

AN2606 Application note

STM32 microcontroller system memory boot mode

Introduction

The bootloader is stored in the internal boot ROM memory (system memory) of STM32 devices. It 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 (USART, CAN, USB, I²C, SPI, etc.). A communication protocol is defined for each serial interface, with a compatible command set and sequences. This document applies to the products listed in *Table 1*. They are referred as STM32 throughout the document.

Table 1. Applicable products

Туре	Part number or product series
Microcontrollers	STM32F0 Series: STM32F03xxx, STM32F04xxx, STM32F05xxx, STM32F07xxx, STM32F09xxx STM32F1 Series. STM32F2 Series: STM32F301xx, STM32F302xx, STM32F303xx, STM32F318xx, STM32F328xx, STM32F3 Series: STM32F334xx, STM32F358xx, STM32F373xx, STM32F378xx, STM32F338xx, STM32F4 Series: STM32F401xx, STM32F405xx, STM32F407xx, STM32F410xx, STM32F411xx, STM32F412xx, STM32F412xx, STM32F415xx, STM32F415xx, STM32F417xx, STM32F423xx, STM32F427xx, STM32F429xx, STM32F437xx, STM32F439xx, STM32F446xx, STM32F769xx, STM32F765xx, STM32F732xx, STM32F733xx, STM32F745xx, STM32F776xx, STM32F776xx, STM32F776xx, STM32F765xx, STM32F765xx, STM32F767xx, STM32F769xx, STM32G0 Series: STM32G030xx,STM32G031xx, STM32G041xx, STM32G07xxx, STM32G08xxx, STM32G4 Series: STM32G431xx, STM32G441xx, STM32G47xxx, STM32G48xxx STM32H7 Series: STM32H743xx, STM32H753xx STM32L0 Series. STM32L1 Series: STM32L431xx, STM32L451xx, STM32L432xx, STM32L462xx, STM32L476xx, STM32L451xx, STM32L462xx, STM32L471xx, STM32L475xx, STM32L476xx, STM32L486xx, STM32L496xx, STM32L471xx, STM32L475xx, STM32L476xx, STM32L4R9xx, STM32L496xx, STM32L4A5xx, STM32L4R5xx, STM32L4R9xx, STM32L4S5xx, STM32L4A5xx, STM32L4A5xx, STM32L4R9xx, STM32L445xx, STM32L4A5xx, STM32

This application note describes the supported peripherals and hardware requirements to be considered when using the bootloader of STM32 devices. However the specifications of the low-level communication protocol for each supported serial peripheral are documented in separate documents as referred in *Section 2: Related documents*.

July 2019 AN2606 Rev 38 1/329

Contents AN2606

Contents

1	Gen	eral information1	7			
2	Related documents					
3	Glos	ssary	8			
4	Gen	eral bootloader description	2			
	4.1	Bootloader activation	2			
	4.2	Bootloader identification	4			
	4.3	Hardware connection requirements	1			
	4.4	Bootloader memory management	3			
5	STM	l32F03xx4/6 devices bootloader	5			
	5.1	Bootloader configuration	5			
	5.2	Bootloader selection	6			
	5.3	Bootloader version	6			
6	STM	l32F030xC devices bootloader3	7			
	6.1	Bootloader configuration	7			
	6.2	Bootloader selection	8			
	6.3	Bootloader version	8			
7	STM	32F05xxx and STM32F030x8 devices bootloader	9			
	7.1	Bootloader configuration	9			
	7.2	Bootloader selection	0			
	7.3	Bootloader version	0			
8	STM	l32F04xxx devices bootloader	1			
	8.1	Bootloader configuration	1			
	8.2	Bootloader selection	3			
	8.3	Bootloader version	4			
9	STM	l32F070x6 devices bootloader	5			



	9.1		ader configuration	
	9.2		ader selection	
	9.3	Bootloa	ader version	48
10	STM	32F070x	αB devices bootloader	49
	10.1	Bootloa	ader configuration	49
	10.2	Bootloa	ader selection	51
	10.3	Bootloa	ader version	52
11	STM	32F071x	xx/072xx devices bootloader	53
	11.1	Bootloa	ader configuration	53
	11.2	Bootloa	ader selection	. 55
	11.3	Bootloa	ader version	55
12	STM	32F09xx	xx devices bootloader	56
	12.1	Bootloa	ader configuration	56
	12.2	Bootloa	ader selection	. 57
	12.3	Bootloa	ader version	57
13	STM	32F10xx	xx devices bootloader	58
	13.1	Bootloa	ader configuration	. 58
	13.2	Bootloa	ader selection	. 59
	13.3	Bootloa	ader version	59
14	STM	32F105x	xx/107xx devices bootloader	61
	14.1		ader configuration	
	14.2	Bootloa	ader selection	63
	14.3	Bootloa	ader version	64
		14.3.1	How to identify STM32F105xx/107xx bootloader versions	
		14.3.2	Bootloader unavailability on STM32F105xx/STM32F107xx devices with a date code below 937	. 65
		14.3.3	USART bootloader Get-Version command returns 0x20 instead of 0x22	. 66
		14.3.4	PA9 excessive power consumption when USB cable is plugged in bootloader V2.0	. 66
15	STM:	32F10xx	xx XL-density devices bootloader	67
	- -		•	
#				



	15.1	Bootloader configuration	67		
	15.2	Bootloader selection	68		
	15.3	Bootloader version	68		
16	STM	32F2xxxx devices bootloader	70		
	16.1	Bootloader V2.x	70		
		16.1.1 Bootloader configuration	70		
		16.1.2 Bootloader selection			
		16.1.3 Bootloader version			
	16.2	Bootloader V3.x			
		16.2.1 Bootloader configuration			
		16.2.2 Bootloader selection			
		16.2.3 Bootloader version	76		
17	STM	32F301xx/302x4(6/8) devices bootloader	77		
	17.1	Bootloader configuration	77		
	17.2	Bootloader selection	79		
	17.3	Bootloader version	79		
18	STM32F302xB(C)/303xB(C) devices bootloader				
	18.1	Bootloader configuration	80		
	18.2	Bootloader selection	82		
	18.3	Bootloader version	82		
19	STM:	32F302xD(E)/303xD(E) devices bootloader	83		
	19.1	Bootloader configuration	83		
	19.2	Bootloader selection	85		
	19.3	Bootloader version	86		
20	STM:	32F303x4(6/8)/334xx/328xx devices bootloader	87		
	20.1	Bootloader configuration	87		
	20.2	Bootloader selection			
	20.3	Bootloader version	88		
21	STM	32F318xx devices bootloader	89		
	21.1	Bootloader configuration	89		

AN2606	Contents

	21.2	Bootloa	ader selection	90
	21.3	Bootloa	ader version	91
22	STM	32F358x	xx devices bootloader	92
	22.1	Bootloa	ader configuration	92
	22.2	Bootloa	ader selection	93
	22.3	Bootloa	ader version	93
23	STM	32F373x	xx devices bootloader	94
	23.1	Bootloa	ader configuration	94
	23.2	Bootloa	ader selection	96
	23.3	Bootloa	ader version	96
24	STM	32F378x	xx devices bootloader	97
	24.1	Bootloa	ader configuration	97
	24.2	Bootloa	ader selection	98
	24.3	Bootloa	ader version	98
25	STM	32F398x	xx devices bootloader	99
	25.1	Bootloa	ader configuration	99
	25.2	Bootloa	ader selection	100
	25.3	Bootloa	ader version	100
26	STM	32F40xx	xx/41xxx devices bootloader	101
	26.1	Bootloa	ader V3.x	101
		26.1.1	Bootloader configuration	101
		26.1.2	Bootloader selection	103
		26.1.3	Bootloader version	104
	26.2	Bootloa	der V9.x	105
		26.2.1	Bootloader configuration	
		26.2.2	Bootloader selection	
		26.2.3	Bootloader version	110
27			B(C) devices bootloader	
	27.1		ader configuration	
	27.2	Bootloa	ader selection	

	27.3	Bootloader version			
28	STM	32F401xD(E) devices bootloader	117		
	28.1	Bootloader configuration			
	28.2	Bootloader selection	120		
	28.3	Bootloader version	121		
29	STM	32F410xx devices bootloader	122		
	29.1	Bootloader configuration	122		
	29.2	Bootloader selection	125		
	29.3	Bootloader version	126		
30	STM	32F411xx devices bootloader	127		
	30.1	Bootloader configuration	127		
	30.2	Bootloader selection	131		
	30.3	Bootloader version	132		
31	STM32F412xx devices bootloader				
	31.1	Bootloader configuration	133		
	31.2	Bootloader selection	137		
	31.3	Bootloader version	138		
32	STM	32F413xx/423xx devices bootloader	139		
	32.1	Bootloader configuration	139		
	32.2	Bootloader selection	143		
	32.3	Bootloader version	144		
33	STM	32F42xxx/43xxx devices bootloader	145		
	33.1	Bootloader V7.x	145		
		33.1.1 Bootloader configuration	145		
		33.1.2 Bootloader selection	147		
		33.1.3 Bootloader version	149		
	33.2	Bootloader V9.x			
		33.2.1 Bootloader configuration			
		33.2.2 Bootloader selection			
		33.2.3 Bootloader version			
6/329		AN2606 Rev 38	577		

AN2606	Contents

34	STM	32F446x	xx devices bootloader	157
	34.1	Bootloa	ader configuration	157
	34.2	Bootloa	ader selection	161
	34.3	Bootloa	ader version	162
35	STM	32F469x	xx/479xx devices bootloader	163
	35.1	Bootloa	ader configuration	163
	35.2	Bootloa	ader selection	167
	35.3	Bootloa	ader version	169
36	STM	32F72xx	xx/73xxx devices bootloader	170
	36.1	Bootloa	ader configuration	170
	36.2	Bootloa	ader selection	174
	36.3	Bootloa	ader version	175
37	STM	32F74xx	xx/75xxx devices bootloader	176
	37.1	Bootloa	ader V7.x	176
		37.1.1	Bootloader configuration	176
		37.1.2	Bootloader selection	179
		37.1.3	Bootloader version	180
	37.2	Bootloa	ader V9.x	181
		37.2.1	Bootloader configuration	181
		37.2.2	Bootloader selection	
		37.2.3	Bootloader version	186
38	STM	32F76xx	xx/77xxx devices bootloader	187
	38.1	Bootloader configuration		187
	38.2	Bootloa	ader selection	190
	38.3	Bootloa	ader version	193
39	STM	32G03x	xx/ STM32G04xxx devices bootloader	194
	39.1	Bootloa	ader configuration	194
	39.2	Bootloa	ader selection	196
	39.3	Bootloa	ader version	197
40	STM	32G07x	xx/08xxx device bootloader	198



	40.1	Bootloader configuration	198
	40.2	Bootloader selection	201
	40.3	Bootloader version	201
41	STM	32G431xx/441xx devices bootloader	202
	41.1	Bootloader configuration	202
	41.2	Bootloader selection	206
	41.3	Bootloader version	207
42	STM	32G47xxx/48xxx devices bootloader	208
	42.1	Bootloader Configuration	208
	42.2	Bootloader selection	212
	42.3	Bootloader version	213
43	STM	32H74xxx/75xxx devices bootloader	214
	43.1	Bootloader configuration	214
	43.2	Bootloader selection	218
	43.3	Bootloader version	218
44	STM	32L01xxx/02xxx devices bootloader	220
	44.1	Bootloader configuration	220
	44.2	Bootloader selection	222
	44.3	Bootloader version	223
45	STM	32L031xx/041xx devices bootloader	224
	45.1	Bootloader configuration	224
	45.2	Bootloader selection	226
	45.3	Bootloader version	226
46	STM	32L05xxx/06xxx devices bootloader	227
	46.1	Bootloader configuration	227
	46.2	Bootloader selection	229
	46.3	Bootloader version	229
47	STM	32L07xxx/08xxx devices bootloader	230



	47.1	Bootloader V4.x	230		
		47.1.1 Bootloader configuration			
		47.1.2 Bootloader selection			
		47.1.3 Bootloader version			
	47.2	Bootloader V11.x			
		47.2.1 Bootloader configuration			
		47.2.2 Bootloader selection			
		47.2.5 Bootiloader version	230		
48	STM	32L1xxx6(8/B)A devices bootloader	239		
	48.1	Bootloader configuration	239		
	48.2	Bootloader selection	240		
	48.3	Bootloader version	240		
49	STM	32L1xxx6(8/B) devices bootloader	241		
	49.1	Bootloader configuration	241		
	49.2	Bootloader selection	242		
	49.3	Bootloader version	242		
50	STM32L1xxxC devices bootloader				
	50.1	Bootloader configuration	243		
	50.2	Bootloader selection	245		
	50.3	Bootloader version	245		
51	STM	32L1xxxD devices bootloader	246		
	51.1	Bootloader configuration	246		
	51.2	Bootloader selection	248		
	51.3	Bootloader version	249		
52	STM	32L1xxxE devices bootloader	250		
	52.1	Bootloader configuration	250		
	52.2	Bootloader selection	252		
	52.3	Bootloader version	253		
53	STM	32L412xx/L422xx devices bootloader	254		
	53.1	Bootloader configuration	254		



	53.2	Bootloa	ader selection	257
	53.3	Bootloa	ader version	258
54	STM	32L43xx	xx/44xxx devices bootloader	259
	54.1	Bootloa	ader configuration	259
	54.2	Bootloa	ader selection	263
	54.3	Bootloa	ader version	264
55	STM	32L45xx	xx/46xxx devices bootloader	265
	55.1	Bootloa	ader configuration	265
	55.2	Bootloa	ader selection	269
	55.3	Bootloa	ader version	270
56	STM	32L47xx	xx/48xxx devices bootloader	271
	56.1	Bootloa	ader V10.x	271
		56.1.1	Bootloader configuration	271
		56.1.2	Bootloader selection	274
		56.1.3	Bootloader version	276
	56.2	Bootloa	ader V9.x	277
		56.2.1	Bootloader configuration	277
		56.2.2	Bootloader selection	280
		56.2.3	Bootloader version	282
57	STM	32L496x	xx/4A6xx devices bootloader	283
	57.1	Bootloa	ader configuration	283
	57.2	Bootloader selection		
	57.3	Bootloa	ader version	288
58	STM	32L4Rxx	xx/4Sxxx devices bootloader	289
	58.1	Bootloa	ader configuration	289
	58.2	Bootloa	ader selection	293
	58.3	Bootloa	ader version	295
59	STM	32WB55	ixx devices bootloader	296
	59.1	Bootloa	ader configuration	296
	59.2	Bootloa	ader selection	299

AN2606		Cont	ents
	59.3	Bootloader version	300
60	Devi	ce-dependent bootloader parameters	301
61	Boot	loader timing	304
	61.1	Bootloader Startup timing	304
	61.2	USART connection timing	307
	61.3	USB connection timing	309
	61.4	I2C connection timing	312
	61.5	SPI connection timing	314
62	Revi	sion history	315



List of tables AN2606

List of tables

Table 1.	Applicable products	. 1
Table 2.	Bootloader activation patterns	22
Table 3.	Embedded bootloaders	25
Table 4.	STM32 F2, F4 and F7 Voltage Range configuration using bootloader	34
Table 5.	Supported memory area by Write, Read, Erase and Go Commands	34
Table 6.	STM32F03xx4/6 configuration in system memory boot mode	
Table 7.	STM32F03xx4/6 bootloader versions	
Table 8.	STM32F030xC configuration in system memory boot mode	
Table 9.	STM32F030xC bootloader versions	
Table 10.	STM32F05xxx and STM32F030x8 devices configuration in system memory boot mode	
Table 11.	STM32F05xxx and STM32F030x8 devices bootloader versions	
Table 12.	STM32F04xxx configuration in system memory boot mode	
Table 13.	STM32F04xxx bootloader versions	
Table 14.	STM32F070x6 configuration in system memory boot mode	
Table 15.	STM32F070x6 bootloader versions	48
Table 16.	STM32F070xB configuration in system memory boot mode	
Table 17.	STM32F070xB bootloader versions	52
Table 18.	STM32F071xx/072xx configuration in system memory boot mode	
Table 19.	STM32F071xx/072xx bootloader versions	
Table 20.	STM32F09xxx configuration in system memory boot mode	
Table 21.	STM32F09xxx bootloader versions	
Table 22.	STM32F10xxx configuration in system memory boot mode	
Table 23.	STM32F10xxx bootloader versions	
Table 24.	STM32F105xx/107xx configuration in system memory boot mode	61
Table 25.	STM32F105xx/107xx bootloader versions	
Table 26.	STM32F10xxx XL-density configuration in system memory boot mode	67
Table 27.	STM32F10xxx XL-density bootloader versions	
Table 28.	STM32F2xxxx configuration in system memory boot mode	
Table 29.	STM32F2xxxx bootloader V2.x versions	
Table 30.	STM32F2xxxx configuration in system memory boot mode	
Table 31.	STM32F2xxxx bootloader V3.x versions	
Table 32.	STM32F301xx/302x4(6/8) configuration in system memory boot mode	77
Table 33.	STM32F301xx/302x4(6/8) bootloader versions	
Table 34.	STM32F302xB(C)/303xB(C) configuration in system memory boot mode	
Table 35.	STM32F302xB(C)/303xB(C) bootloader versions	82
Table 36.	STM32F302xD(E)/303xD(E) configuration in system memory boot mode	
Table 37.	STM32F302xD(E)/303xD(E) bootloader versions	86
Table 38.	STM32F303x4(6/8)/334xx/328xx configuration in system memory boot mode	87
Table 39.	STM32F303x4(6/8)/334xx/328xx bootloader versions	
Table 40.	STM32F318xx configuration in system memory boot mode	89
Table 41.	STM32F318xx bootloader versions	
Table 42.	STM32F358xx configuration in system memory boot mode	92
Table 43.	STM32F358xx bootloader versions	93
Table 44.	STM32F373xx configuration in system memory boot mode	
Table 45.	STM32F373xx bootloader versions	96
Table 46.	STM32F378xx configuration in system memory boot mode	
Table 47.	STM32F378xx bootloader versions	
Table 48	STM32F398xx configuration in system memory boot mode	99



AN2606 List of tables

Table 49.	STM32F398xx bootloader versions	
Table 50.	STM32F40xxx/41xxx configuration in system memory boot mode	
Table 51.	STM32F40xxx/41xxx bootloader V3.x versions	
Table 52.	STM32F40xxx/41xxx configuration in system memory boot mode	
Table 53.	STM32F40xxx/41xxx bootloader V9.x versions	
Table 54.	STM32F401xB(C) configuration in system memory boot mode	. 111
Table 55.	STM32F401xB(C) bootloader versions	
Table 56.	STM32F401xD(E) configuration in system memory boot mode	. 11/
Table 57.	STM32F401xD(E) bootloader versions	
Table 58.	STM32F410xx configuration in system memory boot mode	
Table 59.	STM32F410xx bootloader V11.x versions	
Table 60.	STM32F411xx configuration in system memory boot mode	
Table 61.	STM32F411xx bootloader versions	
Table 62.	STM32F412xx configuration in system memory boot mode	
Table 63.	STM32F412xx bootloader V9.x versions	
Table 64.	STM32F413xx/423xx configuration in system memory boot mode	
Table 65.	STM32F413xx/423xx bootloader V9.x versions	
Table 66.	STM32F42xxx/43xxx configuration in system memory boot mode	
Table 67.	STM32F42xxx/43xxx bootloader V7.x versions	
Table 68.	STM32F42xxx/43xxx configuration in system memory boot mode	
Table 69.	STM32F42xxx/43xxx bootloader V9.x versions	
Table 70.	STM32F446xx configuration in system memory boot mode	
Table 71.	STM32F446xx bootloader V9.x versions	
Table 72.	STM32F469xx/479xx configuration in system memory boot mode	. 163
Table 73.	STM32F469xx/479xx bootloader V9.x versions	
Table 74.	STM32F72xxx/73xxx configuration in system memory boot mode	
Table 75.	STM32F72xxx/73xxx bootloader V9.x versions	
Table 76.	STM32F74xxx/75xxx configuration in system memory boot mode	. 1//
Table 77.	STM32F74xxx/75xxx bootloader V7.x versions	
Table 78.	STM32F74xxx/75xxx configuration in system memory boot mode	
Table 79.	STM32F74xxx/75xxx bootloader V9.x versions	
Table 80.	STM32F76xxx/77xxx configuration in system memory boot mode	
Table 81.	STM32F76xxx/77xxx bootloader V9.x versions	193
Table 82.	STM32G03xxx/G04xxx configuration in system memory boot mode	
Table 83.	STM32G03xx/04xxx bootloader versions	
Table 84. Table 85.	The state of the s	
Table 86.	STM32G07xx/08xxx bootloader versions	
Table 87.	STM32G431xx/441xx bootloader version	
Table 87.	STM32G47xxx/48xxx configuration in system memory boot mode	
Table 89.	STM32G47xxx/48xxx bootloader version	
Table 90.	STM32H74xxx/75xxx configuration in system memory boot mode	
Table 90.	STM32H74xxx/75xxx bootloader version	
Table 91.	STM32L01xxx/02xxx configuration in system memory boot mode	
Table 93.	STM32L01xxx/02xxx bootloader versions	
Table 94.	STM32L031xx/041xx configuration in system memory boot mode	
Table 95.	STM32L031xx/041xx bootloader versions	
Table 95.	STM32L05xxx/06xxx configuration in system memory boot mode	
Table 90.	STM32L05xxx/06xxx bootloader versions	
Table 97.	STM32L07xxx/08xxx configuration in system memory boot mode	
Table 90.	STM32L07xxx/08xxx bootloader versions	
Table 100.	STM32L07xxx/08xxx configuration in system memory boot mode	
. 45.5 100.	5 1 110 = 201 1000 00 00 00 mgaration in dystolli molliony boot mode	



AN2606 Rev 38 13/329

List of tables AN2606

STM32L07xxx/08xxx bootloader V11.x versions	. 238
STM32L1xxx6(8/B)A bootloader versions	. 240
STM32L1xxx6(8/B) configuration in system memory boot mode	. 241
STM32L1xxx6(8/B) bootloader versions	. 242
STM32L1xxxC configuration in system memory boot mode	. 243
STM32L1xxxC bootloader versions	. 245
STM32L1xxxD configuration in system memory boot mode	. 246
STM32L1xxxD bootloader versions	. 249
STM32L1xxxE configuration in system memory boot mode	. 250
STM32L1xxxE bootloader versions	. 253
STM32L412xx/422xx configuration in system memory boot mode	. 254
STM32L412xx/422xx bootloader versions	. 258
STM32L43xxx/44xxx configuration in system memory boot mode	. 259
STM32L45xxx/46xxx configuration in system memory boot mode	. 265
STM32L45xxx/46xxx bootloader versions	. 270
STM32L47xxx/48xxx bootloader V10.x versions	. 276
STM32L47xxx/48xxx bootloader V9.x versions	. 282
STM32L496xx/4A6xx configuration in system memory boot mode	. 283
STM32L4Rxxx/4Sxxx configuration in system memory boot mode	. 289
STM32WB55xx configuration in system memory boot mode	. 296
STM32WB55xx bootloader versions	. 300
Bootloader device-dependent parameters	. 301
Bootloader startup timings of STM32 devices	. 304
USART bootloader minimum timings of STM32 devices	. 307
USB bootloader minimum timings of STM32 devices	. 310
SPI bootloader minimum timings of STM32 devices	. 314
Document revision history	. 315
	STM32L1xxx6(8/B)A configuration in system memory boot mode. STM32L1xxx6(8/B)A bootloader versions STM32L1xxx6(8/B)A bootloader versions STM32L1xxx6(8/B) bootloader versions. STM32L1xxx6(8/B) bootloader versions. STM32L1xxxC configuration in system memory boot mode. STM32L1xxxC bootloader versions STM32L1xxxD configuration in system memory boot mode. STM32L1xxxD configuration in system memory boot mode. STM32L1xxxD bootloader versions STM32L1xxxE configuration in system memory boot mode. STM32L1xxxE configuration in system memory boot mode. STM32L1xxxE bootloader versions STM32L412xx/422xx configuration in system memory boot mode STM32L412xx/422xx bootloader versions STM32L43xxx/44xxx configuration in system memory boot mode. STM32L43xxx/44xxx bootloader versions STM32L45xxx/46xxx configuration in system memory boot mode. STM32L45xxx/46xxx configuration in system memory boot mode. STM32L45xxx/48xxx configuration in system memory boot mode. STM32L47xxx/48xxx bootloader V10.x versions STM32L47xxx/48xxx configuration in system memory boot mode. STM32L47xxx/48xxx configuration in system memory boot mode. STM32L47xxx/48xxx bootloader V9.x versions STM32L476xx/48xxx configuration in system memory boot mode STM32L476xx/48xxx configuration in system memory boot mode STM32L476xx/48xxx bootloader version. STM32L496xx/4A6xx bootloader version. STM32L48xx/4Sxxx configuration in system memory boot mode STM32L4Rxx/4Sxxx bootloader versions STM32L4Rxx/4Sxxx bootloader versions STM32L4Rxx/4Sxxx bootloader version. STM32L4Rxx/4Sxxx bootloader version. STM32L4Rxx/4Sxxx bootloader versions SOURCE STM32 devices USART bootloader minimum timings of STM32 devices USART bootloader minimum timings of STM32 devices. SPI bootloader minimum timings of STM32 devices Document revision history



AN2606 List of figures

List of figures

Figure 1.	USART Connection	31
Figure 2.	USB Connection	31
Figure 3.	I2C Connection	32
Figure 4.	SPI Connection	32
Figure 5.	CAN Connection	33
Figure 6.	Bootloader selection for STM32F03xx4/6 devices	36
Figure 7.	Bootloader selection for STM32F030xC	38
Figure 8.	Bootloader selection for STM32F05xxx and STM32F030x8 devices	40
Figure 9.	Bootloader selection for STM32F04xxx	
Figure 10.	Bootloader selection for STM32F070x6	47
Figure 11.	Bootloader selection for STM32F070xB	51
Figure 12.	Bootloader selection for STM32F071xx/072xx	55
Figure 13.	Bootloader selection for STM32F09xxx	57
Figure 14.	Bootloader selection for STM32F10xxx	
Figure 15.	Bootloader selection for STM32F105xx/107xx devices	
Figure 16.	Bootloader selection for STM32F10xxx XL-density devices	
Figure 17.	Bootloader V2.x selection for STM32F2xxxx devices	
Figure 18.	Bootloader V3.x selection for STM32F2xxxx devices	75
Figure 19.	Bootloader selection for STM32F301xx/302x4(6/8)	
Figure 20.	Bootloader selection for STM32F302xB(C)/303xB(C) devices	
Figure 21.	Bootloader selection for STM32F302xD(E)/303xD(E)	
Figure 22.	Bootloader selection for STM32F303x4(6/8)/334xx/328xx	
Figure 23.	Bootloader selection for STM32F318xx	
Figure 24.	Bootloader selection for STM32F358xx devices	
Figure 25.	Bootloader selection for STM32F373xx devices	
Figure 26.	Bootloader selection for STM32F378xx devices	
Figure 27.	Bootloader selection for STM32F398xx	
Figure 28.	Bootloader V3.x selection for STM32F40xxx/41xxx devices	
Figure 29.	Bootloader V9.x selection for STM32F40xxx/41xxx	
Figure 30.	Bootloader selection for STM32F401xB(C)	
Figure 31.	Bootloader selection for STM32F401xD(E)	
Figure 32.	Bootloader V11.x selection for STM32F410xx	
Figure 33.	Bootloader selection for STM32F411xx	
Figure 34.	Bootloader V9.x selection for STM32F412xx	
Figure 35.	Bootloader V9.x selection for STM32F413xx/423xx	
Figure 36.	Dual Bank Boot Implementation for STM32F42xxx/43xxx Bootloader V7.x	
Figure 37.	Bootloader V7.x selection for STM32F42xxx/43xxx	
Figure 38.	Dual Bank Boot Implementation for STM32F42xxx/43xxx bootloader V9.x	
Figure 39.	Bootloader V9.x selection for STM32F42xxx/43xxx	155
Figure 40.	Bootloader V9.x selection for STM32F446xx	
Figure 41.	Dual Bank Boot Implementation for STM32F469xx/479xx Bootloader V9.x	
Figure 42.	Bootloader V9.x selection for STM32F469xx/479xx	
Figure 43.	Bootloader V9.x selection for STM32F72xxx/73xxx	
Figure 44.	Bootloader V7.x selection for STM32F74xxx/75xxx	
Figure 45.	Bootloader V9.x selection for STM32F74xxx/75xxx	
Figure 46.	Dual Bank Boot Implementation for STM32F76xxx/77xxx Bootloader V9.x	
Figure 47.	Bootloader V9.x selection for STM32F76xxx/77xxx	
Figure 48.	Access to securable memory area from the bootloader for STM32G03xxx/G04xxx	



AN2606 Rev 38 15/329

List of figures AN2606

Figure 49.	Bootloader V5.x selection for STM32G03xxx/G04xxx	. 197
Figure 50.	Access to securable memory area from the bootloader for STM32G07xxx/G08xxx	. 200
Figure 51.	Bootloader V11.0 selection for STM32G07xxx/G08xxx	. 201
Figure 52.	Access to securable memory area	. 205
Figure 53.	Bootloader selection for STM32G431xx/441xx	. 206
Figure 54.	Access to securable memory area	. 211
Figure 55.	Bootloader selection for STM32G47xxx/48xxx	. 212
Figure 56.	Bootloader V9.x selection for STM32H74xxx/75xxx	. 218
Figure 57.	Bootloader selection for STM32L01xxx/02xxx	. 222
Figure 58.	Bootloader selection for STM32L031xx/041xx	. 226
Figure 59.	Bootloader selection for STM32L05xxx/06xxx	
Figure 60.	Dual Bank Boot Implementation for STM32L07xxx/08xxx bootloader V4.x	. 232
Figure 61.	Bootloader V4.x selection for STM32L07xxx/08xxx	. 233
Figure 62.	Dual Bank Boot Implementation for STM32L07xxx/08xxx bootloader V11.x	. 236
Figure 63.	Bootloader V11.x selection for STM32L07xxx/08xxx	. 237
Figure 64.	Bootloader selection for STM32L1xxx6(8/B)A devices	. 240
Figure 65.	Bootloader selection for STM32L1xxx6(8/B) devices	. 242
Figure 66.	Bootloader selection for STM32L1xxxC devices	. 245
Figure 67.	Bootloader selection for STM32L1xxxD devices	. 248
Figure 68.	Bootloader selection for STM32L1xxxE devices	
Figure 69.	Bootloader V13.x selection for STM32L412xx/L422xx	. 257
Figure 70.	Bootloader V9.x selection for STM32L43xxx/44xxx	. 263
Figure 71.	Bootloader V9.x selection for STM32L45xxx/46xxx	
Figure 72.	Dual Bank Boot Implementation for STM32L47xxx/48xxx bootloader V10.x	
Figure 73.	Bootloader V10.x selection for STM32L47xxx/48xxx	
Figure 74.	Dual Bank Boot Implementation for STM32L47xxx/48xxx bootloader V9.x	. 280
Figure 75.	Bootloader V9.x selection for STM32L47xxx/48xxx	
Figure 76.	Bootloader V9.x selection for STM32L496xx/4A6xx	
Figure 77.	Dual bank boot implementation for STM32L4Rxxx/STM32L4Sxxx bootloader V9.x	
Figure 78.	Bootloader V9.x selection for STM32L4Rxx/4Sxx	. 294
Figure 79.	Bootloader V13.0 selection for STM32WB55xx	. 299
Figure 80.	Bootloader Startup timing description	. 304
Figure 81.	USART connection timing description	
Figure 82.	USB connection timing description	
Figure 83.	I2C connection timing description	
Figure 84.	SPI connection timing description	. 314



AN2606 General information

1 General information

This document applied to Arm®-based devices.

arm

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or

elsewhere

2 Related documents

For each supported product (listed in *Table 1*), please refer to the following documents available from *www.st.com*:

- · Datasheet or databrief
- Reference manual
- Application Note:
 - 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

577

AN2606 Rev 38 17/329

Glossary AN2606

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 Kbyte.

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

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

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

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

High-density value line devices are STM32F100xx microcontrollers where the Flash memory density ranges between 256 and 5128 Kbyte.

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 Kbyte and 1 Mbyte.

F2 Series:

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

AN2606 Glossary

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, STM32F469xI, STM32F479xG and STM32F479xI 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:



AN2606 Rev 38 19/329

Glossary AN2606

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:

STM32H74xxx/75xxx is used to refer to STM32H743xx and STM32H753xx 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, STM32L1xxCBH6 and STM32L1xxCBH6 ultralow power devices.

STM32L1xxx6(8/B)A is used to refer to STM32L1xxV6T6-A, STM32L1xxV6H6-A, STM32L1xxR6T6-A, STM32L1xxR6H6-A, STM32L1xxC6H6-A, STM32L1xxC8H6-A, STM32L1xxV8T6-A, STM32L1xxV8H6-A, STM32L1xxC8H6-A, STM32L1xxC8H6-A, STM32L1xxC8H6-A, STM32L1xxC8H6-A, STM32L1xxC8H6-A, STM32L1xxC8H6-A, STM32L1xxCBH6-A, STM32L1xxCBH6-A, STM32L1xxCBH6-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, STM32L1xxQEH6, STM32L1xxVET6, STM32L1xxVET6 ultralow power devices.

AN2606 Glossary

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.

WB Series:

STM32WB55xx is used to refer to STM32WB55Cx, STM32WB55Rx, STM32WB55Vx 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.

5/

AN2606 Rev 38 21/329

4 General bootloader description

4.1 Bootloader activation

The bootloader is activated by applying one of the patterns described in *Table 2: Bootloader activation patterns*.

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 STM32xxxxx" where STM32xxxxx is the relative STM32 product.

Otherwise, bootloader selection protocol is executed as described in figures "Bootloader VY.x selection for STM32xxxx" where STM32xxxx is the relative STM32 product.

When readout protection Level2 is activated, STM32 does not boot on system memory in any case and bootloader can't 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

Patterns	Condition				
Pattern1	Boot0(pin) = 1 and Boot1(pin) = 0				
Pattern2	Boot0(pin) = 1 and nBoot1(bit) = 1				
	Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 1				
Pattern3	Boot0(pin) = 0, BFB2(bit) = 0 and both banks don't contain valid code				
	Boot0(pin) = 1, Boot1(pin) = 0, BFB2(bit) = 0 and both banks don't contain valid code				
	Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 1				
Pattern4	Boot0(pin) = 0, BFB2(bit) = 0 and both banks don't contain valid code				
	Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 0				
	Boot0(pin) = 1, Boot1(pin) = 0 and BFB2(bit) = 0				
Pattern5	Boot0(pin) = 0, BFB2(bit) = 1 and both banks don't contain valid code				
	Boot0(pin) = 1, Boot1(pin) = 0 and BFB2 (bit) = 1				
	Boot0(pin) = 1, nBoot1(bit) = 1 and nBoot0_SW(bit) = 1				
Pattern6	nBoot0(bit) = 0, nBoot1(bit) = 1 and nBoot0_SW(bit) = 0				
Fatterno	Boot0(pin) = 0, nBoot0_SW(bit) = 1 and main flash empty				
	nBoot0(bit) = 1, nBoot0_SW(bit)=0 and main flash empty				
	Boot0(pin) = 1, nBoot1(bit) = 1 and BFB2(bit) = 0				
Pattern7	Boot0(pin) = 0, BFB2(bit) = 1 and both banks don't contain valid code				
	Boot0(pin) = 1, nBoot1(bit) = 1 and BFB2(bit) = 1				
Pattern8	Boot(pin) = 0 and BOOT_ADD0(optionbyte) = 0x0040				
Fallellio	Boot(pin) = 1 and BOOT_ADD1(optionbyte) = 0x0040				

Patterns Condition 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) = 0x0040nDBANK(bit) = 0, nDBOOT(bit) = 1, Boot(pin) = 1 and Pattern9 BOOT ADD1(optionbyte) = 0x0040nDBANK(bit) = 0, nDBOOT(bit) = 0, BOOT_ADDx(optionbyte) out of memory range or in ICP memory range nDBANK(bit) = 0, nDBOOT(bit) = 0, BOOT ADDx(optionbyte) in Flash memory range and both banks don't contain valid code Boot(pin) = 0 and BOOT_ADD0(optionbyte) = 0x1FF0 Pattern10 Boot(pin) = 1 and BOOT_ADD1(optionbyte) = 0x1FF0 nBoot0(bit) = 0, nBoot1(bit) = 1, USE_BOOT0_OPT(bit) = 1 and BOOT EP(bit) = 0Boot0(pin) = 1, nBoot1(bit) = 1 and USE_BOOT0_OPT (bit) = 1 nBoot0(bit) = 1, USE BOOT0 OPT(bit) = 1, BOOT EP(bit) = 0 and main Patten 11 Flash memory empty Boot0(pin) = 0, USE_BOOT0_OPT(bit) = 0, BOOT_EP(bit) = 0 and main Flash memory empty BOOT EP(bit) = 1 and main flash empty

Table 2. Bootloader activation patterns (continued)

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:

If you choose to execute 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 should 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 please refer to the known limitations detailed for each product's bootloader versions.

Note:

For STM32 devices having the Dual Bank Boot feature, in order 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.



AN2606 Rev 38 23/329

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).

Thus, when due to temperature 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 dysfunction or might 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:

- Bootloader (protocol) version: version of the serial peripheral (USART, CAN, USB, etc.) 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^2C are used
 - X = 6: I^2C is used
 - X = 7: USART, CAN, DFU and I²C are used
 - X = 8: I^2C and SPI are used
 - X = 9: USART, CAN, DFU, I²C and SPI are used
 - X = 10: USART, DFU and I²C are used
 - X = 11: USART, I²C and SPI are used
 - X = 12: USART and SPI are used
 - X = 13: USART, DFU, I²C 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's bootloader version and not to its supported protocols.

The table below provides identification information about the bootloaders embedded in STM32 devices.



Table 3. Embedded bootloaders

STM32	Device		Supported serial peripherals	Во	otloader ID	Bootloader (protocol) version
series				ID	Memory location	
	STM32F05xxx devices	/STM32F030x8	USART1/USART2	0x21	0x1FFFF7A6	USART (V3.1)
	STM32F03xx4	ł/6	USART1	0x10	0x1FFFF7A6	USART (V3.1)
	STM32F030x0)	USART1/I2C1	0x52	0x1FFFF796	USART (V3.1) I2C1(V1.0)
F0	STM32F04xxx	(USART1/USART2/ I2C1/ DFU (USB Device FS)	0xA1	0x1FFFF6A6	USART (V3.1) DFU (V2.2) I2C (V1.0)
	STM32F071xx	x/072xx	USART1/USART2/ I2C1/ DFU (USB Device FS)	0xA1	0x1FFFF6A6	USART (V3.1) DFU (V2.2) I2C (V1.0)
	STM32F070x6		USART1/USART2/ DFU (USB Device FS)/I2C1	0xA2	0x1FFFF6A6	USART (V3.1) DFU (V2.2) I2C (V1.0)
F0	STM32F070xB		USART1/USART2/ DFU (USB Device FS)/I2C1	0xA3	0x1FFFF6A6	USART (V3.1) DFU (V2.2) I2C (V1.0)
	STM32F09xxx		USART1/USART2/ I2C1	0x50	0x1FFFF796	USART (V3.1) I2C (V1.0)
	STM32F10xx x	Low-density	USART1	NA	NA	USART (V2.2)
		Medium- density	USART1	NA	NA	USART (V2.2)
		High-density	USART1	NA	NA	USART (V2.2)
		Medium- density value line	USART1	0x10	0x1FFFF7D6	USART (V2.2)
F1		High-density value line	USART1	0x10	0x1FFFF7D6	USART (V2.2)
	STM32F105xx/107xx		USART1 / USART2 (remapped) / CAN2 (remapped) / DFU (USB Device)	NA	NA	USART (V2.2 ⁽¹⁾) CAN (V2.0) DFU(V2.2)
	STM32F10xxx XL-density		USART1/USART2 (remapped)	0x21	0x1FFFF7D6	USART (V3.0)
			USART1/USART3	0x20	0x1FFF77DE	USART (V3.0)
F2	STM32F2xxxx		USART1/USART3/ CAN2/ DFU (USB Device FS)	0x33	0x1FFF77DE	USART (V3.1) CAN (V2.0) DFU (V2.2)



AN2606 Rev 38 25/329

Table 3. Embedded bootloaders (continued)

STM32 series		Supported serial peripherals	Boo	otloader ID	Bootloader (protocol) version
	Device		ID	Memory location	
	STM32F373xx	USART1/USART2/ DFU (USB Device FS)	0x41	0x1FFFF7A6	USART (V3.1) DFU (V2.2)
	STM32F378xx	USART1/USART2/ I2C1	0x50	0x1FFFF7A6	USART (V3.1) I2C (V1.0)
	STM32F302xB(C)/303xB(C)	USART1/USART2/ DFU (USB Device FS)	0x41	0x1FFFF796	USART (V3.1) DFU (V2.2)
	STM32F358xx	USART1/USART2/ I2C1	0x50	0x1FFFF796	USART (V3.1) I2C (V1.0)
F3	STM32F301xx/302x4(6/8)	USART1/USART2/ DFU (USB Device FS)	0x40	0x1FFFF796	USART (V3.1) DFU (V2.2)
	STM32F318xx	USART1/USART2/ I2C1/ I2C3	0x50	0x1FFFF796	USART (V3.1) I2C (V1.0)
	STM32F302xD(E)/303xD(E)	USART1/USART2/ DFU (USB Device FS)	0x40	0x1FFFF796	USART (V3.1) DFU (V2.2)
	STM32F303x4(6/8)/334xx/32 8xx	USART1/USART2/ I2C1	0x50	0x1FFFF796	USART (V3.1) I2C (V1.0)
	STM32F398xx	USART1/USART2/ I2C1/I2C3	0x50	0x1FFFF796	USART (V3.1) I2C (V1.0)



Table 3. Embedded bootloaders (continued)

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



AN2606 Rev 38 27/329

Table 3. Embedded bootloaders (continued)

STM32	Device	Supported serial peripherals	Вос	otloader ID	Bootloader
series			ID	Memory location	(protocol) version
F4	STM32F469xx/479xx	USART1/USART3/ I2C1/I2C2/I2C3/ CAN2/ DFU (USB Device FS)/ SPI1/ SPI2/ SPI4	0x90	0x1FFF76DE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2) SPI (V1.1)
	STM32F72xxx/73xxx	USART1/USART3/ CAN1/ DFU (USB Device FS)/ I2C1/I2C2/I2C3/ SPI1/SPI2/SPI4	0x90	0x1FF0EDBE	USART (V3.1) CAN (V2.0) DFU (V2.2) I2C (V1.2) SPI (V1.2)
		USART1/USART3/ I2C1/I2C2/I2C3/ CAN2/ DFU (USB Device FS)	0x70	0x1FF0EDBE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2)
F7	STM32F74xxx/75xxx	USART1/USART3/ I2C1/I2C2/I2C3/ CAN2/ DFU (USB Device FS)/ SPI1/SPI2/SPI4	0x90	0x1FF0EDBE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2) SPI (V1.2)
	STM32F76xxx/77xxx	USART1/USART3/ CAN2/ DFU (USB Device FS)/ I2C1/I2C2/I2C3/ SPI1/SPI2/SPI4	0x93	0x1FF0EDBE	USART (V3.1) CAN (V2.0) DFU (V2.2) I2C (V1.2) SPI (V1.2)
G0	STM32G07xxx/08xxx	USART1/USART2/ USART3/I2C1/I2C2/ SPI1/SPI2	0xB2	0x1FFF6FFE	USART (V3.1) I2C (V1.2) SPI (V1.1)
	STM32G03xxx/04xxx	USART1/USART2/ I2C1\I2C2	0x52	0x1FFF1FFE	USART (V3.1) I2C (V1.2)
64	STM32G431xx/441xx	USART1/USART2/USART3 I2C2/I2C3 SPI1/SPI2 DFU (USB Device FS)	0xD3	0x1FFF6FFE	USART (V3.1) I2C (V1.2) SPI (V1.1) DFU (V2.2)
G4	STM32G47xxx/48xxx	USART1/USART2/USART3 I2C2/I2C3/I2C4 SPI1/SPI2 DFU (USB Device FS)	0xD4	0x1FFF6FFE	USART (V3.1) I2C (V1.2) SPI (V1.1) DFU (V2.2)
H7	STM32H74xxx/75xxx	USART1/USART2/ USART3 I2C1/I2C2/I2C3/ DFU (USB Device FS)/ SPI1/SPI2/SPI3/SPI4/ FDCAN1	0x90	0x1FF1E7FE	USART (V3.1) I2C (V1.1) DFU (V2.2) SPI (V1.2) FDCAN (V1.0)



Table 3. Embedded bootloaders (continued)

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



AN2606 Rev 38 29/329

Table 3. Embedded bootloaders (continued)

STM32 series	Device	Supported serial peripherals	Bootloader ID		Bootloader
			ID	Memory location	(protocol) version
L4	STM32L43xxx/44xxx	USART1/USART2/USART3/ I2C1/I2C2/I2C3/ CAN1/ DFU (USB Device FS)/ SPI1/SPI2	0x91	0x1FFF6FFE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2) SPI (V1.1)
	STM32L45xxx/46xxx	USART1/USART2/ I2C1/I2C2/I2C3/ CAN1/ DFU (USB Device FS)/ SPI1/SPI2	0x92	0x1FFF6FFE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2) SPI (V1.1)
	STM32L47xxx/48xxx	USART1/USART2/ USART3/ I2C1/I2C2/I2C3/ DFU (USB Device FS)	0xA3	0x1FFF6FFE	USART (V3.1) I2C (V1.2) DFU (V2.2)
		USART1/USART2/ USART3/ I2C/I2C2/I2C3/ SPI1/SPI2/CAN1/ DFU (USB Device FS)	0x92	0x1FFF6FFE	USART (V3.1) I2C (V1.2) SPI (V1.1) CAN(V2.0) DFU(V2.2)
	STM32L496xx/4A6xx	USART1/USART2/ I2C1/I2C2/I2C3/ CAN1/ DFU (USB Device FS)/ SPI1/SPI2	0x93	0x1FFF6FFE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2) SPI (V1.1)
	STM32L4Rxxx/STM32L4Sxxx	USART1/USART2/ I2C1/I2C2/I2C3/ CAN1/ DFU (USB Device FS)/ SPI1/SPI2	0x92	0x1FFF6FFE	USART (V3.1) I2C (V1.2) CAN (V2.0) DFU (V2.2) SPI (V1.1)
WB	STM32WB55xx	USART1/ I2C1/I2C3 SPI1/SPI2 DFU (USB Device FS)	0xD5	0x1FFF6FFE	USART (V3.2) I2C (V1.2) SPI (V1.1) DFU (V2.2)

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



MSv35098V1

4.3 Hardware connection requirements

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

UART Host

RX

RS232

Transceiver

RX

RS232

Transceiver

RX

Microcontroller

GND

Figure 1. USART Connection

1. A Pull-UP resistor should be added, if pull-up resistor are not connected in host side.

GND

An RS232 transceiver must be connected to adapt voltage level (3.3V - 12V) between STM32 device and host.

Note:

+V typically 3.3 V and R value typically 100KOhm. This value depend on the application and the used hardware.

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

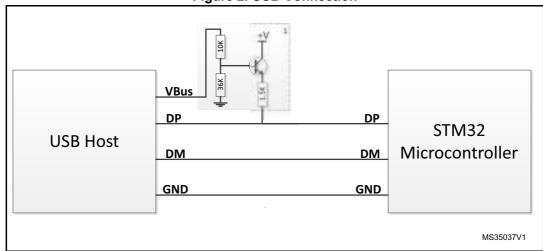


Figure 2. USB Connection

This additional circuit permits to connect a Pull-Up resistor to (DP) pin using VBus when needed. Refer to
product section (Table which describes STM32 Configuration in system memory boot mode) to know if an
external pull-up resistor must be connected to (DP) pin.

Note:

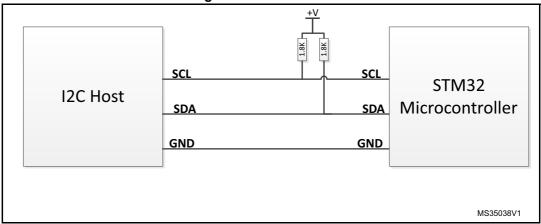
+V typically 3.3 V.This value depends on the application and the used hardware.



AN2606 Rev 38 31/329

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 KOhm pull-up resistor has to be connected to both (SDA) and (SCL) lines.

Figure 3. I2C Connection

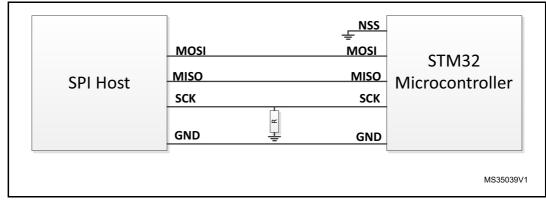


Note:

+V typically 3.3 V.This value depends on 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 should be connected to the (SCK) line.

Figure 4. SPI Connection



Note:

R value typically 10KOhm. 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 Ohm resistor should be added as terminating resistor.



CAN H RX TX **STM32** CAN CAN **CAN Host** Transceiv Transceiv Microcontroller TX RX er CAN L GND **GND** MS35040V1

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 interface.

4.4 Bootloader memory management

All write operations using bootloader commands must only be Word-aligned (the address should 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 don't 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, please 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 should be a multiple of 4) and the number of data must also be a multiple of 4. To erase a Data memory location, you can 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, please refer to product reference manual for more information. OTP memory can be read and



AN2606 Rev 38 33/329

- 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 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 should 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 which are described in table below. It can be accessed by 1, 2, 3 or 4 bytes. However, reserved bytes should remain at their default values (0xFF), otherwise the request will be NACKed.

Table 4. STM32 F2, F4 and F7 Voltage Range configuration using bootloader

Address	Size	Description
0xFFFF0000	1 byte	This byte controls the current value of the voltage range. 0x00: voltage range [1.8 V, 2.1 V] 0x01: voltage range [2.1 V, 2.4 V] 0x02: voltage range [2.4 V, 2.7 V] 0x03: voltage range [2.7 V, 3.6 V] 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). Other: all other values are not supported and will be NACKed.
0xFFFF0001	1 byte	Reserved. 0xFF: default value. Other: all other values are not supported and will be NACKed.
0xFFFF0002	1 byte	Reserved. 0xFF: default value. Other: all other values are not supported and will be NACKed.
0xFFFF0003	1 byte	Reserved. 0xFF: default value. Other: all other values are not supported and will be NACKed.

The table below lists the valid memory area depending on 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		



5 STM32F03xx4/6 devices bootloader

5.1 Bootloader configuration

The STM32F03xx4/6 bootloader is activated by applying pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

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

Bootloader	Feature/Peripheral	State	Comment	
	RCC	HSI Enabled	The system clock frequency is 24 MHz (using PLL clocked by HSI). 1 Flash Wait State.	
	RAM	-	2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.	
Common to all bootloaders	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	USART1	Enabled	Once initialized, the USART1 configuration is 8 bits, even parity and 1 Stop bit.	
bootloader (on PA10/PA9)	USART1_RX pin	Input	PA10 pin: USART1 in reception mode.	
1 410/1 43)	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode.	
USART1	USART1	Enabled	Once initialized, the USART1 configuration is 8 bits, even parity and 1 Stop bit.	
bootloader (on PA14/PA15)	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

The figure below shows the bootloader selection mechanism.

System Reset

System Init (Clock, GPIOs, IWDG, SysTick)

Disable all interrupt sources

Configure USARTx

Execute BL_USART_Loop for USARTx

Figure 6. Bootloader selection for STM32F03xx4/6 devices

5.3 Bootloader version

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

Table 7. STM32F03xx4/6 bootloader versions

6 STM32F030xC devices bootloader

6.1 Bootloader configuration

The STM32F030xC bootloader is activated by applying pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 8. STM32F030xC configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	RCC	HSI enabled	The system clock frequency is 48 MHz with HSI 8 MHz as clock source.
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA15 pin: USART2 in reception mode
U	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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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.



AN2606 Rev 38 37/329

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx yes 0x7F received on Disable all interrupt **USART**x sources and other interfaces clock's no Disable all interrupt Configure sources and other USARTx interfaces clock's I2Cx Address Detected no Execute Execute BL_USART_Loop BL I2C Loop for for USARTx I2Cx MSv36789V1

Figure 7.Bootloader selection for STM32F030xC

6.3 Bootloader version

The following table lists the STM32F030xC devices bootloader versions.

Table 9. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 10. STM32F05xxx and STM32F030x8 devices configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	RCC	HSI Enabled	The system clock frequency is 24 MHz (using PLL clocked by HSI). 1 Flash Wait State.
	RAM	-	2 Kbyte starting from address 0x20000000 are used by the bootloader firmware.
Common to all bootloaders	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	USART1	Enabled	Once initialized, the USART1 configuration is 8 bits, even parity and 1 Stop bit.
bootloader	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) which is already used by the bootloader (USART2_TX).



AN2606 Rev 38 39/329

The figure below shows the bootloader selection mechanism.

System Reset

System Init (Clock, GPIOs, IWDG, SysTick)

Ox7F received on USARTx

Disable all interrupt sources

Configure USARTx

Execute BL_USART_Loop for USARTx

MS35014V1

Figure 8. Bootloader selection for STM32F05xxx and STM32F030x8 devices

7.3 Bootloader version

The following table lists the STM32F05xxx and STM32F030x8 devices bootloader versions.

Table 11. STM32F05xxx and STM32F030x8 devices bootloader versions

Bootloader version number	Description	Known limitations
V2.1	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 consequence a deviation is generated in crystal measurement. For better results, please use the smallest supported crystal value (ie. 4 MHz). 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.

8 STM32F04xxx devices bootloader

8.1 Bootloader configuration

The STM32F04xxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 12. STM32F04xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.
	RCC	-	The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.
0	RAM	-	6 Kbyte starting from address 0x20000000 are used by the bootloader firmware
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2			Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA15 pin: USART2 in reception mode
	USART2_TX pin	Enabled Coutput Enabled Enabled Enabled	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 I2C1configuration is: 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.



AN2606 Rev 38 41/329

Table 12. 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 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 will result 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 (ie. erase first sector before jump or execute code from SRAM while Flash is empty), then system bootloader will be executed when jumped to.



The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx Configure USB FS device 0x7F received on USARTx no Disable all interrupt Disable all interrupt sources and other sources and other 12Cx Address interfaces clock's yes Detected interfaces clock's Disable other Configure interfaces clock's no Execute BL_I2C_Loop for USARTx I2Cx USB Execute DFU Detected Execute bootloader using USB BL USART_Loop interrupts for USARTx MS35025V1

Figure 9. Bootloader selection for STM32F04xxx



AN2606 Rev 38 43/329

8.3 Bootloader version

The following table lists the STM32F04xxx devices bootloader versions:

Table 13. STM32F04xxx bootloader versions

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



9 STM32F070x6 devices bootloader

9.1 Bootloader configuration

The STM32F070x6 bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 14. STM32F070x6 configuration in system memory boot mode

RCC HSI enabled HSI enabled HSI enabled HSI 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.	Bootloader	Feature/Periphe ral	State	Comment
RCC HSE enabled Interfaces and should 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.			HSI enabled	to 48 MHz using the HSI. If an external clock (HSE) is
From 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 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 reception mode USART2 Enabled Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit USART2 Enabled Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit USART2 Enabled USART2 in reception mode USART2_RX pin Input PA15 pin: USART2 in reception mode USART2_TX pin Output PA14 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. The I2C1 configuration is: 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.	Common to all	RCC	HSE enabled	interfaces and should have one of the following values [24, 18, 16, 12, 8, 6, 4] MHz. The PLL is used
by the bootloader firmware System memory - 13 Kbyte starting from address 0x1FFC400, contain the bootloader firmware. USART1	bootloaders		-	for HSE. Any failure (or removal) of the external clock
USART1 bootloader USART1 USART1 USART1 Enabled USART1_RX pin Input USART1_TX pin Output USART2 Enabled USART2_RX pin Input USART2_RX pin Input USART2_RX pin Input USART2_RX pin Input USART2_TX pin Output USART2_TX pin Output USART2_TX pin Output USART2_TX pin Output USART2 in reception mode USART2_TX pin USART2 in reception mode USART2_TX pin Output USART2 in transmission mode Usart2_TX pin USART2 in transmission mode Usart2_TX pin Output Used to automatically detect the serial baud rate from the host for USARTx bootloaders. The I2C1 configuration is: 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.		RAM	-	
USART1 bootloader USART1_RX pin Input PA10 pin: USART1 in reception mode USART1_TX pin Output PA9 pin: USART1 in transmission mode USART2 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 PA15 pin: USART2 in transmission mode USART2_TX pin Output PA14 pin: USART2 in transmission mode USARTX bootloaders USARTX bootloaders SysTick timer Enabled Used to automatically detect the serial baud rate from the host for USARTx bootloaders. The I2C1 configuration is: 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.		System memory	-	
USART2	USART1	USART1	Enabled	· · · · · · · · · · · · · · · · · · ·
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 for USARTx bootloaders. The I2C1 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b01111110x 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.	bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
USART2 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. The I2C1 configuration is: 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.		USART1_TX pin	Output	PA9 pin: USART1 in transmission 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. The I2C1 configuration is: 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.	USART2	USART2	Enabled	
USARTx bootloaders SysTick timer Enabled Used to automatically detect the serial baud rate from the host for USARTx bootloaders. The I2C1 configuration is: 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.	bootloader	USART2_RX pin	Input	PA15 pin: USART2 in reception mode
the host for USARTx bootloaders. The I2C1 configuration is: I2C2 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.		USART2_TX pin	Output	PA14 pin: USART2 in transmission mode
I2C1 bootloader Enabled Enabled 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.	USARTx bootloaders	SysTick timer	Enabled	
I2C1_SCL pin Input/Output PB6 pin: clock line is used in open-drain mode.	I2C1 bootloader	I2C1	Enabled	I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111110x where x = 0 for write
		I2C1 SCI nin	Input/Qutput	,
		_ :	•	-



AN2606 Rev 38 45/329

Table 14.	STM32F070x6	configuration in	system memory	/ boot mode (continued)

Bootloader	Feature/Periphe ral	State	Comment
	USB	Enabled	USB FS configured in forced device mode. USB FS interrupt vector is enabled and used for USB DFU communications.
DFU bootloader	USB_DM pin		PA11 pin: USB FS DM line
	USB_DP pin	Input/Output	PA12 pin: USB FS DP line. 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

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

SWD uses PA14 pin (SWCLK) which is already used by the bootloader (USART2_RX).

- 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's connected at bootloader startup because it will be 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 will result 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 (ie. erase first sector before jump or execute code from SRAM while Flash is empty), then system bootloader will be executed when jumped to.

577

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 48 MHz using HSI HSE= 24, 18, 16, 12, 8, 6, 4 MHz ? Reconfigure System clock to 48 MHz using HSE System Init (Clock, GPIOs, System Init (Clock, GPIOs, IWDG, SysTick) IWDG, SysTick) Configure USB Configure I2Cx 0x7F received on USARTx ves no Disable all interrupt sources and other interfaces clock's I2Cx Address ves Detected Disable all interrupt Disable other sources and other Configure interfaces clock's interfaces clock's USARTx no no **Execute DFU** Execute Execute USB cable BL_I2C_Loop for BL_USART_Loop bootloader using USB Detected & USB interrupts I2Cx for USARTx configured MSv36794V1

Figure 10. Bootloader selection for STM32F070x6



AN2606 Rev 38 47/329

9.3 Bootloader version

The following table lists the STM32F070x6 devices bootloader versions.

Table 15. STM32F070x6 bootloader versions

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



10 STM32F070xB devices bootloader

10.1 Bootloader configuration

The STM32F070xB bootloader is activated by applying pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 16. STM32F070xB configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
Common to all	RCC	HSE enabled	The external clock can be used for all bootloader interfaces and should 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.
bootloaders		-	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	HSI enabled ex sy Th bo HSE enabled of 4] MI Th is of res - 6 H are - 20x firm Enabled Or is: Input PA Enabled Or is: Input PA Enabled Us rat Enabled Us rat Enabled Sla Sla (w Input/Output PE Input/Output PE	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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 16. STM32F070xB configuration in system memory boot mo	ode (conti	nued)
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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		PA11 pin: USB FS DM line
	USB_DP pin	Input/Output	PA12 pin: USB FS DP line. 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's connected at bootloader startup because it will be used as system clock source.

47/

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 48 MHz using HSI HSE= 24, 18, 16, 12, 8, 6, 4 MHz ? yes ***** Reconfigure System clock to 48 MHz using HSE System Init (Clock, GPIOs, System Init (Clock, GPIOs, IWDG, SysTick) IWDG, SysTick) Configure USB Configure I2Cx 0x7F received yes on USARTx nο Disable all interrupt sources and other interfaces clock's **I2Cx Address** yes Detected Disable all interrupt Disable other sources and other Configure interfaces clock's interfaces clock's **USART**x no no **Execute DFU** Execute Execute **USB** cable BL_I2C_Loop for BL_USART_Loop bootloader using USB Detected & USB interrupts I2Cx for USARTx configured MSv36795V1

Figure 11.Bootloader selection for STM32F070xB



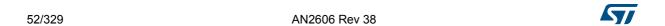
AN2606 Rev 38 51/329

10.3 Bootloader version

The following table lists the STM32F070xB devices bootloader versions.

Table 17. STM32F070xB bootloader versions

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



11 STM32F071xx/072xx devices bootloader

11.1 Bootloader configuration

The STM32F071xx/072xx bootloader is activated by applying pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 18. STM32F071xx/072xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.
	RCC	-	The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz.
Oursen to all	RAM	-	6 Kbyte starting from address 0x20000000 are used by the bootloader firmware
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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.



AN2606 Rev 38 53/329

Table 18. 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		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line 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.



The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx Configure USB FS device 0x7F received on **USART**x no Disable all interrupt Disable all interrupt sources and other sources and other 12Cx Address interfaces clock's Detected interfaces clock's Disable other Configure interfaces clock's Execute no no BL I2C Loop for USARTx I2Cx USB **Execute DFU** Detected Execute bootloader using USB BL USART Loop interrupts for USARTx MS35026V1

Figure 12. Bootloader selection for STM32F071xx/072xx

11.3 **Bootloader version**

The following table lists the STM32F071xx/072xx devices 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 consequence a deviation is generated in crystal measurement. For better results, please use the smallest supported crystal value (ie. 4 MHz).

Table 19. STM32F071xx/072xx bootloader versions



AN2606 Rev 38 55/329

12 STM32F09xxx devices bootloader

12.1 Bootloader configuration

The STM32F09xxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 20. STM32F09xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	RCC	HSI enabled	The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	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
USART2	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
bootloader			PA15 pin: USART2 in reception mode
	LICADTO TV nin	Output	PA2 pin: USART2 in transmission mode
	USART2_TX pin		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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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.



The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx 0x7F received on Disable all interrupt **USART**x sources and other interfaces clock's no Disable all interrupt Configure sources and other USARTx interfaces clock's I2Cx Address Detected no Execute Execute BL_USART_Loop BL_I2C_Loop for for USARTx I2Cx MSv36789V1

Figure 13. Bootloader selection for STM32F09xxx

12.3 Bootloader version

The following table lists the STM32F09xxx devices bootloader versions.

Table 21. STM32F09xxx bootloader versions

AN2606 Rev 38 57/329

13 STM32F10xxx devices bootloader

13.1 Bootloader configuration

The STM32F10xxx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 22. STM32F10xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
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
	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.

The figure below shows the bootloader selection mechanism.

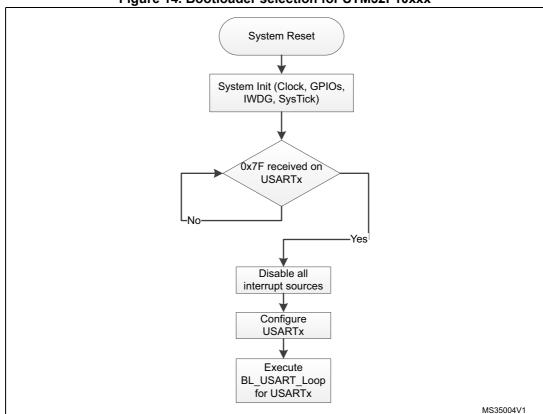


Figure 14. Bootloader selection for STM32F10xxx

13.3 Bootloader version

The following table lists the STM32F10xxx devices bootloader versions:

Bootloader version number Description V2.0 Initial bootloader version - Updated Go Command to initialize the main stack pointer - Updated Go command to return NACK when jump address is in V2.1 the Option byte area or System memory area Updated Get ID command to return the device ID on two bytes Update the bootloader version to V2.1 Updated Read Memory, Write Memory and Go commands to deny access with a NACK response to the first 0x200 bytes of V2.2 RAM memory used by the bootloader Updated Readout Unprotect command to initialize the whole RAM content to 0x0 before ROP disable operation

Table 23. STM32F10xxx bootloader versions

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 pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 24. STM32F105xx/107xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment	
Common to all		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 will be derived from the external crystal).	
	RCC	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. For CAN bootloader, the PLL is used only to generate 48 MHz when 14.7456 MHz is used as HSE. For DFU bootloader, the PLL is used to generate a 48 MHz system clock from all supported external clock frequencies.	
bootloaders		-	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	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 bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode	
	USART1_TX pin	Output push-pull	PA9 pin: USART1 in transmission mode	



AN2606 Rev 38 61/329

Table 24. 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. Note: 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		PA11 pin: USB_DM line
	USB_DP pin	Input/Output	PA12 pin: USB_DP line. 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.



The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure USB USB cable yes Detected yes Disable all interrupt sources HSE= 8MHz, 14.7456MHz or USARTx 25 MHz Configure **USART**x no yes Execute Frame detected on BL USART Loop Reconfigure System for USARTx clock to 48MHz and USB clock to 48 MHz yes HSE= 8MHz, **Execute DFU** no bootloader using USB 14.7456MHz or 25 MHz interrupts Generate System reset Reconfigure System clock to 48MHz Disable all interrupt sources Configure CAN Execute BL_CAN_Loop for CANx MS35005V1

Figure 15. Bootloader selection for STM32F105xx/107xx devices



AN2606 Rev 38 63/329

14.3 Bootloader version

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

Table 25. STM32F105xx/107xx bootloader versions

Bootloader version number	Description		
V1.0	Initial bootloader version		
V2.0	 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. For more details please refer to Section 14.3.2. Vector table set to 0x1FFFB000 instead of 0x00000000 Go command updated (for all bootloaders): USART1, USART2, CAN2, GPIOA, GPIOB, GPIOD and SysTick peripheral registers are set to their default reset values DFU bootloader: USB pending interrupt cleared before executing the Leave DFU command DFU subprotocol version changed from V1.0 to V1.2 Bootloader version updated to V2.0 		
V2.1	 Fixed PA9 excessive consumption described in Section 14.3.4. Get-Version command (defined in AN3155) corrected. It returns 0x22 instead of 0x20 in bootloader V2.0. Refer to Section 14.3.3 for more details. Bootloader version updated to V2.1 		
V2.2	 Fixed DFU option bytes descriptor (set to 'e' instead of 'g' because it is read/write and not erasable). Fixed DFU polling timings for Flash Read/Write/Erase operations. Robustness enhancements for DFU bootloader interface. Updated bootloader version to V2.2. 		

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 which date code is below 937 (refer to STM32F105xx and STM32F107xx datasheet for where to find the date code on the device marking).

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

Bootloader V2.2 is implemented on devices with a date code higher 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 0x1FFFE945 at address 0x1FFFB004 for
 bootloader V2.0 0x1FFFE9A1 for bootloader V2.1, and 0x1FFFE9C1 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 a date code below 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.



AN2606 Rev 38 65/329

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 pattern3 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader:

Table 26. STM32F10xxx XL-density configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
Common to all	System memory	-	6 Kbyte starting from address 0x1FFFE000 contain the bootloader firmware.
bootloaders	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	USART1	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output push-pull	PA9 pin: USART1 in transmission mode
	USART2	Enabled	Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit.
USART2 bootloader	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.



AN2606 Rev 38 67/329

The figure below shows the bootloader selection mechanism.

System Reset BFB2 bit reset (BFB2 = 0)If Value @0x08080000 is within int. SRAM address Jump to user code in Bank2 no no If Value @0x08000000 is within int. SRAM address Jump to user code in Bank1 Continue Bootloader execution Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure yes USARTx 0x7F received on Execute USARTx BL USART Loop for USARTx MS35006V1

Figure 16. Bootloader selection for STM32F10xxx XL-density devices

15.3 Bootloader version

The following table lists the STM32F10xxx XL-density devices bootloader versions:

Table 27. 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's 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 STM32F2xxxx devices revision B.
- V3.x supporting USART1, USART3, CAN2 and DFU (USB FS Device)
 This version is embedded in STM32F2xxxx devices revision X and Y.

16.1 Bootloader V2.x

16.1.1 Bootloader configuration

The STM32F2xxxx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 28. 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 (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



Bootloader	Feature/Peripheral	State	Comment
USART3 bootloader (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.

Table 28. STM32F2xxxx configuration in system memory boot mode (continued)

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**

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) 0x7F received on **USART**x -yes Disable all interrupt sources Configure USARTx Execute BL USART Loop for USARTx MS35010V1

Figure 17. Bootloader V2.x selection for STM32F2xxxx devices

AN2606 Rev 38 71/329

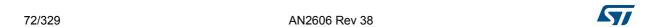
16.1.3 Bootloader version

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

Table 29. STM32F2xxxx bootloader V2.x 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 (ie. 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. For the CAN interface, the Write Unprotect command is not functional. Instead you can use Write Memory command and write directly to the option bytes in order to disable the write protection. (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 pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 30. STM32F2xxxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 24 MHz using the PLL. 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 will be 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.
Common to all bootloaders		-	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.
bootioaders	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.



AN2606 Rev 38 73/329

Table 30. STM32F2xxxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	USART1	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.
USART1 bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3 bootloader	USART3	Enabled	Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.
(on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3 bootloader	USART3	Enabled	Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.
(on PC10/PC11)	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. Note: 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
	USB	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line 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.

16.2.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Disable all yes System Init (Clock, GPIOs, interrupt sources IWDG, SysTick) Configure Configure USB OTG FS **USART**x device Execute 0x7F received on BL_USART_Loop for USARTx USARTx -yesno HSE detected Frame detected no on CANx pin yes yes no Disable all HSE detected no interrupt sources Generate System USB cable reset Reconfigure System Yes Detected clock to 60MHz Reconfigure System clock to 60MHz and Configure CAN USB clock to 48 MHz Execute Execute DFU BL_CAN_Loop for bootloader using USB CANx interrupts MS35011V1

Figure 18. Bootloader V3.x selection for STM32F2xxxx devices



AN2606 Rev 38 75/329

16.2.3 Bootloader version

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

Table 31. STM32F2xxxx bootloader V3.x versions

Bootloader version number	Description	Known limitations
V3.2	Initial bootloader version.	 When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (ie. 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⁽¹⁾. Option bytes, OTP and Device Feature descriptors (in DFU interface) are set to "g" instead of "e" (not erasable memory areas).
V3.3	Fix V3.2 limitations. DFU interface robustness enhancement.	 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. For the CAN interface, the Write Unprotect command is not functional. Instead you can use Write Memory command and write directly to the option bytes in order to disable the write protection.

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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 32. STM32F301xx/302x4(6/8) configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.
	RCC	HSE enabled	The external clock can be used for all bootloader interfaces and should have one the following values [24,18,16,12,9,8,6,4,3] MHz. The PLL is used to generate the USB48 MHz clock and the 48 MHz clock for the system clock.
Common to all bootloaders		-	The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.
	RAM System memory	-	6 Kbyte starting from address 0x20000000 are used by the bootloader firmware
		-	8 Kbyte starting from address 0x1FFFD800, contain the bootloader firmware
IWDG	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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.



AN2606 Rev 38 77/329

Table 32. STM32F301xx/302x4(6/8) configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	USB	Enabled	USB used in FS mode
	USB_DM pin		PA11: USB DM line.
DFU bootloader	USB_DP pin	Input/Output	PA12: USB DP line An external pull-up resistor 1.5 KOhm 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's connected at bootloader startup because it will be used as system clock source.



17.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 48 MHz using HSI HSE= 24, 18, 16, 12, 9, 8, 6, 4, 3 MHz ? Yes Reconfigure System clock to 48 MHz using HSE System Init (Clock, GPIOs, System Init (Clock, GPIOs, IWDG, SysTick) IWDG, SysTick) Configure USB FS device **USB** cable Detected & USB Disable all interrupt configured sources and other Disable other interfaces clock's no interfaces clock's Configure **USART**x 0x7F received on Execute DFU **USART**x bootloader using USB no Execute interrupts BL USART Loop for USARTx MS35027V1

Figure 19. Bootloader selection for STM32F301xx/302x4(6/8)

17.3 Bootloader version

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

Table 33. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 34. STM32F302xB(C)/303xB(C) configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	HSE enabled	The external clock can be used for all bootloader interfaces and should have one the following values [24, 18,16, 12, 9, 8, 6, 4, 3] MHz. The PLL is used to generate the USB 48 MHz clock and the 48 MHz clock for the system clock.
Common to all bootloaders		-	The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.
	RAM System memory	-	5 Kbyte starting from address 0x20000000 are used by the bootloader firmware.
		-	8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware.
יו	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 bootloader	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.
25/11/12 5001104401	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 34. STM32F302xB	(C)/303xB(C	configuration in sy	vstem memory	, boot mode	(continued)
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Bootloader	Feature/Peripheral	State	Comment
	USB	Enabled	USB used in FS mode
USB_DI	USB_DM pin		PA11: USB DM line.
DFU bootloader	USB_DP pin	Input/Output	PA12: USB DP line An external pull-up resistor 1.5 KOhm 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's connected at bootloader startup because it will be used as system clock source.



AN2606 Rev 38 81/329

18.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 48MHz using HSI HSE = 24, 18, 16, 12, 9, 8, 6, 4, 3 MHz yes Reconfigure System clock to 48MHz using HSE System Init (Clock, GPIOs, IWDG, SysTick) System Init (Clock, GPIOs, IWDG, SysTick) Configure USB USB configured yes **Execute DFU** and cable Detected bootloader using USB Disable all interrupts interrupt sources no Configure USARTx 0x7F received no on USARTx Execute BL USART_Loop for USARTx MS35016V3

Figure 20. 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 35. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 36.STM32F302xD(E)/303xD(E) configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 48 MHz with HSI48 48 MHz as clock source.
	RCC	HSE enabled	The external clock can be used for all bootloader interfaces and should have one the following values [24,18,16, 12, 9, 8, 6, 4, 3] MHz. The PLL is used to generate the USB 48 MHz clock and the 48 MHz clock for the system clock.
Common to all bootloaders		-	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
IWDG	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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.
	USB	Enabled	USB FS configured in forced device mode. USB FS interrupt vector is enabled and used for USB DFU communications.
DFU bootloader	USB_DM pin		PA11 pin: USB FS DM line.
	Input/Output		PA12 pin: USB FS DP line. An external pull-up resistor 1.5 KOhm must be connected to USB_DP pin.



AN2606 Rev 38 83/329

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.

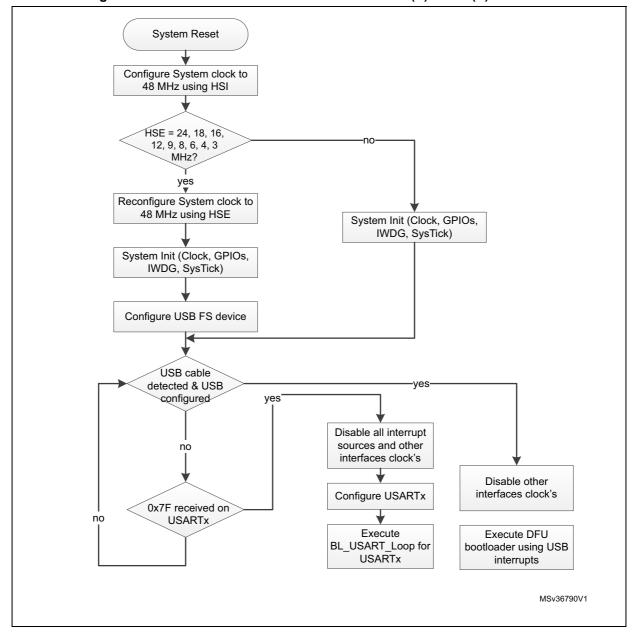
The external clock (HSE) must be kept if it's connected at bootloader startup because it will be used as system clock source.



19.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

Figure 21. Bootloader selection for STM32F302xD(E)/303xD(E)





AN2606 Rev 38 85/329

19.3 Bootloader version

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

Table 37. STM32F302xD(E)/303xD(E) bootloader versions

Bootloader version 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 38. STM32F303x4(6/8)/334xx/328xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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.



AN2606 Rev 38 87/329

20.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx ves 12C Address Execute yes detected BL_I2C_Loop for Configure USARTx I2Cx no Execute BL_USART_Loop 0x7F received on for USARTx **USART**x no MS35029V2

Figure 22. 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 39. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 40. STM32F318xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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.



AN2606 Rev 38 89/329

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: 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.

Table 40. STM32F318xx configuration in system memory boot mode (continued)

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.

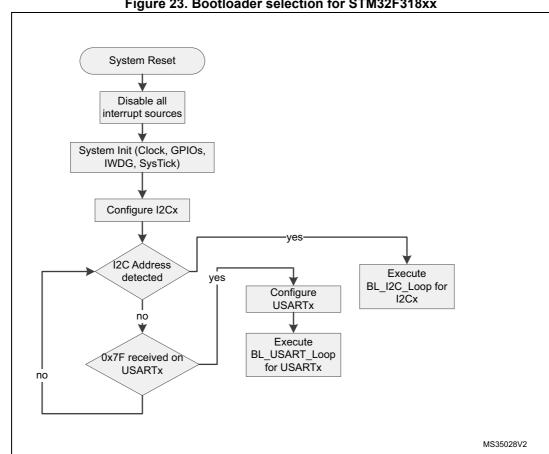


Figure 23. Bootloader selection for STM32F318xx

21.3 Bootloader version

The following table lists the STM32F318xx devices bootloader versions:

Table 41. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 42. STM32F358xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
Common to all	System memory	-	8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware.
bootloaders	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	USART1	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode.
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode.
USART2	USART2	Enabled	Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.
bootloader	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: 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.

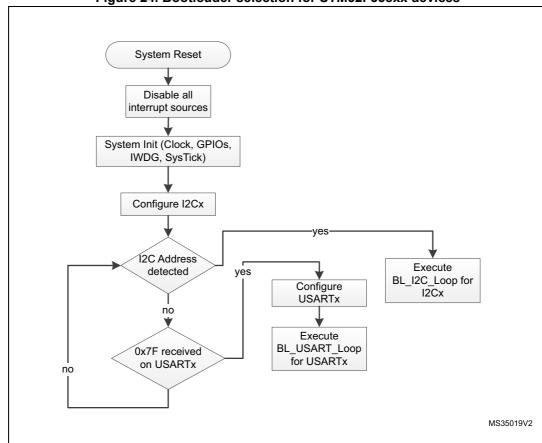


Figure 24. Bootloader selection for STM32F358xx devices

22.3 Bootloader version

The following table lists the STM32F358xx devices bootloader versions.

Table 43. 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.



93/329

23 STM32F373xx devices bootloader

23.1 Bootloader configuration

The STM32F373xx bootloader is activated by applying pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 44. STM32F373xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	HSE enabled	The external clock can be used for all bootloader interfaces and should have one the following values [24,18,16,12,9,8,6,4,3] MHz. The PLL is used to generate the USB 48 MHz clock and the 48 MHz clock for the system clock.
Common to all bootloaders		-	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	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.
USART1 bootloader	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.

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

Table 44. STM32F373xx configuration in system memory boot mode (continued)

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's connected at bootloader startup because it will be used as system clock source.



AN2606 Rev 38 95/329

23.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 48MHz using HSI HSE = 24, 18, 16, 12, 9, 8, 6, 4, 3 MHz no yes Reconfigure System clock to 48MHz using HSE System Init (Clock, GPIOs, IWDG, SysTick) System Init (Clock, GPIOs, IWDG, SysTick) Configure USB ves USB configured Execute DFU and cable Detected yes bootloader using USB Disable all interrupts interrupt sources no Configure **USART**x 0x7F received on USARTx no Execute BL USART Loop for USARTx MS35016V4

Figure 25. Bootloader selection for STM32F373xx devices

23.3 Bootloader version

The following table lists the STM32F373xx devices bootloader versions.

Table 45. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 46. STM32F378xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
Common to all bootloaders	System memory	-	8 Kbyte starting from address 0x1FFFD800, contains the bootloader firmware
bootioaders	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	USART1	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode.
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode.
USART2	USART2	Enabled	Once initialized, the USART2 configuration is: 8 bits, even parity and 1 Stop bit. The USART2 uses its remapped pins.
bootloader	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: 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.



AN2606 Rev 38 97/329

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.

System Reset Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx 12C Address Execute detected yes BL_I2C_Loop for Configure I2Cx USARTx no Execute BL_USART_Loop for USARTx 0x7F received on USARTx no MS35018V2

Figure 26. Bootloader selection for STM32F378xx devices

24.3 Bootloader version

The following table lists the STM32F378xx devices bootloader versions.

Table 47. 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 pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 48.STM32F398xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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	12C3	Enabled	The I2C3 configuration is: 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.



AN2606 Rev 38 99/329

25.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx 0x7F received yes on USARTx Disable all interrupt sources and other yes interfaces clock's no Disable other interfaces clock's Configure USARTx 12Cx Address Detected no Execute Execute BL I2C Loop BL USART Loop for I2Cx for USARTx MSv36791V1

Figure 27.Bootloader selection for STM32F398xx

25.3 Bootloader version

The following table lists the STM32F398xx devices bootloader versions.

Table 49. 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 pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 50. STM32F40xxx/41xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	RCC	HSI enabled	The system clock frequency is 24 MHz using the PLL. 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 will be 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.
Common to all bootloaders		-	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 0x1FFF 0000 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.



AN2606 Rev 38 101/329

Table 50. 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	USART3	Enabled	Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.
(on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3 bootloader	USART3	Enabled	Once initialized, the USART3 configuration is: 8 bits, even parity and 1 Stop bit.
(on PC10/PC11)	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. Note: 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		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line 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.

26.1.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Disable all yes System Init (Clock, GPIOs, interrupt sources IWDG, SysTick) Configure Configure USB OTG FS USARTx device Execute BL USART Loop 0x7F received on for USARTx **USART**x no HSE detected Frame detected no on CANx pin yes yes Disable all no ▼ HSE detected no interrupt sources Generate System USB cable reset Reconfigure System yes Detected clock to 60MHz Reconfigure System clock to 60MHz and Configure CAN USB clock to 48 MHz Execute

Execute DFU bootloader using USB

interrupts

Figure 28. Bootloader V3.x selection for STM32F40xxx/41xxx devices



AN2606 Rev 38 103/329

BL_CAN_Loop for

CANx

MS35012V3

26.1.3 Bootloader version

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

Table 51. STM32F40xxx/41xxx bootloader V3.x versions

Bootloader version number	Description	Known limitations	
V3.0	Initial bootloader version	 When a Read Memory command or Write Memory command is issued with an unsupported memory address and a correct address checksum (ie. 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⁽¹⁾. 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 (shall be re-enabled by user code at startup) 	
V3.1	Fix V3.0 limitations. DFU interface robustness enhancement.	 For the USART interface, two consecutive NACKs (instead of 1 NACK) are sent when a Read Memory or Write Memory command is seand the RDP level is active. For the CAN interface, the Write Unprotect command is not functional. Instead you can use Write Memory command and write directly to to option bytes in order to disable the write protection. 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 (shall be re-enabled by user code at starter 	

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 pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Note:

The bootloader version V9.x is only embedded in STM32F405xx/415xx WCSP90 package devices.

Table 52. STM32F40xxx/41xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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 will be 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.
Common to all		-	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.
bootloaders	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.



AN2606 Rev 38 105/329

Table 52. 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	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
1 510/1 511)	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
1 010/1 011)	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. Note: 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: 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: 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 52. STM32F40xxx/41xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	12C3	Enabled	The I2C3 configuration is: 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).
1200 20040401	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	Enabled	The SPI1 configuration is: 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 bootloader	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	Enabled	The SPI2 configuration is: 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 bootloader	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 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.



AN2606 Rev 38 107/329

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.



26.2.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure USB OTG FS device Configure I2Cx Disable all interrupt sources Configure SPIx Configure USARTx Execute 0x7F received on BL USART Loo USARTx p for USARTx no yes Frame detected on CANx HSE detected ves HSE detected no Generate System yes Yes reset USB cable Detected Reconfigure System clock to 60MHz and Disable all Disable all interrupt interrupt sources USB clock to 48 MHz no yes Reconfigure System **Execute DFU** clock to 60MHz Execute
BL_I2C_Loop for I2Cx Address bootloader using Detected USB interrupts Configure CAN no Execute Disable all BL_CAN_Loop for interrupt sources CANx SPIx detects Synchro mechanism Execute BL_SPI_Loop for SPIx MS35012V2

Figure 29. Bootloader V9.x selection for STM32F40xxx/41xxx



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

Table 53. STM32F40xxx/41xxx bootloader V9.x versions

Bootloader version number	Description	Known limitations
V9.0	This bootloader is an updated version of bootloader v3.1. This new version of bootloader supports I2C1, I2C2, I2C3, SPI1 and SPI2 interfaces. The RAM used by this bootloader is increased from 8Kb to 12Kb. The ID of this bootloader is 0x90. The connection time is increased.	 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. For the CAN interface, the Write Unprotect command is not functional. Instead you can use Write Memory command and write directly to the option bytes in order to disable the write protection. 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 (shall be re-enabled by user code at startup)



27 STM32F401xB(C) devices bootloader

27.1 Bootloader configuration

The STM32F401xB(C) bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 54. STM32F401xB(C) configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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 interface is selected (once DFU bootloader is selected, the clock source will be derived from the external crystal).
	RCC	HSE enabled	The system clock frequency is 60 MHz. The HSE clock source is used only when the DFU (USB FS Device) interface is selected. The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.
Common to all		-	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.
bootloaders	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.



AN2606 Rev 38 111/329

Table 54. STM32F401xB(C) configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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	12C2	Enabled	The I2C2 configuration is: 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)
1202 3001104401	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: 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 54. STM32F401xB(C) configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	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	Enabled	The SPI2 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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	Enabled	The SPI3 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI3 bootloader	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.



113/329

Table 54. STM32F401xB(C) configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	USB	Enabled	USB OTG FS configured in forced device mode
	USB_DM pin	Input/Output	PA11: USB DM line.
DFU bootloader	USB_DP pin		PA12: USB DP line 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.



27.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure USB OTG FS device Disable all interrupt sources Configure I2Cx Configure **USART**x yes Configure SPIx Execute BL_USART_Loop for USARTx 0x7F received on **USART**x no HSE detected USB cable Detected Generate System yes yes reset Disable all no interrupt sources Reconfigure System clock to 60MHz and USB clock to 48 MHz 12Cx Address Execute Detected BL_I2C_Loop for I2Cx no Execute DFU bootloader using USB yes no interrupts Disable all interrupt sources SPIx detects Synchro mechanism Execute BL SPI Loop for SPIx MS35030V1

Figure 30. Bootloader selection for STM32F401xB(C)



AN2606 Rev 38 115/329

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

Table 55. 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 (shall 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 pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 56. STM32F401xD(E) configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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 interface is selected (once DFU bootloader is selected, the clock source will be derived from the external crystal).
	RCC	HSE enabled	The system clock frequency is 60 MHz. The HSE clock source is used only when the DFU (USB FS Device) interface is selected. The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.
Common to all bootloaders		-	The Clock Security System (CSS) interrupt is enabled for the DFU bootloader. Any failure (or removal) of the external clock generates system reset.
bootioaders	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.



AN2606 Rev 38 117/329

Table 56. STM32F401xD(E) configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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	12C2	Enabled	The I2C2 configuration is: 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	12C3	Enabled	The I2C3 configuration is: 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 56. STM32F401xD(E) configuration in system memory boot mode (continued)

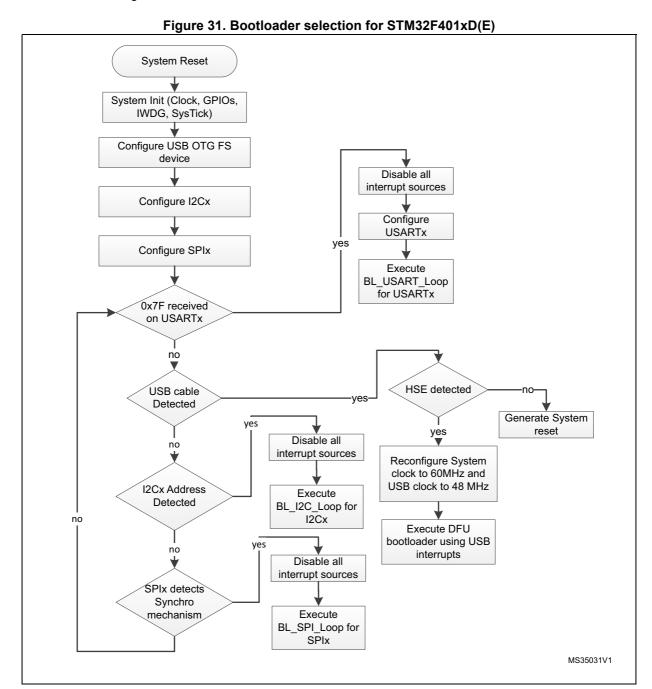
Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push-pull pull-down mode
	SPI1_MISO pin	Output	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	Enabled	The SPI2 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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	Enabled	The SPI3 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI3 bootloader	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.
	USB	Enabled	USB OTG FS configured in forced device mode
	USB_DM pin		PA11: USB DM line.
DFU bootloader	USB_DP pin	Input/Output	PA12: USB DP line 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.

28.2 Bootloader selection

The figure below shows the bootloader selection mechanism.





120/329 AN2606 Rev 38

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

Table 57. 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 (shall be re-enabled by user code at startup)



AN2606 Rev 38 121/329

29 STM32F410xx devices bootloader

29.1 Bootloader configuration

The STM32F410xx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 58. STM32F410xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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] In this range: - Flash wait states 3 System clock Frequency 60 MHz ART Accelerator enabled Flash write operation by byte (refer to bootloader memory management section for more information).
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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.

122/329 AN2606 Rev 38

Table 58. STM32F410xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C1 bootloader	I2C1	Enabled	The I2C1 configuration is: 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: 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	Enabled	The I2C4 configuration is: 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 bootloader	I2C4_SCL pin	Input/Output	PB15 pin: clock line is used in open-drain mode for STM32F410Cx/Rx devices. 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. PB3 pin: data line is used in open-drain mode for STM32F410Tx devices.



Table 58. STM32F410xx configuration in system memory boot mode (continued)

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

The Figure 32 shows the bootloader selection mechanism.

System Reset Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx Configure SPIx 0x7F received on USARTx no 12Cx Address yes-Detected Disable all other no interfaces clocks Disable all other Disable all other interfaces clocks interfaces clocks Configure USARTx SPIx detects Synchro mechanism Execute Execute Execute BL SPI Loop for BL I2C Loop for BL USART Loop for USARTx SPIx I2Cx no MSv38431V2

Figure 32.Bootloader V11.x selection for STM32F410xx



AN2606 Rev 38 125/329

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

Table 59. 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 (shall 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 (shall be re-enabled by user code at startup)



30 STM32F411xx devices bootloader

30.1 Bootloader configuration

The STM32F411xx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 60. STM32F411xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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 interface is selected (once DFU bootloader is selected, the clock source will be derived from the external crystal).
	RCC	HSE enabled	The system clock frequency is 60 MHz. The HSE clock source is used only when the DFU (USB FS Device) interface is selected. The external clock must provide a frequency multiple of 1 MHz and ranging from 4 MHz to 26 MHz.
Common to all bootloaders		-	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 60. STM32F411xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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	12C2	Enabled	The I2C2 configuration is: 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: 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.

128/329 AN2606 Rev 38

Table 60. STM32F411xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: 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 bootloader	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	Enabled	The SPI2 configuration is: 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 bootloader	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	Enabled	The SPI3 configuration is: 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 bootloader	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 60. STM32F411xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	USB	Enabled	USB OTG FS configured in forced device mode
	USB_DM pin	Input/Output	PA11: USB DM line.
DFU bootloader	USB_DP pin		PA12: USB DP line 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.



30.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure USB OTG FS device Disable all interrupt sources Configure I2Cx Configure **USART**x yes Configure SPIx Execute BL USART Loop for USARTx 0x7F received on **USART**x no HSE detected USB cable Detected Generate System yes Yes reset Disable all no interrupt sources Reconfigure System clock to 60MHz and USB clock to 48 MHz I2Cx Address Execute Detected BL_I2C_Loop for I2Cx **Execute DFU** bootloader using USB yes interrupts Disable all interrupt sources SPIx detects Synchro mechanism Execute BL_SPI_Loop for MS35032V1 SPIx

Figure 33. Bootloader selection for STM32F411xx



AN2606 Rev 38 131/329

The following table lists the STM32F411xx devices bootloader version.

Table 61. STM32F411xx bootloader versions

Bootloader version num- ber	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 (shall be re-enabled by user code at startup)



31 STM32F412xx devices bootloader

31.1 Bootloader configuration

The STM32F412xx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The table shows the hardware resources used by this bootloader.

Table 62.STM32F412xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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. 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.
Common to all	RAM	-	16 Kbyte starting from address 0x20000000 are used by the bootloader firmware
bootloaders	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] In this range: - Flash wait states 3 System clock Frequency 60 MHz ART Accelerator enabled Flash write operation by byte (refer to bootloader memory management section for more information).



AN2606 Rev 38 133/329

Table 62.STM32F412xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PD6 pin: USART2 in reception mode
	USART2_TX pin	Output	PD5 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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. Note: 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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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.
I2C	I2C1_SDA pin	Input/Output	PB7 pin: data line is used in open-drain mode.
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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 62.STM32F412xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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	12C4	Enabled	The I2C4 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. 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	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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	Enabled	The SPI3 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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 62.STM32F412xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI4	Enabled	The SPI4 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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.
	USB	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin		PA11 pin: USB DM line.
	USB_DP pin Input	Input/Output	PA12 pin: USB DP line 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.

136/329 AN2606 Rev 38

31.2 Bootloader selection

The Figure 34 shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) ves-Configure USB OTG FS device Disable all interrupt ves sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt sources and other Configure sources and other **USART**x interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL SPI Loop BL I2C Loop BL_USART_Loop for I2Cx for USARTx for SPIx 0x7F received on USARTx no 12Cx Address Detected no HSE detected HSE detected Generate System Synchro mechanism yes detected on SPIx yes reset Disable all interrupt Disable other sources and other interfaces clocks no interfaces clocks no Reconfigure System Reconfigure System Frame detected clock to 60MHz and clock to 60MHz on CANx USB clock to 48 MHz Configure CANx no Execute DFU bootloader using USB interrupts **USB** cable Execute Detected BL CAN Loop for CANx MSv38454V2

Figure 34.Bootloader V9.x selection for STM32F412xx

577

AN2606 Rev 38 137/329

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

Table 63. 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 (shall 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 (shall 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 pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 64. 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. 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] In this range: - Flash wait states 4. - System clock Frequency 60 MHz. - ART Accelerator enabled. - Flash write operation by byte (refer to Bootloader memory management for more information).



AN2606 Rev 38 139/329

Table 64. 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-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	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PD6 pin: USART2 in reception mode
	USART2_TX pin	Output	PD5 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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. Note: 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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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 64. STM32F413xx/423xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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 opendrain mode.
	I2C2_SDA pin	Input/Output	PF0 pin: data line is used in opendrain mode.
I2C3 bootloader	12C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. 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 opendrain mode.
	I2C4_SDA pin	Input/Output	PB14 pin: data line is used in open-drain mode.
SPI1 bootloader	SPI1	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB, speed up to 8MHz - 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.



Table 64. STM32F413xx/423xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
SPI3 bootloader	SPI3	Enabled	The SPI3 configuration is: - Slave mode - Full Duplex - 8-bit MSB, speed up to 8MHz - 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.
SPI4 bootloader	SPI4	Enabled	The SPI4 configuration is: - Slave mode - Full Duplex - 8-bit MSB, speed up to 8MHz - 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 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.

142/329 AN2606 Rev 38



32.2 Bootloader selection

The Figure 35 shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) yes Configure USB OTG FS device Disable all interrupt sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other USARTx interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL SPI Loop BL I2C Loop BL USART Loop for USARTx for I2Cx for SPIx 0x7F received on **USART**x no 12C Address Detected no HSE detected **HSE** detected Synchro mechanism Generate System detected on SPIx yes yes reset Disable all interrupt Disable other sources and other interfaces clocks no interfaces clocks no Reconfigure System Reconfigure System Frame detected clock to 60MHz clock to 60MHz and on CANx USB clock to 48 MHz Configure CAN no Execute DFU bootloader using USB interrupts USB cable Execute Detected BL_CAN_Loop for CAN2 MSv42229V1

Figure 35.Bootloader V9.x selection for STM32F413xx/423xx



AN2606 Rev 38 143/329

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

Table 65. 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 (shall 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 pattern5 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 66. STM32F42xxx/43xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 24 MHz using the PLL. 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 will be derived from the external crystal).
	RCC	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.
Common to all		-	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.
bootloaders	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.



AN2606 Rev 38 145/329

Table 66. STM32F42xxx/43xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8 bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8 bits, even parity and 1 Stop bit
bootloader (on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
(**** = **** = ***,	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8 bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
(**** **** ****,	USART3_TX pin	Input 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. Note: 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: 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).
120 1 2001104401	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.
	USB	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line
	OOB_DF PIII		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.

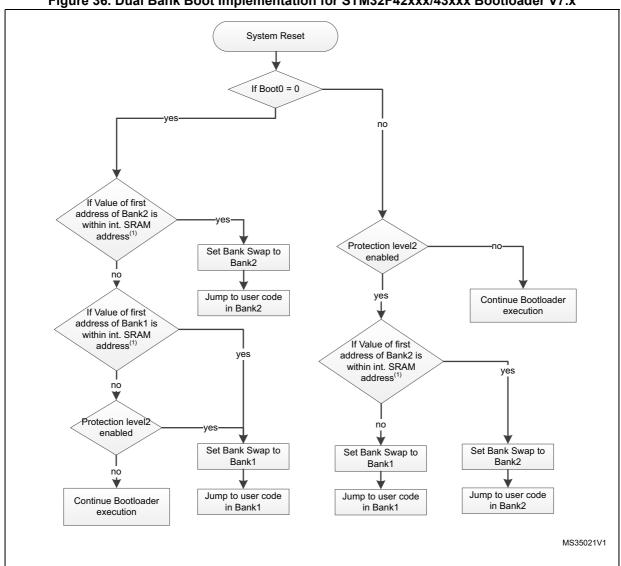


The system clock is derived from the embedded internal high-speed RC for USARTx and I2Cx bootloaders. This internal clock is also used for CAN and DFU (USB FS Device) but only for the selection phase. An external clock multiple of 1 MHz (between 4 and 26 MHz) is required for CAN and DFU bootloader execution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

33.1.2 Bootloader selection

The Figure 36 and Figure 37 show the bootloader selection mechanism.

Figure 36. Dual Bank Boot Implementation for STM32F42xxx/43xxx Bootloader V7.x



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



AN2606 Rev 38 147/329

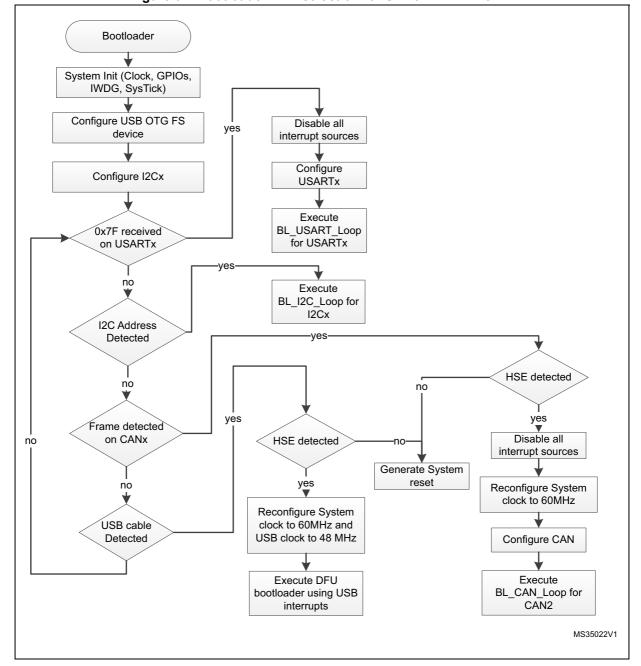


Figure 37. Bootloader V7.x selection for STM32F42xxx/43xxx



33.1.3 Bootloader version

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

Table 67. 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. Instead you can use Write Memory command and write directly to the option bytes in order to disable the write protection. For the USB DFU interface, in Dual Bank mode, the Erase operation is not functional for the second bank. Instead you can return to Single Bank mode, erase desired sector(s) and then reactivate the Dual Bank mode. 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 (shall be re-enabled by user code at startup)



AN2606 Rev 38 149/329

33.2 Bootloader V9.x

33.2.1 Bootloader configuration

The STM32F42xxx/43xxx bootloader is activated by applying pattern5 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 68. STM32F42xxx/43xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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 will be derived from the external crystal).
	RCC	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.
Common to all		-	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.
bootloaders	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	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode



Table 68. STM32F42xxx/43xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
1 010/1 011)	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. Note: 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	12C1	Enabled	The I2C1 configuration is: 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: 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: 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.



AN2606 Rev 38 151/329

Table 68. STM32F42xxx/43xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: 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 bootloader	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	Enabled	The SPI2 configuration is: 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 bootloader	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	Enabled	The SPI4 configuration is: 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 bootloader	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.
	USB	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin		PA11: USB DM line.
51 0 boottoadel	USB_DP pin	Input/Output	PA12: USB DP line 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.

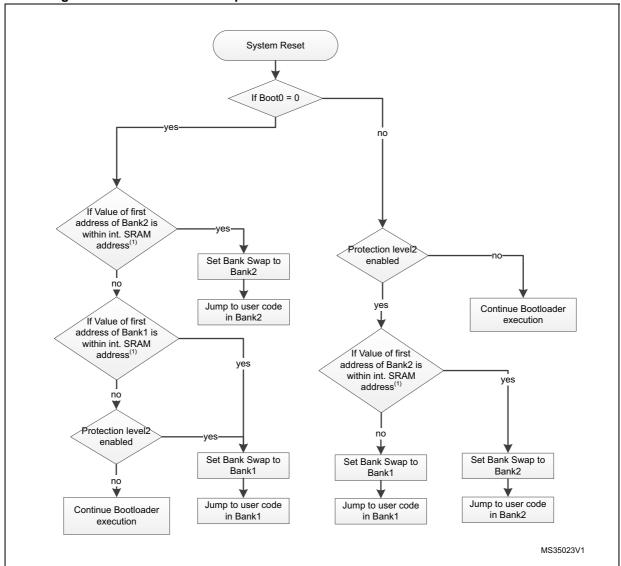


AN2606 Rev 38 153/329

33.2.2 Bootloader selection

The Figure 38 and Figure 39 show the bootloader selection mechanism.

Figure 38. Dual Bank Boot Implementation for STM32F42xxx/43xxx bootloader V9.x



^{1.} CCM RAM is not considered valid as stack pointer address for the dual bank boot mechanism.



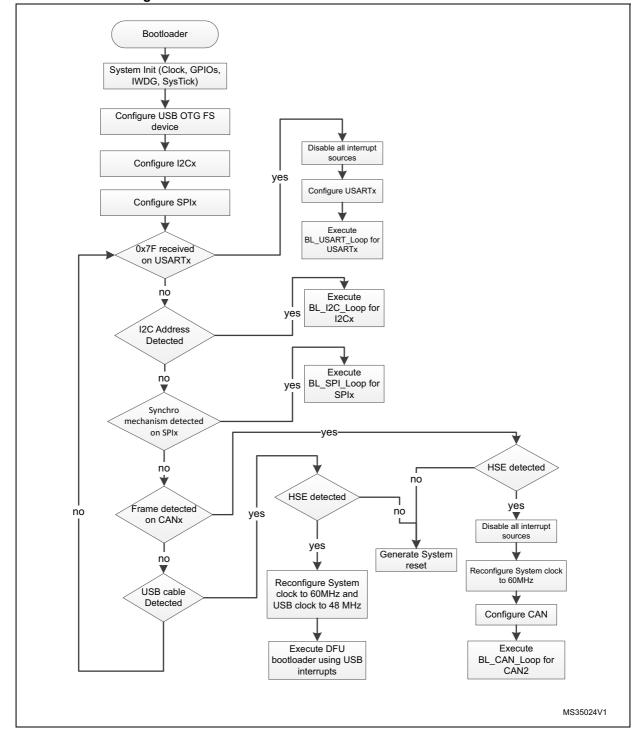


Figure 39. Bootloader V9.x selection for STM32F42xxx/43xxx



AN2606 Rev 38 155/329

33.2.3 Bootloader version

The following table lists the STM32F42xxx/43xxx devices bootloader V9.x versions.

Table 69. STM32F42xxx/43xxx bootloader V9.x versions

Bootloader version number	Description	Known limitations
V9.0	This bootloader is an updated version of bootloader v7.0. This new version of bootloader supports I2C2, I2C3, SPI1, SPI2 and SPI4 interfaces. The RAM used by this bootloader is increased from 8Kb to 12Kb. The ID of this bootloader is 0x90 The connection time is increased.	For the USB DFU interface, in Dual Bank mode, the Erase operation is not functional for the second bank. Instead you can return to Single Bank mode, erase desired sector(s) and then reactivate the Dual Bank mode. 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 (shall be re-enabled by user code at startup)
V9.1	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	For the CAN interface, the Write Unprotect command is not functional. Instead you can use Write Memory command and write directly to the option bytes in order to disable the write protection. For the USB DFU interface, in Dual Bank mode, the Erase operation is not functional for the second bank. Instead you can return to Single Bank mode, erase desired sector(s) and then reactivate the Dual Bank mode. 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 (shall be re-enabled by user code at startup)



34 STM32F446xx devices bootloader

34.1 Bootloader configuration

The STM32F446xx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 70.STM32F446xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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. 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.
Common to all	RAM	-	12 Kbyte starting from address 0x20000000 are used by the bootloader firmware
bootloaders	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]. In this range: - Flash wait states 3 System Clock 60 MHz Prefetch disabled Flash write operation by byte (refer to section bootloader memory management for more information).



AN2606 Rev 38 157/329

Table 70.STM32F446xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
1 5 10/1 5 11)	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
1 010/1 011)	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. Note: 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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111100x (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	12C2	Enabled	The I2C2 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111100x (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 70.STM32F446xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b0111100x (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	Enabled	The SPI1 configuration is: 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 bootloader	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.
	SPI2	Enabled	The SPI2 configuration is: 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 bootloader	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-up mode.



Table 70.STM32F446xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI4	Enabled	The SPI4 configuration is: 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 bootloader	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-up mode.
	USB	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line 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.



34.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Disable all System Init (Clock, GPIOs, interrupt sources IWDG, SysTick) yes Configure Configure USB OTG FS **USART**x device Execute Configure I2Cx BL USART Loop for USARTx 0x7F received on USARTx Disable all yes interrupt sources no Execute I2C Address BL_I2C_Loop for Detected I2Cx Disable all yes no interrupt sources Execute Synchro mechanism BL_SPI_Loop for detected on SPIx SPIx no HSE detected no yes Frame detected on CANx Disable all HSE detected interrupt sources Generate System reset yes Reconfigure System no clock to 60MHz Reconfigure System clock to 60MHz and USB cable USB clock to 48 MHz Configure CAN Detected Execute DFU Execute BL_CAN_Loop for bootloader using USB interrupts CAN2 MSv36763V1

Figure 40.Bootloader V9.x selection for STM32F446xx



AN2606 Rev 38 161/329

34.3 Bootloader version

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

Table 71. 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 (shall 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 pattern5 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 72. STM32F469xx/479xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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 will be derived from external crystal).
	RCC	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.
Common to all		-	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.
bootloaders	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 72. STM32F469xx/479xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
1 510/1 511)	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
1 010/1 011)	USART3_TX pin	Output F	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. Note: 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: 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: 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 72. STM32F469xx/479xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: 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	Enabled	The SPI1 configuration is: 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 bootloader	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.
	SPI2	Enabled	The SPI2 configuration is: 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 bootloader	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-up mode.



165/329

Table 72. STM32F469xx/479xx configuration in system memory boot mode (continued)

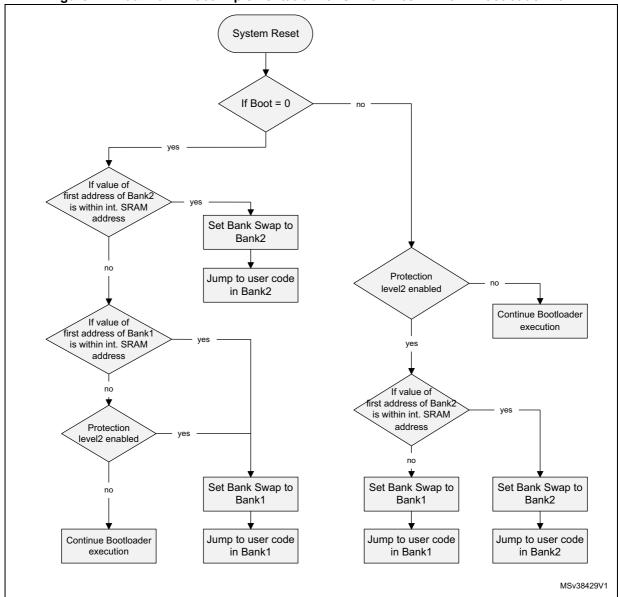
Bootloader	Feature/Peripheral	State	Comment
	SPI4	Enabled	The SPI4 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
	SPI4_MOSI pin	Input	PE14 pin: Slave data Input line, used in push-pull pull-down mode
SPI4 bootloader	SPI4_MISO pin	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_OTG_FS interrupt vector is enabled and used for USB DFU communications.
Di o boottoadei	USB_DM pin		PA11 pin: USB DM line.
	USB_DP pin	Input/Output	PA12 pin: USB DP line. 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.

35.2 Bootloader selection

The Figure 41 and Figure 42 show the bootloader selection mechanism.

Figure 41. Dual Bank Boot Implementation for STM32F469xx/479xx Bootloader V9.x



577

AN2606 Rev 38 167/329

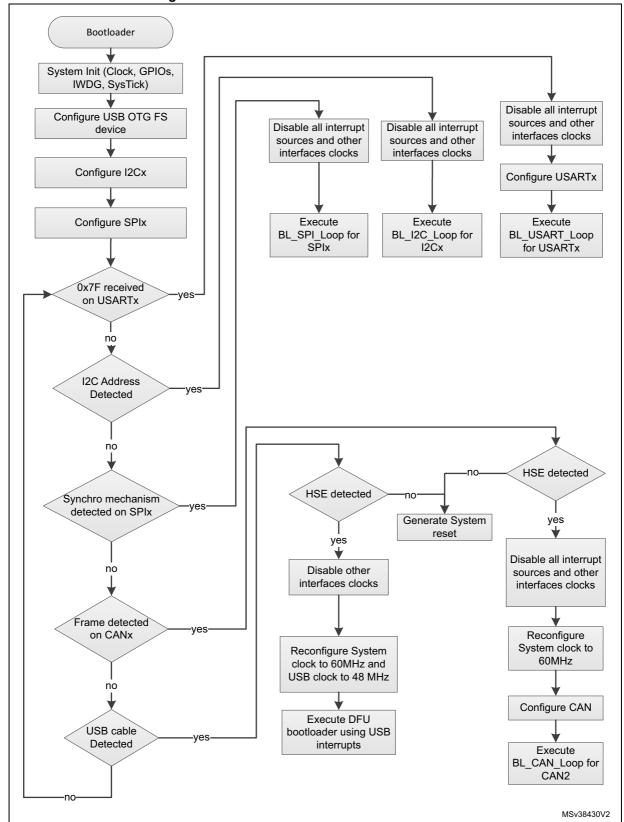


Figure 42.Bootloader V9.x selection for STM32F469xx/479xx



35.3 Bootloader version

The following table lists the STM32F469xx/479xx devices V9.x bootloader versions:

Table 73. 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 (shall 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 pattern8 (described in *Table 2: Bootloader activation patterns*). The *Table 74* shows the hardware resources used by this bootloader.

Table 74. STM32F72xxx/73xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
Common to all bootloaders	RCC	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. 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] In this range: - Flash wait states 3 System clock Frequency 60 MHz ART Accelerator enabled Flash write operation by byte (refer to bootloader memory management section for more information).

Table 74. STM32F72xxx/73xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB11/PB10)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC11/PC10)	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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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 74. STM32F72xxx/73xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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 opendrain mode.
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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.
	SPI2	Enabled	The SPI2 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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-up mode.

Table 74. STM32F72xxx/73xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI4	Enabled	The SPI4 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
ODIAL AND A	SPI4_MOSI pin	Input	PE14 pin: Slave data Input line, used in push-pull pull-down mode
SPI4 bootloader	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.
	USB Enable	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin	Input/Output	PA11 pin: USB DM line.
2. 3 33333333	USB_DP pin		PA12 pin: USB DP line No external Pull-Up resistor is required.
CAN1 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.



AN2606 Rev 38 173/329

36.2 Bootloader selection

The Figure 43 below show the bootloader selection mechanism:

System Reset System Init (Clock, GPIOs, IWDG, SysTick) yes Configure USB OTG FS device Disable all interrupt sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other USARTx interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL_I2C_Loop BL_USART_Loop BL_SPI_Loop for USARTx for SPIx for I2Cx 0x7F received on **USART**x no **I2C Address** Detected no **HSE** detected **HSE** detected Synchro mechanism Generate System yes detected on SPIx yes reset Disable all interrupt Disable other sources and other interfaces clocks no interfaces clocks no Reconfigure System Frame detected Reconfigure System clock to 60 MHz clock to 60 MHz and on CANx USB clock to 48 MHz Configure CAN no **Execute DFU** bootloader using USB interrupts **USB** cable Execute Detected BL_CAN_Loop for CANx MSv44807V1

Figure 43. Bootloader V9.x selection for STM32F72xxx/73xxx



36.3 Bootloader version

The *Table 75* lists the STM32F72xxx/73xxx devices bootloader V9.x versions.

Table 75. STM32F72xxx/73xxx bootloader V9.x versions

Bootloader version number	Description	Known limitations
V9.0	Initial bootloader version	None



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 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 pattern8 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

47/

Table 76. STM32F74xxx/75xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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. 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.
Common to all bootloaders	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]. In this range: - Flash wait states 3 System clock Frequency 60 MHz ART Accelerator enabled Flash write operation by byte (refer to bootloader memory management section for more information).
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
PB10/PB11)	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	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.



AN2606 Rev 38 177/329

Table 76. STM32F74xxx/75xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
			Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier.
CAN2 bootloader	CAN2	Enabled	Note: 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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000101x
			(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	12C2	Enabled	The I2C2 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000101x (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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000101x (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.
	USB	Enabled	USB OTG FS configured in forced device mode.
DFU bootloader	USB_DM pin		PA11 pin: USB DM line.
Di o boolloadei	USB_DP pin	Input/Output	PA12 pin: USB DP line 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.

37.1.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Disable all interrupt sources and other Configure USB OTG FS interfaces clocks device Disable all interrupt sources and other Configure USARTx interfaces clocks Configure I2Cx Execute
BL_USART_Loop Execute BL_I2C_Loop for USARTx for I2Cx 0x7F received on **USART**x **12C Address** Detected HSE detected HSE detected no Generate System yes yes reset Disable all interrupt Frame detected Disable other sources and other interfaces clocks on CANx interfaces clocks Reconfigure System Reconfigure System no clock to 60MHz and clock to 60MHz USB clock to 48 MHz USB cable Detected Configure CAN Execute DFU bootloader using USB interrupts Execute BL_CAN_Loop for CAN2 MSv37792V1

Figure 44.Bootloader V7.x selection for STM32F74xxx/75xxx



AN2606 Rev 38 179/329

37.1.3 Bootloader version

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

Table 77. STM32F74xxx/75xxx bootloader V7.x versions

Bootloader version number	Description	Known limitations
V7.0	Initial bootloader version	None

37.2 Bootloader V9.x

37.2.1 Bootloader configuration

The STM32F74xxx/75xxx bootloader is activated by applying pattern8 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 78. STM32F74xxx/75xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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. 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.
Common to all bootloaders	RAM	-	16 Kbyte starting from address 0x20000000 are used by the bootloader firmware
bootiouders	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] In this range: - Flash wait states 3 System clock Frequency 60 MHz ART Accelerator enabled Flash write operation by byte (refer to bootloader memory management section for more information).



AN2606 Rev 38 181/329

Table 78. STM32F74xxx/75xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB10/PB11)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC10/PC11)	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
1 0 10/1 0 11)	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. Note: 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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000101x (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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000101x (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 78. STM32F74xxx/75xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000101x (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	Enabled	The SPI1 configuration is: 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 bootloader	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.
	SPI2	Enabled	The SPI2 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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-up mode.



183/329

Table 78. STM32F74xxx/75xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI4	Enabled	The SPI4 configuration is: 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 bootloader	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.
	USB	Enabled	USB OTG FS configured in forced device mode.
DFU bootloader	USB_DM pin	Input/Output	PA11 pin: USB DM line.
	USB_DP pin		PA12 pin: USB DP line 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.

37.2.2 Bootloader selection

The Figure 45 shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) ves-Configure USB OTG FS device Disable all interrupt sources and other ves interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other **USART**x interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL_SPI_Loop BL I2C Loop BL USART Loop for USARTx for I2Cx for SPIx 0x7F received on **USART**x no 12C Address Detected no HSE detected HSE detected Synchro mechanism Generate System detected on SPIx yes yes reset Disable all interrupt Disable other sources and other interfaces clocks no interfaces clocks no Reconfigure System Reconfigure System Frame detected clock to 60MHz and clock to 60MHz on CANx USB clock to 48 MHz Configure CAN no Execute DFU bootloader using USB interrupts USB cable Execute ves-BL_CAN_Loop for Detected CAN2

Figure 45.Bootloader V9.x selection for STM32F74xxx/75xxx

5

MSv36793V1

37.2.3 Bootloader version

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

Table 79. STM32F74xxx/75xxx bootloader V9.x versions

Bootloader version number	Description	Known limitations
V9.0	Initial bootloader version	None

38 STM32F76xxx/77xxx devices bootloader

38.1 Bootloader configuration

The STM32F76xxx/77xxx bootloader is activated by applying pattern9 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 80. STM32F76xxx/77xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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. 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.
Common to all	RAM	-	16 Kbyte starting from address 0x20000000 are used by the bootloader firmware
bootloaders	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] In this range: - Flash wait states 3 System clock Frequency 60 MHz ART Accelerator enabled Flash write operation by byte (refer to bootloader memory management section for more information).



AN2606 Rev 38 187/329

Table 80. STM32F76xxx/77xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Enabled Input Output Enabled Input Continist Input Enabled Input Coutput Enabled Input Continist Input Continist Input Continist Input Continist Input Continist Input Input	PA9 pin: USART1 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB11/PB10)	USART3_RX pin	Input	PB11 pin: USART3 in reception mode
	USART3_TX pin	Output	PB10 pin: USART3 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PC11/PC10)	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 Ena	Enabled	Once initialized the CAN2 configuration is: Baudrate 125 kbps, 11-bit identifier. Note: 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
		PB13 pin: CAN2 in transmission mode	
I2C1 bootloader	I2C1	Enabled	The I2C1 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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 80. STM32F76xxx/77xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. 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	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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.
	SPI2	Enabled	The SPI2 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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-up mode.



Table 80. STM32F76xxx/77xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI4	Enabled	The SPI4 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8MHz, 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 bootloader	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.
	USB	Enabled	USB OTG FS configured in forced device mode
DFU bootloader	USB_DM pin		PA11 pin: USB DM line.
	USB_DP pin	Input/Output	PA12 pin: USB DP line 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.

38.2 Bootloader selection

The Figure 46 and Figure 47 show the bootloader selection mechanism.

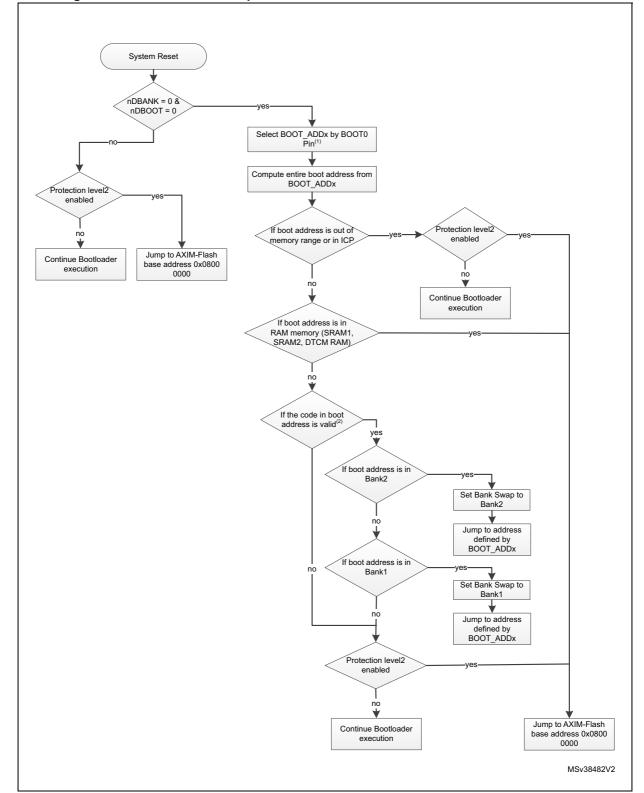


Figure 46. Dual Bank Boot Implementation for STM32F76xxx/77xxx Bootloader V9.x

- 1. Only BOOT_ADD0 value is considered whatever the BOOT0 pin state, as described in Known limitation under Table 81.
- 2. ITCM RAM is not considered valid as stack pointer address for the dual bank boot mechanism.



AN2606 Rev 38 191/329

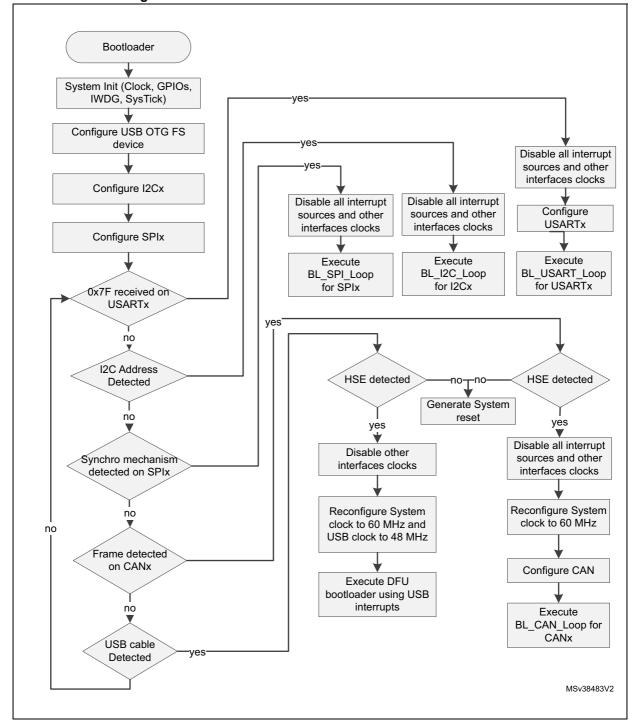


Figure 47. Bootloader V9.x selection for STM32F76xxx/77xxx



38.3 Bootloader version

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

Table 81. STM32F76xxx/77xxx bootloader V9.x versions

Bootloader version number	Description	Known limitations
V9.3	Initial bootloader version	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). Workaround: in order to manage dual bank boot with BOOT_ADD0 and values refer to the
		with BOOT_ADD0 only, please refer to the AN4826: "STM32F7 Series Flash memory dual bank mode"



AN2606 Rev 38 193/329

39 STM32G03xxx/ STM32G04xxx devices bootloader

39.1 Bootloader configuration

The STM32G03xxx/G04xxx bootloader is activated by applying pattern11 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 82. STM32G03xxx/G04xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	System memory	-	8 Kbytes starting from address 0x1FFF0000
boottoaders	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 secrable memory area: @0x1FFF1D00
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010001x (where x = 0 for write and x = 1 for read)
	I2C1_SCL pin	Input/Output	PC4 pin: clock line is used in open-drain mode.
	I2C1_SDA pin	Input/Output	PA8 pin: data line is used in open-drain mode.



Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010001x (where x = 0 for write and x = 1 for read)
	I2C2_SCL pin	Input/Output	PC6 pin: clock line is used in open-drain mode.
	I2C2_SDA pin	Input/Output	PC7 pin: data line is used in open-drain mode.

Table 82. STM32G03xxx/G04xxx configuration in system memory boot mode (continued)

The sticky area is used to isolate boot code/data which manipulate sensitive information (secrets) from application code:

- Access is controlled by a sticky bit STICKY_PROT (write once), in the Flash memory CR register;
- Executed once at boot then locked by writing the sticky bit;
- Width (number of Flash memory pages) is defined through an OB, STICKY_SIZE, in the Flash memory STICKYR register;

The chain of trust is seeded by a unique boot entry via an additional option byte, the BOOT EP option byte in the Flash memory STICKYR register.

The BOOT_EP forces boot from user Flash memory, regardless from boot configuration and RDP level.

Note:

For more information regarding the STM32G03xxx/ STM32G04xxx option bytes configuration, refer to the STM32G0 reference manual.

Figure 48 shows the flow to access to securable memory area from the bootloader.



AN2606 Rev 38 195/329

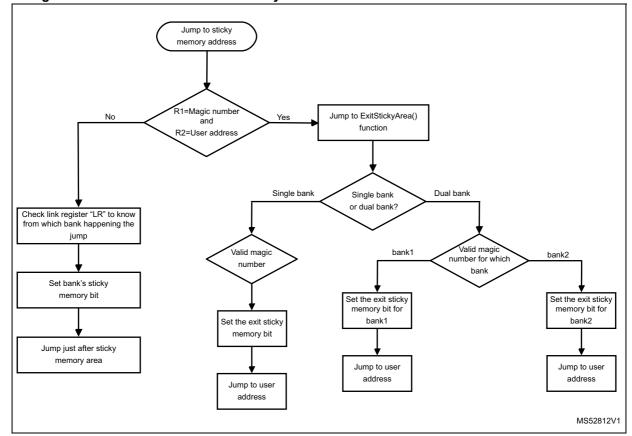


Figure 48. Access to securable memory area from the bootloader for STM32G03xxx/G04xxx

Note: The bootloader doesn't check on the integrity of the user address, it's up to the user to ensure the validity of the address to jump to.

39.2 Bootloader selection

Figure 49 shows the bootloader selection mechanism.



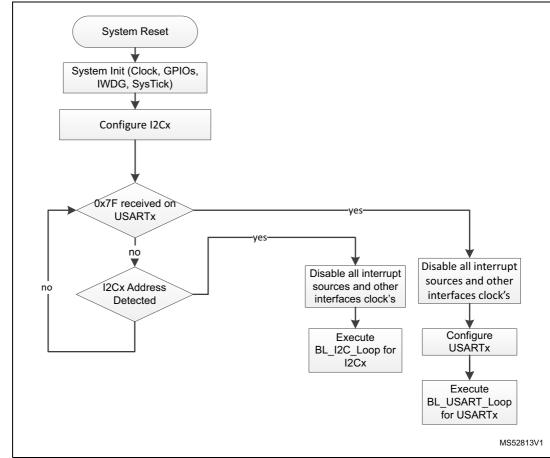


Figure 49. Bootloader V5.x selection for STM32G03xxx/G04xxx

39.3 Bootloader version

Table 83 lists the STM32G03xxx/G4xxx devices bootloader versions.

Table 83. STM32G03xx/04xxx bootloader versions

Bootloader version number	Description	Known limitations
V5.1	Initial bootloader version	Supporting only 48 and 32 pins packages
V5.2	Add support to small packages 8/20 and 28 pins	None



AN2606 Rev 38 197/329

40 STM32G07xxx/08xxx device bootloader

40.1 **Bootloader configuration**

The STM32G07xxx/G08xxx bootloader is activated by applying pattern11 (described in Table 2: Bootloader activation patterns). The following table shows the hardware resources used by this bootloader.

Table 84. STM32G07xxx/8xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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 secrable memory area: @0x1FFF6800
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010001x (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 84. STM32G07xxx/8xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010001x (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	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push-pull, pull-down mode.
or in bookedaci	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. Note : This IO can be tied to Gnd if the SPI Master does not use it.
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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-up. Note: This IO can be tied to GND if the SPI master does not use it.



AN2606 Rev 38 199/329

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

- Access is controlled by a sticky bit SEC_PROT (write once), in the flash CR register;
- Executed once at boot then locked by writing the sticky bit;
- Width (number of FLASH pages) is defined through an OB, SEC_SIZE, in the flash SEC_R register;

The chain of trust is seeded by a unique boot entry via an additional option byte, the BOOT_EP option byte in the flash SEC_R register.

The BOOT_EP forces boot from user flash, regardless from boot configuration and RDP level.

Note:

For more information regarding the STM32G0xxxx option bytes configuration, refer to the STM32G0 reference manual

Figure 50 shows the flow to access to securable memory area from the bootloader.

Jump to secure memory address R1=Magic numbe No R2=User address Flash dual bank Check link register to know from Jump to ExitSecArea() Single bank Dual bank which bank happening the jump function Valid magic Valid magic bank1 Set bank's securable number for which number hank Set securable memory bit for memory bit for Jump just after securable Set securable bank2 memory bit memory area Jump to user Jump to user address address Jump to user MS51971V1

Figure 50. Access to securable memory area from the bootloader for STM32G07xxx/G08xxx

The Bootloader doesn't check on the integrity of the user address, it's up to the user to ensure the validity of the address to jump to.

40.2 Bootloader selection

Figure 51 shows the bootloader selection mechanism.

Bootloader Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure I2Cx Configure SPIx 0x7F received on USARTx yes Disable all other no interfaces clocks **I2C Address** Disable all other Disable all other Configure Detected interfaces clocks interfaces clocks **USART**x no Execute Execute Execute BL_USART_Loop BL SPI Loop BL_I2C_Loop for SPIx for I2Cx for USARTx no Synchro mechanism detected on SPIx MS51450V1

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

40.3 Bootloader version

Table 85 lists the STM32G07xxx/8xxx devices bootloader versions.

Table 85. STM32G07xx/08xxx bootloader versions

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



201/329

41 STM32G431xx/441xx devices bootloader

41.1 Bootloader configuration

The STM32G431xx/441xx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 86. STM32G431xx/441xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 72 MHz (using the PLL clocked by HSI)
	RCC	-	The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz
Common to all	RAM	-	16 Kbyte starting from address 0x20000000 are used by the bootloader firmware
bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
	USART3_TX pin	Output	PC10 pin: USART3 in transmission mode

Table 86. STM32G431xx/441xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010100x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010100x (where x = 0 for write and x = 1 for read)
	I2C3_SCL pin	Input/Output	PC6 pin: clock line is used in open-drain mode.
	I2C3_SDA pin	Input/Output	PC7 pin: data line is used in open-drain mode.
	SPI1	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	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, no pull-up no pull-down mode.



AN2606 Rev 38 203/329

Table 86. STM32G431xx/441xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	SPI2_MOSI pin	Input	PB15 pin: Slave data Input line, used in push-pull, no pull-up no pull-down mode.
	SPI2_MISO pin	Output	PB14 pin: Slave data output line, used in push-pull, no pull-up no pull-down mode.
	SPI2_SCK pin	Input	PB13 pin: Slave clock line, used in push-pull, no pull-up no pull-down mode.
	SPI2_NSS pin	Input	PB12 pin: slave chip select pin used in push-pull, no pull-up no pull-down mode. 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. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3 V for USB to be operational.
	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line No external Pull-up resistor is required

The securable memory area is used to isolate boot code/data which manipulate 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;
- Width (number of Flash memory pages) is defined through an OB, SEC_SIZE, in the Flash SEC_R register;

The chain of trust is seeded by a unique boot entry via an additional option byte, the BOOT_EP option byte in the Flash SEC_R register.

The BOOT_EP forces boot from user Flash memory, regardless from boot configuration and RDP level.

Note:

For more information regarding the STM32G431xx/441xx option bytes configuration, refer to the STM32G4 reference manual (RM0440).

Next figure shows the flow to access to securable memory area from the bootloader.

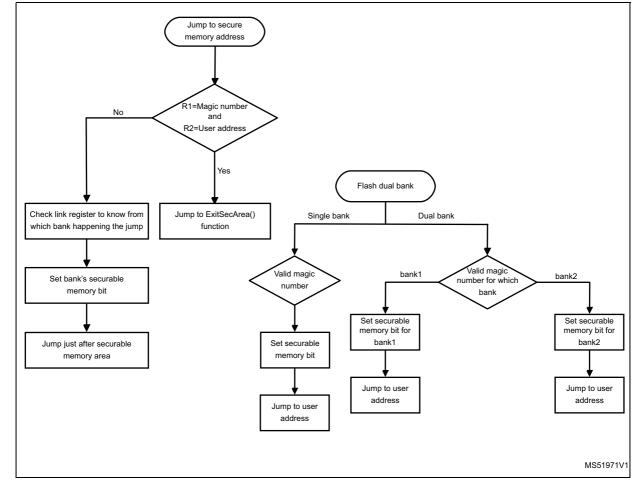


Figure 52. Access to securable memory area

Note: The bootloader does not check the integrity of the user address, but the user must ensure the validity of the address to jump to.



AN2606 Rev 38 205/329

41.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 72 MHz with HSI System Init (Clock, GPIOs, IWDG, SysTick) Configure USB Device FS using CRS and HSI48 as Disable all interrupt clock source sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other USARTx interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL_USART_Loop BL_I2C_Loop BL_SPI_Loop for SPIx for I2Cx for USARTx 0x7F received on USARTx no **12C Address** Detected no Disable other interfaces clocks Synchro mechanism detected on SPIx Execute DFU bootloader using USB no interrupts no USB cable Detected MS51432V1

Figure 53. Bootloader selection for STM32G431xx/441xx



41.3 Bootloader version

Table 87. STM32G431xx/441xx bootloader version

Bootloader version number	Description	Known limitations
V13.3	Initial bootloader version	None



42 STM32G47xxx/48xxx devices bootloader

42.1 Bootloader Configuration

The STM32G47xxx/48xxx bootloader is activated by applying pattern5 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader

Table 88. STM32G47xxx/48xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		HSI enabled	The system clock frequency is 72 MHz (using the PLL clocked by HSI)
	RCC	-	The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI48 48 MHz
Common to all	RAM	-	16 Kbyte starting from address 0x20000000 are used by the bootloader firmware
bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART3_RX pin	Input	PC11 pin: USART3 in reception mode
	USART3_TX pin	Output	PC10 pin: USART3 in transmission mode

Table 88. STM32G47xxx/48xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010100x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010100x (where x = 0 for write and x = 1 for read)
	I2C3_SCL pin	Input/Output	PC6 pin: clock line is used in open-drain mode.
	I2C3_SDA pin	Input/Output	PC7 pin: data line is used in open-drain mode.
I2C4 bootloader	I2C4	Enabled	The I2C4 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010100x (where x = 0 for write and x = 1 for read)
	I2C4_SCL pin	Input/Output	PC8 pin: clock line is used in open-drain mode.
	I2C4_SDA pin	Input/Output	PC9 pin: data line is used in open-drain mode.
	SPI1	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	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, no pull-up no pull-down mode.



Table 88. STM32G47xxx/48xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	SPI2_MOSI pin	Input	PB15 pin: Slave data Input line, used in push-pull, no pull-up no pull-down mode.
	SPI2_MISO pin	Output	PB14 pin: Slave data output line, used in push-pull, no pull-up no pull-down mode.
	SPI2_SCK pin	Input	PB13 pin: Slave clock line, used in push-pull, no pull-up no pull-down mode.
	SPI2_NSS pin	Input	PB12 pin: slave chip select pin used in push-pull, no pull-up no pull-down mode. 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. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3 V for USB to be operational.
	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line No external Pull-up resistor is required

The securable memory area is used to isolate boot code/data which manipulate 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;
- Width (number of Flash memory pages) is defined through an OB, SEC_SIZE, in the Flash SEC_R register;

The chain of trust is seeded by a unique boot entry via an additional option byte, the BOOT_EP option byte in the Flash SEC_R register.

The BOOT_EP forces boot from user Flash memory, regardless from boot configuration and RDP level.

Note:

For more information regarding the STM32G47xxx/48xxx option bytes configuration, refer to the RM0433 reference manual

Next figure shows the flow to access to securable memory area from the bootloader.

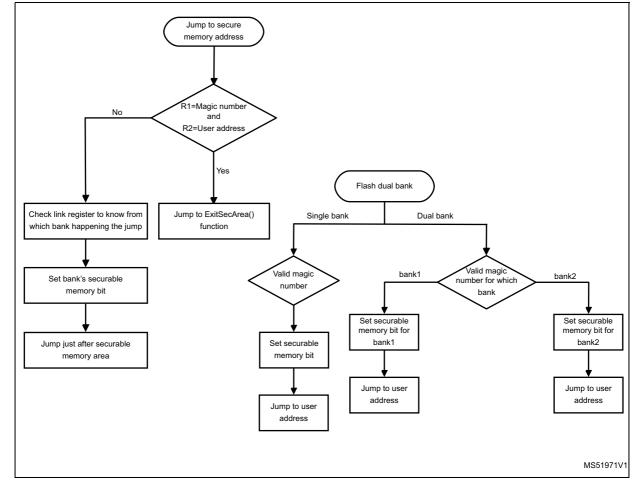


Figure 54. Access to securable memory area

Note: The bootloader does not check the integrity of the user address, but the user must ensure the validity of the address to jump to.



AN2606 Rev 38 211/329

42.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 72 MHz with HSI System Init (Clock, GPIOs, IWDG, SysTick) Configure USB Device FS using CRS and HSI48 as Disable all interrupt clock source sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other USARTx interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL_USART_Loop BL_I2C_Loop BL_SPI_Loop for SPIx for I2Cx for USARTx 0x7F received on USARTx no **12C Address** Detected no Disable other interfaces clocks Synchro mechanism detected on SPIx Execute DFU bootloader using USB no interrupts no USB cable Detected MS51432V1

Figure 55. Bootloader selection for STM32G47xxx/48xxx



42.3 Bootloader version

Table 89. STM32G47xxx/48xxx bootloader version

Bootloader version number	Description	Known limitations
V13.4	Initial bootloader version	None



43 STM32H74xxx/75xxx devices bootloader

43.1 Bootloader configuration

The STM32H74xxx/75xxx bootloader is activated by applying pattern10 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 90. 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. 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 PPLQ
	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PA9/PA10)	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PB14/PB15)	USART1_RX pin	Input	PB15 pin: USART1 in reception mode
11 517 1010)	USART1_TX pin	Output	PB14 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	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode

Table 90. 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-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
I2C1 bootloader	12C1	Enabled	The I2C1 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001110x (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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001110x (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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001110x (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: - 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, 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, no pull-up no pull-down mode.



AN2606 Rev 38 215/329

Table 90. STM32H74xxx/75xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
SPI2 bootloader	SPI2	Enabled	The SPI2 configuration is: - 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, no pull-up no pull-down mode.
	SPI2_MISO pin	Output	PI2 pin: Slave data output line, used in push-pull, no pull-up no pull-down mode.
	SPI2_SCK pin	Input	PI1 pin: Slave clock line, used in push-pull, no pull-up no pull-down mode.
	SPI2_NSS pin	Input	PI0 pin: slave chip select pin used in push-pull, no pull-up no pull-down mode.
SPI3 bootloader	SPI3	Enabled	The SPI3 configuration is: - 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, no pull-up no-pull down mode
	SPI3_MISO pin	Output	PC11 pin: Slave data output line, used in push-pull, no pull-up no-pull down mode.
	SPI3_SCK pin	Input	PC10 pin: Slave clock line, used in push-pull, no pull-up no-pull down mode.
	SPI3_NSS pin	Input	PA15 pin: slave chip select pin used in push-pull, no pull-up no pull-down mode.
SPI4 bootloader	SPI4	Enabled	The SPI4 configuration is: - 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, no pull-up no pull-down mode.
	SPI4_MISO pin	Output	PE13 pin: Slave data output line, used in push-pull, no pull-up no pull-down mode.
	SPI4_SCK pin	Input	PE12 pin: Slave clock line, used in push-pull, no pull-up no pull-down mode.
	SPI4_NSS pin	Input	PE11 pin: slave chip select pin used in push-pull, no pull-up no pull-down mode.

Table 90. STM32H74xxx/75xxx configuration in system memory boot mode (continued)

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

Note: To be able to connect to the bootloader USART1 using PB14/PB15 pins, you need to send two synchronization bytes.



AN2606 Rev 38 217/329

43.2 Bootloader selection

The Figure 56 shows the bootloader selection mechanism.

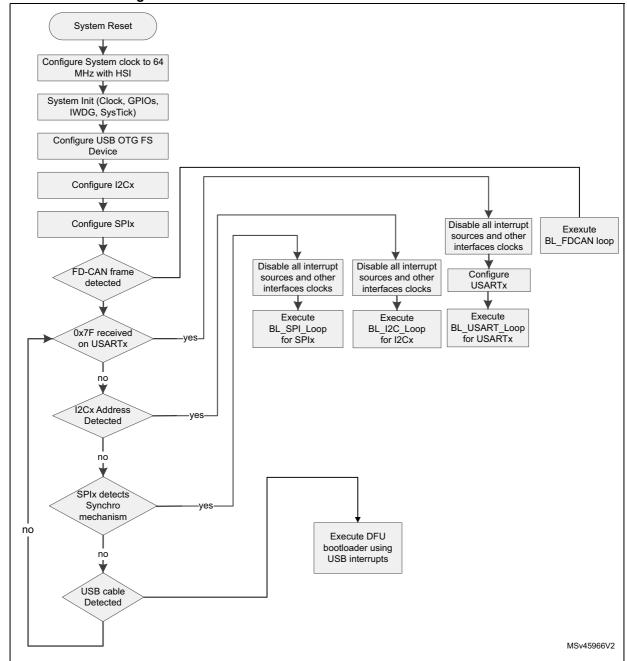


Figure 56. Bootloader V9.x selection for STM32H74xxx/75xxx

43.3 Bootloader version

218/329

Table 91 lists the STM32H74xxx/75xxx devices bootloader versions.

AN2606 Rev 38

Table 91. STM32H74xxx/75xxx bootloader version

Bootloader version number	Description	Known limitations
V13.2	Initial bootloader version	 "Go" Command is not working USART2 connection is not working SPI1 connection is not working Mass erase is not working well on I2C (Only Bank2 is erased in this command)
V13.3	 Switch USB clock input from HSE to HSI48 with CRS Fix known limitations on the V13.2 	Bank erase is not working on USART/SPI and I2C
V9.0	Add support of FDCAN interfaceFix V13.3 limitations	 First ACK not received on "Go" Command when using USART or SPI Limitation on the FDCAN write memory, write of data with length > 63 bytes is failing



AN2606 Rev 38 219/329

44 STM32L01xxx/02xxx devices bootloader

44.1 Bootloader configuration

The STM32L01xxx/02xxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following *Table 92* shows the hardware resources used by this bootloader.

Table 92. STM32L01xxx/02xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PA9/PA10)	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
1 73/1 7 10)	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PA2/PA3)	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
17(2/17(0)	USART2_TX pin	Input I	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	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push-pull pull-down mode
(for all device packages except	SPI1_MISO pin	Output	PA6 pin: Slave data output line, used in push-pull pull-down mode
TSSOP14)	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. Note: This IO can be tied to GND if the SPI Master does not use it.

Table 92. STM32L01xxx/02xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: 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 bootloader (only for devices on TSSOP14 package)	SPI1_MISO pin	Output	PA14 pin: Slave data output line, used in push-pull pull-down mode. Note: This IO is also used as SWCLK for debug interface, as consequence debugger can not 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- up mode. Note: 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 space. But if the first 4 bytes of user lash memory (at 0x0800 0000) are empty at the moment of the jump (ie. erase first sector before jump or execute code from SRAM while Flash is empty), then system bootloader will be executed when jumped to.



AN2606 Rev 38 221/329

44.2 **Bootloader selection**

The *Table 57* shows the bootloader selection mechanism.

System Reset Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure SPIx 0x7F received yes on USARTx Disable all other interfaces clocks no Disable all other Configure interfaces clocks USARTx SPIx detects no Synchro Execute mechanism Execute BL_USART_Loop BL SPI Loop for SPIx for USARTx MSv38476V1

Figure 57. Bootloader selection for STM32L01xxx/02xxx



44.3 Bootloader version

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

Table 93. 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.



AN2606 Rev 38 223/329

45 STM32L031xx/041xx devices bootloader

45.1 Bootloader configuration

The STM32L031xx/041xx bootloader is activated by applying pattern2 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 94. STM32L031xx/041xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PA9/PA10)	USART2_RX pin	Input	PA10 pin: USART2 in reception mode
(OII I A9/I A 10)	USART2_TX pin	Output	PA9 pin: USART2 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader (on PA2/PA3)	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
(OII FAZ/FAS)	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.

Table 94. STM32L031xx/041xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: 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 bootloader	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. Note: 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 don't support SRAM memory space for this product.



AN2606 Rev 38 225/329

45.2 Bootloader selection

The Figure 58 shows the bootloader selection mechanism.

System Reset Disable all interrupt sources System Init (Clock, GPIOs, IWDG, SysTick) Configure SPIx 0x7F received on yes **USART**x Disable all other interfaces clocks no yes Configure USARTx Disable all other interfaces clocks SPIx detects Execute no Synchro BL USART Loop mechanism Execute for USARTx BL_SPI_Loop for SPIx MS35035V1

Figure 58. Bootloader selection for STM32L031xx/041xx

45.3 Bootloader version

The *Table 95* lists the STM32L031xx/041xx devices bootloader versions:

Table 95. STM32L031xx/041xx bootloader versions

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



46 STM32L05xxx/06xxx devices bootloader

46.1 Bootloader configuration

The STM32L05xxx/06xxx bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 96. STM32L05xxx/06xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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.



AN2606 Rev 38 227/329

Table 96. STM32L05xxx/06xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
05141 # 1	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push-pull pull-down mode
SPI1 bootloader	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	Enabled	The SPI2 configuration is: 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 bootloader	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.

46.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

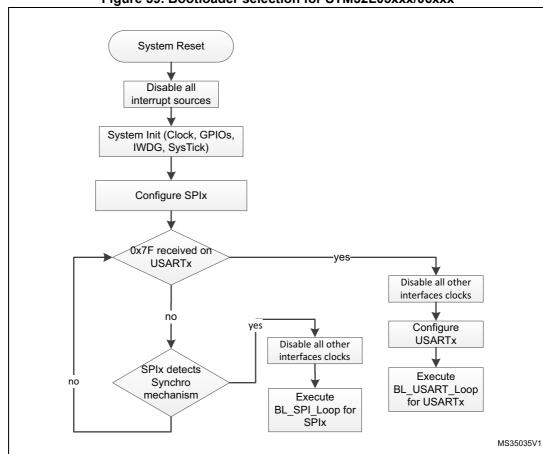


Figure 59. Bootloader selection for STM32L05xxx/06xxx

46.3 Bootloader version

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

 Bootloader version number
 Description
 Known limitations

 V12.0
 Initial bootloader version
 None

Table 97. STM32L05xxx/06xxx bootloader versions

577

47 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.

47.1 Bootloader V4.x

47.1.1 Bootloader configuration

The STM32L07xxx/08xxx bootloader is activated by applying pattern2 or pattern7 when dual bank boot feature is available (described in *Table 2: Bootloader activation patterns*). The *Table 98* shows the hardware resources used by this bootloader.

Table 98. STM32L07xxx/08xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
Common to all	System memory	-	8 Kbyte starting from address 0x1FF00000, contain the bootloader firmware.
bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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-bits, 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 98. 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. USB FS interrupt vector is enabled and used for USB DFU communications.
	USB_DM pin		PA11 pin: USB FS DM line
	USB_DP pin	Input/Output	PA12 pin: USB FS DP line. 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.

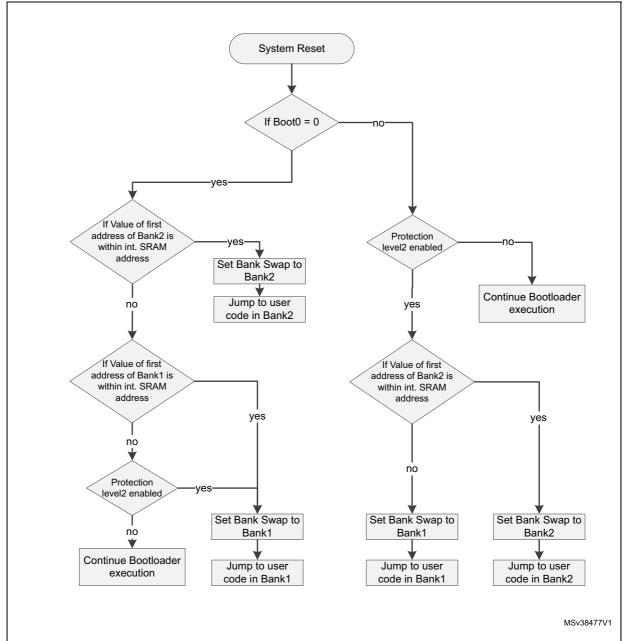


AN2606 Rev 38 231/329

47.1.2 Bootloader selection

The Figure 60 and Figure 61 show the bootloader selection mechanism.

Figure 60. Dual Bank Boot Implementation for STM32L07xxx/08xxx bootloader V4.x





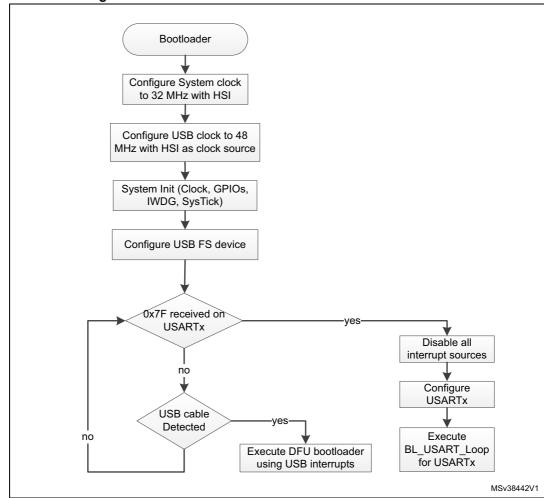


Figure 61. Bootloader V4.x selection for STM32L07xxx/08xxx

47.1.3 Bootloader version

The Table 99 lists the STM32L07xxx/08xxx devices bootloader versions:

Table 99. STM32L07xxx/08xxx bootloader versions

Bootloader version number	Description	Known limitations
V4.0	Initial bootloader version	None
V4.1	This bootloader is an updated version of bootloader V4.0. This new version implements the Dual Bank Boot feature.	None



AN2606 Rev 38 233/329

47.2 Bootloader V11.x

47.2.1 Bootloader configuration

The STM32L07xxx/08xxx bootloader is activated by applying pattern2 or pattern7 when dual bank boot feature is available (described in *Table 2: Bootloader activation patterns*). The *Table 100* shows the hardware resources used by this bootloader.

Table 100. STM32L07xxx/08xxx configuration in system memory boot mode

Bootloader Feature/Peripheral		State	Comment
	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
Common to all bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART2 in reception mode
	USART1_TX pin	Output	PA9 pin: USART2 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000010x (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 opendrain mode.

Table 100. STM32L07xxx/08xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1000010x (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	Enabled	The SPI1 configuration is: 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 bootloader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
	SPI2	Enabled	The SPI2 configuration is: 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 bootloader	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-up mode. Note: This IO can be tied to GND if the SPI Master does not use it.

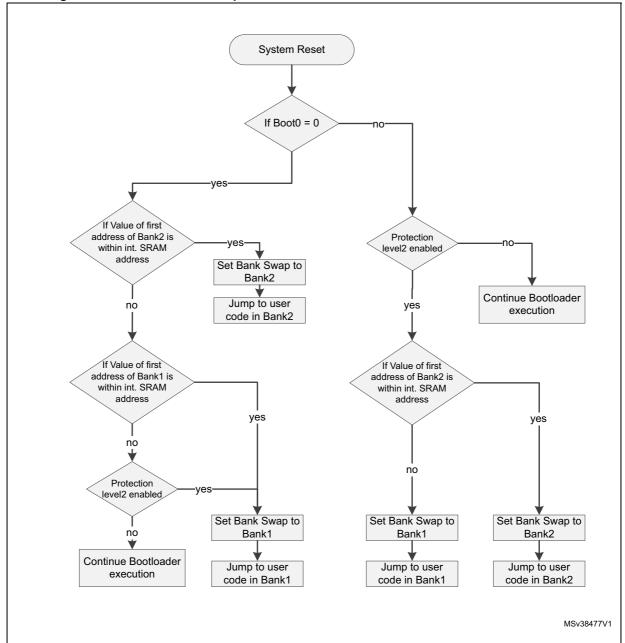
The system clock is derived from the embedded internal high-speed RC for all bootloader interfaces. No external quartz is required for bootloader operations.



47.2.2 Bootloader selection

The Figure 62 and Figure 63 show the bootloader selection mechanism.

Figure 62. Dual Bank Boot Implementation for STM32L07xxx/08xxx bootloader V11.x





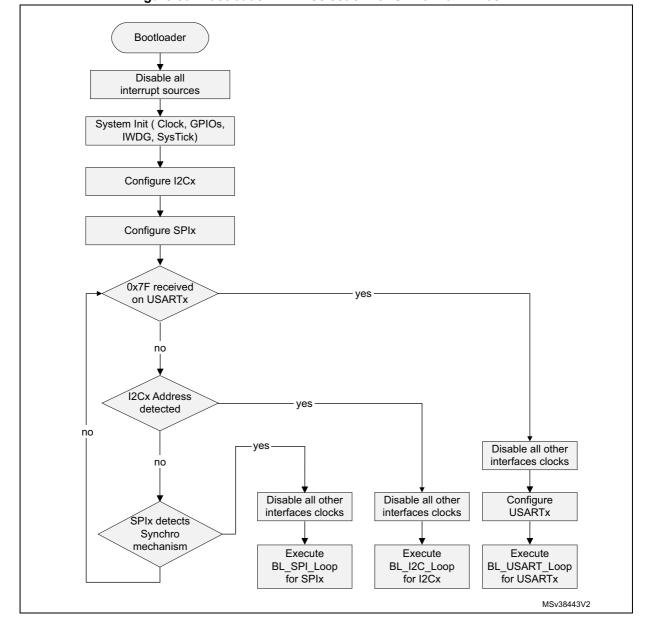


Figure 63. Bootloader V11.x selection for STM32L07xxx/08xxx



AN2606 Rev 38 237/329

47.2.3 Bootloader version

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

Table 101. 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. This new version implements the Dual Bank Boot feature.	None



48 STM32L1xxx6(8/B)A devices bootloader

48.1 Bootloader configuration

The STM32L1xxx6(8/B)A bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 102. STM32L1xxx6(8/B)A configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
Common to all bootloaders	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	USART1	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.
bootloader	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.



48.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset

System Init (Clock, GPIOs, IWDG, SysTick)

Ox7F received on USARTx

Disable all interrupt sources

Configure USARTx

Execute BL_USART_Loop for USARTx

MS35033V1

Figure 64. Bootloader selection for STM32L1xxx6(8/B)A devices

48.3 Bootloader version

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

Table 103. 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 (ie. 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. ⁽¹⁾

^{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).

49 STM32L1xxx6(8/B) devices bootloader

49.1 Bootloader configuration

The STM32L1xxx6(8/B) bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 104. STM32L1xxx6(8/B) configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
Common to all bootloaders	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	USART1	Enabled	Once initialized, the USART1 configuration is: 8 bits, even parity and 1 Stop bit.
bootloader	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.



AN2606 Rev 38 241/329

49.2 **Bootloader selection**

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) 0x7F received on **USART**x Disable all interrupt sources Configure **USART**x Execute BL_USART_Loop for USARTx MS35007V1

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

49.3 **Bootloader version**

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

Table 105. 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 (ie. 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.

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).

50 STM32L1xxxC devices bootloader

50.1 Bootloader configuration

The STM32L1xxxC bootloader is activated by applying pattern1 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 106. STM32L1xxxC configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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: [24, 16, 12, 8, 6, 4, 3, 2] MHz. The PLL is used to generate the USB 48 MHz clock and the 32 MHz clock for the system clock.
Common to all bootloaders		-	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).
	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 bootloader	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



AN2606 Rev 38 243/329

Table 106. STM32L1xxxC configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USARTx bootloaders	SysTick timer	Enabled	Used to automatically detect the serial baud rate from the host for the USARTx bootloader.
DFU bootloader	USB	Enabled	USB used in FS mode
	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line An external pull-up resistor 1.5 KOhm must be connected to USB_DP pin.

The system clock is derived from the embedded internal high-speed RC for the USARTx bootloader. This internal clock is also used the 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.



50.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset System Init (Clock, GPIOs, IWDG, SysTick) Configure USB USB cable Detected no HSE = 24, 16, 12, 8, 6, 4, 3, 2 MHz 0x7F received on **USART**x no Generate System yes reset Reconfigure System clock to 32MHz and Disable all USB clock to 48 MHz interrupt sources Configure Execute DFU **USART**x bootloader using USB interrupts Execute BL_USART_Loop for USARTx MS35008V1

Figure 66. Bootloader selection for STM32L1xxxC devices

50.3 Bootloader version

The following table lists the STM32L1xxxC devices bootloader versions:

Table 107. 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.



AN2606 Rev 38 245/329

51 STM32L1xxxD devices bootloader

51.1 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 108. STM32L1xxxD configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
Common to all bootloaders		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 will be derived from the external crystal).
	RCC	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. 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).
	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 bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode

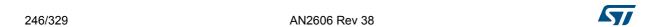


Table 108. STM32L1xxxD configuration in system memory boot mode (continued)

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 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.
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 An external pull-up resistor 1.5 KOhm must be connected to USB_DP pin.

The system clock is derived from the embedded internal high-speed RC for USARTx 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.



AN2606 Rev 38 247/329

51.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset BFB2 bit reset (BFB2 = 0)Protection Jevel2 enabled If Value @0x08030000 is within int. SRAM yes address Jump to user code in Bank2 If Value no @0x08030000 is within int. SRAM If Value address Jump to user code @0x08000000 is in Bank2 within int. SRAM address Jump to user code no in Bank1 If Value @0x08000000 is Continue Bootloader execution within int. SRAM address Jump to user code Disable all in Bank1 interrupt sources no CPU blocked System Init (Clock, GPIOs, (halted) IWDG, SysTick) Configure USB USB cable Generate System HSE detected Detected reset yes yes no Configure Reconfigure System 0x7F received on **USART**x clock to 32MHz and **USART**x USB clock to 48 MHz no Execute BL USART Loop for USARTx **Execute DFU** bootloader using USB interrupts MS35009V2

Figure 67. Bootloader selection for STM32L1xxxD devices



51.3 Bootloader version

The following table lists the STM32L1xxxD devices bootloader versions:

Table 109. STM32L1xxxD bootloader versions

Bootloader version number	Description	Known limitations
V4.1	Initial bootloader version	 In the bootloader code the PA13 (JTMS/SWDIO) I/O output speed is configured to 400 KHz, as consequence some debugger can not connect to the device in Serial Wire mode when the bootloader is running. When the DFU bootloader is selected, the RTC is reset and thus all RTC information (calendar, alarm,) will be lost including backup registers. Note: When the USART bootloader is selected there is no change on the RTC configuration (including backup registers).
V4.2	Fix V4.1 limitations (available on Rev.Z devices only.)	 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 should 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. When the Stack of the user code is placed outside the SRAM (ie. @ 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 (ie. @ 0x2000C000). Workaround: place manually the stack at a physical address.
V4.5	Fix V4.2 limitations. DFU interface robustness enhancements (available on Rev.Y devices only).	- 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.



52 STM32L1xxxE devices bootloader

52.1 Bootloader configuration

The STM32L1xxxE 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 110. STM32L1xxxE configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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 will be 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. The PLL is used to generate the USB 48 MHz clock and the 32 MHz clock for the
			system clock.
Common to all bootloaders		-	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).
	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



Table 110. STM32L1xxxE 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 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.
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 An external pull-up resistor 1.5 KOhm must be connected to USB_DP pin.

The system clock is derived from the embedded internal high-speed RC for USARTx 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.



AN2606 Rev 38 251/329

52.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

Figure 68. Bootloader selection for STM32L1xxxE devices System Reset BFB2 bit reset Protection level2 (BFB2 = 0)enabled If Value If Value @0x08040000 is @0x08040000 is within within int. SRAM address int. SRAM address Jump to user code Jump to user code in Bank2 in Bank2 If Value @0x08000000 is If Value @0x08000000 is within int. SRAM address within int. SRAM address Jump to user code in Bank1 Jump to user code in Bank1 Continue Bootloader execution CPU blocked (halted) Disable all interrupt sources System Init (Clock, GPIOs, Generate HSE IWDG, SysTick) detected System Reset Configure USB Reconfigure System clock to 32MHz and USB cable USB clock to 48 MHz detected Execute DFU bootloader using USB 0x7F received interrupts Configure USARTx on USARTx Execute BL_USART_Loop for USARTx



MS35034V3

52.3 Bootloader version

The following table lists the STM32L1xxxE devices bootloader versions:

Table 111. 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.



53 STM32L412xx/L422xx devices bootloader

53.1 Bootloader configuration

The STM32L412xx/L422xx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 112. STM32L412xx/422xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
	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.
	RCC	-	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
Common to all bootloaders	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 can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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.

254/329 AN2606 Rev 38

Table 112. STM32L412xx/422xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C1 bootloader	I2C1	Enabled	The I2C1 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010010x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010010x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010010x (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	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push-pull pull-down mode
SI II boolloadei	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.



AN2606 Rev 38 255/329

Table 112. STM32L412xx/422xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz Polarity: CPOL Low, CPHA Low, NSS hardware
SPI2 bootloader	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-up mode. 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. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin	Input/Output	PA11: USB DM line.
	USB_DP pin		PA12: USB DP line No external Pull-up resistor is required



53.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 72 MHz with HSI System Init (Clock, GPIOs, IWDG, SysTick) Configure USB Device FS using CRS and HSI48 as Disable all interrupt clock source sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other USARTx interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL_SPI_Loop BL_I2C_Loop BL_USART_Loop for I2Cx for USARTx for SPIx 0x7F received on USARTx no I2C Address ves Detected no Disable other interfaces clocks Synchro mechanism detected on SPIx Execute DFU bootloader using USB no interrupts no USB cable Detected MS51432V1

Figure 69.Bootloader V13.x selection for STM32L412xx/L422xx



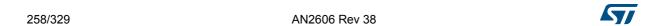
AN2606 Rev 38 257/329

53.3 Bootloader version

The Table 113 lists the STM32L412xx/422xx devices bootloader version.

Table 113. STM32L412xx/422xx bootloader versions

Bootloa versio numbe	n	Description	Known limitations
V13.1	1	Initial bootloader version	On connection phase, USART responds with two ACK bytes (0x79) instead of only one.



54 STM32L43xxx/44xxx devices bootloader

54.1 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 115* for more details).

The STM32L43xxx/44xxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 114. STM32L43xxx/44xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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.
Common to all		-	The Clock Security System (CSS) interrupt is enabled when HSE is enabled. Any failure (or removal) of the external clock generates system reset
bootloaders	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 can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode



AN2606 Rev 38 259/329

Table 114. STM32L43xxx/44xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001000x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001000x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001000x (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.

260/329 AN2606 Rev 38

Table 114. STM32L43xxx/44xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push-pull pull-down mode
or it boottoader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz Polarity: CPOL Low, CPHA Low, NSS hardware
SPI2 bootloader	SPI2_MOSI pin	Input	PB15 pin: Slave data Input line, used in push-pull pull-down mode
SPI2 boottoader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
	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 bootloader	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 114. 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. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin	Input/Output	PA11: USB DM line.
	USB_DP pin		PA12: USB DP line No external Pull-up resistor is required



54.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 60 MHz with HSI Disable all interrupt sources and other System Init (Clock, GPIOs, interfaces clocks IWDG, SysTick) Disable all interrupt Disable all interrupt Configure sources and other Configure USB Device FS sources and other USARTX using CRS and HSI48 as interfaces clocks interfaces clocks clock source Execute Execute Execute BL_I2C_Loop BL USART Loop BL_SPI_Loop Configure I2Cx for I2Cx for USARTx for SPIx Configure SPIx 0x7F received on **USART**x HSE detected no Generate System reset 12C Address yes Detected Disable all interrupt sources and other no interfaces clocks SPIx detects Reconfigure System Synchro mechanism clock to 60 MHz no Disable other Configure CAN no interfaces clocks Frame detected on CANx **Execute DFU** Execute BL CAN Loop for bootloader using USB CANx no interrupts **USB** cable Detected MSv38484V1

Figure 70. Bootloader V9.x selection for STM32L43xxx/44xxx

5

AN2606 Rev 38 263/329

54.3 Bootloader version

The Table 115 lists the STM32L43xxx/44xxx devices bootloader versions.

Table 115. STM32L43xxx/44xxx bootloader versions

Bootloader version number	Description	Known limitations
		Check the Version Information ID of your STM32L43xxx/44xxx device, which can be read at 0x1FFF6FF2 address. Version Information ID equal to 0xFF:
V9.1	Initial bootloader version	 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. Workaround: if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size. 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. On the "Go" command, system bootloader deinit clears the RTCAPBEN bit in the RCC_APB1ENR register Workaround: manually callHAL_RCC_RTC_CLK_ENABLE() in the software which sets the RTCAPBEN bit. Version Information ID equal to 0x10: None



55 STM32L45xxx/46xxx devices bootloader

55.1 Bootloader configuration

The STM32L45xxx/46xxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 116. STM32L45xxx/46xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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.
Common to all bootloaders		-	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).
	Power	-	The DFU can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode



AN2606 Rev 38 265/329

Table 116. STM32L45xxx/46xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001010x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001010x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1001010x (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 116. STM32L45xxx/46xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI1	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
	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 bootloader	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.



AN2606 Rev 38 267/329

Table 116. 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. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line No external Pull-up resistor is required



55.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 72 MHz with HSI System Init (Clock, GPIOs, IWDG, SysTick) Configure USB Device FS using CRS and HSI48 as Disable all interrupt clock source sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other **USART**x interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL SPI_Loop BL I2C Loop BL USART Loop for USARTx for SPIx for I2Cx 0x7F received on USARTx no 12C Address HSE detected Detected Generate System no reset yes Disable all interrupt sources and other Synchro mechanism interfaces clocks detected on SPIx Reconfigure System no clock to 60 MHz Frame detected Disable other Configure CAN on CANx interfaces clocks Execute DFU Execute no BL CAN Loop for bootloader using USB CANx interrupts USB cable Detected MSv45964V1

Figure 71.Bootloader V9.x selection for STM32L45xxx/46xxx



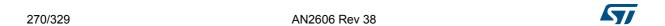
AN2606 Rev 38 269/329

55.3 Bootloader version

Table 117 lists the STM32L45xxx/46xxx devices bootloader versions.

Table 117. STM32L45xxx/46xxx bootloader versions

Bootloader version number	Description	Known limitations
V9.2	Initial bootloader version	None



56 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.

56.1 Bootloader V10.x

56.1.1 Bootloader configuration

The STM32L47xxx/48xxx bootloader is activated by applying pattern7 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 118. STM32L47xxx/48xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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 will be used instead if USB is connected.
		MSI enabled	The MSI is configured to 48 MHz and will be used as USB clock source. The MSI is used only if LSE is detected, otherwise, HSE will be used if USB is connected.
Common to all bootloaders		-	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 can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.



AN2606 Rev 38 271/329

Table 118. STM32L47xxx/48xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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: 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 Inpu	Input/Output	PB10 pin: clock line is used in open-drain mode.	
		PB11 pin: data line is used in open-drain mode.	
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 400 KHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address is 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.
	USB	Enabled	USB OTG FS configured in forced device mode
	USB_DM pin		PA11: USB DM line.
DFU bootloader	USB_DP pin	Input/Output	PA12: USB DP line 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 will be 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 will be configured respectively to 24 MHz and 48 MHz with HSE as clock source.

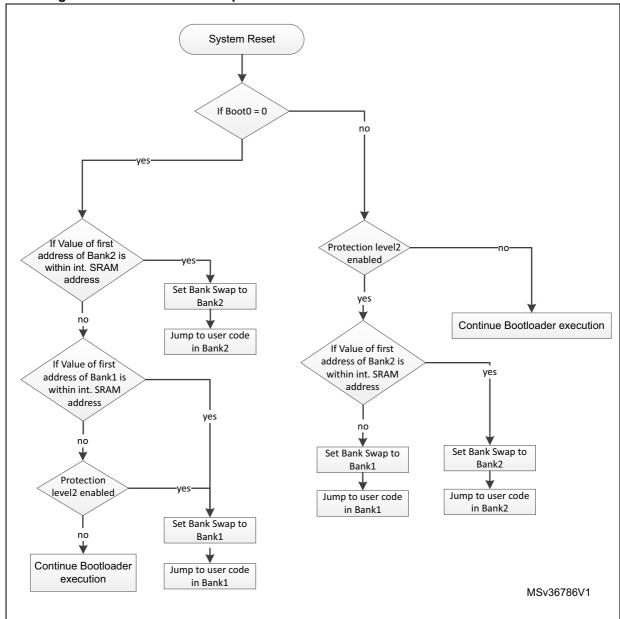


AN2606 Rev 38 273/329

56.1.2 Bootloader selection

The Figure 72 and Figure 73 show the bootloader selection mechanism.

Figure 72. Dual Bank Boot Implementation for STM32L47xxx/48xxx bootloader V10.x





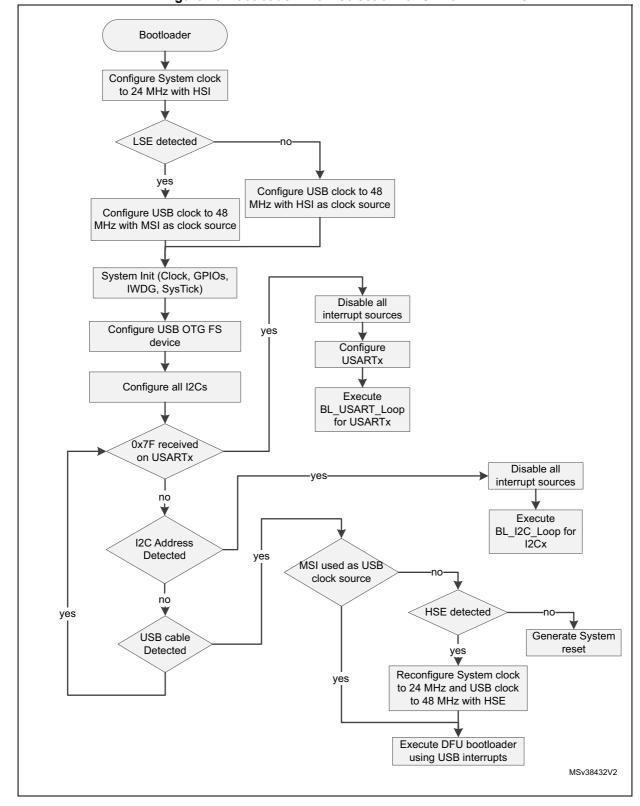


Figure 73.Bootloader V10.x selection for STM32L47xxx/48xxx



AN2606 Rev 38 275/329

56.1.3 Bootloader version

The following table lists the STM32L47xxx/48xxx devices bootloader V10.x versions:

Table 119. STM32L47xxx/48xxx bootloader V10.x versions

Bootloader version number	Description	Known limitations
V10.1	Initial bootloader version	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. Workaround: if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size. Write in SRAM is corrupted.
V10.2	Fix write in SRAM issue	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. Workaround: if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.
V10.3	Add support of MSI as USB clock source (MSI is trimmed by LSE). Update dual bank boot feature to support the case when user stack is mapped in SRAM2.	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. Workaround: if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.



56.2 Bootloader V9.x

56.2.1 Bootloader configuration

The STM32L47xxx/48xxx bootloader is activated by applying pattern7 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 120. STM32L47xxx/48xxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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 LSE enabled MSI enabled CSS	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. System is clocked at 72 MHz if USB is used or 60 MHz if CAN is used.
	RCC		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 will be used instead if USB is connected.
Common to all			The MSI is configured to 48 MHz and will be used as USB clock source. The MSI is used only if LSE is detected, otherwise, HSE will be used if USB is connected.
bootloaders			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 can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART2 in reception mode
	USART1_TX pin	MSI enabled The use only use CSS The ena failugen 13 Fare - 28 Fcon The is con peri rese prev The bood selection Con PW Enabled Input The use PA1	PA9 pin: USART2 in transmission mode



AN2606 Rev 38 277/329

Table 120. STM32L47xxx/48xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: 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: 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: 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	Enabled	The SPI1 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware.
CDI1 hastlands	SPI1_MOSI pin	Input	PA7 pin: Slave data Input line, used in push- pull pull-down mode
SPI1 bootloader	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.

278/329 AN2606 Rev 38

Table 120. STM32L47xxx/48xxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
	SPI2	Enabled	The SPI2 configuration is: Slave mode, Full Duplex, 8-bit MSB, Speed up to 8 MHz, Polarity: CPOL Low, CPHA Low, NSS hardware
SPI2 bootloader	SPI2_MOSI pin	Input	PB15 pin: Slave data Input line, used in push- pull pull-down mode
SPI2 boottoader	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.
CANA bashasday	CAN1	Enabled	Once initialized the CAN1 configuration is: Baudrate 125 kbps, 11-bit identifier.
CAN1 bootloader	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. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin		PA11 pin: USB FS DM line
	USB_DP pin	Input/Output	PA12 pin: USB FS DP line. No external Pull-up resistor is required.

In case, the HSE is present, the system clock and USB clock will be configured respectively to 72 MHz and 48 MHz with PLL (clocked by HSE) as a clock source.



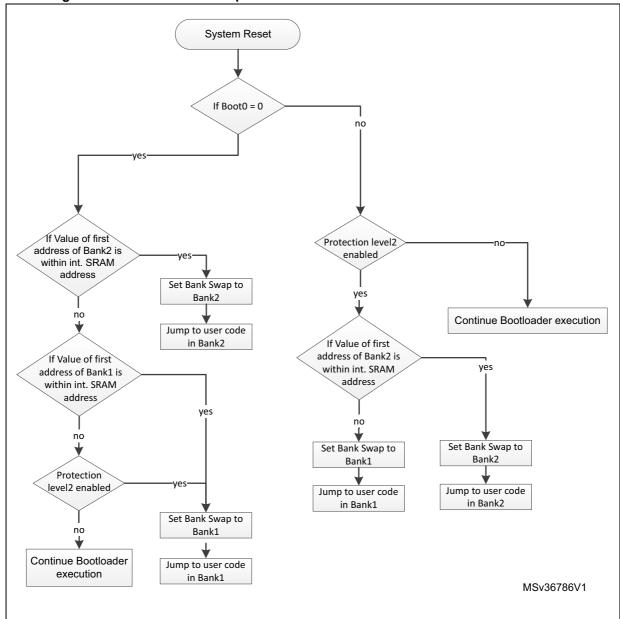
AN2606 Rev 38 279/329

56.2.2 Bootloader selection

280/329

The Figure 74 and Figure 75 show the bootloader selection mechanism.

Figure 74. Dual Bank Boot Implementation for STM32L47xxx/48xxx bootloader V9.x





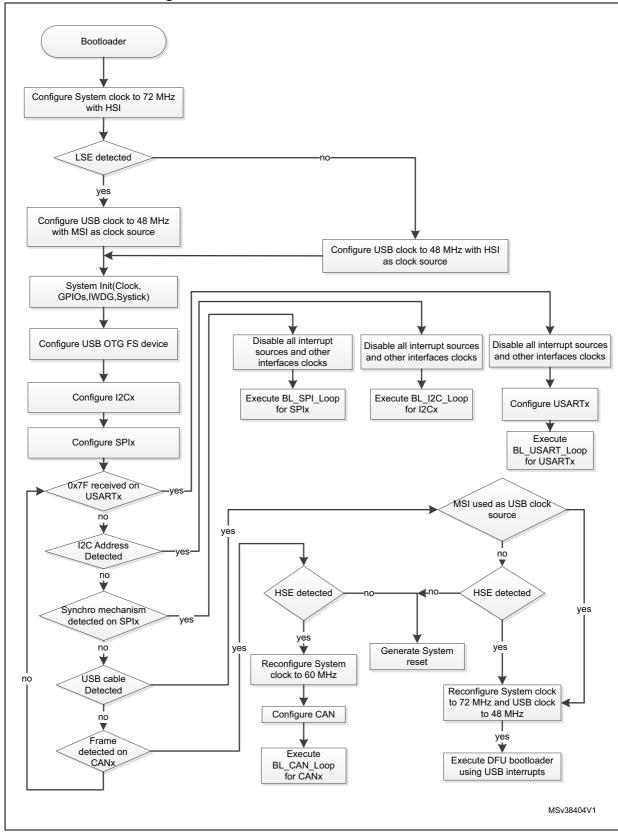


Figure 75.Bootloader V9.x selection for STM32L47xxx/48xxx

5

AN2606 Rev 38 281/329

56.2.3 Bootloader version

The following table lists the STM32L47xxx/48xxx devices bootloader V9.x versions:

Table 121. STM32L47xxx/48xxx bootloader V9.x versions

Bootloader version number	Description	Known limitations
V9.0	Initial bootloader version	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. Workaround: if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size. Write in SRAM is corrupted
V9.1	Deprecated version (not used)	None
V9.2	Fix write in SRAM issue	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. Workaround: if the file size is larger than 256 bytes, add byte padding to align it on 8-bytes multiple size.



57 STM32L496xx/4A6xx devices bootloader

57.1 Bootloader configuration

The STM32L496xx/4A6xx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The *Table 122* shows the hardware resources used by this bootloader.

Table 122. STM32L496xx/4A6xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
	RCC	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
Common to all bootloaders	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 can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode



AN2606 Rev 38 283/329

Table 122. STM32L496xx/4A6xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode
	USART2_TX pin	Enabled Input Output Enabled Input Output Input Output Enabled Input Enabled Input Enabled Input/Output Inpu	PA2 pin: USART2 in transmission mode
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. 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	I2C1_SDA pin	Input/Output	PB7 pin: data line is used in open-drain mode.
I2C2 bootloader	I2C2	Enabled	The I2C2 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. 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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. 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 122. STM32L496xx/4A6xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
SPI1 bootloader	SPI1	Enabled	The SPI1 configuration is: - 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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
SPI2 bootloader	SPI2	Enabled	The SPI2 configuration is: - 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. Note: 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.



AN2606 Rev 38 285/329

Table 122. 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. USB OTG FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin	Input/Output	PA11: USB DM line.
	USB_DP pin		PA12: USB DP line No external Pull-up resistor is required



57.2 Bootloader selection

The Figure 76 shows the bootloader selection mechanism.

System Reset Configure System clock to 72 MHz with HSI System Init (Clock, GPIOs, IWDG, SysTick) Configure USB OTG FS using CRS and HSI48 as clock Disable all interrupt source sources and other interfaces clocks Configure I2Cx Disable all interrupt Disable all interrupt Configure sources and other sources and other USARTx interfaces clocks interfaces clocks Configure SPIx Execute Execute Execute BL_SPI_Loop BL USART Loop BL_I2C_Loop for USARTx for SPIx for I2Cx 0x7F received on USARTx no 12C Address HSE detected Detected Generate System no reset yes Disable all interrupt Synchro mechanism sources and other detected on SPIx interfaces clocks Reconfigure System clock to 60 MHz no Frame detected Disable other Configure CAN on CANx interfaces clocks Execute **Execute DFU** no BL CAN_Loop for bootloader using USB CANx interrupts USB cable Detected MSv44808V1

Figure 76.Bootloader V9.x selection for STM32L496xx/4A6xx



AN2606 Rev 38 287/329

57.3 Bootloader version

The Table 123 lists the STM32L496xx/4A6xx devices bootloader versions.

Table 123. STM32L496xx/4A6xx bootloader version

Bootloader version number	Description	Known limitations
V9.3	Initial bootloader version	 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). SPI write operation fail Limitation: a. During Bootloader SPI write Flash memory operation, some random 64-bits (2 double-words) may be left blank at 0xFF. Root cause: 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 Workarounds: a. WA1: add a delay between sending write command and its ACK request. Its duration should be the duration of the 256-Bytes Flash memory write time. b. WA2: read back after write and in case of error start write again. c. WA3: Patch in RAM to write in Flash memory that implements write memory without 64-bits cast. WA1 and WA3 are more efficient than WA2 in terms of total programming time How critical is the limitation: a. The limitation leads to a modification in customer SPI host software by adding 3-4 ms delay to each write operation. b. The delay is not waste because it's 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). c. Limitation has been seen only on SPI and cannot impact USART/I2C/CAN.



58 STM32L4Rxxx/4Sxxx devices bootloader

58.1 Bootloader configuration

The STM32L4Rxx/4Sxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The *Table 124* shows the hardware resources used by this bootloader.

Table 124. STM32L4Rxxx/4Sxxx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		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.
Common to all bootloaders	RCC	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 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).
	Power	-	The DFU can't be used to communicate with bootloader if the voltage scaling range 2 is selected. Bootloader firmware doesn't configure voltage scaling range value in PWR_CR1 register.



Table 124. STM32L4Rxxx/4Sxxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment	
USART1	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit	
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode	
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode	
USART2	USART2	Enabled	Once initialized the USART2 configuration is: 8-bits, even parity and 1 Stop bit	
bootloader	USART2_RX pin	Input	PA3 pin: USART2 in reception mode	
	USART2_TX pin	Output	PA2 pin: USART2 in transmission mode	
USART3	USART3	Enabled	Once initialized the USART3 configuration is: 8-bits, even parity and 1 Stop bit	
bootloader	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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010000x (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: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010000x (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.	



Table 124. STM32L4Rxxx/4Sxxx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment	
I2C3 bootloader	12C3	Enabled	The I2C3 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010000x (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	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.	
SPI1 bootloader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.	
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.	
SPI2 bootloader	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-up mode. Note: This IO can be tied to Gnd if the SPI Master does not use it.	



AN2606 Rev 38 291/329

Table 124. STM32L4Rxxx/4Sxxx configuration in system memory boot mode (continued)

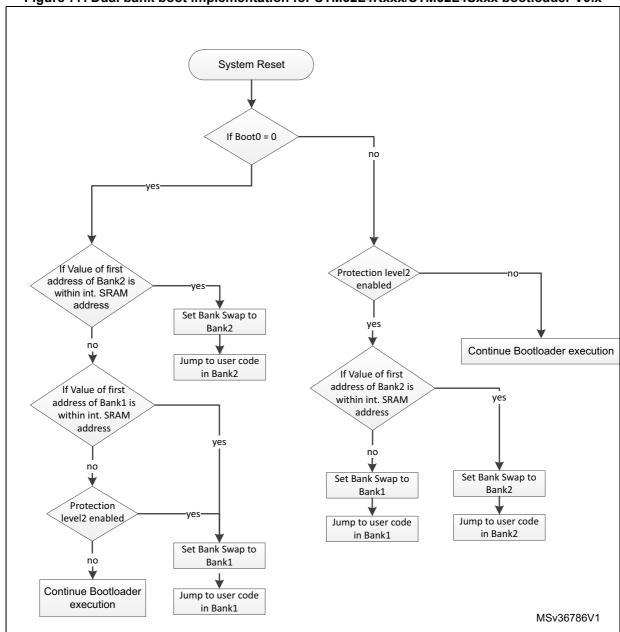
Bootloader	Feature/Peripheral	State	Comment
	CAN1	Enabled	Once initialized the CAN1 configuration is: Baudrate 125 kbps, 11 -bit identifier.
	CAN1_RX pin	Input	PB8 pin: CAN1 in reception mode
CAN1 bootloader	CAN1_TX pin	Output	PB9 pin: CAN1 in transmission mode
	TIM16	Enabled	This timer is used to determine the value of the HSE. Once the HSE frequency is determined, the system clock is configured to 60 MHz using PLL and HSE.
DFU bootloader	USB	Enabled	USB FS configured in forced device mode. USB FS interrupt vector is enabled and used for USB DFU communications. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line No external Pull-up resistor is required



58.2 Bootloader selection

The Figure 77 and Figure 78 show the bootloader selection mechanisms.

Figure 77. Dual bank boot implementation for STM32L4Rxxx/STM32L4Sxxx bootloader V9.x





AN2606 Rev 38 293/329

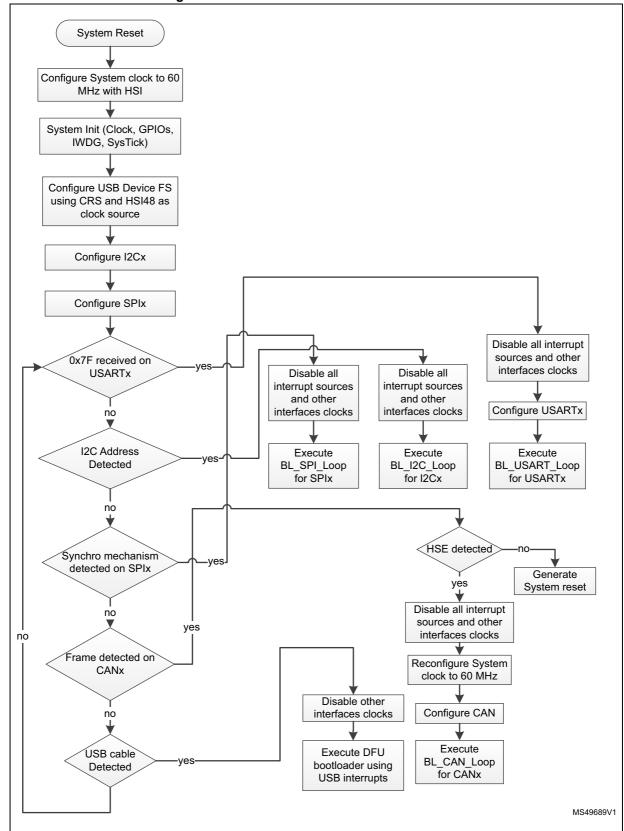


Figure 78.Bootloader V9.x selection for STM32L4Rxx/4Sxx



58.3 Bootloader version

The Table 125 lists the STM32L4Rxx/4Sxx devices bootloader versions.

Table 125. STM32L4Rxx/4Sxx bootloader versions

Bootloader version number	Description	Known limitations
V9.0	Initial bootloader version	None



59 STM32WB55xx devices bootloader

59.1 Bootloader configuration

The STM32WBxxx bootloader is activated by applying pattern6 (described in *Table 2: Bootloader activation patterns*). The following table shows the hardware resources used by this bootloader.

Table 126. STM32WB55xx configuration in system memory boot mode

Bootloader	Feature/Peripheral	State	Comment
		MSI enabled	The system clock frequency is 64 MHz (using PLL clocked by MSI).
	RCC	-	The clock recovery system (CRS) is enabled for the DFU bootloader to allow USB to be clocked by HSI 48 MHz.
Common to all	RAM	-	20 Kbytes starting from address 0x20000000 are used by the bootloader firmware
bootloaders	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	USART1	Enabled	Once initialized the USART1 configuration is: 8-bits, even parity and 1 Stop bit
bootloader	USART1_RX pin	Input	PA10 pin: USART1 in reception mode
	USART1_TX pin	Output	PA9 pin: USART1 in transmission mode
I2C1 bootloader	I2C1	Enabled	The I2C1 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010000x (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 126. STM32WB55xx configuration in system memory boot mode (continued)

Bootloader	Feature/Peripheral	State	Comment
I2C3 bootloader	I2C3	Enabled	The I2C3 configuration is: I2C speed: up to 1 MHz, 7-bit address, slave mode, analog filter ON. Slave 7-bit address: 0b1010000x (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	Enabled	The SPI1 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI1 bootloader	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. Note: This IO can be tied to Gnd if the SPI Master does not use it.
	SPI2	Enabled	The SPI2 configuration is: - Slave mode - Full Duplex - 8-bit MSB - Speed up to 8 MHz - Polarity: CPOL Low, CPHA Low, NSS hardware.
SPI2 bootloader	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-up mode. Note: This IO can be tied to Gnd if the SPI Master does not use it.



Table 126. STM32WB55xx 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. Note: VDDUSB IO must be connected to 3.3V for USB to be operational.
	USB_DM pin		PA11: USB DM line.
	USB_DP pin	Input/Output	PA12: USB DP line No external Pull-up resistor is required



59.2 Bootloader selection

The figure below shows the bootloader selection mechanism.

System Reset Configure System clock to 64 MHz with MSI System Init (Clock, GPIOs, IWDG, SysTick) Configure USB Device FS using CRS and HSI48 as clock source Configure I2Cx Configure SPIx Disable all interrupt sources and other 0x7F received on interfaces clocks **USART**x Disable all Disable all interrupt sources interrupt sources and other and other Configure USARTx interfaces clocks interfaces clocks no **I2C Address** Execute Execute Execute Detected BL SPI Loop BL I2C Loop BL USART Loop for SPIx for I2Cx for USARTx no Synchro mechanism detected on SPIx no Disable other interfaces clocks no Execute DFU USB cable bootloader using Detected **USB** interrupts MS51473V1

Figure 79. Bootloader V13.0 selection for STM32WB55xx



AN2606 Rev 38 299/329

59.3 Bootloader version

Table 127. STM32WB55xx bootloader versions

Bootloader version number	Description	Known limitations
V13.5	Initial bootloader version	 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. This makes the change of the RDP level not effective until a power off power on.



60 Device-dependent bootloader parameters

The bootloader protocol's 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.

The table below shows the values of these parameters for each STM32 device bootloader in production.

Table 128. Bootloader device-dependent parameters

STM32 series	De	vice	PID	BL ID	RAM memory	System memory
	STM32F05xx STM32F030x		0x440	0x21	0x20000800 - 0x20001FFF	0x1FFFEC00 - 0x1FFFF7FF
	STM32F03xx	4/6	0x444	0x10	0x20000800 - 0x20000FFF	
	STM32F030x	С	0x442	0x52	0x20001800 - 0x20007FFF	0x1FFFD800 - 0x1FFFF7FF
F0	STM32F04xx	х	0x445	0xA1	NA	0x1FFFC400 - 0x1FFFF7FF
	STM32F070x	6	0x445	0xA2	NA	0x1FFFC400 - 0x1FFFF7FF
	STM32F070x	В	0x448	0xA2	NA	0x1FFFC800 - 0x1FFFF7FF
	STM32F071x	x/072xx	0x448	0xA1	0x20001800 - 0x20003FFF	0x1FFFC800 - 0x1FFFF7FF
	STM32F09xx	х	0x442	0x50	NA	0x1FFFD800 - 0x1FFFF7FF
		Low-density	0x412	NA	0x20000200 - 0x200027FF	
		Medium- density	0x410	NA	0x20000200 - 0x20004FFF	
	STM32F10x	High-density	0x414	NA	0x20000200 - 0x2000FFFF	
F1	xx	Medium- density value line	0x420	0x10	0x20000200 - 0x20001FFF	0x1FFFF000 - 0x1FFFF7FF
		High-density value line	0x428	0x10	0x20000200 - 0x20007FFF	
	STM32F105x	x/107xx	0x418	NA	0x20001000 - 0x2000FFFF	0x1FFFB000 - 0x1FFFF7FF
	STM32F10xx	x XL-density	0x430	0x21	0x20000800 - 0x20017FFF	0x1FFFE000 - 0x1FFFF7FF
F2	F2 STM32F2xxxx		0x411	0x20	0x20002000 - 0x2001FFFF	0x1FFF0000 - 0x1FFF77FF
FZ STIVISZEZXXXX		^	UX 4 11	0x33	UX1FFFUUUU - UX1FFF//FF	



AN2606 Rev 38 301/329

Table 128. Bootloader device-dependent parameters (continued)

STM32 series	Device	PID	BL ID	RAM memory	System memory
	STM32F373xx	0400	0x41	0x20001400 - 0x20007FFF	
	STM32F378xx	0x432	0x50	0x20001000 - 0x20007FFF	
	STM32F302xB(C)/303xB(C)	0400	0x41	000004400 000000555	
	STM32F358xx	0x422	0x50	0x20001400 - 0x20009FFF	
F3	STM32F301xx/302x4(6/8)	0x439	0x40	0x20001800 - 0x20003FFF	0x1FFFD800 - 0x1FFFF7FF
	STM32F318xx	08439	0x50	0X20001000 - 0X20003FFF	SX
	STM32F303x4(6/8)/ 334xx/328xx	0x438	0x50	0x20001800 - 0x20002FFF	
	STM32F302xD(E)/303xD(E)	0x446	0x40	0x20001800 - 0x2000FFFF	
	STM32F398xx	0x446	0x50	0x20001800 - 0x2000FFFF	
	STM32F40xxx/41xxx	0x413	0x31	0x20002000 - 0x2001FFFF	
	3110132F40XXX/41XXX	08413	0x90	0x20003000 - 0x2001FFFF	
	STM32F42xxx/43xxx	0x419	0x70	0x20003000 - 0x2002FFFF	
	31W32F42XXX/43XXX	000419	0x91	0.0000000 - 0.000211111	
	STM32F401xB(C)	0x423	0xD1	0x20003000 - 0x2000FFFF	
F4	STM32F401xD(E)	0x433	0xD1	0x20003000 - 0x20017FFF	0x1FFF0000 - 0x1FFF77FF
14	STM32F410xx	0x458	0xB1	0x20003000 - 0x20007FFF	0.0000-0.000-0.000
	STM32F411xx	0x431	0xD0	0x20003000 - 0x2001FFFF	
	STM32F412xx	0x441	0x90	0x20003000 - 0x2003FFFF	
	STM32F446xx	0x421	0x90	0x20003000 - 0x2001FFFF	
	STM32F469xx/479xx	0x434	0x90	0x20003000 - 0x2005FFFF	
	STM32F413xx/423xx	0x463	0x90	0x20003000 - 0x2004FFFF	
	STM32F72xxx/73xxx	0x452	0x90	0x20004000 - 0x2003FFFF	0x1FF00000 - 0x1FF0EDBF
F7	STM32F74xxx/75xxx	0x449	0x70	0x20004000 - 0x2004FFFF	0x1FF00000 - 0x1FF0EDBF
' '	011VI021 74XXX/10XXX	0,443	0x90	0x20004000 - 0x2004FFFF	0x1FF00000 - 0x1FF0EDBF
	STM32F76xxx/77xxx	0x451	0x93	0x20004000 - 0x2007FFFF	0x1FF00000 - 0x1FF0EDBF
G0	STM32G03xxx/04xxx	0x466	0x52	0x20000000 - 0x20000FFF	0x1FFF0000 - 0x1FFF1FFF
	STM32G07xxx/08xxx	0x460	0xB2	0x20000000 - 0x200026FF	0x1FFF0000 - 0x1FFF6FFF
G4	STM32G431xx/441xx	0x468	0xD3	0x20000000 - 0x20004000	0x1FFF0000 - 0x1FFF7000
	STM32G47xxx/48xxx	0x469	0xD4	0x20000000 - 0x20004000	0x1FFF0000 - 0x1FFF7000
H7	STM32H74xxx/75xxx	0x450	0x90	0x20004100 - 0x2001FFFF 0x24034000 - 0x2407FFFF	0x1FF00000 - 0x1FF1E7FF

302/329 AN2606 Rev 38

Table 128. Bootloader device-dependent parameters (continued)

STM32 series	Device	PID	BL ID	RAM memory	System memory
	STM32L01xxx/02xxx	0x457	0xC3	NA	0x1FF00000 - 0x1FF00FFF
	STM32L031xx/041xx	0x425	0xC0	0x20001000 - 0x20001FFF	0x1FF00000 - 0x1FF00FFF
L0	STM32L05xxx/06xxx	0x417	0xC0	0x20001000 - 0x20001FFF	0x1FF00000 - 0x1FF00FFF
	STM32L07xxx/08xxx	0x447	0x41	0x20001000 - 0x20004FFF	0x1FF00000 - 0x1FF01FFF
	3 TWI32LU7 XXX/U0XXX	0.447	0xB2	0x20001400 - 0x20004FFF	0.00000 - 0.00000
	STM32L1xxx6(8/B)	0x416	0x20	0x20000800 - 0x20003FFF	
	STM32L1xxx6(8/B)A	0x429	0x20	0x20001000 - 0x20007FFF	
L1	STM32L1xxxC	0x427	0x40		0x1FF00000 - 0x1FF01FFF
	STM32L1xxxD	0x436	0x45	0x20001000 - 0x2000BFFF	
	STM32L1xxxE	0x437	0x40	0x20001000 - 0x20013FFF	
	STM32L43xxx/44xxx	0x435	0x91	0x20003100 - 0x2000BFFF	0x1FFF0000 - 0x1FFF6FFF
	STM32L45xxx/46xxx	0x462	0x92	0x20003100 - 0x2001FFFF	0x1FFF0000 - 0x1FFF6FFF
14	STM32L47xxx/48xxx	0x415	0xA3	0x20003000 - 0x20017FFF	0x1FFF0000 - 0x1FFF6FFF
L4	31W32L47XXX/40XXX	UX415	0x92	0x20003100 - 0x20017FFF	0x1FFF0000 - 0x1FFF0FFF
	STM32L496xx/4A6xx	0x461	0x93	0x20003100 - 0x2003FFFF	0x1FFF0000 - 0x1FFF6FFF
	STM32L4Rxx/4Sxx	0x470	0x92	0x20003200 - 0x2009FFFF	0x1FFF0000 - 0x1FFF6FFF
WB	STM32WB55xx	0x495	0xD5	0x20000000 - 0x20005000	0x1FFF0000 - 0x1FFF7000



AN2606 Rev 38 303/329

Bootloader timing AN2606

61 **Bootloader timing**

This section presents the typical timings of the bootloader firmware that should be used to ensure correct synchronization between host and STM32 device.

Two types of timings will be described herein:

- STM32 device bootloader resources initialization duration.
- Communication interface selection duration.

After these timings the bootloader is ready to receive and execute host commands.

61.1 **Bootloader Startup timing**

After bootloader reset, the host should 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.

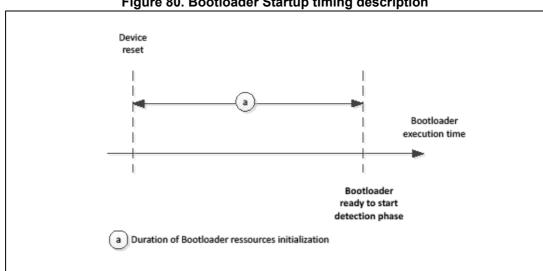


Figure 80. Bootloader Startup timing description

The table below contains the minimum startup timing for each STM32 product:

Minimum Device bootloader Startup **HSE Timeout (ms)** (ms) STM32F03xx4/6 1.612 NA STM32F05xxx and STM32F030x8 devices 1.612 NA STM32F04xxx 0.058 NA STM32F071xx/072xx 0.058 NA HSE connected 3 STM32F070x6 200 HSE not connected 230

Table 129. Bootloader startup timings of STM32 devices

AN2606 Bootloader timing

Table 129. Bootloader startup timings of STM32 devices (continued)

Device		Minimum bootloader Startup (ms)	HSE Timeout (ms)
CTM22F070vD	HSE connected	6	200
STM32F070xB	HSE not connected	230	200
STM32F09xxx		2	NA
STM32F10xxx		1.227	NA
STM32F105xx/107xx	PA9 pin low	1.396	NA
31W32F103XX/107XX	PA9 pin high	524.376	INA.
STM32F10xxx XL-density	·	1.227	NA
STM32F2xxxx	V2.x	134	NA
STMSZFZXXXX	V3.x	84.59	0.790
OTMO0F004/0004/0/0	HSE connected	45	500.5
STM32F301xx/302x4(6/8)	HSE not connected	560.8	560.5
OTMOSTORO DIOVORO DIOV	HSE connected	43.4	0.000
STM32F302xB(C)/303xB(C)	HSE not connected	2.36	2.236
	HSE connected	7.53	NA
STM32F302xD(E)/303xD	HSE not connected	146.71	NA
STM32F303x4(6/8)/334xx/328xx	0.155	NA	
STM32F318xx	0.182	NA	
STM32F358xx		1.542	NA
OTMO0F070	HSE connected	43.4	0.000
STM32F373xx	HSE not connected	2.36	2.236
STM32F378xx		1.542	NA
STM32F398xx		1.72	NA
OTM20540/44	V3.x	84.59	0.790
STM32F40xxx/41xxx	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
CTM22F420.m/420	V7.x	82	97
STM32F429xx/439xx	V9.x	74	97
STM32F446xx		73.61	96



Bootloader timing AN2606

Table 129. Bootloader startup timings of STM32 devices (continued)

Device		Minimum bootloader Startup (ms)	HSE Timeout (ms)	
STM32F469xx/479xx		73.68	230	
STM32F72xxx/73xxx			17.93	50
STM32F74xxx/75xxx			16.63	50
STM32G03xxx/04xxx			0.390	NA
STM32G07xxx/08xxx			0.390	NA
STM32G4xxxx			0.390	NA
STM32H74xxx/75xxx			53.975	2
STM32L01xxx/02xxx			0.63	NA
STM32L031xx/041xx			0.62	NA
STM32L05xxx/06xxx			0.22	NA
STM32L07xxx/08xxx	V4.x		0.61	NA
STIVISZLU/XXX/U6XXX	V11.x		0.71	NA
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
	V10.x	LSE connected	55	100
STM32L47xxx/48xxx	V 10.X	LSE not connected	2560	100
511VI32L47XXX/40XXX	V9.x	LSE connected	55.40	100
	V9.X	LSE not connected	2560.51	100
STM32L412xx/L422xx			0.12	NA
STM32L496xx/4A6xx			76.93	100
STM32L4Rxx/4Sxx			NA	NA
STM32WB55xx			0.390	NA

AN2606 Bootloader timing

61.2 USART connection timing

USART connection timing is the time that the host should wait for between sending the synchronization data (0x7F) and receiving the first acknowledge response (0x79).

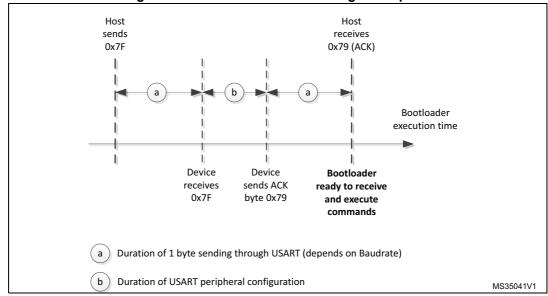


Figure 81. USART connection timing description

- 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
- Bootloader does not re-align the calculated baudrate to standard baudrate values (ie. 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 till a device ACK is sent.

Table 130. USART bootloader minimum timings of STM32 devices

Device	One USART byte sending (ms)	USART configuration (ms)	USART connection (ms)
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



AN2606 Rev 38 307/329

Bootloader timing AN2606

Table 130. USART bootloader minimum timings of STM32 devices (continued)

Device		One USART byte sending (ms)	USART configuration (ms)	USART connection (ms)
STM32F09xxx		0.078125	0.07	0.22
STM32F10xxx		0.078125	0.002	0.15825
STM32F105xx/107xx	PA9 pin low	0.078125	0.007	0.16325
31W32F103XX/107XX	PA9 pin High	0.076125	105	105.15625
STM32F10xxx XL-density		0.078125	0.006	0.16225
STM32F2xxxx	V2.x	0.078125	0.009	0.16525
31W32F2XXX	V3.x	0.076125	0.009	0.10525
CTM22F204vv/202v4/6/0)	HSE connected	0.079125	0.003	0.45925
STM32F301xx/302x4(6/8)	HSE not connected	0.078125	0.002	0.15825
CTM22F202vD/C\/202vD/C\	HSE connected	0.070405	0.000	0.45005
STM32F302xB(C)/303xB(C)	HSE not connected	0.078125	0.002	0.15825
STM32F302xD(E)/303xD		0.078125	0.002	0.15885
STM32F303x4(6/8)/334xx/328	xx	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
31W32F373XX	HSE not connected	0.076125		0.13023
STM32F378xx	•	0.15625	0.001	0.3135
STM32F398xx		0.078125	0.002	0.15885
STM32F40xxx/41xxx	V3.x	0.078125	0.009	0.16525
31W32F40XXX/41XXX	V9.x	0.076125	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
CTM22F420m/420m	V7.x	0.070405	0.007	0.16325
STM32F429xx/439xx V9.x		0.078125	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

308/329 AN2606 Rev 38

AN2606 Bootloader timing

Table 130. USART bootloader minimum timings of STM32 devices (continued)

Device		One USART byte sending (ms)	USART configuration (ms)	USART connection (ms)
STM32G03xxx/04xxx		0.078125	0.01	0.11
STM32G07xxx/08xxx		0.078125	0.01	0.11
STM32G4xxxx		0.078125	0.003	0.159
STM32H74xxx/75xxx		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	0.173
STW32LU/XXX/UOXXX	V11.x	0.078125	0.017	0.158
STM32L1xxx6(8/B)A	•	0.078125	0.008	0.16425
STM32L1xxx6(8/B)	STM32L1xxx6(8/B)		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/L422xx		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	0.159
STIVIOZL4/XXX/40XXX	V9.x	0.078125	0.003	0.159
STM32L496xx/4A6xx		0.078125	0.003	0.159
STM32L4Rxx/4Sxx		NA	NA	NA
STM32WB55xx		0.078125	0.003	0.159

61.3 USB connection timing

USB connection timing is the time that the host should 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.

Bootloader timing AN2606

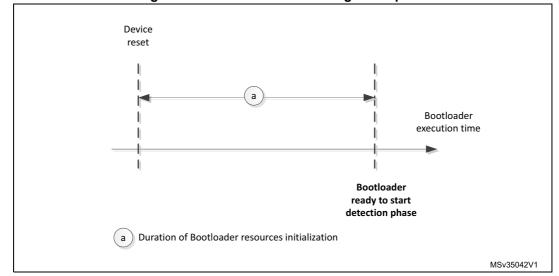


Figure 82. USB connection timing description

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 131. USB bootloader minimum timings of STM32 devices

Device		USB connection (ms)	
STM32F04xxx		350	
STM32F070x6		TBD	
STM32F070xB		320	
	HSE = 25 MHz	460	
STM32F105xx/107xx	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	
3 1 W 32 F 4 U X X X / 4 1 X X X	V9.x	250	
STM32F401xB(C)		250	
STM32F401xD(E)		250	
STM32F411xx		250	
STM32F412xx		380	
STM32F413xx/423xx		350	

AN2606 Bootloader timing

Table 131. USB bootloader minimum timings of STM32 devices (continued)

Device		USB connection (ms)
STM32F429xx/439xx	V7.x	250
31W32F429XX/439XX	V9.x	250
STM32F446xx		200
STM32F469xx/479xx		270
STM32F72xxx/73xxx		320
STM32F74xxx/75xxx		230
STM32G4xxxx		300
STM32H74xxx/75xxx		53.9764
STM32L07xxx/08xxx		140
STM32L1xxxC		849
STM32L1xxxD		849
STM32L412xx/L422xx		820
STM32L43xxx/44xxx		820
STM32L45xxx/46xxx		330
OTMOOL 47/40	V10.x	200
STM32L47xxx/48xxx	V9.x	300
STM32L496xx/4A6xx		430
STM32L4Rxx/4Sxx		NA
STM32WB55xx		300

Bootloader timing AN2606

61.4 I2C connection timing

I2C connection timing is the time that the host should wait for between sending I2C device address and sending command code. This timing includes I2C line stretching duration.

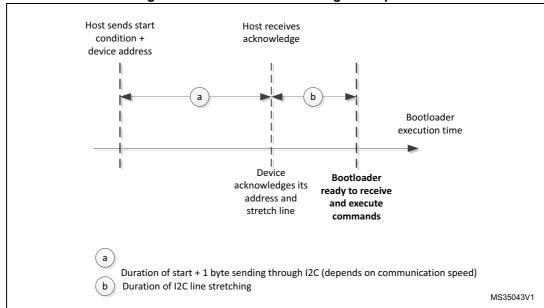


Figure 83. I2C connection timing description

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 reception or transmission 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 unprotect command, the duration of flash operation should be taken into consideration when implementing the host side. After sending the code of pages to be erased, the host should wait until the bootloader device performs page erasing to complete the remaining steps of erase command.

Table 132. 120 bootloader minimum timings of 31 M32 devices				
Device	Start condition + one I2C byte sending (ms)	I2C line stretching (ms)	I2C connection (ms)	I2C Timeout (ms)
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
STM32F303x4(6/8)/334xx/328xx	0.0225	0.0027	0.0252	1000

Table 132. I2C bootloader minimum timings of STM32 devices

312/329 AN2606 Rev 38

AN2606 Bootloader timing

Table 132. I2C bootloader minimum timings of STM32 devices (continued)

Dev	ice	Start condition + one I2C byte sending (ms)	I2C line stretching (ms)	I2C connection (ms)	I2C Timeout (ms)
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	1000
311/132F42XXX/43XXX	V9.x	0.0225	0.0022	0.0247	1000
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
STM32H74xxx/75xxx		0.0225	0.05	0.0725	1000
STM32L07xxx/08xxx		0.0225	0.0020	0.0245	1000
STM32L412xx/L422xx		0.0225	0.0020	0.o245	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	1000
CTWOZETI AAAITOAAA	V9.x	0.0225	0.0020	0.0245	1000
STM32L496xx/4A6xx		0.0225	0.0020	0.0245	1000
STM32L4Rxx/4Sxx		NA	NA	NA	NA
STM32WB55xx		0.0225	0.0020	0.0245	1000



Bootloader timing AN2606

61.5 SPI connection timing

SPI connection timing is the time that the host should wait for between sending the synchronization data (0xA5) and receiving the first acknowledge response (0x79).

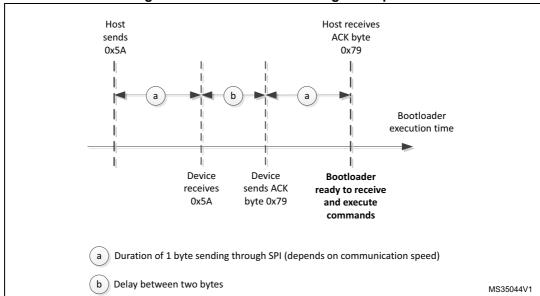


Figure 84. SPI connection timing description

Table 133. SPI bootloader minimum timings of STM32 devices

Device	One SPI byte sending (ms)	Delay between two bytes(ms)	SPI connection (ms)
All products	0.001	0.008	0.01

AN2606 Revision history

Revision history

Table 134. Document revision history

Revision	Changes
1	Initial release.
2	All STM32 in production (rev. B and rev. Z) include the bootloader described in this application note. Modified: Section 3.1: Bootloader activation and Section 1.4: Bootloader code sequence. Added: Section 1.3: Hardware requirements, Section 1.5: Choosing the USART baud rate, Section 1.6: Using the bootloader and Section: Note 2 linked to Get, Get Version & Read Protection Status and Get ID commands in Table 3: Bootloader commands, Note 3 added. Notion of "permanent" (Permanent Write Unprotect/Readout Protect/Unprotect) removed from document. Small text changes. Bootloader version upgraded to 2.0.
3	Small text changes. RAM and System memory added to Table: The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution. Section 1.6: Using the bootloader on page 8 removed. Erase modified, Note 3 modified and Note 1 added in Table 3: Bootloader commands on page 9. Byte 3: on page 11 modified. Byte 2: on page 13 modified. Byte 2:, Bytes 3-4: and Byte 5: on page 15 modified, Note 3 modified. Byte 8: on page 18 modified. Notes added to Section 2.5: Go command on page 18. Figure 11: Go command: device side on page 20 modified. Note added in Section 2.6: Write Memory command on page 21. Byte 8: on page 24 modified. Figure 14: Erase Memory command: host side and Figure 15: Erase Memory command: device side modified. Byte 3: on page 26 modified. Table 3: Bootloader commands on page 9. Note modified and note added in Section 2.8: Write Protect command on page 27. Figure 16: Write Protect command: host side, Figure 17: Write Protect command: device side, Figure 19: Write Unprotect command: device side, Figure 21: Readout Protect command: device side and Figure 23: Readout Unprotect command: device side modified.
4	Unprotect command: device side modified. This application note also applies to the STM32F102xx microcontrollers. Bootloader version updated to V2.2 (see Table 4: Bootloader versions).
	2

Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
19-Nov-2009	5	IWDG added to Table: The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution. Note added. BL changed bootloader in the entire document. Go command description modified in Table: The system clock is derived from the embedded internal high-speed RC, no external quartz is required for the bootloader execution. Number of bytes awaited by the bootloader corrected in Section 2.4: Read Memory command. Note modified below Figure 10: Go command: host side. Note removed in Section 2.5: Go command and note added. Start RAM address specified and note added in Section 2.6: Write Memory command. All options are erased when a Write Memory command is issued to the Option byte area. Figure 11: Go command: device side modified. Figure 13: Write Memory command: device side modified. Note added and bytes 3 and 4 sent by the host modified in Section 2.7: Erase Memory command. Note added to Section 2.8: Write Protect command.
09-Mar-2010	6	Application note restructured. Value line and connectivity line device bootloader added (Replaces AN2662). Introduction changed. Glossary added.
20-Apr-2010	7	Related documents: added XL-density line datasheets and programming manual. Glossary: added XL-density line devices. Table 3: added information for XL-density line devices. Section 4.1: Bootloader configuration: updated first sentence. Section 5.1: Bootloader configuration: updated first sentence. Added Section 6: STM32F10xxx XL-density devices bootloader. Table 65: added information for XL-density line devices.
08-Oct-2010	8	Added information for high-density value line devices in <i>Table 3</i> and <i>Table 65</i> .
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 Section 32: Bootloader timing
06-Jun-2011	12	Updated: - Table 12: STM32L1xxx6(8/B) bootloader versions - Table 17: STM32F2xxxx configuration in System memory boot mode - Table 18: STM32F2xxxx bootloader V2.x versions - Table 20: STM32F2xxxx bootloader V3.x versions
28-Nov-2011	13	Added information related to STM32F405/415xx and STM32F407/417xx bootloader, and STM32F105xx/107xx bootloader V2.1. Added value line devices in Section 4: STM32F10xxx devices bootloader title and overview.



AN2606 Revision history

Table 134. Document revision history (continued)

Date	Revision	Changes
Date 30-Jul-2012	Revision 14	Changes Added information related to STM32F051x6/STM32F051x8 and to Highdensity ultralow power STM32L151xx, STM32L152xx bootloader. Added case of BOOT1 bit in Section 3.1: Bootloader activation. Updated Connectivity line, High-density ultralow power line, STM32F2xx and STM32F4xx in Table 3: Embedded bootloaders. Added bootloader version V2.2 in Table 8: STM32F105xx/107xx bootloader versions. Added bootloader V2.2 in Section 5.3.1: How to identify STM32F105xx/107xx bootloader versions. Added note related to DFU interface below Table 15: STM32L1xxxx high-density configuration in System memory boot mode. Added V4.2 bootloader know limitations and updated description, and added V4.5 bootloader in Table 16: STM32L1xxxx high-density bootloader versions.
		Table 16: STM32L1xxxx high-density bootloader versions. Added note related to DFU interface below Table 19: STM32F2xxxx configuration in System memory boot mode. Added V3.2 bootloader know limitations, and added V3.3 bootloader in Table 20: STM32F2xxxx bootloader V3.x versions. Updated STM32F2xx and STM32F4xx system memory end address in Table 21: STM32F40xxx/41xxx configuration in System memory
		boot mode. Added note related to DFU interface below Table 21: STM32F40xxx/41xxx configuration in System memory boot mode. Added V3.0 bootloader know limitations, and added V3.1 bootloader in Table 22: STM32F40xxx/41xxx bootloader V3.x version.
		Added bootloader V2.1 know limitations in <i>Table 26: STM32F051xx bootloader versions</i> .
		Updated STM32F051x6/x8 system memory end address in <i>Table 65:</i> Bootloader device-dependent parameters.
		Added Table 75: USART bootloader timings for high-density ultralow power devices, and Table 78: USART bootloader timings for STM32F051xx devices. Added Table 88: USB minimum timings for high-density ultralow power devices.



AN2606 Rev 38 317/329

Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
24-Jan-2013	15	Updated generic product names throughout the document (see <i>Glossary</i>). Added the following new sections: - Section 8: STM32L1xxxC devices bootloader. - Section 13: STM32F031xx devices bootloader. - Section 14: STM32F373xx devices bootloader. - Section 15: STM32F302xB(C)/303xB(C) devices bootloader. - Section 16: STM32F378xx devices bootloader. - Section 17: STM32F358xx devices bootloader. - Section 18: STM32F427xx/437xx devices bootloader. - Section 34.3: I2C bootloader timing characteristics. Updated Section 1: Related documents and Section 2: Glossary. Added Table 79 to Table 85 (USART bootloader timings). Replaced Figure 6 to Figure 16, and Figures 18, 19 and 42. Modified Tables 3, 5, 9, 11, 17, 20, 21, 22 to 13, 27, 29, 31, 33, 35, 37 and 65. Removed "X = 6: one USART is used" in Section 3.3: Hardware connection requirement. Replaced address 0x1FFFF 8002 with address 0x1FFF F802 in Section 12.1: Bootloader configuration. Modified procedure related to execution of the bootloader code in Note: on page 28, in Section 6.2: Bootloader selection and in Section 9.2: Bootloader selection.
06-Feb-2013	16	Added information related to I ² C throughout the document. Streamlined <i>Table 1: Applicable products</i> and <i>Section 1: Related documents</i> . Modified <i>Table 3: Embedded bootloaders</i> as follows: Replaced "V6.0" with "V1.0" Replaced "0x1FFFF7A6" with "0x1FFFF796" in row STM32F31xx Replaced "0x1FFF7FA6" with "0x1FFF7A6" in row STM32F051xx Updated figures 6, 9 and 11. Added <i>Note:</i> in <i>Glossary</i> and <i>Note:</i> in <i>Section 3.1: Bootloader activation</i> . Replaced: "1.62 V" with "1.8 V" in tables17, 19, 19, 22, 21, 27, 37 and 59 "5 Kbyte" with "4 Kbyte" in row RAM of <i>Table 33</i> "127 pages (2 KB each)" with "4 KB (2 pages of 2 KB each)" in rows F3 of <i>Table 65</i> "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 <i>Section 3.3: Hardware connection requirement</i> . "STM32F2xxxx devices revision Y" by "STM32F2xxxx devices revision X and Y" in <i>Section 10: STM32F2xxxx devices bootloader</i> "Voltage Range 2" with "Voltage Range 1" in tables 11, 15 and 26.



AN2606 Revision history

Table 134. Document revision history (continued)

Date	Revision	Changes
21-May-2013	17	Updated: - Introduction - Section 2: Glossary - Section 3.3: Hardware connection requirement - Section 7: STM32L1xxx6(8/B) devices bootloader to include STM32L100 value line - Section 32.2: USART connection timing - Section 34.2: USB bootloader timing characteristics - Section 34.3: I2C bootloader timing characteristics - Table 1: Applicable products - Table 3: Embedded bootloaders - Table 25: STM32F051xx configuration in System memory boot mode - Table 27: STM32F031xx configuration in System memory boot mode - Table 65: Bootloader device-dependent parameters - Figure 17: Bootloader selection for STM32F031xx devices Added Section 19: STM32F429xx/439xx devices bootloader.
19-May-2014	18	Add: - Figure 1 to Figure 5, Figure 68, Figure 6, Figure 25, Figure 26, Figure 24, from Figure 38 to Figure 80, Figure 84 - Table 4, Table 110, Table 111, from Table 6 to Table 45, from Table 46 to Table 43, from Table 68 to Table 69, from Table to Table 133 - Section 38.4, Section 33.2, Section 61.1, Section 61.5 - Section 5, Section 23, Section 24, Section 22, from Section 17 to Section 56 - note under Figure 1, Figure 2, Figure 3 and Figure 4 Updated: - Updated starting from Section 4 to Section 7 and Section 18, Section 33 and Section 33 the chapter structure organized in three subsection: Bootloader configuration, Bootloader selection and Bootloader version. Updated Section 56 and Section 61 - Updated block diagram of Figure 25 and Figure 20. - Fixed I2C address for STM32F429xx/439xx devices in Table 66 - Table 1, Table 2, Table 3, Table 24, Table 104, Table 106, Table 108, Table 28, Table 30, Table 50, Table 128 - from Figure 14, to Figure 28, Figure 8, from Figure 80 to Figure 84 - note on Table 105

Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
29-Jul-2014	19	Updated: - notes under Table 2 - Figure 67 and Figure 68 - Section 3: Glossary - replaced any reference to STM32F427xx/437xx with STM32F42xxx/43xxx on Section 33: STM32F42xxx/43xxx devices bootloader - replace any occurrence of 'STM32F072xx' with 'STM32F07xxx' - replace any occurrence of 'STM32F051xx' with 'STM32F051xx and STM32F030x8 devices'. - comment field related to OTG_FS_DP and OTG_FS_DM on Table 24, Table 30, Table 50, Table 110, Table 66, Table 68, Table 12, Table 18, Table 54, Table 56 and Table 60 - comment field related to USB_DM on Table 110. - replace reference to "STM32F429xx/439xx" by "STM32F42xxx/43xxx" on Table 3 - comment field related to SPI2_MOSI, SPI2_MISO, SPI2_SCK and SPI2_NSS pins on Table 68 Added: - note under Table 2 - reference to STM32F411 on Table 1, Section 3: Glossary, Table 129, Table 130, Table 131, Table 132 - Section 30: STM32F411xx devices bootloader Removed reference to STM32F427xx/437xx on Table 3, Section 3: Glossary, Table 128, Table 129, Table 130, Table 131
24-Nov-2014	20	Updated: - comment in "SPI1_NSS pin" and "SPI2_NSS pin" rows on <i>Table 110</i> and <i>Table 96</i> - comment in "SPI1_NSS pin", "SPI2_NSS pin" and "SPI3_NSS pin" rows on <i>Table 54</i> , <i>Table 56</i> and <i>Table 60</i> - <i>Figure 1</i>
11-Mar-2015	21	Updated: - Table 1, Table 3, Table 22, Table 26, Table 104, Table 28, Table 30, Table 31, Table 50, Table 110, Table 10, Table 11, Table 6, Table 34, Table 66, Table 68, Table 12, Table 13, Table 18, Table 19, Table 32, Table 102, Table 118, Table 128, Table 129, Table 130, Table 131 and Table 132 - Figure 73 - Chapter 3: Glossary - Section 4.1 and Section 4.4 Added: - Section 56: STM32L47xxx/48xxx devices bootloader and Section 34: STM32F446xx devices bootloader



320/329

AN2606 Revision history

Table 134. Document revision history (continued)

Date	Revision	134. Document revision history (continued) Changes
09-Jun-2015	22	Added: - Section 9: STM32F070x6 devices bootloader - Section 10: STM32F070xB devices bootloader - Section 12: STM32F09xxx devices bootloader - Section 19: STM32F302xD(E)/303xD(E) devices bootloaderSection 25: STM32F398xx devices bootloader - Section 36: STM32F72xxx/73xxx devices bootloader - Section 56.2: Bootloader V9.x - Notes 1 and 2 on Figure 81 Updated: - Table 1 - Section 3: Glossary - Table 2 - Table 3 - Section 4.4: Bootloader memory management - Table 128, Table 129, Table 130, Table 131 and Table 132
29-Sep-2015	23	Added: Section 29: STM32F410xx devices bootloader Section 35: STM32F469xx/479xx devices bootloader Section 45: STM32L031xx/041xx devices bootloader Section 47: STM32L07xxx/08xxx devices bootloader Updated: Table 1 Section 3: Glossary Table 3 Figure 73, Table 120, Table 129, Table 130, Table 131, Table 132
02-Nov-2015	24	Updated: - Table 1, Table 3, Table 128, Table 129, Table 130, Table 131, Table 132 - Section 35 Added: - Note on Section 26.2.1 - Section 31
01-Dec-2015	25	Updated: - Section 4.1, Section 47 - Table 128
03-Mar-2016	26	Updated: - Table 1, Table 3, Table 63, Table 99, Table 101, Table 128 - Section 3, Section 47.1.1, Section 47.2.1, Section 56 Added: - Section 44: STM32L01xxx/02xxx devices bootloader - Figure 60, Figure 62



Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
21-Apr-2016	27	 Added: Section 38: STM32F76xxx/77xxx devices bootloader, Section 54: STM32L43xxx/44xxx devices bootloader. Note on: Section 4.1: Bootloader activation, Section 8.1: Bootloader configuration, Section 9.1: Bootloader configuration, Figure 36: Dual Bank Boot Implementation for STM32F42xxx/43xxx Bootloader V7.x, Figure 38: Dual Bank Boot Implementation for STM32F42xxx/43xxx bootloader V9.x Updated: Table 1: Applicable products, Table 2: Bootloader activation patterns, Table 8: STM32F030xC configuration in system memory boot mode, Table 14: STM32F070x6 configuration in system memory boot mode, Table 16: STM32F070xB configuration in system memory boot mode, Table 20: STM32F09xxx configuration in system memory boot mode, Table 32: STM32F301xx/302x4(6/8) configuration in system memory boot mode, Table 36: STM32F302xB(C)/303xB(C) configuration in system memory boot mode, Table 44: STM32F373xx configuration in system memory boot mode, Table 44: STM32F373xx configuration in system memory boot mode, Table 56: STM32F401xB(C) configuration in system memory boot mode, Table 56: STM32F401xD(E) configuration in system memory boot mode, Table 60: STM32F411xx configuration in system memory boot mode, Table 60: STM32F411xx configuration in system memory boot mode, Table 119: STM32L47xxx/48xxx bootloader V10.x versions, Table 121: STM32L47xxx/48xxx bootloader V9.x versions, Table 128: Bootloader device-dependent parameters Section 3: Glossary,

AN2606 Revision history

Table 134. Document revision history (continued)

Date	Revision	Changes
05-Sep-2016	28	Updated: Table 1: Applicable products, Table 8: STM32F030xC configuration in system memory boot mode, Table 10: STM32F05xxx and STM32F030x8 devices configuration in system memory boot mode, Table 12: STM32F070x6 configuration in system memory boot mode, Table 14: STM32F070x8 configuration in system memory boot mode, Table 16: STM32F070xB configuration in system memory boot mode, Table 18: STM32F071xx/072xx configuration in system memory boot mode, Table 20: STM32F00xxx configuration in system memory boot mode, Table 26: STM32F105xx/107xx configuration in system memory boot mode, Table 26: STM32F10xxx XL-density configuration in system memory boot mode, Table 28: STM32F2xxxx configuration in system memory boot mode, Table 30: STM32F2xxxx configuration in system memory boot mode, Table 32: STM32F301xx/302x4(6/8) configuration in system memory boot mode, Table 32: STM32F301xx/302x4(6/8) configuration in system memory boot mode, Table 34: STM32F302xB(C)/303xB(C) configuration in system memory boot mode, Table 35: STM32F302xD(E)/303xD(E) configuration in system memory boot mode, Table 36: STM32F302xX configuration in system memory boot mode, Table 40: STM32F318xx configuration in system memory boot mode, Table 40: STM32F318xx configuration in system memory boot mode, Table 42: STM32F373xx configuration in system memory boot mode, Table 44: STM32F373xx configuration in system memory boot mode, Table 45: STM32F378xx configuration in system memory boot mode, Table 45: STM32F308xx configuration in system memory boot mode, Table 50: STM32F40xxx/41xxx configuration in system memory boot mode, Table 50: STM32F40xxx/41xxx configuration in system memory boot mode, Table 50: STM32F40xxx/41xxx configuration in system memory boot mode, Table 60: STM32F40xxx/41xxx configuration in system memory boot mode, Table 60: STM32F40xxx/41xxx configuration in system memory boot mode, Table 60: STM32F40xxx/41xxx configuration in system memory boot mode, Table 60: STM32F40xxx/43xxx configuration in system memory boot mode, Table 60: STM32F



Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
05-Sep-2016	28 (continued)	- Figure 22: Bootloader selection for STM32F303x4(6/8)/334xx/328xx, Figure 23: Bootloader selection for STM32F318xx, Figure 25: Bootloader selection for STM32F373xx devices, Figure 26: Bootloader selection for STM32F378xx devices, Figure 29: Bootloader V9.x selection for STM32F40xxx/41xxx, Figure 32: Bootloader V11.x selection for STM32F410xx, Figure 34: Bootloader V9.x selection for STM32F412xx, Figure 42: Bootloader V9.x selection for STM32F469xx/479xx, Figure 47: Bootloader V9.x selection for STM32F76xxx/77xxx, Figure 63: Bootloader V11.x selection for STM32L07xxx/08xxx, Figure 73: Bootloader V10.x selection for STM32L47xxx/48xxx
07-Dec-2016	29	Updated: - Table 1: Applicable products, Section 3: Glossary, Section 4.1: Bootloader activation, Table 3: Embedded bootloaders, Table 12: STM32F09xxx devices bootloader, Table 14: STM32F105xx/107xx devices bootloader, Table 15: STM32F10xxx XL-density devices bootloader, Table 16: STM32F2xxxx devices bootloader, Table 17: STM32F301xx/302x4(6/8) devices bootloader, Table 18: STM32F302xB(C)/303xB(C) devices bootloader, Table 20: STM32F303x4(6/8)/334xx/328xx devices bootloader, Table 22: STM32F358xx devices bootloader, Table 25: STM32F398xx devices bootloader, Table 29: STM32F410xx devices bootloader, Table 32: STM32F413xx/423xx devices bootloader, Table 56: STM32F401xD(E) configuration in system memory boot mode, Section 14.3.1: How to identify STM32F105xx/107xx bootloader versions, Section 28.1: Bootloader configuration, Table 58: STM32F410xx configuration in system memory boot mode, Table 60: STM32F411xx configuration in system memory boot mode, Section 30.1: Bootloader configuration, Table 67: STM32F42xxx/43xxx bootloader V7.x versions, Table 69: STM32F42xxx/43xxx bootloader V7.x versions, Table 69: STM32F42xxx/43xxx bootloader V9.x versions, Table 80: STM32F76xxx/77xxx configuration in system memory boot mode, Table 81: STM32F76xxx/77xxx bootloader V9.x versions, Table 81: STM32F76xxx/77xxx bootloader V9.x versions, Table 83: STM32F76xxx/77xxx bootloader V9.x versions, Table 81: STM32F76xxx/77xxx bootloader V9.x versions, Table 114: STM32L07xxx/08xxx bootloader V1.x versions, Table 119: STM32L47xxx/48xxx bootloader V10.x versions, Table 128: Bootloader device-dependent parameters, Table 129: Bootloader startup timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices

324/329 AN2606 Rev 38

AN2606 Revision history

Table 134. Document revision history (continued)

Date	Revision	Changes
13-Mar-2017	30	Updated: — Table 1: Applicable products, Table 3: Embedded bootloaders, Table 11: STM32F05xxx and STM32F030x8 devices bootloader versions, Table 12: STM32F04xxx configuration in system memory boot mode, Table 13: STM32F04xxx bootloader versions, Table 15: STM32F070x6 bootloader versions, Table 17: STM32F070xB bootloader versions, Table 18: STM32F071xx/072xx configuration in system memory boot mode, Table 19: STM32F071xx/072xx bootloader versions, Table 20: STM32F09xxx configuration in system memory boot mode, Table 21: STM32F09xxx bootloader versions, Table 32: STM32F301xx/302x4(6/8) configuration in system memory boot mode, Table 35: STM32F302xB(C)/303xB(C) bootloader versions, Table 81: STM32F76xxx/77xxx bootloader V9.x versions, Table 92: STM32L01xxx/02xxx configuration in system memory boot mode, Table 115: STM32L43xxx/44xxx bootloader versions, Table 128: Bootloader device-dependent parameters, Table 120: STM32L47xxx/48xxx configuration in system memory boot mode, Table 129: Bootloader startup timings of STM32 devices, Table 130: USART bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 131: USB bootloader configuration, Section 14.3.3: USART bootloader Get-Version command returns 0x20 instead of 0x22, RPN reference in Section 54: STM32L43xxx/44xxx devices bootloader and in Section 56: STM32L47xxx/48xxx devices bootloader Added Section 36: STM32F72xxx/73xxx devices bootloader and Section 57: STM32L496xx/4A6xx devices bootloader

Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
04-Jul-2017	31	Updated: Table 1: Applicable products, Table 2: Bootloader activation patterns, Table 3: Embedded bootloaders, Table 25: STM32F105xx/107xx bootloader versions, Table 30: STM32F2xxxx configuration in system memory boot mode, Table 34: STM32F302xB(C)/303xB(C) configuration in system memory boot mode, Table 42: STM32F358xx configuration in system memory boot mode, Table 44: STM32F378xx configuration in system memory boot mode, Table 46: STM32F378xx configuration in system memory boot mode, Table 52: STM32F40xxx/41xxx configuration in system memory boot mode, Table 54: STM32F401xB(C) configuration in system memory boot mode, Table 56: STM32F401xD(E) configuration in system memory boot mode, Table 66: STM32F411xx configuration in system memory boot mode, Table 66: STM32F446xx configuration in system memory boot mode, Table 70: STM32F446xx configuration in system memory boot mode, Table 70: STM32F446xx configuration in system memory boot mode, Table 72: STM32F469xx/479xx configuration in system memory boot mode, Table 76: STM32F72xxx/73xxx configuration in system memory boot mode, Table 76: STM32F74xxx/75xxx configuration in system memory boot mode, Table 90: STM32F74xxx/75xxx configuration in system memory boot mode, Table 108: STM32F1xxxC configuration in system memory boot mode, Table 108: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L1xxxC configuration in system memory boot mode, Table 116: STM32L45xxx/46xxx conf
16-Feb-2018	32	Updated Table 3: Embedded bootloaders, Table 91: STM32H74xxx/75xxx bootloader version, Table 122: STM32L496xx/4A6xx configuration in system memory boot mode, Table 123: STM32L496xx/4A6xx bootloader version, Table 128: Bootloader device-dependent parameters, Table 129: Bootloader startup timings of STM32 devices, Table 130: USART bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 132: I2C bootloader minimum timings of STM32 devices. Added Section 58: STM32L4Rxxx/4Sxxx devices bootloader
07-Aug-2018	33	Updated Note: in Section 8.1: Bootloader configuration, Note: in Section 9.1: Bootloader configuration



AN2606 Revision history

Table 134. Document revision history (continued)

Date	Revision	Changes
05-Nov-2018	34	Updated Table 1: Applicable products, Table 51: STM32F40xxx/41xxx bootloader V3.x versions, Table 53: STM32F40xxx/41xxx bootloader V9.x versions, Table 55: STM32F401xB(C) bootloader versions, Table 57: STM32F401xD(E) bootloader versions, Table 59: STM32F410xx bootloader V11.x versions, Table 61: STM32F411xx bootloader versions, Table 63: STM32F412xx bootloader V9.x versions, Table 65: STM32F413xx/423xx bootloader V9.x versions, Table 67: STM32F42xxx/43xxx bootloader V7.x versions, Table 69: STM32F42xxx/43xxx bootloader V9.x versions, Table 71: STM32F446xx bootloader V9.x versions, Table 73: STM32F469xx/479xx bootloader V9.x versions, Table 75: STM32F72xxx/73xxx bootloader V9.x versions, Table 77: STM32F74xxx/75xxx bootloader V7.x versions, Table 79: STM32F74xxx/75xxx bootloader V9.x versions, Table 81: STM32F76xxx/77xxx bootloader V9.x versions, Table 128: Bootloader device-dependent parameters, Table 129: Bootloader startup timings of STM32 devices, Table 130: USART bootloader minimum timings of STM32 devices. Added Section 53: STM32L412xx/L422xx devices bootloader
06-Dec-2018	35	Updated Table 1: Applicable products, Section 3: Glossary, Table 129: Bootloader startup timings of STM32 devices, Table 130: USART bootloader minimum timings of STM32 devices, Table 132: I2C bootloader minimum timings of STM32 devices. Added Section 40: STM32G07xxx/08xxx device bootloader
21-Feb-2019	36	Updated Table 1: Applicable products, Section 3: Glossary, Table 3: Embedded bootloaders, Table 128: Bootloader device-dependent parameters, Table 129: Bootloader startup timings of STM32 devices, Table 130: USART bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 132: I2C bootloader minimum timings of STM32 devices. Added Section 59: STM32WB55xx devices bootloader
06-May-2019	37	Updated Table 1: Applicable products, Section 3: Glossary, Table 128: Bootloader device-dependent parameters, Table 129: Bootloader startup timings of STM32 devices, Table 130: USART bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 132: I2C bootloader minimum timings of STM32 devices. Added Section 41: STM32G431xx/441xx devices bootloader, Section 42: STM32G47xxx/48xxx devices bootloader

Revision history AN2606

Table 134. Document revision history (continued)

Date	Revision	Changes
08-Jul-2019	38	Upadated: — Table 1: Applicable products, Table 2: Bootloader activation patterns, Table 3: Embedded bootloaders, Table 64: STM32F413xx/423xx configuration in system memory boot mode, Table 90: STM32H74xxx/75xxx configuration in system memory boot mode, Table 91: STM32H74xxx/75xxx bootloader version, Table 94: STM32L031xx/041xx configuration in system memory boot mode, Table 115: STM32L43xxx/44xxx bootloader versions, Table 116: STM32L45xxx/46xxx configuration in system memory boot mode, Table 123: STM32L496xx/46xx bootloader version, Table 127: STM32WB55xx bootloader versions, Table 128: Bootloader device-dependent parameters, Table 129: Bootloader startup timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices, Table 131: USB bootloader minimum timings of STM32 devices — Section 3: Glossary, Section 4.1: Bootloader activation, Section 39.1: Bootloader configuration, Section 41.1: Bootloader configuration — Figure 56: Bootloader V9.x selection for STM32H74xxx/75xxx, Figure 77: Dual bank boot implementation for STM32L4Rxxx/STM32L4Sxxx bootloader V9.x Added Note: in Section 4.2, Note: in Section 13.3, Note: in Section 43.1, Note: in Section 44.1, Section 39: STM32G03xxx/ STM32G04xxx devices bootloader

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AN2606 Rev 38 329/329