

ECE 477 Digital Systems Senior Design Project

Module 3

Microcontrollers for Embedded Applications

Outline

- General μ C Selection Guidelines
 - Memory Requirements / Types
 - Development Environment
 - Interfacing / Bus Expansion
- PIC Microcontrollers
- Atmel Microcontrollers
- Freescale Microcontrollers
- Analog Devices DSPs
- ATOM Boards
- ARM Modules

General μ C Selection Guidelines

- Memory requirements/types

- Beware of hidden liabilities
 - Data acquisition (ADC) buffers
 - Large file storage (mp3)
 - Library routines (floating point emulation, printf)
- Nonvolatile memory
 - Flash (code, static data)
 - in-circuit programmable?
 - programming “dongle” availability?
 - programming connector requirements?
 - EEPROM (storage of calibration or configuration parameters, history data, control panel settings)
 - granularity of erase/write?
 - software driver availability?

General μ C Selection Guidelines

- Volatile memory (SRAM)
 - stack
 - heap
 - I/O buffers
 - run-time variables
 - (generally no executable code except for “specialty functions” like erasing and reprogramming a sector in Flash)
 - note initialization requirements when system boots

General μ C Selection Guidelines

- Interfacing/Bus Expansion
 - Number of general purpose I/O pins
 - programmable data direction?
 - programmable pull device?
 - Bus expansion capability
 - multiplexed or simplex external bus?
 - “glue logic” requirements?
- Number/types of integrated peripherals
(objective: want to “match” project requirements to μ C capabilities)

General μ C Selection Guidelines

- Development environment
 - Useful to have an asynchronous serial port dedicated to debugging
 - Useful to have spare I/O pins dedicated to debugging (e.g., “heartbeat” LED)
 - In-circuit programmable Flash available for quickly downloading and testing code revs (but typically require a “programming dongle” so *be sure to include a header/connector on your PCB*)
 - BDM (background debug mode) *VERY helpful be sure to include a 6-pin BDM header on your PCB if using a Freescale microcontroller*
 - Assembler/Compiler/Linker/Loader/(Simulator)?

General μ C Selection Guidelines

- Carefully note **package options** available
 - QFP, SOIC, and SSOP types generally preferable
 - QFN type “doable” (but avoid if possible)
 - watch out for “tabs” on bottom of chip
 - DIP types OK (good for prototyping) but compromise PCB density
 - avoid PGA and BGA
- Price/availability
 - get **at least two more** than you need of every IC
 - now (sooner rather than later)

Package Options (Sample)

**PLASTIC QUAD FLATPACK
(QFP)**



**44-Lead MQFP
"PQ"**

**PLASTIC SHRINK SMALL
OUTLINE (SSOP)**



**20-Lead SSOP
"SS"**



**28-Lead SSOP
"SS"**

**PLASTIC THIN QUAD
FLATPACK (TQFP)**



**44-Lead TQFP
"PT"**



**64-Lead TQFP
"PT"**



**80-Lead TQFP
"PT"**

**PLASTIC THIN SHRINK
SMALL OUTLINE (TSSOP)**



**8-Lead TSSOP
(4.4mm) "ST"**



**14-Lead TSSOP
(4.4mm) "ST"**



**20-Lead TSSOP
(4.4mm) "ST"**

**PLASTIC SMALL OUTLINE
(SOIC)**



**8-Lead SOIC (EIAJ)
(.208") "SM"**



**8-Lead SOIC
(.150") "SN"**



**14-Lead SOIC
(.150") "SL"**



**16-Lead SOIC
(.150") "SL"**



**18-Lead SOIC
"SO"**



**28-Lead SOIC
"SO"**

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Architecture: 8 16 32

Max Speed (MHz): 1 5 10 20 40 80+

Flash (KB): 1 2 4 8 16 32 64 128 256 512

RAM (KB): 0 64 128 256 512 1024+

EEPROM (Bytes): 6 8 14 20 28 44 64 80 100+

Package Pins: 3.0 to 3.6

App. Voltage (V):

Low Power: Low Sleep Fast Wake Active Control XLP

SPI: 1+ 2+ 3+ 4+

I2C: 1+ 2+ 3+ 4+

UART: 1+ 2+ 3+ 4+

Other Comms: USB LIN CAN PSP Ethernet

8 Bit Timers: 1+ 2+ 3+ 4+

16 Bit Timers: 1+ 2+ 3+ 4+

32 Bit Timers: 1+ 2+ 3+ 4+

Real Time Clock: Timer H/W RTCC

PWM Channels: 1+ 2+ 3+ 4+

PWM Resolution (bits): 8+ 10+ 16+

Input Captures: 1+ 2+ 3+ 4+

ADC Channels: 0 4 8 12 16+

ADC Resolutions (bits): 8+ 10+ 12+

Comparators: 1+ 2+ 3+ 4+

Touch Channels: 0 4 8 12 16+

LCD Segments: 0 60 90 120 150 180+

Total Products: 532 To sort, click on the column header

Product Family	Architecture	5K \$ Pricing	Flash (KB)	EEPROM (Bytes)	RAM (KB)	CPU Speed (MHz, MIPS)	LowPower	Comparators	ADC Channels	ADC Bits	Total UART	SPI	I2C	USB	Ethernet	LIN	CAN	Total Timers	Input Capture	PWM Channels	Parallel Port	Segment LCD	Supply Voltage
PIC10F200	8	0.30	0.37	0	0.01	[4,1]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC10F204	8	0.33	0.37	0	0.01	[4,1]	Yes	1	0		0	0						1	0	0	0	0	2 to 5.5
PIC10F202	8	0.33	0.75	0	0.02	[4,1]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC10F220	8	0.36	0.37	0	0.01	[8,2]	Yes	2	8		0	0						1	0	0	0	0	2 to 5.5
PIC10F206	8	0.36	0.75	0	0.02	[4,1]	Yes	1	0		0	0						1	0	0	0	0	2 to 5.5
PIC16F54	8	0.39	0.75	0	0.02	[20,5]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC10F222	8	0.39	0.75	0	0.02	[8,2]	Yes	2	8		0	0						1	0	0	0	0	2 to 5.5
PIC12F508	8	0.41	0.75	0	0.02	[4,1]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC12F509	8	0.45	1.5	0	0.04	[4,1]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC16F505	8	0.48	1.5	0	0.07	[20,5]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC12F519	8	0.49	1.5	64	0.04	[8,2]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC12F510	8	0.49	1.5	0	0.03	[8,2]	Yes	1	3	8	0	0						1	0	0	0	0	2 to 5.5
PIC16F506	8	0.52	1.5	0	0.06	[20,5]	Yes	2	3	8	0	0						1	0	0	0	0	2 to 5.5
PIC12F609	8	0.52	1.75	0	0.06	[20,5]	Yes	1	0		0	0						2	0	0	0	0	2 to 15
PIC16F57	8	0.52	3	0	0.07	[20,5]	Yes	0	0		0	0						1	0	0	0	0	2 to 5.5
PIC12F615	8	0.55	1.75	0	0.06	[20,5]	Yes	1	4	10	0	0						3	1	1	0	0	2 to 15
PIC16F526	8	0.55	1.5	64	0.06	[20,5]	Yes	2	3	8	0	0						1	0	0	0	0	2 to 5.5
PIC12F617	8	0.59	3.5	0	0.13	[20,5]	Yes	1	4	10	0	0						3	1	1	0	0	2 to 5.5
PIC16F610	8	0.59	1.75	0	0.06	[20,5]	Yes	2	0		0	0						2	0	0	0	0	2 to 15
PIC16F616	8	0.69	3.5	0	0.13	[20,5]	Yes	2	8	10	0	0						3	1	1	0	0	2 to 15
PIC12F629	8	0.70	1.75	128	0.06	[20,5]	Yes	1	0		0	0						2	0	0	0	0	2 to 5.5

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ADC Resolutions (bits): 8+ 10+ 12+

Comparators: 1+ 2+ 3+ 4+

Touch Channels: 0 4 8 12 16+

LCD Segments: 0 60 90 120 150 180+

Total Products: 22 To sort, click on the column header

Product Family	Architecture	5K \$ Pricing	Flash (KB)	EEPROM (Bytes)	RAM (KB)	CPU Speed (MHz, MIPS)	LowPower	Comparators	ADC Channels	ADC Bits	Total UART	SPI	I2C	USB	Ethernet	LIN	CAN	Total Timers	Input Capture	PWM Channels	Parallel Port	Segment LCD	Supply Voltage
PIC24FJ64GB1	16	3.57	64	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ128GB	16	3.81	128	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ64GB1	16	3.84	64	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ192GB	16	4.02	192	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ64GB1	16	4.05	64	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ128GB	16	4.07	128	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ256GB	16	4.23	256	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ128GB	16	4.28	128	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ192GB	16	4.28	192	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ128GB	16	4.30	128	0	96.0	[32,16]		3	16	10	4	3	3	3	Devi	Yes		5	18	18	EPMP	0	2.2 to 3.6
PIC24FJ128DA	16	4.34	128	0	24.0	[32,16]		3	16	10	4	3	3	3	Devi	Yes		5	18	18		0	2.2 to 3.6
PIC24FJ192GB	16	4.49	192	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ256GB	16	4.49	256	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ256GB	16	4.65	256	0	96.0	[32,16]		3	16	10	4	3	3	3	Devi	Yes		5	17	17	EPMP	0	2.2 to 3.6
PIC24FJ256DA	16	4.69	256	0	24.0	[32,16]		3	16	10	4	3	3	3	Devi	Yes		5	18	18		0	2.2 to 3.6
PIC24FJ256GB	16	4.70	256	0	16.0	[32,16]	Yes	3	16	10	4	3	3	3	Devi	Yes		5	18	18	PMP	0	2 to 3.6
PIC24FJ128GB	16	4.79	128	0	96.0	[32,16]		3	24	10	4	3	3	3	Devi	Yes		5	18	18	EPMP	0	2.2 to 3.6
PIC24FJ128DA	16	4.83	128	0	24.0	[32,16]		3	24	10	4	3	3	3	Devi	Yes		5	18	18	EPMP	0	2.2 to 3.6
PIC24FJ256DA	16	5.11	256	0	96.0	[32,16]		3	16	10	4	3	3	3	Devi	Yes		5	18	18		0	2.2 to 3.6
PIC24FJ256GB	16	5.14	256	0	96.0	[32,16]		3	24	10	4	3	3	3	Devi	Yes		5	18	18	EPMP	0	2.2 to 3.6
PIC24FJ256DA	16	5.18	256	0	24.0	[32,16]		3	24	10	4	3	3	3	Devi	Yes		5	18	18	EPMP	0	2.2 to 3.6

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32-bit AVR UC3

The 32-bit AVR UC3 product family is built on the high-performance 32-bit AVR architecture and optimized for highly integrated applications. The 32-bit AVR UC3 microcontrollers deliver high computational throughput, deterministic real-time control, low power consumption, low system cost, high reliability and ease of use. The 32-bit AVR CPU includes cutting-edge features such as integer and fixed point DSP arithmetic, single-cycle multiply and accumulate instructions, and single-cycle SRAM access. The peripheral DMA controller and multi-layer high-speed bus architecture make the UC3 core ideal for high throughput applications. UC3 devices are perfectly suited for portable and battery-powered applications due to their outstanding low power properties. UC3 will be offering a new series of devices with Floating Point Unit (FPU) which improves processing performance by allowing the MCU to perform arithmetic calculations on decimal numbers in fewer clock cycles with higher precision and wider dynamic range. [Read more.](#)

8/16-bit AVR XMEGA

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All AVR XMEGA devices are compatible with tinyAVR and megaAVR devices. Within the XMEGA family, devices are 100% code compatible across all devices from the smallest to the largest. This makes it possible to develop with any XMEGA device, and switch to any other XMEGA device later without having to change any code. This allows multi-project development teams to keep and maintain only one code base and use and re-use this across multiple projects. The result is much faster development and prototyping cycles. [Read more.](#)



January 13, 2011
Atmel AT32UC3L Wins 2010 Top Products Award from China's AET Magazine

January 06, 2011
Atmel and Bang & Olufsen ICEpower Collaborate To

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32-bit AVR UC3

Automotive AVR

Battery Management AVR

megaAVR

tinyAVR

XMEGA

AVR UC3

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Devices	AVR Core	Hardware Multiplier	DSP Instructions	FPU MPU/Flash Vault	HW Touch Support	Flash (Kbytes)	Boot Code (Bytes)	ISP	Self Program Memory	SRAM (Bytes)	Debug	RTC w/Osc.	16-bit Timers	Input Capture Block/Channels	Max QTouch/QMatrix Channels	PWM Channels	Enhanced PWM	Ethernet MAC 10/100	USB	Sync Serial Controller (125)	SPI	TWI	USART	I2C Support/ISO7816	LIN	10-bit A/D Single-Ended Channels	12-bit A/D Single-Ended Channels	Analog Comparator	12-bit D/A Channels or 16-bit Audio DAC	Temp. Sensor	D	
AT32UC3A0128	32-bit	Yes	yes	no	yes/no	no	128	included	Yes	yes	32K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	1	LS/FS device + OTG	yes	2 + 4	USART 1	4	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3A0256	32-bit	Yes	yes	no	yes/no	no	256	included	Yes	yes	64K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	1	LS/FS device + OTG	yes	2 + 4	USART 1	4	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3A0512	32-bit	Yes	yes	no	yes/no	no	512	included	Yes	yes	64K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	1	LS/FS device + OTG	yes	2 + 4	USART 1	4	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3A1128	32-bit	Yes	yes	no	yes/no	no	128	included	Yes	yes	32K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	1	LS/FS device + OTG	yes	2 + 4	USART 1	4	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3A1256	32-bit	Yes	yes	no	yes/no	no	256	included	Yes	yes	64K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	1	LS/FS device + OTG	yes	2 + 4	USART 1	4	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3A1512	32-bit	Yes	yes	no	yes/no	no	512	included	Yes	yes	64K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	1	LS/FS device + OTG	yes	2 + 4	USART 1	4	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3A1128	32-bit	Yes	yes	no	yes/no	no	128	included	Yes	yes	128K	JTAG/Nexus	yes	6	12/12	32/-	12	no	no	Hi-Speed device + OTG	yes	2 + 4	USART 2	4	Yes/Yes 4 (UART)	8	0	0	0	2x 16-bit	no	1
AT32UC3A1285	32-bit	Yes	yes	no	yes/no	no	128	included	Yes	yes	128K	JTAG/Nexus	yes	6	12/12	32/-	12	no	no	Hi-Speed device + OTG	yes	2 + 4	USART 2	4	Yes/Yes 4 (UART)	8	0	0	0	2x 16-bit	no	1
AT32UC3A3256	32-bit	Yes	yes	no	yes/no	no	256	included	Yes	yes	128K	JTAG/Nexus	yes	6	12/12	32/-	12	no	no	Hi-Speed device + OTG	yes	2 + 4	USART 2	4	Yes/Yes 4 (UART)	8	0	0	0	2x 16-bit	no	1
AT32UC3A3256S	32-bit	Yes	yes	no	yes/no	no	256	included	Yes	yes	128K	JTAG/Nexus	yes	6	12/12	32/-	12	no	no	Hi-Speed device + OTG	yes	2 + 4	USART 2	4	Yes/Yes 4 (UART)	8	0	0	0	2x 16-bit	no	1
AT32UC3A364	32-bit	Yes	yes	no	yes/no	no	64	included	Yes	yes	128K	JTAG/Nexus	yes	6	12/12	32/-	12	no	no	Hi-Speed device + OTG	yes	2 + 4	USART 2	4	Yes/Yes 4 (UART)	8	0	0	0	2x 16-bit	no	1
AT32UC3A364S	32-bit	Yes	yes	no	yes/no	no	64	included	Yes	yes	128K	JTAG/Nexus	yes	6	12/12	32/-	12	no	no	Hi-Speed device + OTG	yes	2 + 4	USART 2	4	Yes/Yes 4 (UART)	8	0	0	0	2x 16-bit	no	1
AT32UC3B0128	32-bit	Yes	yes	no	yes/no	no	128	included	Yes	yes	32K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device + OTG	yes	1 + 3	USART 1	3	Yes/Yes	0	8	0	0	0	0	no
AT32UC3B0256	32-bit	Yes	yes	no	yes/no	no	256	included	Yes	yes	32K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device + OTG	yes	1 + 3	USART 1	3	Yes/Yes	0	8	0	0	0	0	no
AT32UC3B0512	32-bit	Yes	yes	no	yes/no	no	512	included	Yes	yes	96K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device + OTG	yes	1 + 3	USART 1	3	Yes/Yes	0	8	0	0	2x 16-bit	no	1
AT32UC3B064	32-bit	Yes	yes	no	yes/no	no	64	included	Yes	yes	16K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device + OTG	yes	1 + 3	USART 1	3	Yes/Yes	0	8	0	0	0	0	no
AT32UC3B1128	32-bit	Yes	yes	no	yes/no	no	128	included	Yes	yes	32K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device	no	1 + 2	USART 1	2	Yes/Yes	0	6	0	0	0	0	no
AT32UC3B1256	32-bit	Yes	yes	no	yes/no	no	256	included	Yes	yes	32K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device	no	1 + 2	USART 1	2	Yes/Yes	0	6	0	0	0	0	no
AT32UC3B1512	32-bit	Yes	yes	no	yes/no	no	512	included	Yes	yes	96K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device	no	1 + 2	USART 1	2	Yes/Yes	0	6	0	0	2x 16-bit	no	1
AT32UC3B164	32-bit	Yes	yes	no	yes/no	no	64	included	Yes	yes	16K	JTAG/Nexus	yes	10	6/6	32/-	13	yes	no	LS/FS device	no	1 + 2	USART 1	2	Yes/Yes	0	6	0	0	0	0	no
AT32UC3C0128C	32-bit	yes	yes	yes	yes/yes	no	128	included	yes	yes	36K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C0256C	32-bit	yes	yes	yes	yes/yes	no	256	included	yes	yes	68K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C0512C	32-bit	yes	yes	yes	yes/yes	no	512	included	yes	yes	68K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C064C	32-bit	yes	yes	yes	yes/yes	no	64	included	yes	yes	20K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C1128C	32-bit	yes	yes	yes	yes/yes	no	128	included	yes	yes	36K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C1256C	32-bit	yes	yes	yes	yes/yes	no	256	included	yes	yes	68K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C1512C	32-bit	yes	yes	yes	yes/yes	no	512	included	yes	yes	68K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C164C	32-bit	yes	yes	yes	yes/yes	no	64	included	yes	yes	20K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	-/-	16	yes	1	FS device + LS/FS OTG	yes	2 + 5	USART 3	5	yes/yes 5 (UART)	0	16	4	4x 12-bit	no	1	
AT32UC3C2128C	32-bit	yes	yes	yes	yes/yes	no	128	included	yes	yes	36K	JTAG/Nexus/AwI	RE yes, AST	3	6/6	-/-	10	yes	1	FS device + LS/FS OTG	yes	1 + 4	USART 2	4	yes/yes 4 (UART)	0	11	2	2x 12-bit	no	1	
AT32UC3C2256C	32-bit	yes	yes	yes	yes/yes	no	256	included	yes	yes	68K	JTAG/Nexus/AwI	RE yes, AST	3	6/6	-/-	10	yes	1	FS device + LS/FS OTG	yes	1 + 4	USART 2	4	yes/yes 4 (UART)	0	11	2	2x 12-bit	no	1	
AT32UC3C2512C	32-bit	yes	yes	yes	yes/yes	no	512	included	yes	yes	68K	JTAG/Nexus/AwI	RE yes, AST	3	6/6	-/-	10	yes	1	FS device + LS/FS OTG	yes	1 + 4	USART 2	4	yes/yes 4 (UART)	0	11	2	2x 12-bit	no	1	
AT32UC3C264C	32-bit	yes	yes	yes	yes/yes	no	64	included	yes	yes	20K	JTAG/Nexus/AwI	RE yes, AST	3	6/6	-/-	10	yes	1	FS device + LS/FS OTG	yes	1 + 4	USART 2	4	yes/yes 4 (UART)	0	11	2	2x 12-bit	no	1	
AT32UC3I016	32-bit	Yes	yes	no	yes/yes	yes	16	included	Yes	yes	8K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	17/136	35	no	no	0	no	1 + 4	USART 2	4	no/no 4 (UART)	0	8	8	0	yes	1	
AT32UC3I032	32-bit	Yes	yes	no	yes/yes	yes	32	included	Yes	yes	16K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	17/136	35	no	no	0	no	1 + 4	USART 2	4	no/no 4 (UART)	0	8	8	0	yes	1	
AT32UC3I064	32-bit	Yes	yes	no	yes/yes	yes	64	included	Yes	yes	16K	JTAG/Nexus/AwI	RE yes, AST	6	12/12	17/136	35	no	no	0	no	1 + 4	USART 2	4	no/no 4 (UART)	0	8	8	0	yes	1	

Automotive AVR

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Devices	AVR Core	Hardware Multiplier	Flash (Kbytes)	Boot Code (Bytes)	ISP	Self Program Memory	EEPROM (Bytes)	SRAM (Bytes)	Debug	RTC w/Osc.	8-bit Timers	16-bit Timers	Input Capture Block/Channels	Max QTouch/QMatrix Channels	PWM Channels	Enhanced PWM	SPI	TWI	USART	CAN LIN	10-bit A/D Single-Ended Channels	Analog Comparator	
T90CAN128 Automotive	8-bit	yes	128	included	yes	yes	4K	4K	JTAG	yes	2	2	2/3	16/64	7	no	1	1	2	1	0	8	1

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Battery Management AVR

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Devices	AVR Core	Hardware Multiplier	Flash (Kbytes)	Boot Code (Bytes)	ISP	Self Program Memory (Bytes)	EEPROM (Bytes)	SRAM (Bytes)	Debug	RTC w/Osc.	8-bit Timers	16-bit Timers	Input Capture Block/Channels	Max QTouch/QMatrix Channels	PWM Channels	SPI	TWI	USART	CAN LIN	10-bit A/D Single-Ended Channels	Analog Comparator	10-bit D/A Channels	Temp Sens
ATmega406	8-bit	yes	40	included	yes	yes	512	2K	JTAG	yes	1	1	0/0	8/-	2	0	1			10 + CC	yes		23
ATmega16HVA	8-bit	yes	16	included	yes	yes	256	512	DebugWire	no	no	2	2/4	3/-	0	1	0			5 + CC	yes		21
ATmega8HVA	8-bit	yes	8	included	yes	yes	256	512	DebugWire	no	no	2	2/4	3/-	0	yes	0			5 + CC	yes		21
ATmega16HV8	8-bit	yes	16	included	yes	yes	512	1K	DebugWire	no	no	2	2/4	8/-	0	1	1			7 + CC	yes		29
ATmega32HV8	8-bit	yes	32	included	Yes	Yes	1K	2K	DebugWire	no	no	2	2/4	8/-	0	1	1			7 + CC	yes		29

megaAVR

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Devices	AVR Core	Hardware Multiplier	Flash (Kbytes)	Boot Code (Bytes)	ISP	Self Program Memory (Bytes)	EEPROM (Bytes)	SRAM (Bytes)	Debug	RTC w/Osc.	8-bit Timers	16-bit Timers	Input Capture Block/Channels	Max QTouch/QMatrix Channels	PWM Channels	Enhanced PWM	USB	SPI	TWI	USART	CAN LIN	10-bit A/D Single-Ended Channels	Analog Comparator	10-bit D/A Channels	Temp Sens	
ATmega8	8-bit	Yes	8	included	Yes	Yes	512	1K	no	Yes	2	1	1/2	12/-	3	no	0	1	1	1	0	0	8	1	0	no
ATmega8515	8-bit	Yes	8	included	Yes	Yes	512	512	no	no	1	1	1/2	16/-	3	no	0	1	0	1	0	0	0	0	0	no
ATmega8535	8-bit	Yes	8	included	Yes	Yes	512	512	no	Yes	2	1	1/2	16/16	3	no	0	1	1	1	0	0	8	1	0	no
ATmega16	8-bit	Yes	16	included	Yes	Yes	512	1K	JTAG	Yes	2	1	1/2	16/32	4	no	0	1	1	1	0	0	8	1	0	no
ATmega32	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1	1	1	0	0	8	1	0	no
ATmega64	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	2	1/2	16/-	7	no	0	1	1	2	0	0	8	1	0	no
ATmega128	8-bit	Yes	128	included	Yes	Yes	4K	4K	JTAG	Yes	2	2	1/2	16/-	7	no	0	1	1	2	0	0	8	1	0	no
ATmega162	8-bit	Yes	16	included	Yes	Yes	512	1K	JTAG	Yes	2	2	1/2	16/-	6	no	0	1	0	2	0	0	0	1	0	no
ATmega48	8-bit	Yes	4	no	Yes	no	256	512	DebugWire	Yes	2	1	1/2	12/16	6	no	0	1+1 USART master	1	1	0	0	8	1	0	yes
ATmega88	8-bit	Yes	8	included	Yes	Yes	512	1K	DebugWire	Yes	2	1	1/2	12/32	6	no	0	1+1 USART master	1	1	0	0	8	1	0	Yes
ATmega168	8-bit	Yes	16	included	Yes	Yes	512	1K	DebugWire	Yes	2	1	1/2	16/64	6	no	0	1+1 USART master	1	1	0	0	8	1	0	Yes
AT90CAN128	8-bit	Yes	128	included	Yes	Yes	4K	4K	JTAG	Yes	2	2	2/3	16/64	7	no	0	1	1	2	1	0	8	1	0	no
ATmega325	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/64	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega3250	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega6450	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	1	1/2	-/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega645	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	1	1/2	16/64	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega329	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/64	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega3290	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega649	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega6490	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega640	8-bit	Yes	64	included	Yes	Yes	4K	8K	JTAG	Yes	2	4	4/5	16/-	15	no	0	1+4 USART master	1	4	0	0	16	1	0	no
ATmega1281	8-bit	Yes	128	included	Yes	Yes	4K	8K	JTAG	Yes	2	4	2/3	16/64	8	no	0	1+2 USART master	1	2	0	0	8	1	0	no
ATmega2561	8-bit	Yes	256	included	Yes	Yes	4K	8K	JTAG	Yes	2	4	2/3	-/-	8	no	0	1+2 USART master	1	2	0	0	8	1	0	no
ATmega2560	8-bit	Yes	256	included	Yes	Yes	4K	8K	JTAG	Yes	2	4	4/5	-/-	15	no	0	1+4 USART master	1	4	0	0	16	1	0	no
ATmega1280	8-bit	Yes	128	included	Yes	Yes	4K	8K	JTAG	Yes	2	4	4/5	16/64	15	no	0	1+4 USART master	1	4	0	0	16	1	0	no
ATmega644	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	1	1/2	16/64	6	no	0	1+2 USART master	1	2	0	0	8	1	0	no
AT90CAN32	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	2/3	16/64	7	no	0	1	1	2	1	0	8	1	0	no
AT90CAN64	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	2	2/3	16/64	7	no	0	1	1	2	1	0	8	1	0	no
AT90US1286	8-bit	Yes	128	included	Yes	Yes	4K	8K	JTAG	Yes	2	2	1/2	16/64	9	no	LS/FS device	1+1 USART master	1	1	0	0	8	1	0	no
AT90US1287	8-bit	Yes	128	included	Yes	Yes	4K	8K	JTAG	Yes	2	2	1/2	16/64	9	no	LS/FS device + OTG	1+1 USART master	1	1	0	0	8	1	0	no
AT90US8647	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	2	1/2	16/64	9	no	LS/FS device + OTG	1+1 USART master	1	1	0	0	8	1	0	no
AT90US8646	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	2	1/2	16/64	9	no	LS/FS device	1+1 USART master	1	1	0	0	8	1	0	no
ATmega164P	8-bit	Yes	16	included	Yes	Yes	512	1K	JTAG	Yes	2	1	1/2	16/64	6	no	0	1+2 USART master	1	2	0	0	8	1	0	no
ATmega324P	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/64	6	no	0	1+2 USART master	1	2	0	0	8	1	0	no
ATmega165P	8-bit	Yes	16	included	Yes	Yes	512	1K	JTAG	Yes	2	1	1/2	16/64	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega169P	8-bit	Yes	16	included	Yes	Yes	512	1K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega644P	8-bit	Yes	64	included	Yes	Yes	2K	4K	JTAG	Yes	2	1	1/2	16/64	6	no	0	1+2 USART master	1	2	0	0	8	1	0	no
AT90PWM1	8-bit	Yes	8	included	Yes	Yes	512	512	DebugWire	no	1	1+PSC	1/2	8/-	7	Yes	0	1	0	0	0	0	8	2	0	no
ATmega329P	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega3290P	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega325P	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/64	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
ATmega3250P	8-bit	Yes	32	included	Yes	Yes	1K	2K	JTAG	Yes	2	1	1/2	16/-	4	no	0	1+1 USI	1 USI	1	0	0	8	1	0	no
AT90US82	8-bit	no	8	included	Yes	Yes	512	512	DebugWire	no	1	1	1/2	12/8	4	no	FS device	1+1 USART master	0	1	0	0	0	1	0	no
AT90US162	8-bit	no	16	included	Yes	Yes	512	512	DebugWire	no	1	1	1/2	-/8	4	no	FS device	1+1 USART master	0	1	0	0	0	1	0	no

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Product (# of Parts)	Datasheet / Part Data	Order	Description	Device Type	Core Type	Core Operating Frequency Max (MHz)	Internal Flash (kByte)	Internal RAM (kByte)	EEPROM (kByte)	Serial Interface Type	CAN	A/D Converter Channels	A/D Conv (b)
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BLACKFIN PROCESSORS



Blackfin® 16/32-bit embedded processors offer software flexibility and scalability for convergent applications: multi-format audio, video, voice and image processing, multimode baseband and packet processing, control processing, and real-time security

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- Audio
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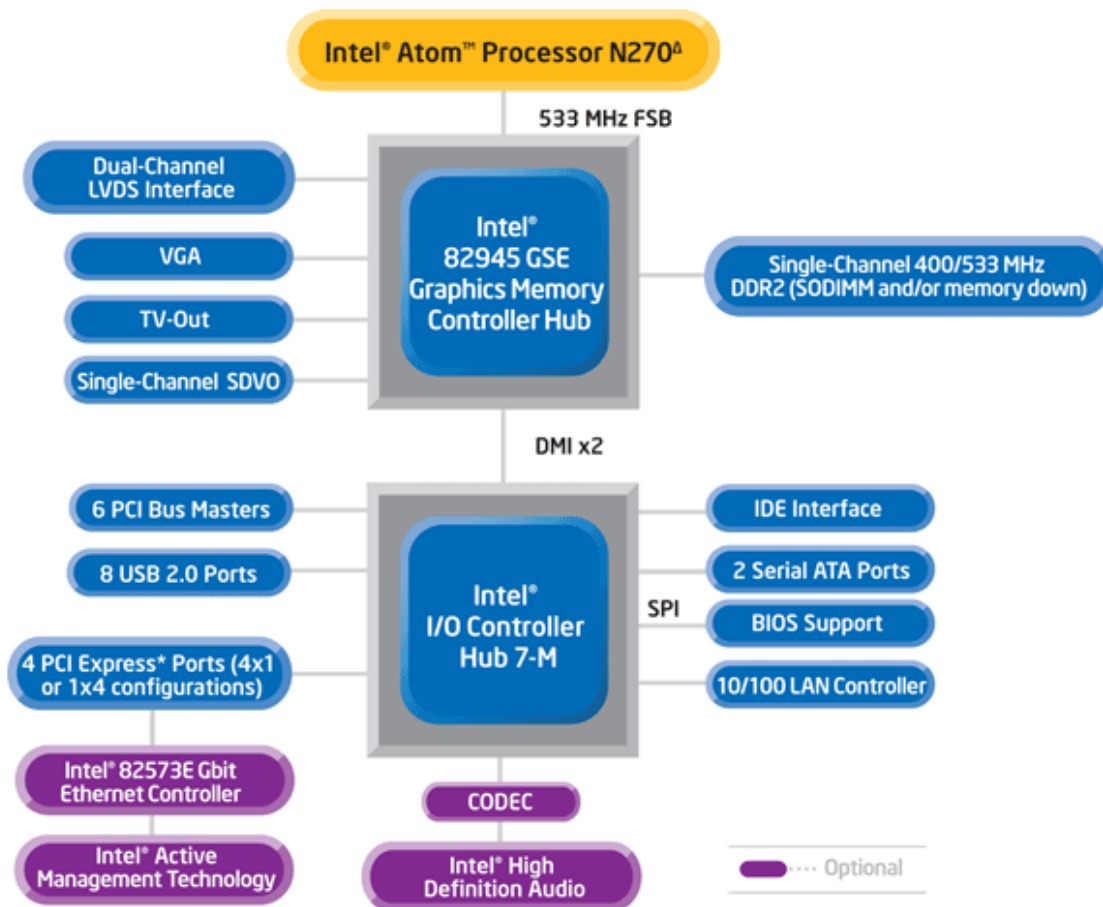
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Board Peripheral Features

- VGA port and DVI-D
- Two (2) SATA ports
- One (1) parallel ATA port (44-pin mobile header)
- Eight (8) USB 2.0 ports (four back-panel, two front-panel, one internal, one PCIe mini-card)
- One (1) PCIe x1 port
- One (1) PCIe mini-card connector for wireless adapter
- Realtek ALC268* High Definition Audio codec
- Front-panel headphone and mic-in support
- 10/100/1000 Realtek RTL8111* Ethernet Controller
- Legacy I/O:
 - PS/2
 - Serial
- 12 VDC input

<http://www.intel.com/products/processor/atom/index.htm>



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MCB2370 Evaluation Board

The Keil MCB2370 Evaluation Board introduces you to the NXP LPC2378 microcontroller. It allows you to create and test working programs for this advanced architecture.



Components Included

The MCB2370 Evaluation Board includes the following:

- [MCB2300 Evaluation Board](#) populated with an LPC2378,
- [RealView MDK-ARM Evaluation Tools](#).
- [MCB2300 Quick Start Guide](#).

System Requirements

- PC with one available USB port,
- Windows 2000, XP and Vista,
- One CD-ROM drive,
- [ULINK family USB-JTAG Adapter](#) for high-performance Debug/Download (optional).

Evaluation Software

The MCB2370 Evaluation Board includes [RealView MDK-ARM Evaluation Tools](#). These tools help you get started writing programs and testing the microcontroller and its capabilities. Sample applications which run on the MCB2370 are included.

<http://www.keil.com/mcb2300/mcb2370.asp>