Programming T89C51xx and AT89C51xx with Device Programmers

C51 Flash Microcontrollers

Application Note

Overview

Most of the new T89C51xx and AT89C51xx from Atmel have one, two, or three memory areas and configuration bytes while device programmers usually provide a single programming buffer.

This application note explains how to program Atmel T89C51xx and AT89C51xx microcontrollers with device programmers that use this type of single buffer.

Abbreviations

- T89C51xx : T89C51RD2, T89C51RB2/RC2, T89C51IC2, T89C51CC01, T89C51CC02, T89C51AC2, T89C5115.
- AT89C51xx : AT89C5130A, AT89C5131A, AT89C5131, AT89C5132, AT89C51RB2/RC2, AT89C51IC2, AT89C51RD2, AT89C51ED2, AT89C51SND1C, AT89C51SND2C and AT89C51CC03.
- ISP: In System Programming
- Bootloader: Atmel dedicated program located on chip to do In System Programming.
- XAF: EXtra Row Area: where dedicated bytes for ISP are located
- HSB: Hardware Security byte
- BSB: Boot Status Byte (XAF configuration byte used for starting ISP mode)
- SBV: Software Boot Vector: Bootloader starting address (an XAF configuration byte)
- SSB: Software Security Byte: Security information for ISP (an XAF configuration byte)
- EB: Extra Byte (an XAF configuration byte for general purpose use)

References

- 8051 products : T89C51RD2, T89C51RB2/RC2, T89C51IC2, T89C51AC2, AT89C51AC3, T89C5115, AT89C51RB2/RC2, AT89C51IC2, AT89C51RD2, AT89C51ED2 datasheets
- CAN Products : AT89C51CC03, T89C51CC01, T89C51CC02 datasheets
- MP3 Product : AT89C51SND1C, AT89C51SND2C datasheets
- USB Products : AT89C5130A, AT89C5131A, AT89C5131, AT89C5132 datasheets
- UART T89C51RD2, T89C51RB2/RC2,,T89C51IC2, T89C51CC01, T89C51CC02, T89C51AC2, AT89C51SND1C, AT89C51SND2C, T89C5115, AT89C5130A, AT89C5131A, AT89C5131, AT89C5132, AT89C51RB2/RC2, AT89C51IC2, AT89C51RD2, AT89C51ED2 bootloader datasheets

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- CAN T89C51CC01, T89C51CC02, AT89C51CC03 bootloader datasheets
- USB AT89C51SND1, AT89C5130A, AT89C5131A, AT89C5131, AT89C5132 bootloader datasheets

(A)T89C51xx Security Levels

Ready to be programmed using In-System Programming, Atmel (A)T89C51xx microcontrollers are distributed with the highest level of security that can be secured from any parallel reading access.

To program an Atmel (A)T89C51xx with a device programmer, a full chip erase operation must be achieved to remove all security levels.

For devices with bootloader program in Flash memory (T89C51RD2, T89C51CC01, T89C51CC02, AT89C51CC03, T89C51AC2, AT89C51AC3, AT89C51SND1C, AT89C51SND2C, T89C5115, AT89C5130A, AT89C5131A, AT89C5131, AT89C5132), this operation will **remove the bootloader program and set configuration bytes to default values**.

For devices with bootloader program in ROM memory (T89C51RB2/RC2, T89C51IC2, AT89C51RB2/RC2, AT89C51IC2, AT89C51RD2, AT89C51ED2), only **configuration bytes will be set to default values** when full chip erase will be performed.

(A)T89C51xx Memory Mapping

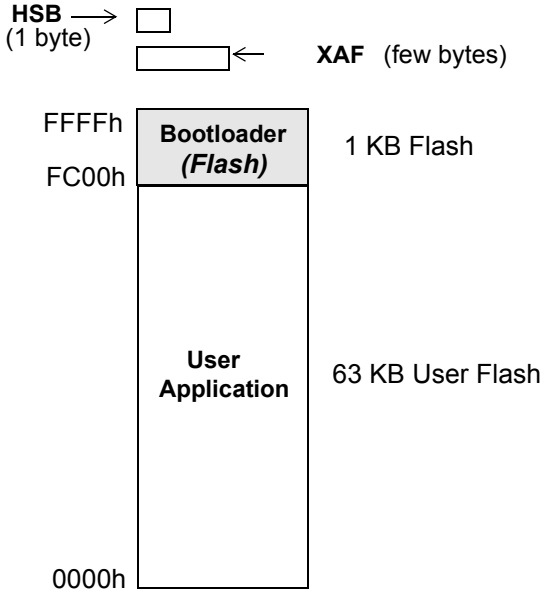
T89C51RD2

T89C51RD2 has the following memory areas:

- User memory area 64 KB size where the upper 1 KB is used for bootloader program.
- A hardware security byte for configuration information and security levels.
- XAF area for ISP:
  - Boot Status Byte (BSB)
  - Software Boot Vector (SBV)
  - Software Security Byte (SSB)

Note: Refer to T89C51RD2 datasheet and bootloader datasheet for HSB and XAF description.

Figure 1. T89C51RD2 Memory Mapping



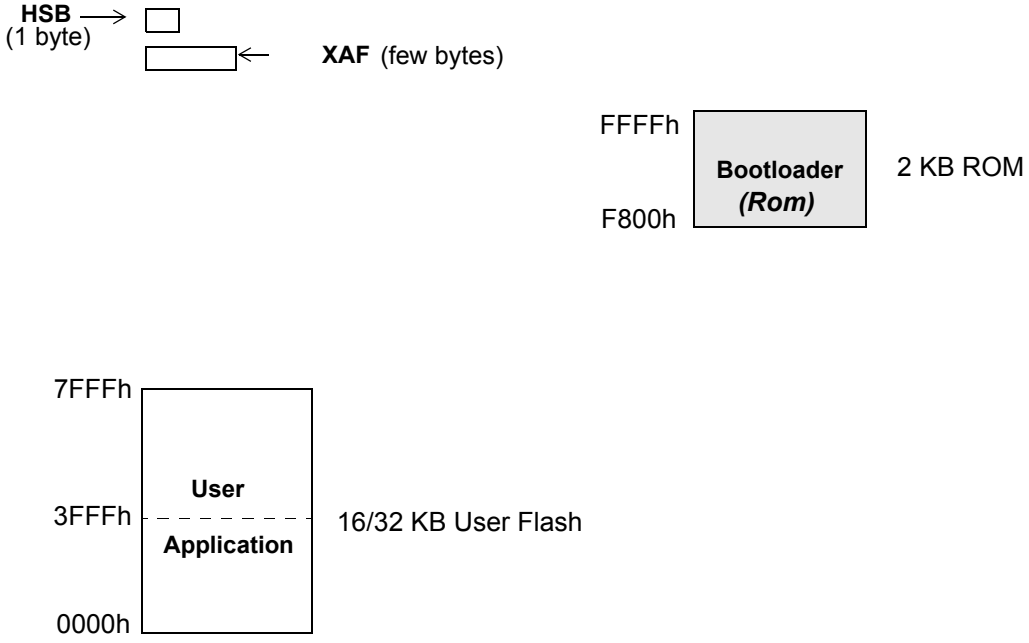
T89C51RC2/T89C51RB2/ T89C51IC2/AT89C51RB2/ AT89C51RC2

These products have the following memory areas:

- User memory area 16 - 32 KB size
- ROM bootloader memory 2 KB size
- Hardware security byte for configuration information and security levels.
- XAF area for ISP:
  - Boot Status Byte (BSB)
  - Software Boot Vector (SBV)
  - Software Security Byte (SSB)

Notes: 1. Refer to (A)T89C51RC2/RB2 or (A)T89C51IC2 datasheets and bootloader datasheets for HSB and XAF description
2. As bootloader is in ROM memory, no erase or write action is possible on this area.

Figure 2. (A)T89C51RC2/RB2/IC2 Memory Mapping



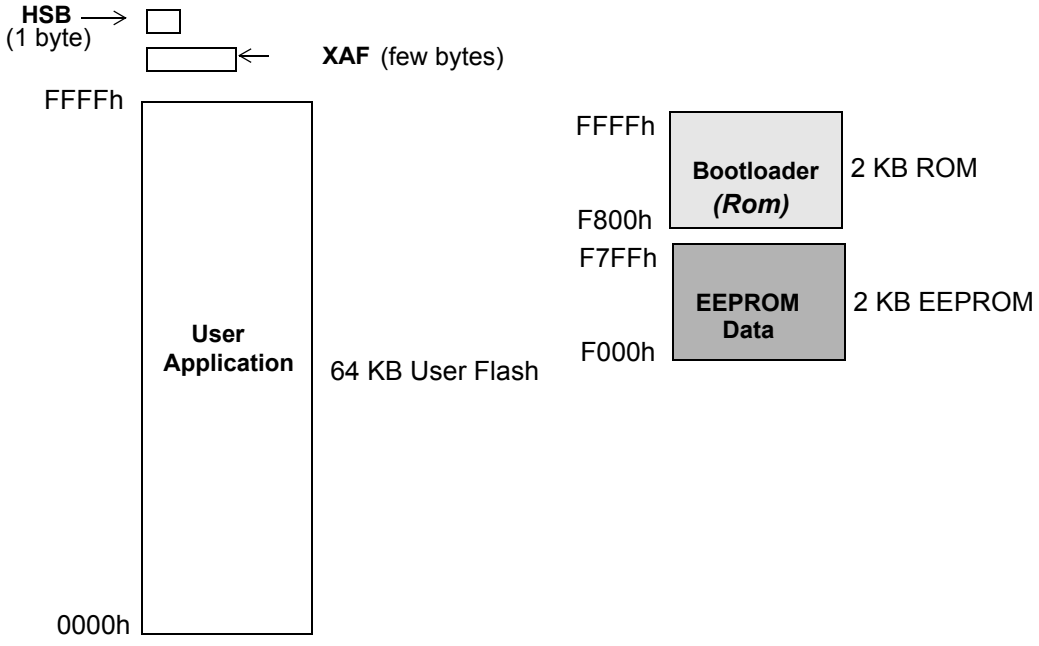
AT89C51RD2/ AT89C51ED2

These products have the following memory areas:

- User memory area 64 KB size
- ROM bootloader memory 2 KB size
- Data memory 2 KB size.
- Hardware security byte for configuration information and security levels.
- XAF area for ISP:
  - Boot Status Byte (BSB),
  - Software Boot Vector (SBV)
  - Software Security Byte (SSB)

Notes: 1. Refer to AT89C51RD2/ED2 datasheets and bootloader datasheets for HSB and XAF description
2. As bootloader is in ROM memory, no erase or write action is possible on this area.

Figure 3. AT89C51RD2, AT89C51ED2 Memory Mapping



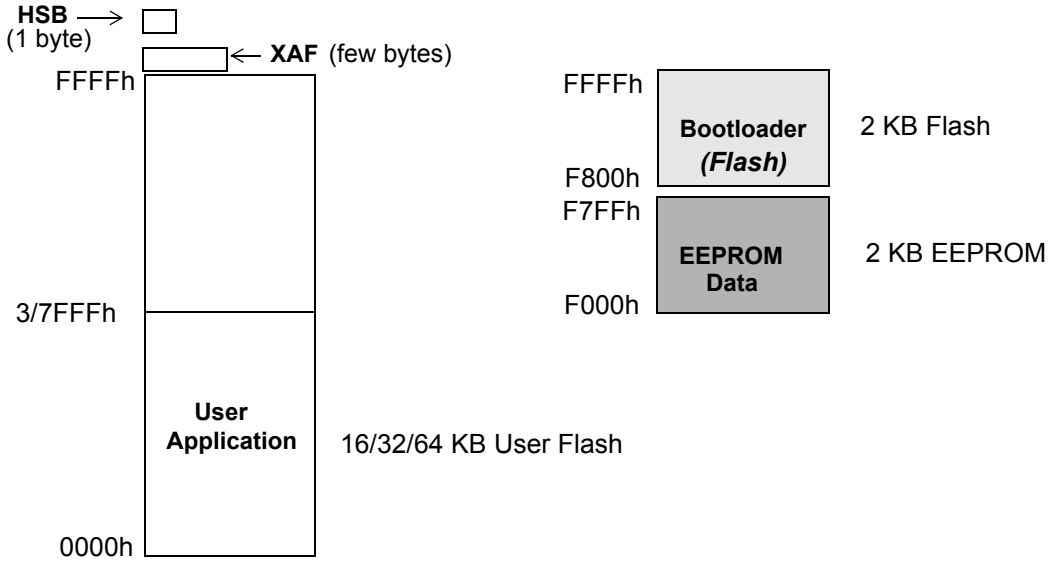
T89C51CC01/ T89C51CC02/T89C51AC2 /T89C5115/AT89C51CC03 /AT89C51AC3

T89C51CC01/T89C51CC02/T89C51AC2/T89C5115 have the following memory areas:

- User memory area 16-32-64 KB size
- Bootloader memory 2 KB size
- EEPROM data memory 2 KB size
- A hardware security byte for configuration information and security levels.
- XAF area for ISP:
  - Boot Status Byte (BSB)
  - Software Boot Vector (SBV)
  - Software Security Byte (SSB)
  - Extra Byte (EB)
  - Additional ISP bytes (Pn_F) (for T89C51CC02 and T89C5115 only)

Note: Refer to AT89C51CC03, T89C51CC01, T89C51CC02, T89C51AC2 or T89C5115 datasheets and bootloader datasheets for HSB and XAF description

Figure 4. T89C51AC2/CC01/CC02/15 and AT89C51CC03 Memory Mapping



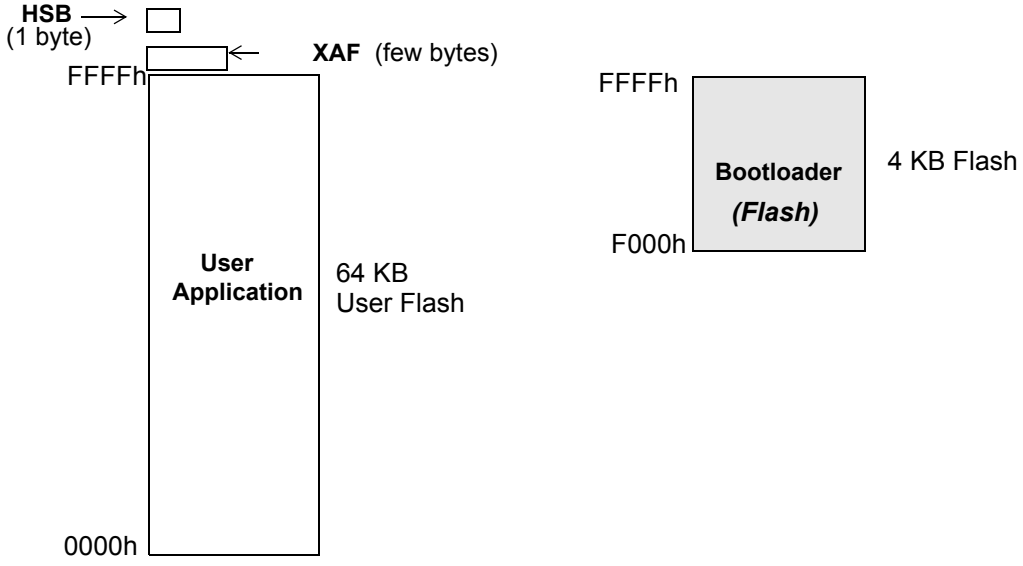
AT89C51SND1C/ AT89C51SND2C/ AT89C5132

AT89C51SND1 and AT89C5132 have the following memory areas:

- User memory area 64 KB size
- Bootloader memory 4 KB size
- Hardware security byte for configuration information and security levels.
- XAF area for ISP:
  - Software Boot Vector (SBV)
  - Software Security Byte (SSB)

Note: Refer to (A)T89C51SND1 and AT89C5132 datasheets and bootloader datasheets for HSB and XAF description

Figure 5. AT89C51SND1 and AT89C5132 Memory Mapping

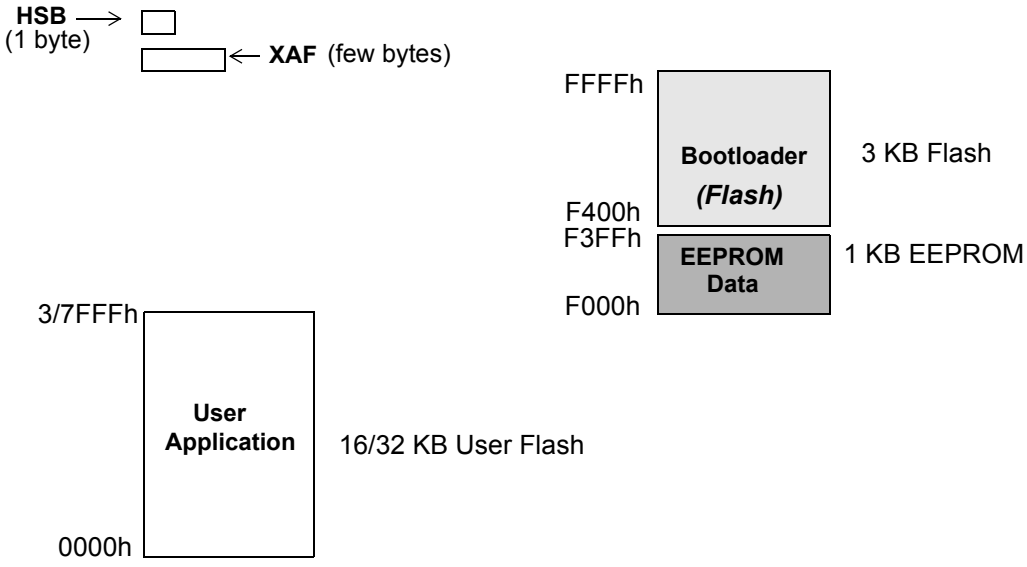


AT89C5130A, AT89C5131A, AT89C5131 have the following memory areas:

- User memory area 16/32 KB size
- Bootloader memory 3 KB size
- EEPROM data memory 1 KB size
- Hardware security byte for configuration information and security levels.
- XAF area for ISP:
  - Software Boot Vector (SBV)
  - Software Security Byte (SSB)

Note: Refer to AT89C5131 datasheet and bootloader datasheets for HSB and XAF description

Figure 6. AT89C5130/AT89C5131 Memory Mapping



Bootloader Programs

Bootloader programs are provided by Atmel. They are dedicated to a (A)T89C51xx, however they can differ for the same product depending on the communication interface for ISP.

- T89C51RD2: RS232 communication protocol
- (A)T89C51RC2/RB2/IC2: RS232 communication protocol
- AT89C51RD2/ED2: RS232 communication protocol
- T89C51CC01/CC02 and AT89C51CC03 : RS232 or CAN communication protocol
- T89C51AC2 and AT89C51AC3: RS232 communication protocol
- T89C5115: RS232 communication protocol
- AT89C51SND1C, AT89C51SND2C: USB communication protocol
- AT89C5130A, AT89C5131A, AT89C5131: USB communication protocol
- AT89C5132: USB communication protocol

Start address of bootloader program will be the upper address of the 64K address space when taking in account its size.

1 KB size: Start address: FC00h

2 KB size: Start address: F800h

4 KB size: Start address: F000h

etc.

The last updated release of bootloader program for each device is available on Atmel website : www.atmel.com.

Device Programmers

State of the Art

Due to historical reasons, most device programmers use a single buffer memory to load a file to program into the device.

Some have moved to separate buffers to adapt to these new (A)T89C51xx.

The usage of a single buffer to program or to read an Atmel (A)T89C51xx has major drawbacks:

- Since user memory and bootloader memory share the same address space, the bootloader program must be placed at a different address than the regular bootloader address.

A copy of the bootloader from the regular start address has to be placed in the proper bootloader start address in the buffer.

- When read, all areas are read.
- When program, all areas are programmed even if the user does not want to modify the bootloader program.
- When erase, all areas are erased, Bootloader must be reprogrammed for ISP purposes. Users have to download the bootloader program from Atmel website.

Even using a single buffer, some device programmers ask for the dedicated memory area which the user wants to access. In any case, whatever the buffer type and access to these memory areas, users have to be careful when using a device programmer to program Atmel (A)T89C51xx.

Programming Procedure

The procedure to program in the Atmel (A)T89C51xx for a dedicated user code and the bootloader program is the following:

1. First download from the Atmel website (www.atmel.com), the latest software release of bootloader program for the dedicated Atmel (A)T89C51xx.
2. On the device programmer, select the microcontroller to program.
3. Check on device programmer, the location of the different memory areas: **User memory**, **Bootloader memory**, **EEPROM data memory** and **Extra Row Area** (XAF).
4. Load the bootloader program in INTEL hex file format. This file will be placed in the buffer area at the start address of bootloader program (e.g: FC00h, F800h, F000h,...).
5. Move this buffer area from the start address to the regular address given by the programmer device.
6. Load the user program ensuring that the previous buffer is not cleared by a default value such as FFh or 00h.
7. The whole code: user application code + Bootloader program is now ready to be programmed. Select the program operation.
8. Remember to program XAF configuration bytes according to the configuration setup. This can be done either automatically or separately.
9. Program HSB: Hardware configuration information and product security levels.

CAUTION: To prevent the user code from parallel or ISP access, the user has to lock the device on the two following steps:

- The lock bits in HSB for parallel access
- The lock bits in SSB for ISP access

Programming EEPROM data memory will meet the same considerations as user or bootloader memory areas. This will prevent a the same non-correct programming place or non-desired memory erased.

Example

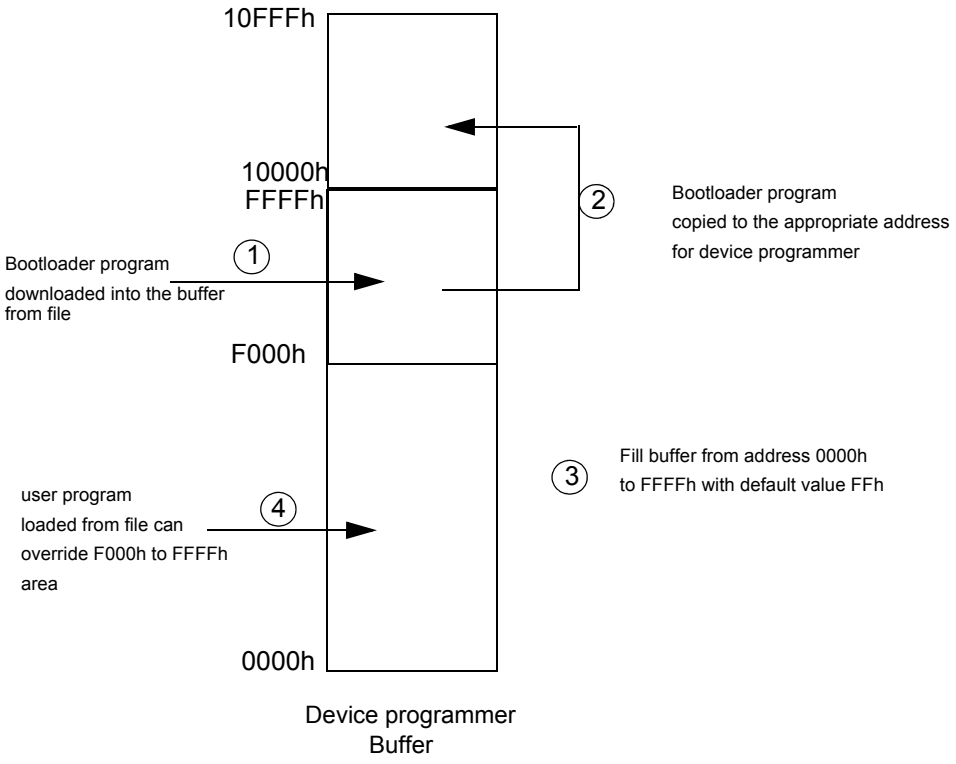
Purpose: Program a user code in a Atmel T89C51xx and the last bootloader program.

Prepare the programming buffer properly before program operations.

A bootloader program which will start at F000h to FFFFh should be located above the 64 KB in the buffer area at 10000h.

Sequence:

1. Load the bootloader program, check that the program starts at F000h.
2. Move or copy the buffer area between F000h and FFFFh to the destination address: 10000h.
3. Fill memory area from F000h to FFFFh with default value FFh.
4. Load the user program and be careful not to prefill buffer with a specific value.



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www.atmel.com/literature

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