
C51 General Information about Bootloader and In System Programming

Overview

This document describes the Atmel Bootloaders for 8051 family processors.

Abbreviations

- ISP: In-System Programming
- API : Applications Programming Interface



C51 Bootloaders

Application Note

7716A-8051-03/07



1. Introduction

This is a general document. Please refer to the datasheets of individual devices for more precise information.

2. Booting or Entry into the Bootloader

When the microcontroller exits reset it tests certain signals and flags to determine which of several possible actions it should take: Should it run your application from address 0000H (Reset address) or possibly from another address (on 256 byte page boundary) which you may define or should it enter the on-chip bootloader application program.

2.1 Hardware Conditions

The hardware conditions concern three I/Os :

- The PSEN signal (if available) is usually used as a means of forcing the execution of the bootloader and this signal is sampled at the exit of the reset state to see if the user is pulling it low at this time and thus requesting that the bootloader be executed irrespective of the other flags and conditions that may or may not be configured. Thus this signal is principle in forcing the entry of the microcontroller into the bootloader via what we refer to as the hardware conditions, a kind of safety net for the microcontroller. For Low Pin Count Product versions, PSEN I/O is not available and the hardware condition is defined with standard I/Os which can be configured by user. Please refer to the Bootloader datasheet of the Product.
- ALE must be left FLOATING
- EA must be directly tied to Vdd

Two important points must be remembered when using the PSEN for forcing entry into the bootloader :

(a)THE PSEN MUST NOT BE TIED PERMANENTLY TO GROUND !

Neglecting this can cause the device to become unresponsive as it is important that the PSEN be free to toggle at power-on !

(b)THE PSEN IS NORMALLY AN OUTPUT SO USE A PULLDOWN RESISTOR e.g. 1k ohm.

Neglecting this could possibly damage the device and will provoke superior current consumption than normal.

2.2 Boot Loader Jump Bit (BLJB)

This Non-Volatile flag bit can be used to force the microcontroller to always enter the bootloader after reset. Note that this bit is considered set (active) when it is at ZERO and there may be other registers whose values are important in ensuring that the bootloader is executed rather than the user application. Such is the case for example with the AT89C5131A device where two further non-volatile registers the BSB and SBV bytes play a role in deciding what application is finally executed.

3. The Bootloader Application.

If the microcontroller is directed to run the Atmel bootloader software then the microcontroller hardware is initialised to try to establish communications with a host system so that the microcontroller can be commanded to program its application memory etc. In accordance with Product features, different and specific Bootloader programs are provided which can use various communication channels eg. : UART, CAN, USB ...

The Bootloader is pre-programmed in the device at factory. But the customer can erase and reprogram at will parts which contain the bootloader in flash memory (check device datasheet) using a parallel programmer.

As an example, we describe the operation of the bootloader that communicates via the on-chip UART however the principles of operation are similar using other communications peripherals such as USB, CAN etc.

Refer to the Bootloader datasheets of each Atmel Product to get the protocol description.

4. Synchronization for UART

To synchronize the communications the UART bootloader expects an ASCII "U" character to be sent to it. This character is composed of alternating 101010.. bits and thus allows the bootloader to try to determine the number of clock cycles between each bit and thus estimate the appropriate baudrate of the communication. The microcontroller's capacity to match this baudrate is limited by its own clock frequency and the degree to which the timers can be adapted to generate this baudrate with the given clock frequency. This is why it is sometimes not possible to communicate with the bootloader at all baudrates especially at the highest speeds where the tolerance for error is lowest.

4.1 Communication for UART

The UART bootloader communicates via Intel HEX format record packets e.g. sending
:01001000559A

to the bootloader, instructs it to program a hexadecimal 55H at address 0010H in the Flash memory.

See the details in the appropriate device datasheet for further information on the commands available and the communications protocol. As the Intel HEX format is a format frequently used by compilers, assemblers, etc. for storing the program executable it is convenient that the bootloader can accept this format with little or no need for translation when programming. This does not however mean that you can just dump the hex file to the microcontroller as timing and handshaking is also important.

5. In System Programming (ISP)

The Program Flash of the parts can be programmed in ISP mode through the Bootloader. It can be done from a PC with an Atmel Software you can download from Atmel Web site : FLIP.

5.1 FLIP (FLexible In-system Programmer)

Is the free Atmel software that gives the user the friendly and powerful Graphical User Interface to the bootloader. The software communicates with the bootloader via Intel HEX records and turns on the Debug option in FLIP allowing you to watch the communications protocol in action. Nothing stops you from creating your own communications application to dialog with the bootloader you can even use Hyperterminal.

6. In Application Programming using API (Applications Programming Interface)

Many of the functions used in the bootloader are available via calls to the bootloader API. This means that the user's application program can make use of the bootloader program functions to perform actions that affect the microcontroller's configuration, memory contents etc. Invoking the API amounts essentially to configuring certain of the microcontroller registers with suitable values e.g. R0=09H DPTR=0100H and then executing a CALL instruction to the API address in the bootloader memory space e.g. 0FFF0H. When the function returns the requested operation has completed, you can also use this capability to force the execution of the bootloader from your application program. Beware all this power also allows you to block your microcontroller so that it can only be recovered with the "Hardware Conditions" or an external programmer so use this capability with care. For fuller details refer to the device datasheets. Note that no assumptions should be made as to the transparency of API calls or running of the bootloader, it is the responsibility of the user's program to ensure that all essential register contents are saved and that peripherals are properly reinitialised following execution of the bootloader software.

7. Conclusion

The bootloader software gives a powerful and flexible interface to the microcontroller which allows the device to be easily adapted and securely modified in the field.



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7716A-8051-03/07