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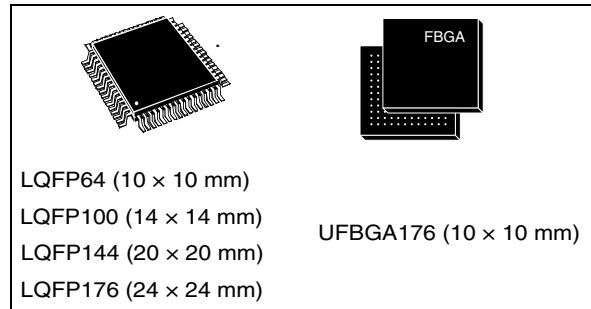


ARM[®]-based 32-bit MCU, 150DMIPs, up to 1 MB Flash/128+4KB RAM, crypto, USB OTG HS/FS, Ethernet, 17 TIMs, 3 ADCs, 15 comm. interfaces & camera

Datasheet - production data

Features

- Core: ARM[®] 32-bit Cortex[®]-M3 CPU (120 MHz max) with Adaptive real-time accelerator (ART Accelerator[™]) allowing 0-wait state execution performance from Flash memory, MPU, 150 DMIPS/1.25 DMIPS/MHz (Dhrystone 2.1)
- Memories
 - Up to 1 Mbyte of Flash memory
 - 512 bytes of OTP memory
 - Up to 128 + 4 Kbytes of SRAM
 - Flexible static memory controller that supports Compact Flash, SRAM, PSRAM, NOR and NAND memories
 - LCD parallel interface, 8080/6800 modes
- Clock, reset and supply management
 - From 1.8 to 3.6 V application supply + I/Os
 - POR, PDR, PVD and BOR
 - 4 to 26 MHz crystal oscillator
 - Internal 16 MHz factory-trimmed RC
 - 32 kHz oscillator for RTC with calibration
 - Internal 32 kHz RC with calibration
- Low-power modes
 - Sleep, Stop and Standby modes
 - V_{BAT} supply for RTC, 20 × 32 bit backup registers, and optional 4 Kbytes backup SRAM
- 3 × 12-bit, 0.5 μs ADCs with up to 24 channels and up to 6 MSPS in triple interleaved mode
- 2 × 12-bit D/A converters
- General-purpose DMA: 16-stream controller with centralized FIFOs and burst support
- Up to 17 timers
 - Up to twelve 16-bit and two 32-bit timers, up to 120 MHz, each with up to four IC/OC/PWM or pulse counter and quadrature (incremental) encoder input
- Debug mode: Serial wire debug (SWD), JTAG, and Cortex[®]-M3 Embedded Trace Macrocell[™]



- Up to 140 I/O ports with interrupt capability:
 - Up to 136 fast I/Os up to 60 MHz
 - Up to 138 5 V-tolerant I/Os
- Up to 15 communication interfaces
 - Up to three I²C interfaces (SMBus/PMBus)
 - Up to four USARTs and two UARTs (7.5 Mbit/s, ISO 7816 interface, LIN, IrDA, modem control)
 - Up to three SPIs (30 Mbit/s), two with muxed I²S to achieve audio class accuracy via audio PLL or external PLL
 - 2 × CAN interfaces (2.0B Active)
 - SDIO interface
- Advanced connectivity
 - USB 2.0 full-speed device/host/OTG controller with on-chip PHY
 - USB 2.0 high-speed/full-speed device/host/OTG controller with dedicated DMA, on-chip full-speed PHY and ULPI
 - 10/100 Ethernet MAC with dedicated DMA: supports IEEE 1588v2 hardware, MII/RMII
- 8- to 14-bit parallel camera interface (48 Mbyte/s max.)
- Cryptographic acceleration
 - Hardware acceleration for AES 128, 192, 256, Triple DES, HASH (MD5, SHA-1)
 - Analog true random number generator
- CRC calculation unit
- 96-bit unique ID

Table 1. Device summary

Reference	Part numbers
STM32F215xx	STM32F215RG, STM32F215VG, STM32F215ZG STM32F215RE, STM32F215VE, STM32F215ZE
STM32F217xx	STM32F217VG, STM32F217IG, STM32F217ZG STM32F217VE, STM32F217IE, STM32F217ZE

Contents

1	Introduction	13
2	Description	14
2.1	Full compatibility throughout the family	17
3	Functional overview	20
3.1	ARM® Cortex®-M3 core with embedded Flash and SRAM	20
3.2	Adaptive real-time memory accelerator (ART Accelerator™)	20
3.3	Memory protection unit	20
3.4	Embedded Flash memory	21
3.5	CRC (cyclic redundancy check) calculation unit	21
3.6	Embedded SRAM	21
3.7	Multi-AHB bus matrix	21
3.8	DMA controller (DMA)	22
3.9	Flexible static memory controller (FSMC)	23
3.10	Nested vectored interrupt controller (NVIC)	23
3.11	External interrupt/event controller (EXTI)	24
3.12	Clocks and startup	24
3.13	Boot modes	24
3.14	Power supply schemes	25
3.15	Power supply supervisor	25
3.16	Voltage regulator	25
3.16.1	Regulator ON	25
3.16.2	Regulator OFF	26
3.16.3	Regulator ON/OFF and internal reset ON/OFF availability	28
3.17	Real-time clock (RTC), backup SRAM and backup registers	29
3.18	Low-power modes	29
3.19	V _{BAT} operation	30
3.20	Timers and watchdogs	30
3.20.1	Advanced-control timers (TIM1, TIM8)	31
3.20.2	General-purpose timers (TIMx)	32
3.20.3	Basic timers TIM6 and TIM7	32

3.20.4	Independent watchdog	32
3.20.5	Window watchdog	33
3.20.6	SysTick timer	33
3.21	Inter-integrated circuit interface (I ² C)	33
3.22	Universal synchronous/asynchronous receiver transmitters (UARTs/USARTs)	33
3.23	Serial peripheral interface (SPI)	34
3.24	Inter-integrated sound (I ² S)	34
3.25	SDIO	34
3.26	Ethernet MAC interface with dedicated DMA and IEEE 1588 support	35
3.27	Controller area network (CAN)	35
3.28	Universal serial bus on-the-go full-speed (OTG_FS)	36
3.29	Universal serial bus on-the-go high-speed (OTG_HS)	36
3.30	Audio PLL (PLLI2S)	37
3.31	Digital camera interface (DCMI)	37
3.31.1	Cryptographic acceleration	38
3.32	True random number generator (RNG)	38
3.33	GPIOs (general-purpose inputs/outputs)	38
3.34	ADCs (analog-to-digital converters)	38
3.35	DAC (digital-to-analog converter)	39
3.36	Temperature sensor	39
3.37	Serial wire JTAG debug port (SWJ-DP)	39
3.38	Embedded Trace Macrocell™	40
4	Pinouts and pin description	41
5	Memory mapping	66
6	Electrical characteristics	68
6.1	Parameter conditions	68
6.1.1	Minimum and maximum values	68
6.1.2	Typical values	68
6.1.3	Typical curves	68
6.1.4	Loading capacitor	68
6.1.5	Pin input voltage	68

6.1.6	Power supply scheme	69
6.1.7	Current consumption measurement	70
6.2	Absolute maximum ratings	70
6.3	Operating conditions	71
6.3.1	General operating conditions	71
6.3.2	VCAP1/VCAP2 external capacitor	74
6.3.3	Operating conditions at power-up / power-down (regulator ON)	75
6.3.4	Operating conditions at power-up / power-down (regulator OFF)	75
6.3.5	Embedded reset and power control block characteristics	76
6.3.6	Supply current characteristics	77
6.3.7	Wakeup time from low-power mode	88
6.3.8	External clock source characteristics	89
6.3.9	Internal clock source characteristics	92
6.3.10	PLL characteristics	94
6.3.11	PLL spread spectrum clock generation (SSCG) characteristics	97
6.3.12	Memory characteristics	98
6.3.13	EMC characteristics	100
6.3.14	Absolute maximum ratings (electrical sensitivity)	102
6.3.15	I/O current injection characteristics	103
6.3.16	I/O port characteristics	104
6.3.17	NRST pin characteristics	109
6.3.18	TIM timer characteristics	110
6.3.19	Communications interfaces	111
6.3.20	12-bit ADC characteristics	124
6.3.21	DAC electrical characteristics	128
6.3.22	Temperature sensor characteristics	130
6.3.23	V _{BAT} monitoring characteristics	131
6.3.24	Embedded reference voltage	131
6.3.25	FSMC characteristics	131
6.3.26	Camera interface (DCMI) timing specifications	149
6.3.27	SD/SDIO MMC card host interface (SDIO) characteristics	149
6.3.28	RTC characteristics	150
7	Package information	151
7.1	LQFP64 package information	151
7.2	LQFP100 package information	153
7.3	LQFP144 package information	156

7.4	LQFP176 package information	160
7.5	UFBGA176+25 package information	163
7.6	Thermal characteristics	166
8	Ordering information	167
9	Revision history	168

List of tables

Table 1.	Device summary	2
Table 2.	STM32F215xx and STM32F217xx: features and peripheral counts.	15
Table 3.	Regulator ON/OFF and internal reset ON/OFF availability.	28
Table 4.	Timer feature comparison.	30
Table 5.	USART feature comparison	34
Table 6.	Legend/abbreviations used in the pinout table	45
Table 7.	STM32F21x pin and ball definitions	46
Table 8.	FSMC pin definition	57
Table 9.	Alternate function mapping	60
Table 10.	Voltage characteristics	70
Table 11.	Current characteristics	71
Table 12.	Thermal characteristics.	71
Table 13.	General operating conditions	71
Table 14.	Limitations depending on the operating power supply range	73
Table 15.	VCAP1/VCAP2 operating conditions	74
Table 16.	Operating conditions at power-up / power-down (regulator ON)	75
Table 17.	Operating conditions at power-up / power-down (regulator OFF).	75
Table 18.	Embedded reset and power control block characteristics.	76
Table 19.	Typical and maximum current consumption in Run mode, code with data processing running from Flash memory (ART accelerator enabled) or RAM	78
Table 20.	Typical and maximum current consumption in Run mode, code with data processing running from Flash memory (ART accelerator disabled)	79
Table 21.	Typical and maximum current consumption in Sleep mode	82
Table 22.	Typical and maximum current consumptions in Stop mode	84
Table 23.	Typical and maximum current consumptions in Standby mode	85
Table 24.	Typical and maximum current consumptions in V _{BAT} mode.	85
Table 25.	Peripheral current consumption	86
Table 26.	Low-power mode wakeup timings	88
Table 27.	High-speed external user clock characteristics.	89
Table 28.	Low-speed external user clock characteristics	89
Table 29.	HSE 4-26 MHz oscillator characteristics	91
Table 30.	LSE oscillator characteristics (f _{LSE} = 32.768 kHz)	92
Table 31.	HSI oscillator characteristics	92
Table 32.	LSI oscillator characteristics	93
Table 33.	Main PLL characteristics.	94
Table 34.	PLLI2S (audio PLL) characteristics	95
Table 35.	SSCG parameters constraint	97
Table 36.	Flash memory characteristics	99
Table 37.	Flash memory programming	99
Table 38.	Flash memory programming with V _{PP}	100
Table 39.	Flash memory endurance and data retention.	100
Table 40.	EMS characteristics	101
Table 41.	EMI characteristics	102
Table 42.	ESD absolute maximum ratings	102
Table 43.	Electrical sensitivities	103
Table 44.	I/O current injection susceptibility	103
Table 45.	I/O static characteristics	104
Table 46.	Output voltage characteristics	107

Table 47.	I/O AC characteristics	107
Table 48.	NRST pin characteristics	109
Table 49.	Characteristics of TIMx connected to the APB1 domain	110
Table 50.	Characteristics of TIMx connected to the APB2 domain	111
Table 51.	I ² C characteristics	112
Table 52.	SCL frequency ($f_{PCLK1} = 30 \text{ MHz}, V_{DD} = 3.3 \text{ V}$)	113
Table 53.	SPI characteristics	114
Table 54.	I ² S characteristics	117
Table 55.	USB OTG FS startup time	119
Table 56.	USB OTG FS DC electrical characteristics	119
Table 57.	USB OTG FS electrical characteristics	120
Table 58.	USB HS DC electrical characteristics	120
Table 59.	Clock timing parameters	120
Table 60.	ULPI timing	121
Table 61.	Ethernet DC electrical characteristics	121
Table 62.	Dynamics characteristics: Ethernet MAC signals for SMI	122
Table 63.	Dynamics characteristics: Ethernet MAC signals for RMII	122
Table 64.	Dynamics characteristics: Ethernet MAC signals for MII	123
Table 65.	ADC characteristics	124
Table 66.	ADC accuracy	125
Table 67.	DAC characteristics	128
Table 68.	Temperature sensor characteristics	130
Table 69.	V _{BAT} monitoring characteristics	131
Table 70.	Embedded internal reference voltage	131
Table 71.	Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings	132
Table 72.	Asynchronous non-multiplexed SRAM/PSRAM/NOR write timings	133
Table 73.	Asynchronous multiplexed PSRAM/NOR read timings	134
Table 74.	Asynchronous multiplexed PSRAM/NOR write timings	135
Table 75.	Synchronous multiplexed NOR/PSRAM read timings	137
Table 76.	Synchronous multiplexed PSRAM write timings	138
Table 77.	Synchronous non-multiplexed NOR/PSRAM read timings	139
Table 78.	Synchronous non-multiplexed PSRAM write timings	140
Table 79.	Switching characteristics for PC Card/CF read and write cycles in attribute/common space	145
Table 80.	Switching characteristics for PC Card/CF read and write cycles in I/O space	146
Table 81.	Switching characteristics for NAND Flash read cycles	148
Table 82.	Switching characteristics for NAND Flash write cycles	149
Table 83.	DCMI characteristics	149
Table 84.	SD/MMC characteristics	150
Table 85.	RTC characteristics	150
Table 86.	LQFP64 - 64-pin, 10 x 10 mm low-profile quad flat package mechanical data	151
Table 87.	LQPF100 - 100-pin, 14 x 14 mm low-profile quad flat package mechanical data	153
Table 88.	LQFP144 - 144-pin, 20 x 20 mm low-profile quad flat package mechanical data	157
Table 89.	LQFP176 - 176-pin, 24 x 24 mm low profile quad flat package mechanical data	160
Table 90.	UFBGA176+25, - 201-ball, 10 x 10 mm, 0.65 mm pitch, ultra fine pitch ball grid array package mechanical data	163
Table 91.	UFBGA176+25 recommended PCB design rules (0.65 mm pitch BGA)	164
Table 92.	Package thermal characteristics	166

Table 93. Ordering information scheme 167
Table 94. Document revision history 168

List of figures

Figure 1.	Compatible board design between STM32F10x and STM32F2xx for LQFP64 package.	17
Figure 2.	Compatible board design between STM32F10x and STM32F2xx for LQFP100 package.	18
Figure 3.	Compatible board design between STM32F10x and STM32F2xx for LQFP144 package.	18
Figure 4.	STM32F21x block diagram.	19
Figure 5.	Multi-AHB matrix.	22
Figure 6.	Regulator OFF/internal reset ON	27
Figure 7.	Startup in regulator OFF: slow V_{DD} slope, power-down reset risen after V_{CAP_1}/V_{CAP_2} stabilization	28
Figure 8.	Startup in regulator OFF: fast V_{DD} slope, power-down reset risen before V_{CAP_1}/V_{CAP_2} stabilization.	28
Figure 9.	STM32F21x LQFP64 pinout.	41
Figure 10.	STM32F21x LQFP100 pinout.	42
Figure 11.	STM32F21x LQFP144 pinout.	43
Figure 12.	STM32F21x LQFP176 pinout.	44
Figure 13.	STM32F21x UFBGA176 ballout	45
Figure 14.	Memory map	67
Figure 15.	Pin loading conditions.	68
Figure 16.	Pin input voltage	68
Figure 17.	Power supply scheme	69
Figure 18.	Current consumption measurement scheme	70
Figure 19.	Number of wait states versus f_{CPU} and V_{DD} range.	74
Figure 20.	External capacitor C_{EXT}	74
Figure 21.	Typical current consumption vs. temperature, Run mode, code with data processing running from RAM, and peripherals ON	80
Figure 22.	Typical current consumption vs. temperature, Run mode, code with data processing running from RAM, and peripherals OFF	80
Figure 23.	Typical current consumption vs. temperature, Run mode, code with data processing running from Flash, ART accelerator OFF, peripherals ON	81
Figure 24.	Typical current consumption vs. temperature, Run mode, code with data processing running from Flash, ART accelerator OFF, peripherals OFF	81
Figure 25.	Typical current consumption vs. temperature in Sleep mode, peripherals ON	83
Figure 26.	Typical current consumption vs. temperature in Sleep mode, peripherals OFF	83
Figure 27.	Typical current consumption vs. temperature in Stop mode.	84
Figure 28.	High-speed external clock source AC timing diagram	90
Figure 29.	Low-speed external clock source AC timing diagram	90
Figure 30.	Typical application with an 8 MHz crystal	91
Figure 31.	Typical application with a 32.768 kHz crystal	92
Figure 32.	ACC_{HSI} versus temperature	93
Figure 33.	ACC_{LSI} versus temperature	94
Figure 34.	PLL output clock waveforms in center spread mode	98
Figure 35.	PLL output clock waveforms in down spread mode	98
Figure 36.	FT I/O input characteristics.	106
Figure 37.	I/O AC characteristics definition	109

Figure 38.	Recommended NRST pin protection	109
Figure 39.	I ² C bus AC waveforms and measurement circuit	113
Figure 40.	SPI timing diagram - slave mode and CPHA = 0	115
Figure 41.	SPI timing diagram - slave mode and CPHA = 1	115
Figure 42.	SPI timing diagram - master mode	116
Figure 43.	I ² S slave timing diagram (Philips protocol) ⁽¹⁾	118
Figure 44.	I ² S master timing diagram (Philips protocol) ⁽¹⁾	118
Figure 45.	USB OTG FS timings: definition of data signal rise and fall time	120
Figure 46.	ULPI timing diagram	121
Figure 47.	Ethernet SMI timing diagram	122
Figure 48.	Ethernet RMII timing diagram	122
Figure 49.	Ethernet MII timing diagram	123
Figure 50.	ADC accuracy characteristics	126
Figure 51.	Typical connection diagram using the ADC	126
Figure 52.	Power supply and reference decoupling (V_{REF+} not connected to V_{DDA})	127
Figure 53.	Power supply and reference decoupling (V_{REF+} connected to V_{DDA})	128
Figure 54.	12-bit buffered/non-buffered DAC	130
Figure 55.	Asynchronous non-multiplexed SRAM/PSRAM/NOR read waveforms	132
Figure 56.	Asynchronous non-multiplexed SRAM/PSRAM/NOR write waveforms	133
Figure 57.	Asynchronous multiplexed PSRAM/NOR read waveforms	134
Figure 58.	Asynchronous multiplexed PSRAM/NOR write waveforms	135
Figure 59.	Synchronous multiplexed NOR/PSRAM read timings	137
Figure 60.	Synchronous multiplexed PSRAM write timings	138
Figure 61.	Synchronous non-multiplexed NOR/PSRAM read timings	139
Figure 62.	Synchronous non-multiplexed PSRAM write timings	140
Figure 63.	PC Card/CompactFlash controller waveforms for common memory read access	142
Figure 64.	PC Card/CompactFlash controller waveforms for common memory write access	142
Figure 65.	PC Card/CompactFlash controller waveforms for attribute memory read access	143
Figure 66.	PC Card/CompactFlash controller waveforms for attribute memory write access	144
Figure 67.	PC Card/CompactFlash controller waveforms for I/O space read access	144
Figure 68.	PC Card/CompactFlash controller waveforms for I/O space write access	145
Figure 69.	NAND controller waveforms for read access	147
Figure 70.	NAND controller waveforms for write access	147
Figure 71.	NAND controller waveforms for common memory read access	148
Figure 72.	NAND controller waveforms for common memory write access	148
Figure 73.	SDIO high-speed mode	149
Figure 74.	SD default mode	150
Figure 75.	LQFP64 - 64-pin, 10 x 10 mm low-profile quad flat package outline	151
Figure 76.	LQFP64 - 64-pin, 10 x 10 mm low-profile quad flat package recommended footprint	152
Figure 77.	LQFP100 - 100-pin, 14 x 14 mm low-profile quad flat package outline	153
Figure 78.	LQFP100 - 100-pin, 14 x 14 mm low-profile quad flat recommended footprint	154
Figure 79.	LQFP100 marking (package top view)	155
Figure 80.	LQFP144 - 144-pin, 20 x 20 mm low-profile quad flat package outline	156
Figure 81.	LQFP144 - 144-pin, 20 x 20 mm low-profile quad flat package recommended footprint	158
Figure 82.	LQFP144 marking (package top view)	159
Figure 83.	LQFP176 - 176-pin, 24 x 24 mm low profile quad flat package outline	160
Figure 84.	LQFP176 - 176-pin, 24 x 24 mm low profile quad flat package recommended footprint	162
Figure 85.	UFPGA176+25 - 201-ball, 10 x 10 mm, 0.65 mm pitch,	

	ultra fine pitch ball grid array package outline	163
Figure 86.	UFBGA176+25 - 201-ball, 10 x 10 mm, 0.65 mm pitch, ultra fine pitch ball grid array package recommended footprint	164
Figure 87.	UFBGA176+25 marking (package top view)	165

1 Introduction

This datasheet provides the description of the STM32F215xx and STM32F217xx lines of microcontrollers. For more details on the whole STMicroelectronics STM32 family, refer to [Section 2.1: Full compatibility throughout the family](#).

The STM32F215xx and STM32F217xx datasheet should be read in conjunction with the STM32F20x/STM32F21x reference manual. They will be referred to as STM32F21x devices throughout the document.

For information on programming, erasing and protection of the internal Flash memory, refer to the STM32F20x/STM32F21x Flash programming manual (PM0059).

The reference and Flash programming manuals are both available from the STMicroelectronics website www.st.com.

For information on the Cortex[®]-M3 core refer to the Cortex[®]-M3 Technical Reference Manual, available from the www.arm.com website.

2 Description

The STM32F21x family is based on the high-performance ARM[®] Cortex[®]-M3 32-bit RISC core operating at a frequency of up to 120 MHz. The family incorporates high-speed embedded memories (Flash memory up to 1 Mbyte, up to 128 Kbytes of system SRAM), up to 4 Kbytes of backup SRAM, and an extensive range of enhanced I/Os and peripherals connected to two APB buses, three AHB buses and a 32-bit multi-AHB bus matrix.

The devices also feature an adaptive real-time memory accelerator (ART Accelerator[™]) that allows to achieve a performance equivalent to 0 wait state program execution from Flash memory at a CPU frequency up to 120 MHz. This performance has been validated using the CoreMark[®] benchmark.

All devices offer three 12-bit ADCs, two DACs, a low-power RTC, twelve general-purpose 16-bit timers including two PWM timers for motor control, two general-purpose 32-bit timers, a true number random generator (RNG). They also feature standard and advanced communication interfaces. New advanced peripherals include an SDIO, an enhanced flexible static memory control (FSMC) interface (for devices offered in packages of 100 pins and more), a cryptographic acceleration cell, and a camera interface for CMOS sensors. The devices also feature standard peripherals.

- Up to three I²Cs
- Three SPIs, two I²Ss. To achieve audio class accuracy, the I²S peripherals can be clocked via a dedicated internal audio PLL or via an external PLL to allow synchronization.
- Four USARTs and two UARTs
- A USB OTG high-speed with full-speed capability (with the ULPI)
- A second USB OTG (full-speed)
- Two CANs
- An SDIO interface
- Ethernet and camera interface available on STM32F217xx devices only.

Note: The STM32F215xx and STM32F217xx devices operate in the –40 to +105 °C temperature range from a 1.8 V to 3.6 V power supply.

A comprehensive set of power-saving modes allow the design of low-power applications.

STM32F215xx and STM32F217xx devices are offered in various packages ranging from 64 pins to 176 pins. The set of included peripherals changes with the device chosen. These features make the STM32F215xx and STM32F217xx microcontroller family suitable for a wide range of applications:

- Motor drive and application control
- Medical equipment
- Industrial applications: PLC, inverters, circuit breakers
- Printers, and scanners
- Alarm systems, video intercom, and HVAC
- Home audio appliances

Figure 4 shows the general block diagram of the device family.



Table 2. STM32F215xx and STM32F217xx: features and peripheral counts

Peripherals		STM32F215Rx		STM32F215Vx		STM32F215Zx		STM32F217Vx		STM32F217Zx		STM32F217Ix	
Flash memory in Kbytes		512	1024	512	1024	512	1024	512	1024	512	1024	512	1024
SRAM in Kbytes	System	128(112+16)											
	Backup	4		4		4		4		4		4	
FSMC memory controller		No		Yes ⁽¹⁾									
Ethernet ⁽²⁾		No						Yes					
Timers	General-purpose	10											
	Advanced-control	2											
	Basic	2											
	IWDG	Yes											
	WWDG	Yes											
RTC		Yes											
Random number generator		Yes											
Communication interfaces	SPI / (I ² S)	3/(2) ⁽³⁾											
	I ² C	3											
	USART	4											
	UART	2											
	USB OTG FS	Yes											
	USB OTG HS	Yes											
CAN		2											
Camera interface ⁽²⁾		No						Yes					
Encryption		Yes											
GPIOs		51		82		114		82		114		140	
SDIO		Yes											
12-bit ADC Number of channels		3											
		16		16		24		16		24		24	
12-bit DAC Number of channels		Yes 2											
Maximum CPU frequency		120 MHz											
Operating voltage		1.8 V to 3.6 V											


Table 2. STM32F215xx and STM32F217xx: features and peripheral counts (continued)

Peripherals	STM32F215Rx	STM32F215Vx	STM32F215Zx	STM32F217Vx	STM32F217Zx	STM32F217Ix
Operating temperatures	Ambient temperatures: -40 to +85 °C / -40 to +105 °C					
	Junction temperature: -40 to + 125 °C					
Package	LQFP64	LQFP100	LQFP144	LQFP100	LQFP144	UFBGA176, LQFP176

1. For the LQFP100 package, only FSMC Bank1 or Bank2 are available. Bank1 can only support a multiplexed NOR/PSRAM memory using the NE1 Chip Select. Bank2 can only support a 16- or 8-bit NAND Flash memory using the NCE2 Chip Select. The interrupt line cannot be used since Port G is not available in this package.
2. Camera interface and Ethernet are available only in STM32F217x devices.
3. The SPI2 and SPI3 interfaces give the flexibility to work in an exclusive way in either the SPI mode or the I2S audio mode.

2.1 Full compatibility throughout the family

The STM32F215xx and STM32F217xx constitute the STM32F21x family whose members are fully pin-to-pin, software and feature compatible, allowing the user to try different memory densities and peripherals for a greater degree of freedom during the development cycle.

The STM32F215xx and STM32F217xx devices maintain a close compatibility with the whole STM32F10xxx family. All functional pins are pin-to-pin compatible. The STM32F215xx and STM32F217xx, however, are not drop-in replacements for the STM32F10xxx devices: the two families do not have the same power scheme, and so their power pins are different. Nonetheless, transition from the STM32F10xxx to the STM32F21x family remains simple as only a few pins are impacted.

Figure 1, Figure 2 and Figure 3 provide compatible board designs between the STM32F21x and the STM32F10xxx family.

Figure 1. Compatible board design between STM32F10x and STM32F2xx for LQFP64 package

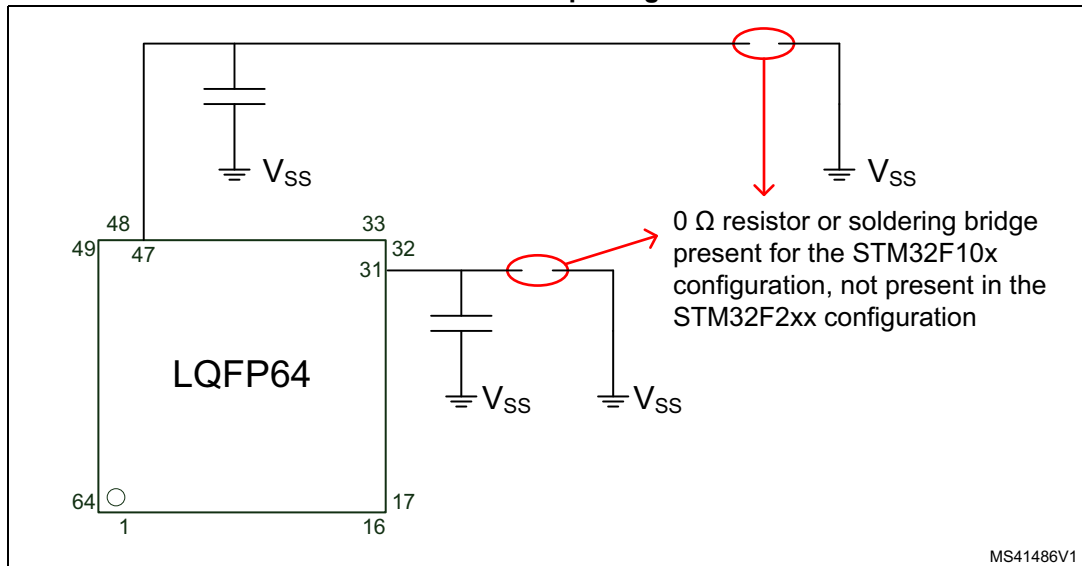
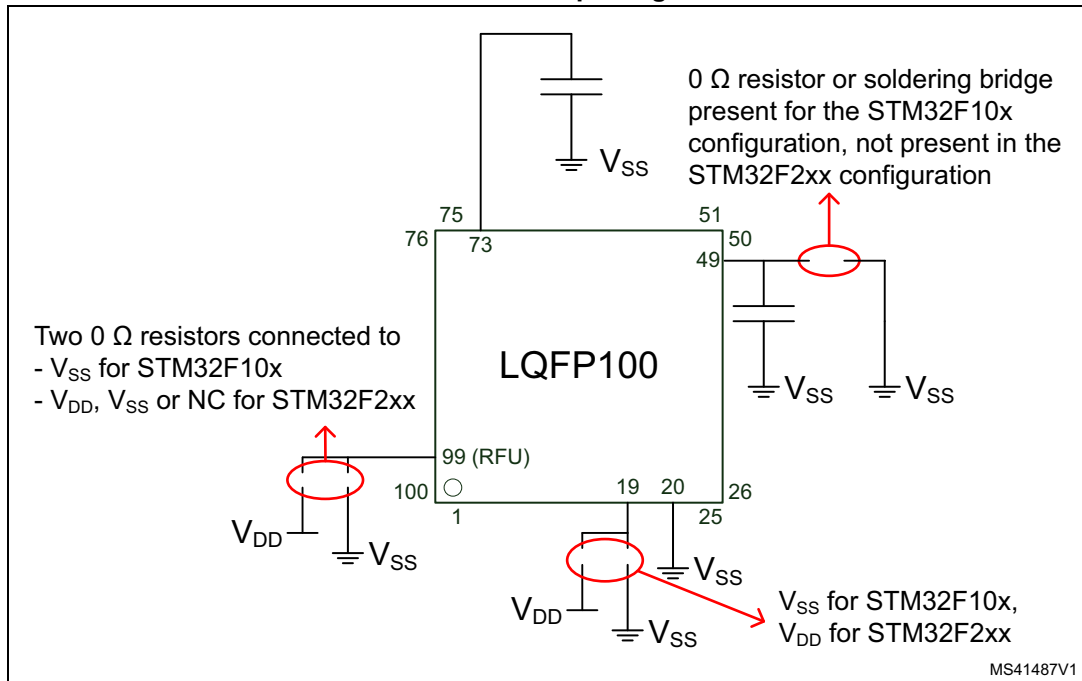
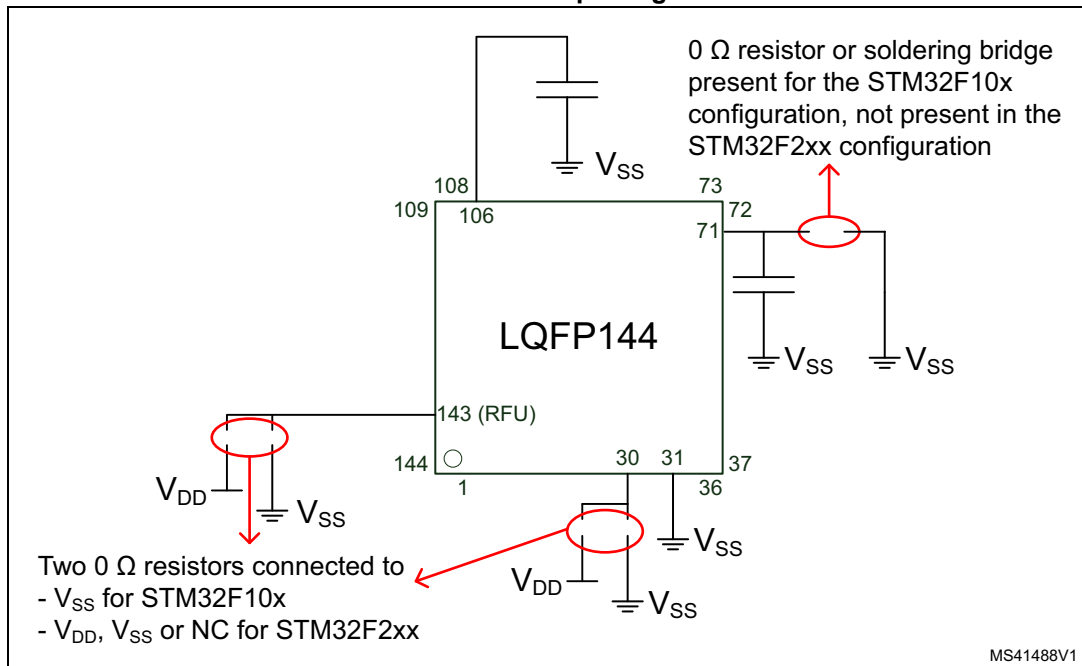


Figure 2. Compatible board design between STM32F10x and STM32F2xx for LQFP100 package



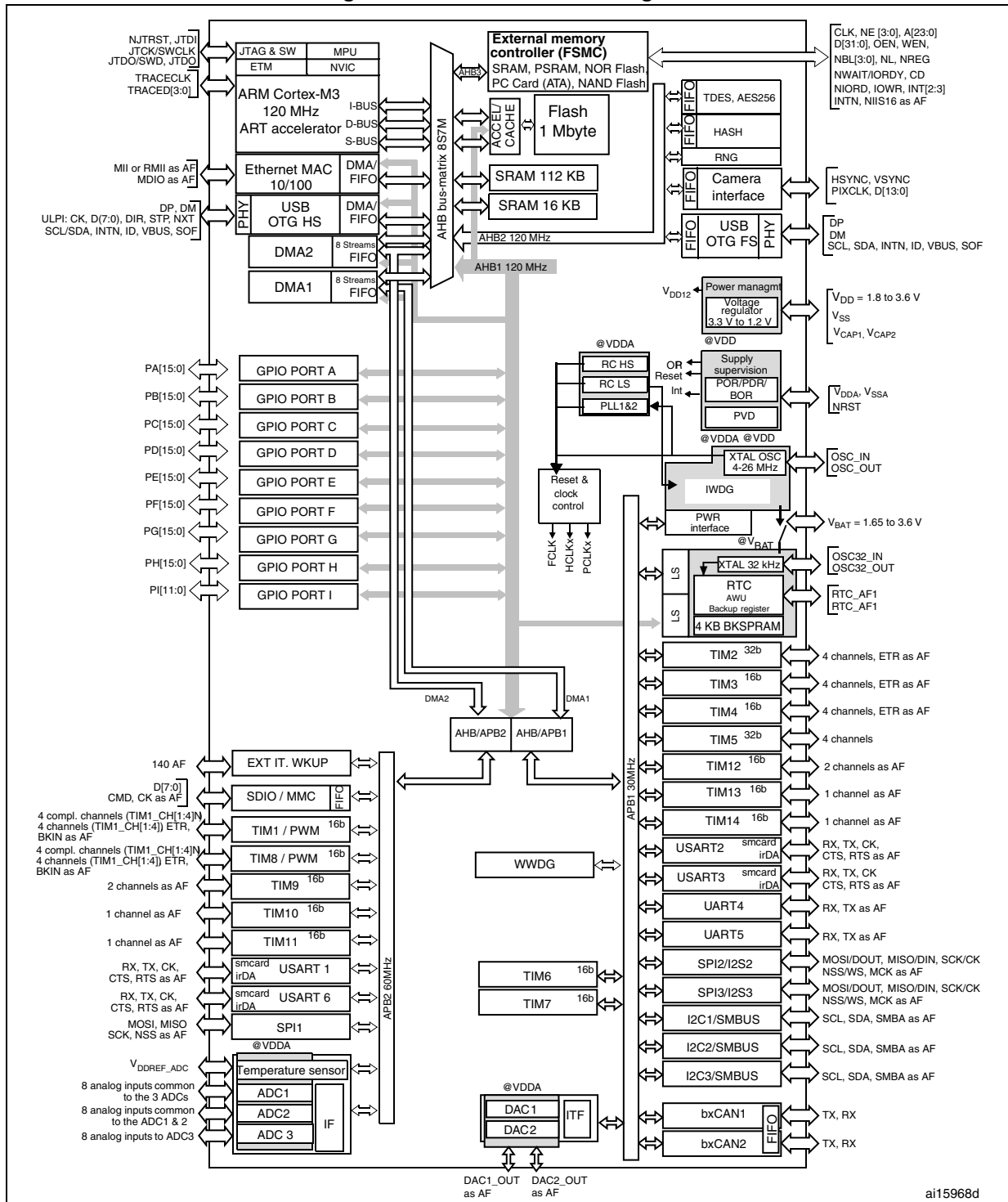
1. RFU = reserved for future use.

Figure 3. Compatible board design between STM32F10x and STM32F2xx for LQFP144 package



1. RFU = reserved for future use.

Figure 4. STM32F21x block diagram



1. The timers connected to APB2 are clocked from TIMxCLK up to 120 MHz, while the timers connected to APB1 are clocked from TIMxCLK up to 60 MHz.
2. The camera interface and Ethernet are available only in STM32F217xx devices.

3 Functional overview

3.1 ARM[®] Cortex[®]-M3 core with embedded Flash and SRAM

The ARM[®] Cortex[®]-M3 processor is the latest generation of ARM processors for embedded systems. It was developed to provide a low-cost platform that meets the needs of MCU implementation, with a reduced pin count and low-power consumption, while delivering outstanding computational performance and an advanced response to interrupts.

The ARM[®] Cortex[®]-M3 32-bit RISC processor features exceptional code-efficiency, delivering the high-performance expected from an ARM core in the memory size usually associated with 8- and 16-bit devices.

With its embedded ARM[®] core, the STM32F21x family is compatible with all ARM[®] tools and software.

Figure 4 shows the general block diagram of the STM32F21x family.

3.2 Adaptive real-time memory accelerator (ART Accelerator[™])

The ART Accelerator[™] is a memory accelerator which is optimized for STM32 industry-standard ARM[®] Cortex[®]-M3 processors. It balances the inherent performance advantage of the ARM[®] Cortex[®]-M3 over Flash memory technologies, which normally requires the processor to wait for the Flash memory at higher operating frequencies.

To release the processor full 150 DMIPS performance at this frequency, the accelerator implements an instruction prefetch queue and branch cache which increases program execution speed from the 128-bit Flash memory. Based on CoreMark[®] benchmark, the performance achieved thanks to the ART accelerator is equivalent to 0 wait state program execution from Flash memory at a CPU frequency up to 120 MHz.

3.3 Memory protection unit

The memory protection unit (MPU) is used to manage the CPU accesses to memory to prevent one task to accidentally corrupt the memory or resources used by any other active task. This memory area is organized into up to 8 protected areas that can in turn be divided up into 8 subareas. The protection area sizes are between 32 bytes and the whole 4 gigabytes of addressable memory.

The MPU is especially helpful for applications where some critical or certified code has to be protected against the misbehavior of other tasks. It is usually managed by an RTOS (real-time operating system). If a program accesses a memory location that is prohibited by the MPU, the RTOS can detect it and take action. In an RTOS environment, the kernel can dynamically update the MPU area setting, based on the process to be executed.

The MPU is optional and can be bypassed for applications that do not need it.

3.4 Embedded Flash memory

The STM32F21x devices embed a 128-bit wide Flash memory of 128 Kbytes, 256 Kbytes, 512 Kbytes, 768 Kbytes or 1 Mbyte available for storing programs and data.

The devices also feature 512 bytes of OTP memory that can be used to store critical user data such as Ethernet MAC addresses or cryptographic keys.

3.5 CRC (cyclic redundancy check) calculation unit

The CRC (cyclic redundancy check) calculation unit is used to get a CRC code from a 32-bit data word and a fixed generator polynomial.

Among other applications, CRC-based techniques are used to verify data transmission or storage integrity. In the scope of the EN/IEC 60335-1 standard, they offer a means of verifying the Flash memory integrity. The CRC calculation unit helps compute a software signature during runtime, to be compared with a reference signature generated at link-time and stored at a given memory location.

3.6 Embedded SRAM

All STM32F21x products embed:

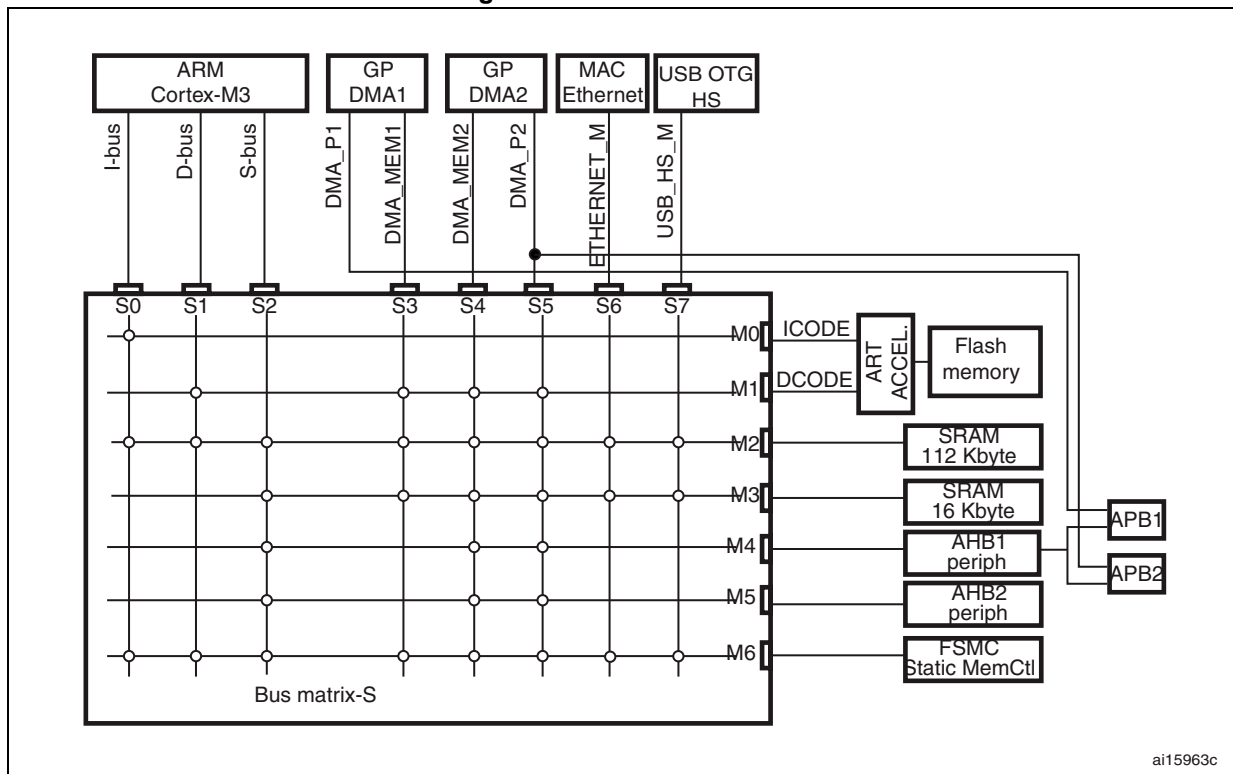
- Up to 128 Kbytes of system SRAM accessed (read/write) at CPU clock speed with 0 wait states
- 4 Kbytes of backup SRAM.

The content of this area is protected against possible unwanted write accesses, and is retained in Standby or VBAT mode.

3.7 Multi-AHB bus matrix

The 32-bit multi-AHB bus matrix interconnects all the masters (CPU, DMAs, Ethernet, USB HS) and the slaves (Flash memory, RAM, FSMC, AHB and APB peripherals) and ensures a seamless and efficient operation even when several high-speed peripherals work simultaneously.

Figure 5. Multi-AHB matrix



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3.8 DMA controller (DMA)

The devices feature two general-purpose dual-port DMAs (DMA1 and DMA2) with 8 streams each. They are able to manage memory-to-memory, peripheral-to-memory and memory-to-peripheral transfers. They share some centralized FIFOs for APB/AHB peripherals, support burst transfer and are designed to provide the maximum peripheral bandwidth (AHB/APB).

The two DMA controllers support circular buffer management, so that no specific code is needed when the controller reaches the end of the buffer. The two DMA controllers also have a double buffering feature, which automates the use and switching of two memory buffers without requiring any special code.

Each stream is connected to dedicated hardware DMA requests, with support for software trigger on each stream. Configuration is made by software and transfer sizes between source and destination are independent.

The DMA can be used with the main peripherals:

- SPI and I²S
- I²C
- USART and UART
- General-purpose, basic and advanced-control timers TIMx
- DAC
- SDIO
- Cryptographic acceleration
- Camera interface (DCMI)
- ADC.

3.9 Flexible static memory controller (FSMC)

The FSMC is embedded in all STM32F21x devices. It has four Chip Select outputs supporting the following modes: PC Card/Compact Flash, SRAM, PSRAM, NOR Flash and NAND Flash.

Functionality overview:

- Write FIFO
- Code execution from external memory except for NAND Flash and PC Card
- Maximum frequency (f_{HCLK}) for external access is 60 MHz

LCD parallel interface

The FSMC can be configured to interface seamlessly with most graphic LCD controllers. It supports the Intel 8080 and Motorola 6800 modes, and is flexible enough to adapt to specific LCD interfaces. This LCD parallel interface capability makes it easy to build cost-effective graphic applications using LCD modules with embedded controllers or high performance solutions using external controllers with dedicated acceleration.

3.10 Nested vectored interrupt controller (NVIC)

The STM32F21x devices embed a nested vectored interrupt controller able to manage 16 priority levels, and handle up to 81 maskable interrupt channels plus the 16 interrupt lines of the Cortex[®]-M3.

The NVIC main features are the following:

- Closely coupled NVIC gives low-latency interrupt processing
- Interrupt entry vector table address passed directly to the core
- Closely coupled NVIC core interface
- Allows early processing of interrupts
- Processing of late arriving, higher-priority interrupts
- Support tail chaining
- Processor state automatically saved
- Interrupt entry restored on interrupt exit with no instruction overhead

This hardware block provides flexible interrupt management features with minimum interrupt latency.

3.11 External interrupt/event controller (EXTI)

The external interrupt/event controller consists of 23 edge-detector lines used to generate interrupt/event requests. Each line can be independently configured to select the trigger event (rising edge, falling edge, both) and can be masked independently. A pending register maintains the status of the interrupt requests. The EXTI can detect an external line with a pulse width shorter than the Internal APB2 clock period. Up to 140 GPIOs can be connected to the 16 external interrupt lines.

3.12 Clocks and startup

On reset the 16 MHz internal RC oscillator is selected as the default CPU clock. The 16 MHz internal RC oscillator is factory-trimmed to offer 1% accuracy. The application can then select as system clock either the RC oscillator or an external 4-26 MHz clock source. This clock is monitored for failure. If failure is detected, the system automatically switches back to the internal RC oscillator and a software interrupt is generated (if enabled). Similarly, full interrupt management of the PLL clock entry is available when necessary (for example if an indirectly used external oscillator fails).

The advanced clock controller clocks the core and all peripherals using a single crystal or oscillator. In particular, the ethernet and USB OTG FS peripherals can be clocked by the system clock.

Several prescalers and PLLs allow the configuration of the three AHB buses, the high-speed APB (APB2) and the low-speed APB (APB1) domains. The maximum frequency of the three AHB buses is 120 MHz and the maximum frequency the high-speed APB domains is 60 MHz. The maximum allowed frequency of the low-speed APB domain is 30 MHz.

The devices embed a dedicate PLL (PLLI2S) that allow them to achieve audio class performance. In this case, the I²S master clock can generate all standard sampling frequencies from 8 kHz to 192 kHz.

3.13 Boot modes

At startup, boot pins are used to select one out of three boot options:

- Boot from user Flash
- Boot from system memory
- Boot from embedded SRAM

The boot loader is located in system memory. It is used to reprogram the Flash memory by using USART1 (PA9/PA10), USART3 (PC10/PC11 or PB10/PB11), CAN2 (PB5/PB13), USB OTG FS in Device mode (PA11/PA12) through DFU (device firmware upgrade).

3.14 Power supply schemes

- $V_{DD} = 1.8$ to 3.6 V: external power supply for I/Os and the internal regulator (when enabled), provided externally through V_{DD} pins.
- V_{SSA} , $V_{DDA} = 1.8$ to 3.6 V: external analog power supplies for ADC, DAC, Reset blocks, RCs and PLL. V_{DDA} and V_{SSA} must be connected to V_{DD} and V_{SS} , respectively.
- $V_{BAT} = 1.65$ to 3.6 V: power supply for RTC, external clock, 32 kHz oscillator and backup registers (through power switch) when V_{DD} is not present.

Refer to [Figure 17: Power supply scheme](#) for more details.

3.15 Power supply supervisor

The devices have an integrated power-on reset (POR) / power-down reset (PDR) circuitry coupled with a Brownout reset (BOR) circuitry.

At power-on, POR/PDR is always active and ensures proper operation starting from 1.8 V. After the 1.8 V POR threshold level is reached, the option byte loading process starts, either to confirm or modify default BOR threshold levels, or to disable BOR permanently. Three BOR thresholds are available through option bytes.

The device remains in reset mode when V_{DD} is below a specified threshold, $V_{POR/PDR}$ or V_{BOR} , without the need for an external reset circuit. .

The devices also feature an embedded programmable voltage detector (PVD) that monitors the V_{DD}/V_{DDA} power supply and compares it to the V_{PVD} threshold. An interrupt can be generated when V_{DD}/V_{DDA} drops below the V_{PVD} threshold and/or when V_{DD}/V_{DDA} is higher than the V_{PVD} threshold. The interrupt service routine can then generate a warning message and/or put the MCU into a safe state. The PVD is enabled by software.

3.16 Voltage regulator

The regulator has four operating modes:

- Regulator ON
 - Main regulator mode (MR)
 - Low-power regulator (LPR)
 - Power-down
- Regulator OFF
 - Regulator OFF/internal reset ON

3.16.1 Regulator ON

The regulator ON modes are activated by default on LQFP packages. On UFBGA176 package, they are activated by connecting REGOFF to V_{SS} .

V_{DD} minimum value is 1.8 V.