

## STM32 microcontroller system memory boot mode

### Introduction

The bootloader is stored in the internal boot ROM (system memory) of STM32 devices, and is programmed by ST during production. Its main task is to download the application program to the internal Flash memory through one of the available serial peripherals (such as USART, CAN, USB, I<sup>2</sup>C, SPI). A communication protocol is defined for each serial interface, with a compatible command set and sequence.

This document applies to the products listed in [Table 1](#), referred to as STM32 throughout the document. It describes the supported peripherals and hardware requirements to consider when using the bootloader of STM32 devices. The specifications of the low-level communication protocol for each supported serial peripheral are detailed in separate documents (see [Section 2](#)).

**Table 1. Applicable products**

| Type             | Part number or product series  |
|------------------|--|
| Microcontrollers | STM32F0 Series: STM32F03xxx, STM32F04xxx, STM32F05xxx, STM32F07xxx, STM32F09xxx<br>STM32F1 Series<br>STM32F2 Series<br>STM32F3 Series: STM32F301xx, STM32F302xx, STM32F303xx, STM32F318xx, STM32F328xx, STM32F334xx, STM32F358xx, STM32F373xx, STM32F378xx, STM32F398xx<br>STM32F4 Series: STM32F401xx, STM32F405xx, STM32F407xx, STM32F410xx, STM32F411xx, STM32F412xx, STM32F413xx, STM32F415xx, STM32F417xx, STM32F423xx, STM32F427xx, STM32F429xx, STM32F437xx, STM32F439xx, STM32F446xx, STM32F469xx, STM32F479xx<br>STM32F7 Series: STM32F722xx, STM32F723xx, STM32F732xx, STM32F733xx, STM32F745xx, STM32F746xx, STM32F756xx, STM32F765xx, STM32F767xx, STM32F769xx, STM32F777xx, STM32F779xx<br>STM32G0 Series: STM32G030xx, STM32G031xx, STM32G041xx, STM32G07xxx, STM32G08xxx<br>STM32G4 Series: STM32G431xx, STM32G441xx, STM32G47xxx, STM32G48xxx<br>STM32H7 Series: STM32H72xxx, STM32H73xxx, STM32H74xxx, STM32H75xxx, STM32H7A3xx, STM32H7B3xx<br>STM32L0 Series<br>STM32L1 Series: STM32L100xx, STM32L151xx, STM32L152xx, STM32L162xx<br>STM32L4 Series: STM32L431xx, STM32L432xx, STM32L433xx, STM32L442xx, STM32L443xx, STM32L451xx, STM32L452xx, STM32L462xx, STM32L471xx, STM32L475xx, STM32L476xx, STM32L486xx, STM32L496xx, STM32L4A6xx, STM32L4R5xx, STM32L4R7xx, STM32L4R9xx, STM32L4S5xx, STM32L4S7xx, STM32L4S9xx, STM32L412xx, STM32L422xx, STM32L4P5xx, STM32L4Q5xx, STM32L431xx, STM32L432xx, STM32L433xx, STM32L442xx, STM32L443xx, STM32L451xx, STM32L452xx, STM32L462xx, STM32L471xx, STM32L475xx, STM32L476xx, STM32L486xx, STM32L496xx, STM32L4A6xx, STM32L4R5xx, STM32L4R7xx, STM32L4R9xx, STM32L4S5xx, STM32L4S7xx, STM32L4S9xx, STM32L412xx, STM32L422xx, STM32L4P5xx, STM32L4Q5xx<br>STM32L5 Series: STM32L552xx, STM32L562xx<br>STM32WB Series: STM32WB30xx, STM32WB35xx, STM32WB50xx, STM32WB55xx<br>STM32WL Series: STM32WLE5xx STM32WL55xx |

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# 1 General information

This document applies to Arm®<sup>(a)</sup>-based devices.

## 2 Related documents

For each supported product (listed in [Table 1](#)) refer to the following documents available from [www.st.com](http://www.st.com):

- Datasheet or databrief
- Reference manual
- Application notes
  - AN3154: *CAN protocol used in the STM32 bootloader*
  - AN3155: *USART protocol used in the STM32 bootloader*
  - AN3156: *USB DFU protocol used in the STM32 bootloader*
  - AN4221: *I2C protocol used in the STM32 bootloader*
  - AN4286: *SPI protocol used in the STM32 bootloader*
  - AN5405: *FDCAN protocol used in the STM32 bootloader*

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### 3 Glossary

#### F0 Series:

**STM32F03xxx** is used to refer to STM32F030x4, STM32F030x6, STM32F038x6, STM32F030xC, STM32F031x4 and STM32F031x6 devices.

**STM32F04xxx** is used to refer to STM32F042x4 and STM32F042x6 devices.

**STM32F05xxx and STM32F030x8 devices** is used to refer to STM32F051x4, STM32F051x6, STM32F051x8, STM32F058x8 and STM32F030x8 devices.

**STM32F07xxx** is used to refer to STM32F070x6, STM32F070xB, STM32F071xB STM32F072x8 and STM32F072xB devices.

**STM32F09xxx** is used to refer to STM32F091xx and STM32F098xx devices.

#### F1 Series:

**STM32F10xxx** is used to refer to Low-density, Medium-density, High-density, Low-density value line, Medium-density value line and High-density value line devices:

**Low-density devices** are STM32F101xx, STM32F102xx and STM32F103xx microcontrollers where the Flash memory density ranges between 16 and 32 Kbytes.

**Medium-density devices** are STM32F101xx, STM32F102xx and STM32F103xx microcontrollers where the Flash memory density ranges between 64 and 128 Kbytes.

**High-density devices** are STM32F101xx and STM32F103xx microcontrollers where the Flash memory density ranges between 256 and 512 Kbytes.

**Low-density value line devices** are STM32F100xx microcontrollers where the Flash memory density ranges between 16 and 32 Kbytes.

**Medium-density value line devices** are STM32F100xx microcontrollers where the Flash memory density ranges between 64 and 128 Kbytes.

**High-density value line devices** are STM32F100xx microcontrollers where the Flash memory density ranges between 256 and 512 Kbytes.

**STM32F105xx/107xx** is used to refer to STM32F105xx and STM32F107xx devices.

**STM32F10xxx XL-density** is used to refer to STM32F101xx and STM32F103xx devices where the Flash memory density ranges between 768 Kbytes and 1 Mbyte.

#### F2 Series:

**STM32F2xxxx** is used to refer to STM32F215xx, STM32F205xx, STM32F207xx and SMT32F217xx devices.

**F3 Series:**

**STM32F301xx/302x4(6/8)** is used to refer to STM32F301x4, STM32F301x6, STM32F301x8, STM32F302x4, STM32F302x6 and STM32F302x8 devices.

**STM32F302xB(C)/303xB(C)** is used to refer to STM32F302xB, STM32F302xC, STM32F303xB and STM32F303xC devices.

**STM32F302xD(E)/303xD(E)** is used to refer to STM32F302xD, STM32F302xE, STM32F303xD and STM32F303xE devices.

**STM32F303x4(6/8)/334xx/328xx** is used to refer to STM32F303x4, STM32F303x6, STM32F303x8, STM32F334x4, STM32F334x6, STM32F334x8, and STM32F328x8 devices.

**STM32F318xx** is used to refer to STM32F318x8 devices.

**STM32F358xx** is used to refer to STM32F358xC devices.

**STM32F373xx** is used to refer to STM32F373x8, STM32F373xB and STM32F373xC devices.

**STM32F378xx** is used to refer to STM32F378xC devices.

**STM32F398xx** is used to refer to STM32F398xE devices.

**F4 Series:**

**STM32F40xxx/41xxx** is used to refer to STM32F405xx, STM32F407xx, STM32F415xx and SMT32F417xx devices.

**STM32F401xB(C)** is used to refer to STM32F401xB and STM32F401xC devices.

**STM32F401xD(E)** is used to refer to STM32F401xD and STM32F401xE devices.

**STM32F410xx** is used to refer to STM32F410x8 and STM32F410xB devices.

**STM32F411xx** is used to refer to STM32F411xD and STM32F411xE devices.

**STM32F412xx** is used to refer to STM32F412Cx, STM32F412Rx, STM32F412Vx and STM32F412Zx devices.

**STM32F413xx/423xx** is used to refer to STM32F413xG, STM32F413xH and STM32F423xH devices.

**STM32F42xxx/43xxx** is used to refer to STM32F427xx, STM32F429xx, STM32F437xx and STM32F439xx devices.

**STM32F446xx** is used to refer to STM32F446xE and STM32F446xC devices.

**STM32F469xx/479xx** is used to refer to STM32F469xE, STM32F469xG, STM32F469xl, STM32F479xG and STM32F479xl devices.

**F7 Series:**

**STM32F72xxx/73xxx** is used to refer to STM32F722xx, STM32F723xx, STM32F732xx and STM32F733xx devices.

**STM32F74xxx/75xxx** is used to refer to STM32F745xx, STM32F746xx and STM32F756xx devices.

**STM32F76xxx/77xxx** is used to refer to STM32F765xx, STM32F767xx, STM32F769xx, STM32F777xx and STM32F779xx devices.

**G0 Series:**

**STM32G03xxx/04xxx** is used to refer to STM32G03xxx and STM32G04xxx devices.

**STM32G07xxx/08xxx** is used to refer to STM32G07xxx and STM32G08xxx devices.

**G4 Series:**

**STM32G431xx** is used to refer to STM32G431xx devices.

**STM32G441xx** is used to refer to STM32G441xx devices.

**STM32G47xxx** is used to refer to STM32G471xx, STM32G473xx and STM32G474xx devices.

**STM32G48xxx** is used to refer to STM32G483xx and STM32G484xx devices.

**H7 Series:**

**STM32H72xxx/73xxx** is used to refer to STM32H72xxx and STM32H73xxx devices.

**STM32H74xxx/75xxx** is used to refer to STM32H74xxx and STM32H75xxx devices.

**STM32H7A3xx/7B3xx** is used to refer to STM32H7A3xx/ STM32H7B3xx devices.

**L0 Series:**

**STM32L01xxx/02xxx** is used to refer to STM32L011xx and STM32L021xx devices.

**STM32L031xx/041xx** is used to refer to STM32L031xx and STM32L041xx devices.

**STM32L05xxx/06xxx** is used to refer to STM32L051xx, STM32L052xx, STM32L053xx, STM32L062xx and STM32L063xx ultralow power devices.

**STM32L07xxx/08xxx** is used to refer to STM32L071xx, STM32L072xx, STM32L073xx, STM32L081xx, STM32L082xx and STM32L083xx devices

**L1 Series:**

**STM32L1xxx6(8/B)** is used to refer to STM32L1xxV6T6, STM32L1xxV6H6, STM32L1xxR6T6, STM32L1xxR6H6, STM32L1xxC6T6, STM32L1xxC6H6, STM32L1xxV8T6, STM32L1xxV8H6, STM32L1xxR8T6, STM32L1xxR8H6, STM32L1xxC8T6, STM32L1xxC8H6, STM32L1xxVBT6, STM32L1xxVBH6, STM32L1xxRBT6, STM32L1xxRBH6, STM32L1xxCBT6 and STM32L1xxCBH6 ultralow power devices.

**STM32L1xxx6(8/B)A** is used to refer to STM32L1xxV6T6-A, STM32L1xxV6H6-A, STM32L1xxR6T6-A, STM32L1xxR6H6-A, STM32L1xxC6T6-A, STM32L1xxC6H6-A, STM32L1xxV8T6-A, STM32L1xxV8H6-A, STM32L1xxR8T6-A, STM32L1xxR8H6-A, STM32L1xxC8T6-A, STM32L1xxC8H6-A, STM32L1xxVBT6-A, STM32L1xxVBH6-A, STM32L1xxRBT6-A, STM32L1xxRBH6-A, STM32L1xxCBT6-A and STM32L1xxCBH6-A ultralow power devices.

**STM32L1xxxC** is used to refer to STM32L1xxVCT6, STM32L1xxVCH6 , STM32L1xxRCT6, STM32L1xxUCY6, STM32L1xxCCT6 and STM32L1xxCCU6 ultralow power devices.

**STM32L1xxxD** is used to refer to STM32L1xxZDT6, STM32L1xxQDH6, STM32L1xxVDT6, STM32L1xxRDY6, STM32L1xxRDT6, STM32L1xxZCT6, STM32L1xxQCH6, STM32L1xxRCY6, STM32L1xxVCT6-A and STM32L1xxRCT6-A ultralow power devices.

**STM32L1xxxE** is used to refer to STM32L1xxZET6, STM32L1xxQEHE6, STM32L1xxVET6, STM32L1xxVEY6, and STM32L1xxRET6 ultralow power devices.

**L4 Series:**

**STM32L412xx/422xx** is used to refer to STM32L412xB, STM32L412x8, STM32L422xB devices.

**STM32L43xxx/44xxx** is used to refer to STM32L431xx, STM32L432xx, STM32L433xx and STM32L442xx and STM32L443xx devices.

**STM32L45xxx/46xxx** is used to refer to STM32L451xx, STM32L452xx and STM32L462xx devices.

**STM32L47xxx/48xxx** is used to refer to STM32L471xx, STM32L475xx, STM32L476xx and STM32L486xx devices.

**STM32L496xx/4A6xx** is used to refer to STM32L496xE, STM32L496xG and STM32L4A6xG devices.

**STM32L4Rxxx/4Sxxx** is used to refer to STM32L4R5xx, STM32L4R7xx, STM32L4R9xx, STM32L4S5xx, STM32L4S7xx and STM32L4S9xx devices.

**STM32L4P5xx/4Q5xx** is used to refer to STM32L4P5xx/STM32L4Q5xx devices.

**L5 Series:**

**STM32L552xx** is used to refer to STM32L552xx devices.

**STM32L562xx** is used to refer to STM32L562xx devices.

**WB Series:**

**STM32WB30xx** is used to refer to STM32WB30xx devices.

**STM32WB35xx** is used to refer to STM32WB35xx devices.

**STM32WB50xx** is used to refer to STM32WB50xx devices.

**STM32WB55xx** is used to refer to STM32WB55Cx, STM32WB55Rx and STM32WB55Vx devices.

**WL Series:**

**STM32WLE5xx** is used to refer to STM32WLE5JC, STM32WLE5JB and STM32WLE5J8 devices.

**STM32WL55xx** is used to refer to STM32WL55xx devices.

**Note:**

*BL\_USART\_Loop refers to the USART bootloader execution loop.*

*BL\_CAN\_Loop refers to the CAN bootloader execution loop.*

*BL\_I2C\_Loop refers to the I2C bootloader execution loop.*

*BL\_SPI\_Loop refers to the SPI bootloader execution loop.*

## 4 General bootloader description

### 4.1 Bootloader activation

The bootloader is activated by applying one of the patterns described in [Table 2](#).

If Boot from Bank2 option is activated (for products supporting this feature), bootloader executes Dual Boot mechanism as described in figures “Dual bank boot implementation for STM32xxxx” where STM32xxxx is the relative STM32 product (example: [Figure 8](#)), otherwise bootloader selection protocol is executed as described in figures “Bootloader VY.x selection for STM32xxxx” where STM32xxxx is the relative STM32 product (example: [Figure 19](#)).

When readout protection Level2 is activated, STM32 does not boot on system memory in any case and bootloader cannot be executed (unless jumping to it from Flash user code, all commands are not accessible except Get, GetID, and GetVersion).

**Table 2. Bootloader activation patterns**

| Pattern   | Condition  |
|-----------|--|
| Pattern 1 | Boot0(pin) = 1 and Boot1(pin) = 0  |
| Pattern 2 | Boot0(pin) = 1 and nBoot1(bit) = 1   |
| Pattern 3 | Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 1<br>Boot0(pin) = 0, BFB2(bit) = 0 and both banks do not contain valid code<br>Boot0(pin) = 1, Boot1(pin) = 0, BFB2(bit) = 0 and both banks do not contain valid code                                 |
| Pattern 4 | Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 1<br>Boot0(pin) = 0, BFB2(bit) = 0 and both banks do not contain valid code<br>Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 0   |
| Pattern 5 | Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 0<br>Boot0(pin) = 0, BFB2(bit) = 1 and both banks do not contain valid code<br>Boot0(pin) = 1, Boot1(pin) = 0 and BFB2 (bit) = 1  |
| Pattern 6 | Boot0(pin) = 1, nBoot1(bit) = 1 and nBoot0_SW(bit) = 1<br>nBoot0(bit) = 0, nBoot1(bit) = 1 and nBoot0_SW(bit) = 0<br>Boot0(pin) = 0, nBoot0_SW(bit) = 1 and main Flash memory empty<br>nBoot0(bit) = 1, nBoot0_SW(bit)=0 and main Flash memory empty |
| Pattern 7 | Boot0(pin) = 1, nBoot1(bit) = 1 and BFB2(bit) = 0<br>Boot0(pin) = 0, BFB2(bit) = 1 and both banks do not contain valid code<br>Boot0(pin) = 1, nBoot1(bit) = 1 and BFB2(bit) = 1   |
| Pattern 8 | Boot(pin) = 0 and BOOT_ADD0(optionbyte) = 0x0040<br>Boot(pin) = 1 and BOOT_ADD1(optionbyte) = 0x0040   |

**Table 2. Bootloader activation patterns (continued)**

| <b>Pattern</b> | <b>Condition</b>  |
|----------------|---|
| Pattern 9      | nDBANK(bit) = 1, Boot(pin) = 0 and BOOT_ADD0(optionbyte) = 0x0040   |
|                | nDBANK(bit) = 1, Boot(pin) = 1 and BOOT_ADD1(optionbyte) = 0x0040   |
|                | nDBANK(bit) = 0, nDBOOT(bit) = 1, Boot(pin) = 0 and BOOT_ADD0(optionbyte) = 0x0040  |
|                | nDBANK(bit) = 0, nDBOOT(bit) = 1, Boot(pin) = 1 and BOOT_ADD1(optionbyte) = 0x0040  |
|                | nDBANK(bit) = 0, nDBOOT(bit) = 0, BOOT_ADDx(optionbyte) out of memory range or in ICP memory range  |
| Pattern 10     | nDBANK(bit) = 0, nDBOOT(bit) = 0, BOOT_ADDx(optionbyte) in Flash memory range and both banks do not contain valid code  |
|                | Boot(pin) = 0 and BOOT_ADD0(optionbyte) = 0x1FF0  |
| Pattern 11     | Boot(pin) = 1 and BOOT_ADD1(optionbyte) = 0x1FF0  |
|                | nBoot0(bit) = 0, nBoot1(bit) = 1, nBOOT0_SEL(bit) = 1 and BOOT_LOCK(bit) = 0  |
|                | Boot0(pin) = 1, nBoot1(bit) = 1 and nBOOT0_SEL(bit) = 1   |
|                | nBoot0(bit) = 1, nBOOT0_SEL(bit) = 1, BOOT_LOCK(bit) = 0 and main Flash memory empty  |
|                | Boot0(pin) = 0, nBOOT0_SEL(bit) = 0, BOOT_LOCK(bit) = 0 and main Flash memory empty   |
| Pattern 12     | BOOT_LOCK(bit) = 1 and main Flash memory empty  |
|                | TZen = 0, Boot0(pin) = 0, nSWBoot0(bit) = 1 and NSBOOTADD0 [24:0] = 0x017F200   |
|                | TZen = 0, Boot0(pin) = 1, nSWBoot0(bit) = 1 and NSBOOTADD1 [24:0] = 0x017F200   |
|                | TZen = 0, nBoot0(bit) = 0, nSWBoot0(bit) = 0 and NSBOOTADD1 [24:0] = 0x017F200  |
|                | TZen = 0, nBoot0(bit) = 1, nSWBoot0(bit) = 0 and NSBOOTADD0 [24:0] = 0x017F200  |
|                | TZen = 1, Boot0(pin) = 0, nSWBoot0(bit) = 1 and SECBOOTADD0 [24:0] = 0x01FF000 & RSSCMD = 0   |
|                | TZen = 1, Boot0(pin) = 1, nSWBoot0(bit) = 1 & RSSCMD = 0, BOOT_LOCK=0 or (BOOT_LOCK = 1 and SECBOOTADD0 [24:0] = 0x01FF000)                                     |
|                | TZen = 1, nBoot0(bit) = 1, nSWBoot0(bit) = 0 and SECBOOTADD0 [24:0] = 0x01FF000 & RSSCMD = 0, BOOT_LOCK=0 or (BOOT_LOCK = 1 and SECBOOTADD0 [24:0] = 0x01FF000) |
|                | TZen = 1, nBoot0(bit) = 0, nSWBoot0(bit) = 0 & RSSCMD = 0, BOOT_LOCK=0 or BOOT_LOCK = 1 and SECBOOTADD1 [24:0] = 0x01FF000                                      |
| Pattern 13     | TZen = 1, RSSCMD = 0x1C0, BOOT_LOCK=0 or (BOOT_LOCK = 1 and SECBOOTADD0 [24:0] = 0x01FF000)   |
|                | nBoot0(bit) = 0, nBoot1(bit) = 1 and nSWBoot0(bit) = 0  |
|                | nBoot0(bit) = 1, nBoot1(bit) = 1, nSWBoot0(bit) = 0 and user Flash empty  |
|                | nBoot1(bit) = 1, nSWBoot0(bit) = 1 and Boot0(pin) = 1   |
|                | nBoot1(bit) = 1, nSWBoot0(bit) = 1, Boot0(pin) = 0 and user Flash empty   |

**Table 2. Bootloader activation patterns (continued)**

| Pattern    | Condition   |
|------------|---|
| Pattern 14 | BOOT_LOCK(bit) = 0, nBoot1(bit) = 1, Boot0(pin) = 1 and nSWBoot0(bit) = 1                                   |
|            | BOOT_LOCK(bit) = 0, nBoot1(bit) = 1, nBoot0(bit) 0 and nSWBoot0(bit) = 0                                    |
|            | BOOT_LOCK(bit) = 0, Boot0(pin) = 0, nSWBoot0(bit) = 1, BFB2(bit)=1 and both banks do not contain valid code |
|            | BOOT_LOCK(bit) = 0, nBoot0(bit), nSWBoot0(bit) = 0, BFB2(bit)=1 and both banks do not contain valid code    |
| Pattern 15 | BOOT_LOCK(bit)=0, Boot0(pin) = 1, nBoot1(bit) = 1 and nBoot0_SW(bit) = 1                                    |
|            | BOOT_LOCK(bit)=0, nBoot0(bit) = 0, nBoot1(bit) = 1 and nBoot0_SW(bit) = 0                                   |
| Pattern 16 | Boot0(pin) = 1, nBoot1(bit) = 1 and nBoot0_SW(bit) = 1  |
|            | nBoot0(bit) = 0, nBoot1(bit) = 1 and nBoot0_SW(bit) = 0   |
|            | Boot0(pin) = 0, nBoot0_SW(bit) = 1 and main Flash memory empty  |

In addition to patterns described above, user can execute bootloader by performing a jump to system memory from user code. Before jumping to bootloader user must:

- Disable all peripheral clocks
- Disable used PLL
- Disable interrupts
- Clear pending interrupts

System memory boot mode can be exited by getting out from bootloader activation condition and generating hardware reset or using Go command to execute user code.

**Note:** When executing the Go command, the peripheral registers used by the bootloader are not initialized to their default reset values before jumping to the user application. They must be reconfigured in the user application if they are used. So, if the IWDG is being used in the application, the IWDG prescaler value has to be adapted to meet the requirements of the application (since the prescaler was set to its maximum value). For some products, not all reset values are set. For more information refer to the known limitations detailed for each product bootloader versions.

**Note:** For STM32 devices having the Dual Bank Boot feature, to jump to system memory from user code the user has first to remap the System Memory bootloader at address 0x00000000 using SYSCFG register (except for STM32F7 Series), then jump to bootloader. For STM32F7 Series, the user has to disable nDBOOT and/or nDBANK features (in option bytes), then jump to bootloader.

**Note:** For STM32 devices embedding bootloader using the DFU/CAN interface in which the external clock source (HSE) is required for DFU/CAN operations, the detection of the HSE value is done dynamically by the bootloader firmware and is based on the internal oscillator clock (HSI, MSI). When (because of temperature variations or other conditions) the internal oscillator precision is altered above the tolerance band (1% around the theoretical value), the bootloader might calculate a wrong HSE frequency value. In this case, the bootloader DFU/CAN interfaces might malfunction or not work at all.

## 4.2 Bootloader identification

Depending on the STM32 device used, the bootloader may support one or more embedded serial peripherals used to download the code to the internal Flash memory. The bootloader identifier (ID) provides information about the supported serial peripherals.

For a given STM32 device, the bootloader is identified by means of the:

1. **Bootloader (protocol) version:** version of the serial peripheral (e.g. USART, CAN, USB) communication protocol used in the bootloader. This version can be retrieved using the bootloader Get Version command.
2. **Bootloader identifier (ID):** version of the STM32 device bootloader, coded on one byte in the **0xXY** format, where:
  - **X** specifies the embedded serial peripheral(s) used by the device bootloader:  
X = 1: one USART is used  
X = 2: two USARTs are used  
X = 3: USART, CAN and DFU are used  
X = 4: USART and DFU are used  
X = 5: USART and I<sup>2</sup>C are used  
X = 6: I<sup>2</sup>C is used  
X = 7: USART, CAN, DFU and I<sup>2</sup>C are used  
X = 8: I<sup>2</sup>C and SPI are used  
X = 9: USART, CAN (or FDCAN), DFU, I<sup>2</sup>C and SPI are used  
X = 10: USART, DFU and I<sup>2</sup>C are used  
X = 11: USART, I<sup>2</sup>C and SPI are used  
X = 12: USART and SPI are used  
X = 13: USART, DFU, I<sup>2</sup>C and SPI are used
  - **Y** specifies the device bootloader version

Let us take the example of a bootloader ID equal to 0x10. This means that it is the first version of the device bootloader that uses only one USART.

The bootloader ID is programmed in the last byte address - 1 of the device system memory and can be read by using the bootloader “Read memory” command or by direct access to the system memory via JTAG/SWD.

**Note:** *The bootloader ID format is applied to all STM32 devices families except the STM32F1xx family. The bootloader version for the STM32F1xx applies only to the embedded device bootloader version and not to its supported protocols.*

*Table 3* provides identification information of the bootloaders embedded in STM32 devices.

**Table 3. Embedded bootloaders**

| STM32 Series | Device                  | Supported serial peripherals                                  | Bootloader ID |                 | Bootloader (protocol) version                           |
|--------------|-------------------------|---|---------------|-----------------|---|
|              |                         |   | ID            | Memory location |   |
| F0           | STM32F05xxx/STM32F030x8 | USART1/USART2   | 0x21          | 0x1FFFF7A6      | USART (V3.1)  |
|              | STM32F03xx4/6           | USART1  | 0x10          | 0x1FFFF7A6      | USART (V3.1)  |
|              | STM32F030xC             | USART1/ I2C1  | 0x52          | 0x1FFFF796      | USART (V3.1)<br>I2C1(V1.0)                              |
|              | STM32F04xxx             | USART1/USART2/ DFU (USB device FS)/ I2C1                      | 0xA1          | 0x1FFFF6A6      | USART (V3.1)<br>DFU (V2.2)<br>I2C (V1.0)                |
|              | STM32F071xx/072xx       | USART1/USART2/ I2C1/ DFU (USB device FS)                      | 0xA1          | 0x1FFFF6A6      | USART (V3.1)<br>DFU (V2.2)<br>I2C (V1.0)                |
| F0           | STM32F070x6             | USART1/USART2 / DFU (USB device FS) /I2C1                     | 0xA2          | 0x1FFFF6A6      | USART (V3.1)<br>DFU (V2.2)<br>I2C (V1.0)                |
|              | STM32F070xB             | USART1/USART2/ DFU (USB device FS)/I2C1                       | 0xA3          | 0x1FFFF6A6      | USART (V3.1)<br>DFU (V2.2)<br>I2C (V1.0)                |
|              | STM32F09xxx             | USART1/USART2/ I2C1   | 0x50          | 0x1FFFF796      | USART (V3.1)<br>I2C (V1.0)                              |
| F1           | STM32F10xxx             | Low-density   | USART1        | NA              | USART (V2.2)  |
|              |                         | Medium-density  | USART1        | NA              | USART (V2.2)  |
|              |                         | High-density  | USART1        | NA              | USART (V2.2)  |
|              |                         | Medium-density value line                                     | USART1        | 0x10            | 0x1FFFF7D6  |
|              |                         | High-density value line                                       | USART1        | 0x10            | 0x1FFFF7D6  |
|              | STM32F105xx/107xx       | USART1/USART2 (remapped) / CAN2 (remapped) / DFU (USB Device) | NA            | NA              | USART (V2.2 <sup>(1)</sup> )<br>CAN (V2.0)<br>DFU(V2.2) |
|              | STM32F10xxx XL-density  | USART1/USART2 (remapped)                                      | 0x21          | 0x1FFFF7D6      | USART (V3.0)  |
| F2           | STM32F2xxxx             | USART1/USART3   | 0x20          | 0x1FFF77DE      | USART (V3.0)  |
|              |                         | USART1/USART3/ CAN2/ DFU (USB device FS)                      | 0x33          | 0x1FFF77DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)                |

Table 3. Embedded bootloaders (continued)

| STM32 Series | Device                       | Supported serial peripherals       | Bootloader ID |                 | Bootloader (protocol) version |
|--------------|------------------------------|------------------------------------|---------------|-----------------|-------------------------------|
|              |                              |                                    | ID            | Memory location |                               |
| F3           | STM32F373xx                  | USART1/USART2/ DFU (USB device FS) | 0x41          | 0x1FFFF7A6      | USART (V3.1)<br>DFU (V2.2)    |
|              | STM32F378xx                  | USART1/USART2/ I2C1                | 0x50          | 0x1FFFF7A6      | USART (V3.1)<br>I2C (V1.0)    |
|              | STM32F302xB(C)/303xB(C)      | USART1/USART2/ DFU (USB device FS) | 0x41          | 0x1FFFF796      | USART (V3.1)<br>DFU (V2.2)    |
|              | STM32F358xx                  | USART1/USART2/ I2C1                | 0x50          | 0x1FFFF796      | USART (V3.1)<br>I2C (V1.0)    |
|              | STM32F301xx/302x4(6/8)       | USART1/USART2/ DFU (USB device FS) | 0x40          | 0x1FFFF796      | USART (V3.1)<br>DFU (V2.2)    |
|              | STM32F318xx                  | USART1/USART2/ I2C1/ I2C3          | 0x50          | 0x1FFFF796      | USART (V3.1)<br>I2C (V1.0)    |
|              | STM32F302xD(E)/303xD(E)      | USART1/USART2/ DFU (USB device FS) | 0x40          | 0x1FFFF796      | USART (V3.1)<br>DFU (V2.2)    |
|              | STM32F303x4(6/8)/334xx/328xx | USART1/USART2/ I2C1                | 0x50          | 0x1FFFF796      | USART (V3.1)<br>I2C (V1.0)    |
|              | STM32F398xx                  | USART1/USART2/ I2C1/I2C3           | 0x50          | 0x1FFFF796      | USART (V3.1)<br>I2C (V1.0)    |

Table 3. Embedded bootloaders (continued)

| STM32 Series | Device            | Supported serial peripherals   | Bootloader ID |                 | Bootloader (protocol) version  |
|--------------|-------------------|--|---------------|-----------------|--|
|              |                   |  | ID            | Memory location |  |
| F4           | STM32F40xxx/41xxx | USART1/USART3/<br>CAN2/<br>DFU (USB device FS)   | 0x31          | 0x1FFF77DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)                             |
|              |                   | USART1/USART3/<br>CAN2 /<br>DFU (USB device FS)<br>/I2C1/I2C2/I2C3/<br>SPI1/SPI2                 | 0x90          | 0x1FFF77DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI(V1.1)<br>I2C (V1.0)  |
|              | STM32F42xxx/43xxx | USART1/USART3/<br>CAN2 /<br>DFU (USB device FS) /<br>I2C1  | 0x70          | 0x1FFF76DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>I2C (V1.0)               |
|              |                   | USART1/USART3/<br>CAN2 /<br>DFU (USB device FS) /<br>SPI1/ SPI2/ SPI4<br>I2C1/I2C2/I2C3/         | 0x91          | 0x1FFF76DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI(V1.1)<br>I2C (V1.0)  |
|              | STM32F401xB(C)    | USART1/USART2/ DFU (USB device FS)/ I2C1/I2C2/I2C3/<br>SPI1/SPI2/ SPI3                           | 0xD1          | 0x1FFF76DE      | USART (V3.1)<br>DFU (V2.2)<br>SPI(V1.1)<br>I2C (V1.0)                |
|              | STM32F401xD(E)    | USART1/USART2/ DFU (USB device FS)/ I2C1/I2C2/I2C3/<br>SPI1/SPI2/ SPI3                           | 0xD1          | 0x1FFF76DE      | USART (V3.1)<br>DFU (V2.2)<br>SPI(V1.1)<br>I2C (V1.1)                |
|              | STM32F410xx       | USART1/USART2/<br>I2C1/I2C2/I2C4<br>SPI1/SPI2  | 0xB1          | 0x1FFF76DE      | USART (V3.1)<br>I2C (V1.2)<br>SPI (V1.1)                             |
|              | STM32F411xx       | USART1/USART2/<br>DFU (USB device FS)/<br>SPI1/SPI2/ SPI3<br>I2C1/I2C2/I2C3                      | 0xD0          | 0x1FFF76DE      | USART (V3.1)<br>DFU (V2.2)<br>SPI(V1.1)<br>I2C (V1.1)                |
|              | STM32F412xx       | USART1/USART2/<br>USART3/CAN2/<br>DFU (USB device FS)/<br>I2C1/I2C2/I2C3/I2C4/<br>SPI1/SPI3/SPI4 | 0x91          | 0x1FFF76DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1)<br>I2C (V1.2) |
|              | STM32F413xx/423xx | USART1/USART2/<br>USART3/CAN2/<br>DFU (USB device FS)/<br>I2C1/I2C2/I2C3/I2C4/<br>SPI1/SPI3/SPI4 | 0x90          | 0x1FFF76DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>I2C (V1.2)<br>SPI (V1.1) |
|              | STM32F446xx       | USART1/USART3/ CAN2 /<br>DFU (USB device FS) /<br>I2C1/I2C2/I2C3/SPI1/ SPI2/<br>SPI4             | 0x90          | 0x1FFF76DE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI(V1.1)<br>I2C (V1.2)  |
|              | STM32F469xx/479xx | USART1/USART3/<br>I2C1/I2C2/I2C3/<br>CAN2/<br>DFU (USB device FS)/<br>SPI1/ SPI2/ SPI4           | 0x90          | 0x1FFF76DE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1) |

Table 3. Embedded bootloaders (continued)

| STM32 Series | Device            | Supported serial peripherals  | Bootloader ID |                 | Bootloader (protocol) version  |
|--------------|-------------------|---|---------------|-----------------|--|
|              |                   |   | ID            | Memory location |  |
| F7           | STM32F72xxx/73xxx | USART1/USART3/<br>CAN1/<br>DFU (USB device FS)/<br>I2C1/I2C2/I2C3/<br>SPI1/SPI2/SPI4              | 0x90          | 0x1FF0EDBE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>I2C (V1.2)<br>SPI (V1.2)   |
|              |                   | USART1/USART3/<br>I2C1/I2C2/I2C3/<br>CAN2/<br>DFU (USB device FS)                                 | 0x70          | 0x1FF0EDBE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)                 |
|              | STM32F74xxx/75xxx | USART1/USART3/<br>I2C1/I2C2/I2C3/<br>CAN2/<br>DFU (USB device FS)/<br>SPI1/SPI2/SPI4              | 0x90          | 0x1FF0EDBE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.2)   |
|              |                   | USART1/USART3/<br>CAN2/<br>DFU (USB device FS)/<br>I2C1/I2C2/I2C3/<br>SPI1/SPI2/SPI4              | 0x93          | 0x1FF0EDBE      | USART (V3.1)<br>CAN (V2.0)<br>DFU (V2.2)<br>I2C (V1.2)<br>SPI (V1.2)   |
| G0           | STM32G07xxx/08xxx | USART1/USART2/<br>USART3/I2C1/I2C2/<br>SPI1/SPI2  | 0xB2          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>SPI (V1.1)                               |
|              | STM32G03xxx/04xxx | USART1/USART2/<br>I2C1/I2C2   | 0x53          | 0x1FFF1FFE      | USART (V3.1)<br>I2C (V1.2)   |
| G4           | STM32G431xx/441xx | USART1/USART2/USART3<br>I2C2/I2C3<br>SPI1/SPI2<br>DFU (USB device FS)                             | 0xD3          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>SPI (V1.1)<br>DFU (V2.2)                 |
|              | STM32G47xxx/48xxx | USART1/USART2/USART3<br>I2C2/I2C3/I2C4<br>SPI1/SPI2<br>DFU (USB device FS)                        | 0xD4          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>SPI (V1.1)<br>DFU (V2.2)                 |
| H7           | STM32H72xxx/73xxx | USART1/USART2/USART3<br>I2C1/I2C2/I2C3/<br>DFU (USB device FS)/<br>SPI1/SPI2/SPI3/SPI4/<br>FDCAN1 | 0x92          | 0x1FF1E7FE      | USART (V3.1)<br>I2C (V1.2)<br>DFU (V2.2)<br>SPI (V1.1)<br>FDCAN (V1.0) |
|              | STM32H74xxx/75xxx | USART1/USART2/USART3<br>I2C1/I2C2/I2C3/<br>DFU (USB device FS)/<br>SPI1/SPI2/SPI3/SPI4/<br>FDCAN1 | 0x90          | 0x1FF1E7FE      | USART (V3.1)<br>I2C (V1.1)<br>DFU (V2.2)<br>SPI (V1.2)<br>FDCAN (V1.0) |
|              | STM32H7A3xx/B3xx  | USART1/USART2/USART3<br>I2C1/I2C2/I2C3/<br>DFU (USB device FS)/<br>SPI1/SPI2/SPI3/SPI4/<br>FDCAN1 | 0x91          | 0x1FF13FFE      | USART (V3.1)<br>I2C (V1.1)<br>DFU (V2.2)<br>SPI (V1.2)<br>FDCAN (V1.0) |

**Table 3. Embedded bootloaders (continued)**

| STM32 Series | Device            | Supported serial peripherals           | Bootloader ID |                 | Bootloader (protocol) version            |
|--------------|-------------------|--|---------------|-----------------|--|
|              |                   |  | ID            | Memory location |  |
| L0           | STM32L01xxx/02xxx | USART2/SPI1                            | 0xC3          | 0x1FF00FFE      | USART (V3.1)<br>SPI (V1.1)               |
|              | STM32L031xx/041xx | USART2/SPI1                            | 0xC0          | 0x1FF00FFE      | USART (V3.1)<br>SPI (V1.1)               |
|              | STM32L05xxx/06xxx | USART1/USART2/<br>SPI1/ SPI2           | 0xC0          | 0x1FF00FFE      | USART (V3.1)<br>SPI (V1.1)               |
|              | STM32L07xxx/08xxx | USART1/USART2/<br>DFU (USB device FS)  | 0x41          | 0x1FF01FFE      | USART (V3.1)<br>DFU (V2.2)               |
|              |                   | USART1/USART2/ SPI1/SPI2/<br>I2C1/I2C2 | 0xB2          | 0x1FF01FFE      | USART (V3.1)<br>SPI (V1.1)<br>I2C (V1.2) |
| L1           | STM32L1xxx6(8/B)  | USART1/USART2                          | 0x20          | 0x1FF00FFE      | USART (V3.0)                             |
|              | STM32L1xxx6(8/B)A | USART1/USART2                          | 0x20          | 0x1FF00FFE      | USART (V3.1)                             |
|              | STM32L1xxxC       | USART1/USART2/ DFU (USB<br>device FS)  | 0x40          | 0x1FF01FFE      | USART (V3.1)<br>DFU (V2.2)               |
|              | STM32L1xxxD       | USART1/USART2/ DFU (USB<br>device FS)  | 0x45          | 0x1FF01FFE      | USART (V3.1)<br>DFU (V2.2)               |
|              | STM32L1xxxE       | USART1/USART2/ DFU (USB<br>device FS)  | 0x40          | 0x1FF01FFE      | USART (V3.1)<br>DFU (V2.2)               |

Table 3. Embedded bootloaders (continued)

| STM32 Series | Device                  | Supported serial peripherals  | Bootloader ID |                 | Bootloader (protocol) version  |
|--------------|-------------------------|---|---------------|-----------------|--|
|              |                         |   | ID            | Memory location |  |
| L4           | STM32L412xx/422xx       | USART1/USART2/USART3<br>I2C1/I2C2/I2C3/<br>DFU (USB device FS)/<br>SPI1/SPI2              | 0xD1          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>DFU (V2.2)<br>SPI (V1.1)                 |
|              | STM32L43xxx/44xxx       | USART1/USART2/USART3/<br>I2C1/I2C2/I2C3/<br>CAN1/<br>DFU (USB device FS)/<br>SPI1/SPI2    | 0x91          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1)   |
|              | STM32L45xxx/46xxx       | USART1/USART2/USART3/<br>I2C1/I2C2/I2C3/<br>CAN1/<br>DFU (USB device FS)/<br>SPI1/SPI2    | 0x92          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1)   |
|              | STM32L47xxx/48xxx       | USART1/USART2/ USART3/<br>I2C1/I2C2/I2C3/<br>DFU (USB device FS)                          | 0xA3          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>DFU (V2.2)                               |
|              |                         | USART1/USART2/ USART3/<br>I2C/I2C2/I2C3/<br>SPI1/SPI2/<br>CAN1/<br>DFU (USB device FS)    | 0x92          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>SPI (V1.1)<br>CAN(V2.0)<br>DFU(V2.2)     |
|              | STM32L496xx/4A6xx       | USART1/USART2/USART3/<br>I2C1/I2C2/I2C3/<br>CAN1/<br>DFU (USB device FS)/<br>SPI1/SPI2    | 0x93          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1)   |
|              | STM32L4Rxxx/STM32L4Sxxx | USART1/USART2/USART3/<br>I2C1/I2C2/I2C3/<br>CAN1/<br>DFU (USB device FS)/<br>SPI1/SPI2    | 0x95          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1)   |
| L5           | STM32L552xx/562xx       | USART1/USART2/USART3<br>I2C1/I2C2/I2C3<br>SPI1/SPI2/SPI3<br>DFU (USB device FS)<br>FDCAN1 | 0x90          | 0x1FFF6FFE      | USART (V3.1)<br>I2C (V1.2)<br>CAN (V2.0)<br>DFU (V2.2)<br>SPI (V1.1)   |
|              |                         |   | 0x92          | 0x0BF97FFE      | USART (V3.1)<br>I2C (V1.2)<br>SPI (V1.1)<br>DFU (V2.2)<br>FDCAN (V1.0) |

**Table 3. Embedded bootloaders (continued)**

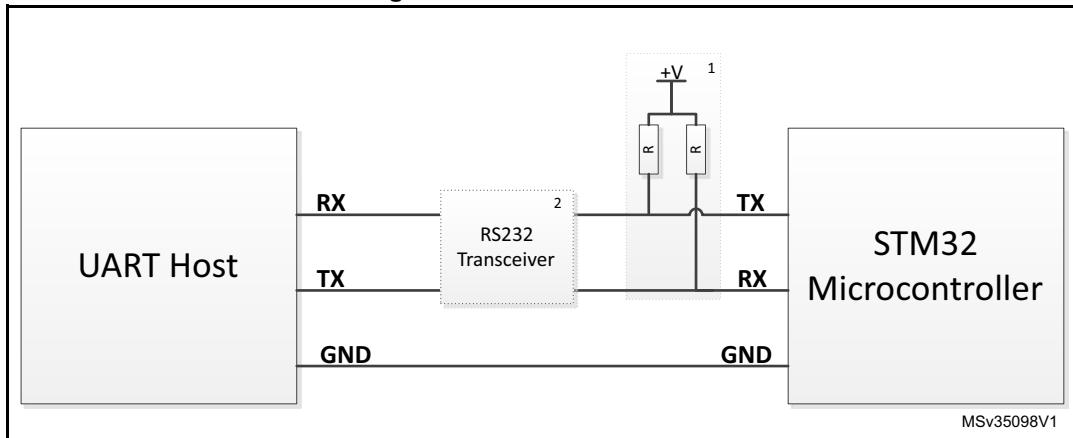
| STM32<br>Series | Device                     | Supported serial peripherals                             | Bootloader ID |                    | Bootloader<br>(protocol)<br>version                    |
|-----------------|----------------------------|--|---------------|--------------------|--|
|                 |                            |  | ID            | Memory<br>location |  |
| WB              | STM32WB30xx/35xx/50xx/55xx | USART1/<br>I2C1/I2C3<br>SPI1/SPI2<br>DFU (USB device FS) | 0xD5          | 0x1FFF6FFE         | USART (V3.2)<br>I2C (V1.2)<br>SPI (V1.1)<br>DFU (V2.2) |
| WL              | STM32WLE5xx/55xx           | USART1/USART2<br>SPI1/SPI2                               | 0xC3          | 0x1FF36EFE         | USART (V3.1)<br>SPI (V1.1)                             |

1. For connectivity line devices, the USART bootloader returns V2.0 instead of V2.2 for the protocol version. For more details refer to the "STM32F105xx and STM32F107xx revision Z" errata sheet available from [www.st.com](http://www.st.com).

## 4.3 Hardware connection requirements

To use the USART bootloader, the host must be connected to the RX and TX pins of the desired USARTx interface via a serial cable.

**Figure 1. USART connection**

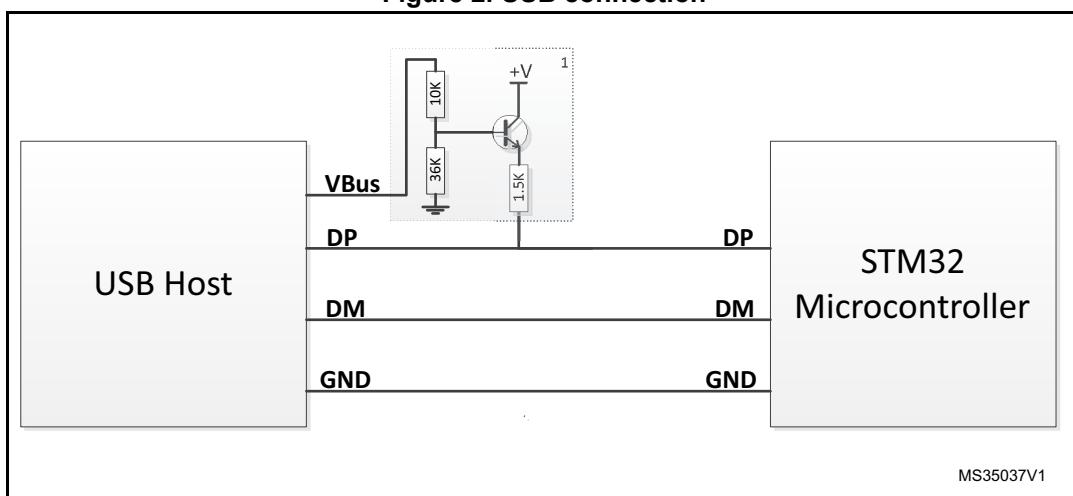


1. A pull-up resistor must be added, if pull-up resistor are not connected in host side.
2. An RS232 transceiver must be connected to adapt voltage level (3.3 to 12 V) between STM32 device and host.

**Note:** *+V typically is 3.3 V and R typically 100 KΩ. These values depend upon the application and the used hardware.*

To use the DFU, connect the microcontroller USB interface to a USB host (i.e. a PC).

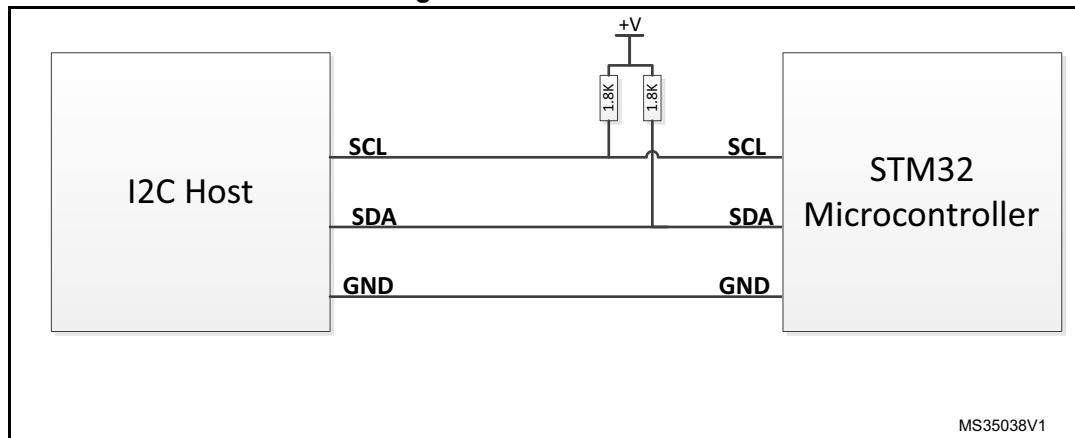
**Figure 2. USB connection**



1. This additional circuit permits to connect a pull-up resistor to DP pin using VBus when needed. Refer to product section (table describing STM32 configuration in system memory boot mode) to know if an external pull-up resistor must be connected to DP pin.

**Note:** *+V typically is 3.3 V. This value depends upon the application and the used hardware.*

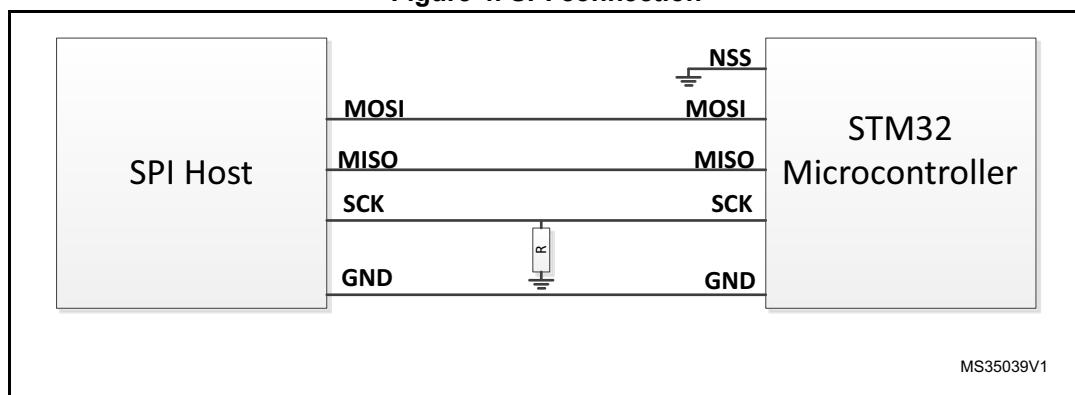
To use the I2C bootloader, connect the host (master) and the desired I2Cx interface (slave) together via the data (SDA) and clock (SCL) pins. A 1.8 KΩ pull-up resistor has to be connected to both SDA and SCL lines.

Figure 3. I<sup>2</sup>C connection**Note:**

*+V is typically 3.3 V. This value depends upon the application and the used hardware.*

To use the SPI bootloader, connect the host (master) and the desired SPIx interface (slave) together via the MOSI, MISO and SCK pins. The NSS pin must be connected to GND. A pull-down resistor must be connected to the SCK line.

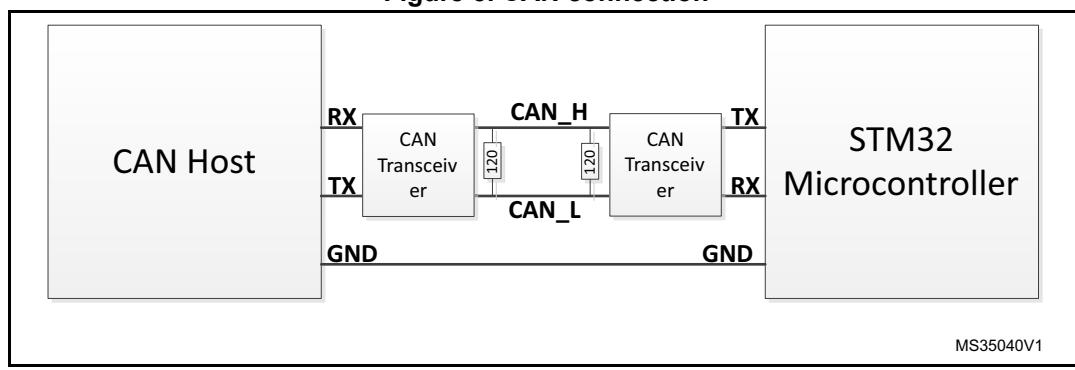
Figure 4. SPI connection

**Note:**

*R is typically 10 KΩ. This value depends on the application and the used hardware.*

To use the CAN interface, the host has to be connected to the RX and TX pins of the desired CANx interface via CAN transceiver and a serial cable. A 120 Ω resistor must be added as terminating resistor.

Figure 5. CAN connection



**Note:** When a bootloader firmware supports DFU, it is mandatory that no USB Host is connected to the USB peripheral during the selection phase of the other interfaces. After selection phase, the user can plug a USB cable without impacting the selected bootloader execution except commands which generate a system reset.

It is recommended to keep the RX pins of unused bootloader interfaces (USART\_RX, SPI\_MOSI, CAN\_RX and USB D+/D- lines if present) at a known (low or high) level at the startup of the bootloader (detection phase). Leaving these pins floating during the detection phase might lead to activating unused interfaces.

## 4.4 Bootloader memory management

All write operations using bootloader commands must only be Word-aligned (the address must be a multiple of 4). The number of data to be written must also be a multiple of 4 (non-aligned half page write addresses are accepted).

Some Products embed bootloader that has some specific features:

- Some products do not support Mass erase operation. To perform a mass erase operation using bootloader, two options are available:
  - Erase all sectors one by one using the Erase command
  - Set protection level to Level 1. Then, set it to Level 0 (using the Read protect command and then the Read Unprotect command). This operation results in a mass erase of the internal Flash memory.
- Bootloader firmware of STM32 L1 and L0 series supports Data Memory in addition to standard memories (internal Flash, internal SRAM, option bytes and System memory). The start address and the size of this area depends on product, refer to product reference manual for more information. Data memory can be read and written but cannot be erased using the Erase Command. When writing in a Data memory location, the bootloader firmware manages the erase operation of this location before any write. A write to Data memory must be Word-aligned (address to be written must be a multiple of 4) and the number of data must also be a multiple of 4. To erase a Data memory location, write zeros at this location.
- Bootloader firmware of STM32 F2, F4, F7 and L4 series supports OTP memory in addition to standard memories (internal Flash, internal SRAM, option bytes and System memory). The start address and the size of this area depends on product, refer to product reference manual for more information. OTP memory can be read and written but cannot be erased using Erase command. When writing in an OTP memory location, make sure that the relative protection bit is not reset.
- For STM32 F2, F4 and F7 series the internal Flash memory write operation format depends on voltage Range. By default write operation are allowed by one byte format (Half-Word, Word and Double-Word operations are not allowed). to increase the speed of write operation, the user must apply the adequate voltage range that allows write operation by Half-Word, Word or Double-Word and update this configuration on the fly by the bootloader software through a virtual memory location. This memory location is not physical but can be read and written using usual bootloader read/write operations according to the protocol in use. This memory location contains 4 bytes described in [Table 4](#). It can be accessed by 1, 2, 3 or 4 bytes. However, reserved bytes must remain at their default values (0xFF), otherwise the request is NACKed.

**Table 4. STM32 F2, F4 and F7 voltage range configuration using bootloader**

| Address     | Size   | Description   |
|-------------|--------|---|
| 0xFFFFF0000 | 1 byte | This byte controls the current value of the voltage range.<br>0x00: voltage range [1.8 V, 2.1 V]<br>0x01: voltage range [2.1 V, 2.4 V]<br>0x02: voltage range [2.4 V, 2.7 V]<br>0x03: voltage range [2.7 V, 3.6 V]<br>0x04: voltage range [2.7 V, 3.6 V] and double word write/erase operation is used. In this case it is mandatory to supply 9 V through the VPP pin (refer to the product reference manual for more details about the double-word write procedure).<br>Other: all other values are not supported and are NACKed. |
| 0xFFFFF0001 | 1 byte | Reserved.<br>0xFF: default value.<br>Other: all other values are not supported and are NACKed.  |
| 0xFFFFF0002 | 1 byte | Reserved.<br>0xFF: default value.<br>Other: all other values are not supported and are NACKed.  |
| 0xFFFFF0003 | 1 byte | Reserved.<br>0xFF: default value.<br>Other: all other values are not supported and are NACKed.  |

The table below lists the valid memory areas, depending upon the bootloader commands.

**Table 5. Supported memory area by Write, Read, Erase and Go commands**

| Memory area   | Write command | Read command | Erase command | Go command    |
|---------------|---------------|--------------|---------------|---------------|
| Flash         | Supported     | Supported    | Supported     | Supported     |
| RAM           | Supported     | Supported    | Not supported | Supported     |
| System memory | Not supported | Supported    | Not supported | Not supported |
| Data memory   | Supported     | Supported    | Not supported | Not supported |
| OTP memory    | Supported     | Supported    | Not supported | Not supported |

## 4.5 Bootloader UART baudrate detection

For the UART interface baudrate detection, there are two types of mechanisms implemented on different STM32 devices:

- Software baudrate detection using internal HSI and timer (use GPIO as input, detect falling edge and rising edge as explained in AN3155).

The devices using this mechanism are subject to software jitter (variable error of baudrate calculation) that can reach up to  $\pm 5\%$ .

So, in that case, the host connecting to the STM32 bootloader UART interface shall support a deviation in baudrate equivalent to  $\pm 5\%$ .

The software jitter value is variable and is different at each retry, so it is possible to use multiple retry connections in order to overcome the software jitter (connect and check for correct bootloader answer, if answer is not correct, reset the device and retry)

connection until the correct answer is received. Once correct answer is received the rest of the communication is not impacted by software jitter).

It is also possible to reduce software jitter by reducing baudrate value (i.e. use 56000 bps instead of 115200).

*Table 6* provides the maximum software jitter value for the baudrate 115200 bps. The lower the baudrate the lower the software jitter.

- Baudrate detection using UART auto-baudrate feature. The devices using this mechanism do not present any software jitter.

**Table 6. Jitter software calculation on bootloader USART detection**

| Series  | Baudrate detection method   | Maximum software jitter for 115200 bps |
|---|-----------------------------|--|
| STM32F0   | Software baudrate detection | -1%                                    |
| STM32F1   | Software baudrate detection | -3%                                    |
| STM32F2   | Software baudrate detection | -5%                                    |
| STM32F3   | Software baudrate detection | -2%                                    |
| STM32F4   | Software baudrate detection | -6%                                    |
| STM32F7   | Software baudrate detection | -6%                                    |
| STM32L0   | Software baudrate detection | -2%                                    |
| STM32L1   | Software baudrate detection | -3%                                    |
| STM32L4   | Software baudrate detection | -5%                                    |
| STM32G07x/8x USART3<br>STM32G03x/4x USART2        | Software baudrate detection | -4%                                    |
| STM32G07x/8x USART1/USART2<br>STM32G03x/4x USART1 | Auto-baudrate               | N/A                                    |
| STM32G4   | Auto-baudrate               | N/A                                    |
| STM32H7   | Auto-baudrate               | N/A                                    |
| STM32WB   | Auto-baudrate               | N/A                                    |
| STM32WL   | Auto-baudrate               | N/A                                    |

## 4.6 Programming constraints

When using bootloader interface to write in the Flash memory, alignment on the programmed address must be respected according to *Table 7*.

If the address to which the write operation is not aligned, then it fails and all following program operations fail as well.

**Table 7. Flash memory alignment constraints on STM32 products**

| Series  | Alignment |
|---------|-----------|
| STM32F0 | 4 bytes   |
| STM32F1 | 4 bytes   |

**Table 7. Flash memory alignment constraints on STM32 products (continued)**

| Series  | Alignment |
|---------|-----------|
| STM32F2 | 4 bytes   |
| STM32F3 | 4 bytes   |
| STM32F4 | 4 bytes   |
| STM32F7 | 8 bytes   |
| STM32L0 | 8 bytes   |
| STM32L1 | 8 bytes   |
| STM32L4 | 8 bytes   |
| STM32G0 | 4 bytes   |
| STM32G4 | 4 bytes   |
| STM32H7 | 8 bytes   |
| STM32WB | 8 bytes   |
| STM32WL | 8 bytes   |

Example of alignment:

- 4 bytes: 0x08000014 is aligned and passes, 0x08000012 is not aligned and fails
- 8 bytes: 0x08000010 is aligned and passes, 0x08000014 is not aligned and fails

Note:

*On some products (STM32F4 and STM32F7) it is possible to change the alignment constraint by writing in the device feature space.*

## 4.7 ExitSecureMemory feature

The securable memory area is used to isolate secure boot code/data, which handle sensitive information (secrets), from application code:

- Access is controlled by a securable memory bit SEC\_PROT (write once), in the FLASH\_CR register
- Executed once at boot then locked by writing the securable memory bit
  - The code protected: in the securable memory area is hidden until the next reset that unlocks the SEC\_PROT bit
- Width (number of Flash memory pages) is defined through an option byte, SEC\_SIZE, in the Flash memory FLASH\_SEC\_R register

The ExitSecureMemory is a software developed and hosted on the system memory. When the user boot code jump to it, the software allows setting the SEC\_PROT bit to “1” and then jumping to the application code. The SEC\_SIZE must be set to the needed value before jumping to the ExitSecureMemory function.

As shown in [Figure 6](#), two jump methods can be used by the customer:

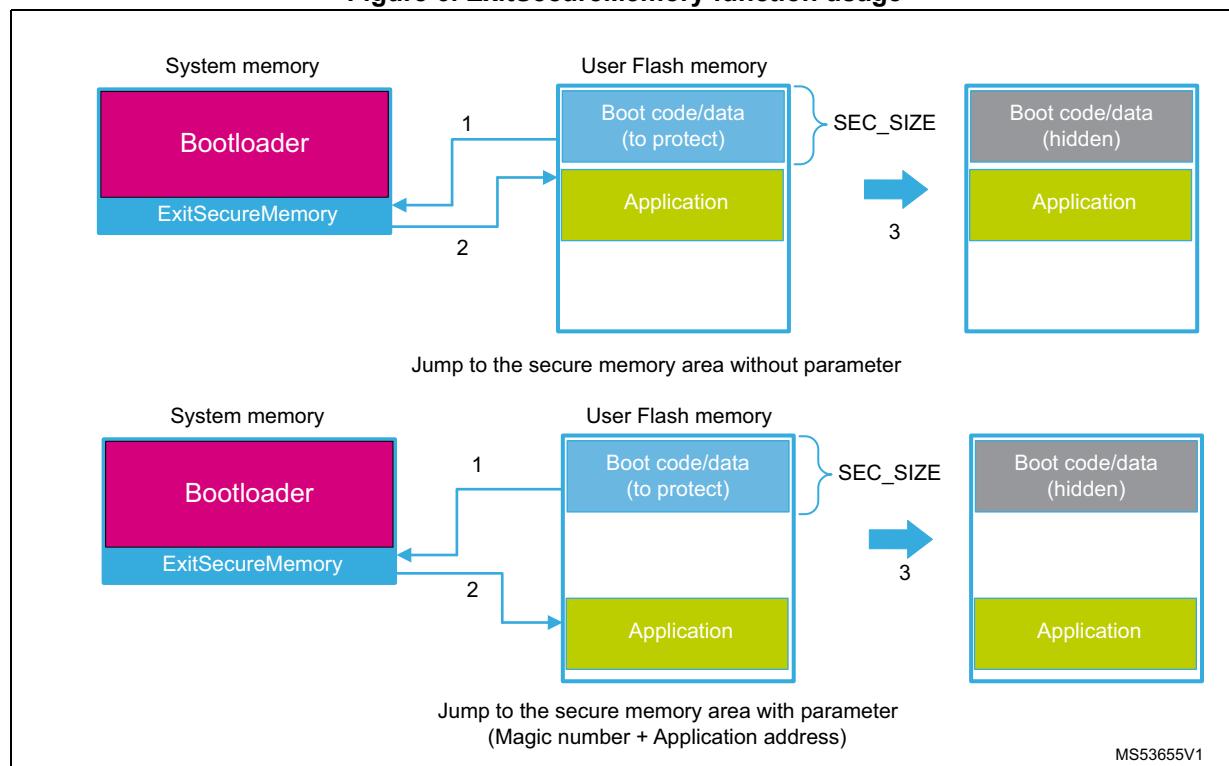
### Jump to the secure memory function without parameter

In this case the application must be loaded just after the secure memory defined.

### Jump to the secure memory function using two parameters

1. Magic number
  - 0x08192A3C
    - Used to secure boot code/data in Flash and jump in case of a single bank product
    - Used to secure boot code/data in Bank1 and jump in case of a dual bank product
  - 0x08192A3D
    - Used to secure boot code/data and jump to application in Bank2 in case of a dual bank product
2. User address = Application address
  - In this case the application can be loaded to any desired address (as per user address defined)

**Figure 6. ExitSecureMemory function usage**



Note: For more information regarding the option bytes configuration refer to the reference manual.

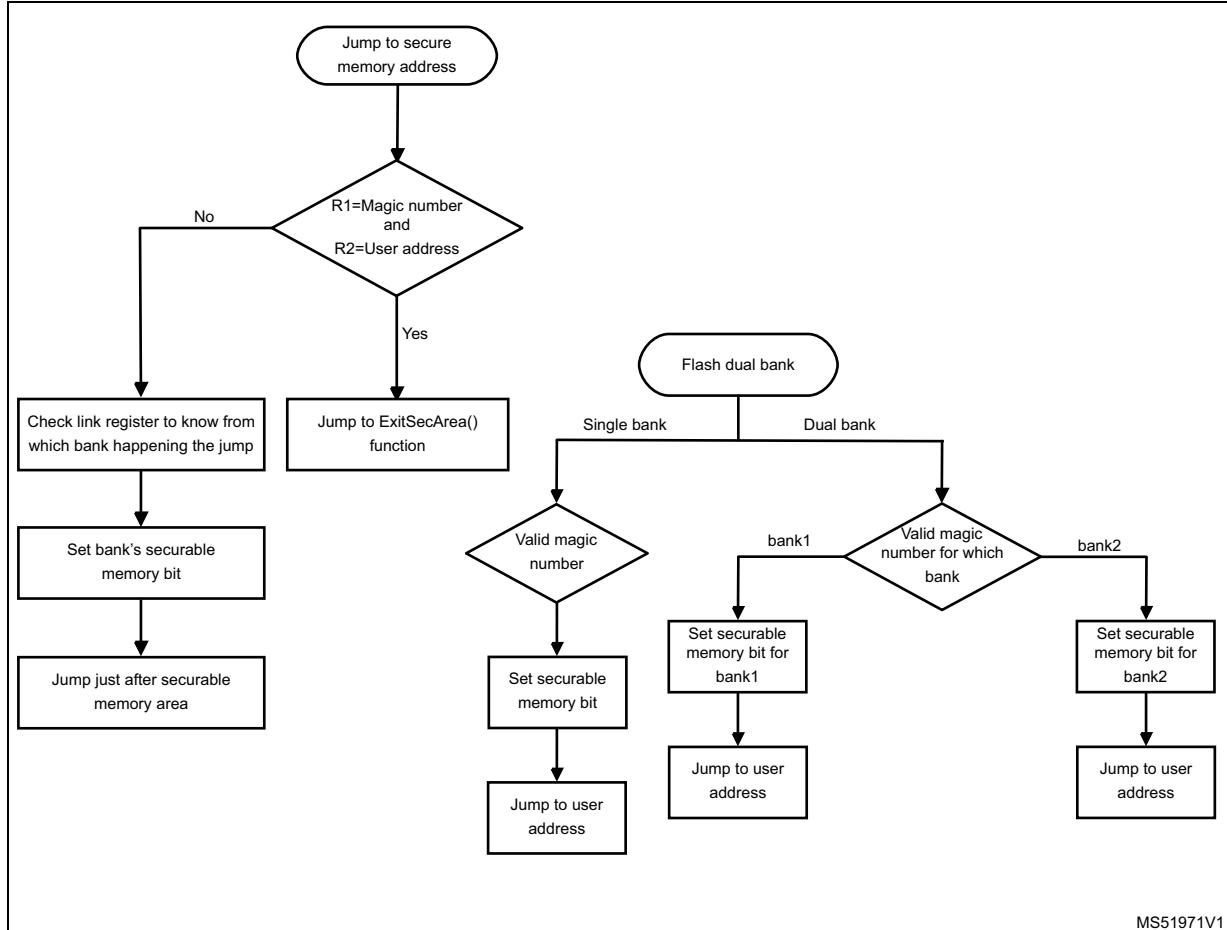
Note: An example of a function that can be used to call the “ExitSecureMemory” is in [Appendix A](#).

**Table 8. ExitSecureMemory entry address**

| MCU     |                   | ExitSecureMemory address |
|---------|-------------------|--------------------------|
| STM32G0 | STM32G07xxx/08xxx | 0x1FFF6800               |
|         | STM32G03xxx/04xxx | 0x1FFF1E00               |
| STM32G4 | STM32G47xxx/48xxx | 0x1FFF6800               |
|         | STM32G431xx/441xx | 0x1FFF6800               |

For more details refer to [Figure 7](#).

**Figure 7. Access to securable memory area from the bootloader**



1. The Bootloader does not check the integrity of the user address, it is up to the user to ensure the validity of the address to jump to.

## 5 STM32F03xx4/6 devices bootloader

### 5.1 Bootloader configuration

The STM32F03xx4/6 bootloader is activated by applying Pattern 2 (see [Table 2: Bootloader activation patterns](#)). [Table 9](#) shows the hardware resources used by this bootloader.

**Table 9. STM32F03xx4/6 configuration in system memory boot mode**

| Bootloader                       | Feature/Peripheral | State       | Comment   |
|----------------------------------|--------------------|-------------|---|
| Common to all bootloaders        | RCC                | HSI enabled | The system clock frequency is 24 MHz (using PLL clocked by HSI).<br>1 Flash Wait State.   |
|                                  | RAM                | -           | 2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                                  | System memory      | -           | 3 Kbyte starting from address 0x1FFFE00 contain the bootloader firmware.  |
|                                  | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset in case the hardware IWDG option was previously enabled by the user. |
| USART1 bootloader (on PA10/PA9)  | USART1             | Enabled     | Once initialized, the USART1 configuration is 8 bits, even parity and 1 Stop bit.   |
|                                  | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode.   |
|                                  | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode.   |
| USART1 bootloader (on PA14/PA15) | USART1             | Enabled     | Once initialized, the USART1 configuration is 8 bits, even parity and 1 Stop bit.   |
|                                  | USART1_RX pin      | Input       | PA15 pin: USART1 in reception mode.   |
|                                  | USART1_TX pin      | Output      | PA14 pin: USART1 in transmission mode.  |
| USART1 bootloaders               | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host.  |

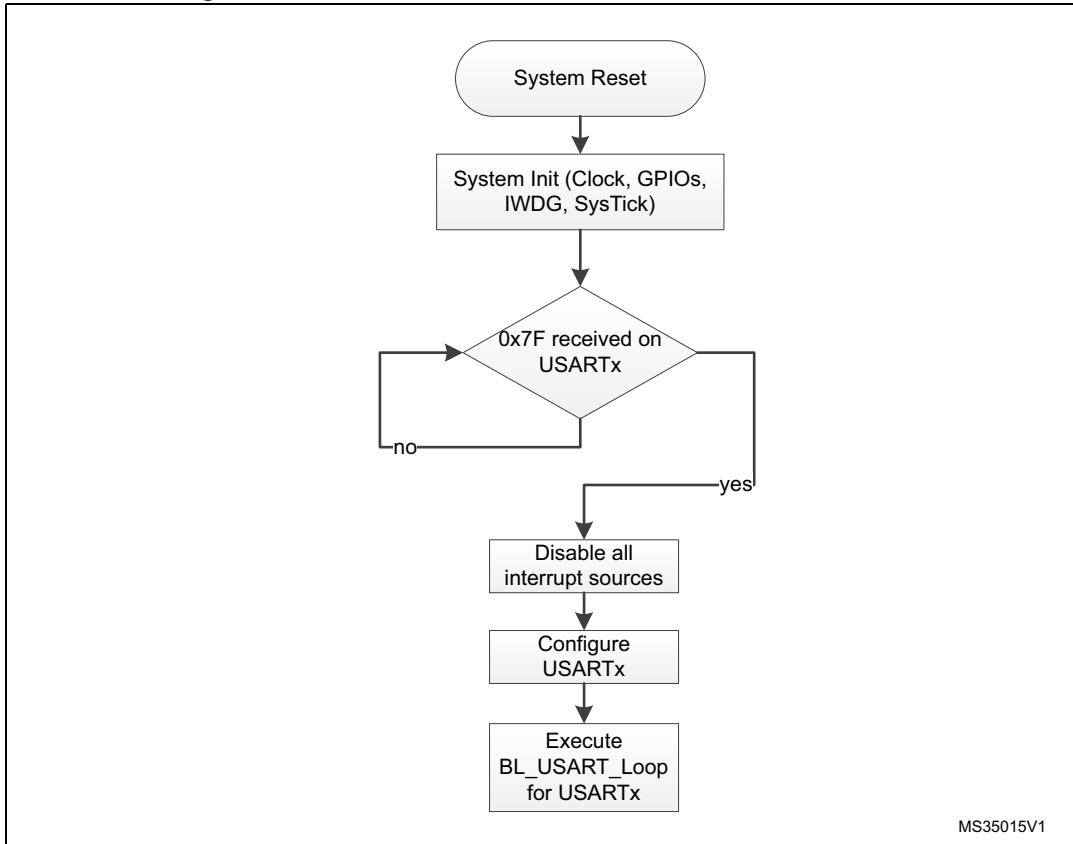
The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

**Note:** After the STM32F03xx4/6 devices has booted in bootloader mode, serial wire debug (SWD) communication is no longer possible until the system is reset. This is because the SWD uses the PA14 pin (SWCLK) which is already used by the bootloader (USART1\_TX).

## 5.2 Bootloader selection

*Figure 8* shows the bootloader selection mechanism.

**Figure 8. Bootloader selection for STM32F03xx4/6 devices**



## 5.3 Bootloader version

The following table lists the STM32F03xx4/6 devices bootloader versions.

**Table 10. STM32F03xx4/6 bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V1.0                      | Initial bootloader version | For the USART interface, two consecutive NACKs instead of 1 NACK are sent when a Read Memory or Write Memory command is sent and the RDP level is active. |

## 6 STM32F030xC devices bootloader

### 6.1 Bootloader configuration

The STM32F030xC bootloader is activated by applying Pattern 2 (see [Table 2: Bootloader activation patterns](#)). [Table 11](#) shows the hardware resources used by this bootloader.

**Table 11. STM32F030xC configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment  |
|---------------------------|--------------------|--------------|--|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 48 MHz with HSI 8 MHz as clock source.   |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware.   |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART2_RX pin      | Input        | PA15 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA14 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000001x (where x = 0 for write and x = 1 for read) |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |

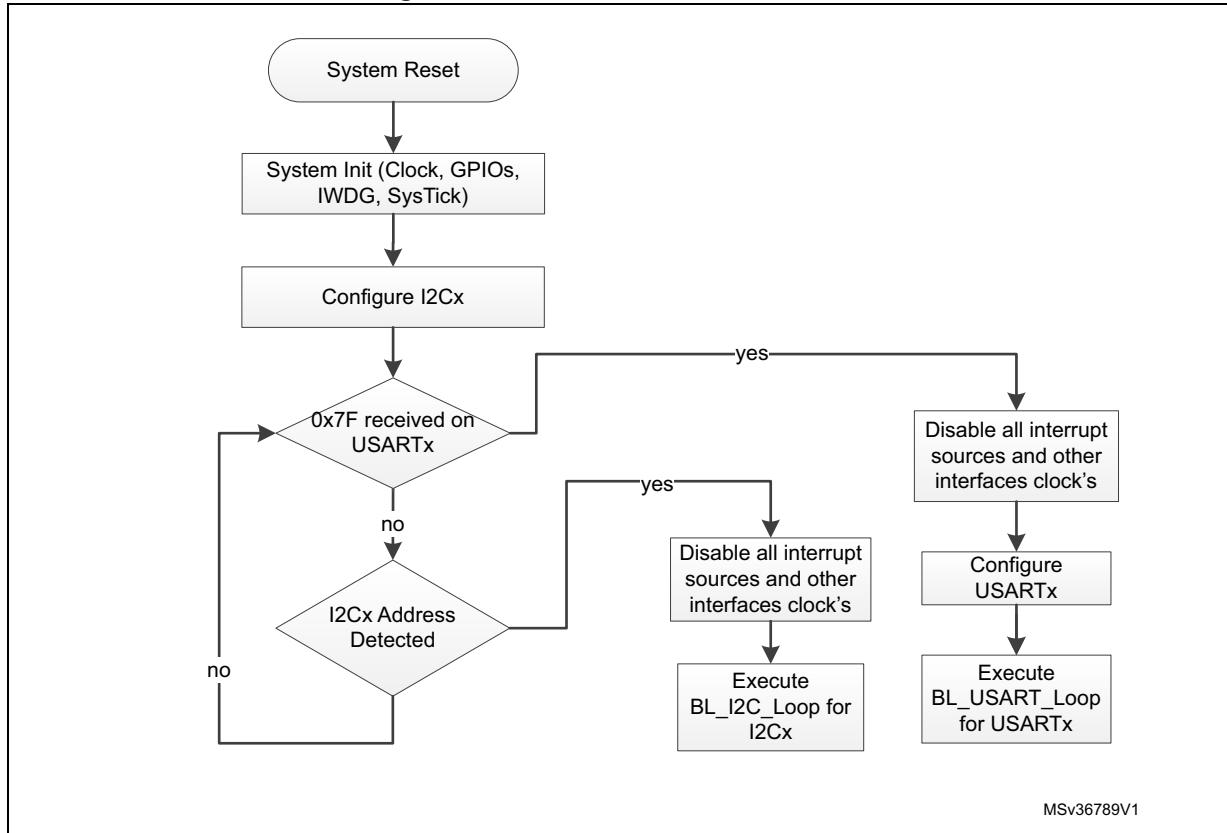
**Note:** After the STM32F030xC devices have booted in bootloader mode using USART2, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2\_RX).

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 6.2 Bootloader selection

*Figure 9* shows the bootloader selection mechanism.

**Figure 9.Bootloader selection for STM32F030xC**



## 6.3 Bootloader version

*Table 12* lists the STM32F030xC devices bootloader versions.

**Table 12. STM32F030xC bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V5.2                      | Initial bootloader version | None              |

## 7 STM32F05xxx and STM32F030x8 devices bootloader

### 7.1 Bootloader configuration

The STM32F05xxx and STM32F030x8 devices bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). [Table 13](#) shows the hardware resources used by this bootloader.

**Table 13. STM32F05xxx and STM32F030x8 devices configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI Enabled | The system clock frequency is 24 MHz (using PLL clocked by HSI).<br>1 Flash Wait State.   |
|                           | RAM                | -           | 2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -           | 3 Kbyte starting from address 0x1FFFEC00, contain the bootloader firmware.  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset in case the hardware IWDG option was previously enabled by the user. |
| USART1 bootloader         | USART1             | Enabled     | Once initialized, the USART1 configuration is 8 bits, even parity and 1 Stop bit.   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode.   |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode.   |
| USART2 bootloader         | USART2             | Enabled     | Once initialized, the USART2 configuration is 8 bits, even parity and 1 Stop bit.   |
|                           | USART2_RX pin      | Input       | PA15 pin: USART2 in reception mode.   |
|                           | USART2_TX pin      | Output      | PA14 pin: USART2 in transmission mode.  |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host.  |

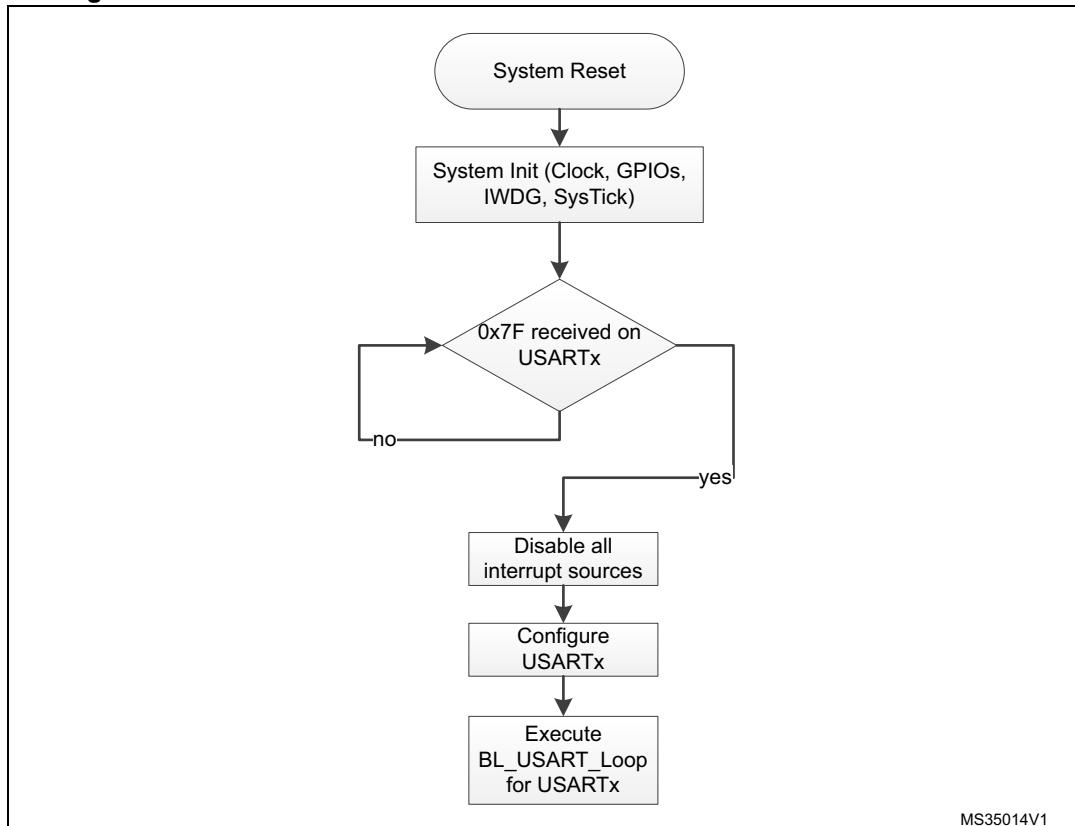
The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

**Note:** After the STM32F05xxx and STM32F030x8 devices have booted in bootloader mode, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK), already used by the bootloader (USART2\_TX).

## 7.2 Bootloader selection

*Figure 10* shows the bootloader selection mechanism.

**Figure 10. Bootloader selection for STM32F05xxx and STM32F030x8 devices**



## 7.3 Bootloader version

*Table 14* lists the STM32F05xxx and STM32F030x8 devices bootloader versions.

**Table 14. STM32F05xxx and STM32F030x8 devices bootloader versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V2.1                      | Initial bootloader version | <ul style="list-style-type: none"> <li>– At bootloader startup, the HSITRIM value is set to 0 (in HSITRIM bits on RCC_CR register) instead of default value (16), as a consequence a deviation is generated in crystal measurement. For better results, use the smallest supported crystal value (i.e. 4 MHz).</li> <li>– For the USART interface, two consecutive NACKs instead of 1 NACK are sent when a Read Memory or Write Memory command is sent and the RDP level is active.</li> </ul> |

## 8 STM32F04xxx devices bootloader

### 8.1 Bootloader configuration

The STM32F04xxx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). [Table 15](#) shows the hardware resources used by this bootloader.

**Table 15. STM32F04xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.   |
|                           |                    | -            | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.   |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 13 Kbyte starting from address 0x1FFFC400, contain the bootloader firmware  |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA15 pin: USART2 in reception mode  |
|                           | USART2_TX pin      | Output       | PA14 pin: USART2 in transmission mode   |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111110x (where x = 0 for write and x = 1 for read).                            |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

**Table 15. STM32F04xxx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment  |
|----------------|--------------------|--------------|--|
| DFU bootloader | USB                | Enabled      | USB used in FS mode  |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required. |

**Note:** *After the STM32F04xxx devices have booted in bootloader mode using USART2, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2\_RX).*

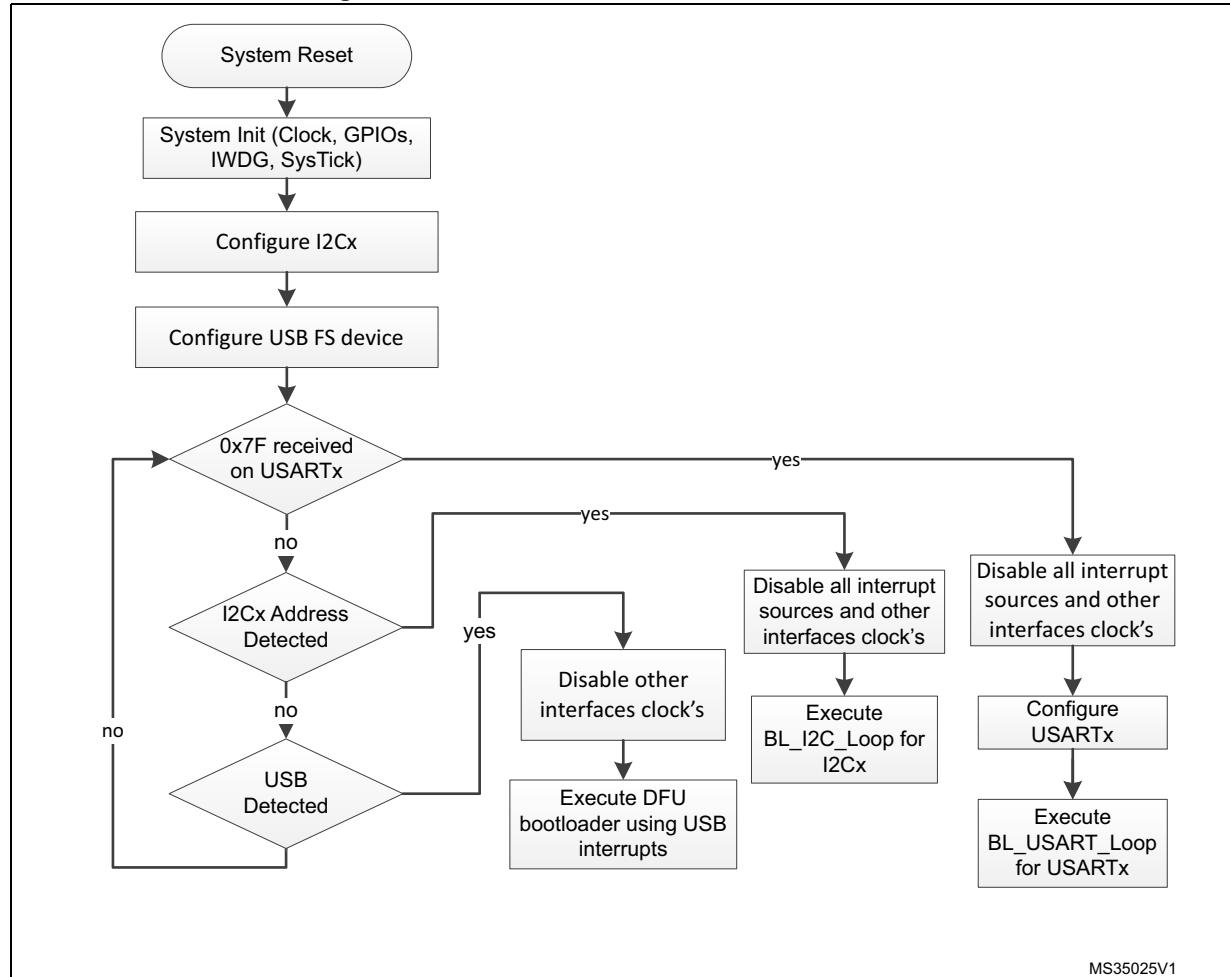
The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

**Note:** *Due to empty check mechanism present on this product, it is not possible to jump from user code to system bootloader. Such jump results in a jump back to user Flash memory space. But if the first 4 bytes of User Flash (at 0x0800 0000) are empty at the moment of jump (i.e. erase first sector before jump or execute code from SRAM while Flash is empty), then system bootloader is executed when jumped to.*

## 8.2 Bootloader selection

*Figure 11* shows the bootloader selection mechanism.

**Figure 11. Bootloader selection for STM32F04xxx**



MS35025V1

## 8.3 Bootloader version

The following table lists the STM32F04xxx devices bootloader versions:

**Table 16. STM32F04xxx bootloader versions**

| Bootloader version number | Description  | Known limitations  |
|---------------------------|--|--|
| V10.0                     | Initial bootloader version   |  |
| V10.1                     | Add dynamic support of USART/USB interfaces on PA11/12 IOs for small packages. | At bootloader startup, the HSITRIM value is set to 0 (in HSITRIM bits on RCC_CR register) instead of default value (16), as a consequence a deviation is generated in crystal measurement.<br>For better results, use the smallest supported crystal value (i.e. 4 MHz). |

## 9 STM32F070x6 devices bootloader

### 9.1 Bootloader configuration

The STM32F070x6 bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). [Table 17](#) shows the hardware resources used by this bootloader.

**Table 17. STM32F070x6 configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment  |
|---------------------------|--------------------|--------------|--|
| Common to all bootloaders | RCC                | HSI enabled  | At startup, the system clock frequency is configured to 48 MHz using the HSI. If an external clock (HSE) is not present, the system is kept clocked from the HSI.                                  |
|                           |                    | HSE enabled  | The external clock can be used for all bootloader interfaces and must have one of the following values [24, 18, 16, 12, 8, 6, 4] MHz. The PLL is used to generate 48 MHz for USB and system clock. |
|                           |                    | -            | The Clock Security System (CSS) interrupt is enabled for HSE. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -            | 13 Kbyte starting from address 0x1FFFC400, contain the bootloader firmware.  |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART2_RX pin      | Input        | PA15 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA14 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0111110x where x = 0 for write and x = 1 for read)                  |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |

**Table 17. STM32F070x6 configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment  |
|----------------|--------------------|--------------|--|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode. USB FS interrupt vector is enabled and used for USB DFU communications. |
|                | USB_DM pin         | Input/Output | PA11 pin: USB FS DM line   |
|                | USB_DP pin         |              | PA12 pin: USB FS DP line.<br>No external pull-up resistor is required.   |

**Note:** *If HSI deviation exceeds 1% the bootloader might not function correctly.*

**Note:** *After the STM32F070x6 devices have booted in bootloader mode using USART2, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2\_RX).*

The bootloader has two cases of operation depending on the presence of the external clock (HSE) at bootloader startup:

- If HSE is present and has a value of 24, 18, 16, 12, 8, 6, 4 MHz, the system clock is configured to 48 MHz with HSE as clock source. The DFU interface, USART1, USART2 and I2C1 are functional and can be used to communicate with the bootloader device.
- If HSE is not present, the HSI is kept as default clock source and only USART1, USART2 and I2C1 are functional.

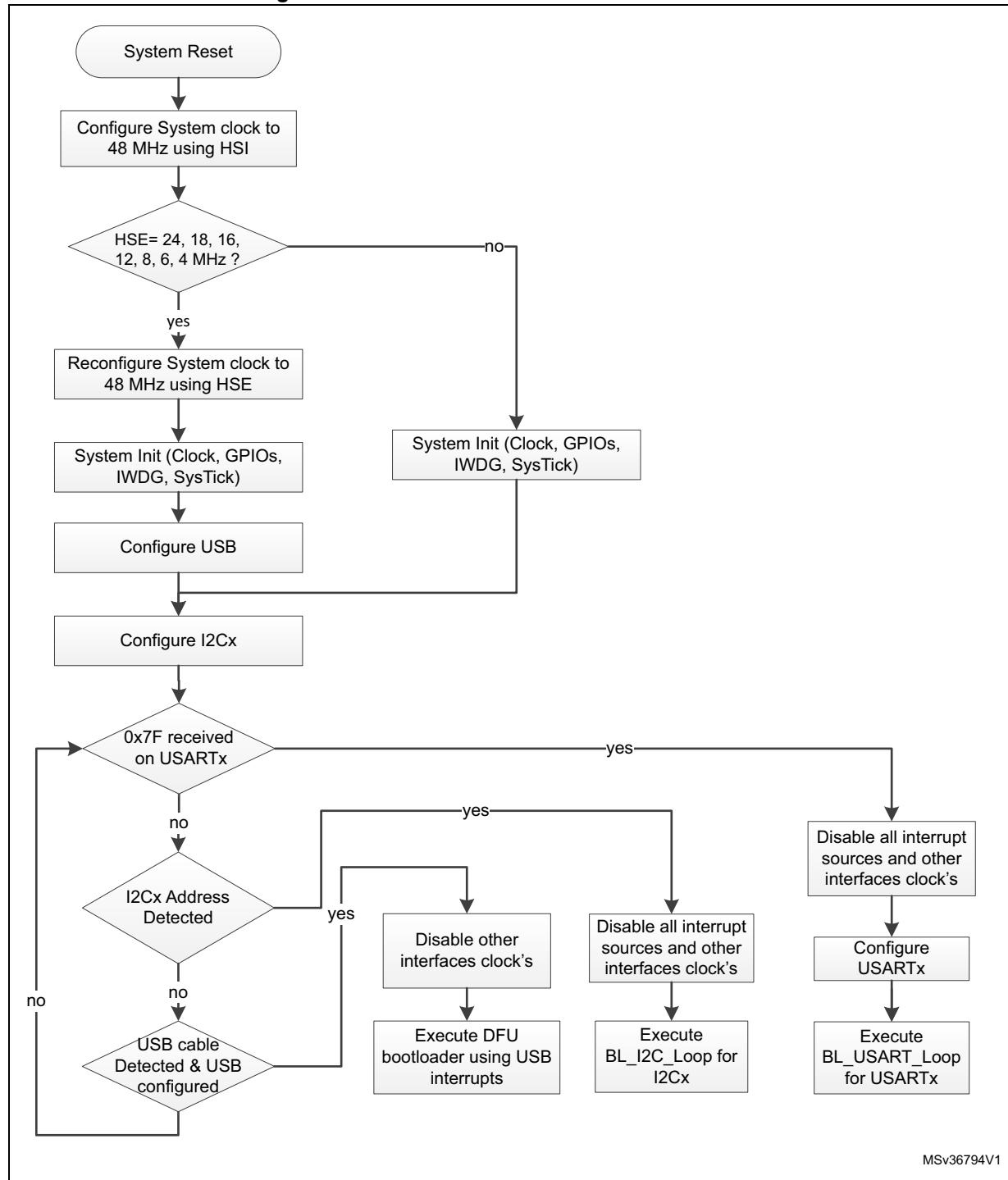
The external clock (HSE) must be kept if it is connected at bootloader startup because it is used as system clock source.

**Note:** *Due to empty check mechanism present on this product, it is not possible to jump from user code to system bootloader. Such jump results in a jump back to user Flash space, but if the first 4 bytes of User Flash (at 0x0800 0000) are empty at the moment of jump (i.e. erase first sector before jump or execute code from SRAM while Flash is empty), then system bootloader is executed when jumped to.*

## 9.2 Bootloader selection

*Figure 12* shows the bootloader selection mechanism.

**Figure 12. Bootloader selection for STM32F070x6**



### 9.3 Bootloader version

*Table 18* lists the STM32F070x6 devices bootloader versions.

**Table 18. STM32F070x6 bootloader versions**

| Bootloader version number | Description                            | Known limitations   |
|---------------------------|--|---|
| V10.2                     | Initial bootloader version             |   |
| V10.3                     | Clock configuration fixed to HSI 8 MHz | At bootloader startup, the HSITRIM value is set to 0 (in HSITRIM bits on RCC_CR register) instead of default value (16), as a consequence a deviation is generated in crystal measurement. For better results, use the smallest supported crystal value (i.e. 4 MHz). |

## 10 STM32F070xB devices bootloader

### 10.1 Bootloader configuration

The STM32F070xB bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). [Table 19](#) shows the hardware resources used by this bootloader.

**Table 19. STM32F070xB configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment  |
|---------------------------|--------------------|--------------|--|
| Common to all bootloaders | RCC                | HSI enabled  | At startup, the system clock frequency is configured to 48 MHz using the HSI. If an external clock (HSE) is not present, the system is kept clocked from the HSI.                                  |
|                           |                    | HSE enabled  | The external clock can be used for all bootloader interfaces and must have one of the following values [24, 18, 16, 12, 8, 6, 4] MHz. The PLL is used to generate 48 MHz for USB and system clock. |
|                           |                    | -            | The Clock Security System (CSS) interrupt is enabled for HSE. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -            | 12 Kbyte starting from address 0x1FFFC800, contain the bootloader firmware.  |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART2_RX pin      | Input        | PA15 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA14 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0111011x<br>(where x = 0 for write and x = 1 for read)              |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |

**Table 19. STM32F070xB configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications. |
|                | USB_DM pin         | Input/Output | PA11 pin: USB FS DM line  |
|                | USB_DP pin         |              | PA12 pin: USB FS DP line.<br>No external pull-up resistor is required.  |

*Note:* If HSI deviation exceeds 1% the bootloader might not function correctly.

*Note:* After the STM32F070xB devices have booted in bootloader mode using USART2, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2\_RX).

The bootloader has two cases of operation depending on the presence of the external clock (HSE) at bootloader startup:

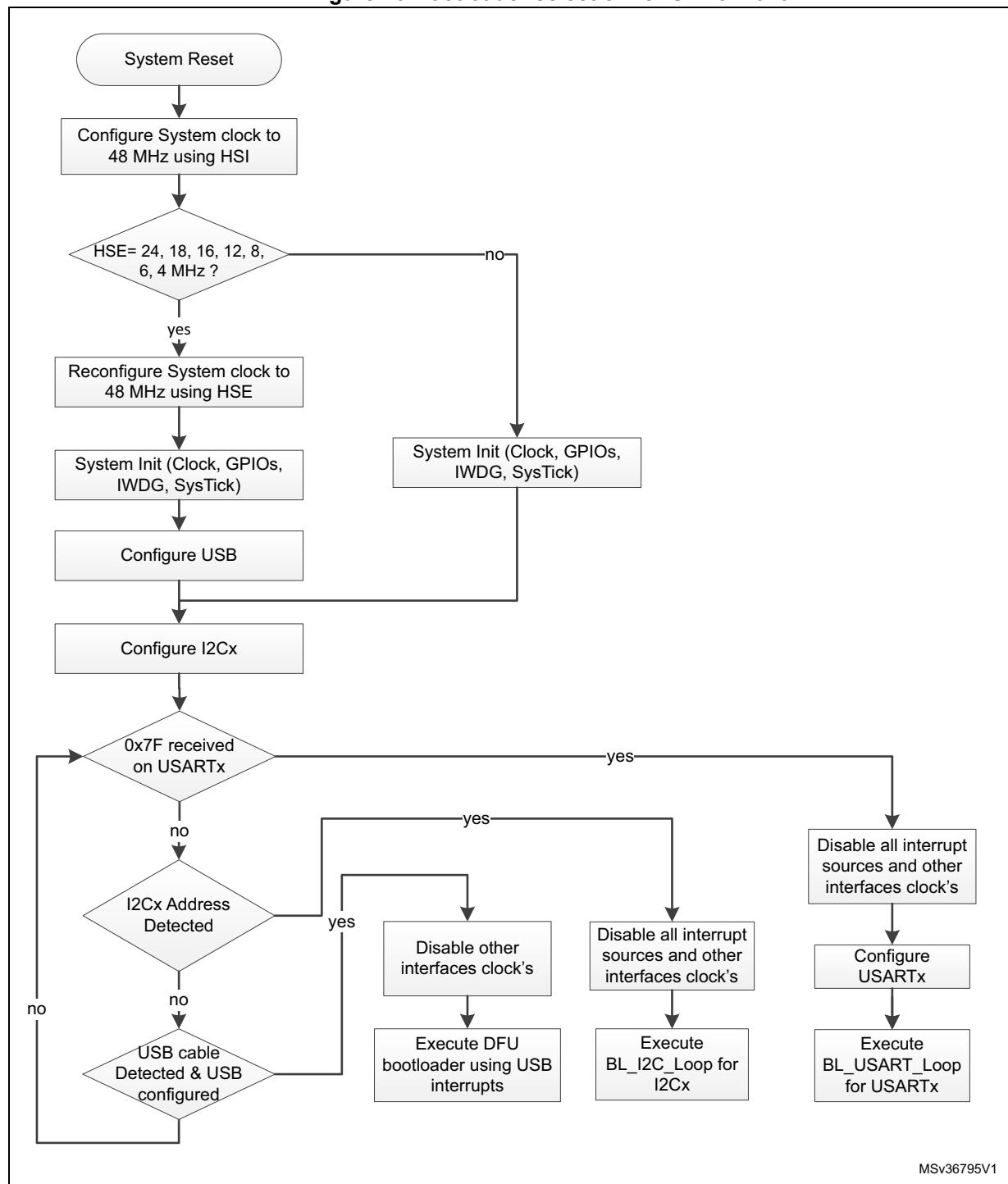
- If HSE is present and has a value of 24, 18, 16, 12, 8, 6, 4 MHz, the system clock is configured to 48 MHz with HSE as clock source. The DFU interface, USART1, USART2 and I2C1 are functional and can be used to communicate with the bootloader device.
- If HSE is not present, the HSI is kept as default clock source and only USART1, USART2 and I2C1 are functional.

The external clock (HSE) must be kept if it is connected at bootloader startup because it is used as system clock source.

## 10.2 Bootloader selection

*Figure 13* shows the bootloader selection mechanism.

**Figure 13.Bootloader selection for STM32F070xB**



MSv36795V1

## 10.3 Bootloader version

*Table 20* lists the STM32F070xB devices bootloader versions.

**Table 20. STM32F070xB bootloader versions**

| Bootloader version number | Description                            | Known limitations   |
|---------------------------|--|---|
| V10.2                     | Initial bootloader version             |   |
| V10.3                     | Clock configuration fixed to HSI 8 MHz | At bootloader startup, the HSITRIM value is set to (0) (in HSITRIM bits on RCC_CR register) instead of default value (16), as a consequence a deviation is generated in crystal measurement. For better results, use the smallest supported crystal value (i.e. 4 MHz). |

## 11 STM32F071xx/072xx devices bootloader

### 11.1 Bootloader configuration

The STM32F071xx/072xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). [Table 21](#) shows the hardware resources used by this bootloader.

**Table 21. STM32F071xx/072xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.   |
|                           |                    | -            | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.   |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 12 Kbyte starting from address 0x1FFFC800, contain the bootloader firmware  |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA15 pin: USART2 in reception mode  |
|                           | USART2_TX pin      | Output       | PA14 pin: USART2 in transmission mode   |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111011x (where x = 0 for write and x = 1 for read)                             |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

**Table 21. STM32F071xx/072xx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment  |
|----------------|--------------------|--------------|--|
| DFU bootloader | USB                | Enabled      | USB used in FS mode  |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required. |

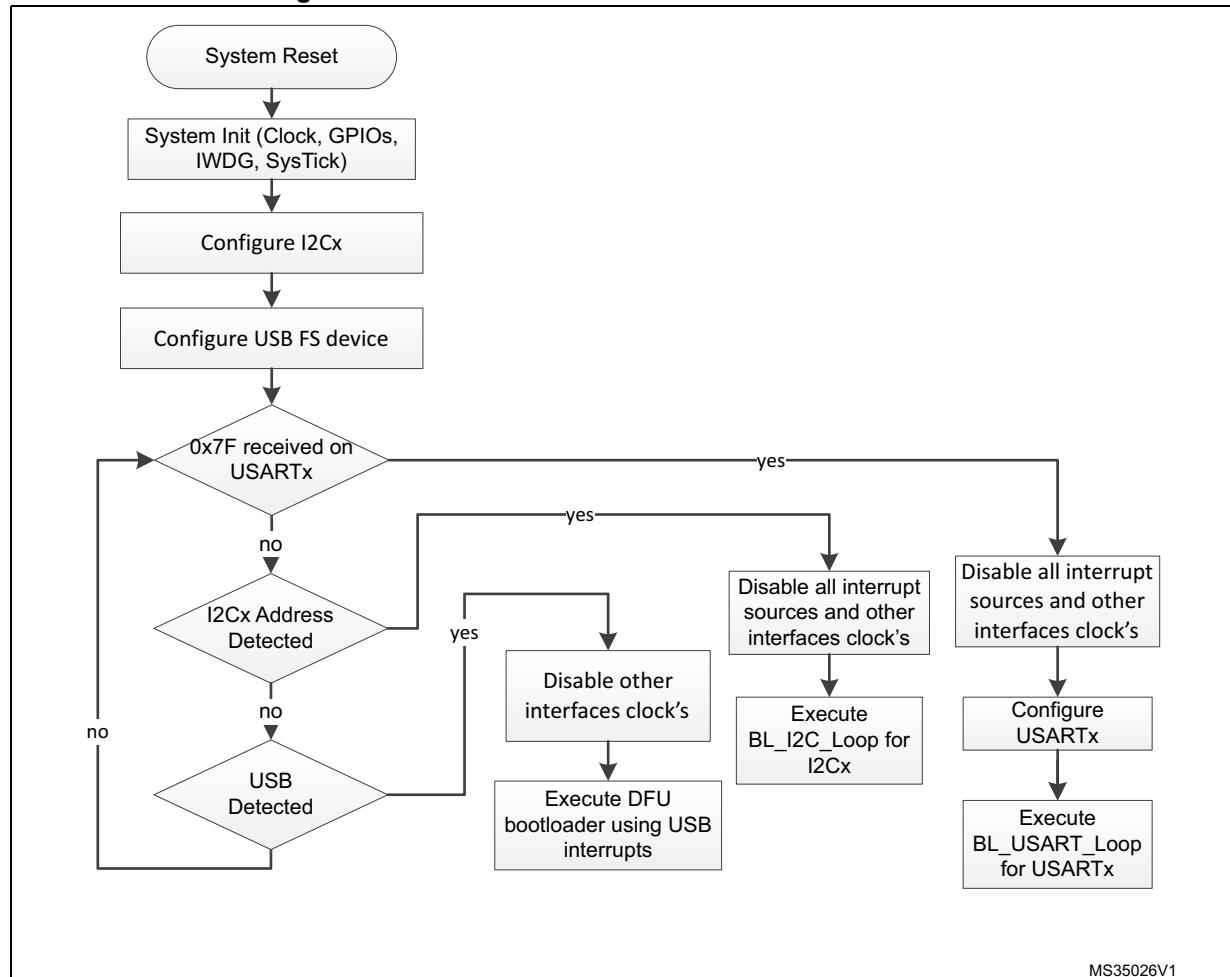
**Note:** *After the STM32F071xx/072xx devices have booted in bootloader mode using USART2, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2\_RX).*

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 11.2 Bootloader selection

*Figure 14* shows the bootloader selection mechanism.

**Figure 14. Bootloader selection for STM32F071xx/072xx**



## 11.3 Bootloader version

*Table 22* lists the STM32F071xx/072xx devices bootloader versions.

**Table 22. STM32F071xx/072xx bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V10.1                     | Initial bootloader version | At bootloader startup, the HSITRIM value is set to (0) (in HSITRIM bits on RCC_CR register) instead of default value (16), as a consequence a deviation is generated in crystal measurement. For better results, use the smallest supported crystal value (i.e. 4 MHz). |

## 12 STM32F09xxx devices bootloader

### 12.1 Bootloader configuration

The STM32F09xxx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 23. STM32F09xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment  |
|---------------------------|--------------------|--------------|--|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.  |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware.   |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode  |
|                           |                    |              | PA15 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode   |
|                           |                    |              | PA14 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000001x (where x = 0 for write and x = 1 for read) |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |

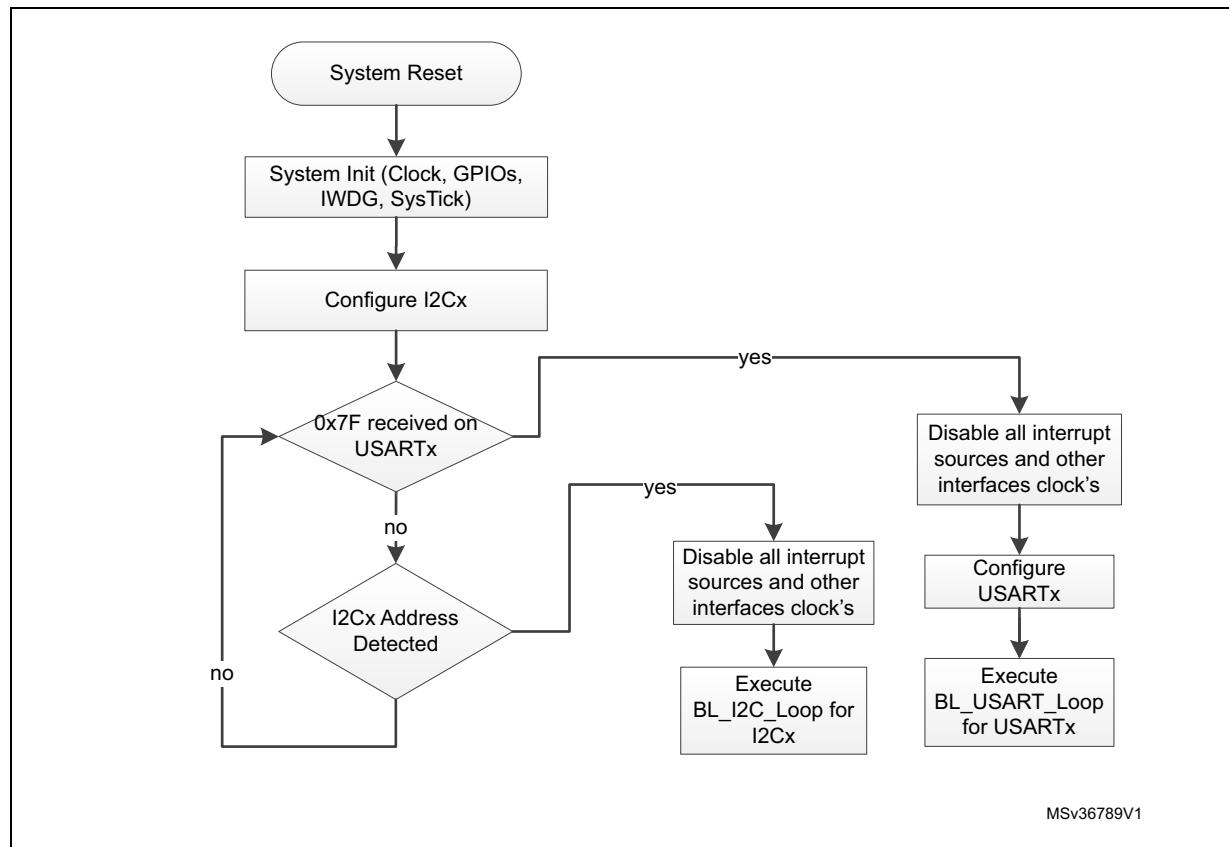
**Note:** After the STM32F09xxx devices have booted in bootloader mode using USART2, the serial wire debug (SWD) communication is no more possible until the system is reset, because SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2\_RX).

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 12.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 15.** Bootloader selection for STM32F09xxx



## 12.3 Bootloader version

The following table lists the STM32F09xxx devices bootloader versions.

**Table 24. STM32F09xxx bootloader versions**

| Table 2: STM32L0xx Bootloader Versions |                            |   |
|--|----------------------------|---|
| Bootloader version number              | Description                | Known limitations   |
| V5.0                                   | Initial bootloader version | At bootloader startup, the HSITRIM value is set to (0) (in HSITRIM bits on RCC_CR register) instead of default value (16), as a consequence a deviation is generated in crystal measurement. For better results, use the smallest supported crystal value (i.e. 4 MHz). |

## 13 STM32F10xxx devices bootloader

### 13.1 Bootloader configuration

The STM32F10xxx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). [Table 25](#) shows the hardware resources used by this bootloader.

**Table 25. STM32F10xxx configuration in system memory boot mode**

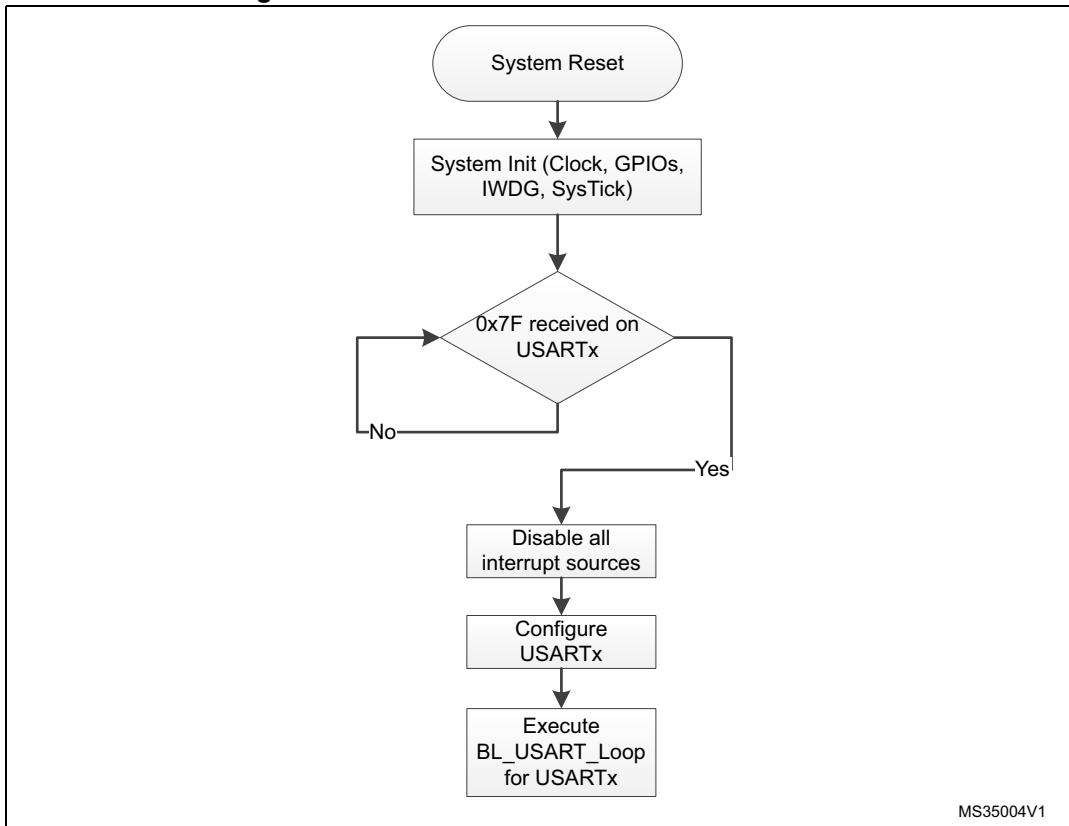
| Bootloader        | Feature/Peripheral | State            | Comment   |
|-------------------|--------------------|------------------|---|
| USART1 bootloader | RCC                | HSI enabled      | The system clock frequency is 24 MHz using the PLL.   |
|                   | RAM                | -                | 512 byte starting from address 0x20000000 are used by the bootloader firmware.  |
|                   | System memory      | -                | 2 Kbyte starting from address 0x1FFFF000 contain the bootloader firmware.   |
|                   | IWDG               | -                | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                   | USART1             | Enabled          | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                   | USART1_RX pin      | Input            | PA10 pin: USART1 in reception mode  |
|                   | USART1_TX pin      | Output push-pull | PA9 pin: USART1 in transmission mode  |
|                   | SysTick timer      | Enabled          | Used to automatically detect the serial baud rate from the host.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 13.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 16. Bootloader selection for STM32F10xxx**



## 13.3 Bootloader version

*Table 26* lists the STM32F10xxx devices bootloader versions:

**Table 26. STM32F10xxx bootloader versions**

| Bootloader version number | Description   |
|---------------------------|---|
| V2.0                      | Initial bootloader version  |
| V2.1                      | <ul style="list-style-type: none"> <li>– Updated Go Command to initialize the main stack pointer</li> <li>– Updated Go command to return NACK when jump address is in the Option byte area or System memory area</li> <li>– Updated Get ID command to return the device ID on two bytes</li> <li>– Update the bootloader version to V2.1</li> </ul> |
| V2.2                      | <ul style="list-style-type: none"> <li>– Updated Read Memory, Write Memory and Go commands to deny access with a NACK response to the first 0x200 bytes of RAM memory used by the bootloader</li> <li>– Updated Readout Unprotect command to initialize the whole RAM content to 0x0 before ROP disable operation</li> </ul>                        |

**Note:** *The bootloader ID format is applied to all STM32 devices families except the STM32F1xx family. The bootloader version for the STM32F1xx applies only to the embedded device's bootloader version and not to its supported protocols.*

## 14 STM32F105xx/107xx devices bootloader

### 14.1 Bootloader configuration

The STM32F105xx/107xx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 27. STM32F105xx/107xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State            | Comment  |
|---------------------------|--------------------|------------------|--|
| Common to all bootloaders | RCC                | HSI enabled      | The system clock frequency is 24 MHz using the PLL. This is used only for USARTx bootloaders and during CAN2, USB detection for CAN and DFU bootloaders (once CAN or DFU bootloader is selected, the clock source is derived from the external crystal).   |
|                           |                    | HSE enabled      | The external clock is mandatory only for DFU and CAN bootloaders and it must provide one of the following frequencies: 8 MHz, 14.7456 MHz or 25 MHz.<br>For CAN bootloader, the PLL is used only to generate 48 MHz when 14.7456 MHz is used as HSE.<br>For DFU bootloader, the PLL is used to generate a 48 MHz system clock from all supported external clock frequencies. |
|                           |                    | -                | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock will generate system reset.   |
|                           | RAM                | -                | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware.  |
|                           | System memory      | -                | 18 Kbyte starting from address 0x1FFFB000 contain the bootloader firmware.   |
|                           | IWDG               | -                | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).  |
| USART1 bootloader         | USART1             | Enabled          | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.   |
|                           | USART1_RX pin      | Input            | PA10 pin: USART1 in reception mode   |
|                           | USART1_TX pin      | Output push-pull | PA9 pin: USART1 in transmission mode   |

**Table 27. STM32F105xx/107xx configuration in system memory boot mode (continued)**

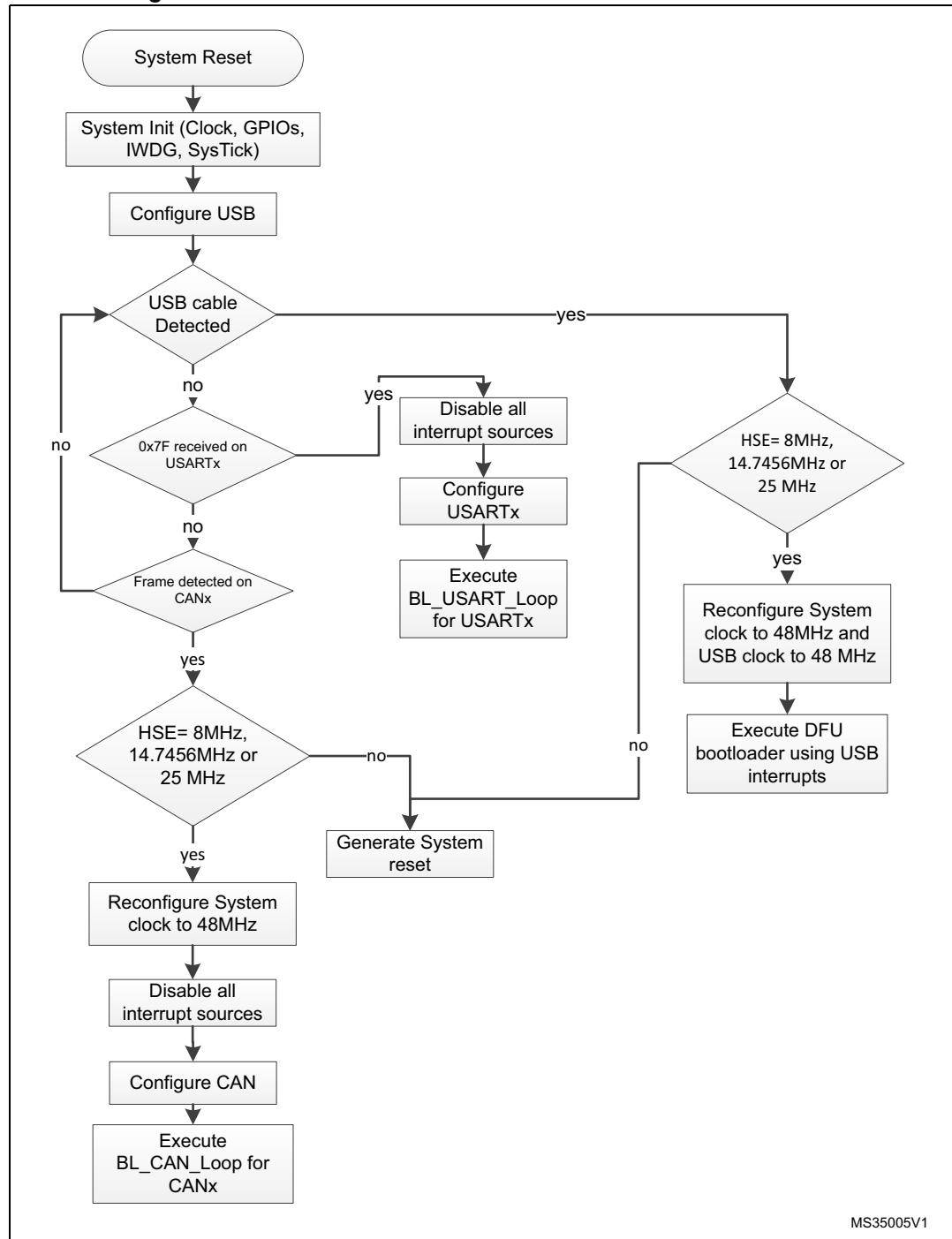
| Bootloader         | Feature/Peripheral | State            | Comment  |
|--------------------|--------------------|------------------|--|
| USART2 bootloader  | USART2             | Enabled          | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.  |
|                    | USART2_RX pin      | Input            | PD6 pin: USART2 receive (remapped pin)   |
|                    | USART2_TX pin      | Output push-pull | PD5 pin: USART2 transmit (remapped pin)  |
| USARTx bootloaders | SysTick timer      | Enabled          | Used to automatically detect the serial baud rate from the host for USARTx bootloader.   |
| CAN2 bootloader    | CAN2               | Enabled          | Once initialized, the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during the CAN bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                    | CAN2_RX pin        | Input            | PB5 pin: CAN2 receives (remapped pin).   |
|                    | CAN2_TX pin        | Output push-pull | PB6 pin: CAN2 transmits (remapped pin).  |
| DFU bootloader     | USB                | Enabled          | USB OTG FS configured in forced device mode  |
|                    | USB_VBUS pin       | Input            | PA9: Power supply voltage line   |
|                    | USB_DM pin         | Input/Output     | PA11 pin: USB_DM line  |
|                    | USB_DP pin         |                  | PA12 pin: USB_DP line.<br>No external pull-up resistor is required   |

The system clock is derived from the embedded internal high-speed RC for USARTx bootloader. This internal clock is used also for DFU and CAN bootloaders but only for the selection phase. An external clock (8 MHz, 14.7456 MHz or 25 MHz) is required for DFU and CAN bootloader execution after the selection phase.

## 14.2 Bootloader selection

*Figure 17* shows the bootloader selection mechanism.

**Figure 17. Bootloader selection for STM32F105xx/107xx devices**



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## 14.3 Bootloader version

The following table lists the STM32F105xx/107xx devices bootloader versions:

**Table 28. STM32F105xx/107xx bootloader versions**

| Bootloader version number | Description  |
|---------------------------|--|
| V1.0                      | Initial bootloader version   |
| V2.0                      | <ul style="list-style-type: none"> <li>– Bootloader detection mechanism updated to fix the issue when GPIOs of unused peripherals in this bootloader are connected to low level or left floating during the detection phase.<br/>For more details refer to <a href="#">Section 14.3.2</a>.</li> <li>– Vector table set to 0x1FFF8000 instead of 0x00000000</li> <li>– Go command updated (for all bootloaders): USART1, USART2, CAN2, GPIOA, GPIOB, GPIOD and SysTick peripheral registers are set to their default reset values</li> <li>– DFU bootloader: USB pending interrupt cleared before executing the Leave DFU command</li> <li>– DFU subprotocol version changed from V1.0 to V1.2</li> <li>– Bootloader version updated to V2.0</li> </ul> |
| V2.1                      | <ul style="list-style-type: none"> <li>– Fixed PA9 excessive consumption described in <a href="#">Section 14.3.4</a>.</li> <li>– Get-Version command (defined in AN3155) corrected. It returns 0x22 instead of 0x20 in bootloader V2.0. Refer to <a href="#">Section 14.3.3</a> for more details.</li> <li>– Bootloader version updated to V2.1</li> </ul>   |
| V2.2                      | <ul style="list-style-type: none"> <li>– Fixed DFU option bytes descriptor (set to 'e' instead of 'g' because it is read/write and not erasable).</li> <li>– Fixed DFU polling timings for Flash Read/Write/Erase operations.</li> <li>– Robustness enhancements for DFU bootloader interface.</li> <li>– Updated bootloader version to V2.2.</li> </ul>   |

**Note:** The bootloader ID format is applied to all STM32 devices families except the STM32F1xx family. The bootloader version for the STM32F1xx applies only to the embedded device's bootloader version and not to its supported protocols.

### 14.3.1 How to identify STM32F105xx/107xx bootloader versions

Bootloader V1.0 is implemented on devices whose date code is lower than 937 (refer to STM32F105xx and STM32F107xx datasheet to find the date code on the device marking).

Bootloader V2.0 and V2.1 are implemented on devices with a date code higher than or equal to 937.

Bootloader V2.2 is implemented on devices with a date code higher than or equal to 227.

There are two ways to distinguish between bootloader versions:

- When using the USART bootloader, the Get-Version command defined in AN2606 and AN3155 has been corrected in V2.1 version. It returns 0x22 instead of 0x20 as in bootloader V2.0.

- The values of the vector table at the beginning of the bootloader code are different. The user software (or via JTAG/SWD) reads 0x1FFE945 at address 0x1FFFB004 for bootloader V2.0 0x1FFE9A1 for bootloader V2.1, and 0x1FFE9C1 for bootloader V2.2.
- The DFU version is the following:
  - V2.1 in bootloader V2.1
  - V2.2 in bootloader V2.2.

It can be read through the bcdDevice field of the DFU Device Descriptor.

### 14.3.2 Bootloader unavailability on STM32F105xx/STM32F107xx devices with date code lower than 937

#### Description

The bootloader cannot be used if the USART1\_RX (PA10), USART2\_RX (PD6, remapped), CAN2\_Rx (PB5, remapped), OTG\_FS\_DM (PA11), and/or OTG\_FS\_DP (PA12) pin(s) are held low or left floating during the bootloader activation phase.

The bootloader cannot be connected through CAN2 (remapped), DFU (OTG FS in Device mode), USART1 or USART2 (remapped).

On 64-pin packages, the USART2\_RX signal remapped PD6 pin is not available and it is internally grounded. In this case, the bootloader cannot be used at all.

#### Workaround

- For 64-pin packages
  - None. The bootloader cannot be used.
- For 100-pin packages
  - Depending on the used peripheral, the pins for the unused peripherals have to be kept at a high level during the bootloader activation phase as described below:
    - If USART1 is used to connect to the bootloader, PD6 and PB5 have to be kept at a high level.
    - If USART2 is used to connect to the bootloader, PA10, PB5, PA11 and PA12 have to be kept at a high level.
    - If CAN2 is used to connect to the bootloader, PA10, PD6, PA11 and PA12 have to be kept at a high level.
    - If DFU is used to connect to the bootloader, PA10, PB5 and PD6 have to be kept at a high level.

*Note:* This limitation applies only to STM32F105xx and STM32F107xx devices with a date code below 937. STM32F105xx and STM32F107xx devices with a date code higher or equal to 937 are not impacted. See STM32F105xx and STM32F107xx datasheets for where to find the date code on the device marking.

**14.3.3 USART bootloader Get-Version command returns 0x20 instead of 0x22****Description**

In USART mode, the Get-Version command (defined in AN3155) returns 0x20 instead of 0x22.

This limitation is present on bootloader versions V1.0 and V2.0, while it is fixed in bootloader version 2.1.

**Workaround**

None.

**14.3.4 PA9 excessive power consumption when USB cable is plugged in bootloader V2.0****Description**

When connecting a USB cable after booting from System-Memory mode, PA9 pin (connected to  $V_{BUS}=5$  V) is also shared with USART TX pin which is configured as alternate push-pull and forced to 0 since the USART peripheral is not yet clocked. As a consequence, a current higher than 25 mA is drained by PA9 I/O and may affect the I/O pad reliability.

This limitation is fixed in bootloader version 2.1 by configuring PA9 as alternate function push-pull when a correct 0x7F is received on RX pin and the USART is clocked. Otherwise, PA9 is configured as alternate input floating.

**Workaround**

None.

## 15 STM32F10xxx XL-density devices bootloader

### 15.1 Bootloader configuration

The STM32F10xxx XL-density bootloader is activated by applying Pattern 3 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 29. STM32F10xxx XL-density configuration in system memory boot mode**

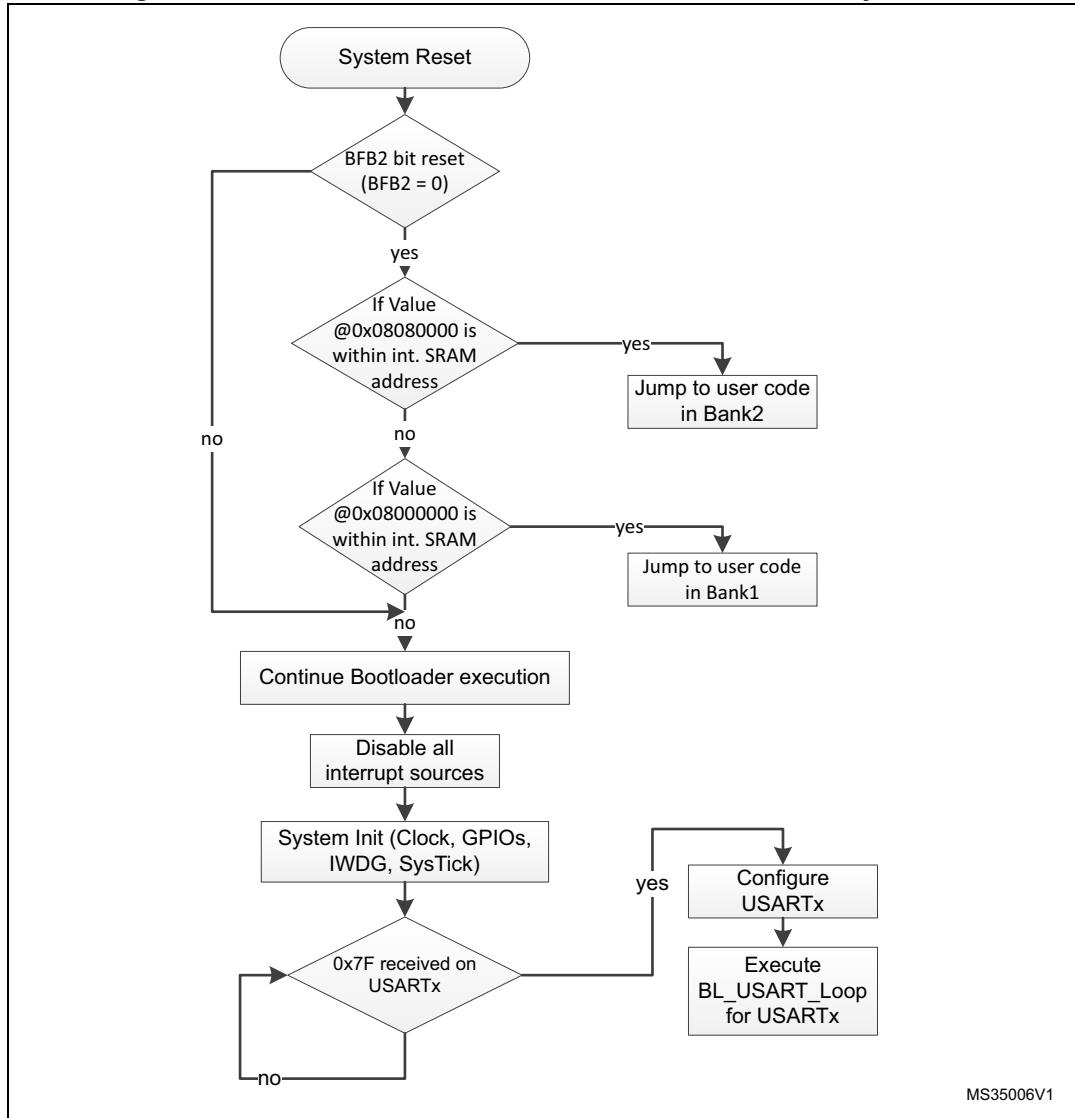
| Bootloader                | Feature/Peripheral | State            | Comment   |
|---------------------------|--------------------|------------------|---|
| Common to all bootloaders | RCC                | HSI enabled      | The system clock frequency is 24 MHz using the PLL.   |
|                           | RAM                | -                | 2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -                | 6 Kbyte starting from address 0x1FFE000 contain the bootloader firmware.  |
|                           | IWDG               | -                | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled          | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART1_RX pin      | Input            | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output push-pull | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled          | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART2_RX pin      | Input            | PD6 pin: USART2 receives (remapped pins).   |
|                           | USART2_TX pin      | Output push-pull | PD5 pin: USART2 transmits (remapped pins).  |
| USARTx bootloaders        | SysTick timer      | Enabled          | Used to automatically detect the serial baud rate from the host.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 15.2 Bootloader selection

*Figure 18* shows the bootloader selection mechanism.

**Figure 18. Bootloader selection for STM32F10xxx XL-density devices**



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## 15.3 Bootloader version

*Table 30* lists the STM32F10xxx XL-density devices bootloader versions.

**Table 30. STM32F10xxx XL-density bootloader versions**

| Bootloader version number | Description                |
|---------------------------|----------------------------|
| V2.1                      | Initial bootloader version |

Note: *The bootloader ID format is applied to all STM32 devices families except the STM32F1xx family. The bootloader version for the STM32F1xx applies only to the embedded device bootloader version and not to its supported protocols.*

## 16 STM32F2xxxx devices bootloader

Two bootloader versions are available on STM32F2xxxx devices:

- V2.x supporting USART1 and USART3  
This version is embedded in revisions A, Z and B
- V3.x supporting USART1, USART3, CAN2 and DFU (USB FS device)  
This version is embedded in all other revisions (Y, X, W, 1, V, 2, 3 and 4)

### 16.1 Bootloader V2.x

#### 16.1.1 Bootloader configuration

The STM32F2xxxx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 31. STM32F2xxxx configuration in system memory boot mode**

| Bootloader                          | Feature/Peripheral | State       | Comment   |
|-------------------------------------|--------------------|-------------|---|
| Common to all bootloaders           | RCC                | HSI enabled | The system clock frequency is 24 MHz.   |
|                                     | RAM                | -           | 8 Kbyte starting from address 0x20000000.   |
|                                     | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware.   |
|                                     | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                                     | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands. |
| USART1 bootloader                   | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled     | Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART3_RX pin      | Input       | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output      | PC10 pin: USART3 in transmission mode   |

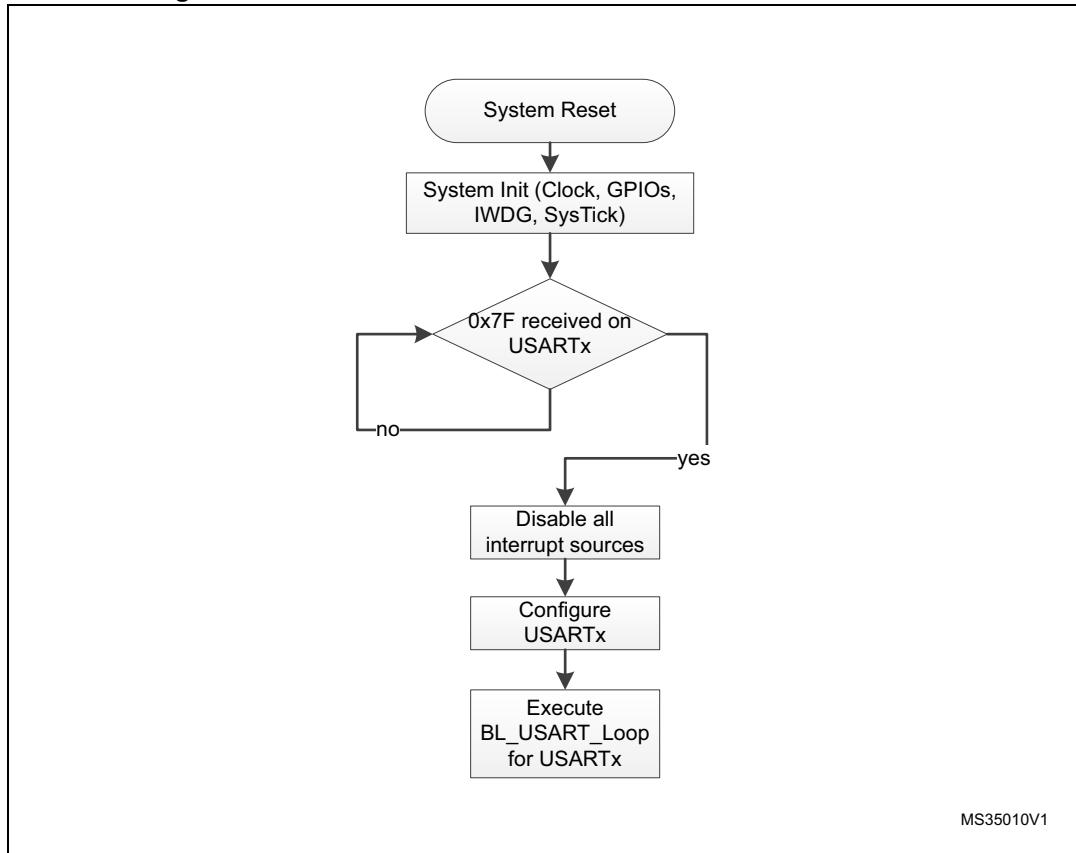
**Table 31. STM32F2xxxx configuration in system memory boot mode (continued)**

| Bootloader                          | Feature/Peripheral | State   | Comment   |
|-------------------------------------|--------------------|---------|---|
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled | Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit |
|                                     | USART3_RX pin      | Input   | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output  | PB10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled | Used to automatically detect the serial baud rate from the host.                  |

The system clock is derived from the embedded internal high-speed RC. No external quartz is required for the bootloader code.

### 16.1.2 Bootloader selection

*Figure 19* shows the bootloader selection mechanism.

**Figure 19. Bootloader V2.x selection for STM32F2xxxx devices**

### 16.1.3 Bootloader version

This following table lists the STM32F2xxxx devices V2.x bootloader versions:

**Table 32. STM32F2xxxx bootloader V2.x versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V2.0                      | Initial bootloader version | <p>When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (i.e. address 0x6000 0000), the command is aborted by the bootloader device, but the NACK (0x1F) is not sent to the host. As a result, the next 2 bytes (which are the number of bytes to be read/written and its checksum) are considered as a new command and its checksum.</p> <p>For the CAN interface, the Write Unprotect command is not functional. Use Write Memory command and write directly to the option bytes in order to disable the write protection.<sup>(1)</sup></p> |

1. If the “number of data - 1” (N-1) to be read/written is not equal to a valid command code (0x00, 0x01, 0x02, 0x11, 0x21, 0x31, 0x43, 0x44, 0x63, 0x73, 0x82 or 0x92), then the limitation is not perceived from the host since the command is NACKed anyway (as an unsupported new command).

## 16.2 Bootloader V3.x

### 16.2.1 Bootloader configuration

The STM32F2xxxx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 33. STM32F2xxxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 24 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USARTx interfaces are selected (once CAN or DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the CAN or the DFU (USB FS Device) interfaces are selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                      |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 8 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FF00000 contain the bootloader firmware.  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.     |

**Table 33. STM32F2xxxx configuration in system memory boot mode (continued)**

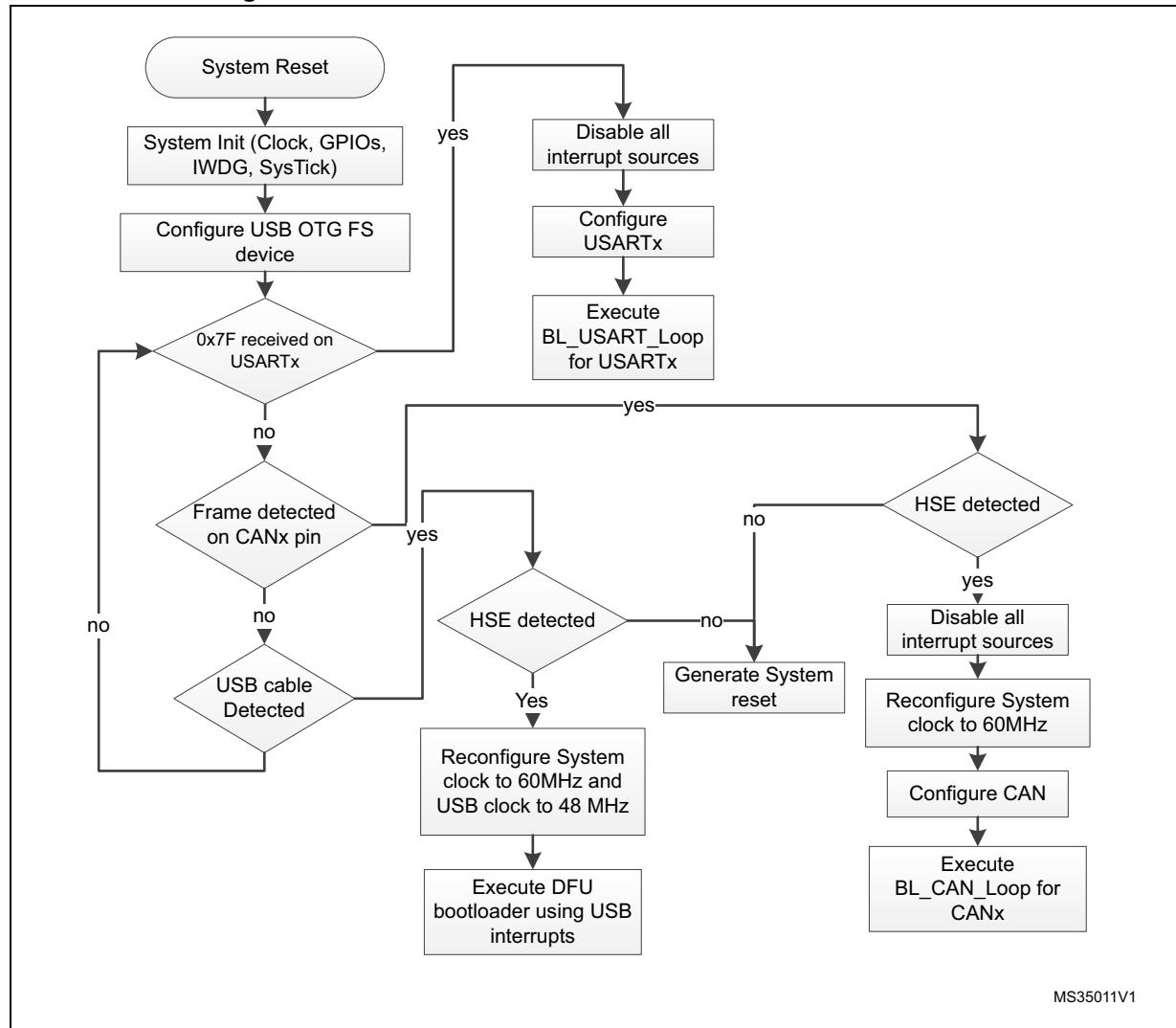
| Bootloader                          | Feature/Peripheral | State        | Comment   |
|-------------------------------------|--------------------|--------------|---|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized, the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode   |
| DFU bootloader                      | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                                     | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                                     | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
| CAN2 and DFU<br>bootloaders         | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE.   |

The system clock is derived from the embedded internal high-speed RC for USARTx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

### 16.2.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 20. Bootloader V3.x selection for STM32F2xxxx devices**



MS35011V1

### 16.2.3 Bootloader version

The following table lists the STM32F2xxxx devices V3.x bootloader versions:

**Table 34. STM32F2xxxx bootloader V3.x versions**

| Bootloader version number | Description   | Known limitations  |
|---------------------------|---|--|
| V3.2                      | Initial bootloader version.                                 | <ul style="list-style-type: none"> <li>– When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (i.e. address 0x6000 0000), the command is aborted by the bootloader device, but the NACK (0x1F) is not sent to the host. As a result, the next 2 bytes (which are the number of bytes to be read/written and its checksum) are considered as a new command and its checksum<sup>(1)</sup>.</li> <li>– Option bytes, OTP and Device Feature descriptors (in DFU interface) are set to “g” instead of “e” (not erasable memory areas).</li> </ul> |
| V3.3                      | Fix V3.2 limitations. DFU interface robustness enhancement. | <ul style="list-style-type: none"> <li>– For the USART interface, two consecutive NACKs (instead of 1 NACK) are sent when a Read Memory or Write Memory command is sent and the RDP level is active.</li> <li>– For the CAN interface, the Write Unprotect command is not functional. Use Write Memory command and write directly to the option bytes in order to disable the write protection.</li> </ul>   |

1. If the “number of data - 1” (N-1) to be read/written is not equal to a valid command code (0x00, 0x01, 0x02, 0x11, 0x21, 0x31, 0x43, 0x44, 0x63, 0x73, 0x82 or 0x92), then the limitation is not perceived from the host since the command is NACKed anyway (as an unsupported new command).

## 17 STM32F301xx/302x4(6/8) devices bootloader

### 17.1 Bootloader configuration

The STM32F301xx/302x4(6/8) bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 35. STM32F301xx/302x4(6/8) configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.   |
|                           |                    | HSE enabled | The external clock can be used for all bootloader interfaces and must have one of the following values [24,18,16,12,9,8,6,4,3] MHz.<br>The PLL is used to generate the USB48 MHz clock and the 48 MHz clock for the system clock. |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware   |
| USART1 bootloader         | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                       |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
| USART2 bootloader         | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
|                           | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
| USARTx bootloaders        | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
|                           | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |

**Table 35. STM32F301xx/302x4(6/8) configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB used in FS mode   |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>An external pull-up resistor 1.5 KΩ must be connected to USB_DP pin. |

The bootloader has two case of operation depending on the presence of the external clock (HSE) at bootloader startup:

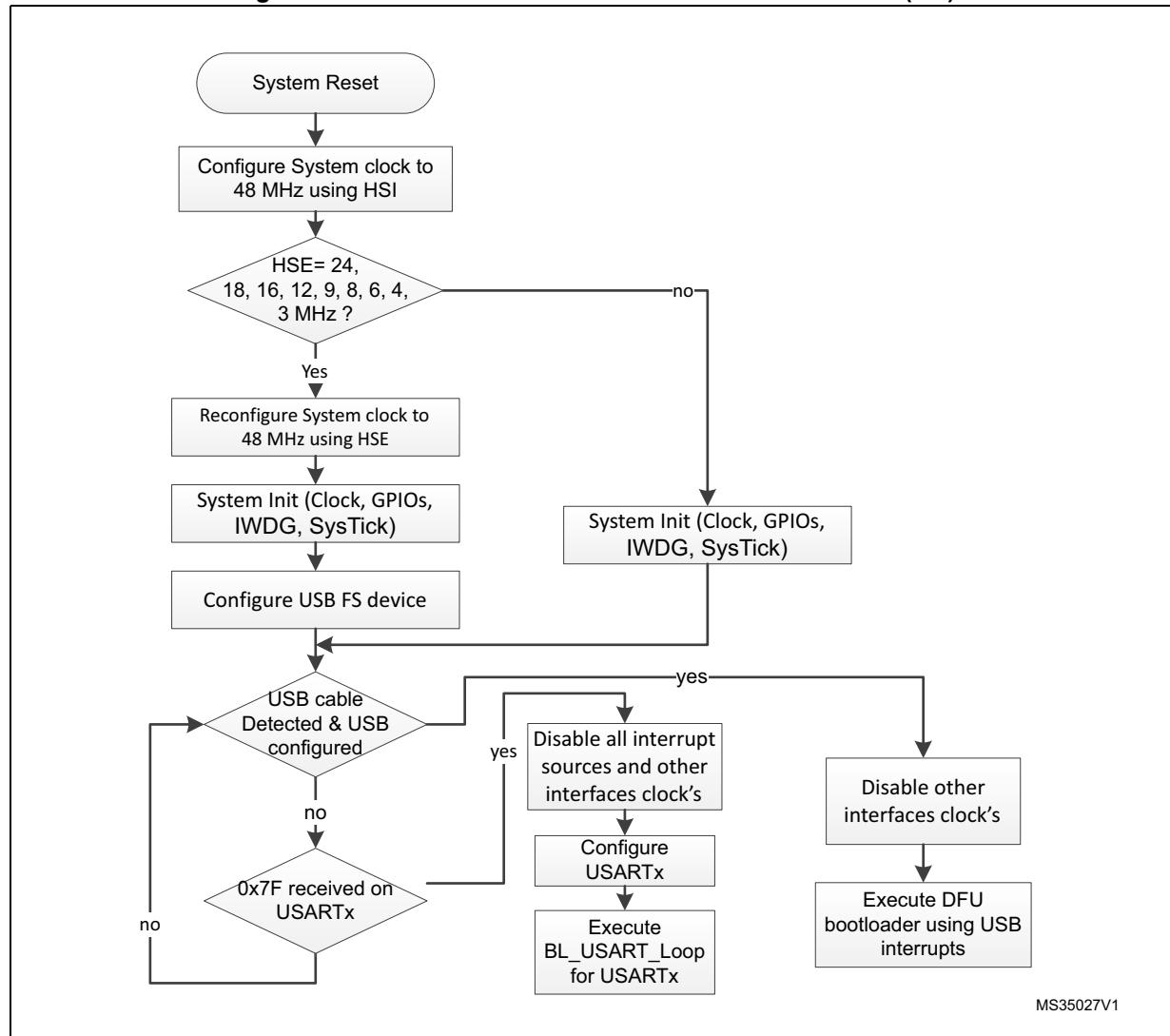
- If HSE is present and has a value of 24, 18, 16, 12, 9, 8, 6, 4 or 3 MHz, the system clock is configured to 48 MHz with HSE as clock source. The DFU interface, USART1 and USART2 are functional and can be used to communicate with the bootloader device.
- If HSE is not present, the HSI is kept as default clock source and only USART1 and USART2 are functional.

*The external clock (HSE) must be kept if it is connected at bootloader startup because it is used as system clock source.*

## 17.2 Bootloader selection

*Figure 21* shows the bootloader selection mechanism.

**Figure 21. Bootloader selection for STM32F301xx/302x4(6/8)**



MS35027V1

## 17.3 Bootloader version

The following table lists the STM32F301xx/302x4(6/8) devices bootloader versions:

**Table 36. STM32F301xx/302x4(6/8) bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V4.0                      | Initial bootloader version | None              |

## 18 STM32F302xB(C)/303xB(C) devices bootloader

### 18.1 Bootloader configuration

The STM32F302xB(C)/303xB(C) bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 37. STM32F302xB(C)/303xB(C) configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | At startup, the system clock frequency is configured to 48 MHz using the HSI. If an external clock (HSE) is not present, the system is kept clocked from the HSI.  |
|                           |                    | HSE enabled | The external clock can be used for all bootloader interfaces and must have one of the following values [24, 18, 16, 12, 9, 8, 6, 4, 3] MHz.<br>The PLL is used to generate the USB 48 MHz clock and the 48 MHz clock for the system clock. |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 5 Kbyte starting from address 0x20000000 are used by the bootloader firmware.  |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware.  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                                |
| USART1 bootloader         | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode   |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode   |
| USART2 bootloader         | USART2             | Enabled     | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.  |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode  |
|                           | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode   |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloader.   |

**Table 37. STM32F302xB(C)/303xB(C) configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB used in FS mode   |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>An external pull-up resistor 1.5 KΩ must be connected to USB_DP pin. |

The bootloader has two case of operation depending on the presence of the external clock (HSE) at bootloader startup:

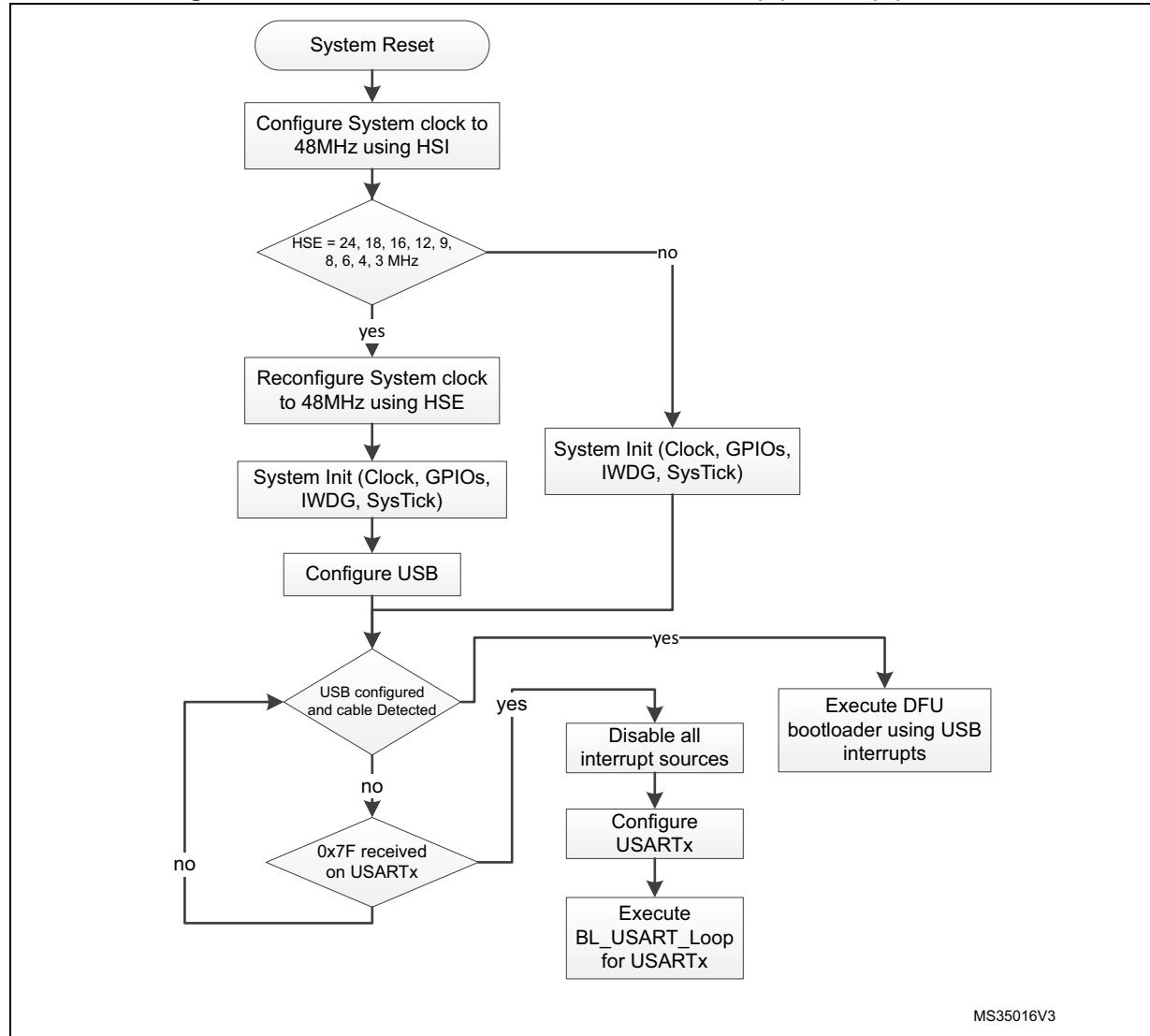
- If HSE is present and has a value of 24, 18, 16, 12, 9, 8, 6, 4 or 3 MHz, the system clock is configured to 48 MHz with HSE as clock source. The DFU interface, USART1 and USART2 are functional and can be used to communicate with the bootloader device.
- If HSE is not present, the HSI is kept as default clock source and only USART1 and USART2 are functional.

*The external clock (HSE) must be kept if it is connected at bootloader startup because it is used as system clock source.*

## 18.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 22. Bootloader selection for STM32F302xB(C)/303xB(C) devices**



## 18.3 Bootloader version

The following table lists the STM32F302xB(C)/303xB(C) devices bootloader versions.

**Table 38. STM32F302xB(C)/303xB(C) bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V4.1                      | Initial bootloader version | None              |

## 19 STM32F302xD(E)/303xD(E) devices bootloader

### 19.1 Bootloader configuration

The STM32F302xD(E)/303xD(E) bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 39. STM32F302xD(E)/303xD(E) configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment  |
|---------------------------|--------------------|--------------|--|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.  |
|                           |                    | HSE enabled  | The external clock can be used for all bootloader interfaces and must have one of the following values [24, 18, 16, 12, 9, 8, 6, 4, 3] MHz.<br>The PLL is used to generate the USB 48 MHz clock and the 48 MHz clock for the system clock. |
|                           |                    | -            | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware  |
| USART1 bootloader         | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                                |
|                           | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
| USART2 bootloader         | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
|                           | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode  |
| USARTx bootloaders        | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode   |
|                           | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| DFU bootloader            | USB                | Enabled      | USB FS configured in forced device mode. USB FS interrupt vector is enabled and used for USB DFU communications.   |
|                           | USB_DM pin         | Input/Output | PA11 pin: USB FS DM line.  |
|                           | USB_DP pin         |              | PA12 pin: USB FS DP line. An external pull-up resistor 1.5 KΩ must be connected to USB_DP pin.   |

The bootloader has two cases of operation depending on the presence of the external clock (HSE) at bootloader startup:

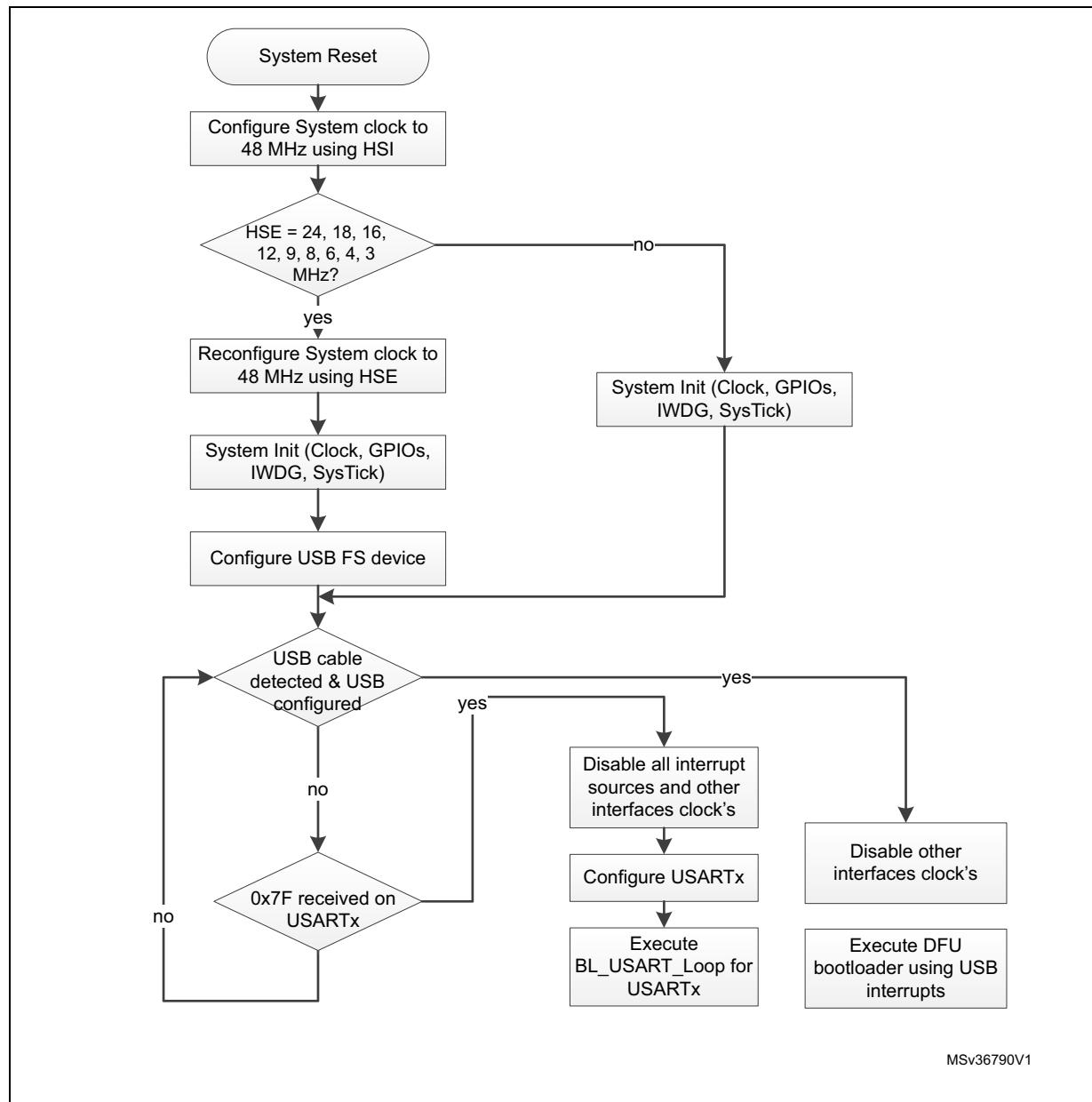
- If HSE is present and has a value of 24, 18, 16, 12, 9, 8, 6, 4 or 3 MHz, the system clock is configured to 48 MHz with HSE as clock source. The DFU interface, USART1 and USART2 are functional and can be used to communicate with the bootloader device.
- If HSE is not present, the HSI is kept as default clock source and only USART1 and USART2 are functional.

*The external clock (HSE) must be kept if it is connected at bootloader startup because it is used as system clock source.*

## 19.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 23. Bootloader selection for STM32F302xD(E)/303xD(E)**



MSv36790V1

### 19.3 Bootloader version

The following table lists the STM32F302xD(E)/303xD(E) devices bootloader versions.

**Table 40. STM32F302xD(E)/303xD(E) bootloader versions**

| Bootloader<br>version<br>number | Description                | Known limitations |
|---------------------------------|----------------------------|-------------------|
| V4.0                            | Initial bootloader version | None              |

## 20 STM32F303x4(6/8)/334xx/328xx devices bootloader

### 20.1 Bootloader configuration

The STM32F303x4(6/8)/334xx/328xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 41. STM32F303x4(6/8)/334xx/328xx configuration in system memory boot mode**

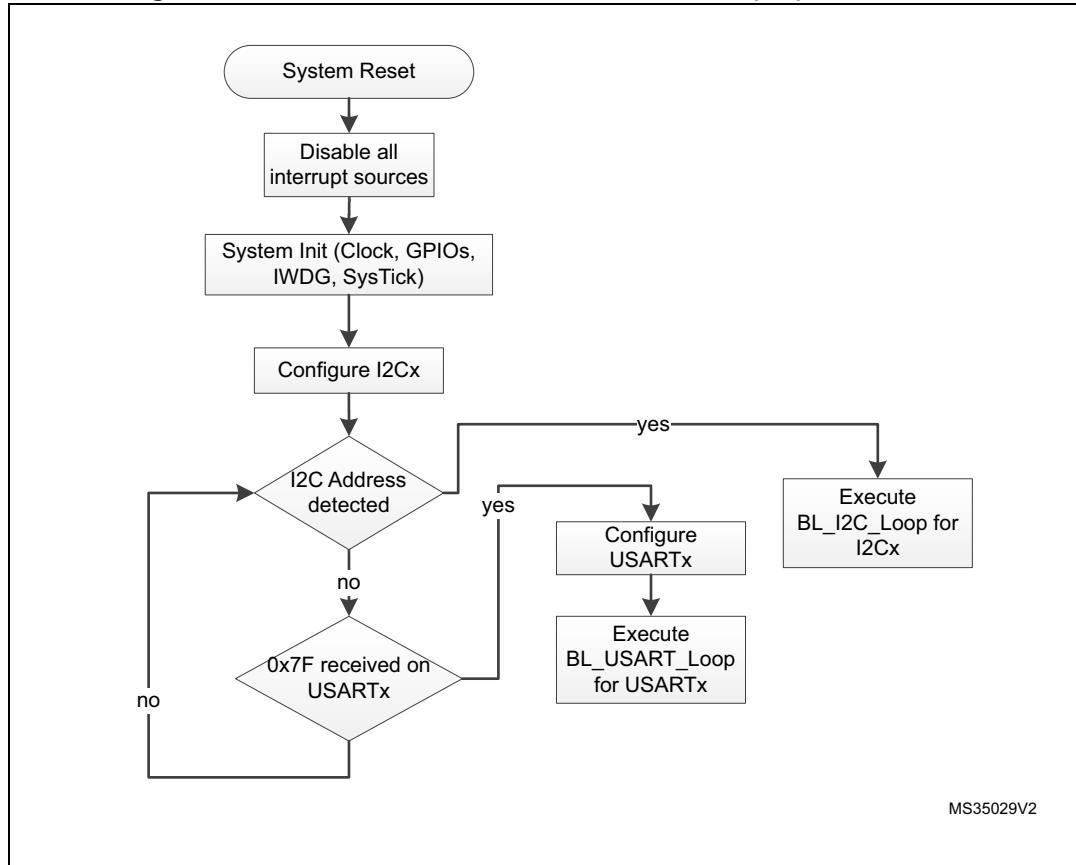
| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 60 MHz with HSI 8 MHz as clock source.  |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111111x (where x = 0 for write and x = 1 for read)                             |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 20.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 24. Bootloader selection for STM32F303x4(6/8)/334xx/328xx**



## 20.3 Bootloader version

The following table lists the STM32F303x4(6/8)/334xx/328xx devices bootloader versions:

**Table 42. STM32F303x4(6/8)/334xx/328xx bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V5.0                      | Initial bootloader version | None              |

## 21 STM32F318xx devices bootloader

### 21.1 Bootloader configuration

The STM32F318xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 43. STM32F318xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 60 MHz with HSI 8 MHz as clock source.  |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111101x (where x = 0 for write and x = 1 for read)                             |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

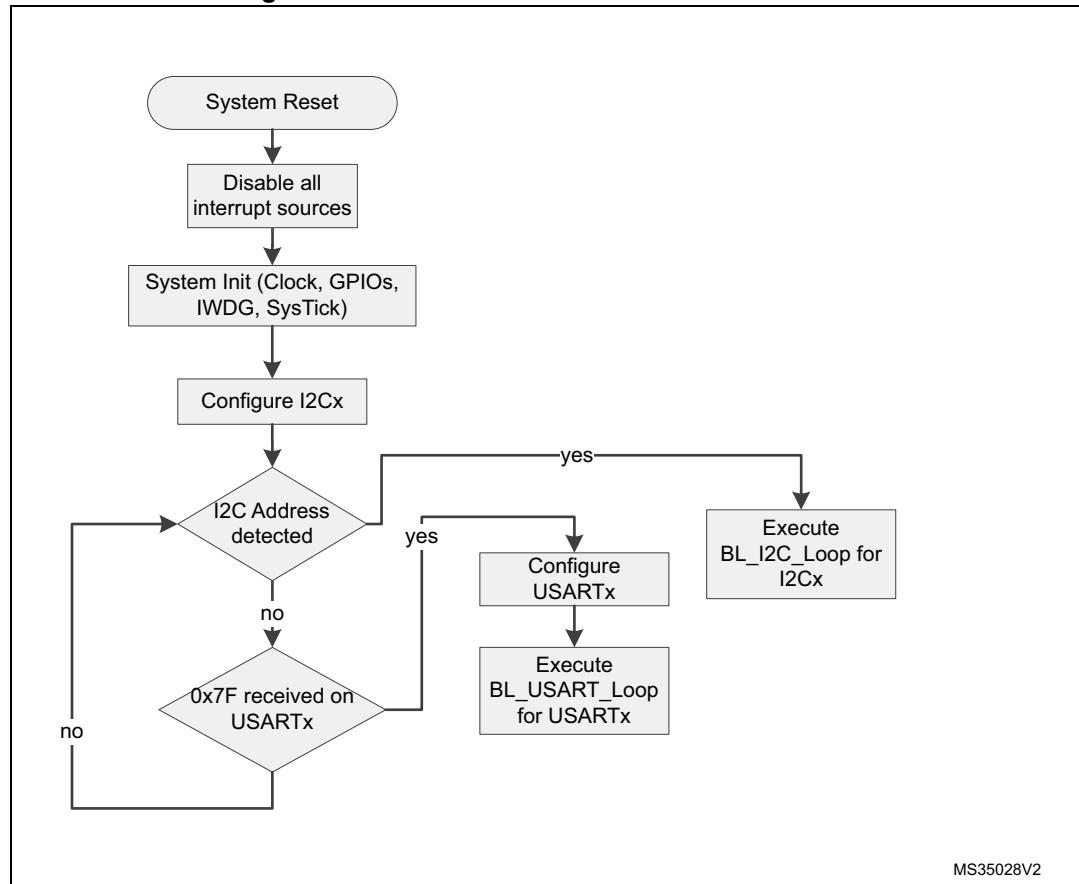
**Table 43. STM32F318xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111101x (where x = 0 for write and x = 1 for read) and digital filter disabled. |
|                 | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                 | I2C3_SDA pin       | Input/Output | PB5 pin: data line is used in open-drain mode.   |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 21.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 25. Bootloader selection for STM32F318xx**

## 21.3 Bootloader version

The following table lists the STM32F318xx devices bootloader versions:

**Table 44. STM32F318xx bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V5.0                      | Initial bootloader version | None              |

## 22 STM32F358xx devices bootloader

### 22.1 Bootloader configuration

The STM32F358xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 45. STM32F358xx configuration in system memory boot mode**

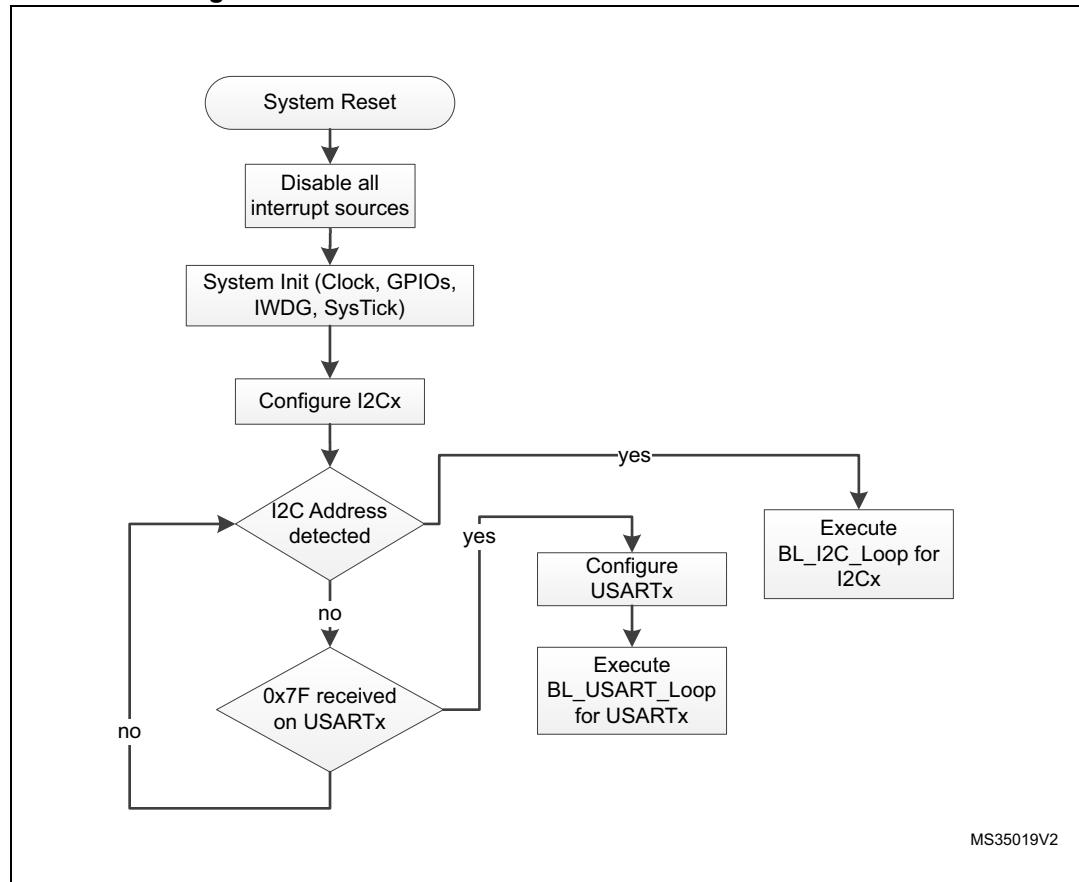
| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 8 MHz using the HSI.  |
|                           | RAM                | -            | 5 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware.   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). Window feature is disabled. |
| USART1 bootloader         | USART1             | Enabled      | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode.   |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode.   |
| USART2 bootloader         | USART2             | Enabled      | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.   |
|                           | USART2_RX pin      | Input        | PD6 pin: USART2 in reception mode.  |
|                           | USART2_TX pin      | Output       | PD5 pin: USART2 in transmission mode.   |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloader.  |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0110111x (where x = 0 for write and x = 1 for read)   |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 22.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 26. Bootloader selection for STM32F358xx devices**



## 22.3 Bootloader version

The following table lists the STM32F358xx devices bootloader versions.

**Table 46. STM32F358xx bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V5.0                      | Initial bootloader version | For USART1 and USART2 interfaces, the maximum baudrate supported by the bootloader is 57600 baud. |

## 23 STM32F373xx devices bootloader

### 23.1 Bootloader configuration

The STM32F373xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 47. STM32F373xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | At startup, the system clock frequency is configured to 48 MHz using the HSI. If an external clock (HSE) is not present, the system is kept clocked from the HSI.  |
|                           |                    | HSE enabled | The external clock can be used for all bootloader interfaces and must have one of the following values [24,18,16,12,9,8,6,4,3] MHz.<br>The PLL is used to generate the USB 48 MHz clock and the 48 MHz clock for the system clock. |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 5 Kbyte starting from address 0x20000000 are used by the bootloader firmware.  |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware   |
| USART1 bootloader         | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                        |
|                           | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode   |
| USART2 bootloader         | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode   |
|                           | USART2             | Enabled     | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.  |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode  |
| USARTx bootloaders        | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode   |
|                           | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloader.   |

**Table 47. STM32F373xx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB used in FS mode   |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>An external pull-up resistor 1.5 KΩ must be connected to USB_DP pin. |

The bootloader has two case of operation depending on the presence of the external clock (HSE) at bootloader startup:

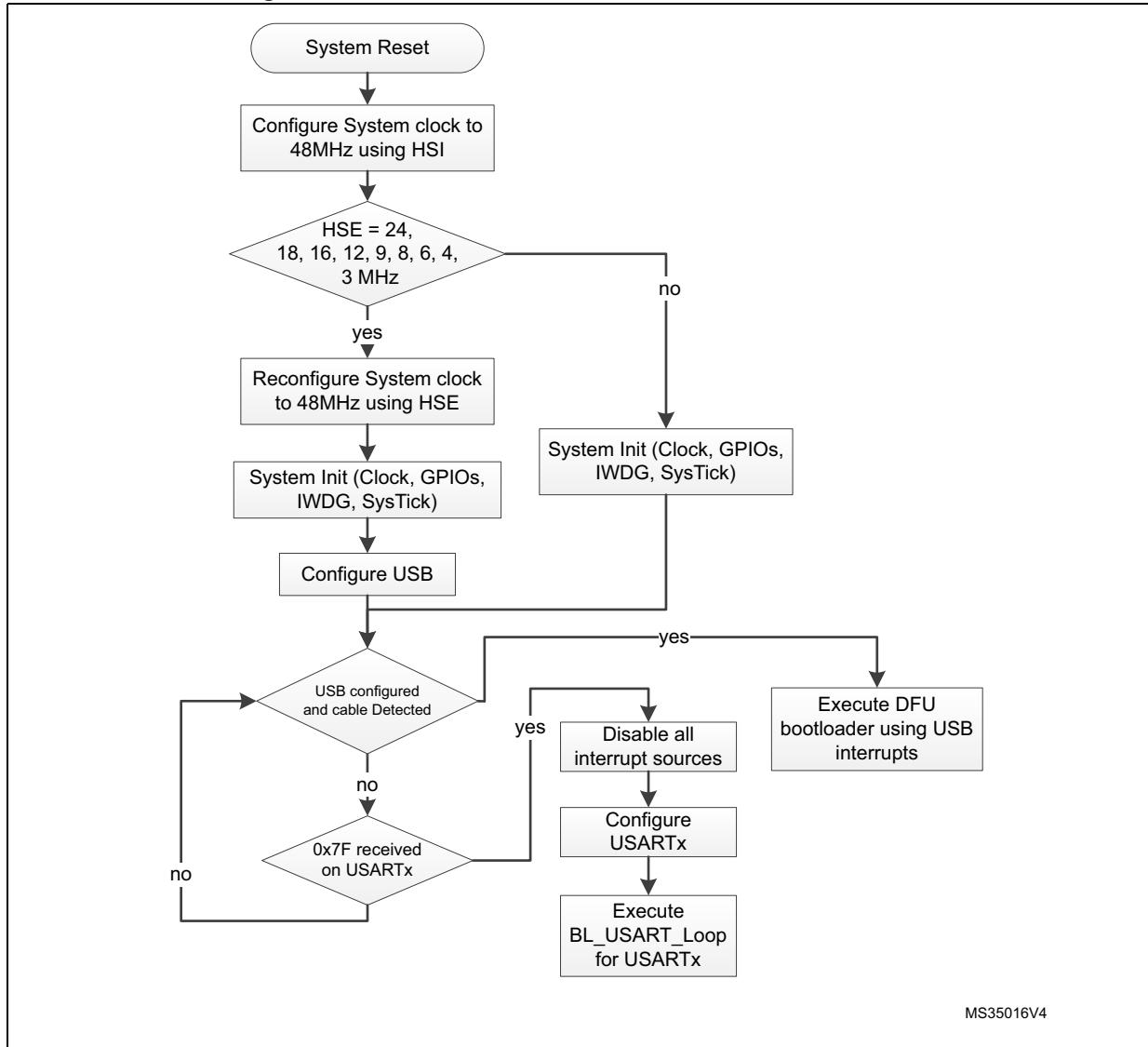
- If HSE is present and has a value of 24, 18, 16, 12, 9, 8, 6, 4 or 3 MHz, the system clock is configured to 48 MHz with HSE as clock source. The DFU interface, USART1 and USART2 are functional and can be used to communicate with the bootloader device.
- If HSE is not present, the HSI is kept as default clock source and only USART1 and USART2 are functional.

*Note:* *The external clock (HSE) must be kept if it is connected at bootloader startup because it is used as system clock source.*

## 23.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 27. Bootloader selection for STM32F373xx devices**



## 23.3 Bootloader version

The following table lists the STM32F373xx devices bootloader versions.

**Table 48. STM32F373xx bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V4.1                      | Initial bootloader version | None              |

## 24 STM32F378xx devices bootloader

### 24.1 Bootloader configuration

The STM32F378xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 49. STM32F378xx configuration in system memory boot mode**

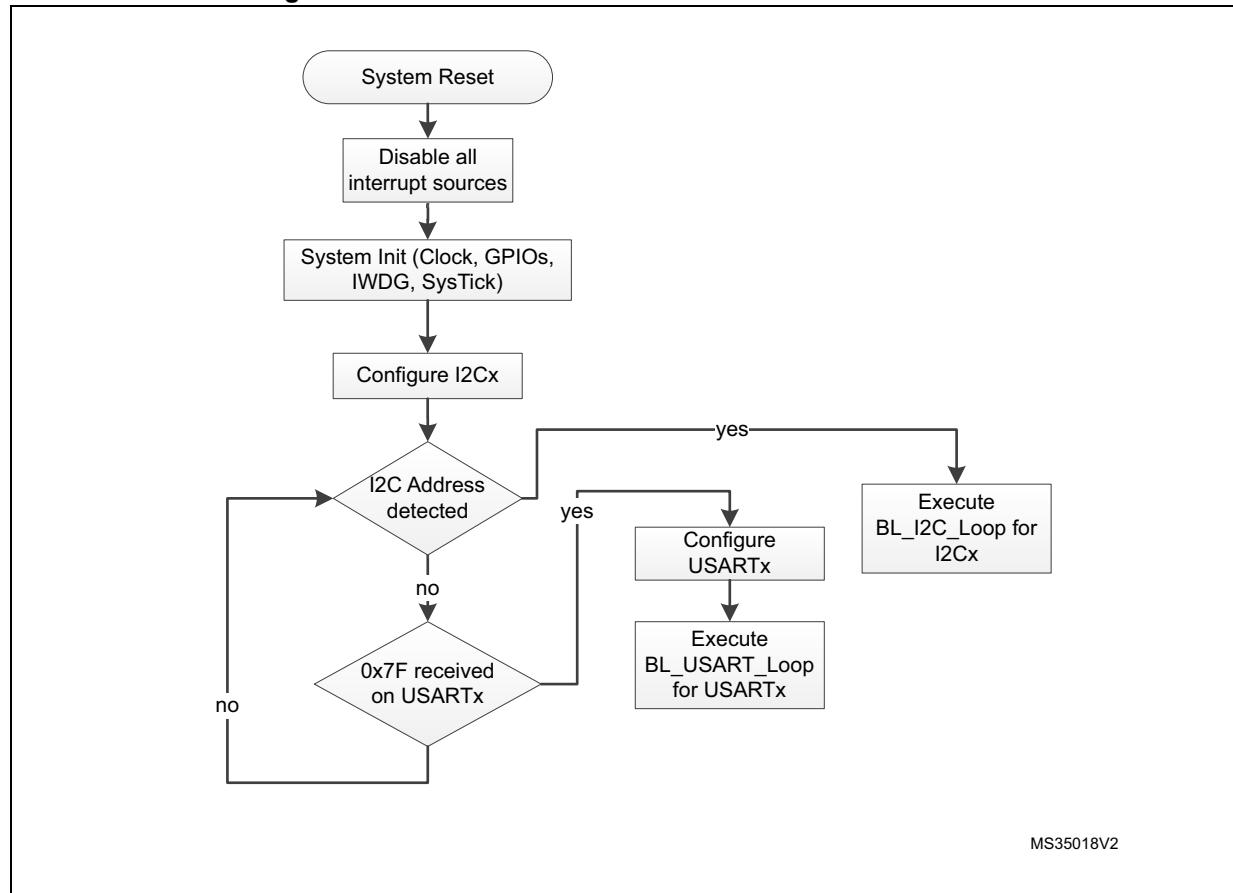
| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 8 MHz using the HSI.  |
|                           | RAM                | -            | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware  |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). Window feature is disabled. |
| USART1 bootloader         | USART1             | Enabled      | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode.   |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode.   |
| USART2 bootloader         | USART2             | Enabled      | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.   |
|                           | USART2_RX pin      | Input        | PD6 pin: USART2 in reception mode.  |
|                           | USART2_TX pin      | Output       | PD5 pin: USART2 in transmission mode.   |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloader.  |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0110111x (where x = 0 for write and x = 1 for read).  |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 24.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 28. Bootloader selection for STM32F378xx devices**



## 24.3 Bootloader version

The following table lists the STM32F378xx devices bootloader versions.

**Table 50. STM32F378xx bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V5.0                      | Initial bootloader version | For USART1 and USART2 interfaces, the maximum baudrate supported by the bootloader is 57600 baud. |

## 25 STM32F398xx devices bootloader

### 25.1 Bootloader configuration

The STM32F398xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 51. STM32F398xx configuration in system memory boot mode**

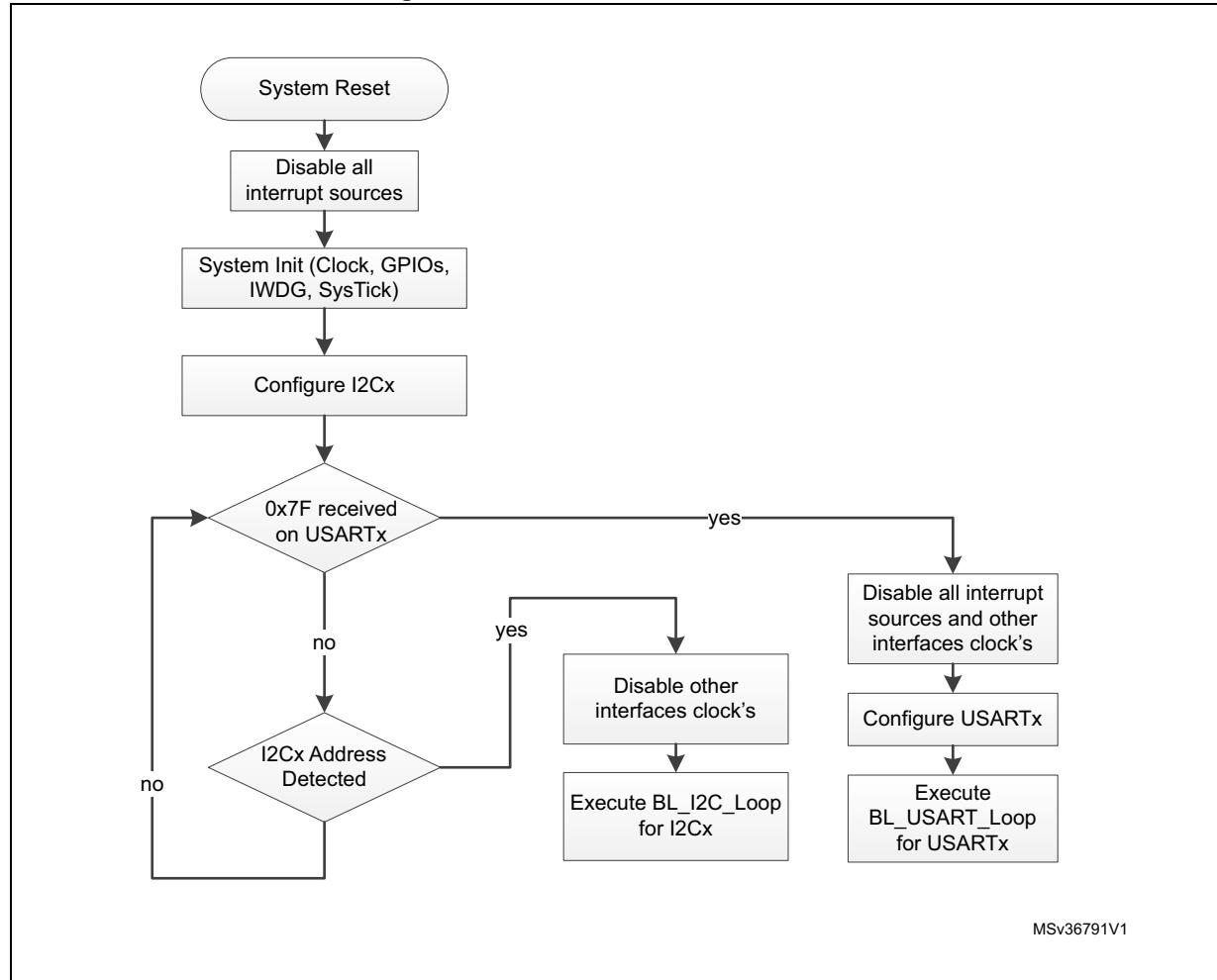
| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 60 MHz with HSI 8 MHz as clock source.  |
|                           | RAM                | -            | 6 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 7 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000000x (where x = 0 for write and x = 1 for read).                            |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C3 bootloader           | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000000x (where x = 0 for write and x = 1 for read).                            |
|                           | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                           | I2C3_SDA pin       | Input/Output | PB5 pin: data line is used in open-drain mode.  |

The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

## 25.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 29.Bootloader selection for STM32F398xx**



## 25.3 Bootloader version

The following table lists the STM32F398xx devices bootloader versions.

**Table 52. STM32F398xx bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V5.0                      | Initial bootloader version | None              |

## 26 STM32F40xxx/41xxx devices bootloader

### 26.1 Bootloader V3.x

#### 26.1.1 Bootloader configuration

The STM32F40xxx/41xxx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 53. STM32F40xxx/41xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 24 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USARTx interfaces are selected (once CAN or DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the CAN or the DFU (USB FS Device) interfaces are selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                      |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 8 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000 contain the bootloader firmware.  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.     |

**Table 53. STM32F40xxx/41xxx configuration in system memory boot mode (continued)**

| Bootloader                          | Feature/Peripheral | State        | Comment   |
|-------------------------------------|--------------------|--------------|---|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized, the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode   |
| DFU bootloader                      | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                                     | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                                     | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
| CAN2 and DFU bootloaders            | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE.   |

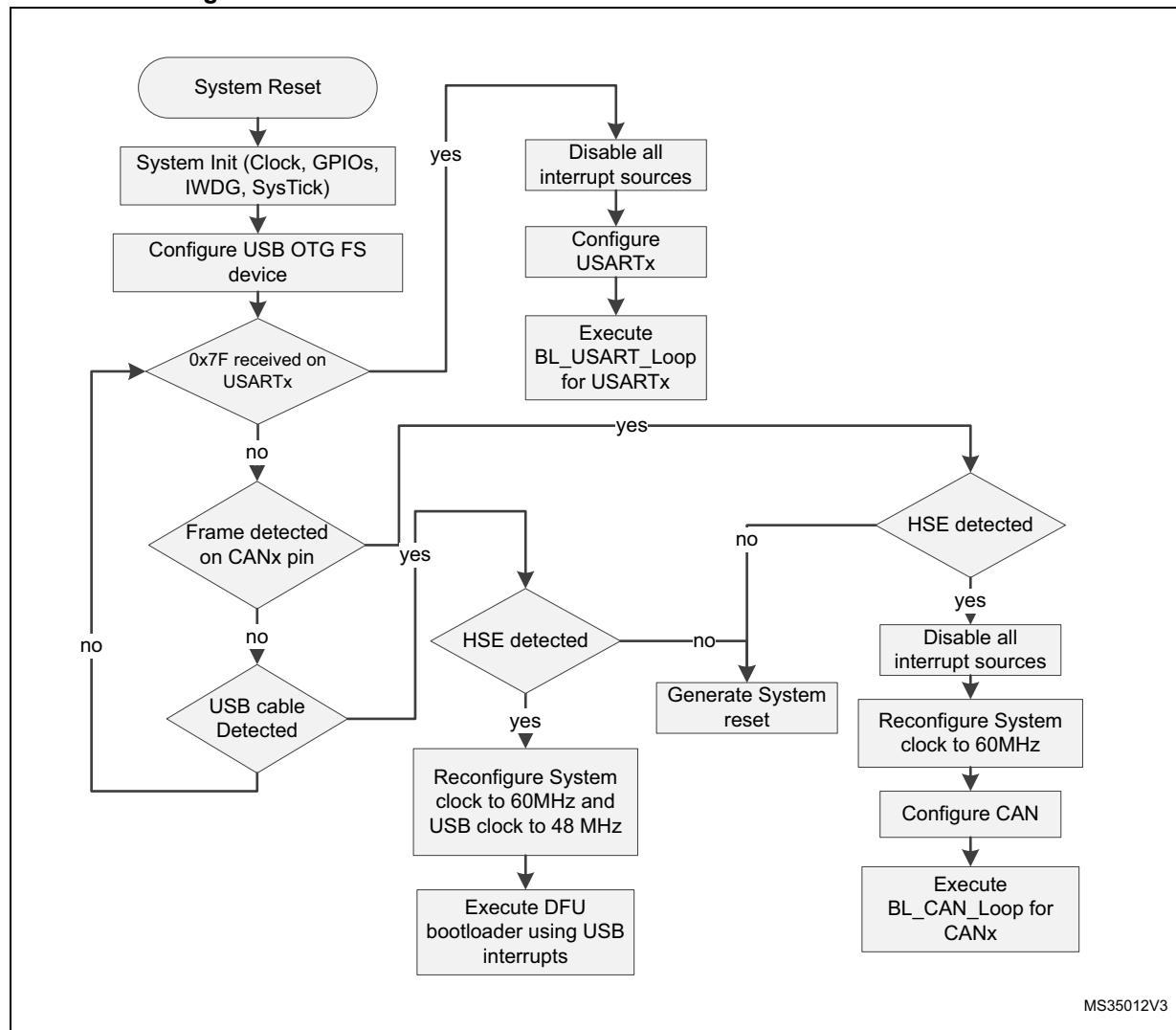
The system clock is derived from the embedded internal high-speed RC for USARTx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

### **26.1.2 Bootloader selection**

The figure below shows the bootloader selection mechanism.

**Figure 30. Bootloader V3.x selection for STM32F40xxx/41xxx devices**



### 26.1.3 Bootloader version

The following table lists the STM32F40xxx/41xxx devices V3.x bootloader versions:

**Table 54. STM32F40xxx/41xxx bootloader V3.x versions**

| Bootloader version number | Description   | Known limitations   |
|---------------------------|---|---|
| V3.0                      | Initial bootloader version                                  | <ul style="list-style-type: none"> <li>– When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (i.e. address 0x6000 0000), the command is aborted by the bootloader device, but the NACK (0x1F) is not sent to the host. As a result, the next 2 bytes (which are the number of bytes to be read/written and its checksum) are considered as a new command and its checksum<sup>(1)</sup>.</li> <li>– Option bytes, OTP and Device Feature descriptors (in DFU interface) are set to “g” instead of “e” (not erasable memory areas). After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup)</li> </ul> |
| V3.1                      | Fix V3.0 limitations. DFU interface robustness enhancement. | <ul style="list-style-type: none"> <li>– For the USART interface, two consecutive NACKs (instead of 1 NACK) are sent when a Read Memory or Write Memory command is sent and the RDP level is active.</li> <li>– For the CAN interface, the Write Unprotect command is not functional. Use Write Memory command and write directly to the option bytes in order to disable the write protection.</li> </ul> <p>After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup)</p>  |

1. If the “number of data - 1” (N-1) to be read/written is not equal to a valid command code (0x00, 0x01, 0x02, 0x11, 0x21, 0x31, 0x43, 0x44, 0x63, 0x73, 0x82 or 0x92), then the limitation is not perceived from the host since the command is NACKed anyway (as an unsupported new command).

## 26.2 Bootloader V9.x

### 26.2.1 Bootloader configuration

The STM32F40xxx/41xxx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). [Table 55](#) shows the hardware resources used by this bootloader.

**Note:** *The bootloader version V9.x is embedded only in STM32F405xx/415xx devices in WLCSP90 package.*

**Table 55. STM32F40xxx/41xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interfaces are selected (once CAN or DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the CAN or the DFU (USB FS Device) interfaces are selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                                   |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).  |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.                  |

**Table 55. STM32F40xxx/41xxx configuration in system memory boot mode (continued)**

| Bootloader                          | Feature/Peripheral | State        | Comment   |
|-------------------------------------|--------------------|--------------|---|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is:<br>Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode   |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111010x (where x = 0 for write and x = 1 for read).                                    |
|                                     | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                                     | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111010x (where x = 0 for write and x = 1 for read).                                    |
|                                     | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.   |
|                                     | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.  |

**Table 55. STM32F40xxx/41xxx configuration in system memory boot mode (continued)**

| Bootloader               | Feature/Peripheral | State        | Comment  |
|--------------------------|--------------------|--------------|--|
| I2C3 bootloader          | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111010x (where x = 0 for write and x = 1 for read). |
|                          | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                          | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.   |
| SPI1 bootloader          | SPI1               | Enabled      | The SPI1 configuration is:<br>slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                          | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader          | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                          | SPI2_MOSI pin      | Input        | PI3 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI2_MISO pin      | Output       | PI2 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SPI2_SCK pin       | Input        | PI1 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI2_NSS pin       | Input        | PI0 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader           | USB                | Enabled      | USB OTG FS configured in forced device mode  |
|                          | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                          | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required  |
| CAN2 and DFU bootloaders | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE.                          |

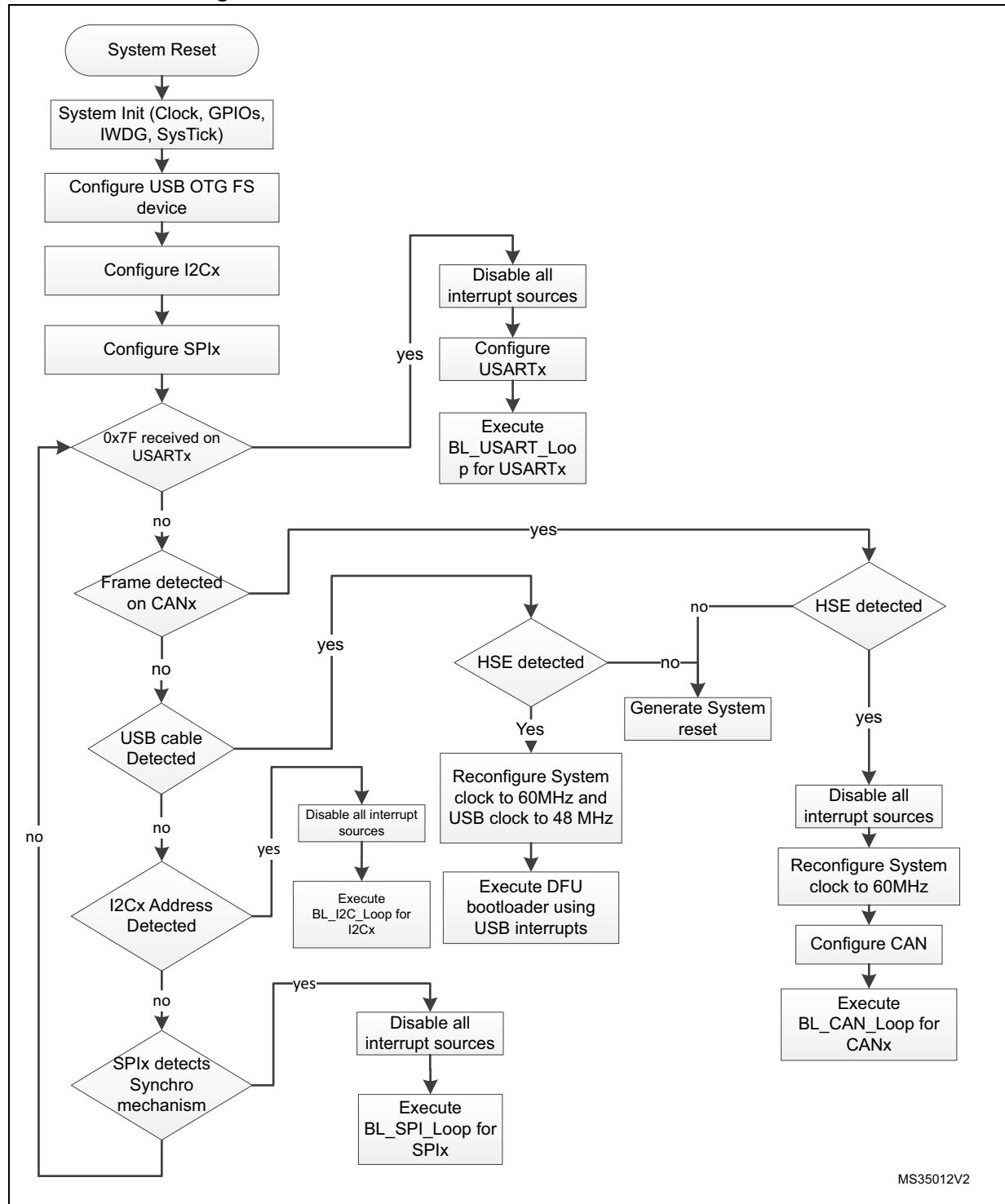
The system clock is derived from the embedded internal high-speed RC for USARTx, I2Cx and SPIx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 26.2.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 31. Bootloader V9.x selection for STM32F40xxx/41xxx**



### 26.2.3 Bootloader version

The following table lists the STM32F40xxx/41xxx devices V9.x bootloader versions.

**Table 56. STM32F40xxx/41xxx bootloader V9.x versions**

| Bootloader version number | Description  | Known limitations  |
|---------------------------|--|--|
| V9.0                      | <p>This bootloader is an updated version of bootloader v3.1.</p> <p>This new version of bootloader supports I2C1, I2C2, I2C3, SPI1 and SPI2 interfaces.</p> <p>The RAM used by this bootloader is increased from 8Kb to 12Kb.</p> <p>The ID of this bootloader is 0x90.</p> <p>The connection time is increased.</p> | <ul style="list-style-type: none"> <li>– For the USART interface, two consecutive NACKs (instead of 1 NACK) are sent when a Read Memory or Write Memory command is sent and the RDP level is active.</li> <li>– For the CAN interface, the Write Unprotect command is not functional. Use Write Memory command and write directly to the option bytes in order to disable the write protection.</li> </ul> <p>After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup)</p> |

## 27 STM32F401xB(C) devices bootloader

### 27.1 Bootloader configuration

The STM32F401xB(C) bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 57. STM32F401xB(C) configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interface is selected (once DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the DFU (USB FS Device) interface is selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                                       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.         |

**Table 57. STM32F401xB(C) configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART1 bootloader  | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                    | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PD6 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PD5 pin: USART2 in transmission mode  |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB3 pin: data line is used in open-drain mode.  |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PB4 pin: data line is used in open-drain mode.  |

**Table 57. STM32F401xB(C) configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State   | Comment  |
|-----------------|--------------------|---------|--|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI3 bootloader | SPI3               | Enabled | The SPI3 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI3_MOSI pin      | Input   | PC12 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI3_MISO pin      | Output  | PC11 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI3_SCK pin       | Input   | PC10 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI3_NSS pin       | Input   | PA15 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 57. STM32F401xB(C) configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
|                | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

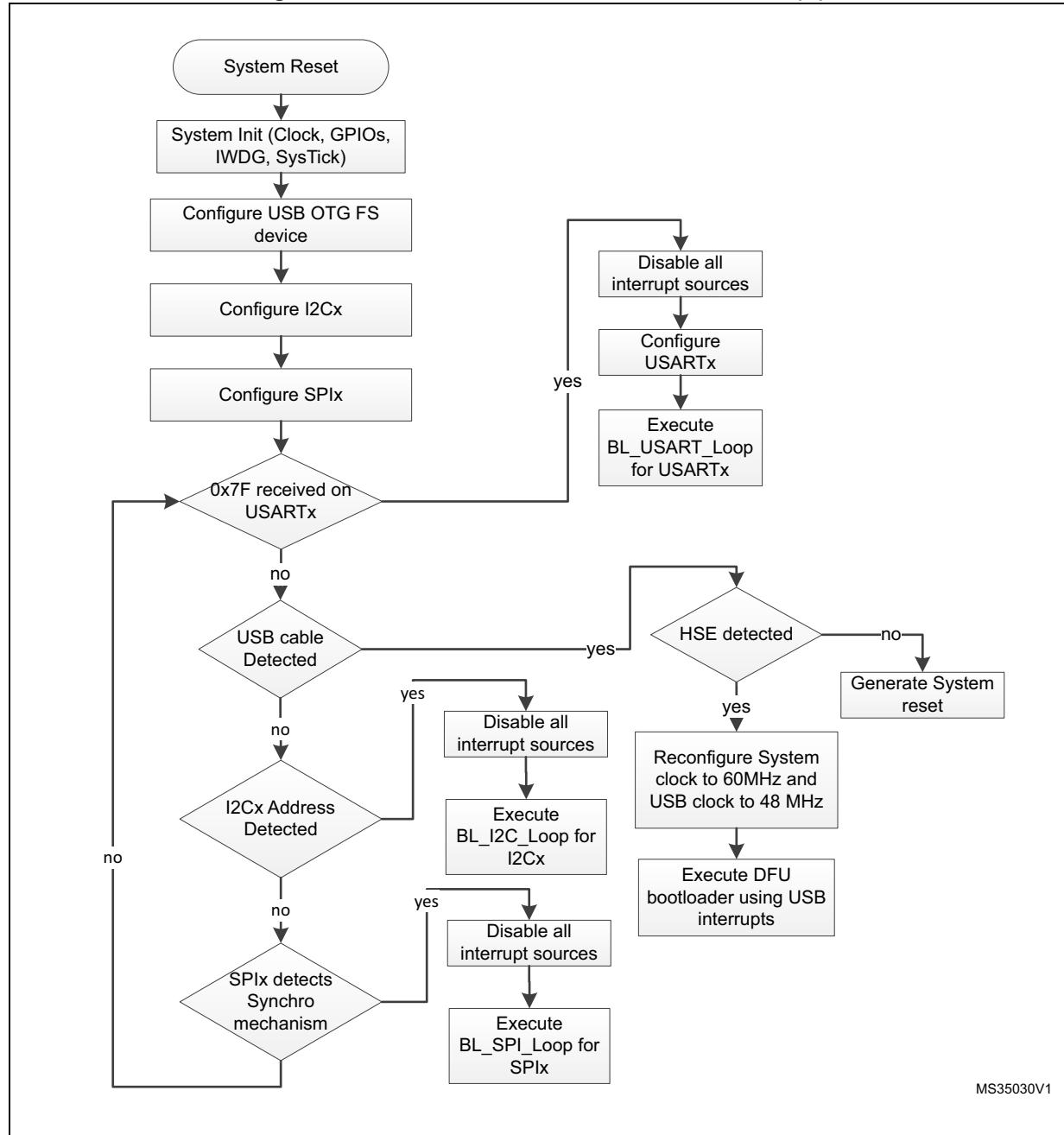
The system clock is derived from the embedded internal high-speed RC for USARTx, I2Cx and SPIx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 27.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 32. Bootloader selection for STM32F401xB(C)**



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## 27.3 Bootloader version

The following table lists the STM32F401xB(C) devices bootloader version.

**Table 58. STM32F401xB(C) bootloader versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V13.0                     | Initial bootloader version | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 28 STM32F401xD(E) devices bootloader

### 28.1 Bootloader configuration

The STM32F401xD(E) bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 59. STM32F401xD(E) configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interface is selected (once DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the DFU (USB FS Device) interface is selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                                       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
| USART1 bootloader         | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.         |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 59. STM32F401xD(E) configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PD6 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PD5 pin: USART2 in transmission mode  |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB3 pin: data line is used in open-drain mode.  |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PA4 pin: data line is used in open-drain mode.  |
| SPI1 bootloader    | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                    | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                    | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                    | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                    | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 59. STM32F401xD(E) configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                        |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI3 bootloader | SPI3               | Enabled      | The SPI3 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                        |
|                 | SPI3_MOSI pin      | Input        | PC12 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI3_MISO pin      | Output       | PC11 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI3_SCK pin       | Input        | PC10 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI3_NSS pin       | Input        | PA15 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader  | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                 | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                 | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
|                 | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

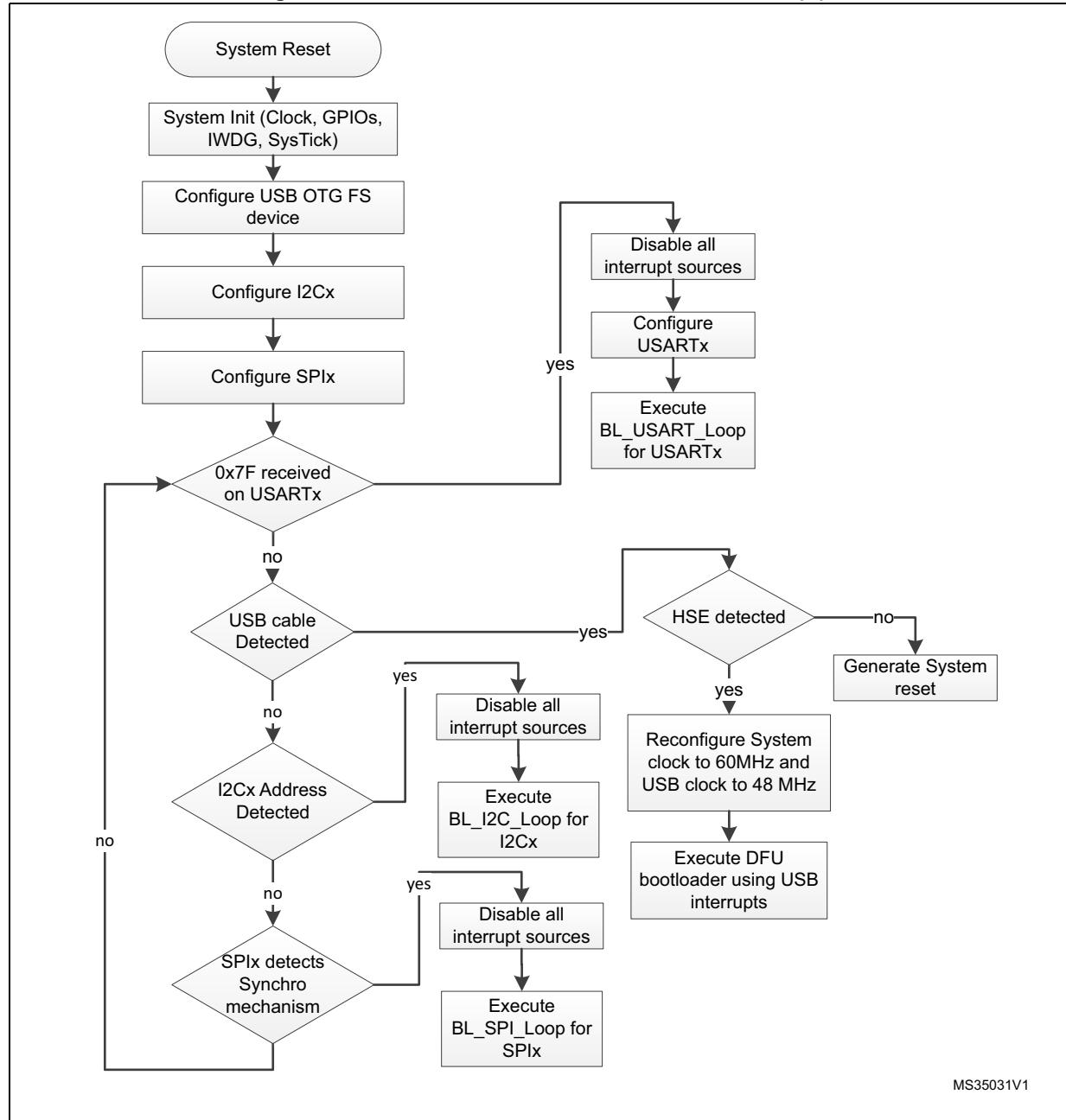
The system clock is derived from the embedded internal high-speed RC for USARTx, I2Cx and SPIx bootloaders. This internal clock is also used for DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 28.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 33. Bootloader selection for STM32F401xD(E)**



MS35031V1

## 28.3 Bootloader version

The following table lists the STM32F401xD(E) devices bootloader version.

**Table 60. STM32F401xD(E) bootloader versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V13.1                     | Initial bootloader version | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 29 STM32F410xx devices bootloader

### 29.1 Bootloader configuration

The STM32F410xx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 61. STM32F410xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART and I2C bootloader operation.  |
|                           | RAM                | -           | 5 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | The voltage range is [1.8V, 3.6V]<br>In this range:<br>- Flash wait states: 3.<br>- System clock frequency 60 MHz.<br>- ART Accelerator enabled.<br>- Flash write operation by byte (refer to bootloader memory management section for more information). |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |

**Table 61. STM32F410xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C1 bootloader | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000111x (where x = 0 for write and x = 1 for read) |
|                 | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                 | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000111x (where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C4 bootloader | I2C4               | Enabled      | The I2C4 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000111x (where x = 0 for write and x = 1 for read)   |
|                 | I2C4_SCL pin       | Input/Output | PB15 pin: clock line is used in open-drain mode for STM32F410Cx/Rx devices.<br>PB10 pin: clock line is used in open-drain mode for STM32F410Tx devices.                         |
|                 | I2C4_SDA pin       | Input/Output | PB14 pin: data line is used in open-drain mode for STM32F410Cx/Rx devices.<br>PB3 pin: data line is used in open-drain mode for STM32F410Tx devices.                            |

**Table 61. STM32F410xx configuration in system memory boot mode (continued)**

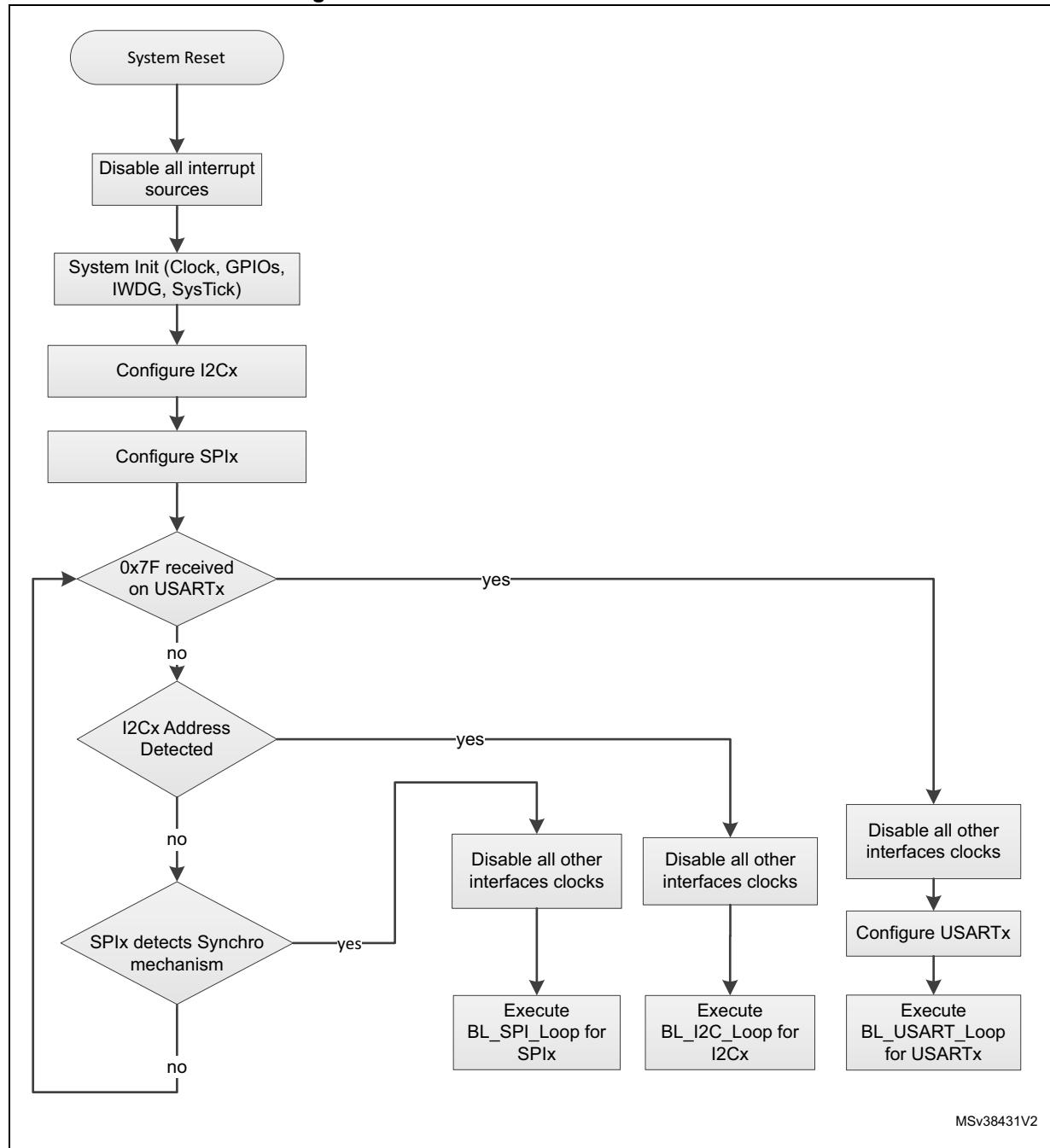
| Bootloader      | Feature/Peripheral | State   | Comment   |
|-----------------|--------------------|---------|---|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB,<br>Speed up to 8 MHz, Polarity: CPOL Low,<br>CPHA Low, NSS hardware.  |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in<br>push-pull, pull-down mode for<br>STM32F410Cx/Rx devices.<br>PB5 pin: Slave data Input line, used in<br>push-pull, pull-down mode for<br>STM32F410Tx devices.   |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in<br>push-pull, pull-down mode for<br>STM32F410Cx/Rx devices.<br>PB4 pin: Slave data output line, used in<br>push-pull, pull-down mode for<br>STM32F410Tx devices. |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-<br>pull, pull-down mode.   |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in<br>push-pull pull-up mode for<br>STM32F410Cx/Rx devices.<br>PA15 pin: slave chip select pin used in<br>push-pull, pull-down mode for<br>STM32F410Tx devices.       |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB,<br>Speed up to 8 MHz, Polarity: CPOL Low,<br>CPHA Low, NSS hardware.  |
|                 | SPI2_MOSI pin      | Input   | PC3 pin: Slave data Input line, used in<br>push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output  | PC2 pin: Slave data output line, used in<br>push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-<br>pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in<br>push-pull, pull-down mode.   |

The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

## 29.2 Bootloader selection

*Figure 34* shows the bootloader selection mechanism.

**Figure 34.Bootloader V11.x selection for STM32F410xx**



## 29.3 Bootloader version

The following table lists the STM32F410xx devices bootloader V11.x versions.

**Table 62. STM32F410xx bootloader V11.x versions**

| Bootloader version number | Description                                    | Known limitations  |
|---------------------------|--|--|
| V11.0                     | Initial bootloader version                     | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |
| V11.1                     | Support I2C4 and SPI1 for STM32F410Tx devices. | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 30 STM32F411xx devices bootloader

### 30.1 Bootloader configuration

The STM32F411xx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 63. STM32F411xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interface is selected (once DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the DFU (USB FS Device) interface is selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                                       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.         |

**Table 63. STM32F411xx configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART1 bootloader  | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                    | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PD6 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PD5 pin: USART2 in transmission mode  |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB3 pin: data line is used in open-drain mode.  |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111001x (where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PB4 pin: data line is used in open-drain mode.  |

**Table 63. STM32F411xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State   | Comment  |
|-----------------|--------------------|---------|--|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI3 bootloader | SPI3               | Enabled | The SPI3 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI3_MOSI pin      | Input   | PC12 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI3_MISO pin      | Output  | PC11 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI3_SCK pin       | Input   | PC10 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI3_NSS pin       | Input   | PA15 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 63. STM32F411xx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
|                | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

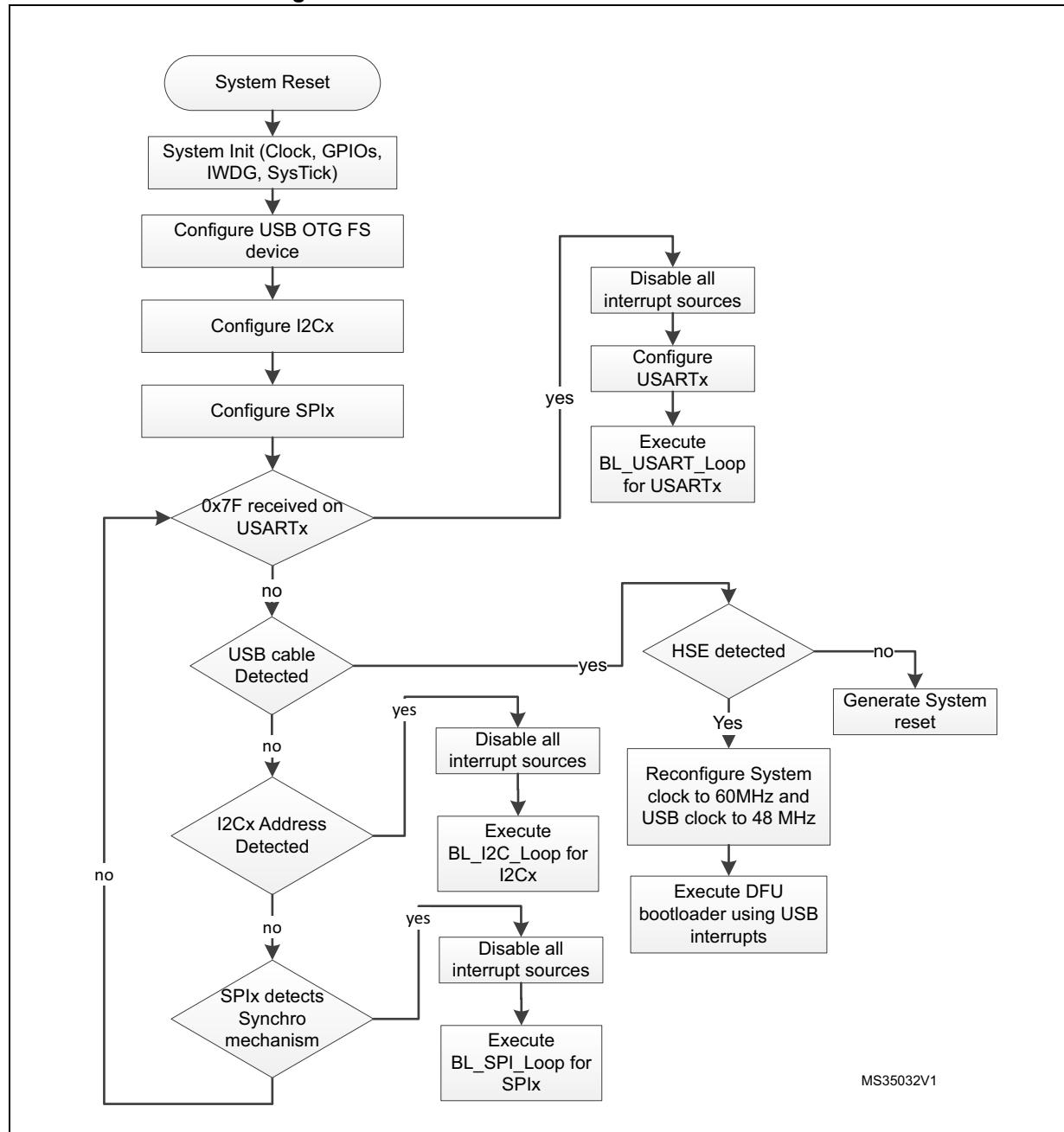
The system clock is derived from the embedded internal high-speed RC for USARTx, I2Cx and SPIx bootloaders. This internal clock is also used for DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 30.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 35. Bootloader selection for STM32F411xx**



### 30.3 Bootloader version

The following table lists the STM32F411xx devices bootloader version.

**Table 64. STM32F411xx bootloader versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V13.0                     | Initial bootloader version | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 31 STM32F412xx devices bootloader

### 31.1 Bootloader configuration

The STM32F412xx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The table shows the hardware resources used by this bootloader.

**Table 65. STM32F412xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART and I2C bootloader operation.  |
|                           |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz.       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
| USART1 bootloader         | Power              | -           | The voltage range is [1.8V, 3.6V]<br>In this range:<br>- Flash wait states: 3.<br>- System clock frequency 60 MHz.<br>- ART Accelerator enabled.<br>- Flash write operation by byte (refer to bootloader memory management section for more information). |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 65. STM32F412xx configuration in system memory boot mode (continued)**

| <b>Bootloader</b>  | <b>Feature/Peripheral</b> | <b>State</b> | <b>Comment</b>   |
|--------------------|---------------------------|--------------|--|
| USART2 bootloader  | USART2                    | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                    | USART2_RX pin             | Input        | PD6 pin: USART2 in reception mode  |
|                    | USART2_TX pin             | Output       | PD5 pin: USART2 in transmission mode   |
| USART3 bootloader  | USART3                    | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                    | USART3_RX pin             | Input        | PB11 pin: USART3 in reception mode   |
|                    | USART3_TX pin             | Output       | PB10 pin: USART3 in transmission mode  |
| USARTx bootloaders | SysTick timer             | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN2 bootloader    | CAN2                      | Enabled      | Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                    | CAN2_RX pin               | Input        | PB5 pin: CAN2 in reception mode  |
|                    | CAN2_TX pin               | Output       | PB13 pin: CAN2 in transmission mode  |
| I2C1 bootloader    | I2C1                      | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000110x (where x = 0 for write and x = 1 for read)                               |
|                    | I2C1_SCL pin              | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                    | I2C1_SDA pin              | Input/Output | PB7 pin: data line is used in open-drain mode.   |
| I2C2 bootloader    | I2C2                      | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000110x (where x = 0 for write and x = 1 for read)                               |
|                    | I2C2_SCL pin              | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin              | Input/Output | PF0 pin: data line is used in open-drain mode.   |

**Table 65. STM32F412xx configuration in system memory boot mode (continued)**

| <b>Bootloader</b> | <b>Feature/Peripheral</b> | <b>State</b> | <b>Comment</b>   |
|-------------------|---------------------------|--------------|--|
| I2C3 bootloader   | I2C3                      | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000110x (where x = 0 for write and x = 1 for read) |
|                   | I2C3_SCL pin              | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                   | I2C3_SDA pin              | Input/Output | PB4 pin: data line is used in open-drain mode.   |
| I2C4 bootloader   | I2C4                      | Enabled      | The I2C4 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000110x (where x = 0 for write and x = 1 for read)   |
|                   | I2C4_SCL pin              | Input/Output | PB15 pin: clock line is used in open-drain mode.   |
|                   | I2C4_SDA pin              | Input/Output | PB14 pin: data line is used in open-drain mode.  |
| SPI1 bootloader   | SPI1                      | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                   | SPI1_MOSI pin             | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                   | SPI1_MISO pin             | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                   | SPI1_SCK pin              | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                   | SPI1_NSS pin              | Input        | PA4 pin: slave chip select pin used in push-pull pull-up mode.   |
| SPI3 bootloader   | SPI3                      | Enabled      | The SPI3 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                   | SPI3_MOSI pin             | Input        | PC12 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                   | SPI3_MISO pin             | Output       | PC11 pin: Slave data output line, used in push-pull, pull-down mode  |
|                   | SPI3_SCK pin              | Input        | PC10 pin: Slave clock line, used in push-pull, pull-down mode  |
|                   | SPI3_NSS pin              | Input        | PA15 pin: slave chip select pin used in push-pull pull-up mode.  |

**Table 65. STM32F412xx configuration in system memory boot mode (continued)**

| <b>Bootloader</b>        | <b>Feature/Peripheral</b> | <b>State</b> | <b>Comment</b>  |
|--------------------------|---------------------------|--------------|---|
| SPI4 bootloader          | SPI4                      | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                    |
|                          | SPI4_MOSI pin             | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI4_MISO pin             | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SP4_SCK pin               | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI4_NSS pin              | Input        | PE11 pin: slave chip select pin used in push-pull pull-up mode.   |
| DFU bootloader           | USB                       | Enabled      | USB OTG FS configured in forced device mode   |
|                          | USB_DM pin                | Input/Output | PA11 pin: USB DM line.  |
|                          | USB_DP pin                |              | PA12 pin: USB DP line<br>No external Pull-Up resistor is required.  |
| CAN2 and DFU bootloaders | TIM11                     | Enabled      | This timer is used to determine the value of the HSE. Once HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

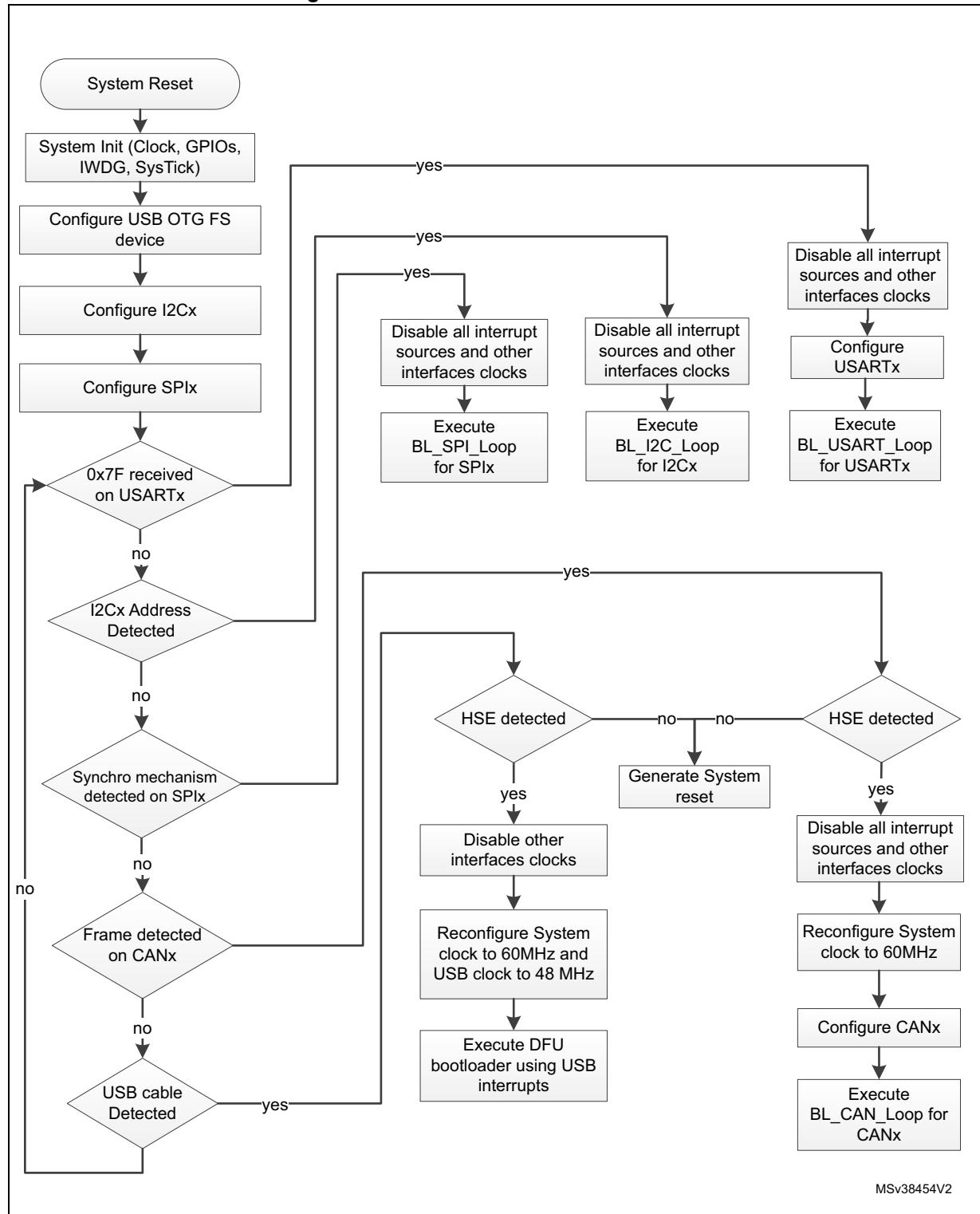
The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 31.2 Bootloader selection

*Figure 36* shows the bootloader selection mechanism.

**Figure 36.Bootloader V9.x selection for STM32F412xx**



### 31.3 Bootloader version

The following table lists the STM32F412xx devices bootloader V9.x versions.

**Table 66. STM32F412xx bootloader V9.x versions**

| Bootloader version number | Description                 | Known limitations  |
|---------------------------|-----------------------------|--|
| V9.0                      | Initial bootloader version  | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |
| V9.1                      | Fix USART3 interface pinout | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 32 STM32F413xx/423xx devices bootloader

### 32.1 Bootloader configuration

The STM32F413xx/423xx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 67. STM32F413xx/423xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART and I2C bootloader operation.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz.              |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 60 Kbyte starting from address 0x1FF00000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).  |
|                           | Power              | -           | The voltage range is [1.8V, 3.6V]<br>In this range:<br>– Flash wait states 4.<br>– System clock frequency 60 MHz.<br>– ART Accelerator enabled.<br>– Flash write operation by byte (refer to <a href="#">Bootloader memory management</a> for more information). |

**Table 67. STM32F413xx/423xx configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment  |
|--------------------|--------------------|--------------|--|
| USART1 bootloader  | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                    | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                    | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                    | USART2_RX pin      | Input        | PD6 pin: USART2 in reception mode  |
|                    | USART2_TX pin      | Output       | PD5 pin: USART2 in transmission mode   |
| USART3 bootloader  | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                    | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode   |
|                    | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode  |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN2 bootloader    | CAN2               | Enabled      | Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                    | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode  |
|                    | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode  |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001011x (where x = 0 for write and x = 1 for read)                               |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |

Table 67. STM32F413xx/423xx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001011x (where x = 0 for write and x = 1 for read)                         |
|                 | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.   |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001011x (where x = 0 for write and x = 1 for read)                         |
|                 | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                 | I2C3_SDA pin       | Input/Output | PB4 pin: data line is used in open-drain mode.   |
| I2C4 bootloader | I2C4               | Enabled      | The I2C4 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001011x (where x = 0 for write and x = 1 for read)                           |
|                 | I2C4_SCL pin       | Input/Output | PB15 pin: clock line is used in open-drain mode.   |
|                 | I2C4_SDA pin       | Input/Output | PB14 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is: <ul style="list-style-type: none"><li>– Slave mode</li><li>– Full Duplex</li><li>– 8-bit MSB, speed up to 8 MHz</li><li>– Polarity: CPOL Low, CPHA Low, NSS hardware.</li></ul> |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |

**Table 67. STM32F413xx/423xx configuration in system memory boot mode (continued)**

| Bootloader               | Feature/Peripheral | State        | Comment   |
|--------------------------|--------------------|--------------|---|
| SPI3 bootloader          | SPI3               | Enabled      | The SPI3 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB, speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                          | SPI3_MOSI pin      | Input        | PC12 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI3_MISO pin      | Output       | PC11 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SPI3_SCK pin       | Input        | PC10 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI3_NSS pin       | Input        | PA15 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI4 bootloader          | SPI4               | Enabled      | The SPI4 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB, speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                          | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SPI4_SCK pin       | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader           | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                          | USB_DM pin         | Input/Output | PA11 pin: USB DM line.  |
|                          | USB_DP pin         |              | PA12 pin: USB DP line<br>No external Pull-Up resistor is required.  |
| CAN2 and DFU bootloaders | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

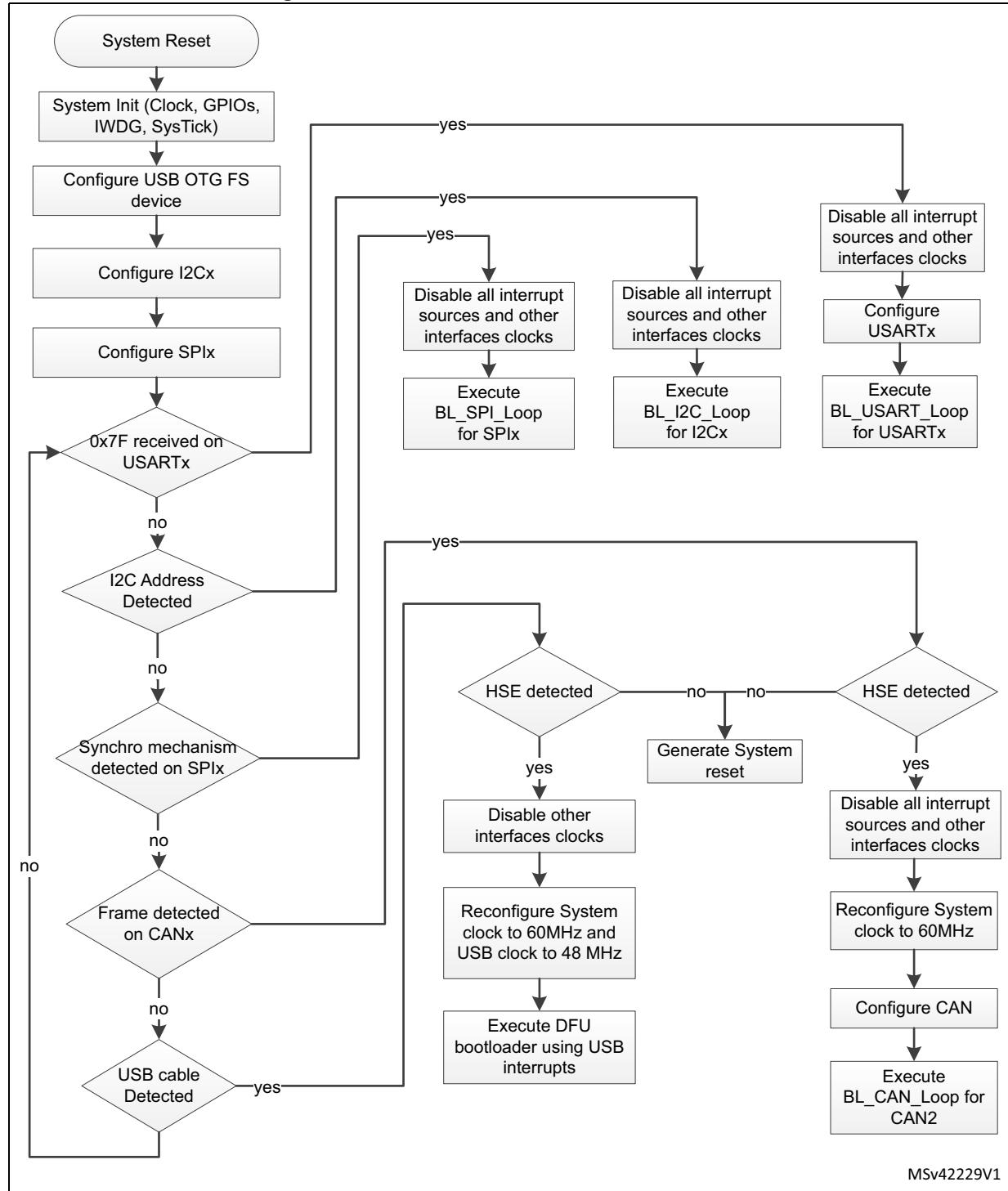
The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

Note: *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 32.2 Bootloader selection

*Figure 37* shows the bootloader selection mechanism.

**Figure 37.Bootloader V9.x selection for STM32F413xx/423xx**



### 32.3 Bootloader version

The following table lists the STM32F413xx/423xx devices bootloader V9.x versions.

**Table 68. STM32F413xx/423xx bootloader V9.x versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V9.0                      | Initial bootloader version | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 33 STM32F42xxx/43xxx devices bootloader

### 33.1 Bootloader V7.x

#### 33.1.1 Bootloader configuration

The STM32F42xxx/43xxx bootloader is activated by applying Pattern 5 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 69. STM32F42xxx/43xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 24 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USART or I2C interfaces are selected (once CAN or DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the CAN or the DFU (USB FS Device) interfaces are selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                            |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 8 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.           |

Table 69. STM32F42xxx/43xxx configuration in system memory boot mode (continued)

| Bootloader                          | Feature/Peripheral | State        | Comment   |
|-------------------------------------|--------------------|--------------|---|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized the USART1 configuration is: 8 bits, even parity and 1 Stop bit  |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8 bits, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8 bits, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is:<br>Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode   |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111000x (where x = 0 for write and x = 1 for read).                                    |
|                                     | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                                     | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.  |
| DFU bootloader                      | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                                     | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                                     | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
| CAN2 and DFU bootloaders            | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE.   |

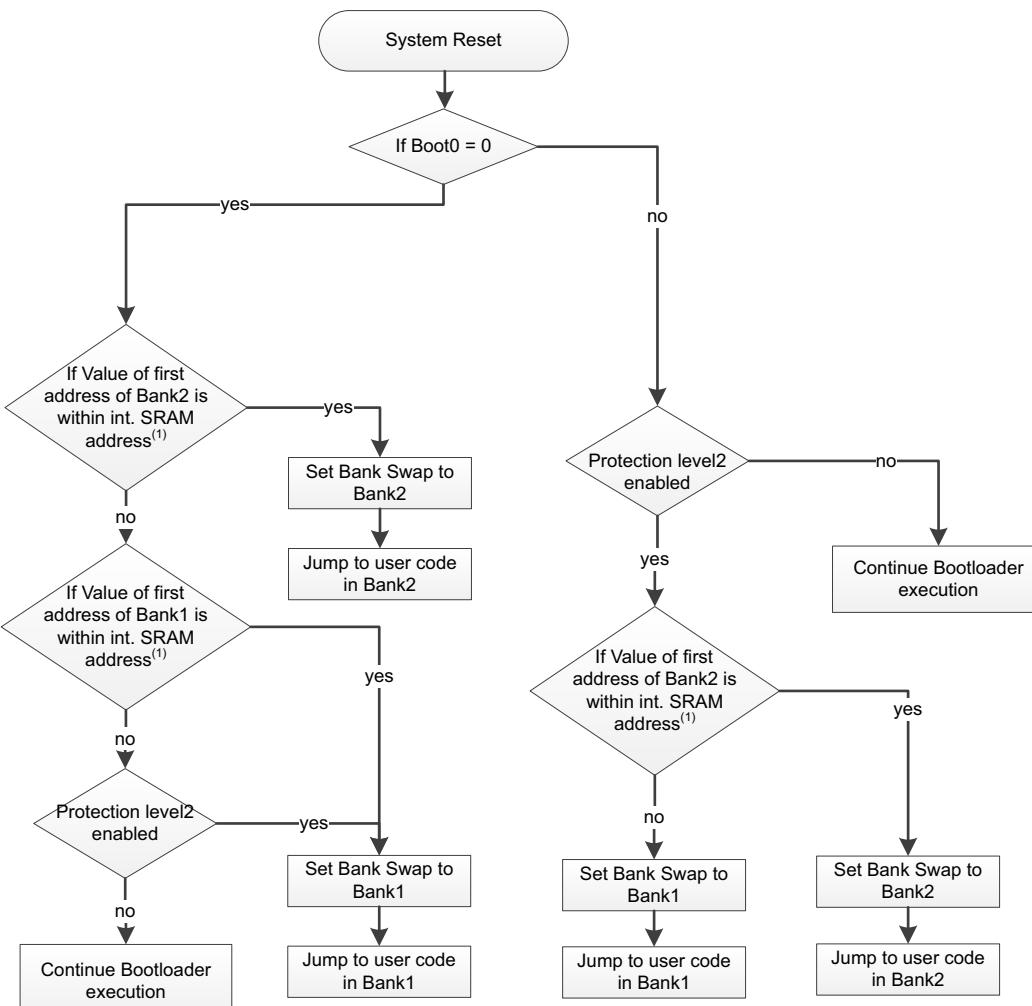
The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.

### 33.1.2 Bootloader selection

Figure 38 and Figure 39 show the bootloader selection mechanism.

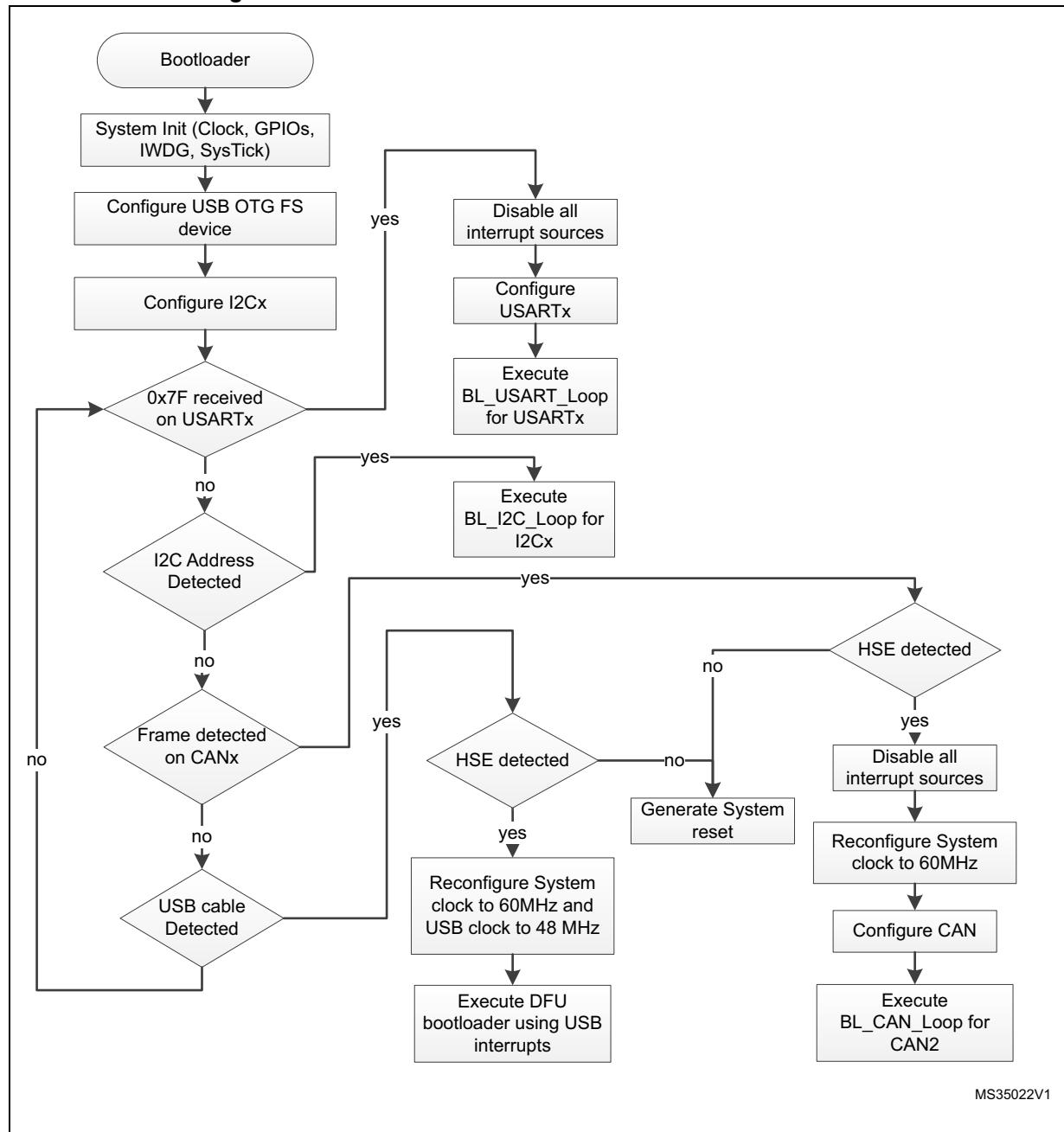
**Figure 38. Dual bank boot implementation for STM32F42xxx/43xxx Bootloader V7.x**



MS35021V1

- CCM RAM is not considered valid as stack pointer address for the dual bank boot mechanism.

Figure 39. Bootloader V7.x selection for STM32F42xxx/43xxx



MS35022V1

### 33.1.3 Bootloader version

The following table lists the STM32F42xxx/43xxx devices bootloader V7.x versions.

**Table 70. STM32F42xxx/43xxx bootloader V7.x versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V7.0                      | Initial bootloader version | For the CAN interface, the Write Unprotect command is not functional. Use Write Memory command and write directly to the option bytes to disable the write protection.<br>For the USB DFU interface, in Dual Bank mode, the Erase operation is not functional for the second bank. Return to Single Bank mode, erase desired sector(s) and then reactivate the Dual Bank mode.<br>After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup). |

## 33.2 Bootloader V9.x

### 33.2.1 Bootloader configuration

The STM32F42xxx/43xxx bootloader is activated by applying Pattern 5 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 71. STM32F42xxx/43xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz using the PLL. The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interfaces are selected (once CAN or DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz. The HSE clock source is used only when the CAN or the DFU (USB FS Device) interfaces are selected. The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                                      |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
| USART1 bootloader         | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.               |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 71. STM32F42xxx/43xxx configuration in system memory boot mode (continued)**

| Bootloader                          | Feature/Peripheral | State        | Comment  |
|-------------------------------------|--------------------|--------------|--|
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode   |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode  |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode  |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode  |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111000x (where x = 0 for write and x = 1 for read).                                 |
|                                     | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                                     | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.   |
| I2C2 bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111000x (where x = 0 for write and x = 1 for read).                                 |
|                                     | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|                                     | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.   |
| I2C3 bootloader                     | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111000x (where x = 0 for write and x = 1 for read).                                 |
|                                     | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                                     | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.   |

**Table 71. STM32F42xxx/43xxx configuration in system memory boot mode (continued)**

| Bootloader               | Feature/Peripheral | State        | Comment   |
|--------------------------|--------------------|--------------|---|
| SPI1 bootloader          | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, -bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                         |
|                          | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                          | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                          | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                          | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI2 bootloader          | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                        |
|                          | SPI2_MOSI pin      | Input        | PI3 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                          | SPI2_MISO pin      | Output       | PI2 pin: Slave data output line, used in push-pull, pull-down mode  |
|                          | SPI2_SCK pin       | Input        | PI1 pin: Slave clock line, used in push-pull, pull-down mode  |
|                          | SPI2_NSS pin       | Input        | PI0 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI4 bootloader          | SPI4               | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                        |
|                          | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SPI4_SCK pin       | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader           | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                          | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                          | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
| CAN2 and DFU bootloaders | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

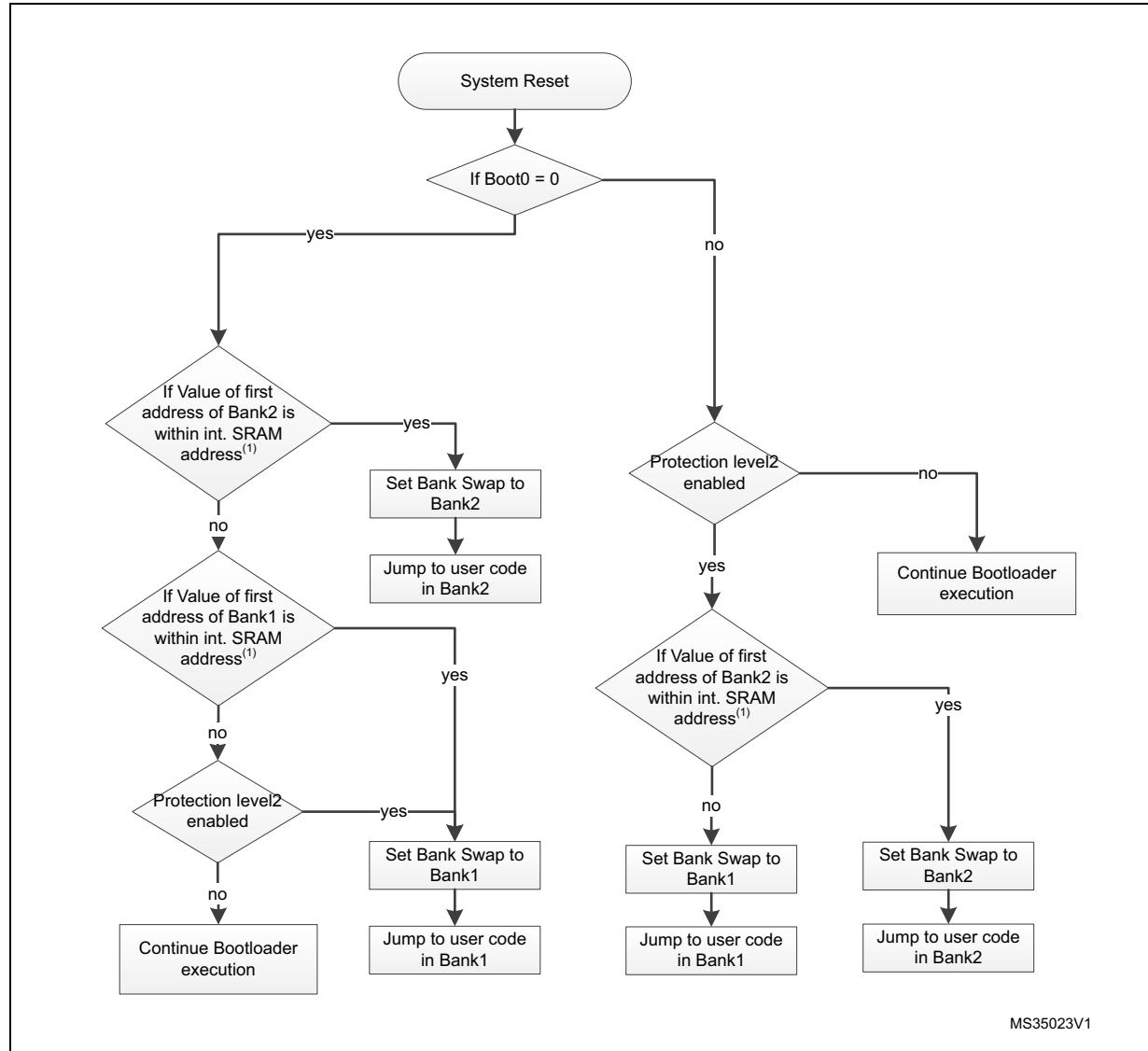
The system clock is derived from the embedded internal high-speed RC for USARTx, I2Cx and SPIx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

### 33.2.2 Bootloader selection

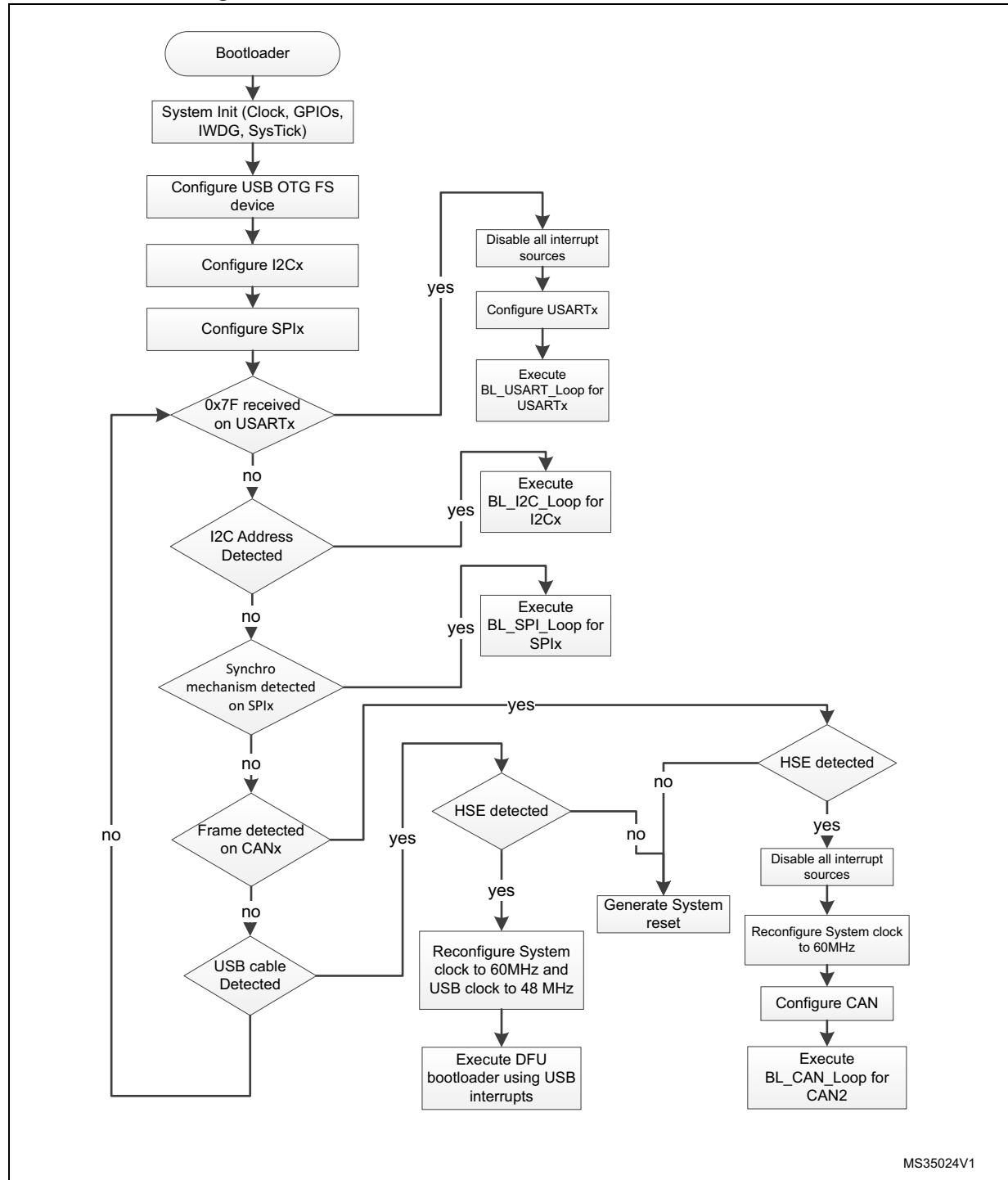
*Figure 40* and *Figure 41* show the bootloader selection mechanism.

**Figure 40. Dual bank boot implementation for STM32F42xxx/43xxx bootloader V9.x**



- CCM RAM is not considered valid as stack pointer address for the dual bank boot mechanism.

Figure 41. Bootloader V9.x selection for STM32F42xxx/43xxx



### 33.2.3 Bootloader version

*Table 72* lists the STM32F42xxx/43xxx devices bootloader V9.x versions.

**Table 72. STM32F42xxx/43xxx bootloader V9.x versions**

| Bootloader version number | Description  | Known limitations  |
|---------------------------|--|--|
| V9.0                      | <p>This bootloader is an updated version of bootloader v7.0. This new version of bootloader supports I2C2, I2C3, SPI1, SPI2 and SPI4 interfaces.</p> <p>The RAM used by this bootloader is increased from 8 Kb to 12 Kb. The ID of this bootloader is 0x90</p> <p>The connection time is increased.</p>                      | <p>For the USB DFU interface, in Dual Bank mode, the Erase operation is not functional for the second bank. Return to Single Bank mode, erase desired sector(s) and then reactivate the Dual Bank mode.</p> <p>After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup)</p>  |
| V9.1                      | <p>This bootloader is an updated version of bootloader v9.0. This new version implements the new I2C No-stretch commands (I2C protocol v1.1) and the capability of disabling PcrOP when RDP1 is enabled with ReadOutUnprotect command for all protocols(USB, USART, CAN, I2C and SPI). The ID of this bootloader is 0x91</p> | <p>For the CAN interface, the Write Unprotect command is not functional. Use Write Memory command and write directly to the option bytes in order to disable the write protection.</p> <p>For the USB DFU interface, in Dual Bank mode, the Erase operation is not functional for the second bank. Return to Single Bank mode, erase desired sector(s) and then reactivate the Dual Bank mode.</p> <p>After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup)</p> |

## 34 STM32F446xx devices bootloader

### 34.1 Bootloader configuration

The STM32F446xx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 73. STM32F446xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART, I2C and SPI bootloader operation.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz. |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | The voltage range is [1.71 V, 3.6 V].<br>In this range:<br>- Flash wait states: 3.<br>- System Clock 60 MHz.<br>- Prefetch disabled.<br>- Flash write operation by byte (refer to section bootloader memory management for more information).       |

Table 73. STM32F446xx configuration in system memory boot mode (continued)

| Bootloader                          | Feature/Peripheral | State        | Comment  |
|-------------------------------------|--------------------|--------------|--|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode   |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode  |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is:<br>Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because in CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode  |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode  |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0111100x<br>(where x = 0 for write and x = 1 for read)                                  |
|                                     | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                                     | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.   |
| I2C2 bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0111100x<br>(where x = 0 for write and x = 1 for read)                                  |
|                                     | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|                                     | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.   |

**Table 73. STM32F446xx configuration in system memory boot mode (continued)**

| <b>Bootloader</b> | <b>Feature/Peripheral</b> | <b>State</b> | <b>Comment</b>  |
|-------------------|---------------------------|--------------|---|
| I2C3 bootloader   | I2C3                      | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0111100x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C3_SCL pin              | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                   | I2C3_SDA pin              | Input/Output | PC9 pin: data line is used in open-drain mode.  |
| SPI1 bootloader   | SPI1                      | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                   | SPI1_MOSI pin             | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                   | SPI1_MISO pin             | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                   | SPI1_SCK pin              | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                   | SPI1_NSS pin              | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI2 bootloader   | SPI2                      | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                   | SPI2_MOSI pin             | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                   | SPI2_MISO pin             | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                   | SPI2_SCK pin              | Input        | PC7 pin: Slave clock line, used in push-pull, pull-down mode  |
|                   | SPI2_NSS pin              | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.  |

**Table 73. STM32F446xx configuration in system memory boot mode (continued)**

| Bootloader               | Feature/Peripheral | State        | Comment   |
|--------------------------|--------------------|--------------|---|
| SPI4 bootloader          | SPI4               | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                          |
|                          | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SPI4_SCK pin       | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader           | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                          | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                          | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
| CAN2 and DFU bootloaders | TIM17              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determinated, the system clock is configured to 60 MHz using PLL and HSE. |

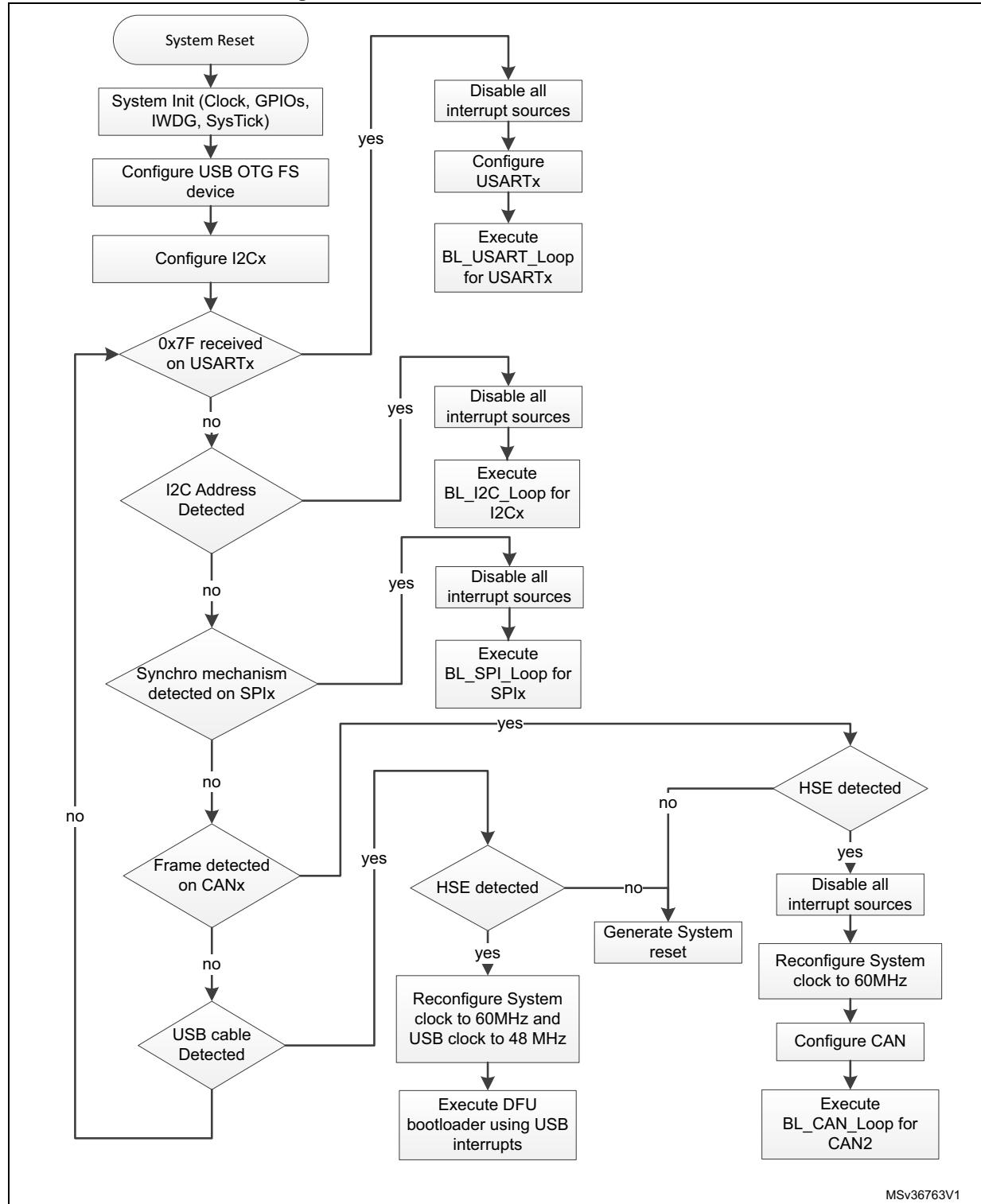
The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 34.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 42.Bootloader V9.x selection for STM32F446xx**



MSv36763V1

### 34.3 Bootloader version

The following table lists the STM32F446xx devices bootloader V9.x versions:

**Table 74. STM32F446xx bootloader V9.x versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V9.0                      | Initial bootloader version | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup) |

## 35 STM32F469xx/479xx devices bootloader

### 35.1 Bootloader configuration

The STM32F469xx/479xx bootloader is activated by applying Pattern 5 (described in [Table 2: Bootloader activation patterns](#)). [Table 75](#) shows the hardware resources used by this bootloader.

**Table 75. STM32F469xx/479xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz using the PLL.<br>The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interfaces are selected (once CAN or DFU bootloader is selected, the clock source is derived from external crystal). |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz.<br>The HSE clock source is used only when the CAN or the DFU (USB FS Device) interfaces are selected.<br>The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.                               |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 29 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).  |
|                           | Power              | -           | Voltage range is set to [1.62 V, 2.1 V]. In this range internal Flash write operations are allowed only in byte format (Half-Word, Word and Double-Word operations are not allowed). The voltage range can be configured in run time using bootloader commands.              |

Table 75. STM32F469xx/479xx configuration in system memory boot mode (continued)

| Bootloader                          | Feature/Peripheral | State        | Comment  |
|-------------------------------------|--------------------|--------------|--|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode   |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode  |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB05 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode  |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000100x (where x = 0 for write and x = 1 for read).                                 |
|                                     | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                                     | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.   |
| I2C2 bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000100x (where x = 0 for write and x = 1 for read).                                 |
|                                     | I2C2_SCL pin       | Input/Output | PF0 pin: clock line is used in open-drain mode.  |
|                                     | I2C2_SDA pin       | Input/Output | PF1 pin: data line is used in open-drain mode.   |

**Table 75. STM32F469xx/479xx configuration in system memory boot mode (continued)**

| <b>Bootloader</b> | <b>Feature/Peripheral</b> | <b>State</b> | <b>Comment</b>   |
|-------------------|---------------------------|--------------|--|
| I2C3 bootloader   | I2C3                      | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000100x (where x = 0 for write and x = 1 for read). |
|                   | I2C3_SCL pin              | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                   | I2C3_SDA pin              | Input/Output | PC9 pin: data line is used in open-drain mode.   |
| SPI1 bootloader   | SPI1                      | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                   | SPI1_MOSI pin             | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                   | SPI1_MISO pin             | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                   | SPI1_SCK pin              | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                   | SPI1_NSS pin              | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader   | SPI2                      | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                   | SPI2_MOSI pin             | Input        | PI3 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                   | SPI2_MISO pin             | Output       | PI2 pin: Slave data output line, used in push-pull, pull-down mode   |
|                   | SPI2_SCK pin              | Input        | PI1pin: Slave clock line, used in push-pull, pull-down mode  |
|                   | SPI2_NSS pin              | Input        | PI0 pin: slave chip select pin used in push-pull, pull-down mode.  |

**Table 75. STM32F469xx/479xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| SPI4 bootloader | SPI4               | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB,<br>Speed up to 8 MHz, Polarity: CPOL Low,<br>CPHA Low, NSS hardware. |
|                 | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SP4_SCK pin        | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in push-pull, pull-down mode.   |
| DFU bootloader  | USB                | Enabled      | USB OTG FS configured in forced device mode. USB_OTG_FS interrupt vector is enabled and used for USB DFU communications.               |
|                 | USB_DM pin         | Input/Output | PA11 pin: USB DM line.   |
|                 | USB_DP pin         |              | PA12 pin: USB DP line.<br>No external Pull-Up resistor is required.  |

The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 48 MHz) is required for CAN and DFU bootloaders execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 35.2 Bootloader selection

*Figure 43* and *Figure 44* show the bootloader selection mechanism.

**Figure 43. Dual bank boot implementation for STM32F469xx/479xx Bootloader V9.x**

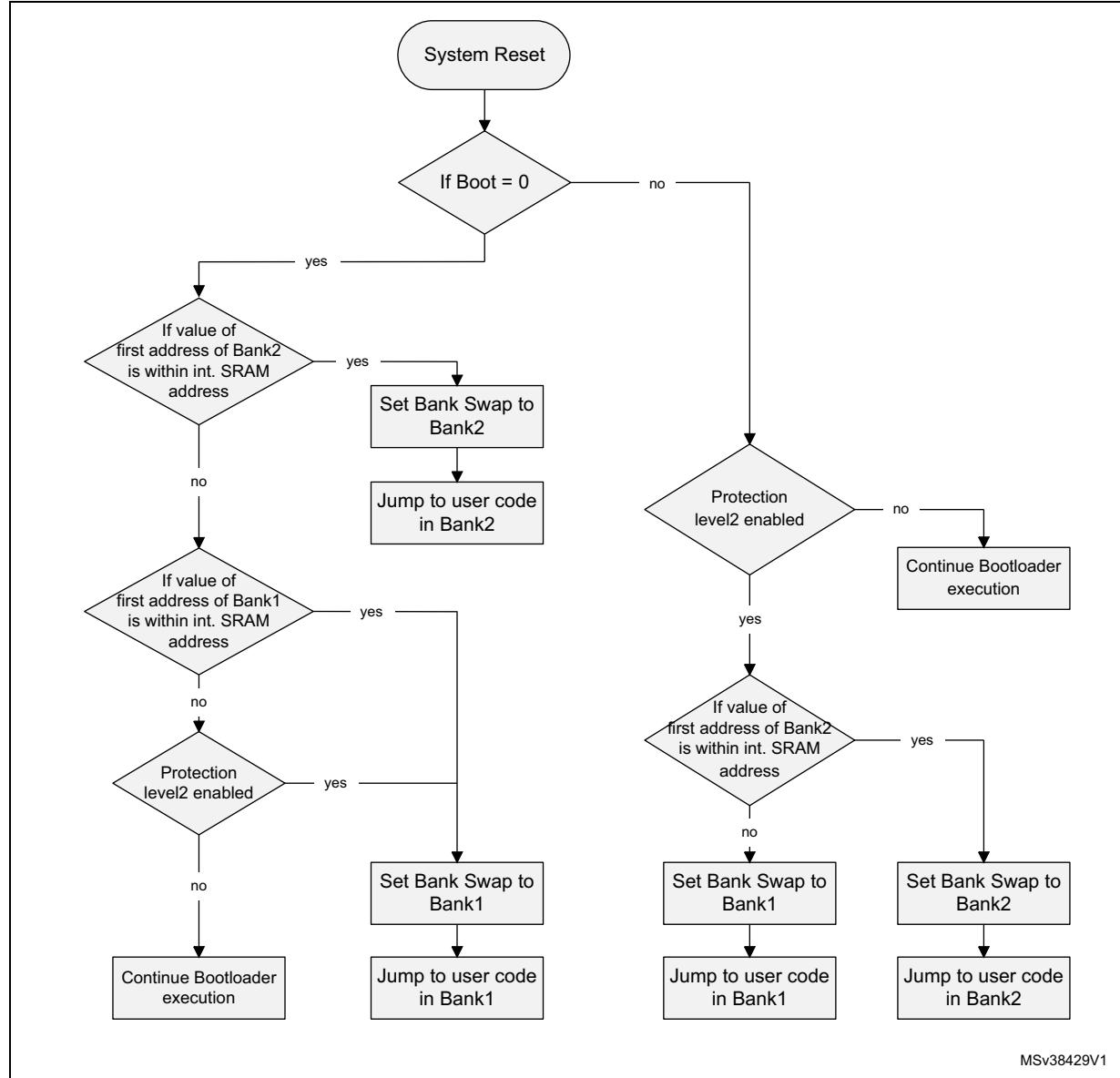
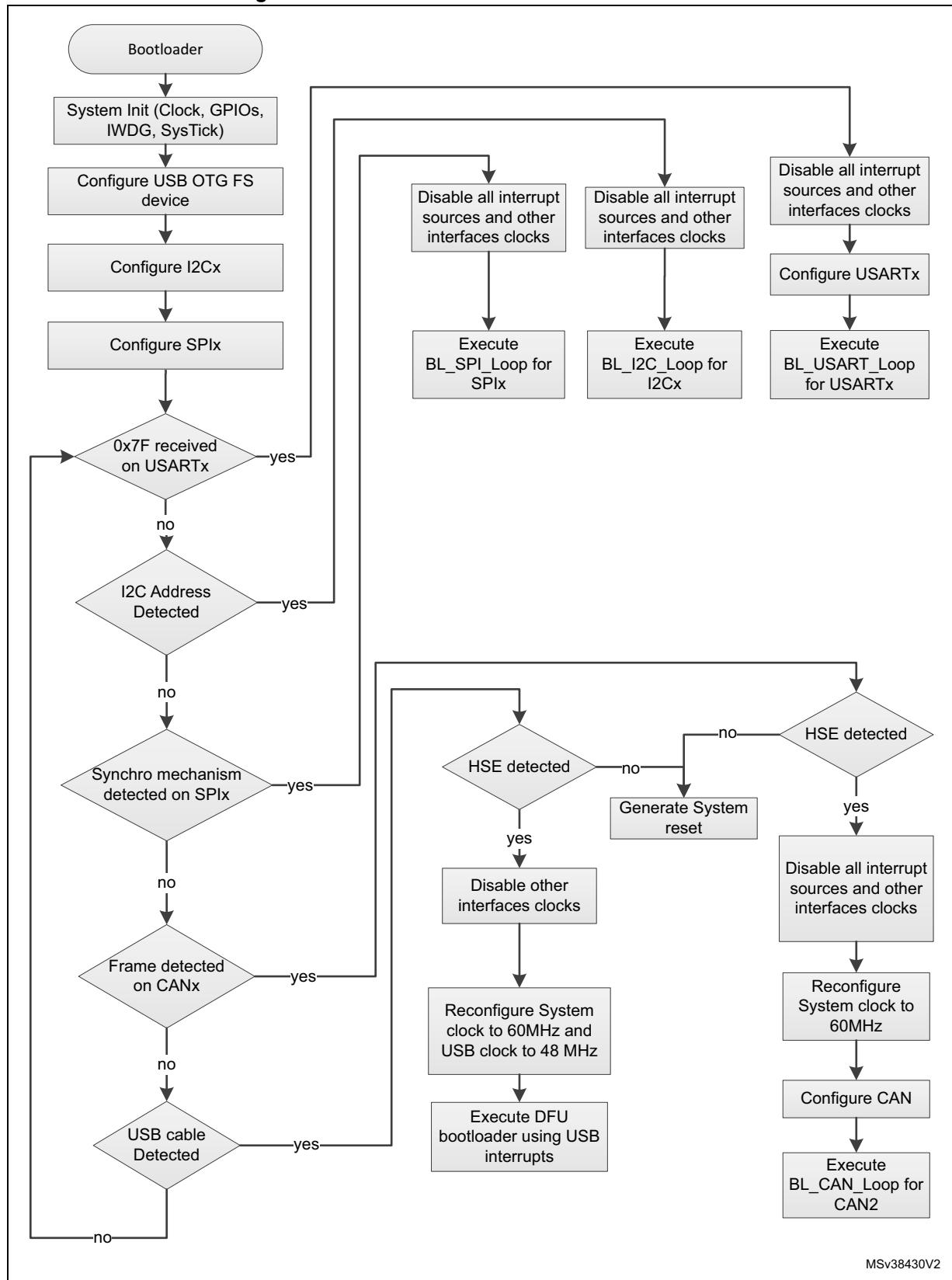


Figure 44.Bootloader V9.x selection for STM32F469xx/479xx



### 35.3 Bootloader version

*Table 76* lists the STM32F469xx/479xx devices V9.x bootloader versions:

**Table 76. STM32F469xx/479xx bootloader V9.x versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V9.0                      | Initial bootloader version | After executing Go command (jump to user code) the bootloader resets AHB1ENR value to 0x0000 0000 and thus CCM RAM, when present, is not active (must be re-enabled by user code at startup). |

## 36 STM32F72xxx/73xxx devices bootloader

### 36.1 Bootloader configuration

The STM32F72xxx/73xxx bootloader is activated by applying Pattern 8 (described in [Table 2: Bootloader activation patterns](#)). [Table 77](#) shows the hardware resources used by this bootloader.

**Table 77. STM32F72xxx/73xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART and I2C bootloader operation.  |
|                           |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz.       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 59 Kbyte starting from address 0x1FF00000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | The voltage range is [1.8V, 3.6V]<br>In this range:<br>- Flash wait states: 3.<br>- System clock frequency 60 MHz.<br>- ART Accelerator enabled.<br>- Flash write operation by byte (refer to bootloader memory management section for more information). |

**Table 77. STM32F72xxx/73xxx configuration in system memory boot mode (continued)**

| Bootloader                       | Feature/Peripheral | State        | Comment  |
|----------------------------------|--------------------|--------------|--|
| USART1 bootloader                | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                  | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode   |
|                                  | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode   |
| USART3 bootloader (on PB11/PB10) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                  | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode   |
|                                  | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode  |
| USART3 bootloader (on PC11/PC10) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                                  | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|                                  | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx bootloaders               | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN1 bootloader                  | CAN1               | Enabled      | Once initialized the CAN1 configuration is: Baudrate 125 kbps, 11-bit identifier.  |
|                                  | CAN1_RX pin        | Input        | PD0 pin: CAN1 in reception mode  |
|                                  | CAN1_TX pin        | Output       | PD1 pin: CAN1 in transmission mode   |
| I2C1 bootloader                  | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001001x (where x = 0 for write and x = 1 for read) |
|                                  | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                                  | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.   |

**Table 77. STM32F72xxx/73xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001101x (where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.   |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001001x (where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                 | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.   |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                 | SPI2_MOSI pin      | Input        | PI3 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output       | PI2 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input        | PI1 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input        | PI0 pin: slave chip select pin used in push-pull, pull-down mode.  |

**Table 77. STM32F72xxx/73xxx configuration in system memory boot mode (continued)**

| Bootloader                  | Feature/Peripheral | State        | Comment   |
|-----------------------------|--------------------|--------------|---|
| SPI4 bootloader             | SPI4               | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB,<br>Speed up to 8 MHz, Polarity: CPOL<br>Low, CPHA Low, NSS hardware.                          |
|                             | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used<br>in push-pull, pull-down mode   |
|                             | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used<br>in push-pull, pull-down mode  |
|                             | SP4_SCK pin        | Input        | PE12 pin: Slave clock line, used in<br>push-pull, pull-down mode  |
|                             | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in<br>push-pull, pull-down mode.   |
| DFU bootloader              | USB                | Enabled      | USB OTG FS configured in forced<br>device mode  |
|                             | USB_DM pin         | Input/Output | PA11 pin: USB DM line.  |
|                             | USB_DP pin         |              | PA12 pin: USB DP line<br>No external Pull-Up resistor is<br>required.   |
| CAN1 and DFU<br>bootloaders | TIM11              | Enabled      | This timer is used to determine the<br>value of the HSE. Once HSE<br>frequency is determined, the system<br>clock is configured to 60 MHz using<br>PLL and HSE. |

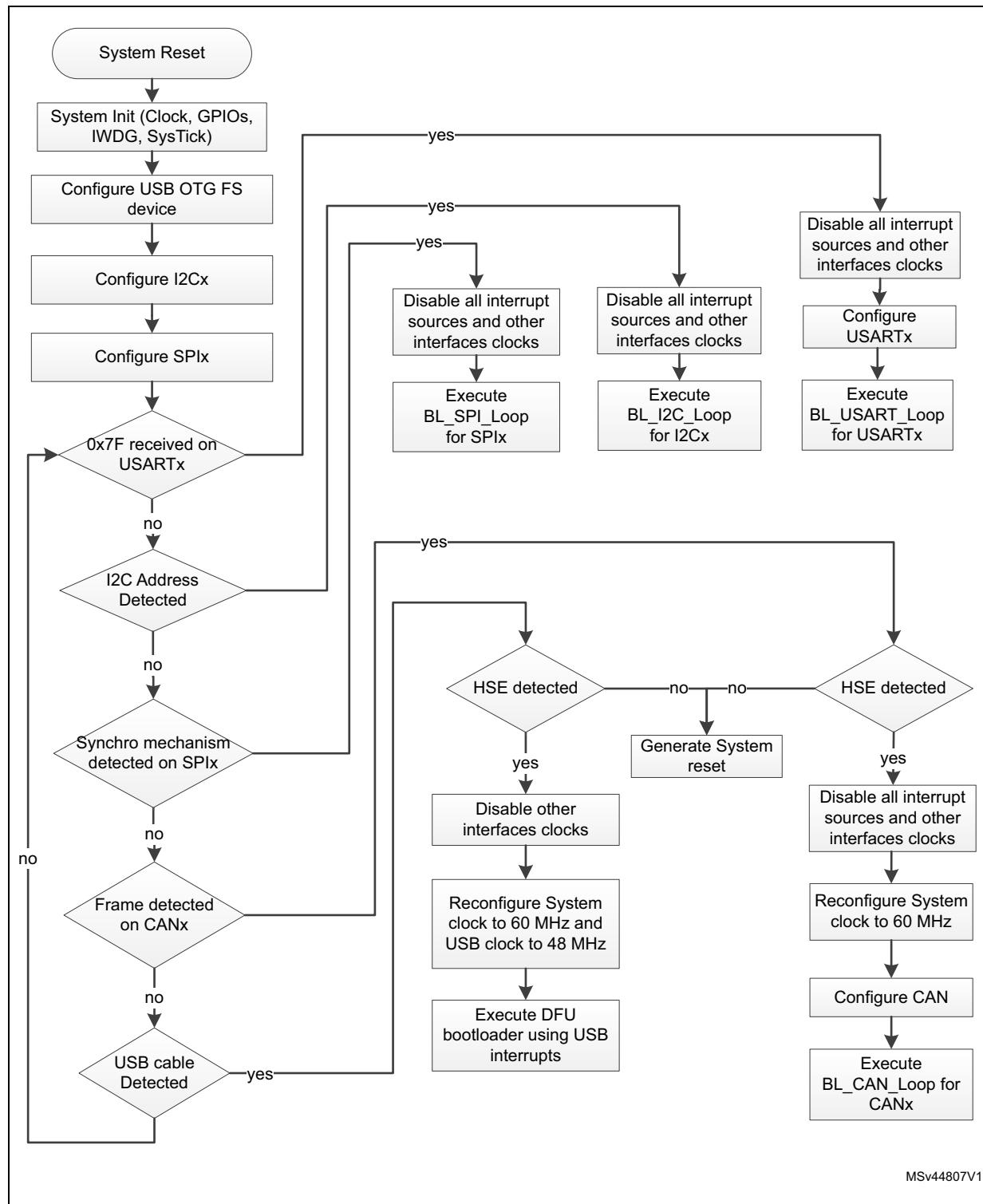
The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 36.2 Bootloader selection

*Figure 45* shows the bootloader selection mechanism.

**Figure 45. Bootloader V9.x selection for STM32F72xxx/73xxx**



### 36.3 Bootloader version

*Table 78* lists the STM32F72xxx/73xxx devices bootloader V9.x versions.

**Table 78. STM32F72xxx/73xxx bootloader V9.x versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V9.0                      | Initial bootloader version | At high UART baudrates (115200 bps) connection may fail due to software jitter leading to wrong baudrate calculation.<br>In that case bootloader may respond with a baudrate up to $\pm 5\%$ different from host baudrate.<br>Workaround: use baudrates lower than 57600 bps if host tolerance to baudrate error is lower than $\pm 5\%$ |

## 37 STM32F74xxx/75xxx devices bootloader

Two bootloader versions are available on STM32F74xxx/75xxx:

- V7.x supporting USART1, USART3, CAN2, I2C1, I2C2, I2C3 and DFU (USB FS Device). This version is embedded in STM32F74xxx/75xxx rev. A devices.
- V9.x supporting USART1, USART3, CAN2, I2C1, I2C2, I2C3, SPI1, SPI2, SPI4 and DFU (USB FS Device). This version is embedded in STM32F74xxx/75xxx rev. Z and rev. 1 devices.

**Note:** *When readout protection Level2 is activated, STM32F74xxx/75xxx devices can boot also on system memory and all commands are not accessible except Get, GetID, and GetVersion.*

## 37.1 Bootloader V7.x

### 37.1.1 Bootloader configuration

The STM32F74xxx/75xxx bootloader is activated by applying Pattern 8 (described in [Table 2: Bootloader activation patterns](#)). [Table 79](#) shows the hardware resources used by this bootloader.

**Table 79. STM32F74xxx/75xxx configuration in system memory boot mode**

| Bootloader                          | Feature/Peripheral | State       | Comment   |
|-------------------------------------|--------------------|-------------|---|
| Common to all bootloaders           | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART and I2C bootloader operation.  |
|                                     |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz.     |
|                                     |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                                     | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                                     | System memory      | -           | 60 Kbyte starting from address 0x1FF00000, contain the bootloader firmware  |
|                                     | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
| USART1 bootloader                   | Power              | -           | The voltage range is [1.8V, 3.6V]. In this range:<br>- Flash wait states: 3.<br>- System clock frequency 60 MHz.<br>- ART Accelerator enabled.<br>- Flash write operation by byte (refer to bootloader memory management section for more information). |
|                                     | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
| USART3 bootloader<br>(on PB10/PB11) | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
|                                     | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input       | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output      | PB10 pin: USART3 in transmission mode   |

**Table 79. STM32F74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader                             | Feature/Peripheral | State        | Comment  |
|--|--------------------|--------------|--|
| USART3<br>bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|  | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|  | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx<br>bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| CAN2<br>bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|  | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode  |
|  | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode  |
| I2C1<br>bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000101x<br>(where x = 0 for write and x = 1 for read)                            |
|  | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|  | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.   |
| I2C2<br>bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000101x<br>(where x = 0 for write and x = 1 for read)                            |
|  | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|  | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.   |
| I2C3<br>bootloader                     | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000101x<br>(where x = 0 for write and x = 1 for read)                            |
|  | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|  | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.   |
| DFU<br>bootloader                      | USB                | Enabled      | USB OTG FS configured in forced device mode.   |
|  | USB_DM pin         | Input/Output | PA11 pin: USB DM line.   |
|  | USB_DP pin         |              | PA12 pin: USB DP line<br>No external Pull-Up resistor is required.   |
| CAN2 and DFU<br>bootloaders            | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE.  |

The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but

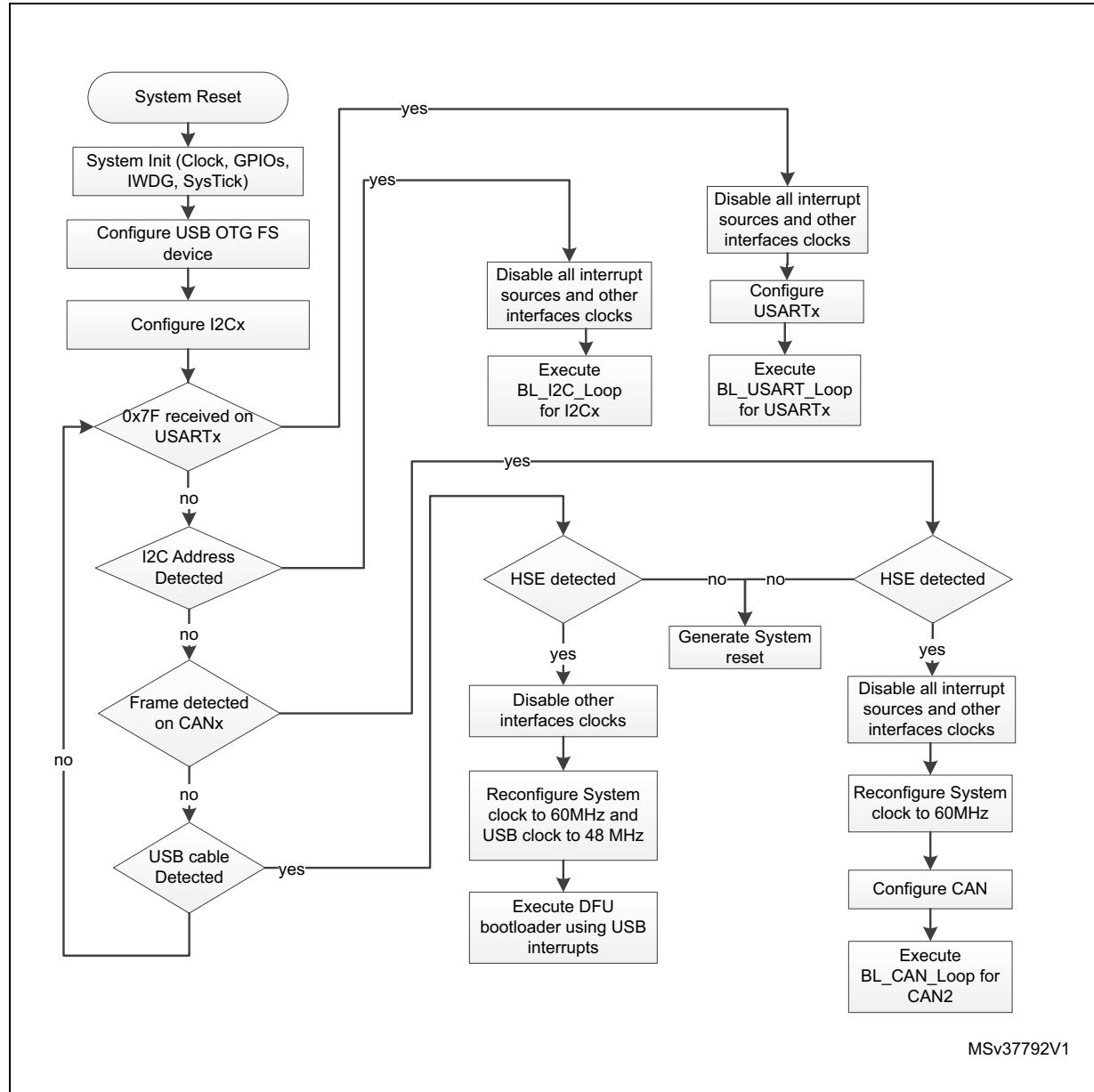
only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

### 37.1.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 46.Bootloader V7.x selection for STM32F74xxx/75xxx**



MSv37792V1

### 37.1.3 Bootloader version

The following table lists the STM32F74xxx/75xxx devices bootloader V7.x versions:

Table 80. STM32F74xxx/75xxx bootloader V7.x versions

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V7.0                      | Initial bootloader version | <p>At high UART baudrates (115200 bps) connection may fail due to software jitter leading to wrong baudrate calculation.</p> <p>In that case bootloader may respond with a baudrate up to <math>\pm 5\%</math> different from host baudrate.</p> <p>Workaround: use baudrates lower than 57600 bps if host tolerance to baudrate error is lower than <math>\pm 5\%</math></p> |

## 37.2 Bootloader V9.x

### 37.2.1 Bootloader configuration

The STM32F74xxx/75xxx bootloader is activated by applying Pattern 8 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 81. STM32F74xxx/75xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART, I2C and SPI bootloader operation.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz.       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 60 Kbyte starting from address 0x1FF00000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | The voltage range is [1.8V, 3.6V]<br>In this range:<br>- Flash wait states: 3.<br>- System clock frequency 60 MHz.<br>- ART Accelerator enabled.<br>- Flash write operation by byte (refer to bootloader memory management section for more information). |

**Table 81. STM32F74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader                          | Feature/Peripheral | State        | Comment   |
|-------------------------------------|--------------------|--------------|---|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PB10/PB11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader<br>(on PC10/PC11) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is:<br>Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode   |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000101x<br>(where x = 0 for write and x = 1 for read)                               |
|                                     | I2C1_SCL pin       | Input/output | PB6 pin: clock line is used in open-drain mode.   |
|                                     | I2C1_SDA pin       | Input/output | PB9 pin: data line is used in open-drain mode.  |
| I2C2 bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000101x<br>(where x = 0 for write and x = 1 for read)                               |
|                                     | I2C2_SCL pin       | Input/output | PF1 pin: clock line is used in open-drain mode.   |
|                                     | I2C2_SDA pin       | Input/output | PF0 pin: data line is used in open-drain mode.  |

**Table 81. STM32F74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000101x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/output | PA8 pin: clock line is used in open-drain mode.   |
|                 | I2C3_SDA pin       | Input/output | PC9 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                 | SPI2_MOSI pin      | Input        | PI3 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output       | PI2 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input        | PI1 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input        | PI0 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 81. STM32F74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader               | Feature/Peripheral | State        | Comment   |
|--------------------------|--------------------|--------------|---|
| SPI4 bootloader          | SPI4               | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                    |
|                          | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SP4_SCK pin        | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader           | USB                | Enabled      | USB OTG FS configured in forced device mode.  |
|                          | USB_DM pin         | Input/Output | PA11 pin: USB DM line.  |
|                          | USB_DP pin         |              | PA12 pin: USB DP line<br>No external pull-Up resistor is required.  |
| CAN2 and DFU bootloaders | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

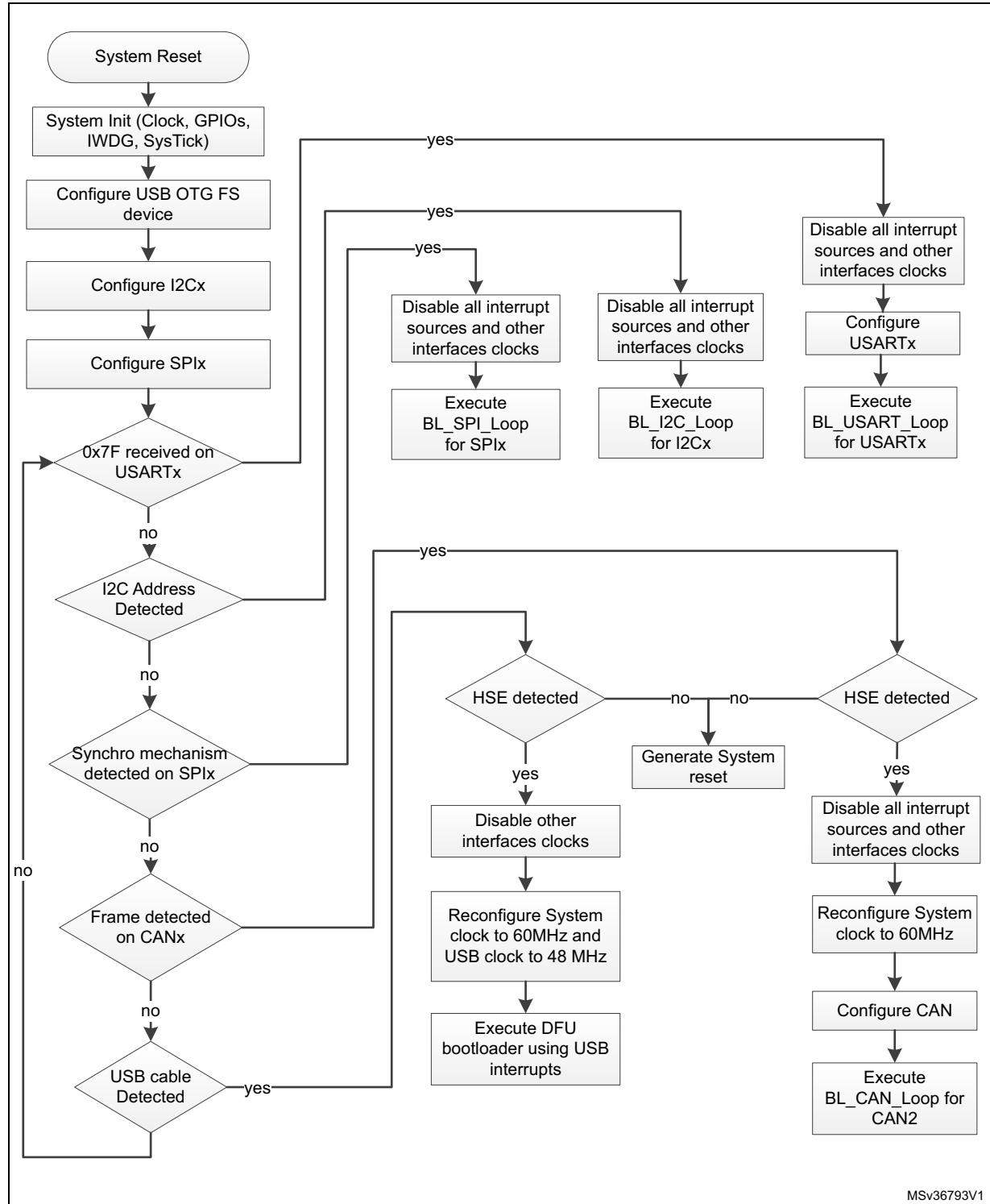
The system clock is derived from the embedded internal high-speed RC for USARTx, I2Cx and SPIx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

### 37.2.2 Bootloader selection

*Figure 47* shows the bootloader selection mechanism.

**Figure 47.Bootloader V9.x selection for STM32F74xxx/75xxx**



### 37.2.3 Bootloader version

The following table lists the STM32F74xxx/75xxx bootloader V9.x versions:

Table 82. STM32F74xxx/75xxx bootloader V9.x versions

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V9.0                      | Initial bootloader version | At high UART baudrates (115200 bps) connection may fail due to software jitter leading to wrong baudrate calculation.<br>In that case bootloader may respond with a baudrate up to $\pm 5\%$ different from host baudrate.<br>Workaround: use baudrates lower than 57600 bps if host tolerance to baudrate error is lower than $\pm 5\%$ |

## 38 STM32F76xxx/77xxx devices bootloader

### 38.1 Bootloader configuration

The STM32F76xxx/77xxx bootloader is activated by applying Pattern 9 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 83. STM32F76xxx/77xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART and I2C bootloader operation.  |
|                           |                    | HSE enabled | The HSE is used only when the CAN or the DFU (USB FS Device) interfaces are selected. In this case the system clock configured to 60 MHz with HSE as clock source.<br>The HSE frequency must be multiple of 1 MHz and ranging from 4 MHz to 26 MHz.       |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the CAN and DFU bootloaders. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 59 Kbyte starting from address 0x1FF00000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).   |
|                           | Power              | -           | The voltage range is [1.8V, 3.6V]<br>In this range:<br>- Flash wait states: 3.<br>- System clock frequency 60 MHz.<br>- ART Accelerator enabled.<br>- Flash write operation by byte (refer to bootloader memory management section for more information). |

**Table 83. STM32F76xxx/77xxx configuration in system memory boot mode (continued)**

| Bootloader                          | Feature/Peripheral | State        | Comment   |
|-------------------------------------|--------------------|--------------|---|
| USART1 bootloader                   | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART3 bootloader<br>(on PB11/PB10) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader<br>(on PC11/PC10) | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                                     | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders                  | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| CAN2 bootloader                     | CAN2               | Enabled      | Once initialized the CAN2 configuration is:<br>Baudrate 125 kbps, 11-bit identifier.<br><b>Note:</b> CAN1 is clocked during CAN2 bootloader execution because CAN1 manages the communication between CAN2 and SRAM. |
|                                     | CAN2_RX pin        | Input        | PB5 pin: CAN2 in reception mode   |
|                                     | CAN2_TX pin        | Output       | PB13 pin: CAN2 in transmission mode   |
| I2C1 bootloader                     | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001001x (where x = 0 for write and x = 1 for read)                                  |
|                                     | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                                     | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.  |
| I2C2 bootloader                     | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001001x (where x = 0 for write and x = 1 for read)                                  |
|                                     | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.   |
|                                     | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.  |

**Table 83. STM32F76xxx/77xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001001x (where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                 | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.   |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                 | SPI2_MOSI pin      | Input        | PI3 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output       | PI2 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input        | PI1 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input        | PI0 pin: slave chip select pin used in push-pull, pull-down mode.  |

**Table 83. STM32F76xxx/77xxx configuration in system memory boot mode (continued)**

| Bootloader               | Feature/Peripheral | State        | Comment   |
|--------------------------|--------------------|--------------|---|
| SPI4 bootloader          | SPI4               | Enabled      | The SPI4 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.                    |
|                          | SPI4_MOSI pin      | Input        | PE14 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                          | SPI4_MISO pin      | Output       | PE13 pin: Slave data output line, used in push-pull, pull-down mode   |
|                          | SP4_SCK pin        | Input        | PE12 pin: Slave clock line, used in push-pull, pull-down mode   |
|                          | SPI4_NSS pin       | Input        | PE11 pin: slave chip select pin used in push-pull, pull-down mode.  |
| DFU bootloader           | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                          | USB_DM pin         | Input/Output | PA11 pin: USB DM line.  |
|                          | USB_DP pin         |              | PA12 pin: USB DP line<br>No external pull-Up resistor is required.  |
| CAN2 and DFU bootloaders | TIM11              | Enabled      | This timer is used to determine the value of the HSE. Once HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

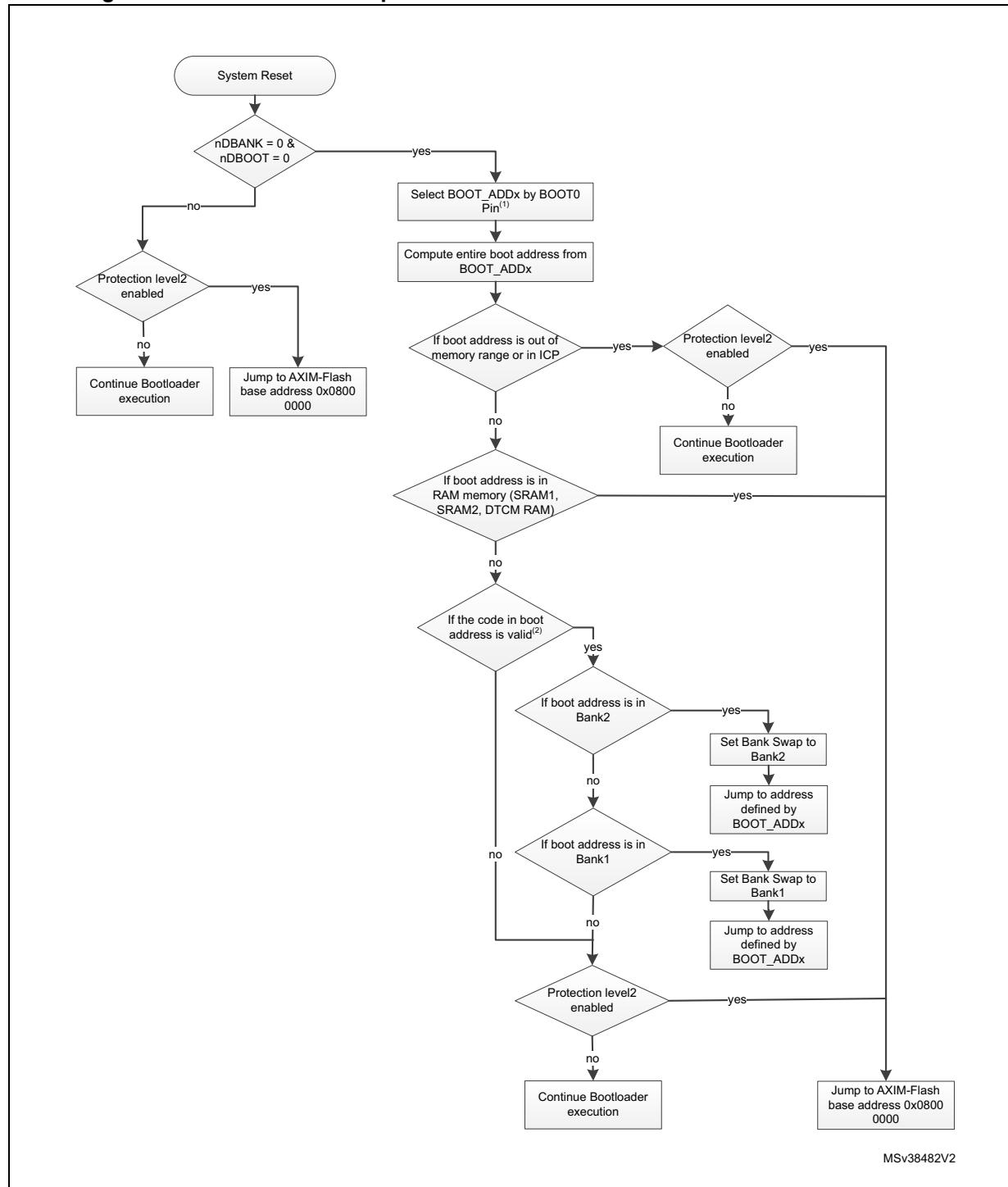
The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution after the selection phase.

**Note:** *Due to HSI deviation and since HSI is used to detect HSE value, the user must use low frequency rather than high frequency HSE crystal values (low frequency values are better detected due to larger error margin). For example, it is better to use 8 MHz instead of 25 MHz.*

## 38.2 Bootloader selection

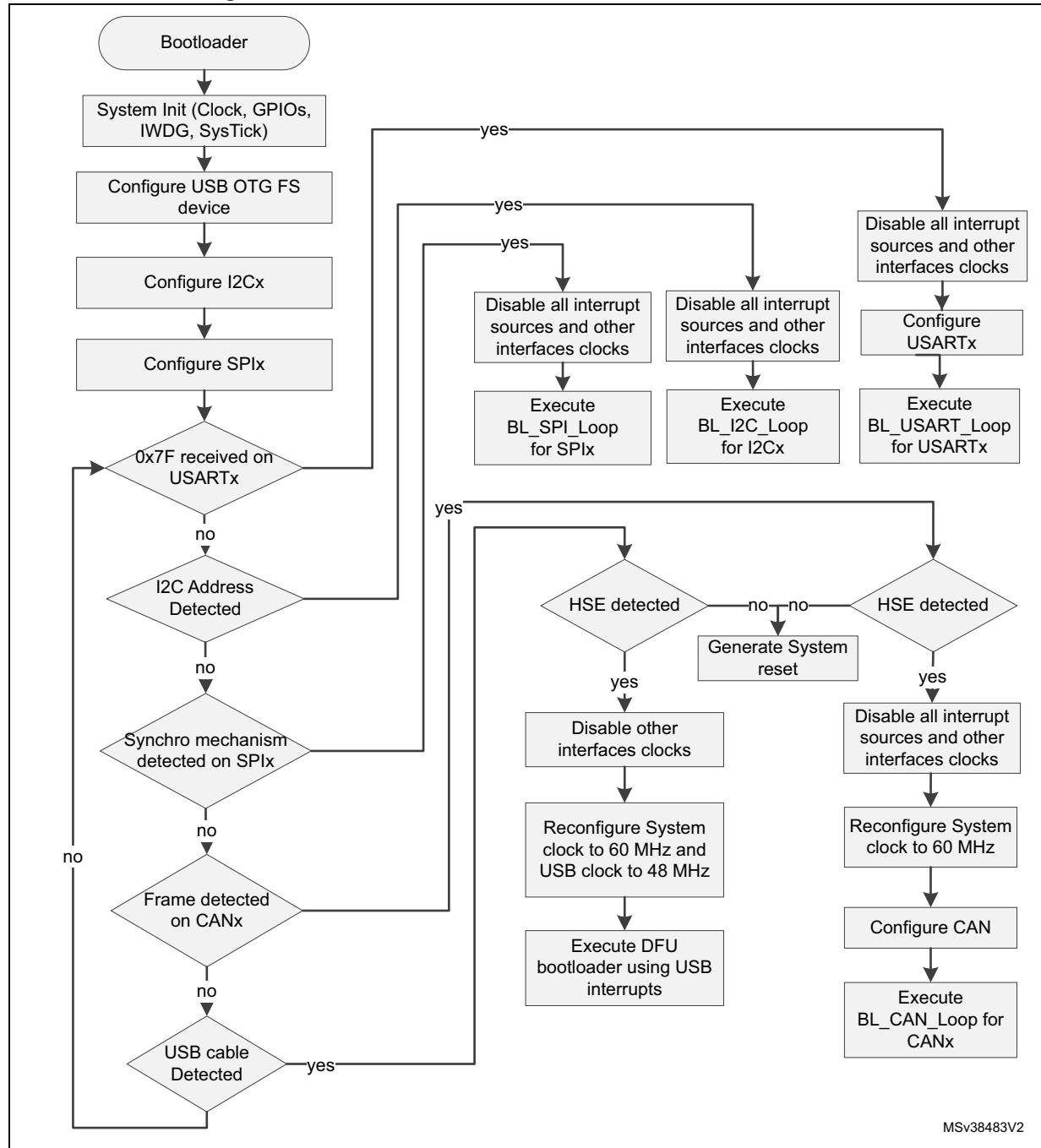
*Figure 48* and *Figure 49* show the bootloader selection mechanism.

**Figure 48. Dual bank boot implementation for STM32F76xxx/77xxx Bootloader V9.x**



1. Only BOOT\_ADD0 value is considered whatever the BOOT0 pin state, as described in Known limitation under [Table 84](#).
2. ITCM RAM is not considered valid as stack pointer address for the dual bank boot mechanism.

Figure 49. Bootloader V9.x selection for STM32F76xxx/77xxx



### 38.3 Bootloader version

The following table lists the STM32F76xxx/77xxx devices bootloader V9.x versions.

**Table 84. STM32F76xxx/77xxx bootloader V9.x versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V9.3                      | Initial bootloader version | <p>When the Flash memory is configured to the dual bank boot mode (nDBANK=nDBOOT=0), whatever the BOOT0 Pin state only BOOT_ADD0 value is considered (when BOOT0 Pin=1, BOOT_ADD0 value is considered not the BOOT_ADD1).</p> <p>Workaround: in order to manage dual bank boot with BOOT_ADD0 only, refer to the AN4826: "STM32F7 Series Flash memory dual bank mode"</p> <p>At high UART baudrates (115200 bps) connection may fail due to software jitter leading to wrong baudrate calculation.</p> <p>In that case bootloader may respond with a baudrate up to <math>\pm 5\%</math> different from host baudrate.</p> <p>Workaround: use baudrates lower than 57600 bps if host tolerance to baudrate error is lower than <math>\pm 5\%</math></p> |

## 39 STM32G03xxx/ STM32G04xxx devices bootloader

### 39.1 Bootloader configuration

The STM32G03xxx/G04xxx bootloader is activated by applying Pattern 11 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 85. STM32G03xxx/G04xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 24 MHz (using PLL clocked by HSI).  |
|                           | RAM                | -            | 4 Kbytes starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -            | 8 Kbytes starting from address 0x1FFF0000   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| Securable memory area     | -                  | -            | The Address to jump to for the securable memory area: @0x1FFF1D00   |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USARTx bootloader         | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010001x<br>(where x = 0 for write and x = 1 for read)                         |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

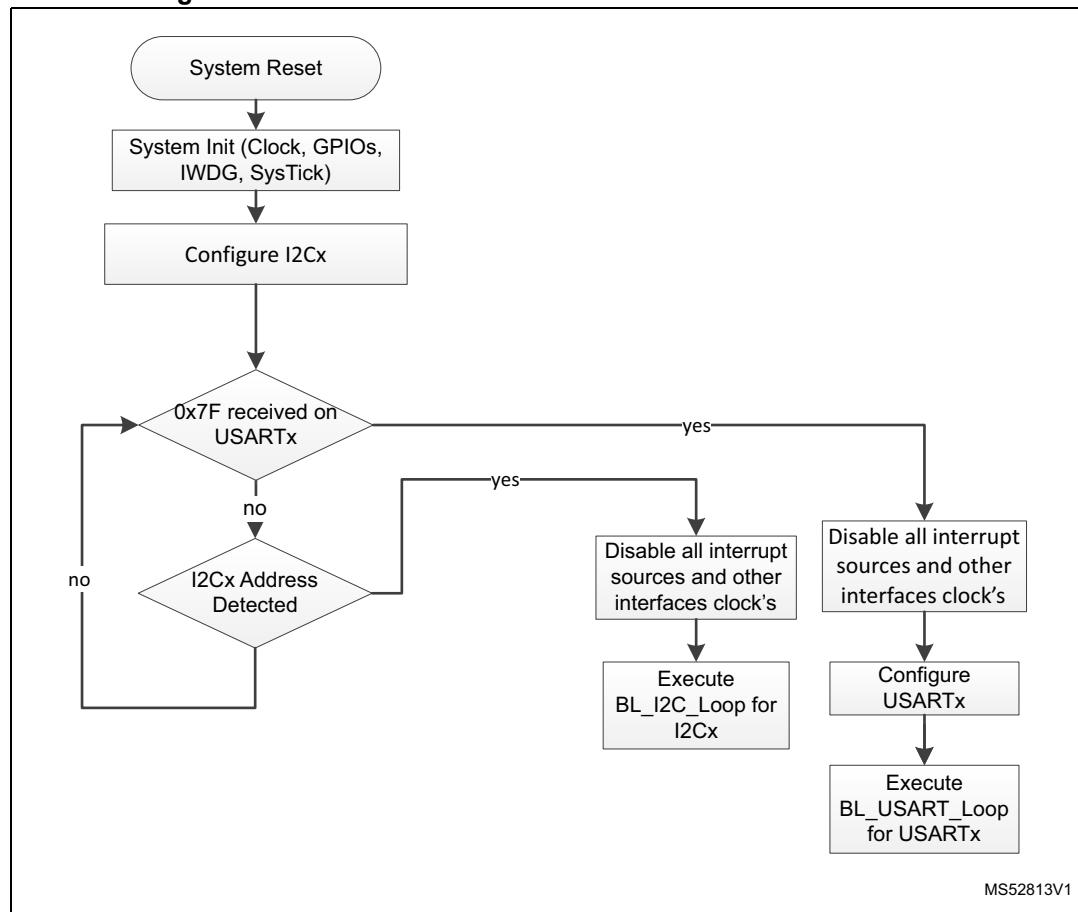
**Table 85. STM32G03xxx/G04xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010001x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |

**Note:** On SO8, WLCSP18, TSSOP20 and UFQFN28 packages USART1 PA9/PA10 IOs are remapped on PA11/PA12.

## 39.2 Bootloader selection

*Figure 50* shows the bootloader selection mechanism.

**Figure 50. Bootloader V5.x selection for STM32G03xxx/G04xxx**

### 39.3 Bootloader version

*Table 86* lists the STM32G03xxx/G4xxx devices bootloader versions.

**Table 86. STM32G03xx/04xxx bootloader versions**

| Bootloader version number | Description                                    | Known limitations  |
|---------------------------|--|--|
| V5.1                      | Initial bootloader version                     | <ul style="list-style-type: none"><li>– Supports only 48- and 32-pin packages</li><li>– Issue is seen for both packages, if PA3 stays to low level, system is stuck in the USART2 detection sequence and no other interface is detected.</li></ul> |
| V5.2                      | Add support to small packages 8/20 and 28 pins | Issue is seen for all packages (except SO8, no PA3 pin), if PA3 stays to low level, system is stuck in the USART2 detection sequence and no other interface is detected.   |
| V5.3                      | Fix V5.2 limitations                           | None   |

## 40 STM32G07xxx/08xxx device bootloader

### 40.1 Bootloader configuration

The STM32G07xxx/G08xxx bootloader is activated by applying Pattern 11 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 87. STM32G07xxx/8xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 24 MHz (using PLL clocked by HSI).  |
|                           | RAM                | -            | 12 Kbytes starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 28 Kbytes starting from address 0x1FFF0000, contain the bootloader firmware   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| Securable memory area     | -                  | -            | The Address to jump to for the securable memory area:<br>@0x1FFF6800  |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader         | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                           | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010001x<br>(where x = 0 for write and x = 1 for read)                         |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

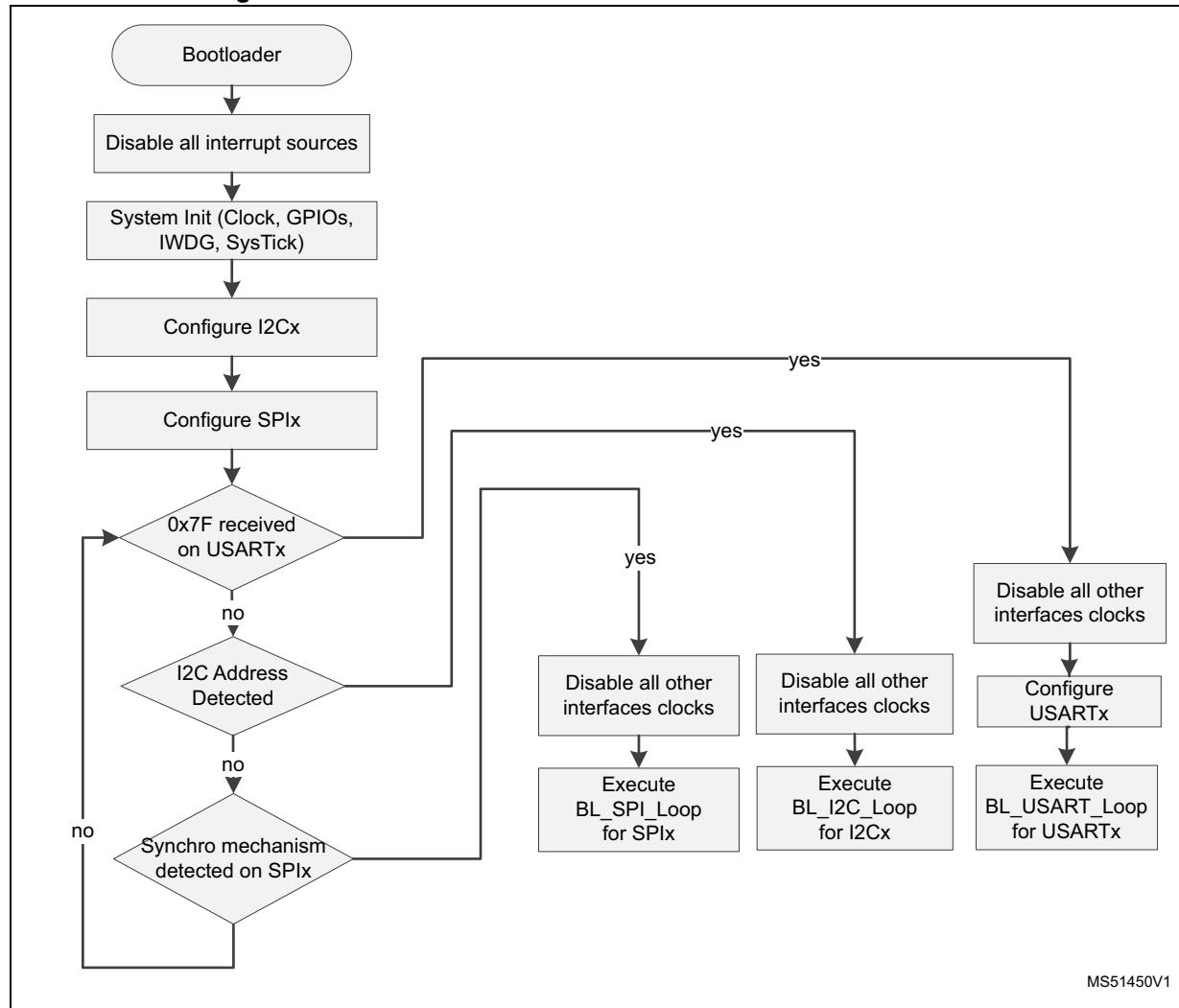
Table 87. STM32G07xxx/8xxx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010001x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.                                     |
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                  |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode.   |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode.  |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode.  |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down.<br><b>Note:</b> This IO can be tied to GND if the SPI master does not use it.   |

## 40.2 Bootloader selection

*Figure 51* shows the bootloader selection mechanism.

**Figure 51. Bootloader V11.0 selection for STM32G07xxx/G08xxx**



## 40.3 Bootloader version

*Table 88* lists the STM32G07xxx/8xxx devices bootloader versions.

**Table 88. STM32G07xx/08xxx bootloader versions**

| Bootloader version number | Description                       | Known limitations                           |
|---------------------------|-----------------------------------|---|
| V11.0                     | Initial bootloader version        | Not supporting packages smaller than LQFP64 |
| V11.1                     | Supporting all packages           | None  |
| V11.2                     | Add securable memory area feature | None  |

## 41 STM32G431xx/441xx devices bootloader

### 41.1 Bootloader configuration

The STM32G431xx/441xx bootloader is activated by applying Pattern 15 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 89. STM32G431xx/441xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 72 MHz (using the PLL clocked by HSI)   |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz  |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| Securable memory area     | -                  | -           | The address to jump to the exit securable memory area @0x1FFF6800   |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader         | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART3_RX pin      | Input       | PC11 pin: USART3 in reception mode  |
|                           | USART3_TX pin      | Output      | PC10 pin: USART3 in transmission mode   |

**Table 89. STM32G431xx/441xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PC4 pin: clock line is used in open-drain mode.   |
|                 | I2C2_SDA pin       | Input/Output | PA8 pin: data line is used in open-drain mode.  |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PC8 pin: clock line is used in open-drain mode.   |
|                 | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |

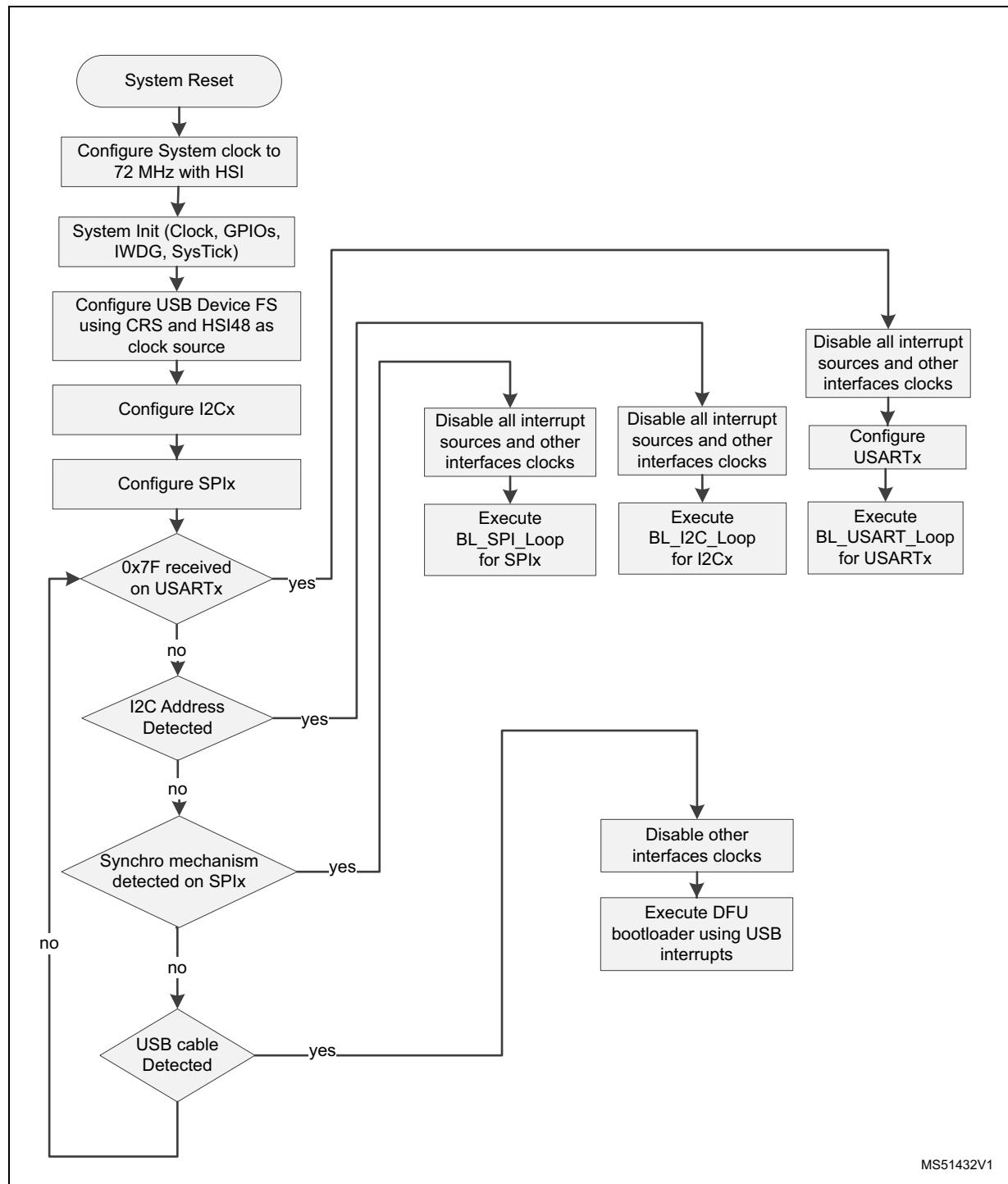
**Table 89. STM32G431xx/441xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br>Note: This IO can be tied to GND if the SPI Master does not use it.          |
| DFU bootloader  | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.                                |
|                 | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                 | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required  |

## 41.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 52. Bootloader selection for STM32G431xx/441xx**



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### 41.3 Bootloader version

Table 90. STM32G431xx/441xx bootloader version

| Bootloader version number | Description                | Known limitations    |
|---------------------------|----------------------------|----------------------|
| V13.3 (0xD3)              | Initial bootloader version | CCSRAM not supported |
| V13.4 (0xD4)              | Fix V13.3 limitations      | Add CCSRAM support   |

## 42 STM32G47xxx/48xxx devices bootloader

### 42.1 Bootloader configuration

The STM32G47xxx/48xxx bootloader is activated by applying Pattern 14 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 91. STM32G47xxx/48xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 72 MHz (using the PLL clocked by HSI)   |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz  |
|                           | RAM                | -           | 16 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| Securable memory area     | -                  | -           | The address to jump to the exit securable memory area @0x1FFF6800   |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader         | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART3_RX pin      | Input       | PC11 pin: USART3 in reception mode  |
|                           | USART3_TX pin      | Output      | PC10 pin: USART3 in transmission mode   |

**Table 91. STM32G47xxx/48xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PC4 pin: clock line is used in open-drain mode.   |
|                 | I2C2_SDA pin       | Input/Output | PA8 pin: data line is used in open-drain mode.  |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PC8 pin: clock line is used in open-drain mode.   |
|                 | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.  |
| I2C4 bootloader | I2C4               | Enabled      | The I2C4 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C4_SCL pin       | Input/Output | PC6 pin: clock line is used in open-drain mode.   |
|                 | I2C4_SDA pin       | Input/Output | PC7 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull no pull-up, pull-down mode.  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |

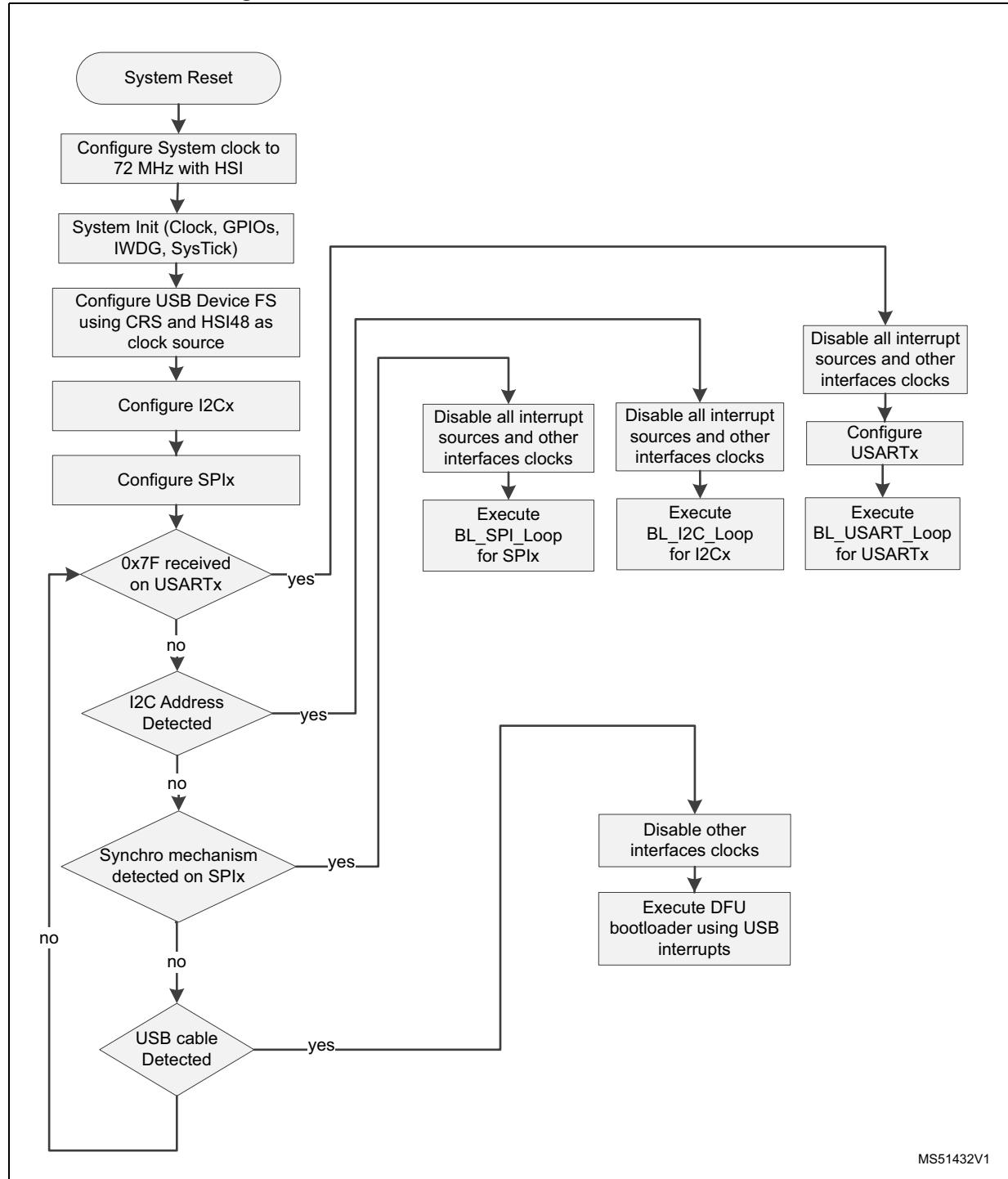
**Table 91. STM32G47xxx/48xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, n pull-down mode.   |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode.  |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, n pull-down mode.  |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.  |
| DFU bootloader  | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                 | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                 | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 42.2 Bootloader selection

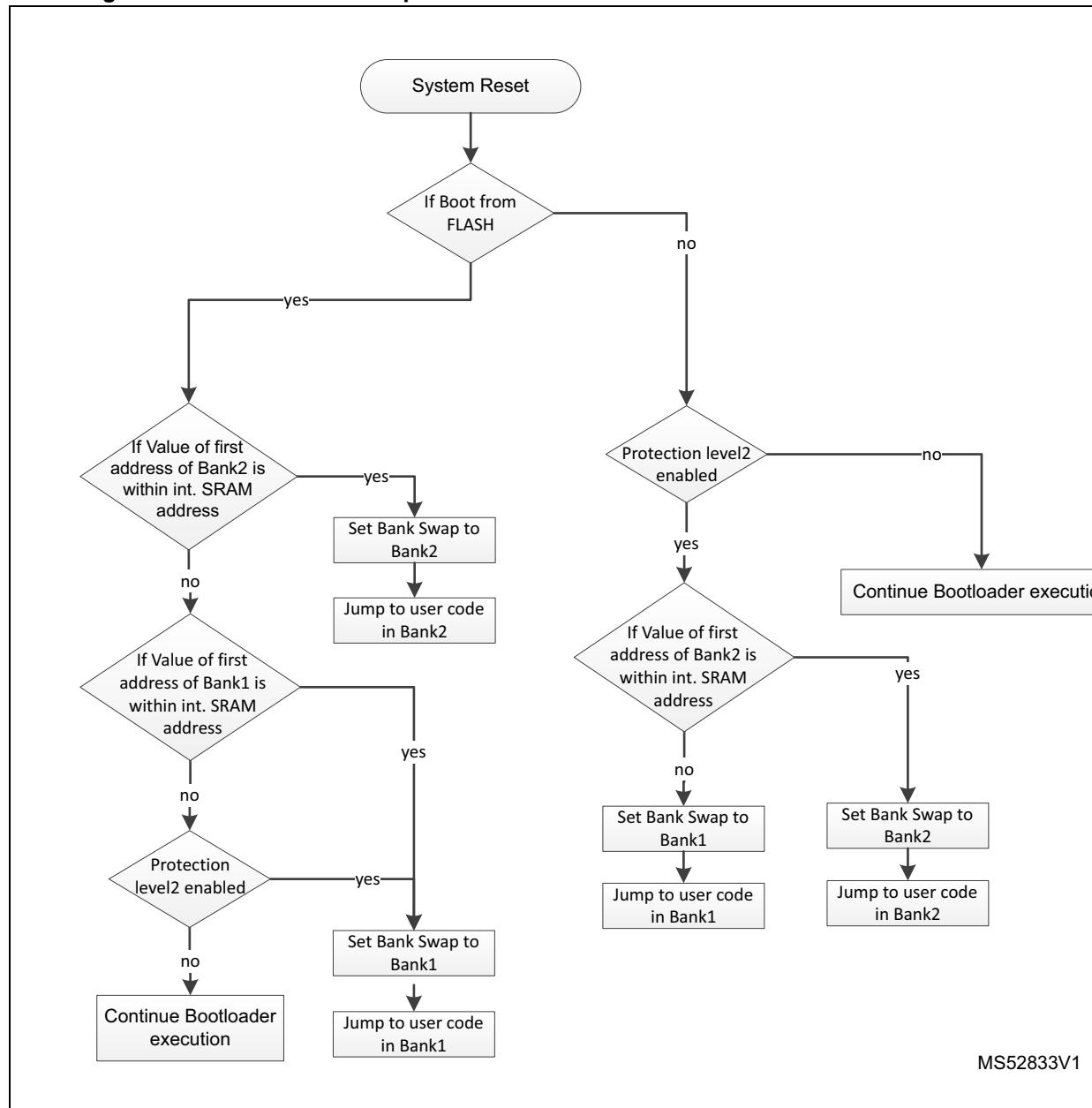
The figures below show the bootloader selection mechanism.

**Figure 53. Bootloader selection for STM32G47xxx/48xxx**



MS51432V1

Figure 54. Dual bank boot implementation for STM32G47xxx/48xxx bootloader V13.x



## 42.3 Bootloader version

Table 92. STM32G47xxx/48xxx bootloader version

| Bootloader version number | Description                | Known limitations              |
|---------------------------|----------------------------|--------------------------------|
| V13.3 (0xD3)              | Initial bootloader version | Boot from bank2 is not working |
| V13.4 (0xD4)              | Fix V13.3 limitations      | CCSRAM not supported           |
| V13.5 (0xD5)              | Fix V13.4 limitations      | Add CCSRAM support             |

## 43 STM32H72xxx/73xxx devices bootloader

### 43.1 Bootloader configuration

The STM32H72xxx/73xxx bootloader is activated by applying Pattern 10 (described in [Table 2: Bootloader activation patterns](#)). [Table 93](#) shows the hardware resources used by this bootloader.

**Table 93. STM32H72xxx/73xxx configuration in system memory boot mode**

| Bootloader                       | Feature/Peripheral | State       | Comment   |
|----------------------------------|--------------------|-------------|---|
| Common to all bootloaders        | RCC                | HSI enabled | The system clock frequency is 66 MHz (using PLL clocked by the HSI)   |
|                                  |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz  |
|                                  |                    | -           | 20 MHz derived from the PLLQ is used for FDCAN  |
|                                  | RAM                | -           | 16 Kbyte starting from address 0x24000000 are used by the bootloader firmware   |
|                                  | System memory      | -           | 84 Kbyte starting from address 0x1FFF9800 contain the bootloader firmware   |
|                                  | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader                | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                                  | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader                | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                                  | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader (on PB10/PB11) | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART3_RX pin      | Input       | PB11 pin: USART3 in reception mode  |
|                                  | USART3_TX pin      | Output      | PB10 pin: USART3 in transmission mode   |
| USART3 bootloader (on PD8/PD9)   | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART3_RX pin      | Input       | PD9 pin: USART3 in reception mode   |
|                                  | USART3_TX pin      | Output      | PD8 pin: USART3 in transmission mode  |

**Table 93. STM32H72xxx/73xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| I2C1 bootloader | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b101011x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                 | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.   |
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b101011x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.   |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b101011x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.  |
|                 | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.   |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                 |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode.   |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode.  |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode.  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |

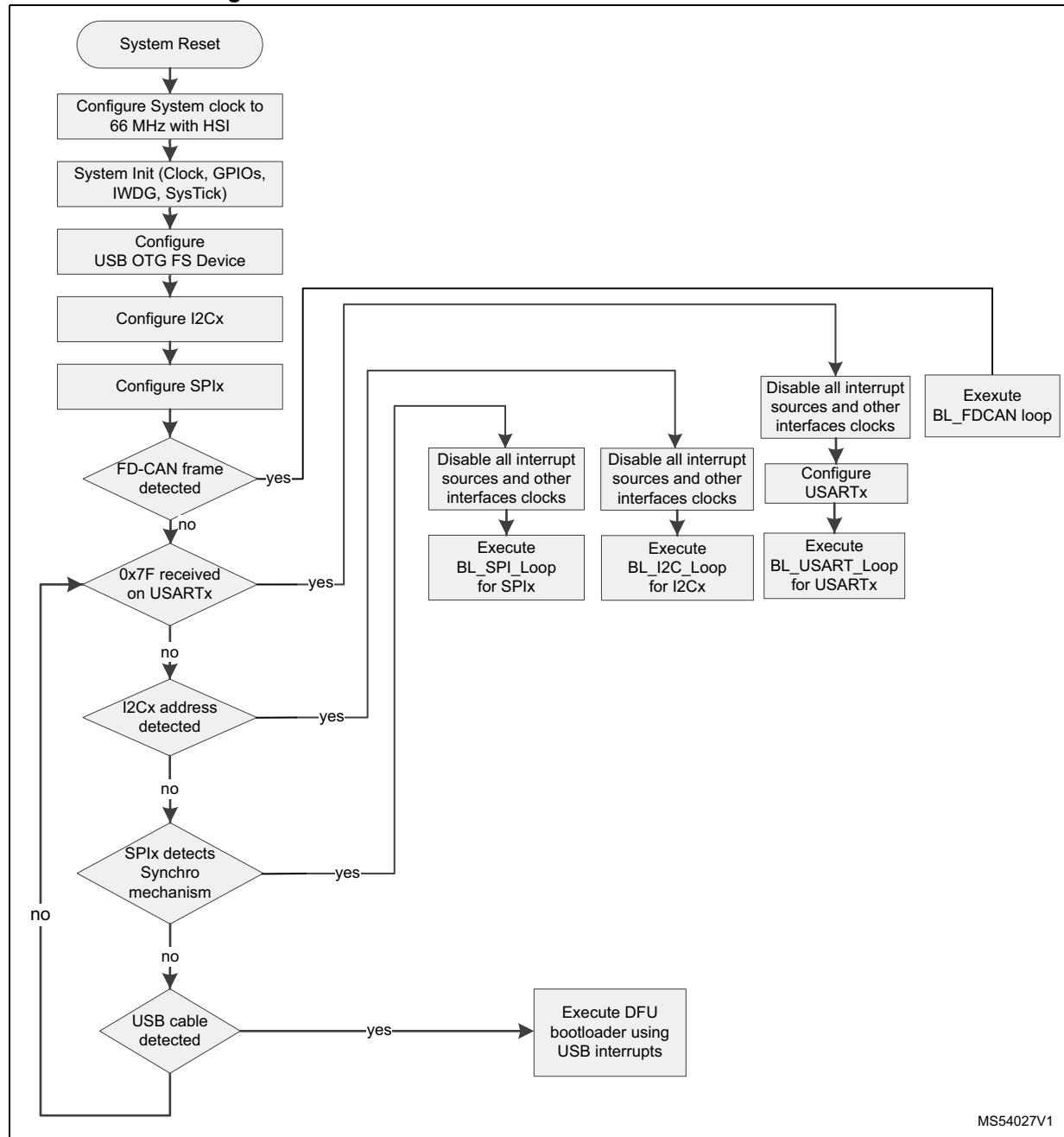
**Table 93. STM32H72xxx/73xxx configuration in system memory boot mode (continued)**

| Bootloader                         | Feature/Peripheral | State        | Comment  |
|------------------------------------|--------------------|--------------|--|
| SPI3 bootloader                    | SPI3               | Enabled      | The SPI3 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                                    | SPI3_MOSI pin      | Input        | PC12 pin: Slave data Input line, used in push-pull pull down mode  |
|                                    | SPI3_MISO pin      | Output       | PC11 pin: Slave data output line, used in push-pull pull down mode.  |
|                                    | SPI3_SCK pin       | Input        | PC10 pin: Slave clock line, used in push-pull pull down mode.  |
|                                    | SPI3_NSS pin       | Input        | PA15 pin: slave chip select pin used in push-pull, pull-down mode.   |
| DFU bootloader                     | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.  |
|                                    | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                                    | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required  |
| FDCAN bootloader<br>(on PH13/PH14) | FDCAN1             | Enabled      | Once initialized the FDCAN1 configuration is:<br>bit-rate 0.5 Mbps<br>FrameFormat = FDCAN_FRAME_FD_BRS<br>Mode = FDCAN_MODE_NORMAL<br>AutoRetransmission = ENABLE<br>TransmitPause = DISABLE<br>ProtocolException = ENABLE |
|                                    | FDCAN1_Rx pin      | Input        | PH14 pin: FDCAN1 in reception mode   |
|                                    | FDCAN1_Tx pin      | Output       | PH13 pin: FDCAN1 in transmission mode  |
| FDCAN bootloader<br>(onPD1/PD0)    | FDCAN1             | Enabled      | Once initialized the FDCAN1 configuration is:<br>bit-rate 0.5 Mbps<br>FrameFormat = FDCAN_FRAME_FD_BRS<br>Mode = FDCAN_MODE_NORMAL<br>AutoRetransmission = ENABLE<br>TransmitPause = DISABLE<br>ProtocolException = ENABLE |
|                                    | FDCAN1_Rx pin      | Input        | PD0 pin: FDCAN1 in reception mode  |
|                                    | FDCAN1_Tx pin      | Output       | PD1 pin: FDCAN1 in transmission mode   |

## 43.2 Bootloader selection

*Figure 55* shows the bootloader selection mechanism.

**Figure 55. Bootloader V9.0 selection for STM32H72xxx/73xxx**



MS54027V1

### 43.3 Bootloader version

[Table 96](#) lists the STM32H72xxx/73xxx devices bootloader versions.

**Table 94. STM32H72xxx/73xxx bootloader version**

| Bootloader version number | Description                        | Known limitations  |
|---------------------------|------------------------------------|--|
| V9.1                      | Initial bootloader version         | <ul style="list-style-type: none"><li>– TCM_AXI OB cannot be modified using all BL interfaces</li><li>– String returned describing the memory size when using USB is wrong</li></ul> |
| V9.2                      | Fix all issues of previous release | None   |

## 44 STM32H74xxx/75xxx devices bootloader

### 44.1 Bootloader configuration

The STM32H74xxx/75xxx bootloader is activated by applying Pattern 10 (described in [Table 2: Bootloader activation patterns](#)). [Table 95](#) shows the hardware resources used by this bootloader.

**Table 95. STM32H74xxx/75xxx configuration in system memory boot mode**

| Bootloader                          | Feature/Peripheral | State       | Comment   |
|-------------------------------------|--------------------|-------------|---|
| Common to all bootloaders           | RCC                | HSI enabled | The system clock frequency is 64 MHz using the HSI.<br>The HSI clock source is used at startup (interface detection phase) and when USART or SPI or I2C interface is selected.                              |
|                                     |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz  |
|                                     |                    | -           | Clock used for the FDCAN is fixed to 20 MHz and is derived from PLLQ  |
|                                     | RAM                | -           | 16 Kbyte starting from address 0x20000000, and 208 Kbyte starting from address 0x24000000 are used by the bootloader firmware   |
|                                     | System memory      | -           | 122 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware   |
|                                     | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                                     | Power              | -           | Voltage range is set to Voltage Range 3.  |
| USART1 bootloader<br>(on PA9/PA10)  | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART1 bootloader<br>(on PB14/PB15) | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART1_RX pin      | Input       | PB15 pin: USART1 in reception mode  |
|                                     | USART1_TX pin      | Output      | PB14 pin: USART1 in transmission mode   |
| USART2 bootloader                   | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                     | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                                     | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |

**Table 95. STM32H74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader        | Feature/Peripheral | State        | Comment   |
|-------------------|--------------------|--------------|---|
| USART3 bootloader | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                   | USART3_RX pin      | Input        | PB11 pin: USART3 in reception mode  |
|                   | USART3_TX pin      | Output       | PB10 pin: USART3 in transmission mode   |
| I2C1 bootloader   | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001110x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                   | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.  |
| I2C2 bootloader   | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001110x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.   |
|                   | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.  |
| I2C3 bootloader   | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001110x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                   | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.  |
| SPI1 bootloader   | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                    |
|                   | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                   | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                   | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                   | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 95. STM32H74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State   | Comment  |
|-----------------|--------------------|---------|--|
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input   | PI3 pin: Slave data Input line, used in push-pull, pull-down mode.   |
|                 | SPI2_MISO pin      | Output  | PI2 pin: Slave data output line, used in push-pull, pull-down mode.  |
|                 | SPI2_SCK pin       | Input   | PI1 pin: Slave clock line, used in push-pull, pull-down mode.  |
|                 | SPI2_NSS pin       | Input   | PI0 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI3 bootloader | SPI3               | Enabled | The SPI3 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI3_MOSI pin      | Input   | PC12 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI3_MISO pin      | Output  | PC11 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI3_SCK pin       | Input   | PC10 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI3_NSS pin       | Input   | PA15 pin: slave chip select pin used in push-pull, n pull-down mode.   |
| SPI4 bootloader | SPI4               | Enabled | The SPI4 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI4_MOSI pin      | Input   | PE14 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                 | SPI4_MISO pin      | Output  | PE13 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI4_SCK pin       | Input   | PE12 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI4_NSS pin       | Input   | PE11 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 95. STM32H74xxx/75xxx configuration in system memory boot mode (continued)**

| Bootloader       | Feature/Peripheral | State        | Comment  |
|------------------|--------------------|--------------|--|
| DFU bootloader   | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.  |
|                  | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                  | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required  |
| FDCAN bootloader | FDCAN1             | Enabled      | Once initialized the FDCAN1 configuration is:<br>bit-rate 0.5 Mbps<br>FrameFormat = FDCAN_FRAME_FD_BRS<br>Mode = FDCAN_MODE_NORMAL<br>AutoRetransmission = ENABLE<br>TransmitPause = DISABLE<br>ProtocolException = ENABLE |
|                  | FDCAN1_Rx pin      | Input        | PH14 pin: FDCAN1 in reception mode   |
|                  | FDCAN1_Tx pin      | Output       | PH13 pin: FDCAN1 in transmission mode  |

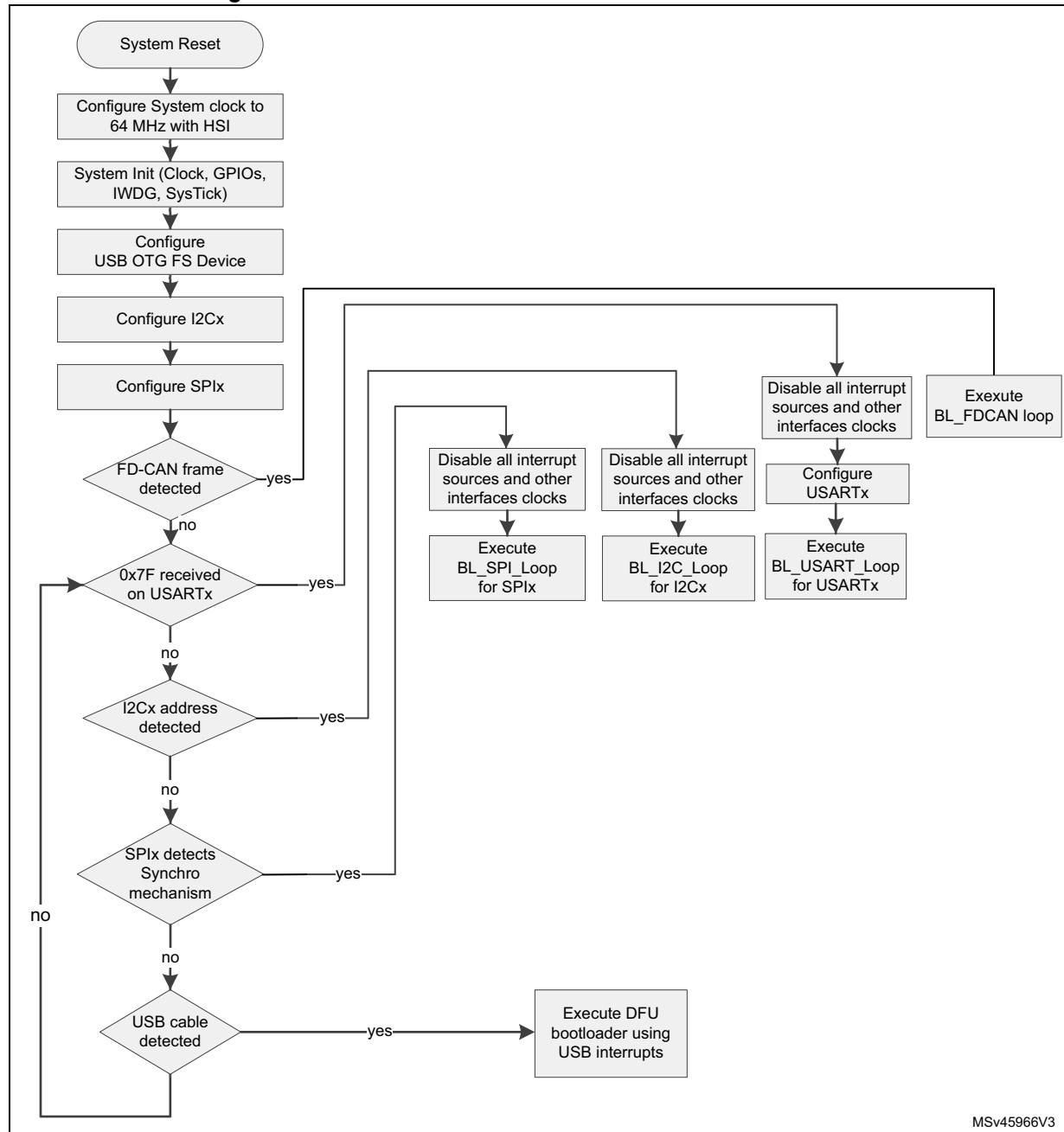
**Note:** *To connect to the bootloader USART1 using PB14/PB15 pins, user must send two synchronization bytes.*

*DFU mode does not support USBREGEN mode. If STM32 is powered by 1.8 V source, it is not possible to use the BL DFU unless 3.3 V is provided*

## 44.2 Bootloader selection

*Figure 56* shows the bootloader selection mechanism.

**Figure 56. Bootloader V9.x selection for STM32H74xxx/75xxx**



MSv45966V3

## 44.3 Bootloader version

[Table 96](#) lists the STM32H74xxx/75xxx devices bootloader versions.

**Table 96. STM32H74xxx/75xxx bootloader version**

| Bootloader version number | Description  | Known limitations   |
|---------------------------|--|---|
| V13.2<br>(0xD2)           | Initial bootloader version   | <ul style="list-style-type: none"> <li>– “Go” Command is not working</li> <li>– USART2 connection is not working</li> <li>– SPI1 connection is not working</li> <li>– Mass erase is not working well on I2C (only Bank2 is erased in this command)</li> </ul>   |
| V13.3<br>(0xD3)           | <ul style="list-style-type: none"> <li>– Switch USB clock input from HSE to HSI48 with CRS</li> <li>– Fix known limitations on the V13.2</li> </ul>  | <ul style="list-style-type: none"> <li>– Bank erase is not working on USART/SPI and I2C</li> <li>– DFU bootloader mass-erase not working</li> </ul>   |
| V9.0<br>(0x90)            | <ul style="list-style-type: none"> <li>– Add support of FDCAN interface</li> <li>– Fix V13.3 limitations</li> <li>– V9.0 is the latest version in production and replaces V13.2 and V13.3</li> </ul> | <ul style="list-style-type: none"> <li>– First ACK not received on “Go” Command when using USART or SPI</li> <li>– Limitation on the FDCAN write memory, write of data with length &gt; 63 bytes is failing</li> <li>– If PB15 is set to GND, user will not be able to connect to BL interfaces. Only the USB is able to connect as it uses interrupt for detection. PB15 must not be pulled down if USART1 on PB14/PB15 is not used</li> <li>– Jump issue on some application. Application stack pointer must be lower than (RAM end @ - 16 bytes) to guarantee it is working</li> <li>– Additional reset needed after power off/on to enable connection to the BL interfaces</li> </ul> |

## 45 STM32H7A3xx/B3xx devices bootloader

### 45.1 Bootloader configuration

The STM32H7A3xx/7B3xx bootloader is activated by applying Pattern 10 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 97. STM32H7A3xx/7B3xx configuration in system memory boot mode**

| Bootloader                       | Feature/Peripheral | State       | Comment   |
|----------------------------------|--------------------|-------------|---|
| Common to all bootloaders        | RCC                | HSI enabled | The system clock frequency is 64 MHz using the HSI.   |
|                                  |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz  |
|                                  |                    | -           | Clock used for the FDCAN is fixed to 20 MHz and is derived from PLLQ  |
|                                  | RAM                | -           | 16 Kbyte starting from address 0x24000000 are used by the bootloader firmware   |
|                                  | System memory      | -           | 40 Kbytes starting from address 0x1FFFA000, contain the bootloader firmware   |
| USART1 bootloader                | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                                  | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
| USART2 bootloader                | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
|                                  | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
| USART3 bootloader on (PB10/PB11) | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
|                                  | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART3_RX pin      | Input       | PB11 pin: USART3 in reception mode  |
| USART3 bootloader on (PD8/PD9)   | USART3_TX pin      | Output      | PB10 pin: USART3 in transmission mode   |
|                                  | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                  | USART3_RX pin      | Input       | PD9 pin: USART3 in reception mode   |
|                                  | USART3_TX pin      | Output      | PD8 pin: USART3 in transmission mode  |

**Table 97. STM32H7A3xx/7B3xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C1 bootloader | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010111x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                 | I2C1_SDA pin       | Input/Output | PB9 pin: data line is used in open-drain mode.  |
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010111x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PF1 pin: clock line is used in open-drain mode.   |
|                 | I2C2_SDA pin       | Input/Output | PF0 pin: data line is used in open-drain mode.  |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010111x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PA8 pin: clock line is used in open-drain mode.   |
|                 | I2C3_SDA pin       | Input/Output | PC9 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                    |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, no pull-up no pull-down mode.  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, no pull-up no pull-down mode.   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull no pull-up, no pull-up no pull-down mode.  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |

**Table 97. STM32H7A3xx/7B3xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode.  |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.   |
| SPI3 bootloader | SPI3               | Enabled      | The SPI3 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI3_MOSI pin      | Input        | PC12 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI3_MISO pin      | Output       | PC11 pin: Slave data output line, used in push-pull, pull-down mode.   |
|                 | SPI3_SCK pin       | Input        | PC10 pin: Slave clock line, used in push-pull, pull-down mode.   |
|                 | SPI3_NSS pin       | Input        | PA15 pin: slave chip select pin used in push-pull, pull-down mode.   |
| DFU bootloader  | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.                                |
|                 | USB_DM pin         | Input/Output | PA11: USB DM line.   |
|                 | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required  |

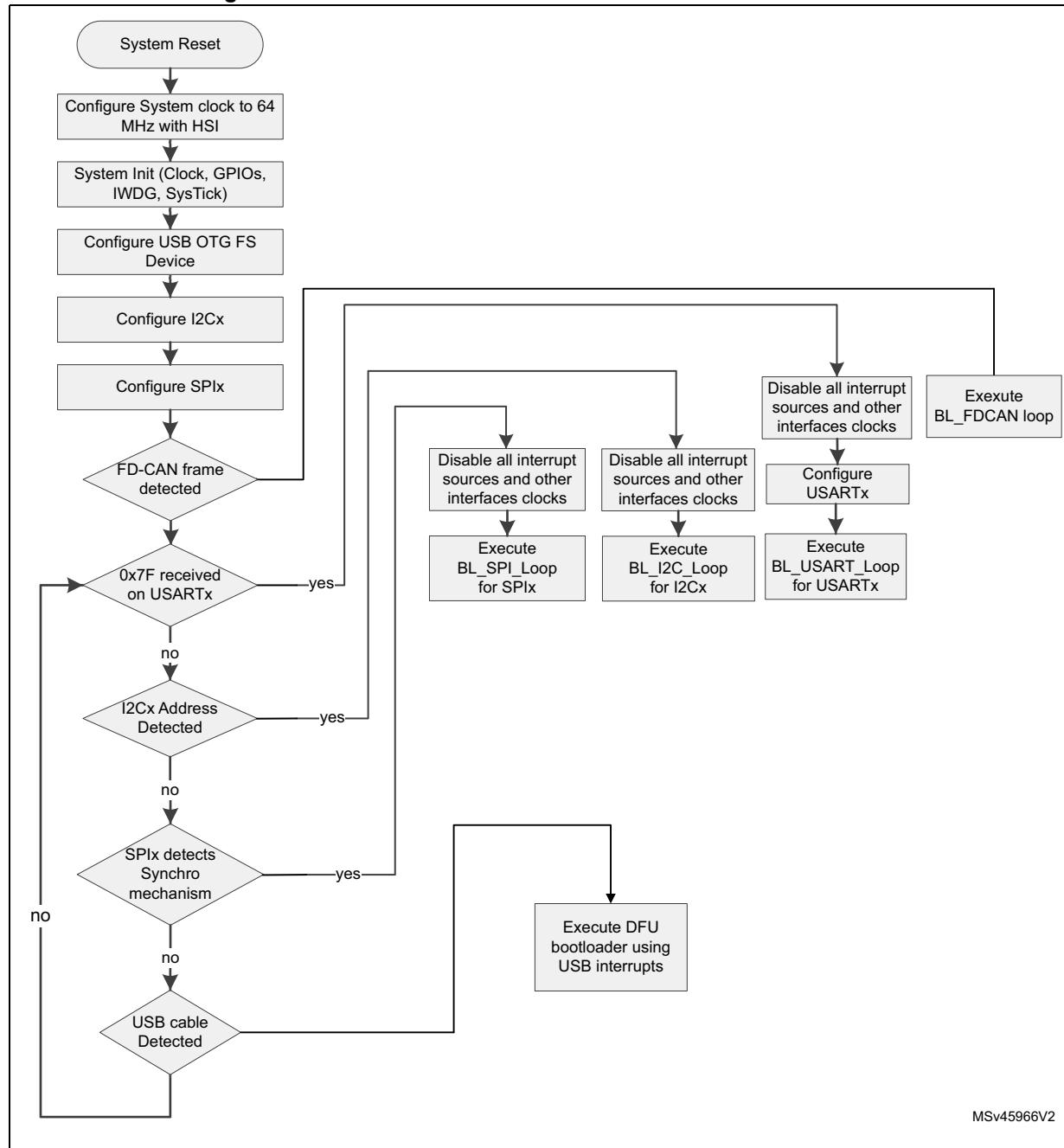
**Table 97. STM32H7A3xx/7B3xx configuration in system memory boot mode (continued)**

| Bootloader                         | Feature/Peripheral | State   | Comment  |
|------------------------------------|--------------------|---------|--|
| FDCAN bootloader<br>on (PH13/PH14) | FDCAN1             | Enabled | Once initialized the FDCAN1 configuration is:<br>bit-rate 0.5 Mbps<br>FrameFormat = FDCAN_FRAME_FD_BRS<br>Mode = FDCAN_MODE_NORMAL<br>AutoRetransmission = ENABLE<br>TransmitPause = DISABLE<br>ProtocolException = ENABLE |
|                                    | FDCAN1_Rx pin      | Input   | PH14 pin: FDCAN1 in reception mode   |
|                                    | FDCAN1_Tx pin      | Output  | PH13 pin: FDCAN1 in transmission mode  |
| FDCAN bootloader<br>on (PD1/PD0)   | FDCAN1             | Enabled | Once initialized the FDCAN1 configuration is:<br>bit-rate 0.5 Mbps<br>FrameFormat = FDCAN_FRAME_FD_BRS<br>Mode = FDCAN_MODE_NORMAL<br>AutoRetransmission = ENABLE<br>TransmitPause = DISABLE<br>ProtocolException = ENABLE |
|                                    | FDCAN1_Rx pin      | Input   | PD0 pin: FDCAN1 in reception mode  |
|                                    | FDCAN1_Tx pin      | Output  | PD1 pin: FDCAN1 in transmission mode   |

## 45.2 Bootloader selection

*Figure 56* shows the bootloader selection mechanism.

**Figure 57. Bootloader V9.x selection for STM32H7A3xx/7B3xx**



### 45.3 Bootloader version

*Table 96* lists the STM32H7A3xx/7B3xx devices bootloader versions.

**Table 98. STM32H7A3xx/7B3xx bootloader version**

| Bootloader version number | Description                           | Known limitations  |
|---------------------------|---------------------------------------|--|
| V9.0                      | Initial bootloader version            | <ul style="list-style-type: none"><li>– String returned describing the Flash memory size when using USB is wrong (expected value 256 x 8 KB, but returns 256 x 2 KB)</li><li>– OTP memory is not supported by the bootloader</li></ul> |
| V9.1                      | Fixes all issues of previous release. | None   |

## 46 STM32L01xxx/02xxx devices bootloader

### 46.1 Bootloader configuration

The STM32L01xxx/02xxx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). [Table 99](#) shows the hardware resources used by this bootloader.

**Table 99. STM32L01xxx/02xxx configuration in system memory boot mode**

| Bootloader  | Feature/Peripheral | State       | Comment   |
|---|--------------------|-------------|---|
| Common to all bootloaders                                   | RCC                | HSI enabled | The system clock frequency is 32 MHz with HSI 16 MHz as clock source.   |
|   | RAM                | -           | 2 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|   | System memory      | -           | 4 Kbyte starting from address 0x1FF00000, contain the bootloader firmware   |
|   | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader<br>(on PA9/PA10)                          | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|   | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|   | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader<br>(on PA2/PA3)                           | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|   | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|   | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USART2 bootloader   | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| SPI1 bootloader<br>(for all device packages except TSSOP14) | SPI1               | Enabled     | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|   | SPI1_MOSI pin      | Input       | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|   | SPI1_MISO pin      | Output      | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|   | SPI1_SCK pin       | Input       | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|   | SPI1_NSS pin       | Input       | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.   |

**Table 99. STM32L01xxx/02xxx configuration in system memory boot mode (continued)**

| Bootloader   | Feature/Peripheral | State   | Comment   |
|--|--------------------|---------|---|
| SPI1 bootloader<br>(only for devices on TSSOP14 package) | SPI1               | Enabled | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|  | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|  | SPI1_MISO pin      | Output  | PA14 pin: Slave data output line, used in push-pull, pull-down mode.<br><b>Note:</b> This IO is also used as SWCLK for debug interface, as a consequence debugger cannot connect to the device in "on-the-fly" mode when the bootloader is running. |
|  | SPI1_SCK pin       | Input   | PA13 pin: Slave clock line, used in push-pull, pull-down mode   |
|  | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> NSS pin synchronization is required on bootloader with SPI1 interface for devices on TSSOP14 package.   |

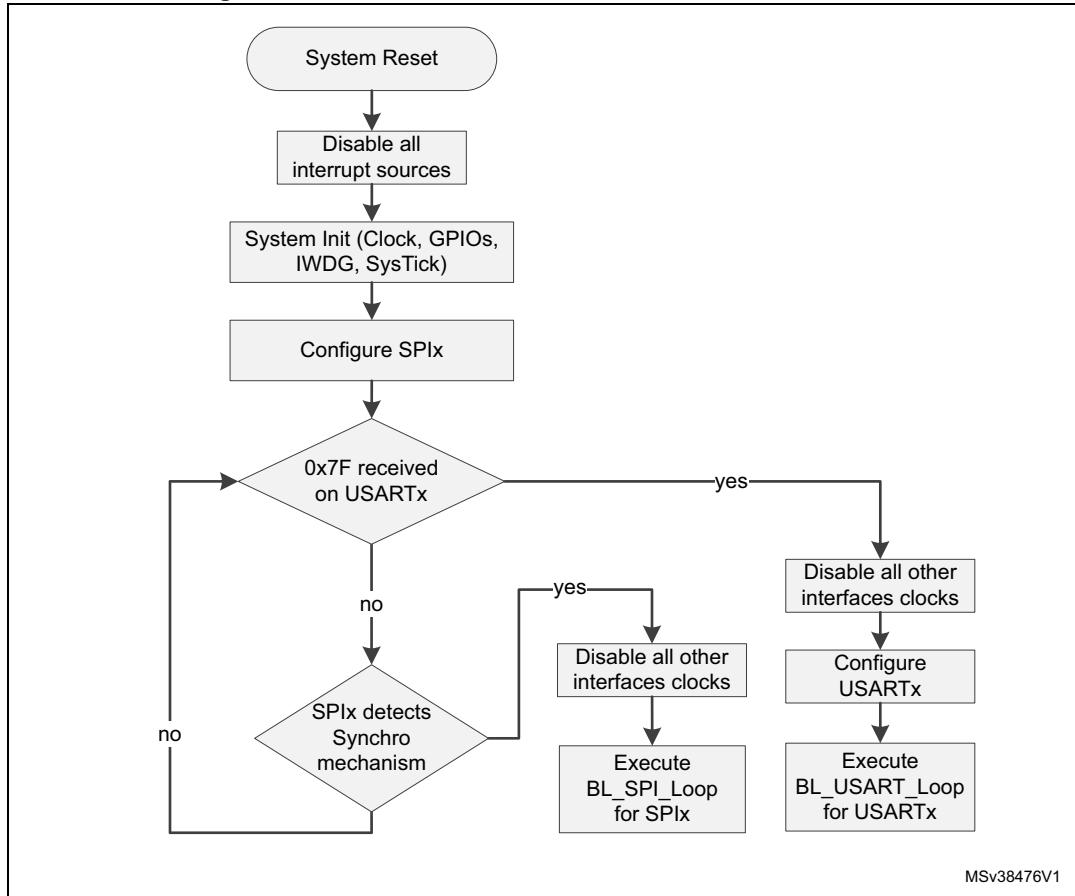
The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

**Note:** *Due to empty check mechanism present on this product, it is not possible to jump from user code to system bootloader. Such jump results in a jump back to user Flash memory space. But if the first 4 bytes of user flash memory (at 0x0800 0000) are empty at the moment of the jump (i.e. erase first sector before jump or execute code from SRAM while Flash is empty), then system bootloader is executed when jumped to.*

## 46.2 Bootloader selection

The [Table 58](#) shows the bootloader selection mechanism.

**Figure 58. Bootloader selection for STM32L01xxx/02xxx**



## 46.3 Bootloader version

The following table lists the STM32L01xxx/02xxx devices bootloader versions.

Table 100. STM32L01xxx/02xxx bootloader versions

| Bootloader version number | Description  | Known limitations   |
|---------------------------|--|---|
| V12.2                     | Initial bootloader version   | Bootloader not functional with SPI1 interface for devices on TSSOP14 package.   |
| V12.3                     | This bootloader is an updated version of bootloader V12.2. This new version add support of SPI interface for devices on TSSOP14 package. | For the SPI1 interface for devices in TSSOP14, a falling edge on NSS pin is required before staring communication, to properly synchronize the SPI interface. If the NSS pin is grounded (all time from device reset) the SPI communication is not synchronized and bootloader does not work properly with the SPI interface. |

## 47 STM32L031xx/041xx devices bootloader

### 47.1 Bootloader configuration

The STM32L031xx/041xx bootloader is activated by applying Pattern 2 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 101. STM32L031xx/041xx configuration in system memory boot mode**

| Bootloader                         | Feature/Peripheral | State       | Comment   |
|------------------------------------|--------------------|-------------|---|
| Common to all bootloaders          | RCC                | HSI enabled | The system clock frequency is 32 MHz with HSI 16 MHz as clock source.   |
|                                    | RAM                | -           | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                                    | System memory      | -           | 4 Kbyte starting from address 0x1FF00000, contain the bootloader firmware   |
|                                    | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART2 bootloader<br>(on PA9/PA10) | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                    | USART2_RX pin      | Input       | PA10 pin: USART2 in reception mode  |
|                                    | USART2_TX pin      | Output      | PA9 pin: USART2 in transmission mode  |
| USART2 bootloader<br>(on PA2/PA3)  | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                                    | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                                    | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USART2 bootloader                  | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| SPI1 bootloader                    | SPI1               | Enabled     | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                                    | SPI1_MOSI pin      | Input       | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                                    | SPI1_MISO pin      | Output      | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                                    | SPI1_SCK pin       | Input       | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                                    | SPI1_NSS pin       | Input       | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.   |

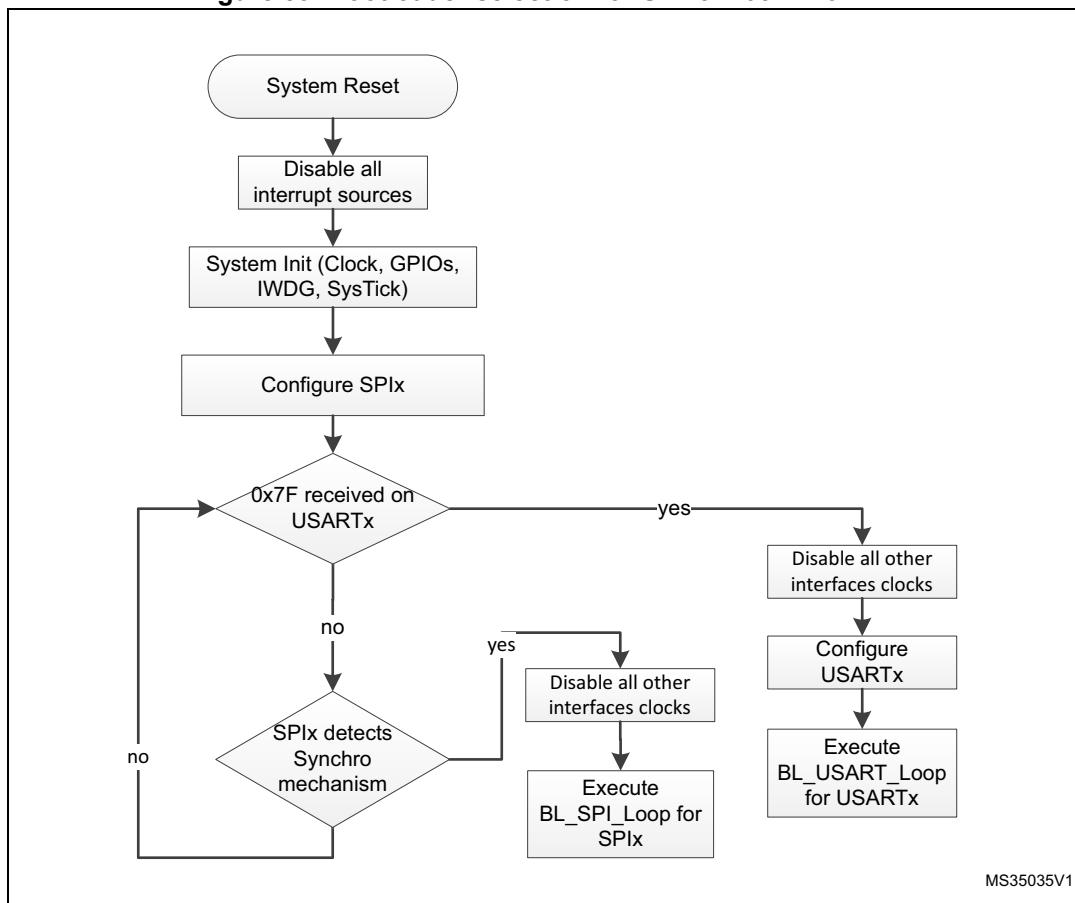
The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

The bootloader Read/Write commands do not support SRAM space for this product.

## 47.2 Bootloader selection

*Figure 59* shows the bootloader selection mechanism.

**Figure 59. Bootloader selection for STM32L031xx/041xx**



## 47.3 Bootloader version

*Table 102* lists the STM32L031xx/041xx devices bootloader versions.

**Table 102. STM32L031xx/041xx bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V12.0                     | Initial bootloader version | None              |

## 48 STM32L05xxx/06xxx devices bootloader

### 48.1 Bootloader configuration

The STM32L05xxx/06xxx bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 103. STM32L05xxx/06xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 32 MHz with HSI 16 MHz as clock source.   |
|                           | Power              | -           | Voltage range is set to Voltage Range 1.  |
|                           | RAM                | -           | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 4 Kbyte starting from address 0x1FF00000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |

**Table 103. STM32L05xxx/06xxx configuration in system memory boot mode (continued)**

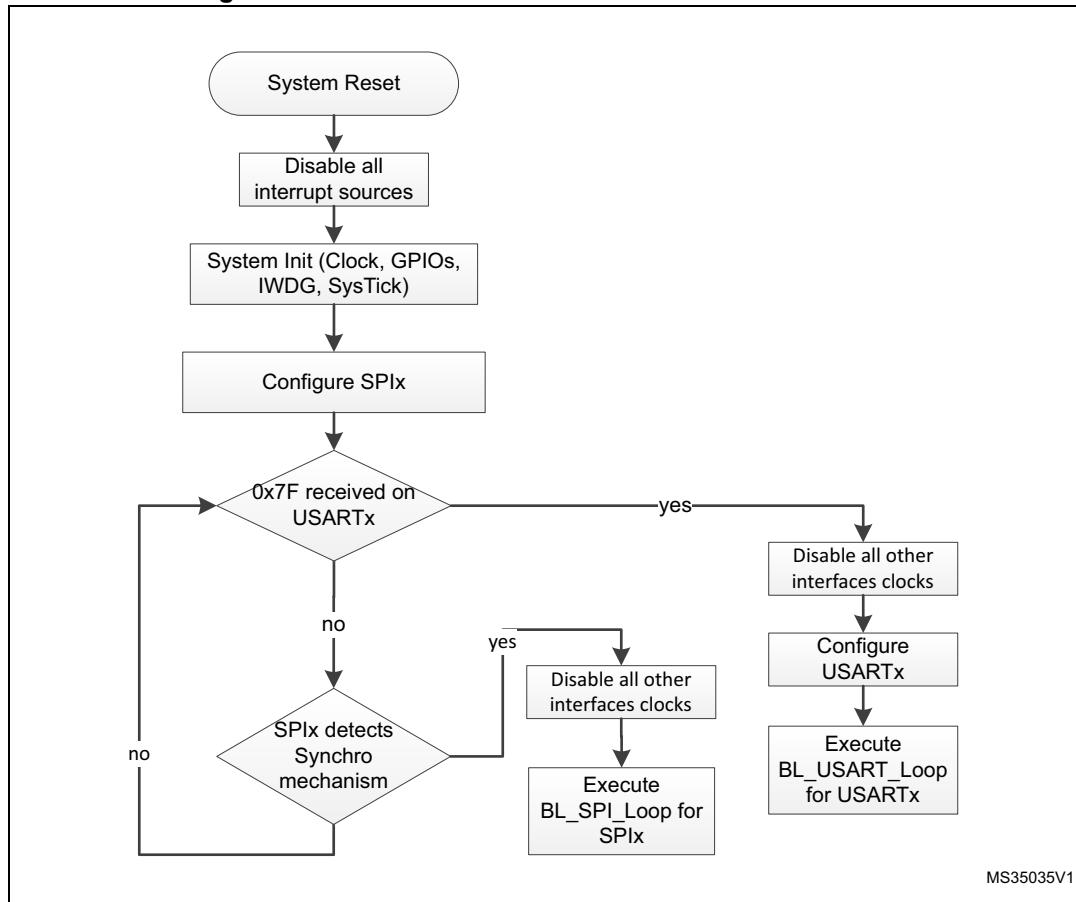
| Bootloader      | Feature/Peripheral | State   | Comment  |
|-----------------|--------------------|---------|--|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.  |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.   |

The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

## 48.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 60. Bootloader selection for STM32L05xxx/06xxx**



## 48.3 Bootloader version

The following table lists the STM32L05xxx/06xxx devices bootloader versions:

**Table 104. STM32L05xxx/06xxx bootloader versions**

| Bootloader version number | Description                | Known limitations |
|---------------------------|----------------------------|-------------------|
| V12.0                     | Initial bootloader version | None              |

## 49 STM32L07xxx/08xxx devices bootloader

Two bootloader versions are available on STM32L07xxx/08xxx devices:

- V4.x supporting USART1, USART2 and DFU (USB FS Device).  
This version is embedded in STM32L072xx/73xx and STM32L082xx/83xx devices.
- V11.x supporting USART1, USART2, I2C1, I2C2, SPI1 and SPI2.  
This version is embedded in other STM32L071xx/081xx devices.

### 49.1 Bootloader V4.x

#### 49.1.1 Bootloader configuration

The STM32L07xxx/08xxx bootloader is activated by applying Pattern 2 or Pattern 7 when dual bank boot feature is available (described in [Table 2: Bootloader activation patterns](#)). [Table 105](#) shows the hardware resources used by this bootloader.

**Table 105. STM32L07xxx/08xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 32 MHz with HSI 16 MHz as clock source.   |
|                           | RAM                | -           | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FF00000, contain the bootloader firmware.  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART2 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART2 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |

**Table 105. STM32L07xxx/08xxx configuration in system memory boot mode (continued)**

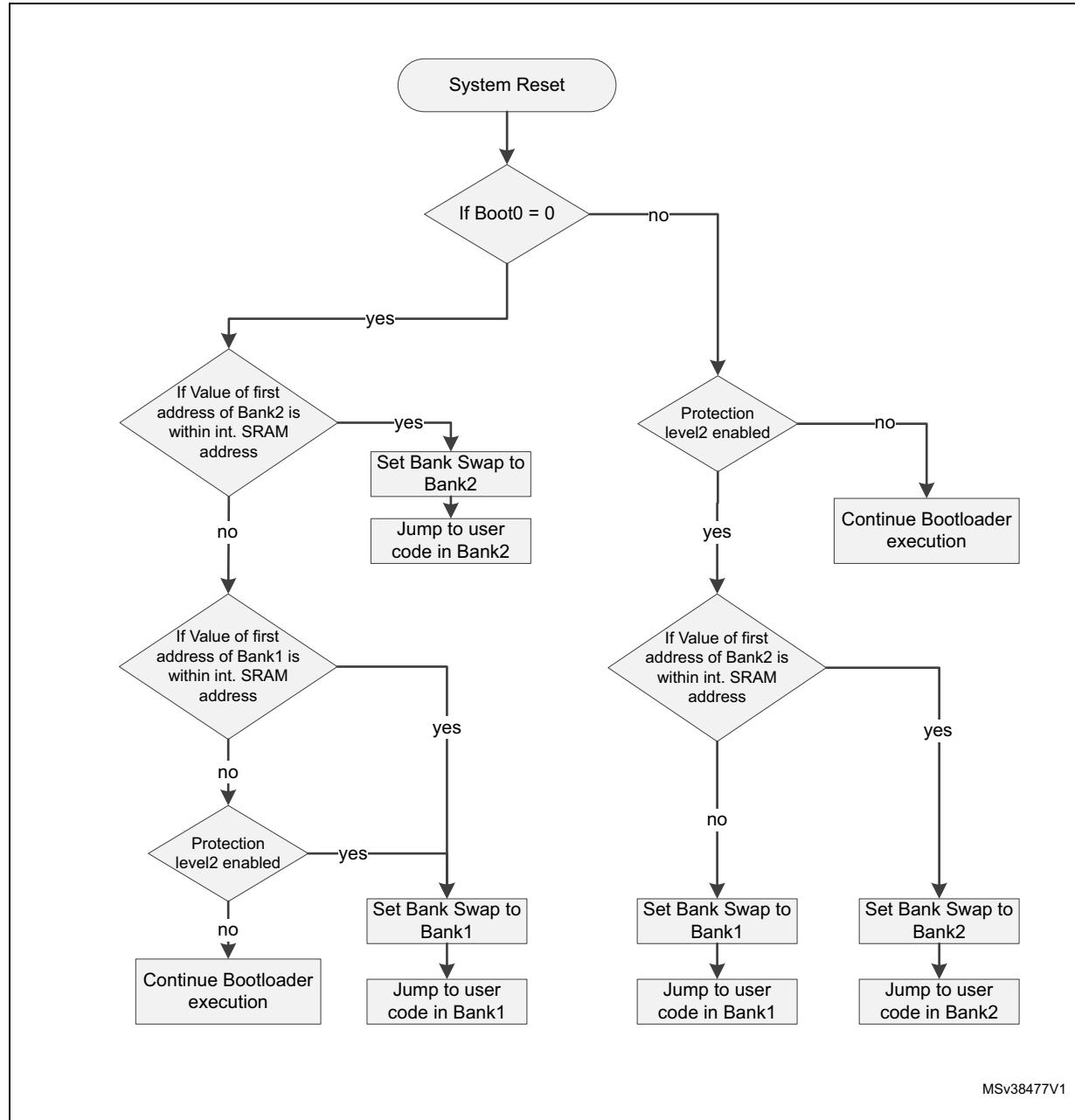
| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications. |
|                | USB_DM pin         | Input/Output | PA11 pin: USB FS DM line  |
|                | USB_DP pin         |              | PA12 pin: USB FS DP line.<br>No external pull-up resistor is required.  |

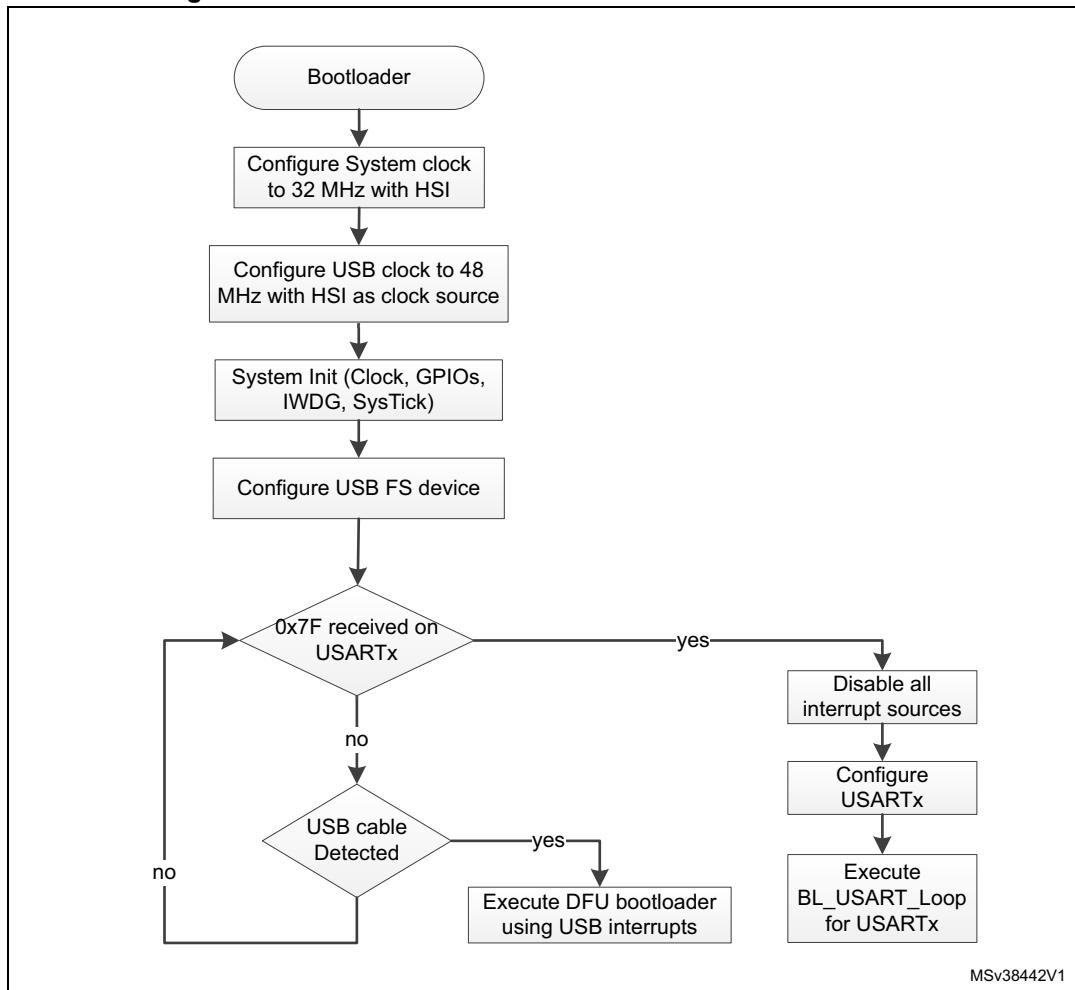
The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

### 49.1.2 Bootloader selection

*Figure 61* and *Figure 62* show the bootloader selection mechanism.

**Figure 61. Dual bank boot implementation for STM32L07xxx/08xxx bootloader V4.x**



**Figure 62. Bootloader V4.x selection for STM32L07xxx/08xxx**

#### 49.1.3 Bootloader version

*Table 106* lists the STM32L07xxx/08xxx devices bootloader versions.

**Table 106. STM32L07xxx/08xxx bootloader versions**

| Bootloader version number | Description   | Known limitations   |
|---------------------------|---|---|
| V4.0                      | Initial bootloader version  | PA4, PA5, PA6 and PA7 IOs are configured in pull down mode despite not used by bootloader |
| V4.1                      | This bootloader is an updated version of bootloader V4.0. This new version implements the Dual Bank Boot feature. | PA4, PA5, PA6 and PA7 IOs are configured in pull down mode despite not used by bootloader |

## 49.2 Bootloader V11.x

### 49.2.1 Bootloader configuration

The STM32L07xxx/08xxx bootloader is activated by applying Pattern 2 or Pattern 7 when dual bank boot feature is available (see in [Table 2: Bootloader activation patterns](#)).

[Table 107](#) shows the hardware resources used by this bootloader.

**Table 107. STM32L07xxx/08xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | HSI enabled  | The system clock frequency is 32 MHz with HSI 16 MHz as clock source.   |
|                           | RAM                | -            | 5 Kbyte starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 8 Kbyte starting from address 0x1FF00000, contain the bootloader firmware   |
|                           | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART2 in reception mode  |
|                           | USART1_TX pin      | Output       | PA9 pin: USART2 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USARTTx bootloaders       | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000010x<br>(where x = 0 for write and x = 1 for read)                       |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: I2C1 clock line is used in open-drain mode.  |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: I2C1 data line is used in open-drain mode.   |

Table 107. STM32L07xxx/08xxx configuration in system memory boot mode (continued)

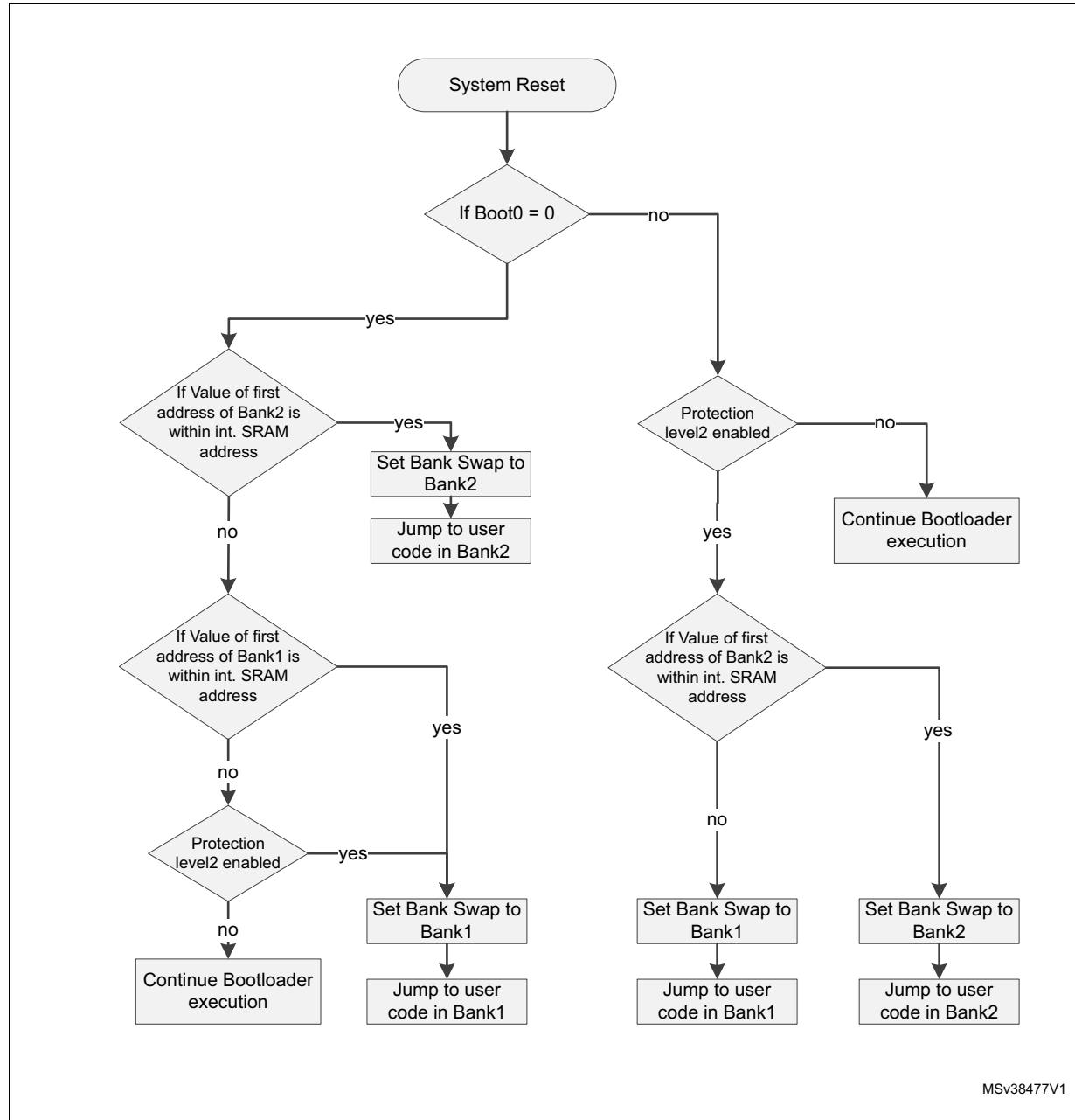
| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000010x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PB10 pin: I2C2 clock line is used in open-drain mode.   |
|                 | I2C2_SDA pin       | Input/Output | PB11 pin: I2C2 data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.                                       |
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.                                      |

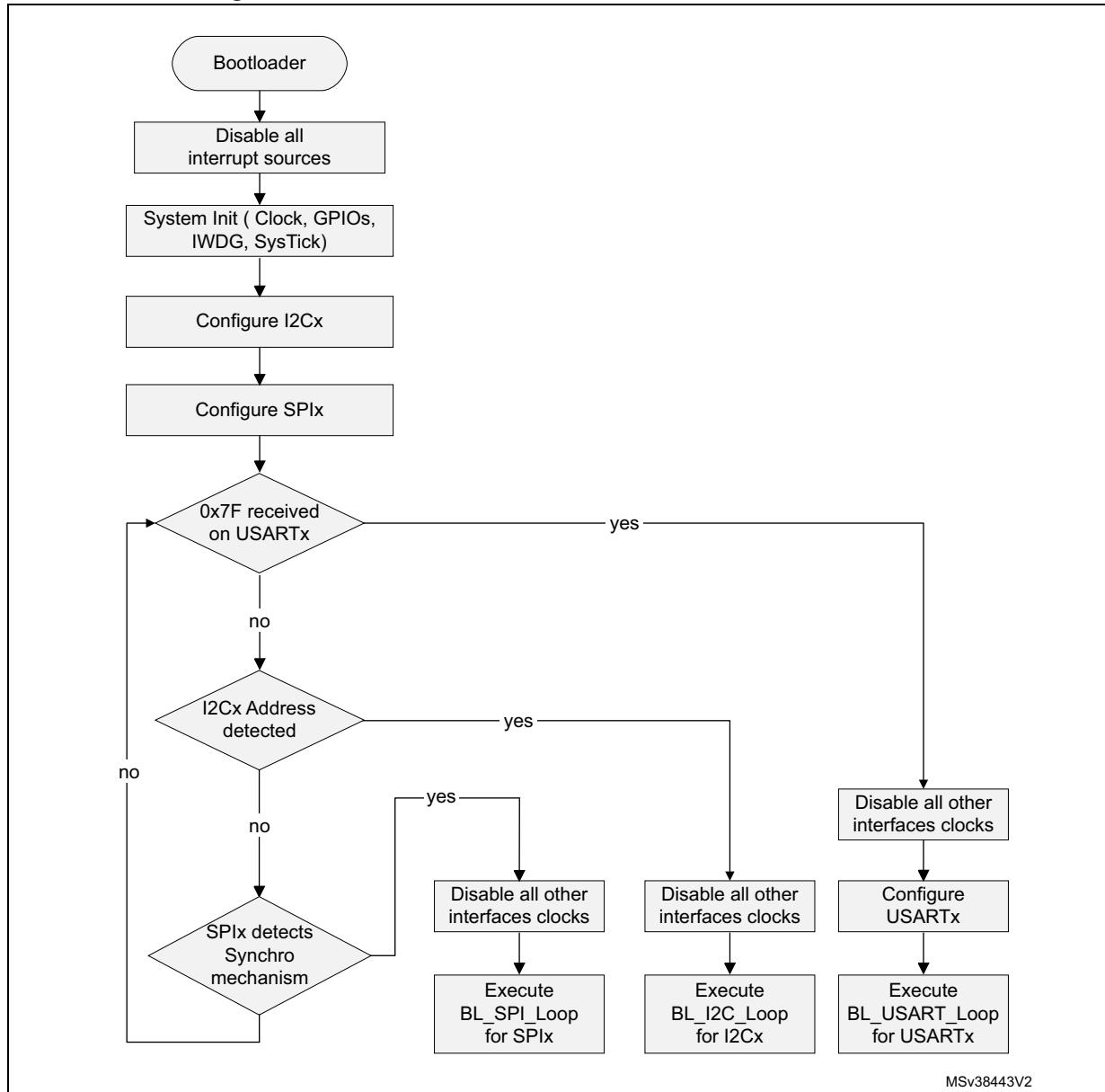
The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.

### 49.2.2 Bootloader selection

*Figure 63* and *Figure 64* show the bootloader selection mechanism.

**Figure 63. Dual bank boot implementation for STM32L07xxx/08xxx bootloader V11.x**



**Figure 64. Bootloader V11.x selection for STM32L07xxx/08xxx**

### 49.2.3 Bootloader version

The following table lists the STM32L07xxx/08xxx devices bootloader versions:

**Table 108. STM32L07xxx/08xxx bootloader V11.x versions**

| Bootloader version number | Description   | Known limitations |
|---------------------------|---|-------------------|
| V11.1                     | Initial bootloader version  | None              |
| V11.2                     | This bootloader is an updated version of bootloader V11.1.<br>This new version implements the Dual Bank Boot feature. | None              |

## 50 STM32L1xxx6(8/B)A devices bootloader

### 50.1 Bootloader configuration

The STM32L1xxx6(8/B)A bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 109. STM32L1xxx6(8/B)A configuration in system memory boot mode**

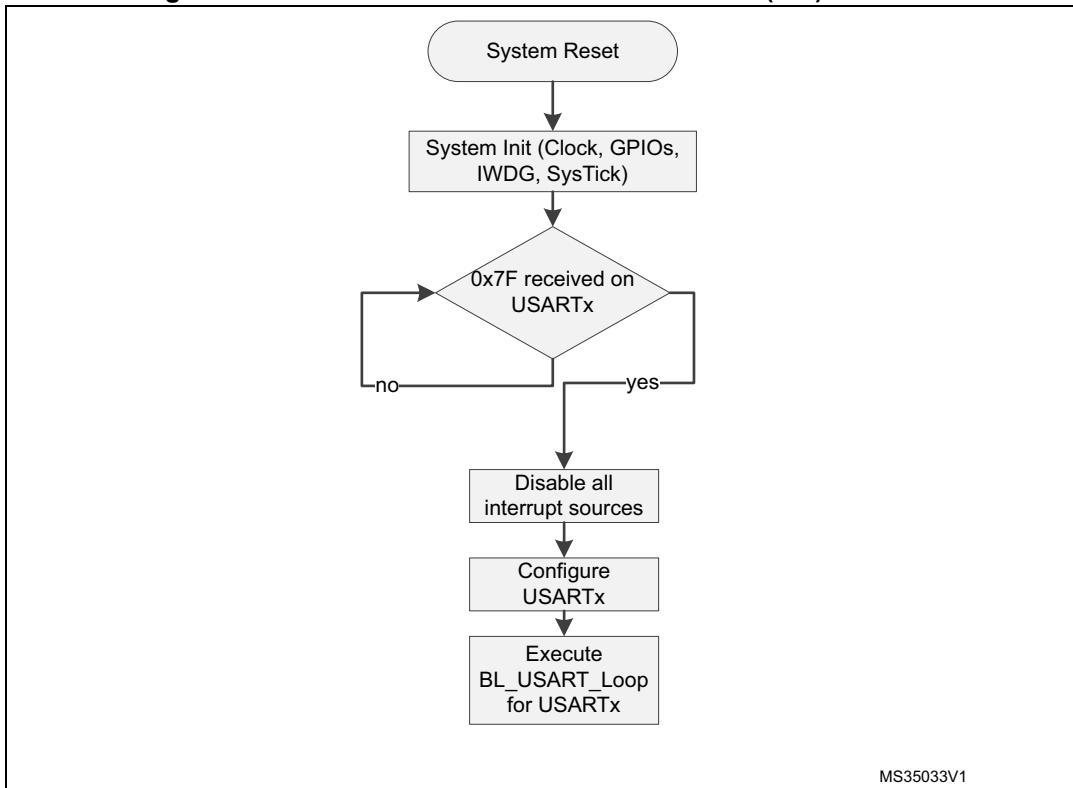
| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 16 MHz.   |
|                           | RAM                | -           | 2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -           | 4 Kbyte starting from address 0x1FF00000 contain the bootloader firmware.   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | Power              | -           | Voltage range is set to Voltage Range 1.  |
| USART1 bootloader         | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 50.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 65. Bootloader selection for STM32L1xxx6(8/B)A devices**



## 50.3 Bootloader version

The following table lists the STM32L1xxx6(8/B)A devices bootloader versions:

**Table 110. STM32L1xxx6(8/B)A bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V2.0                      | Initial bootloader version | When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (i.e. address 0x6000 0000), the command is aborted by the bootloader device, but the NACK (0x1F) is not sent to the host. As a result, the next 2 bytes (which are the number of bytes to be read/written and its checksum) are considered as a new command and its checksum. <sup>(1)</sup> |

1. If the “number of data - 1” (N-1) to be read/written is not equal to a valid command code, then the limitation is not perceived from the host since the command is NACKed anyway (as an unsupported new command).

## 51 STM32L1xxx6(8/B) devices bootloader

### 51.1 Bootloader configuration

The STM32L1xxx6(8/B) bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 111. STM32L1xxx6(8/B) configuration in system memory boot mode**

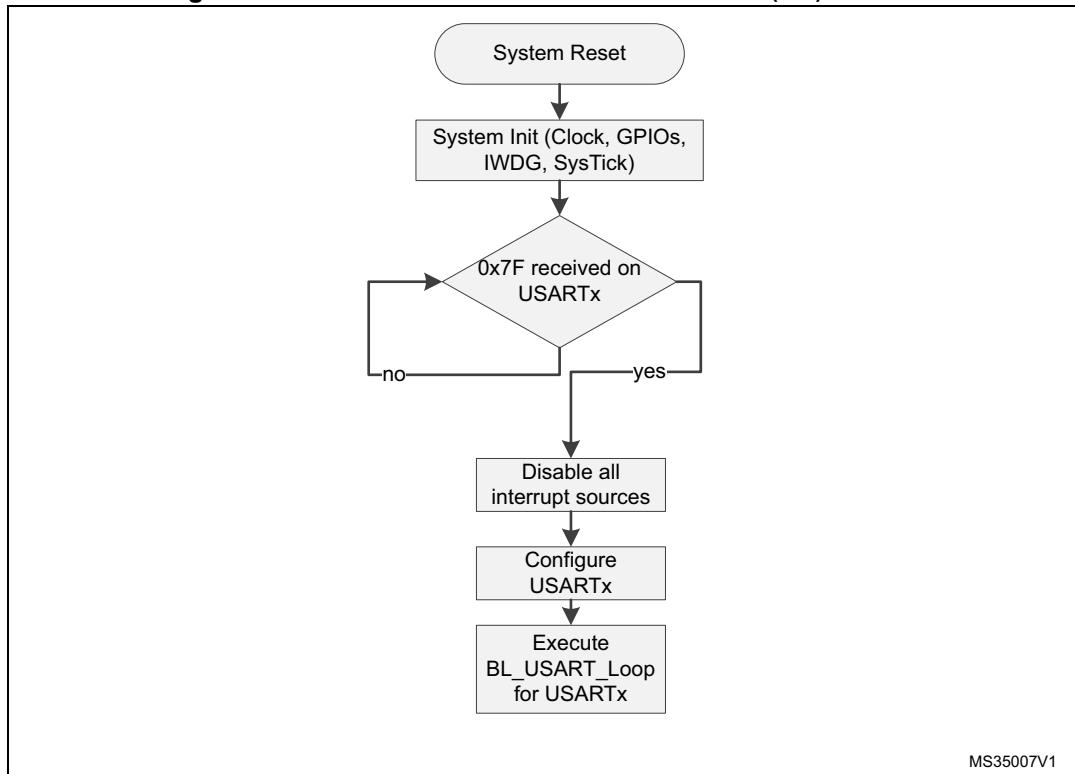
| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 16 MHz.   |
|                           | RAM                | -           | 2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.   |
|                           | System memory      | -           | 4 Kbyte starting from address 0x1FF00000 contain the bootloader firmware.   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | Power              | -           | Voltage range is set to Voltage Range 1.  |
| USART1 bootloader         | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit.  |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode  |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host.  |

The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.

## 51.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 66. Bootloader selection for STM32L1xxx6(8/B) devices**



## 51.3 Bootloader version

The following table lists the STM32L1xxx6(8/B) devices bootloader versions:

**Table 112. STM32L1xxx6(8/B) bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V2.0                      | Initial bootloader version | When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (i.e. address 0x6000 0000), the command is aborted by the bootloader device, but the NACK (0x1F) is not sent to the host. As a result, the next 2 bytes (which are the number of bytes to be read/written and its checksum) are considered as a new command and its checksum. <sup>(1)</sup> |

1. If the “number of data - 1” (N-1) to be read/written is not equal to a valid command code, then the limitation is not perceived from the host since the command is NACKed anyway (as an unsupported new command).

## 52 STM32L1xxxC devices bootloader

### 52.1 Bootloader configuration

The STM32L1xxxC bootloader is activated by applying Pattern 1 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 113. STM32L1xxxC configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 16 MHz using the HSI. This is used only for USARTx bootloaders and during USB detection for DFU bootloader (once the DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The external clock is mandatory only for the DFU bootloader and must be in the following range:<br>[24, 16, 12, 8, 6, 4, 3, 2] MHz.<br>The PLL is used to generate the USB 48 MHz clock and the 32 MHz clock for the system clock.     |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates a system reset.  |
|                           | RAM                | -           | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware.  |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FF00000 contains the bootloader firmware.   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog resets (in case the hardware IWDG option was previously enabled by the user).                           |
| USART1 bootloader         | Power              | -           | Voltage range is set to Voltage Range 1.   |
|                           | USART1             | Enabled     | Once initialized, the USART1 configuration is 8 bits, even parity and 1 stop bit.  |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode   |
| USART2 bootloader         | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode   |
|                           | USART2             | Enabled     | Once initialized, the USART2 configuration is 8 bits, even parity and 1 stop bit. The USART2 uses its remapped pins.   |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode  |
|                           | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode   |

**Table 113. STM32L1xxxC configuration in system memory boot mode (continued)**

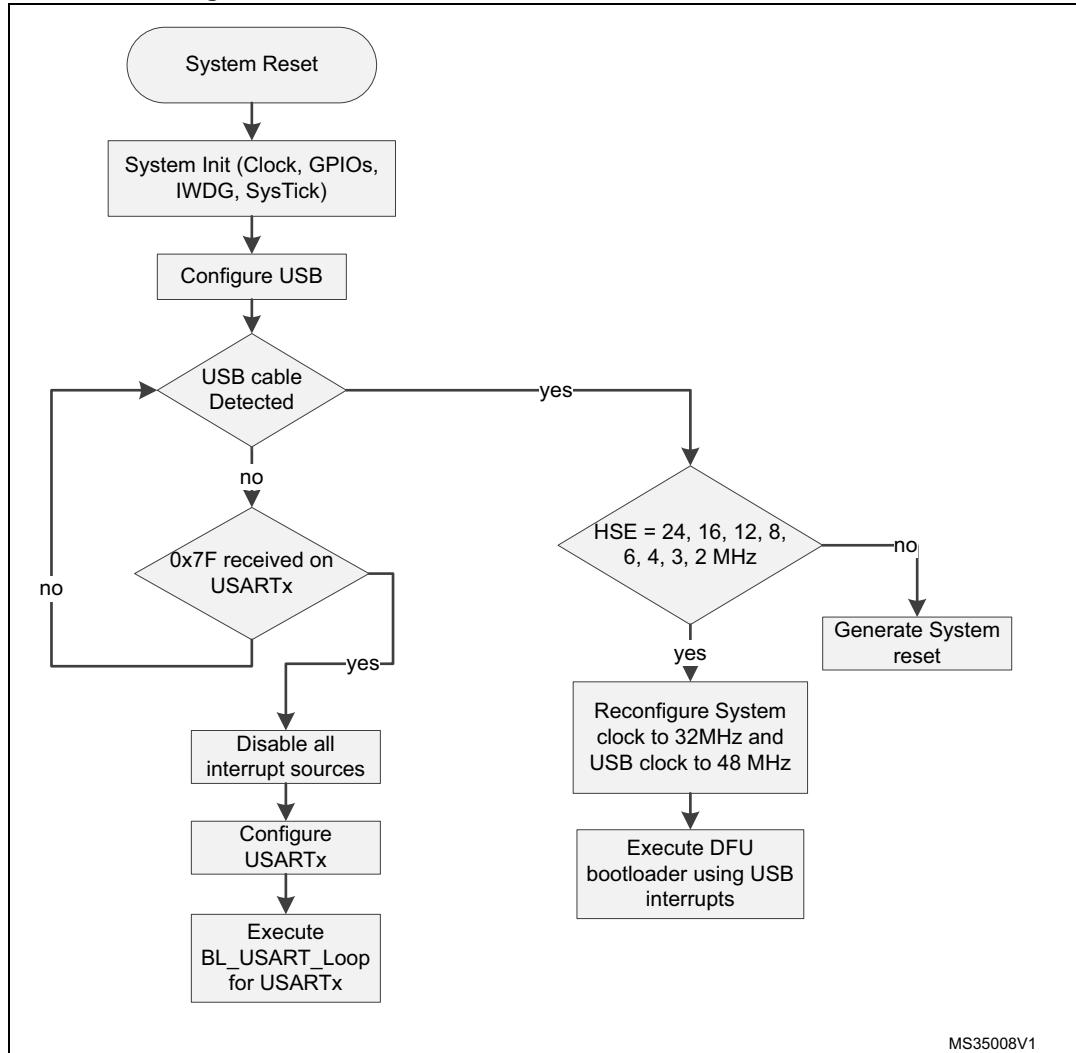
| Bootloader          | Feature/Peripheral | State        | Comment   |
|---------------------|--------------------|--------------|---|
| USARTTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for the USARTTx bootloader. |
| DFU bootloader      | USB                | Enabled      | USB used in FS mode   |
|                     | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                     | USB_DP pin         |              | PA12: USB DP line   |

The system clock is derived from the embedded internal high-speed RC for the USARTTx bootloader. This internal clock is also used for DFU bootloader but only for the selection phase. An external clock in the range of [24, 16, 12, 8, 6, 4, 3, 2] MHz is required for the execution of the DFU bootloader after the selection phase.

## 52.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 67. Bootloader selection for STM32L1xxxC devices**



## 52.3 Bootloader version

The following table lists the STM32L1xxxC devices bootloader versions.

**Table 114. STM32L1xxxC bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V4.0                      | Initial bootloader version | For the USART interface, two consecutive NACKs instead of 1 NACK are sent when a Read Memory or Write Memory command is sent and the RDP level is active. |

## 53 STM32L1xxxD devices bootloader

### 53.1 Bootloader configuration

The STM32L1xxxD bootloader is activated by applying pattern4 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 115. STM32L1xxxD configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 16 MHz using the HSI. This is used only for USARTx bootloaders and during USB detection for DFU bootloader (once the DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The external clock is mandatory only for DFU bootloader and it must be in the following range: [24, 16, 12, 8, 6, 4, 3, 2] MHz.<br>The PLL is used to generate the USB 48 MHz clock and the 32 MHz clock for the system clock.         |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware.  |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FF00000 contains the bootloader firmware.   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                            |
| USART1 bootloader         | Power              | -           | Voltage range is set to Voltage Range 1.   |
|                           | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode   |
| USART2 bootloader         | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode   |
|                           | USART2             | Enabled     | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.  |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode  |
|                           | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode   |

**Table 115. STM32L1xxxD configuration in system memory boot mode (continued)**

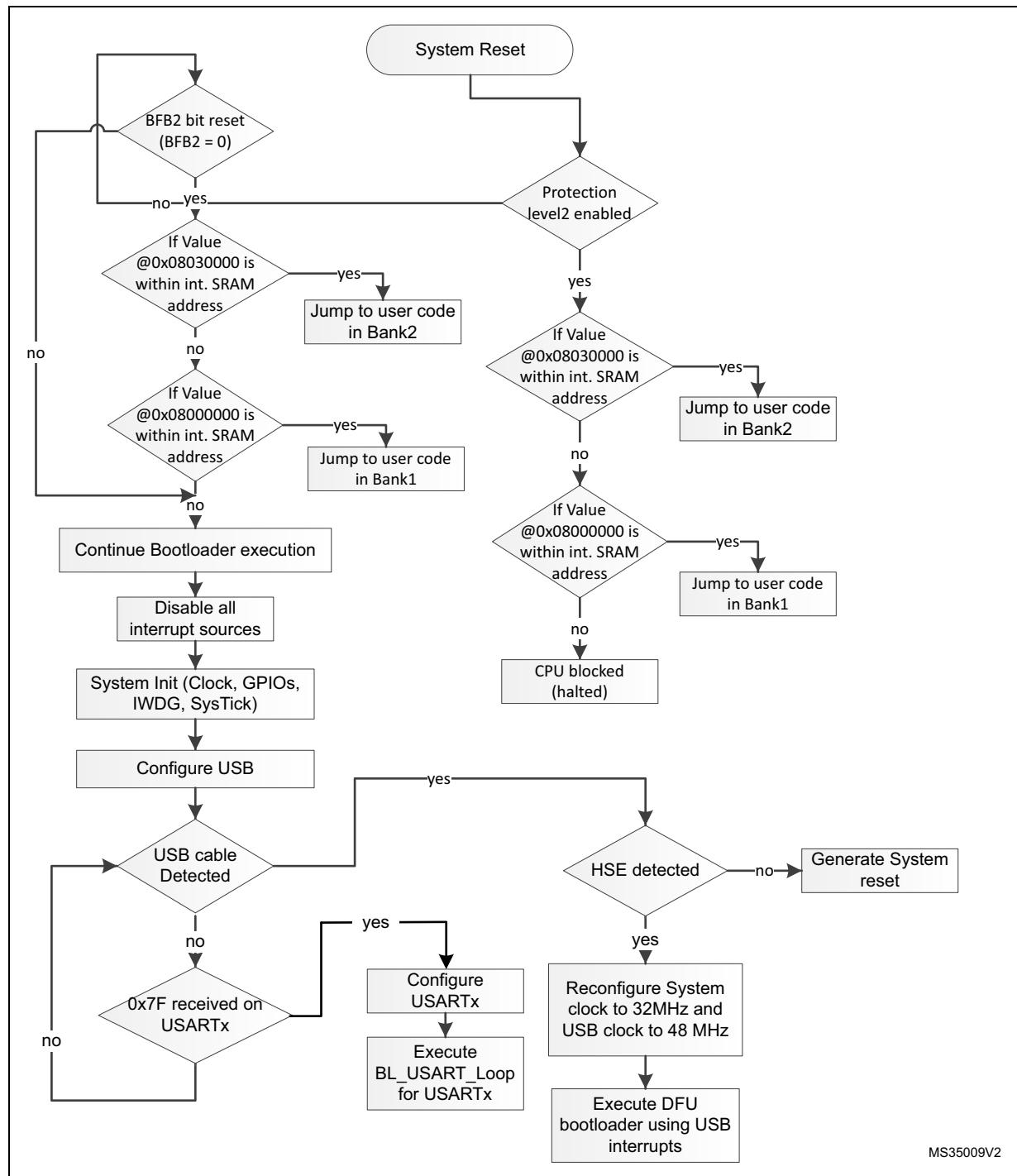
| Bootloader          | Feature/Peripheral | State        | Comment   |
|---------------------|--------------------|--------------|---|
| USARTTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTTx bootloader. |
| DFU bootloader      | USB                | Enabled      | USB used in FS mode   |
|                     | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                     | USB_DP pin         |              | PA12: USB DP line.  |

The system clock is derived from the embedded internal high-speed RC for USARTTx bootloader. This internal clock is used also for DFU bootloader but only for the selection phase. An external clock in the range of [24, 16, 12, 8, 6, 4, 3, 2] MHz is required for DFU bootloader execution after the selection phase.

## 53.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 68. Bootloader selection for STM32L1xxxD devices**



### 53.3 Bootloader version

The following table lists the STM32L1xxxD devices bootloader versions:

**Table 116. STM32L1xxxD bootloader versions**

| Bootloader version number | Description   | Known limitations  |
|---------------------------|---|--|
| V4.1                      | Initial bootloader version  | <ul style="list-style-type: none"> <li>– In the bootloader code the PA13 (JTMS/SWDIO) I/O output speed is configured to 400 kHz, as a consequence some debugger cannot connect to the device in Serial Wire mode when the bootloader is running.</li> <li>– When the DFU bootloader is selected, the RTC is reset and thus all RTC information (such as calendar, alarm) are lost including backup registers.</li> </ul> <p><b>Note:</b> When the USART bootloader is selected there is no change on the RTC configuration (including backup registers).</p>   |
| V4.2                      | Fix V4.1 limitations (available on Rev.Z devices only)  | <ul style="list-style-type: none"> <li>– Stack overflow by 8 bytes when jumping to Bank1/Bank2 if BFB2=0 or when Read Protection level is set to 2. Workaround: the user code must force in the startup file the top of stack address before to jump to the main program. This can be done in the “Reset_Handler” routine.</li> <li>– When the Stack of the user code is placed outside the SRAM (i.e. @ 0x2000C000) the bootloader cannot jump to that user code which is considered invalid. This might happen when using compilers which place the stack at a non-physical address at the top of the SRAM (i.e. @ 0x2000C000). Workaround: place manually the stack at a physical address.</li> </ul> |
| V4.5                      | Fix V4.2 limitations.<br>DFU interface robustness enhancements (available on Rev.Y devices only). | <ul style="list-style-type: none"> <li>– For the USART interface, two consecutive NACKs (instead of 1 NACK) are sent when a Read Memory or Write Memory command is sent and the RDP level is active.</li> </ul>  |

## 54 STM32L1xxxE devices bootloader

### 54.1 Bootloader configuration

The STM32L1xxxE bootloader is activated by applying pattern 4 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 117. STM32L1xxxE configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment  |
|---------------------------|--------------------|-------------|--|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 16 MHz using the HSI. This is used only for USARTx bootloaders and during USB detection for DFU bootloader (once the DFU bootloader is selected, the clock source is derived from the external crystal). |
|                           |                    | HSE enabled | The external clock is mandatory only for DFU bootloader and it must be in the following range: [24, 16, 12, 8, 6, 4, 3, 2] MHz.<br>The PLL is used to generate the USB 48 MHz clock and the 32 MHz clock for the system clock.         |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.  |
|                           | RAM                | -           | 4 Kbyte starting from address 0x20000000 are used by the bootloader firmware.  |
|                           | System memory      | -           | 8 Kbyte starting from address 0x1FF00000 contains the bootloader firmware.   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value and is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                            |
| USART1 bootloader         | Power              | -           | Voltage range is set to Voltage Range 1.   |
|                           | USART1             | Enabled     | Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode   |
| USART2 bootloader         | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode   |
|                           | USART2             | Enabled     | Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.  |
|                           | USART2_RX pin      | Input       | PD6 pin: USART2 in reception mode  |
|                           | USART2_TX pin      | Output      | PD5 pin: USART2 in transmission mode   |

**Table 117. STM32L1xxxE configuration in system memory boot mode (continued)**

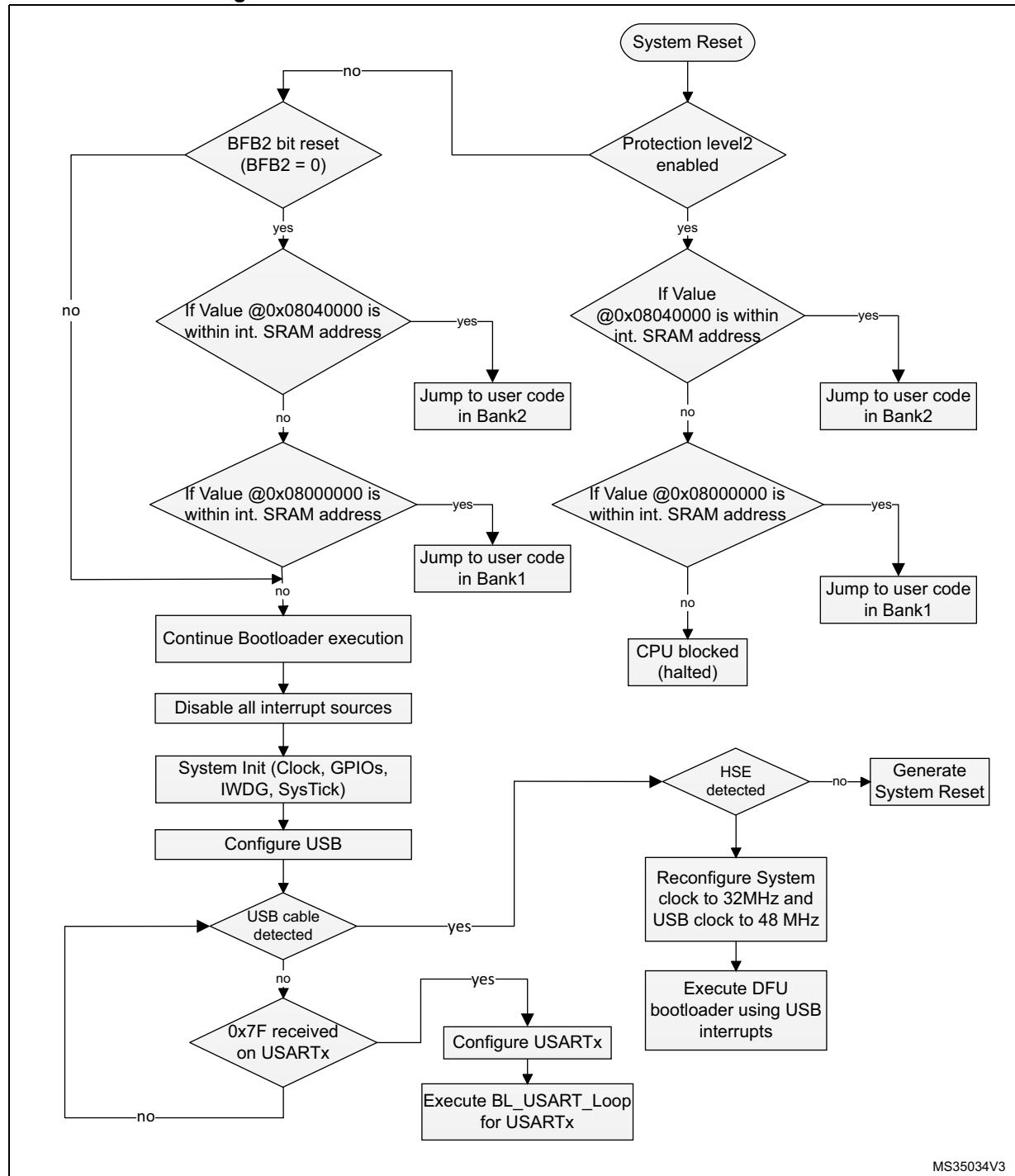
| Bootloader          | Feature/Peripheral | State        | Comment   |
|---------------------|--------------------|--------------|---|
| USARTTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTTx bootloader. |
| DFU bootloader      | USB                | Enabled      | USB used in FS mode   |
|                     | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                     | USB_DP pin         |              | PA12: USB DP line.  |

The system clock is derived from the embedded internal high-speed RC for USARTTx bootloader. This internal clock is used also for DFU bootloader but only for the selection phase. An external clock in the range of [24, 16, 12, 8, 6, 4, 3, 2] MHz is required for DFU bootloader execution after the selection phase.

## 54.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 69. Bootloader selection for STM32L1xxxE devices**



MS35034V3

## 54.3 Bootloader version

The following table lists the STM32L1xxxE devices bootloader versions:

**Table 118. STM32L1xxxE bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V4.0                      | Initial bootloader version | For the USART interface, two consecutive NACKs (instead of 1 NACK) are sent when a Read Memory or Write Memory command is sent and the RDP level is active. |

## 55 STM32L412xx/422xx devices bootloader

### 55.1 Bootloader configuration

The STM32L412xx/422xx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 119. STM32L412xx/422xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 72 MHz and for USART, I2C, SPI and USB bootloader operation.  |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader         | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART3_RX pin      | Input       | PC11 pin: USART3 in reception mode  |
|                           | USART3_TX pin      | Output      | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders        | SysTick timer      | Enabled     | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |

**Table 119. STM32L412xx/422xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C1 bootloader | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010010x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                 | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010010x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1010010x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                 | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.                                     |

Table 119. STM32L412xx/422xx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>Polarity: CPOL Low, CPHA Low, NSS hardware   |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.  |
| DFU bootloader  | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                 | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                 | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 55.2 Bootloader selection

The figures below show the bootloader selection mechanism.

**Figure 70. Dual bank boot Implementation for STM32L412xx/422xx bootloader V9.x**

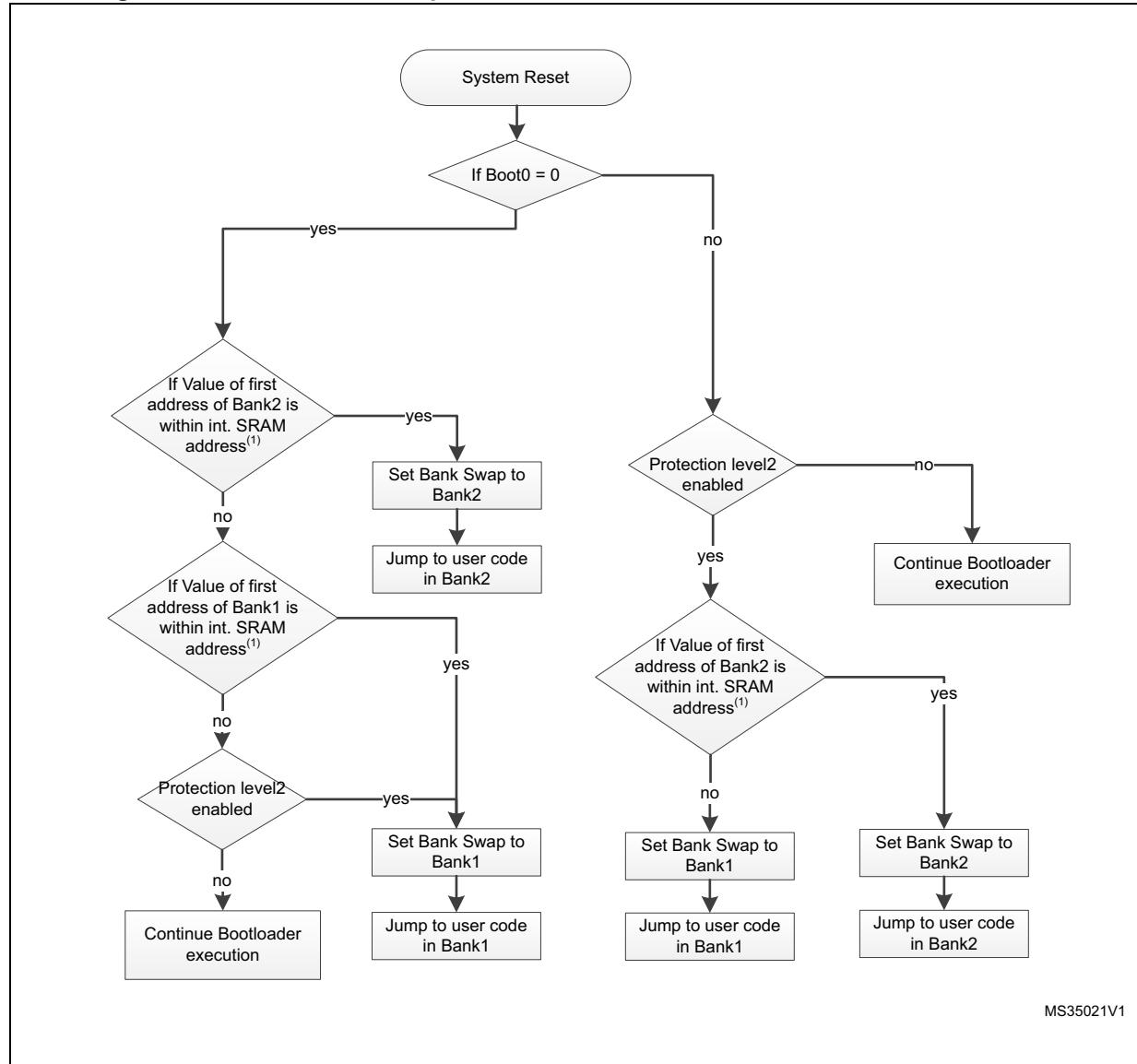
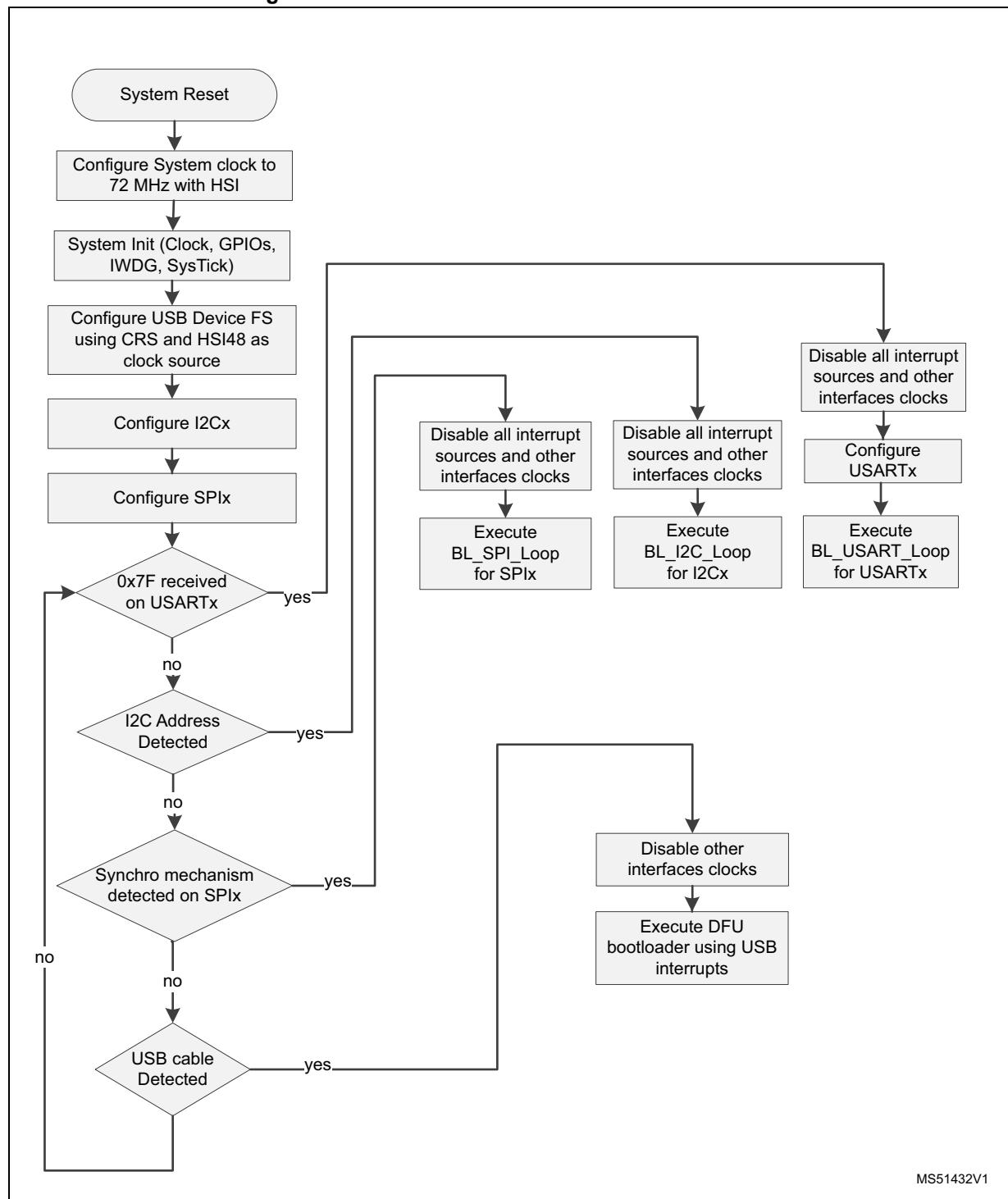


Figure 71.Bootloader V13.x selection for STM32L412xx/422xx



## 55.3 Bootloader version

*Table 120* lists the STM32L412xx/422xx devices bootloader version.

**Table 120. STM32L412xx/422xx bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V13.1                     | Initial bootloader version | <ul style="list-style-type: none"><li>– On connection phase, USART responds with two ACK bytes (0x79) instead of only one.</li><li>– PcROP option bytes cannot be written as Bootloader uses Byte access while PcROP must be accessed using Half-Word access.<br/><b>Workaround:</b> load a code snippet in SRAM using Bootloader interface then jump to it, and that code would write PcROP value.</li></ul> |

## 56 STM32L43xxx/44xxx devices bootloader

### 56.1 Bootloader configuration

The bootloader V9.1 version is updated to fix known limitations relative to USB-DFU interface, and is implemented on devices with version information ID equal to 0x10 (refer to [Table 122](#) for more details).

The STM32L43xxx/44xxx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 121. STM32L43xxx/44xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART, I2C, SPI and USB bootloader operation.  |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN interface is selected. The HSE must have one of the following values [24,20,18,16,12,9,8,6,4] MHz.  |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled when HSE is enabled. Any failure (or removal) of the external clock generates system reset   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 121. STM32L43xxx/44xxx configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader  | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                    | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001000x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001000x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001000x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |

Table 121. STM32L43xxx/44xxx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State   | Comment   |
|-----------------|--------------------|---------|---|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.         |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>Polarity: CPOL Low, CPHA Low, NSS hardware         |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.        |
| CAN1 bootloader | CAN1               | Enabled | Once initialized the CAN1 configuration is:<br>Baudrate 125 kbps, 11 -bit identifier.   |
|                 | CAN1_RX pin        | Input   | PB8 pin: CAN1 in reception mode   |
|                 | CAN1_TX pin        | Output  | PB9 pin: CAN1 in transmission mode  |
|                 | TIM16              | Enabled | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

**Table 121. STM32L43xxx/44xxx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 56.2 Bootloader selection

The figures below show the bootloader selection mechanism.

**Figure 72. Dual bank boot Implementation for STM32L3x2xx/44xxx bootloader V9.x**

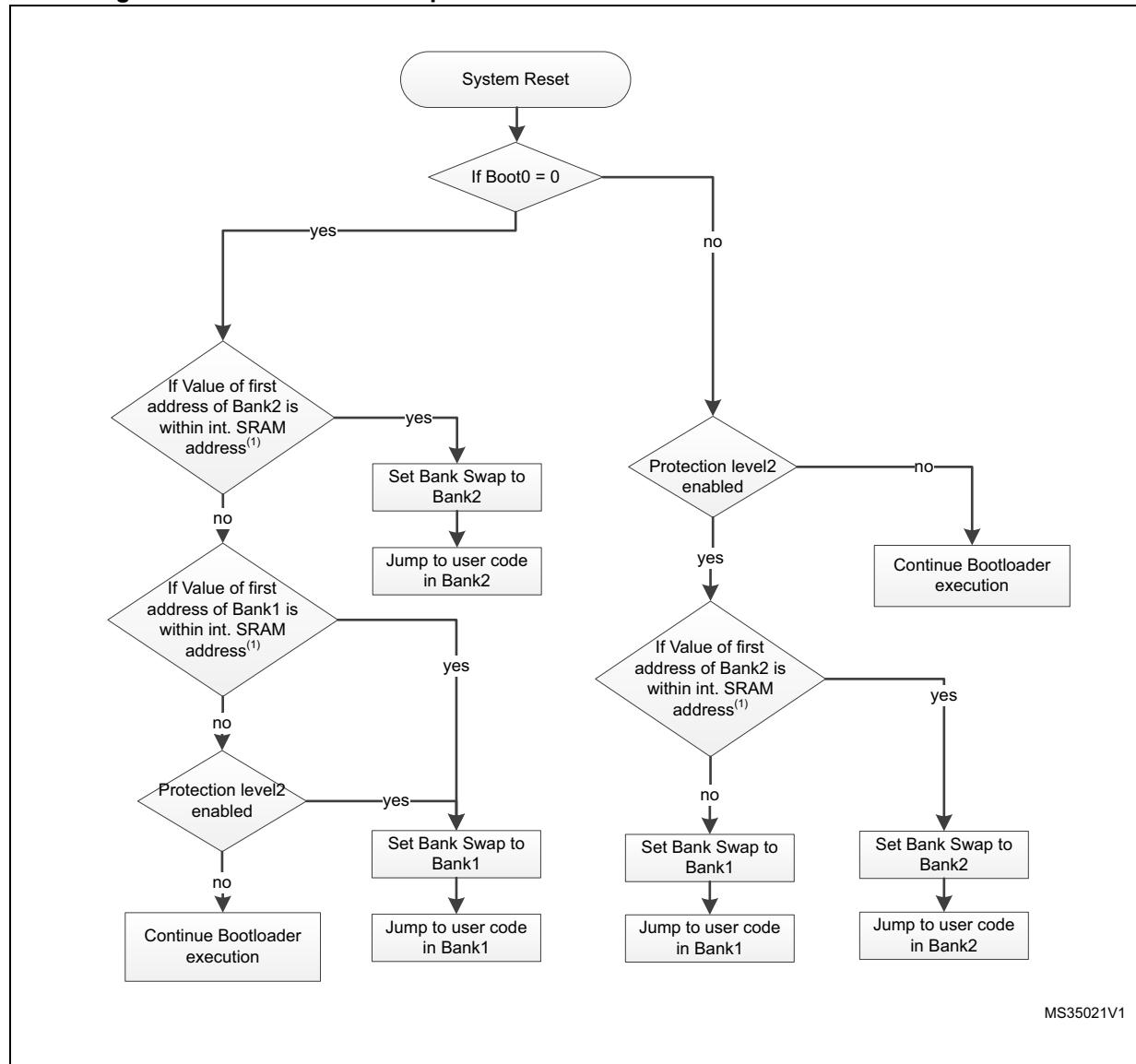
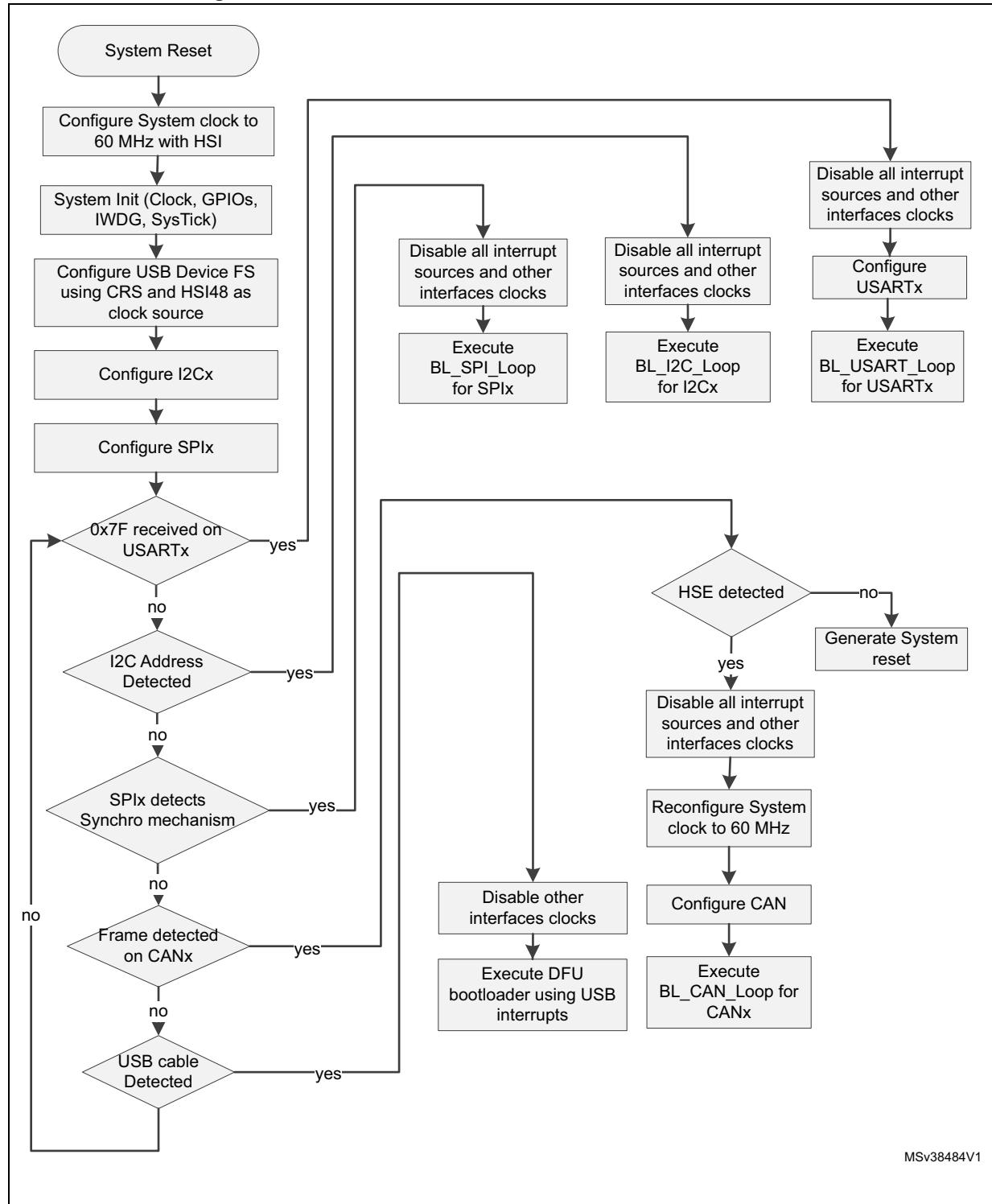


Figure 73. Bootloader V9.x selection for STM32L43xxx/44xxx



MSv38484V1

## 56.3 Bootloader version

*Table 122* lists the STM32L43xxx/44xxx devices bootloader versions.

**Table 122. STM32L43xxx/44xxx bootloader versions**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V9.1                      | Initial bootloader version | <p>Check the Version Information ID of your STM32L43xxx/44xxx device, which can be read at 0x1FFF6FF2 address.</p> <p><b>Version Information ID equal to 0xFF:</b></p> <ul style="list-style-type: none"> <li>For memory write operations using DFU interface: If the buffer size is larger than 256 bytes and not multiple of 8 bytes, the write memory operation result is corrupted.<br/><b>Workaround:</b> if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.</li> <li>For the USB-DFU interface, the CRS (clock recovery system) is not correctly configured and this may lead to random USB communication errors (depending on temperature and voltage). In most case communication error will manifest by a "Stall" response to setup packets.</li> <li>On the "Go" command, system bootloader deinit clears the RTCAPBEN bit in the RCC_APB1ENR register<br/><b>Workaround:</b> manually call <code>__HAL_RCC_RTC_CLK_ENABLE()</code> in the software which sets the RTCAPBEN bit.</li> </ul> <p><b>Version Information ID equal to 0x10:</b> None</p> <ul style="list-style-type: none"> <li>PcROP option bytes cannot be written as Bootloader uses Byte access while PcROP must be accessed using Half-Word access.<br/><b>Workaround:</b> load a code snippet in SRAM using Bootloader interface then jump to it, and that code would write PcROP value.</li> </ul> |

## 57 STM32L45xxx/46xxx devices bootloader

### 57.1 Bootloader configuration

The STM32L45xxx/46xxx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 123. STM32L45xxx/46xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 72 MHz and for USART, I2C, SPI and USB bootloader operation.  |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.   |
|                           |                    | HSE enabled | The system clock frequency is 60 MHz. The HSE is used only when the CAN interface is selected. The HSE must have one of the following values [24,20,18,16,12,9,8,6,4] MHz.                                  |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled when HSE is enabled. Any failure (or removal) of the external clock generates system reset   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
| USART1 bootloader         | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 123. STM32L45xxx/46xxx configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader  | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                    | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001010x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001010x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001010x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |

Table 123. STM32L45xxx/46xxx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State   | Comment   |
|-----------------|--------------------|---------|---|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.         |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.        |
| CAN1 bootloader | CAN1               | Enabled | Once initialized the CAN1 configuration is:<br>Baudrate 125 kbps, 11 -bit identifier.   |
|                 | CAN1_RX pin        | Input   | PB8 pin: CAN1 in reception mode   |
|                 | CAN1_TX pin        | Output  | PB9 pin: CAN1 in transmission mode  |
|                 | TIM16              | Enabled | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

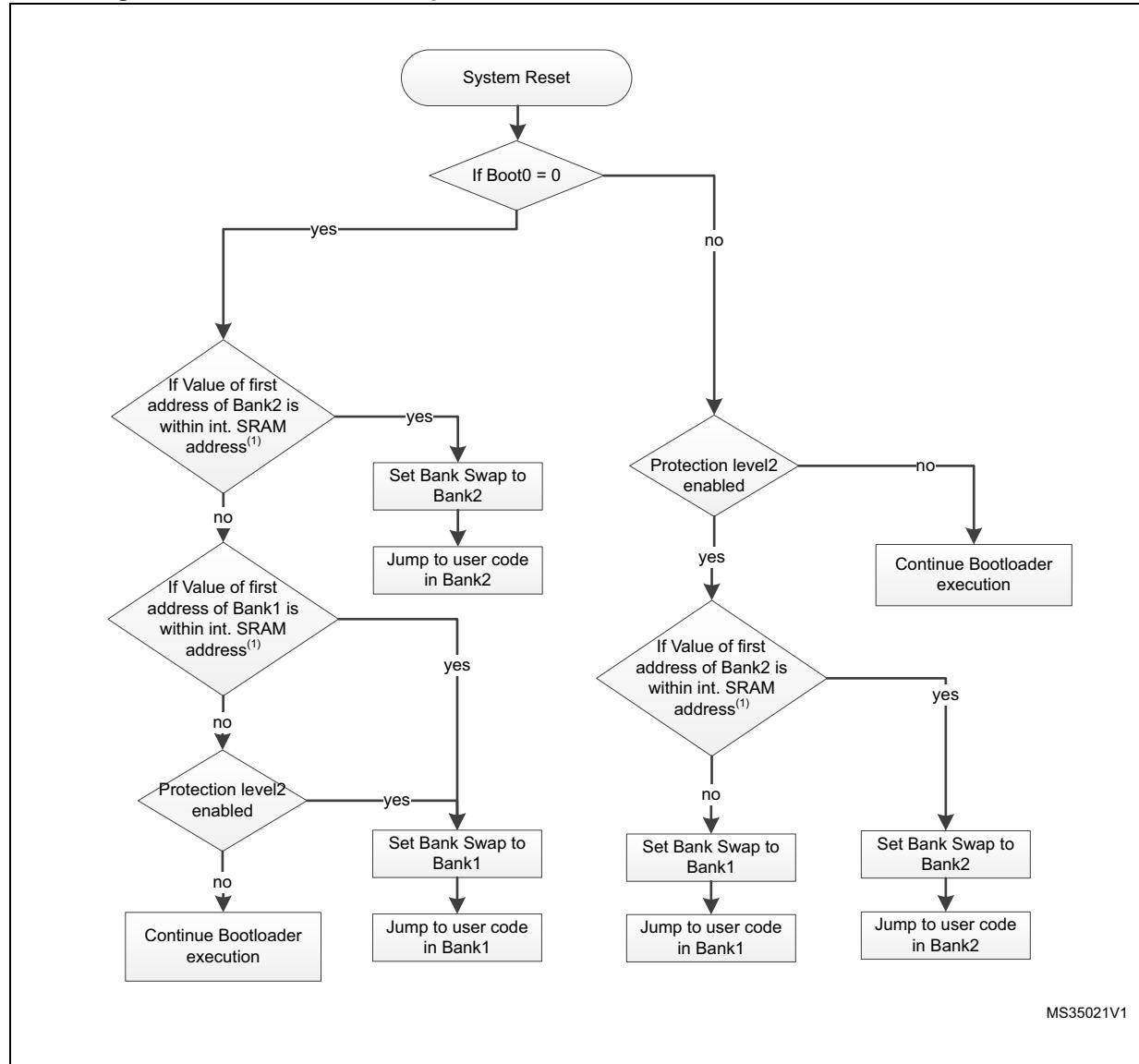
Table 123. STM32L45xxx/46xxx configuration in system memory boot mode (continued)

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 57.2 Bootloader selection

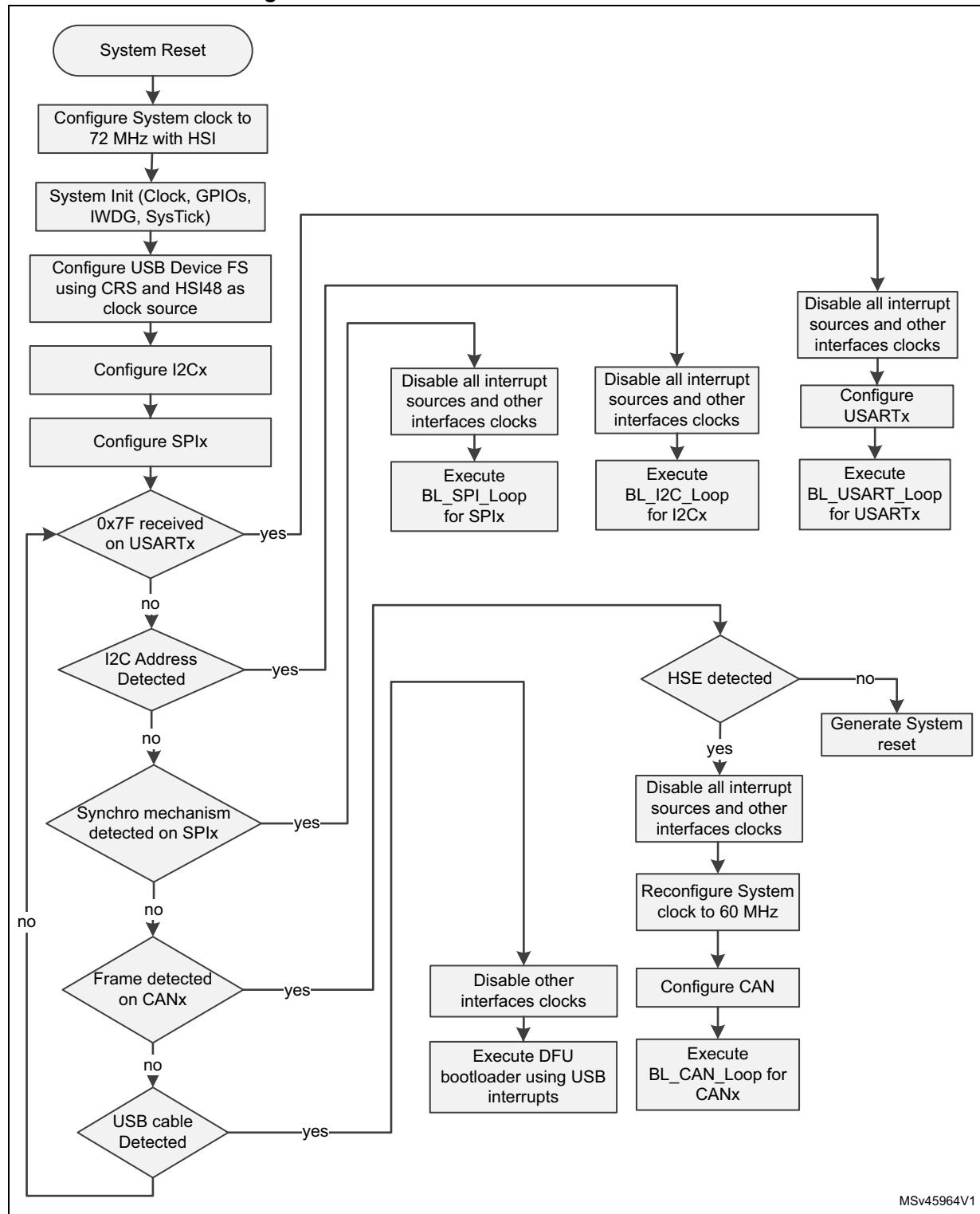
The figures below show the bootloader selection mechanism.

**Figure 74. Dual bank boot Implementation for STM32L45xxx/46xxx bootloader V9.x**



MS35021V1

Figure 75.Bootloader V9.x selection for STM32L45xxx/46xxx



MSv45964V1

### 57.3 Bootloader version

*Table 124* lists the STM32L45xxx/46xxx devices bootloader versions.

**Table 124. STM32L45xxx/46xxx bootloader versions**

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V9.2                      | Initial bootloader version | <ul style="list-style-type: none"><li>– PcROP option bytes cannot be written as Bootloader uses Byte access while PcROP must be accessed using Half-Word access.</li></ul> <p><b>Workaround:</b> load a code snippet in SRAM using Bootloader interface then jump to it, and that code would write PcROP value.</p> |

## 58 STM32L47xxx/48xxx devices bootloader

Two bootloader versions are available on STM32L47xxx/48xxx:

- V10.x supporting USART, I2C and DFU (USB FS Device).  
This version is embedded in STM32L47xxx/48xxx rev. 2 and rev. 3 devices.
- V9.x supporting USART, I2C, SPI, CAN and DFU (USB FS Device).  
This version is embedded in STM32L47xxx/48xxx rev. 4 devices.

### 58.1 Bootloader V10.x

#### 58.1.1 Bootloader configuration

The STM32L47xxx/48xxx bootloader is activated by applying Pattern 7 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 125. STM32L47xxx/48xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 24 MHz and for USART and I2C bootloader operation.  |
|                           |                    | HSE enabled | The HSE is used only when the USB interface is selected and the LSE is not present. The HSE must have one of the following values [24,20,18,16,12,9,8,6,4] MHz.   |
|                           |                    | LSE enabled | The LSE is used to trim the MSI which is configured to 48 MHz as USB clock source. The LSE must be equal to 32,768 kHz. If the LSE is not detected, the HSE is used instead if USB is connected.            |
|                           |                    | MSI enabled | The MSI is configured to 48 MHz and is used as USB clock source. The MSI is used only if LSE is detected, otherwise, HSE is used if USB is connected.   |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled when LSE or HSE is enabled. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |

**Table 125. STM32L47xxx/48xxx configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART1 bootloader  | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
|                    | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader  | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                    | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000011x<br>(where x = 0 for write and x = 1 for read)   |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1000011x<br>(where x = 0 for write and x = 1 for read)   |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address is 0b1000011x<br>(where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |
| DFU bootloader     | USB                | Enabled      | USB OTG FS configured in forced device mode   |
|                    | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                    | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |
|                    | TIM17              | Enabled      | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 24 MHz using PLL and HSE.                                 |

For USARTx and I2Cx bootloaders no external clock is required.

USB bootloader (DFU) requires either an LSE (low-speed external clock) or a HSE (high-speed external clock):

- In case, the LSE is present regardless the HSE presence, the MSI is configured and trimmed by the LSE to provide an accurate clock equal to 48 MHz which is the clock source of the USB. The system clock is kept clocked to 24 MHz by the HSI.
- In case, the HSE is present, the system clock and USB clock is configured respectively to 24 MHz and 48 MHz with HSE as clock source.

### 58.1.2 Bootloader selection

*Figure 76* and *Figure 77* show the bootloader selection mechanism.

**Figure 76. Dual bank boot implementation for STM32L47xxx/48xxx bootloader V10.x**

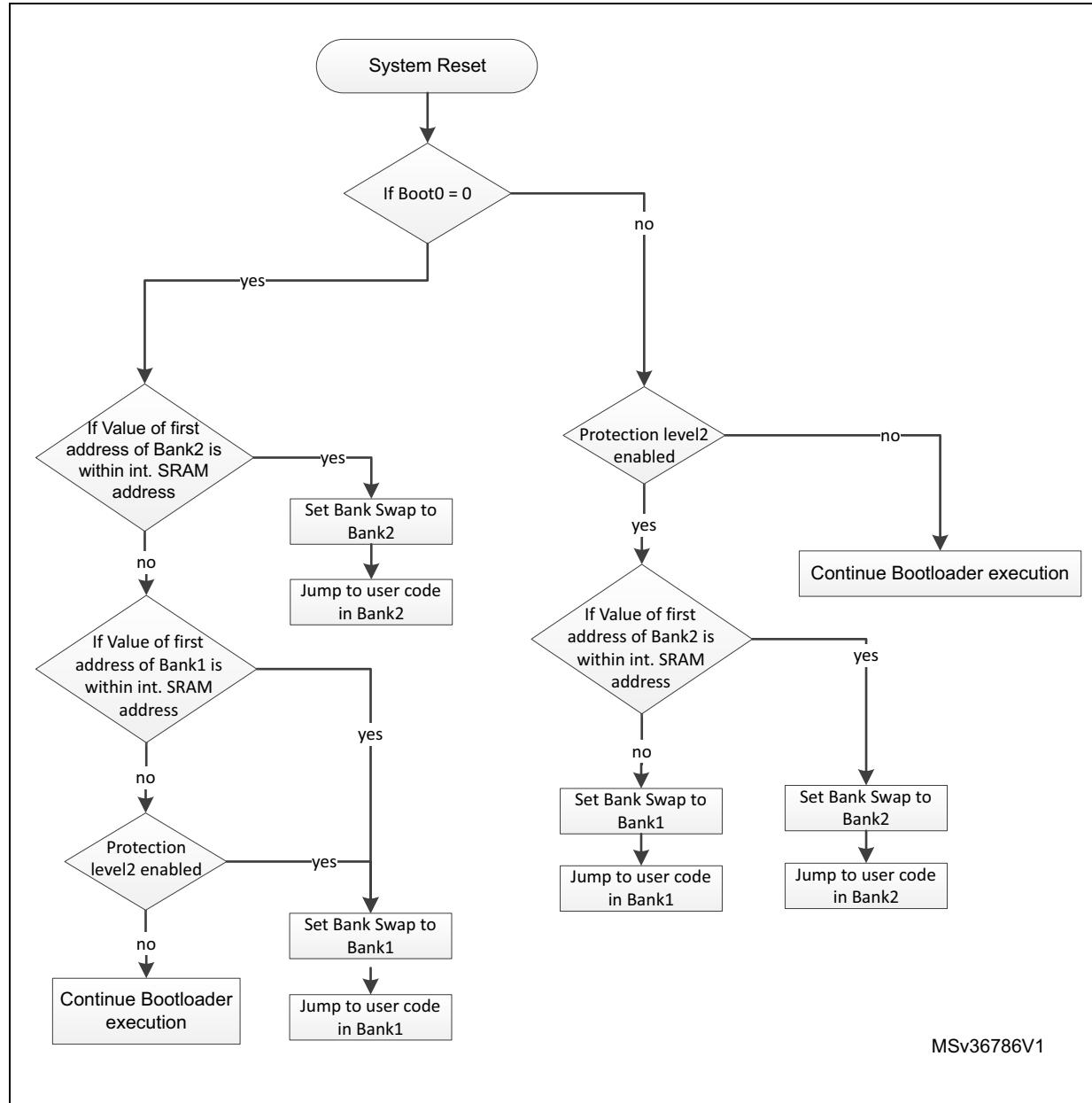
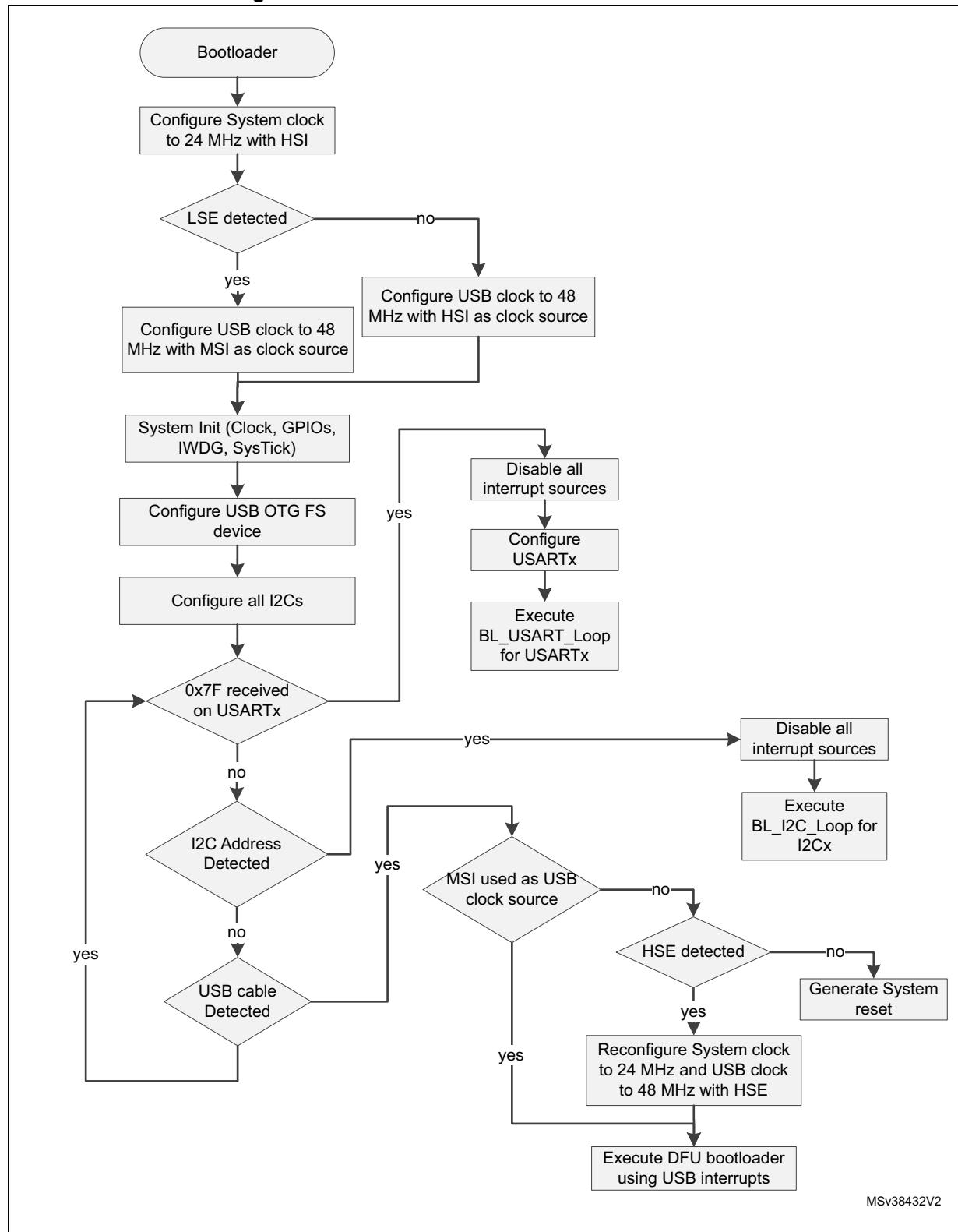


Figure 77.Bootloader V10.x selection for STM32L47xxx/48xxx



### 58.1.3 Bootloader version

The following table lists the STM32L47xxx/48xxx devices bootloader V10.x versions:

**Table 126. STM32L47xxx/48xxx bootloader V10.x versions**

| Bootloader version number | Description  | Known limitations  |
|---------------------------|--|--|
| V10.1                     | Initial bootloader version   | <p>For memory write operations using DFU interface:<br/>If the buffer size is larger than 256 bytes and not multiple of 8 bytes, the write memory operation result is corrupted.<br/><b>Workaround:</b> if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.<br/>Write in SRAM is corrupted.</p>  |
| V10.2                     | Fix write in SRAM issue  | <p>For memory write operations using DFU interface:<br/>If the buffer size is larger than 256 bytes and not multiple of 8 bytes, the write memory operation result is corrupted.<br/><b>Workaround:</b> if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.</p>  |
| V10.3                     | Add support of MSI as USB clock source (MSI is trimmed by LSE).<br>Update dual bank boot feature to support the case when user stack is mapped in SRAM2. | <ul style="list-style-type: none"> <li>– For memory write operations using DFU interface: If the buffer size is larger than 256 bytes and not multiple of 8 bytes, the write memory operation result is corrupted.<br/><b>Workaround:</b> if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.</li> <li>– PcROP option bytes cannot be written as Bootloader uses Byte access while PcROP must be accessed using Half-Word access.<br/><b>Workaround:</b> load a code snippet in SRAM using Bootloader interface then jump to it, and that code would write PcROP value.</li> </ul> |

## 58.2 Bootloader V9.x

### 58.2.1 Bootloader configuration

The STM32L47xxx/48xxx bootloader is activated by applying Pattern 7 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 127. STM32L47xxx/48xxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 72 MHz and for USART and I2C bootloader operation.  |
|                           |                    | HSE enabled | The HSE is used only when the USB interface is selected and the LSE is not present. The HSE must have one of the following values [24,20,18,16,12,8,6,4] MHz.<br>System is clocked at 72 MHz if USB is used or 60 MHz if CAN is used. |
|                           |                    | LSE enabled | The LSE is used to trim the MSI which is configured to 48 MHz as USB clock source. The LSE must be equal to 32,768 kHz. If the LSE is not detected, the HSE is used instead if USB is connected.                                      |
|                           |                    | MSI enabled | The MSI is configured to 48 MHz and is used as USB clock source. The MSI is used only if LSE is detected, otherwise, HSE is used if USB is connected.   |
|                           |                    | CSS         | The Clock Security System (CSS) interrupt is enabled when LSE or HSE is enabled. Any failure (or removal) of the external clock generates system reset.   |
|                           | RAM                | -           | 13 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user).                           |
|                           | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.   |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART2 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART2 in transmission mode  |

**Table 127. STM32L47xxx/48xxx configuration in system memory boot mode (continued)**

| Bootloader         | Feature/Peripheral | State        | Comment   |
|--------------------|--------------------|--------------|---|
| USART2 bootloader  | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                    | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader  | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                    | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                    | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| USARTx bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.   |
| I2C1 bootloader    | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000011x (where x = 0 for write and x = 1 for read) |
|                    | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                    | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader    | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000011x (where x = 0 for write and x = 1 for read) |
|                    | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                    | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader    | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 400 kHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000011x (where x = 0 for write and x = 1 for read) |
|                    | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                    | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |
| SPI1 bootloader    | SPI1               | Enabled      | The SPI1 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                    | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                    | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                    | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                    | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.   |

Table 127. STM32L47xxx/48xxx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware   |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.  |
| CAN1 bootloader | CAN1               | Enabled      | Once initialized the CAN1 configuration is:<br>Baudrate 125 kbps, 11-bit identifier.  |
|                 | CAN1_RX pin        | Input        | PB8 pin: CAN1 in reception mode   |
|                 | CAN1_TX pin        | Output       | PB9 pin: CAN1 in transmission mode  |
| DFU bootloader  | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                 | USB_DM pin         | Input/Output | PA11 pin: USB FS DM line  |
|                 | USB_DP pin         |              | PA12 pin: USB FS DP line.<br>No external pull-up resistor is required.  |

In case, the HSE is present, the system clock and USB clock is configured respectively to 72 MHz and 48 MHz with PLL (clocked by HSE) as a clock source.

### 58.2.2 Bootloader selection

*Figure 78* and *Figure 79* show the bootloader selection mechanism.

**Figure 78. Dual bank boot implementation for STM32L47xxx/48xxx bootloader V9.x**

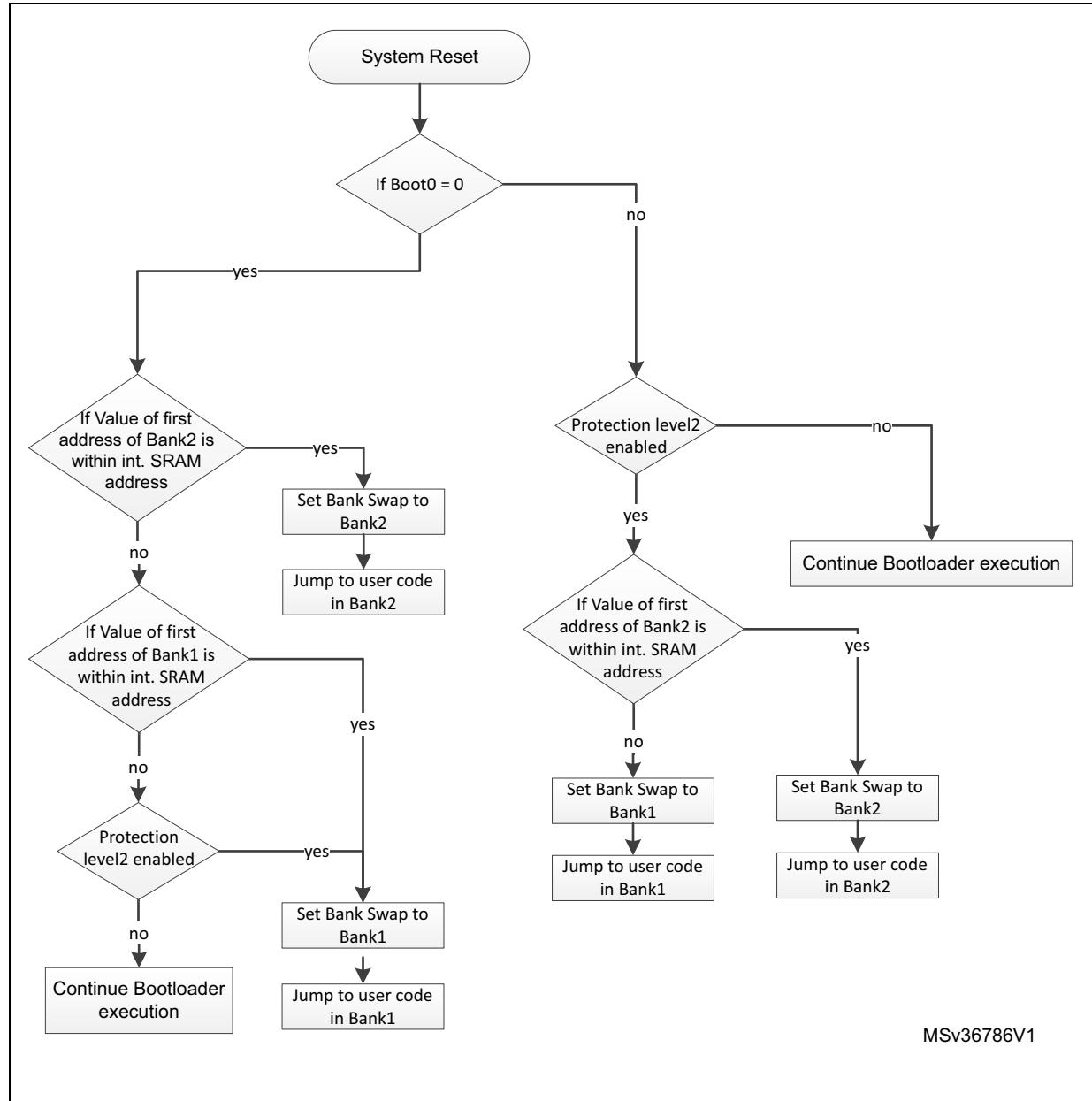
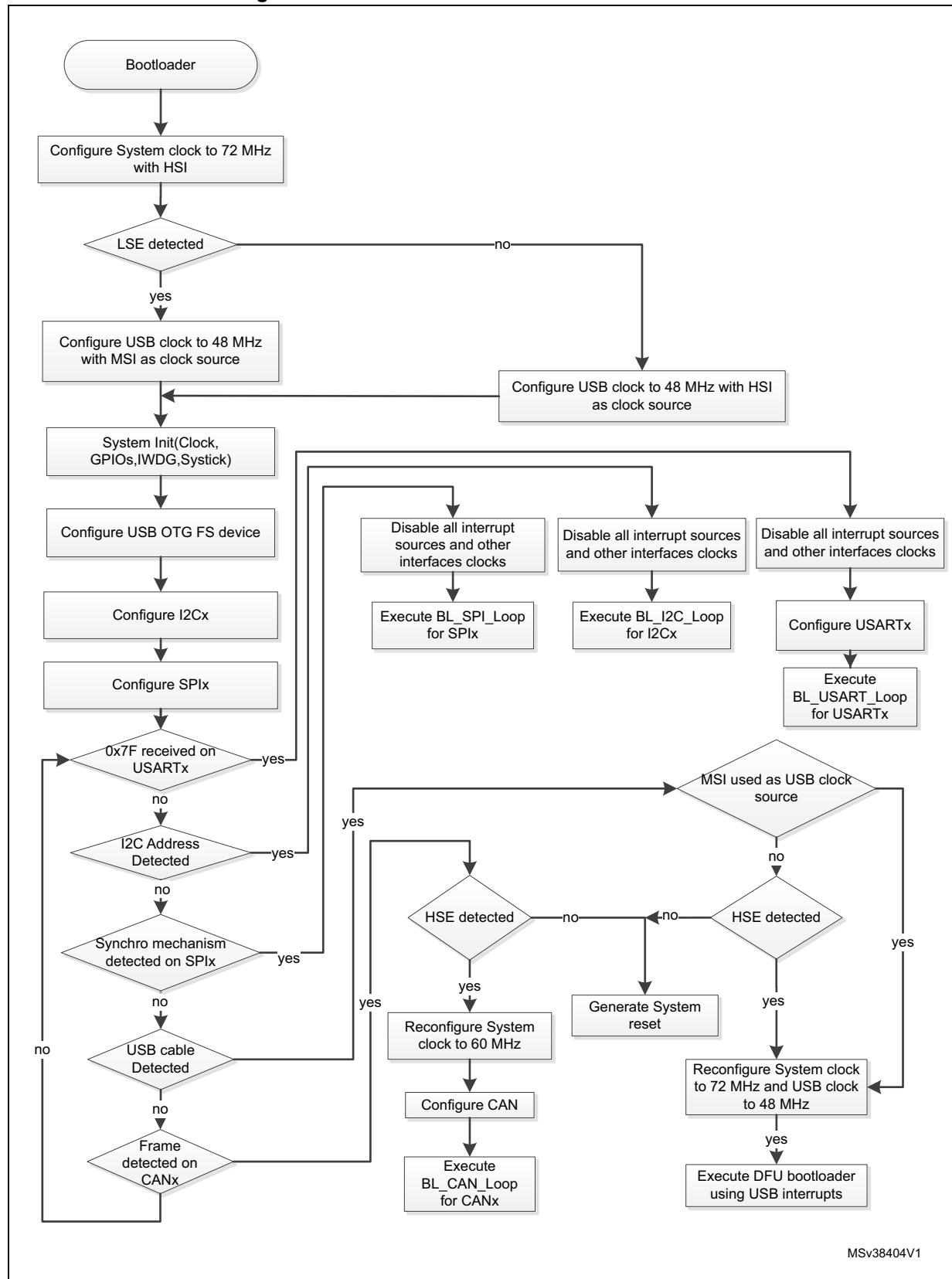


Figure 79.Bootloader V9.x selection for STM32L47xxx/48xxx



MSv38404V1

### 58.2.3 Bootloader version

The following table lists the STM32L47xxx/48xxx devices bootloader V9.x versions:

**Table 128. STM32L47xxx/48xxx bootloader V9.x versions**

| Bootloader version number | Description                   | Known limitations  |
|---------------------------|-------------------------------|--|
| V9.0                      | Initial bootloader version    | <p>For memory write operations using DFU interface:<br/>If the buffer size is larger than 256 bytes and not multiple of 8 bytes, the write memory operation result is corrupted.<br/><b>Workaround:</b> if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.<br/>Write in SRAM is corrupted</p>   |
| V9.1                      | Deprecated version (not used) | None   |
| V9.2                      | Fix write in SRAM issue       | <ul style="list-style-type: none"> <li>– For memory write operations using DFU interface: If the buffer size is larger than 256 bytes and not multiple of 8 bytes, the write memory operation result is corrupted.<br/><b>Workaround:</b> if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.</li> <li>– PcROP option bytes cannot be written as Bootloader uses Byte access while PcROP must be accessed using Half-Word access.<br/><b>Workaround:</b> load a code snippet in SRAM using Bootloader interface then jump to it, and that code would write PcROP value.</li> </ul> |

## 59 STM32L496xx/4A6xx devices bootloader

### 59.1 Bootloader configuration

The STM32L496xx/4A6xx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). [Table 129](#) shows the hardware resources used by this bootloader.

**Table 129. STM32L496xx/4A6xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 72 MHz and for USART, I2C and SPI bootloader operation.   |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI 48 MHz.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN interface is selected . The HSE must have one of the following value [24,20,18,16,12,9,8,6,4] MHz.  |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled when HSE is enabled. Any failure (or removal) of the external clock generates system reset   |
|                           | RAM                | -           | 12 Kbyte starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 28 Kbyte starting from address 0x1FFF0000, contain the bootloader firmware  |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 129. STM32L496xx/4A6xx configuration in system memory boot mode (continued)**

| Bootloader            | Feature/Peripheral | State        | Comment  |
|-----------------------|--------------------|--------------|--|
| USART2 bootloader     | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                       | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode  |
|                       | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode   |
| USART3 bootloader     | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                       | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|                       | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx<br>bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| I2C1 bootloader       | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001100x (where x = 0 for write and x = 1 for read) |
|                       | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                       | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |
| I2C2 bootloader       | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001100x (where x = 0 for write and x = 1 for read) |
|                       | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.   |
|                       | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.  |
| I2C3 bootloader       | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001100x (where x = 0 for write and x = 1 for read) |
|                       | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.  |
|                       | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.   |

Table 129. STM32L496xx/4A6xx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State   | Comment   |
|-----------------|--------------------|---------|---|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.         |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.        |
| CAN1 bootloader | CAN1               | Enabled | Once initialized the CAN1 configuration is:Baudrate 125 kbps, 11 -bit identifier.   |
|                 | CAN1_RX pin        | Input   | PB8 pin: CAN1 in reception mode   |
|                 | CAN1_TX pin        | Output  | PB9 pin: CAN1 in transmission mode  |
|                 | TIM16              | Enabled | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

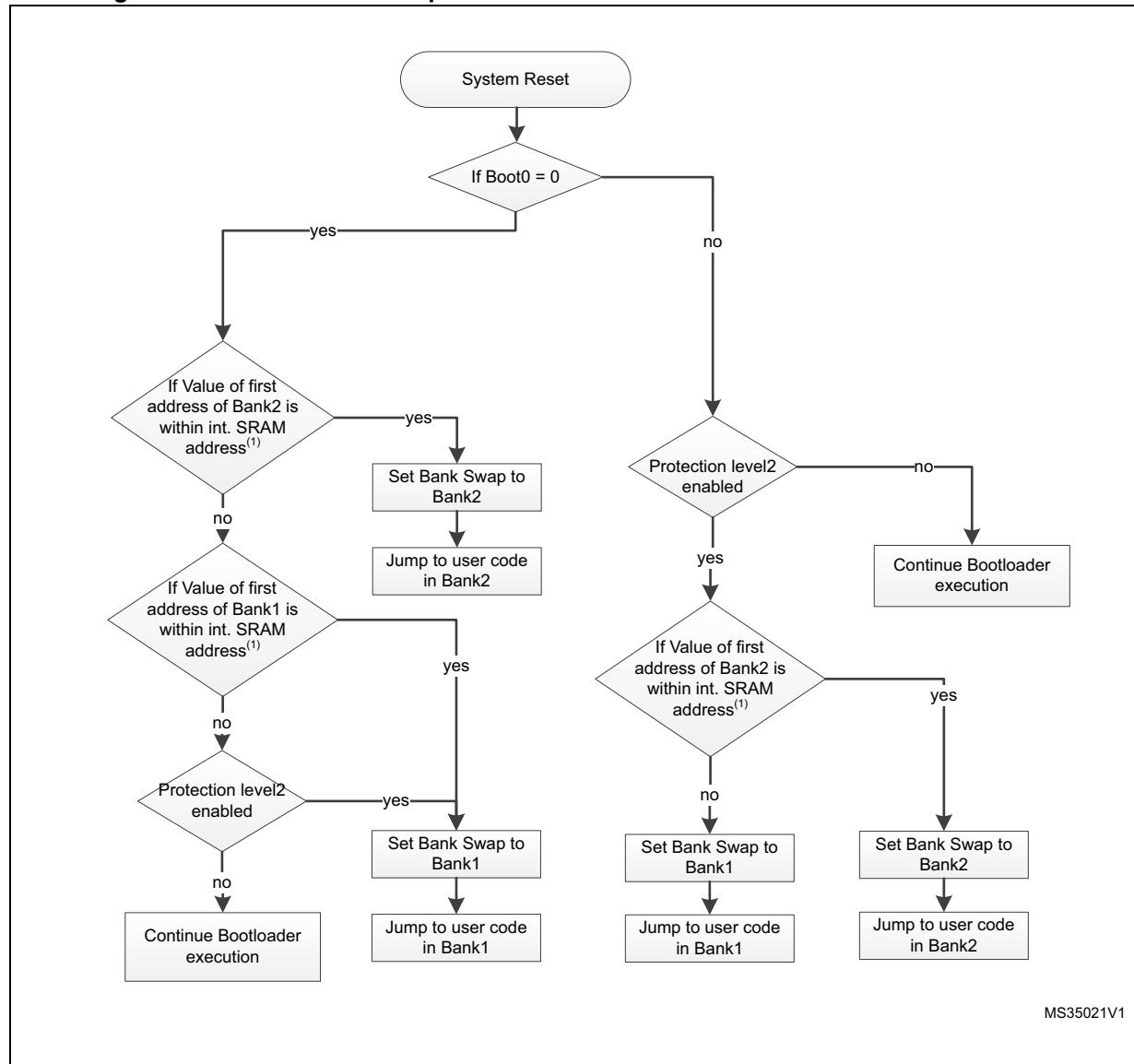
**Table 129. STM32L496xx/4A6xx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB OTG FS configured in forced device mode.<br>USB OTG FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 59.2 Bootloader selection

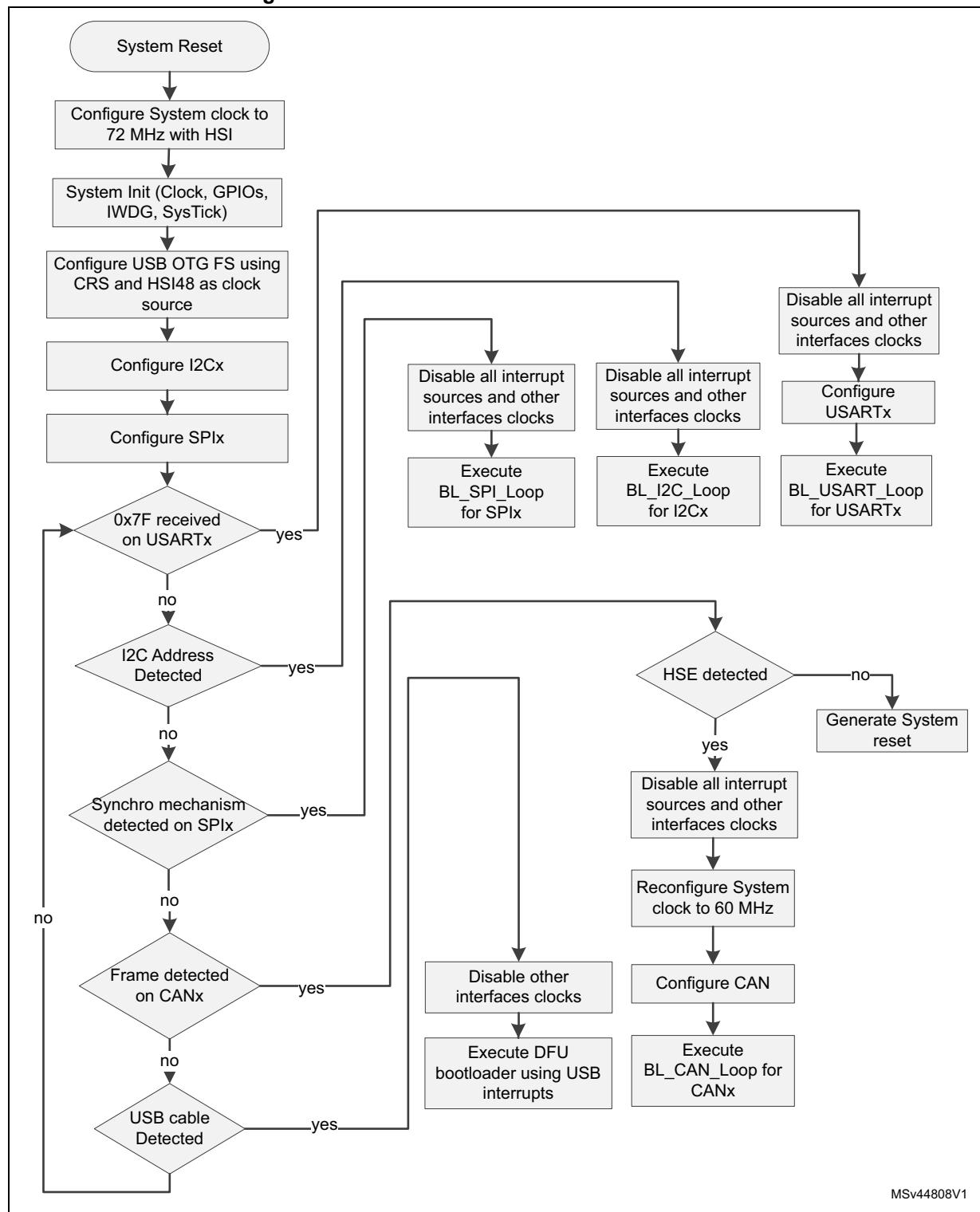
The figures below show the bootloader selection mechanism.

**Figure 80. Dual bank boot Implementation for STM32L496xx/4A6xx bootloader V9.x**



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**Figure 81. Bootloader V9.x selection for STM32L496xx/4A6xx**



## 59.3 Bootloader version

*Table 130* lists the STM32L496xx/4A6xx devices bootloader versions.

**Table 130. STM32L496xx/4A6xx bootloader version**

| Bootloader version number | Description                | Known limitations  |
|---------------------------|----------------------------|--|
| V9.3                      | Initial bootloader version | <ul style="list-style-type: none"> <li>– The Bank Erase command is aborted by the bootloader device, and the NACK (0x1F) is sent to the host. Workaround: Perform Bank erase operation through page erase using the Erase command (0x44).</li> <li>– SPI write operation fail</li> </ul> <p><b>Limitation:</b></p> <ul style="list-style-type: none"> <li>a. During Bootloader SPI write Flash memory operation, some random 64-bits (2 double-words) may be left blank at 0xFF.</li> </ul> <p><b>Root cause:</b></p> <ul style="list-style-type: none"> <li>a. Bootloader uses 64-bits cast write operation which is interrupted by SPI DMA and it leads to double access on same Flash memory address and the 64-bits are not written</li> </ul> <p><b>Workarounds:</b></p> <ul style="list-style-type: none"> <li>a. WA1: add a delay between sending write command and its ACK request. Its duration must be the duration of the 256-Bytes Flash memory write time.</li> <li>b. WA2: read back after write and in case of error start write again.</li> <li>c. WA3: Patch in RAM to write in Flash memory that implements write memory without 64-bits cast.</li> </ul> <p>WA1 and WA3 are more efficient than WA2 in terms of total programming time</p> <p><b>How critical is the limitation:</b></p> <ul style="list-style-type: none"> <li>a. The limitation leads to a modification in customer SPI host software by adding 3-4 ms delay to each write operation.</li> <li>b. The delay is not waste because it is anyway the Flash memory write period of time that host has to wait anyway (so instead of waiting by sending ACK requests, host will wait by delay).</li> <li>c. Limitation has been seen only on SPI and cannot impact USART/I2C/CAN.</li> </ul> <ul style="list-style-type: none"> <li>– PcROP option bytes cannot be written as Bootloader uses Byte access while PcROP must be accessed using Half-Word access.</li> </ul> <p><b>Workaround:</b> load a code snippet in SRAM using Bootloader interface then jump to it, and that code would write PcROP value.</p> |

## 60 STM32L4P5xx/4Q5xx devices bootloader

### 60.1 Bootloader configuration

The STM32L4P5xx/4Q5xx bootloader is activated by applying Pattern 7 (described in [Table 2: Bootloader activation patterns](#)). [Table 133](#) shows the hardware resources used by this bootloader.

**Table 131. STM32L4P5xx/4Q5xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART, I2C, SPI and USB bootloader operation.  |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI 48 MHz.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN interface is selected . The HSE must have one of the following value [24,20,18,16,12,9,8,6,4] MHz.  |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled when HSE is enabled. Any failure (or removal) of the external clock generates system reset   |
|                           | RAM                | -           | 16 Kbytes starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 28 Kbytes starting from address 0x1FFF0000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 131. STM32L4P5xx/4Q5xx configuration in system memory boot mode (continued)**

| Bootloader        | Feature/Peripheral | State        | Comment   |
|-------------------|--------------------|--------------|---|
| USART2 bootloader | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                   | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode   |
|                   | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode  |
| USART3 bootloader | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                   | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode  |
|                   | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode   |
| I2C1 bootloader   | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1011011x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                   | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader   | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1011011x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                   | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader   | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1011011x<br>(where x = 0 for write and x = 1 for read) |
|                   | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                   | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |

**Table 131. STM32L4P5xx/4Q5xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State   | Comment  |
|-----------------|--------------------|---------|--|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.    |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.   |
| CAN1 bootloader | CAN1               | Enabled | Once initialized the CAN1 configuration is:<br>Baudrate 125 kbps, 11 -bit identifier.  |
|                 | CAN1_RX pin        | Input   | PB8 pin: CAN1 in reception mode  |
|                 | CAN1_TX pin        | Output  | PB9 pin: CAN1 in transmission mode   |

**Table 131. STM32L4P5xx/4Q5xx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 60.2 Bootloader selection

*Figure 84* and *Figure 85* show the bootloader selection mechanisms.

**Figure 82. Dual bank boot implementation for STM32L4P5xx/4Q5xx bootloader V9.x**

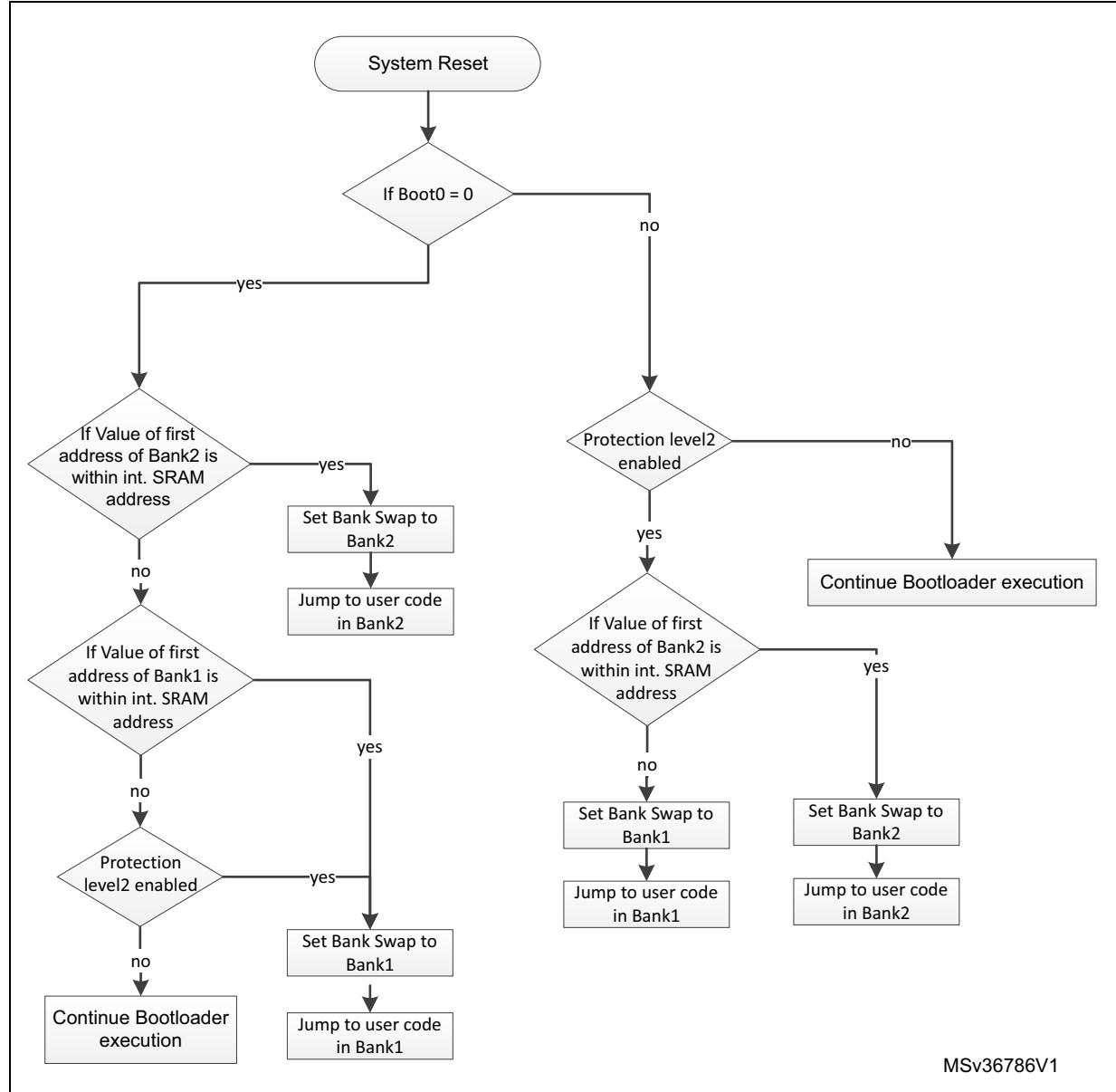
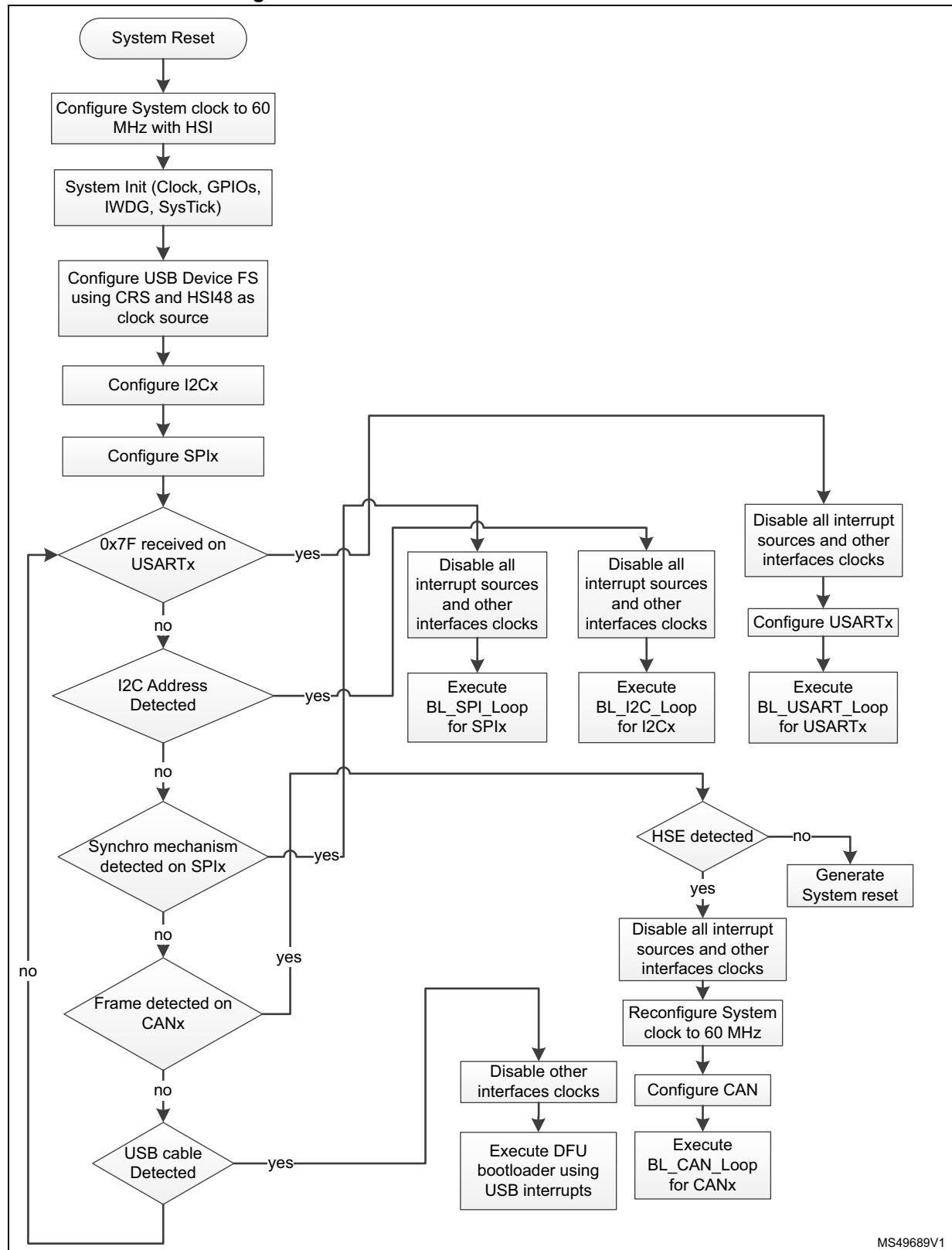


Figure 83.Bootloader V9.x selection for STM32L4P5xx/4Q5xx



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## 60.3 Bootloader version

*Table 132* lists the STM32L4P5xx/4Q5xx devices bootloader versions.

**Table 132. STM32L4P5xx/4Q5xx bootloader versions**

| Bootloader version number | Description                                   | Known limitations  |
|---------------------------|---|--|
| V9.0                      | Initial bootloader version on cut 1.0 samples | <ul style="list-style-type: none"><li>– PcROP option bytes cannot be written as bootloader uses byte access while PcROP must be accessed using half-word access.</li></ul> <p><b>Workaround:</b> load a code snippet in SRAM using bootloader interface then jump to it, and that code writes PcROP value.</p> |

## 61 STM32L4Rxxx/4Sxxx devices bootloader

### 61.1 Bootloader configuration

The STM32L4Rxx/4Sxx bootloader is activated by applying Pattern 6 (described in [Table 2: Bootloader activation patterns](#)). [Table 133](#) shows the hardware resources used by this bootloader.

**Table 133. STM32L4Rxxx/4Sxxx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The HSI is used at startup as clock source for system clock configured to 60 MHz and for USART, I2C, SPI and USB bootloader operation.  |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI 48 MHz.   |
|                           |                    | HSE enabled | The HSE is used only when the CAN interface is selected . The HSE must have one of the following values [24,20,18,16,12,9,8,6,4] MHz.   |
|                           |                    | -           | The Clock Security System (CSS) interrupt is enabled when HSE is enabled. Any failure (or removal) of the external clock generates system reset   |
|                           | RAM                | -           | 12 Kbytes starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 28672 bytes starting from address 0x1FFF0000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | Power              | -           | The DFU cannot be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware does not configure voltage scaling range value in PWR_CR1 register.                   |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |

**Table 133. STM32L4Rxxx/4Sxxx configuration in system memory boot mode (continued)**

| Bootloader            | Feature/Peripheral | State        | Comment  |
|-----------------------|--------------------|--------------|--|
| USART2 bootloader     | USART2             | Enabled      | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit  |
|                       | USART2_RX pin      | Input        | PA3 pin: USART2 in reception mode  |
|                       | USART2_TX pin      | Output       | PA2 pin: USART2 in transmission mode   |
| USART3 bootloader     | USART3             | Enabled      | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit  |
|                       | USART3_RX pin      | Input        | PC11 pin: USART3 in reception mode   |
|                       | USART3_TX pin      | Output       | PC10 pin: USART3 in transmission mode  |
| USARTx<br>bootloaders | SysTick timer      | Enabled      | Used to automatically detect the serial baud rate from the host for USARTx bootloaders.  |
| I2C1 bootloader       | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b101000x<br>(where x = 0 for write and x = 1 for read) |
|                       | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.  |
|                       | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.   |
| I2C2 bootloader       | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b101000x<br>(where x = 0 for write and x = 1 for read) |
|                       | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.   |
|                       | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.  |
| I2C3 bootloader       | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b101000x<br>(where x = 0 for write and x = 1 for read) |
|                       | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.  |
|                       | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.   |

Table 133. STM32L4Rxxx/4Sxxx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State   | Comment   |
|-----------------|--------------------|---------|---|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.         |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.      |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.        |
| CAN1 bootloader | CAN1               | Enabled | Once initialized the CAN1 configuration is:<br>Baudrate 125 kbps, 11 -bit identifier.   |
|                 | CAN1_RX pin        | Input   | PB8 pin: CAN1 in reception mode   |
|                 | CAN1_TX pin        | Output  | PB9 pin: CAN1 in transmission mode  |
|                 | TIM16              | Enabled | This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE. |

**Table 133. STM32L4Rxxx/4Sxxx configuration in system memory boot mode (continued)**

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 61.2 Bootloader selection

*Figure 84* and *Figure 85* show the bootloader selection mechanisms.

**Figure 84. Dual bank boot implementation for STM32L4Rxxx/STM32L4Sxxx bootloader V9.x**

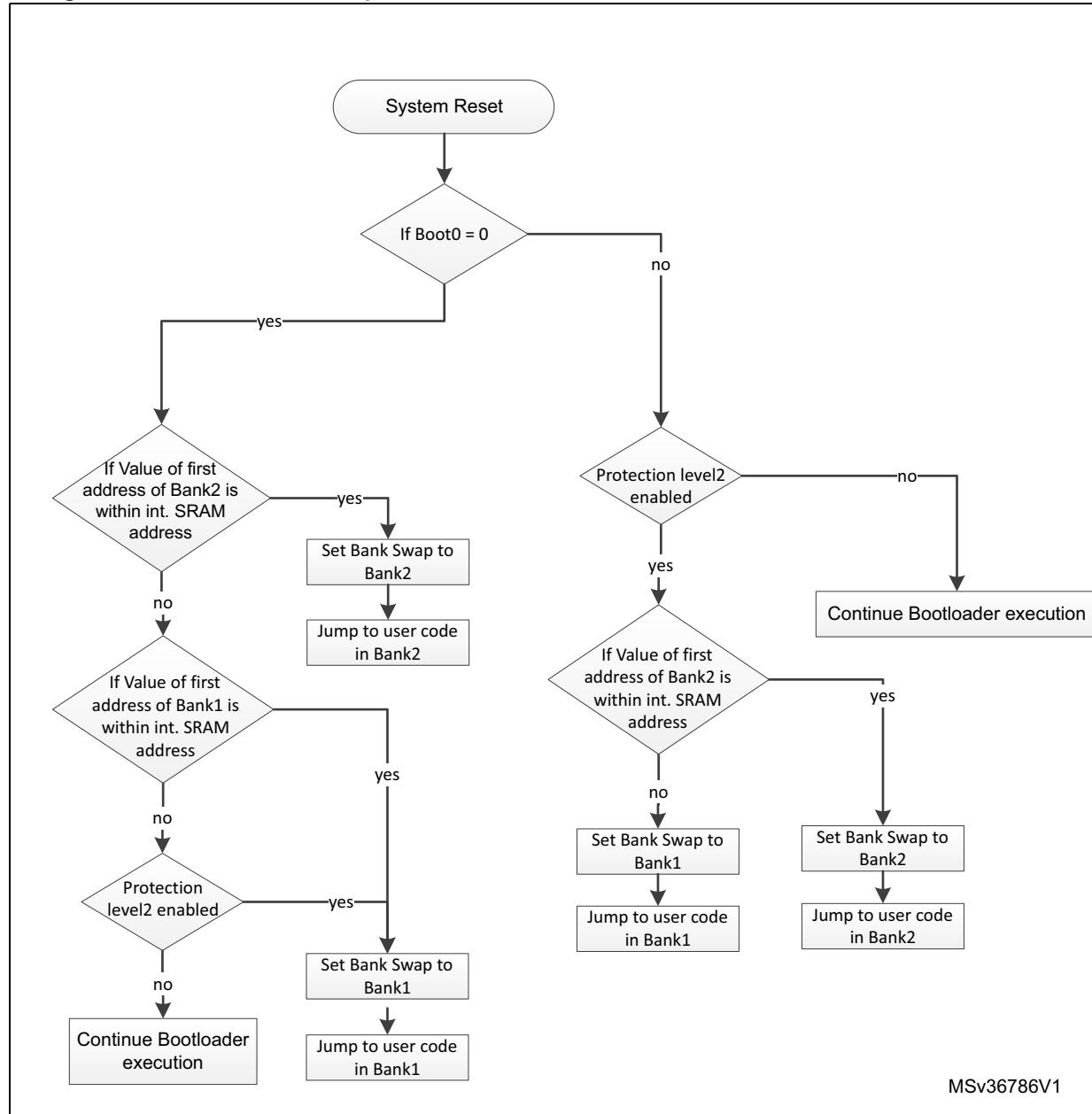
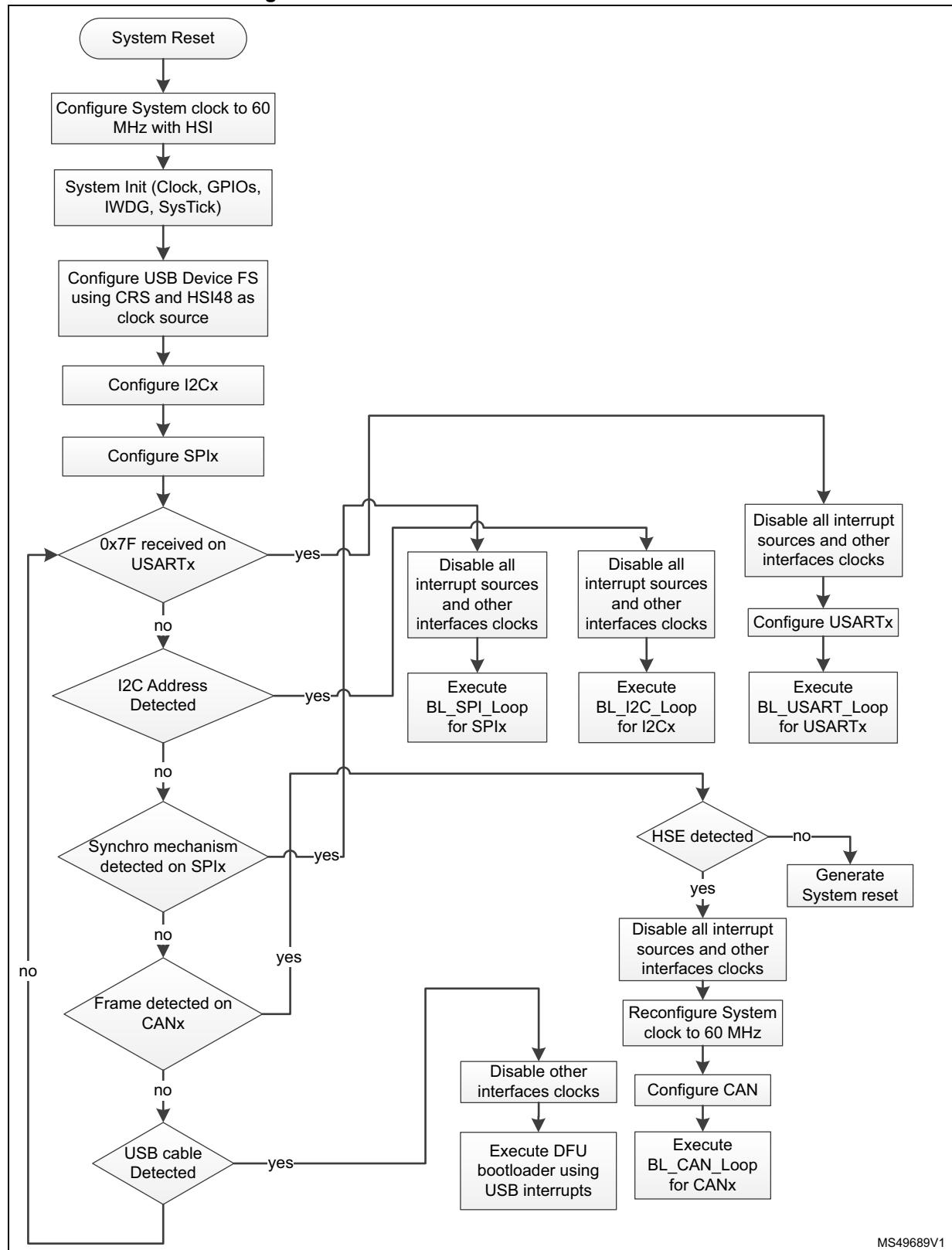


Figure 85.Bootloader V9.x selection for STM32L4Rxx/4Sxx



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## 61.3 Bootloader version

*Table 134* lists the STM32L4Rxx/4Sxx devices bootloader versions.

**Table 134. STM32L4Rxx/4Sxx bootloader versions**

| Bootloader<br>version<br>number | Description                                   | Known limitations |
|---------------------------------|---|-------------------|
| V9.0                            | Initial bootloader version on cut 1.0 samples | – None            |

## 62 STM32L552xx/STM32L562xx devices bootloader

### 62.1 Bootloader configuration

The STM32L552xx/562xx bootloader is activated by applying Pattern 12 (described in [Table 2: Bootloader activation patterns](#)). The following table shows the hardware resources used by this bootloader.

**Table 135. STM32L552xx/562xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 60 MHz (using PLL clocked by HSI).  |
|                           |                    | -           | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI 48 MHz.   |
|                           |                    | -           | 20 MHZ derived from the PLLQ is used for FDCAN  |
|                           | RAM                | -           | 16 Kbytes starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -           | 32 Kbytes starting from address 0x0BF90000.   |
| USART1 bootloader         | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
| USART2 bootloader         | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
|                           | USART2             | Enabled     | Once initialized the USART2 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART2 in reception mode   |
| USART3 bootloader         | USART2_TX pin      | Output      | PA2 pin: USART2 in transmission mode  |
|                           | USART3             | Enabled     | Once initialized the USART3 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART3_RX pin      | Input       | PC11 pin: USART3 in reception mode  |
|                           | USART3_TX pin      | Output      | PC10 pin: USART3 in transmission mode   |

**Table 135. STM32L552xx/562xx configuration in system memory boot mode (continued)**

| Bootloader      | Feature/Peripheral | State        | Comment   |
|-----------------|--------------------|--------------|---|
| I2C1 bootloader | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0101100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                 | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |
| I2C2 bootloader | I2C2               | Enabled      | The I2C2 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0101100x<br>(where x = 0 for write and x = 1 for read) |
|                 | I2C2_SCL pin       | Input/Output | PB10 pin: clock line is used in open-drain mode.  |
|                 | I2C2_SDA pin       | Input/Output | PB11 pin: data line is used in open-drain mode.   |
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b0101100x (where x = 0 for write and x = 1 for read)    |
|                 | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.   |
|                 | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.  |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                                  |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br>Note: This IO can be tied to GND if the SPI Master does not use it.  |

Table 135. STM32L552xx/562xx configuration in system memory boot mode (continued)

| Bootloader       | Feature/Peripheral | State   | Comment   |
|------------------|--------------------|---------|---|
| SPI2 bootloader  | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.  |
|                  | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                  | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode   |
|                  | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode   |
|                  | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.  |
| SPI3 bootloader  | SPI3               | Enabled | The SPI configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.   |
|                  | SPI3_MOSI pin      | Input   | PB5 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                  | SPI3_MISO pin      | Output  | PG10 pin: Slave data output line, used in push-pull, pull-down mode   |
|                  | SPI3_SCK pin       | Input   | PG9 pin: Slave clock line, used in push-pull, pull-down mode  |
|                  | SPI3_NSS pin       | Input   | PG12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.  |
| FDCAN bootloader | FDCAN1             | Enabled | Once initialized the FDCAN1 configuration is:<br>Bitrate 0.5 Mbps<br>FrameFormat = FDCAN_FRAME_FD_BRS<br>Mode = FDCAN_MODE_NORMAL<br>AutoRetransmission = ENABLE<br>TransmitPause = DISABLE<br>ProtocolException = ENABLE |
|                  | FDCAN1_Rx pin      | Input/  | PB9 pin: FDCAN1 in reception mode   |
|                  | FDCAN1_Tx pin      | Output  | PB8 pin: FDCAN1 in transmission mode  |

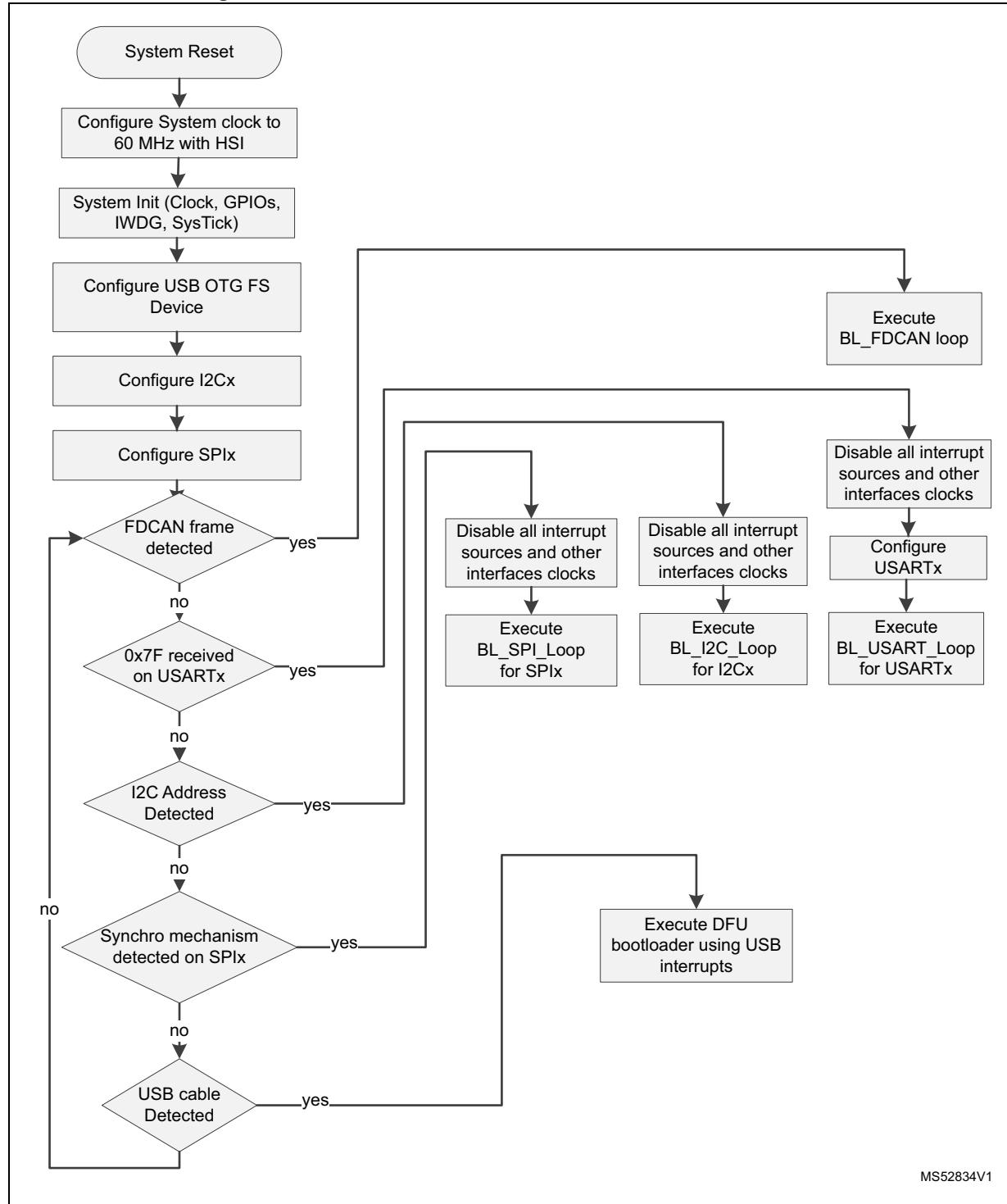
Table 135. STM32L552xx/562xx configuration in system memory boot mode (continued)

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 62.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 86. Bootloader V9.x selection for STM32L552xx/562xx**



MS52834V1

## 62.3 Bootloader version

*Table 136* lists the STM32L552xx/562xx devices bootloader versions.

**Table 136. STM32L552xx/562xx bootloader versions**

| Bootloader version number | Description   | Known limitations   |
|---------------------------|---|---|
| V13.0                     | Initial bootloader version on cut1.0 samples  | <ul style="list-style-type: none"> <li>– USART3 not working</li> <li>– SPI3 not working</li> <li>– OB launch not working on USB-DFU</li> <li>– No read/write SRAM2 in all protocols</li> <li>– Read Secure Option bytes only implemented on USART/I2C</li> <li>– Regression from TZen = 1 to TZen = 0 is done automatically on RDP regression</li> </ul>  |
| V9.0                      | Release supported only in cut2.0 <ul style="list-style-type: none"> <li>– Fix all issues on previous release</li> <li>– Add FDCAN support</li> <li>– New command added for TZen disable</li> <li>– Support of sales type 256KB</li> </ul> | <ul style="list-style-type: none"> <li>– Not able to set TZen to 1 option byte using all interfaces of the BL<br/>No WA available</li> <li>– Cannot set RDP level 0.5 nor option bytes in RDP level 0.5 using BL interfaces<br/>No WA available</li> <li>– Multiple reset seen when enabling HW IWDG option byte in TZen = 1<br/>No WA available</li> <li>– Not able to set secure option bytes setting when TZen = 1 and RDP level is 0<br/>No WA available</li> <li>– “Go” Command on USB is not working</li> </ul> |
| V9.1                      | <ul style="list-style-type: none"> <li>– Fix all known limitations of previous release</li> <li>– Add enable BOOT_LOCK BL command</li> <li>– Add support of RDP L1 to 0.5 regression</li> </ul>   | Option byte programming is not working properly when using FDCAN interface<br>This makes the change of the Option byte not effective until a power off power on.  |
| V9.2                      | <ul style="list-style-type: none"> <li>– Fix all known limitations of previous release</li> <li>– Version for silicon revision Z</li> </ul>   | None  |

*Note:* When jumping to the BL the cache must be disabled.

## 63 STM32WB30xx/35xx/50xx/55xx devices bootloader

### 63.1 Bootloader configuration

The STM32WBxxx bootloader is activated by applying Pattern 16 (described in [Table 2: Bootloader activation patterns](#)). [Table 137](#) shows the hardware resources used by this bootloader.

**Table 137. STM32WB30xx/35xx/50xx/55xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State        | Comment   |
|---------------------------|--------------------|--------------|---|
| Common to all bootloaders | RCC                | MSI enabled  | The system clock frequency is 64 MHz (using PLL clocked by MSI).  |
|                           |                    | -            | The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI 48 MHz.   |
|                           | RAM                | -            | 20 Kbytes starting from address 0x20000000 are used by the bootloader firmware  |
|                           | System memory      | -            | 28 Kbytes starting from address 0x1FFF0000, contain the bootloader firmware   |
| USART1 bootloader         | IWDG               | -            | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
|                           | USART1             | Enabled      | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input        | PA10 pin: USART1 in reception mode  |
| I2C1 bootloader           | USART1_TX pin      | Output       | PA9 pin: USART1 in transmission mode  |
|                           | I2C1               | Enabled      | The I2C1 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001111x (where x = 0 for write and x = 1 for read)                            |
|                           | I2C1_SCL pin       | Input/Output | PB6 pin: clock line is used in open-drain mode.   |
|                           | I2C1_SDA pin       | Input/Output | PB7 pin: data line is used in open-drain mode.  |

Table 137. STM32WB30xx/35xx/50xx/55xx configuration in system memory boot mode

| Bootloader      | Feature/Peripheral | State        | Comment  |
|-----------------|--------------------|--------------|--|
| I2C3 bootloader | I2C3               | Enabled      | The I2C3 configuration is:<br>I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON.<br>Slave 7-bit address: 0b1001111x (where x = 0 for write and x = 1 for read) |
|                 | I2C3_SCL pin       | Input/Output | PC0 pin: clock line is used in open-drain mode.  |
|                 | I2C3_SDA pin       | Input/Output | PC1 pin: data line is used in open-drain mode.   |
| SPI1 bootloader | SPI1               | Enabled      | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                               |
|                 | SPI1_MOSI pin      | Input        | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output       | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input        | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input        | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.                                  |
| SPI2 bootloader | SPI2               | Enabled      | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware.                               |
|                 | SPI2_MOSI pin      | Input        | PB15 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output       | PB14 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input        | PB13 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input        | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.                                 |

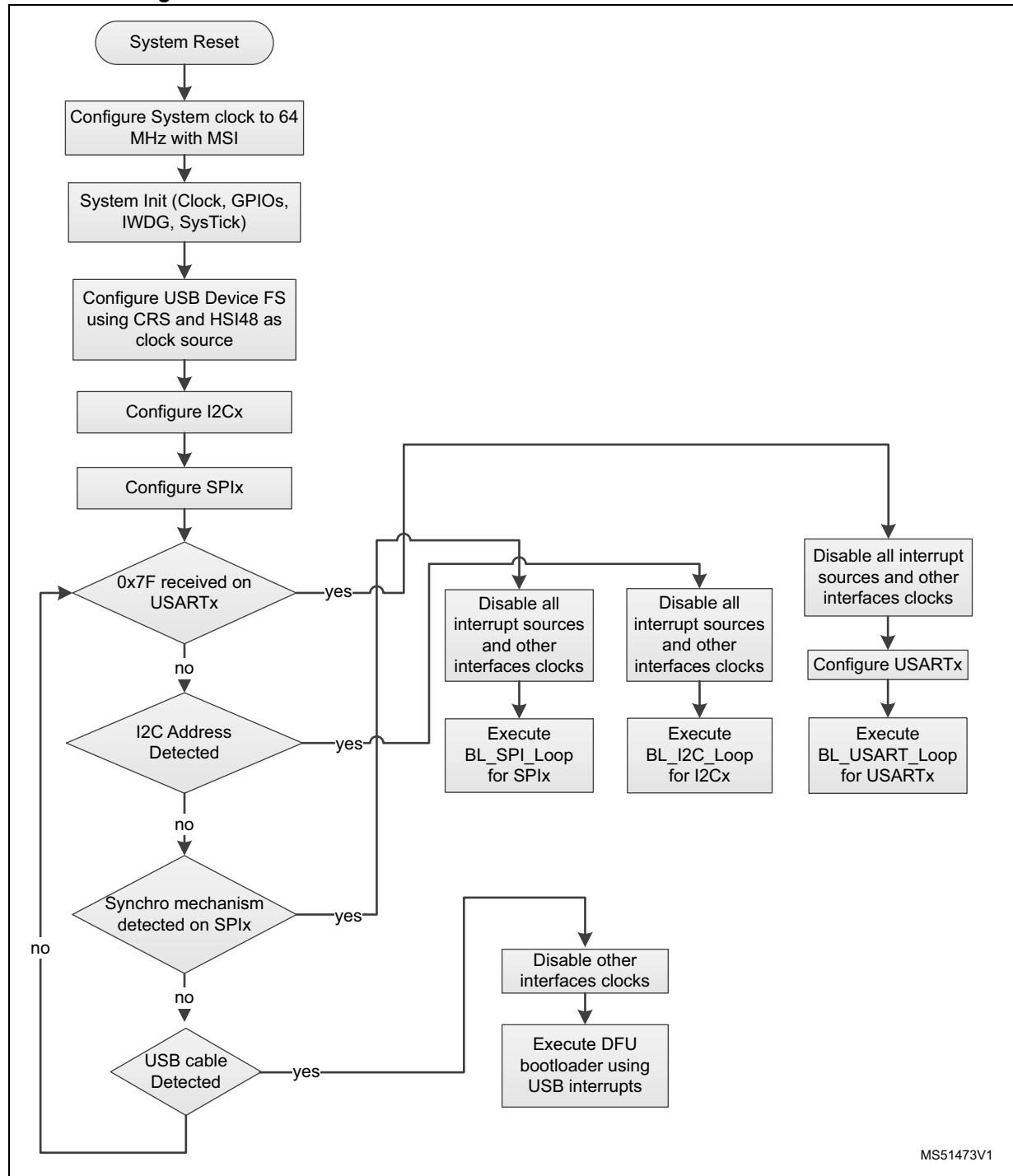
Table 137. STM32WB30xx/35xx/50xx/55xx configuration in system memory boot mode

| Bootloader     | Feature/Peripheral | State        | Comment   |
|----------------|--------------------|--------------|---|
| DFU bootloader | USB                | Enabled      | USB FS configured in forced device mode.<br>USB FS interrupt vector is enabled and used for USB DFU communications.<br><b>Note:</b> VDDUSB IO must be connected to 3.3 V for USB to be operational. |
|                | USB_DM pin         | Input/Output | PA11: USB DM line.  |
|                | USB_DP pin         |              | PA12: USB DP line<br>No external pull-up resistor is required   |

## 63.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

**Figure 87. Bootloader V13.0 selection for STM32WB30xx/35xx/50xx/55xx**



### 63.3 Bootloader version

Table 138. STM32WB30xx/35xx/50xx/55xx bootloader versions

| Bootloader version number | Description                | Known limitations   |
|---------------------------|----------------------------|---|
| V13.5                     | Initial bootloader version | <ul style="list-style-type: none"><li>– Readout Unprotect Command is not working properly as at the end of the command an NVIC_SystemReset is done instead of a Flash option bytes reload.</li><li>– This makes the change of the RDP level not effective until a power off power on.</li></ul> |

Note: *Instability when performing multiple resets during operations ongoing causing Overrun or FrameError errors on USART Bootloader and not recoverable unless Hardware Reset is performed. Fixed by workaround in FUS V1.0.1 and V1.0.2.*

## 64 STM32WLE5xx/55xx devices bootloader

### 64.1 Bootloader configuration

The STM32WLE5xx/55xx bootloader is activated by applying Pattern 13 (described in [Table 2: Bootloader activation patterns](#)). [Table 139](#) shows the hardware resources used by this bootloader.

**Table 139. STM32WLE5xx/55xx configuration in system memory boot mode**

| Bootloader                | Feature/Peripheral | State       | Comment   |
|---------------------------|--------------------|-------------|---|
| Common to all bootloaders | RCC                | HSI enabled | The system clock frequency is 48 MHz (using PLL clocked by HSI).  |
|                           | RAM                | -           | 8 Kbytes starting from address 0x20000000 are used by the bootloader firmware   |
|                           | System memory      | -           | 16 Kbytes starting from address 0x1FFF0000, contain the bootloader firmware   |
|                           | IWDG               | -           | The independent watchdog (IWDG) prescaler is configured to its maximum value. It is periodically refreshed to prevent watchdog reset (in case the hardware IWDG option was previously enabled by the user). |
| USART1 bootloader         | USART1             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART1_RX pin      | Input       | PA10 pin: USART1 in reception mode  |
|                           | USART1_TX pin      | Output      | PA9 pin: USART1 in transmission mode  |
| USART2 bootloader         | USART2             | Enabled     | Once initialized the USART1 configuration is: 8-bit, even parity and 1 Stop bit   |
|                           | USART2_RX pin      | Input       | PA3 pin: USART1 in reception mode   |
|                           | USART2_TX pin      | Output      | PA2 pin: USART1 in transmission mode  |

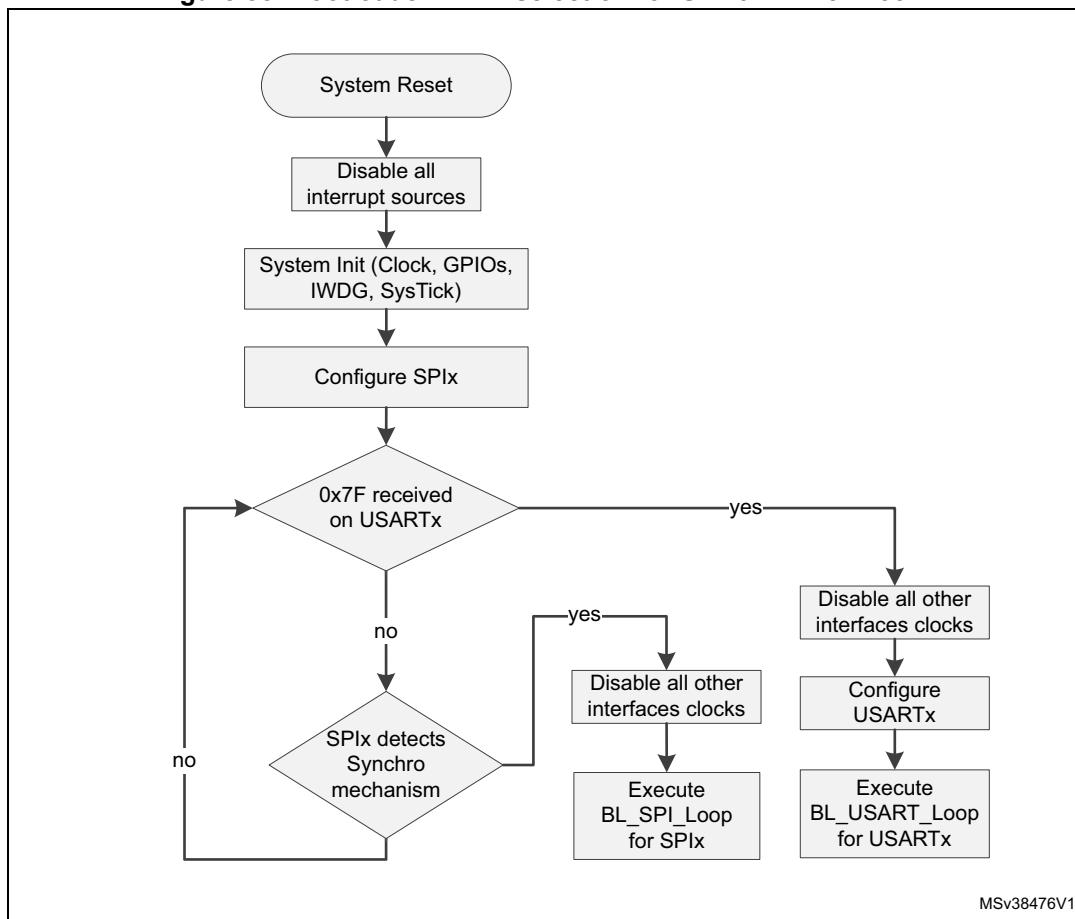
Table 139. STM32WLE5xx/55xx configuration in system memory boot mode (continued)

| Bootloader      | Feature/Peripheral | State   | Comment  |
|-----------------|--------------------|---------|--|
| SPI1 bootloader | SPI1               | Enabled | The SPI1 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI1_MOSI pin      | Input   | PA7 pin: Slave data Input line, used in push-pull, pull-down mode  |
|                 | SPI1_MISO pin      | Output  | PA6 pin: Slave data output line, used in push-pull, pull-down mode   |
|                 | SPI1_SCK pin       | Input   | PA5 pin: Slave clock line, used in push-pull, pull-down mode   |
|                 | SPI1_NSS pin       | Input   | PA4 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.    |
| SPI2 bootloader | SPI2               | Enabled | The SPI2 configuration is:<br>– Slave mode<br>– Full Duplex<br>– 8-bit MSB<br>– Speed up to 8 MHz<br>– Polarity: CPOL Low, CPHA Low, NSS hardware. |
|                 | SPI2_MOSI pin      | Input   | PB15 pin: Slave data Input line, used in push-pull, pull-down mode   |
|                 | SPI2_MISO pin      | Output  | PB14 pin: Slave data output line, used in push-pull, pull-down mode  |
|                 | SPI2_SCK pin       | Input   | PB13 pin: Slave clock line, used in push-pull, pull-down mode  |
|                 | SPI2_NSS pin       | Input   | PB12 pin: slave chip select pin used in push-pull, pull-down mode.<br><b>Note:</b> This IO can be tied to GND if the SPI Master does not use it.   |

## 64.2 Bootloader selection

*Figure 88* shows the bootloader selection mechanism.

**Figure 88. Bootloader V12.x selection for STM32WLE5xx/55xx**



## 64.3 Bootloader version

**Table 140. STM32WLE5xx/55xx bootloader versions**

| Bootloader version number | Description                                  | Known limitations |
|---------------------------|--|-------------------|
| V12.2                     | Initial bootloader version on rev. Z samples | None              |
| V12.3                     | Final bootloader version on rev Z samples    | None              |

## 65 Device-dependent bootloader parameters

The bootloader protocol command set and sequences for each serial peripheral are the same for all STM32 devices. However, some parameters depend on device and bootloader version:

- PID (Product ID)
- Valid RAM memory addresses (RAM area used during bootloader execution is not accessible) accepted by the bootloader when the Read Memory, Go and Write Memory commands are requested.
- System Memory area.

*Table 141* shows the values of these parameters for each STM32 device.

**Table 141. Bootloader device-dependent parameters**

| STM32 Series | Device                      | PID   | BL ID | RAM                     | System memory           |
|--------------|-----------------------------|-------|-------|-------------------------|-------------------------|
| F0           | STM32F05xxx and STM32F030x8 | 0x440 | 0x21  | 0x20000800 - 0x20001FFF | 0x1FFFEC00 - 0x1FFFF7FF |
|              | STM32F03xx4/6               | 0x444 | 0x10  | 0x20000800 - 0x20000FFF |                         |
|              | STM32F030xC                 | 0x442 | 0x52  | 0x20001800 - 0x20007FFF | 0x1FFFD800 - 0x1FFFF7FF |
|              | STM32F04xxx                 | 0x445 | 0xA1  | NA                      | 0x1FFFC400 - 0x1FFFF7FF |
|              | STM32F070x6                 | 0x445 | 0xA2  | NA                      | 0x1FFFC400 - 0x1FFFF7FF |
|              | STM32F070xB                 | 0x448 | 0xA2  | NA                      | 0x1FFFC800 - 0x1FFFF7FF |
|              | STM32F071xx/072xx           | 0x448 | 0xA1  | 0x20001800 - 0x20003FFF | 0x1FFFC800 - 0x1FFFF7FF |
|              | STM32F09xxx                 | 0x442 | 0x50  | NA                      | 0x1FFFD800 - 0x1FFFF7FF |

Table 141. Bootloader device-dependent parameters (continued)

| STM32 Series | Device                       |                           | PID   | BL ID | RAM                     | System memory            |
|--------------|------------------------------|---------------------------|-------|-------|-------------------------|--------------------------|
| F1           | STM32F10xxx                  | Low-density               | 0x412 | NA    | 0x20000200 - 0x200027FF | 0x1FFFF000 - 0x1FFFF7FF  |
|              |                              | Medium-density            | 0x410 | NA    | 0x20000200 - 0x20004FFF |                          |
|              |                              | High-density              | 0x414 | NA    | 0x20000200 - 0x2000FFFF |                          |
|              |                              | Medium-density value line | 0x420 | 0x10  | 0x20000200 - 0x20001FFF |                          |
|              |                              | High-density value line   | 0x428 | 0x10  | 0x20000200 - 0x20007FFF |                          |
|              | STM32F105xx/107xx            |                           | 0x418 | NA    | 0x20001000 - 0x2000FFFF | 0x1FFFFB000 - 0x1FFFF7FF |
| F2           | STM32F10xxx XL-density       |                           | 0x430 | 0x21  | 0x20000800 - 0x20017FFF | 0x1FFFE000 - 0x1FFFF7FF  |
| F3           | STM32F2xxxx                  |                           | 0x411 | 0x20  | 0x20002000 - 0x2001FFFF | 0x1FFF0000 - 0x1FFF77FF  |
|              |                              |                           |       | 0x33  | 0x2001FFFF              |                          |
|              | STM32F373xx                  |                           | 0x432 | 0x41  | 0x20001400 - 0x20007FFF |                          |
|              | STM32F378xx                  |                           |       | 0x50  | 0x20001000 - 0x20007FFF |                          |
|              | STM32F302xB(C)/303xB(C)      |                           | 0x422 | 0x41  | 0x20001400 - 0x20009FFF |                          |
|              | STM32F358xx                  |                           |       | 0x50  | 0x20001400 - 0x20009FFF |                          |
|              | STM32F301xx/302x4(6/8)       |                           | 0x439 | 0x40  | 0x20001800 - 0x20003FFF |                          |
|              | STM32F318xx                  |                           |       | 0x50  | 0x20001800 - 0x20003FFF |                          |
|              | STM32F303x4(6/8)/334xx/328xx |                           | 0x438 | 0x50  | 0x20001800 - 0x20002FFF |                          |
|              | STM32F302xD(E)/303xD(E)      |                           | 0x446 | 0x40  | 0x20001800 - 0x2000FFFF |                          |
|              | STM32F398xx                  |                           | 0x446 | 0x50  | 0x20001800 - 0x2000FFFF |                          |

Table 141. Bootloader device-dependent parameters (continued)

| STM32 Series | Device            | PID   | BL ID | RAM                     | System memory           |
|--------------|-------------------|-------|-------|-------------------------|-------------------------|
| F4           | STM32F40xxx/41xxx | 0x413 | 0x31  | 0x20002000 - 0x2001FFFF | 0x1FFF0000 - 0x1FFF77FF |
|              |                   |       | 0x90  | 0x20003000 - 0x2001FFFF |                         |
|              | STM32F42xxx/43xxx | 0x419 | 0x70  | 0x20003000 - 0x2002FFFF |                         |
|              |                   |       | 0x91  | 0x20003000 - 0x2002FFFF |                         |
|              | STM32F401xB(C)    | 0x423 | 0xD1  | 0x20003000 - 0x2000FFFF |                         |
|              | STM32F401xD(E)    | 0x433 | 0xD1  | 0x20003000 - 0x20017FFF |                         |
|              | STM32F410xx       | 0x458 | 0xB1  | 0x20003000 - 0x20007FFF |                         |
|              | STM32F411xx       | 0x431 | 0xD0  | 0x20003000 - 0x2001FFFF |                         |
|              | STM32F412xx       | 0x441 | 0x90  | 0x20003000 - 0x2003FFFF |                         |
|              | STM32F446xx       | 0x421 | 0x90  | 0x20003000 - 0x2001FFFF |                         |
| F7           | STM32F469xx/479xx | 0x434 | 0x90  | 0x20003000 - 0x2005FFFF | 0x1FF00000 - 0x1FF0EDBF |
|              | STM32F413xx/423xx | 0x463 | 0x90  | 0x20003000 - 0x2004FFFF |                         |
|              | STM32F72xxx/73xxx | 0x452 | 0x90  | 0x20004000 - 0x2003FFFF |                         |
| G0           | STM32F74xxx/75xxx | 0x449 | 0x70  | 0x20004000 - 0x2004FFFF | 0x1FF00000 - 0x1FF0EDBF |
|              |                   |       | 0x90  | 0x20004000 - 0x2004FFFF | 0x1FF00000 - 0x1FF0EDBF |
|              | STM32F76xxx/77xxx |       | 0x451 | 0x93                    | 0x20004000 - 0x2007FFFF |
| G4           | STM32G03xxx/04xxx | 0x466 | 0x52  | 0x20001000 - 0x20001FFF | 0x1FFF0000 - 0x1FFF1FFF |
|              | STM32G07xxx/08xxx | 0x460 | 0xB2  | 0x20002700 - 0x20009000 | 0x1FFF0000 - 0x1FFF6FFF |
| G4           | STM32G431xx/441xx | 0x468 | 0xD4  | 0x20004000 - 0x20005800 | 0x1FFF0000 - 0x1FFF7000 |
|              | STM32G47xxx/48xxx | 0x469 | 0xD5  | 0x20004000 - 0x20018000 | 0x1FFF0000 - 0x1FFF7000 |

Table 141. Bootloader device-dependent parameters (continued)

| STM32 Series | Device            | PID   | BL ID | RAM  | System memory           |
|--------------|-------------------|-------|-------|--|-------------------------|
| H7           | STM32H72xxx/73xxx | 0x483 | 0x91  | 0x20004100 - 0x2001FFFF<br>0x24004000 - 0x2404FFFF | 0x1FF00000 - 0x1FF1E7FF |
|              | STM32H74xxx/75xxx | 0x450 | 0x90  | 0x20004100 - 0x2001FFFF<br>0x24034000 - 0x2407FFFF | 0x1FF00000 - 0x1FF1E7FF |
|              | STM32H7A3xx/B3xx  | 0x480 | 0x90  | 0x20004100 - 0x2001FFFF<br>0x24034000 - 0x2407FFFF | 0x1FF00000 - 0x1FF13FFF |
| L0           | STM32L01xxx/02xxx | 0x457 | 0xC3  | NA   | 0x1FF00000 - 0x1FF00FFF |
|              | STM32L031xx/041xx | 0x425 | 0xC0  | 0x20001000 - 0x20001FFF                            | 0x1FF00000 - 0x1FF00FFF |
|              | STM32L05xxx/06xxx | 0x417 | 0xC0  | 0x20001000 - 0x20001FFF                            | 0x1FF00000 - 0x1FF00FFF |
|              | STM32L07xxx/08xxx | 0x447 | 0x41  | 0x20001000 - 0x20004FFF                            | 0x1FF00000 - 0x1FF01FFF |
| L1           | STM32L1xxx6(8/B)  |       | 0x416 | 0x20   |                         |
|              | STM32L1xxx6(8/B)A | 0x429 | 0x20  | 0x20001000 - 0x20007FFF                            | 0x1FF00000 - 0x1FF01FFF |
|              | STM32L1xxxC       | 0x427 | 0x40  | 0x20001000 - 0x2000BFFF                            |                         |
|              | STM32L1xxxD       | 0x436 | 0x45  | 0x20001000 - 0x20013FFF                            |                         |
|              | STM32L1xxxE       | 0x437 | 0x40  | 0x20001000 - 0x20013FFF                            |                         |

**Table 141. Bootloader device-dependent parameters (continued)**

| <b>STM32 Series</b> | <b>Device</b>                | <b>PID</b> | <b>BL ID</b> | <b>RAM</b>              | <b>System memory</b>    |
|---------------------|------------------------------|------------|--------------|-------------------------|-------------------------|
| L4                  | STM32L412xx/422xx            | 0x464      | 0xD1         | 0x20002100 - 0x20008000 | 0x1FFF0000 - 0x1FFF6FFF |
|                     | STM32L43xxx/44xxx            | 0x435      | 0x91         | 0x20003100 - 0x2000BFFF | 0x1FFF0000 - 0x1FFF6FFF |
|                     | STM32L45xxx/46xxx            | 0x462      | 0x92         | 0x20003100 - 0x2001FFFF | 0x1FFF0000 - 0x1FFF6FFF |
|                     | STM32L47xxx/48xxx            | 0x415      | 0xA3         | 0x20003000 - 0x20017FFF | 0x1FFF0000 - 0x1FFF6FFF |
|                     |                              |            | 0x92         | 0x20003100 - 0x20017FFF |                         |
|                     | STM32L496xx/4A6xx            | 0x461      | 0x93         | 0x20003100 - 0x2003FFFF | 0x1FFF0000 - 0x1FFF6FFF |
|                     | STM32L4Rxx/4Sxx              | 0x470      | 0x95         | 0x20003200 - 0x2009FFFF | 0x1FFF0000 - 0x1FFF6FFF |
| L5                  | STM32L552xx/562xx            | 0x472      | 0x92         | 0x20004000 - 0x2003FFFF | 0x0BF90000 - 0x0BF97FFF |
|                     | STM32WB30xx/35xx/50xx/WB55xx | 0x495      | 0xD5         | 0x20005000 - 0x20040000 | 0x1FFF0000 - 0x1FFF7000 |
| WL                  | STM32WLE5xx/WL55xx           | 0x497      | 0xC3         | 0x20002000 - 0x2000FFFF | 0x1FFF0000 - 0x1FFF3FFF |

## 66 Bootloader timings

This section presents the typical timings of the bootloader firmware to be used to ensure correct synchronization between host and STM32 device.

Two types of timings are described:

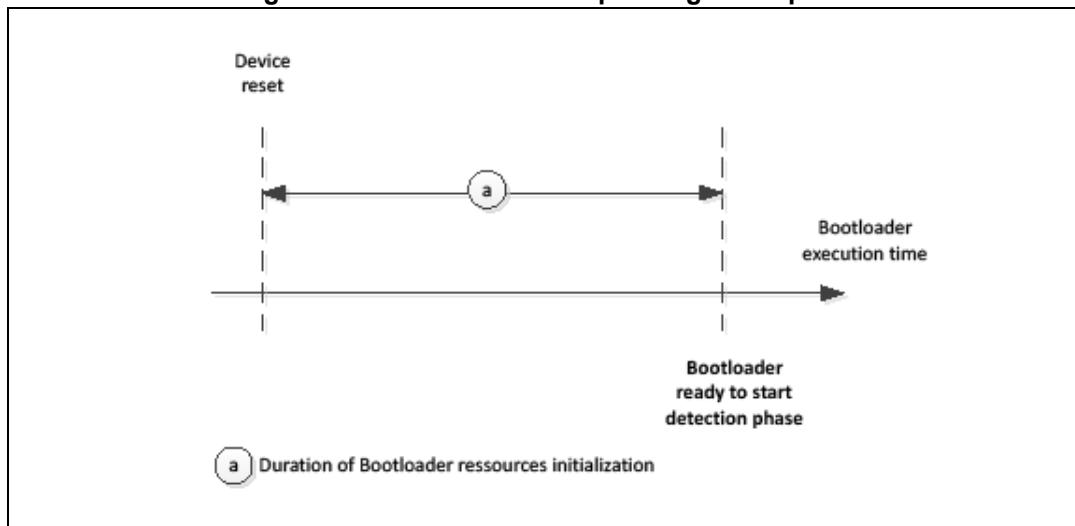
- STM32 device bootloader resources initialization duration.
- Communication interface selection duration.

After these timings the bootloader is ready to receive and execute host commands.

### 66.1 Bootloader startup timing

After bootloader reset, the host must wait until the STM32 bootloader is ready to start detection phase with a specific interface communication. This time corresponds to bootloader startup timing, during which resources used by bootloader are initialized.

**Figure 89. Bootloader Startup timing description**



**Table 142. Bootloader startup timings (ms) for STM32 devices**

| Device                              | Minimum bootloader startup | HSE timeout |
|-------------------------------------|----------------------------|-------------|
| STM32F03xx4/6                       | 1.612                      | NA          |
| STM32F05xxx and STM32F030x8 devices | 1.612                      | NA          |
| STM32F04xxx                         | 0.058                      | NA          |
| STM32F071xx/072xx                   | 0.058                      | NA          |
| STM32F070x6                         | HSE connected              | 3           |
|                                     | HSE not connected          | 230         |
| STM32F070xB                         | HSE connected              | 6           |
|                                     | HSE not connected          | 230         |

**Table 142. Bootloader startup timings (ms) for STM32 devices (continued)**

| Device                       |                   | Minimum bootloader startup | HSE timeout |
|------------------------------|-------------------|----------------------------|-------------|
| STM32F09xxx                  |                   | 2                          | NA          |
| STM32F030xC                  |                   | 2                          | NA          |
| STM32F10xxx                  |                   | 1.227                      | NA          |
| STM32F105xx/107xx            | PA9 pin low       | 1.396                      | NA          |
|                              | PA9 pin high      | 524.376                    |             |
| STM32F10xxx XL-density       |                   | 1.227                      | NA          |
| STM32F2xxxx                  | V2.x              | 134                        | NA          |
|                              | V3.x              | 84.59                      | 0.790       |
| STM32F301xx/302x4(6/8)       | HSE connected     | 45                         | 560.5       |
|                              | HSE not connected | 560.8                      |             |
| STM32F302xB(C)/303xB(C)      | HSE connected     | 43.4                       | 2.236       |
|                              | HSE not connected | 2.36                       |             |
| STM32F302xD(E)/303xD         | HSE connected     | 7.53                       | NA          |
|                              | HSE not connected | 146.71                     | NA          |
| STM32F303x4(6/8)/334xx/328xx |                   | 0.155                      | NA          |
| STM32F318xx                  |                   | 0.182                      | NA          |
| STM32F358xx                  |                   | 1.542                      | NA          |
| STM32F373xx                  | HSE connected     | 43.4                       | 2.236       |
|                              | HSE not connected | 2.36                       |             |
| STM32F378xx                  |                   | 1.542                      | NA          |
| STM32F398xx                  |                   | 1.72                       | NA          |
| STM32F40xxx/41xxx            | V3.x              | 84.59                      | 0.790       |
|                              | V9.x              | 74                         | 96          |
| STM32F401xB(C)               |                   | 74.5                       | 85          |
| STM32F401xD(E)               |                   | 74.5                       | 85          |
| STM32F410xx                  |                   | 0.614                      | NA          |
| STM32F411xx                  |                   | 74.5                       | 85          |
| STM32F412xx                  |                   | 0.614                      | 180         |
| STM32F413xx/423xx            |                   | 0.642                      | 165         |
| STM32F429xx/439xx            | V7.x              | 82                         | 97          |
|                              | V9.x              | 74                         | 97          |
| STM32F446xx                  |                   | 73.61                      | 96          |
| STM32F469xx/479xx            |                   | 73.68                      | 230         |
| STM32F72xxx/73xxx            |                   | 17.93                      | 50          |

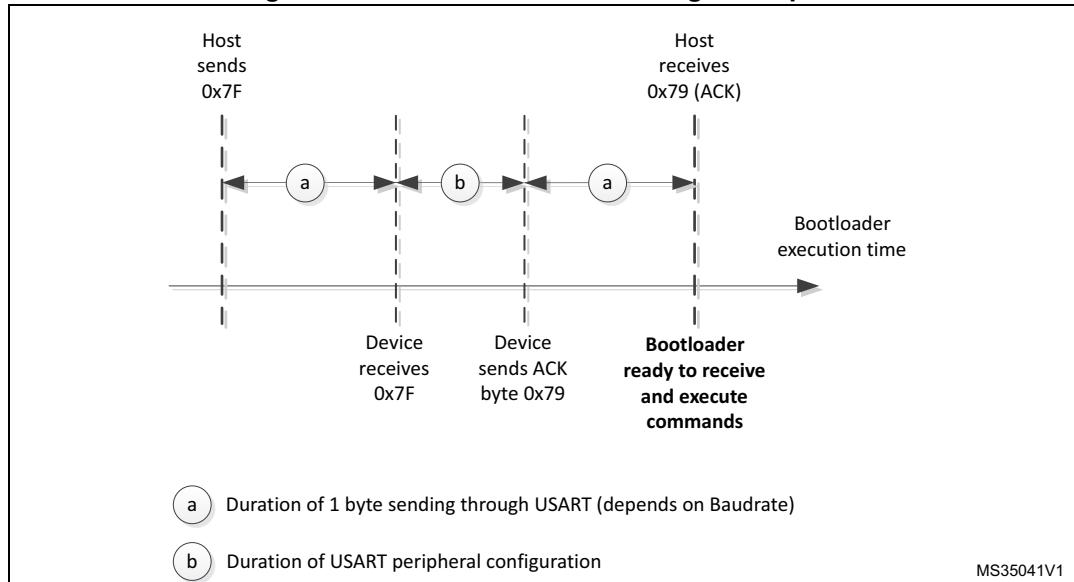
**Table 142. Bootloader startup timings (ms) for STM32 devices (continued)**

| Device                     | Minimum bootloader startup | HSE timeout       |         |     |
|----------------------------|----------------------------|-------------------|---------|-----|
| STM32F74xxx/75xxx          | 16.63                      | 50                |         |     |
| STM32G03xxx/04xxx          | 0.390                      | NA                |         |     |
| STM32G07xxx/08xxx          | 0.390                      | NA                |         |     |
| STM32G4xxxx                | 0.390                      | NA                |         |     |
| STM32H72xxx/73xxx          | 53.975                     | NA                |         |     |
| STM32H74xxx/75xxx          | 53.975                     | 2                 |         |     |
| STM32H7A3xx/B3xx           | 53.975                     | NA                |         |     |
| STM32L01xxx/02xxx          | 0.63                       | NA                |         |     |
| STM32L031xx/041xx          | 0.62                       | NA                |         |     |
| STM32L05xxx/06xxx          | 0.22                       | NA                |         |     |
| STM32L07xxx/08xxx          | V4.x                       | 0.61              |         |     |
|                            | V11.x                      | 0.71              |         |     |
| STM32L1xxx6(8/B)A          | 0.542                      | NA                |         |     |
| STM32L1xxx6(8/B)           | 0.542                      | NA                |         |     |
| STM32L1xxxC                | 0.708                      | 80                |         |     |
| STM32L1xxxD                | 0.708                      | 80                |         |     |
| STM32L1xxxE                | 0.708                      | 200               |         |     |
| STM32L43xxx/44xxx          | 0.3335                     | 100               |         |     |
| STM32L45xxx/46xxx          | 50.93                      | NA                |         |     |
| STM32L47xxx/48xxx          | V10.x                      | LSE connected     | 55      | 100 |
|                            |                            | LSE not connected | 2560    |     |
|                            | V9.x                       | LSE connected     | 55.40   | 100 |
|                            |                            | LSE not connected | 2560.51 |     |
| STM32L412xx/422xx          |                            | 0.12              | NA      |     |
| STM32L496xx/4A6xx          |                            | 76.93             | 100     |     |
| STM32L4P5xx /Q5xx          |                            | NA                | NA      |     |
| STM32L4Rxx/4Sxx            |                            | NA                | NA      |     |
| STM32L552xx/562xx          |                            | 0.390             | NA      |     |
| STM32WB30xx/35xx/50xx/55xx |                            | 0.390             | NA      |     |
| STM32WLE5xx/WL55xx         |                            | 0.390             | NA      |     |

## 66.2 USART connection timing

USART connection timing is the time that the host must wait for between sending the synchronization data (0x7F) and receiving the first acknowledge response (0x79).

**Figure 90. USART connection timing description**



1. Receiving any other character different from 0x7F (or line glitches) will cause bootloader to start communication using a wrong baudrate. Bootloader measures the signal length between rising edge of first 1 bit in 0x7F to the falling edge of the last 1 bit in 0x7F to deduce the baudrate value
2. Bootloader does not re-align the calculated baudrate to standard baudrate values (i.e. 1200, 9600, 115200..).

Note:

For STM32F105xx/107xx line devices, PA9 pin (USB\_VBUS) is used to detect the USB host connection. The initialization of USB peripheral is performed only if PA9 is high at detection phase which means that a host is connected to the port and delivering 5 V on the USB bus. When PA9 level is high at detection phase, more time is required to initialize and shutdown the USB peripheral. To minimize bootloader detection time when PA9 pin is not used, keep PA9 state low during USART detection phase from the moment the device is reset until a device ACK is sent.

**Table 143. USART bootloader minimum timings (ms) for STM32 devices**

| Device                              | One USART byte sending | USART configuration | USART connection |
|-------------------------------------|------------------------|---------------------|------------------|
| STM32F03xx4/6                       | 0.078125               | 0.0064              | 0.16265          |
| STM32F05xxx and STM32F030x8 devices | 0.078125               | 0.0095              | 0.16575          |
| STM32F04xxx                         | 0.078125               | 0.007               | 0.16325          |
| STM32F071xx/072xx                   | 0.078125               | 0.007               | 0.16325          |
| STM32F070x6                         | 0.078125               | 0.014               | 0.17             |
| STM32F070xB                         | 0.078125               | 0.08                | 0.23             |
| STM32F09xxx                         | 0.078125               | 0.07                | 0.22             |
| STM32F030xC                         | 0.078125               | 0.07                | 0.22             |

**Table 143. USART bootloader minimum timings (ms) for STM32 devices (continued)**

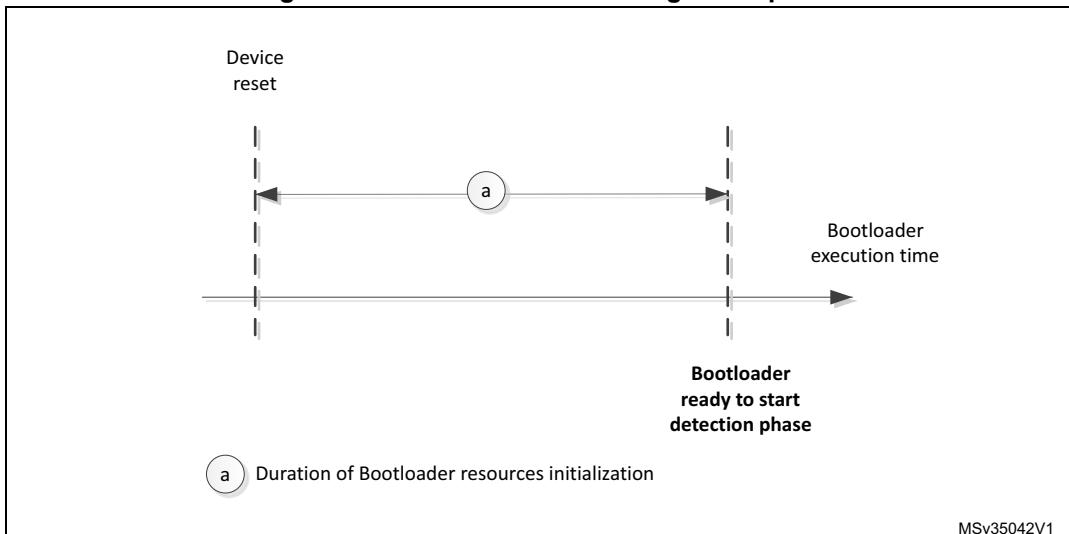
| Device                       |                   | One USART byte sending | USART configuration | USART connection |
|------------------------------|-------------------|------------------------|---------------------|------------------|
| STM32F10xxx                  |                   | 0.078125               | 0.002               | 0.15825          |
| STM32F105xx/107xx            | PA9 pin low       | 0.078125               | 0.007               | 0.16325          |
|                              | PA9 pin High      |                        | 105                 | 105.15625        |
| STM32F10xxx XL-density       |                   | 0.078125               | 0.006               | 0.16225          |
| STM32F2xxxx                  | V2.x              | 0.078125               | 0.009               | 0.16525          |
|                              | V3.x              |                        |                     |                  |
| STM32F301xx/302x4(6/8)       | HSE connected     | 0.078125               | 0.002               | 0.15825          |
|                              | HSE not connected |                        |                     |                  |
| STM32F302xB(C)/303xB(C)      | HSE connected     | 0.078125               | 0.002               | 0.15825          |
|                              | HSE not connected |                        |                     |                  |
| STM32F302xD(E)/303xD         |                   | 0.078125               | 0.002               | 0.15885          |
| STM32F303x4(6/8)/334xx/328xx |                   | 0.078125               | 0.002               | 0.15825          |
| STM32F318xx                  |                   | 0.078125               | 0.002               | 0.15825          |
| STM32F358xx                  |                   | 0.15625                | 0.001               | 0.3135           |
| STM32F373xx                  | HSE connected     | 0.078125               | 0.002               | 0.15825          |
|                              | HSE not connected |                        |                     |                  |
| STM32F378xx                  |                   | 0.15625                | 0.001               | 0.3135           |
| STM32F398xx                  |                   | 0.078125               | 0.002               | 0.15885          |
| STM32F40xxx/41xxx            | V3.x              | 0.078125               | 0.009               | 0.16525          |
|                              | V9.x              |                        | 0.0035              | 0.15975          |
| STM32F401xB(C)               |                   | 0.078125               | 0.00326             | 0.15951          |
| STM32F401xD(E)               |                   | 0.078125               | 0.00326             | 0.15951          |
| STM32F410xx                  |                   | 0.078125               | 0.002               | 0.158            |
| STM32F411xx                  |                   | 0.078125               | 0.00326             | 0.15951          |
| STM32F412xx                  |                   | 0.078125               | 0.002               | 0.158            |
| STM32F413xx/423xx            |                   | 0.078125               | 0.002               | 0.158            |
| STM32F429xx/439xx            | V7.x              | 0.078125               | 0.007               | 0.16325          |
|                              | V9.x              |                        | 0.00326             | 0.15951          |
| STM32F446xx                  |                   | 0.078125               | 0.004               | 0.16             |
| STM32F469xx/479xx            |                   | 0.078125               | 0.003               | 0.159            |
| STM32F72xxx/73xxx            |                   | 0.078125               | 0.070               | 0.22             |
| STM32F74xxx/75xxx            |                   | 0.078125               | 0.065               | 0.22             |
| STM32G03xxx/04xxx            |                   | 0.078125               | 0.01                | 0.11             |
| STM32G07xxx/08xxx            |                   | 0.078125               | 0.01                | 0.11             |

**Table 143. USART bootloader minimum timings (ms) for STM32 devices (continued)**

| Device                     | One USART byte sending | USART configuration | USART connection |
|----------------------------|------------------------|---------------------|------------------|
| STM32G4xxxx                | 0.078125               | 0.003               | 0.159            |
| STM32H72xxx/73xxx          | 0.078125               | 0.072               | 0.22825          |
| STM32H74xxx/75xxx          | 0.078125               | 0.072               | 0.22825          |
| STM32H7A3xx/B3xx           | 0.078125               | 0.072               | 0.22825          |
| STM32L01xxx/02xxx          | 0.078125               | 0.016               | 0.17             |
| STM32L031xx/041xx          | 0.078125               | 0.018               | 0.174            |
| STM32L05xxx/06xxx          | 0.078125               | 0.018               | 0.17425          |
| STM32L07xxx/08xxx          | V4.x                   | 0.078125            | 0.017            |
|                            | V11.x                  | 0.078125            | 0.017            |
| STM32L1xxx6(8/B)A          | 0.078125               | 0.008               | 0.16425          |
| STM32L1xxx6(8/B)           | 0.078125               | 0.008               | 0.16425          |
| STM32L1xxxC                | 0.078125               | 0.008               | 0.16425          |
| STM32L1xxxD                | 0.078125               | 0.008               | 0.16425          |
| STM32L1xxxE                | 0.078125               | 0.008               | 0.16425          |
| STM32L412xx/422xx          | 0.078125               | 0.005               | 0.2              |
| STM32L43xxx/44xxx          | 0.078125               | 0.003               | 0.159            |
| STM32L45xxx/46xxx          | 0.078125               | 0.07                | 0.22             |
| STM32L47xxx/48xxx          | V10.x                  | 0.078125            | 0.003            |
|                            | V9.x                   | 0.078125            | 0.003            |
| STM32L496xx/4A6xx          | 0.078125               | 0.003               | 0.159            |
| STM32L4Rxx/4Sxx            | NA                     | NA                  | NA               |
| STM32L4P5xx/4Q5xx          | NA                     | NA                  | NA               |
| STM32L552xx/562xx          | 0.078125               | 0.01                | 0.11             |
| STM32WB30xx/35xx/50xx/55xx | 0.078125               | 0.003               | 0.159            |
| STM32WLE5xx/WL55xx         | 0.078125               | 0.001               | 0.110            |

### 66.3 USB connection timing

USB connection timing is the time that the host must wait for between plugging the USB cable and establishing a correct connection with the device. This timing includes enumeration and DFU components configuration. USB connection depends on the host.

**Figure 91. USB connection timing description**

**Note:** For STM32F105xx/107xx devices, if the external HSE crystal frequency is different from 25 MHz (14.7456 MHz or 8 MHz), the device performs several unsuccessful enumerations (with connect / disconnect sequences) before being able to establish a correct connection with the host. This is due to the HSE automatic detection mechanism based on Start Of Frame (SOF) detection.

**Table 144. USB bootloader minimum timings (ms) for STM32 devices**

| Device                  | USB connection    |       |
|-------------------------|-------------------|-------|
| STM32F04xxx             | 350               |       |
| STM32F070x6             | TBD               |       |
| STM32F070xB             | 320               |       |
| STM32F105xx/107xx       | HSE = 25 MHz      | 460   |
|                         | HSE = 14.7465 MHz | 4500  |
|                         | HSE = 8 MHz       | 13700 |
| STM32F2xxxx             | 270               |       |
| STM32F301xx/302x4(6/8)  | 300               |       |
| STM32F302xB(C)/303xB(C) | 300               |       |
| STM32F302xD(E)/303xD    | 100               |       |
| STM32F373xx             | 300               |       |
| STM32F40xxx/41xxx       | V3.x              | 270   |
|                         | V9.x              | 250   |
| STM32F401xB(C)          | 250               |       |
| STM32F401xD(E)          | 250               |       |
| STM32F411xx             | 250               |       |
| STM32F412xx             | 380               |       |
| STM32F413xx/423xx       | 350               |       |

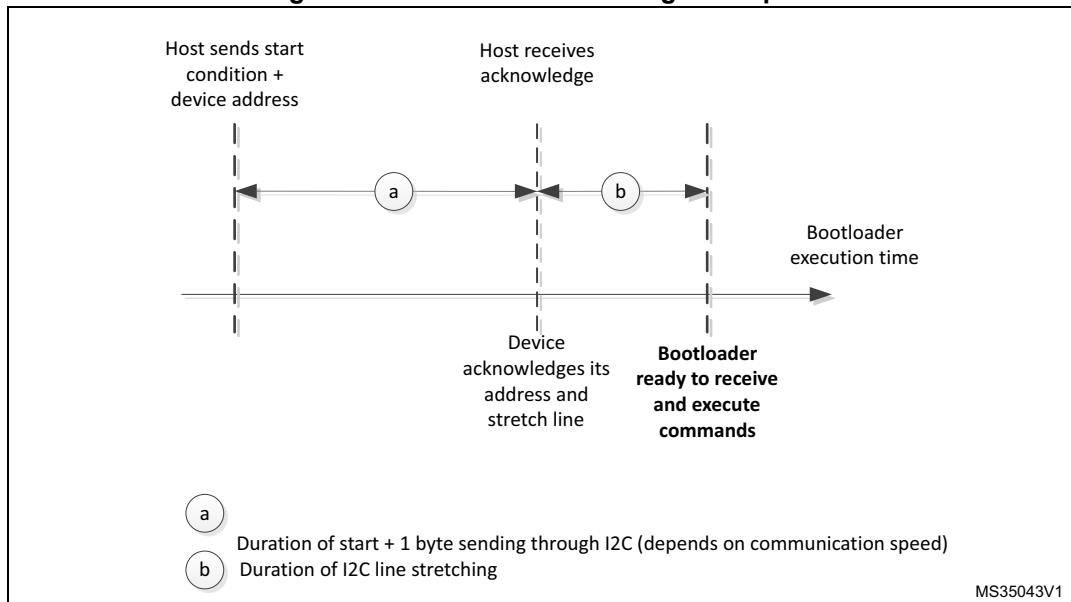
**Table 144. USB bootloader minimum timings (ms) for STM32 devices (continued)**

| Device                     | USB connection |
|----------------------------|----------------|
| STM32F429xx/439xx          | V7.x           |
|                            | V9.x           |
| STM32F446xx                | 200            |
| STM32F469xx/479xx          | 270            |
| STM32F72xxx/73xxx          | 320            |
| STM32F74xxx/75xxx          | 230            |
| STM32G4xxxx                | 300            |
| STM32H72xxx/73xxx          | 53.9764        |
| STM32H74xxx/75xxx          | 53.9764        |
| STM32H7A3xx/B3xx           | 53.9764        |
| STM32L07xxx/08xxx          | 140            |
| STM32L1xxxC                | 849            |
| STM32L1xxxD                | 849            |
| STM32L412xx/422xx          | 820            |
| STM32L43xxx/44xxx          | 820            |
| STM32L45xxx/46xxx          | 330            |
| STM32L47xxx/48xxx          | V10.x          |
|                            | V9.x           |
| STM32L496xx/4A6xx          | 430            |
| STM32L4P5xx/4Q5xx          | NA             |
| STM32L4Rxx/4Sxx            | NA             |
| STM32L552xx/L562xx         | 300            |
| STM32WB30xx/35xx/50xx/55xx | 300            |

## 66.4 I2C connection timing

I2C connection timing is the time that the host must wait for between sending I2C device address and sending command code. This timing includes I2C line stretching duration.

**Figure 92. I2C connection timing description**



**Note:** For I2C communication, a timeout mechanism is implemented and it must be respected to execute bootloader commands correctly. This timeout is implemented between two I2C frames in the same command (eg: for Write memory command a timeout is inserted between command sending frame and address memory sending frame). Also the same timeout period is inserted between two successive data receptions or transmissions in the same I2C frame. If the timeout period is elapsed a system reset is generated to avoid bootloader crash.

In erase memory command and read-out unprotected command, the duration of the operation must be taken into consideration when implementing the host side. After sending the code of pages to be erased, the host must wait until the bootloader device performs page erasing to complete the remaining steps of erase command.

**Table 145. I2C bootloader minimum timings (ms) for STM32 devices**

| Device                       | Start condition + one I2C byte sending | I2C line stretching | I2C connection | I2C timeout |
|------------------------------|--|---------------------|----------------|-------------|
| STM32F04xxx                  | 0.0225                                 | 0.0025              | 0.0250         | 1000        |
| STM32F070x6                  | 0.0225                                 | 0.0025              | 0.0245         | 1000        |
| STM32F070xB                  | 0.0225                                 | 0.0025              | 0.0245         | 1000        |
| STM32F071xx/072xx            | 0.0225                                 | 0.0025              | 0.0250         | 1000        |
| STM32F09xxx                  | 0.0225                                 | 0.0025              | 0.0245         | 1000        |
| STM32F030xC                  | 0.0225                                 | 0.0025              | 0.0250         | 1000        |
| STM32F303x4(6/8)/334xx/328xx | 0.0225                                 | 0.0027              | 0.0252         | 1000        |

**Table 145. I2C bootloader minimum timings (ms) for STM32 devices (continued)**

| Device            | Start condition<br>+ one I2C byte<br>sending | I2C line<br>stretching | I2C connection | I2C timeout |
|-------------------|--|------------------------|----------------|-------------|
| STM32F318xx       | 0.0225                                       | 0.0027                 | 0.0252         | 1000        |
| STM32F358xx       | 0.0225                                       | 0.0055                 | 0.0280         | 10          |
| STM32F378xx       | 0.0225                                       | 0.0055                 | 0.0280         | 10          |
| STM32F398xx       | 0.0225                                       | 0.0020                 | 0.0245         | 1500        |
| STM32F40xxx/41xxx | 0.0225                                       | 0.0022                 | 0.0247         | 1000        |
| STM32F401xB(C)    | 0.0225                                       | 0.0022                 | 0.0247         | 1000        |
| STM32F401xD(E)    | 0.0225                                       | 0.0022                 | 0.0247         | 1000        |
| STM32F410xx       | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32F411xx       | 0.0225                                       | 0.0022                 | 0.0247         | 1000        |
| STM32F412xx       | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32F413xx/423xx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32F42xxx/43xxx | V7.x   | 0.0225                 | 0.0033         | 0.0258      |
|                   | V9.x   | 0.0225                 | 0.0022         | 0.0247      |
| STM32F446xx       | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32F469xx/479xx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32F72xxx/73xxx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32F74xxx/75xxx | 0.0225                                       | 0.0020                 | 0.0245         | 500         |
| STM32G03xxx/04xxx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32G07xxx/08xxx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32G4xxxx       | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32H72xxx/73xxx | 0.0225                                       | 0.05                   | 0.0745         | 1000        |
| STM32H74xxx/75xxx | 0.0225                                       | 0.05                   | 0.0725         | 1000        |
| STM32H7A3xx/7B3xx | 0.0225                                       | 0.05                   | 0.0745         | 1000        |
| STM32L07xxx/08xxx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32L412xx/422xx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32L43xxx/44xxx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32L45xxx/46xxx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32L47xxx/48xxx | V10.x  | 0.0225                 | 0.0020         | 0.0245      |
|                   | V9.x   | 0.0225                 | 0.0020         | 0.0245      |
| STM32L496xx/4A6xx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32L4P5xx/4Q5xx | NA   | NA                     | NA             | NA          |
| STM32L4Rxx/4Sxx   | NA   | NA                     | NA             | NA          |

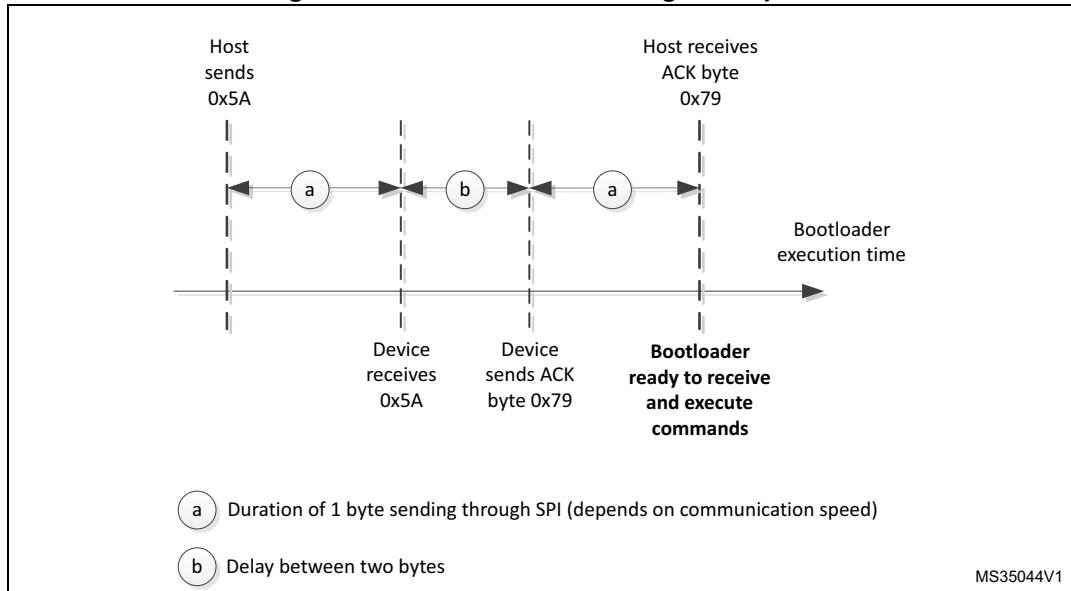
**Table 145. I2C bootloader minimum timings (ms) for STM32 devices (continued)**

| Device                     | Start condition<br>+ one I2C byte<br>sending | I2C line<br>stretching | I2C connection | I2C timeout |
|----------------------------|--|------------------------|----------------|-------------|
| STM32L552xx/L562xx         | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |
| STM32WB30xx/35xx/50xx/55xx | 0.0225                                       | 0.0020                 | 0.0245         | 1000        |

## 66.5 SPI connection timing

SPI connection timing is the time that the host must wait for between sending the synchronization data (0xA5) and receiving the first acknowledge response (0x79).

**Figure 93. SPI connection timing description**



**Table 146. SPI bootloader minimum timings (ms) for STM32 devices**

| Device       | One SPI byte sending | Delay between two bytes | SPI connection |
|--------------|----------------------|-------------------------|----------------|
| All products | 0.001                | 0.008                   | 0.01           |

## Appendix A    Example of function to use the “ExitSecureMemory” function

```
/***
*****
* @file      main.c
*****
*****
*/
/* Includes -----
---*/
#include "main.h"

/* Private function prototypes -----
---*/
static void ConfigClock(void);

void JUMP_WITHOUT_PARAM(uint32_t jump_address);
void JUMP_WITH_PARAM(uint32_t jump_address, uint32_t magic, uint32_t
applicationVectorAddress);

/* Private functions -----
---*/
/*@
 * @brief Main program
 * @param None
 * @retval None
 */
int main(void)
{
    ConfigClock();

    uint32_t application_address          = 0x08000800;
    uint32_t exit_secure_memory_address   = 0x1FFF1E00;
    uint32_t magic_number                = 0x08192A3C;
    uint32_t exit_with_magic_number      = 0x0;

    if (exit_with_magic_number)
    {
        JUMP_WITH_PARAM(exit_secure_memory_address, magic_number,
application_address);
    }
}
```

```
        else
        {
            JUMP_WITHOUT_PARAM(exit_secure_memory_address);
        }
    }

/***
 * @brief ConfigClock
 * @param None
 * @retval None
 */
static void ConfigClock(void)
{
    /* Will be developped as per the template of the needed project */
}

/***
 * @brief JUMP_WITHOUT_PARAM
 * @param jump_address
 * @retval None
 */
void JUMP_WITHOUT_PARAM(uint32_t jump_address)
{
    asm ("LDR R1, [R0]");           // jump_address
    asm ("LDR R2, [R0,#4]");
    asm ("MOV SP, R1");
    asm ("BX R2");
}

/***
 * @brief JUMP_WITH_PARAM
 * @param jump_address, magic, applicationVectorAddress
 * @retval None
 */
void JUMP_WITH_PARAM(uint32_t jump_address, uint32_t magic, uint32_t
applicationVectorAddress)
{
    asm ("MOV R3, R0");           // jump_address
    asm ("LDR R0, [R3]");
    asm ("MOV SP, R0");
    asm ("LDR R0, [R3,#4]");
    asm ("BX R0");
}
```

```
/***** (C) COPYRIGHT STMicroelectronics *****END OF  
FILE****/
```

## 67 Revision history

**Table 147. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 22-Oct-2007 | 1        | Initial release.   |
| 22-Jan-2008 | 2        | <p>All STM32 in production (rev. B and rev. Z) include the bootloader described in this application note.</p> <p>Modified: <a href="#">Section 3.1: Bootloader activation</a> and <a href="#">Section 1.4: Bootloader code sequence</a>.</p> <p>Added: <a href="#">Section 1.3: Hardware requirements</a>, <a href="#">Section 1.5: Choosing the USART baud rate</a>, <a href="#">Section 1.6: Using the bootloader</a> and <a href="#">Section Note 2</a> linked to Get, Get Version &amp; Read Protection Status and Get ID commands in <a href="#">Table 3: Bootloader commands</a>, <a href="#">Note 3</a> added.</p> <p>Notion of “permanent” (Permanent Write Unprotect/Readout Protect/Unprotect) removed from document. Small text changes.</p> <p>Bootloader version upgraded to 2.0.</p>   |
| 26-May-2008 | 3        | <p>Small text changes. RAM and System memory added to <a href="#">Table : The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution</a>.</p> <p><a href="#">Section 1.6: Using the bootloader on page 8</a> removed.</p> <p>Erase modified, <a href="#">Note 3</a> modified and <a href="#">Note 1</a> added in <a href="#">Table 3: Bootloader commands on page 9</a>.</p> <p><a href="#">Byte 3: on page 11</a> modified.</p> <p><a href="#">Byte 2: on page 13</a> modified.</p> <p><a href="#">Byte 2:, Bytes 3-4: and Byte 5: on page 15</a> modified, <a href="#">Note 3</a> modified.</p> <p><a href="#">Byte 8: on page 18</a> modified.</p> <p>Notes added to <a href="#">Section 2.5: Go command on page 18</a>.</p> <p><a href="#">Figure 11: Go command: device side on page 20</a> modified.</p> <p>Note added in <a href="#">Section 2.6: Write Memory command on page 21</a>.</p> <p><a href="#">Byte 8: on page 24</a> modified.</p> <p><a href="#">Figure 14: Erase Memory command: host side</a> and <a href="#">Figure 15: Erase Memory command: device side</a> modified.</p> <p><a href="#">Byte 3: on page 26</a> modified.</p> <p><a href="#">Table 3: Bootloader commands on page 9</a>.</p> <p>Note modified and note added in <a href="#">Section 2.8: Write Protect command on page 27</a>.</p> <p><a href="#">Figure 16: Write Protect command: host side</a>, <a href="#">Figure 17: Write Protect command: device side</a>, <a href="#">Figure 19: Write Unprotect command: device side</a>, <a href="#">Figure 21: Readout Protect command: device side</a> and <a href="#">Figure 23: Readout Unprotect command: device side</a> modified.</p> |
| 29-Jan-2009 | 4        | This application note also applies to the STM32F102xx microcontrollers.<br>Bootloader version updated to V2.2 (see <a href="#">Table 4: Bootloader versions</a> ).   |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 19-Nov-2009 | 5        | <p>IWDG added to <a href="#">Table : The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution.. Note</a> added.</p> <p>BL changed bootloader in the entire document.</p> <p>Go command description modified in <a href="#">Table : The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution</a>.</p> <p>Number of bytes awaited by the bootloader corrected in <a href="#">Section 2.4: Read Memory command</a>.</p> <p>Note modified below <a href="#">Figure 10: Go command: host side</a>.</p> <p>Note removed in <a href="#">Section 2.5: Go command</a> and note added.</p> <p>Start RAM address specified and note added in <a href="#">Section 2.6: Write Memory command</a>. All options are erased when a Write Memory command is issued to the Option byte area.</p> <p><a href="#">Figure 11: Go command: device side</a> modified.</p> <p><a href="#">Figure 13: Write Memory command: device side</a> modified.</p> <p>Note added and bytes 3 and 4 sent by the host modified in <a href="#">Section 2.7: Erase Memory command</a>.</p> <p>Note added to <a href="#">Section 2.8: Write Protect command</a>.</p> |
| 09-Mar-2010 | 6        | <p>Application note restructured. Value line and connectivity line device bootloader added (Replaces AN2662).</p> <p><a href="#">Introduction</a> changed. <a href="#">Glossary</a> added.</p>  |
| 20-Apr-2010 | 7        | <p><a href="#">Related documents</a>: added XL-density line datasheets and programming manual.</p> <p><a href="#">Glossary</a>: added XL-density line devices.</p> <p><a href="#">Table 3</a>: added information for XL-density line devices.</p> <p><a href="#">Section 4.1: Bootloader configuration</a>: updated first sentence.</p> <p><a href="#">Section 5.1: Bootloader configuration</a>: updated first sentence.</p> <p>Added <a href="#">Section 6: STM32F10xxx XL-density devices bootloader</a>.</p> <p><a href="#">Table 65</a>: added information for XL-density line devices.</p>  |
| 08-Oct-2010 | 8        | Added information for high-density value line devices in <a href="#">Table 3</a> and <a href="#">Table 65</a> .   |
| 14-Oct-2010 | 9        | Removed references to obsolete devices.   |
| 26-Nov-2010 | 10       | Added information on ultralow power devices.  |
| 13-Apr-2011 | 11       | Added information related to STM32F205/215xx and STM32F207/217xx devices.   |
|             |          | Added <a href="#">Section 32: Bootloader timing</a>   |
| 06-Jun-2011 | 12       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 12: STM32L1xxx6(8/B) bootloader versions</a></li> <li>– <a href="#">Table 17: STM32F2xxxx configuration in System memory boot mode</a></li> <li>– <a href="#">Table 18: STM32F2xxxx bootloader V2.x versions</a></li> <li>– <a href="#">Table 20: STM32F2xxxx bootloader V3.x versions</a></li> </ul>  |
| 28-Nov-2011 | 13       | <p>Added information related to STM32F405/415xx and STM32F407/417xx bootloader, and STM32F105xx/107xx bootloader V2.1.</p> <p>Added value line devices in <a href="#">Section 4: STM32F10xxx devices bootloader</a> title and overview.</p>   |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 30-Jul-2012 | 14       | <p>Added information related to STM32F051x6/STM32F051x8 and to High-density ultralow power STM32L151xx, STM32L152xx bootloader.</p> <p>Added case of BOOT1 bit in <a href="#">Section 3.1: Bootloader activation</a>.</p> <p>Updated Connectivity line, High-density ultralow power line, STM32F2xx and STM32F4xx in <a href="#">Table 3: Embedded bootloaders</a>.</p> <p>Added bootloader version V2.2 in <a href="#">Table 8: STM32F105xx/107xx bootloader versions</a>.</p> <p>Added bootloader V2.2 in <a href="#">Section 5.3.1: How to identify STM32F105xx/107xx bootloader versions</a>.</p> <p>Added note related to DFU interface below <a href="#">Table 15: STM32L1xxxx high-density configuration in System memory boot mode</a>. Added V4.2 bootloader know limitations and updated description, and added V4.5 bootloader in <a href="#">Table 16: STM32L1xxxx high-density bootloader versions</a>.</p> <p>Added note related to DFU interface below <a href="#">Table 19: STM32F2xxxx configuration in System memory boot mode</a>. Added V3.2 bootloader know limitations, and added V3.3 bootloader in <a href="#">Table 20: STM32F2xxxx bootloader V3.x versions</a>. Updated STM32F2xx and STM32F4xx system memory end address in <a href="#">Table 21: STM32F40xxx/41xxx configuration in System memory boot mode</a>.</p> <p>Added note related to DFU interface below <a href="#">Table 21: STM32F40xxx/41xxx configuration in System memory boot mode</a>. Added V3.0 bootloader know limitations, and added V3.1 bootloader in <a href="#">Table 22: STM32F40xxx/41xxx bootloader V3.x version</a>.</p> <p>Added bootloader V2.1 know limitations in <a href="#">Table 26: STM32F051xx bootloader versions</a>.</p> <p>Updated STM32F051x6/x8 system memory end address in <a href="#">Table 65: Bootloader device-dependent parameters</a>.</p> <p>Added <a href="#">Table 75: USART bootloader timings for high-density ultralow power devices</a>, and <a href="#">Table 78: USART bootloader timings for STM32F051xx devices</a>.</p> <p>Added <a href="#">Table 88: USB minimum timings for high-density ultralow power devices</a>.</p> |
| 24-Jan-2013 | 15       | <p>Updated generic product names throughout the document (see <a href="#">Glossary</a>).</p> <p>Added the following new sections:</p> <ul style="list-style-type: none"> <li>- <a href="#">Section 8: STM32L1xxxC devices bootloader</a>.</li> <li>- <a href="#">Section 13: STM32F031xx devices bootloader</a>.</li> <li>- <a href="#">Section 14: STM32F373xx devices bootloader</a>.</li> <li>- <a href="#">Section 15: STM32F302xB(C)/303xB(C) devices bootloader</a>.</li> <li>- <a href="#">Section 16: STM32F378xx devices bootloader</a>.</li> <li>- <a href="#">Section 17: STM32F358xx devices bootloader</a>.</li> <li>- <a href="#">Section 18: STM32F427xx/437xx devices bootloader</a>.</li> <li>- <a href="#">Section 34.3: I2C bootloader timing characteristics</a>.</li> </ul> <p>Updated <a href="#">Section 1: Related documents</a> and <a href="#">Section 2: Glossary</a>.</p> <p>Added <a href="#">Table 79</a> to <a href="#">Table 85</a> (USART bootloader timings).</p> <p>Replaced <a href="#">Figure 6</a> to <a href="#">Figure 16</a>, and Figures <a href="#">18</a>, <a href="#">19</a> and <a href="#">42</a>.</p> <p>Modified Tables <a href="#">3</a>, <a href="#">5</a>, <a href="#">9</a>, <a href="#">11</a>, <a href="#">17</a>, <a href="#">20</a>, <a href="#">21</a>, <a href="#">22</a> to <a href="#">13</a>, <a href="#">27</a>, <a href="#">29</a>, <a href="#">31</a>, <a href="#">33</a>, <a href="#">35</a>, <a href="#">37</a> and <a href="#">65</a>.</p> <p>Removed “X = 6: one USART is used” in <a href="#">Section 3.3: Hardware connection requirement</a>.</p> <p>Replaced address 0xFFFF F8002 with address 0xFFFF F802 in <a href="#">Section 12.1: Bootloader configuration</a>.</p> <p>Modified procedure related to execution of the bootloader code in <a href="#">Note: on page 28</a>, in <a href="#">Section 6.2: Bootloader selection</a> and in <a href="#">Section 9.2: Bootloader selection</a>.</p>   |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 06-Feb-2013 | 16       | <p>Added information related to I<sup>2</sup>C throughout the document.</p> <p>Streamlined <a href="#">Table 1: Applicable products</a> and <a href="#">Section 1: Related documents</a>.</p> <p>Modified <a href="#">Table 3: Embedded bootloaders</a> as follows:</p> <ul style="list-style-type: none"> <li>– Replaced "V6.0" with "V1.0"</li> <li>– Replaced "0xFFFF7A6" with "0xFFFF796" in row STM32F31xx</li> <li>– Replaced "0xFFFF7FA6" with "0xFFFF7A6" in row STM32F051xx</li> </ul> <p>Updated figures <a href="#">6</a>, <a href="#">9</a> and <a href="#">11</a>.</p> <p>Added <a href="#">Note</a>: in <a href="#">Glossary</a> and <a href="#">Note</a>: in <a href="#">Section 3.1: Bootloader activation</a>.</p> <p>Replaced:</p> <ul style="list-style-type: none"> <li>– "1.62 V" with "1.8 V" in tables <a href="#">17</a>, <a href="#">19</a>, <a href="#">19</a>, <a href="#">22</a>, <a href="#">21</a>, <a href="#">27</a>, <a href="#">37</a> and <a href="#">59</a></li> <li>– "5 Kbyte" with "4 Kbyte" in row RAM of <a href="#">Table 33</a></li> <li>– "127 pages (2 KB each)" with "4 KB (2 pages of 2 KB each)" in rows F3 of <a href="#">Table 65</a></li> <li>– "The bootloader ID is programmed in the last two bytes of the device system memory" with "The bootloader ID is programmed in the last byte address - 1 of the device system memory" in <a href="#">Section 3.3: Hardware connection requirement</a>.</li> <li>– "STM32F2xxxx devices revision Y" by "STM32F2xxxx devices revision X and Y" in <a href="#">Section 10: STM32F2xxxx devices bootloader</a></li> <li>– "Voltage Range 2" with "Voltage Range 1" in tables <a href="#">11</a>, <a href="#">15</a> and <a href="#">26</a>.</li> </ul> |
| 21-May-2013 | 17       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Introduction</a></li> <li>– <a href="#">Section 2: Glossary</a></li> <li>– <a href="#">Section 3.3: Hardware connection requirement</a></li> <li>– <a href="#">Section 7: STM32L1xxx6(8/B) devices bootloader</a> to include STM32L100 value line</li> <li>– <a href="#">Section 32.2: USART connection timing</a></li> <li>– <a href="#">Section 34.2: USB bootloader timing characteristics</a></li> <li>– <a href="#">Section 34.3: I<sup>2</sup>C bootloader timing characteristics</a></li> <li>– <a href="#">Table 1: Applicable products</a></li> <li>– <a href="#">Table 3: Embedded bootloaders</a></li> <li>– <a href="#">Table 25: STM32F051xx configuration in System memory boot mode</a></li> <li>– <a href="#">Table 27: STM32F031xx configuration in System memory boot mode</a></li> <li>– <a href="#">Table 65: Bootloader device-dependent parameters</a></li> <li>– <a href="#">Figure 17: Bootloader selection for STM32F031xx devices</a></li> </ul> <p>Added <a href="#">Section 19: STM32F429xx/439xx devices bootloader</a>.</p>  |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 19-May-2014 | 18       | <p>Add:</p> <ul style="list-style-type: none"> <li>– <i>Figure 1</i> to <i>Figure 5</i>, <i>Figure 69</i>, <i>Figure 8</i>, <i>Figure 27</i>, <i>Figure 28</i>, <i>Figure 26</i>, from <i>Figure 40</i> to <i>Figure 89</i>, <i>Figure 93</i></li> <li>– <i>Table 4</i>, <i>Table 117</i>, <i>Table 118</i>, from <i>Table 9</i> to <i>Table 48</i>, from <i>Table 49</i> to <i>Table 46</i>, from <i>Table 71</i> to <i>Table 72</i>, from <i>Table 1</i> to <i>Table 146</i></li> <li>– <i>Section 38.4</i>, <i>Section 33.2</i>, <i>Section 66.1</i>, <i>Section 66.5</i></li> <li>– <i>Section 5</i>, <i>Section 23</i>, <i>Section 24</i>, <i>Section 22</i>, from <i>Section 17</i> to <i>Section 58</i></li> <li>– note under <i>Figure 1</i>, <i>Figure 2</i>, <i>Figure 3</i> and <i>Figure 4</i></li> </ul> <p>Updated:</p> <ul style="list-style-type: none"> <li>– Updated starting from <i>Section 4</i> to <i>Section 7</i> and <i>Section 18</i>, <i>Section 33</i> and <i>Section 33</i> the chapter structure organized in three subsection: Bootloader configuration, Bootloader selection and Bootloader version.</li> <li>– Updated <i>Section 58</i> and <i>Section 66</i></li> <li>– Updated block diagram of <i>Figure 27</i> and <i>Figure 22</i>.</li> <li>– Fixed I2C address for STM32F429xx/439xx devices in <i>Table 69</i></li> <li>– <i>Table 1</i>, <i>Table 2</i>, <i>Table 3</i>, <i>Table 27</i>, <i>Table 111</i>, <i>Table 113</i>, <i>Table 115</i>, <i>Table 31</i>, <i>Table 33</i>, <i>Table 53</i>, <i>Table 141</i></li> <li>– from <i>Figure 16</i>, to <i>Figure 30</i>, <i>Figure 10</i>, from <i>Figure 89</i> to <i>Figure 93</i></li> <li>– note on <i>Table 112</i></li> </ul> |
| 29-Jul-2014 | 19       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– notes under <i>Table 2</i></li> <li>– <i>Figure 68</i> and <i>Figure 69</i></li> <li>– <i>Section 3: Glossary</i></li> <li>– replaced any reference to STM32F427xx/437xx with STM32F42xxx/43xxx on <i>Section 33: STM32F42xxx/43xxx devices bootloader</i></li> <li>– replace any occurrence of 'STM32F072xx' with 'STM32F07xxx'</li> <li>– replace any occurrence of 'STM32F051xx' with 'STM32F051xx and STM32F030x8 devices'.</li> <li>– comment field related to OTG_FS_DP and OTG_FS_DM on <i>Table 27</i>, <i>Table 33</i>, <i>Table 53</i>, <i>Table 117</i>, <i>Table 69</i>, <i>Table 71</i>, <i>Table 15</i>, <i>Table 21</i>, <i>Table 57</i>, <i>Table 59</i> and <i>Table 63</i></li> <li>– comment field related to USB_DM on <i>Table 117</i>.</li> <li>– replace reference to "STM32F429xx/439xx" by "STM32F42xxx/43xxx" on <i>Table 3</i></li> <li>– comment field related to SPI2_MOSI, SPI2_MISO, SPI2_SCK and SPI2_NSS pins on <i>Table 71</i></li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– note under <i>Table 2</i></li> <li>– reference to STM32F411 on <i>Table 1</i>, <i>Section 3: Glossary</i>, <i>Table 142</i>, <i>Table 143</i>, <i>Table 144</i>, <i>Table 145</i></li> <li>– <i>Section 30: STM32F411xx devices bootloader</i></li> </ul> <p>Removed reference to STM32F427xx/437xx on <i>Table 3</i>, <i>Section 3: Glossary</i>, <i>Table 141</i>, <i>Table 142</i>, <i>Table 143</i>, <i>Table 144</i></p>   |
| 24-Nov-2014 | 20       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– comment in "SPI1_NSS pin" and "SPI2_NSS pin" rows on <i>Table 117</i> and <i>Table 103</i></li> <li>– comment in "SPI1_NSS pin", "SPI2_NSS pin" and "SPI3_NSS pin" rows on <i>Table 57</i>, <i>Table 59</i> and <i>Table 63</i></li> <li>– <i>Figure 1</i></li> </ul>   |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 11-Mar-2015 | 21       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1</a>, <a href="#">Table 3</a>, <a href="#">Table 25</a>, <a href="#">Table 29</a>, <a href="#">Table 111</a>, <a href="#">Table 31</a>, <a href="#">Table 33</a>, <a href="#">Table 34</a>, <a href="#">Table 53</a>, <a href="#">Table 117</a>, <a href="#">Table 13</a>, <a href="#">Table 14</a>, <a href="#">Table 9</a>, <a href="#">Table 37</a>, <a href="#">Table 69</a>, <a href="#">Table 71</a>, <a href="#">Table 15</a>, <a href="#">Table 16</a>, <a href="#">Table 21</a>, <a href="#">Table 22</a>, <a href="#">Table 35</a>, <a href="#">Table 109</a>, <a href="#">Table 125</a>, <a href="#">Table 141</a>, <a href="#">Table 142</a>, <a href="#">Table 143</a>, <a href="#">Table 144</a> and <a href="#">Table 145</a></li> <li>– <a href="#">Figure 77</a></li> <li>– <a href="#">Chapter 3: Glossary</a></li> <li>– <a href="#">Section 4.1</a> and <a href="#">Section 4.4</a></li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 58: STM32L47xxx/48xxx devices bootloader</a> and <a href="#">Section 34: STM32F446xx devices bootloader</a></li> </ul> |
| 09-Jun-2015 | 22       | <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 9: STM32F070x6 devices bootloader</a></li> <li>– <a href="#">Section 10: STM32F070xB devices bootloader</a></li> <li>– <a href="#">Section 12: STM32F09xxx devices bootloader</a></li> <li>– <a href="#">Section 19: STM32F302xD(E)/303xD(E) devices bootloader</a></li> <li>– <a href="#">Section 25: STM32F398xx devices bootloader</a></li> <li>– <a href="#">Section 36: STM32F72xxx/73xxx devices bootloader</a></li> <li>– <a href="#">Section 58.2: Bootloader V9.x</a></li> <li>– Notes 1 and 2 on <a href="#">Figure 90</a></li> </ul> <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1</a></li> <li>– <a href="#">Section 3: Glossary</a></li> <li>– <a href="#">Table 2</a></li> <li>– <a href="#">Table 3</a></li> <li>– <a href="#">Section 4.4: Bootloader memory management</a></li> <li>– <a href="#">Table 141</a>, <a href="#">Table 142</a>, <a href="#">Table 143</a>, <a href="#">Table 144</a> and <a href="#">Table 145</a></li> </ul>   |
| 29-Sep-2015 | 23       | <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 29: STM32F410xx devices bootloader</a></li> <li>– <a href="#">Section 35: STM32F469xx/479xx devices bootloader</a></li> <li>– <a href="#">Section 47: STM32L031xx/041xx devices bootloader</a></li> <li>– <a href="#">Section 49: STM32L07xxx/08xxx devices bootloader</a></li> </ul> <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1</a></li> <li>– <a href="#">Section 3: Glossary</a></li> <li>– <a href="#">Table 3</a></li> <li>– <a href="#">Figure 77</a>, <a href="#">Table 127</a>, <a href="#">Table 142</a>, <a href="#">Table 143</a>, <a href="#">Table 144</a>, <a href="#">Table 145</a></li> </ul>   |
| 02-Nov-2015 | 24       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1</a>, <a href="#">Table 3</a>, <a href="#">Table 141</a>, <a href="#">Table 142</a>, <a href="#">Table 143</a>, <a href="#">Table 144</a>, <a href="#">Table 145</a></li> <li>– <a href="#">Section 35</a></li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– Note on <a href="#">Section 26.2.1</a></li> <li>– <a href="#">Section 31</a></li> </ul>   |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 01-Dec-2015 | 25       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 4.1</a>, <a href="#">Section 49</a></li> <li>– <a href="#">Table 141</a></li> </ul>  |
| 03-Mar-2016 | 26       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1</a>, <a href="#">Table 3</a>, <a href="#">Table 66</a>, <a href="#">Table 106</a>, <a href="#">Table 108</a>, <a href="#">Table 141</a></li> <li>– <a href="#">Section 3</a>, <a href="#">Section 49.1.1</a>, <a href="#">Section 49.2.1</a>, <a href="#">Section 58</a></li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 46: STM32L01xxx/02xxx devices bootloader</a></li> <li>– <a href="#">Figure 61</a>, <a href="#">Figure 63</a></li> </ul>   |
| 21-Apr-2016 | 27       | <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 38: STM32F76xxx/77xxx devices bootloader</a>, <a href="#">Section 56: STM32L43xxx/44xxx devices bootloader</a>.</li> <li>– Note on: <a href="#">Section 4.1: Bootloader activation</a>, <a href="#">Section 8.1: Bootloader configuration</a>, <a href="#">Section 9.1: Bootloader configuration</a>, <a href="#">Figure 38: Dual bank boot implementation for STM32F42xxx/43xxx Bootloader V7.x</a>, <a href="#">Figure 40: Dual bank boot implementation for STM32F42xxx/43xxx bootloader V9.x</a></li> </ul> <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 11: STM32F030xC configuration in system memory boot mode</a>, <a href="#">Table 17: STM32F070x6 configuration in system memory boot mode</a>, <a href="#">Table 19: STM32F070xB configuration in system memory boot mode</a>, <a href="#">Table 23: STM32F09xxx configuration in system memory boot mode</a>, <a href="#">Table 35: STM32F301xx/302x4(6/8) configuration in system memory boot mode</a>, <a href="#">Table 37: STM32F302xB(C)/303xB(C) configuration in system memory boot mode</a>, <a href="#">Table 39: STM32F302xD(E)/303xD(E) configuration in system memory boot mode</a>, <a href="#">Table 47: STM32F373xx configuration in system memory boot mode</a>, <a href="#">Table 57: STM32F401xB(C) configuration in system memory boot mode</a>, <a href="#">Table 59: STM32F401xD(E) configuration in system memory boot mode</a>, <a href="#">Table 63: STM32F411xx configuration in system memory boot mode</a>, <a href="#">Table 126: STM32L47xxx/48xxx bootloader V10.x versions</a>, <a href="#">Table 128: STM32L47xxx/48xxx bootloader V9.x versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a></li> <li>– <a href="#">Section 3: Glossary</a>,</li> </ul> |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 05-Sep-2016 | 28       | <p>Updated:</p> <ul style="list-style-type: none"> <li>- <i>Table 1: Applicable products, Table 11: STM32F030xC configuration in system memory boot mode, Table 13: STM32F05xxx and STM32F030x8 devices configuration in system memory boot mode, Table 15: STM32F04xxx configuration in system memory boot mode, Table 17: STM32F070x6 configuration in system memory boot mode, Table 19: STM32F070xB configuration in system memory boot mode, Table 21: STM32F071xx/072xx configuration in system memory boot mode, Table 23: STM32F09xxx configuration in system memory boot mode, Table 27: STM32F105xx/107xx configuration in system memory boot mode, Table 29: STM32F10xxx XL-density configuration in system memory boot mode, Table 31: STM32F2xxxx configuration in system memory boot mode, Table 33: STM32F2xxxx configuration in system memory boot mode, Table 35: STM32F301xx/302x4(6/8) configuration in system memory boot mode, Table 37: STM32F302xB(C)/303xB(C) configuration in system memory boot mode, Table 39: STM32F302xD(E)/303xD(E) configuration in system memory boot mode, Table 41: STM32F303x4(6/8)/334xx/328xx configuration in system memory boot mode, Table 43: STM32F318xx configuration in system memory boot mode, Table 45: STM32F358xx configuration in system memory boot mode, Table 47: STM32F373xx configuration in system memory boot mode, Table 49: STM32F378xx configuration in system memory boot mode, Table 51: STM32F398xx configuration in system memory boot mode, Table 53: STM32F40xxx/41xxx configuration in system memory boot mode, Table 55: STM32F40xxx/41xxx configuration in system memory boot mode, Table 57: STM32F401xB(C) configuration in system memory boot mode, Table 59: STM32F401xD(E) configuration in system memory boot mode, Table 63: STM32F411xx configuration in system memory boot mode, Table 69: STM32F42xxx/43xxx configuration in system memory boot mode, Table 71: STM32F42xxx/43xxx configuration in system memory boot mode, Table 73: STM32F446xx configuration in system memory boot mode, Table 75: STM32F469xx/479xx configuration in system memory boot mode, Table 79: STM32F74xxx/75xxx configuration in system memory boot mode, Table 81: STM32F74xxx/75xxx configuration in system memory boot mode, Table 103: STM32L05xxx/06xxx configuration in system memory boot mode, Table 109: STM32L1xxx6(8/B)A configuration in system memory boot mode, Table 111: STM32L1xxx6(8/B) configuration in system memory boot mode, Table 113: STM32L1xxxC configuration in system memory boot mode, Table 115: STM32L1xxxD configuration in system memory boot mode, Table 117: STM32L1xxxE configuration in system memory boot mode, Table 122: STM32L43xxx/44xxx bootloader versions, Table 125: STM32L47xxx/48xxx configuration in system memory boot mode, Table 141: Bootloader device-dependent parameters</i></li> <li>- <i>Section 56.1: Bootloader configuration</i></li> <li>- <i>Figure 24: Bootloader selection for STM32F303x4(6/8)/334xx/328xx, Figure 25: Bootloader selection for STM32F318xx, Figure 27: Bootloader selection for STM32F373xx devices, Figure 28: Bootloader selection for STM32F378xx devices, Figure 31: Bootloader V9.x selection for STM32F40xxx/41xxx, Figure 34: Bootloader V11.x selection for STM32F410xx, Figure 36: Bootloader V9.x selection for STM32F412xx, Figure 44: Bootloader V9.x selection for STM32F469xx/479xx, Figure 49: Bootloader V9.x selection for STM32F76xxx/77xxx, Figure 64: Bootloader V11.x selection for STM32L07xxx/08xxx, Figure 77: Bootloader V10.x selection for STM32L47xxx/48xxx</i></li> </ul> |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 07-Dec-2016 | 29       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1: Applicable products</a>, <a href="#">Section 3: Glossary</a>, <a href="#">Section 4.1: Bootloader activation</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 12: STM32F09xxx devices bootloader</a>, <a href="#">Table 14: STM32F105xx/107xx devices bootloader</a>, <a href="#">Table 15: STM32F10xxx XL-density devices bootloader</a>, <a href="#">Table 16: STM32F2xxxx devices bootloader</a>, <a href="#">Table 17: STM32F301xx/302x4(6/8) devices bootloader</a>, <a href="#">Table 18: STM32F302xB(C)/303xB(C) devices bootloader</a>, <a href="#">Table 20: STM32F303x4(6/8)/334xx/328xx devices bootloader</a>, <a href="#">Table 22: STM32F358xx devices bootloader</a>, <a href="#">Table 25: STM32F398xx devices bootloader</a>, <a href="#">Table 29: STM32F410xx devices bootloader</a>, <a href="#">Table 32: STM32F413xx/423xx devices bootloader</a>, <a href="#">Table 59: STM32F401xD(E) configuration in system memory boot mode</a>, <a href="#">Section 14.3.1: How to identify STM32F105xx/107xx bootloader versions</a>, <a href="#">Section 28.1: Bootloader configuration</a>, <a href="#">Table 61: STM32F410xx configuration in system memory boot mode</a>, <a href="#">Table 63: STM32F411xx configuration in system memory boot mode</a>, <a href="#">Table 65: STM32F412xx configuration in system memory boot mode</a>, <a href="#">Section 30.1: Bootloader configuration</a>, <a href="#">Table 70: STM32F42xxx/43xxx bootloader V7.x versions</a>, <a href="#">Table 72: STM32F42xxx/43xxx bootloader V9.x versions</a>, <a href="#">Table 83: STM32F76xxx/77xxx configuration in system memory boot mode</a>, <a href="#">Table 84: STM32F76xxx/77xxx bootloader V9.x versions</a>, <a href="#">Table 100: STM32L01xxx/02xxx bootloader versions</a>, <a href="#">Table 108: STM32L07xxx/08xxx bootloader V11.x versions</a>, <a href="#">Table 121: STM32L43xxx/44xxx configuration in system memory boot mode</a>, <a href="#">Table 122: STM32L43xxx/44xxx bootloader versions</a>, <a href="#">Table 126: STM32L47xxx/48xxx bootloader V10.x versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a></li> <li>Added:</li> <li>– <a href="#">Section 32: STM32F413xx/423xx devices bootloader</a></li> </ul> |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 13-Mar-2017 | 30       | <p>Updated:</p> <ul style="list-style-type: none"> <li>- <a href="#">Table 1: Applicable products</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 14: STM32F05xxx and STM32F030x8 devices bootloader versions</a>, <a href="#">Table 15: STM32F04xxx configuration in system memory boot mode</a>, <a href="#">Table 16: STM32F04xxx bootloader versions</a>, <a href="#">Table 18: STM32F070x6 bootloader versions</a>, <a href="#">Table 20: STM32F070xB bootloader versions</a>, <a href="#">Table 21: STM32F071xx/072xx configuration in system memory boot mode</a>, <a href="#">Table 22: STM32F071xx/072xx bootloader versions</a>, <a href="#">Table 23: STM32F09xxx configuration in system memory boot mode</a>, <a href="#">Table 24: STM32F09xxx bootloader versions</a>, <a href="#">Table 35: STM32F301xx/302x4(6/8) configuration in system memory boot mode</a>, <a href="#">Table 38: STM32F302xB(C)/303xB(C) bootloader versions</a>, <a href="#">Table 84: STM32F76xxx/77xxx bootloader V9.x versions</a>, <a href="#">Table 99: STM32L01xxx/02xxx configuration in system memory boot mode</a>, <a href="#">Table 122: STM32L43xxx/44xxx bootloader versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 127: STM32L47xxx/48xxx configuration in system memory boot mode</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 146: SPI bootloader minimum timings (ms) for STM32 devices</a></li> <li>- <a href="#">Section 3: Glossary</a>, <a href="#">Section 6.1: Bootloader configuration</a>, <a href="#">Section 14.3.3: USART bootloader Get-Version command returns 0x20 instead of 0x22</a>, RPN reference in <a href="#">Section 56: STM32L43xxx/44xxx devices bootloader</a> and in <a href="#">Section 58: STM32L47xxx/48xxx devices bootloader</a></li> </ul> <p>Added <a href="#">Section 36: STM32F72xxx/73xxx devices bootloader</a> and <a href="#">Section 59: STM32L496xx/4A6xx devices bootloader</a></p> |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 04-Jul-2017 | 31       | <p>Updated:</p> <ul style="list-style-type: none"> <li>- <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 28: STM32F105xx/107xx bootloader versions</a>, <a href="#">Table 33: STM32F2xxxx configuration in system memory boot mode</a>, <a href="#">Table 37: STM32F302xB(C)/303xB(C) configuration in system memory boot mode</a>, <a href="#">Table 45: STM32F358xx configuration in system memory boot mode</a>, <a href="#">Table 47: STM32F373xx configuration in system memory boot mode</a>, <a href="#">Table 49: STM32F378xx configuration in system memory boot mode</a>, <a href="#">Table 55: STM32F40xxx/41xxx configuration in system memory boot mode</a>, <a href="#">Table 57: STM32F401xB(C) configuration in system memory boot mode</a>, <a href="#">Table 59: STM32F401xD(E) configuration in system memory boot mode</a>, <a href="#">Table 63: STM32F411xx configuration in system memory boot mode</a>, <a href="#">Table 69: STM32F42xxx/43xxx configuration in system memory boot mode</a>, <a href="#">Table 73: STM32F446xx configuration in system memory boot mode</a>, <a href="#">Table 75: STM32F469xx/479xx configuration in system memory boot mode</a>, <a href="#">Table 77: STM32F72xxx/73xxx configuration in system memory boot mode</a>, <a href="#">Table 79: STM32F74xxx/75xxx configuration in system memory boot mode</a>, <a href="#">Table 81: STM32F74xxx/75xxx configuration in system memory boot mode</a>, <a href="#">Table 95: STM32H74xxx/75xxx configuration in system memory boot mode</a>, <a href="#">Table 113: STM32L1xxxC configuration in system memory boot mode</a>, <a href="#">Table 115: STM32L1xxxD configuration in system memory boot mode</a>, <a href="#">Table 117: STM32L1xxxE configuration in system memory boot mode</a>, <a href="#">Table 123: STM32L45xxx/46xxx configuration in system memory boot mode</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a></li> <li>- <a href="#">Introduction</a>, <a href="#">Section 3: Glossary</a></li> <li>- <a href="#">Figure 73: Bootloader V9.x selection for STM32L43xxx/44xxx</a></li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>- <a href="#">Section 44: STM32H74xxx/75xxx devices bootloader</a>, <a href="#">Section 57: STM32L45xxx/46xxx devices bootloader</a></li> </ul> |
| 16-Feb-2018 | 32       | <p>Updated <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 96: STM32H74xxx/75xxx bootloader version</a>, <a href="#">Table 129: STM32L496xx/4A6xx configuration in system memory boot mode</a>, <a href="#">Table 130: STM32L496xx/4A6xx bootloader version</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a>.</p> <p>Added <a href="#">Section 61: STM32L4Rxxx/4Sxxx devices bootloader</a></p>   |
| 07-Aug-2018 | 33       | <p>Updated <a href="#">Note: in Section 8.1: Bootloader configuration</a>, <a href="#">Note: in Section 9.1: Bootloader configuration</a></p>  |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 05-Nov-2018 | 34       | <p>Updated <a href="#">Table 1: Applicable products</a>, <a href="#">Table 54: STM32F40xxx/41xxx bootloader V3.x versions</a>, <a href="#">Table 56: STM32F40xxx/41xxx bootloader V9.x versions</a>, <a href="#">Table 58: STM32F401xB(C) bootloader versions</a>, <a href="#">Table 60: STM32F401xD(E) bootloader versions</a>, <a href="#">Table 62: STM32F410xx bootloader V11.x versions</a>, <a href="#">Table 64: STM32F411xx bootloader versions</a>, <a href="#">Table 66: STM32F412xx bootloader V9.x versions</a>, <a href="#">Table 68: STM32F413xx/423xx bootloader V9.x versions</a>, <a href="#">Table 70: STM32F42xxx/43xxx bootloader V7.x versions</a>, <a href="#">Table 72: STM32F42xxx/43xxx bootloader V9.x versions</a>, <a href="#">Table 74: STM32F446xx bootloader V9.x versions</a>, <a href="#">Table 76: STM32F469xx/479xx bootloader V9.x versions</a>, <a href="#">Table 78: STM32F72xxx/73xxx bootloader V9.x versions</a>, <a href="#">Table 80: STM32F74xxx/75xxx bootloader V7.x versions</a>, <a href="#">Table 82: STM32F74xxx/75xxx bootloader V9.x versions</a>, <a href="#">Table 84: STM32F76xxx/77xxx bootloader V9.x versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>.</p> <p>Added <a href="#">Section 55: STM32L412xx/422xx devices bootloader</a></p> |
| 06-Dec-2018 | 35       | <p>Updated <a href="#">Table 1: Applicable products</a>, <a href="#">Section 3: Glossary</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a>.</p> <p>Added <a href="#">Section 40: STM32G07xxx/08xxx device bootloader</a></p>  |
| 21-Feb-2019 | 36       | <p>Updated <a href="#">Table 1: Applicable products</a>, <a href="#">Section 3: Glossary</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a>.</p> <p>Added <a href="#">Section 63: STM32WB30xx/35xx/50xx/55xx devices bootloader</a></p>  |
| 06-May-2019 | 37       | <p>Updated <a href="#">Table 1: Applicable products</a>, <a href="#">Section 3: Glossary</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a>.</p> <p>Added <a href="#">Section 41: STM32G431xx/441xx devices bootloader</a>, <a href="#">Section 42: STM32G47xxx/48xxx devices bootloader</a></p>  |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 08-Jul-2019 | 38       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 67: STM32F413xx/423xx configuration in system memory boot mode</a>, <a href="#">Table 95: STM32H74xxx/75xxx configuration in system memory boot mode</a>, <a href="#">Table 96: STM32H74xxx/75xxx bootloader version</a>, <a href="#">Table 101: STM32L031xx/041xx configuration in system memory boot mode</a>, <a href="#">Table 122: STM32L43xxx/44xxx bootloader versions</a>, <a href="#">Table 123: STM32L45xxx/46xxx configuration in system memory boot mode</a>, <a href="#">Table 130: STM32L496xx/4A6xx bootloader version</a>, <a href="#">Table 138: STM32WB30xx/35xx/50xx/55xx bootloader versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a></li> <li>– <a href="#">Section 3: Glossary</a>, <a href="#">Section 4.1: Bootloader activation</a>, <a href="#">Section 39.1: Bootloader configuration</a>, <a href="#">Section 41.1: Bootloader configuration</a></li> <li>– <a href="#">Figure 56: Bootloader V9.x selection for STM32H74xxx/75xxx</a>, <a href="#">Figure 84: Dual bank boot implementation for STM32L4Rxxx/STM32L4Sxxx bootloader V9.x</a></li> </ul> <p>Added Note: in <a href="#">Section 4.2</a>, Note: in <a href="#">Section 13.3</a>, Note: in <a href="#">Section 44.1</a>, Note: in <a href="#">Section 46.1</a>, Section 39: <a href="#">STM32G03xxx/ STM32G04xxx devices bootloader</a></p> |
| 16-Sep-2019 | 39       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 86: STM32G03xx/04xxx bootloader versions</a>, <a href="#">Table 120: STM32L412xx/422xx bootloader versions</a>, <a href="#">Table 122: STM32L43xxx/44xxx bootloader versions</a>, <a href="#">Table 124: STM32L45xxx/46xxx bootloader versions</a>, <a href="#">Table 126: STM32L47xxx/48xxx bootloader V10.x versions</a>, <a href="#">Table 128: STM32L47xxx/48xxx bootloader V9.x versions</a>, <a href="#">Table 130: STM32L496xx/4A6xx bootloader version</a>, <a href="#">Table 132: STM32L4P5xx/4Q5xx bootloader versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a></li> <li>– <a href="#">Section 3: Glossary</a>, <a href="#">Section 4.2: Bootloader identification</a></li> </ul> <p>Added <a href="#">Figure 54: Dual bank boot implementation for STM32G47xxx/48xxx bootloader V13.x</a>, <a href="#">Section 62: STM32L552xx/STM32L562xx devices bootloader</a>, note in <a href="#">Section 63.3: Bootloader version</a></p>  |
| 03-Oct-2019 | 40       | Updated <a href="#">Table 3: Embedded bootloaders</a> , <a href="#">Table 136: STM32L552xx/562xx bootloader versions</a> , <a href="#">Table 138: STM32WB30xx/35xx/50xx/55xx bootloader versions</a>   |
| 25-Oct-2019 | 41       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 78: STM32F72xxx/73xxx bootloader V9.x versions</a>, <a href="#">Table 80: STM32F74xxx/75xxx bootloader V7.x versions</a>, <a href="#">Table 82: STM32F74xxx/75xxx bootloader V9.x versions</a>, <a href="#">Table 84: STM32F76xxx/77xxx bootloader V9.x versions</a>, <a href="#">Table 85: STM32G03xxx/G04xxx configuration in system memory boot mode</a>, <a href="#">Table 96: STM32H74xxx/75xxx bootloader version</a>, <a href="#">Table 132: STM32L4P5xx/4Q5xx bootloader versions</a>, <a href="#">Table 135: STM32L552xx/562xx configuration in system memory boot mode</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a></li> <li>– <a href="#">Section 16: STM32F2xxxx devices bootloader</a></li> </ul>   |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 05-Dec-2019 | 42       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a></li> <li>– <a href="#">Section 3: Glossary</a></li> </ul> <p>Added: <a href="#">Section 45: STM32H7A3xx/B3xx devices bootloader</a>, <a href="#">Section 60: STM32L4P5xx/4Q5xx devices bootloader</a>, <a href="#">Section 64: STM32WLE5xx/55xx devices bootloader</a></p>  |
| 04-Jun-2020 | 43       | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 89: STM32G431xx/441xx configuration in system memory boot mode</a>, <a href="#">Table 91: STM32G47xxx/48xxx configuration in system memory boot mode</a>, <a href="#">Table 92: STM32G47xxx/48xxx bootloader version</a>, <a href="#">Table 96: STM32H74xxx/75xxx bootloader version</a>, <a href="#">Table 98: STM32H7A3xx/7B3xx bootloader version</a>, <a href="#">Table 132: STM32L4P5xx/4Q5xx bootloader versions</a>, <a href="#">Table 135: STM32L552xx/562xx configuration in system memory boot mode</a>, <a href="#">Table 136: STM32L552xx/562xx bootloader versions</a>, <a href="#">Table 137: STM32WB30xx/35xx/50xx/55xx configuration in system memory boot mode</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a></li> <li>– <a href="#">Section 3: Glossary</a>, <a href="#">Section 37: STM32F74xxx/75xxx devices bootloader</a>, <a href="#">Section 39.1: Bootloader configuration</a>, <a href="#">Section 40.1: Bootloader configuration</a>, <a href="#">Section 41.1: Bootloader configuration</a>, <a href="#">Section 42.1: Bootloader configuration</a>, <a href="#">Section 44.1: Bootloader configuration</a></li> </ul> <p>Added:</p> <ul style="list-style-type: none"> <li>– <a href="#">Section 4.5: Bootloader UART baudrate detection</a>, <a href="#">Section 4.6: Programming constraints</a>, <a href="#">Section 4.7: ExitSecureMemory feature</a></li> <li>– Note: in: <a href="#">Section 26.1.1: Bootloader configuration</a>, <a href="#">Section 26.2.1: Bootloader configuration</a>, <a href="#">Section 27.1: Bootloader configuration</a>, <a href="#">Section 28.1: Bootloader configuration</a>, <a href="#">Section 30.1: Bootloader configuration</a>, <a href="#">Section 31.1: Bootloader configuration</a>, <a href="#">Section 32.1: Bootloader configuration</a>, <a href="#">Section 33.1.1: Bootloader configuration</a>, <a href="#">Section 33.2.1: Bootloader configuration</a><a href="#">Section 34.1: Bootloader configuration</a>, <a href="#">Section 35.1: Bootloader configuration</a>, <a href="#">Section 36.1: Bootloader configuration</a>, <a href="#">Section 37.1.1: Bootloader configuration</a>, <a href="#">Section 37.2.1: Bootloader configuration</a>, <a href="#">Section 38.1: Bootloader configuration</a></li> <li>– <a href="#">Figure 72: Dual bank boot Implementation for STM32L3x2xx/44xxx bootloader V9.x</a>, <a href="#">Figure 74: Dual bank boot Implementation for STM32L45xxx/46xxx bootloader V9.x</a>, <a href="#">Figure 80: Dual bank boot Implementation for STM32L496xx/4A6xx bootloader V9.x</a></li> <li>– <a href="#">Appendix A: Example of function to use the “ExitSecureMemory” function</a></li> </ul> <p>Deleted Figure 48. Access to securable memory area from the bootloader for STM32G03xxx/G04xxx, Figure 50. Access to securable memory area from the bootloader for STM32G07xxx/G08xxx, Figure 52. Access to securable memory area, Figure 54. Access to securable memory area</p> |

**Table 147. Document revision history (continued)**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 29-Jul-2020 | 44       | <p>Introduced STM32H72xxx/73xxx devices, hence added <a href="#">Section 43: STM32H72xxx/73xxx devices bootloader</a> and its subsections.</p> <p>Updated <a href="#">Section 3: Glossary</a>, note in <a href="#">Section 39.1: Bootloader configuration</a> and <a href="#">Section 63.1: Bootloader configuration</a>.</p> <p>Updated <a href="#">Table 1: Applicable products</a>, <a href="#">Table 2: Bootloader activation patterns</a>, <a href="#">Table 3: Embedded bootloaders</a>, <a href="#">Table 8: ExitSecureMemory entry address</a>, <a href="#">Table 91: STM32G47xxx/48xxx configuration in system memory boot mode</a>, <a href="#">Table 98: STM32H7A3xx/7B3xx bootloader version</a>, <a href="#">Table 113: STM32L1xxxC configuration in system memory boot mode</a>, <a href="#">Table 115: STM32L1xxxD configuration in system memory boot mode</a>, <a href="#">Table 117: STM32L1xxxE configuration in system memory boot mode</a>, <a href="#">Table 135: STM32L552xx/562xx configuration in system memory boot mode</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a>, <a href="#">Table 144: USB bootloader minimum timings (ms) for STM32 devices</a> and <a href="#">Table 145: I2C bootloader minimum timings (ms) for STM32 devices</a>.</p> <p>Updated <a href="#">Figure 56: Bootloader V9.x selection for STM32H74xxx/75xxx</a>.</p> <p>Minor text edits across the whole document.</p>  |
| 11-Nov-2020 | 45       | <p>Introduced STM32WB30xx, STM32WB35xx, STM32WL55xx in <a href="#">Table 1: Applicable products</a>, <a href="#">Table 3: Embedded bootloaders</a> and in <a href="#">Section 3: Glossary</a></p> <p>Updated:</p> <ul style="list-style-type: none"> <li>- <a href="#">Table 61: STM32F410xx configuration in system memory boot mode</a>, <a href="#">Table 67: STM32F413xx/423xx configuration in system memory boot mode</a>, <a href="#">Table 73: STM32F446xx configuration in system memory boot mode</a>, <a href="#">Table 75: STM32F469xx/479xx configuration in system memory boot mode</a>, <a href="#">Table 77: STM32F72xxx/73xxx configuration in system memory boot mode</a>, <a href="#">Table 81: STM32F74xxx/75xxx configuration in system memory boot mode</a>, <a href="#">Table 83: STM32F76xxx/77xxx configuration in system memory boot mode</a>, <a href="#">Table 87: STM32G07xxx/8xxx configuration in system memory boot mode</a>, <a href="#">Table 89: STM32G431xx/441xx configuration in system memory boot mode</a>, <a href="#">Table 90: STM32G431xx/441xx bootloader version</a>, <a href="#">Table 91: STM32G47xxx/48xxx configuration in system memory boot mode</a>, <a href="#">Table 95: STM32H74xxx/75xxx configuration in system memory boot mode</a>, <a href="#">Table 96: STM32H74xxx/75xxx bootloader version</a>, <a href="#">Table 97: STM32H7A3xx/7B3xx configuration in system memory boot mode</a>, <a href="#">Table 98: STM32H7A3xx/7B3xx bootloader version</a>, <a href="#">Table 99: STM32L01xxx/02xxx configuration in system memory boot mode</a>, <a href="#">Table 101: STM32L031xx/041xx configuration in system memory boot mode</a>, <a href="#">Table 106: STM32L07xxx/08xxx bootloader versions</a>, <a href="#">Table 107: STM32L07xxx/08xxx configuration in system memory boot mode</a>, <a href="#">Table 119: STM32L412xx/422xx configuration in system memory boot mode</a>, <a href="#">Table 131: STM32L4P5xx/4Q5xx configuration in system memory boot mode</a>, <a href="#">Table 133: STM32L4Rxxx/4Sxxx configuration in system memory boot mode</a>, <a href="#">Table 135: STM32L552xx/562xx configuration in system memory boot mode</a>, <a href="#">Table 137: STM32WB30xx/35xx/50xx/55xx configuration in system memory boot mode</a>, <a href="#">Table 139: STM32WLE5xx/55xx configuration in system memory boot mode</a>, <a href="#">Table 140: STM32WLE5xx/55xx bootloader versions</a>, <a href="#">Table 141: Bootloader device-dependent parameters</a>, <a href="#">Table 142: Bootloader startup timings (ms) for STM32 devices</a>, <a href="#">Table 143: USART bootloader minimum timings (ms) for STM32 devices</a></li> <li>- title of <a href="#">Table 63: STM32WB30xx/35xx/50xx/55xx devices bootloader</a>, <a href="#">Table 137: STM32WB30xx/35xx/50xx/55xx configuration in system memory boot mode</a>, <a href="#">Table 64: STM32WLE5xx/55xx devices bootloader</a>, <a href="#">Table 139: STM32WLE5xx/55xx configuration in system memory boot mode</a>, <a href="#">Table 88: Bootloader V12.x selection for STM32WLE5xx/55xx</a>, <a href="#">Table 140: STM32WLE5xx/55xx bootloader versions</a></li> </ul> |

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