MICROCHIP

8-bit PIC® and AVR® Microcontrollers

www.microchip.com/8bit

As a designer of innovative products, you have a desire to make technology smart, more efficient and accessible to everyone. Microchip has a passion for developing products and tools that make it easier for you to solve your design problems and adapt to future needs. Our current lineup of PIC® and AVR® MCUs is the pinnacle of innovation in the 8-bit embedded space and incorporates the latest technologies to enhance system performance while reducing power consumption and development time.

The PIC and AVR MCU brands represent the two dominant architectures in the embedded design universe. With more than 45 years of combined experience developing commercially available and cost-effective MCUs, Microchip is the supplier of choice for thousands of customers worldwide. With a strong history of innovation in 8-bit MCUs, Microchip's extensive portfolio has the right product for any application.

History of Inovation

PIC® MCU

1985 PIC CPU Invention

1990 First Microchip MCU Introduction

1999 1 Billion PIC MCUs shipped

2010 Introduction of PIC MCU Core Independent Peripherals

2013 More than 12 Billion PIC MCUs shipped

2016 Creation of 8-bit MCU Powerhouse

1992 AVR CPU Invention

1997 First AVR MCU Introduction

2003 500 Million AVR MCUs shipped

2007 Introduction of AVR MCU **Event System**

2015 More than 7 Billion AVR MCUs shipped

AVR® MCU

Unified Strength

Microchip's portfolio of more than 1,200 8-bit PIC and AVR MCUs is not only the industry's largest, but also offers superior flexibility and performance in areas of utmost importance to modern embedded designers.

Leadership in Embedded Technologies

- Core Independent Peripherals with minimal CPU overhead
- Interconnectivity of analog and digital peripherals
- Industry's lowest power solutions (XLP and picoPower® technologies)
- Robust touch sensing technologies (mTouch® and QTouch® technologies)
- Widest operating range: 1.6V to 5.5V
- Robustness in hostile environments

World-class Development Experience

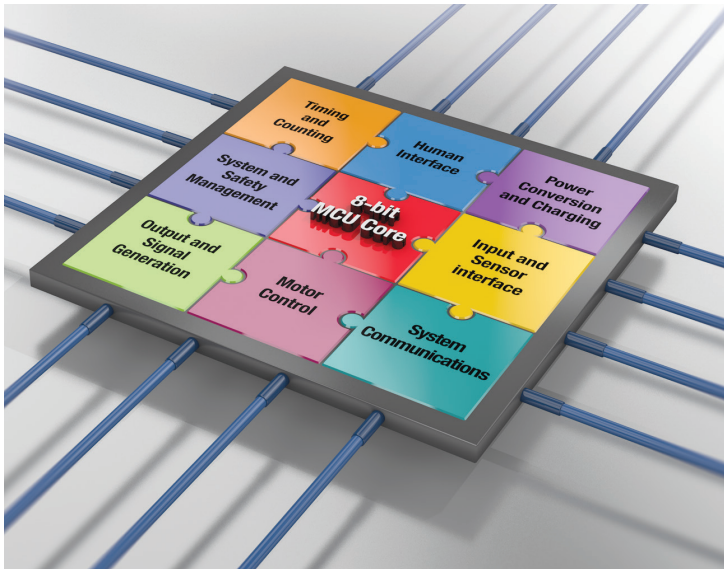
- Separate and dedicated tool chains for both PIC and AVR MCU development
- Intuitive graphical configuration tools, IDEs, compilers and development boards
- Extensive portfolio of libraries and support tools

Longevity and Legacy

- Industry recognition for having the best-in-class product non-obsolescence operating model
- Best-in-class legacy support, ensuring easy package, pin-out and software migration

Core Independent Peripherals

Today's cost-sensitive embedded designs require a paradigm shift away from the traditional "Bytes and Megahertz" approach. Every embedded system contains a combination of common functions, such as power conversion, motor drive, sensor or human interface and signal generation. By crafting the PIC and AVR MCU portfolios to suit your evolving needs, we can support a wide variety of functions and applications.



Today's PIC and AVR MCUs include on-chip Core Independent Peripherals (CIPs) that can operate without constant interaction from the CPU and have the ability to communicate directly with other peripherals to create flexible feedback loops. These "core independent" blocks of configurable hardware intelligence require little to no code, consume very little power and are much smaller than the RAM and Flash needed to implement the same function in software. Additionally, many simultaneous functions can be enabled into a single MCU. This leads to flexible, power-efficient 8-bit MCU designs with the capability to perform the same tasks as much larger and more expensive devices.

Core Independent Peripherals enable 8-bit PIC and AVR microcontrollers to retain their class-leading low-power performance while meeting or exceeding your design requirements for functionality and performance.

A Solution for Every Application

Microchip's 8-bit MCUs provide high-performance and power-efficient processing and are an ideal solution for a wide range of applications, from control logic to fully integrated systems involving USB, Ethernet and LCD. Every device includes a range of powerful peripherals including motor control timers, communication interfaces, powerful ADC and advanced on-chip safety features.

Microchip's online design centers provide all the necessary information to get started on a new design within a specific application segment. Items found on the design centers include supporting products, application notes, reference designs and development tools. Here are some design centers to help you with your next 8-bit design.

Automotive

8-bit microcontrollers are used in a wide range of automotive applications including remote keyless entry, lighting control and instrument cluster to name a few.

www.microchip.com/lin
www.microchip.com/can
www.microchip.com/automotive

Displays

Microchip microcontrollers offer integrated LCD solutions that directly drive segmented displays with letters, numbers, characters and icons. They are used in a wide variety of applications, ranging from meters to portable medical devices to thermostats to exercise equipment.

www.microchip.com/lcd

Wireless Connectivity

Microchip helps you design cost-effective, highly reliable wireless products. Microchip wireless technologies enable innovative, scalable and dedicated designs that fit small footprints, consume very little power and operate in rugged environments.

www.microchip.com/wireless

Motor Control

Microchip's PIC and AVR microcontrollers contain innovative motor control PWM peripherals including complimentary waveforms and dedicated time bases.

www.microchip.com/motorcontrol

Medical

Medical applications can benefit from MCU peripheral features such as analog signal conditioning, LCD control and mTouch input sensing.

www.microchip.com/medical

Touch and Gesture

Microchip's MCUs allow you to integrate touch-sensing interfaces, thereby reducing total system costs.

www.microchip.com/touch

Home Appliance

Microchip helps implement the new features and functionality required for your next appliance design with MCUs integrated with fault-detecting hardware for safety-critical applications. Microchip MCUs may be used for motor control, analog sensor measurements, front panel keypad control and LCD/LED displays.

www.microchip.com/homeappliance

Lighting

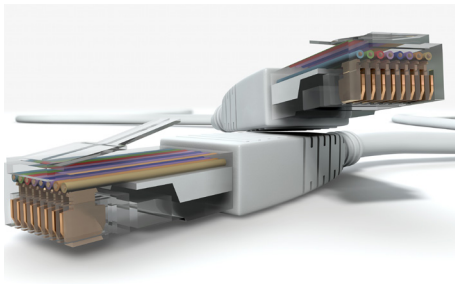
With advanced peripheral integration and support for all lighting technologies, a scalable Microchip solution provides significant flexibility and innovation that expands lighting product capabilities and provides product differentiation.

www.microchip.com/lighting

Smart Energy

Microchip is well-positioned to address various requirements of smart metering systems with a combination of discrete and highly integrated system-on-chip solutions built around the same processing platforms. This will reduce time-to-market and enable an unmatched level of flexibility in addressing new requirements.

www.microchip.com/smartenergy



Ethernet

Microchip's Ethernet solutions are designed to support the growing needs of this market with a full complement of robust, highly integrated Ethernet devices.

www.microchip.com/ethernet

Low Power

Microchip offers low-power solutions with eXtreme Low Power (XLP) technology with sleep currents down to 9 nA. Our products are equipped with peripherals like USB, LCD and analog which enables solutions with smaller physical footprints and reduced bill of material costs.

www.microchip.com/lowpower

USB

Microchip offers USB solutions capable of full-speed USB operation with the PIC and AVR device families.

www.microchip.com/usb

8-bit MCU Quick Reference

Our flexible 8-bit PIC and AVR MCU portfolio offers a number of product families with varying levels of intelligent peripheral integration and operating capabilities, enabling you to find the best MCU for your specific application and is summarized in the Quick Reference Guides.

The 8-bit MCU portfolio's true strength lies in the vast array of flexible hardware peripherals that are available to increase capability in any control system. Working together, our selection of Core Independent Peripherals, Intelligent Analog, user interface peripherals and on-board communications can enable system functions on MCUs with minimal code footprint, reduced power consumption and accelerated time-to-market. Common application functions like power and motor control, environmental sensing, system management and user interface can be combined onto a single MCU to develop an extremely cost-effective solution. For more details about Microchip products, please visit our website at www.microchip.com/8bit.

8-bit PIC Microcontroller Peripheral Integration

Product Family	Pin Count	Program Flash Memory (KB)	RAM (B)	Data EE (B)	Intelligent Analog								Waveform Cont				
					ADC (# of bits)	Comp	HSComp	DAC (# of bits)	OPA	PRG	SlopeComp	ZCD	CCP/ECCP	10-bit PWM	16-bit PWM	COG	CWG
PIC10(L)F3XX	6	384–896	64	HEF	8									✓			✓
PIC12LF1552	8	3.5	256	HEF	10												
PIC16LF155X/6X	14–20	7–14	1024	HEF	10[2]									✓			
PIC16(L)F145X	14–20	14	1024	HEF	10	✓								✓			✓
PIC1X(L)F157X	8–20	1.75–14	1024	HEF	10	✓		5							✓		✓
PIC16(L)F153XX	8–48	3.5–28	2048	HEF	10	✓		5				✓	✓	4			✓
PIC1X(HV)F752/53	8–14	1.75–3.5	128	–	10		✓	5/9	✓		✓		✓			✓	
PIC1X(L)F1612/3	8–14	3.5	256	HEF	10	✓		8				✓	✓				✓
PIC16(L)F161X	14–20	7–14	1024	HEF	10	✓		8				✓	✓	✓			✓
PIC16(L)F170X	14–20	3.5–14	1024	HEF	10		✓	5/8	✓			✓	✓	✓		✓	
PIC16(L)F171X	28–40	7–28	2048	HEF	10		✓	5/8	✓			✓	✓	✓		✓	
PIC16(L)F176X/7X	14–40	7–28	2048	HEF	10		✓	5/10	✓	✓	✓	✓	✓	✓	✓	✓	
PIC16(L)F183XX	8–20	3.5–14	2048	256	10	✓		5					✓	✓			✓
PIC16(L)F184XX	14–28	7–28	2048	256	12[3]	✓		5				✓	✓	✓			✓
PIC16(L)F188XX	28–40	7–56	4096	256	10[3]	✓		5				✓	✓	✓			✓
PIC16(L)F191XX	28–64	14–56	4096	256	12[3]	✓		5				✓	✓	✓			✓
PIC18(L)FXXK40	28–64	16–128	3728	256–1K	10[3]	✓		5				✓	✓	✓			✓
PIC18(L)FXXK42	28–48	16–128	8192	256–1K	12[3]	✓		5				✓	✓	4			✓
PIC18(L)FXXJ94	64–100	32–128	4096	–	12	✓							✓				
PIC18(L)FXXK83	28	32–64	4096	1K	12[3]	✓		5				✓	✓	✓			✓
PIC18FXXQ10	28–40	128	3728	1024	10[3]	✓		5				✓	✓	✓			✓

Note 1: In addition to standard 8-bit and 16-bit timers **2:** Independent Dual ADC Modules **3.** ADCC: Analog-to-Digital Converter with Computation **4.** CAN capable **5.** LCD with Charge Pump

Peripheral Function Focus																													
trol		Timing and Measurements[1]							Logic and Math			Safety and Monitoring			Communications					User Interface			Low Power and System Flexibility						
NCO	DSM	AngTMR	HLT (8-bit)	16-bit PWM (16-bit)	NCO (20-bit)	SMT (24-bit)	RTCC	TEMP/TS	CLC	MULT	MathACC	CRC/SCAN	HLT	WWDT	EUSART/ AUSART	UART with Protocols	I²C/SPI	USB with ACT	LIN Capable	mTouch® Sensing	HCVD	LCD	PPS	IDLE/DOZE/ PMD	DMA/VI	DIA/MAP			
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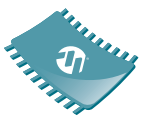
8-bit PIC MCU Terminology

INTELLIGENT ANALOG: Sensor Interfacing and Signal Conditioning	
ADC: Analog-to-Digital Converter	General purpose 8-/10-/12-bit ADC
ADC²/ADCC: Analog-to-Digital Converter with Computation	General purpose 10-/12-bit ADC with automated analog signal analysis (ex. oversampling, averaging, etc.)
Comp: Comparator	General purpose rail-to-rail comparator
DAC: Digital-to-Analog Converter	Programmable voltage reference with multiple internal and external connections
HC I/O: High-Current I/O	Up to 50 mA or 100 mA current drive on select I/O pins
HSComp: High-Speed Comparator	General purpose rail-to-rail comparator with < 50 ns response time
OPA: Operational Amplifier	General purpose op amp for internal and external signal source conditioning
PRG: Programmable Ramp Generator	Analog ramp generator (with slope compensation) for current/voltage mode power supplies
SlopeComp: Slope Compensation	Slope compensation for Peak Current Mode power supplies
VREF: Voltage Reference	Stable fixed voltage reference for use with integrated analog peripherals
ZCD: Zero Cross Detect	AC high-voltage zero-crossing detection for simplifying TRIAC control, synchronized switching control and timing
WAVEFORM CONTROL: PWM Drive and Waveform Generation	
CCP/ECCP: (Enhanced) Capture Compare PWM	1. CCP/ECCP: 10-bit PWM control with 16-bit capture and compare 2. ECCP: Addition of auto shutdown control
COG: Complementary Output Generator	Automated complementary output with control of key parameters such as programmable rising/falling edge events, polarity, phase, precision dead-band, blanking and auto shutdown
CWG: Complementary Waveform Generator	Automated complementary output with control of key parameters such as dead-band and auto shutdown
DSM: Data Signal Modulator	1. Modulates up to two carrier signals with digital data to create custom carrier synchronized output waveforms 2. LED dimming engine functionality via interconnection with 10-/16-bit PWM, DSM and op amp
NCO: Numerically Controlled Oscillator and 16-/20-bit Timer/Counter	1. Precision linear frequency generator (@ 50% duty cycle) with 0.0001% step size of source input clock frequency 2. General purpose 16-/20-bit timer/counter
PWM: Pulse Width Modulation	General purpose 10-bit PWM control
16-bit PWM: Standalone 16-bit PWM and 16-bit Timer/Counter	1. High-resolution 16-bit PWM with edge- and center-aligned modes 2. General purpose 16-bit timer/counter
TIMING AND MEASUREMENTS: Signal Measurement with Timing and Counter Control	
AngTMR: Angular Timer	Phase angle timer for measurement and control of rotational and periodic events (ex. motor, AC mains, TRIAC, etc.)
HLT: Hardware Limit Timer and 8-bit Timer/Counter	1. Hardware monitoring for missed periodic events and fault detection 2. General purpose 8-bit timer/counter with external reset capabilities
NCO: Numerically Controller Oscillator and 16-/20-bit Timer/Counter	1. Precision linear frequency generator (@ 50% duty cycle) with 0.0001% step size of source input clock frequency 2. General purpose 16-/20-bit timer/counter
RTCC: Real-Time Clock/Calendar	Maintains accurate clock and calendar timing with external 32.768 kHz crystal
SMT: 24-bit Signal Measurement Timer and 24-bit Timer/Counter	1. Accurate measurement of any digital signal including period, duty cycle, time of flight; instantaneous vs. average measurements 2. General purpose 24-bit timer/counter
TEMP: Temperature Indicator	Provides relative temperature measurements utilizing the ADC
TS: Temperature Sensor	Provides linear relative temperature measurements utilizing the ADC with two factory-calibrated reference values
8-/16-bit Timer	General purpose 8-/16-bit timer/counter
16-bit PWM: Standalone 16-bit PWM and 16-bit Timer/Counter	1. High-resolution 16-bit PWM with edge- and center-aligned modes 2. General purpose 16-bit timer/counter



FLEXIBLE INTELLIGENCE MADE EASY
8-BIT PIC® MICROCONTROLLERS

Learn more about 8-bit PIC Microcontrollers at www.microchip.com/8bit.
Learn more about Core Independent Peripherals (CIP) at www.microchip.com/CIP.

LOGIC AND MATH: Customizable Logic and Math Functions	
CLC: Configurable Logic Cell	1. Integrated combinational and sequential logic 2. Customer interconnection and re-routing of digital peripherals
MULT: Hardware Multiplier	MULTIPLY function of two 8-bit values with 16-bit result
MathACC: Math Accelerator	1. MULTIPLY, ADD, ACCUMULATE functions of 8-/16-bit values with 35-bit result 2. Calculates a 16-bit PID function based on configurable K_p, K_i, K_d constants with a 34-bit result
SAFETY AND MONITORING: Hardware Monitoring and Fault Detection	
CRC/SCAN: Cyclical Redundancy Check with Memory Scan	1. Automatically calculates CRC checksum of Program/DataEE memory for NVM integrity 2. General purpose 16-bit CRC for use with memory and communications data
HLT: Hardware Limit Timer and 8-bit Timer/Counter	1. Hardware monitoring for missed periodic events and fault detection of external hardware 2. General purpose 8-bit timer/counter with external reset capabilities
WWDT: Windowed Watch Dog Timer	System supervisory circuit that generates a reset when software timing anomalies are detected within a configurable critical window
COMMUNICATIONS: General, Industrial, Lighting and Automotive	
ACT: Active Clock Tuning for Crystal-Free USB	1. Auto-tuning of internal oscillator when connected to USB host (eliminates need for external crystal) 2. Tunes internal oscillator to match accuracy of external clock source
CAN: Controller Area Network	Industrial- and automotive-centric communication bus
LIN: Local Interconnect Network	1. Industrial- and automotive-centric communication bus 2. Support for LIN when using the EUSART
EUSART/AUSART: Enhanced/ Addressable Universal Synchronous Asynchronous Receiver Transmitter	1. General purpose serial communications 2. Support for LIN when using the EUSART
I^2C: Inter-Integrated Circuit	General purpose 2-wire serial communications
SPI: Serial Peripheral Interface	General purpose 4-wire serial communications
UART: Universal Asynchronous Receiver Transmitter	Supports LIN master and slave, DMX, DALI and device protocols
USB: Universal Serial Bus	Support for full-speed USB 2.0 device profiles
USER INTERFACE: Capacitive Touch Sensing and LCD Control	
HCVD: Hardware Capacitive Voltage Divider	Simplifies implementation and reduces overhead of mTouch sensing applications
LCD: Liquid Crystal Display	Highly integrated segmented LCD controller
LCD w/Charge Pump: Liquid Crystal Display with Charge Pump	The LCD charge pump provides proper bias voltage and contrast for the LCD regardless of the V_{DD} level.
mTouch: Microchip Proprietary Capacitive Touch Technology	1. Capacitive sensing for touch buttons and sliders 2. Capacitive sensing for system measurements and detection (ex. water level, intrusion detection, etc.)
LOW POWER AND SYSTEM FLEXIBILITY: XLP Low-Power Technology, Peripheral and Interconnects	
DIA: Device Information Area	Dedicated memory area for data storage of temp sensor factory calibration values, factory ID and FVR values for ADC and COMP
DMA: Direct Memory Access	Moves data between memories and peripherals without CPU overhead, improving overall system performance and efficiency
DOZE: Power Saving Mode	Ability to run the CPU core slower than the system clock used by the internal peripherals
HEF: High-Endurance Flash	128B Non-volatile data storage with high-endurance 100k E/W cycles
IDLE: Power Saving Mode	Ability to put the CPU core to sleep while the internal peripherals continue to operate from the system clock
MAP: Memory Access Partition	Customizable Flash partitioning with bootloader write protection option
PMD: Peripheral Module Disable	Peripheral power disable hardware to minimize power consumption of unused peripherals
PPS: Peripheral Pin Select	I/O pin remapping of digital peripherals for greater design flexibility and optimized board layout
VI: Vectored Interrupts	Offers faster and more predictable interrupt response times, with lower software overhead
XLP: eXtreme Low Power Technology	XLP technology devices with extreme low-power operation modes for battery/low-power applications

PDF version available for download at www.microchip.com/8bitquickreference.

8-bit AVR Microcontroller Peripheral Integration

Product Family	Pin Count	Program Flash Memory (KB)	SRAM (KB)	Intelligent Analog							Waveform Control			
				ADC (# of bits)	ADC (# of channels)	Comparators	ADC Gain Stage	DAC (# of bits)	Temperature Sensor	Internal Voltage Reference	8-bit PWM	16-bit PWM	Quadrature Decoder	Waveform Extension
ATtiny4/5/9/10	6	0.5–1	0.032	10[3]	4[(3)]	✓						2		
ATtiny102/104	8/14	1	0.032	10	5/8	✓				✓		2		
ATtiny13A	8–20	1	0.064	10	4	✓						2		
ATtiny20/40	12–20	2/4	0.128/0.256	10	8/12	✓			✓		2	2		
ATtiny24A/44A/84A	14–20	2–8	Up to 0.512	10	8	✓	✓		✓	✓	2	2		
ATtiny25(V)/45(V)/85(V)	8–20	2–8	Up to 0.512	10	4	✓	✓		✓	✓	4			
ATtiny48/88	28–32	4/8	Up to 0.512	10	8	✓			✓	✓	1	1		
ATtiny87/167	20–32	8/16	0.512	10	11	✓			✓	✓	1	2		
ATtiny261A/461A/861A	20–32	2–8	Up to 0.512	10	11	✓	✓		✓	✓				
ATtiny20x/40x/80x/160x	8–24	2–16	Up to 1	10	12	✓			✓	✓		2		
ATtiny21x/41x/81x/161x/321x	8–24	2–32	Up to 2	10	12	✓		8	✓	✓		2		
ATtiny441/841	14–20	4/8	Up to 0.512	10	12	✓	✓		✓		1	2		
ATtiny1634	20	16	1	10	12	✓			✓	✓	2	2		
ATtiny2313A	20	2	0.128	–	–	✓				✓	2	2		
ATmega8A/16A/32A	28–44	8–32	1–2	10	8	✓					2	1		
ATmega8U2/16U2/32U2	32	8–32	0.5–1	–	–	✓			✓	✓	4	6		
ATmega16U4/32U4	32	16/32	1/2	10	12	✓			✓	✓	5			
ATmega48PB/88PB/168PB/328PB	32	4–32	0.5–2	10	8	✓			✓	✓	4	2/6[(6)]		
ATmega320x/480x	28–48	32–48	Up to 6	10	16	✓			✓	✓	4	3		
ATmega64A/128A	64	64–128	4	10	8	✓	✓			✓	2	6		
ATmega164PA/324PA/644PA/1284P	44	16–128	1–16	10	8	✓	✓			✓	4	2/2/4		
ATmega165PA/325PA/645P	44	16–64	1–4	10	8	✓				✓	4	6		
ATmega169PA/329PA/649P	64	16–64	1–4	10	8	✓				✓	2	2		
ATmega324PB	44	32	2	10	8	✓				✓	2	2		
ATmega640/1280/2560/1281/2561	64–100	64–256	8	10	8/16	✓	✓			✓	4	6/12		
ATmega3290PA/6490P	100	32–64	2–4	10	8	✓	✓			✓	2	2		
ATmega3250PA/6450P	100	32–64	2–4	10	8	✓	✓			✓	2	2		
ATxmega A1U Family	100	64–128	4–8	12	16	✓	✓	12	✓	✓		8	✓	✓
ATxmega A3U Family	64	64–256	4–16	12	16	✓	✓	12	✓	✓		7	✓	✓
ATxmega A4U Family	44–49	16–128	2–8	12	12	✓	✓	12	✓	✓		5	✓	✓
ATxmega B1/B3 Family	64–100	64–128	4–8	12	8	✓	✓		✓	✓		2/3	✓	✓
ATxmega C3/D3 Family	64	32–384	4–32	12	16	✓	✓		✓	✓		5	✓	✓
ATxmega C4/D4 Family	44–49	16–128	2–8	12	12	✓	✓		✓	✓		4	✓	✓
ATxmega E5 Family	32	8–32	1–4	12	16	✓	✓	12	✓	✓		3	✓	✓

1: LIN port also **2:** Peripheral Touch Controller **3:** Only on the ATtiny5/10 **4:** Not on the ATtiny212/214/412/414/416 **5:** Only on the ATmega1281/2561 **6:** Only on the ATmega328PB **7:** Only on the C3 ar

Peripheral Function Focus

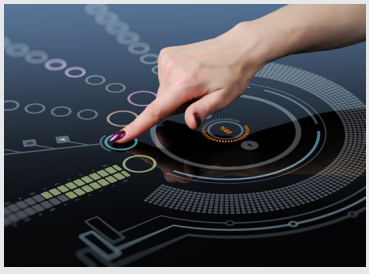
Timing and Measurements				Logic, Crypto and Math			Safety and Monitoring				Communications						User Interface			System Flexibility					
Real-Time Counter	8-bit Timer/ Counters	12-bit Timer Counter	16-bit Timer/ Counter	CCL	MULT	Crypto (AES/DES)	CRC	POR	BOD	WDT	UART	USART	USB	I²C	SPI	IRCOM	QTouch® Technology	QTouch Technology with PTC[2]	LCD	External Bus Interface	DMA Channels	Event System	SleepWalking	Sleep Modes	picoPower® Technology
			1					✓		✓							✓								4	
			2					✓		✓		1													4	
								✓	✓	✓							✓								3	✓
	1		1					✓	✓	✓				1	1		✓								4	
	1		1					✓	✓	✓				1	1		✓								4	✓
	2							✓	✓	✓				1	1		✓								3	
	1		1					✓	✓	✓				1	1										3	✓
	1		1					✓	✓	✓	1[1]			1	2										4	
	1		1					✓	✓	✓				1	1		✓								4	✓
✓			1	✓	✓		✓	✓	✓	✓		1[1]		1	1							✓	✓		3	✓
✓		1	1	✓	✓		✓	✓	✓	✓		1[1]		1	1			✓[4]				✓	✓		3	✓
	1		2					✓	✓	✓		2		1	1										4	✓
	1		1					✓	✓	✓		2		1				✓							4	✓
	1		1					✓	✓	✓		1		1	2										3	✓
✓	2		1		✓			✓	✓	✓		1		1	1		✓								5	
✓	2		3		✓			✓	✓	✓		2	✓	2	2			✓							6	
	1		1		✓			✓	✓	✓		1	✓		1										6	
✓	2		1/3[6]		✓			✓	✓	✓		1/2[6]		1/2[6]	1/2[6]		✓	1[6]							6	
1			5	✓	✓		✓	✓	✓	✓	4			1	1								✓		3	✓
	2		2		✓			✓	✓	✓		2		1	1		✓								6	
✓	2		1/1/2		✓			✓	✓	✓		2		1	1		✓								6	✓
✓	2		3		✓			✓	✓	✓		3		2	2			✓							6	✓
✓	2		1		✓			✓	✓	✓		1		1	1		✓		✓						5	
✓	2		1		✓			✓	✓	✓		1		1	1		✓	✓							5	
✓	2		4		✓			✓	✓	✓		2/4		1	1		✓			✓[5]					6	
✓	2		1		✓			✓	✓	✓		1		1	1		✓		✓						5	
✓	2		1		✓			✓	✓	✓		1		1	1		✓								5	
✓			8		✓	✓	✓	✓	✓	✓		8	✓	4	4	✓	✓			✓	4	✓			5	✓
✓			7		✓	✓	✓	✓	✓	✓		7	✓	2	3	✓	✓				4	✓			5	✓
✓			5		✓	✓	✓	✓	✓	✓		5	✓	2	2	✓	✓				4	✓			5	✓
✓			2/3		✓	✓	✓	✓	✓	✓		1/2	✓	1	1	✓	✓		✓		2	✓			5	✓
✓			5		✓		✓	✓	✓	✓		3	✓[7]	2	2	✓	✓					✓			5	✓
✓			4		✓		✓	✓	✓	✓		2	✓[7]	2	2	✓	✓					✓			5	✓
✓			3	✓	✓		✓	✓	✓	✓		2		1	1	✓	✓				4	✓			5	✓

nd C4

INTELLIGENT ANALOG: Sensor Interfacing and Signal Conditioning	
ADC: Analog-to-Digital Converter	General purpose 10-/12-bit ADC
ADC Gain Stage: Analog-to-Digital Converter Gain Stage	Programmable gain stage, providing amplification steps on the differential input voltage
Comp: Comparator	General purpose rail-to-rail comparator
DAC: Digital-to-Analog Converter	Programmable voltage reference with multiple internal and external connections
VREF: Voltage Reference	Stable fixed voltage reference for use with integrated analog peripherals
WAVEFORM CONTROL: PWM Drive and Waveform Generation	
PWM: Pulse Width Modulation	General purpose 10-bit PWM control
16-bit PWM: Standalone 16-bit PWM and 16-bit Timer/Counter	1. High-resolution 16-bit PWM with edge- and center-aligned modes 2. General purpose 16-bit timer/counter
TIMING AND MEASUREMENTS: Signal Measurement with Timing and Counter Control	
8-/12-/16-bit Timer	General purpose 8-/12-/16-bit timer/counter
LOGIC, CRYPTO AND MATH: Customizable Logic and Math Functions	
CCL: Configurable Custom Logic	1. Integrated combinational and sequential logic 2. Customer interconnection and re-routing of digital peripherals
MULT: Hardware Multiplier	MULTIPLY function of two 8-bit values with 16-bit result
Crypto (AES/DES)	Data encryption and decryption can be easily performed for both internally stored data or for small external data packets
SAFETY AND MONITORING: Hardware Monitoring and Fault Detection	
CRC/SCAN: Cyclical Redundancy Check with Memory Scan	Automatically calculates CRC checksum of Program/DataEE memory for NVM integrity

Peripheral Spotlight

Peripheral Touch Controller



The powerful tiny ONE series (tiny416/817/1617) MCUs feature the Peripheral Touch Controller (PTC), which enables you to easily add capacitive buttons and sliders to your embedded application. The PTC autonomously acquires and processes capacitive touch inputs without external components. On-chip hardware based noise filtering, moisture tolerance and zero-drift temperature compensation ensure reliable sensor operation in the harshest of operating climates. Additionally, the PTC's core-independent operation gives you the ability to reduce your design's power consumption with the wake-on-touch or wake-on-proximity features. No matter the requirements, your next touch-based solution just became easier with the Peripheral Touch Controller.

COMMUNICATIONS: General, Industrial, Lighting and Automotive	
USART: Universal Synchronous Asynchronous Receiver Transmitter	1. General purpose serial communications 2. Support for LIN/IrDA®
I²C: Inter-Integrated Circuit	General purpose 2-wire serial communications
SPI: Serial Peripheral Interface	General purpose 4-wire serial communications
IRCOM: Infrared Communication Module	Encodes and decodes data according to the IrDA communication protocol
USER INTERFACE: Capacitive Touch Sensing and LCD Control	
LCD: Liquid Crystal Display	Highly integrated segmented LCD controller
QTouch®: Microchip Proprietary Touch Technology	Provides a simple-to-use solution to realize touch-sensitive interfaces
QTouch with PTC: QTouch with Peripheral Touch Controller	Provides a simple-to-use solution to realize touch-sensitive interfaces with a Peripheral Touch Controller
LOW POWER AND SYSTEM FLEXIBILITY: Low-Power Technology, Peripheral and Interconnects	
DMA: Direct Memory Access	Moves data between memories and peripherals without CPU overhead, improving overall system performance and efficiency
Event System	Flexible routing of peripheral events, ability to control peripheral independent from the CPU
External Bus Interface	Highly flexible module for interfacing external memories and memory-addressable peripherals
picoPower® Technology	Low-power technology
Sleep Modes	Low-power saving modes, IDLE, power-down, power-save, standby and extended standby
SleepWalking	Ability to put the CPU core to sleep until a relevant event occurs

Peripheral Spotlight

Analog-to-Digital Converter with Computation

Many embedded applications require the measurement of analog voltages, along with a significant amount of post-processing and signal analysis. Typically, these tasks place a heavy burden on MCU hardware and can significantly lengthen your code development cycle. The Analog-to-Digital Converter with Computation (ADC²) peripheral, available on several PIC MCU families, implements a suite of post-processing features in hardware, including low-pass filtering, oversampling and averaging. The ADC² also automates signal acquisition tasks and adds new capabilities, such as continuous mode retrigger (which waits for a certain threshold before triggering a conversion) and auto conversion (which allows triggering a conversion based on variety of internal and external sources) to significantly reduce CPU load and software development time. With the ADC², you don't have to spend valuable cycles performing expensive computations; this Core Independent Peripheral does the heavy lifting for you.

8-bit PIC MCU Product Families

Microchip's 8-bit PIC microcontrollers fall into three product architecture categories providing a variety of options for any application requirement. All device families have low power capability, flexible Flash program memory and instructions and data on separate buses.

PIC10 MCUs

PIC10 microcontrollers have a simple instruction set for ease of use and quick development. They offer the smallest form factor that can be easily implemented into the most space constrained designs. This microcontroller family includes an internal oscillator, a comparator, ADC and data memory for data-logging, giving engineers the ability to add smarts in various entry-level applications. Its low cost and easy implementation can also help designers to replace multiple discrete components with an integrated MCU solution, resulting in additional savings in board space.

PIC12/PIC16 MCUs

PIC12/PIC16 microcontrollers are ideal for many applications that require a higher level of embedded control and more memory. These peripheral-rich devices feature various serial analog and digital peripherals, such as: SPI, I^2C, USART, LCD and ADCs. With low sleep and dynamic current consumption, these MCUs are highly suited for energy efficient and battery powered applications.

PIC18 MCUs

Offering the largest pin count and memory size, PIC18 microcontrollers combine the maximum level of performance and integration with the ease-of-use of an 8-bit architecture. With up to 16 MIPS of processing power, PIC18 microcontrollers feature advanced peripherals such as CAN, USB, Ethernet, touch sensing and LCD display drivers. The PIC18 family has a flexible range of self-programming Flash memory from 4 KB to 128 KB and up to 8 KB RAM. Many PIC18 products conserve power with XLP technology and specialized clocking and sleep modes for battery applications.

8-bit AVR Product Families

Microchip's 8-bit AVR MCUs are an excellent choice for a wide variety of embedded systems. These devices offer a unique combination of performance, power efficiency and design flexibility. Optimized to reduce development time, they are based on the industry's most code-efficient architecture for C and assembly programming.

tinyAVR® MCUs

The tinyAVR MCU family is optimized for applications that require performance, power efficiency and ease of use in a small package. All tinyAVR devices are based on the same architecture and compatible with other AVR® devices. The integrated ADC, DAC, comparators, EEPROM memory and brown-out detector let you build applications without adding external components. tinyAVR devices also offer Flash memory and on-chip debug for fast, secure and cost-effective in-circuit upgrades that significantly cut your time to market.

megaAVR®

The megaAVR family is the ideal choice for designs that need some extra muscle. For applications requiring large amounts of code, megaAVR devices offer substantial program and data memories with performance up to 20 MIPS. Meanwhile, innovative picoPower technology helps minimize power consumption. All megaAVR devices offer self-programmability for fast, secure and cost-effective in-circuit upgrades. You can even upgrade the Flash memory while running your application.

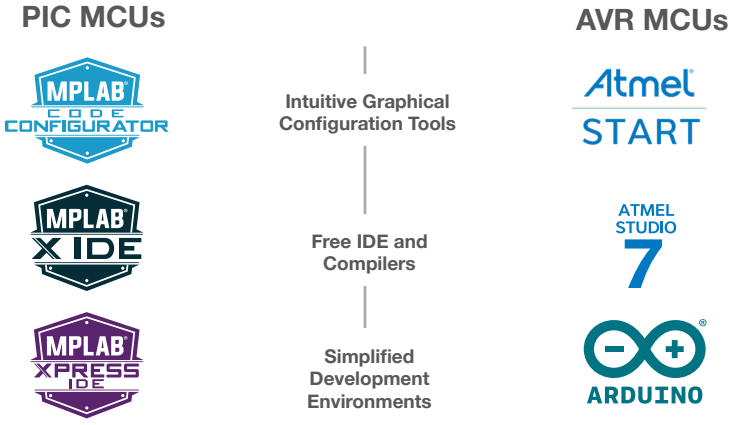
XMEGA® MCUs

The XMEGA family of MCUs delivers the best possible combination of real-time performance, high integration and low power consumption for 8/16-bit MCU applications.

Software Development

Dedicated PIC and AVR MCU Tool Chains

Microchip Technology offers two best-in-class tool chains for PIC and AVR MCUs. These separate and dedicated development ecosystems will help streamline your next design, from prototype to production. Microchip offers easy-to-use software and hardware development resources to accelerate your next PIC or AVR MCU-based design. The PIC microcontrollers are finding their way into new applications like smartphones, audio accessories, video gaming peripherals and advanced medical devices. Microchip provides solutions for the entire performance range of 8-bit microcontrollers, with easy-to-use development tools, complete technical documentation and post design-in support through a global sales and distribution network.



Rapid Protoyping Options

Microchip's MPLAB® Xpress and Xplained Development boards make it easy to get started building your application with PIC and AVR MCUs. Both board series feature integrated programmers to help you get up and running as quickly as possible while minimizing startup cost. Xpress and Xplained boards are available with a wide variety of on-board MCUs, making them an excellent entry point for those who are new to PIC or AVR MCU architectures.

MPLAB Xpress Evaluation Board (DM164140) (PIC MCUs)

The Xpress Evaluation Board features an on-board drag-and-drop programmer, a mikroBUS™ expansion header and the popular PIC16F18345 MCU for easy development with the latest generation of PIC MCUs. The board integrates seamlessly with the free, cloud-based MPLAB Xpress IDE (www.microchip.com/xpress).

ATTiny817 Xplained Mini (ATTINY817-XMINI) (AVR MCUs)

The tiny817 Xplained Mini Evaluation Kit is a hardware platform for evaluating tiny817, tiny816, tiny814 and tiny417 microcontrollers. The evaluation kit comes with a fully integrated debugger that provides seamless integration with Atmel START and Atmel Studio development environment.

Other Popular Development Boards	
PIC® MCUs	**AVR® MCUs**
MPLAB® Xpress Evaluation Boards (DM164141/2/3)	Xplained Nano (ATTINY-XNANO)
8-bit Curiosity Development Board (DM164137)	Xplained Pro (ATMEGA324PB-XPRO)
Explorer 8 Development Board (DM160228)	Xplained Mini (ATMEGA168PB-XMINI) (ATMEGA328PB-XMINI)
PICDEM™ Lab II Development Platform (DM163046)	STK600 Development Board (ATSTK600)

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Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. For more information, please visit www.microchip.com:

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If additional training interests you, Microchip offers several resources including in-depth technical training and reference material, self-paced tutorials and significant online resources.

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