products are also supported by Atmel Studio 7 IDE, Atmel START configuration tool and ASF software framework. For new projects, please start with MPLAB^{*} X IDE and MPLAB Harmony v3.

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