



# Application Note

## BRT\_AN\_050

# FT9xx SD Bootloader

**Version 1.0**

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This application note describes the use of a SD Bootloader with the FT9xx series of MCU.

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# 1 Introduction

The FT9xx series of MCUs are shipped with a default bootloader. The bootloader provides boot support from UART and on-chip flash and a failsafe USB Device Firmware Update (DFU) option. Besides these, it also provides software based debug support. This application note describes an additional boot loading method from SD cards. This is achieved by using the bootloader chaining feature in the native bootloader of the FT9xx MCU.

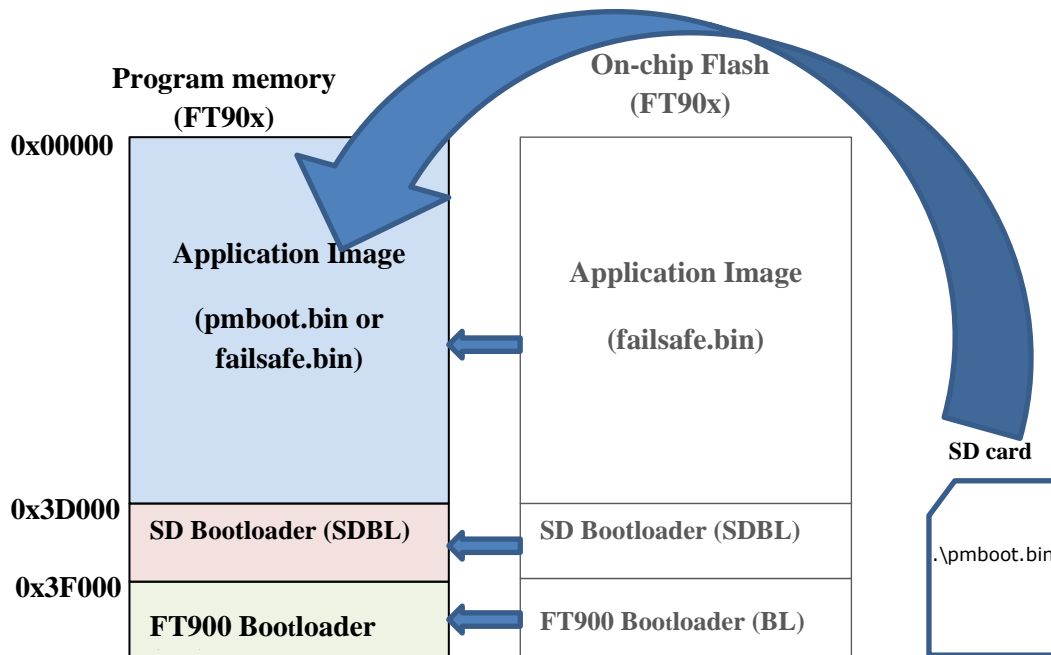
## 1.1 Overview

After a chip reset, the contents of the on-chip flash are copied to the program memory of the MCU and execution begins. The bootloader initializes the UART0 interface and waits for 200ms for a confirmation character from the host. If a confirmation character is received, then the bootloader remains in UART mode and responds to further commands. After the 200ms timeout, the bootloader proceeds to check if a valid program exists on the on-chip flash (copied to the program memory). If a valid program is found, then that program is executed. If no valid program is found, then the bootloader vectors into the USB DFU function. The USB DFU allows a new program to be flashed.

The vector is reprogrammable and may be pointed to a secondary bootloader. The secondary bootloader may store the original vector and if the secondary bootloader should fail, control may be transferred to the previous vector. Thus, a chain of bootloaders may be linked beginning from the vector.

This application note describes an example implementation of the above chain by inserting a SD bootloader as a secondary bootloader. The SD bootloader can read and execute programs stored on external SD cards. If a valid program is not found on the SD card, the bootloader then loads another program, called the failsafe program, which is stored in the on-chip flash.

Figure 1.1 shows a representation of the boot-loading order.



**Figure 1.1 Representation of boot-loading order**

## 1.2 Scope

The application note describes the SD bootloader setup and usage.

### 1.2.1 Features

Loading and executing programs from SD card.

## 2 Package

Folders\Files	Description
Project	FT9xx Eclipse C project folder used as a sample on-chip flash application that is a failsafe image when the booting from SD card fails.
Images\FT900\ FT900_SDBL+BL.bin	FT900 Bootloader and SD Bootloader image (size: 12K)
Images\FT900\ FT900_SDBL_debug+BL.bin	FT900 Bootloader and SD Bootloader image with debug prints enabled (size: 12K)
Images\FT900\failsafe.bin	On-chip flash application built for FT900 Debug configuration using the 'failsafe' eclipse project that is part of this package.
Images\FT900\failsafe+ SDBL+BL.bin	Single image that contains the failsafe flash application along with both the bootloaders.
Images\FT900\failsafe+ SDBL_debug+BL.bin	Single image that contains the failsafe flash application along with both the bootloaders. SD Bootloader with debug prints is used.
Images\FT930\ FT930_SDBL+BL.bin	FT930 Bootloader and SD Bootloader image (size: 12K)
Images\FT930\ FT930_SDBL_debug+BL.bin	FT930 Bootloader and SD Bootloader image with debug prints enabled (size: 12K)
Images\FT930\failsafe.bin	On-chip flash application built for FT930 Debug configuration using the 'failsafe' eclipse project that is part of this package.
Images\FT930\failsafe+SDBL+BL.bin	Single image that contains the failsafe flash application along with both the bootloaders.
Images\FT900\failsafe+ SDBL_debug+BL.bin	Single image that contains the failsafe flash application along with both the bootloaders. SD Bootloader with debug prints is used.
SDCardRoot\pmboot_ft900.bin	FT900 application image to be renamed to 'pmboot.bin' and then to be placed in the root folder of the SD card
SDCardRoot\pmboot_ft930.bin	FT930 application image to be renamed to 'pmboot.bin' and then to be placed in the root folder of the SD card
Tools\FT90xUartProg.exe	Bridgetek's Internal tool for programming via UART Boot mode of the Bootloader.
Tools\combine_image.py	Python script to combine the 'fail safe application image' and the bootloaders. Usage: <i>python combine_image.py "failsafe.bin" "FT930_SDBL+BL.bin"</i> This generates "output.bin" which is a concatenation of the input binary files to the script.

**Table 2.1 Package Files**

## 3 System Description

The FT90x has an on-chip flash capacity of 256KB and 4KB is used by the default bootloader and an additional 8KB is used by the SD bootloader. This leaves 244KB of flash capacity for user programs. The FT93x has an on-chip flash capacity of 128KB and 4KB is used by the default bootloader and an additional 8KB is used by the SD bootloader. This leaves 116KB of flash capacity for user programs.

The FT90x SD bootloader mounts the SD card as a FAT32 file system and looks for a program called, pmboot.bin in the root folder. This program is a regular FT9xx program compiled using the [FT9xx Toolchain](#). For this application note, "USB Example BOMS to SDcard" example from [AN\\_360 FT9xx Example Applications](#) has been compiled and renamed as pmboot.bin.

### 3.1 SD Bootloader

#### 3.1.1 Hardware

1. [MM900EV1B](#) for [FT90x](#)
2. [MM930Lite](#) for [FT93x](#)
3. [UMFTPD2A](#) Port C or [UART to USB converter cable](#)
4. SD card formatted with FAT32 file system

#### 3.1.2 Setup

1. Connect UART0 of FT9xx to the host PC using a UMFTPD2A Port C or a UART to USB converter cable.
2. Copy pmboot.bin to the root folder of SD card.

Run the FT90xUARTProg tool that is part of this release. After selecting the COM port for UART0 of the MM900EVxA board and the baud rate as 115200bps, Press 'Connect' button as shown in Figure 3.1.

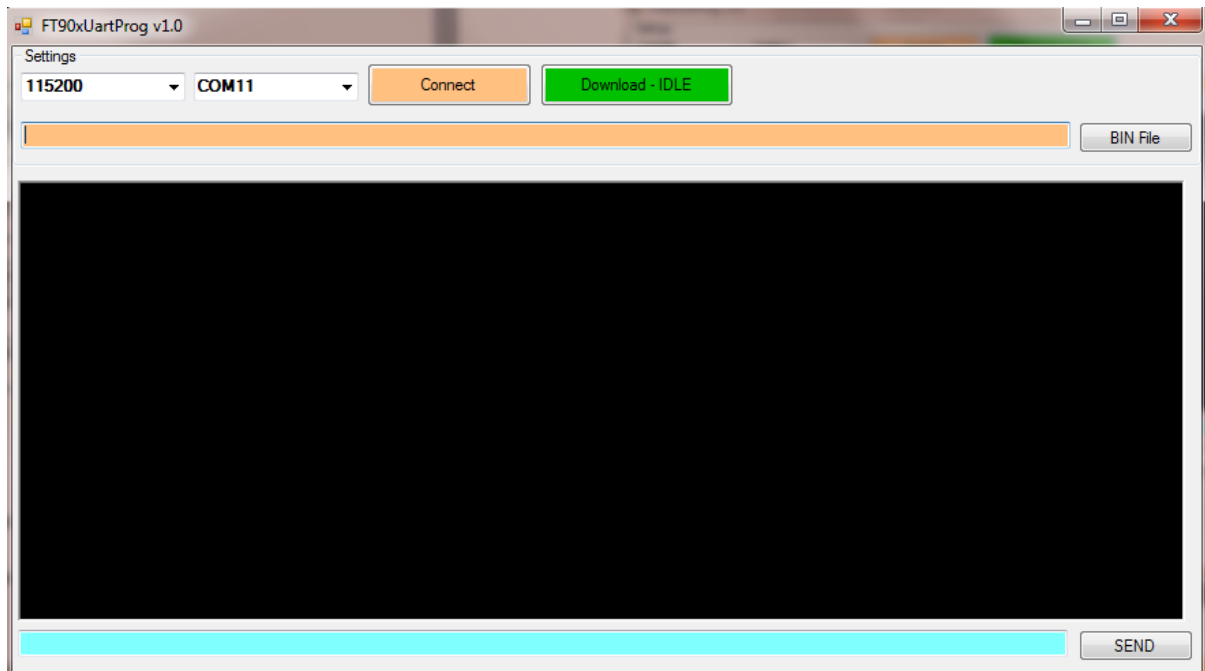


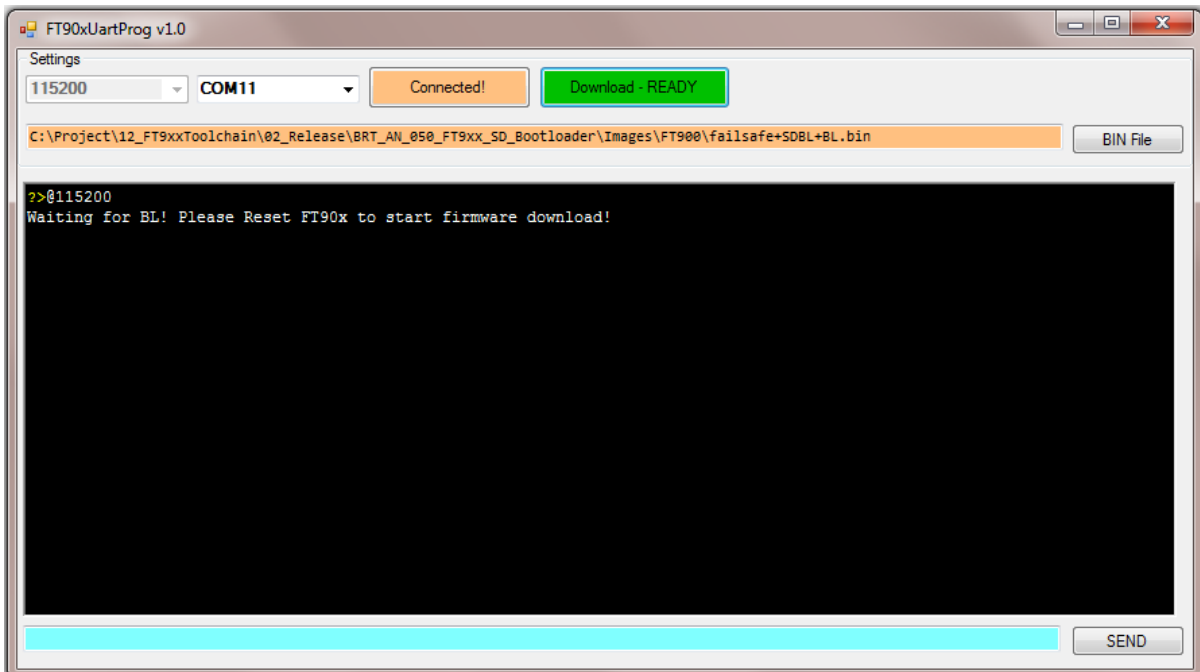
Figure 3.1 FT90xUARTProg Setup

In the entry field for 'BIN File', select the modified FT9xx bootloader binary (FT900\_BL\_v108.bin) from the release folder. Press 'Download - IDLE' button as shown in Figure 3.2.



**Figure 3.2 FT90xUARTProg Download**

The message is displayed from the UART interface as shown in Figure 3.3.



**Figure 3.3 FT90xUARTProg UART Message**

Reset the MCU and the tool will start programming the flash with the binary image. "Writing Sector N" is displayed as sectors are written (shown in green text on screen) as shown in Figure 3.4.

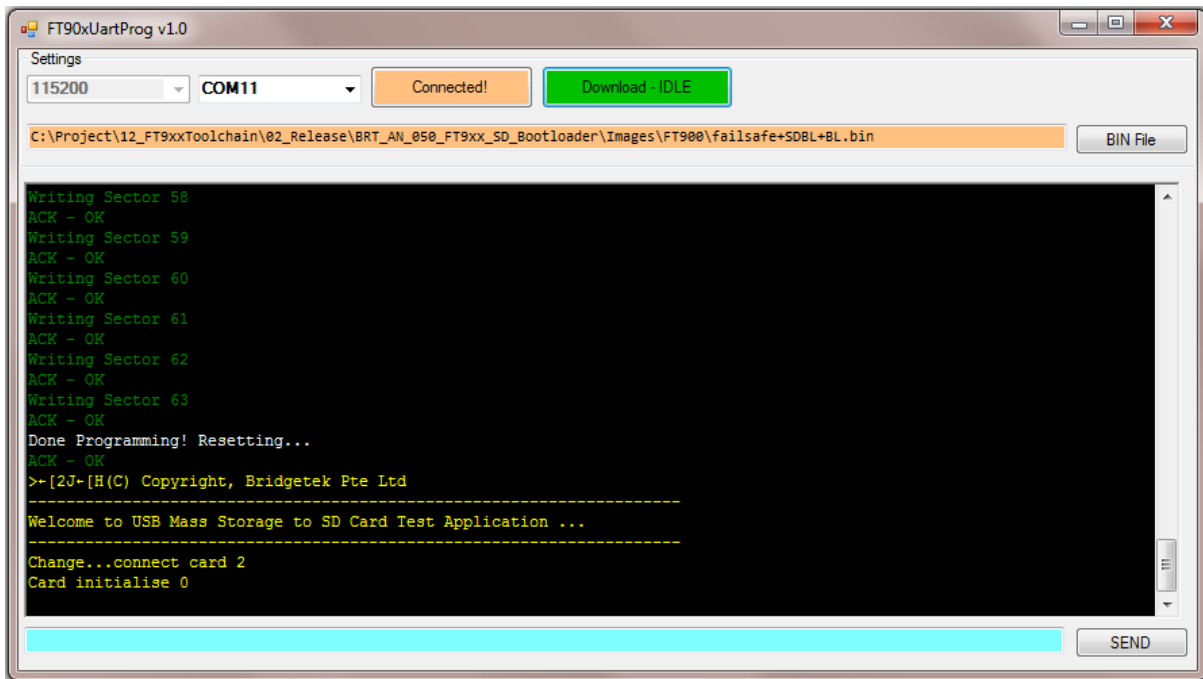


Figure 3.4 FT90xUARTProg Programming

After reset, pmboot.bin is automatically loaded from the SD card. Pmboot execution is observed on the screen as it prints the “Welcome to USB ...” message.

To test the failsafe mode, remove the SD card or delete the pmboot.bin file from the SD card. Reset the board and the SDBL jumps to the fail-safe program from on-chip flash. The failsafe program simply prints, “A failsafe program” as shown in Figure 3.5.

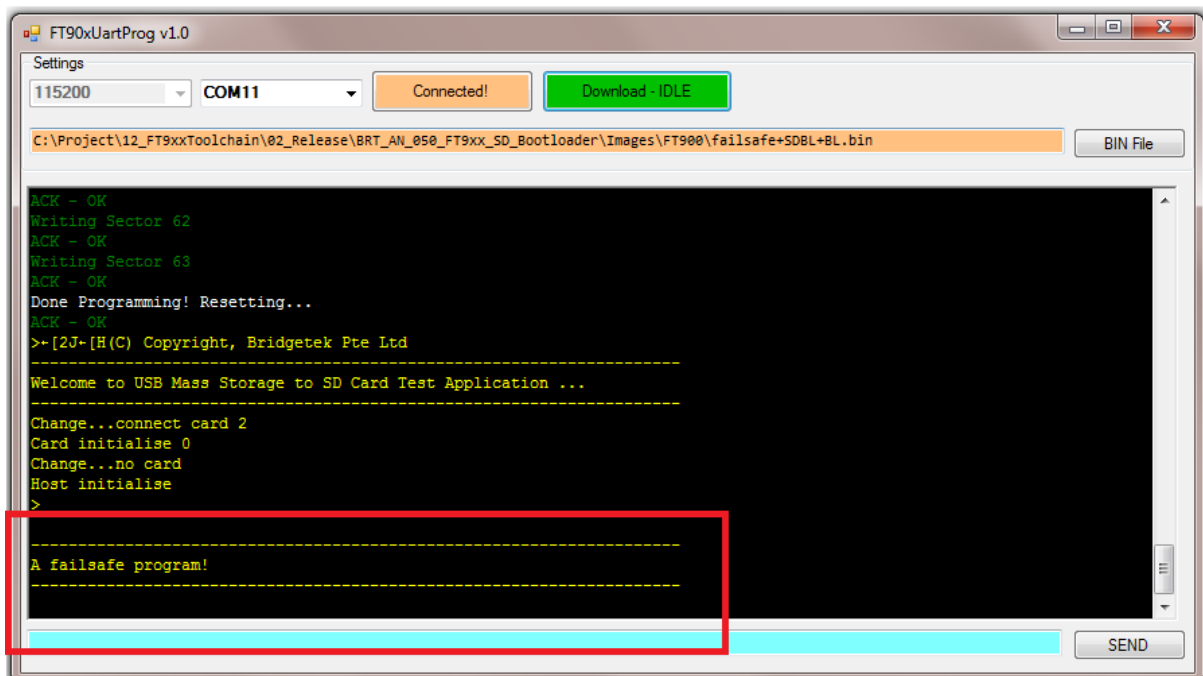


Figure 3.5 FT90xUARTProg Failsafe Program



## 4 Failsafe and pmboot.bin programs

The failsafe program and pmboot.bin programs are normal FT9xx programs built with the FT9xx Toolchain. The SDbootloader occupies 8KB and therefore, the failsafe and pmboot.bin shall not exceed the remainder of the flash capacity. This is 244KB for FT90x and 116KB for FT930x. The sample failsafe project contains a modified linker script to constrain this size automatically.

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## Appendix A – References

### Document References

[FT90x](#) Product Page

[FT93x](#) Product Page

[MM900EV1B](#)

[MM930Lite](#)

[UMFTPD2A](#)

[UART to USB converter cable](#)

[BRT\\_AN\\_020 FT90X Revision C User Manual](#)

[BRT\\_AN\\_010 FT93x User Manual](#)

[FT9xx Toolchain](#)

[AN\\_360 FT9xx Example Applications](#)

### Acronyms and Abbreviations

Terms	Description
USB	Universal Serial Bus
USB-IF	USB Implementers Forum
DFU	Device Firmware Upgrade
SD	Secure Digital

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## Appendix C – Revision History

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1.0	Initial Release	08-05-2021