



16-BIT MICROPROCESSORS

Company name	Device family or device	CPU frequency	Bus interface (address/data) (bits)	Instruction width (bits)	Operating voltages (V)	Typical power at maximum frequency	Power-down modes	DSP/multiplication hardware support (bits)	FPU	Caching
Fujitsu Microelectronics America www.fma.fujitsu.com Enter No. 490	F2MC16L F2MC16LX F2MC16F	4 to 20 MHz, subclock 32.768 kHz	24/16, external: 8 or 16 (multiplexed)	16	1.8 to 5.5	125 mW (16 MHz)	Stop, sleep, subclock, hardware standby, watch, timer			
Hitachi Semiconductor www.semiconductor.hitachi.com Enter No. 491	H8/3062F	25 MHz	Internal: 24/16 external: (24 or 20)/(16 and/or 8)	16 to 80	3 to 5.5	175 mW	Five	8×8, 16×16		
	H8/3069F	25 MHz	Internal: 24/16 external: (24 or 20)/(16 and/or 8)	16 to 80	4.5 to 5.5	120 mW	Five	8×8, 16×16		
	H8 Tiny Series	16 to 20 MHz	16/16	16 to 80	2.7 to 5.5	75 to 100 mW	Four to six	8×8		
	H8S/2148A	10 or 20 MHz	Internal: 24/16, external: (24 or 16)/(16 and/or 8)	16 to 80	3 to 5.5	150 (10 MHz), 425 mW (20 MHz)	Sleep, medium speed, hardware standby, software standby, module stop, subclock	8×8, 16×16 MUL, 16/8, 32/16 DIV instruction		
	H8S/2268	13 or 20 MHz	24/16	16 to 80	2.7 to 5.5	80 mW (13 MHz), 133 mW (20 MHz)	Sleep, medium speed, hardware standby, software standby, module stop, subclock, sub-sleep, watch	8×8, 16×16 multiply, 16/8, 32/16 divide instruction		
	H8S/2215	16 MHz	Internal: 24/16, external: 24/(16 and/or 8)	16 to 80	2.7 to 3.3	89 mW	Sleep, medium speed, hardware standby, software standby, module stop	8×8, 16×16 multiply, 16/8, 32/16 divide instruction		
	H8S/2329B	25 MHz	Internal: 24/16, external: 24/(16 and/or 8)	16 to 80	2.7 to 3.3	181 mW	Sleep, medium speed, hardware standby, software standby, module stop	8×8, 16×16 multiply, 16/8, 32/16 divide instruction		
	H8S/2612	20 MHz	24/16	16 to 80	4.5 to 5.5	325 mW	Sleep, medium speed, hardware standby, software standby, module stop	8×8, 16×16 multiply and MAC, 16/8, 32/16 divide instruction		
	H8S/2674R	33 MHz	Internal: 24/16, external: 24/(16 and/or 8)	16 to 80	3 to 3.6	264 mW	Sleep, hardware standby, software standby, module stop, all module clock stop, clock	8×8, 16×16 division, multiply and MAC, 16/8, 32/16 divide instruction		
Infineon Technologies www.infineon.com/microcontrollers Enter No. 492	C161K/O	25 MHz (20 MHz at 3.3V)	19/16 or 8 external plus two or four chip selects, 24/16 internal	16, 32	3.3 or 5.5	250 mW	Idle, power-down	16×16		
	C161PI	25 MHz (20 MHz at 3.3V)	23/16 or 8 external plus five chip selects, 24/16 internal	16, 32	3.3 or 5.5	187 mW	Idle, power-down	16×16		
	C161CS/JC/JI	25 MHz	24/16 or 8 external plus five chip selects, 24/16 or 32 internal	16, 32	5	300 mW	Idle, sleep power-down	16×16		
	XC161CI	40 MHz	24/16 or 8 external plus five chip selects, 24/16 or 64 internal	16, 32	5 and 2.5	245 mW	Idle, sleep, power-down	Single-cycle MAC		

	Memory	Memory controller	MMU	Package selection	Timers	Serial, parallel I/O	Interrupts	ADC/DAC	Additional features	Price (10,000)
	32- to 384-kbyte masked ROM, 64- to 512-kbyte flash, 640-kbyte to 16-kbyte RAM			48/120 QFP/LQFP/SQFP/SDIP (plastic)	16-bit, reload, PPG, PWM, 18-bit watchdog, PWC, timebase timer	SIO, triple CAN, I ² C, UART, IE bus, up to 102 PIOs	Eight external	Four/eight/16-channel 8/10-bit ADC, two-channel 8-bit DAC	LCD and VFD controller, ac/dc and stepper-motor control, PLL, sound and wave generator, level comparator, input capture, output compare	From \$2.50
	128-kbyte flash, 4-kbyte SRAM	Yes		100 QFP/TQFP	Four 8-bit, three 16-bit, watchdog	Two asynchronous/synchronous	27 internal, seven external	Eight-channel 10-bit, two-channel 8-bit	Bus controller, interrupt controller, TPC, smart-card interface	\$6.25
	512-kbyte flash, 16-kbyte SRAM	Yes		100 QFP/TQFP	Four 8-bit, three 16-bit, watchdog	Three asynchronous/synchronous	30 internal, seven external	Eight-channel 10-bit, two-channel 8-bit	Bus controller, TPC, refresh controller	\$10.25
	512-bytes to 4-kbyte SRAM, 32- to 56-kbyte flash, 8- to 56-kbyte mask ROM			42 DIP, 48 LQFP 64 QFP/LQFP	8-bit, 16-bit, watchdog, PWM	Asynchronous/synchronous, I ² C	17 to 38 internal, seven to 11 external	Four-channel 10-bit	On-chip debug, address break, power-on reset, low-voltage detection, 32-kHz subclock	\$1.60 to \$4.80
	128-kbyte flash, 4-kbyte RAM	Yes		100 TQFP/CFP	Four 8-bit, 16-bit, two watchdog, two to 16 PWMs	Three asynchronous/synchronous (one with IrDA), I ² C	44 internal, nine external	Eight-channel 10-bit, two-channel 8-bit	Data-transfer controller	\$9
	256-kbyte flash, 16-kbyte RAM			100 TFPQ/TFPB/FPB	Eight 8-bit, three 16-bit two watchdogs	Three asynchronous/synchronous, I ² C	48 internal, 14 external	10-channel 10-bit, two-channel 8-bit	PC-break controller, data-transfer controller	\$11.75
	256-kbyte flash, 16-kbyte RAM		Yes	120 TQFP, 112 PLFBGA	Two 8-bit, three 16-bit, watchdog	Three asynchronous/synchronous	40 internal, eight external	Six-channel 10-bit, two-channel 8-bit	Four DMACs, USB 1.1, data-transfer controller, boundary scan	\$10.80
	384-kbyte flash, 32-kbyte RAM	Yes		120 TFP, 128 FP	Two 8-bit, six 16-bit, watchdog	Three asynchronous/synchronous	52 internal, nine external	Eight-channel 10-bit, two-channel 8-bit	Four DMACs, data-transfer controller, smart-card interface, on-chip debug	\$12.50
	128-kbyte flash, 4-kbyte RAM			80 FPA	Six 16-bit, watchdog	Three asynchronous/synchronous	49 internal, seven external	12-channel 10-bit	HCAN, data-transfer controller, motor-management timer, PC break controller	\$12
	32-kbyte RAM	SDRAM		144 LQFP	Two 8-bit, six 16-bit, watchdog	Three asynchronous/synchronous	57 internal, 17 external	12-channel 10-bit, four-channel 8-bit	Four EXDMAC and DMAC, data-transfer controller, 16-bit PPG	\$8.50
	1- to 2-kbyte RAM			80 PMQFP	Three to five 16-bit, watchdog	UART, SPI 63 PIOs	Four to seven external, 10 to 13 internal			\$4
	3-kbyte RAM			100 PTQFP/PMQFP	Five 16-bit, real-time clock, watchdog	UART, SPI, I ² C, 76 PIOs	Eight external, 19 internal	Four-channel 10-bit ADC	PLL	\$4
	10-kbyte RAM, 256-kbyte ROM, or ROMless			128 PTQFP	Nine 16-bit, real-time clock, watchdog, 16 channel PWM	Up to two CANs, two UARTs, SPI, I ² C, up to one J1850, 93 PIOs	As many as 19 external, as many as 59 internal	12-channel 10-bit ADC	As many as two CAN 2.0B active controllers, PLL	\$11 (ROMless)
	8-kbyte RAM, 128-kbyte flash			144 PTQFP	Nine 16-bit, real-time clock, watchdog, 32 channel PWM	TwinCAN, two UARTs, two SPIs, I ² C, J1850, 103 PIOs	As many as 32 external, as many as 74 internal	16-channel 10-bit ADC	Two CAN 2.0B active controllers, PLL	\$13

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	C164C/CM	25 MHz	Up to 21/16 or 8 external plus up to four chip selects, 24/16 or 32 internal	16, 32	5	250 mW (ROM version)	Idle, sleep, power-down	16×16		
	XC164CS	40 MHz	24/16 or 8 external plus five chip selects, 24/16 or 64 internal	16, 32	5 and 2.5	250 mW	Idle, sleep, power-down	Single-cycle MAC		
	C165	25 MHz (20 MHz at 3.3V)	24/16 or 8 external plus five chip selects, 24/16 internal	16, 32	3.3 or 5.5	250 mW	Idle, power-down	16×16		
	C167CR/CS	33 or 40 MHz	24/16 or 8 external plus five chip selects, 24/16 or 32 internal	16, 32	5 or 3.3	600 mW	Idle, sleep, power-down	16×16		
Intel Corp www.intel.com Enter No. 493	80C186-EA/XL, 80C188EA/XL	8, 12, 13, 20, or 25 MHz	External 16/16	8, 16	3 or 5	100 to 105 mA	Idle, power-down, power save		Coprocessor	
	80C186-EB80C-188EB	8, 13, 16, 20, or 25 MHz	External 16/16	8, 16	3 or 5	115 mA	Idle, power-down		Coprocessor	
	80C186-EC80C-188EC	13, 16, 20, or 25 MHz	External 16/16	8, 16	5/3, 5.5 tolerant	125 mA	Idle, power-down, power save		Coprocessor	
	MCS-96 HSI0 8XC-196KB/KC/KD	16 or 20 MHz	16 to 24/16	24	4.4 to 5.5	150 mA	Idle, power-down			
	MCS-96 Motion Control	16 MHz	16 to 24/16	24	4.4 to 5.5	150 mA	Idle, power-down			
	8XC196MC/MD/MH									
	MCS-96 EPA (8XC-196CA/CB/NP/NT/NU/EA)	14, 16, 20, 25, 40, or 50 MHz	16 to 24/16	24	4.4 to 5.5	150 mA	Idle, power-down			
	MCS-296 (80C296SA)	40 or 50 MHz	16 to 24/16	24	4.4 to 5.5	150 mA	Idle, power-down	Enhanced instructions, 40-bit accumulator		
Mitsubishi Electric & Electronics USA www.mitsubishi-chips.com Enter No. 494	M16C	32 kHz to 20 MHz	20/16, external: 20/8 or 16	16	2.5 to 5.5	25 to 250 mW	Standby: 20 μW, sleep: 0.5 μW	16×16 MAC instruction		
Motorola www.motorola.com/semiconductors Enter No. 495	68HC12 family, HCS12 family	8 or 25 MHz	16	16	3 or 5	250 mW (8 MHz)	Wait, stop			
	68HC16 family	25 MHz	20/16	16	5	770 mW (16 MHz)	Wait, stop	MAC instruction		
Oki Semiconductor www.okisemi.com Enter No. 496	MSM-66573 family	14 to 30 MHz	20/8	8 to 32	2.4 to 3.6 or 4.5 to 5.5	36 mA	Stop, halt	Multiplier instruction		
Philips Semiconductors www.philips.semiconductors.com Enter No. 497	XA family	30 or 32 MHz	16	16	2.7 to 5.5	200 to 400 mW	Idle: 20 to 40 mA, power-down: 5 to 30 μA	16×16		

	Memory	Memory controller	MMU	Package selection	Timers	Serial, parallel I/O	Interrupts	ADC/DAC	Additional features	Price (10,000)
	2- to 4-kbyte RAM, 32- to 64-kbyte ROM or OTP			80 PMQFP, 64 PTQFP	Seven 16-bit, real-time clock, watchdog, up-to-19-channel PWM	CAN, UART, SPI, up to 59 PIOs	As many as 11 external, as many as 28 internal	Up to eight-channel, up to 12-bit ADC	CAN 2.0B active controller, motor-control peripheral, PLL	\$5 to \$10
	6-kbyte RAM, 128-kbyte flash			100 PTQFP	11 16-bit, real-time clock, watchdog, 19-channel PWM	TwinCAN, UART, two SPI, 79 PIOs	As many as 11 external, as many as 75 internal	14-channel 10-bit ADC	Two CAN 2.0B active controllers, PLL	\$12
	2-kbyte RAM			100 PTQFP/PMQFP	Five 16-bit, watchdog	UART, SPI, 77 PIOs	Eight external, 13 internal			\$7
	Up to 11-kbyte RAM, up to 128-kbyte ROM, or ROMless			144 PMQFP	13 16-bit, real-time clock, watchdog, up to 36-channel PWM	Up to two CAN, UART, SPI, 111 PIOs	As many as 33 external, as many as 55 internal	16 to 24-channel 10-bit ADC	As many as two CAN 2.0B active controllers, PLL	\$10 to \$11 (ROMless)
				68 PLCC/PGA/LCC, 80 QFP/SQFP	Three 16-bit		Two internal, five external			\$3.90 to \$20.35
				80 QFP/SQFP, 84 PLCC	Three 16-bit	Two	As many as 129 external			\$5.05 to \$7.75
				100 QFP(EIAJ)/PQFP/SQFP	Three 16-bit	Two	External (8259A)			\$8.81 to \$10
	8/16/32 kbyte OTP, ROM, 232/488/1000-bytes register RAM			PLCC, QFP	Two 16-bit, PWM, HSIO	One UART	19 to 37	Eight-channel, 10-bit	PTS	\$5.27 to \$16.07
	16/32-kbyte OTP, ROM, 488/744-byte register RAM			PLCC, QFP, SQFP	Two 16-bit, PWM, HSIO	Two UART (MH only)	19 to 37	Eight-channel, 10-bit	PTS, three-phase waveform generator, frequency generator (MD)	\$7.33 to \$13.33
	4/32/56-kbyte OTP, ROM, 1000/1500-byte register RAM, 256/512/3072-byte code RAM			PLCC, QFP, SQFP, SDIP, CDIP	Two to four 16-bit, PWM, HSIO	One, two, or three UARTs	19 to 37	Eight-channel, 10-bit	CAN 2.0 (CA/CB), EPA	\$11.73 to \$19.53
	512-byte register RAM, 2-kbyte code RAM			SQFP	Two 16-bit, PWM	One UART	19		Six chip selects, 6-Mbyte linear-address range, EPA	\$14 to \$15.40
	16- to 512-kbyte flash, OTP, mask, 3- to 20-kbyte SRAM	DRAM		80 to 144 QFP	11 16-bit, zero to two PWMs, watchdog	Up to five UARTs, SIO, USB, CAN, up to 123 GPIOs	As many as 25 internal, eight external, four software, seven levels	Up to 26-channel, 10-bit, DAC	LCD, CRC, key-on wake-up	\$2.49 to \$15
	32- to 512-kbyte flash, 1- to 12-kbyte SRAM			112 LQFP, 80 QFP	Eight-channel 16-bit IC or OCRTI, pulse accumulator, 8- and 16-bit PWM	SCI, SPI, J1850, CAN, I2C, up to 91 PIOs	As many as 64	10-bit	Voltage regulator, clock module with PLL	\$6 to \$15
	1- to 4-kbyte SRAM		Integrated	132 PQFP, 144 LQFP, 120/160 QFP	CTM7, GPT, TPU, TPU2	SCI, SPI, queued SPI, up to 64 PIOs	As many as 252	10-bit		\$6 to \$35
	64-kbyte flash, 4-kbyte SRAM			100 QFP/TQFP	Real-time, watchdog		27 internal, six external, nonmaskable	Eight 10-bit		\$5.50
	256- to 2048-byte RAM			44/68 PLCC, 44/80/100 LQFP	Three 16-bit, watchdog, five capture/compare/PWM	Two UARTs, SPI, I ² C, CAN 2.0B, quad USART, PIO	38 to 46 sources, eight levels, two to eight external	Eight-channel 8-bit	DRAM controller, DMA, HDLC	\$3 to \$10

16-BIT MICROPROCESSORS (CONTINUED)

Company name	Device family or device	CPU frequency	Bus interface (address/data) (bits)	Instruction width (bits)	Operating voltages (V)	Typical power at maximum frequency	Power-down modes	DSP/multiplication hardware support (bits)	FPU	Caching
Sharp Micro-electronics of the Americas www.sharpsma.com Enter No. 498	LH75400 LH75401 LH75410 LH75411	50 MHz	16/24, 8/16, 16	16, 32	3.3	70 mA	Standby: 110 μ A, stop: 18 μ A	Yes		
STMicroelectronics www.st.com Enter No. 499	ST10F269	40 MHz	As much as 24/16 demultiplexed (customizable)	16, 32	5	190 mA	Idle: 20 mA, power-down: 500 μ A	One-cycle MAC		
Texas Instruments www.ti.com/sc/msp430 Enter No. 500	MSP-430X1XX	As much as 8 MHz	16/16	16	1.8 to 3.6	250 μ A	Standby: 1 μ A, off: 0.1 μ A	One-cycle MPY, MPYS, MAC, MACS		
	MSP-430X3XX	As much as 4 MHz	16/16	16	2.5 to 5.5	400 μ A/MIP	Standby: 1.6 μ A, off: 0.1 μ A	One-cycle MPY, MPYS, MAC, MACS		
	MSP-430X4XX	As much as 8 MHz	16/16	16	1.8 to 3.6	250 μ A/MIP	Standby: 0.8 μ A, off: 0.1 μ A	One-cycle MPY, MPYS, MAC, MACS		
Toshiba America Electronic Components www.toshiba.com Enter No. 501	TLCS900/L1	As much as 27 MHz	24/16	8, 16, 32	1.8 to 5.5	30 mA	Idle 2: 4.5 mA, idle 1: 2 mA, stop: 1.0 μ A	16 \times 16 to 32 (signed/unsigned)		
	TLCS900/L	As much as 20 MHz	24/16	8, 16, 32	2.7 to 5.5	24 mA	Run: 17 mA, idle 2: 2.5 mA, idle 1: 0.7 mA, stop: 0.2 μ A	16 \times 16 to 32 (signed/unsigned)		
	TLCS900/H	As much as 25 MHz	24/16	8, 16, 32	2.7 to 5.5	40 mA	Idle 2: 30 mA, idle 1: 3.5 mA, stop: 0.5 μ A	16 \times 16 to 32 (signed/unsigned)		

	Memory	Memory controller	MMU	Package selection	Timers	Serial, parallel I/O	Interrupts	ADC/DAC	Additional features	Price (10,000)
	2× 16-kbyte SRAM	SRAM/ROM/flash, asynchronous, glueless interface, two DMA channels		144 LQFP	Three 16-bit capture/compare/PWM, real-time, watchdog	CAN 2.0B, three UART, SPI, Microwire, TI's SSI, 78 PIOs	Seven external	Eight-channel 10-bit A/D touch screen controller	Gray-scale LCDC-vectored interrupt	\$13.36 to \$15.60
	256-kbyte flash, 12-kbyte SRAM		Yes	144 PQFP	Two units with five timers	Two CAN, synchronous/asynchronous, high speed	Eight-channel, 16-priorities for 56 sources	16-channel, 10-bit	On-chip bootstrap loader and PLL	\$20.40
	1- to 60-kbyte flash, up to 2-kbyte SRAM			20/28 SOIC/TSSOP, 64 QFP	16-bit watchdog, 16-bit PWM	USART, 48 PIOs	All peripherals and I/O	12-bit		99 cents to \$5.95
	16- or 32-kbyte OTP, 128-byte to 2-kbyte SRAM			48/56 SSOP, 64/100 QFP	Two 8-bit, 16-bit watchdog, 16-bit PWM	USART, 40 PIOs	All peripherals and I/O	14-bit		\$1.75 to \$6.95
	4- to 60-kbyte flash, 256-byte to 2-kbyte SRAM			64/80/100 PQFP	Two 8-bit, 16-bit watchdog, 16-bit PWM	USART, 48 PIOs	All peripherals and I/O	12-bit		\$2.55 to \$6.95
	Up to 256-kbyte ROM/flash, up to 16-kbyte SRAM	Yes	Yes	64 to 144 QFP/LQFP	As many as eight 8-bit, one or two 16-bit, 22-bit watchdog, RTC, 8/16-bit PWM	Up to five UARTs, synchronous SIO, SIE, CAN, I2C, up to 81 PIOs	Nine CPU, 28 internal, 10 external, seven levels	Up to 12-channel, 10-bit	Four 32-bit register banks, four micro-DMA channels	\$4.5 to \$7
	Up to 192-kbyte ROM, up to 4-kbyte RAM	Yes		80 to 100 QFP, 44 -100 LQFP	As many as four 8-bit, as many as five 16-bit, 22-bit watchdog, 8/14-bit PWM	Up to five UARTs, synchronous SIO, I ² C, up to 85 PIOs	Nine CPU, 14 internal, 6 external, seven levels	Up to 16-channel, 8-bit; up to eight-channel, 10-bit	Four 32-bit register banks, four micro-DMA channels	\$2.75 to \$5
	Up to 256-kbyte ROM/flash, up to 8-kbyte RAM	Yes		64 to 144 QFP/LQFP	As many as eight 8-bit, one or two 16-bit, 22-bit watchdog	Up to three UARTs, synchronous SIO, SEI, CAN, IrDA, I ² C, up to 81 PIOs	Nine CPU, 28 internal, 10 external, seven levels	Up to eight-channel, 10-bit	Four 32-bit register banks, four micro-DMA channels	\$5.75 to \$6