



The Truth About AVR

The Truth About AVR®

Setting the Record Straight

Over the past several months, Microchip has obtained a number of statements that have been made in various public media (Web Site, Press Releases, Seminars and Advertisements) about the AVR 8-bit RISC MCU (Microcontroller). Some of these statements made by Atmel are about comparisons to the Microchip PICmicro 8-bit RISC MCU. In addition, Microchip is being asked questions by customers in regard to the comparisons made in these public media statements.

This review is designed to indicate competitive positioning and no defamation of the AVR or Atmel is intended.

As new information is obtained on the AVR 8-bit RISC MCU, this web site review will be updated.

All information in this discussion is based on the latest Atmel AVR MCU data sheets and other technical information obtained from the Atmel AVR Data Book (May 1997) and the Atmel web site.

The following is a summary of some of the areas / items that have been questioned, and Microchip's comments in regards to AVR MCU claims:

- **Overall Comparison Comments Heard**
- **General Comparison Comments Heard**
- **General Comparison Comments Heard (PIC16C5X or PIC16C62X)**
- **General Comparison Comments Heard (PIC16CXXX or PIC17CXXX)**
- **Architecture Comparisons**
- **Watchdog Timer**
- **Comparator**
- **Oscillator**
- **Reset**
- **Brown Out Reset (BOR)**
- **Timers/counters (PIC16C5X or PIC16C62X)**
- **Timers/counters (PIC16CXXX or PIC17CXXX)**
- **Capture/Compare/PWM**
- **UART**
- **I/O Structure**
- **Sink/Source Currents (PIC16C5X or PIC16C62X)**
- **Sink/Source Currents (PIC16C7XX)**
- **Current Consumption (PIC16C5X or PIC16C62X)**
- **Current Consumption (PIC16C6XX or PIC16C7XX)**
- **EEPROM/FLASH Memory**
- **Development Tools**

The Truth About AVR

Customers have told us about competitive comparison by the Atmel AVR 8-bit RISC MCU to Microchip 8-bit PIC16C5X RISC MCU device. The PIC16C5X is a FAMILY of devices in the x12-bit word architecture and the comparison needs to be on all of the 18-pin versions. Whereas, the AVR is a x16-bit word architecture and they are only comparing their 20-pin version. A **better** comparison would be to the 18-pin versions of one of the many members of Microchip's PIC16CXXX FAMILY of x14-bit architecture, such as the PIC16C62X devices.

Overall Comparison Comments Heard (PIC16C5X or PIC16C62X)

Feature	AVR	PIC16C5X	PIC16C62X
Program memory	AT90S1200 = 1K bytes <i>In actuality it is 512 x16-bit words</i> AT90S2313 = 2K bytes <i>In actuality it is 1K x16-bit words</i> You have to program the entire 16 bit word for each program instruction and thus the amount of program memory available in each device is overstated	Claim PIC16C5X = 768 bytes OTP <i>In actuality PIC16C54 = 768 bytes or 512 x12-bit words</i> <i>In actuality PIC16C56 = 1536 bytes or 1K x12-bit words</i> <i>In actuality PIC16C58A = 3072 bytes or 2K x12-bit words</i> All devices are OTP and there are some ROM versions	 <i>In actuality PIC16C620 = 896 bytes or 512 x14-bit words</i> <i>In actuality PIC16C621 = 1792 bytes or 1K x14-bit words</i> <i>In actuality PIC16C622 = 3584 bytes or 2K x14-bit words</i> All are OTP
RAM	AT90S1200 = 0 bytes AT90S2313 = 128 bytes	Claim PIC16C5X = 25 bytes <i>In actuality PIC16C54 = 25 bytes</i> <i>In actuality PIC16C56 = 25 bytes</i> <i>In actuality PIC16C58A = 72 bytes</i>	 <i>PIC16C620 = 80 bytes</i> <i>PIC16C621 = 80 bytes</i> <i>PIC16C622 = 128 bytes</i>
Interrupts	AT90S1200 = 3 AT90S2313 = 11	Claim PIC16C5X = None <i>True Statement</i>	PIC16C62X = 4

The Truth About AVR

Overall Comparison Comments Heard (PIC16C5X or PIC16C62X) (Continued)

Feature	AVR	PIC16C5X	PIC16C62X
Number of clocks per instruction (average) or throughput of number of clock normalized	AVR = 1.3	<p>Claim PICmicro = 5.5</p> <p>Not sure how this is determined or measured.</p> <p><i>7 of 33 PIC16C5X instructions are 2 cycles or 21% of them for 4.84 clocks per instruction in total using a simple straight calculation.</i></p> <p>If it is based on some code routine, then we all need to see the routine in order to evaluate it's content and therefore the determination the validity of the claim.</p>	<p>No Claim made, presume to be the same as PIC16C5X of PICmicro = 5.5</p> <p>Not sure how this is determined or measured.</p> <p><i>9 of 35 PIC16C62X instructions are 2 cycles or 25% of them for 5.0 clocks per instruction in total using a simple straight calculation.</i></p> <p><i>If it is based on some code routine, then we all need to see the routine in order to evaluate it's content and therefore the determination the validity of the claim.</i></p>

General Comparison Comments Heard

Feature	AVR	PICmicro	
Complete Family	<p>AVR claims:</p> <p>Base-Line <16K</p> <p><i>Only 7 devices discussed so far and they are ALL under <8K.</i></p> <p>Mid-Range 16K — 64K</p> <p>High-End >64K</p>	<p>PICmicro</p> <p>51 Devices under 16K bytes</p> <p>3 Device between 16K — 64K bytes</p> <p>No Devices over 64K bytes</p> <p>Does not count ROM devices</p>	

General Comparison Comments Heard (PIC16C5X or PIC16C62X)

Feature	AVR	PIC16C5X	PIC16C62X
Assembly code efficiency in number of bytes	AVR = 1.0	<p>Claim PICmicro = 1.6</p> <p>Availability of the Assembly code routine that perform the test is NOT AVAILABLE to allow a determination or verify the claim.</p>	No Claim made, presume to be the same as PIC16C5X

The Truth About AVR

General Comparison Comments Heard (PIC16C5X or PIC16C62X) (Continued)

Feature	AVR	PIC16C5X	PIC16C62X
Most single clock cycle execution	<p>An AVR claim of "most single cycle execution":</p> <p>In pure instruction counts the AT90S1200 has:</p> <p>55 are 1 cycle or 62% 5 are 2 cycle or 6% 2 are 3 cycle or 2% 2 are 4 cycle or 2% 25 are 1-2 cycles or 28% of the 89 instructions.</p> <p>The AT90S2313 has:</p> <p>57 are 1 cycle or 47% 30 are 2 cycle or 25% 6 are 3 cycle or 5% 2 are 4 cycle or 2% 25 are 1-2 cycles or 21% of the 120 instructions</p>	<p>In the PIC16C5X PICmicro:</p> <p>In pure instruction counts the x12 architecture has:</p> <p>26 are 1 cycle or 79% 3 are 2 cycle or 9% 4 are 1-2 cycles or 12% of the 33 instructions</p>	<p>In the PIC16C62X PICmicro:</p> <p>In pure instruction counts the x14 architecture has:</p> <p>26 are 1 cycle or 74% 5 are 2 cycle or 15% 4 are 1-2 cycles or 11% of the 35 instructions</p>
AT90S1220	<p>AVR claim:</p> <p>8-pin 8-bit AVR MCU</p> <p><i>No data sheet on web site or in May 1997 Atmel CD-ROM. (May 1997 AVR Data Book)</i></p>	<p>PICmicro: PIC12CXXX – World's first and ONLY 8-pin 8-bit MCU</p> <p><i>Shipping in volume the PIC12C508/509 to customers</i></p>	

General Comparison Comments Heard (PIC16CXXX or PIC17CXXX)

Feature	AVR	PIC16CXXX	PIC17CXXX
Program memory	<p>AT90S4414 = 4K bytes</p> <p><i>In actuality it is 2K x16-bit words</i></p> <p>AT90S8515 = 8K bytes</p> <p><i>In actuality it is 4K x16-bit words</i></p> <p>You have to program the entire 16-bit word for each program instruction and thus the amount of program memory available in each device is overstated.</p>	<p>PIC16CXXX's are available from 896 – 14,336 bytes or 512 – 8K x14-bit words</p> <p>All devices are OTP or FLASH and there are some ROM versions.</p>	<p>PIC17CXXX's are available from 4K – 32K bytes or 2K – 16K x16-bit words</p> <p>All devices are OTP and there are some ROM versions</p>
RAM	<p>AT90S4414 = 256 bytes</p> <p>AT90S8515 = 512 bytes</p>	<p>PIC16CXXX's are available from 36 – 368 bytes</p>	<p>PIC17CXXX' s are available from 232 – 902 bytes</p>
Interrupts	<p>AT90S4144 = 13</p> <p>AT90S8515 = 13</p>	<p>PIC16CXXX's are available from 3 to 12</p>	<p>PIC17CXXX's are available from 11 to 15</p>

The Truth About AVR

General Comparison Comments Heard (PIC16CXXX or PIC17CXXX) (Continued)

Feature	AVR	PIC16CXXX	PIC17CXXX
Most single clock cycle execution	An AVR claim of "most single cycle execution": In pure instruction counts the AT90S4144 or AT90S8515 has: 57 are 1-cycle or 47% 30 are 2-cycle or 25% 6 are 3 cycle or 5% 2 are 4 cycle or 2% 25 are 1-2 cycles or 21% of the 120 instructions	In the PIC16CXXX PICmicro: In pure instruction counts the x14 architecture has: 26 are 1 cycle or 74% 5 are 2 cycle or 15% 4 are 1-2 cycles or 11% of the 35 instructions	In the PIC17CXXX PICmicro: In pure instruction counts the x16 architecture has: 40 are 1 cycle or 69% 7 are 2 cycle or 12% 10 are 1-2 cycles or 17% 1 is 2-3 cycles or 2% of the 58 instructions
EEPROM Data Memory	AT90S4414 = 256 bytes AT90S8515 = 512 bytes	PIC16FXX's are available with 64 bytes	

Architecture Comparisons

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X, PIC16CXXX or PIC17CXXX	Comment
Instruction Set	89 for AT90S1200. 120 for all others. All are x16-bit word	33 for x12-bit word 35 for x14-bit word 58 for x16-bit word	
Stack	3 for AT90S1200. RAM size for all others	2 for x12-bit word 8 for x14-bit word 16 for x16-bit word	
Upward Migration & Registers	AT90S1200 contains 32 working registers which allows direct manipulation of data AT90S2313/4414/8515 contain the same 32 working registers and 128/256/512 RAM, respectively. Data must be transferred from RAM to the working registers, manipulated and then transferred back to RAM. Migrating from the AT90S1200 to these devices requires that the RAM data must be remapped and the program code modified / increased to accommodate data transfers and manipulation.	All PICmicro data manipulation remains the same on any device.	

The Truth About AVR

Architecture Comparisons (Continued)

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X, PIC16CXXX or PIC17CXXX	Comment
Register Space	<p>Limited by the instruction set to 64 total I/O registers</p> <p>Will limit the total number of peripherals allowed on any device</p>	<p>Limited only by the maximum data address reach.</p> <p>The maximum number is 512 bytes.</p> <p>The number of peripherals can be eight times greater than the AVR.</p>	
Register Set	<p>Limited to 32 working registers</p> <p>Context switching requires AVR device to update up to 32 registers from general purpose SRAM</p> <p>This would require 128 cycles for paging per context switch to a CALL and another 128 cycles for the RETURN</p>	<p>Limited to 512 bytes of general purpose address space in 4 banks of 128</p> <p>A context switch from one bank to another only requires one instruction cycle</p>	<p>This AVR feature is NOT C-compiler friendly</p>
Register Set Continued	<p>No direct I/O manipulation in the AT90S1200.</p> <p>No direct peripheral manipulation in the AT90S1200.</p> <p>All arithmetic and logical instructions must be carried out in a file register and then transferred to and from the I/O space</p> <p>Special instructions are required to address the I/O space in the AT90S1200.</p>	<p>The PICmicro instruction set is orthogonal</p> <p>All instructions can operate on any registers in one instruction cycle, including I/O registers</p>	

The Truth About AVR

Architecture Comparisons (Continued)

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X, PIC16CXXX or PIC17CXXX	Comment
Register Set Continued	<p>AVR is not capable of direct I/O bit manipulation for address above \$1Fh</p> <p>This could lead to problems with interrupts for example. An Interrupt flag register is read into a working file register. The user manipulates a bit in the working register to be written back to the interrupt registrar-general interrupt occurs while the user is modifying the current "shadow" register. The user writes the shadow register back to the interrupt register and overwrites the new pending interrupt flag and the interrupt is not serviced correctly</p>	<p>PICmicro does a read modify write instruction in one cycle</p>	
Program Counter	<p>PC is not an addressable register in the AT90S1200</p> <p>AT90S1200 does not have indirect jump. Not allowed to build jump tables</p>	<p>The PC is an addressable register</p> <p>Provides a user with the flexibility to add offset to the PC for fast jump tables</p>	
Read program memory	<p>AT90S1200 does not have this ability.</p>	<p>All PICmicro architectures give the user the ability to create non-volatile tables</p>	
C-Compiler Worthy?	<p>The AVR stack pointer is located in I/O space.</p> <p>The stack pointer contents must be read into the working register file in order to be modified and then written back.</p> <p>If an interrupt occurs during this time, this could lead to stack corruption</p>		

The Truth About AVR

Watchdog Timer

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X or PIC16CXXX	Comment
WDE - Watchdog enable bit	RAM enable bit which when cleared disables the WDT operation.	WDT, once enabled in configuration byte, always operates.	WDT, helps to recover from software error, AVR's WDT may not.
WDT delay interval	Typically 16uS to 2.05mS	Typically 18mS to 2.3S	By having a short delay, Slow crystal start-up times will cause a WDT reset
WDT reset	Always resets part	Wakes part from sleeps or resets part.	Useful as an additional timer

Comparator

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C62X/64X/66X	Comment
Number	1	2	
On chip Programming Voltage Reference	None	Yes	Useful to check different levels on comparator inputs
Configuration	1 mode	8 modes	
Output	Internal access only	Internal access or can be routed to Output pin	Useful for A/D techniques with low level analog signals or for adding hysteresis
Offset Voltage	20 mV Max.	10 mV Max.	
Propagation delay	500 nS typical	400 nS Max.	
Response time	750 ns	400 ns	
Noise rejection	None specified	-35 dB	
Settling time	None specified	10 uS Max.	

Oscillator

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X or PIC16CXXX	Comment
Internal RC accuracy (on AT90S1200 Only)	Not calibrated	Not Available on these devices. However, PIC12CXXX's (8-pin PICmicro MCU) are calibrated at factory to 5% at 25C/5V.	In PIC12CXXX can replace a crystal in some applications
External RC oscillator mode	No	Yes	External RC represents a low cost solution for clock
Crystal gain	Only 1 for DC to 20Mhz	3 gain levels: LP, XT and HS	Useful for power conservation.
32 kHz operation	32 kHz crystals can be damaged at high gain levels	LP mode gain is tuned for 32kHz crystals	AVR does not clearly specify operation below 2 MHz in Crystal mode
32 kHz Idd	Not specified	Typically 15uA	Low power, low Freq operation is not something which the AVR can do.

The Truth About AVR

Reset

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X or PIC16CXXX	Comment
Sources of Reset	Power On RESET pin WDT	Power On MCLR pin WDT. Brown Out (PIC16C62X/6XX/7XX)	
Power On Reset	Vdd = 1.8V-2.2V POR delay 2-4mS Reset delay 16mS	Vdd = 1.6V-1.8V POR delay 18mS (PIC16C5X) PWRT delay 72mS if enabled (PIC16C62X/6XX/7XX) OST delay 1024 clock cycles if enabled (PIC16C62X/6XX/7XX)	This indicates that the AVR has no OST for crystal stabilization AVR does not have a long delay PWRT for crystal start up modes
External Reset	RESET pin low for >2 clock cycle Reset delay 16mS typical FRST option on AT90S2313/4414/8515 or fast reset of 1 – 1.2mS Internal 100K-500K pull up resistor	MCLR pin low for >2 micro second No delay	
WDT Reset	WDT is enabled and disabled in SW The 16mS reset delay always follows WDT reset	WDT is program time enabled No delay after WDT reset	
Upon Reset Condition	No indication of what causes the reset	Status bits indicate the source of reset: Power on Brown out (PIC16CXXX) WDT Reset WDT Wake up MCLR during normal MCLR during sleep	
Delay Upon Wake Up from Sleep	The reset delay of 16mS (or 1.2mS fast reset) delay is always executed If a level triggered interrupt is used to wake-up from power down, the signal must be held for longer than 16ms Sleep must be enabled before the instruction is executed (and the sleep mode must be selected)	No delay for RC oscillator mode OST delay for LP, XT, and HS mode if enabled	

The Truth About AVR

Brown Out Reset (BOR)

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16C5X or PIC16CXXX	Comment
Brown Out Reset	Not available	Not Available (PIC16C5X) For PIC16CXXXs: Vdd < 4V (3.7-4.3V range)	

Timers / Counters (PIC16C5X or PIC16C62X)

Feature	AVR AT90S1200 or AT90S2313	PIC16C5X or PIC16C62X	Comment
Timer 0	Maximum External Clock is 8 MHz	Counter Mode Supports External Clocks Up To 50 MHz	
Timer 1	No External Oscillator Mode No Asynchronous Counter Mode No Prescaler for External Counter Mode Maximum External Clock is 8 MHz	Not Implemented at this time on PIC16C5X or PIC16C62X	

Timers / Counters (PIC16C6XXX or PIC16C7XXX)

Feature	AVR AT90S4414/8515	PIC16C6XXX or PIC16C7XXX	Comment
Timer 0	Maximum External Clock is 8 MHz	Counter Mode Supports External Clocks Up To 50 MHz	
Timer 1	No External Oscillator Mode No Asynchronous Counter Mode No Prescaler for External Counter Mode Maximum External Clock is 8 MHz	External Oscillator Mode Typically Used for Time Base for 32 kHz Oscillator Asynchronous Counter Mode Allows Wake-up From SLEEP Prescaler for External Counter Mode Counter Mode Supports External Clocks Up To 33.3 MHz	

Capture / Compare / PWM

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16CXXX	Comment
		Not Implemented at this time on PIC16C5X or PIC16C62X	
Capture Module	Capture Can Only Occur on The Next Edge	Capture Can Occur on 4th and 16th Edges	Increases Overall Capture Resolution on Period Events
Compare Module	No Special Trigger Mode	Special Trigger Mode	Used for Periodic Events

The Truth About AVR

Capture / Compare / PWM (Continued)

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16CXXX	Comment
PWM Module	<p>Only 8, 9, or 10 bit Resolution Available</p> <p>PWM Frequencies are Fixed Based on Resolution</p> <p>MAXIMUM PWM Frequency For 8-bits is Limited to 31.3 kHz</p> <p>Duty Cycle Period Register Control is Limited to 125 nS</p>	<p>User Selectable PWM Resolution from 1 to 10-bits</p> <p>PWM Frequency is User Selectable Based on Resolution</p> <p>10-bit PWM Frequency = 19.53 kHz</p> <p>9-bit PWM Frequency = 39.06 kHz</p> <p>8-bit PWM Frequency = 78.12 kHz</p> <p>7-bit PWM Frequency = 156.25 kHz ... and so on</p> <p>Duty Cycle Period Register Control is 50 nS</p>	

UART

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16CXXX	Comment
		Not Implemented at this time on PIC16C5X or PIC16C62X	
Type	UART	USART	Only asynchronous mode will be compared
Majority detect (noise rejection)	Yes	Yes	AVR uses the term noise rejection instead of "majority-detect."
Double buffer receive buffer	No	Yes	PICmicro can receive two character in a row
Synchronous mode	No	Yes	

I/O Structure

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16CXXX	Comment
Pull-up resistors	<p>100KΩ to 500KΩ</p> <p>The pin register should avoid that pull-up resistors are accidentally switched on</p> <p>Each port has its dedicated pin-register</p>	<p>The PIC16CXXX devices have pull-up resistors available on PORTB. They are either all enabled or all disabled.</p> <p>The value of the pull-up is between 100KΩ and 12.5KΩ @5V</p>	AVR does not provide the test parameters arithmetic, for their pull-up resistors. It is unclear if the given resistive range is valid for the entire voltage range.
PORT-pin interrupt	<p>Only external interrupt on either falling edge or rising edge or low level</p> <p>No interrupt on Pin Change</p>	<p>External Interrupt on either rising, falling on external interrupt pin (PIC16CXXX)</p> <p>Interrupt on Pin change</p>	

The Truth About AVR

I/O Structure

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16CXXX	Comment
Input buffer	ST	PORTA=TTL/ST, PORTB=TTL/ST, PORTC= ST, PORTD= TTL/ST	
Max DC current per I/O pin	20mA	25mA	
Max DC current for ALL I/O pin	80mA	200mA	

Sink/Source Currents (PIC16C5X or PIC16C62X)

Feature	AVR AT90S1200 or AT90S2313	PIC16C5X or PIC16C62X	Comment
Output source current (only typical values available for AVR)	4mA typ. 2mA typ.	25mA max 25mA max 20mA max (PIC16C5X)	V _{cc} =5.0V V _{cc} =3.0V
Output sink current (only typical values available for AVR)	28mA typ. 11mA typ.	25mA max 25mA max	V _{cc} =5.0V V _{cc} =3.0V
ESD Protection	No data	4,000 volts	
Input Clamp current	No data	20mA	

Sink/Source Currents (PIC16C6XX or PIC16C7XX)

Feature	AVR AT90S4414 or AT90S8515	PIC16C6XX or PIC16C7XX	Comment
Output source current (only typical values available for AVR)	10mA typ. 5mA typ.	25mA max 25mA max	V _{cc} =5.0V V _{cc} =2.7V
Output sink current (only typical values available for AVR)	20mA typ. 10mA typ.	25mA max 25mA max	V _{cc} =5.0V V _{cc} =2.7V

Current Consumption (PIC16C5X or PIC16C62X)

Feature	AVR AT90S1200 or AT90S2313	PIC16C5X or PIC16C62X	Comment
Supply current (only typical values available for AVR)	2.0mA / 2.5mA	1.4mA Typ	V _{cc} =3.0V 4MHZ
Supply current idle (only typical values available for AVR)	500μA / 800μA		V _{cc} =3.0V

The Truth About AVR

Current Consumption (PIC16C5X or PIC16C62X) (Continued)

Feature	AVR AT90S1200 or AT90S2313	PIC16C5X or PIC16C62X	Comment
Power down current (only typical values available for AVR)	15 μ A / 50 μ A <1 μ A / <1 μ A	6 μ A Typ 0.7 μ A Typ	WDT enabled, 3V WDT disabled, 3V

Current Consumption (PIC16C6XX or PIC16C7XX)

Feature	AVR AT90S4414 or AT90S8515	PIC16C6XX or PIC16C7XX	Comment
Supply current (only typical values available for AVR)	3.5mA	2.0mA Typ	V _{cc} =3.0V 4MHZ
Supply current idle (only typical values available for AVR)	1mA		V _{cc} =3.0V
Power down current (only typical values available for AVR)	50 mA <1mA	7.5mA Typ 0.9mA Typ	WDT enabled, 3V WDT disabled, 3V

EEPROM/FLASH Memory

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16F8X	Comment
Program memory endurance	1,000 cycles	10,000 cycles	
Data memory endurance	100K cycles	1M cycles typical	
Code protect	Individual read and write	Read and write together	
Program memory word erase/write	"CHIP ERASE" required for program memory.	Yes	Allows users to update one program location at a time (e.g. table updates, subroutine change, etc.)
Data EEPROM read accessible during EEPROM write	No	Yes	Allows users to continue full code execution (i.e. access to data EEPROM registers) while writing.
EEPROM interrupt	No	Yes	Interrupts (if enabled) when programming is complete so monitoring is not required.
Write error flag	No	Yes	Flags users if an external event (e. g. WDT timeout, MCLR reset) occurs during write and corrupts data.
Inadvertent programming	Sequence exists, but less robust	Special programming sequence to reduce chance of it	

The Truth About AVR

EEPROM/FLASH Memory (Continued)

Feature	AVR AT90S1200 or AT90S2313/4414/8515	PIC16F8X	Comment
Program memory write time	10mS bulk erase, No word erase. 2.5mS write at 5V to each word The CPU is halted for two cycles before the next instruction is executed (reads too)	5mS erase + 5mS write to each word	
Data memory write time	10mS erase, 2.5mS write at 5V to each byte	5mS erase + 5mS write to each byte	

Development Tools

Development Tool Support

Tool Class	AVR AT90S1200	Comments	PICmicro MCUs	Comments
Integrated Development Environment	Unknown		MPLAB	Supports Editing, Projects, Compiling, Assembling, Simulating, Emulating, Programming. FREE
Debugger	AVR Studio	Trace and watch windows, appears to be either serial or parallel interface, trace and customizable watch windows, not integrated with assembler, editor or compiler, no assembler symbolic debugging, no project support. FREE.	MPLAB	Symbolic debugging environment, supporting assembler, C compiler, other third party languages, trace windows, customizable watch windows, editor, projects, and specific features of each integrated tool. FREE.
Emulator Systems	AT90ICE1200	1 Complex breakpoint, conditional data break, appears to support only AT90S1200, simple device programmer (\$2495)	PICMASTER	Universal PICmicro support, full symbolic debugging, unlimited trace and break points, conditional data break, MPLAB compatible, high speed PC-ISA interface, demonstration board, \$2490
Low Cost Emulator System	Unknown		ICEPIC	Baseline and mid-range PICmicro support, full symbolic debugging, limited trace and break points, serial communication, \$799

The Truth About AVR

Development Tool Support (Continued)

Tool Class	AVR AT90S1200	Comments	PICmicro MCUs	Comments
Third Party Emulators	Unknown		ICEPIC Jr., ICEPIC II - RF Solutions, CEIBO, Dr. Krohn and Stiller, Parallax, SoftAid, Advanced Transdata, 12 additional manufacturers.	Broad market acceptance, providing a wide range of features with emulator systems starting at under \$300
Simulator Systems	AVR Studio	Peripheral simulation, break and trace, stimulus, no symbolic debugging with assembler. Not integrated with editor or assembler. FREE.	MPLAB-SIM	Universal simulator, integrated with MPLAB, peripheral simulation, unlimited break and trace, break on data, timestamps, animation capabilities, asynchronous stimulus, register injection from file. FREE
Third Party Simulators	Unknown		5 Manufacturers Available	Broad support of the PICmicro processor architecture.
Macro Assemblers	AVR Macro Assembler	No symbolic debugging information, windows based editor, limited macro capability, no conditional assembly, compatible with Studio product. FREE.	MPASM Universal Macro Assembler	Universal assembler, extensive macro capabilities, rich directive language, conditional assembly, enhanced pseudo instruction set for calls, goto's, and logical comparisons, MPLAB, MPLINK(1), and MPLIB(1) compatible. FREE.
Third Party Macro Assemblers	IAR (Not for AT90S1200)	2500 AD, Avocet, Hi-Tech, Parallax	Broad support of the PICmicro processor architecture.	
C Compilers	Unknown		MPLAB-C (2)	ANSI compatible compiler integrated MPLINK(1), MPLIB(1), MPLAB compatible, extensive PICmicro C library support including specific peripheral and interrupt routines, local and global optimization, reentrant, floating point support, in-line assembly support. \$695
Third Party C Compilers		IAR (not for AT90S1200)	Avocet, Byte Craft Limited, CCS, Hi-Tech	Broad support by industry leading developers of ANSI compatible and quick C vendors starting at \$99.

The Truth About AVR

Development Tool Support (Continued)

Tool Class	AVR AT90S1200	Comments	PICmicro MCUs	Comments
Third Party Basic Compiler	Unknown		Parallax, VersaTech	Good, quick application development.
Relocatable Linker	Unknown		MPLINK(Note 1)	Creates entire applications from single, multiple or libaried relocatable objects. Supports Relocatable objects created by MPASM or MPLAB-C(2).
Third Party Linkers		IAR (not for AT90S1200)	Avocet, Byte Craft Limited, Hi-Tech	Broad support of the PICmicro processor architecture.
Librarian	Unknown		MPLIB(1)	Universal librarian utility that allows logically grouped functions to be managed as a collection. Supports Relocatable objects created by MPASM or MPLAB-C.
Third Party Librarian		IAR (not for AT90S1200)	Avocet, Hi-Tech	
Device Programmers	Unknown	Status of stand alone device programmer unknown	PRO MATE II	Universal, CE Compliant, programs Microchip PICmicro's, memory products, and secure data products, production environment features, in-system programming capabilities, serialized programming, integrated with MPLAB, PC hosted or stand-alone, field upgradeable, \$695
Low Cost Device Programmer	AT90DEV 1200	Regulated power supplies, 8 push buttons, 8 I/O port LED interface, and simple programming capability. \$99.	PICSTART Plus	Universal, CE Compliant, programs all Microchip PICmicro's, integrated with MPLAB, field upgradeable, low cost, \$199, over 25,000 installed world wide
Third Party Device Programmers	Unknown		Data I/O, Logical Devices, BP Microsystems, Emulation Technology, Stag, Parallax, Advanced Transdata, 48 additional manufacturers	Extremely broad acceptance at a variety of price points with market rich features. Starting at \$29

The Truth About AVR

Development Tool Support (Continued)

Tool Class	AVR AT90S1200	Comments	PICmicro MCUs	Comments
Gang Programmers	Unknown		BP Microsystems, Advanced Transdata, 11 additional manufacturers	For high volume, production environments
Fuzzy Logic Development Kit	Unknown		fuzzyTech-MP - Inform Software Corporation	Windows compatible, 8-inputs - 4-outputs, MAX-MIN and MAX-DOT inference methods, CoM and MoM defuzzification methods, MPASM compatible, \$795. Explorer version with limited inputs and outputs \$195.
Application Development Kit	Unknown		MP-DriveWay - Aisys Limited	Windows based application code generator, visually configure peripherals, automatic initialization code generator and functional modules, MPLAB-C compatible. \$495.
Development Boards	AT90DEV12 00	Application development board, regulated power supply, 8 push buttons, 8 I/O port LED interface, simple programming capability. \$99.	PICDEM-1	Application development board, powers from emulator system or 9v supply, 3 buttons and 5K pot for analog input simulation, serial interface, 18, 28 and 40 pin sockets, 8 I/O port LED interface, generous prototyping area. \$99.
Note (1): MPASM, MPLINK and MPLIB are in development to support relocatable objects.				
Note (2): MPLAB-C Version 2.00 supporting features noted currently in development.				

The Truth About AVR

Miscellaneous Comments

- *“Atmel Shipping World’s First 8-bit Flash RISC Microcontroller.”* PRNewswire / June 9, 1997 / Atmel Corporation. **When actually, Microchip introduced the PIC16F84 and PIC16F83 8-bit Flash RISC Microcontroller in July 1996 and has shipped over 3 Million units to date.**
- *The AVR has two fuse bits, Serial Program Downloading (SPIEN), and fast startup (FSTRT).* **These fuse bits are not accessible during serial download and are not affected by a chip erase.** The AVR device can be ordered with FSTRT blown, and if you want In-Circuit Programming and that option, you must order it that way, with no chance of changing your mind.
- Even though *there are 89 instructions in the AT90S1200, there are 20 branch instructions and 4 skips.* These test flags in the SREG. Similarly, the 16 CLZ, SEI, CLV, etc. flag set/clear instructions offer no clear advantages of being separate instructions. In fact they seem redundant when you look at the BSET, BCLR, SBI and CBI instructions which can affect these same bit flags. It appears that these instructions were added to fix the problem of corrupting the register while it is being updated, you must use the CLZ, SEI, CLV, etc. instructions to guarantee integrity of the rest of the flags.
- On the AT90S1200 the LD and ST are used for indirect load and stores. **The PICmicro has the advantage**, because with the INDF register, the PICmicro can do most logical and arithmetic operations indirectly with one instruction. The AT90S1200 would require a <LD reg> then the operation <AND reg> then <ST reg>, whereas the PICmicro could simply do <ANDWF reg>.