

AVR093: Replacing AT90S1200 by ATtiny2313



1 Features

- AT90S1200 Errata Corrected in ATtiny2313
- Changes to Bit and Register names
- Changes to Interrupt Vector
- Oscillators and Selecting Start-up Delays
- Enhanced Watch Dog Timer
- Changes to EEPROM Writing
- Programming Interface
- Operational Voltage Ranges
- Changes to Electrical Characteristics

2 Introduction

This application note is a guide to assist current AT90S1200 users in converting existing designs to the ATtiny2313. In addition to the functional changes, the electrical characteristics of the ATtiny2313 are different including an increase in operating frequency because of a change in process technology. Refer to the data sheet for detailed information.

Improvements and added features that are not in conflict with those available in AT90S1200 are not listed in this document.

3 AT90S1200 Errata Corrected in ATtiny2313

The following items from the Errata Sheets of the AT90S1200 do not apply to the ATtiny2313. Refer to the AT90S1200 Errata Sheet for a more details.

3.1 Releasing Reset Condition without Clock

ATtiny2313 has a new reset circuit which for any External Reset Pulse exceeding the minimum pulse width t_{RST} causes an internal reset even though the condition disappears before any valid clock is present.

3.2 Reset During EEPROM Write

In ATtiny2313, the erroneous behavior of the EEPROM address register is no longer an issue. See the datasheet for general information about preventing EEPROM corruption.

3.3 Serial Programming at Voltages below 2.9V

In relation to the serial programming there are no restrictions on the supply voltage or system frequency as long as the device is operated within the voltage and frequency range specified in the data sheet for the ATtiny2313.

4 Changes to Names

The following control bits have changed names, but have the same functionality and placement when accessed as in AT90S1200.

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Table 1, Changed Bit Names

Bit Name in AT90S1200	Bit Name in ATtiny2313	I/O Register (AT90S1200)
SM	SM0	MCUCR
EEWE	EEPE	EECR

The following I/O Registers have changed names on ATtiny2313, but include the same functionality and location when accessed as in AT90S1200.

Table 2, Changed Register Names

Register name in AT90S1200	Register name ATtiny2313
TCCR0	TCCR0B

5 Changes to Interrupt vector

The interrupt vector table of the ATtiny2313 differs from the one of AT90S1200. Due to the added number of interrupts, the Timer0 Overflow interrupt and the Analog Comparator interrupt have been placed in new locations in the interrupt vector in ATtiny2313. Update the AT90S1200 code to reflect the new locations when porting code.

Table 3, Changes to Interrupt Vectors

Vector No.	Program Address	AT90S1200	ATtiny2313
1	0x0000	RESET	RESET
2	0x0001	INT0	INT0
3	0x0002	TIMER0, OVFO	INT1
4	0x0003	ANA_COMP	TIMER1 CAPT
5	0x0004		TIMER1 COMPA
6	0x0005		TIMER1 OVF
7	0x0006		TIMER0 OVF
8	0x0007		USART0 RX
9	0x0008		USART0 UDRE
10	0x0009		USART0 TX
11	0x000A		ANALOG COMP
12	0x000B		PCINT
13	0x000C		TIMER1 COMPB
14	0x000D		TIMER0 COMPA
15	0x000E		TIMER0 COMPB
16	0x000F		USI START
17	0x0010		USI OVERFLOW
18	0x0011		EE READY

19	0x0012		WDT OVERFLOW
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6 Oscillators and Selecting Start-up Delays

ATtiny2313 provides more Oscillators and Start-up Time options than AT90S1200.

The default clock source setting on AT90S1200 is crystal oscillator or external clock. The start-up delay is 16K WDT clock cycles which is typical 16ms at 5V.

The default clock source setting on ATtiny2313 is 1MHz sourced from the Internal RC Oscillator. The internal RC oscillator is set to run at 8MHz, but with the system clock prescaling preset to divide by 8. The default start-up delay is 65ms. There is no setting that results in a 16ms startup delay; 4ms or 64ms must be selected.

Fuses must be programmed to enable the ATtiny2313 to use the XTAL1 and XTAL2 pins as clock source as on the AT90S1200. The correct fuse setting for ATtiny2313 depend on if the selected clock source is external clock or a crystal oscillator, and which frequency it will be running at.

During wake-up from Power-down mode, the ATtiny2313 uses the CPU frequency to determine the delay of the wake-up delay, while AT90S1200 determines the delay from the WDT Oscillator frequency.

Follow the guidelines from the section “System Clock and Clock Options” in the ATtiny2313 data sheet to find appropriate clock settings and start-up values.

The crystal Oscillator in AT90S1200 is capable of driving an addition clock buffer from the XTAL2 output. The ATtiny2313 does not have a rail-to-rail swing on oscillator pins and can therefore not be used for this purpose. Note however that one could alternatively use the new Clock Out (CKOUT) feature to drive an additional clock buffer. Be aware that the CKOUT is located on PD2, which is also used for the External Interrupt 0.

7 Enhanced Watch Dog Timer

The ATtiny2313 has the Enhanced Watchdog Timer (WDT) and is improved compared to the one in AT90S1200.

If the WDT is not used, it is still recommended to disable it initially in the application code to clear unintentional WDT enabled events.

The frequency of the Watchdog Oscillator in ATtiny2313 is approximately to 128kHz for all supply voltages. The typical frequency of the Watchdog Oscillator in AT90S1200 is close to 1.0 MHz at 5V, but the Time-out period increases with decreasing VCC. This means that the selection of Time-out period for the Watchdog Timer (in terms of number of WDT Oscillator cycles) must be reconsidered when porting the design to ATtiny2313.

The disabling procedure of the WDT has changed from AT90S1200 to ATtiny2313. On ATtiny2313 a timed sequence is needed to disable an enabled WDT. In the same operation, write a logic one to WDCE and WDE. Within the next four clock cycles, in the same operation, write the WDE and WDP bits as desired, but with the WDCE bit cleared.

In AT90S1200, the Watchdog Timer is either enabled or disabled, while ATtiny2313 supports two safety levels selected by the WDTON Fuse.

If the operation voltage is 5V and the WDTON fuse is left unprogrammed, the WDT will behave similar on AT90S1200 and ATtiny2313.

Refer to the data sheet for ATtiny2313 or the Application note “AVR132 – Enhanced Watchdog Timer” for further information.

8 Changes to EEPROM Writing

8.1 EEPROM write sequence

The EEPROM write sequence has changed from AT90S1200 to ATtiny2313. Before setting the EEPE bit in EECR, the EEMPE must be set. Then within four clock cycles set the EEPE bit to program the EEPROM at the preselected address.

8.2 EEPROM write timing

In AT90S1200, the EEPROM write time is dependent on supply voltage, typically 2.5 ms @ VCC = 5V and 4 ms @ VCC = 2.7V. It is the internal RC oscillator that sources the EEPROM write time counter. The internal RC oscillator on ATtiny2313 is close to the calibrated value for all supply voltages. In ATtiny2313, the EEPROM write time will therefore always be 3.4ms.

Note: Changing the value in the OSCCAL Register affects the frequency of the calibrated RC Oscillator and hence the EEPROM write time.

9 Programming Interface

Changes have been made to the programming interfaces. The changes are valid for both low voltage serial programming and high voltage parallel programming.

- Programming of both flash and EEPROM is now done in pages instead of per byte. The EEPROM can however also be programmed pr byte over the serial interface.
- Added support for new fuses.

See the ATtiny2313 data sheet for details.

9.1 Fuse settings

AT90S1200 has 2 fuses. ATtiny2313 has 17 fuses. These fuses control many of the important features on the ATtiny2313 and setting of them is crucial for correct operation of the device. The fuses on ATtiny2313 are listed in Table 4, together with a suggested setting for "AT90S1200 compatibility". See the datasheet for ATtiny2313 for more information about the fuses.

Table 4, Fuse settings on ATtiny2313. Bits changed from default are marked in bold.

Fuse Byte	Bit	Name	Description	Default Value (1)(3)	AT90S1200 compatible setting (1)(2)
Extended Fuse Byte	7	–	–	1	1
	6	–	–	1	1
	5	–	–	1	1
	4	–	–	1	1
	3	–	–	1	1
	2	–	–	1	1
	1	–	–	1	1
	0	SPMEN	Self Programming Enable	1	1
High Fuse Byte	7	DWEN	debugWIRE Enable	1	1
	6	EESAVE	EEPROM memory is preserved through the Chip Erase	1	1
	5	SPIEN	Enable Serial Program and Data Downloading	0	0
	4	WDTON	Watchdog Timer always on	1	1
	3	BODLEVEL2	Brown-out Detector trigger level	1	1
	2	BODLEVEL1	Brown-out Detector trigger level	1	1
	1	BODLEVEL0	Brown-out Detector trigger level	1	1
	0	RSTDISBL	External Reset disable	1	1
L 0	7	CKDIV8	Divide clock by 8	0	1

	6	CKOUT	Output Clock on CKOUT pin	1	1
	5	SUT1	Select start-up time	1	0
	4	SUT0	Select start-up time	0	1
	3	CKSEL3	Select Clock source	0	1
	2	CKSEL2	Select Clock source	0	1
	1	CKSEL1	Select Clock source	1	0
	0	CKSEL0	Select Clock source	0	0

(1) 0 = programmed, 1 = unprogrammed

(2) Sets the clock setting for Crystal Oscillator 3-8MHz, with startup time from reset to 14CK+65ms. Note that the default setting on AT90S1200 gives a startup time of ~16ms. Refer to the ATtiny2313 datasheet for more information on clock and startup delay settings.

(3) Default fuse settings on ATtiny2313 give an equivalent setting as running AT90S1200 with its internal RC oscillator.

9.2 Device signatures

AT90S2313 has Signature Bytes: 0x1E 0x91 0x01.

ATtiny2313 has Signature Bytes: 0x1E 0x91 0x0A.

10 Operational Voltage Ranges

AT90S1200 can operate from 2.7 - 6.0V.

ATtiny2313 can operate from 1.8 - 5.5V.

11 Changes to Electrical Characteristics

The ATtiny2313 is produced in a different process than the AT90S1200 and electrical characteristics will thus differ between these devices. Please consult the data sheets for details on electrical characteristics.