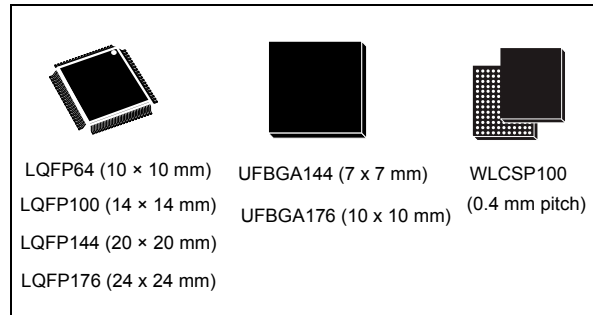


Arm® Cortex®-M7 32b MCU+FPU, 462DMIPS, up to 512KB Flash  
256+16+4KB RAM, USB OTG HS/FS, 18 TIMs, 3 ADCs, 21 com IF

Datasheet - production data

## Features

- Core: Arm® 32-bit Cortex®-M7 CPU with FPU, adaptive real-time accelerator (ART Accelerator) and L1-cache: 8 Kbytes of data cache and 8 Kbytes of instruction cache, allowing 0-wait state execution from embedded Flash memory and external memories, frequency up to 216 MHz, MPU, 462 DMIPS/2.14 DMIPS/MHz (Dhrystone 2.1) and DSP instructions.
- Memories
  - Up to 512 Kbytes of Flash memory with protection mechanisms (read and write protections, proprietary code readout protection (PCROP))
  - 528 bytes of OTP memory
  - SRAM: 256 Kbytes (including 64 Kbytes of data TCM RAM for critical real-time data) + 16 Kbytes of instruction TCM RAM (for critical real-time routines) + 4 Kbytes of backup SRAM (available in the lowest power modes)
  - Flexible external memory controller with up to 32-bit data bus: SRAM, PSRAM, SDRAM/LPDDR SDRAM, NOR/NAND memories
- Dual mode Quad-SPI
- Clock, reset and supply management
  - 1.7 V to 3.6 V application supply and I/Os
  - POR, PDR, PVD and BOR
  - Dedicated USB power
  - 4-to-26 MHz crystal oscillator
  - Internal 16 MHz factory-trimmed RC (1% accuracy)
  - 32 kHz oscillator for RTC with calibration
  - Internal 32 kHz RC with calibration
- Low-power
  - Sleep, Stop and Standby modes
- V<sub>BAT</sub> supply for RTC, 32×32 bit backup registers + 4 Kbytes of backup SRAM
- 3×12-bit, 2.4 MSPS ADC: up to 24 channels and 7.2 MSPS in triple interleaved mode
- 2×12-bit D/A converters
- Up to 18 timers: up to thirteen 16-bit (1x low-power 16-bit timer available in Stop mode) and two 32-bit timers, each with up to 4 IC/OC/PWMs or pulse counter and quadrature (incremental) encoder inputs. All 15 timers running up to 216 MHz. 2x watchdogs, SysTick timer
- General-purpose DMA: 16-stream DMA controller with FIFOs and burst support
- Debug mode
  - SWD and JTAG interfaces
  - Cortex®-M7 Trace Macrocell™
- Up to 140 I/O ports with interrupt capability
  - Up to 136 fast I/Os up to 108 MHz
  - Up to 138 5 V-tolerant I/Os
- Up to 21 communication interfaces
  - Up to 3× I<sup>2</sup>C interfaces (SMBus/PMBus)
  - Up to 4 USARTs/4 UARTs (27 Mbit/s, ISO7816 interface, LIN, IrDA, modem control)
  - Up to 5 SPIs (up to 54 Mbit/s), 3 with muxed simplex I2Ss for audio class accuracy via internal audio PLL or external clock
  - 2 x SAls (serial audio interface)



- 1 x CAN (2.0B active)
- 2 x SDMMCs
- 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 on-chip Hi-speed PHY or ULPI depending on the part number
- True random number generator
- CRC calculation unit
- RTC: subsecond accuracy, hardware calendar
- 96-bit unique ID

**Table 1. Device summary**

| Reference   | Part number                                                                                            |
|-------------|--------------------------------------------------------------------------------------------------------|
| STM32F722xx | STM32F722IC, STM32F722IE, STM32F722RC, STM32F722RE, STM32F722VC, STM32F722VE, STM32F722ZC, STM32F722ZE |
| STM32F723xx | STM32F723IC, STM32F723IE, STM32F723VC, STM32F723VE, STM32F723ZC, STM32F723ZE                           |

# Contents

|          |                                                                      |           |
|----------|----------------------------------------------------------------------|-----------|
| <b>1</b> | <b>Introduction</b>                                                  | <b>13</b> |
| <b>2</b> | <b>Description</b>                                                   | <b>14</b> |
| 2.1      | Full compatibility throughout the family                             | 16        |
| 2.2      | STM32F723xx versus STM32F722xx LQFP100/ LQFP144/<br>LQFP176 packages | 19        |
| <b>3</b> | <b>Functional overview</b>                                           | <b>22</b> |
| 3.1      | Arm Cortex-M7 with FPU                                               | 22        |
| 3.2      | Memory protection unit                                               | 22        |
| 3.3      | Embedded Flash memory                                                | 23        |
| 3.4      | CRC (cyclic redundancy check) calculation unit                       | 23        |
| 3.5      | Embedded SRAM                                                        | 23        |
| 3.6      | AXI-AHB bus matrix                                                   | 24        |
| 3.7      | DMA controller (DMA)                                                 | 25        |
| 3.8      | Flexible memory controller (FMC)                                     | 25        |
| 3.9      | Quad-SPI memory interface (QUADSPI)                                  | 26        |
| 3.10     | Nested vectored interrupt controller (NVIC)                          | 26        |
| 3.11     | External interrupt/event controller (EXTI)                           | 26        |
| 3.12     | Clocks and startup                                                   | 27        |
| 3.13     | Boot modes                                                           | 27        |
| 3.14     | Power supply schemes                                                 | 27        |
| 3.15     | Power supply supervisor                                              | 30        |
| 3.15.1   | Internal reset ON                                                    | 30        |
| 3.15.2   | Internal reset OFF                                                   | 30        |
| 3.16     | Voltage regulator                                                    | 31        |
| 3.16.1   | Regulator ON                                                         | 31        |
| 3.16.2   | Regulator OFF                                                        | 32        |
| 3.16.3   | Regulator ON/OFF and internal reset ON/OFF availability              | 35        |
| 3.17     | Real-time clock (RTC), backup SRAM and backup registers              | 35        |
| 3.18     | Low-power modes                                                      | 36        |
| 3.19     | V <sub>BAT</sub> operation                                           | 37        |

|          |                                                                            |           |
|----------|----------------------------------------------------------------------------|-----------|
| 3.20     | Timers and watchdogs                                                       | 37        |
| 3.20.1   | Advanced-control timers (TIM1, TIM8)                                       | 38        |
| 3.20.2   | General-purpose timers (TIMx)                                              | 39        |
| 3.20.3   | Basic timers TIM6 and TIM7                                                 | 39        |
| 3.20.4   | Low-power timer (LPTIM1)                                                   | 39        |
| 3.20.5   | Independent watchdog                                                       | 40        |
| 3.20.6   | Window watchdog                                                            | 40        |
| 3.20.7   | SysTick timer                                                              | 40        |
| 3.21     | Inter-integrated circuit interface (I2C)                                   | 40        |
| 3.22     | Universal synchronous/asynchronous receiver transmitters (USART)           | 41        |
| 3.23     | Serial peripheral interface (SPI)/inter- integrated sound interfaces (I2S) | 42        |
| 3.24     | Serial audio interface (SAI)                                               | 43        |
| 3.25     | Audio PLL (PLLI2S)                                                         | 43        |
| 3.26     | Audio PLL (PLLSAI)                                                         | 43        |
| 3.27     | SD/SDIO/MMC card host interface (SDMMC)                                    | 43        |
| 3.28     | Controller area network (bxCAN)                                            | 44        |
| 3.29     | Universal serial bus on-the-go full-speed (OTG_FS)                         | 44        |
| 3.30     | Universal serial bus on-the-go high-speed (OTG_HS)                         | 44        |
| 3.31     | Random number generator (RNG)                                              | 45        |
| 3.32     | General-purpose input/outputs (GPIOs)                                      | 45        |
| 3.33     | Analog-to-digital converters (ADCs)                                        | 46        |
| 3.34     | Temperature sensor                                                         | 46        |
| 3.35     | Digital-to-analog converter (DAC)                                          | 46        |
| 3.36     | Serial-wire JTAG debug port (SWJ-DP)                                       | 47        |
| 3.37     | Embedded Trace Macrocell™                                                  | 47        |
| <b>4</b> | <b>Pinouts and pin description</b>                                         | <b>48</b> |
| <b>5</b> | <b>Memory mapping</b>                                                      | <b>95</b> |
| <b>6</b> | <b>Electrical characteristics</b>                                          | <b>96</b> |
| 6.1      | Parameter conditions                                                       | 96        |
| 6.1.1    | Minimum and maximum values                                                 | 96        |
| 6.1.2    | Typical values                                                             | 96        |
| 6.1.3    | Typical curves                                                             | 96        |

|        |                                                                       |     |
|--------|-----------------------------------------------------------------------|-----|
| 6.1.4  | Loading capacitor                                                     | 96  |
| 6.1.5  | Pin input voltage                                                     | 96  |
| 6.1.6  | Power supply scheme                                                   | 97  |
| 6.1.7  | Current consumption measurement                                       | 99  |
| 6.2    | Absolute maximum ratings                                              | 99  |
| 6.3    | Operating conditions                                                  | 101 |
| 6.3.1  | General operating conditions                                          | 101 |
| 6.3.2  | VCAP1/VCAP2 external capacitor                                        | 104 |
| 6.3.3  | Operating conditions at power-up/power-down (regulator ON)            | 105 |
| 6.3.4  | Operating conditions at power-up/power-down (regulator OFF)           | 105 |
| 6.3.5  | Reset and power control block characteristics                         | 106 |
| 6.3.6  | Over-drive switching characteristics                                  | 107 |
| 6.3.7  | Supply current characteristics                                        | 107 |
| 6.3.8  | Wakeup time from low-power modes                                      | 125 |
| 6.3.9  | External clock source characteristics                                 | 126 |
| 6.3.10 | Internal clock source characteristics                                 | 130 |
| 6.3.11 | PLL characteristics                                                   | 132 |
| 6.3.12 | PLL spread spectrum clock generation (SSCG) characteristics           | 135 |
| 6.3.13 | USB OTG HS PHY PLLs characteristics (on STM32F723xx devices)          | 136 |
| 6.3.14 | USB OTG HS PHY regulator characteristics                              | 137 |
| 6.3.15 | USB HS PHY external resistor characteristics (on STM32F723xx devices) | 138 |
| 6.3.16 | Memory characteristics                                                | 138 |
| 6.3.17 | EMC characteristics                                                   | 140 |
| 6.3.18 | Absolute maximum ratings (electrical sensitivity)                     | 141 |
| 6.3.19 | I/O current injection characteristics                                 | 142 |
| 6.3.20 | I/O port characteristics                                              | 143 |
| 6.3.21 | NRST pin characteristics                                              | 149 |
| 6.3.22 | TIM timer characteristics                                             | 150 |
| 6.3.23 | RTC characteristics                                                   | 150 |
| 6.3.24 | 12-bit ADC characteristics                                            | 150 |
| 6.3.25 | Temperature sensor characteristics                                    | 156 |
| 6.3.26 | V <sub>BAT</sub> monitoring characteristics                           | 156 |
| 6.3.27 | Reference voltage                                                     | 156 |
| 6.3.28 | DAC electrical characteristics                                        | 157 |
| 6.3.29 | Communications interfaces                                             | 159 |

|                   |                                                                                             |            |
|-------------------|---------------------------------------------------------------------------------------------|------------|
| 6.3.30            | FMC characteristics .....                                                                   | 172        |
| 6.3.31            | Quad-SPI interface characteristics .....                                                    | 192        |
| 6.3.32            | SD/SDIO MMC card host interface (SDMMC) characteristics .....                               | 194        |
| <b>7</b>          | <b>Package information .....</b>                                                            | <b>197</b> |
| 7.1               | LQFP64 – 10 x 10 mm, low-profile quad flat package information .....                        | 197        |
| 7.2               | LQFP100, 14 x 14 mm low-profile quad flat package information .....                         | 200        |
| 7.3               | LQFP144, 20 x 20 mm low-profile quad flat package information .....                         | 203        |
| 7.4               | LQFP176 24 x 24 mm low-profile quad flat package information .....                          | 206        |
| 7.5               | UFBGA144 package information .....                                                          | 210        |
| 7.6               | UFBGA176+25, 10 x 10, 0.65 mm ultra thin-pitch ball grid<br>array package information ..... | 213        |
| 7.7               | WLCSP100 package information .....                                                          | 216        |
| 7.8               | Thermal characteristics .....                                                               | 220        |
| <b>8</b>          | <b>Ordering information .....</b>                                                           | <b>221</b> |
| <b>Appendix A</b> | <b>Recommendations when using internal reset OFF .....</b>                                  | <b>222</b> |
| A.1               | Operating conditions .....                                                                  | 222        |
| <b>9</b>          | <b>Revision history .....</b>                                                               | <b>223</b> |

## List of tables

|           |                                                                                                                                                                                                            |     |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table 1.  | Device summary . . . . .                                                                                                                                                                                   | 2   |
| Table 2.  | STM32F722xx and STM32F723xx features and peripheral counts . . . . .                                                                                                                                       | 15  |
| Table 3.  | Voltage regulator configuration mode versus device operating mode . . . . .                                                                                                                                | 32  |
| Table 4.  | Regulator ON/OFF and internal reset ON/OFF availability. . . . .                                                                                                                                           | 35  |
| Table 5.  | Voltage regulator modes in Stop mode . . . . .                                                                                                                                                             | 36  |
| Table 6.  | Timer feature comparison. . . . .                                                                                                                                                                          | 37  |
| Table 7.  | I2C implementation . . . . .                                                                                                                                                                               | 41  |
| Table 8.  | USART implementation . . . . .                                                                                                                                                                             | 42  |
| Table 9.  | Legend/abbreviations used in the pinout table . . . . .                                                                                                                                                    | 59  |
| Table 10. | STM32F722xx and STM32F723xx pin and ball definition . . . . .                                                                                                                                              | 60  |
| Table 11. | FMC pin definition . . . . .                                                                                                                                                                               | 81  |
| Table 12. | STM32F722xx and STM32F723xx alternate function mapping. . . . .                                                                                                                                            | 84  |
| Table 13. | Voltage characteristics . . . . .                                                                                                                                                                          | 99  |
| Table 14. | Current characteristics . . . . .                                                                                                                                                                          | 100 |
| Table 15. | Thermal characteristics. . . . .                                                                                                                                                                           | 101 |
| Table 16. | General operating conditions . . . . .                                                                                                                                                                     | 101 |
| Table 17. | Limitations depending on the operating power supply range . . . . .                                                                                                                                        | 103 |
| Table 18. | VCAP1/VCAP2 operating conditions . . . . .                                                                                                                                                                 | 104 |
| Table 19. | VCAP1 operating conditions in the LQFP64 package . . . . .                                                                                                                                                 | 105 |
| Table 20. | Operating conditions at power-up/power-down (regulator ON) . . . . .                                                                                                                                       | 105 |
| Table 21. | Operating conditions at power-up/power-down (regulator OFF). . . . .                                                                                                                                       | 105 |
| Table 22. | Reset and power control block characteristics . . . . .                                                                                                                                                    | 106 |
| Table 23. | Over-drive switching characteristics . . . . .                                                                                                                                                             | 107 |
| Table 24. | Typical and maximum current consumption in Run mode, code with data processing<br>running from ITCM RAM, regulator ON . . . . .                                                                            | 108 |
| Table 25. | Typical and maximum current consumption in Run mode, code with data processing<br>running from Flash memory (ART ON except prefetch / L1-cache ON)<br>or SRAM on AXI (L1-cache ON), regulator ON . . . . . | 109 |
| Table 26. | Typical and maximum current consumption in Run mode, code with data processing<br>running from Flash memory or SRAM on AXI (L1-cache disabled), regulator ON . . . . .                                     | 110 |
| Table 27. | Typical and maximum current consumption in Run mode, code with data processing<br>running from Flash memory on ITCM interface (ART disabled), regulator ON . . . . .                                       | 111 |
| Table 28. | Typical and maximum current consumption in Run mode, code with data processing<br>running from Flash memory (ART ON except prefetch / L1-cache ON)<br>or SRAM on AXI (L1-cache ON), regulator OFF. . . . . | 112 |
| Table 29. | Typical and maximum current consumption in Sleep mode, regulator ON. . . . .                                                                                                                               | 113 |
| Table 30. | Typical and maximum current consumption in Sleep mode, regulator OFF. . . . .                                                                                                                              | 113 |
| Table 31. | Typical and maximum current consumptions in Stop mode . . . . .                                                                                                                                            | 114 |
| Table 32. | Typical and maximum current consumptions in Standby mode . . . . .                                                                                                                                         | 115 |
| Table 33. | Typical and maximum current consumptions in V <sub>BAT</sub> mode. . . . .                                                                                                                                 | 116 |
| Table 34. | Switching output I/O current consumption . . . . .                                                                                                                                                         | 120 |
| Table 35. | Peripheral current consumption . . . . .                                                                                                                                                                   | 122 |
| Table 36. | USB OTG HS and USB OTG PHY HS current consumption . . . . .                                                                                                                                                | 125 |
| Table 37. | Low-power mode wakeup timings . . . . .                                                                                                                                                                    | 125 |
| Table 38. | High-speed external user clock characteristics. . . . .                                                                                                                                                    | 126 |
| Table 39. | Low-speed external user clock characteristics . . . . .                                                                                                                                                    | 127 |
| Table 40. | HSE 4-26 MHz oscillator characteristics. . . . .                                                                                                                                                           | 128 |
| Table 41. | LSE oscillator characteristics (f <sub>LSE</sub> = 32.768 kHz) . . . . .                                                                                                                                   | 129 |

|           |                                                                                     |     |
|-----------|-------------------------------------------------------------------------------------|-----|
| Table 42. | HSI oscillator characteristics                                                      | 130 |
| Table 43. | LSI oscillator characteristics                                                      | 131 |
| Table 44. | Main PLL characteristics                                                            | 132 |
| Table 45. | PLLI2S characteristics                                                              | 133 |
| Table 46. | PLLI2S characteristics                                                              | 134 |
| Table 47. | SSCG parameters constraint                                                          | 135 |
| Table 48. | USB OTG HS PLL1 characteristics                                                     | 136 |
| Table 49. | USB OTG HS PLL2 characteristics                                                     | 137 |
| Table 50. | USB OTG HS PHY regulator characteristics                                            | 137 |
| Table 51. | USB HS PHY external resistor characteristics (on STM32F723xx devices)               | 138 |
| Table 52. | Flash memory characteristics                                                        | 138 |
| Table 53. | Flash memory programming                                                            | 138 |
| Table 54. | Flash memory programming with VPP                                                   | 139 |
| Table 55. | Flash memory endurance and data retention                                           | 139 |
| Table 56. | EMS characteristics                                                                 | 140 |
| Table 57. | EMI characteristics                                                                 | 141 |
| Table 58. | ESD absolute maximum ratings                                                        | 142 |
| Table 59. | Electrical sensitivities                                                            | 142 |
| Table 60. | I/O current injection susceptibility                                                | 143 |
| Table 61. | I/O static characteristics                                                          | 143 |
| Table 62. | Output voltage characteristics                                                      | 146 |
| Table 63. | I/O AC characteristics                                                              | 147 |
| Table 64. | NRST pin characteristics                                                            | 149 |
| Table 65. | TIMx characteristics                                                                | 150 |
| Table 66. | RTC characteristics                                                                 | 150 |
| Table 67. | ADC characteristics                                                                 | 150 |
| Table 68. | ADC static accuracy at $f_{\text{ADC}} = 18 \text{ MHz}$                            | 152 |
| Table 69. | ADC static accuracy at $f_{\text{ADC}} = 30 \text{ MHz}$                            | 152 |
| Table 70. | ADC static accuracy at $f_{\text{ADC}} = 36 \text{ MHz}$                            | 153 |
| Table 71. | ADC dynamic accuracy at $f_{\text{ADC}} = 18 \text{ MHz}$ - limited test conditions | 153 |
| Table 72. | ADC dynamic accuracy at $f_{\text{ADC}} = 36 \text{ MHz}$ - limited test conditions | 153 |
| Table 73. | Temperature sensor characteristics                                                  | 156 |
| Table 74. | Temperature sensor calibration values                                               | 156 |
| Table 75. | V <sub>BAT</sub> monitoring characteristics                                         | 156 |
| Table 76. | internal reference voltage                                                          | 156 |
| Table 77. | Internal reference voltage calibration values                                       | 157 |
| Table 78. | DAC characteristics                                                                 | 157 |
| Table 79. | Minimum I2CCLK frequency in all I2C modes                                           | 160 |
| Table 80. | I2C analog filter characteristics                                                   | 160 |
| Table 81. | SPI dynamic characteristics                                                         | 161 |
| Table 82. | I <sup>2</sup> S dynamic characteristics                                            | 164 |
| Table 83. | SAI characteristics                                                                 | 166 |
| Table 84. | USB OTG full speed startup time                                                     | 168 |
| Table 85. | USB OTG full speed DC electrical characteristics                                    | 168 |
| Table 86. | USB OTG full speed electrical characteristics                                       | 169 |
| Table 87. | USB HS DC electrical characteristics                                                | 169 |
| Table 88. | USB HS clock timing parameters                                                      | 170 |
| Table 89. | Dynamic characteristics: USB ULPI                                                   | 171 |
| Table 90. | USB OTG high speed DC electrical characteristics                                    | 171 |
| Table 91. | USB OTG high speed electrical characteristics                                       | 171 |
| Table 92. | USB FS PHY BCD electrical characteristics                                           | 172 |
| Table 93. | Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings                            | 174 |



|            |                                                                               |     |
|------------|-------------------------------------------------------------------------------|-----|
| Table 94.  | Asynchronous non-multiplexed SRAM/PSRAM/NOR read - NWAIT timings . . . . .    | 174 |
| Table 95.  | Asynchronous non-multiplexed SRAM/PSRAM/NOR write timings . . . . .           | 175 |
| Table 96.  | Asynchronous non-multiplexed SRAM/PSRAM/NOR write - NWAIT timings . . . . .   | 176 |
| Table 97.  | Asynchronous multiplexed PSRAM/NOR read timings . . . . .                     | 177 |
| Table 98.  | Asynchronous multiplexed PSRAM/NOR read-NWAIT timings . . . . .               | 177 |
| Table 99.  | Asynchronous multiplexed PSRAM/NOR write timings . . . . .                    | 178 |
| Table 100. | Asynchronous multiplexed PSRAM/NOR write-NWAIT timings . . . . .              | 179 |
| Table 101. | Synchronous multiplexed NOR/PSRAM read timings . . . . .                      | 181 |
| Table 102. | Synchronous multiplexed PSRAM write timings . . . . .                         | 183 |
| Table 103. | Synchronous non-multiplexed NOR/PSRAM read timings . . . . .                  | 184 |
| Table 104. | Synchronous non-multiplexed PSRAM write timings . . . . .                     | 186 |
| Table 105. | Switching characteristics for NAND Flash read cycles . . . . .                | 188 |
| Table 106. | Switching characteristics for NAND Flash write cycles . . . . .               | 188 |
| Table 107. | SDRAM read timings . . . . .                                                  | 190 |
| Table 108. | LPDDR SDRAM read timings . . . . .                                            | 190 |
| Table 109. | SDRAM write timings . . . . .                                                 | 191 |
| Table 110. | LPDDR SDRAM write timings . . . . .                                           | 192 |
| Table 111. | Quad-SPI characteristics in SDR mode . . . . .                                | 192 |
| Table 112. | Quad-SPI characteristics in DDR mode . . . . .                                | 193 |
| Table 113. | Dynamic characteristics: SD / MMC characteristics, VDD=2.7V to 3.6V . . . . . | 195 |
| Table 114. | Dynamic characteristics: eMMC characteristics, VDD=1.71V to 1.9V . . . . .    | 196 |
| Table 115. | LQFP64 mechanical data . . . . .                                              | 197 |
| Table 116. | LQFP100 mechanical data . . . . .                                             | 200 |
| Table 117. | LQFP144 mechanical data . . . . .                                             | 203 |
| Table 118. | LQFP176 - Mechanical data . . . . .                                           | 206 |
| Table 119. | UFBGA144 mechanical data . . . . .                                            | 210 |
| Table 120. | UFBGA144 recommended PCB design rules (0.50 mm pitch BGA) . . . . .           | 211 |
| Table 121. | UFBGA(176+25) - Mechanical data . . . . .                                     | 213 |
| Table 122. | UFBGA(176+25) - Recommended PCB design rules (0.65 mm pitch BGA) . . . . .    | 214 |
| Table 123. | WLCSP100 - Mechanical data . . . . .                                          | 217 |
| Table 124. | WLCSP100 - Recommended PCB design rules . . . . .                             | 218 |
| Table 125. | Package thermal characteristics . . . . .                                     | 220 |
| Table 126. | Ordering information scheme . . . . .                                         | 221 |
| Table 127. | Limitations depending on the operating power supply range . . . . .           | 222 |
| Table 128. | Document revision history . . . . .                                           | 223 |

## List of figures

|            |                                                                                               |     |
|------------|-----------------------------------------------------------------------------------------------|-----|
| Figure 1.  | Compatible board design for LQFP100 package                                                   | 17  |
| Figure 2.  | Compatible board design for LQFP64 package                                                    | 18  |
| Figure 3.  | Compatible board design for LQFP100 package                                                   | 19  |
| Figure 4.  | Compatible board design for LQFP144 package                                                   | 19  |
| Figure 5.  | Compatible board design for LQFP176 package                                                   | 20  |
| Figure 6.  | STM32F722xx and STM32F723xx block diagram                                                     | 21  |
| Figure 7.  | STM32F722xx and STM32F723xx AXI-AHB bus matrix architecture <sup>(1)</sup>                    | 24  |
| Figure 8.  | VDDUSB connected to VDD power supply                                                          | 29  |
| Figure 9.  | VDDUSB connected to external power supply                                                     | 29  |
| Figure 10. | Power supply supervisor interconnection with internal reset OFF                               | 30  |
| Figure 11. | PDR_ON control with internal reset OFF                                                        | 31  |
| Figure 12. | Regulator OFF                                                                                 | 33  |
| Figure 13. | Startup in regulator OFF: slow $V_{DD}$ slope                                                 |     |
|            | - power-down reset risen after $V_{CAP\_1}/V_{CAP\_2}$ stabilization                          | 34  |
| Figure 14. | Startup in regulator OFF mode: fast $V_{DD}$ slope                                            |     |
|            | - power-down reset risen before $V_{CAP\_1}/V_{CAP\_2}$ stabilization                         | 34  |
| Figure 15. | STM32F722xx LQFP64 pinout                                                                     | 48  |
| Figure 16. | STM32F722xx LQFP100 pinout                                                                    | 49  |
| Figure 17. | STM32F723xx LQFP100 pinout                                                                    | 50  |
| Figure 18. | STM32F723xx WLCSP100 ballout (with OTG PHY HS)                                                | 51  |
| Figure 19. | STM32F722xx LQFP144 pinout                                                                    | 52  |
| Figure 20. | STM32F723xx LQFP144 pinout                                                                    | 53  |
| Figure 21. | STM32F723xx UFBGA144 ballout (with OTG PHY HS)                                                | 54  |
| Figure 22. | STM32F722xx LQFP176 pinout                                                                    | 55  |
| Figure 23. | STM32F723xx LQFP176 pinout                                                                    | 56  |
| Figure 24. | STM32F723xx UFBGA176 ballout                                                                  | 57  |
| Figure 25. | STM32F723xx UFBGA176 ballout (with OTG PHY HS)                                                | 58  |
| Figure 26. | Pin loading conditions                                                                        | 96  |
| Figure 27. | Pin input voltage                                                                             | 96  |
| Figure 28. | STM32F722xx power supply scheme                                                               | 97  |
| Figure 29. | STM32F723xx power supply scheme                                                               | 98  |
| Figure 30. | Current consumption measurement scheme                                                        | 99  |
| Figure 31. | External capacitor $C_{EXT}$                                                                  | 104 |
| Figure 32. | Typical $V_{BAT}$ current consumption (RTC ON/BKP SRAM OFF and LSE in low drive mode)         | 117 |
| Figure 33. | Typical $V_{BAT}$ current consumption (RTC ON/BKP SRAM OFF and LSE in medium low drive mode)  | 117 |
| Figure 34. | Typical $V_{BAT}$ current consumption (RTC ON/BKP SRAM OFF and LSE in medium high drive mode) | 118 |
| Figure 35. | Typical $V_{BAT}$ current consumption (RTC ON/BKP SRAM OFF and LSE in high drive mode)        | 118 |
| Figure 36. | Typical $V_{BAT}$ current consumption (RTC ON/BKP SRAM OFF and LSE in high medium drive mode) | 119 |
| Figure 37. | High-speed external clock source AC timing diagram                                            | 127 |
| Figure 38. | Low-speed external clock source AC timing diagram                                             | 128 |
| Figure 39. | Typical application with an 8 MHz crystal                                                     | 129 |
| Figure 40. | Typical application with a 32.768 kHz crystal                                                 | 130 |
| Figure 41. | ACCHSI versus temperature                                                                     | 131 |

|            |                                                                                           |     |
|------------|-------------------------------------------------------------------------------------------|-----|
| Figure 42. | LSI deviation versus temperature . . . . .                                                | 132 |
| Figure 43. | PLL output clock waveforms in center spread mode . . . . .                                | 136 |
| Figure 44. | PLL output clock waveforms in down spread mode . . . . .                                  | 136 |
| Figure 45. | FT I/O input characteristics . . . . .                                                    | 145 |
| Figure 46. | I/O AC characteristics definition . . . . .                                               | 148 |
| Figure 47. | Recommended NRST pin protection . . . . .                                                 | 149 |
| Figure 48. | ADC accuracy characteristics . . . . .                                                    | 154 |
| Figure 49. | Typical connection diagram using the ADC . . . . .                                        | 154 |
| Figure 50. | Power supply and reference decoupling ( $V_{REF+}$ not connected to $V_{DDA}$ ) . . . . . | 155 |
| Figure 51. | Power supply and reference decoupling ( $V_{REF+}$ connected to $V_{DDA}$ ) . . . . .     | 155 |
| Figure 52. | 12-bit buffered /non-buffered DAC . . . . .                                               | 159 |
| Figure 53. | SPI timing diagram - slave mode and CPHA = 0 . . . . .                                    | 162 |
| Figure 54. | SPI timing diagram - slave mode and CPHA = 1 . . . . .                                    | 163 |
| Figure 55. | SPI timing diagram - master mode . . . . .                                                | 163 |
| Figure 56. | I <sup>2</sup> S slave timing diagram (Philips protocol) <sup>(1)</sup> . . . . .         | 165 |
| Figure 57. | I <sup>2</sup> S master timing diagram (Philips protocol) <sup>(1)</sup> . . . . .        | 165 |
| Figure 58. | SAI master timing waveforms . . . . .                                                     | 167 |
| Figure 59. | SAI slave timing waveforms . . . . .                                                      | 167 |
| Figure 60. | USB OTG full speed timings: definition of data signal rise and fall time . . . . .        | 169 |
| Figure 61. | ULPI timing diagram . . . . .                                                             | 170 |
| Figure 62. | Asynchronous non-multiplexed SRAM/PSRAM/NOR read waveforms . . . . .                      | 173 |
| Figure 63. | Asynchronous non-multiplexed SRAM/PSRAM/NOR write waveforms . . . . .                     | 175 |
| Figure 64. | Asynchronous multiplexed PSRAM/NOR read waveforms . . . . .                               | 176 |
| Figure 65. | Asynchronous multiplexed PSRAM/NOR write waveforms . . . . .                              | 178 |
| Figure 66. | Synchronous multiplexed NOR/PSRAM read timings . . . . .                                  | 180 |
| Figure 67. | Synchronous multiplexed PSRAM write timings . . . . .                                     | 182 |
| Figure 68. | Synchronous non-multiplexed NOR/PSRAM read timings . . . . .                              | 184 |
| Figure 69. | Synchronous non-multiplexed PSRAM write timings . . . . .                                 | 185 |
| Figure 70. | NAND controller waveforms for read access . . . . .                                       | 187 |
| Figure 71. | NAND controller waveforms for write access . . . . .                                      | 187 |
| Figure 72. | NAND controller waveforms for common memory read access . . . . .                         | 187 |
| Figure 73. | NAND controller waveforms for common memory write access . . . . .                        | 188 |
| Figure 74. | SDRAM read access waveforms (CL = 1) . . . . .                                            | 189 |
| Figure 75. | SDRAM write access waveforms . . . . .                                                    | 191 |
| Figure 76. | Quad-SPI timing diagram - SDR mode . . . . .                                              | 194 |
| Figure 77. | Quad-SPI timing diagram - DDR mode . . . . .                                              | 194 |
| Figure 78. | SDIO high-speed mode . . . . .                                                            | 195 |
| Figure 79. | SD default mode . . . . .                                                                 | 195 |
| Figure 80. | LQFP64 outline . . . . .                                                                  | 197 |
| Figure 81. | LQFP64 recommended footprint . . . . .                                                    | 198 |
| Figure 82. | LQFP64 top view example . . . . .                                                         | 199 |
| Figure 83. | LQFP100 outline . . . . .                                                                 | 200 |
| Figure 84. | LQFP100 recommended footprint . . . . .                                                   | 201 |
| Figure 85. | LQFP100 top view example . . . . .                                                        | 202 |
| Figure 86. | LQFP144 outline . . . . .                                                                 | 203 |
| Figure 87. | LQFP144 recommended footprint . . . . .                                                   | 204 |
| Figure 88. | LQFP144 top view example . . . . .                                                        | 205 |
| Figure 89. | LQFP176 - Outline . . . . .                                                               | 206 |
| Figure 90. | LQFP176 - Recommended footprint . . . . .                                                 | 208 |
| Figure 91. | LQFP176 top view example . . . . .                                                        | 209 |
| Figure 92. | UFBGA144 outline . . . . .                                                                | 210 |
| Figure 93. | UFBGA144 recommended footprint . . . . .                                                  | 211 |

|             |                                       |     |
|-------------|---------------------------------------|-----|
| Figure 94.  | UFBGA144 top view example             | 212 |
| Figure 95.  | UFBGA(176+25) - Outline               | 213 |
| Figure 96.  | UFBGA(176+25) - Recommended footprint | 214 |
| Figure 97.  | UFBGA176 top view example             | 215 |
| Figure 98.  | WLCSP100 - Outline                    | 216 |
| Figure 99.  | WLCSP100 - Recommended footprint      | 217 |
| Figure 100. | WLCSP100 top view example             | 219 |

# 1 Introduction

This datasheet provides the ordering information and mechanical device characteristics of the STM32F722xx and STM32F723xx microcontrollers.

This document should be read in conjunction with the *STM32F72xxx and STM32F73xxx advanced Arm<sup>®</sup>-based 32-bit MCUs* reference manual (RM0431). The reference manual is available from the STMicroelectronics website [www.st.com](http://www.st.com).

For information on the Arm<sup>®</sup>(a) Cortex<sup>®</sup>-M7 core, refer to the Cortex<sup>®</sup>-M7 technical reference manual available from the <http://www.arm.com> website.



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## 2 Description

The STM32F722xx and STM32F723xx devices are based on the high-performance Arm® Cortex®-M7 32-bit RISC core operating at up to 216 MHz frequency. The Cortex®-M7 core features a single floating point unit (SFPU) precision which supports Arm® single-precision data-processing instructions and data types. It also implements a full set of DSP instructions and a memory protection unit (MPU) which enhances the application security.

The STM32F722xx and STM32F723xx devices incorporate high-speed embedded memories with a Flash memory up to 512 Kbytes, 256 Kbytes of SRAM (including 64 Kbytes of data TCM RAM for critical real-time data), 16 Kbytes of instruction TCM RAM (for critical real-time routines), 4 Kbytes of backup SRAM available in the lowest power modes, and an extensive range of enhanced I/Os and peripherals connected to two APB buses, two AHB buses, a 32-bit multi-AHB bus matrix and a multi layer AXI interconnect supporting internal and external memories access.

All the devices offer three 12-bit ADCs, two DACs, a low-power RTC, thirteen general-purpose 16-bit timers including two PWM timers for motor control, two general-purpose 32-bit timers, a true random number generator (RNG). They also feature standard and advanced communication interfaces.

- Up to three I<sup>2</sup>Cs
- Five SPIs, three I<sup>2</sup>Ss in half duplex mode. To achieve the audio class accuracy, the I<sup>2</sup>S peripherals can be clocked via a dedicated internal audio PLL or via an external clock to allow synchronization.
- Four USARTs plus four UARTs
- An USB OTG full-speed and a USB OTG high-speed with full-speed capability (with the ULPI or with the integrated HS PHY depending on the part number)
- One CAN
- Two SAI serial audio interfaces
- Two SDMMC host interfaces

Advanced peripherals include two SDMMC interfaces, a flexible memory control (FMC) interface, a Quad-SPI Flash memory interface.

The STM32F722xx and STM32F723xx devices operate in the –40 to +105 °C temperature range from a 1.7 to 3.6 V power supply. Dedicated supply inputs for the USB (OTG\_FS and OTG\_HS) and the SDMMC2 (clock, command and 4-bit data) are available on all the packages except LQFP100 and LQFP64 for a greater power supply choice.

The supply voltage can drop to 1.7 V with the use of an external power supply supervisor. A comprehensive set of power-saving mode allows the design of low-power applications.

The STM32F722xx and STM32F723xx devices offer devices in 7 packages ranging from 64 pins to 176 pins. The set of included peripherals changes with the device chosen.

These features make the STM32F722xx and STM32F723xx microcontrollers 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,
- Mobile applications, Internet of Things,
- Wearable devices: smart watches.

The following table lists the peripherals available on each part number.

**Table 2. STM32F722xx and STM32F723xx features and peripheral counts**

| Peripherals              |                                     | STM32F72xRx                  |     | STM32F72xVx                  |     | STM32F72xZx                  |     | STM32F72xLx |     |
|--------------------------|-------------------------------------|------------------------------|-----|------------------------------|-----|------------------------------|-----|-------------|-----|
| Flash memory in Kbytes   |                                     | 256                          | 512 | 256                          | 512 | 256                          | 512 | 256         | 512 |
| SRAM in Kbytes           | System                              | 256(176+16+64)               |     |                              |     |                              |     |             |     |
|                          | Instruction                         | 16                           |     |                              |     |                              |     |             |     |
|                          | Backup                              | 4                            |     |                              |     |                              |     |             |     |
| FMC memory controller    |                                     | No                           |     | Yes <sup>(1)</sup>           |     |                              |     |             |     |
| QUADSPI                  |                                     | Yes                          |     |                              |     |                              |     |             |     |
| Timers                   | General-purpose                     | 10 <sup>(2)</sup>            |     |                              |     |                              |     |             |     |
|                          | Advanced-control                    | 2                            |     |                              |     |                              |     |             |     |
|                          | Basic                               | 2                            |     |                              |     |                              |     |             |     |
|                          | Low-power                           | No                           |     | 1                            |     |                              |     |             |     |
| Random number generator  |                                     | Yes                          |     |                              |     |                              |     |             |     |
| Communication interfaces | SPI/I2S                             | 3/3 (simplex) <sup>(3)</sup> |     | 4/3 (simplex) <sup>(3)</sup> |     | 5/3 (simplex) <sup>(3)</sup> |     |             |     |
|                          | I2C                                 | 3                            |     |                              |     |                              |     |             |     |
|                          | USART/UART                          | 4/2                          |     | 4/4                          |     |                              |     |             |     |
|                          | USB OTG FS                          | Yes                          |     |                              |     |                              |     |             |     |
|                          | USB OTG HS <sup>(4)</sup>           | Yes                          |     |                              |     |                              |     |             |     |
|                          | USB OTG PHY HS controller (USBPHYC) | No                           |     | Yes <sup>(10)</sup>          |     |                              |     |             |     |
|                          | CAN                                 | 1                            |     |                              |     |                              |     |             |     |
|                          | SAI                                 | 2                            |     |                              |     |                              |     |             |     |
|                          | SDMMC1                              | Yes                          |     |                              |     |                              |     |             |     |
|                          | SDMMC2                              | No                           |     | Yes <sup>(5)(6)</sup>        |     |                              |     |             |     |

Table 2. STM32F722xx and STM32F723xx features and peripheral counts (continued)

| Peripherals                      | STM32F72xRx                                          | STM32F72xVx                                  | STM32F72xZx                                    | STM32F72xLx                                    |
|----------------------------------|------------------------------------------------------|----------------------------------------------|------------------------------------------------|------------------------------------------------|
| GPIOs                            | 50                                                   | 82 in<br>STM32F722xx<br>79 in<br>STM32F723xx | 114 in<br>STM32F722xx<br>112 in<br>STM32F723xx | 140 in<br>STM32F722xx<br>138 in<br>STM32F723xx |
| 12-bit ADC<br>Number of channels | 3                                                    |                                              |                                                |                                                |
|                                  | 16                                                   |                                              | 24                                             |                                                |
| 12-bit DAC<br>Number of channels | Yes<br>2                                             |                                              |                                                |                                                |
| Maximum CPU frequency            | 216 MHz <sup>(7)</sup>                               |                                              |                                                |                                                |
| Operating voltage                | 1.7 to 3.6 V <sup>(8)</sup>                          |                                              |                                                |                                                |
| Operating temperatures           | Ambient temperatures: -40 to +85 °C / -40 to +105 °C |                                              |                                                |                                                |
|                                  | Junction temperature: -40 to + 125 °C                |                                              |                                                |                                                |
| Package                          | LQFP64 <sup>(9)</sup>                                | LQFP100<br>WLCSP100 <sup>(10)</sup>          | LQFP144<br>UFBGA144 <sup>(10)</sup>            | UFBGA176<br>LQFP176                            |

- For the LQFP100 package, only FMC Bank1 is available. Bank1 can only support a multiplexed NOR/PSRAM memory using the NE1 Chip Select.
- On the STM32F723xx device packages, except the 176-pin ones, the TIM12 is not available, so there are 9 general-purpose timers.
- The SPI1, SPI2 and SPI3 interfaces give the flexibility to work in an exclusive way in either the SPI mode or the I<sup>2</sup>S audio mode.
- USB OTG HS with the ULPI on the STM32F722xx devices and with integrated HS PHY on the STM32F723xx devices.
- The SDMMC2 supports a dedicated power rail for clock, command and data 0..4 lines, feature available starting from 144 pin package.
- The SDMMC2 is not available on the STM32F723Vx devices.
- 216 MHz maximum frequency for - 40°C to + 85°C ambient temperature range (200 MHz maximum frequency for - 40°C to + 105°C ambient temperature range).
- V<sub>DD</sub>/V<sub>DDA</sub> minimum value of 1.7 V is obtained when the internal reset is OFF (refer to [Section 3.15.2: Internal reset OFF](#)).
- Available only on the STM32F722xx devices.
- Available only on the STM32F723xx devices.

## 2.1 Full compatibility throughout the family

The STM32F722xx devices are fully pin-to-pin, compatible with the STM32F7x5xx, STM32F7x6xx, STM32F7x7xx devices.

The STM32F722xx devices are partially pin-to-pin, compatible with the STM32F4xxxx devices, allowing the user to try different peripherals, and reaching higher performances (higher frequency) for a greater degree of freedom during the development cycle.

[Figure 1](#) and [Figure 2](#) give compatible board designs between the STM32F722xx, with LQFP64 and LQFP100 packages, and STM32F4xx families.



Figure 1. Compatible board design for LQFP100 package

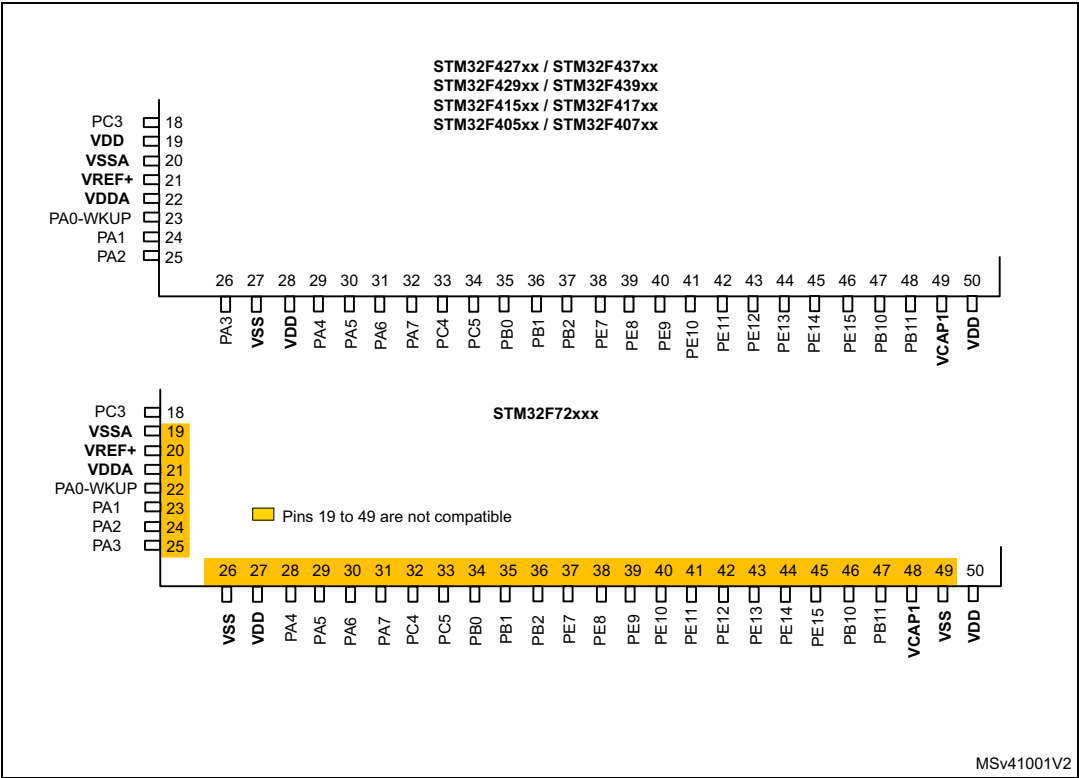
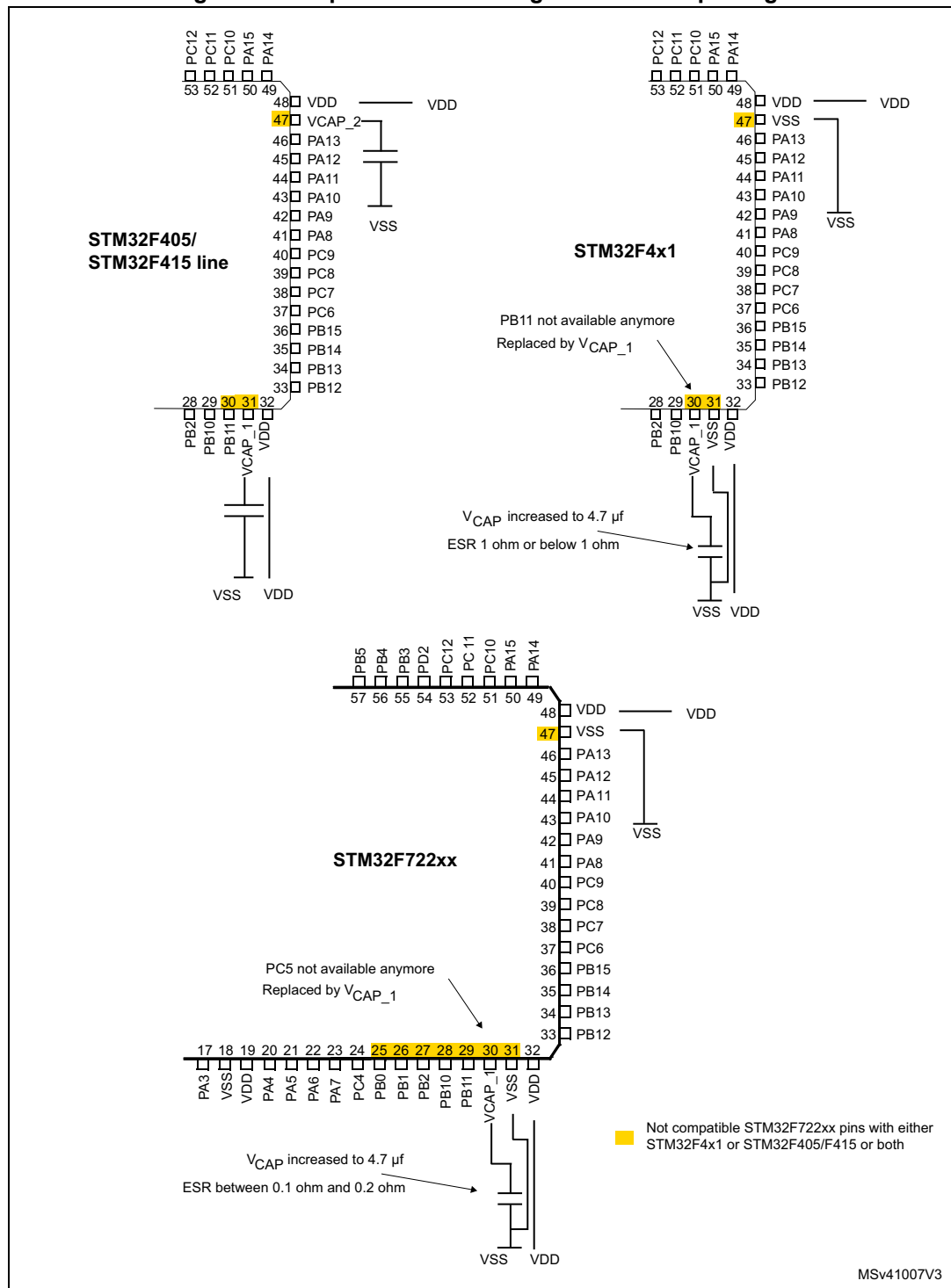


Figure 2. Compatible board design for LQFP64 package



The STM32F722xx LQFP144, UFBGA176 and LQFP176 packages are fully pin to pin compatible with the STM32F4xx devices.

# 2.2 STM32F723xx versus STM32F722xx LQFP100/ LQFP144/ LQFP176 packages

Figure 3. Compatible board design for LQFP100 package

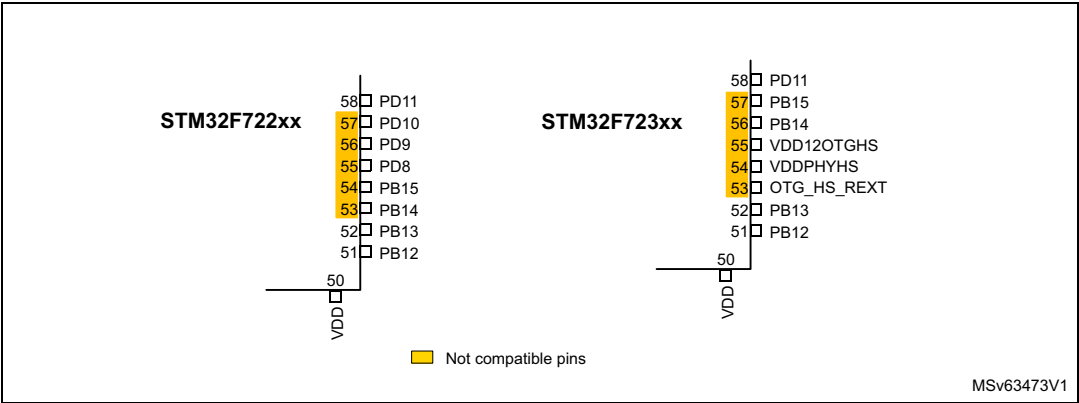


Figure 4. Compatible board design for LQFP144 package

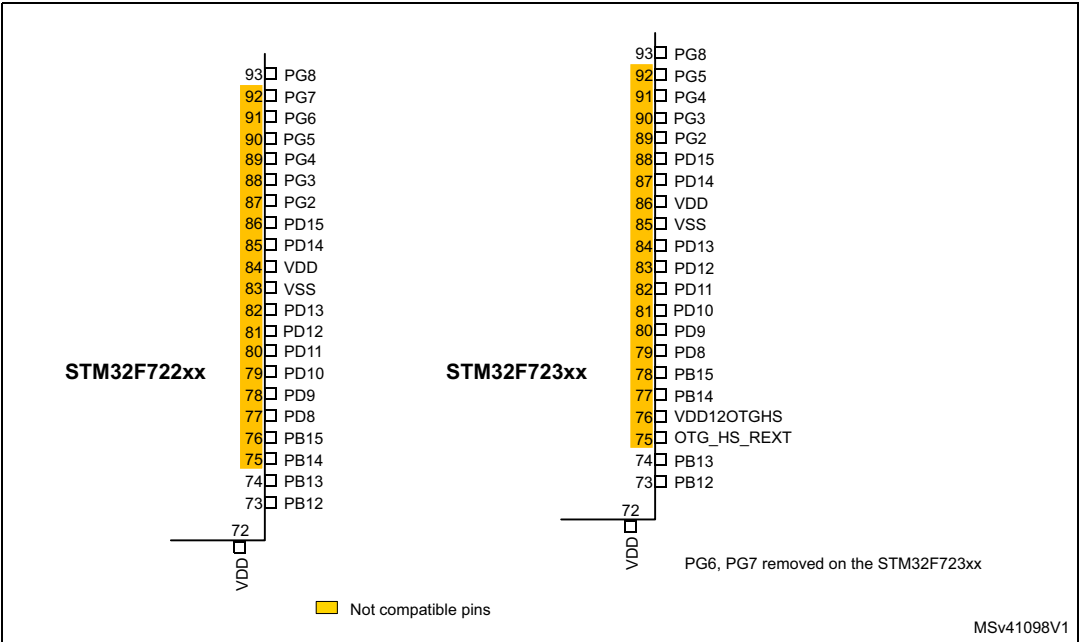


Figure 5. Compatible board design for LQFP176 package

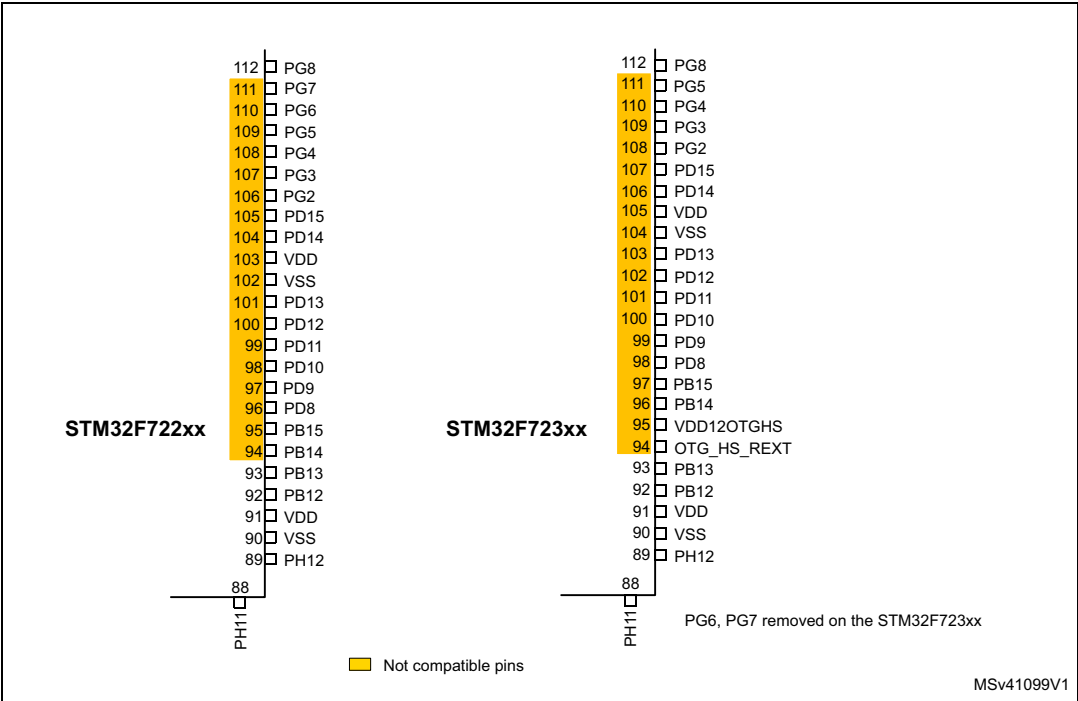
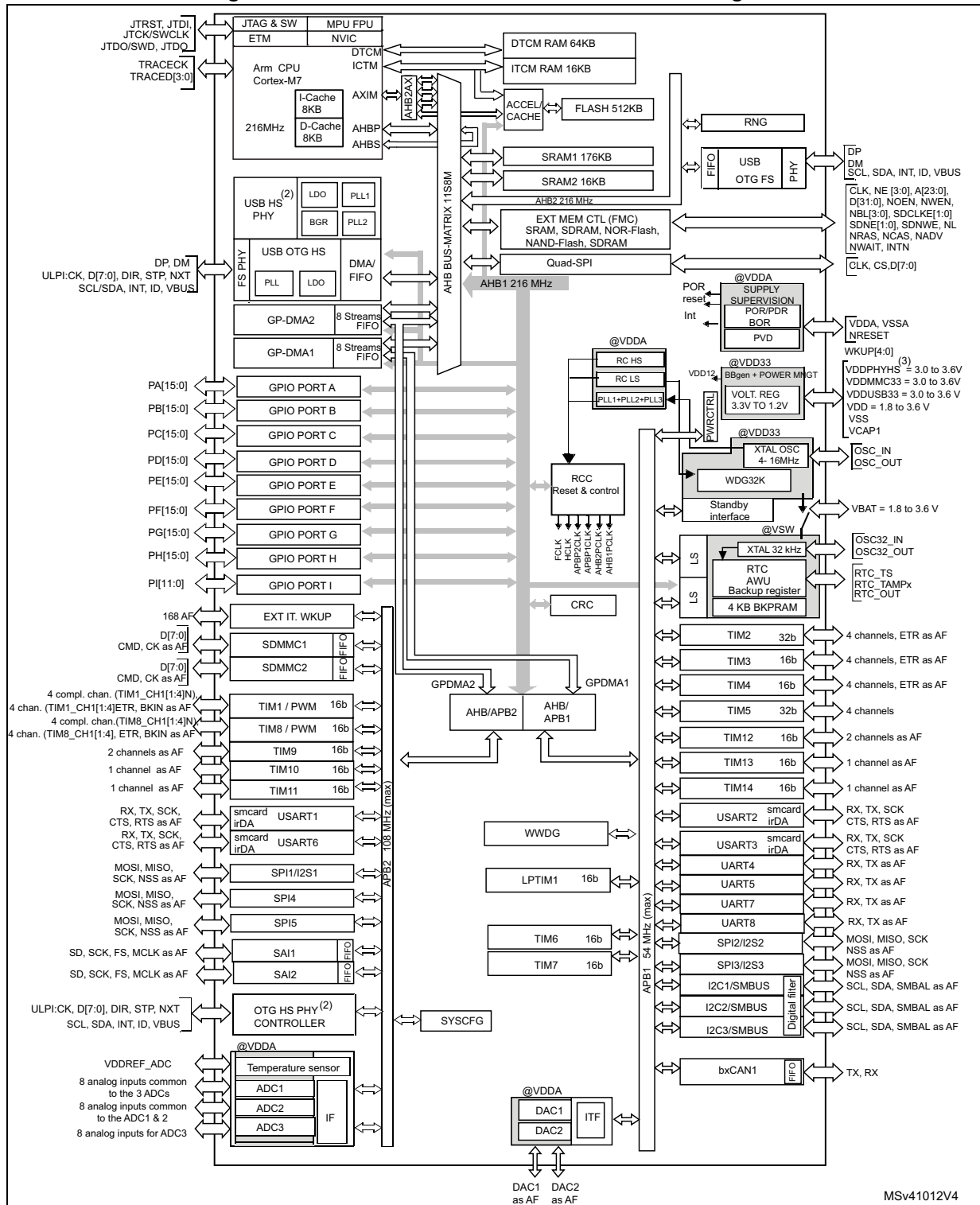


Figure 6 shows the general block diagram of the device family.

Figure 6. STM32F722xx and STM32F723xx block diagram



1. The timers connected to APB2 are clocked from TIMxCLK up to 216 MHz, while the timers connected to APB1 are clocked from TIMxCLK either up to 108 MHz or 216 MHz depending on TIMPRE bit configuration in the RCC\_DCKCFGR register.
2. Available only on the STM32F723xx devices.
3. Available only on the STM32F723xx LQFP100 package.

## 3 Functional overview

### 3.1 Arm Cortex-M7 with FPU

The Arm Cortex-M7 with FPU 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 low interrupt latency.

The Cortex-M7 processor is a highly efficient high-performance featuring:

- Six-stage dual-issue pipeline
- Dynamic branch prediction
- Harvard caches (8 Kbytes of I-cache and 8 Kbytes of D-cache)
- 64-bit AXI4 interface
- 64-bit ITCM interface
- 2x32-bit DTCM interfaces

The processor supports the following memory interfaces:

- tightly-coupled memory (TCM) interface
- Harvard instruction and data caches and AXI master (AXIM) interface
- dedicated low-latency AHB-Lite peripheral (AHBP) interface

The processor supports a set of DSP instructions which allow efficient signal processing and complex algorithm execution.

It supports single precision FPU (floating point unit), speeds up software development by using metalanguage development tools, while avoiding saturation.

[Figure 6](#) shows the general block diagram of the STM32F722xx and STM32F723xx family.

*Note:* Cortex-M7 with FPU core is binary compatible with the Cortex-M4 core.

### 3.2 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 eight protected areas that can in turn be divided up into eight subareas. The protection area sizes are between 32 bytes and the whole 4 Gbytes 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.

### 3.3 Embedded Flash memory

The STM32F722xx and STM32F723xx devices embed a Flash memory of up to 512 Kbytes available for storing programs and data.

The flexible protections can be configured thanks to option bytes:

- Readout protection (RDP) to protect the whole memory. Three levels are available:
  - Level 0: no readout protection
  - Level 1: no access (read, erase, program) to the Flash memory or backup SRAM can be performed while the debug feature is connected or while booting from RAM or system memory bootloader.
  - Level 2: debug/chip read protection disabled
- Write protection (WRP): the protected area is protected against erasing and programming.
- Proprietary code readout protection (PCROP): Flash memory user sectors (0 to 7) can be protected against D-bus read accesses by using the proprietary readout protection (PCROP). The protected area is execute-only.

### 3.4 CRC (cyclic redundancy check) calculation unit

The CRC (cyclic redundancy check) calculation unit is used to get a CRC code using a configurable generator polynomial value and size.

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 signature of the software during runtime, to be compared with a reference signature generated at link-time and stored at a given memory location.

### 3.5 Embedded SRAM

All the devices feature:

- System SRAM up to 256 Kbytes:
  - SRAM1 on AHB bus Matrix: 176 Kbytes
  - SRAM2 on AHB bus Matrix: 16 Kbytes
  - DTCM-RAM on TCM interface: 64 Kbytes for critical real-time data
- Instruction RAM (ITCM-RAM) 16 Kbytes:
  - It is mapped on TCM interface and reserved only for CPU execution/instruction useful for critical real-time routines.

The data TCM RAM is accessible by the GP-DMA's and peripheral DMA's through the specific AHB slave of the CPU. The instruction TCM RAM is reserved only for CPU. It is accessed at CPU clock speed with 0 wait states.

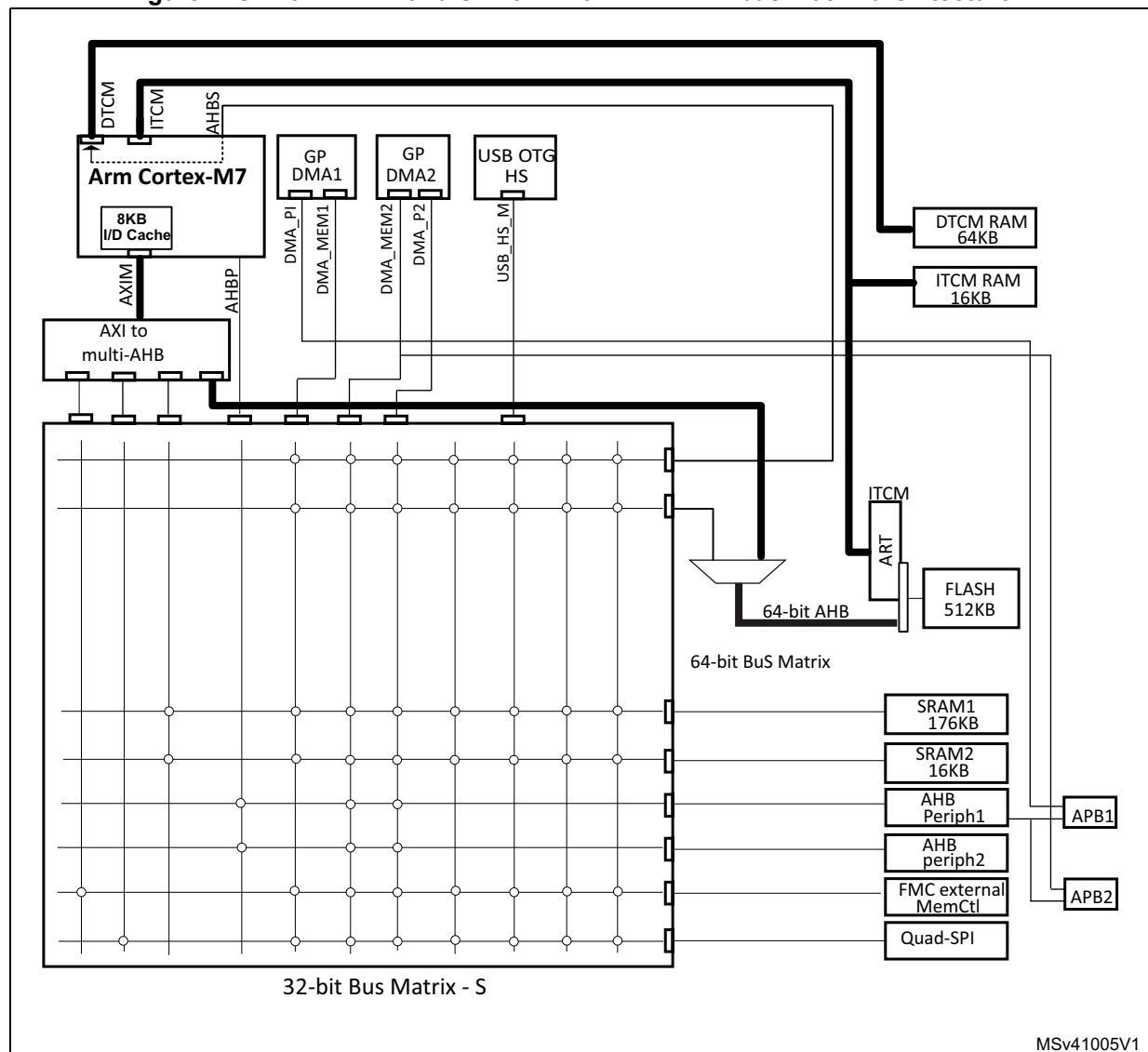
- 4 Kbytes of backup SRAM  
This area is accessible only from the CPU. Its content is protected against possible unwanted write accesses, and is retained in Standby or VBAT mode.

### 3.6 AXI-AHB bus matrix

The STM32F722xx and STM32F723xx system architecture is based on two subsystems:

- an AXI-to-multi-AHB bridge converting AXI4 protocol to AHB-Lite protocol:
  - 3x AXI-to-32-bit-AHB bridges connected to AHB bus matrix
  - 1x AXI-to-64-bit-AHB bridge connected to the embedded Flash memory
- a multi-AHB bus matrix
  - The 32-bit multi-AHB bus matrix interconnects all the masters (CPU, DMAs, USB HS) and the slaves (Flash memory, RAM, FMC, QUADSPI, AHB and APB peripherals), and ensures a seamless and efficient operation even when several high-speed peripherals work simultaneously.

Figure 7. STM32F722xx and STM32F723xx AXI-AHB bus matrix architecture<sup>(1)</sup>



1. The above figure has large wires for 64-bits bus and thin wires for 32-bits bus.



### 3.7 DMA controller (DMA)

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

The two DMA controllers support a 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. The 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
- General-purpose, basic and advanced-control timers TIMx
- DAC
- SDMMC
- ADC
- SAI
- QUADSPI

### 3.8 Flexible memory controller (FMC)

The flexible memory controller (FMC) includes three memory controllers:

- NOR/PSRAM memory controller
- NAND/memory controller
- synchronous DRAM (SDRAM/mobile LPDDR SDRAM) controller

The main features of the FMC controller are the following:

- Interface with static-memory mapped devices including:
  - Static random access memory (SRAM)
  - NOR Flash memory/oneNAND Flash memory
  - PSRAM (four memory banks)
  - NAND Flash memory with ECC hardware to check up to 8 Kbytes of data
- Interface with synchronous DRAM (SDRAM/Mobile LPDDR SDRAM) memories
- 8-, 16-, 32-bit data bus width
- Independent chip select control for each memory bank
- Independent configuration for each memory bank
- Write FIFO
- Read FIFO for SDRAM controller

- HCLK/2 maximum FMC\_CLK/FMC\_SDCLK frequency for synchronous accesses

### LCD parallel interface

The FMC can be configured to interface seamlessly with most graphic LCD controllers. It supports 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.

## 3.9 Quad-SPI memory interface (QUADSPI)

All the devices embed a Quad-SPI memory interface, which is a specialized communication interface targeting single, dual or quad-SPI Flash memories. It can work in:

- Direct mode through registers
- External Flash status register polling mode
- Memory-mapped mode

Up to 256 Mbytes of external Flash are memory mapped, supporting 8-, 16-, and 32-bit access. The code execution is supported.

The opcode and the frame format are fully programmable. The communication can be either in single-data rate or dual-data rate.

## 3.10 Nested vectored interrupt controller (NVIC)

The devices embed a nested vectored interrupt controller able to manage 16 priority levels, and handle up to 110 maskable interrupt channels, plus the 16 interrupt lines of the Cortex-M7 with FPU core.

- Closely coupled NVIC gives low-latency interrupt processing
- Interrupt entry vector table address passed directly to the core
- 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 a minimum interrupt latency.

## 3.11 External interrupt/event controller (EXTI)

The external interrupt/event controller consists of 24 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 in the STM32F722xx devices (138 GPIOs in the STM32F723xx devices) can be connected to the 16 external interrupt lines.

### 3.12 Clocks and startup

On reset the 16 MHz internal HSI 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 can be monitored for failure. If a failure is detected, the system automatically switches back to the internal RC oscillator and a software interrupt is generated (if enabled). This clock source is input to a PLL thus allowing to increase the frequency up to 216 MHz. Similarly, a full interrupt management of the PLL clock entry is available when necessary (for example if an indirectly used external oscillator fails).

Several prescalers allow the configuration of the two AHB buses, the high-speed APB (APB2), and the low-speed APB (APB1) domains. The maximum frequency of the two AHB buses is 216 MHz, while the maximum frequency of the high-speed APB domains is 108 MHz. The maximum allowed frequency of the low-speed APB domain is 54 MHz.

The devices embed two dedicated PLLs (PLLI2S and PLLSAI) which allow audio class performance to be achieved. In this case, the I<sup>2</sup>S and SAI master clock can generate all standard sampling frequencies from 8 kHz to 192 kHz.

The STM32F723xx devices embed two PLLs inside the PHY HS controller: PLL1 and PLL2. The PLL1 allows an output of 60 MHz used as an input for PLL2 which itself allows the generation of 480 Mbps in the USB OTG High Speed mode.

The PLL1 has as input HSE clock.

### 3.13 Boot modes

At startup, the boot memory space is selected by the BOOT pin and BOOT\_ADDx option bytes, allowing any boot memory address to be programmed from 0x0000 0000 to 0x3FFF FFFF, which includes:

- all Flash address space mapped on ITCM or AXIM interface
- all RAM address space: ITCM, DTCM RAMs, and SRAMs mapped on AXIM interface
- system memory bootloader

The bootloader is located in system memory. It is used to reprogram the Flash memory through a serial interface.

### 3.14 Power supply schemes

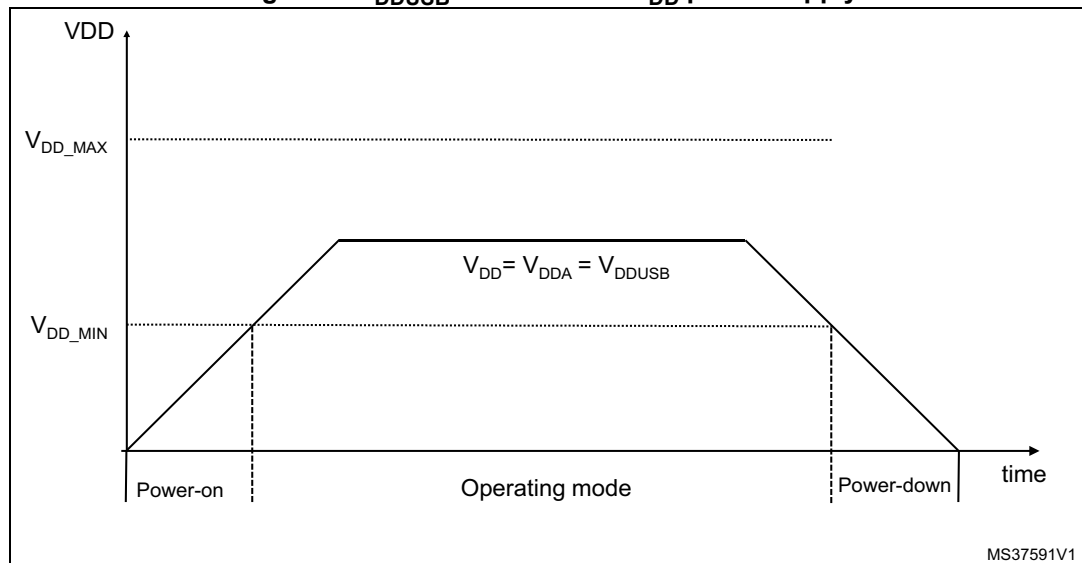
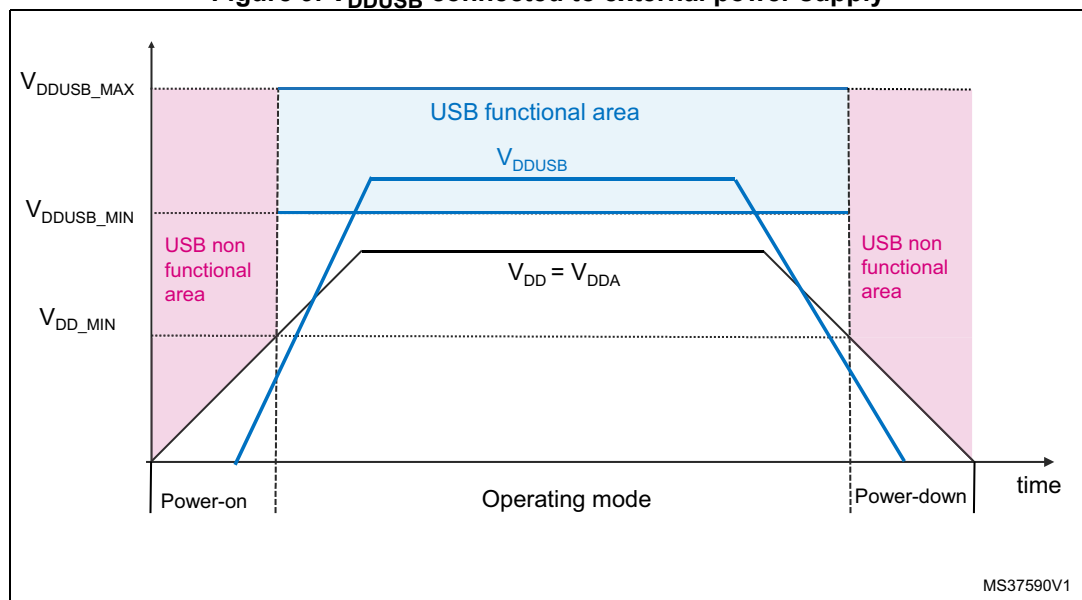
- $V_{DD} = 1.7$  to  $3.6$  V: external power supply for I/Os and the internal regulator (when enabled), provided externally through VDD pins.
- $V_{SSA}$ ,  $V_{DDA} = 1.7$  to  $3.6$  V: external analog power supplies for ADC, DAC, reset blocks, RCs and PLL.  $V_{DDA}$  and  $V_{SSA}$  must be connected 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.

**Note:** The  $V_{DD}/V_{DDA}$  minimum value of 1.7 V is obtained when the internal reset is OFF (refer to [Section 3.15.2: Internal reset OFF](#)). Refer to [Table 3: Voltage regulator configuration mode versus device operating mode](#) to identify the packages supporting this option.

- The  $V_{DDSDMMC}$  can be connected either to  $V_{DD}$  or to an external independent power supply (1.8 to 3.6 V) for the SDMMC2 pins (clock, command, and 4-bit data).

For example, when the device is powered at 1.8 V, an independent power supply 2.7 V can be connected to  $V_{DDSDMMC}$ . When the  $V_{DDSDMMC}$  is connected to a separated power supply, it is independent from  $V_{DD}$  or  $V_{DDA}$ , but it must be the last supply to be provided, and the first to disappear. The following conditions  $V_{DDSDMMC}$  must be respected:

- During the power-on phase ( $V_{DD} < V_{DD\_MIN}$ ),  $V_{DDSDMMC}$  must be always lower than  $V_{DD}$ .
- During the power-down phase ( $V_{DD} < V_{DD\_MIN}$ ),  $V_{DDSDMMC}$  must be always lower than  $V_{DD}$ .
- The  $V_{DDSDMMC}$  rising and falling time rate specifications must be respected.
- In the operating mode phase,  $V_{DDSDMMC}$  can be lower or higher than  $V_{DD}$ :  
All associated GPIOs powered by  $V_{DDSDMMC}$  are operating between  $V_{DDSDMMC\_MIN}$  and  $V_{DDSDMMC\_MAX}$ .
- The  $V_{DDUSB}$  can be connected either to  $V_{DD}$  or to an external independent power supply (3.0 to 3.6 V) for USB transceivers (refer to [Figure 8](#) and [Figure 9](#)).  
For example, when the device is powered at 1.8 V, an independent power supply 3.3 V can be connected to the  $V_{DDUSB}$ . When the  $V_{DDUSB}$  is connected to a separated power supply, it is independent from  $V_{DD}$  or  $V_{DDA}$ , but it must be the last supply to be provided, and the first to disappear. The following conditions  $V_{DDUSB}$  must be respected:
  - During the power-on phase ( $V_{DD} < V_{DD\_MIN}$ ),  $V_{DDUSB}$  must be always lower than  $V_{DD}$ .
  - During the power-down phase ( $V_{DD} < V_{DD\_MIN}$ ),  $V_{DDUSB}$  must be always lower than  $V_{DD}$ .
  - The  $V_{DDUSB}$  rising and falling time rate specifications must be respected.
  - In the operating mode phase,  $V_{DDUSB}$  can be lower or higher than  $V_{DD}$ :
    - If the USB (USB OTG\_HS/OTG\_FS) is used, the associated GPIOs powered by  $V_{DDUSB}$  are operating between  $V_{DDUSB\_MIN}$  and  $V_{DDUSB\_MAX}$ .
    - The  $V_{DDUSB}$  supplies both USB transceiver (USB OTG\_HS and USB OTG\_FS). If only one USB transceiver is used in the application, the GPIOs associated to the other USB transceiver are still supplied by  $V_{DDUSB}$ .
    - If the USB (USB OTG\_HS/OTG\_FS) is not used, the associated GPIOs powered by  $V_{DDUSB}$  are operating between  $V_{DD\_MIN}$  and  $V_{DD\_MAX}$ .

Figure 8.  $V_{DDUSB}$  connected to  $V_{DD}$  power supplyFigure 9.  $V_{DDUSB}$  connected to external power supply

On the STM32F7x3xx devices, the USB OTG HS subsystem uses one or two additional power supply pins depending on the package:

- The VDD12OTGHS pin is the output of PHY HS regulator (1.2 V). An external capacitor of 2.2  $\mu\text{F}$  must be connected on the VDD12OTGHS pin.
- On the LQFP100 only, a second power pin VDDPHYHS is used to supply the USB OTG PHY HS and associated GPIOs. The VDDPHYHS follows the same rules provided for the VDDUSB power pin.

## 3.15 Power supply supervisor

### 3.15.1 Internal reset ON

On packages embedding the PDR\_ON pin, the power supply supervisor is enabled by holding PDR\_ON high. On the other packages, the power supply supervisor is always enabled.

The device has 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 thresholds, 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.

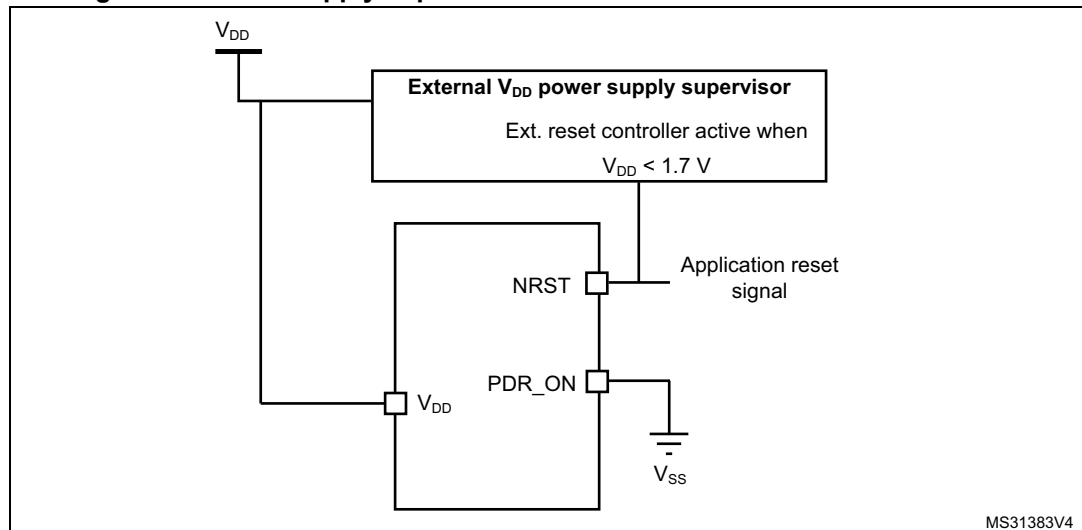
The device also features an embedded programmable voltage detector (PVD) that monitors the  $V_{DD}/V_{DDA}$  power supply, and compares it to the  $V_{PVD}$  threshold. An interrupt can be generated when  $V_{DD}/V_{DDA}$  drops below the  $V_{PVD}$  threshold, and/or when  $V_{DD}/V_{DDA}$  is higher 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.

### 3.15.2 Internal reset OFF

This feature is available only on packages featuring the PDR\_ON pin. The internal POR/PDR circuitry is disabled through the PDR\_ON pin.

An external power supply supervisor monitors  $V_{DD}$  and NRST, and maintains the device in reset mode as long as  $V_{DD}$  is below a specified threshold. PDR\_ON must be connected to  $V_{SS}$  (see the figure below).

**Figure 10. Power supply supervisor interconnection with internal reset OFF**



The  $V_{DD}$  specified threshold, below which the device must be maintained under reset, is 1.7 V (see [Figure 11](#)).

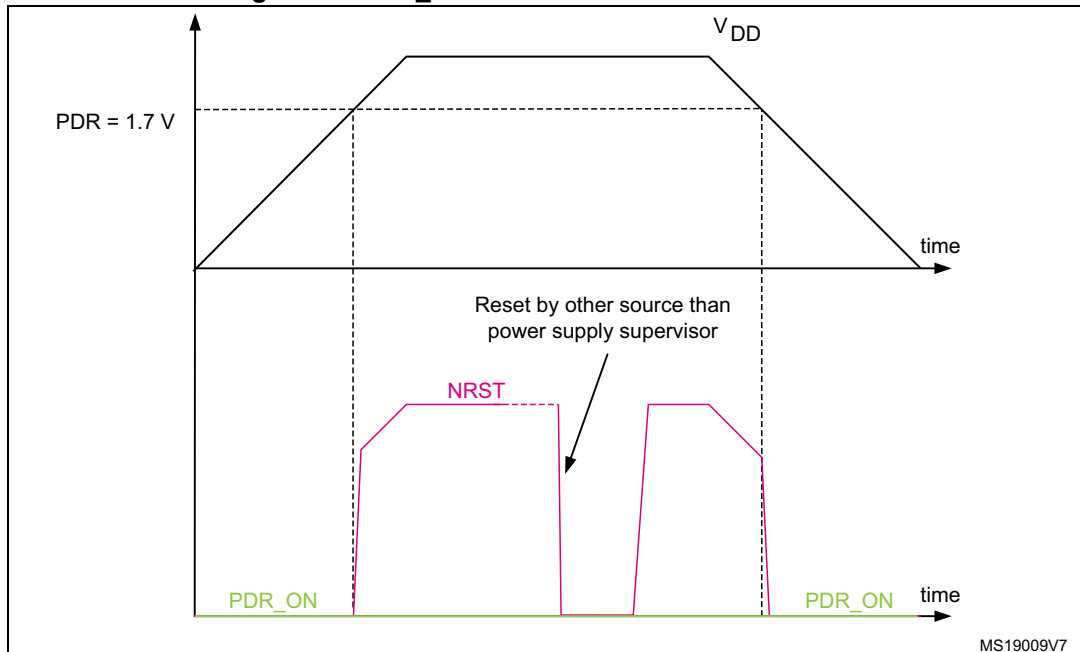
A comprehensive set of power-saving mode allows design low-power applications.

When the internal reset is OFF, the following integrated features are no more supported:

- The integrated POR/PDR circuitry is disabled.
- The BOR circuitry must be disabled.
- The embedded PVD is disabled.
- $V_{BAT}$  functionality is no more available, and  $V_{BAT}$  pin must be connected to  $V_{DD}$ .

All packages, except the LQFP100, disables the internal reset through the PDR\_ON signal when connected to  $V_{SS}$ .

**Figure 11. PDR\_ON control with internal reset OFF**



## 3.16 Voltage regulator

The regulator has four operating modes:

- Regulator ON
  - main regulator mode (MR)
  - low-power regulator (LPR)
  - power-down
- Regulator OFF

### 3.16.1 Regulator ON

On packages embedding the BYPASS\_REG pin, the regulator is enabled by holding BYPASS\_REG low. On all other packages, the regulator is always enabled.

There are three power modes configured by software when the regulator is ON:

- MR mode used in Run/Sleep modes, or in Stop modes:
  - In Run/Sleep modes
 

The MR mode is used either in the normal mode (default mode) or the over-drive mode (enabled by software). A different voltage scaling is provided to reach the best compromise between maximum frequency and dynamic power consumption. The over-drive mode allows operating at a higher frequency than the normal mode for a given voltage scaling.
  - In Stop modes
 

The MR can be configured in two ways during stop mode:

    - MR operates in normal mode (default mode of MR in Stop mode).
    - MR operates in under-drive mode (reduced leakage mode).
- LPR is used in Stop mode:
 

The LP regulator mode is configured by software when entering Stop mode. Like the MR mode, the LPR can be configured in two ways during stop mode:

  - LPR operates in normal mode (default mode when LPR is ON).
  - LPR operates in under-drive mode (reduced leakage mode).
- Power-down is used in Standby mode.
 

The power-down mode is activated only when entering in Standby mode. The regulator output is in high impedance, and the kernel circuitry is powered down, inducing zero consumption. The contents of the registers and SRAM are lost.

Refer to [Table 3](#) for a summary of voltage regulator modes versus device operating modes.

$V_{CAP\_1}$  and  $V_{CAP\_2}$  pins must be connected to  $2 \times 2.2 \mu\text{F}$ ,  $\text{ESR} < 2 \Omega$  (or  $1 \times 4.7 \mu\text{F}$ ,  $\text{ESR}$  between  $0.1 \Omega$  and  $0.2 \Omega$  if only the  $V_{CAP\_1}$  pin is provided (on LQFP64 package)).

All the packages have the regulator ON feature.

**Table 3. Voltage regulator configuration mode versus device operating mode<sup>(1)</sup>**

| Voltage regulator configuration | Run mode | Sleep mode | Stop mode | Standby mode |
|---------------------------------|----------|------------|-----------|--------------|
| Normal mode                     | MR       | MR         | MR or LPR | -            |
| Over-drive mode <sup>(2)</sup>  | MR       | MR         | -         | -            |
| Under-drive mode                | -        | -          | MR or LPR | -            |
| Power-down mode                 | -        | -          | -         | Yes          |

1. '-' means that the corresponding configuration is not available.

2. The over-drive mode is not available when  $V_{DD} = 1.7$  to  $2.1 \text{ V}$ .

### 3.16.2 Regulator OFF

This feature is available only on packages featuring the BYPASS\_REG pin. The regulator is disabled by holding BYPASS\_REG high. The regulator OFF mode supplies externally a  $V_{12}$  voltage source through  $V_{CAP\_1}$  and  $V_{CAP\_2}$  pins.

Since the internal voltage scaling is not managed internally, the external voltage value must be aligned with the targeted maximum frequency. The two  $2.2 \mu\text{F}$  ceramic capacitors must be replaced by two  $100 \text{ nF}$  decoupling capacitors.

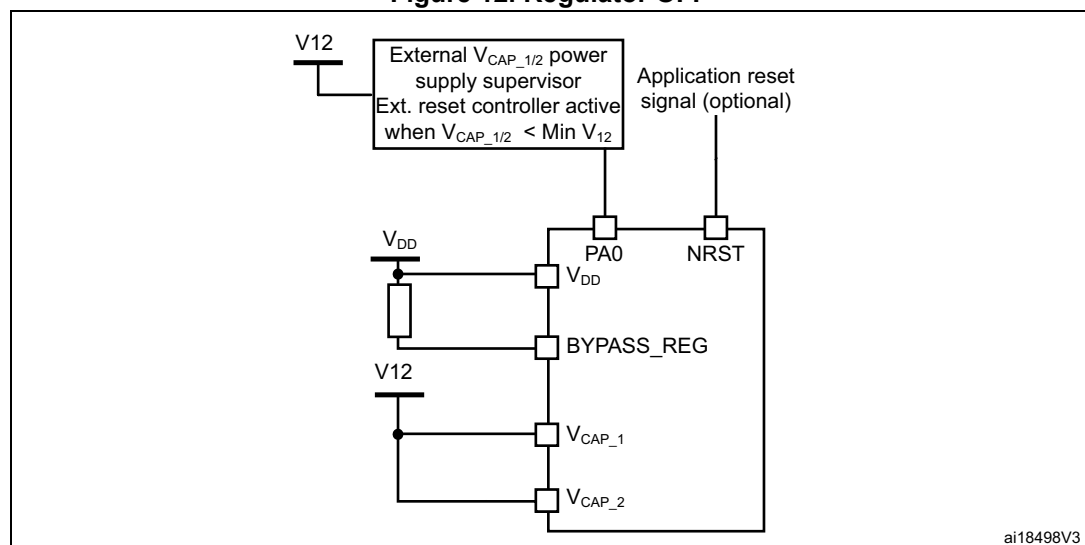


When the regulator is OFF, there is no more internal monitoring on  $V_{12}$ . An external power supply supervisor can be used to monitor the  $V_{12}$  of the logic power domain. The PA0 pin can be used for this purpose, and act as power-on reset on  $V_{12}$  power domain.

In regulator OFF mode, the following features are no more supported:

- PA0 cannot be used as a GPIO pin since it is used to reset a part of the  $V_{12}$  logic power domain which is not reset by the NRST pin.
- As long as PA0 is kept low, the debug mode cannot be used under power-on reset. As a consequence, PA0 and NRST pins must be managed separately if the debug connection under reset or pre-reset is required.
- The over-drive and under-drive modes are not available.
- The Standby mode is not available.

**Figure 12. Regulator OFF**

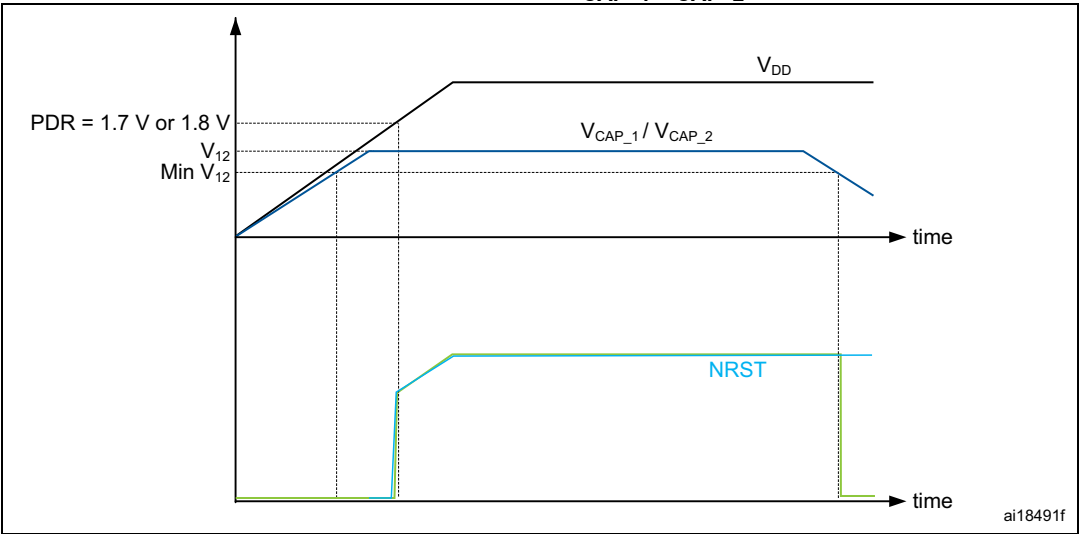


The following conditions must be respected:

- $V_{DD}$  must always be higher than  $V_{CAP\_1}$  and  $V_{CAP\_2}$  to avoid current injection between power domains.
- If the time for  $V_{CAP\_1}$  and  $V_{CAP\_2}$  to reach  $V_{12}$  minimum value is faster than the time for  $V_{DD}$  to reach 1.7 V, then PA0 must be kept low to cover both conditions: until  $V_{CAP\_1}$  and  $V_{CAP\_2}$  reach  $V_{12}$  minimum value and until  $V_{DD}$  reaches 1.7 V (see [Figure 13](#)).
- Otherwise, if the time for  $V_{CAP\_1}$  and  $V_{CAP\_2}$  to reach  $V_{12}$  minimum value is slower than the time for  $V_{DD}$  to reach 1.7 V, then PA0 can be asserted low externally (see [Figure 14](#)).
- If  $V_{CAP\_1}$  and  $V_{CAP\_2}$  go below  $V_{12}$  minimum value, and  $V_{DD}$  is higher than 1.7 V, then a reset must be asserted on PA0 pin.

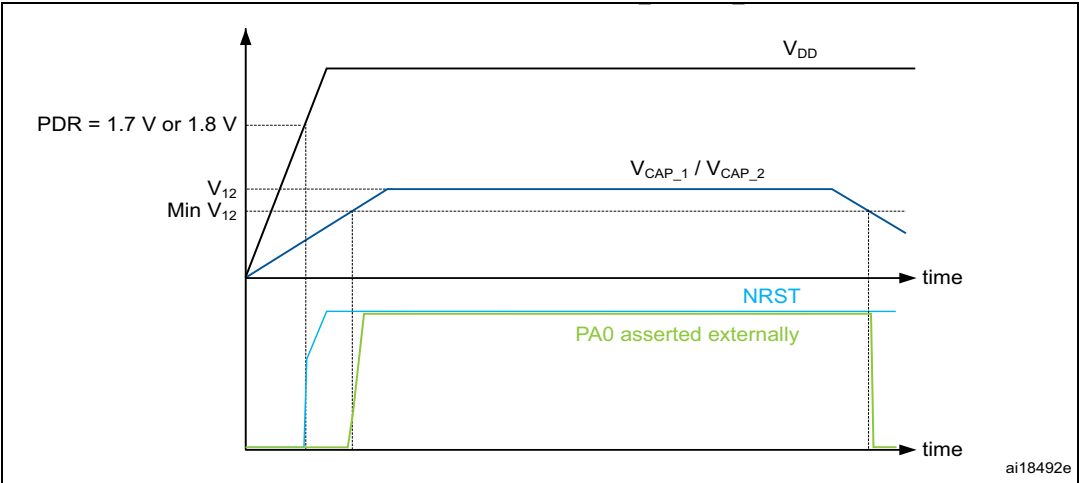
**Note:** The minimum value of  $V_{12}$  depends on the maximum frequency targeted in the application. On the LQFP64 pin package, the  $V_{CAP\_2}$  is not available.

**Figure 13. Startup in regulator OFF: slow  $V_{DD}$  slope  
- power-down reset risen after  $V_{CAP\_1}/V_{CAP\_2}$  stabilization**



1. This figure is valid whatever the internal reset mode (ON or OFF).

**Figure 14. Startup in regulator OFF mode: fast  $V_{DD}$  slope  
- power-down reset risen before  $V_{CAP\_1}/V_{CAP\_2}$  stabilization**



1. This figure is valid whatever the internal reset mode (ON or OFF).

### 3.16.3 Regulator ON/OFF and internal reset ON/OFF availability

Table 4. Regulator ON/OFF and internal reset ON/OFF availability

| Package                           | Regulator ON                                | Regulator OFF                               | Internal reset ON                    | Internal reset OFF                   |
|-----------------------------------|---------------------------------------------|---------------------------------------------|--------------------------------------|--------------------------------------|
| LQFP64,<br>LQFP100                | Yes                                         | No                                          | Yes                                  | No                                   |
| LQFP144                           |                                             |                                             | Yes<br>PDR_ON set to V <sub>DD</sub> | Yes<br>PDR_ON set to V <sub>SS</sub> |
| LQFP176,<br>UFBGA144,<br>UFBGA176 | Yes<br>BYPASS_REG set<br>to V <sub>SS</sub> | Yes<br>BYPASS_REG set<br>to V <sub>DD</sub> |                                      |                                      |

## 3.17 Real-time clock (RTC), backup SRAM and backup registers

The RTC is an independent BCD timer/counter. It supports the following features:

- Calendar with subsecond, seconds, minutes, hours (12 or 24 format), week day, date, month, year, in BCD (binary-coded decimal) format
- Automatic correction for 28, 29 (leap year), 30, and 31 days of the month
- Two programmable alarms
- On-the-fly correction from 1 to 32767 RTC clock pulses. This can be used to synchronize it with a master clock.
- Reference clock detection: a more precise second source clock (50 or 60 Hz) can be used to enhance the calendar precision.
- Digital calibration circuit with 0.95 ppm resolution, to compensate for quartz crystal inaccuracy.
- Three anti-tamper detection pins with programmable filter
- Timestamp feature which can be used to save the calendar content. This function can be triggered by an event on the timestamp pin, or by a tamper event, or by a switch to V<sub>BAT</sub> mode.
- 17-bit auto-reload wakeup timer (WUT) for periodic events with programmable resolution and period

The RTC and the 32 backup registers are supplied through a switch that takes power either from the V<sub>DD</sub> supply when present or from the VBAT pin.

The backup registers are 32-bit registers used to store 128 bytes of user application data when V<sub>DD</sub> power is not present. They are not reset by a system or power reset, or when the device wakes up from Standby mode.

The RTC clock sources can be:

- a 32.768 kHz external crystal (LSE)
- an external resonator or oscillator (LSE)
- the internal low-power RC oscillator (LSI, with typical frequency of 32 kHz)
- the high-speed external clock (HSE) divided by 32

The RTC is functional in V<sub>BAT</sub> mode and in all low-power modes when it is clocked by the LSE. When clocked by the LSI, the RTC is not functional in V<sub>BAT</sub> mode, but is functional in all low-power modes.

All the RTC events (alarm, wakeup timer, timestamp, or tamper) can generate an interrupt, and wake up the device from the low-power modes.

### 3.18 Low-power modes

The devices support three low-power modes to achieve the best compromise between low-power consumption, short startup time, and available wakeup sources:

- **Sleep mode**

In Sleep mode, only the CPU is stopped. All peripherals continue to operate, and can wake up the CPU when an interrupt/event occurs.

- **Stop mode**

The Stop mode achieves the lowest power consumption while retaining the contents of SRAM and registers. All clocks in the 1.2 V domain are stopped, the PLL, the HSI RC and the HSE crystal oscillators are disabled.

The voltage regulator can be put either in main regulator mode (MR) or in low-power mode (LPR). Both modes can be configured as follows (see [Table 5: Voltage regulator modes in Stop mode](#)):

- normal mode (default mode when MR or LPR is enabled)
- under-drive mode

The device can be woken up from the Stop mode by any of the EXTI lines (the EXTI line source can be one of the 16 external lines, the PVD output, the RTC alarm, wakeup, tamper, time stamp events, the USB OTG FS/HS wake up, and the LPTIM1 asynchronous interrupt).

**Table 5. Voltage regulator modes in Stop mode**

| Voltage regulator configuration | Main regulator (MR)    | Low-power regulator (LPR) |
|---------------------------------|------------------------|---------------------------|
| Normal mode                     | MR ON                  | LPR ON                    |
| Under-drive mode                | MR in under-drive mode | LPR in under-drive mode   |

- **Standby mode**

The Standby mode is used to achieve the lowest power consumption. The internal voltage regulator is switched off, so that the entire 1.2 V domain is powered off. The PLL, the HSI RC, and the HSE crystal oscillators are also switched off.

After entering Standby mode, the SRAM and register contents are lost except for registers in the backup domain, and the backup SRAM when selected.

The device exits Standby mode when an external reset (NRST pin), an IWDG reset, a rising or falling edge on one of the six WKUP pins (PA0, PA2, PC1, PC13, PI8, PI11), or an RTC alarm, wakeup, tamper, time stamp event occurs.

The Standby mode is not supported when the embedded voltage regulator is bypassed, and the 1.2 V domain is controlled by an external power.

### 3.19 V<sub>BAT</sub> operation

The VBAT pin is used to power the device V<sub>BAT</sub> domain from an external battery, an external super-capacitor, or from V<sub>DD</sub> when no external battery and an external super-capacitor are present.

The V<sub>BAT</sub> operation is activated when V<sub>DD</sub> is not present.

The VBAT pin supplies the RTC, the backup registers, and the backup SRAM.

*Note:* When the microcontroller is supplied from V<sub>BAT</sub>, external interrupts and RTC alarm/events do not exit it from V<sub>BAT</sub> operation.

When the PDR\_ON pin is connected to V<sub>SS</sub> (internal reset OFF), the V<sub>BAT</sub> functionality is no more available, and the VBAT pin must be connected to V<sub>DD</sub>.

### 3.20 Timers and watchdogs

The devices include two advanced-control timers, eight general-purpose timers, two basic timers, and two watchdog timers.

All timer counters can be frozen in debug mode.

Table 6 compares the features of the advanced-control, general-purpose and basic timers.

**Table 6. Timer feature comparison**

| Timer type       | Timer      | Counter resolution | Counter type      | Prescaler factor                | DMA request generation | Capture/compare channels | Complementary output | Max interface clock (MHz) | Max timer clock (MHz) <sup>(1)</sup> |
|------------------|------------|--------------------|-------------------|---------------------------------|------------------------|--------------------------|----------------------|---------------------------|--------------------------------------|
| Advanced-control | TIM1, TIM8 | 16-bit             | Up, Down, Up/down | Any integer between 1 and 65536 | Yes                    | 4                        | Yes                  | 108                       | 216                                  |

Table 6. Timer feature comparison (continued)

| Timer type      | Timer        | Counter resolution | Counter type      | Prescaler factor                | DMA request generation | Capture/compare channels | Complementary output | Max interface clock (MHz) | Max timer clock (MHz) <sup>(1)</sup> |
|-----------------|--------------|--------------------|-------------------|---------------------------------|------------------------|--------------------------|----------------------|---------------------------|--------------------------------------|
| General purpose | TIM2, TIM5   | 32-bit             | Up, Down, Up/down | Any integer between 1 and 65536 | Yes                    | 4                        | No                   | 54                        | 108/216                              |
|                 | TIM3, TIM4   | 16-bit             | Up, Down, Up/down | Any integer between 1 and 65536 | Yes                    | 4                        | No                   | 54                        | 108/216                              |
|                 | TIM9         | 16-bit             | Up                | Any integer between 1 and 65536 | No                     | 2                        | No                   | 108                       | 216                                  |
|                 | TIM10, TIM11 | 16-bit             | Up                | Any integer between 1 and 65536 | No                     | 1                        | No                   | 108                       | 216                                  |
|                 | TIM12        | 16-bit             | Up                | Any integer between 1 and 65536 | No                     | 2                        | No                   | 54                        | 108/216                              |
|                 | TIM13, TIM14 | 16-bit             | Up                | Any integer between 1 and 65536 | No                     | 1                        | No                   | 54                        | 108/216                              |
| Basic           | TIM6, TIM7   | 16-bit             | Up                | Any integer between 1 and 65536 | Yes                    | 0                        | No                   | 54                        | 108/216                              |

1. The maximum timer clock is either 108 or 216 MHz, depending on TIMPRE bit configuration in the RCC\_DCKCFGR register.

### 3.20.1 Advanced-control timers (TIM1, TIM8)

The advanced-control timers (TIM1, TIM8) can be seen as three-phase PWM generators multiplexed on six channels. They have complementary PWM outputs with programmable inserted dead times. They can also be considered as complete general-purpose timers. Their four independent channels can be used for:

- input capture
- output compare
- PWM generation (edge- or center-aligned modes)
- one-pulse mode output

If configured as standard 16-bit timers, they have the same features as the general-purpose TIMx timers. If configured as 16-bit PWM generators, they have full modulation capability (0-100%).

The advanced-control timer can work together with the TIMx timers via the timer Link feature for synchronization or event chaining.

The TIM1 and TIM8 support independent DMA request generation.

### 3.20.2 General-purpose timers (TIMx)

There are ten synchronizable general-purpose timers embedded in the STM32F722xx and STM32F723xx devices (see [Table 6](#) for differences).

- TIM2, TIM3, TIM4, TIM5

The STM32F722xx and STM32F723xx include four full-featured general-purpose timers: TIM2, TIM5, TIM3, and TIM4. The TIM2 and TIM5 timers are based on a 32-bit auto-reload up/downcounter and a 16-bit prescaler. The TIM3 and TIM4 timers are based on a 16-bit auto-reload up/downcounter and a 16-bit prescaler. They all feature 4 independent channels for input capture/output compare, PWM or one-pulse mode output. This gives up to 16 input capture/output compare/PWM on the largest packages.

The TIM2, TIM3, TIM4, TIM5 general-purpose timers can work together, or with the other general-purpose timers and the advanced-control timers TIM1 and TIM8 via the timer link feature for synchronization or event chaining.

Any of these general-purpose timers can be used to generate PWM outputs.

TIM2, TIM3, TIM4, TIM5 all have independent DMA request generation. They are capable of handling quadrature (incremental) encoder signals and the digital outputs from 1 to 4 hall-effect sensors.

- TIM9, TIM10, TIM11, TIM12, TIM13, and TIM14

These timers are based on a 16-bit auto-reload upcounter and a 16-bit prescaler. TIM10, TIM11, TIM13, and TIM14 feature one independent channel, whereas TIM9 and TIM12 have two independent channels for input capture/output compare, PWM or one-pulse mode output. They can be synchronized with the TIM2, TIM3, TIM4, TIM5 full-featured general-purpose timers. They can also be used as simple time bases.

### 3.20.3 Basic timers TIM6 and TIM7

These timers are mainly used for the DAC trigger and waveform generation. They can also be used as a generic 16-bit time base.

The TIM6 and TIM7 support independent DMA request generation.

### 3.20.4 Low-power timer (LPTIM1)

The low-power timer has an independent clock and is running also in Stop mode if it is clocked by LSE, LSI or an external clock. It is able to wakeup the devices from Stop mode.

This low-power timer supports the following features:

- 16-bit up counter with 16-bit autoreload register
- 16-bit compare register
- configurable output: pulse, PWM
- continuous/one-shot mode
- selectable software/hardware input trigger
- selectable clock source:

- internal clock source: LSE, LSI, HSI, or APB clock
- external clock source over LPTIM input (working even with no internal clock source running, used by the pulse-counter application)
- programmable digital glitch filter
- encoder mode

### 3.20.5 Independent watchdog

The independent watchdog is based on a 12-bit downcounter and 8-bit prescaler. It is clocked from an independent 32 kHz internal RC and as it operates independently from the main clock, it can operate in Stop and Standby modes. It can be used either as a watchdog to reset the device when a problem occurs, or as a free-running timer for application timeout management. It is hardware- or software-configurable through the option bytes.

### 3.20.6 Window watchdog

The window watchdog is based on a 7-bit downcounter that can be set as free-running. It can be used as a watchdog to reset the device when a problem occurs. It is clocked from the main clock. It has an early warning interrupt capability and the counter can be frozen in debug mode.

### 3.20.7 SysTick timer

This timer is dedicated to real-time operating systems, but could also be used as a standard downcounter. It features:

- a 24-bit downcounter
- auto-reload capability
- maskable system interrupt generation when the counter reaches 0
- programmable clock source

## 3.21 Inter-integrated circuit interface (I2C)

The devices embed three I2Cs. Refer to [Table 7: I2C implementation](#) for the features implementation.

The I<sup>2</sup>C bus interface handles communications between the microcontroller and the serial I<sup>2</sup>C bus. It controls all I<sup>2</sup>C bus-specific sequencing, protocol, arbitration and timing.

The I2C peripheral supports:

- I<sup>2</sup>C-bus specification and user manual rev. 5 compatibility:
  - Slave and master modes, multimaster capability
  - Standard-mode (Sm), with a bitrate up to 100 kbit/s
  - Fast-mode (Fm), with a bitrate up to 400 kbit/s
  - Fast-mode Plus (Fm+), with a bitrate up to 1 Mbit/s and 20 mA output drive I/Os
  - 7-bit and 10-bit addressing mode, multiple 7-bit slave addresses
  - Programmable setup and hold times
  - Optional clock stretching



- System management bus (SMBus) specification rev 2.0 compatibility:
  - Hardware PEC (packet error checking) generation and verification with ACK control
  - Address resolution protocol (ARP) support
  - SMBus alert
- Power system management protocol (PMBus™) specification rev 1.1 compatibility
- Independent clock: a choice of independent clock sources allowing the I<sup>2</sup>C communication speed to be independent from the PCLK reprogramming.
- Programmable analog and digital noise filters
- 1-byte buffer with DMA capability

Table 7. I2C implementation

| I2C features <sup>(1)</sup>                                  | I2C1 | I2C2 | I2C3 |
|--------------------------------------------------------------|------|------|------|
| Standard-mode (up to 100 kbit/s)                             | X    | X    | X    |
| Fast-mode (up to 400 kbit/s)                                 | X    | X    | X    |
| Fast-mode Plus with 20 mA output drive I/Os (up to 1 Mbit/s) | X    | X    | X    |
| Programmable analog and digital noise filters                | X    | X    | X    |
| SMBus/PMBus hardware support                                 | X    | X    | X    |
| Independent clock                                            | X    | X    | X    |

1. X: supported.

## 3.22 Universal synchronous/asynchronous receiver transmitters (USART)

The devices embed USARTs. Refer to [Table 8: USART implementation](#) for the features implementation.

The universal synchronous asynchronous receiver transmitter (USART) offers a flexible means of full-duplex data exchange with external equipment requiring an industry standard NRZ asynchronous serial data format.

The USART peripheral supports:

- Full-duplex asynchronous communications
- Configurable oversampling method by 16 or 8 to give flexibility between speed and clock tolerance
- Dual clock domain allowing convenient baud rate programming independent from the PCLK reprogramming
- A common programmable transmit and receive baud rate of up to 27 Mbit/s when USART clock source is system clock frequency (max is 216 MHz) and oversampling by eight is used.
- Auto baud rate detection
- Programmable data word length (7 or 8 or 9 bits) word length
- Programmable data order with MSB-first or LSB-first shifting
- Programmable parity (odd, even, no parity)

- Configurable stop bits (1, 1.5, or 2 stop bits)
- Synchronous mode and clock output for synchronous communications
- Single-wire half-duplex communications
- Separate signal polarity control for transmission and reception
- Swappable Tx/Rx pin configuration
- Hardware flow control for modem and RS-485 transceiver
- Multiprocessor communications
- LIN master synchronous break send capability and LIN slave break detection capability
- IrDA SIR encoder decoder supporting 3/16 bit duration for normal mode
- Smartcard mode (T = 0 and T = 1 asynchronous protocols for Smartcards as defined in the ISO/IEC 7816-3 standard)
- Support for Modbus communication

**Table 8** summarizes the implementation of all U(S)ARTs instances

**Table 8. USART implementation**

| Features <sup>(1)</sup>               | USART1/2/3/6    | UART4/5/7/8 |
|---------------------------------------|-----------------|-------------|
| Data length                           | 7, 8 and 9 bits |             |
| Hardware flow control for modem       | X               | X           |
| Continuous communication using DMA    | X               | X           |
| Multiprocessor communication          | X               | X           |
| Synchronous mode                      | X               | -           |
| Smartcard mode                        | X               | -           |
| Single-wire half-duplex communication | X               | X           |
| IrDA SIR ENDEC block                  | X               | X           |
| LIN mode                              | X               | X           |
| Dual clock domain                     | X               | X           |
| Receiver timeout interrupt            | X               | X           |
| Modbus communication                  | X               | X           |
| Auto baud rate detection              | X               | X           |
| Driver enable                         | X               | X           |

1. X: supported.

### 3.23 Serial peripheral interface (SPI)/inter- integrated sound interfaces (I<sup>2</sup>S)

The devices feature up to five SPIs in slave and master modes in full-duplex and simplex communication modes. SPI1, SPI4, and SPI5 can communicate at up to 50 Mbit/s, SPI2 and SPI3 can communicate at up to 25 Mbit/s. The 3-bit prescaler gives 8 master mode frequencies and the frame is configurable from 4 to 16 bits. The SPI interfaces support the NSS pulse mode, TI mode and Hardware CRC calculation. All the SPIs can be served by the DMA controller.

Three standard I<sup>2</sup>S interfaces (multiplexed with SPI1, SPI2 and SPI3) are available. They can be operated in master or slave mode, in simplex communication modes, and can be configured to operate with a 16-/32-bit resolution as an input or output channel. Audio sampling frequencies from 8 kHz up to 192 kHz are supported. When either or both of the I<sup>2</sup>S interfaces is/are configured in master mode, the master clock can be output to the external DAC/CODEC at 256 times the sampling frequency.

All I2Sx can be served by the DMA controller.

### 3.24 Serial audio interface (SAI)

The devices embed two serial audio interfaces.

The serial audio interface is based on two independent audio subblocks which can operate as transmitter or receiver with their FIFO. Many audio protocols are supported by each block: I<sup>2</sup>S standards, LSB or MSB-justified, PCM/DSP, TDM, AC'97 and SPDIF output, supporting audio sampling frequencies from 8 kHz up to 192 kHz. Both subblocks can be configured in master or in slave mode.

In master mode, the master clock can be output to the external DAC/CODEC at 256 times of the sampling frequency.

The two subblocks can be configured in synchronous mode when full-duplex mode is required.

SAI1 and SAI2 can be served by the DMA controller.

### 3.25 Audio PLL (PLLI2S)

The devices feature an additional dedicated PLL for audio I<sup>2</sup>S and SAI applications. It allows the achievement of an error-free I<sup>2</sup>S sampling clock accuracy without compromising on the CPU performance, while using USB peripherals.

The PLLI2S configuration can be modified to manage an I<sup>2</sup>S/SAI sample rate change without disabling the main PLL (PLL) used for CPU and USB interfaces.

The audio PLL can be programmed with very low error to obtain sampling rates ranging from 8 kHz to 192 kHz.

In addition to the audio PLL, a master clock input pin can be used to synchronize the I<sup>2</sup>S/SAI flow with an external PLL (or codec output).

### 3.26 Audio PLL (PLLSAI)

An additional PLL dedicated to audio is used for the SAI1 peripheral in case the PLLI2S is programmed to achieve another audio sampling frequency (49.152 MHz or 11.2896 MHz) and the audio application requires both sampling frequencies simultaneously.

### 3.27 SD/SDIO/MMC card host interface (SDMMC)

SDMMC host interfaces are available, that support MultiMediaCard System Specification Version 4.2 in three different databus modes: 1-bit (default), 4-bit and 8-bit.

The interface allows data transfer at up to 50 MHz, and is compliant with the SD Memory Card Specification Version 2.0.

The SDMMC Card Specification Version 2.0 is also supported with two different databus modes: 1-bit (default) and 4-bit.

The current version supports only one SD/SDMMC/MMC4.2 card at any one time and a stack of MMC4.1 or previous.

The SDMMC can be served by the DMA controller

### 3.28 Controller area network (bxCAN)

The CAN is compliant with the 2.0A and B (active) specifications with a bit rate up to 1 Mbit/s. It can receive and transmit standard frames with 11-bit identifiers as well as extended frames with 29-bit identifiers. The CAN has three transmit mailboxes, two receive FIFOs with three stages and 28 shared scalable filter banks (all of them can be used even if one CAN is used). 256 bytes of SRAM are allocated to the CAN.

### 3.29 Universal serial bus on-the-go full-speed (OTG\_FS)

The devices embed an USB OTG full-speed device/host/OTG peripheral with integrated transceivers. The USB OTG FS peripheral is compliant with the USB 2.0 specification and with the OTG 2.0 specification. It has software-configurable endpoint setting and supports suspend/resume. The USB OTG controller requires a dedicated 48 MHz clock that is generated by a PLL connected to the HSE oscillator.

The major features are:

- Combined Rx and Tx FIFO size of 1.28 Kbytes with dynamic FIFO sizing
- Supports the session request protocol (SRP) and host negotiation protocol (HNP)
- 1 bidirectional control endpoint + 5 IN endpoints + 5 OUT endpoints
- 12 host channels with periodic OUT support
- Software configurable to OTG1.3 and OTG2.0 modes of operation
- USB 2.0 LPM (Link Power Management) support
- Internal FS OTG PHY support
- HNP/SNP/IP inside (no need for any external resistor)
- BCD support

For the OTG/Host modes, a power switch is needed in case bus-powered devices are connected

### 3.30 Universal serial bus on-the-go high-speed (OTG\_HS)

The devices embed an USB OTG high-speed (up to 480 Mbit/s) device/host/OTG peripheral. The USB OTG HS supports both full-speed and high-speed operations. It integrates the transceivers for full-speed operation (12 Mbit/s).

The STM32F722xx devices feature a UTMI low-pin interface (ULPI) for high-speed operation (480 Mbit/s). When using the USB OTG HS in HS mode, an external PHY device connected to the ULPI is required.

The STM32F723xx devices feature an integrated PHY HS.

The USB OTG HS peripheral is compliant with the USB 2.0 specification and with the OTG 2.0 specification. It has a software-configurable endpoint setting and supports suspend/resume. The USB OTG controller requires a dedicated 48 MHz clock that is generated by a PLL connected to the HSE oscillator.

The major features are:

- Combined Rx and Tx FIFO size of 4 Kbytes with dynamic FIFO sizing
- Supports the session request protocol (SRP) and host negotiation protocol (HNP)
- 8 bidirectional endpoints
- 16 host channels with periodic OUT support
- Software configurable to OTG1.3 and OTG2.0 modes of operation
- USB 2.0 LPM (Link Power Management) support
- **For STM32F722xx devices:** External HS or HS OTG operation supporting ULPI in SDR mode. The OTG PHY is connected to the microcontroller ULPI port through 12 signals. It can be clocked using the 60 MHz output.
- **For STM32F723xx devices:** Internal HS OTG PHY support
- Internal USB DMA
- HNP/SNP/IP inside (no need for any external resistor)
- For OTG/Host modes, a power switch is needed in case bus-powered devices are connected

#### **Universal serial-bus controller on-the-go high-speed PHY controller (USBPHYC) only on STM32F723xx devices.**

The USB HS PHY controller:

- Sets the PHYPLL1/2 values for the PHY HS.
- Sets the other controls on the PHY HS.
- Controls and monitors the USB PHY LDO.

### **3.31 Random number generator (RNG)**

All the devices embed an RNG that delivers 32-bit random numbers generated by an integrated analog circuit.

### **3.32 General-purpose input/outputs (GPIOs)**

Each of the GPIO pins can be configured by software as output (push-pull or open-drain, with or without pull-up or pull-down), as input (floating, with or without pull-up or pull-down) or as peripheral alternate function. Most of the GPIO pins are shared with digital or analog alternate functions. All GPIOs are high-current-capable and have speed selection to better manage internal noise, power consumption and electromagnetic emission.

The I/O configuration can be locked if needed by following a specific sequence in order to avoid spurious writing to the I/Os registers.

A fast I/O handling allows a maximum I/O toggling up to 108 MHz.

### 3.33 Analog-to-digital converters (ADCs)

Three 12-bit analog-to-digital converters are embedded and each ADC shares up to 16 external channels, performing conversions in the single-shot or scan mode. In the scan mode, an automatic conversion is performed on a selected group of analog inputs.

Additional logic functions embedded in the ADC interface allow:

- Simultaneous sample and hold
- Interleaved sample and hold

The ADC can be served by the DMA controller. An analog watchdog feature allows very precise monitoring of the converted voltage of one, some or all selected channels. An interrupt is generated when the converted voltage is outside the programmed thresholds.

To synchronize A/D conversion and timers, the ADCs can be triggered by any of TIM1, TIM2, TIM3, TIM4, TIM5, or TIM8 timer.

### 3.34 Temperature sensor

The temperature sensor has to generate a voltage that varies linearly with the temperature. The conversion range is between 1.7 V and 3.6 V. The temperature sensor is internally connected to the same input channel as  $V_{BAT}$ , ADC1\_IN18, which is used to convert the sensor output voltage into a digital value. When the temperature sensor and  $V_{BAT}$  conversion are enabled at the same time, only  $V_{BAT}$  conversion is performed.

As the offset of the temperature sensor varies from chip to chip due to process variation, the internal temperature sensor is mainly suitable for applications that detect temperature changes instead of absolute temperatures. If an accurate temperature reading is needed, then an external temperature sensor part must be used.

### 3.35 Digital-to-analog converter (DAC)

The two 12-bit buffered DAC channels can be used to convert two digital signals into two analog voltage signal outputs.

This dual digital Interface supports the following features:

- Two DAC converters: one for each output channel
- 8-bit or 12-bit monotonic output
- Left or right data alignment in 12-bit mode
- Synchronized update capability
- Noise-wave generation
- Triangular-wave generation
- Dual DAC channel independent or simultaneous conversions
- DMA capability for each channel
- External triggers for conversion
- Input voltage reference  $V_{REF+}$

Eight DAC trigger inputs are used in the device. The DAC channels are triggered through the timer update outputs that are also connected to different DMA streams.

### 3.36 Serial-wire JTAG debug port (SWJ-DP)

The Arm SWJ-DP interface is embedded, and is a combined JTAG and serial-wire debug port that enables either a serial-wire debug, or a JTAG probe to be connected to the target.

The debug is performed using two pins only instead of five required by the JTAG (JTAG pins can be reused as GPIO with alternate function): JTAG TMS and TCK pins are shared with SWDIO and SWCLK, respectively, and a specific sequence on the TMS pin is used to switch between JTAG-DP and SW-DP.

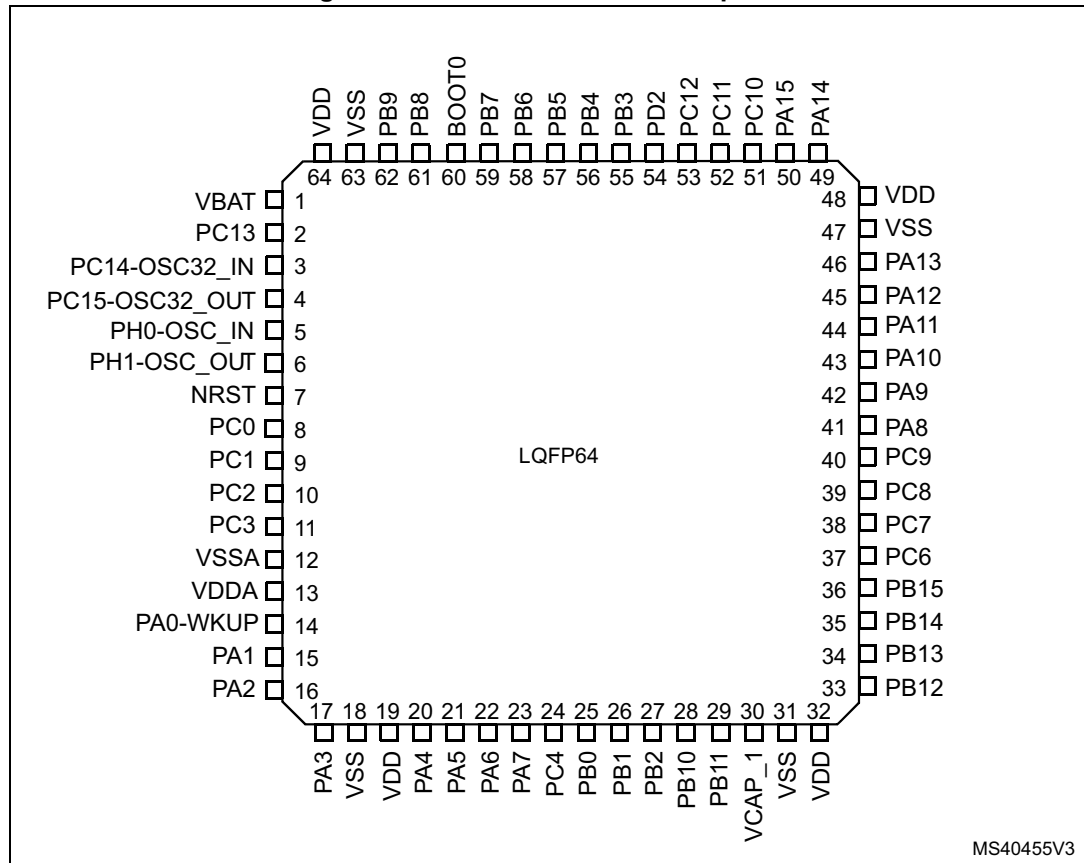
### 3.37 Embedded Trace Macrocell™

The Arm Embedded Trace Macrocell provides a greater visibility of the instruction and data flow inside the CPU core by streaming compressed data at a very high rate from the STM32F722xx and STM32F723xx device through a small number of ETM pins to an external hardware trace port analyser (TPA). The TPA is connected to a host computer using the USB or any other high-speed channel. The real-time instruction and data flow activity can be recorded and then formatted for display on the host computer that runs the debugger software. The TPA hardware is commercially available from common development tool vendors.

The Embedded Trace Macrocell operates with third party debugger software tools.

## 4 Pinouts and pin description

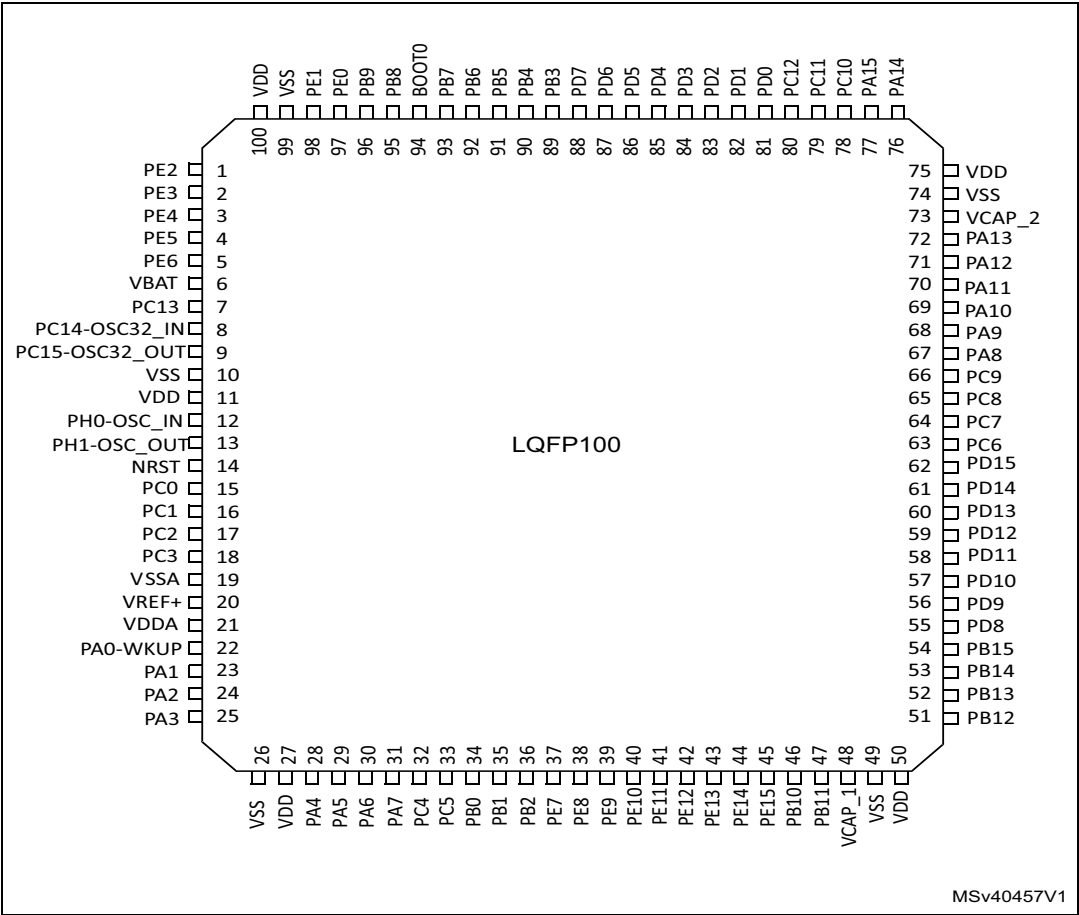
Figure 15. STM32F722xx LQFP64 pinout



1. The above figure shows the package top view.

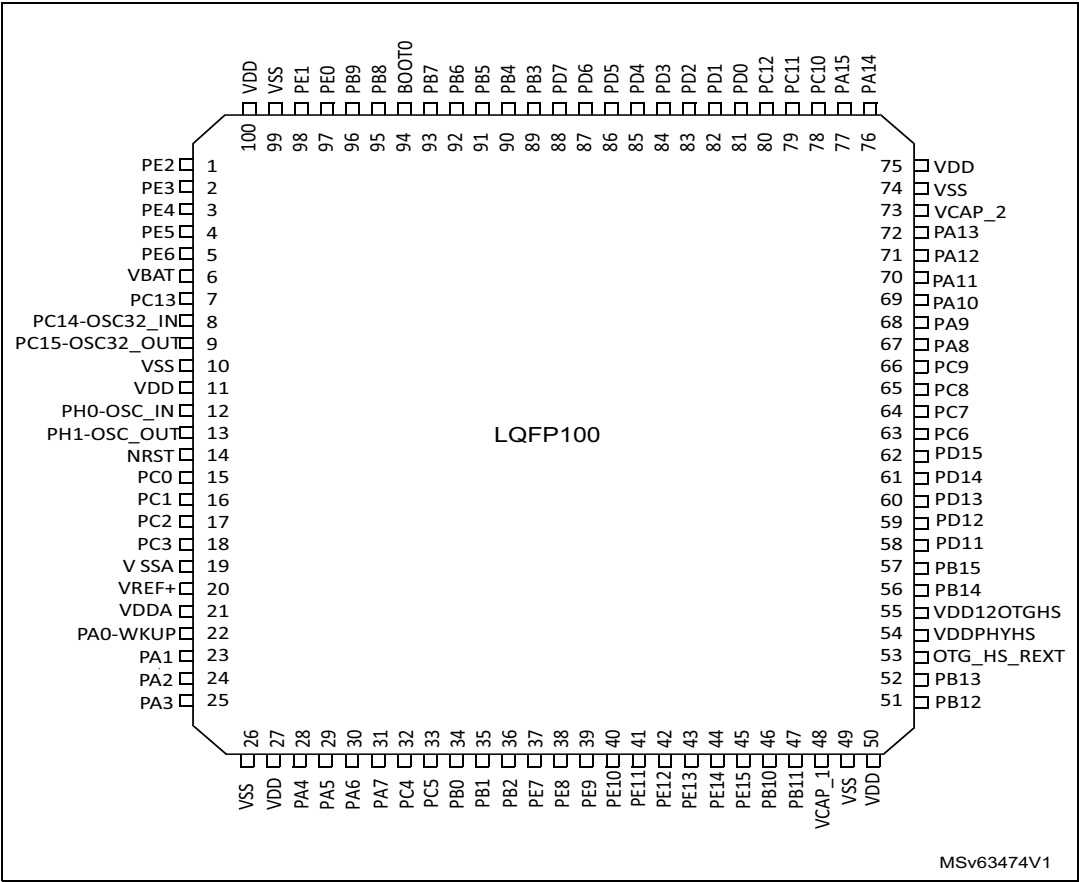


Figure 16. STM32F722xx LQFP100 pinout



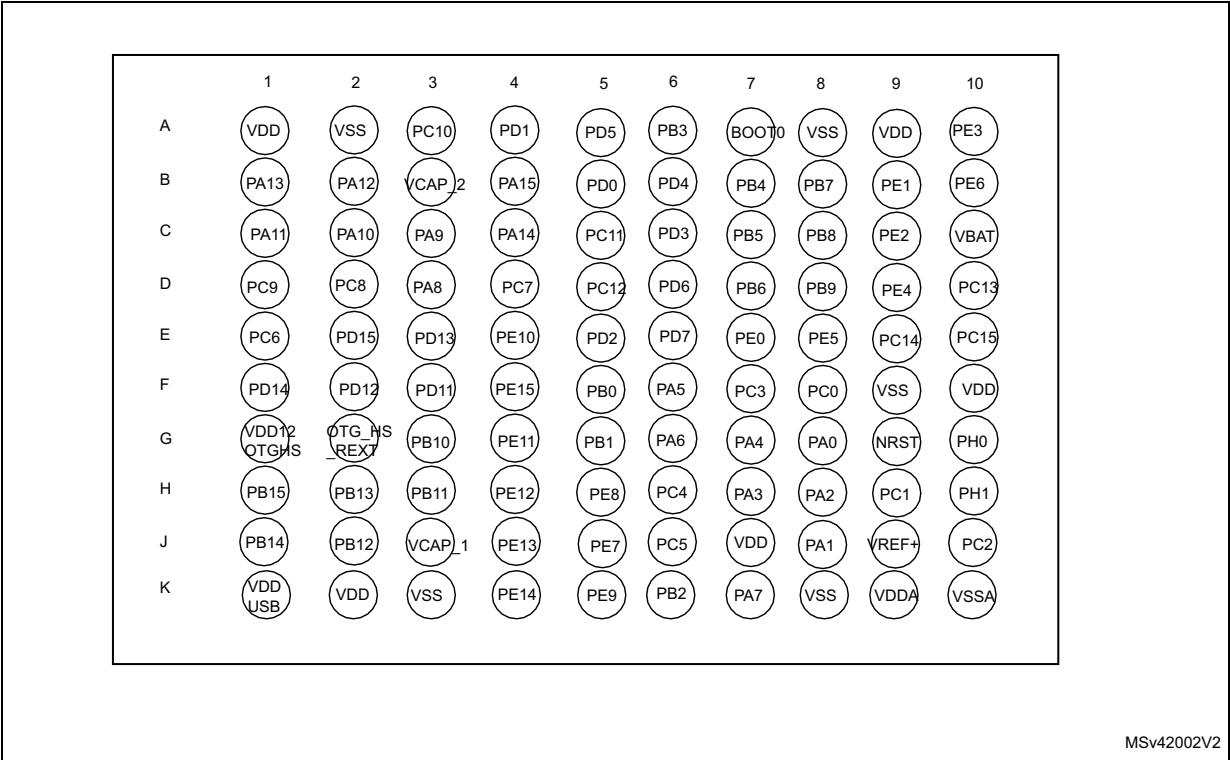
1. The above figure shows the package top view.

Figure 17. STM32F723xx LQFP100 pinout



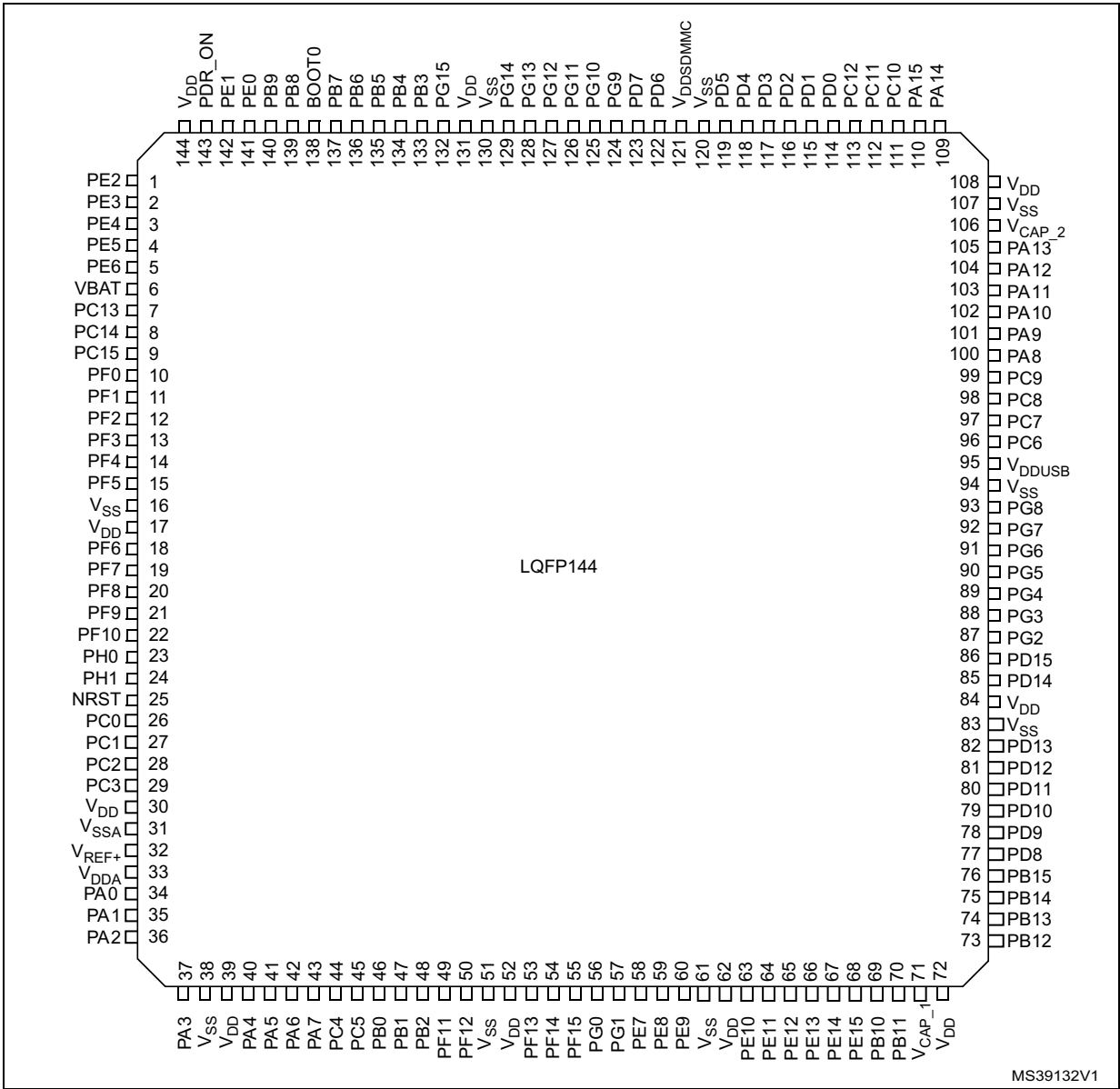
1. The above figure shows the package top view.

Figure 18. STM32F723xx WLCSP100 ballout (with OTG PHY HS)



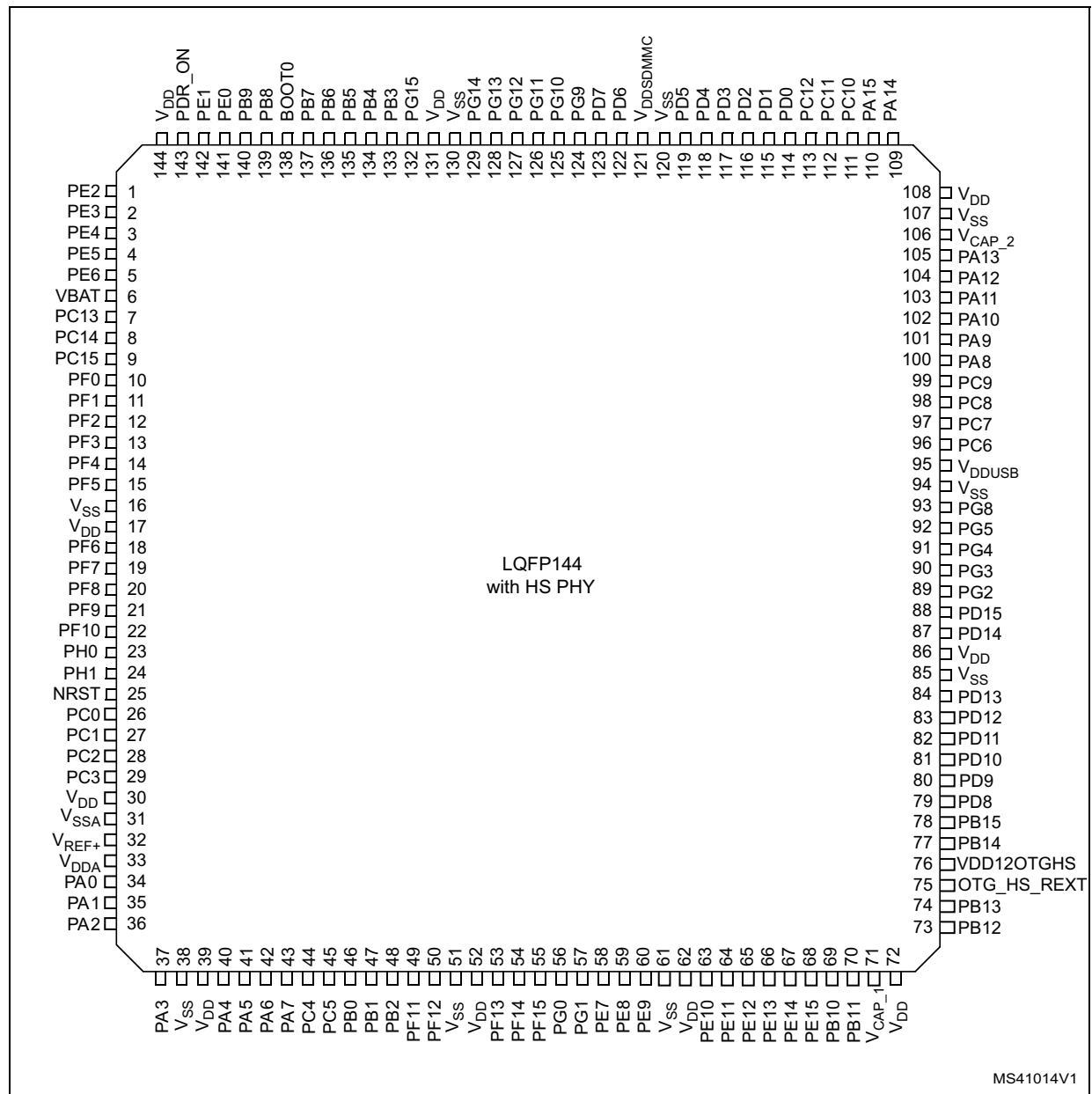
1. The above figure shows the package top view.

Figure 19. STM32F722xx LQFP144 pinout



1. The above figure shows the package top view.

Figure 20. STM32F723xx LQFP144 pinout



MS41014V1

1. The above figure shows the package top view.

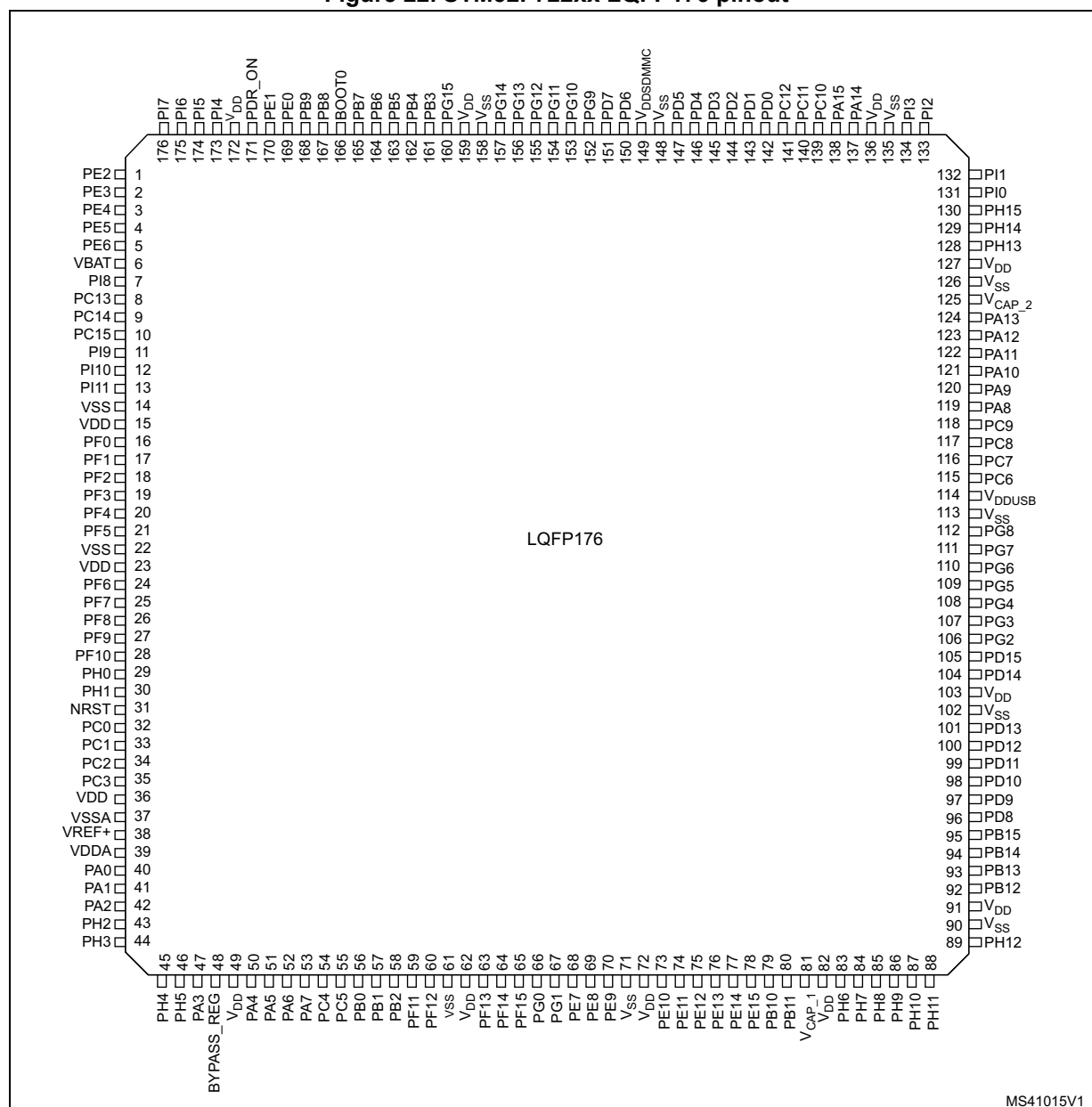
Figure 21. STM32F723xx UFBGA144 ballout (with OTG PHY HS)

|   | 1                  | 2    | 3   | 4   | 5              | 6    | 7      | 8    | 9      | 10             | 11              | 12   |
|---|--------------------|------|-----|-----|----------------|------|--------|------|--------|----------------|-----------------|------|
| A | PC13               | PE3  | PE2 | PE1 | PE0            | PB4  | PB3    | PD6  | PD7    | PA15           | PA14            | PA13 |
| B | PC14-<br>OSC32_IN  | PE4  | PE5 | PE6 | PB9            | PB5  | PG15   | PG12 | PD5    | PC11           | PC10            | PA12 |
| C | PC15-<br>OSC32_OUT | VBAT | PF0 | PF1 | PB8            | PB6  | PG14   | PG11 | PD4    | PC12           | VDDUSB          | PA11 |
| D | PH0 -<br>OSC_IN    | VSS  | VDD | PF2 | BOOT0          | PB7  | PG13   | PG10 | PD3    | PD1            | PA10            | PA9  |
| E | PH1 -<br>OSC_OUT   | PF3  | PF4 | PF5 | PDR_ON         | VSS  | VSS    | PG9  | PD2    | PD0            | PC9             | PA8  |
| F | NRST               | PF7  | PF6 | VDD | VDD            | VDD  | VDD    | VDD  | VDD    | VDD            | PC8             | PC7  |
| G | PF10               | PF9  | PF8 | VSS | VDD            | VDD  | VDD    | VSS  | VCAP_2 | VSS            | PG8             | PC6  |
| H | PC0                | PC1  | PC2 | PC3 | BYPASS_<br>REG | VSS  | VCAP_1 | PE11 | PD11   | VDD12OTG<br>HS | OTG_HS<br>_REXT | PG5  |
| J | VSSA               | PA0  | PA4 | PC4 | PB2            | PG1  | PE10   | PE12 | PD10   | PG4            | PG3             | PG2  |
| K | VREF-              | PA1  | PA5 | PC5 | PF13           | PG0  | PE9    | PE13 | PD9    | PD13           | PD14            | PD15 |
| L | VREF+              | PA2  | PA6 | PB0 | PF12           | PF15 | PE8    | PE14 | PD8    | PD12           | PB14            | PB15 |
| M | VDDA               | PA3  | PA7 | PB1 | PF11           | PF14 | PE7    | PE15 | PB10   | PB11           | PB12            | PB13 |

MSv42000V1

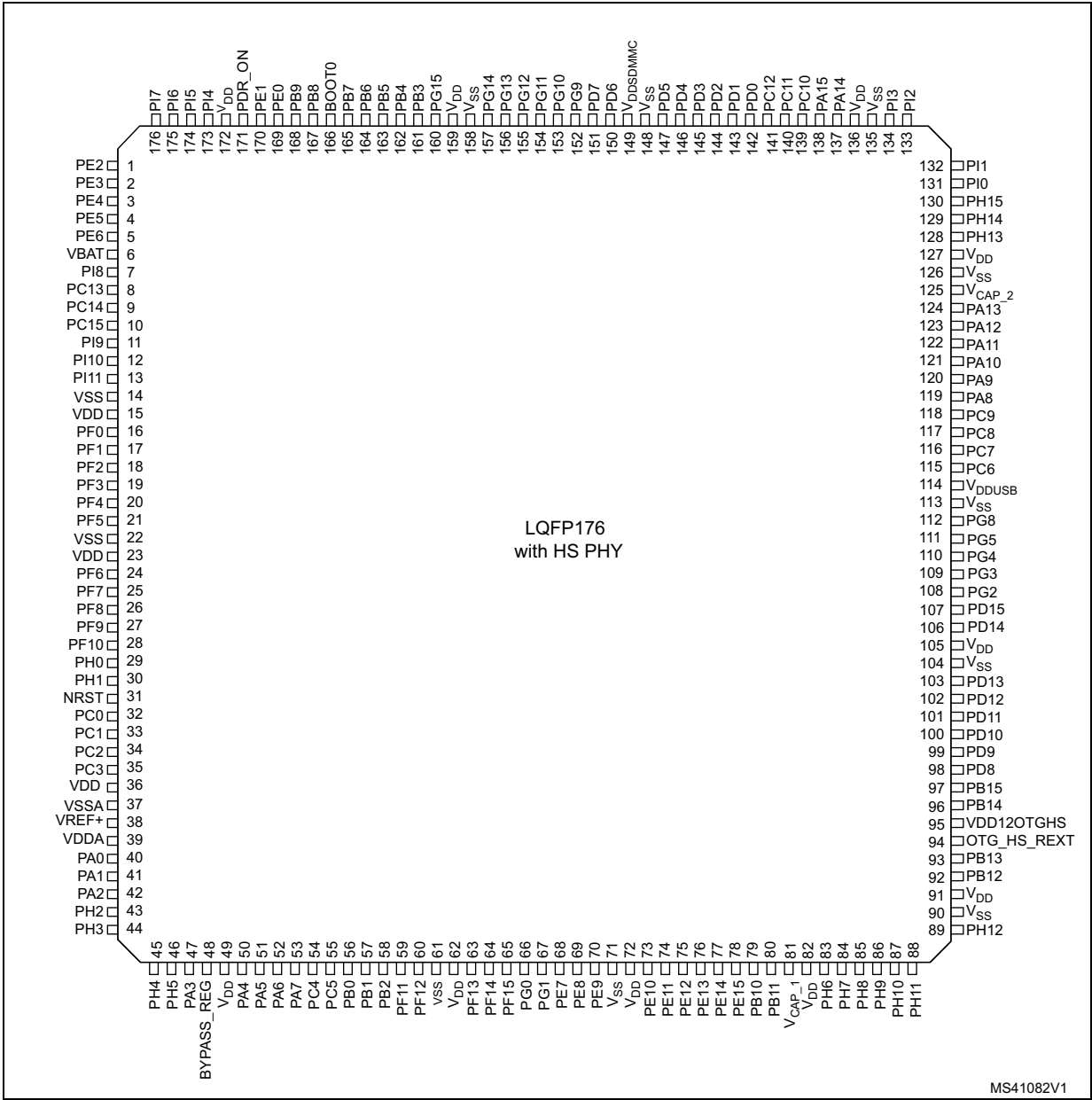
1. The above figure shows the package top view.

**Figure 22. STM32F722xx LQFP176 pinout**



1. The above figure shows the package top view.

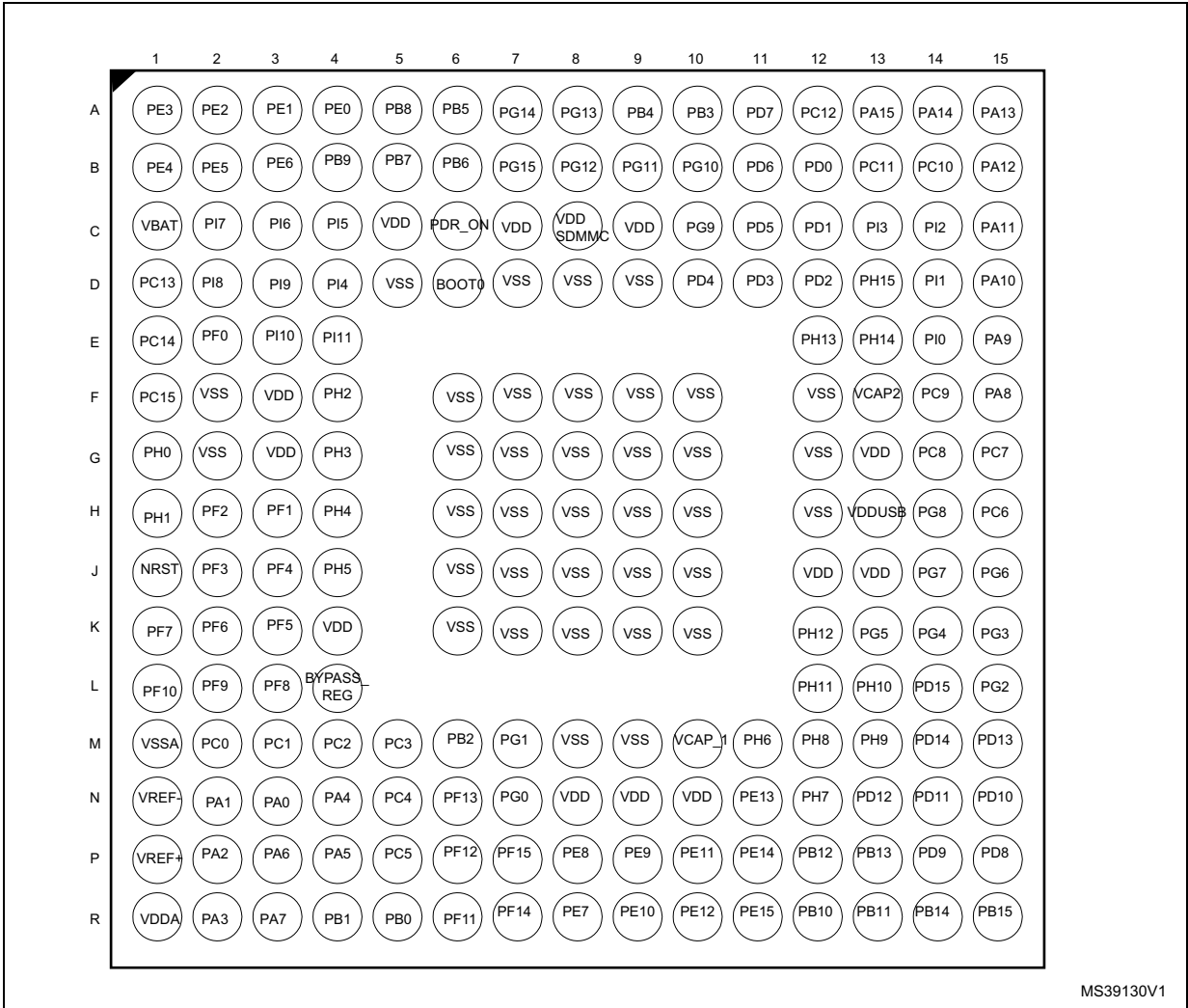
Figure 23. STM32F723xx LQFP176 pinout



1. The above figure shows the package top view.



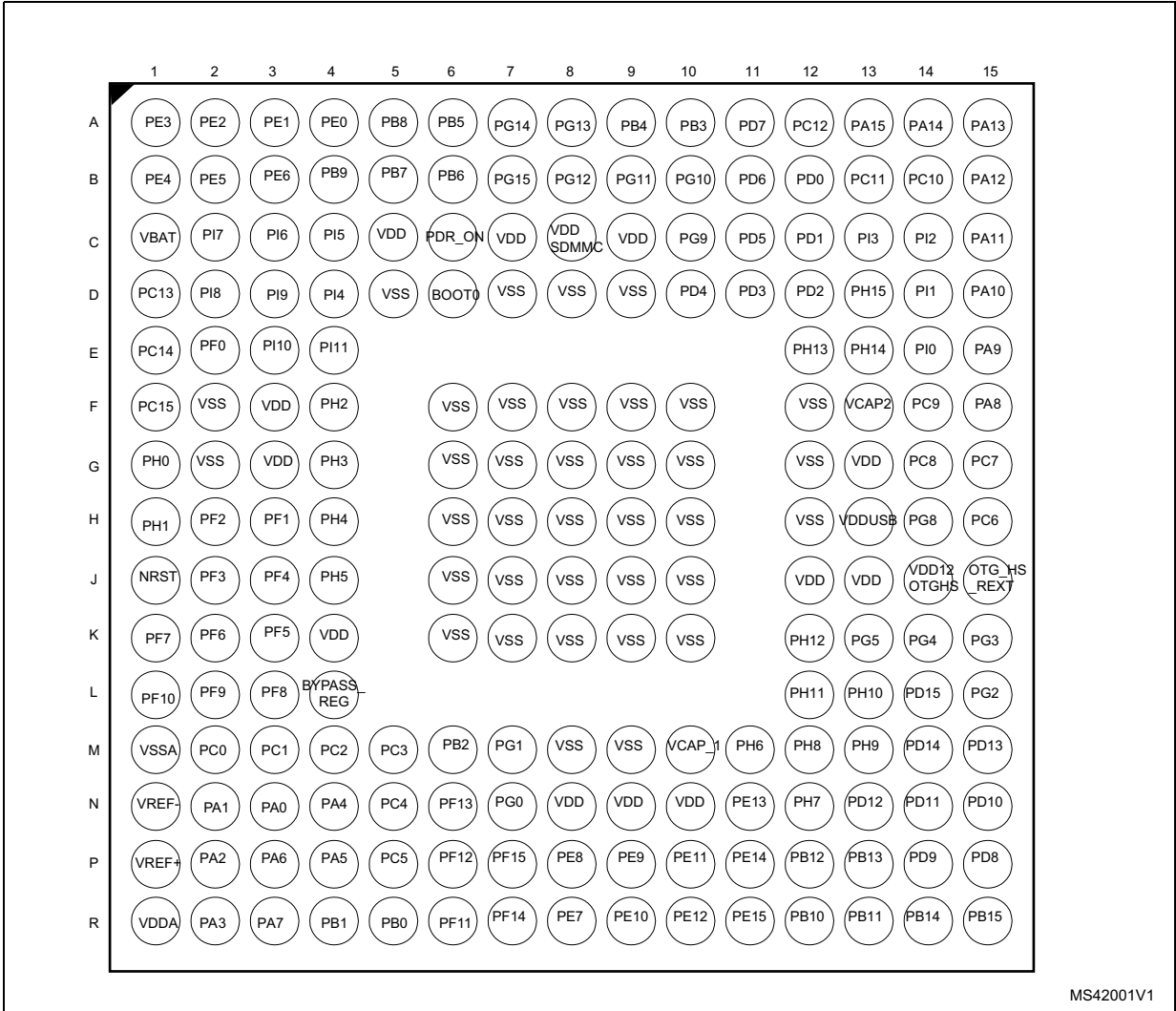
Figure 24. STM32F723xx UFBGA176 ballout



MS39130V1

1. The above figure shows the package top view.

Figure 25. STM32F723xx UFBGA176 ballout (with OTG PHY HS)



MS42001V1

1. The above figure shows the package top view.

Table 9. Legend/abbreviations used in the pinout table

| Name                 | Abbreviation                                                                                                                          | Definition                                         |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Pin name             | Unless otherwise specified in brackets below the pin name, the pin function during and after reset is the same as the actual pin name |                                                    |
| Pin type             | S                                                                                                                                     | Supply pin                                         |
|                      | I                                                                                                                                     | Input only pin                                     |
|                      | I/O                                                                                                                                   | Input / output pin                                 |
| I/O structure        | FT                                                                                                                                    | 5 V tolerant I/O                                   |
|                      | FTf                                                                                                                                   | 5V tolerant I/O, I2C Fm+ option.                   |
|                      | TTa                                                                                                                                   | 3.3 V tolerant I/O directly connected to ADC       |
|                      | B                                                                                                                                     | Dedicated BOOT pin                                 |
|                      | RST                                                                                                                                   | Bidirectional reset pin with weak pull-up resistor |
| Notes                | Unless otherwise specified by a note, all I/Os are set as floating inputs during and after reset                                      |                                                    |
| Alternate functions  | Functions selected through GPIOx_AFR registers                                                                                        |                                                    |
| Additional functions | Functions directly selected/enabled through peripheral registers                                                                      |                                                    |



Table 10. STM32F722xx and STM32F723xx pin and ball definition

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes                            | Alternate functions                                                                         | Additional<br>functions        |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|----------------------------------|---------------------------------------------------------------------------------------------|--------------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |                                  |                                                                                             |                                |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |                                  |                                                                                             |                                |
| -           | 1       | 1       | A2       | 1       | 1           | C9       | A2       | A3       | 1       | 1       | PE2                                                  | I/O      | FT            | -                                | TRACECLK, SPI4_SCK,<br>SAI1_MCLK_A,<br>QUADSPI_BK1_IO2, FMC_A23,<br>EVENTOUT                | -                              |
| -           | 2       | 2       | A1       | 2       | 2           | A10      | A1       | A2       | 2       | 2       | PE3                                                  | I/O      | FT            | -                                | TRACED0, SAI1_SD_B, FMC_A19,<br>EVENTOUT                                                    | -                              |
| -           | 3       | 3       | B1       | 3       | 3           | D9       | B1       | B2       | 3       | 3       | PE4                                                  | I/O      | FT            | -                                | TRACED1, SPI4_NSS,<br>SAI1_FS_A, FMC_A20,<br>EVENTOUT                                       | -                              |
| -           | 4       | 4       | B2       | 4       | 4           | E8       | B2       | B3       | 4       | 4       | PE5                                                  | I/O      | FT            | -                                | TRACED2, TIM9_CH1,<br>SPI4_MISO, SAI1_SCK_A,<br>FMC_A21, EVENTOUT                           | -                              |
| -           | 5       | 5       | B3       | 5       | 5           | B10      | B3       | B4       | 5       | 5       | PE6                                                  | I/O      | FT            | -                                | TRACED3, TIM1_BKIN2,<br>TIM9_CH2, SPI4_MOSI,<br>SAI1_SD_A, SAI2_MCK_B,<br>FMC_A22, EVENTOUT | -                              |
| 1           | 6       | 6       | C1       | 6       | 6           | C10      | C1       | C2       | 6       | 6       | VBAT                                                 | S        | -             | -                                | -                                                                                           | -                              |
| -           | -       | -       | D2       | 7       | -           | -        | D2       | -        | -       | 7       | PI8                                                  | I/O      | FT            | <sup>(2)</sup><br><sup>(3)</sup> | EVENTOUT                                                                                    | RTC_TAMP2/<br>RTC_TS,<br>WKUP5 |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes                                              | Alternate functions                     | Additional<br>functions                    |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|----------------------------------------------------|-----------------------------------------|--------------------------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |                                                    |                                         |                                            |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |                                                    |                                         |                                            |
| 2           | 7       | 7       | D1       | 8       | 7           | D10      | D1       | A1       | 7       | 8       | PC13                                                 | I/O      | FT            | <sup>(2)</sup><br><sup>(3)</sup>                   | EVENTOUT                                | RTC_TAMP1/<br>RTC_TS/<br>RTC_OUT,<br>WKUP4 |
| 3           | 8       | 8       | E1       | 9       | 8           | E9       | E1       | B1       | 8       | 9       | PC14-<br>OSC32_IN<br>(PC14)                          | I/O      | FT            | <sup>(2)</sup><br><sup>(3)</sup><br><sup>(5)</sup> | EVENTOUT                                | OSC32_IN                                   |
| 4           | 9       | 9       | F1       | 10      | 9           | E10      | F1       | C1       | 9       | 10      | PC15-<br>OSC32_OUT(P<br>C15)                         | I/O      | FT            | <sup>(2)</sup><br><sup>(3)</sup><br><sup>(5)</sup> | EVENTOUT                                | OSC32_OUT                                  |
| -           | -       | -       | D3       | 11      | -           | -        | D3       | -        | -       | 11      | PI9                                                  | I/O      | FT            | -                                                  | UART4_RX, CAN1_RX, FMC_D30,<br>EVENTOUT | -                                          |
| -           | -       | -       | E3       | 12      | -           | -        | E3       | -        | -       | 12      | PI10                                                 | I/O      | FT            | -                                                  | FMC_D31, EVENTOUT                       | -                                          |
| -           | -       | -       | E4       | 13      | -           | -        | E4       | -        | -       | 13      | PI11                                                 | I/O      | FT            | <sup>(4)</sup>                                     | OTG_HS_ULPI_DIR, EVENTOUT               | WKUP6                                      |
| -           | -       | -       | F2       | 14      | -           | -        | F2       | -        | -       | 14      | VSS                                                  | S        | -             | -                                                  | -                                       | -                                          |
| -           | -       | -       | F3       | 15      | -           | -        | F3       | -        | -       | 15      | VDD                                                  | S        | -             | -                                                  | -                                       | -                                          |
| -           | -       | 10      | E2       | 16      | -           | -        | E2       | C3       | 10      | 16      | PF0                                                  | I/O      | FTf           | -                                                  | I2C2_SDA, FMC_A0, EVENTOUT              | -                                          |
| -           | -       | 11      | H3       | 17      | -           | -        | H3       | C4       | 11      | 17      | PF1                                                  | I/O      | FTf           | -                                                  | I2C2_SCL, FMC_A1, EVENTOUT              | -                                          |
| -           | -       | 12      | H2       | 18      | -           | -        | H2       | D4       | 12      | 18      | PF2                                                  | I/O      | FT            | -                                                  | I2C2_SMBA, FMC_A2,<br>EVENTOUT          | -                                          |
| -           | -       | 13      | J2       | 19      | -           | -        | J2       | E2       | 13      | 19      | PF3                                                  | I/O      | FT            | -                                                  | FMC_A3, EVENTOUT                        | ADC3_IN9                                   |
| -           | -       | 14      | J3       | 20      | -           | -        | J3       | E3       | 14      | 20      | PF4                                                  | I/O      | FT            | -                                                  | FMC_A4, EVENTOUT                        | ADC3_IN14                                  |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes          | Alternate functions                                                          | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|----------------|------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |                |                                                                              |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |                |                                                                              |                         |
| -           | -       | 15      | K3       | 21      | -           | -        | K3       | E4       | 15      | 21      | PF5                                                  | I/O      | FT            | -              | FMC_A5, EVENTOUT                                                             | ADC3_IN15               |
| -           | 10      | 16      | G2       | 22      | 10          | F9       | G2       | D2       | 16      | 22      | VSS                                                  | S        | -             | -              | -                                                                            | -                       |
| -           | 11      | 17      | G3       | 23      | 11          | F10      | G3       | D3       | 17      | 23      | VDD                                                  | S        | -             | -              | -                                                                            | -                       |
| -           | -       | 18      | K2       | 24      | -           | -        | K2       | F3       | 18      | 24      | PF6                                                  | I/O      | FT            | -              | TIM10_CH1, SPI5_NSS,<br>SAI1_SD_B, UART7_RX,<br>QUADSPI_BK1_IO3, EVENTOUT    | ADC3_IN4                |
| -           | -       | 19      | K1       | 25      | -           | -        | K1       | F2       | 19      | 25      | PF7                                                  | I/O      | FT            | -              | TIM11_CH1, SPI5_SCK,<br>SAI1_MCLK_B, UART7_TX,<br>QUADSPI_BK1_IO2, EVENTOUT  | ADC3_IN5                |
| -           | -       | 20      | L3       | 26      | -           | -        | L3       | G3       | 20      | 26      | PF8                                                  | I/O      | FT            | -              | SPI5_MISO, SAI1_SCK_B,<br>UART7_RTS, TIM13_CH1,<br>QUADSPI_BK1_IO0, EVENTOUT | ADC3_IN6                |
| -           | -       | 21      | L2       | 27      | -           | -        | L2       | G2       | 21      | 27      | PF9                                                  | I/O      | FT            | -              | SPI5_MOSI, SAI1_FS_B,<br>UART7_CTS, TIM14_CH1,<br>QUADSPI_BK1_IO1, EVENTOUT  | ADC3_IN7                |
| -           | -       | 22      | L1       | 28      | -           | -        | L1       | G1       | 22      | 28      | PF10                                                 | I/O      | FT            | -              | EVENTOUT                                                                     | ADC3_IN8                |
| 5           | 12      | 23      | G1       | 29      | 12          | G10      | G1       | D1       | 23      | 29      | PH0-OSC_IN                                           | I/O      | FT            | <sup>(5)</sup> | EVENTOUT                                                                     | OSC_IN                  |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                            | Additional<br>functions                                       |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|----------------------------------------------------------------|---------------------------------------------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                |                                                               |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                |                                                               |
| 6           | 13      | 24      | H1       | 30      | 13          | H10      | H1       | E1       | 24      | 30      | PH1-OSC_OUT                                          | I/O      | FT            | (5)   | EVENTOUT                                                       | OSC_OUT                                                       |
| 7           | 14      | 25      | J1       | 31      | 14          | G9       | J1       | F1       | 25      | 31      | NRST                                                 | I/O      | RS<br>T       | -     | -                                                              | -                                                             |
| 8           | 15      | 26      | M2       | 32      | 15          | F8       | M2       | H1       | 26      | 32      | PC0                                                  | I/O      | FT            | (4)   | SAI2_FS_B, OTG_HS_ULPI_STP,<br>FMC_SDNWE, EVENTOUT             | ADC1_IN10,<br>ADC2_IN10,<br>ADC3_IN10                         |
| 9           | 16      | 27      | M3       | 33      | 16          | H9       | M3       | H2       | 27      | 33      | PC1                                                  | I/O      | FT            | -     | TRACED0, SPI2_MOSI/I2S2_SD,<br>SAI1_SD_A, EVENTOUT             | ADC1_IN11,<br>ADC2_IN11,<br>ADC3_IN11,<br>RTC_TAMP3,<br>WKUP3 |
| 10          | 17      | 28      | M4       | 34      | 17          | J10      | M4       | H3       | 28      | 34      | PC2                                                  | I/O      | FT            | (4)   | SPI2_MISO, OTG_HS_ULPI_DIR,<br>FMC_SDNE0, EVENTOUT             | ADC1_IN12,<br>ADC2_IN12,<br>ADC3_IN12                         |
| 11          | 18      | 29      | M5       | 35      | 18          | F7       | M5       | H4       | 29      | 35      | PC3                                                  | I/O      | FT            | (4)   | SPI2_MOSI/I2S2_SD,<br>OTG_HS_ULPI_NXT,<br>FMC_SDCKE0, EVENTOUT | ADC1_IN13,<br>ADC2_IN13,<br>ADC3_IN13                         |
| -           | -       | 30      | -        | 36      | -           | J7       | -        | F10      | 30      | 36      | VDD                                                  | S        | -             | -     | -                                                              | -                                                             |
| 12          | 19      | 31      | M1       | 37      | 19          | K10      | M1       | J1       | 31      | 37      | VSSA                                                 | S        | -             | -     | -                                                              | -                                                             |
| -           | -       | -       | N1       | -       | -           | -        | N1       | K1       | -       | -       | VREF-                                                | S        | -             | -     | -                                                              | -                                                             |
| 13          | 20      | 32      | P1       | 38      | 20          | J9       | P1       | L1       | 32      | 38      | VREF+                                                | S        | -             | -     | -                                                              | -                                                             |
| -           | 21      | 33      | R1       | 39      | 21          | K9       | R1       | M1       | 33      | 39      | VDDA                                                 | S        | -             | -     | -                                                              | -                                                             |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                                       | Additional<br>functions                      |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-------------------------------------------------------------------------------------------|----------------------------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                           |                                              |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                           |                                              |
| 14          | 22      | 34      | N3       | 40      | 22          | G8       | N3       | J2       | 34      | 40      | PA0-WKUP                                             | I/O      | FT            | (5)   | TIM2_CH1/TIM2_ETR, TIM5_CH1,<br>TIM8_ETR, USART2_CTS,<br>UART4_TX, SAI2_SD_B,<br>EVENTOUT | ADC1_IN0,<br>ADC2_IN0,<br>ADC3_IN0,<br>WKUP1 |
| 15          | 23      | 35      | N2       | 41      | 23          | J8       | N2       | K2       | 35      | 41      | PA1                                                  | I/O      | FT            | -     | TIM2_CH2, TIM5_CH2,<br>USART2_RTS, UART4_RX,<br>QUADSPI_BK1_IO3,<br>SAI2_MCK_B, EVENTOUT  | ADC1_IN1,<br>ADC2_IN1,<br>ADC3_IN1           |
| 16          | 24      | 36      | P2       | 42      | 24          | H8       | P2       | L2       | 36      | 42      | PA2                                                  | I/O      | FT            | -     | TIM2_CH3, TIM5_CH3, TIM9_CH1,<br>USART2_TX, SAI2_SCK_B,<br>EVENTOUT                       | ADC1_IN2,<br>ADC2_IN2,<br>ADC3_IN2,<br>WKUP2 |
| -           | -       | -       | F4       | 43      | -           | -        | F4       | -        | -       | 43      | PH2                                                  | I/O      | FT            | -     | LPTIM1_IN2, QUADSPI_BK2_IO0,<br>SAI2_SCK_B, FMC_SDCKE0,<br>EVENTOUT                       | -                                            |
| -           | -       | -       | G4       | 44      | -           | -        | G4       | -        | -       | 44      | PH3                                                  | I/O      | FT            | -     | QUADSPI_BK2_IO1,<br>SAI2_MCK_B, FMC_SDNE0,<br>EVENTOUT                                    | -                                            |
| -           | -       | -       | H4       | 45      | -           | -        | H4       | -        | -       | 45      | PH4                                                  | I/O      | FTf           | (4)   | I2C2_SCL, OTG_HS_ULPI_NXT,<br>EVENTOUT                                                    | -                                            |
| -           | -       | -       | J4       | 46      | -           | -        | J4       | -        | -       | 46      | PH5                                                  | I/O      | FTf           | -     | I2C2_SDA, SPI5_NSS,<br>FMC_SDNWE, EVENTOUT                                                | -                                            |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes          | Alternate functions                                                                        | Additional<br>functions            |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|----------------|--------------------------------------------------------------------------------------------|------------------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |                |                                                                                            |                                    |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |                |                                                                                            |                                    |
| 17          | 25      | 37      | R2       | 47      | 25          | H7       | R2       | M2       | 37      | 47      | PA3                                                  | I/O      | FT            | <sup>(4)</sup> | TIM2_CH4, TIM5_CH4, TIM9_CH2,<br>USART2_RX, OTG_HS_ULPI_D0,<br>EVENTOUT                    | ADC1_IN3,<br>ADC2_IN3,<br>ADC3_IN3 |
| 18          | 26      | 38      | -        | -       | 26          | K8       | -        | G4       | 38      | -       | VSS                                                  | S        | -             | -              | -                                                                                          | -                                  |
| -           | -       | -       | L4       | 48      | -           | -        | L4       | H5       | -       | 48      | BYPASS_REG                                           | I        | FT            | -              | -                                                                                          | -                                  |
| 19          | 27      | 39      | K4       | 49      | 27          | -        | K4       | F4       | 39      | 49      | VDD                                                  | S        | -             | -              | -                                                                                          | -                                  |
| 20          | 28      | 40      | N4       | 50      | 28          | G7       | N4       | J3       | 40      | 50      | PA4                                                  | I/O      | TTa           | -              | SPI1_NSS/I2S1_WS,<br>SPI3_NSS/I2S3_WS,<br>USART2_CK, OTG_HS_SOF,<br>EVENTOUT               | ADC1_IN4,<br>ADC2_IN4,<br>DAC_OUT1 |
| 21          | 29      | 41      | P4       | 51      | 29          | F6       | P4       | K3       | 41      | 51      | PA5                                                  | I/O      | TTa           | <sup>(4)</sup> | TIM2_CH1/TIM2_ETR,<br>TIM8_CH1N, SPI1_SCK/I2S1_CK,<br>OTG_HS_ULPI_CK, EVENTOUT             | ADC1_IN5,<br>ADC2_IN5,<br>DAC_OUT2 |
| 22          | 30      | 42      | P3       | 52      | 30          | G6       | P3       | L3       | 42      | 52      | PA6                                                  | I/O      | FT            | -              | TIM1_BKIN, TIM3_CH1,<br>TIM8_BKIN, SPI1_MISO,<br>TIM13_CH1, EVENTOUT                       | ADC1_IN6,<br>ADC2_IN6              |
| 23          | 31      | 43      | R3       | 53      | 31          | K7       | R3       | M3       | 43      | 53      | PA7                                                  | I/O      | FT            | -              | TIM1_CH1N, TIM3_CH2,<br>TIM8_CH1N,<br>SPI1_MOSI/I2S1_SD, TIM14_CH1,<br>FMC_SDNWE, EVENTOUT | ADC1_IN7,<br>ADC2_IN7              |
| 24          | 32      | 44      | N5       | 54      | 32          | H6       | N5       | J4       | 44      | 54      | PC4                                                  | I/O      | FT            | -              | I2S1_MCK, FMC_SDNE0,<br>EVENTOUT                                                           | ADC1_IN14,<br>ADC2_IN14            |
| -           | 33      | 45      | P5       | 55      | 33          | J6       | P5       | K4       | 45      | 55      | PC5                                                  | I/O      | FT            | -              | FMC_SDCKE0, EVENTOUT                                                                       | ADC1_IN15,<br>ADC2_IN15            |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                       | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|---------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                           |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                           |                         |
| 25          | 34      | 46      | R5       | 56      | 34          | F5       | R5       | L4       | 46      | 56      | PB0                                                  | I/O      | FT            | (4)   | TIM1_CH2N, TIM3_CH3,<br>TIM8_CH2N, UART4_CTS,<br>OTG_HS_ULPI_D1, EVENTOUT | ADC1_IN8,<br>ADC2_IN8   |
| 26          | 35      | 47      | R4       | 57      | 35          | G5       | R4       | M4       | 47      | 57      | PB1                                                  | I/O      | FT            | (4)   | TIM1_CH3N, TIM3_CH4,<br>TIM8_CH3N, OTG_HS_ULPI_D2,<br>EVENTOUT            | ADC1_IN9,<br>ADC2_IN9   |
| 27          | 36      | 48      | M6       | 58      | 36          | K6       | M6       | J5       | 48      | 58      | PB2                                                  | I/O      | FT            | -     | SAI1_SD_A, SPI3_MOSI/I2S3_SD,<br>QUADSPI_CLK, EVENTOUT                    | -                       |
| -           | -       | 49      | R6       | 59      | -           | -        | R6       | M5       | 49      | 59      | PF11                                                 | I/O      | FT            | -     | SPI5_MOSI, SAI2_SD_B,<br>FMC_SDNRAS, EVENTOUT                             | -                       |
| -           | -       | 50      | P6       | 60      | -           | -        | P6       | L5       | 50      | 60      | PF12                                                 | I/O      | FT            | -     | FMC_A6, EVENTOUT                                                          | -                       |
| -           | -       | 51      | M8       | 61      | -           | -        | M8       | -        | 51      | 61      | VSS                                                  | S        | -             | -     | -                                                                         | -                       |
| -           | -       | 52      | N8       | 62      | -           | -        | N8       | G5       | 52      | 62      | VDD                                                  | S        | -             | -     | -                                                                         | -                       |
| -           | -       | 53      | N6       | 63      | -           | -        | N6       | K5       | 53      | 63      | PF13                                                 | I/O      | FT            | -     | FMC_A7, EVENTOUT                                                          | -                       |
| -           | -       | 54      | R7       | 64      | -           | -        | R7       | M6       | 54      | 64      | PF14                                                 | I/O      | FT            | -     | FMC_A8, EVENTOUT                                                          | -                       |
| -           | -       | 55      | P7       | 65      | -           | -        | P7       | L6       | 55      | 65      | PF15                                                 | I/O      | FT            | -     | FMC_A9, EVENTOUT                                                          | -                       |
| -           | -       | 56      | N7       | 66      | -           | -        | N7       | K6       | 56      | 66      | PG0                                                  | I/O      | FT            | -     | FMC_A10, EVENTOUT                                                         | -                       |
| -           | -       | 57      | M7       | 67      | -           | -        | M7       | J6       | 57      | 67      | PG1                                                  | I/O      | FT            | -     | FMC_A11, EVENTOUT                                                         | -                       |
| -           | 37      | 58      | R8       | 68      | 37          | J5       | R8       | M7       | 58      | 68      | PE7                                                  | I/O      | FT            | -     | TIM1_ETR, UART7_Rx,<br>QUADSPI_BK2_IO0, FMC_D4,<br>EVENTOUT               | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                           | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|---------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                               |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                               |                         |
| -           | 38      | 59      | P8       | 69      | 38          | H5       | P8       | L7       | 59      | 69      | PE8                                                  | I/O      | FT            | -     | TIM1_CH1N, UART7_Tx,<br>QUADSPI_BK2_IO1, FMC_D5,<br>EVENTOUT  | -                       |
| -           | 39      | 60      | P9       | 70      | 39          | K5       | P9       | K7       | 60      | 70      | PE9                                                  | I/O      | FT            | -     | TIM1_CH1, UART7_RTS,<br>QUADSPI_BK2_IO2, FMC_D6,<br>EVENTOUT  | -                       |
| -           | -       | 61      | M9       | 71      | -           | -        | M9       | H6       | 61      | 71      | VSS                                                  | S        | -             | -     | -                                                             | -                       |
| -           | -       | 62      | N9       | 72      | -           | -        | N9       | G6       | 62      | 72      | VDD                                                  | S        | -             | -     | -                                                             | -                       |
| -           | 40      | 63      | R9       | 73      | 40          | E4       | R9       | J7       | 63      | 73      | PE10                                                 | I/O      | FT            | -     | TIM1_CH2N, UART7_CTS,<br>QUADSPI_BK2_IO3, FMC_D7,<br>EVENTOUT | -                       |
| -           | 41      | 64      | P10      | 74      | 41          | G4       | P10      | H8       | 64      | 74      | PE11                                                 | I/O      | FT            | -     | TIM1_CH2, SPI4_NSS,<br>SAI2_SD_B, FMC_D8, EVENTOUT            | -                       |
| -           | 42      | 65      | R10      | 75      | 42          | H4       | R10      | J8       | 65      | 75      | PE12                                                 | I/O      | FT            | -     | TIM1_CH3N, SPI4_SCK,<br>SAI2_SCK_B, FMC_D9,<br>EVENTOUT       | -                       |
| -           | 43      | 66      | N11      | 76      | 43          | J4       | N11      | K8       | 66      | 76      | PE13                                                 | I/O      | FT            | -     | TIM1_CH3, SPI4_MISO,<br>SAI2_FS_B, FMC_D10,<br>EVENTOUT       | -                       |
| -           | 44      | 67      | P11      | 77      | 44          | K4       | P11      | L8       | 67      | 77      | PE14                                                 | I/O      | FT            | -     | TIM1_CH4, SPI4_MOSI,<br>SAI2_MCK_B, FMC_D11,,<br>EVENTOUT     | -                       |
| -           | 45      | 68      | R11      | 78      | 45          | F4       | R11      | M8       | 68      | 78      | PE15                                                 | I/O      | FT            | -     | TIM1_BKIN, FMC_D12,<br>EVENTOUT                               | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                             | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|---------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                 |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                 |                         |
| 28          | 46      | 69      | R12      | 79      | 46          | G3       | R12      | M9       | 69      | 79      | PB10                                                 | I/O      | FTf           | (4)   | TIM2_CH3, I2C2_SCL,<br>SPI2_SCK/I2S2_CK, USART3_TX,<br>OTG_HS_ULPI_D3, EVENTOUT | -                       |
| 29          | 47      | 70      | R13      | 80      | 47          | H3       | R13      | M10      | 70      | 80      | PB11                                                 | I/O      | FTf           | (4)   | TIM2_CH4, I2C2_SDA,<br>USART3_RX, OTG_HS_ULPI_D4,<br>EVENTOUT                   | -                       |
| 30          | 48      | 71      | M10      | 81      | 48          | J3       | M10      | H7       | 71      | 81      | VCAP_1                                               | S        | -             | -     | -                                                                               | -                       |
| 31          | 49      | -       | -        | -       | 49          | K3       | -        | -        | -       | -       | VSS                                                  | S        | -             | -     | -                                                                               | -                       |
| 32          | 50      | 72      | N10      | 82      | 50          | K2       | N10      | G7       | 72      | 82      | VDD                                                  | S        | -             | -     | -                                                                               | -                       |
| -           | -       | -       | M11      | 83      | -           | -        | M11      | -        | -       | 83      | PH6                                                  | I/O      | FT            | -     | I2C2_SMBA, SPI5_SCK,<br>TIM12_CH1, FMC_SDNE1,<br>EVENTOUT                       | -                       |
| -           | -       | -       | N12      | 84      | -           | -        | N12      | -        | -       | 84      | PH7                                                  | I/O      | FTf           | -     | I2C3_SCL, SPI5_MISO,<br>FMC_SDCKE1, EVENTOUT                                    | -                       |
| -           | -       | -       | M12      | 85      | -           | -        | M12      | -        | -       | 85      | PH8                                                  | I/O      | FTf           | -     | I2C3_SDA, FMC_D16, EVENTOUT                                                     | -                       |
| -           | -       | -       | M13      | 86      | -           | -        | M13      | -        | -       | 86      | PH9                                                  | I/O      | FT            | -     | I2C3_SMBA, TIM12_CH2,<br>FMC_D17, EVENTOUT                                      | -                       |
| -           | -       | -       | L13      | 87      | -           | -        | L13      | -        | -       | 87      | PH10                                                 | I/O      | FT            | -     | TIM5_CH1, FMC_D18, EVENTOUT                                                     | -                       |
| -           | -       | -       | L12      | 88      | -           | -        | L12      | -        | -       | 88      | PH11                                                 | I/O      | FT            | -     | TIM5_CH2, FMC_D19, EVENTOUT                                                     | -                       |
| -           | -       | -       | K12      | 89      | -           | -        | K12      | -        | -       | 89      | PH12                                                 | I/O      | FT            | -     | TIM5_CH3, FMC_D20, EVENTOUT                                                     | -                       |

Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                                             | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-------------------------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                                 |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                                 |                         |
| -           | -       | -       | H12      | 90      | -           | -        | H12      | -        | -       | 90      | VSS                                                  | S        | -             | -     | -                                                                                               | -                       |
| -           | -       | -       | J12      | 91      | -           | K2       | J12      | -        | -       | 91      | VDD                                                  | S        | -             | -     | -                                                                                               | -                       |
| 33          | 51      | 73      | P12      | 92      | 51          | J2       | P12      | M11      | 73      | 92      | PB12                                                 | I/O      | FT            | (4)   | TIM1_BKIN, I2C2_SMBA,<br>SPI2_NSS/I2S2_WS,<br>USART3_CK, OTG_HS_ULPI_D5,<br>OTG_HS_ID, EVENTOUT | -                       |
| 34          | 52      | 74      | P13      | 93      | 52          | H2       | P13      | M12      | 74      | 93      | PB13                                                 | I/O      | FT            | (4)   | TIM1_CH1N, SPI2_SCK/I2S2_CK,<br>USART3_CTS,<br>OTG_HS_ULPI_D6, EVENTOUT                         | OTG_HS_VBUS             |
| -           | -       | -       | -        | -       | 53          | G2       | J15      | H11      | 75      | 94      | OTG_HS_REXT                                          | -        | -             | -     | USB HS OTG PHY calibration resistor                                                             |                         |
| -           | -       | -       | -        | -       | 54          | -        | -        | -        | -       | -       | VDDPHYHS                                             | -        | -             | -     | -                                                                                               | -                       |
| -           | -       | -       | -        | -       | 55          | G1       | J14      | H10      | 76      | 95      | VDD12OTGHS                                           | -        | -             | -     | -                                                                                               | -                       |
| 35          | 53      | 75      | R14      | 94      | -           | -        | -        | -        | -       | -       | PB14                                                 | I/O      | FT            | -     | TIM1_CH2N, TIM8_CH2N,<br>SPI2_MISO, USART3_RTS,<br>TIM12_CH1, SDMMC2_D0,<br>OTG_HS_DM, EVENTOUT | -                       |
| -           | -       | -       | -        | -       | 56          | J1       | R14      | L11      | 77      | 96      | PB14                                                 | I/O      | FT            | -     | OTG_HS_DM                                                                                       | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                                                       | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-----------------------------------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                                           |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                                           |                         |
| 36          | 54      | 76      | R15      | 95      | -           | -        | -        | -        | -       | -       | PB15                                                 | I/O      | FT            | -     | RTC_REFIN, TIM1_CH3N,<br>TIM8_CH3N,<br>SPI2_MOSI/I2S2_SD, TIM12_CH2,<br>SDMMC2_D1, OTG_HS_DP,<br>EVENTOUT | -                       |
| -           | -       | -       | -        | -       | 57          | H1       | R15      | L12      | 78      | 97      | PB15                                                 | I/O      | FT            | -     | OTG_HS_DP                                                                                                 | -                       |
| -           | 55      | 77      | P15      | 96      | -           | -        | P15      | L9       | 79      | 98      | PD8                                                  | I/O      | FT            | -     | USART3_TX, FMC_D13,<br>EVENTOUT                                                                           | -                       |
| -           | 56      | 78      | P14      | 97      | -           | -        | P14      | K9       | 80      | 99      | PD9                                                  | I/O      | FT            | -     | USART3_RX, FMC_D14,<br>EVENTOUT                                                                           | -                       |
| -           | 57      | 79      | N15      | 98      | -           | -        | N15      | J9       | 81      | 100     | PD10                                                 | I/O      | FT            | -     | USART3_CK, FMC_D15,<br>EVENTOUT                                                                           | -                       |
| -           | 58      | 80      | N14      | 99      | 58          | F3       | N14      | H9       | 82      | 101     | PD11                                                 | I/O      | FT            | -     | USART3_CTS,<br>QUADSPI_BK1_IO0, SAI2_SD_A,<br>FMC_A16/FMC_CLE, EVENTOUT                                   | -                       |
| -           | 59      | 81      | N13      | 100     | 59          | F2       | N13      | L10      | 83      | 102     | PD12                                                 | I/O      | FT            | -     | TIM4_CH1, LPTIM1_IN1,<br>USART3_RTS,<br>QUADSPI_BK1_IO1, SAI2_FS_A,<br>FMC_A17/FMC_ALE, EVENTOUT          | -                       |
| -           | 60      | 82      | M15      | 101     | 60          | E3       | M15      | K10      | 84      | 103     | PD13                                                 | I/O      | FT            | -     | TIM4_CH2, LPTIM1_OUT,<br>QUADSPI_BK1_IO3,<br>SAI2_SCK_A, FMC_A18,<br>EVENTOUT                             | -                       |
| -           | -       | 83      | -        | 102     | -           | -        | -        | G8       | 85      | 104     | VSS                                                  | S        | -             | -     | -                                                                                                         | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                           | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                               |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                               |                         |
| -           | -       | 84      | J13      | 103     | -           | -        | J13      | F8       | 86      | 105     | VDD                                                  | S        | -             | -     | -                                                                             | -                       |
| -           | 61      | 85      | M14      | 104     | 61          | F1       | M14      | K11      | 87      | 106     | PD14                                                 | I/O      | FT            | -     | TIM4_CH3, UART8_CTS,<br>FMC_D0, EVENTOUT                                      | -                       |
| -           | 62      | 86      | L14      | 105     | 62          | E2       | L14      | K12      | 88      | 107     | PD15                                                 | I/O      | FT            | -     | TIM4_CH4, UART8_RTS,<br>FMC_D1, EVENTOUT                                      | -                       |
| -           | -       | 87      | L15      | 106     | -           | -        | L15      | J12      | 89      | 108     | PG2                                                  | I/O      | FT            | -     | FMC_A12, EVENTOUT                                                             | -                       |
| -           | -       | 88      | K15      | 107     | -           | -        | K15      | J11      | 90      | 109     | PG3                                                  | I/O      | FT            | -     | FMC_A13, EVENTOUT                                                             | -                       |
| -           | -       | 89      | K14      | 108     | -           | -        | K14      | J10      | 91      | 110     | PG4                                                  | I/O      | FT            | -     | FMC_A14/FMC_BA0, EVENTOUT                                                     | -                       |
| -           | -       | 90      | K13      | 109     | -           | -        | K13      | H12      | 92      | 111     | PG5                                                  | I/O      | FT            | -     | FMC_A15/FMC_BA1, EVENTOUT                                                     | -                       |
| -           | -       | 91      | J15      | 110     | -           | -        | -        | -        | -       | -       | PG6                                                  | I/O      | FT            | -     | EVENTOUT                                                                      | -                       |
| -           | -       | 92      | J14      | 111     | -           | -        | -        | -        | -       | -       | PG7                                                  | I/O      | FT            | -     | USART6_CK, FMC_INT,<br>EVENTOUT                                               | -                       |
| -           | -       | 93      | H14      | 112     | -           | -        | H14      | G11      | 93      | 112     | PG8                                                  | I/O      | FT            | -     | USART6_RTS, FMC_SDCLK,<br>EVENTOUT                                            | -                       |
| -           | -       | 94      | G12      | 113     | -           | -        | G12      | -        | 94      | 113     | VSS                                                  | S        | -             | -     | -                                                                             | -                       |
| -           | -       | -       | -        | -       | -           | -        | -        | F10      | -       | -       | VDD                                                  | -        | -             | -     | -                                                                             | -                       |
| -           | -       | 95      | H13      | 114     | -           | K1       | H13      | C11      | 95      | 114     | VDDUSB                                               | S        | -             | -     | -                                                                             | -                       |
| 37          | 63      | 96      | H15      | 115     | 63          | E1       | H15      | G12      | 96      | 115     | PC6                                                  | I/O      | FT            | -     | TIM3_CH1, TIM8_CH1, I2S2_MCK,<br>USART6_TX, SDMMC2_D6,<br>SDMMC1_D6, EVENTOUT | -                       |
| 38          | 64      | 97      | G15      | 116     | 64          | D4       | G15      | F12      | 97      | 116     | PC7                                                  | I/O      | FT            | -     | TIM3_CH2, TIM8_CH2, I2S3_MCK,<br>USART6_RX, SDMMC2_D7,<br>SDMMC1_D7, EVENTOUT | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                                                    | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|--------------------------------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                                        |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                                        |                         |
| 39          | 65      | 98      | G14      | 117     | 65          | D2       | G14      | F11      | 98      | 117     | PC8                                                  | I/O      | FT            | -     | TRACED1, TIM3_CH3, TIM8_CH3,<br>UART5_RTS, USART6_CK,<br>SDMMC1_D0, EVENTOUT                           | -                       |
| 40          | 66      | 99      | F14      | 118     | 66          | D1       | F14      | E11      | 99      | 118     | PC9                                                  | I/O      | FTf           | -     | MCO2, TIM3_CH4, TIM8_CH4,<br>I2C3_SDA, I2S_CKIN,<br>UART5_CTS, QUADSPI_BK1_IO0,<br>SDMMC1_D1, EVENTOUT | -                       |
| 41          | 67      | 100     | F15      | 119     | 67          | D3       | F15      | E12      | 100     | 119     | PA8                                                  | I/O      | FTf           | -     | MCO1, TIM1_CH1, TIM8_BKIN2,<br>I2C3_SCL, USART1_CK,<br>OTG_FS_SOF, EVENTOUT                            | -                       |
| 42          | 68      | 101     | E15      | 120     | 68          | C3       | E15      | D12      | 101     | 120     | PA9                                                  | I/O      | FT            | -     | TIM1_CH2, I2C3_SMBA,<br>SPI2_SCK/I2S2_CK, USART1_TX,<br>EVENTOUT                                       | OTG_FS_VBUS             |
| 43          | 69      | 102     | D15      | 121     | 69          | C2       | D15      | D11      | 102     | 121     | PA10                                                 | I/O      | FT            | -     | TIM1_CH3, USART1_RX,<br>OTG_FS_ID, EVENTOUT                                                            | -                       |
| 44          | 70      | 103     | C15      | 122     | 70          | C1       | C15      | C12      | 103     | 122     | PA11                                                 | I/O      | FT            | -     | TIM1_CH4, USART1_CTS,<br>CAN1_RX, OTG_FS_DM,<br>EVENTOUT                                               | -                       |
| 45          | 71      | 104     | B15      | 123     | 71          | B2       | B15      | B12      | 104     | 123     | PA12                                                 | I/O      | FT            | -     | TIM1_ETR, USART1_RTS,<br>SAI2_FS_B, CAN1_TX,<br>OTG_FS_DP, EVENTOUT                                    | -                       |
| 46          | 72      | 105     | A15      | 124     | 72          | B1       | A15      | A12      | 105     | 124     | PA13(JTMS-SWDIO)                                     | I/O      | FT            | -     | JTMS-SWDIO, EVENTOUT                                                                                   | -                       |
| -           | 73      | 106     | F13      | 125     | 73          | B3       | F13      | G9       | 106     | 125     | VCAP_2                                               | S        | -             | -     | -                                                                                                      | -                       |
| 47          | 74      | 107     | F12      | 126     | 74          | A2       | F12      | G10      | 107     | 126     | VSS                                                  | S        | -             | -     | -                                                                                                      | -                       |
| 48          | 75      | 108     | G13      | 127     | 75          | A1       | G13      | F9       | 108     | 127     | VDD                                                  | S        | -             | -     | -                                                                                                      | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                                       | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-------------------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                           |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                           |                         |
| -           | -       | -       | E12      | 128     | -           | -        | E12      | -        | -       | 128     | PH13                                                 | I/O      | FT            | -     | TIM8_CH1N, UART4_TX,<br>CAN1_TX, FMC_D21, EVENTOUT                                        | -                       |
| -           | -       | -       | E13      | 129     | -           | -        | E13      | -        | -       | 129     | PH14                                                 | I/O      | FT            | -     | TIM8_CH2N, UART4_RX,<br>CAN1_RX, FMC_D22, EVENTOUT                                        | -                       |
| -           | -       | -       | D13      | 130     | -           | -        | D13      | -        | -       | 130     | PH15                                                 | I/O      | FT            | -     | TIM8_CH3N, FMC_D23,<br>EVENTOUT                                                           | -                       |
| -           | -       | -       | E14      | 131     | -           | -        | E14      | -        | -       | 131     | PI0                                                  | I/O      | FT            | -     | TIM5_CH4, SPI2_NSS/I2S2_WS,<br>FMC_D24, EVENTOUT                                          | -                       |
| -           | -       | -       | D14      | 132     | -           | -        | D14      | -        | -       | 132     | PI1                                                  | I/O      | FT            | -     | TIM8_BKIN2, SPI2_SCK/I2S2_CK,<br>FMC_D25, EVENTOUT                                        | -                       |
| -           | -       | -       | C14      | 133     | -           | -        | C14      | -        | -       | 133     | PI2                                                  | I/O      | FT            | -     | TIM8_CH4, SPI2_MISO,<br>FMC_D26, EVENTOUT                                                 | -                       |
| -           | -       | -       | C13      | 134     | -           | -        | C13      | -        | -       | 134     | PI3                                                  | I/O      | FT            | -     | TIM8_ETR, SPI2_MOSI/I2S2_SD,<br>FMC_D27, EVENTOUT                                         | -                       |
| -           | -       | -       | D9       | 135     | -           | -        | D9       | -        | -       | 135     | VSS                                                  | S        | -             | -     | -                                                                                         | -                       |
| -           | -       | -       | C9       | 136     | -           | -        | C9       | -        | -       | 136     | VDD                                                  | S        | -             | -     | -                                                                                         | -                       |
| 49          | 76      | 109     | A14      | 137     | 76          | C4       | A14      | A11      | 109     | 137     | PA14(JTCK-<br>SWCLK)                                 | I/O      | FT            | -     | JTCK-SWCLK, EVENTOUT                                                                      | -                       |
| 50          | 77      | 110     | A13      | 138     | 77          | B4       | A13      | A10      | 110     | 138     | PA15(JTDI)                                           | I/O      | FT            | -     | JTDI, TIM2_CH1/TIM2_ETR,<br>SPI1_NSS/I2S1_WS,<br>SPI3_NSS/I2S3_WS, UART4_RTS,<br>EVENTOUT | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                               | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-----------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                   |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                   |                         |
| 51          | 78      | 111     | B14      | 139     | 78          | A3       | B14      | B11      | 111     | 139     | PC10                                                 | I/O      | FT            | -     | SPI3_SCK/I2S3_CK, USART3_TX,<br>UART4_TX, QUADSPI_BK1_IO1,<br>SDMMC1_D2, EVENTOUT | -                       |
| 52          | 79      | 112     | B13      | 140     | 79          | C5       | B13      | B10      | 112     | 140     | PC11                                                 | I/O      | FT            | -     | SPI3_MISO, USART3_RX,<br>UART4_RX, QUADSPI_BK2_NCS,<br>SDMMC1_D3, EVENTOUT        | -                       |
| 53          | 80      | 113     | A12      | 141     | 80          | D5       | A12      | C10      | 113     | 141     | PC12                                                 | I/O      | FT            | -     | TRACED3, SPI3_MOSI/I2S3_SD,<br>USART3_CK, UART5_TX,<br>SDMMC1_CK, EVENTOUT        | -                       |
| -           | 81      | 114     | B12      | 142     | 81          | B5       | B12      | E10      | 114     | 142     | PD0                                                  | I/O      | FT            | -     | CAN1_RX, FMC_D2, EVENTOUT                                                         | -                       |
| -           | 82      | 115     | C12      | 143     | 82          | A4       | C12      | D10      | 115     | 143     | PD1                                                  | I/O      | FT            | -     | CAN1_TX, FMC_D3, EVENTOUT                                                         | -                       |
| 54          | 83      | 116     | D12      | 144     | 83          | E5       | D12      | E9       | 116     | 144     | PD2                                                  | I/O      | FT            | -     | TRACED2, TIM3_ETR,<br>UART5_RX, SDMMC1_CMD,<br>EVENTOUT                           | -                       |
| -           | 84      | 117     | D11      | 145     | 84          | C6       | D11      | D9       | 117     | 145     | PD3                                                  | I/O      | FT            | -     | SPI2_SCK/I2S2_CK,<br>USART2_CTS, FMC_CLK,<br>EVENTOUT                             | -                       |
| -           | 85      | 118     | D10      | 146     | 85          | B6       | D10      | C9       | 118     | 146     | PD4                                                  | I/O      | FT            | -     | USART2_RTS, FMC_NOE,<br>EVENTOUT                                                  | -                       |
| -           | 86      | 119     | C11      | 147     | 86          | A5       | C11      | B9       | 119     | 147     | PD5                                                  | I/O      | FT            | -     | USART2_TX, FMC_NWE,<br>EVENTOUT                                                   | -                       |
| -           | -       | 120     | D8       | 148     | -           | -        | D8       | E7       | 120     | 148     | VSS                                                  | S        | -             | -     | -                                                                                 | -                       |
| -           | -       | 121     | C8       | 149     | -           | -        | C8       | F7       | 121     | 149     | VDDSDMMC                                             | S        | -             | -     | -                                                                                 | -                       |

Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                               | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|-----------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                   |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                   |                         |
| -           | 87      | 122     | B11      | 150     | 87          | D6       | B11      | A8       | 122     | 150     | PD6                                                  | I/O      | FT            | -     | SPI3_MOSI/I2S3_SD, SAI1_SD_A,<br>USART2_RX, SDMMC2_CK,<br>FMC_NWAIT, EVENTOUT     | -                       |
| -           | 88      | 123     | A11      | 151     | 88          | E6       | A11      | A9       | 123     | 151     | PD7                                                  | I/O      | FT            | -     | USART2_CK SDMMC2_CMD,<br>FMC_NE1, EVENTOUT                                        | -                       |
| -           | -       | 124     | C10      | 152     | -           | -        | C10      | E8       | 124     | 152     | PG9                                                  | I/O      | FT            | -     | USART6_RX, QUADSPI_BK2_IO2,<br>SAI2_FS_B, SDMMC2_D0,<br>FMC_NE2/FMC_NCE, EVENTOUT | -                       |
| -           | -       | 125     | B10      | 153     | -           | -        | B10      | D8       | 125     | 153     | PG10                                                 | I/O      | FT            | -     | SAI2_SD_B, SDMMC2_D1,<br>FMC_NE3, EVENTOUT                                        | -                       |
| -           | -       | 126     | B9       | 154     | -           | -        | B9       | C8       | 126     | 154     | PG11                                                 | I/O      | FT            | -     | SDMMC2_D2, FMC_INT,<br>EVENTOUT                                                   | -                       |
| -           | -       | 127     | B8       | 155     | -           | -        | B8       | B8       | 127     | 155     | PG12                                                 | I/O      | FT            | -     | LPTIM1_IN1, USART6_RTS,<br>SDMMC2_D3, FMC_NE4,<br>EVENTOUT                        | -                       |
| -           | -       | 128     | A8       | 156     | -           | -        | A8       | D7       | 128     | 156     | PG13                                                 | I/O      | FT            | -     | TRACED0, LPTIM1_OUT,<br>USART6_CTS, FMC_A24,<br>EVENTOUT                          | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes          | Alternate functions                                                                                         | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|----------------|-------------------------------------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |                |                                                                                                             |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |                |                                                                                                             |                         |
| -           | -       | 129     | A7       | 157     | -           | -        | A7       | C7       | 129     | 157     | PG14                                                 | I/O      | FT            | -              | TRACED1, LPTIM1_ETR,<br>USART6_TX, QUADSPI_BK2_IO3,<br>FMC_A25, EVENTOUT                                    | -                       |
| -           | -       | 130     | D7       | 158     | -           | -        | D7       | -        | 130     | 158     | VSS                                                  | S        | -             | -              | -                                                                                                           | -                       |
| -           | -       | 131     | C7       | 159     | -           | -        | C7       | F6       | 131     | 159     | VDD                                                  | S        | -             | -              | -                                                                                                           | -                       |
| -           | -       | 132     | B7       | 160     | -           | -        | B7       | B7       | 132     | 160     | PG15                                                 | I/O      | FT            | -              | USART6_CTS, FMC_SDNCAS,<br>EVENTOUT                                                                         | -                       |
| 55          | 89      | 133     | A10      | 161     | 89          | A6       | A10      | A7       | 133     | 161     | PB3(JTDO/TRACESWO)                                   | I/O      | FT            | -              | JTDO/TRACESWO, TIM2_CH2,<br>SPI1_SCK/I2S1_CK,<br>SPI3_SCK/I2S3_CK,<br>SDMMC2_D2, EVENTOUT                   | -                       |
| 56          | 90      | 134     | A9       | 162     | 90          | B7       | A9       | A6       | 134     | 162     | PB4(NJTRST)                                          | I/O      | FT            | -              | NJTRST, TIM3_CH1, SPI1_MISO,<br>SPI3_MISO, SPI2_NSS/I2S2_WS,<br>SDMMC2_D3, EVENTOUT                         | -                       |
| 57          | 91      | 135     | A6       | 163     | 91          | C7       | A6       | B6       | 135     | 163     | PB5                                                  | I/O      | FT            | <sup>(4)</sup> | TIM3_CH2, I2C1_SMBA,<br>SPI1_MOSI/I2S1_SD,<br>SPI3_MOSI/I2S3_SD,<br>OTG_HS_ULPI_D7,<br>FMC_SDCKE1, EVENTOUT | -                       |

Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                                                                               | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|---------------------------------------------------------------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                                                                                   |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                                                                                   |                         |
| 58          | 92      | 136     | B6       | 164     | 92          | D7       | B6       | C6       | 136     | 164     | PB6                                                  | I/O      | FTf           | -     | TIM4_CH1, I2C1_SCL,<br>USART1_TX,<br>QUAD SPI_BK1_NCS,<br>FMC_SDNE1, EVENTOUT                     | -                       |
| 59          | 93      | 137     | B5       | 165     | 93          | B8       | B5       | D6       | 137     | 165     | PB7                                                  | I/O      | FTf           | -     | TIM4_CH2, I2C1_SDA,<br>USART1_RX, FMC_NL,<br>EVENTOUT                                             | -                       |
| 60          | 94      | 138     | D6       | 166     | 94          | A7       | D6       | D5       | 138     | 166     | BOOT                                                 | I        | B             | -     | -                                                                                                 | VPP                     |
| 61          | 95      | 139     | A5       | 167     | 95          | C8       | A5       | C5       | 139     | 167     | PB8                                                  | I/O      | FTf           | -     | TIM4_CH3, TIM10_CH1,<br>I2C1_SCL, CAN1_RX,<br>SDMMC2_D4, SDMMC1_D4,<br>EVENTOUT                   | -                       |
| 62          | 96      | 140     | B4       | 168     | 96          | D8       | B4       | B5       | 140     | 168     | PB9                                                  | I/O      | FTf           | -     | TIM4_CH4, TIM11_CH1,<br>I2C1_SDA, SPI2_NSS/I2S2_WS,<br>CAN1_TX, SDMMC2_D5,<br>SDMMC1_D5, EVENTOUT | -                       |
| -           | 97      | 141     | A4       | 169     | 97          | E7       | A4       | A5       | 141     | 169     | PE0                                                  | I/O      | FT            | -     | TIM4_ETR, LPTIM1_ETR,<br>UART8_Rx, SAI2_MCK_A,<br>FMC_NBL0, EVENTOUT                              | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions                          | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|----------------------------------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                                              |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                                              |                         |
| -           | 98      | 142     | A3       | 170     | 98          | B9       | A3       | A4       | 142     | 170     | PE1                                                  | I/O      | FT            | -     | LPTIM1_IN2, UART8_Tx,<br>FMC_NBL1, EVENTOUT  | -                       |
| 63          | 99      | -       | D5       | -       | 99          | A8       | D5       | E6       | -       | -       | VSS                                                  | S        | -             | -     | -                                            | -                       |
| -           | -       | 143     | C6       | 171     | -           | -        | C6       | E5       | 143     | 171     | PDR_ON                                               | S        | -             | -     | -                                            | -                       |
| 64          | 100     | 144     | C5       | 172     | 100         | A9       | C5       | F5       | 144     | 172     | VDD                                                  | S        | -             | -     | -                                            | -                       |
| -           | -       | -       | D4       | 173     | -           | -        | D4       | -        | -       | 173     | PI4                                                  | I/O      | FT            | -     | TIM8_BKIN, SAI2_MCK_A,<br>FMC_NBL2, EVENTOUT | -                       |
| -           | -       | -       | C4       | 174     | -           | -        | C4       | -        | -       | 174     | PI5                                                  | I/O      | FT            | -     | TIM8_CH1, SAI2_SCK_A,<br>FMC_NBL3, EVENTOUT  | -                       |
| -           | -       | -       | C3       | 175     | -           | -        | C3       | -        | -       | 175     | PI6                                                  | I/O      | FT            | -     | TIM8_CH2, SAI2_SD_A,<br>FMC_D28, EVENTOUT    | -                       |
| -           | -       | -       | C2       | 176     | -           | -        | C2       | -        | -       | 176     | PI7                                                  | I/O      | FT            | -     | TIM8_CH3, SAI2_FS_A,<br>FMC_D29, EVENTOUT    | -                       |
| -           | -       | -       | F6       | -       | -           | -        | F6       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                                            | -                       |
| -           | -       | -       | F7       | -       | -           | -        | F7       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                                            | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|---------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                     |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                     |                         |
| -           | -       | -       | F8       | -       | -           | -        | F8       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | F9       | -       | -           | -        | F9       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | F10      | -       | -           | -        | F10      | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | G6       | -       | -           | -        | G6       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | G7       | -       | -           | -        | G7       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | G8       | -       | -           | -        | G8       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | G9       | -       | -           | -        | G9       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | G10      | -       | -           | -        | G10      | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | H6       | -       | -           | -        | H6       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | H7       | -       | -           | -        | H7       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | H8       | -       | -           | -        | H8       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | H9       | -       | -           | -        | H9       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | H10      | -       | -           | -        | H10      | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | J6       | -       | -           | -        | J6       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | J7       | -       | -           | -        | J7       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | J8       | -       | -           | -        | J8       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | J9       | -       | -           | -        | J9       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | J10      | -       | -           | -        | J10      | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | K6       | -       | -           | -        | K6       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | K7       | -       | -           | -        | K7       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | K8       | -       | -           | -        | K8       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |



Table 10. STM32F722xx and STM32F723xx pin and ball definition (continued)

| Pin number  |         |         |          |         |             |          |          |          |         |         | Pin name<br>(function after<br>reset) <sup>(1)</sup> | Pin type | I/O structure | Notes | Alternate functions | Additional<br>functions |
|-------------|---------|---------|----------|---------|-------------|----------|----------|----------|---------|---------|------------------------------------------------------|----------|---------------|-------|---------------------|-------------------------|
| STM32F722xx |         |         |          |         | STM32F723xx |          |          |          |         |         |                                                      |          |               |       |                     |                         |
| LQFP64      | LQFP100 | LQFP144 | UFBGA176 | LQFP176 | LQFP100     | WLCSP100 | UFBGA176 | UFBGA144 | LQFP144 | LQFP176 |                                                      |          |               |       |                     |                         |
| -           | -       | -       | K9       | -       | -           | -        | K9       | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |
| -           | -       | -       | K10      | -       | -           | -        | K10      | -        | -       | -       | VSS                                                  | S        | -             | -     | -                   | -                       |

- Function availability depends on the chosen device.
- PC13, PC14, PC15 and PI8 are supplied through the power switch. Since the switch only sinks a limited amount of current (3 mA), the use of GPIOs PC13 to PC15 and PI8 in output mode is limited:
  - The speed should not exceed 2 MHz with a maximum load of 30 pF.
  - These I/Os must not be used as a current source (e.g. to drive an LED).
- Main function after the first backup domain power-up. Later on, it depends on the contents of the RTC registers even after reset (because these registers are not reset by the main reset).
- ULPI signals not available on the STM32F723xx devices.
- If the device is in regulator OFF/internal reset ON mode (BYPASS\_REG pin is set to VDD), then PA0 is used as an internal reset (active low).



Table 11. FMC pin definition

| Pin name | NOR/PSRAM/<br>SRAM | NOR/PSRAM<br>Mux | NAND16 | SDRAM |
|----------|--------------------|------------------|--------|-------|
| PF0      | A0                 | -                | -      | A0    |
| PF1      | A1                 | -                | -      | A1    |
| PF2      | A2                 | -                | -      | A2    |
| PF3      | A3                 | -                | -      | A3    |
| PF4      | A4                 | -                | -      | A4    |
| PF5      | A5                 | -                | -      | A5    |
| PF12     | A6                 | -                | -      | A6    |
| PF13     | A7                 | -                | -      | A7    |
| PF14     | A8                 | -                | -      | A8    |
| PF15     | A9                 | -                | -      | A9    |
| PG0      | A10                | -                | -      | A10   |
| PG1      | A11                | -                | -      | A11   |
| PG2      | A12                | -                | -      | A12   |
| PG3      | A13                | -                | -      | -     |
| PG4      | A14                | -                | -      | BA0   |
| PG5      | A15                | -                | -      | BA1   |
| PD11     | A16                | A16              | CLE    | -     |
| PD12     | A17                | A17              | ALE    | -     |
| PD13     | A18                | A18              | -      | -     |
| PE3      | A19                | A19              | -      | -     |
| PE4      | A20                | A20              | -      | -     |
| PE5      | A21                | A21              | -      | -     |
| PE6      | A22                | A22              | -      | -     |
| PE2      | A23                | A23              | -      | -     |
| PG13     | A24                | A24              | -      | -     |
| PG14     | A25                | A25              | -      | -     |
| PD14     | D0                 | DA0              | D0     | D0    |
| PD15     | D1                 | DA1              | D1     | D1    |
| PD0      | D2                 | DA2              | D2     | D2    |
| PD1      | D3                 | DA3              | D3     | D3    |
| PE7      | D4                 | DA4              | D4     | D4    |
| PE8      | D5                 | DA5              | D5     | D5    |
| PE9      | D6                 | DA6              | D6     | D6    |
| PE10     | D7                 | DA7              | D7     | D7    |

Table 11. FMC pin definition (continued)

| Pin name | NOR/PSRAM/<br>SRAM | NOR/PSRAM<br>Mux | NAND16 | SDRAM |
|----------|--------------------|------------------|--------|-------|
| PE11     | D8                 | DA8              | D8     | D8    |
| PE12     | D9                 | DA9              | D9     | D9    |
| PE13     | D10                | DA10             | D10    | D10   |
| PE14     | D11                | DA11             | D11    | D11   |
| PE15     | D12                | DA12             | D12    | D12   |
| PD8      | D13                | DA13             | D13    | D13   |
| PD9      | D14                | DA14             | D14    | D14   |
| PD10     | D15                | DA15             | D15    | D15   |
| PH8      | D16                | -                | -      | D16   |
| PH9      | D17                | -                | -      | D17   |
| PH10     | D18                | -                | -      | D18   |
| PH11     | D19                | -                | -      | D19   |
| PH12     | D20                | -                | -      | D20   |
| PH13     | D21                | -                | -      | D21   |
| PH14     | D22                | -                | -      | D22   |
| PH15     | D23                | -                | -      | D23   |
| PI0      | D24                | -                | -      | D24   |
| PI1      | D25                | -                | -      | D25   |
| PI2      | D26                | -                | -      | D26   |
| PI3      | D27                | -                | -      | D27   |
| PI6      | D28                | -                | -      | D28   |
| PI7      | D29                | -                | -      | D29   |
| PI9      | D30                | -                | -      | D30   |
| PI10     | D31                | -                | -      | D31   |
| PD7      | NE1                | NE1              | -      | -     |
| PG9      | NE2                | NE2              | NCE    | -     |
| PG10     | NE3                | NE3              | -      | -     |
| PG11     | -                  | -                | -      | -     |
| PG12     | NE4                | NE4              | -      | -     |
| PD3      | CLK                | CLK              | -      | -     |
| PD4      | NOE                | NOE              | NOE    | -     |
| PD5      | NWE                | NWE              | NWE    | -     |
| PD6      | NWAIT              | NWAIT            | NWAIT  | -     |
| PB7      | NADV               | NADV             | -      | -     |

Table 11. FMC pin definition (continued)

| Pin name | NOR/PSRAM/<br>SRAM | NOR/PSRAM<br>Mux | NAND16 | SDRAM  |
|----------|--------------------|------------------|--------|--------|
| PF6      | -                  | -                | -      | -      |
| PF7      | -                  | -                | -      | -      |
| PF8      | -                  | -                | -      | -      |
| PF9      | -                  | -                | -      | -      |
| PF10     | -                  | -                | -      | -      |
| PG6      | -                  | -                | -      | -      |
| PG7      | -                  | -                | INT    | -      |
| PE0      | NBL0               | NBL0             | -      | NBL0   |
| PE1      | NBL1               | NBL1             | -      | NBL1   |
| PI4      | NBL2               | -                | -      | NBL2   |
| PI5      | NBL3               | -                | -      | NBL3   |
| PG8      | -                  | -                | -      | SDCLK  |
| PC0      | -                  | -                | -      | SDNWE  |
| PF11     | -                  | -                | -      | SDNRAS |
| PG15     | -                  | -                | -      | SDNCAS |
| PH2      | -                  | -                | -      | SDCKE0 |
| PH3      | -                  | -                | -      | SDNE0  |
| PH6      | -                  | -                | -      | SDNE1  |
| PH7      | -                  | -                | -      | SDCKE1 |
| PH5      | -                  | -                | -      | SDNWE  |
| PC2      | -                  | -                | -      | SDNE0  |
| PC3      | -                  | -                | -      | SDCKE0 |
| PB5      | -                  | -                | -      | SDCKE1 |
| PB6      | -                  | -                | -      | SDNE1  |



Table 12. STM32F722xx and STM32F723xx alternate function mapping

| Port   |      | AF0  | AF1                       | AF2      | AF3                     | AF4                 | AF5                                              | AF6                                                      | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|------|---------------------------|----------|-------------------------|---------------------|--------------------------------------------------|----------------------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS  | TIM1/2                    | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SPI4/5 | SPI2/I2S2/<br>SPI3/I2S3/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port A | PA0  | -    | TIM2_CH1<br>/TIM2_<br>ETR | TIM5_CH1 | TIM8_ETR                | -                   | -                                                | -                                                        | USART2_<br>CTS                                   | UART4_TX                                | -                                                    | SAI2_SD_B                                           | -      | -                                    | EVEN<br>TOUT |
|        | PA1  | -    | TIM2_CH2                  | TIM5_CH2 | -                       | -                   | -                                                | -                                                        | USART2_<br>RTS                                   | UART4_RX                                | QUADSPI_<br>BK1_IO3                                  | SAI2_<br>MCK_B                                      | -      | -                                    | EVEN<br>TOUT |
|        | PA2  | -    | TIM2_CH3                  | TIM5_CH3 | TIM9_CH1                | -                   | -                                                | -                                                        | USART2_TX                                        | SAI2_SCK_B                              | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PA3  | -    | TIM2_CH4                  | TIM5_CH4 | TIM9_CH2                | -                   | -                                                | -                                                        | USART2_RX                                        | -                                       | -                                                    | OTG_HS_<br>ULPI_D0                                  | -      | -                                    | EVEN<br>TOUT |
|        | PA4  | -    | -                         | -        | -                       | -                   | SPI1_NSS<br>/I2S1_WS                             | SPI3_NSS<br>/I2S3_WS                                     | USART2_CK                                        | -                                       | -                                                    | -                                                   | -      | OTG_HS_<br>SOF                       | EVEN<br>TOUT |
|        | PA5  | -    | TIM2_CH1<br>/TIM2_<br>ETR | -        | TIM8_CH1N               | -                   | SPI1_SCK<br>/I2S1_CK                             | -                                                        | -                                                | -                                       | -                                                    | OTG_HS_<br>ULPI_CK                                  | -      | -                                    | EVEN<br>TOUT |
|        | PA6  | -    | TIM1_<br>BKIN             | TIM3_CH1 | TIM8_BKIN               | -                   | SPI1_<br>MISO                                    | -                                                        | -                                                | -                                       | TIM13_CH1                                            | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PA7  | -    | TIM1_<br>CH1N             | TIM3_CH2 | TIM8_CH1N               | -                   | SPI1_MO<br>SI/I2S1_S<br>D                        | -                                                        | -                                                | -                                       | TIM14_CH1                                            | -                                                   | -      | FMC_SDN<br>WE                        | EVEN<br>TOUT |
|        | PA8  | MCO1 | TIM1_CH1                  | -        | TIM8_BKIN2              | I2C3_SCL            | -                                                | -                                                        | USART1_CK                                        | -                                       | -                                                    | OTG_FS_<br>SOF                                      | -      | -                                    | EVEN<br>TOUT |
|        | PA9  | -    | TIM1_CH2                  | -        | -                       | I2C3_SMB<br>A       | SPI2_SCK<br>/I2S2_CK                             | -                                                        | USART1_TX                                        | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PA10 | -    | TIM1_CH3                  | -        | -                       | -                   | -                                                | -                                                        | USART1_RX                                        | -                                       | -                                                    | OTG_FS_ID                                           | -      | -                                    | EVEN<br>TOUT |
|        | PA11 | -    | TIM1_CH4                  | -        | -                       | -                   | -                                                | -                                                        | USART1_<br>CTS                                   | -                                       | CAN1_RX                                              | OTG_FS_<br>DM                                       | -      | -                                    | EVEN<br>TOUT |

**Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)**

| Port   |      | AF0               | AF1                       | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|-------------------|---------------------------|----------|-------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS               | TIM1/2                    | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port A | PA12 | -                 | TIM1_ETR                  | -        | -                       | -                   | -                                                        | -                                          | USART1_<br>RTS                                   | SAI2_FS_B                               | CAN1_TX                                              | OTG_FS_DP                                           | -      | -                                    | EVEN<br>TOUT |
|        | PA13 | JTMS-<br>SWDIO    | -                         | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PA14 | JTCK-<br>SWCLK    | -                         | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PA15 | JTDI              | TIM2_CH1<br>/TIM2_<br>ETR | -        | -                       | -                   | SPI1_NSS<br>/I2S1_WS                                     | SPI3_NSS<br>/I2S3_WS                       | -                                                | UART4_RTS                               | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
| Port B | PB0  | -                 | TIM1_<br>CH2N             | TIM3_CH3 | TIM8_CH2N               | -                   | -                                                        | -                                          | -                                                | UART4_CTS                               | -                                                    | OTG_HS_<br>ULPI_D1                                  | -      | -                                    | EVEN<br>TOUT |
|        | PB1  | -                 | TIM1_<br>CH3N             | TIM3_CH4 | TIM8_CH3N               | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | OTG_HS_<br>ULPI_D2                                  | -      | -                                    | EVEN<br>TOUT |
|        | PB2  | -                 | -                         | -        | -                       | -                   | -                                                        | SAI1_<br>SD_A                              | SPI3_MOSI<br>/I2S3_SD                            | -                                       | QUADSPI_<br>CLK                                      | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PB3  | JTDO/TR<br>ACESWO | TIM2_CH2                  | -        | -                       | -                   | SPI1_SCK<br>/I2S1_CK                                     | SPI3_SCK<br>/I2S3_CK                       | -                                                | -                                       | -                                                    | SDMMC2_<br>D2                                       | -      | -                                    | EVEN<br>TOUT |
|        | PB4  | NJTRST            | -                         | TIM3_CH1 | -                       | -                   | SPI1_<br>MISO                                            | SPI3_<br>MISO                              | SPI2_NSS<br>/I2S2_WS                             | -                                       | -                                                    | SDMMC2_<br>D3                                       | -      | -                                    | EVEN<br>TOUT |
|        | PB5  | -                 | -                         | TIM3_CH2 | -                       | I2C1_<br>SMBA       | SPI1_<br>MOSI/<br>I2S1_SD                                | SPI3_<br>MOSI/<br>I2S3_SD                  | -                                                | -                                       | -                                                    | OTG_HS_<br>ULPI_D7                                  | -      | FMC_<br>SDCKE1                       | EVEN<br>TOUT |
|        | PB6  | -                 | -                         | TIM4_CH1 | -                       | I2C1_SCL            | -                                                        | -                                          | USART1_TX                                        | -                                       | -                                                    | QUADSPI_<br>BK1_NCS                                 | -      | FMC_<br>SDNE1                        | EVEN<br>TOUT |
|        | PB7  | -                 | -                         | TIM4_CH2 | -                       | I2C1_SDA            | -                                                        | -                                          | USART1_RX                                        | -                                       | -                                                    | -                                                   | -      | FMC_NL                               | EVEN<br>TOUT |
|        | PB8  | -                 | -                         | TIM4_CH3 | TIM10_CH1               | I2C1_SCL            | -                                                        | -                                          | -                                                | -                                       | CAN1_RX                                              | SDMMC2_<br>D4                                       | -      | SDMMC1_<br>_D4                       | EVEN<br>TOUT |



Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0       | AF1       | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                                      | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15      |
|--------|------|-----------|-----------|----------|-------------------------|---------------------|----------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|-----------|
|        |      | SYS       | TIM1/2    | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS       |
| Port B | PB9  | -         | -         | TIM4_CH4 | TIM11_CH1               | I2C1_SDA            | SPI2_NSS<br>/I2S2_WS                                     | -                                                        | -                                                | -                                       | CAN1_TX                                              | SDMMC2_D5                                           | -      | SDMMC1_D5                            | EVEN TOUT |
|        | PB10 | -         | TIM2_CH3  | -        | -                       | I2C2_SCL            | SPI2_SCK<br>/I2S2_CK                                     | -                                                        | USART3_TX                                        | -                                       | -                                                    | OTG_HS_ULPI_D3                                      | -      | -                                    | EVEN TOUT |
|        | PB11 | -         | TIM2_CH4  | -        | -                       | I2C2_SDA            | -                                                        | -                                                        | USART3_RX                                        | -                                       | -                                                    | OTG_HS_ULPI_D4                                      | -      | -                                    | EVEN TOUT |
|        | PB12 | -         | TIM1_BKIN | -        | -                       | I2C2_SMBA           | SPI2_NSS<br>/I2S2_WS                                     | -                                                        | USART3_CK                                        | -                                       | -                                                    | OTG_HS_ULPI_D5                                      | -      | OTG_HS_ID                            | EVEN TOUT |
|        | PB13 | -         | TIM1_CH1N | -        | -                       | -                   | SPI2_SCK<br>/I2S2_CK                                     | -                                                        | USART3_CTS                                       | -                                       | -                                                    | OTG_HS_ULPI_D6                                      | -      | -                                    | EVEN TOUT |
|        | PB14 | -         | TIM1_CH2N | -        | TIM8_CH2N               | -                   | SPI2_MISO                                                | -                                                        | USART3_RTS                                       | -                                       | TIM12_CH1                                            | SDMMC2_D0                                           | -      | OTG_HS_DM                            | EVEN TOUT |
|        | PB15 | RTC_REFIN | TIM1_CH3N | -        | TIM8_CH3N               | -                   | SPI2_MOSI/<br>I2S2_SD                                    | -                                                        | -                                                | -                                       | TIM12_CH2                                            | SDMMC2_D1                                           | -      | OTG_HS_DP                            | EVEN TOUT |
| Port C | PC0  | -         | -         | -        | -                       | -                   | -                                                        | -                                                        | -                                                | SAI2_FS_B                               | -                                                    | OTG_HS_ULPI_STP                                     | -      | FMC_SDNWE                            | EVEN TOUT |
|        | PC1  | TRACED0   | -         | -        | -                       | -                   | SPI2_MOSI/<br>I2S2_SD                                    | SAI1_SD_A                                                | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN TOUT |
|        | PC2  | -         | -         | -        | -                       | -                   | SPI2_MISO                                                | -                                                        | -                                                | -                                       | -                                                    | OTG_HS_ULPI_DIR                                     | -      | FMC_SDNE0                            | EVEN TOUT |
|        | PC3  | -         | -         | -        | -                       | -                   | SPI2_MOSI/<br>I2S2_SD                                    | -                                                        | -                                                | -                                       | -                                                    | OTG_HS_ULPI_NXT                                     | -      | FMC_SDCKE0                           | EVEN TOUT |

Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0     | AF1    | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|---------|--------|----------|-------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS     | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port C | PC4  | -       | -      | -        | -                       | -                   | I2S1_MCK                                                 | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_S<br>DNE0                        | EVEN<br>TOUT |
|        | PC5  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC<br>SDCKE0                        | EVEN<br>TOUT |
|        | PC6  | -       | -      | TIM3_CH1 | TIM8_CH1                | -                   | I2S2_MCK                                                 | -                                          | -                                                | USART6_TX                               | -                                                    | SDMMC2_<br>D6                                       | -      | SDMMC1_<br>D6                        | EVEN<br>TOUT |
|        | PC7  | -       | -      | TIM3_CH2 | TIM8_CH2                | -                   | I2S3_MCK                                                 | -                                          | -                                                | USART6_RX                               | -                                                    | SDMMC2_<br>D7                                       | -      | SDMMC1_<br>D7                        | EVEN<br>TOUT |
|        | PC8  | TRACED1 | -      | TIM3_CH3 | TIM8_CH3                | -                   | -                                                        | -                                          | UART5_RTS                                        | USART6_CK                               | -                                                    | -                                                   | -      | SDMMC1_<br>D0                        | EVEN<br>TOUT |
|        | PC9  | MCO2    | -      | TIM3_CH4 | TIM8_CH4                | I2C3_SDA            | I2S_CKIN                                                 | -                                          | UART5_CTS                                        | -                                       | QUADSPI_<br>BK1_IO0                                  | -                                                   | -      | SDMMC1_<br>D1                        | EVEN<br>TOUT |
|        | PC10 | -       | -      | -        | -                       | -                   | -                                                        | SPI3_SCK<br>/I2S3_CK                       | USART3_TX                                        | UART4_TX                                | QUADSPI_<br>BK1_IO1                                  | -                                                   | -      | SDMMC1_<br>D2                        | EVEN<br>TOUT |
|        | PC11 | -       | -      | -        | -                       | -                   | -                                                        | SPI3_<br>MISO                              | USART3_RX                                        | UART4_RX                                | QUADSPI_<br>BK2_NCS                                  | -                                                   | -      | SDMMC1_<br>D3                        | EVEN<br>TOUT |
|        | PC12 | TRACED3 | -      | -        | -                       | -                   | -                                                        | SPI3_<br>MOSI/<br>I2S3_SD                  | USART3_CK                                        | UART5_TX                                | -                                                    | -                                                   | -      | SDMMC1_<br>CK                        | EVEN<br>TOUT |
|        | PC13 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PC14 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PC15 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |



Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0     | AF1    | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11       | AF12                                 | AF15         |
|--------|------|---------|--------|----------|-------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|------------|--------------------------------------|--------------|
|        |      | SYS     | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2     | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port D | PD0  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | CAN1_RX                                              | -                                                   | -          | FMC_D2                               | EVEN<br>TOUT |
|        | PD1  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | CAN1_TX                                              | -                                                   | -          | FMC_D3                               | EVEN<br>TOUT |
|        | PD2  | TRACED2 | -      | TIM3_ETR | -                       | -                   | -                                                        | -                                          | -                                                | UART5_RX                                | -                                                    | -                                                   | -          | SDMMC1_CMD                           | EVEN<br>TOUT |
|        | PD3  | -       | -      | -        | -                       | -                   | SPI2_SCK<br>/I2S2_CK                                     | -                                          | USART2_CTS                                       | -                                       | -                                                    | -                                                   | -          | FMC_CLK                              | EVEN<br>TOUT |
|        | PD4  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART2_RTS                                       | -                                       | -                                                    | -                                                   | -          | FMC_NOE                              | EVEN<br>TOUT |
|        | PD5  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART2_TX                                        | -                                       | -                                                    | -                                                   | -          | FMC_NWE                              | EVEN<br>TOUT |
|        | PD6  | -       | -      | -        | -                       | -                   | SPI3_MOSI/<br>I2S3_SD                                    | SAI1_SD_A                                  | USART2_RX                                        | -                                       | -                                                    | -                                                   | SDMMC2_CK  | FMC_NWAIT                            | EVEN<br>TOUT |
|        | PD7  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART2_CK                                        | -                                       | -                                                    | -                                                   | SDMMC2_CMD | FMC_NE1                              | EVEN<br>TOUT |
|        | PD8  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART3_TX                                        | -                                       | -                                                    | -                                                   | -          | FMC_D13                              | EVEN<br>TOUT |
|        | PD9  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART3_RX                                        | -                                       | -                                                    | -                                                   | -          | FMC_D14                              | EVEN<br>TOUT |
|        | PD10 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART3_CK                                        | -                                       | -                                                    | -                                                   | -          | FMC_D15                              | EVEN<br>TOUT |
|        | PD11 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | USART3_CTS                                       | -                                       | QUADSPI_BK1_IO0                                      | SAI2_SD_A                                           | -          | FMC_A16/<br>FMC_CLE                  | EVEN<br>TOUT |
|        | PD12 | -       | -      | TIM4_CH1 | LPTIM1_IN1              | -                   | -                                                        | -                                          | USART3_RTS                                       | -                                       | QUADSPI_BK1_IO1                                      | SAI2_FS_A                                           | -          | FMC_A17/<br>FMC_ALE                  | EVEN<br>TOUT |
|        | PD13 | -       | -      | TIM4_CH2 | LPTIM1_OUT              | -                   | -                                                        | -                                          | -                                                | -                                       | QUADSPI_BK1_IO3                                      | SAI2_SCK_A                                          | -          | FMC_A18                              | EVEN<br>TOUT |
|        | PD14 | -       | -      | TIM4_CH3 | -                       | -                   | -                                                        | -                                          | -                                                | UART8_CTS                               | -                                                    | -                                                   | -          | FMC_D0                               | EVEN<br>TOUT |
|        | PD15 | -       | -      | TIM4_CH4 | -                       | -                   | -                                                        | -                                          | -                                                | UART8_RTS                               | -                                                    | -                                                   | -          | FMC_D1                               | EVEN<br>TOUT |





Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0      | AF1        | AF2      | AF3                     | AF4                 | AF5                                              | AF6                                | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15      |
|--------|------|----------|------------|----------|-------------------------|---------------------|--------------------------------------------------|------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|-----------|
|        |      | SYS      | TIM1/2     | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SPI4/5 | SPI2/I2S2/<br>SPI3/I2S3/<br>SPI4/5 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS       |
| Port E | PE0  | -        | -          | TIM4_ETR | LPTIM1_ETR              | -                   | -                                                | -                                  | -                                                | UART8_Rx                                | -                                                    | SAI2_MCK_A                                          | -      | FMC_NBL0                             | EVEN TOUT |
|        | PE1  | -        | -          | -        | LPTIM1_IN2              | -                   | -                                                | -                                  | -                                                | UART8_Tx                                | -                                                    | -                                                   | -      | FMC_NBL1                             | EVEN TOUT |
|        | PE2  | TRACECLK | -          | -        | -                       | -                   | SPI4_SCK                                         | SAI1_MCLK_A                        | -                                                | -                                       | QUADSPI_BK1_IO2                                      | -                                                   | -      | FMC_A23                              | EVEN TOUT |
|        | PE3  | TRACED0  | -          | -        | -                       | -                   | -                                                | SAI1_SD_B                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A19                              | EVEN TOUT |
|        | PE4  | TRACED1  | -          | -        | -                       | -                   | SPI4_NSS                                         | SAI1_FS_A                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A20                              | EVEN TOUT |
|        | PE5  | TRACED2  | -          | -        | TIM9_CH1                | -                   | SPI4_MISO                                        | SAI1_SCK_A                         | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A21                              | EVEN TOUT |
|        | PE6  | TRACED3  | TIM1_BKIN2 | -        | TIM9_CH2                | -                   | SPI4_MOSI                                        | SAI1_SD_A                          | -                                                | -                                       | -                                                    | SAI2_MCK_B                                          | -      | FMC_A22                              | EVEN TOUT |
|        | PE7  | -        | TIM1_ETR   | -        | -                       | -                   | -                                                | -                                  | -                                                | UART7_Rx                                | -                                                    | QUADSPI_BK2_IO0                                     | -      | FMC_D4                               | EVEN TOUT |
|        | PE8  | -        | TIM1_CH1N  | -        | -                       | -                   | -                                                | -                                  | -                                                | UART7_Tx                                | -                                                    | QUADSPI_BK2_IO1                                     | -      | FMC_D5                               | EVEN TOUT |
|        | PE9  | -        | TIM1_CH1   | -        | -                       | -                   | -                                                | -                                  | -                                                | UART7_RTS                               | -                                                    | QUADSPI_BK2_IO2                                     | -      | FMC_D6                               | EVEN TOUT |
|        | PE10 | -        | TIM1_CH2N  | -        | -                       | -                   | -                                                | -                                  | -                                                | UART7_CTS                               | -                                                    | QUADSPI_BK2_IO3                                     | -      | FMC_D7                               | EVEN TOUT |
|        | PE11 | -        | TIM1_CH2   | -        | -                       | -                   | SPI4_NSS                                         | -                                  | -                                                | -                                       | -                                                    | SAI2_SD_B                                           | -      | FMC_D8                               | EVEN TOUT |
|        | PE12 | -        | TIM1_CH3N  | -        | -                       | -                   | SPI4_SCK                                         | -                                  | -                                                | -                                       | -                                                    | SAI2_SCK_B                                          | -      | FMC_D9                               | EVEN TOUT |
|        | PE13 | -        | TIM1_CH3   | -        | -                       | -                   | SPI4_MISO                                        | -                                  | -                                                | -                                       | -                                                    | SAI2_FS_B                                           | -      | FMC_D10                              | EVEN TOUT |
|        | PE14 | -        | TIM1_CH4   | -        | -                       | -                   | SPI4_MOSI                                        | -                                  | -                                                | -                                       | -                                                    | SAI2_MCK_B                                          | -      | FMC_D11                              | EVEN TOUT |
|        | PE15 | -        | TIM1_BKIN  | -        | -                       | -                   | -                                                | -                                  | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D12                              | EVEN TOUT |



Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0 | AF1    | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|-----|--------|----------|-------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port F | PF0  | -   | -      | -        | -                       | I2C2_SDA            | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A0                               | EVEN<br>TOUT |
|        | PF1  | -   | -      | -        | -                       | I2C2_SCL            | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A1                               | EVEN<br>TOUT |
|        | PF2  | -   | -      | -        | -                       | I2C2_<br>SMBA       | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A2                               | EVEN<br>TOUT |
|        | PF3  | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A3                               | EVEN<br>TOUT |
|        | PF4  | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A4                               | EVEN<br>TOUT |
|        | PF5  | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A5                               | EVEN<br>TOUT |
|        | PF6  | -   | -      | -        | TIM10_CH1               | -                   | SPI5_NSS                                                 | SAI1_SD<br>_B                              | -                                                | UART7_Rx                                | QUADSPI_<br>BK1_IO3                                  | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PF7  | -   | -      | -        | TIM11_CH1               | -                   | SPI5_SCK                                                 | SAI1_MCL<br>K_B                            | -                                                | UART7_Tx                                | QUADSPI_<br>BK1_IO2                                  | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PF8  | -   | -      | -        | -                       | -                   | SPI5_MISO                                                | SAI1_SCK<br>_B                             | -                                                | UART7_RTS                               | TIM13_CH1                                            | QUADSPI_<br>BK1_IO0                                 | -      | -                                    | EVEN<br>TOUT |
|        | PF9  | -   | -      | -        | -                       | -                   | SPI5_MOSI                                                | SAI1_FS<br>_B                              | -                                                | UART7_CTS                               | TIM14_CH1                                            | QUADSPI_<br>BK1_IO1                                 | -      | -                                    | EVEN<br>TOUT |
|        | PF10 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PF11 | -   | -      | -        | -                       | -                   | SPI5_MOSI                                                | -                                          | -                                                | -                                       | -                                                    | SAI2_SD_B                                           | -      | FMC_<br>SDNRAS                       | EVEN<br>TOUT |
|        | PF12 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A6                               | EVEN<br>TOUT |
|        | PF13 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A7                               | EVEN<br>TOUT |
|        | PF14 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A8                               | EVEN<br>TOUT |
|        | PF15 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_A9                               | EVEN<br>TOUT |



Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0     | AF1    | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11          | AF12                                 | AF15         |
|--------|------|---------|--------|----------|-------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|---------------|--------------------------------------|--------------|
|        |      | SYS     | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2        | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port G | PG0  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | FMC_A10                              | EVEN<br>TOUT |
|        | PG1  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | FMC_A11                              | EVEN<br>TOUT |
|        | PG2  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | FMC_A12                              | EVEN<br>TOUT |
|        | PG3  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | FMC_A13                              | EVEN<br>TOUT |
|        | PG4  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | FMC_A14/<br>FMC_BA0                  | EVEN<br>TOUT |
|        | PG5  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | FMC_A15/<br>FMC_BA1                  | EVEN<br>TOUT |
|        | PG6  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -             | -                                    | EVEN<br>TOUT |
|        | PG7  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | USART6_CK                               | -                                                    | -                                                   | -             | FMC_INT                              | EVEN<br>TOUT |
|        | PG8  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | USART6_RTS                              | -                                                    | -                                                   | -             | FMC_<br>SDCLK                        | EVEN<br>TOUT |
|        | PG9  | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | USART6_RX                               | QUADSPI_<br>BK2_IO2                                  | SAI2_FS_B                                           | SDMMC2_<br>D0 | FMC_NE2<br>/FMC_<br>NCE              | EVEN<br>TOUT |
|        | PG10 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | SAI2_SD_B                                           | SDMMC2_<br>D1 | FMC_NE3                              | EVEN<br>TOUT |
|        | PG11 | -       | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | SDMMC2_<br>D2                                       | -             | -                                    | EVEN<br>TOUT |
|        | PG12 | -       | -      | -        | LPTIM1_IN1              | -                   | -                                                        | -                                          | -                                                | USART6_RTS                              | -                                                    | -                                                   | SDMMC2_<br>D3 | FMC_NE4                              | EVEN<br>TOUT |
|        | PG13 | TRACED0 | -      | -        | LPTIM1_<br>OUT          | -                   | -                                                        | -                                          | -                                                | USART6_CTS                              | -                                                    | -                                                   | -             | FMC_A24                              | EVEN<br>TOUT |



Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0     | AF1    | AF2      | AF3                     | AF4                 | AF5                                              | AF6                                                      | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|---------|--------|----------|-------------------------|---------------------|--------------------------------------------------|----------------------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS     | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SPI4/5 | SPI2/I2S2/<br>SPI3/I2S3/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port G | PG14 | TRACED1 | -      | -        | LPTIM1_ETR              | -                   | -                                                | -                                                        | -                                                | USART6_TX                               | QUADSPI_<br>BK2_IO3                                  | -                                                   | -      | FMC_A25                              | EVEN<br>TOUT |
|        | PG15 | -       | -      | -        | -                       | -                   | -                                                | -                                                        | -                                                | USART6_CTS                              | -                                                    | -                                                   | -      | FMC_<br>SDNCAS                       | EVEN<br>TOUT |
| Port H | PH0  | -       | -      | -        | -                       | -                   | -                                                | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PH1  | -       | -      | -        | -                       | -                   | -                                                | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PH2  | -       | -      | -        | LPTIM1_IN2              | -                   | -                                                | -                                                        | -                                                | -                                       | QUADSPI_<br>BK2_IO0                                  | SAI2_SCK_B                                          | -      | FMC_<br>SDCKE0                       | EVEN<br>TOUT |
|        | PH3  | -       | -      | -        | -                       | -                   | -                                                | -                                                        | -                                                | -                                       | QUADSPI_<br>BK2_IO1                                  | SAI2_MCK_<br>B                                      | -      | FMC_<br>SDNE0                        | EVEN<br>TOUT |
|        | PH4  | -       | -      | -        | -                       | I2C2_SCL            | -                                                | -                                                        | -                                                | -                                       | -                                                    | OTG_HS_<br>ULPI_NXT                                 | -      | -                                    | EVEN<br>TOUT |
|        | PH5  | -       | -      | -        | -                       | I2C2_SDA            | SPI5_NSS                                         | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_<br>SDNWE                        | EVEN<br>TOUT |
|        | PH6  | -       | -      | -        | -                       | I2C2_<br>SMBA       | SPI5_SCK                                         | -                                                        | -                                                | -                                       | TIM12_CH1                                            | -                                                   | -      | FMC_<br>SDNE1                        | EVEN<br>TOUT |
|        | PH7  | -       | -      | -        | -                       | I2C3_SCL            | SPI5_<br>MISO                                    | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_<br>SDCKE1                       | EVEN<br>TOUT |
|        | PH8  | -       | -      | -        | -                       | I2C3_SDA            | -                                                | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D16                              | EVEN<br>TOUT |
|        | PH9  | -       | -      | -        | -                       | I2C3_SMB<br>A       | -                                                | -                                                        | -                                                | -                                       | TIM12_CH2                                            | -                                                   | -      | FMC_D17                              | EVEN<br>TOUT |
|        | PH10 | -       | -      | TIM5_CH1 | -                       | -                   | -                                                | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D18                              | EVEN<br>TOUT |
|        | PH11 | -       | -      | TIM5_CH2 | -                       | -                   | -                                                | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D19                              | EVEN<br>TOUT |
|        | PH12 | -       | -      | TIM5_CH3 | -                       | -                   | -                                                | -                                                        | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D20                              | EVEN<br>TOUT |
|        | PH13 | -       | -      | -        | TIM8_CH1N               | -                   | -                                                | -                                                        | -                                                | UART4_TX                                | CAN1_TX                                              | -                                                   | -      | FMC_D21                              | EVEN<br>TOUT |

**Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)**

| Port   |      | AF0 | AF1    | AF2      | AF3                     | AF4                 | AF5                                              | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|-----|--------|----------|-------------------------|---------------------|--------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SPI4/5 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port H | PH14 | -   | -      | -        | TIM8_CH2N               | -                   | -                                                | -                                          | -                                                | UART4_RX                                | CAN1_RX                                              | -                                                   | -      | FMC_D22                              | EVEN<br>TOUT |
|        | PH15 | -   | -      | -        | TIM8_CH3N               | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D23                              | EVEN<br>TOUT |
| Port I | PI0  | -   | -      | TIM5_CH4 | -                       | -                   | SPI2_NSS<br>/I2S2_WS                             | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D24                              | EVEN<br>TOUT |
|        | PI1  | -   | -      | -        | TIM8_BKIN2              | -                   | SPI2_SCK<br>/I2S2_CK                             | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D25                              | EVEN<br>TOUT |
|        | PI2  | -   | -      | -        | TIM8_CH4                | -                   | SPI2_MIS<br>O                                    | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D26                              | EVEN<br>TOUT |
|        | PI3  | -   | -      | -        | TIM8_ETR                | -                   | SPI2_MO<br>SI/I2S2_S<br>D                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D27                              | EVEN<br>TOUT |
|        | PI4  | -   | -      | -        | TIM8_BKIN               | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | SAI2_MCK_<br>A                                      | -      | FMC_NBL<br>2                         | EVEN<br>TOUT |
|        | PI5  | -   | -      | -        | TIM8_CH1                | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | SAI2_SCK_A                                          | -      | FMC_NBL<br>3                         | EVEN<br>TOUT |
|        | PI6  | -   | -      | -        | TIM8_CH2                | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | SAI2_SD_A                                           | -      | FMC_D28                              | EVEN<br>TOUT |
|        | PI7  | -   | -      | -        | TIM8_CH3                | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | SAI2_FS_A                                           | -      | FMC_D29                              | EVEN<br>TOUT |
|        | PI8  | -   | -      | -        | -                       | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PI9  | -   | -      | -        | -                       | -                   | -                                                | -                                          | -                                                | UART4_RX                                | CAN1_RX                                              | -                                                   | -      | FMC_D30                              | EVEN<br>TOUT |
|        | PI10 | -   | -      | -        | -                       | -                   | -                                                | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | FMC_D31                              | EVEN<br>TOUT |

Table 12. STM32F722xx and STM32F723xx alternate function mapping (continued)

| Port   |      | AF0 | AF1    | AF2      | AF3                     | AF4                 | AF5                                                      | AF6                                        | AF7                                              | AF8                                     | AF9                                                  | AF10                                                | AF11   | AF12                                 | AF15         |
|--------|------|-----|--------|----------|-------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|--------------------------------------------------|-----------------------------------------|------------------------------------------------------|-----------------------------------------------------|--------|--------------------------------------|--------------|
|        |      | SYS | TIM1/2 | TIM3/4/5 | TIM8/9/10/11/<br>LPTIM1 | I2C1/2/3/<br>USART1 | SPI1/I2S1/<br>SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/<br>SPI3/I2S3/<br>SAI1/<br>UART4 | SPI2/I2S2/S<br>PI3/I2S3/<br>USART1/2/3/<br>UART5 | SAI2/USART6<br>/UART4/5/7/8/<br>OTG1_FS | CAN1/<br>TIM12/13/14<br>/QUADSPI/<br>FMC/<br>OTG2_HS | SAI2/<br>QUADSPI/<br>SDMMC2/<br>OTG2_HS/<br>OTG1_FS | SDMMC2 | UART7/<br>FMC/<br>SDMMC1/<br>OTG2_FS | SYS          |
| Port I | PI11 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | OTG_HS_UL<br>PI_DIR                                 | -      | -                                    | EVEN<br>TOUT |
|        | PI12 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PI13 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PI14 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |
|        | PI15 | -   | -      | -        | -                       | -                   | -                                                        | -                                          | -                                                | -                                       | -                                                    | -                                                   | -      | -                                    | EVEN<br>TOUT |

## 5 Memory mapping

Refer to the product line reference manual for details on the memory mapping as well as the boundary addresses for all peripherals.

## 6 Electrical characteristics

### 6.1 Parameter conditions

Unless otherwise specified, all voltages are referenced to  $V_{SS}$ .

#### 6.1.1 Minimum and maximum values

Unless otherwise specified the minimum and maximum values are guaranteed in the worst conditions of ambient temperature, supply voltage and frequencies by tests in production on 100% of the devices with an ambient temperature at  $T_A = 25\text{ }^{\circ}\text{C}$  and  $T_A = T_{A\text{max}}$  (given by the selected temperature range).

Data based on characterization results, design simulation and/or technology characteristics are indicated in the table footnotes. Based on characterization, the minimum and maximum values refer to sample tests and represent the mean value plus or minus three times the standard deviation ( $\text{mean} \pm 3\sigma$ ).

#### 6.1.2 Typical values

Unless otherwise specified, typical data are based on  $T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 3.3\text{ V}$  (for the  $1.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$  voltage range). They are given only as design guidelines and are not tested.

Typical ADC accuracy values are determined by characterization of a batch of samples from a standard diffusion lot over the full temperature range, where 95% of the devices have an error less than or equal to the value indicated ( $\text{mean} \pm 2\sigma$ ).

#### 6.1.3 Typical curves

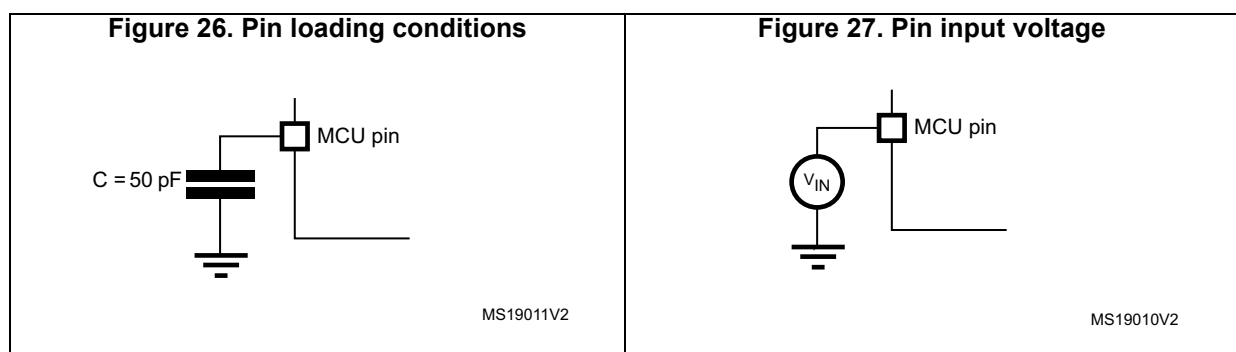
Unless otherwise specified, all typical curves are given only as design guidelines and are not tested.

#### 6.1.4 Loading capacitor

The loading conditions used for pin parameter measurement are shown in [Figure 26](#).

#### 6.1.5 Pin input voltage

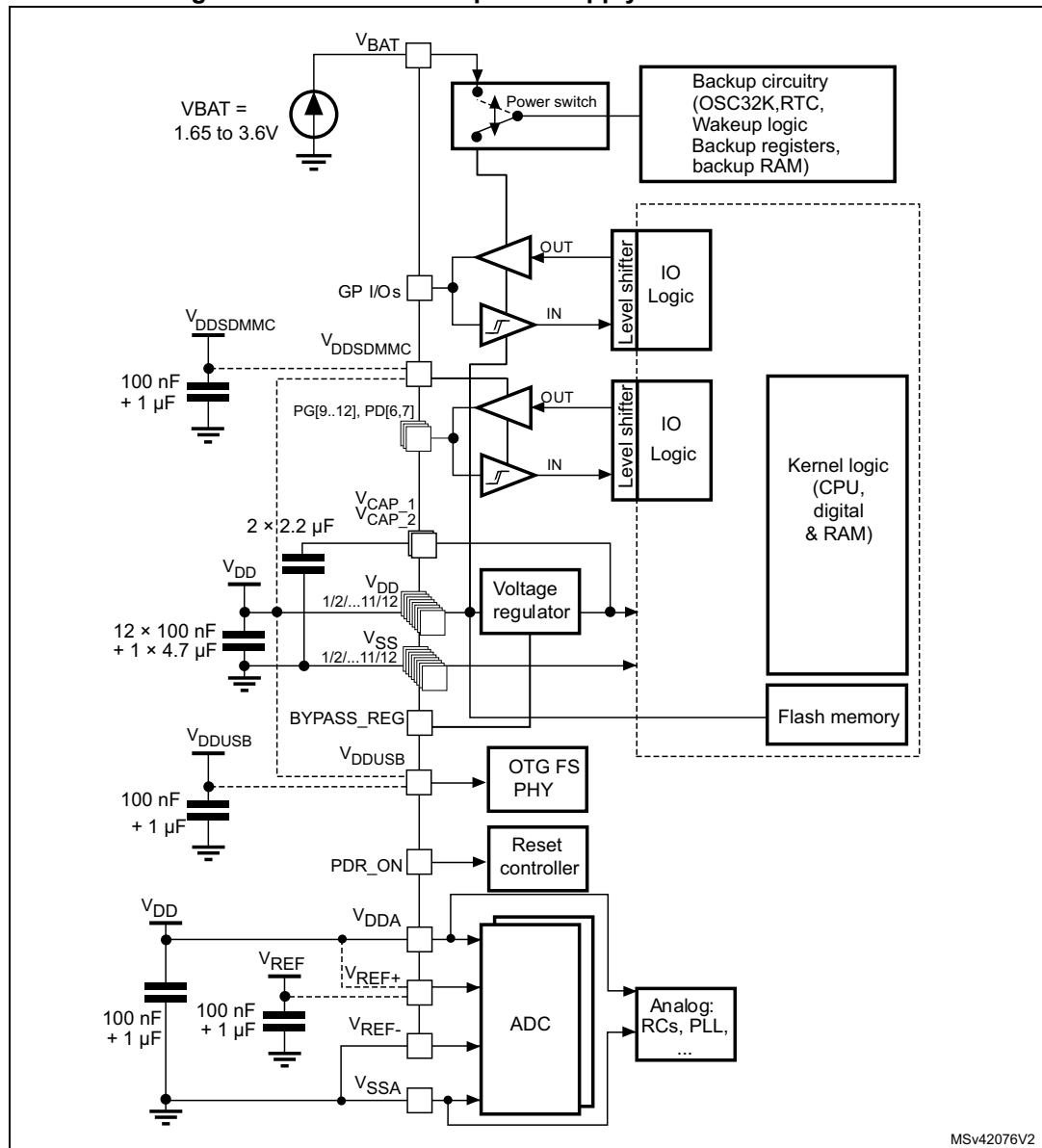
The input voltage measurement on a pin of the device is described in [Figure 27](#).





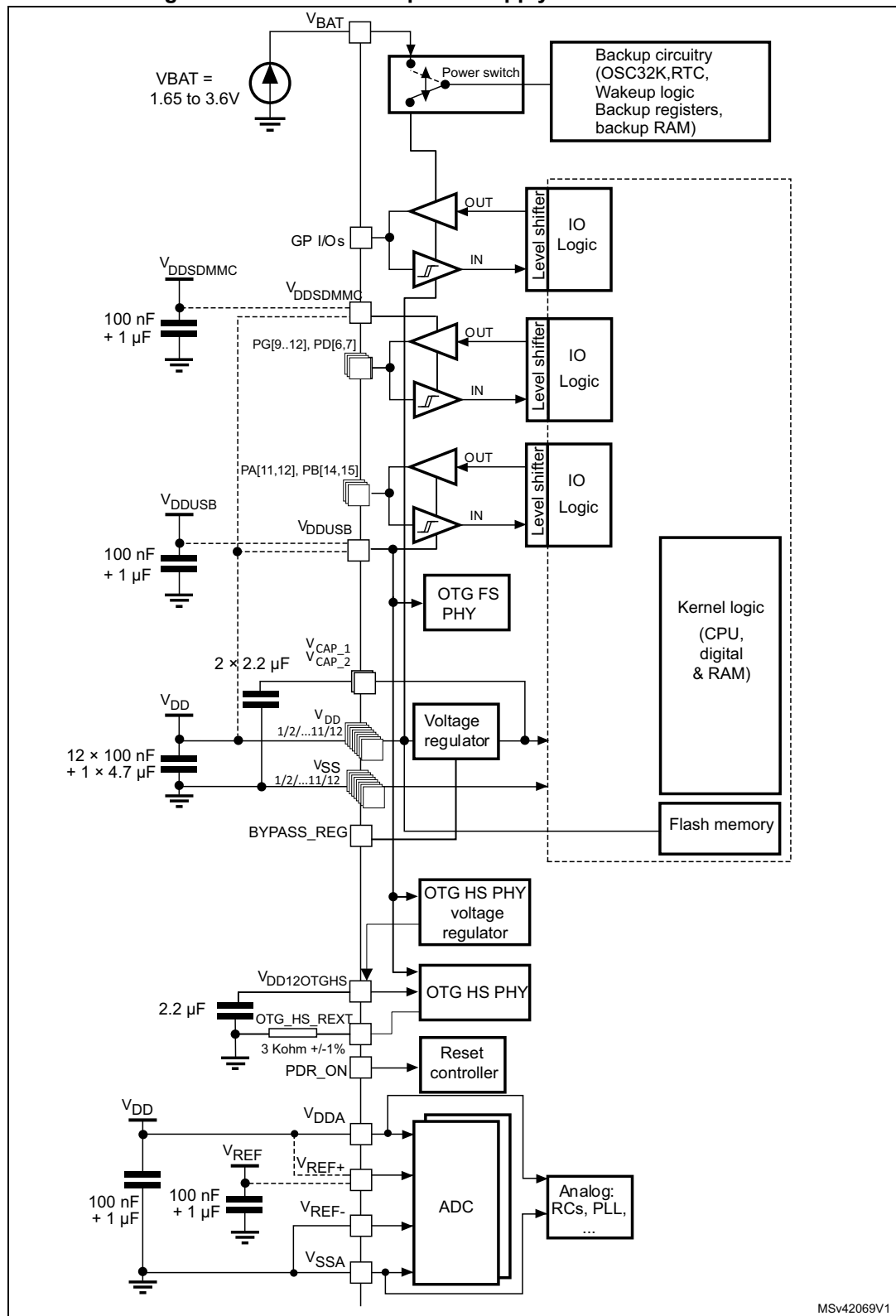
## 6.1.6 Power supply scheme

Figure 28. STM32F722xx power supply scheme



1. The two 2.2 µF ceramic capacitors must be replaced by two 100 nF decoupling capacitors when the voltage regulator is OFF.
2. The 4.7 µF ceramic capacitor must be connected to one of the VDD pin.
3.  $V_{DDA} = V_{DD}$  and  $V_{SSA} = V_{SS}$ .

Figure 29. STM32F723xx power supply scheme



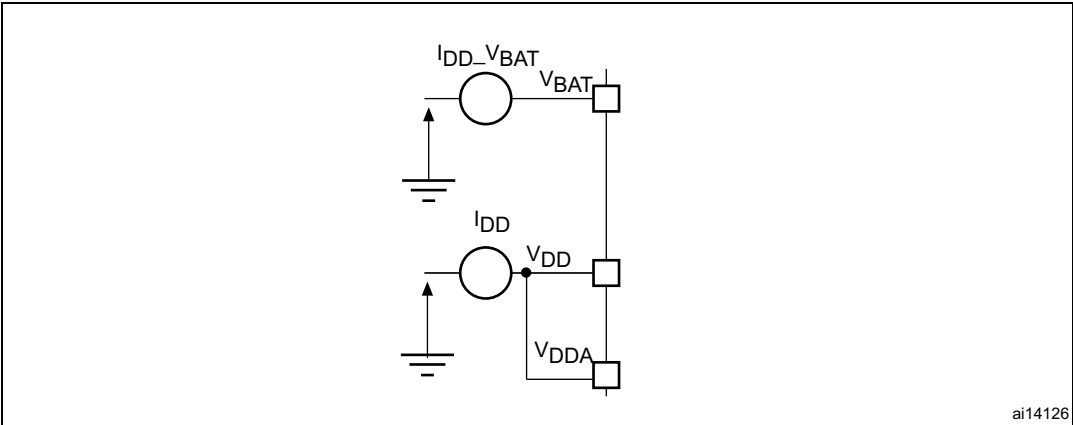
1. In all the packages (except LQFP100), the  $V_{DDUSB}$  allows supplying the PHY FS in PA11/PA12 and the PHY HS on PB14/PB15. In the LQFP100, the PHY HS on PB14/PB15 is supplied by  $V_{DDPHYHS}$ .

2. The two 2.2  $\mu\text{F}$  ceramic capacitors must be replaced by two 100 nF decoupling capacitors when the voltage regulator is OFF.
3. The 4.7  $\mu\text{F}$  ceramic capacitor must be connected to one of the VDD pin.
4.  $V_{\text{DDA}} = V_{\text{DD}}$  and  $V_{\text{SSA}} = V_{\text{SS}}$ .

**Caution:** Each power supply pair (such as  $V_{\text{DD}}/V_{\text{SS}}$  or  $V_{\text{DDA}}/V_{\text{SSA}}$ ) must be decoupled with filtering ceramic capacitors as shown above. These capacitors must be placed as close as possible to, or below, the appropriate pins on the underside of the PCB to ensure good operation of the device. It is not recommended to remove filtering capacitors to reduce PCB size or cost. This may cause incorrect operation of the device.

### 6.1.7 Current consumption measurement

Figure 30. Current consumption measurement scheme



## 6.2 Absolute maximum ratings

Stresses above the absolute maximum ratings listed in [Table 13: Voltage characteristics](#), [Table 14: Current characteristics](#), and [Table 15: Thermal characteristics](#) may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability. The device mission profile (application conditions) is compliant with JEDEC JESD47 Qualification Standard. Extended mission profiles are available on demand.

Table 13. Voltage characteristics

| Symbol                        | Ratings                                                                                                                                                                             | Min                   | Max                   | Unit |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|------|
| $V_{\text{DD}}-V_{\text{SS}}$ | External main supply voltage (including $V_{\text{DDA}}$ , $V_{\text{DD}}$ , $V_{\text{BAT}}$ , $V_{\text{DDUSB}}$ , $V_{\text{DDPHYHS}}$ and $V_{\text{DDSDMMC}}$ ) <sup>(1)</sup> | - 0.3                 | 4.0                   | V    |
| $V_{\text{IN}}$               | Input voltage on FT pins <sup>(2)</sup>                                                                                                                                             | $V_{\text{SS}} - 0.3$ | $V_{\text{DD}} + 4.0$ |      |
|                               | Input voltage on TTa pins                                                                                                                                                           | $V_{\text{SS}} - 0.3$ | 4.0                   |      |
|                               | Input voltage on any other pin                                                                                                                                                      | $V_{\text{SS}} - 0.3$ | 4.0                   |      |
|                               | Input voltage on BOOT pin                                                                                                                                                           | $V_{\text{SS}}$       | 9.0                   |      |

Table 13. Voltage characteristics (continued)

| Symbol               | Ratings                                                         | Min                                                                                   | Max | Unit |
|----------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------|-----|------|
| $ \Delta V_{DDx} $   | Variations between different $V_{DD}$ power pins                | -                                                                                     | 50  | mV   |
| $ V_{SSx} - V_{SS} $ | Variations between all the different ground pins <sup>(3)</sup> | -                                                                                     | 50  |      |
| $V_{ESD(HBM)}$       | Electrostatic discharge voltage (human body model)              | see <a href="#">Section 6.3.18: Absolute maximum ratings (electrical sensitivity)</a> |     | -    |

1. All main power ( $V_{DD}$ ,  $V_{DDA}$ ,  $V_{DDSDMMC}$ ,  $V_{DDPHYHS}$ ,  $V_{DDUSB}$ ) and ground ( $V_{SS}$ ,  $V_{SSA}$ ) pins must always be connected to the external power supply, in the permitted range.
2.  $V_{IN}$  maximum value must always be respected. Refer to [Table 14](#) for the values of the maximum allowed injected current.
3. Include VREF- pin.

Table 14. Current characteristics

| Symbol                      | Ratings                                                                         | Max.   | Unit |
|-----------------------------|---------------------------------------------------------------------------------|--------|------|
| $\Sigma I_{VDD}$            | Total current into sum of all $V_{DD\_x}$ power lines (source) <sup>(1)</sup>   | 300    | mA   |
| $\Sigma I_{VSS}$            | Total current out of sum of all $V_{SS\_x}$ ground lines (sink) <sup>(1)</sup>  | - 300  |      |
| $\Sigma I_{VDDUSB}$         | Total current into $V_{DDUSB}$ power line (source)                              | 25     |      |
| $\Sigma I_{VDDSDMMC}$       | Total current into $V_{DDSDMMC}$ power line (source)                            | 60     |      |
| $I_{VDD}$                   | Maximum current into each $V_{DD\_x}$ power line (source) <sup>(1)</sup>        | 100    |      |
| $I_{VDDSDMMC}$              | Maximum current into $V_{DDSDMMC}$ power line (source): PG[12:9], PD[7:6]       | 100    |      |
| $I_{VSS}$                   | Maximum current out of each $V_{SS\_x}$ ground line (sink) <sup>(1)</sup>       | - 100  |      |
| $I_{IO}$                    | Output current sunk by any I/O and control pin                                  | 25     |      |
|                             | Output current sourced by any I/Os and control pin                              | - 25   |      |
| $\Sigma I_{IO}$             | Total output current sunk by sum of all I/O and control pins <sup>(2)</sup>     | 120    |      |
|                             | Total output current sunk by sum of all USB I/Os                                | 25     |      |
|                             | Total output current sourced by sum of all I/Os and control pins <sup>(2)</sup> | - 120  |      |
| $I_{INJ(PIN)}$              | Injected current on FT, FTf, RST and B pins <sup>(3)</sup>                      | - 5/+0 |      |
|                             | Injected current on TTa pins <sup>(4)</sup>                                     | ±5     |      |
| $\Sigma I_{INJ(PIN)}^{(4)}$ | Total injected current (sum of all I/O and control pins) <sup>(5)</sup>         | ±25    |      |

1. All main power ( $V_{DD}$ ,  $V_{DDA}$ ) and ground ( $V_{SS}$ ,  $V_{SSA}$ ) pins must always be connected to the external power supply, in the permitted range.
2. This current consumption must be correctly distributed over all I/Os and control pins. The total output current must not be sunk/sourced between two consecutive power supply pins referring to high pin count LQFP packages.
3. Positive injection is not possible on these I/Os and does not occur for input voltages lower than the specified maximum value.
4. A positive injection is induced by  $V_{IN} > V_{DDA}$  while a negative injection is induced by  $V_{IN} < V_{SS}$ .  $I_{INJ(PIN)}$  must never be exceeded. Refer to [Table 13: Voltage characteristics](#) for the values of the maximum allowed input voltage.
5. When several inputs are submitted to a current injection, the maximum  $\Sigma I_{INJ(PIN)}$  is the absolute sum of the positive and negative injected currents (instantaneous values).

Table 15. Thermal characteristics

| Symbol           | Ratings                      | Value        | Unit |
|------------------|------------------------------|--------------|------|
| T <sub>STG</sub> | Storage temperature range    | – 65 to +150 | °C   |
| T <sub>J</sub>   | Maximum junction temperature | 125          |      |

## 6.3 Operating conditions

### 6.3.1 General operating conditions

Table 16. General operating conditions

| Symbol             | Parameter                     | Conditions <sup>(1)</sup>                                                             | Min | Typ | Max                | Unit |
|--------------------|-------------------------------|---------------------------------------------------------------------------------------|-----|-----|--------------------|------|
| f <sub>HCLK</sub>  | Internal AHB clock frequency  | Power scale 3 (VOS[1:0] bits in PWR_CR register = 0x01), regulator ON, over-drive OFF | 0   | -   | 144                | MHz  |
|                    |                               | Power scale 2 (VOS[1:0] bits in PWR_CR register = 0x10), Regulator ON                 | 0   | -   | 168                |      |
|                    |                               |                                                                                       |     | -   | 180                |      |
|                    |                               | Power scale 1 (VOS[1:0] bits in PWR_CR register= 0x11), Regulator ON                  | 0   | -   | 180                |      |
|                    |                               |                                                                                       |     | -   | 216 <sup>(2)</sup> |      |
|                    |                               |                                                                                       |     |     |                    |      |
| f <sub>PCLK1</sub> | Internal APB1 clock frequency | Over-drive OFF                                                                        | 0   | -   | 45                 |      |
|                    |                               | Over-drive ON                                                                         | 0   | -   | 54                 |      |
| f <sub>PCLK2</sub> | Internal APB2 clock frequency | Over-drive OFF                                                                        | 0   | -   | 90                 |      |
|                    |                               | Over-drive ON                                                                         | 0   | -   | 108                |      |
|                    |                               |                                                                                       |     |     |                    |      |
|                    |                               |                                                                                       |     |     |                    |      |

Table 16. General operating conditions (continued)

| Symbol             | Parameter                                                                                                                     | Conditions <sup>(1)</sup>                                                                                                               | Min                                        | Typ  | Max  | Unit            |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|------|------|-----------------|
| $V_{DD}$           | Standard operating voltage                                                                                                    | -                                                                                                                                       | 1.7 <sup>(3)</sup>                         | -    | 3.6  | V               |
| $V_{DDA}^{(4)(5)}$ | Analog operating voltage (ADC limited to 1.2 M samples)                                                                       | Must be the same potential as $V_{DD}^{(6)}$                                                                                            | 1.7 <sup>(3)</sup>                         | -    | 2.4  |                 |
|                    | Analog operating voltage (ADC limited to 2.4 M samples)                                                                       |                                                                                                                                         | 2.4                                        | -    | 3.6  |                 |
| $V_{DDUSB}$        | USB supply voltage (supply voltage for PA11, PA12, PB14 and PB15 pins)                                                        | USB not used                                                                                                                            | 1.7                                        | 3.3  | 3.6  |                 |
|                    |                                                                                                                               | USB used                                                                                                                                | 3.0                                        | -    | 3.6  |                 |
| $V_{DDSPHYHS}$     | USB PHY HS supply voltage in the STM32F723 LQFP100 (supply voltage for PB14 and PB15)                                         | USB PHY HS not used                                                                                                                     | 1.7                                        | 3.3  | 3.6  |                 |
|                    |                                                                                                                               | USB PHY HS used                                                                                                                         | 3.0                                        | -    | 3.6  |                 |
| $V_{BAT}$          | Backup operating voltage                                                                                                      | -                                                                                                                                       | 1.65                                       | -    | 3.6  | V               |
| $V_{DDSDMMC}$      | SDMMC2 supply voltage (supply voltage for PG[12:9] and PD6 pins)                                                              | It can be different from $V_{DD}$                                                                                                       | 1.7                                        | -    | 3.6  |                 |
| $V_{12}$           | Regulator ON: 1.2 V internal voltage on $V_{CAP\_1}/V_{CAP\_2}$ pins                                                          | Power scale 3 ((VOS[1:0] bits in PWR_CR register = 0x01), 144 MHz HCLK max frequency)                                                   | 1.08                                       | 1.14 | 1.20 |                 |
|                    |                                                                                                                               | Power scale 2 ((VOS[1:0] bits in PWR_CR register = 0x10), 168 MHz HCLK max frequency with over-drive OFF or 180 MHz with over-drive ON) | 1.20                                       | 1.26 | 1.32 |                 |
|                    |                                                                                                                               | Power scale 1 ((VOS[1:0] bits in PWR_CR register = 0x11), 180 MHz HCLK max frequency with over-drive OFF or 216 MHz with over-drive ON) | 1.26                                       | 1.32 | 1.40 |                 |
|                    | Regulator OFF: 1.2 V external voltage must be supplied from external regulator on $V_{CAP\_1}/V_{CAP\_2}$ pins <sup>(7)</sup> | Max frequency 144 MHz                                                                                                                   | 1.10                                       | 1.14 | 1.20 |                 |
|                    |                                                                                                                               | Max frequency 168MHz                                                                                                                    | 1.20                                       | 1.26 | 1.32 |                 |
|                    |                                                                                                                               | Max frequency 180 MHz                                                                                                                   | 1.26                                       | 1.32 | 1.38 |                 |
|                    | $V_{IN}$                                                                                                                      | Input voltage on RST and FT pins <sup>(8)</sup>                                                                                         | $2\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | -0.3 | -    | 5.5             |
|                    |                                                                                                                               |                                                                                                                                         | $V_{DD} \leq 2\text{ V}$                   | -0.3 | -    | 5.2             |
|                    |                                                                                                                               | Input voltage on TTa pins                                                                                                               | -                                          | -0.3 | -    | $V_{DDA} + 0.3$ |
|                    |                                                                                                                               | Input voltage on BOOT pin                                                                                                               | -                                          | 0    | -    | 9               |

Table 16. General operating conditions (continued)

| Symbol | Parameter                                                                                                   | Conditions <sup>(1)</sup>             | Min  | Typ | Max  | Unit |
|--------|-------------------------------------------------------------------------------------------------------------|---------------------------------------|------|-----|------|------|
| $P_D$  | Power dissipation at $T_A = 85\text{ °C}$ for suffix 6 or $T_A = 105\text{ °C}$ for suffix 7 <sup>(9)</sup> | LQFP64                                | -    | -   | 881  | mW   |
|        |                                                                                                             | LQFP100                               | -    | -   | 1117 |      |
|        |                                                                                                             | WLCSP100                              | -    | -   | 558  |      |
|        |                                                                                                             | LQFP144                               | -    | -   | 1587 |      |
|        |                                                                                                             | LQFP176                               | -    | -   | 1869 |      |
|        |                                                                                                             | UFBGA144                              | -    | -   | 476  |      |
|        |                                                                                                             | UFBGA176                              | -    | -   | 485  |      |
| $T_A$  | Ambient temperature for 6 suffix version                                                                    | Maximum power dissipation             | - 40 | -   | 85   | °C   |
|        |                                                                                                             | Low power dissipation <sup>(10)</sup> | - 40 | -   | 105  |      |
|        | Ambient temperature for 7 suffix version                                                                    | Maximum power dissipation             | - 40 | -   | 105  | °C   |
|        |                                                                                                             | Low power dissipation <sup>(10)</sup> | - 40 | -   | 125  |      |
| $T_J$  | Junction temperature range                                                                                  | 6 suffix version                      | - 40 | -   | 105  | °C   |
|        |                                                                                                             | 7 suffix version                      | - 40 | -   | 125  |      |

1. The over-drive mode is not supported at the voltage ranges from 1.7 to 2.1 V.
2. 216 MHz maximum frequency for 6 suffix version (200 MHz maximum frequency for 7 suffix version).
3.  $V_{DD}/V_{DDA}$  minimum value of 1.7 V is obtained with the use of an external power supply supervisor (refer to [Section 3.15.2: Internal reset OFF](#)).
4. When the ADC is used, refer to [Table 67: ADC characteristics](#).
5. If VREF+ pin is present, it must respect the following condition:  $V_{DDA} - V_{REF+} < 1.2\text{ V}$ .
6. It is recommended to power  $V_{DD}$  and  $V_{DDA}$  from the same source. A maximum difference of 300 mV between  $V_{DD}$  and  $V_{DDA}$  can be tolerated during power-up and power-down operation.
7. The over-drive mode is not supported when the internal regulator is OFF.
8. To sustain a voltage higher than  $V_{DD} + 0.3$ , the internal pull-up and pull-down resistors must be disabled.
9. If  $T_A$  is lower, higher  $P_D$  values are allowed as long as  $T_J$  does not exceed  $T_{Jmax}$ .
10. In low power dissipation state,  $T_A$  can be extended to this range as long as  $T_J$  does not exceed  $T_{Jmax}$ .

Table 17. Limitations depending on the operating power supply range

| Operating power supply range                | ADC operation                  | Maximum Flash memory access frequency with no wait states ( $f_{Flashmax}$ ) | Maximum HCLK frequency vs Flash memory wait states <sup>(1)(2)</sup> | I/O operation       | Possible Flash memory operations        |
|---------------------------------------------|--------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------|-----------------------------------------|
| $V_{DD} = 1.7\text{ to }2.1\text{ V}^{(3)}$ | Conversion time up to 1.2 Msps | 20 MHz                                                                       | 180 MHz with 8 wait states and over-drive OFF                        | No I/O compensation | 8-bit erase and program operations only |
| $V_{DD} = 2.1\text{ to }2.4\text{ V}$       | Conversion time up to 1.2 Msps | 22 MHz                                                                       | 216 MHz with 9 wait states and over-drive ON                         | No I/O compensation | 16-bit erase and program operations     |

Table 17. Limitations depending on the operating power supply range (continued)

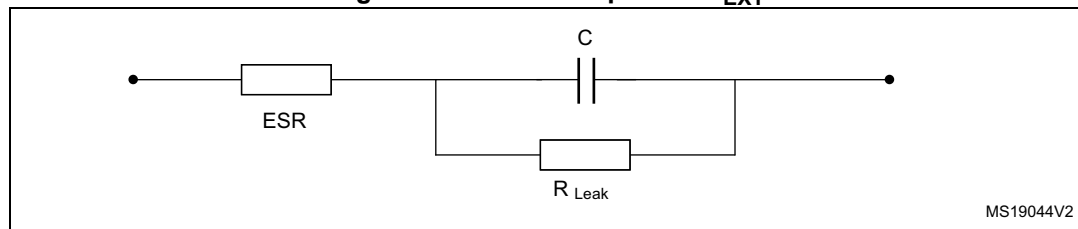
| Operating power supply range                    | ADC operation                  | Maximum Flash memory access frequency with no wait states ( $f_{\text{Flashmax}}$ ) | Maximum HCLK frequency vs Flash memory wait states <sup>(1)(2)</sup> | I/O operation          | Possible Flash memory operations    |
|-------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------------|-------------------------------------|
| $V_{\text{DD}} = 2.4$ to $2.7$ V                | Conversion time up to 2.4 Msps | 24 MHz                                                                              | 216 MHz with 8 wait states and over-drive ON                         | I/O compensation works | 16-bit erase and program operations |
| $V_{\text{DD}} = 2.7$ to $3.6$ V <sup>(4)</sup> | Conversion time up to 2.4 Msps | 30 MHz                                                                              | 216 MHz with 7 wait states and over-drive ON                         | I/O compensation works | 32-bit erase and program operations |

1. Applicable only when the code is executed from Flash memory. When the code is executed from RAM, no wait state is required.
2. Thanks to the ART accelerator on ITCM interface and L1-cache on AXI interface, the number of wait states given here does not impact the execution speed from Flash memory since the ART accelerator or L1-cache is used to achieve a performance equivalent to 0-wait state program execution.
3.  $V_{\text{DD}}/V_{\text{DDA}}$  minimum value of 1.7 V is obtained with the use of an external power supply supervisor (refer to [Section 3.15.2: Internal reset OFF](#)).
4. The voltage range for USB full speed PHYs can drop down to 2.7 V. However the electrical characteristics of D- and D+ pins are degraded between 2.7 and 3 V.

### 6.3.2 VCAP1/VCAP2 external capacitor

Stabilization for the main regulator is achieved by connecting an external capacitor  $C_{\text{EXT}}$  to the VCAP1/VCAP2 pins.  $C_{\text{EXT}}$  is specified in [Table 18](#).

*Note:* The VCAP2 pin is not available on the LQFP64 package.

Figure 31. External capacitor  $C_{\text{EXT}}$ 

1. Legend: ESR is the equivalent series resistance.

Table 18. VCAP1/VCAP2 operating conditions<sup>(1)</sup>

| Symbol | Parameter                         | Conditions        |
|--------|-----------------------------------|-------------------|
| CEXT   | Capacitance of external capacitor | 2.2 $\mu\text{F}$ |
| ESR    | ESR of external capacitor         | < 2 $\Omega$      |

1. When bypassing the voltage regulator, the two 2.2  $\mu\text{F}$   $V_{\text{CAP}}$  capacitors are not required and should be replaced by two 100 nF decoupling capacitors.



**Table 19. VCAP1 operating conditions in the LQFP64 package<sup>(1)</sup>**

| Symbol | Parameter                         | Conditions                            |
|--------|-----------------------------------|---------------------------------------|
| CEXT   | Capacitance of external capacitor | 4.7 $\mu$ F                           |
| ESR    | ESR of external capacitor         | between 0.1 $\Omega$ and 0.2 $\Omega$ |

1. When bypassing the voltage regulator, the 4.7  $\mu$ F  $V_{CAP}$  capacitor is not required and should be replaced by two 100 nF decoupling capacitors.

### 6.3.3 Operating conditions at power-up/power-down (regulator ON)

Subject to general operating conditions for  $T_A$ .

**Table 20. Operating conditions at power-up/power-down (regulator ON)**

| Symbol    | Parameter               | Min | Max      | Unit      |
|-----------|-------------------------|-----|----------|-----------|
| $t_{VDD}$ | $V_{DD}$ rise time rate | 20  | $\infty$ | $\mu$ s/V |
|           | $V_{DD}$ fall time rate | 20  | $\infty$ |           |

### 6.3.4 Operating conditions at power-up/power-down (regulator OFF)

Subject to general operating conditions for  $T_A$ .

**Table 21. Operating conditions at power-up/power-down (regulator OFF)<sup>(1)</sup>**

| Symbol     | Parameter                                    | Conditions | Min | Max      | Unit      |
|------------|----------------------------------------------|------------|-----|----------|-----------|
| $t_{VDD}$  | $V_{DD}$ rise time rate                      | Power-up   | 20  | $\infty$ | $\mu$ s/V |
|            | $V_{DD}$ fall time rate                      | Power-down | 20  | $\infty$ |           |
| $t_{VCAP}$ | $V_{CAP\_1}$ and $V_{CAP\_2}$ rise time rate | Power-up   | 20  | $\infty$ |           |
|            | $V_{CAP\_1}$ and $V_{CAP\_2}$ fall time rate | Power-down | 20  | $\infty$ |           |

1. To reset the internal logic at power-down, a reset must be applied on pin PA0 when  $V_{DD}$  reaches below 1.08 V.

### 6.3.5 Reset and power control block characteristics

The parameters given in [Table 22](#) are derived from tests performed under ambient temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#).

**Table 22. Reset and power control block characteristics**

| Symbol               | Parameter                                     | Conditions                  | Min  | Typ  | Max  | Unit |
|----------------------|-----------------------------------------------|-----------------------------|------|------|------|------|
| $V_{PVD}$            | Programmable voltage detector level selection | PLS[2:0]=000 (rising edge)  | 2.09 | 2.14 | 2.19 | V    |
|                      |                                               | PLS[2:0]=000 (falling edge) | 1.98 | 2.04 | 2.08 | V    |
|                      |                                               | PLS[2:0]=001 (rising edge)  | 2.23 | 2.30 | 2.37 | V    |
|                      |                                               | PLS[2:0]=001 (falling edge) | 2.13 | 2.19 | 2.25 | V    |
|                      |                                               | PLS[2:0]=010 (rising edge)  | 2.39 | 2.45 | 2.51 | V    |
|                      |                                               | PLS[2:0]=010 (falling edge) | 2.29 | 2.35 | 2.39 | V    |
|                      |                                               | PLS[2:0]=011 (rising edge)  | 2.54 | 2.60 | 2.65 | V    |
|                      |                                               | PLS[2:0]=011 (falling edge) | 2.44 | 2.51 | 2.56 | V    |
|                      |                                               | PLS[2:0]=100 (rising edge)  | 2.70 | 2.76 | 2.82 | V    |
|                      |                                               | PLS[2:0]=100 (falling edge) | 2.59 | 2.66 | 2.71 | V    |
|                      |                                               | PLS[2:0]=101 (rising edge)  | 2.86 | 2.93 | 2.99 | V    |
|                      |                                               | PLS[2:0]=101 (falling edge) | 2.65 | 2.84 | 2.92 | V    |
|                      |                                               | PLS[2:0]=110 (rising edge)  | 2.96 | 3.03 | 3.10 | V    |
|                      |                                               | PLS[2:0]=110 (falling edge) | 2.85 | 2.93 | 2.99 | V    |
|                      |                                               | PLS[2:0]=111 (rising edge)  | 3.07 | 3.14 | 3.21 | V    |
|                      |                                               | PLS[2:0]=111 (falling edge) | 2.95 | 3.03 | 3.09 | V    |
| $V_{PVDhyst}^{(1)}$  | PVD hysteresis                                | -                           | -    | 100  | -    | mV   |
| $V_{POR/PDR}$        | Power-on/power-down reset threshold           | Falling edge                | 1.60 | 1.68 | 1.76 | V    |
|                      |                                               | Rising edge                 | 1.64 | 1.72 | 1.80 | V    |
| $V_{PDRhyst}^{(1)}$  | PDR hysteresis                                | -                           | -    | 40   | -    | mV   |
| $V_{BOR1}$           | Brownout level 1 threshold                    | Falling edge                | 2.13 | 2.19 | 2.24 | V    |
|                      |                                               | Rising edge                 | 2.23 | 2.29 | 2.33 | V    |
| $V_{BOR2}$           | Brownout level 2 threshold                    | Falling edge                | 2.44 | 2.50 | 2.56 | V    |
|                      |                                               | Rising edge                 | 2.53 | 2.59 | 2.63 | V    |
| $V_{BOR3}$           | Brownout level 3 threshold                    | Falling edge                | 2.75 | 2.83 | 2.88 | V    |
|                      |                                               | Rising edge                 | 2.85 | 2.92 | 2.97 | V    |
| $V_{BORhyst}^{(1)}$  | BOR hysteresis                                | -                           | -    | 100  | -    | mV   |
| $T_{RSTTEMPO(1)(2)}$ | POR reset temporization                       | -                           | 0.5  | 1.5  | 3.0  | ms   |

Table 22. Reset and power control block characteristics (continued)

| Symbol           | Parameter                                                                 | Conditions                                                                                                                | Min | Typ | Max | Unit          |
|------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| $I_{RUSH}^{(1)}$ | InRush current on voltage regulator power-on (POR or wakeup from Standby) | -                                                                                                                         | -   | 160 | 250 | mA            |
| $E_{RUSH}^{(1)}$ | InRush energy on voltage regulator power-on (POR or wakeup from Standby)  | $V_{DD} = 1.7\text{ V}$ , $T_A = 105\text{ }^{\circ}\text{C}$ ,<br>$I_{RUSH} = 171\text{ mA}$ for $31\text{ }\mu\text{s}$ | -   | -   | 5.4 | $\mu\text{C}$ |

1. Guaranteed by design.
2. The reset temporization is measured from the power-on (POR reset or wakeup from  $V_{BAT}$ ) to the instant when first instruction is read by the user application code.

### 6.3.6 Over-drive switching characteristics

When the over-drive mode switches from enabled to disabled or disabled to enabled, the system clock is stalled during the internal voltage set-up.

The over-drive switching characteristics are given in [Table 23](#). They are subject to general operating conditions for  $T_A$ .

Table 23. Over-drive switching characteristics<sup>(1)</sup>

| Symbol    | Parameter                      | Conditions                            | Min | Typ | Max | Unit          |
|-----------|--------------------------------|---------------------------------------|-----|-----|-----|---------------|
| Tod_swen  | Over_drive switch enable time  | HSI                                   | -   | 45  | -   | $\mu\text{s}$ |
|           |                                | HSE max for 4 MHz and min for 26 MHz  | 45  | -   | 100 |               |
|           |                                | External HSE 50 MHz                   | -   | 40  | -   |               |
| Tod_swdis | Over_drive switch disable time | HSI                                   | -   | 20  | -   |               |
|           |                                | HSE max for 4 MHz and min for 26 MHz. | 20  | -   | 80  |               |
|           |                                | External HSE 50 MHz                   | -   | 15  | -   |               |

1. Guaranteed by design.

### 6.3.7 Supply current characteristics

The current consumption is a function of several parameters and factors such as the operating voltage, ambient temperature, I/O pin loading, device software configuration, operating frequencies, I/O pin switching rate, program location in memory and executed binary code.

The current consumption is measured as described in [Figure 30: Current consumption measurement scheme](#).

All the run-mode current consumption measurements given in this section are performed with a reduced code that gives a consumption equivalent to CoreMark code.

### Typical and maximum current consumption

The MCU is placed under the following conditions:

- All I/O pins are in input mode with a static value at  $V_{DD}$  or  $V_{SS}$  (no load).
- All peripherals are disabled except if it is explicitly mentioned.
- The Flash memory access time is adjusted both to  $f_{HCLK}$  frequency and  $V_{DD}$  range (see [Table 17: Limitations depending on the operating power supply range](#)).
- When the regulator is ON, the voltage scaling and over-drive mode are adjusted to  $f_{HCLK}$  frequency as follows:
  - Scale 3 for  $f_{HCLK} \leq 144$  MHz
  - Scale 2 for  $144 \text{ MHz} < f_{HCLK} \leq 168$  MHz
  - Scale 1 for  $168 \text{ MHz} < f_{HCLK} \leq 216$  MHz. The over-drive is only ON at 216 MHz.
- When the regulator is OFF, the V12 is provided externally as described in [Table 16: General operating conditions](#):
- The system clock is HCLK,  $f_{PCLK1} = f_{HCLK}/4$ , and  $f_{PCLK2} = f_{HCLK}/2$ .
- External clock frequency is 25 MHz and PLL is ON when  $f_{HCLK}$  is higher than 25 MHz.
- The typical current consumption values are obtained for  $1.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$  voltage range and for  $T_A = 25^\circ\text{C}$  unless otherwise specified.
- The maximum values are obtained for  $1.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$  voltage range and a maximum ambient temperature ( $T_A$ ) unless otherwise specified.
- For the voltage range  $1.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ , the maximum frequency is 180 MHz.

**Table 24. Typical and maximum current consumption in Run mode, code with data processing running from ITCM RAM, regulator ON**

| Symbol   | Parameter                  | Conditions                                | $f_{HCLK}$ (MHz) | Typ | Max <sup>(1)</sup>       |                          |                           | Unit |
|----------|----------------------------|-------------------------------------------|------------------|-----|--------------------------|--------------------------|---------------------------|------|
|          |                            |                                           |                  |     | $T_A = 25^\circ\text{C}$ | $T_A = 85^\circ\text{C}$ | $T_A = 105^\circ\text{C}$ |      |
| $I_{DD}$ | Supply current in Run mode | All peripherals enabled <sup>(2)(3)</sup> | 216              | 156 | 170 <sup>(4)</sup>       | 180 <sup>(4)</sup>       | 200                       | mA   |
|          |                            |                                           | 200              | 144 | 154                      | 164.6                    | 183                       |      |
|          |                            |                                           | 180              | 127 | 134 <sup>(4)</sup>       | 143 <sup>(4)</sup>       | 158 <sup>(4)</sup>        |      |
|          |                            |                                           | 168              | 113 | 119                      | 127.4                    | 141                       |      |
|          |                            |                                           | 144              | 86  | 96                       | 112.6                    | 126                       |      |
|          |                            |                                           | 60               | 41  | 44                       | 52.8                     | 65                        |      |
|          |                            |                                           | 25               | 22  | 24                       | 33.5                     | 45                        |      |
|          |                            | All peripherals disabled <sup>(3)</sup>   | 216              | 99  | 110 <sup>(4)</sup>       | 119.6 <sup>(4)</sup>     | 138.5                     |      |
|          |                            |                                           | 200              | 92  | 102                      | 113.1                    | 132                       |      |
|          |                            |                                           | 180              | 81  | 90 <sup>(4)</sup>        | 96.7 <sup>(4)</sup>      | 125 <sup>(4)</sup>        |      |
|          |                            |                                           | 168              | 72  | 78                       | 86.5                     | 100.1                     |      |
|          |                            |                                           | 144              | 55  | 61                       | 77.1                     | 90.8                      |      |
|          |                            |                                           | 60               | 24  | 25                       | 38.5                     | 50.3                      |      |
|          |                            |                                           | 25               | 12  | 13                       | 26.3                     | 38.1                      |      |

1. Guaranteed by characterization results.

- When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
- When the ADC is ON (ADON bit set in the ADC\_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.
- Guaranteed by test in production.

**Table 25. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory (ART ON except prefetch / L1-cache ON) or SRAM on AXI (L1-cache ON), regulator ON**

| Symbol          | Parameter                  | Conditions                                | f <sub>HCLK</sub> (MHz) | Typ   | Max <sup>(1)</sup>     |                        |                         | Unit |
|-----------------|----------------------------|-------------------------------------------|-------------------------|-------|------------------------|------------------------|-------------------------|------|
|                 |                            |                                           |                         |       | T <sub>A</sub> = 25 °C | T <sub>A</sub> = 85 °C | T <sub>A</sub> = 105 °C |      |
| I <sub>DD</sub> | Supply current in Run mode | All peripherals enabled <sup>(2)(3)</sup> | 216                     | 155.3 | 164                    | 175.8                  | 185                     | mA   |
|                 |                            |                                           | 200                     | 144.7 | 153.6                  | 165.2                  | 176                     |      |
|                 |                            |                                           | 180                     | 127.3 | 135                    | 143.5                  | 154                     |      |
|                 |                            |                                           | 168                     | 113.1 | 119.1                  | 127.8                  | 138                     |      |
|                 |                            |                                           | 144                     | 86.9  | 91.6                   | 99.5                   | 110                     |      |
|                 |                            |                                           | 60                      | 41.2  | 43.6                   | 53.1                   | 64                      |      |
|                 |                            |                                           | 25                      | 21.7  | 24                     | 33.6                   | 43.8                    |      |
|                 |                            | All peripherals disabled <sup>(3)</sup>   | 216                     | 90    | 106                    | 120.4                  | 130                     |      |
|                 |                            |                                           | 200                     | 84    | 99                     | 113.8                  | 124                     |      |
|                 |                            |                                           | 180                     | 74    | 86.6                   | 97.3                   | 107                     |      |
|                 |                            |                                           | 168                     | 66    | 76                     | 87                     | 97                      |      |
|                 |                            |                                           | 144                     | 51    | 59                     | 68.2                   | 78                      |      |
|                 |                            |                                           | 60                      | 23    | 27                     | 38.8                   | 49                      |      |
|                 |                            |                                           | 25                      | 11    | 13.6                   | 26.4                   | 36.8                    |      |

- Guaranteed by characterization results.
- When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
- When the ADC is ON (ADON bit set in the ADC\_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.

**Table 26. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory or SRAM on AXI (L1-cache disabled), regulator ON**

| Symbol          | Parameter                  | Conditions                                | f <sub>HCLK</sub> (MHz) | Typ   | Max <sup>(1)</sup> |          |           | Unit |
|-----------------|----------------------------|-------------------------------------------|-------------------------|-------|--------------------|----------|-----------|------|
|                 |                            |                                           |                         |       | TA= 25 °C          | TA=85 °C | TA=105 °C |      |
| I <sub>DD</sub> | Supply current in Run mode | All peripherals enabled <sup>(2)(3)</sup> | 216                     | 129.3 | 137.6              | 162.8    | 173       | mA   |
|                 |                            |                                           | 200                     | 122   | 128                | 153.2    | 163.3     |      |
|                 |                            |                                           | 180                     | 108   | 117                | 136.4    | 146       |      |
|                 |                            |                                           | 168                     | 99    | 104.5              | 122.3    | 132       |      |
|                 |                            |                                           | 144                     | 80    | 84.7               | 99.3     | 109.2     |      |
|                 |                            |                                           | 60                      | 42    | 45                 | 59.5     | 70        |      |
|                 |                            |                                           | 25                      | 23    | 23.4               | 37.8     | 48        |      |
|                 |                            | All peripherals disabled <sup>(3)</sup>   | 216                     | 73.3  | 82.3               | 107.4    | 119       |      |
|                 |                            |                                           | 200                     | 70    | 77                 | 101.8    | 113.5     |      |
|                 |                            |                                           | 180                     | 62    | 71                 | 90.2     | 101       |      |
|                 |                            |                                           | 168                     | 59    | 63.6               | 81.4     | 92.1      |      |
|                 |                            |                                           | 144                     | 49    | 53.3               | 67.9     | 79        |      |
|                 |                            |                                           | 60                      | 26    | 31                 | 45.1     | 56        |      |
|                 |                            |                                           | 25                      | 14    | 16                 | 30.6     | 41.2      |      |

1. Guaranteed by characterization results.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
3. When the ADC is ON (ADON bit set in the ADC\_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.

**Table 27. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory on ITCM interface (ART disabled), regulator ON**

| Symbol          | Parameter                  | Conditions                                | f <sub>HCLK</sub> (MHz) | Typ | Max <sup>(1)</sup> |          |           | Unit |
|-----------------|----------------------------|-------------------------------------------|-------------------------|-----|--------------------|----------|-----------|------|
|                 |                            |                                           |                         |     | TA= 25 °C          | TA=85 °C | TA=105 °C |      |
| I <sub>DD</sub> | Supply current in Run mode | All peripherals enabled <sup>(2)(3)</sup> | 216                     | 138 | 151                | 174.7    | 184       | mA   |
|                 |                            |                                           | 200                     | 133 | 141                | 164.3    | 174       |      |
|                 |                            |                                           | 180                     | 110 | 131                | 149.2    | 159       |      |
|                 |                            |                                           | 168                     | 99  | 117                | 134      | 144       |      |
|                 |                            |                                           | 144                     | 79  | 98                 | 111.7    | 121       |      |
|                 |                            |                                           | 60                      | 49  | 53                 | 64       | 75        |      |
|                 |                            |                                           | 25                      | 27  | 30                 | 38.3     | 48        |      |
|                 |                            | All peripherals disabled <sup>(3)</sup>   | 216                     | 82  | 96                 | 119.5    | 131       |      |
|                 |                            |                                           | 200                     | 81  | 89                 | 113.1    | 124       |      |
|                 |                            |                                           | 180                     | 65  | 85                 | 103.1    | 114       |      |
|                 |                            |                                           | 168                     | 58  | 76                 | 93.2     | 104       |      |
|                 |                            |                                           | 144                     | 48  | 67                 | 80.4     | 91        |      |
|                 |                            |                                           | 60                      | 33  | 36                 | 49.7     | 60        |      |
|                 |                            |                                           | 25                      | 18  | 21                 | 31.1     | 41        |      |

1. Guaranteed by characterization results.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
3. When the ADC is ON (ADON bit set in the ADC\_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.

**Table 28. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory (ART ON except prefetch / L1-cache ON) or SRAM on AXI (L1-cache ON), regulator OFF**

| Symbol        | Parameter                                                                    | Conditions                                | f <sub>HCLK</sub><br>(MHz) | Typ   |     | Max <sup>(1)</sup> |     |           |     |            |     | Unit |
|---------------|------------------------------------------------------------------------------|-------------------------------------------|----------------------------|-------|-----|--------------------|-----|-----------|-----|------------|-----|------|
|               |                                                                              |                                           |                            |       |     | TA= 25 °C          |     | TA= 85 °C |     | TA= 105 °C |     |      |
|               |                                                                              |                                           |                            | IDD12 | IDD | IDD12              | IDD | IDD12     | IDD | IDD12      | IDD |      |
| IDD12/<br>IDD | Supply current in Run mode from V <sub>12</sub> and V <sub>DD</sub> supplies | All peripherals enabled <sup>(2)(3)</sup> | 180                        | 112   | 1.4 | 120                | 2   | 132.7     | 2   | 142        | 2   | mA   |
|               |                                                                              |                                           | 168                        | 110   | 1.4 | 106.4              | 2   | 118.7     | 2   | 130        | 2   |      |
|               |                                                                              |                                           | 144                        | 78    | 1.3 | 82.5               | 2   | 93.6      | 2   | 103        | 2   |      |
|               |                                                                              |                                           | 60                         | 37    | 1.1 | 37.6               | 2   | 49.3      | 2   | 60         | 2   |      |
|               |                                                                              |                                           | 25                         | 19    | 1.1 | 18.5               | 2   | 30.4      | 2   | 40         | 2   |      |
|               |                                                                              | All peripherals disabled <sup>(3)</sup>   | 180                        | 74    | 1.4 | 78                 | 2   | 89.3      | 2   | 99         | 2   |      |
|               |                                                                              |                                           | 168                        | 64    | 1.4 | 68                 | 2   | 80.1      | 2   | 90         | 2   |      |
|               |                                                                              |                                           | 144                        | 51    | 1.3 | 54                 | 2   | 63.5      | 2   | 74         | 2   |      |
|               |                                                                              |                                           | 60                         | 22    | 1.1 | 24                 | 2   | 35.2      | 2   | 45         | 2   |      |
|               |                                                                              |                                           | 25                         | 10    | 1.2 | 12                 | 2   | 23.2      | 2   | 35         | 2   |      |

1. Guaranteed by characterization results.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
3. When the ADC is ON (ADON bit set in the ADC\_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.



Table 29. Typical and maximum current consumption in Sleep mode, regulator ON

| Symbol          | Parameter                    | Conditions                             | f <sub>HCLK</sub> (MHz) | Typ | Max <sup>(1)</sup> |                      |                    | Unit |
|-----------------|------------------------------|----------------------------------------|-------------------------|-----|--------------------|----------------------|--------------------|------|
|                 |                              |                                        |                         |     | TA= 25 °C          | TA=85 °C             | TA=105 °C          |      |
| I <sub>DD</sub> | Supply current in Sleep mode | All peripherals enabled <sup>(2)</sup> | 216                     | 82  | 96 <sup>(3)</sup>  | 109.3 <sup>(3)</sup> | 128.3              | mA   |
|                 |                              |                                        | 200                     | 77  | 84                 | 103.4                | 122.6              |      |
|                 |                              |                                        | 180                     | 67  | 72 <sup>(3)</sup>  | 88.3 <sup>(3)</sup>  | 120 <sup>(3)</sup> |      |
|                 |                              |                                        | 168                     | 60  | 64                 | 78.9                 | 92.7               |      |
|                 |                              |                                        | 144                     | 46  | 49                 | 61.8                 | 73.6               |      |
|                 |                              |                                        | 60                      | 24  | 26                 | 37.2                 | 49                 |      |
|                 |                              |                                        | 25                      | 14  | 16                 | 27                   | 38.8               |      |
|                 |                              | All peripherals disabled               | 216                     | 24  | 28 <sup>(3)</sup>  | 42.9 <sup>(3)</sup>  | 62.2               |      |
|                 |                              |                                        | 200                     | 22  | 26                 | 41.9                 | 61.2               |      |
|                 |                              |                                        | 180                     | 19  | 21 <sup>(3)</sup>  | 33.2 <sup>(3)</sup>  | 48 <sup>(3)</sup>  |      |
|                 |                              |                                        | 168                     | 17  | 19                 | 30.1                 | 43.9               |      |
|                 |                              |                                        | 144                     | 13  | 15                 | 24.6                 | 36.3               |      |
|                 |                              |                                        | 60                      | 7   | 9                  | 20.5                 | 32.3               |      |
|                 |                              |                                        | 25                      | 5   | 7                  | 18.8                 | 30.6               |      |

1. Guaranteed by characterization results.

2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.

3. Guaranteed by test in production.

Table 30. Typical and maximum current consumption in Sleep mode, regulator OFF

| Symbol        | Parameter                                                                             | Conditions                                | f <sub>HCLK</sub><br>(MHz) | Typ   |     | Max <sup>(1)</sup> |     |           |     |            |     | Unit |
|---------------|---------------------------------------------------------------------------------------|-------------------------------------------|----------------------------|-------|-----|--------------------|-----|-----------|-----|------------|-----|------|
|               |                                                                                       |                                           |                            |       |     | TA= 25 °C          |     | TA= 85 °C |     | TA= 105 °C |     |      |
|               |                                                                                       |                                           |                            | IDD12 | IDD | IDD12              | IDD | IDD12     | IDD | IDD12      | IDD |      |
| IDD12/<br>IDD | Supply current<br>in Run mode<br>from V <sub>12</sub> and<br>V <sub>DD</sub> supplies | All peripherals<br>enabled <sup>(2)</sup> | 180                        | 62    | 1.3 | 67.5               | 2   | 84.4      | 2   | 95         | 2   | mA   |
|               |                                                                                       |                                           | 168                        | 55    | 1.3 | 59.8               | 2   | 75.4      | 2   | 86         | 2   |      |
|               |                                                                                       |                                           | 144                        | 43    | 1.3 | 46.3               | 2   | 59.6      | 2   | 70         | 2   |      |
|               |                                                                                       |                                           | 60                         | 22    | 1   | 24                 | 2   | 35.8      | 2   | 46         | 2   |      |
|               |                                                                                       |                                           | 25                         | 13    | 1   | 15                 | 2   | 25.8      | 2   | 36         | 2   |      |
|               |                                                                                       | All peripherals<br>disabled               | 180                        | 17    | 1.3 | 19                 | 2   | 31.4      | 2   | 42         | 2   |      |
|               |                                                                                       |                                           | 168                        | 15    | 1.3 | 17                 | 2   | 28.4      | 2   | 40         | 2   |      |
|               |                                                                                       |                                           | 144                        | 12    | 1.2 | 14                 | 2   | 23.2      | 2   | 33         | 2   |      |
|               |                                                                                       |                                           | 60                         | 5     | 1   | 6                  | 2   | 19.3      | 2   | 29         | 2   |      |
|               |                                                                                       |                                           | 25                         | 3     | 1   | 4                  | 2   | 17.6      | 2   | 28         | 2   |      |

1. Guaranteed by characterization results.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.

**Table 31. Typical and maximum current consumptions in Stop mode**

| Symbol                                         | Parameter                                                                        | Conditions                                                                                      | Typ                     | Max <sup>(1)</sup>     |                        |                         |    | Unit |
|------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------|------------------------|------------------------|-------------------------|----|------|
|                                                |                                                                                  |                                                                                                 | V <sub>DD</sub> = 3.6 V |                        |                        |                         |    |      |
|                                                |                                                                                  |                                                                                                 | T <sub>A</sub> = 25 °C  | T <sub>A</sub> = 25 °C | T <sub>A</sub> = 85 °C | T <sub>A</sub> = 105 °C |    |      |
| I <sub>DD_STOP_NM</sub><br>(normal mode)       | Supply current in Stop mode, main regulator in Run mode                          | Flash memory in Stop mode, all oscillators OFF, no IWDG                                         | 0.45                    | 2                      | 12                     | 22                      | mA |      |
|                                                |                                                                                  | Flash memory in Deep power down mode, all oscillators OFF                                       | 0.4                     | 2                      | 12                     | 22                      |    |      |
|                                                | Supply current in Stop mode, main regulator in low-power mode                    | Flash memory in Stop mode, all oscillators OFF, no IWDG                                         | 0.32                    | 1.5                    | 10                     | 18                      |    |      |
|                                                |                                                                                  | Flash memory in Deep power down mode, all oscillators OFF, no IWDG                              | 0.27                    | 1.5                    | 10                     | 18                      |    |      |
| I <sub>DD_STOP_UDM</sub><br>(under-drive mode) | Supply current in Stop mode, main regulator in low-voltage and under-drive modes | Regulator in Run mode, Flash memory in Deep power down mode, all oscillators OFF, no IWDG       | 0.15                    | 0.8                    | 5                      | 7                       |    |      |
|                                                |                                                                                  | Regulator in Low-power mode, Flash memory in Deep power down mode, all oscillators OFF, no IWDG | 0.1                     | 0.7                    | 4                      | 7                       |    |      |

1. Data based on characterization, tested in production.

Table 32. Typical and maximum current consumptions in Standby mode

| Symbol               | Parameter                      | Conditions                                                | Typ <sup>(1)</sup>      |                         |                         | Max <sup>(2)</sup>      |                        |                         | Unit |
|----------------------|--------------------------------|-----------------------------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------------------------|------|
|                      |                                |                                                           | T <sub>A</sub> = 25 °C  |                         |                         | T <sub>A</sub> = 25 °C  | T <sub>A</sub> = 85 °C | T <sub>A</sub> = 105 °C |      |
|                      |                                |                                                           | V <sub>DD</sub> = 1.7 V | V <sub>DD</sub> = 2.4 V | V <sub>DD</sub> = 3.3 V | V <sub>DD</sub> = 3.3 V |                        |                         |      |
| I <sub>DD_STBY</sub> | Supply current in Standby mode | Backup SRAM OFF, RTC and LSE OFF                          | 1.09                    | 1.13                    | 1.4                     | 4                       | 27                     | 55                      | µA   |
|                      |                                | Backup SRAM ON, RTC and LSE OFF                           | 1.85                    | 1.88                    | 2.17                    | 5                       | 30                     | 60                      |      |
|                      |                                | Backup SRAM OFF, RTC ON and LSE in low drive mode         | 1.65                    | 1.86                    | 2.43                    | 7                       | 47                     | 95.5                    |      |
|                      |                                | Backup SRAM OFF, RTC ON and LSE in medium low drive mode  | 1.67                    | 1.88                    | 2.46                    | 7                       | 47.5                   | 97                      |      |
|                      |                                | Backup SRAM OFF, RTC ON and LSE in medium high drive mode | 1.8                     | 2.01                    | 2.61                    | 7.5                     | 50.5                   | 102.5                   |      |
|                      |                                | Backup SRAM OFF, RTC ON and LSE in high drive mode        | 1.92                    | 2.13                    | 2.73                    | 8                       | 53                     | 107                     |      |
|                      |                                | Backup SRAM ON, RTC ON and LSE in low drive mode          | 2.39                    | 2.6                     | 3.23                    | 9                       | 62                     | 127                     |      |
|                      |                                | Backup SRAM ON, RTC ON and LSE in medium low drive mode   | 2.41                    | 2.64                    | 3.25                    | 9                       | 63                     | 128                     |      |
|                      |                                | Backup SRAM ON, RTC ON and LSE in medium high drive mode  | 2.67                    | 2.89                    | 2.53                    | 10                      | 68                     | 139                     |      |
|                      |                                | Backup SRAM ON, RTC ON and LSE in high drive mode         | 2.68                    | 2.9                     | 3.51                    | 10                      | 68                     | 138                     |      |

1. PDR is OFF for V<sub>DD</sub>=1.7V. When the PDR is OFF (internal reset OFF), the typical current consumption is reduced by additional 1.2 µA.
2. Guaranteed by characterization results.

Table 33. Typical and maximum current consumptions in V<sub>BAT</sub> mode

| Symbol               | Parameter                                  | Conditions <sup>(1)</sup>                                       | Typ                         |                             |                             | Max <sup>(2)</sup>       |                        | Unit |
|----------------------|--------------------------------------------|-----------------------------------------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------|------------------------|------|
|                      |                                            |                                                                 | T <sub>A</sub> =25 °C       |                             |                             | T <sub>A</sub> =85 °C    | T <sub>A</sub> =105 °C |      |
|                      |                                            |                                                                 | V <sub>BAT</sub> =<br>1.7 V | V <sub>BAT</sub> =<br>2.4 V | V <sub>BAT</sub> =<br>3.3 V | V <sub>BAT</sub> = 3.6 V |                        |      |
| I <sub>DD_VBAT</sub> | Supply current<br>in V <sub>BAT</sub> mode | Backup SRAM OFF, RTC and<br>LSE OFF                             | 0.035                       | 0.037                       | 0.043                       | 4                        | 10                     | μA   |
|                      |                                            | Backup SRAM ON, RTC and<br>LSE OFF                              | 0.69                        | 0.71                        | 0.73                        | 9                        | 20                     |      |
|                      |                                            | Backup SRAM OFF, RTC ON<br>and LSE in low drive mode            | 0.57                        | 0.74                        | 1.05                        | 98                       | 244                    |      |
|                      |                                            | Backup SRAM OFF, RTC ON<br>and LSE in medium low drive<br>mode  | 0.59                        | 0.76                        | 1.08                        | 101                      | 251                    |      |
|                      |                                            | Backup SRAM OFF, RTC ON<br>and LSE in medium high drive<br>mode | 0.69                        | 0.86                        | 1.19                        | 111                      | 277                    |      |
|                      |                                            | Backup SRAM OFF, RTC ON<br>and LSE in high drive mode           | 0.8                         | 0.98                        | 1.31                        | 122                      | 305                    |      |
|                      |                                            | Backup SRAM ON, RTC ON and<br>LSE in low drive mode             | 1.22                        | 1.41                        | 1.74                        | 162                      | 405                    |      |
|                      |                                            | Backup SRAM ON, RTC ON and<br>LSE in Medium low drive mode      | 1.25                        | 1.43                        | 1.78                        | 166                      | 414                    |      |
|                      |                                            | Backup SRAM ON, RTC ON and<br>LSE in Medium high drive mode     | 1.46                        | 1.65                        | 2.01                        | 187                      | 468                    |      |
|                      |                                            | Backup SRAM ON, RTC ON and<br>LSE in High drive mode            | 1.46                        | 1.65                        | 2.01                        | 187                      | 468                    |      |

1. Crystal used: Abracon ABS07-120-32.768 kHz-T with a C<sub>L</sub> of 6 pF for typical values.

2. Guaranteed by characterization results.

Figure 32. Typical  $V_{BAT}$  current consumption (RTC ON/BKP SRAM OFF and LSE in low drive mode)

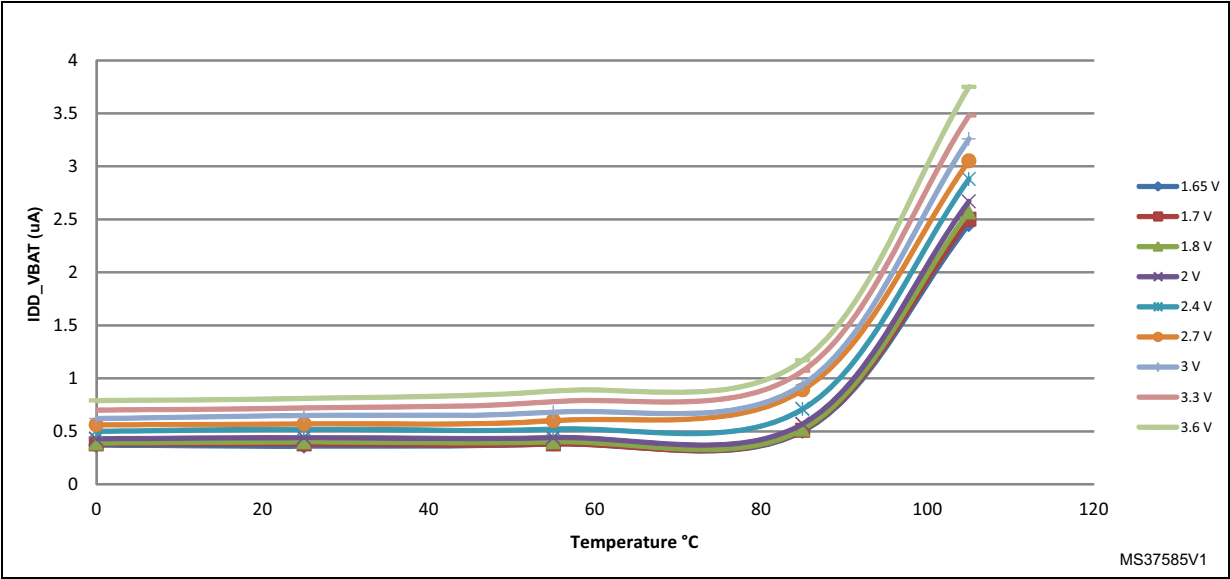


Figure 33. Typical  $V_{BAT}$  current consumption (RTC ON/BKP SRAM OFF and LSE in medium low drive mode)

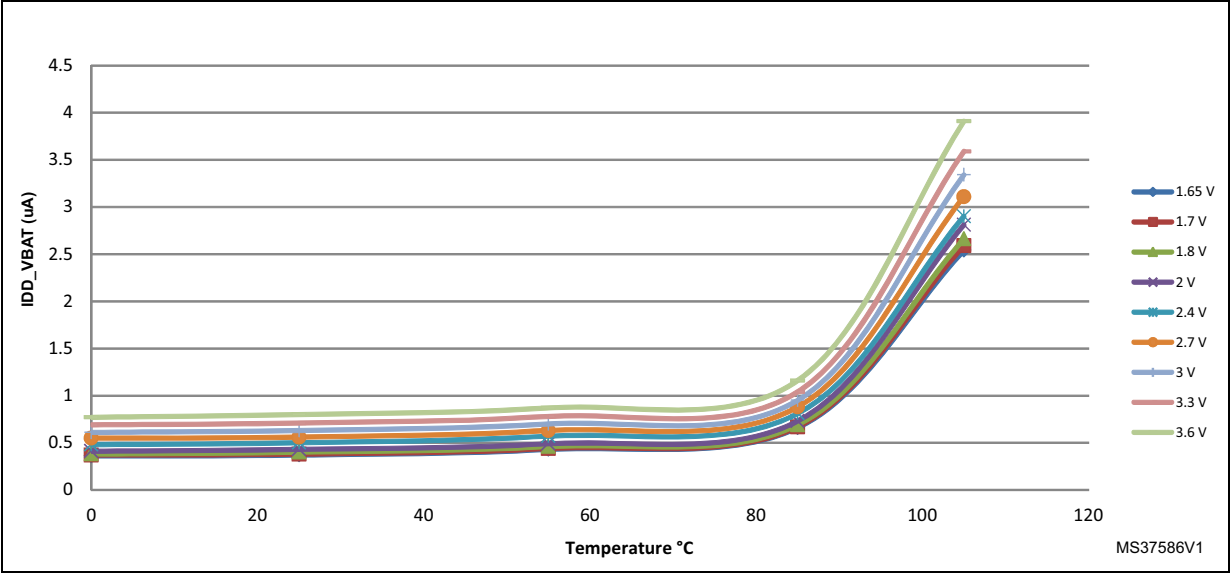


Figure 34. Typical  $V_{BAT}$  current consumption (RTC ON/BKP SRAM OFF and LSE in medium high drive mode)

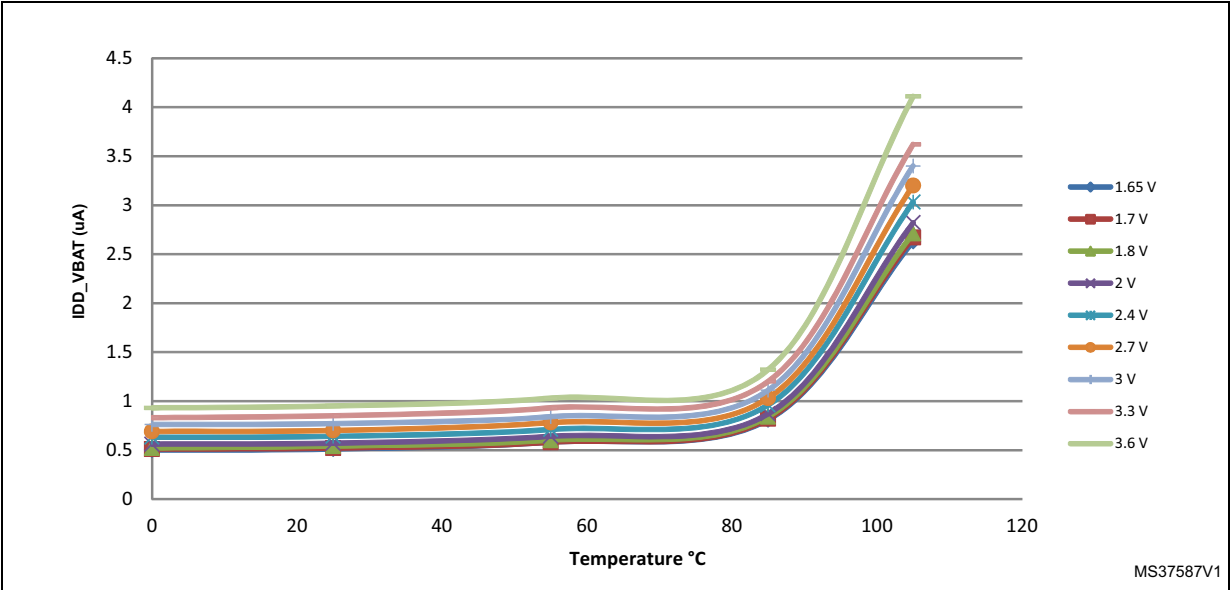


Figure 35. Typical  $V_{BAT}$  current consumption (RTC ON/BKP SRAM OFF and LSE in high drive mode)

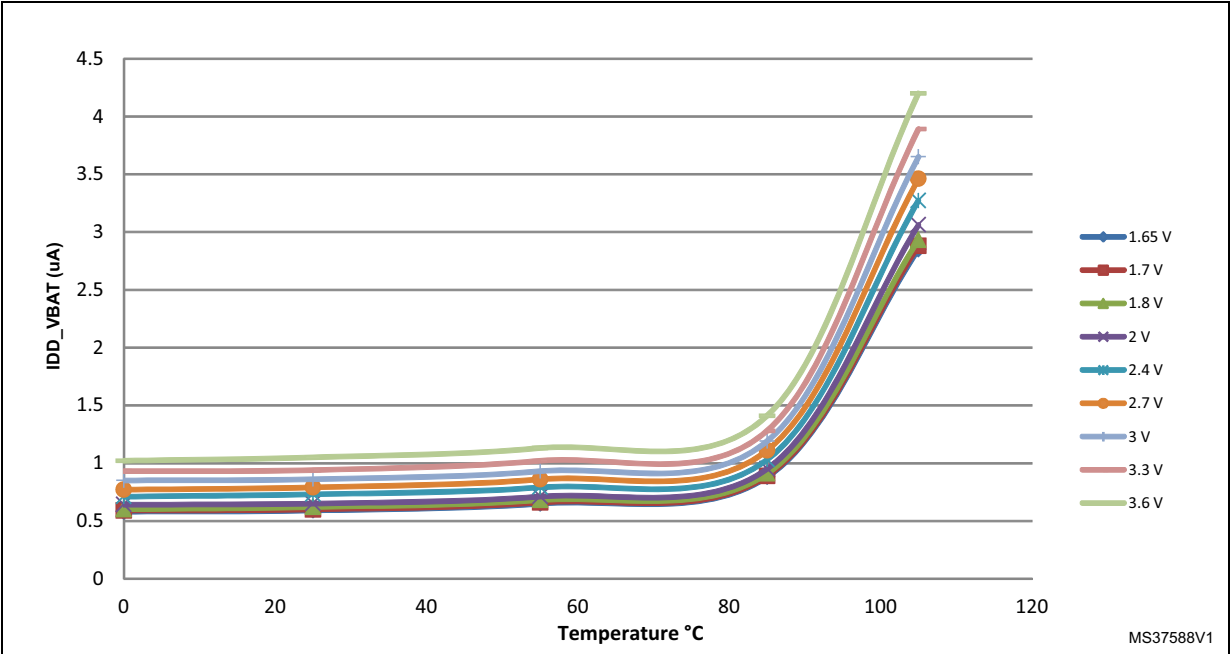
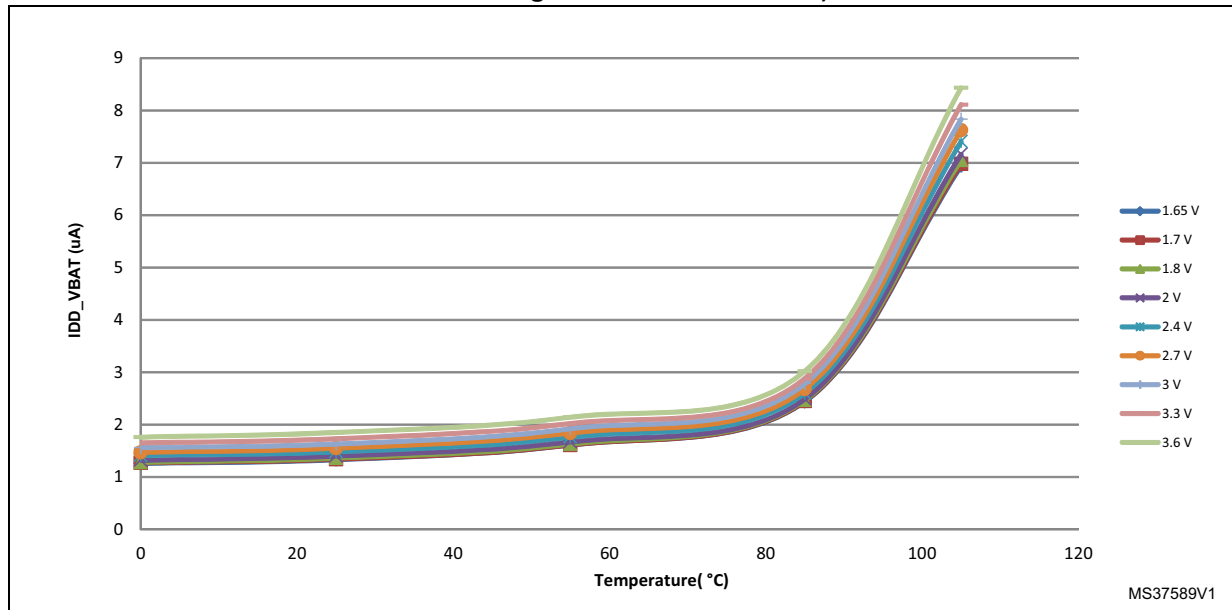


Figure 36. Typical  $V_{BAT}$  current consumption (RTC ON/BKP SRAM OFF and LSE in high medium drive mode)



### I/O system current consumption

The current consumption of the I/O system has two components: static and dynamic.

#### I/O static current consumption

All the I/Os used as inputs with pull-up generate current consumption when the pin is externally held low. The value of this current consumption can be simply computed by using the pull-up/pull-down resistors values given in [Table 61: I/O static characteristics](#).

For the output pins, any external pull-down or external load must also be considered to estimate the current consumption.

Additional I/O current consumption is due to I/Os configured as inputs if an intermediate voltage level is externally applied. This current consumption is caused by the input Schmitt trigger circuits used to discriminate the input value. Unless this specific configuration is required by the application, this supply current consumption can be avoided by configuring these I/Os in analog mode. This is notably the case of ADC input pins which must be configured as analog inputs.

**Caution:** Any floating input pin can also settle to an intermediate voltage level or switch inadvertently, as a result of external electromagnetic noise. To avoid current consumption related to floating pins, they must either be configured in analog mode, or forced internally to a definite digital value. This can be done either by using pull-up/down resistors or by configuring the pins in output mode.

#### I/O dynamic current consumption

In addition to the internal peripheral current consumption (see [Table 35: Peripheral current consumption](#)), the I/Os used by an application also contribute to the current consumption. When an I/O pin switches, it uses the current from the MCU supply voltage to supply the I/O

pin circuitry and to charge/discharge the capacitive load (internal or external) connected to the pin:

$$I_{SW} = V_{DD} \times f_{SW} \times C$$

Where

$I_{SW}$  is the current sunk by a switching I/O to charge/discharge the capacitive load.

$V_{DD}$  is the MCU supply voltage.

$f_{SW}$  is the I/O switching frequency.

$C$  is the total capacitance seen by the I/O pin:  $C = C_{INT} + C_{EXT}$ .

The test pin is configured in push-pull output mode and is toggled by software at a fixed frequency.

**Table 34. Switching output I/O current consumption<sup>(1)</sup>**

| Symbol     | Parameter             | Conditions                                                | I/O toggling frequency (fsw) MHz | Typ<br>$V_{DD} = 3.3\text{ V}$ | Typ<br>$V_{DD} = 1.8\text{ V}$ | Unit |
|------------|-----------------------|-----------------------------------------------------------|----------------------------------|--------------------------------|--------------------------------|------|
| $I_{DDIO}$ | I/O switching current | $C_{EXT} = 0\text{ pF}$<br>$C = C_{INT} + C_S + C_{EXT}$  | 2                                | 0.1                            | 0.1                            | mA   |
|            |                       |                                                           | 8                                | 0.4                            | 0.2                            |      |
|            |                       |                                                           | 25                               | 1.1                            | 0.7                            |      |
|            |                       |                                                           | 50                               | 2.4                            | 1.3                            |      |
|            |                       |                                                           | 60                               | 3.1                            | 1.6                            |      |
|            |                       |                                                           | 84                               | 4.3                            | 2.4                            |      |
|            |                       |                                                           | 90                               | 4.9                            | 2.6                            |      |
|            |                       |                                                           | 100                              | 5.4                            | 2.8                            |      |
|            |                       |                                                           | 108                              | 5.6                            | -                              |      |
|            |                       | $C_{EXT} = 10\text{ pF}$<br>$C = C_{INT} + C_S + C_{EXT}$ | 2                                | 0.2                            | 0.1                            |      |
|            |                       |                                                           | 8                                | 0.6                            | 0.3                            |      |
|            |                       |                                                           | 25                               | 1.8                            | 1.1                            |      |
|            |                       |                                                           | 50                               | 3.1                            | 2.3                            |      |
|            |                       |                                                           | 60                               | 4.6                            | 3.4                            |      |
|            |                       |                                                           | 84                               | 9.7                            | 3.6                            |      |
|            |                       |                                                           | 90                               | 10.12                          | 5.2                            |      |
|            |                       |                                                           | 100                              | 14.92                          | 5.4                            |      |
|            |                       |                                                           | 108                              | 18.11                          | -                              |      |



Table 34. Switching output I/O current consumption<sup>(1)</sup> (continued)

| Symbol            | Parameter             | Conditions                                                                           | I/O toggling frequency (fsw) MHz | Typ<br>V <sub>DD</sub> = 3.3 V | Typ<br>V <sub>DD</sub> = 1.8 V | Unit |
|-------------------|-----------------------|--------------------------------------------------------------------------------------|----------------------------------|--------------------------------|--------------------------------|------|
| I <sub>DDIO</sub> | I/O switching current | C <sub>EXT</sub> = 22 pF<br>C = C <sub>INT</sub> + C <sub>S</sub> + C <sub>EXT</sub> | 2                                | 0.3                            | 0.1                            | mA   |
|                   |                       |                                                                                      | 8                                | 1.0                            | 0.5                            |      |
|                   |                       |                                                                                      | 25                               | 3.5                            | 1.6                            |      |
|                   |                       |                                                                                      | 50                               | 5.9                            | 4.2                            |      |
|                   |                       |                                                                                      | 60                               | 10.0                           | 4.4                            |      |
|                   |                       |                                                                                      | 84                               | 19.12                          | 5.8                            |      |
|                   |                       |                                                                                      | 90                               | 19.6                           | -                              |      |
|                   |                       | C <sub>EXT</sub> = 33 pF<br>C = C <sub>INT</sub> + C <sub>S</sub> + C <sub>EXT</sub> | 2                                | 0.3                            | 0.2                            |      |
|                   |                       |                                                                                      | 8                                | 1.3                            | 0.7                            |      |
|                   |                       |                                                                                      | 25                               | 3.5                            | 2.3                            |      |
|                   |                       |                                                                                      | 50                               | 10.26                          | 5.19                           |      |
|                   |                       |                                                                                      | 60                               | 16.53                          | -                              |      |

1. C<sub>INT</sub> + C<sub>S</sub>, PCB board capacitance including the pad pin is estimated to 15 pF.

### On-chip peripheral current consumption

The MCU is placed under the following conditions:

- At startup, all I/O pins are in analog input configuration.
- All peripherals are disabled unless otherwise mentioned.
- I/O compensation cell enabled
- The ART/L1-cache is ON.
- Scale 1 mode selected, internal digital voltage V<sub>12</sub> = 1.32 V.
- HCLK is the system clock. f<sub>PCLK1</sub> = f<sub>HCLK</sub>/4, and f<sub>PCLK2</sub> = f<sub>HCLK</sub>/2.

The given value is calculated by measuring the difference of current consumption

- with all peripherals clocked off
- with only one peripheral clocked on
- f<sub>HCLK</sub> = 216 MHz (Scale 1 + over-drive ON), f<sub>HCLK</sub> = 168 MHz (Scale 2), f<sub>HCLK</sub> = 144 MHz (Scale 3)
- Ambient operating temperature is 25 °C and V<sub>DD</sub>=3.3 V.

Table 35. Peripheral current consumption

| Peripheral                 |             | I <sub>DD</sub> (Typ) <sup>(1)</sup> |                 |                 | Unit   |
|----------------------------|-------------|--------------------------------------|-----------------|-----------------|--------|
|                            |             | Scale 1                              | Scale 2         | Scale 3         |        |
| AHB1<br>(up to<br>216 MHz) | GPIOA       | 3.6                                  | 3.4             | 2.9             | μA/MHz |
|                            | GPIOB       | 3.7                                  | 3.6             | 3.1             |        |
|                            | GPIOC       | 3.7                                  | 3.4             | 3.0             |        |
|                            | GPIOD       | 3.7                                  | 3.6             | 3.0             |        |
|                            | GPIOE       | 3.6                                  | 3.4             | 2.9             |        |
|                            | GPIOF       | 3.5                                  | 3.4             | 2.9             |        |
|                            | GPIOG       | 3.5                                  | 3.3             | 2.8             |        |
|                            | GPIOH       | 3.5                                  | 3.4             | 2.9             |        |
|                            | GPIOI       | 3.5                                  | 3.3             | 2.9             |        |
|                            | CRC         | 1.2                                  | 1.1             | 0.9             |        |
|                            | BKPSRAM     | 0.8                                  | 0.7             | 0.6             |        |
|                            | DMA1        | 3.07 x N + 8.7                       | 2.98 x N + 8.4  | 2.52 x N + 7.02 |        |
|                            | DMA2        | 3.01 x N + 7.98                      | 2.95 x N + 7.95 | 2.48 x N + 6.69 |        |
|                            | OTG_HS+ULPI | 54.4                                 | 53.2            | 44.6            |        |
| AHB2<br>(up to<br>216 MHz) | RNG         | 1.9                                  | 1.8             | 1.6             | μA/MHz |
|                            | USB_OTG_FS  | 28.7                                 | 27.9            | 23.5            |        |
| AHB3<br>(up to<br>216 MHz) | FMC         | 16.2                                 | 15.8            | 13.3            | μA/MHz |
|                            | QSPI        | 16.9                                 | 16.3            | 13.8            |        |
| Bus matrix <sup>(2)</sup>  |             | 15.8                                 | 12.8            | 8.5             | μA/MHz |

Table 35. Peripheral current consumption (continued)

| Peripheral                |                          | I <sub>DD</sub> (Typ) <sup>(1)</sup> |         |         | Unit   |
|---------------------------|--------------------------|--------------------------------------|---------|---------|--------|
|                           |                          | Scale 1                              | Scale 2 | Scale 3 |        |
| APB1<br>(up to<br>54 MHz) | TIM2                     | 19.3                                 | 18.2    | 15.6    | μA/MHz |
|                           | TIM3                     | 15                                   | 14      | 12.2    |        |
|                           | TIM4                     | 15.7                                 | 15.1    | 12.8    |        |
|                           | TIM5                     | 18                                   | 16.9    | 14.4    |        |
|                           | TIM6                     | 3.7                                  | 3.1     | 2.8     |        |
|                           | TIM7                     | 3.5                                  | 2.9     | 2.5     |        |
|                           | TIM12                    | 8.1                                  | 7.8     | 6.4     |        |
|                           | TIM13                    | 6.1                                  | 5.1     | 4.7     |        |
|                           | TIM14                    | 6.3                                  | 5.6     | 4.7     |        |
|                           | LPTIM1                   | 9.4                                  | 9.8     | 8.3     |        |
|                           | WWDG                     | 2.4                                  | 1.3     | 1.4     |        |
|                           | SPI2/I2S2 <sup>(3)</sup> | 6.7                                  | 6       | 5.3     |        |
|                           | SPI3/I2S3 <sup>(3)</sup> | 4.8                                  | 3.8     | 3.3     |        |
|                           | USART2                   | 13.3                                 | 12      | 10.6    |        |
|                           | USART3                   | 12.8                                 | 12      | 10.3    |        |
|                           | UART4                    | 11.7                                 | 10.7    | 9.2     |        |
|                           | UART5                    | 11.7                                 | 10.2    | 8.9     |        |
|                           | I2C1                     | 10.6                                 | 9.6     | 8.3     |        |
|                           | I2C2                     | 10.6                                 | 9.6     | 8.3     |        |
|                           | I2C3                     | 10.7                                 | 9.8     | 8.3     |        |
|                           | CAN1                     | 8.9                                  | 8       | 6.9     |        |
|                           | PWR                      | 11.3                                 | 11.3    | 8.9     |        |
|                           | DAC <sup>(4)</sup>       | 6.1                                  | 5.1     | 4.4     |        |
|                           | UART7                    | 13.3                                 | 12      | 10.3    |        |
|                           | UART8                    | 12.6                                 | 11.6    | 9.7     |        |

Table 35. Peripheral current consumption (continued)

| Peripheral                 |                          | I <sub>DD</sub> (Typ) <sup>(1)</sup> |         |         | Unit   |
|----------------------------|--------------------------|--------------------------------------|---------|---------|--------|
|                            |                          | Scale 1                              | Scale 2 | Scale 3 |        |
| APB2<br>(up to<br>108 MHz) | TIM1                     | 24.9                                 | 23.8    | 20      | μA/MHz |
|                            | TIM8                     | 24.5                                 | 23.7    | 20      |        |
|                            | USART1                   | 12.4                                 | 11.6    | 10      |        |
|                            | USART6                   | 12.3                                 | 11.7    | 10      |        |
|                            | ADC1 <sup>(5)</sup>      | 6.3                                  | 5.8     | 4.9     |        |
|                            | ADC2 <sup>(5)</sup>      | 6.3                                  | 5.6     | 4.9     |        |
|                            | ADC3 <sup>(5)</sup>      | 6.4                                  | 5.8     | 5       |        |
|                            | SDMMC1                   | 9.1                                  | 8.3     | 7.1     |        |
|                            | SDMMC2                   | 7                                    | 7.2     | 6       |        |
|                            | SPI1/I2S1 <sup>(3)</sup> | 3.2                                  | 3.2     | 2.6     |        |
|                            | SPI4                     | 2.9                                  | 2.9     | 2.2     |        |
|                            | SYSCFG                   | 1                                    | 1       | 0.7     |        |
|                            | TIM9                     | 9.9                                  | 9.1     | 7.8     |        |
|                            | TIM10                    | 7                                    | 6.4     | 5.6     |        |
|                            | TIM11                    | 7.2                                  | 6.8     | 5.7     |        |
|                            | SPI5                     | 4.8                                  | 4.1     | 3.6     |        |
|                            | SAI1                     | 5.6                                  | 4.9     | 4.2     |        |
|                            | SAI2                     | 5.4                                  | 4.7     | 4       |        |
|                            | USB PHY HS<br>Controller | 8.3                                  | 7.9     | 6.7     |        |

1. When the I/O compensation cell is ON, I<sub>DD</sub> typical value increases by 0.22 mA.
2. The BusMatrix is automatically active when at least one master is ON.
3. To enable an I2S peripheral, first set the I2SMOD bit and then the I2SE bit in the SPI\_I2SCFGR register.
4. When the DAC is ON and EN1/2 bits are set in DAC\_CR register, add an additional power consumption of 0.75 mA per DAC channel for the analog part.
5. When the ADC is ON (ADON bit set in the ADC\_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.

### USB OTG HS and USB OTG HS PHY current consumption (on STM32F723xx devices)

The MCU is placed under the following conditions:

- STM32 MCU is enumerated as a HID device.
- $f_{HCLK} = 216$  MHz (Scale 1 + over-drive ON),  $f_{HCLK} = 168$  MHz (Scale 2),  
 $f_{HCLK} = 144$  MHz (Scale 3)

The given value is calculated by measuring the difference of current consumption in case:

- USB is configured but no transfer is done.
- USB is configured and there is a transmission on going.

- Ambient operating temperature is 25 °C,  $V_{DD} = V_{DDUSB} = 3.3$  V.

**Table 36. USB OTG HS and USB OTG PHY HS current consumption**

|                                                   | $I_{DD}$ (Typ) |         |         | Unit |
|---------------------------------------------------|----------------|---------|---------|------|
|                                                   | Scale 1        | Scale 2 | Scale 3 |      |
| USB OTG HS and USB OTG HS PHY current consumption | 50.16          | 44.92   | 38.98   | mA   |

### 6.3.8 Wakeup time from low-power modes

The wakeup times given in [Table 37](#) are measured starting from the wakeup event trigger up to the first instruction executed by the CPU:

- For Stop or Sleep modes: the wakeup event is WFE.
- WKUP (PA0) pin is used to wakeup from Standby, Stop and Sleep modes.

All timings are derived from tests performed under ambient temperature and  $V_{DD} = 3.3$  V.

**Table 37. Low-power mode wakeup timings**

| Symbol              | Parameter                                                 | Conditions                                                         | Typ <sup>(1)</sup> | Max <sup>(1)</sup> | Unit             |
|---------------------|-----------------------------------------------------------|--------------------------------------------------------------------|--------------------|--------------------|------------------|
| $t_{WUSLEEP}^{(2)}$ | Wakeup from Sleep mode                                    | -                                                                  | 13                 | 13                 | CPU clock cycles |
| $t_{WUSTOP}^{(2)}$  | Wakeup from Stop mode with MR/LP regulator in normal mode | Main regulator is ON                                               | 14                 | 14.9               | $\mu$ s          |
|                     |                                                           | Main regulator is ON and Flash memory in Deep power down mode      | 104.1              | 107.6              |                  |
|                     |                                                           | Low power regulator is ON                                          | 21.4               | 24.2               |                  |
|                     |                                                           | Low power regulator is ON and Flash memory in Deep power down mode | 111.5              | 116.5              |                  |

Table 37. Low-power mode wakeup timings (continued)

| Symbol              | Parameter                                                      | Conditions                                                                     | Typ <sup>(1)</sup> | Max <sup>(1)</sup> | Unit    |
|---------------------|----------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------|--------------------|---------|
| $t_{WUSTOP}^{(2)}$  | Wakeup from Stop mode with MR/LP regulator in Under-drive mode | Main regulator in under-drive mode (Flash memory in Deep power-down mode)      | 107.4              | 113.2              | $\mu s$ |
|                     |                                                                | Low power regulator in under-drive mode (Flash memory in Deep power-down mode) | 112.7              | 120                |         |
| $t_{WUSTDBY}^{(2)}$ | Wakeup from Standby mode                                       | Exit Standby mode on rising edge                                               | 308                | 313                | $\mu s$ |
|                     |                                                                | Exit Standby mode on falling edge                                              | 307                | 313                |         |

1. Guaranteed by characterization results.

2. The wakeup times are measured from the wakeup event to the point in which the application code reads the first

### 6.3.9 External clock source characteristics

#### High-speed external user clock generated from an external source

In bypass mode the HSE oscillator is switched off and the input pin is a standard I/O. The external clock signal has to respect the [Table 61: I/O static characteristics](#). However, the recommended clock input waveform is shown in [Figure 37](#).

The characteristics given in [Table 38](#) result from tests performed using an high-speed external clock source, and under ambient temperature and supply voltage conditions summarized in [Table 16](#).

Table 38. High-speed external user clock characteristics

| Symbol                       | Parameter                                           | Conditions                       | Min         | Typ | Max         | Unit    |
|------------------------------|-----------------------------------------------------|----------------------------------|-------------|-----|-------------|---------|
| $f_{HSE\_ext}$               | External user clock source frequency <sup>(1)</sup> | -                                | 1           | -   | 50          | MHz     |
| $V_{HSEH}$                   | OSC_IN input pin high level voltage                 |                                  | $0.7V_{DD}$ | -   | $V_{DD}$    | V       |
| $V_{HSEL}$                   | OSC_IN input pin low level voltage                  |                                  | $V_{SS}$    | -   | $0.3V_{DD}$ |         |
| $t_{w(HSE)}$<br>$t_{f(HSE)}$ | OSC_IN high or low time <sup>(1)</sup>              |                                  | 5           | -   | -           | ns      |
| $t_{r(HSE)}$<br>$t_{f(HSE)}$ | OSC_IN rise or fall time <sup>(1)</sup>             |                                  | -           | -   | 10          |         |
| $C_{in(HSE)}$                | OSC_IN input capacitance <sup>(1)</sup>             | -                                | -           | 5   | -           | pF      |
| $DuCy_{(HSE)}$               | Duty cycle                                          | -                                | 45          | -   | 55          | %       |
| $I_L$                        | OSC_IN Input leakage current                        | $V_{SS} \leq V_{IN} \leq V_{DD}$ | -           | -   | $\pm 1$     | $\mu A$ |

1. Guaranteed by design.

### Low-speed external user clock generated from an external source

In bypass mode the LSE oscillator is switched off and the input pin is a standard I/O. The external clock signal has to respect the [Table 61: I/O static characteristics](#). However, the recommended clock input waveform is shown in [Figure 38](#).

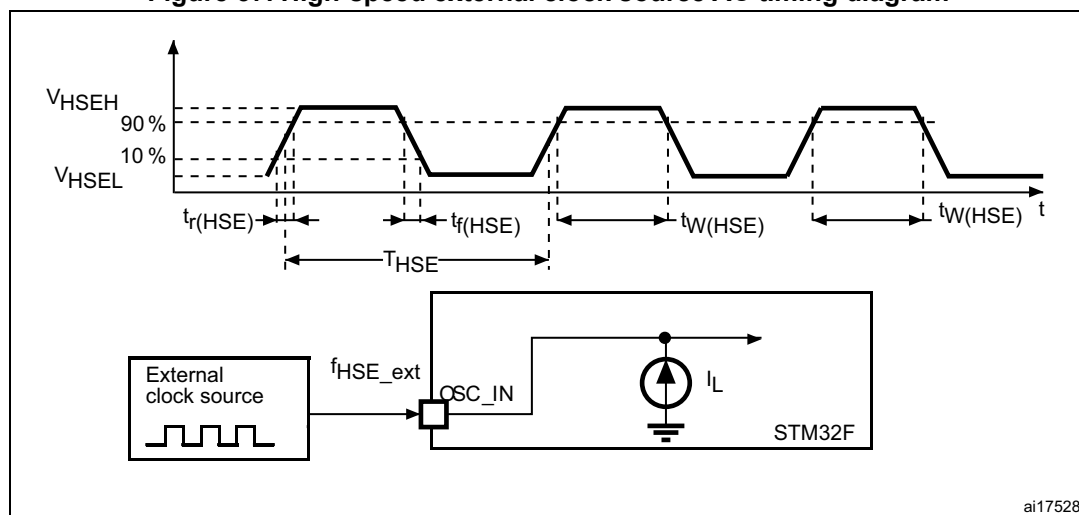
The characteristics given in [Table 39](#) result from tests performed using an low-speed external clock source, and under ambient temperature and supply voltage conditions summarized in [Table 16](#).

**Table 39. Low-speed external user clock characteristics**

| Symbol                       | Parameter                                           | Conditions                       | Min         | Typ    | Max         | Unit    |
|------------------------------|-----------------------------------------------------|----------------------------------|-------------|--------|-------------|---------|
| $f_{LSE\_ext}$               | User External clock source frequency <sup>(1)</sup> | -                                | -           | 32.768 | 1000        | kHz     |
| $V_{LSEH}$                   | OSC32_IN input pin high level voltage               |                                  | $0.7V_{DD}$ | -      | $V_{DD}$    | V       |
| $V_{LSEL}$                   | OSC32_IN input pin low level voltage                |                                  | $V_{SS}$    | -      | $0.3V_{DD}$ |         |
| $t_{w(LSE)}$<br>$t_{f(LSE)}$ | OSC32_IN high or low time <sup>(1)</sup>            |                                  | 450         | -      | -           | ns      |
| $t_{r(LSE)}$<br>$t_{f(LSE)}$ | OSC32_IN rise or fall time <sup>(1)</sup>           |                                  | -           | -      | 50          |         |
| $C_{in(LSE)}$                | OSC32_IN input capacitance <sup>(1)</sup>           | -                                | -           | 5      | -           | pF      |
| $DuCy_{(LSE)}$               | Duty cycle                                          | -                                | 30          | -      | 70          | %       |
| $I_L$                        | OSC32_IN Input leakage current                      | $V_{SS} \leq V_{IN} \leq V_{DD}$ | -           | -      | $\pm 1$     | $\mu A$ |

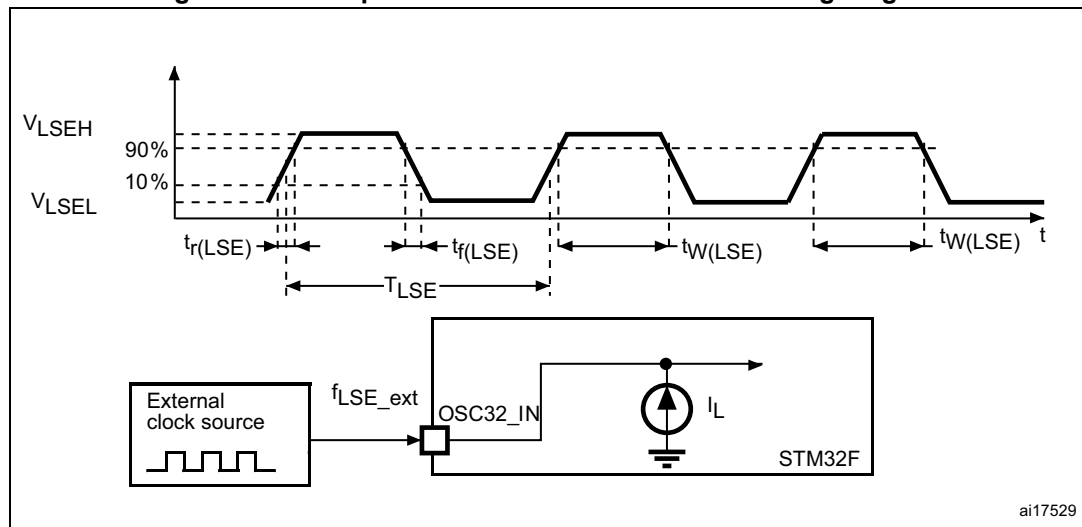
1. Guaranteed by design.

**Figure 37. High-speed external clock source AC timing diagram**



ai17528

Figure 38. Low-speed external clock source AC timing diagram



ai17529

### High-speed external clock generated from a crystal/ceramic resonator

The high-speed external (HSE) clock can be supplied with a 4 to 26 MHz crystal/ceramic resonator oscillator. All the information given in this paragraph are based on characterization results obtained with typical external components specified in [Table 40](#). In the application, the resonator and the load capacitors have to be placed as close as possible to the oscillator pins in order to minimize output distortion and startup stabilization time. Refer to the crystal resonator manufacturer for more details on the resonator characteristics (frequency, package, accuracy).

Table 40. HSE 4-26 MHz oscillator characteristics<sup>(1)</sup>

| Symbol              | Parameter                      | Conditions                                                                        | Min   | Typ | Max | Unit          |
|---------------------|--------------------------------|-----------------------------------------------------------------------------------|-------|-----|-----|---------------|
| $f_{OSC\_IN}$       | Oscillator frequency           | -                                                                                 | 4     | -   | 26  | MHz           |
| $R_F$               | Feedback resistor              | -                                                                                 | -     | 200 | -   | k $\Omega$    |
| $I_{DD}$            | HSE current consumption        | $V_{DD}=3.3\text{ V}$ ,<br>ESR= 30 $\Omega$ ,<br>$C_L=5\text{ pF}@25\text{ MHz}$  | -     | 450 | -   | $\mu\text{A}$ |
|                     |                                | $V_{DD}=3.3\text{ V}$ ,<br>ESR= 30 $\Omega$ ,<br>$C_L=10\text{ pF}@25\text{ MHz}$ | -     | 530 | -   |               |
| $ACC_{HSE}^{(2)}$   | HSE accuracy                   | -                                                                                 | - 500 | -   | 500 | ppm           |
| $G_{m\_crit\_max}$  | Maximum critical crystal $g_m$ | Startup                                                                           | -     | -   | 1   | mA/V          |
| $t_{SU(HSE)}^{(3)}$ | Startup time                   | $V_{DD}$ is stabilized                                                            | -     | 2   | -   | ms            |

1. Guaranteed by design.

2. This parameter depends on the crystal used in the application. The minimum and maximum values must be respected to comply with USB standard specifications.

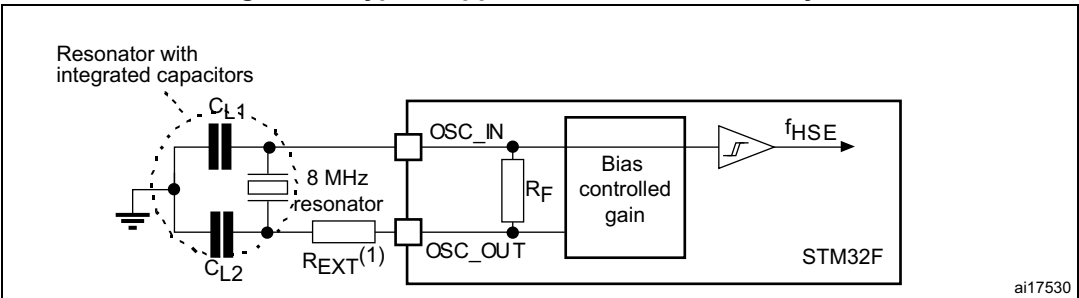
3.  $t_{SU(HSE)}$  is the startup time measured from the moment it is enabled (by software) to a stabilized 8 MHz oscillation is reached. This value is based on characterization results. It is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.



For  $C_{L1}$  and  $C_{L2}$ , it is recommended to use high-quality external ceramic capacitors in the 5 pF to 25 pF range (typ.), designed for high-frequency applications, and selected to match the requirements of the crystal or resonator (see [Figure 39](#)).  $C_{L1}$  and  $C_{L2}$  are usually the same size. The crystal manufacturer typically specifies a load capacitance which is the series combination of  $C_{L1}$  and  $C_{L2}$ . PCB and MCU pin capacitance must be included (10 pF can be used as a rough estimate of the combined pin and board capacitance) when sizing  $C_{L1}$  and  $C_{L2}$ .

**Note:** For information on selecting the crystal, refer to the application note AN2867 “Oscillator design guide for ST microcontrollers” available from the ST website [www.st.com](http://www.st.com).

**Figure 39. Typical application with an 8 MHz crystal**



1.  $R_{EXT}$  value depends on the crystal characteristics.

### Low-speed external clock generated from a crystal/ceramic resonator

The low-speed external (LSE) clock can be supplied with a 32.768 kHz crystal/ceramic resonator oscillator. All the information given in this paragraph are based on characterization results obtained with typical external components specified in [Table 41](#). In the application, the resonator and the load capacitors have to be placed as close as possible to the oscillator pins in order to minimize output distortion and startup stabilization time. Refer to the crystal resonator manufacturer for more details on the resonator characteristics (frequency, package, accuracy).

**Table 41. LSE oscillator characteristics ( $f_{LSE} = 32.768$  kHz) <sup>(1)</sup>**

| Symbol   | Parameter               | Conditions                                     | Min | Typ | Max | Unit |
|----------|-------------------------|------------------------------------------------|-----|-----|-----|------|
| $I_{DD}$ | LSE current consumption | LSEDRV[1:0]=00<br>Low drive capability         | -   | 250 | -   | nA   |
|          |                         | LSEDRV[1:0]=10<br>Medium low drive capability  | -   | 300 | -   |      |
|          |                         | LSEDRV[1:0]=01<br>Medium high drive capability | -   | 370 | -   |      |
|          |                         | LSEDRV[1:0]=11<br>High drive capability        | -   | 480 | -   |      |

**Table 41. LSE oscillator characteristics ( $f_{LSE} = 32.768$  kHz) <sup>(1)</sup> (continued)**

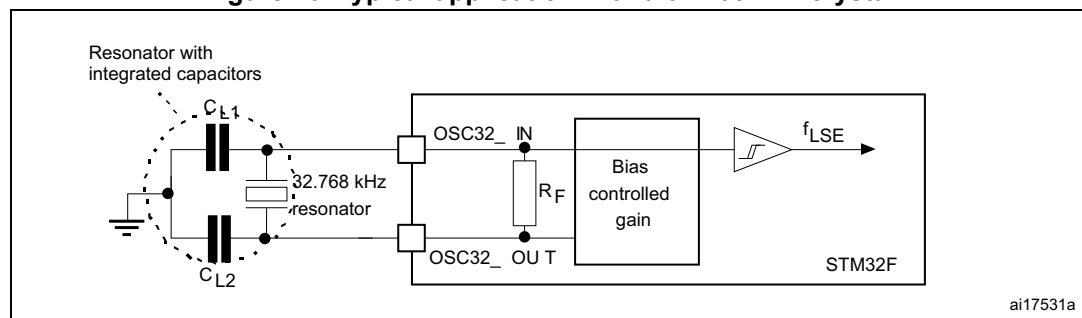
| Symbol             | Parameter                      | Conditions                                     | Min | Typ | Max  | Unit      |
|--------------------|--------------------------------|------------------------------------------------|-----|-----|------|-----------|
| $G_{m\_crit\_max}$ | Maximum critical crystal $g_m$ | LSEDRV[1:0]=00<br>Low drive capability         | -   | -   | 0.48 | $\mu A/V$ |
|                    |                                | LSEDRV[1:0]=10<br>Medium low drive capability  | -   | -   | 0.75 |           |
|                    |                                | LSEDRV[1:0]=01<br>Medium high drive capability | -   | -   | 1.7  |           |
|                    |                                | LSEDRV[1:0]=11<br>High drive capability        | -   | -   | 2.7  |           |
| $t_{SU}^{(2)}$     | start-up time                  | $V_{DD}$ is stabilized                         | -   | 2   | -    | s         |

1. Guaranteed by design.

2. Guaranteed by characterization results.  $t_{SU}$  is the start-up time measured from the moment it is enabled (by software) to a stabilized 32.768 kHz oscillation is reached. This value is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.

Note:

For information on selecting the crystal, refer to the application note AN2867 “Oscillator design guide for ST microcontrollers” available from the ST Microelectronics website [www.st.com](http://www.st.com).

**Figure 40. Typical application with a 32.768 kHz crystal**

### 6.3.10 Internal clock source characteristics

The parameters given in [Table 42](#) and [Table 43](#) are derived from tests performed under ambient temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#).

#### High-speed internal (HSI) RC oscillator

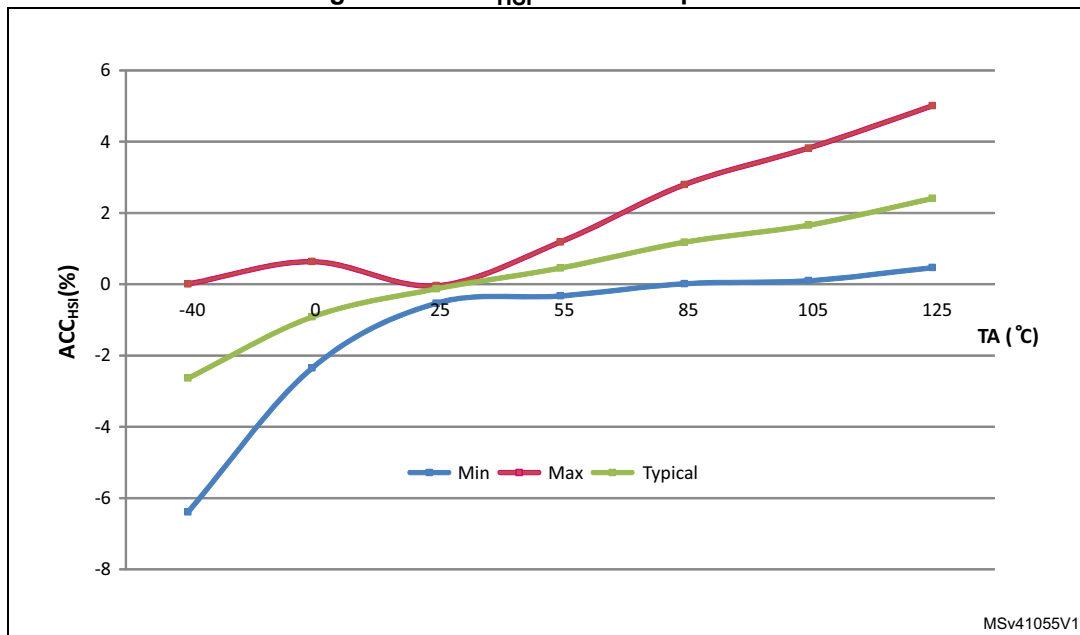
**Table 42. HSI oscillator characteristics <sup>(1)</sup>**

| Symbol      | Parameter                             | Conditions                             | Min | Typ | Max | Unit |
|-------------|---------------------------------------|----------------------------------------|-----|-----|-----|------|
| $f_{HSI}$   | Frequency                             | -                                      | -   | 16  | -   | MHz  |
| $ACC_{HSI}$ | HSI user trimming step <sup>(2)</sup> | -                                      | -   | -   | 1   | %    |
|             | Accuracy of the HSI oscillator        | $T_A = -40$ to $105$ °C <sup>(3)</sup> | - 8 | -   | 4.5 | %    |
|             |                                       | $T_A = -10$ to $85$ °C <sup>(3)</sup>  | - 4 | -   | 4   | %    |
|             |                                       | $T_A = 25$ °C <sup>(4)</sup>           | - 1 | -   | 1   | %    |

Table 42. HSI oscillator characteristics <sup>(1)</sup> (continued)

| Symbol              | Parameter                        | Conditions | Min | Typ | Max | Unit    |
|---------------------|----------------------------------|------------|-----|-----|-----|---------|
| $t_{su(HSI)}^{(2)}$ | HSI oscillator startup time      | -          | -   | 2.2 | 4   | $\mu s$ |
| $I_{DD(HSI)}^{(2)}$ | HSI oscillator power consumption | -          | -   | 60  | 80  | $\mu A$ |

1.  $V_{DD} = 3.3$  V, PLL OFF,  $T_A = -40$  to  $105$  °C unless otherwise specified.
2. Guaranteed by design.
3. Guaranteed by characterization results.
4. Factory calibrated, parts not soldered.

Figure 41.  $ACC_{HSI}$  versus temperature

1. Guaranteed by characterization results.

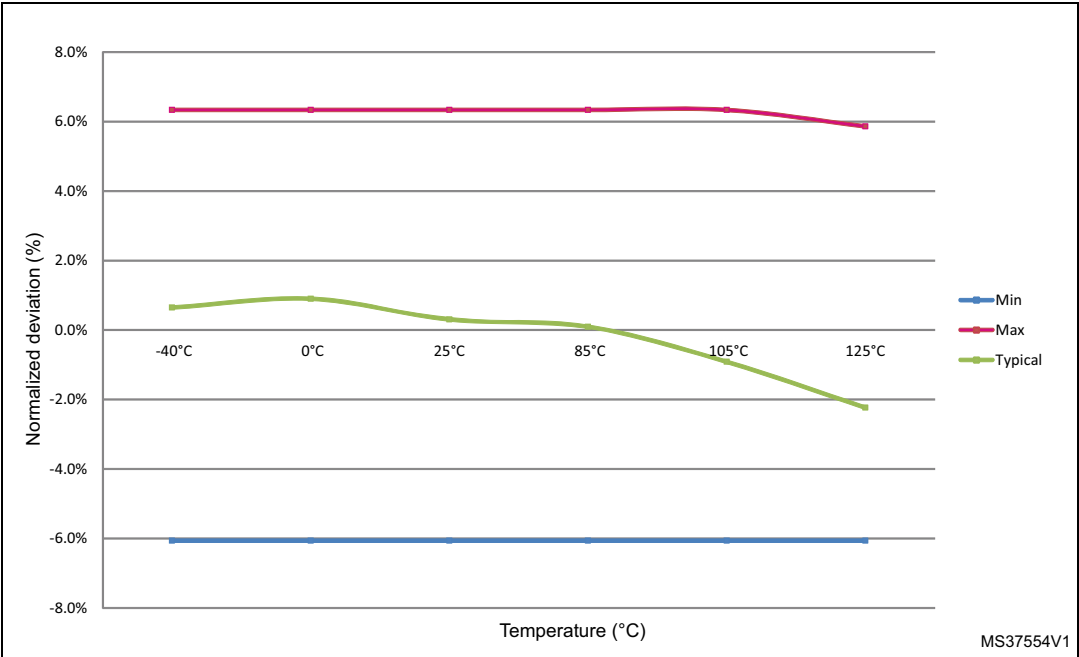
### Low-speed internal (LSI) RC oscillator

Table 43. LSI oscillator characteristics <sup>(1)</sup>

| Symbol              | Parameter                        | Min | Typ | Max | Unit    |
|---------------------|----------------------------------|-----|-----|-----|---------|
| $f_{LSI}^{(2)}$     | Frequency                        | 17  | 32  | 47  | kHz     |
| $t_{su(LSI)}^{(3)}$ | LSI oscillator startup time      | -   | 15  | 40  | $\mu s$ |
| $I_{DD(LSI)}^{(3)}$ | LSI oscillator power consumption | -   | 0.4 | 0.6 | $\mu A$ |

1.  $V_{DD} = 3$  V,  $T_A = -40$  to  $105$  °C unless otherwise specified.
2. Guaranteed by characterization results.
3. Guaranteed by design.

Figure 42. LSI deviation versus temperature



6.3.11 PLL characteristics

The parameters given in [Table 44](#) and [Table 45](#) are derived from tests performed under temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#).

Table 44. Main PLL characteristics

| Symbol                 | Parameter                          | Conditions         | Min                 | Typ | Max  | Unit |
|------------------------|------------------------------------|--------------------|---------------------|-----|------|------|
| f <sub>PLL_IN</sub>    | PLL input clock <sup>(1)</sup>     | -                  | 0.95 <sup>(2)</sup> | 1   | 2.10 | MHz  |
| f <sub>PLL_OUT</sub>   | PLL multiplier output clock        | -                  | 24                  | -   | 216  |      |
| f <sub>PLL48_OUT</sub> | 48 MHz PLL multiplier output clock | -                  | -                   | 48  | 75   |      |
| f <sub>VCO_OUT</sub>   | PLL VCO output                     | -                  | 100                 | -   | 432  |      |
| t <sub>LOCK</sub>      | PLL lock time                      | VCO freq = 100 MHz | 75                  | -   | 200  | μs   |
|                        |                                    | VCO freq = 432 MHz | 100                 | -   | 300  |      |

Table 44. Main PLL characteristics (continued)

| Symbol                               | Parameter                                 | Conditions                               |              | Min          | Typ  | Max          | Unit |
|--------------------------------------|-------------------------------------------|------------------------------------------|--------------|--------------|------|--------------|------|
| Jitter <sup>(3)</sup>                | Cycle-to-cycle jitter                     | System clock<br>216 MHz                  | RMS          | -            | 25   | -            | ps   |
|                                      |                                           |                                          | peak to peak | -            | ±150 | -            |      |
|                                      | Period Jitter                             |                                          | RMS          | -            | 15   | -            |      |
|                                      |                                           |                                          | peak to peak | -            | ±200 | -            |      |
|                                      | Main clock output (MCO) for RMII Ethernet | Cycle to cycle at 50 MHz on 1000 samples | -            | 32           | -    |              |      |
|                                      | Main clock output (MCO) for MII Ethernet  | Cycle to cycle at 25 MHz on 1000 samples | -            | 40           | -    |              |      |
|                                      | Bit Time CAN jitter                       | Cycle to cycle at 1 MHz on 1000 samples  | -            | 330          | -    |              |      |
| I <sub>DD(PLL)</sub> <sup>(4)</sup>  | PLL power consumption on V <sub>DD</sub>  | VCO freq = 100 MHz<br>VCO freq = 432 MHz |              | 0.15<br>0.45 | -    | 0.40<br>0.75 | mA   |
| I <sub>DDA(PLL)</sub> <sup>(4)</sup> | PLL power consumption on V <sub>DDA</sub> | VCO freq = 100 MHz<br>VCO freq = 432 MHz |              | 0.30<br>0.55 | -    | 0.40<br>0.85 | mA   |

1. Take care of using the appropriate division factor M to obtain the specified PLL input clock values. The M factor is shared between PLL and PLLI2S.
2. Guaranteed by design.
3. The use of 2 PLLs in parallel could degraded the Jitter up to +30%.
4. Guaranteed by characterization results.

Table 45. PLLI2S characteristics

| Symbol                   | Parameter                              | Conditions                                                           | Min                 | Typ | Max  | Unit |
|--------------------------|----------------------------------------|----------------------------------------------------------------------|---------------------|-----|------|------|
| f <sub>PLLI2S_IN</sub>   | PLLI2S input clock <sup>(1)</sup>      | -                                                                    | 0.95 <sup>(2)</sup> | 1   | 2.10 | MHz  |
| f <sub>PLLI2SQ_OUT</sub> | PLLI2S multiplier output clock for SAI | -                                                                    | -                   | -   | 216  |      |
| f <sub>PLLI2SR_OUT</sub> | PLLI2S multiplier output clock for I2S | -                                                                    | -                   | -   | 216  |      |
| f <sub>VCO_OUT</sub>     | PLLI2S VCO output                      | -                                                                    | 100                 | -   | 432  |      |
| t <sub>LOCK</sub>        | PLLI2S lock time                       | VCO freq = 100 MHz                                                   | 75                  | -   | 200  | µs   |
|                          |                                        | VCO freq = 432 MHz                                                   | 100                 | -   | 300  |      |
| Jitter <sup>(3)</sup>    | Master I2S clock jitter                | Cycle to cycle at 12.288 MHz on 48KHz period, N=432, R=5             | RMS                 | -   | 90   | ps   |
|                          |                                        |                                                                      | peak to peak        | -   | ±280 | ps   |
|                          |                                        | Average frequency of 12.288 MHz<br>N = 432, R = 5<br>on 1000 samples | -                   | 90  | -    | ps   |
|                          | WS I2S clock jitter                    | Cycle to cycle at 48 kHz on 1000 samples                             | -                   | 400 | -    | ps   |

Table 45. PLLI2S characteristics (continued)

| Symbol                  | Parameter                             | Conditions                               | Min          | Typ | Max          | Unit |
|-------------------------|---------------------------------------|------------------------------------------|--------------|-----|--------------|------|
| $I_{DD(PLLI2S)}^{(4)}$  | PLLI2S power consumption on $V_{DD}$  | VCO freq = 100 MHz<br>VCO freq = 432 MHz | 0.15<br>0.45 | -   | 0.40<br>0.75 | mA   |
| $I_{DDA(PLLI2S)}^{(4)}$ | PLLI2S power consumption on $V_{DDA}$ | VCO freq = 100 MHz<br>VCO freq = 432 MHz | 0.30<br>0.55 | -   | 0.40<br>0.85 | mA   |

1. Take care of using the appropriate division factor M to have the specified PLL input clock values.
2. Guaranteed by design.
3. Value given with main PLL running.
4. Guaranteed by characterization results.

Table 46. PLLSAI characteristics

| Symbol                                  | Parameter                                    | Conditions                                                        |              | Min                 | Typ   | Max          | Unit |
|-----------------------------------------|----------------------------------------------|-------------------------------------------------------------------|--------------|---------------------|-------|--------------|------|
| f <sub>PLLSAI_IN</sub>                  | PLLSAI input clock <sup>(1)</sup>            | -                                                                 |              | 0.95 <sup>(2)</sup> | 1     | 2.10         | MHz  |
| f <sub>PLLSAIP_OUT</sub>                | PLLSAI multiplier output clock for 48 MHz    | -                                                                 |              | -                   | 48    | 75           |      |
| f <sub>PLLSAIQ_OUT</sub>                | PLLSAI multiplier output clock for SAI       | -                                                                 |              | -                   | -     | 216          |      |
| f <sub>VCO_OUT</sub>                    | PLLSAI VCO output                            | -                                                                 |              | 100                 | -     | 432          |      |
| t <sub>LOCK</sub>                       | PLLSAI lock time                             | VCO freq = 100 MHz                                                |              | 75                  | -     | 200          | μs   |
|                                         |                                              | VCO freq = 432 MHz                                                |              | 100                 | -     | 300          |      |
| Jitter <sup>(3)</sup>                   | Master SAI clock jitter                      | Cycle to cycle at 12.288 MHz on 48KHz period, N=432, R=5          | RMS          | -                   | 90    | -            | ps   |
|                                         |                                              |                                                                   | peak to peak | -                   | ± 280 | -            | ps   |
|                                         |                                              | Average frequency of 12.288 MHz<br>N = 432, R = 5 on 1000 samples |              | -                   | 90    | -            | ps   |
|                                         | FS clock jitter                              | Cycle to cycle at 48 KHz on 1000 samples                          |              | -                   | 400   | -            | ps   |
| I <sub>DD(PLLSAI)</sub> <sup>(4)</sup>  | PLLSAI power consumption on V <sub>DD</sub>  | VCO freq = 100 MHz<br>VCO freq = 432 MHz                          |              | 0.15<br>0.45        | -     | 0.40<br>0.75 | mA   |
| I <sub>DDA(PLLSAI)</sub> <sup>(4)</sup> | PLLSAI power consumption on V <sub>DDA</sub> | VCO freq = 100 MHz<br>VCO freq = 432 MHz                          |              | 0.30<br>0.55        | -     | 0.40<br>0.85 | mA   |

1. Take care of using the appropriate division factor M to have the specified PLL input clock values.
2. Guaranteed by design.
3. Value given with main PLL running.
4. Guaranteed by characterization results.

### 6.3.12 PLL spread spectrum clock generation (SSCG) characteristics

The spread spectrum clock generation (SSCG) feature is used to reduce electromagnetic interferences (see [Table 57: EMI characteristics](#)). It is available only on the main PLL.

**Table 47. SSCG parameters constraint**

| Symbol            | Parameter             | Min  | Typ | Max <sup>(1)</sup> | Unit |
|-------------------|-----------------------|------|-----|--------------------|------|
| $f_{Mod}$         | Modulation frequency  | -    | -   | 10                 | kHz  |
| md                | Peak modulation depth | 0.25 | -   | 2                  | %    |
| MODEPER * INCSTEP | -                     | -    | -   | $2^{15} - 1$       | -    |

1. Guaranteed by design.

#### Equation 1

The frequency modulation period (MODEPER) is given by the equation below:

$$\text{MODEPER} = \text{round}[f_{\text{PLL\_IN}} / (4 \times f_{\text{Mod}})]$$

$f_{\text{PLL\_IN}}$  and  $f_{\text{Mod}}$  must be expressed in Hz.

As an example:

If  $f_{\text{PLL\_IN}} = 1$  MHz, and  $f_{\text{MOD}} = 1$  kHz, the modulation depth (MODEPER) is given by equation 1:

$$\text{MODEPER} = \text{round}[10^6 / (4 \times 10^3)] = 250$$

#### Equation 2

Equation 2 calculates the increment step (INCSTEP):

$$\text{INCSTEP} = \text{round}[(2^{15} - 1) \times \text{md} \times \text{PLL_N} / (100 \times 5 \times \text{MODEPER})]$$

$f_{\text{VCO\_OUT}}$  must be expressed in MHz.

With a modulation depth (md) =  $\pm 2$  % (4 % peak to peak), and PLL\_N = 240 (in MHz):

$$\text{INCSTEP} = \text{round}[(2^{15} - 1) \times 2 \times 240 / (100 \times 5 \times 250)] = 126 \text{md}(\text{quantitized})\%$$

An amplitude quantization error may be generated because the linear modulation profile is obtained by taking the quantized values (rounded to the nearest integer) of MODPER and INCSTEP. As a result, the achieved modulation depth is quantized. The percentage quantized modulation depth is given by the following formula:

$$\text{md}_{\text{quantized}}\% = (\text{MODEPER} \times \text{INCSTEP} \times 100 \times 5) / ((2^{15} - 1) \times \text{PLL_N})$$

As a result:

$$\text{md}_{\text{quantized}}\% = (250 \times 126 \times 100 \times 5) / ((2^{15} - 1) \times 240) = 2.002\%(\text{peak})$$

Figure 43 and Figure 44 show the main PLL output clock waveforms in center spread and down spread modes, where:

- $F_0$  is  $f_{\text{PLL\_OUT}}$  nominal.
- $T_{\text{mode}}$  is the modulation period.
- $md$  is the modulation depth.

Figure 43. PLL output clock waveforms in center spread mode

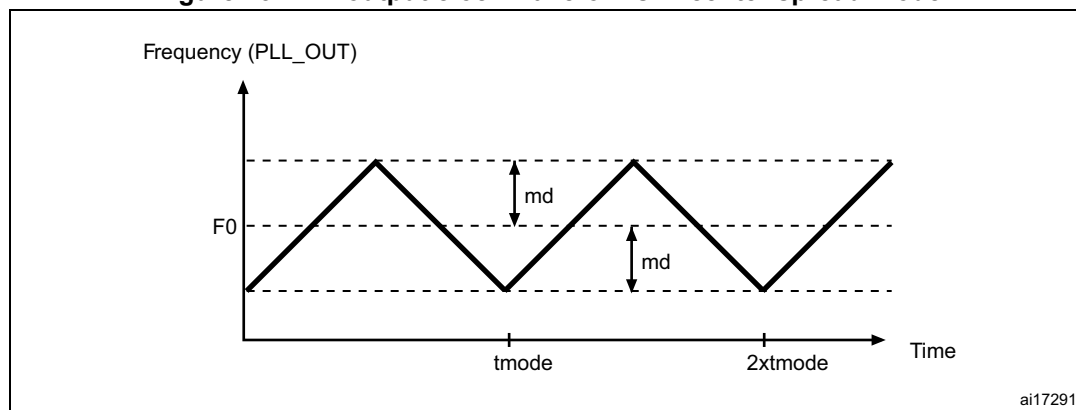
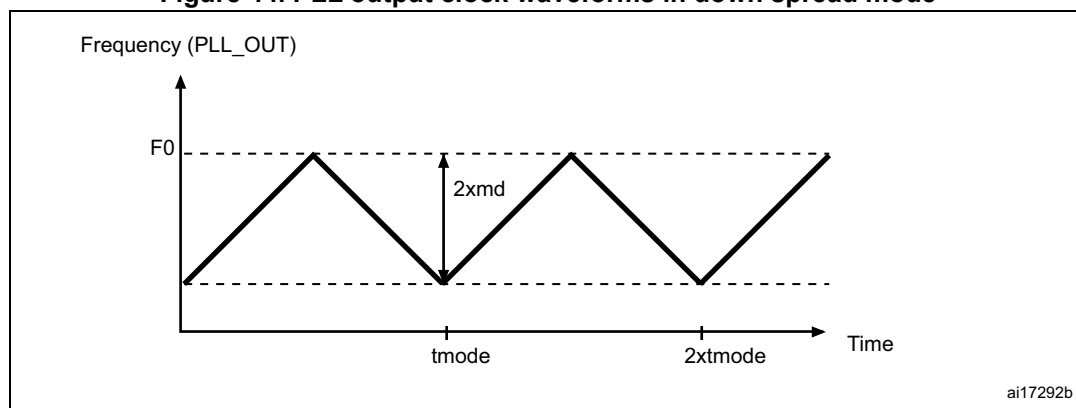


Figure 44. PLL output clock waveforms in down spread mode



### 6.3.13 USB OTG HS PHY PLLs characteristics (on STM32F723xx devices)

The parameters given in Table 48 are derived from tests performed under temperature and  $V_{\text{DD}}$  supply voltage conditions summarized in Table 16.

Table 48. USB OTG HS PLL1 characteristics<sup>(1)</sup>

| Symbol                 | Parameter                        | Conditions | Min                  | Typ | Max  | Unit          |
|------------------------|----------------------------------|------------|----------------------|-----|------|---------------|
| $f_{\text{PLL1\_IN}}$  | PLL1 input clock                 | -          | 12, 12.5, 16, 24, 25 |     |      | MHz           |
| $f_{\text{PLL1\_OUT}}$ | PLL1 output clock <sup>(2)</sup> | -          | -                    | 60  | -    |               |
| $f_{\text{VCO\_OUT}}$  | PLL1 VCO output                  | -          | 600                  | -   | 720  |               |
| $t_{\text{LOCK}}$      | PLL1 lock time <sup>(2)</sup>    | -          | -                    | -   | 22   | $\mu\text{s}$ |
| $I_{\text{DD(PLL1)}}$  | PLL1 digital power consumption   | -          | -                    | -   | 1.8  | mA            |
| $I_{\text{DDA(PLL1)}}$ | PLL1 analog power consumption    | -          | -                    | -   | 2.75 |               |



1. Guaranteed by design.
2. Based on test during characterization.

**Table 49. USB OTG HS PLL2 characteristics<sup>(1)</sup>**

| Symbol                 | Parameter                        | Conditions | Min | Typ | Max | Unit |
|------------------------|----------------------------------|------------|-----|-----|-----|------|
| f <sub>PLL2_IN</sub>   | PLL2 input clock                 | -          | -   | 60  | -   | MHz  |
| f <sub>PLL2_OUT</sub>  | PLL2 output clock <sup>(2)</sup> | -          | -   | 480 | -   |      |
| f <sub>VCO_OUT</sub>   | PLL2 VCO output                  | -          | -   | 480 | -   |      |
| t <sub>LOCK</sub>      | PLL2 lock time <sup>(2)</sup>    | -          | -   | -   | 91  | μs   |
| I <sub>DD(PLL2)</sub>  | PLL2 digital power consumption   | -          | -   | -   | 2.1 | mA   |
| I <sub>DDA(PLL2)</sub> | PLL2 analog power consumption    | -          | -   | -   | 1.5 |      |

1. Guaranteed by design.
2. Based on test during characterization.

### 6.3.14 USB OTG HS PHY regulator characteristics

The parameters given in [Table 50](#) are derived from tests performed under temperature and V<sub>DD</sub> supply voltage conditions summarized in [Table 16](#).

**Table 50. USB OTG HS PHY regulator characteristics<sup>(1)</sup>**

| Symbol                  | Parameter                                        | Conditions | Min  | Typ | Max  | Unit |
|-------------------------|--------------------------------------------------|------------|------|-----|------|------|
| V <sub>DD12OTGHS</sub>  | 1.2 V internal voltage on V <sub>DD12OTGHS</sub> | -          | 1.18 | 1.2 | 1.24 | V    |
| CEXT                    | External capacitor on V <sub>DD12OTGHS</sub>     | -          | 1.1  | 2.2 | 3.3  | μF   |
| I <sub>DDPHYHSREG</sub> | Regulator power consumption                      | -          | 100  | 120 | 125  | μA   |

1. Based on test during characterization.

### 6.3.15 USB HS PHY external resistor characteristics (on STM32F723xx devices)

**Table 51. USB HS PHY external resistor characteristics (on STM32F723xx devices)**

| Symbol | Parameter                                                         | Conditions                   | Min  | Typ  | Max  | Unit       |
|--------|-------------------------------------------------------------------|------------------------------|------|------|------|------------|
| REXT   | External calibration resistor connected (to GND) from OTG_HS_REXT | Required if using USB HS PHY | 2.97 | 3.00 | 3.03 | k $\Omega$ |

### 6.3.16 Memory characteristics

#### Flash memory

The characteristics are given at  $T_A = -40$  to  $105$  °C unless otherwise specified.

The devices are shipped to customers with the Flash memory erased.

**Table 52. Flash memory characteristics**

| Symbol   | Parameter      | Conditions                                | Min | Typ  | Max | Unit |
|----------|----------------|-------------------------------------------|-----|------|-----|------|
| $I_{DD}$ | Supply current | Write/erase 8-bit mode, $V_{DD} = 1.7$ V  | -   | 6.7  | -   | mA   |
|          |                | Write/erase 16-bit mode, $V_{DD} = 2.1$ V | -   | 9.2  | -   |      |
|          |                | Write/erase 32-bit mode, $V_{DD} = 3.3$ V | -   | 12.6 | -   |      |

**Table 53. Flash memory programming**

| Symbol           | Parameter                      | Conditions                                    | Min <sup>(1)</sup> | Typ  | Max <sup>(1)</sup> | Unit    |
|------------------|--------------------------------|-----------------------------------------------|--------------------|------|--------------------|---------|
| $t_{prog}$       | Word programming time          | Program/erase parallelism (PSIZE) = x 8/16/32 | -                  | 16   | 100 <sup>(2)</sup> | $\mu$ s |
| $t_{ERASE16KB}$  | Sector (16 Kbytes) erase time  | Program/erase parallelism (PSIZE) = x 8       | -                  | 346  | 418                | ms      |
|                  |                                | Program/erase parallelism (PSIZE) = x 16      | -                  | 252  | 312                |         |
|                  |                                | Program/erase parallelism (PSIZE) = x 32      | -                  | 208  | 265                |         |
| $t_{ERASE128KB}$ | Sector (128 Kbytes) erase time | Program/erase parallelism (PSIZE) = x 8       | -                  | 1953 | 2500               | ms      |
|                  |                                | Program/erase parallelism (PSIZE) = x 16      | -                  | 1252 | 1639               |         |
|                  |                                | Program/erase parallelism (PSIZE) = x 32      | -                  | 927  | 1322               |         |
| $t_{ERASE64KB}$  | Sector (64 Kbytes) erase time  | Program/erase parallelism (PSIZE) = x 8       | -                  | 1027 | 1298               | ms      |
|                  |                                | Program/erase parallelism (PSIZE) = x 16      | -                  | 675  | 840                |         |
|                  |                                | Program/erase parallelism (PSIZE) = x 32      | -                  | 505  | 682                |         |

Table 53. Flash memory programming (continued)

| Symbol            | Parameter           | Conditions                               | Min <sup>(1)</sup> | Typ  | Max <sup>(1)</sup> | Unit |
|-------------------|---------------------|------------------------------------------|--------------------|------|--------------------|------|
| t <sub>ME</sub>   | Mass erase time     | Program/erase parallelism (PSIZE) = x 8  | -                  | 7718 | 9883               | ms   |
|                   |                     | Program/erase parallelism (PSIZE) = x 16 | -                  | 4869 | 6379               |      |
|                   |                     | Program/erase parallelism (PSIZE) = x 32 | -                  | 3503 | 5180               |      |
| V <sub>prog</sub> | Programming voltage | 32-bit program operation                 | 2.7                | -    | 3.6                | V    |
|                   |                     | 16-bit program operation                 | 2.1                | -    | 3.6                | V    |
|                   |                     | 8-bit program operation                  | 1.7                | -    | 3.6                | V    |

1. Guaranteed by characterization results.
2. The maximum programming time is measured after 10 K erase operations.

Table 54. Flash memory programming with V<sub>PP</sub>

| Symbol                          | Parameter                                               | Conditions                                                                         | Min <sup>(1)</sup> | Typ | Max <sup>(1)</sup> | Unit |
|---------------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------|--------------------|-----|--------------------|------|
| t <sub>prog</sub>               | Double word programming                                 | T <sub>A</sub> = 0 to +40 °C<br>V <sub>DD</sub> = 3.3 V<br>V <sub>PP</sub> = 8.5 V | -                  | 16  | 100 <sup>(2)</sup> | μs   |
| t <sub>ERASE16KB</sub>          | Sector (16 Kbytes) erase time                           |                                                                                    | -                  | 180 | -                  | ms   |
| t <sub>ERASE128KB</sub>         | Sector (128 Kbytes) erase time                          |                                                                                    | -                  | 900 | -                  |      |
| t <sub>ERASE64KB</sub>          | Sector (64 Kbytes) erase time                           |                                                                                    | -                  | 450 | -                  |      |
| t <sub>ME</sub>                 | Mass erase time                                         |                                                                                    | -                  | 6.9 | -                  | s    |
| V <sub>prog</sub>               | Programming voltage                                     | -                                                                                  | 2.7                | -   | 3.6                | V    |
| V <sub>PP</sub>                 | V <sub>PP</sub> voltage range                           | -                                                                                  | 7                  | -   | 9                  | V    |
| I <sub>PP</sub>                 | Minimum current sunk on the V <sub>PP</sub> pin         | -                                                                                  | 10                 | -   | -                  | mA   |
| t <sub>VPP</sub> <sup>(3)</sup> | Cumulative time during which V <sub>PP</sub> is applied | -                                                                                  | -                  | -   | 1                  | hour |

1. Guaranteed by design.
2. The maximum programming time is measured after 10 K erase operations.
3. V<sub>PP</sub> should only be connected during programming/erasing.

Table 55. Flash memory endurance and data retention

| Symbol           | Parameter | Conditions <sup>(1)</sup>                                                                                 | Value              | Unit    |
|------------------|-----------|-----------------------------------------------------------------------------------------------------------|--------------------|---------|
|                  |           |                                                                                                           | Min <sup>(2)</sup> |         |
| N <sub>END</sub> | Endurance | T <sub>A</sub> = -40 to +85 °C (6 suffix versions)<br>T <sub>A</sub> = -40 to +105 °C (7 suffix versions) | 10                 | kcycles |

Table 55. Flash memory endurance and data retention (continued)

| Symbol           | Parameter      | Conditions <sup>(1)</sup>                           | Value              | Unit  |
|------------------|----------------|-----------------------------------------------------|--------------------|-------|
|                  |                |                                                     | Min <sup>(2)</sup> |       |
| t <sub>RET</sub> | Data retention | 1 kcycle <sup>(3)</sup> at T <sub>A</sub> = 85 °C   | 30                 | Years |
|                  |                | 1 kcycle <sup>(3)</sup> at T <sub>A</sub> = 105 °C  | 10                 |       |
|                  |                | 10 kcycles <sup>(3)</sup> at T <sub>A</sub> = 55 °C | 20                 |       |

1. T<sub>j</sub> can not go above 125°C (current consumption limitation).

2. Guaranteed by characterization results.

3. Cycling performed over the whole temperature range.

### 6.3.17 EMC characteristics

Susceptibility tests are performed on a sample basis during device characterization.

#### Functional EMS (electromagnetic susceptibility)

While a simple application is executed on the device (toggling 2 LEDs through I/O ports), the device is stressed by two electromagnetic events until a failure occurs. The failure is indicated by the LEDs:

- **Electrostatic discharge (ESD)** (positive and negative) is applied to all device pins until a functional disturbance occurs. This test is compliant with the IEC 61000-4-2 standard.
- **FTB**: A burst of fast transient voltage (positive and negative) is applied to V<sub>DD</sub> and V<sub>SS</sub> through a 100 pF capacitor, until a functional disturbance occurs. This test is compliant with the IEC 61000-4-4 standard.

A device reset allows normal operations to be resumed.

The test results are given in [Table 56](#). They are based on the EMS levels and classes defined in application note AN1709.

Table 56. EMS characteristics

| Symbol            | Parameter                                                                                                                                       | Conditions                                                                                                     | Level/Class |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------|
| V <sub>FESD</sub> | Voltage limits to be applied on any I/O pin to induce a functional disturbance                                                                  | V <sub>DD</sub> = 3.3 V, T <sub>A</sub> = +25 °C,<br>f <sub>HCLK</sub> = 216 MHz,<br>conforms to IEC 61000-4-2 | 2B          |
| V <sub>EFTB</sub> | Fast transient voltage burst limits to be applied through 100 pF on V <sub>DD</sub> and V <sub>SS</sub> pins to induce a functional disturbance | V <sub>DD</sub> = 3.3 V, T <sub>A</sub> = +25 °C,<br>f <sub>HCLK</sub> = 216 MHz,<br>conforms to IEC 61000-4-2 | 5A          |

As a consequence, it is recommended to add a serial resistor (1 kΩ) located as close as possible to the MCU to the pins exposed to noise (connected to tracks longer than 50 mm on PCB).

### Designing hardened software to avoid noise problems

EMC characterization and optimization are performed at component level with a typical application environment and simplified MCU software. It should be noted that good EMC performance is highly dependent on the user application and the software in particular.

Therefore it is recommended that the user applies EMC software optimization and prequalification tests in relation with the EMC level requested for his application.

#### Software recommendations

The software flowchart must include the management of runaway conditions such as:

- Corrupted program counter
- Unexpected reset
- Critical Data corruption (control registers...)

#### Prequalification trials

Most of the common failures (unexpected reset and program counter corruption) can be reproduced by manually forcing a low state on the NRST pin or the Oscillator pins for 1 second.

To complete these trials, ESD stress can be applied directly on the device, over the range of specification values. When unexpected behavior is detected, the software can be hardened to prevent unrecoverable errors occurring (see application note AN1015).

### Electromagnetic Interference (EMI)

The electromagnetic field emitted by the device are monitored while a simple application, executing EEMBC code, is running. This emission test is compliant with SAE IEC61967-2 standard which specifies the test board and the pin loading.

**Table 57. EMI characteristics**

| Symbol           | Parameter  | Conditions                                                                                                                                                          | Monitored frequency band | Max vs. [f <sub>HSE</sub> /f <sub>CPU</sub> ] | Unit |
|------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------------------------|------|
|                  |            |                                                                                                                                                                     |                          | 25/200 MHz                                    |      |
| S <sub>EMI</sub> | Peak level | V <sub>DD</sub> = 3.6 V, T <sub>A</sub> = 25 °C, conforming to IEC61967-2 ART/L1-cache OFF, over-drive ON, all peripheral clocks enabled, clock dithering disabled. | 0.1 MHz to 30 MHz        | 23                                            | dBμV |
|                  |            |                                                                                                                                                                     | 30 MHz to 130 MHz        | 20                                            |      |
|                  |            |                                                                                                                                                                     | 130 MHz to 1 GHz         | 34                                            |      |
|                  |            |                                                                                                                                                                     | 1 GHz to 2 GHz           | 24                                            |      |
|                  |            |                                                                                                                                                                     | EMI Level                | 4                                             | -    |

### 6.3.18 Absolute maximum ratings (electrical sensitivity)

Based on three different tests (ESD, LU) using specific measurement methods, the device is stressed in order to determine its performance in terms of electrical sensitivity.

#### Electrostatic discharge (ESD)

Electrostatic discharges (a positive then a negative pulse separated by 1 second) are applied to the pins of each sample according to each pin combination. The sample size

depends on the number of supply pins in the device (3 parts  $\times$  (n+1) supply pins). This test conforms to the ANSI/ESDA/JEDEC JS-001-2012 and ANSI/ESD S5.3.1-2009 standards.

**Table 58. ESD absolute maximum ratings**

| Symbol                | Ratings                                               | Conditions                                                                                                   | Class | Maximum value <sup>(1)</sup> | Unit |
|-----------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------|------------------------------|------|
| $V_{\text{ESD(HBM)}}$ | Electrostatic discharge voltage (human body model)    | $T_A = +25\text{ }^{\circ}\text{C}$ conforming to ANSI/ESDA/JEDEC JS-001-2012                                | 2     | 2000                         | V    |
| $V_{\text{ESD(CDM)}}$ | Electrostatic discharge voltage (charge device model) | $T_A = +25\text{ }^{\circ}\text{C}$ conforming to ANSI/ESD STM5.3.1-2009, all the packages excepted WLCSP100 | 3     | 250                          |      |

1. Guaranteed by characterization results.

### Static latchup

Two complementary static tests are required on six parts to assess the latchup performance:

- A supply overvoltage is applied to each power supply pin
- A current injection is applied to each input, output and configurable I/O pin

These tests are compliant with EIA/JESD 78A IC latchup standard.

**Table 59. Electrical sensitivities**

| Symbol | Parameter             | Conditions                                                 | Class      |
|--------|-----------------------|------------------------------------------------------------|------------|
| LU     | Static latch-up class | $T_A = +105\text{ }^{\circ}\text{C}$ conforming to JESD78A | II level A |

### 6.3.19 I/O current injection characteristics

As a general rule, current injection to the I/O pins, due to external voltage below  $V_{\text{SS}}$  or above  $V_{\text{DD}}$  (for standard, 3V-capable I/O pins) should be avoided during normal product operation. However, in order to give an indication of the robustness of the microcontroller in cases when abnormal injection accidentally happens, susceptibility tests are performed on a sample basis during device characterization.

#### Functional susceptibility to I/O current injection

While a simple application is executed on the device, the device is stressed by injecting current into the I/O pins programmed in floating input mode. While current is injected into the I/O pin, one at a time, the device is checked for functional failures.

The failure is indicated by an out of range parameter: ADC error above a certain limit ( $>5$  LSB TUE), out of conventional limits of induced leakage current on adjacent pins (out of  $-5\text{ }\mu\text{A}/+0\text{ }\mu\text{A}$  range), or other functional failure (for example reset, oscillator frequency deviation).

Negative induced leakage current is caused by negative injection and positive induced leakage current by positive injection.

The test results are given in [Table 60](#).

Table 60. I/O current injection susceptibility

| Symbol    | Description                                                                                                         | Functional susceptibility |                    | Unit |
|-----------|---------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------|------|
|           |                                                                                                                     | Negative injection        | Positive injection |      |
| $I_{INJ}$ | Injected current on BOOT0, PDR_ON, BYPASS_REG, OTG_HS_REXT                                                          | -0                        | 0                  | mA   |
|           | Injected current on NRST                                                                                            | -0                        | NA <sup>(1)</sup>  |      |
|           | Injected current on PF9, PF10, PH0_OSCIN, PH1_OSCOUT, PC0, PC1, PC2, PC3, PB14 <sup>(2)</sup> , PB15 <sup>(2)</sup> | -0                        | NA <sup>(1)</sup>  |      |
|           | Injected current on any other FT or FTf pins                                                                        | -5                        | NA <sup>(1)</sup>  |      |
|           | Injected current on any other pins                                                                                  | -5                        | +5                 |      |

1. Injection is not possible.

2. PB14 and PB15 in the STM32F723xx devices.

**Note:** *It is recommended to add a Schottky diode (pin to ground) to analog pins which may potentially inject negative currents.*

### 6.3.20 I/O port characteristics

#### General input/output characteristics

Unless otherwise specified, the parameters given in [Table 61: I/O static characteristics](#) are derived from tests performed under the conditions summarized in [Table 16](#). All I/Os are CMOS and TTL compliant.

Table 61. I/O static characteristics

| Symbol          | Parameter                                                    | Conditions                                                       | Min                                     | Typ | Max                                      | Unit |
|-----------------|--------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------|-----|------------------------------------------|------|
| V <sub>IL</sub> | FT, TTa and NRST I/O input low level voltage                 | 1.7 V≤ V <sub>DD</sub> ≤ 3.6 V                                   | -                                       | -   | 0.35V <sub>DD</sub> -0.04 <sup>(1)</sup> | V    |
|                 |                                                              |                                                                  |                                         |     | 0.3V <sub>DD</sub> <sup>(2)</sup>        |      |
|                 | BOOT I/O input low level voltage                             | 1.75 V≤ V <sub>DD</sub> ≤ 3.6 V, -40 °C≤ T <sub>A</sub> ≤ 105 °C | -                                       | -   | 0.1V <sub>DD</sub> +0.1 <sup>(1)</sup>   |      |
|                 |                                                              | 1.7 V≤ V <sub>DD</sub> ≤ 3.6 V, 0 °C≤ T <sub>A</sub> ≤ 105 °C    | -                                       | -   |                                          |      |
| V <sub>IH</sub> | FT, TTa and NRST I/O input high level voltage <sup>(5)</sup> | 1.7 V≤ V <sub>DD</sub> ≤ 3.6 V                                   | 0.45V <sub>DD</sub> +0.3 <sup>(1)</sup> | -   | -                                        | V    |
|                 |                                                              |                                                                  | 0.7V <sub>DD</sub> <sup>(2)</sup>       |     |                                          |      |
|                 | BOOT I/O input high level voltage                            | 1.75 V≤ V <sub>DD</sub> ≤ 3.6 V, -40 °C≤ T <sub>A</sub> ≤ 105 °C | 0.17V <sub>DD</sub> +0.7 <sup>(1)</sup> | -   | -                                        |      |
|                 |                                                              | 1.7 V≤ V <sub>DD</sub> ≤ 3.6 V, 0 °C≤ T <sub>A</sub> ≤ 105 °C    |                                         |     |                                          |      |

Table 61. I/O static characteristics (continued)

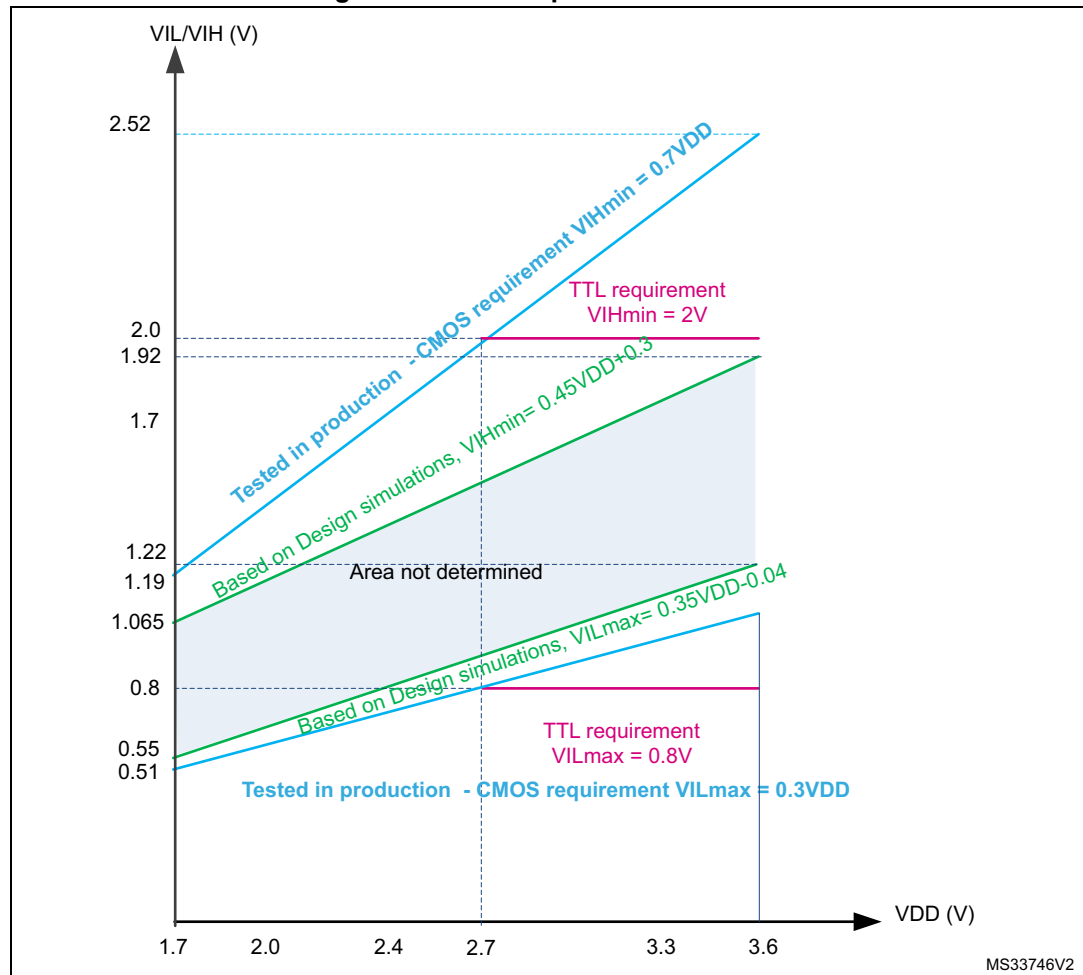
| Symbol                         | Parameter                                         |                                                      | Conditions                                                            | Min                               | Typ | Max | Unit |
|--------------------------------|---------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------|-----|-----|------|
| V <sub>HYS</sub>               | FT, TTA and NRST I/O input hysteresis             |                                                      | 1.7 V ≤ V <sub>DD</sub> ≤ 3.6 V                                       | 10%V <sub>DD</sub> <sup>(3)</sup> | -   | -   | V    |
|                                | BOOT I/O input hysteresis                         |                                                      | 1.75 V ≤ V <sub>DD</sub> ≤ 3.6 V,<br>-40 °C ≤ T <sub>A</sub> ≤ 105 °C | 0.1                               | -   | -   |      |
|                                |                                                   |                                                      | 1.7 V ≤ V <sub>DD</sub> ≤ 3.6 V,<br>0 °C ≤ T <sub>A</sub> ≤ 105 °C    |                                   |     |     |      |
| I <sub>lkg</sub>               | I/O input leakage current <sup>(4)</sup>          |                                                      | V <sub>SS</sub> ≤ V <sub>IN</sub> ≤ V <sub>DD</sub>                   | -                                 | -   | ±1  | μA   |
|                                | I/O FT input leakage current <sup>(5)</sup>       |                                                      | V <sub>IN</sub> = 5 V                                                 | -                                 | -   | 3   |      |
| R <sub>PU</sub>                | Weak pull-up equivalent resistor <sup>(6)</sup>   | All pins except for PA10/PB12 (OTG_FS_ID, OTG_HS_ID) | V <sub>IN</sub> = V <sub>SS</sub>                                     | 30                                | 40  | 50  | kΩ   |
|                                |                                                   | PA10/PB12 (OTG_FS_ID, OTG_HS_ID)                     |                                                                       | 7                                 | 10  | 14  |      |
| R <sub>PD</sub>                | Weak pull-down equivalent resistor <sup>(7)</sup> | All pins except for PA10/PB12 (OTG_FS_ID, OTG_HS_ID) | V <sub>IN</sub> = V <sub>DD</sub>                                     | 30                                | 40  | 50  |      |
|                                |                                                   | PA10/PB12 (OTG_FS_ID, OTG_HS_ID)                     |                                                                       | 7                                 | 10  | 14  |      |
| C <sub>IO</sub> <sup>(8)</sup> | I/O pin capacitance                               |                                                      | -                                                                     | -                                 | 5   | -   | pF   |

1. Guaranteed by design.
2. Tested in production.
3. With a minimum of 200 mV.
4. Leakage could be higher than the maximum value, if negative current is injected on adjacent pins, Refer to [Table 60: I/O current injection susceptibility](#)
5. To sustain a voltage higher than  $V_{DD} + 0.3\text{ V}$ , the internal pull-up/pull-down resistors must be disabled. Leakage could be higher than the maximum value, if negative current is injected on adjacent pins. Refer to [Table 60: I/O current injection susceptibility](#)
6. Pull-up resistors are designed with a true resistance in series with a switchable PMOS. This PMOS contribution to the series resistance is minimum (~10% order).
7. Pull-down resistors are designed with a true resistance in series with a switchable NMOS. This NMOS contribution to the series resistance is minimum (~10% order).
8. Hysteresis voltage between Schmitt trigger switching levels. Guaranteed by characterization results.



All I/Os are CMOS and TTL compliant (no software configuration required). Their characteristics cover more than the strict CMOS-technology or TTL parameters. The coverage of these requirements for FT I/Os is shown in [Figure 45](#).

Figure 45. FT I/O input characteristics



### Output driving current

The GPIOs (general purpose input/outputs) can sink or source up to  $\pm 8$  mA, and sink or source up to  $\pm 20$  mA (with a relaxed  $V_{OL}/V_{OH}$ ) except PC13, PC14, PC15 and PI8 which can sink or source up to  $\pm 3$  mA. When using the PC13 to PC15 and PI8 GPIOs in output mode, the speed must not exceed 2 MHz with a maximum load of 30 pF.

In the user application, the number of I/O pins which can drive current must be limited to respect the absolute maximum rating specified in [Section 6.2](#). In particular:

- The sum of the currents sourced by all the I/Os on  $V_{DD}$ , plus the maximum Run consumption of the MCU sourced on  $V_{DD}$ , cannot exceed the absolute maximum rating  $\Sigma I_{VDD}$  (see [Table 14](#)).
- The sum of the currents sunk by all the I/Os on  $V_{SS}$  plus the maximum Run consumption of the MCU sunk on  $V_{SS}$  cannot exceed the absolute maximum rating  $\Sigma I_{VSS}$  (see [Table 14](#)).

## Output voltage levels

Unless otherwise specified, the parameters given in [Table 62](#) are derived from tests performed under ambient temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#). All I/Os are CMOS and TTL compliant.

**Table 62. Output voltage characteristics**

| Symbol         | Parameter                                            | Conditions                                                                                             | Min                  | Max                | Unit |
|----------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------|--------------------|------|
| $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin              | CMOS port <sup>(2)</sup><br>$I_{IO} = +8 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | -                    | 0.4                | V    |
| $V_{OH}^{(3)}$ | Output high level voltage for an I/O pin except PC14 | CMOS port <sup>(2)</sup><br>$I_{IO} = -8 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | $V_{DD} - 0.4$       | -                  |      |
| $V_{OH}^{(3)}$ | Output high level voltage for PC14                   | CMOS port <sup>(2)</sup><br>$I_{IO} = -2 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | $V_{DD} - 0.4$       | -                  |      |
| $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin              | TTL port <sup>(2)</sup><br>$I_{IO} = +8 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$  | -                    | 0.4                | V    |
| $V_{OH}^{(3)}$ | Output high level voltage for an I/O pin except PC14 | TTL port <sup>(2)</sup><br>$I_{IO} = -8 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$  | 2.4                  | -                  |      |
| $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin              | $I_{IO} = +20 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                            | -                    | 1.3 <sup>(4)</sup> | V    |
| $V_{OH}^{(3)}$ | Output high level voltage for an I/O pin except PC14 | $I_{IO} = -20 \text{ mA}$<br>$2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                            | $V_{DD} - 1.3^{(4)}$ | -                  |      |
| $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin              | $I_{IO} = +6 \text{ mA}$<br>$1.8 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                             | -                    | 0.4 <sup>(4)</sup> | V    |
| $V_{OH}^{(3)}$ | Output high level voltage for an I/O pin except PC14 | $I_{IO} = -6 \text{ mA}$<br>$1.8 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                             | $V_{DD} - 0.4^{(4)}$ | -                  |      |
| $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin              | $I_{IO} = +4 \text{ mA}$<br>$1.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                             | -                    | 0.4 <sup>(5)</sup> | V    |
| $V_{OH}^{(3)}$ | Output high level voltage for an I/O pin except PC14 | $I_{IO} = -4 \text{ mA}$<br>$1.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                             | $V_{DD} - 0.4^{(5)}$ | -                  |      |
| $V_{OH}^{(3)}$ | Output high level voltage for PC14                   | $I_{IO} = -1 \text{ mA}$<br>$1.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$                             | $V_{DD} - 0.4^{(5)}$ | -                  |      |

1. The  $I_{IO}$  current sunk by the device must always respect the absolute maximum rating specified in [Table 14](#). and the sum of  $I_{IO}$  (I/O ports and control pins) must not exceed  $I_{VSS}$ .
2. TTL and CMOS outputs are compatible with JEDEC standards JESD36 and JESD52.
3. The  $I_{IO}$  current sourced by the device must always respect the absolute maximum rating specified in [Table 14](#) and the sum of  $I_{IO}$  (I/O ports and control pins) must not exceed  $I_{VDD}$ .
4. Based on characterization data.
5. Guaranteed by design.

### Input/output AC characteristics

The definition and values of input/output AC characteristics are given in [Figure 46](#) and [Table 63](#), respectively.

Unless otherwise specified, the parameters given in [Table 63](#) are derived from tests performed under the ambient temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#).

**Table 63. I/O AC characteristics<sup>(1)(2)</sup>**

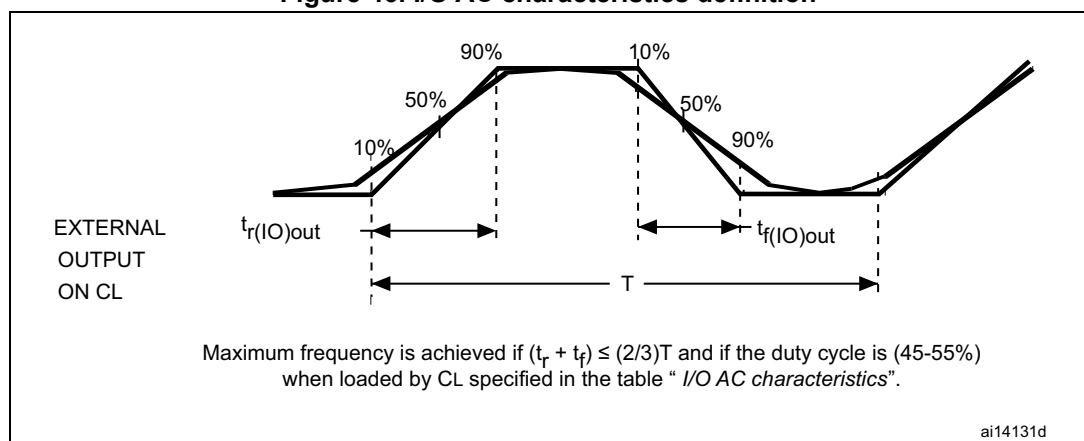
| OSPEEDRy<br>[1:0] bit<br>value <sup>(1)</sup> | Symbol                                                        | Parameter                                                                       | Conditions                                                          | Min | Typ | Max                | Unit |
|-----------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------|-----|-----|--------------------|------|
| 00                                            | $f_{\max(\text{IO})\text{out}}$                               | Maximum frequency <sup>(3)</sup>                                                | $C_L = 50 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 4                  | MHz  |
|                                               |                                                               |                                                                                 | $C_L = 50 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 2                  |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 8                  |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$                    | -   | -   | 4                  |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 3                  |      |
|                                               | $t_{f(\text{IO})\text{out}}/$<br>$t_{r(\text{IO})\text{out}}$ | Output high to low level fall<br>time and output low to high<br>level rise time | $C_L = 50 \text{ pF}, V_{DD} = 1.7 \text{ V to}$<br>$3.6 \text{ V}$ | -   | -   | 100                | ns   |
| 01                                            | $f_{\max(\text{IO})\text{out}}$                               | Maximum frequency <sup>(3)</sup>                                                | $C_L = 50 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 25                 | MHz  |
|                                               |                                                               |                                                                                 | $C_L = 50 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$                    | -   | -   | 12.5               |      |
|                                               |                                                               |                                                                                 | $C_L = 50 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 10                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 50                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$                    | -   | -   | 20                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 12.5               |      |
|                                               | $t_{f(\text{IO})\text{out}}/$<br>$t_{r(\text{IO})\text{out}}$ | Output high to low level fall<br>time and output low to high<br>level rise time | $C_L = 50 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 10                 | ns   |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 6                  |      |
|                                               |                                                               |                                                                                 | $C_L = 50 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 20                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 10                 |      |
| 10                                            | $f_{\max(\text{IO})\text{out}}$                               | Maximum frequency <sup>(3)</sup>                                                | $C_L = 40 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 50 <sup>(4)</sup>  | MHz  |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 100 <sup>(4)</sup> |      |
|                                               |                                                               |                                                                                 | $C_L = 40 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 25                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$                    | -   | -   | 50                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 42.5               |      |
|                                               | $t_{f(\text{IO})\text{out}}/$<br>$t_{r(\text{IO})\text{out}}$ | Output high to low level fall<br>time and output low to high<br>level rise time | $C_L = 40 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 6                  | ns   |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$                    | -   | -   | 4                  |      |
|                                               |                                                               |                                                                                 | $C_L = 40 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 10                 |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$                    | -   | -   | 6                  |      |

Table 63. I/O AC characteristics<sup>(1)(2)</sup> (continued)

| OSPEEDRy<br>[1:0] bit<br>value <sup>(1)</sup> | Symbol                                                        | Parameter                                                                       | Conditions                                       | Min | Typ | Max                | Unit |
|-----------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------|-----|-----|--------------------|------|
| 11                                            | $f_{\max(\text{IO})\text{out}}$                               | Maximum frequency <sup>(3)</sup>                                                | $C_L = 30 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$ | -   | -   | 100 <sup>(4)</sup> | MHz  |
|                                               |                                                               |                                                                                 | $C_L = 30 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$ | -   | -   | 50                 |      |
|                                               |                                                               |                                                                                 | $C_L = 30 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$ | -   | -   | 42.5               |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$ | -   | -   | 180 <sup>(4)</sup> |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$ | -   | -   | 100                |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$ | -   | -   | 72.5               |      |
|                                               | $t_{f(\text{IO})\text{out}}/$<br>$t_{r(\text{IO})\text{out}}$ | Output high to low level fall<br>time and output low to high<br>level rise time | $C_L = 30 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$ | -   | -   | 4                  | ns   |
|                                               |                                                               |                                                                                 | $C_L = 30 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$ | -   | -   | 6                  |      |
|                                               |                                                               |                                                                                 | $C_L = 30 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$ | -   | -   | 7                  |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 2.7 \text{ V}$ | -   | -   | 2.5                |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.8 \text{ V}$ | -   | -   | 3.5                |      |
|                                               |                                                               |                                                                                 | $C_L = 10 \text{ pF}, V_{DD} \geq 1.7 \text{ V}$ | -   | -   | 4                  |      |
| -                                             | $t_{\text{EXTI}pw}$                                           | Pulse width of external signals<br>detected by the EXTI<br>controller           | -                                                | 10  | -   | -                  | ns   |

1. Guaranteed by design.
2. The I/O speed is configured using the OSPEEDRy[1:0] bits. Refer to the STM32F72xxx and STM32F73xxx reference manual for a description of the GPIOx\_SPEEDR GPIO port output speed register.
3. The maximum frequency is defined in [Figure 46](#).
4. For maximum frequencies above 50 MHz and  $V_{DD} > 2.4 \text{ V}$ , the compensation cell should be used.

Figure 46. I/O AC characteristics definition



### 6.3.21 NRST pin characteristics

The NRST pin input driver uses CMOS technology. It is connected to a permanent pull-up resistor,  $R_{PU}$  (see [Table 61: I/O static characteristics](#)).

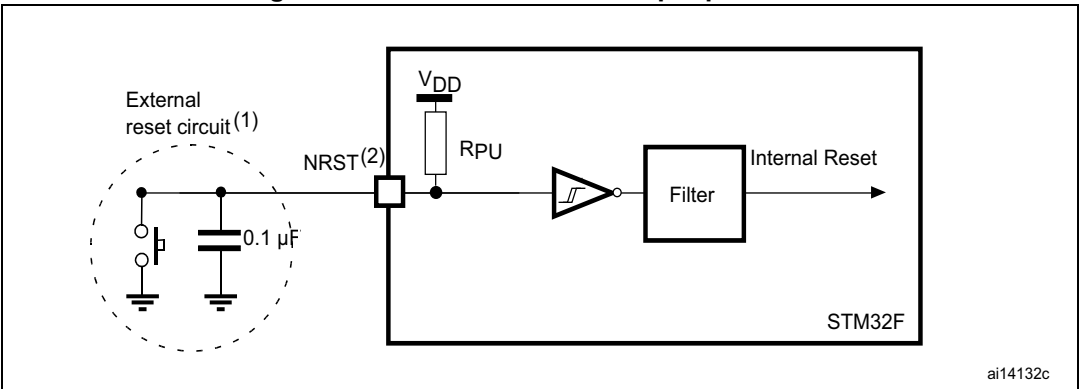
Unless otherwise specified, the parameters given in [Table 64](#) are derived from tests performed under the ambient temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#).

**Table 64. NRST pin characteristics**

| Symbol               | Parameter                                       | Conditions              | Min | Typ | Max | Unit      |
|----------------------|-------------------------------------------------|-------------------------|-----|-----|-----|-----------|
| $R_{PU}$             | Weak pull-up equivalent resistor <sup>(1)</sup> | $V_{IN} = V_{SS}$       | 30  | 40  | 50  | $k\Omega$ |
| $V_{F(NRST)}^{(2)}$  | NRST Input filtered pulse                       | -                       | -   | -   | 100 | ns        |
| $V_{NF(NRST)}^{(2)}$ | NRST Input not filtered pulse                   | $V_{DD} > 2.7\text{ V}$ | 300 | -   | -   | ns        |
| $T_{NRST\_OUT}$      | Generated reset pulse duration                  | Internal Reset source   | 20  | -   | -   | $\mu s$   |

1. The pull-up is designed with a true resistance in series with a switchable PMOS. This PMOS contribution to the series resistance must be minimum (~10% order).
2. Guaranteed by design.

**Figure 47. Recommended NRST pin protection**



1. The reset network protects the device against parasitic resets. 0.1  $\mu F$  capacitor must be placed as close as possible to the chip.
2. The user must ensure that the level on the NRST pin can go below the  $V_{IL(NRST)}$  max level specified in [Table 61](#). Otherwise the reset is not taken into account by the device.

### 6.3.22 TIM timer characteristics

The parameters given in [Table 65](#) are guaranteed by design.

Refer to [Section 6.3.20: I/O port characteristics](#) for details on the input/output alternate function characteristics (output compare, input capture, external clock, PWM output).

**Table 65. TIMx characteristics<sup>(1)(2)</sup>**

| Symbol           | Parameter                                    | Conditions <sup>(3)</sup>                                      | Min | Max                  | Unit          |
|------------------|----------------------------------------------|----------------------------------------------------------------|-----|----------------------|---------------|
| $t_{res(TIM)}$   | Timer resolution time                        | AHB/APBx prescaler=1 or 2 or 4, $f_{TIMxCLK} = 216\text{ MHz}$ | 1   | -                    | $t_{TIMxCLK}$ |
|                  |                                              | AHB/APBx prescaler>4, $f_{TIMxCLK} = 108\text{ MHz}$           | 1   | -                    | $t_{TIMxCLK}$ |
| $f_{EXT}$        | Timer external clock frequency on CH1 to CH4 | $f_{TIMxCLK} = 216\text{ MHz}$                                 | 0   | $f_{TIMxCLK}/2$      | MHz           |
| $Res_{TIM}$      | Timer resolution                             |                                                                | -   | 16/32                | bit           |
| $t_{MAX\_COUNT}$ | Maximum possible count with 32-bit counter   | -                                                              | -   | $65536 \times 65536$ | $t_{TIMxCLK}$ |

1. TIMx is used as a general term to refer to the TIM1 to TIM12 timers.
2. Guaranteed by design.
3. The maximum timer frequency on APB1 or APB2 is up to 216 MHz, by setting the TIMPRE bit in the RCC\_DCKCFGR register, if APBx prescaler is 1 or 2 or 4, then  $TIMxCLK = HCLK$ , otherwise  $TIMxCLK = 4 \times PCLKx$ .

### 6.3.23 RTC characteristics

**Table 66. RTC characteristics**

| Symbol | Parameter                          | Conditions                                       | Min | Max |
|--------|------------------------------------|--------------------------------------------------|-----|-----|
| -      | $f_{PCLK1}/RTCCLK$ frequency ratio | Any read/write operation from/to an RTC register | 4   | -   |

### 6.3.24 12-bit ADC characteristics

Unless otherwise specified, the parameters given in [Table 67](#) are derived from tests performed under the ambient temperature,  $f_{PCLK2}$  frequency and  $V_{DDA}$  supply voltage conditions summarized in [Table 16](#).

**Table 67. ADC characteristics**

| Symbol     | Parameter                  | Conditions                                   | Min                | Typ | Max       | Unit |
|------------|----------------------------|----------------------------------------------|--------------------|-----|-----------|------|
| $V_{DDA}$  | Power supply               | $V_{DDA} - V_{REF+} < 1.2\text{ V}$          | 1.7 <sup>(1)</sup> | -   | 3.6       | V    |
| $V_{REF+}$ | Positive reference voltage |                                              | 1.7 <sup>(1)</sup> | -   | $V_{DDA}$ | V    |
| $V_{REF-}$ | Negative reference voltage | -                                            | -                  | 0   | -         | V    |
| $f_{ADC}$  | ADC clock frequency        | $V_{DDA} = 1.7^{(1)}\text{ to }2.4\text{ V}$ | 0.6                | 15  | 18        | MHz  |
|            |                            | $V_{DDA} = 2.4\text{ to }3.6\text{ V}$       | 0.6                | 30  | 36        | MHz  |

Table 67. ADC characteristics (continued)

| Symbol                    | Parameter                                                                                             | Conditions                                                                                | Min                                                              | Typ | Max               | Unit               |
|---------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------|-----|-------------------|--------------------|
| $f_{\text{TRIG}}^{(2)}$   | External trigger frequency                                                                            | $f_{\text{ADC}} = 30 \text{ MHz}$ ,<br>12-bit resolution                                  | -                                                                | -   | 1764              | kHz                |
|                           |                                                                                                       | -                                                                                         | -                                                                | -   | 17                | $1/f_{\text{ADC}}$ |
| $V_{\text{AIN}}$          | Conversion voltage range <sup>(3)</sup>                                                               | -                                                                                         | 0<br>( $V_{\text{SSA}}$ or $V_{\text{REF}}$ -<br>tied to ground) | -   | $V_{\text{REF+}}$ | V                  |
| $R_{\text{AIN}}^{(2)}$    | External input impedance                                                                              | See <a href="#">Equation 1</a> for<br>details                                             | -                                                                | -   | 50                | $\text{k}\Omega$   |
| $R_{\text{ADC}}^{(2)(4)}$ | Sampling switch resistance                                                                            | -                                                                                         | 1.5                                                              | -   | 6                 | $\text{k}\Omega$   |
| $C_{\text{ADC}}^{(2)}$    | Internal sample and hold<br>capacitor                                                                 | -                                                                                         | -                                                                | 4   | 7                 | pF                 |
| $t_{\text{lat}}^{(2)}$    | Injection trigger conversion<br>latency                                                               | $f_{\text{ADC}} = 30 \text{ MHz}$                                                         | -                                                                | -   | 0.100             | $\mu\text{s}$      |
|                           |                                                                                                       | -                                                                                         | -                                                                | -   | 3 <sup>(5)</sup>  | $1/f_{\text{ADC}}$ |
| $t_{\text{latr}}^{(2)}$   | Regular trigger conversion<br>latency                                                                 | $f_{\text{ADC}} = 30 \text{ MHz}$                                                         | -                                                                | -   | 0.067             | $\mu\text{s}$      |
|                           |                                                                                                       | -                                                                                         | -                                                                | -   | 2 <sup>(5)</sup>  | $1/f_{\text{ADC}}$ |
| $t_{\text{S}}^{(2)}$      | Sampling time                                                                                         | $f_{\text{ADC}} = 30 \text{ MHz}$                                                         | 0.100                                                            | -   | 16                | $\mu\text{s}$      |
|                           |                                                                                                       | -                                                                                         | 3                                                                | -   | 480               | $1/f_{\text{ADC}}$ |
| $t_{\text{STAB}}^{(2)}$   | Power-up time                                                                                         | -                                                                                         | -                                                                | 2   | 3                 | $\mu\text{s}$      |
| $t_{\text{CONV}}^{(2)}$   | Total conversion time (including<br>sampling time)                                                    | $f_{\text{ADC}} = 30 \text{ MHz}$<br>12-bit resolution                                    | 0.50                                                             | -   | 16.40             | $\mu\text{s}$      |
|                           |                                                                                                       | $f_{\text{ADC}} = 30 \text{ MHz}$<br>10-bit resolution                                    | 0.43                                                             | -   | 16.34             | $\mu\text{s}$      |
|                           |                                                                                                       | $f_{\text{ADC}} = 30 \text{ MHz}$<br>8-bit resolution                                     | 0.37                                                             | -   | 16.27             | $\mu\text{s}$      |
|                           |                                                                                                       | $f_{\text{ADC}} = 30 \text{ MHz}$<br>6-bit resolution                                     | 0.30                                                             | -   | 16.20             | $\mu\text{s}$      |
|                           |                                                                                                       | 9 to 492 ( $t_{\text{S}}$ for sampling +n-bit resolution for successive<br>approximation) |                                                                  |     |                   | $1/f_{\text{ADC}}$ |
| $f_{\text{S}}^{(2)}$      | Sampling rate<br>( $f_{\text{ADC}} = 36 \text{ MHz}$ , and<br>$t_{\text{S}} = 3 \text{ ADC cycles}$ ) | 12-bit resolution<br>Single ADC                                                           | -                                                                | -   | 2.4               | Msp/s              |
|                           |                                                                                                       | 12-bit resolution<br>Interleave Dual ADC<br>mode                                          | -                                                                | -   | 4.5               | Msp/s              |
|                           |                                                                                                       | 12-bit resolution<br>Interleave Triple ADC<br>mode                                        | -                                                                | -   | 7.2               | Msp/s              |

Table 67. ADC characteristics (continued)

| Symbol            | Parameter                                               | Conditions | Min | Typ | Max | Unit    |
|-------------------|---------------------------------------------------------|------------|-----|-----|-----|---------|
| $I_{VREF+}^{(2)}$ | ADC $V_{REF}$ DC current consumption in conversion mode | -          | -   | 300 | 500 | $\mu A$ |
| $I_{VDDA}^{(2)}$  | ADC $V_{DDA}$ DC current consumption in conversion mode | -          | -   | 1.6 | 1.8 | mA      |

- $V_{DDA}$  minimum value of 1.7 V is obtained with the use of an external power supply supervisor (refer to [Section 3.15.2: Internal reset OFF](#)).
- Guaranteed by characterization results.
- $V_{REF+}$  is internally connected to  $V_{DDA}$  and  $V_{REF-}$  is internally connected to  $V_{SSA}$ .
- $R_{ADC}$  maximum value is given for  $V_{DD} = 1.7$  V, and minimum value for  $V_{DD} = 3.3$  V.
- For external triggers, a delay of  $1/f_{PCLK2}$  must be added to the latency specified in [Table 67](#).

**Equation 1:  $R_{AIN}$  max formula**

$$R_{AIN} = \frac{(k - 0.5)}{f_{ADC} \times C_{ADC} \times \ln(2^{N+2})} - R_{ADC}$$

The formula above ([Equation 1](#)) is used to determine the maximum external impedance allowed for an error below 1/4 of LSB. N = 12 (from 12-bit resolution) and k is the number of sampling periods defined in the ADC\_SMPR1 register.

Table 68. ADC static accuracy at  $f_{ADC} = 18$  MHz

| Symbol | Parameter                    | Test conditions                                                                                               | Typ     | Max <sup>(1)</sup> | Unit |
|--------|------------------------------|---------------------------------------------------------------------------------------------------------------|---------|--------------------|------|
| ET     | Total unadjusted error       | $f_{ADC} = 18$ MHz<br>$V_{DDA} = 1.7$ to $3.6$ V<br>$V_{REF} = 1.7$ to $3.6$ V<br>$V_{DDA} - V_{REF} < 1.2$ V | $\pm 3$ | $\pm 4$            | LSB  |
| EO     | Offset error                 |                                                                                                               | $\pm 2$ | $\pm 3$            |      |
| EG     | Gain error                   |                                                                                                               | $\pm 1$ | $\pm 3$            |      |
| ED     | Differential linearity error |                                                                                                               | $\pm 1$ | $\pm 2$            |      |
| EL     | Integral linearity error     |                                                                                                               | $\pm 2$ | $\pm 3$            |      |

- Guaranteed by characterization results.

Table 69. ADC static accuracy at  $f_{ADC} = 30$  MHz

| Symbol | Parameter                    | Test conditions                                                                                                                                 | Typ       | Max <sup>(1)</sup> | Unit |
|--------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------|------|
| ET     | Total unadjusted error       | $f_{ADC} = 30$ MHz,<br>$R_{AIN} < 10$ k $\Omega$ ,<br>$V_{DDA} = 2.4$ to $3.6$ V,<br>$V_{REF} = 1.7$ to $3.6$ V,<br>$V_{DDA} - V_{REF} < 1.2$ V | $\pm 2$   | $\pm 5$            | LSB  |
| EO     | Offset error                 |                                                                                                                                                 | $\pm 1.5$ | $\pm 2.5$          |      |
| EG     | Gain error                   |                                                                                                                                                 | $\pm 1.5$ | $\pm 4$            |      |
| ED     | Differential linearity error |                                                                                                                                                 | $\pm 1$   | $\pm 2$            |      |
| EL     | Integral linearity error     |                                                                                                                                                 | $\pm 1.5$ | $\pm 3$            |      |

- Guaranteed by characterization results.



Table 70. ADC static accuracy at  $f_{\text{ADC}} = 36 \text{ MHz}$ 

| Symbol | Parameter                    | Test conditions                                                                                                                                                                                    | Typ     | Max <sup>(1)</sup> | Unit |
|--------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------|------|
| ET     | Total unadjusted error       | $f_{\text{ADC}} = 36 \text{ MHz}$ ,<br>$V_{\text{DDA}} = 2.4 \text{ to } 3.6 \text{ V}$ ,<br>$V_{\text{REF}} = 1.7 \text{ to } 3.6 \text{ V}$<br>$V_{\text{DDA}} - V_{\text{REF}} < 1.2 \text{ V}$ | $\pm 4$ | $\pm 7$            | LSB  |
| EO     | Offset error                 |                                                                                                                                                                                                    | $\pm 2$ | $\pm 3$            |      |
| EG     | Gain error                   |                                                                                                                                                                                                    | $\pm 3$ | $\pm 6$            |      |
| ED     | Differential linearity error |                                                                                                                                                                                                    | $\pm 2$ | $\pm 3$            |      |
| EL     | Integral linearity error     |                                                                                                                                                                                                    | $\pm 3$ | $\pm 6$            |      |

1. Guaranteed by characterization results.

Table 71. ADC dynamic accuracy at  $f_{\text{ADC}} = 18 \text{ MHz}$  - limited test conditions<sup>(1)</sup>

| Symbol | Parameter                            | Test conditions                                                                                                                            | Min  | Typ  | Max | Unit |
|--------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|------|-----|------|
| ENOB   | Effective number of bits             | $f_{\text{ADC}} = 18 \text{ MHz}$<br>$V_{\text{DDA}} = V_{\text{REF}+} = 1.7 \text{ V}$<br>Input Frequency = 20 kHz<br>Temperature = 25 °C | 10.3 | 10.4 | -   | bits |
| SINAD  | Signal-to-noise and distortion ratio |                                                                                                                                            | 64   | 64.2 | -   | dB   |
| SNR    | Signal-to-noise ratio                |                                                                                                                                            | 64   | 65   | -   |      |
| THD    | Total harmonic distortion            |                                                                                                                                            | - 67 | - 72 | -   |      |

1. Guaranteed by characterization results.

Table 72. ADC dynamic accuracy at  $f_{\text{ADC}} = 36 \text{ MHz}$  - limited test conditions<sup>(1)</sup>

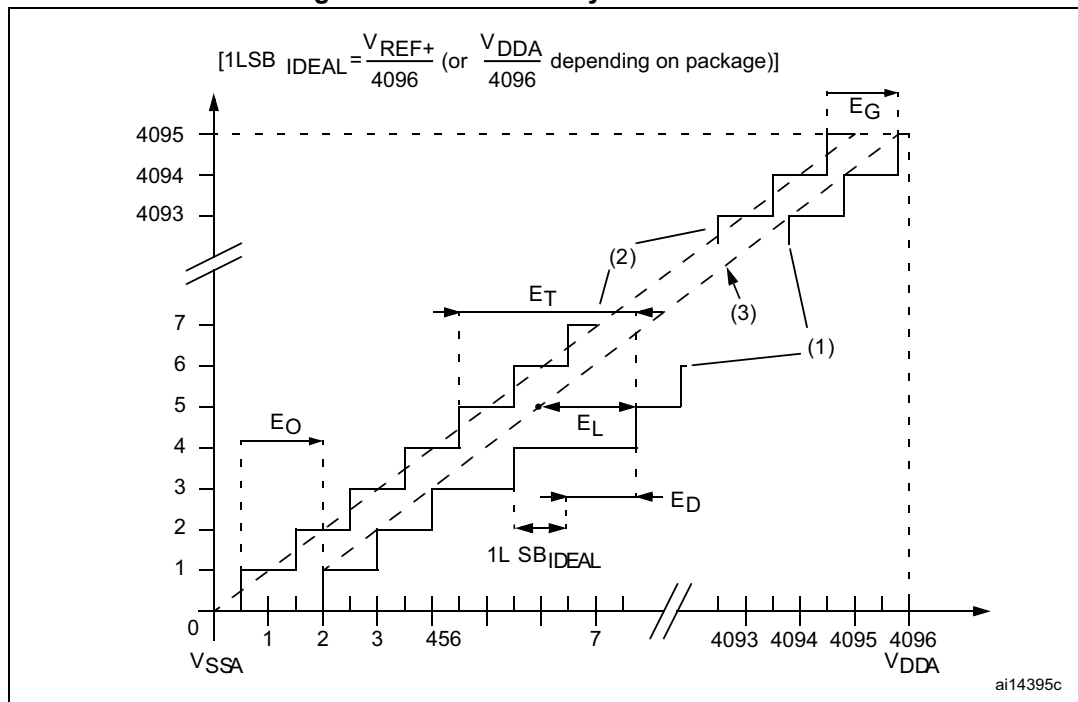
| Symbol | Parameter                            | Test conditions                                                                                                                            | Min  | Typ  | Max | Unit |
|--------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|------|-----|------|
| ENOB   | Effective number of bits             | $f_{\text{ADC}} = 36 \text{ MHz}$<br>$V_{\text{DDA}} = V_{\text{REF}+} = 3.3 \text{ V}$<br>Input Frequency = 20 kHz<br>Temperature = 25 °C | 10.6 | 10.8 | -   | bits |
| SINAD  | Signal-to noise and distortion ratio |                                                                                                                                            | 66   | 67   | -   | dB   |
| SNR    | Signal-to noise ratio                |                                                                                                                                            | 64   | 68   | -   |      |
| THD    | Total harmonic distortion            |                                                                                                                                            | - 70 | - 72 | -   |      |

1. Guaranteed by characterization results.

**Note:** ADC accuracy vs. negative injection current: injecting a negative current on any analog input pins should be avoided as this significantly reduces the accuracy of the conversion being performed on another analog input. It is recommended to add a Schottky diode (pin to ground) to analog pins which may potentially inject negative currents.

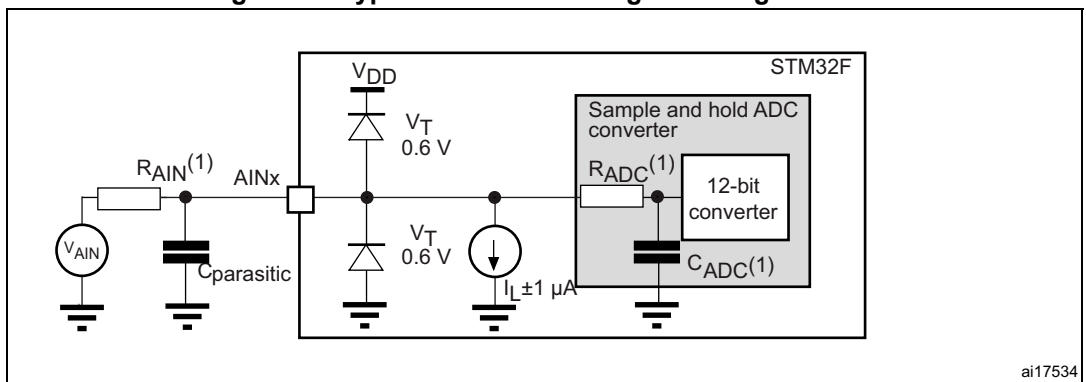
Any positive injection current within the limits specified for  $I_{\text{INJ(PIN)}}$  and  $\Sigma I_{\text{INJ(PIN)}}$  in [Section 6.3.20](#) does not affect the ADC accuracy.

Figure 48. ADC accuracy characteristics



1. See also [Table 69](#).
2. Example of an actual transfer curve.
3. Ideal transfer curve.
4. End point correlation line.
5.  $E_T$  = Total Unadjusted Error: maximum deviation between the actual and the ideal transfer curves.  
 $E_O$  = Offset Error: deviation between the first actual transition and the first ideal one.  
 $E_G$  = Gain Error: deviation between the last ideal transition and the last actual one.  
 $E_D$  = Differential Linearity Error: maximum deviation between actual steps and the ideal one.  
 $E_L$  = Integral Linearity Error: maximum deviation between any actual transition and the end point correlation line.

Figure 49. Typical connection diagram using the ADC

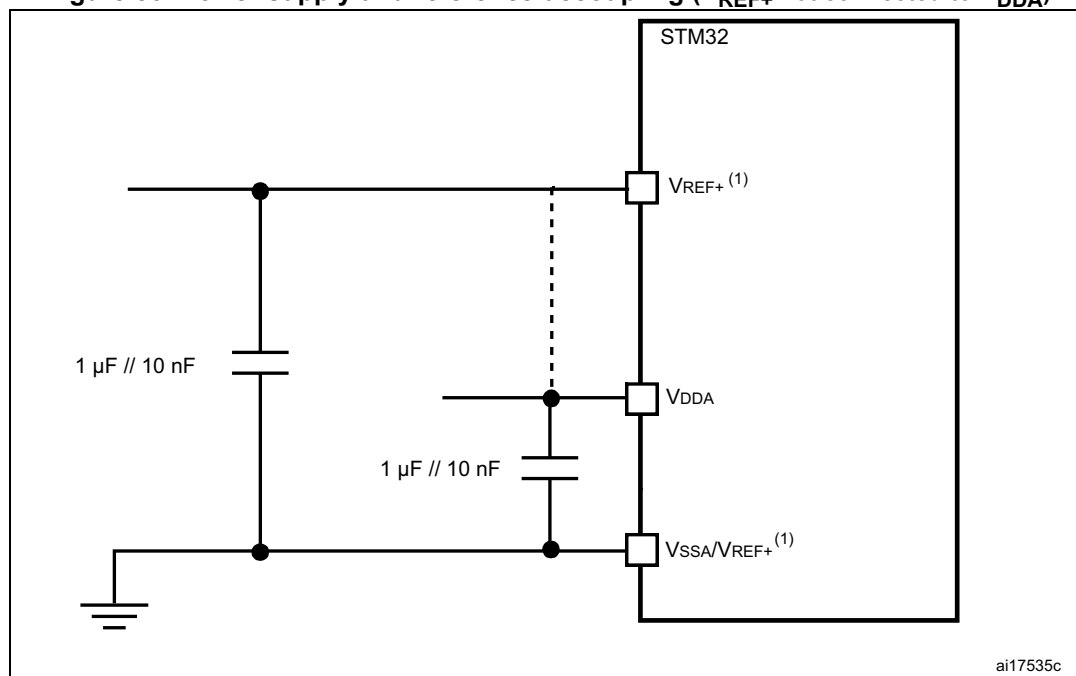


1. Refer to [Table 67](#) for the values of  $R_{AIN}$ ,  $R_{ADC}$  and  $C_{ADC}$ .
2.  $C_{parasitic}$  represents the capacitance of the PCB (dependent on soldering and PCB layout quality) plus the pad capacitance (roughly 5 pF). A high  $C_{parasitic}$  value downgrades conversion accuracy. To remedy this,  $f_{ADC}$  should be reduced.

### General PCB design guidelines

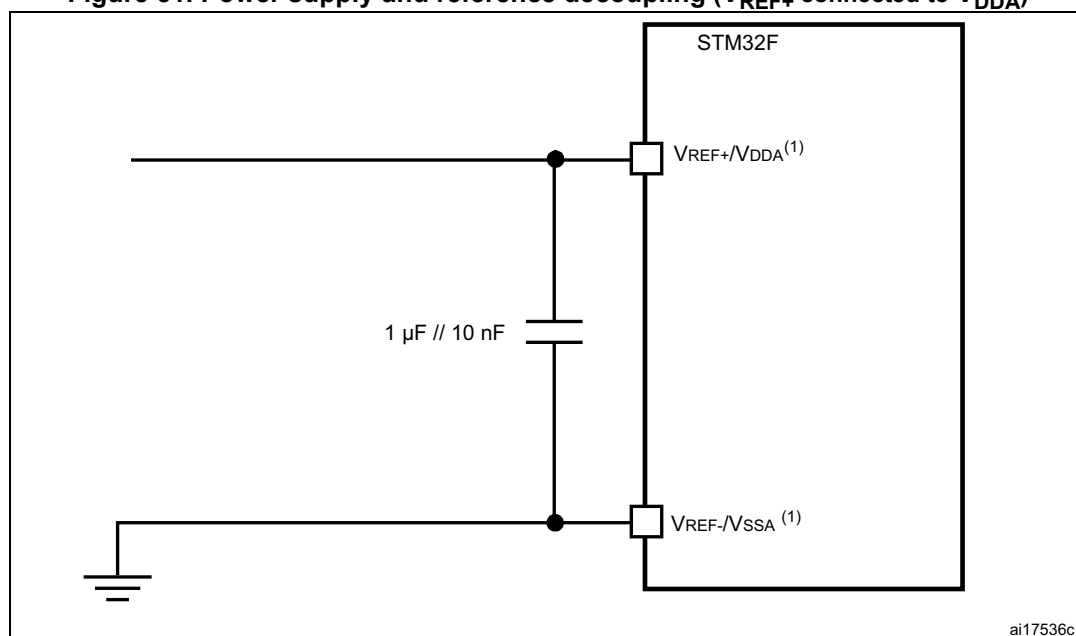
Power supply decoupling should be performed as shown in [Figure 50](#) or [Figure 51](#), depending on whether  $V_{REF+}$  is connected to  $V_{DDA}$  or not. The 10 nF capacitors should be ceramic (good quality). They should be placed as close as possible to the chip.

**Figure 50. Power supply and reference decoupling ( $V_{REF+}$  not connected to  $V_{DDA}$ )**



1.  $V_{REF+}$  input is available on all the packages except LQFP64, whereas the  $V_{REF-}$  is available only on UFBGA176 and UFBGA144. When  $V_{REF-}$  is not available, it is internally connected to  $V_{SSA}$ .

**Figure 51. Power supply and reference decoupling ( $V_{REF+}$  connected to  $V_{DDA}$ )**



1.  $V_{REF+}$  input is available on all the packages except LQFP64, whereas the  $V_{REF-}$  is available only on UFBGA176 and UFBGA144. When  $V_{REF-}$  is not available, it is internally connected to  $V_{SSA}$ .

### 6.3.25 Temperature sensor characteristics

**Table 73. Temperature sensor characteristics**

| Symbol                   | Parameter                                                      | Min | Typ     | Max     | Unit  |
|--------------------------|----------------------------------------------------------------|-----|---------|---------|-------|
| $T_L^{(1)}$              | $V_{SENSE}$ linearity with temperature                         | -   | $\pm 1$ | $\pm 2$ | °C    |
| Avg_Slope <sup>(1)</sup> | Average slope                                                  | -   | 2.5     | -       | mV/°C |
| $V_{25}^{(1)}$           | Voltage at 25 °C                                               | -   | 0.76    | -       | V     |
| $t_{START}^{(2)}$        | Startup time                                                   | -   | 6       | 10      | µs    |
| $T_{S\_temp}^{(2)}$      | ADC sampling time when reading the temperature (1 °C accuracy) | 10  | -       | -       | µs    |

1. Guaranteed by characterization results.

2. Guaranteed by design.

**Table 74. Temperature sensor calibration values**

| Symbol  | Parameter                                                            | Memory address            |
|---------|----------------------------------------------------------------------|---------------------------|
| TS_CAL1 | TS ADC raw data acquired at temperature of 30 °C, $V_{DDA} = 3.3$ V  | 0x1FF0 7A2C - 0x1FF0 7A2D |
| TS_CAL2 | TS ADC raw data acquired at temperature of 110 °C, $V_{DDA} = 3.3$ V | 0x1FF0 7A2E - 0x1FF0 7A2F |

### 6.3.26 $V_{BAT}$ monitoring characteristics

**Table 75.  $V_{BAT}$  monitoring characteristics**

| Symbol                 | Parameter                                                     | Min | Typ | Max | Unit |
|------------------------|---------------------------------------------------------------|-----|-----|-----|------|
| R                      | Resistor bridge for $V_{BAT}$                                 | -   | 50  | -   | KΩ   |
| Q                      | Ratio on $V_{BAT}$ measurement                                | -   | 4   | -   | -    |
| $E_r^{(1)}$            | Error on Q                                                    | -1  | -   | +1  | %    |
| $T_{S\_vbat}^{(2)(2)}$ | ADC sampling time when reading the $V_{BAT}$<br>1 mV accuracy | 5   | -   | -   | µs   |

1. Guaranteed by design.

2. Shortest sampling time can be determined in the application by multiple iterations.

### 6.3.27 Reference voltage

The parameters given in [Table 76](#) are derived from tests performed under ambient temperature and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#).

**Table 76. internal reference voltage**

| Symbol                 | Parameter                                                     | Conditions                             | Min  | Typ  | Max  | Unit |
|------------------------|---------------------------------------------------------------|----------------------------------------|------|------|------|------|
| $V_{REFINT}$           | Internal reference voltage                                    | $-40\text{ °C} < T_A < +105\text{ °C}$ | 1.18 | 1.21 | 1.24 | V    |
| $T_{S\_vrefint}^{(1)}$ | ADC sampling time when reading the internal reference voltage | -                                      | 10   | -    | -    | µs   |
| $V_{RERINT\_s}^{(2)}$  | Internal reference voltage spread over the temperature range  | $V_{DD} = 3V \pm 10mV$                 | -    | 3    | 5    | mV   |

Table 76. internal reference voltage (continued)

| Symbol                   | Parameter               | Conditions | Min | Typ | Max | Unit   |
|--------------------------|-------------------------|------------|-----|-----|-----|--------|
| $T_{\text{Coeff}}^{(2)}$ | Temperature coefficient | -          | -   | 30  | 50  | ppm/°C |
| $t_{\text{START}}^{(2)}$ | Startup time            | -          | -   | 6   | 10  | µs     |

- Shortest sampling time can be determined in the application by multiple iterations.
- Guaranteed by design.

Table 77. Internal reference voltage calibration values

| Symbol                  | Parameter                                                                  | Memory address            |
|-------------------------|----------------------------------------------------------------------------|---------------------------|
| $V_{\text{REFIN\_CAL}}$ | Raw data acquired at temperature of 30 °C $V_{\text{DDA}} = 3.3 \text{ V}$ | 0x1FF0 7A2A - 0x1FF0 7A2B |

### 6.3.28 DAC electrical characteristics

Table 78. DAC characteristics

| Symbol                                | Parameter                              |                               | Min                | Typ | Max                      | Unit | Comments                                                                                                                                                                                     |
|---------------------------------------|----------------------------------------|-------------------------------|--------------------|-----|--------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>DDA</sub>                      | Analog supply voltage                  |                               | 1.7 <sup>(1)</sup> | -   | 3.6                      | V    | -                                                                                                                                                                                            |
| V <sub>REF+</sub>                     | Reference supply voltage               |                               | 1.7 <sup>(1)</sup> | -   | 3.6                      | V    | V <sub>REF+</sub> ≤ V <sub>DDA</sub>                                                                                                                                                         |
| V <sub>SSA</sub>                      | Ground                                 |                               | 0                  | -   | 0                        | V    | -                                                                                                                                                                                            |
| R <sub>LOAD</sub> <sup>(2)</sup>      | Resistive load with buffer ON          | Connected to V <sub>SSA</sub> | 5                  | -   | -                        | kΩ   | -                                                                                                                                                                                            |
|                                       |                                        | Connected to V <sub>DDA</sub> | 25                 | -   | -                        | kΩ   | -                                                                                                                                                                                            |
| R <sub>O</sub> <sup>(2)</sup>         | Impedance output with buffer OFF       |                               | -                  | -   | 15                       | kΩ   | When the buffer is OFF, the Minimum resistive load between DAC_OUT and V <sub>SS</sub> to have a 1% accuracy is 1.5 MΩ                                                                       |
| C <sub>LOAD</sub> <sup>(2)</sup>      | Capacitive load                        |                               | -                  | -   | 50                       | pF   | Maximum capacitive load at DAC_OUT pin (when the buffer is ON).                                                                                                                              |
| DAC_OUT <sub>min</sub> <sup>(2)</sup> | Lower DAC_OUT voltage with buffer ON   |                               | 0.2                | -   | -                        | V    | It gives the maximum output excursion of the DAC.<br>It corresponds to 12-bit input code (0x0E0) to (0xF1C) at V <sub>REF+</sub> = 3.6 V and (0x1C7) to (0xE38) at V <sub>REF+</sub> = 1.7 V |
| DAC_OUT <sub>max</sub> <sup>(2)</sup> | Higher DAC_OUT voltage with buffer ON  |                               | -                  | -   | V <sub>DDA</sub> - 0.2   | V    |                                                                                                                                                                                              |
| DAC_OUT <sub>min</sub> <sup>(2)</sup> | Lower DAC_OUT voltage with buffer OFF  |                               | -                  | 0.5 | -                        | mV   | It gives the maximum output excursion of the DAC.                                                                                                                                            |
| DAC_OUT <sub>max</sub> <sup>(2)</sup> | Higher DAC_OUT voltage with buffer OFF |                               | -                  | -   | V <sub>REF+</sub> - 1LSB | V    |                                                                                                                                                                                              |

Table 78. DAC characteristics (continued)

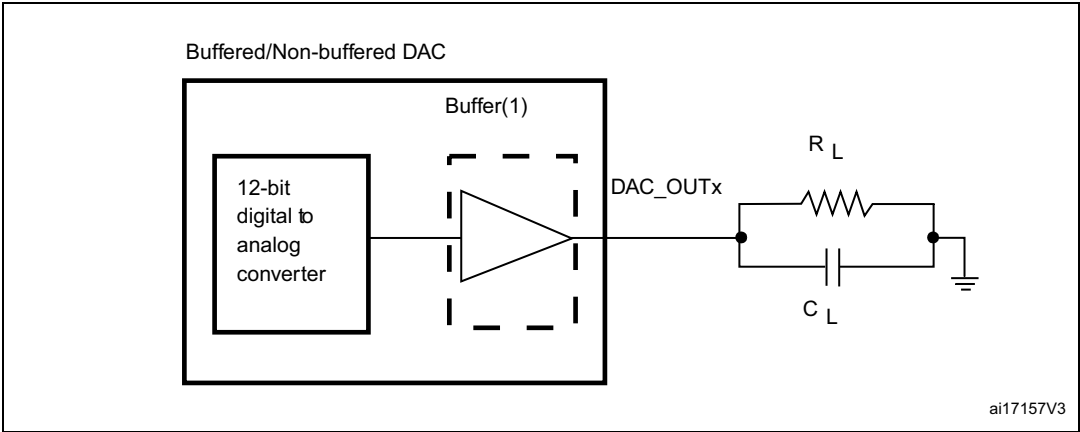
| Symbol                     | Parameter                                                                                                                                                  | Min | Typ | Max       | Unit    | Comments                                                                                        |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----------|---------|-------------------------------------------------------------------------------------------------|
| $I_{VREF+}^{(4)}$          | DAC DC $V_{REF}$ current consumption in quiescent mode (Standby mode)                                                                                      | -   | 170 | 240       | $\mu A$ | With no load, worst code (0x800) at $V_{REF+} = 3.6 V$ in terms of DC consumption on the inputs |
|                            |                                                                                                                                                            | -   | 50  | 75        |         | With no load, worst code (0xF1C) at $V_{REF+} = 3.6 V$ in terms of DC consumption on the inputs |
| $I_{DDA}^{(4)}$            | DAC DC $V_{DDA}$ current consumption in quiescent mode <sup>(3)</sup>                                                                                      | -   | 280 | 380       | $\mu A$ | With no load, middle code (0x800) on the inputs                                                 |
|                            |                                                                                                                                                            | -   | 475 | 625       | $\mu A$ | With no load, worst code (0xF1C) at $V_{REF+} = 3.6 V$ in terms of DC consumption on the inputs |
| DNL <sup>(4)</sup>         | Differential non linearity<br>Difference between two consecutive code-1LSB)                                                                                | -   | -   | $\pm 0.5$ | LSB     | Given for the DAC in 10-bit configuration.                                                      |
|                            |                                                                                                                                                            | -   | -   | $\pm 2$   | LSB     | Given for the DAC in 12-bit configuration.                                                      |
| INL <sup>(4)</sup>         | Integral non linearity<br>(difference between measured value at Code i and the value at Code i on a line drawn between Code 0 and last Code 1023)          | -   | -   | $\pm 1$   | LSB     | Given for the DAC in 10-bit configuration.                                                      |
|                            |                                                                                                                                                            | -   | -   | $\pm 4$   | LSB     | Given for the DAC in 12-bit configuration.                                                      |
| Offset <sup>(4)</sup>      | Offset error<br>(difference between measured value at Code (0x800) and the ideal value = $V_{REF+}/2$ )                                                    | -   | -   | $\pm 10$  | mV      | Given for the DAC in 12-bit configuration                                                       |
|                            |                                                                                                                                                            | -   | -   | $\pm 3$   | LSB     | Given for the DAC in 10-bit at $V_{REF+} = 3.6 V$                                               |
|                            |                                                                                                                                                            | -   | -   | $\pm 12$  | LSB     | Given for the DAC in 12-bit at $V_{REF+} = 3.6 V$                                               |
| Gain error <sup>(4)</sup>  | Gain error                                                                                                                                                 | -   | -   | $\pm 0.5$ | %       | Given for the DAC in 12-bit configuration                                                       |
| $t_{SETTLING}^{(4)}$       | Settling time (full scale: for a 10-bit input code transition between the lowest and the highest input codes when DAC_OUT reaches final value $\pm 4LSB$ ) | -   | 3   | 6         | $\mu s$ | $C_{LOAD} \leq 50 pF$ ,<br>$R_{LOAD} \geq 5 k\Omega$                                            |
| THD <sup>(4)</sup>         | Total Harmonic Distortion<br>Buffer ON                                                                                                                     | -   | -   | -         | dB      | $C_{LOAD} \leq 50 pF$ ,<br>$R_{LOAD} \geq 5 k\Omega$                                            |
| Update rate <sup>(2)</sup> | Max frequency for a correct DAC_OUT change when small variation in the input code (from code i to i+1LSB)                                                  | -   | -   | 1         | MS/s    | $C_{LOAD} \leq 50 pF$ ,<br>$R_{LOAD} \geq 5 k\Omega$                                            |

Table 78. DAC characteristics (continued)

| Symbol                    | Parameter                                                                    | Min | Typ | Max | Unit          | Comments                                                                                                                                |
|---------------------------|------------------------------------------------------------------------------|-----|-----|-----|---------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| $t_{\text{WAKEUP}}^{(4)}$ | Wakeup time from off state (Setting the ENx bit in the DAC Control register) | -   | 6.5 | 10  | $\mu\text{s}$ | $C_{\text{LOAD}} \leq 50 \text{ pF}$ , $R_{\text{LOAD}} \geq 5 \text{ k}\Omega$<br>input code between lowest and highest possible ones. |
| PSRR+ <sup>(2)</sup>      | Power supply rejection ratio (to $V_{\text{DDA}}$ ) (static DC measurement)  | -   | -67 | -40 | dB            | No $R_{\text{LOAD}}$ , $C_{\text{LOAD}} = 50 \text{ pF}$                                                                                |

1.  $V_{\text{DDA}}$  minimum value of 1.7 V is obtained with the use of an external power supply supervisor (refer to [Section 3.15.2: Internal reset OFF](#)).
2. Guaranteed by design.
3. The quiescent mode corresponds to a state where the DAC maintains a stable output level to ensure that no dynamic consumption occurs.
4. Guaranteed by characterization results.

Figure 52. 12-bit buffered /non-buffered DAC



1. The DAC integrates an output buffer that can be used to reduce the output impedance and to drive external loads directly without the use of an external operational amplifier. The buffer can be bypassed by configuring the BOFFx bit in the DAC\_CR register.

### 6.3.29 Communications interfaces

#### I<sup>2</sup>C interface characteristics

The I<sup>2</sup>C interface meets the timings requirements of the I<sup>2</sup>C-bus specification and user manual rev. 03 for:

- Standard-mode (Sm): with a bit rate up to 100 kbit/s
- Fast-mode (Fm): with a bit rate up to 400 kbit/s.
- Fast-mode Plus (Fm+): with a bit rate up to 1Mbit/s.

The I<sup>2</sup>C timings requirements are guaranteed by design when the I2C peripheral is properly configured (refer to RM0431 reference manual) and when the I2CCLK frequency is greater than the minimum shown in the table below:

Table 79. Minimum I2CCLK frequency in all I2C modes

| Symbol    | Parameter        | Condition      |                            | Min  | Unit |
|-----------|------------------|----------------|----------------------------|------|------|
| f(I2CCLK) | I2CCLK frequency | Standard-mode  | -                          | 2    | MHz  |
|           |                  | Fast-mode      | Analog Filter ON<br>DNF=0  | 10   |      |
|           |                  |                | Analog Filter OFF<br>DNF=1 | 9    |      |
|           |                  | Fast-mode Plus | Analog Filter ON<br>DNF=0  | 22.5 |      |
|           |                  |                | Analog Filter OFF<br>DNF=1 | 16   |      |

The SDA and SCL I/O requirements are met with the following restrictions: the SDA and SCL I/O pins are not “true” open-drain. When configured as open-drain, the PMOS connected between the I/O pin and  $V_{DD}$  is disabled, but is still present.

The 20mA output drive requirement in Fast-mode Plus is not supported. This limits the maximum load  $C_{load}$  supported in Fm+, which is given by these formulas:

- $Tr(SDA/SCL) = 0.8473 \times R_p \times C_{load}$
- $R_p(min) = (V_{DD} - V_{OL(max)}) / I_{OL(max)}$

Where  $R_p$  is the I2C lines pull-up. Refer to [Section 6.3.20: I/O port characteristics](#) for the I2C I/Os characteristics.

All I<sup>2</sup>C SDA and SCL I/Os embed an analog filter. Refer to the table below for the analog filter characteristics:

Table 80. I2C analog filter characteristics<sup>(1)</sup>

| Symbol   | Parameter                                                              | Min               | Max                | Unit |
|----------|------------------------------------------------------------------------|-------------------|--------------------|------|
| $t_{AF}$ | Maximum pulse width of spikes that are suppressed by the analog filter | 50 <sup>(2)</sup> | 260 <sup>(3)</sup> | ns   |

1. Guaranteed by characterization results.
2. Spikes with widths below  $t_{AF(min)}$  are filtered.
3. Spikes with widths above  $t_{AF(max)}$  are not filtered



### SPI interface characteristics

Unless otherwise specified, the parameters given in [Table 81](#) for the SPI interface are derived from tests performed under the ambient temperature,  $f_{PCLKx}$  frequency and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#), with the following configuration:

- Output speed set to OSPEEDRy[1:0] = 11
- Capacitive load C = 30 pF
- Measurement points are done at CMOS levels:  $0.5V_{DD}$

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output alternate function characteristics (NSS, SCK, MOSI, MISO for SPI).

**Table 81. SPI dynamic characteristics<sup>(1)</sup>**

| Symbol                    | Parameter             | Conditions                                                                    | Min     | Typ   | Max               | Unit |
|---------------------------|-----------------------|-------------------------------------------------------------------------------|---------|-------|-------------------|------|
| $f_{SCK}$<br>$1/t_c(SCK)$ | SPI clock frequency   | Master mode<br>SPI1,4,5<br>$2.7 \leq V_{DD} \leq 3.6$                         | -       | -     | 54 <sup>(2)</sup> | MHz  |
|                           |                       | Master mode<br>SPI1,4,5<br>$1.71 \leq V_{DD} \leq 3.6$                        | -       | -     | 27                |      |
|                           |                       | Master transmitter mode<br>SPI1,4,5<br>$1.71 \leq V_{DD} \leq 3.6$            | -       | -     | 54                |      |
|                           |                       | Slave receiver mode<br>SPI1,4,5<br>$1.71 \leq V_{DD} \leq 3.6$                | -       | -     | 54                |      |
|                           |                       | Slave mode transmitter/full duplex<br>SPI1,4,5<br>$2.7 \leq V_{DD} \leq 3.6$  | -       | -     | 50 <sup>(3)</sup> |      |
|                           |                       | Slave mode transmitter/full duplex<br>SPI1,4,5<br>$1.71 \leq V_{DD} \leq 3.6$ | -       | -     | 37 <sup>(3)</sup> |      |
|                           |                       | Master & Slave mode<br>SPI2,3<br>$1.71 \leq V_{DD} \leq 3.6$                  | -       | -     | 27                |      |
| tsu(NSS)                  | NSS setup time        | Slave mode, SPI presc = 2                                                     | 4xTpclk | -     | -                 | ns   |
| th(NSS)                   | NSS hold time         | Slave mode, SPI presc = 2                                                     | 2xTpclk | -     | -                 |      |
| tw(SCKH)<br>tw(SCKL)      | SCK high and low time | Master mode                                                                   | Tpclk-1 | Tpclk | Tpclk+1           |      |

Table 81. SPI dynamic characteristics<sup>(1)</sup> (continued)

| Symbol   | Parameter                | Conditions                              | Min | Typ | Max  | Unit |
|----------|--------------------------|-----------------------------------------|-----|-----|------|------|
| tsu(MI)  | Data input setup time    | Master mode                             | 4   | -   | -    | ns   |
| tsu(SI)  |                          | Slave mode                              | 3.5 | -   | -    |      |
| th(MI)   | Data input hold time     | Master mode                             | 3   | -   | -    |      |
| th(SI)   |                          | Slave mode                              | 1   | -   | -    |      |
| ta(SO)   | Data output access time  | Slave mode                              | 7   | 9   | 21   |      |
| tdis(SO) | Data output disable time | Slave mode                              | 5   | 7   | 12   |      |
| tv(SO)   | Data output valid time   | Slave mode $2.7 \leq VDD \leq 3.6V$     | -   | 6.5 | 10   |      |
|          |                          | Slave mode $1.71 \leq VDD \leq 3.6V$    | -   | 6.5 | 13.5 |      |
| tv(MO)   |                          | Master mode                             | -   | 2   | 3    |      |
| th(SO)   | Data output hold time    | Slave mode<br>$1.71 \leq VDD \leq 3.6V$ | 4.5 | -   | -    |      |
| th(MO)   |                          | Master mode                             | 0   | -   | -    |      |

1. Guaranteed by characterization results.
2. Excepting SPI1 with SCK IO=PA5. In this configuration, the maximum achievable frequency is 40 MHz.
3. Maximum frequency of the slave transmitter is determined by sum of Tv(SO) and Tsu(MI) intervals which has to fit into SCK level phase preceding the SCK sampling edge. This value can be achieved when it communicates with a Master having Tsu(MI) = 0 while signal Duty(SCK) = 50%.

Figure 53. SPI timing diagram - slave mode and CPHA = 0

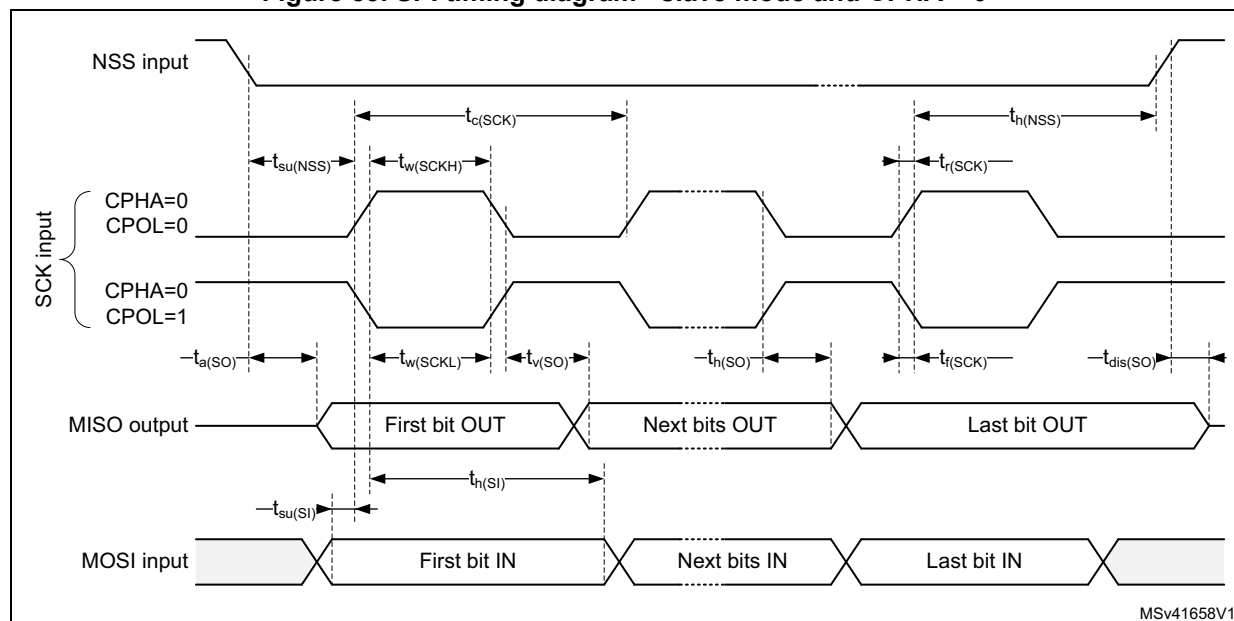


Figure 54. SPI timing diagram - slave mode and CPHA = 1

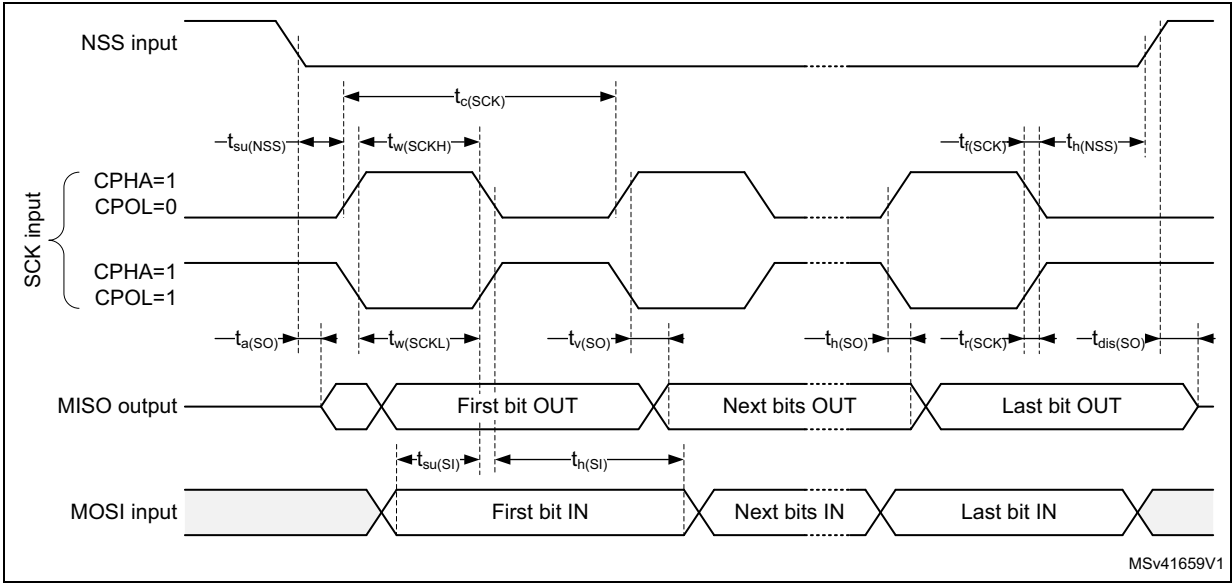
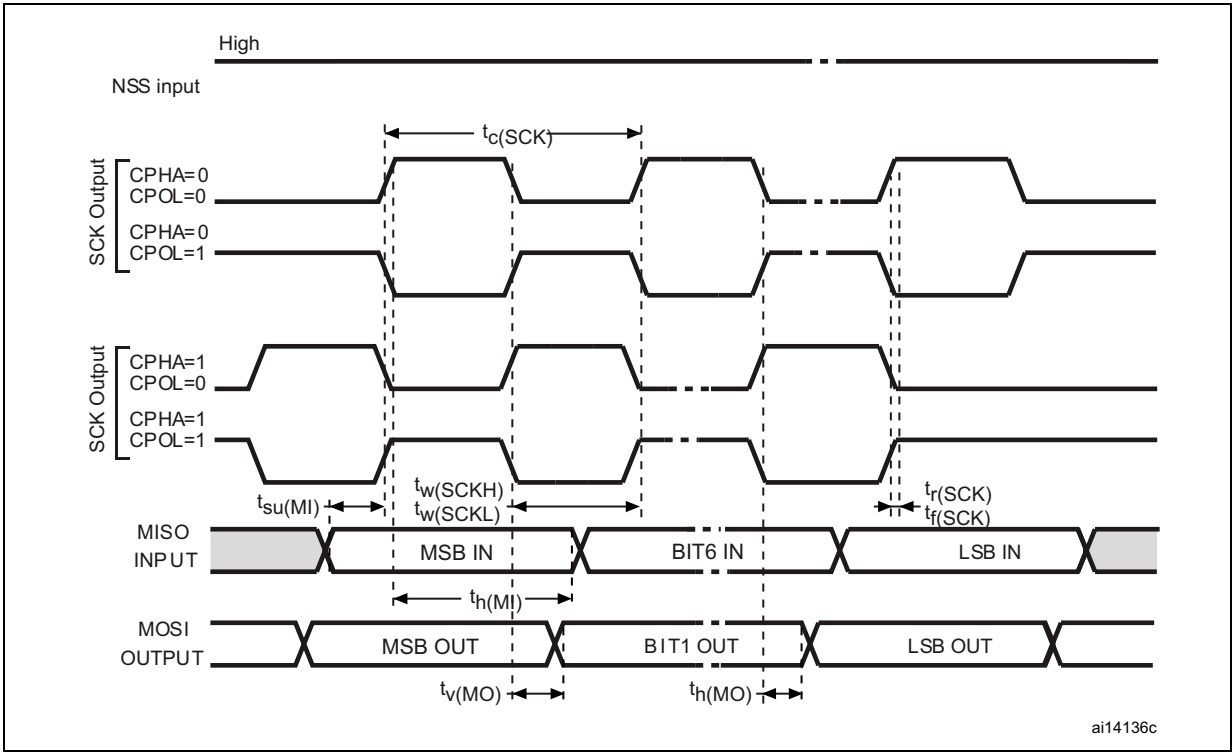


Figure 55. SPI timing diagram - master mode



## I<sup>2</sup>S interface characteristics

Unless otherwise specified, the parameters given in [Table 82](#) for the I<sup>2</sup>S interface are derived from tests performed under the ambient temperature,  $f_{PCLKx}$  frequency and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#), with the following configuration:

- Output speed is set to  $OSPEEDRy[1:0] = 10$
- Capacitive load  $C = 30$  pF
- Measurement points are done at CMOS levels:  $0.5V_{DD}$

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output alternate function characteristics (CK, SD, WS).

**Table 82. I<sup>2</sup>S dynamic characteristics<sup>(1)</sup>**

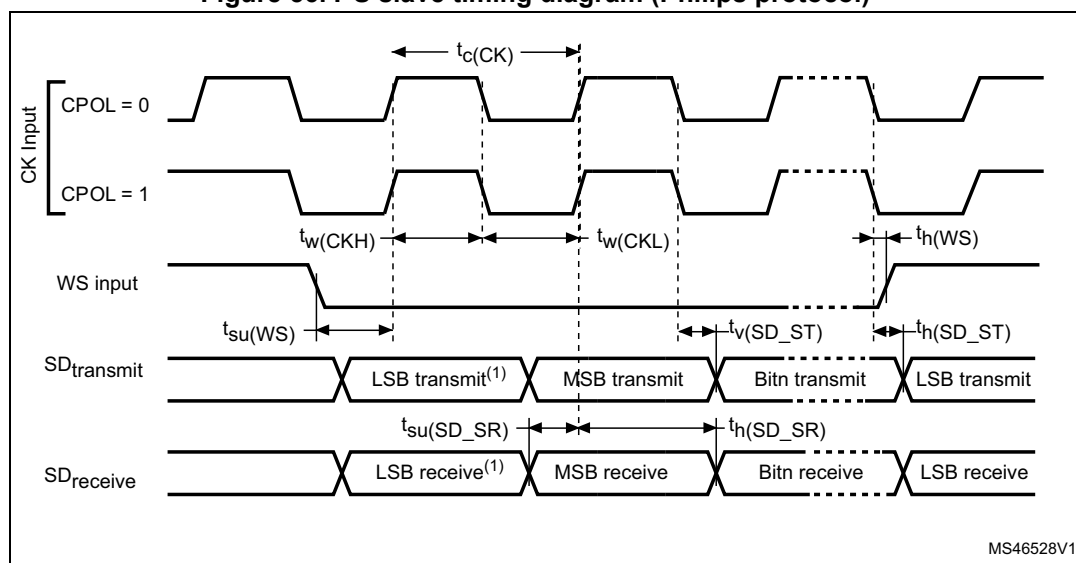
| Symbol           | Parameter                      | Conditions                             | Min      | Max                       | Unit |
|------------------|--------------------------------|----------------------------------------|----------|---------------------------|------|
| $f_{MCK}$        | I2S Main clock output          | -                                      | 256 x 8K | 256x $F_S$ <sup>(2)</sup> | MHz  |
| $f_{CK}$         | I2S clock frequency            | Master data: 32 bits                   | -        | 64x $F_S$                 | MHz  |
|                  |                                | Slave data: 32 bits                    | -        | 64x $F_S$                 |      |
| $D_{CK}$         | I2S clock frequency duty cycle | Slave receiver                         | 30       | 70                        | %    |
| $t_{v(WS)}$      | WS valid time                  | Master mode                            | -        | 3                         | ns   |
| $t_{h(WS)}$      | WS hold time                   | Master mode                            | 0        | -                         |      |
| $t_{su(WS)}$     | WS setup time                  | Slave mode                             | 5        | -                         |      |
| $t_{h(WS)}$      | WS hold time                   | Slave mode                             | 2        | -                         |      |
| $t_{su(SD\_MR)}$ | Data input setup time          | Master receiver                        | 2.5      | -                         |      |
| $t_{su(SD\_SR)}$ |                                | Slave receiver                         | 2.5      | -                         |      |
| $t_{h(SD\_MR)}$  | Data input hold time           | Master receiver                        | 3.5      | -                         |      |
| $t_{h(SD\_SR)}$  |                                | Slave receiver                         | 2        | -                         |      |
| $t_{v(SD\_ST)}$  | Data output valid time         | Slave transmitter (after enable edge)  | -        | 12                        |      |
| $t_{v(SD\_MT)}$  |                                | Master transmitter (after enable edge) | -        | 3                         |      |
| $t_{h(SD\_ST)}$  | Data output hold time          | Slave transmitter (after enable edge)  | 5        | -                         |      |
| $t_{h(SD\_MT)}$  |                                | Master transmitter (after enable edge) | 0        | -                         |      |

1. Guaranteed by characterization results.

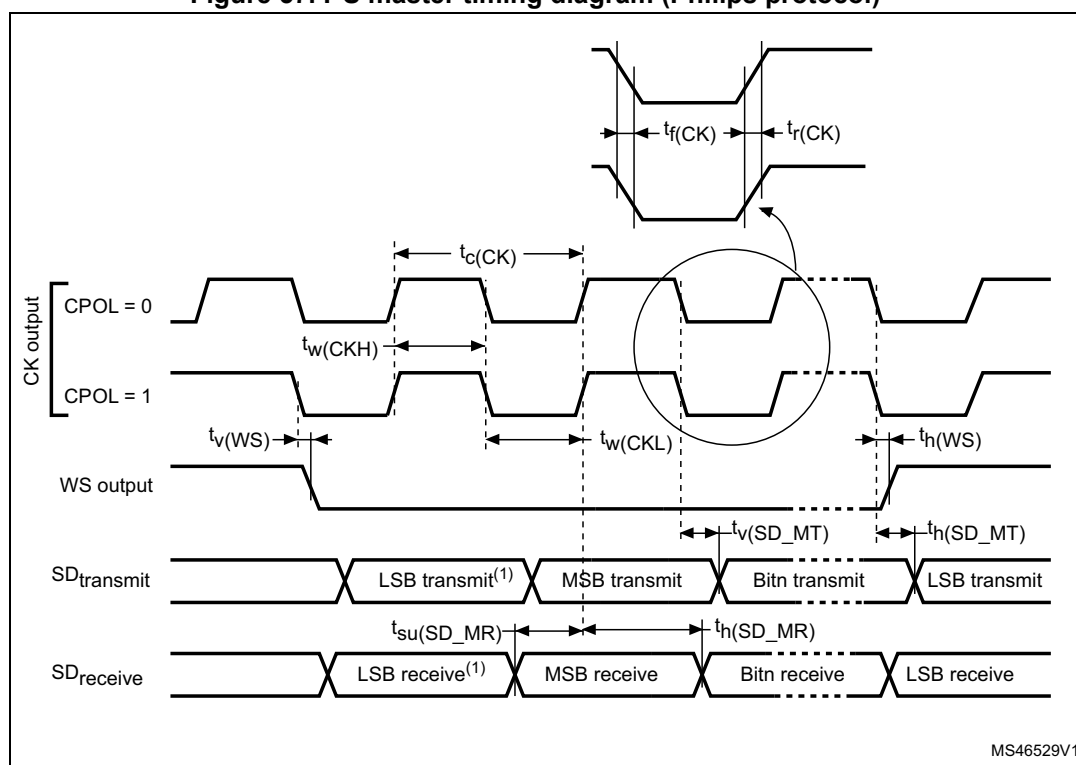
2. 256x $F_S$  maximum is 49.152 MHz (APB1 Maximum frequency).

**Note:** Refer to RM0431 reference manual I2S section for more details on the sampling frequency ( $F_S$ ).

$f_{MCK}$ ,  $f_{CK}$ , and  $D_{CK}$  values reflect only the digital peripheral behavior. The values of these parameters might be slightly impacted by the source clock precision.  $D_{CK}$  depends mainly on the value of ODD bit. The digital contribution leads to a minimum value of  $(I2SDIV/(2*I2SDIV+ODD))$  and a maximum value of  $(I2SDIV+ODD)/(2*I2SDIV+ODD)$ .  $F_S$  maximum value is supported for each mode/condition.

Figure 56. I<sup>2</sup>S slave timing diagram (Philips protocol)<sup>(1)</sup>

1. LSB transmit/receive of the previously transmitted byte. No LSB transmit/receive is sent before the first byte.

Figure 57. I<sup>2</sup>S master timing diagram (Philips protocol)<sup>(1)</sup>

1. LSB transmit/receive of the previously transmitted byte. No LSB transmit/receive is sent before the first byte.

### SAI characteristics

Unless otherwise specified, the parameters given in [Table 83](#) for SAI are derived from tests performed under the ambient temperature,  $f_{PCLKx}$  frequency and VDD supply voltage conditions summarized in [Table 16](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 10
- Capacitive load C=30 pF
- Measurement points are performed at CMOS levels: 0.5V<sub>DD</sub>

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output alternate function characteristics (SCK,SD,WS).

**Table 83. SAI characteristics<sup>(1)</sup>**

| Symbol              | Parameter                          | Conditions                                              | Min    | Max                   | Unit |
|---------------------|------------------------------------|---------------------------------------------------------|--------|-----------------------|------|
| $f_{MCKL}$          | SAI main clock output              | -                                                       | 256x8K | 256xFs                | MHz  |
| $F_{CK}$            | SAI clock frequency <sup>(2)</sup> | Master data: 32 bits                                    | -      | 128xFs <sup>(3)</sup> |      |
|                     |                                    | Slave data: 32 bits                                     | -      | 128xFs <sup>(3)</sup> |      |
| $t_{v(FS)}$         | FS valid time                      | Master mode<br>2.7≤VDD≤3.6V                             | -      | 18                    | ns   |
|                     |                                    | Master mode<br>1.71≤VDD≤3.6V                            | -      | 20                    |      |
| $t_{su(FS)}$        | FS setup time                      | Slave mode                                              | 1      | -                     |      |
| $t_{h(FS)}$         | FS hold time                       | Master mode                                             | 7      | -                     |      |
|                     |                                    | Slave mode                                              | 0.5    | -                     |      |
| $t_{su(SD\_A\_MR)}$ | Data input setup time              | Master receiver                                         | 1      | -                     |      |
| $t_{su(SD\_B\_SR)}$ |                                    | Slave receiver                                          | 2.5    | -                     |      |
| $t_{h(SD\_A\_MR)}$  | Data input hold time               | Master receiver                                         | 3.5    | -                     |      |
| $t_{h(SD\_B\_SR)}$  |                                    | Slave receiver                                          | 0.5    | -                     |      |
| $t_{v(SD\_B\_MT)}$  | Data output valid time             | Slave transmitter (after enable edge)<br>2.7≤VDD≤3.6V   | -      | 11                    |      |
|                     |                                    | Slave transmitter (after enable edge)<br>1.71≤VDD≤3.6V  | -      | 18                    |      |
| $t_{h(SD\_B\_ST)}$  | Data output hold time              | Slave transmitter (after enable edge)                   | 5      | -                     |      |
| $t_{v(SD\_A\_MT)}$  | Data output valid time             | Master transmitter (after enable edge)<br>2.7≤VDD≤3.6V  | -      | 16                    |      |
|                     |                                    | Master transmitter (after enable edge)<br>1.71≤VDD≤3.6V | -      | 18.5                  |      |
| $t_{h(SD\_A\_MT)}$  | Data output hold time              | Master transmitter (after enable edge)                  | 7.5    | -                     |      |

1. Guaranteed by characterization results.

2. APB clock frequency must be at least twice SAI clock frequency.

3. With Fs = 192 kHz.

Figure 58. SAI master timing waveforms

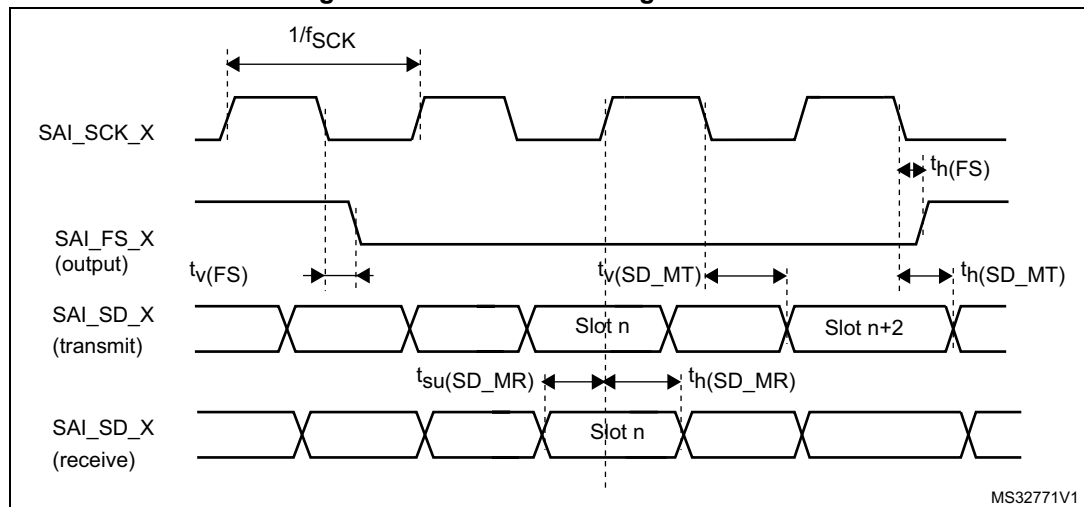
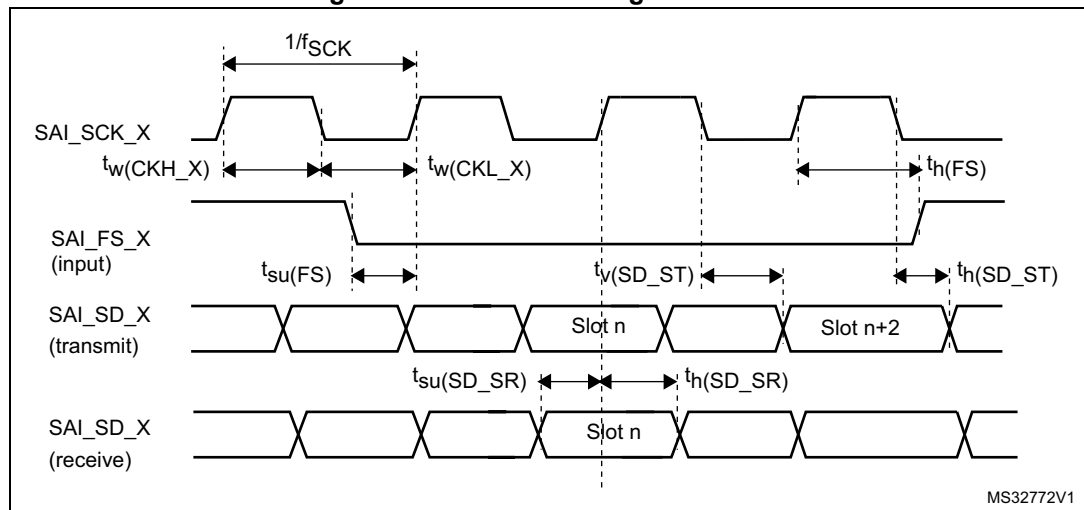


Figure 59. SAI slave timing waveforms



**USB OTG full speed (FS) characteristics**

This interface is present in both the USB OTG HS and USB OTG FS controllers.

**Table 84. USB OTG full speed startup time**

| Symbol                     | Parameter                                   | Max | Unit          |
|----------------------------|---------------------------------------------|-----|---------------|
| $t_{\text{STARTUP}}^{(1)}$ | USB OTG full speed transceiver startup time | 1   | $\mu\text{s}$ |

1. Guaranteed by design.

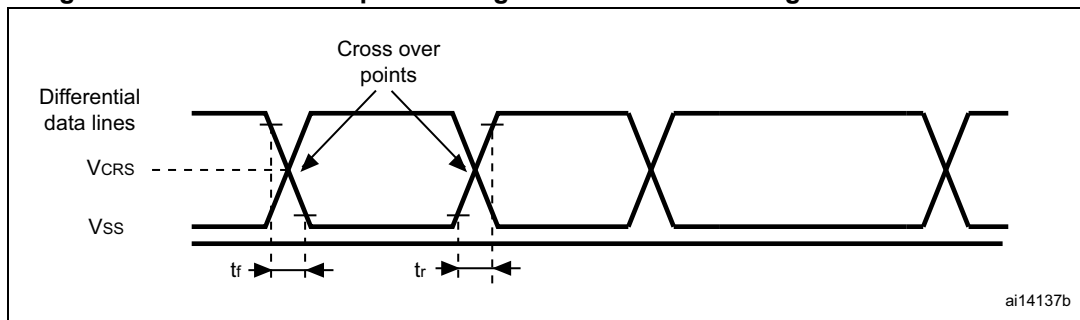
**Table 85. USB OTG full speed DC electrical characteristics**

| Symbol          |                                | Parameter                                        | Conditions                                                | Min.<br>(1)        | Typ. | Max.<br>(1) | Unit |
|-----------------|--------------------------------|--------------------------------------------------|-----------------------------------------------------------|--------------------|------|-------------|------|
| Input levels    | V <sub>DDUSB</sub>             | USB OTG full speed transceiver operating voltage | -                                                         | 3.0 <sup>(2)</sup> | -    | 3.6         | V    |
|                 | V <sub>DI</sub> <sup>(3)</sup> | Differential input sensitivity                   | I(USB_FS_DP/DM, USB_HS_DP/DM)                             | 0.2                | -    | -           | V    |
|                 | V <sub>CM</sub> <sup>(3)</sup> | Differential common mode range                   | Includes V <sub>DI</sub> range                            | 0.8                | -    | 2.5         |      |
|                 | V <sub>SE</sub> <sup>(3)</sup> | Single ended receiver threshold                  | -                                                         | 1.3                | -    | 2.0         |      |
| Output levels   | V <sub>OL</sub>                | Static output level low                          | R <sub>L</sub> of 1.5 kΩ to 3.6 V <sup>(4)</sup>          | -                  | -    | 0.3         | V    |
|                 | V <sub>OH</sub>                | Static output level high                         | R <sub>L</sub> of 15 kΩ to V <sub>SS</sub> <sup>(4)</sup> | 2.8                | -    | 3.6         |      |
| R <sub>PD</sub> |                                | PA11, PA12 (USB_FS_DP/DM)                        | V <sub>IN</sub> = V <sub>DD</sub>                         | 14.25              | -    | 24.8        | kΩ   |
|                 |                                | PA9, PB13 (OTG_FS_VBUS, OTG_HS_VBUS)             | V <sub>IN</sub> = V <sub>DD</sub>                         | 2.4                | 5.2  | 8           |      |
| R <sub>PU</sub> |                                | PA12 (USB_FS_DP)                                 | V <sub>IN</sub> = V <sub>SS</sub> , during idle           | 0.9                | 1.25 | 1.575       |      |
|                 |                                | PA9, PB13 (OTG_FS_VBUS, OTG_HS_VBUS)             | V <sub>IN</sub> = V <sub>SS</sub> , during reception      | 0.55               | 0.95 | 1.35        |      |

1. All the voltages are measured from the local ground potential.
2. The USB OTG full speed transceiver functionality is ensured down to 2.7 V but not the full USB full speed electrical characteristics which are degraded in the 2.7-to-3.0 V  $V_{\text{DDUSB}}$  voltage range.
3. Guaranteed by design.
4.  $R_{\text{L}}$  is the load connected on the USB OTG full speed drivers.

**Note:** When VBUS sensing feature is enabled, PA9 and PB13 should be left at their default state (floating input), not as alternate function. A typical 200  $\mu\text{A}$  current consumption of the sensing block (current to voltage conversion to determine the different sessions) can be observed on PA9 and PB13 when the feature is enabled.



**Figure 60. USB OTG full speed timings: definition of data signal rise and fall time****Table 86. USB OTG full speed electrical characteristics<sup>(1)</sup>**

| Driver characteristics |                                        |                       |     |     |          |
|------------------------|----------------------------------------|-----------------------|-----|-----|----------|
| Symbol                 | Parameter                              | Conditions            | Min | Max | Unit     |
| $t_r$                  | Rise time <sup>(2)</sup>               | $C_L = 50 \text{ pF}$ | 4   | 20  | ns       |
| $t_f$                  | Fall time <sup>(2)</sup>               | $C_L = 50 \text{ pF}$ | 4   | 20  | ns       |
| $t_{rfm}$              | Rise/ fall time matching               | $t_r/t_f$             | 90  | 111 | %        |
| $V_{CRS}$              | Output signal crossover voltage        | -                     | 1.3 | 2.0 | V        |
| $Z_{DRV}$              | Output driver impedance <sup>(3)</sup> | Driving high or low   | 28  | 44  | $\Omega$ |

- Guaranteed by design.
- Measured from 10% to 90% of the data signal. For more detailed informations, refer to USB Specification - Chapter 7 (version 2.0).
- No external termination series resistors are required on DP (D+) and DM (D-) pins since the matching impedance is included in the embedded driver.

### USB high speed (HS) characteristics (through ULPI in STM32F722xx devices)

Unless otherwise specified, the parameters given in [Table 89](#) for ULPI are derived from tests performed under the ambient temperature,  $f_{HCLK}$  frequency summarized in [Table 88](#) and  $V_{DD}$  supply voltage conditions summarized in [Table 87](#), with the following configuration:

- Output speed is set to  $OSPEEDRy[1:0] = 11$ , unless otherwise specified
- Capacitive load  $C = 20 \text{ pF}$ , unless otherwise specified
- Measurement points are done at CMOS levels:  $0.5V_{DD}$ .

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output characteristics.

**Table 87. USB HS DC electrical characteristics**

| Symbol      | Parameter                             | Min. <sup>(1)</sup> | Max. <sup>(1)</sup> | Unit |
|-------------|---------------------------------------|---------------------|---------------------|------|
| Input level | $V_{DD}$ USB OTG HS operating voltage | 1.7                 | 3.6                 | V    |

- All the voltages are measured from the local ground potential.

Table 88. USB HS clock timing parameters<sup>(1)</sup>

| Symbol            | Parameter                                                                          |                  | Min    | Typ | Max    | Unit    |
|-------------------|------------------------------------------------------------------------------------|------------------|--------|-----|--------|---------|
| -                 | $f_{HCLK}$ value to guarantee proper operation of USB HS interface                 |                  | 30     | -   | -      | MHz     |
| $F_{START\_8BIT}$ | Frequency (first transition)                                                       | 8-bit $\pm 10\%$ | 54     | 60  | 66     | MHz     |
| $F_{STEADY}$      | Frequency (steady state) $\pm 500$ ppm                                             |                  | 59.97  | 60  | 60.03  | MHz     |
| $D_{START\_8BIT}$ | Duty cycle (first transition)                                                      | 8-bit $\pm 10\%$ | 40     | 50  | 60     | %       |
| $D_{STEADY}$      | Duty cycle (steady state) $\pm 500$ ppm                                            |                  | 49.975 | 50  | 50.025 | %       |
| $t_{STEADY}$      | Time to reach the steady state frequency and duty cycle after the first transition |                  | -      | -   | 1.4    | ms      |
| $t_{START\_DEV}$  | Clock startup time after the de-assertion of SuspendM                              | Peripheral       | -      | -   | 5.6    | ms      |
| $t_{START\_HOST}$ |                                                                                    | Host             | -      | -   | -      |         |
| $t_{PREP}$        | PHY preparation time after the first transition of the input clock                 |                  | -      | -   | -      | $\mu s$ |

1. Guaranteed by design.

Figure 61. ULPI timing diagram

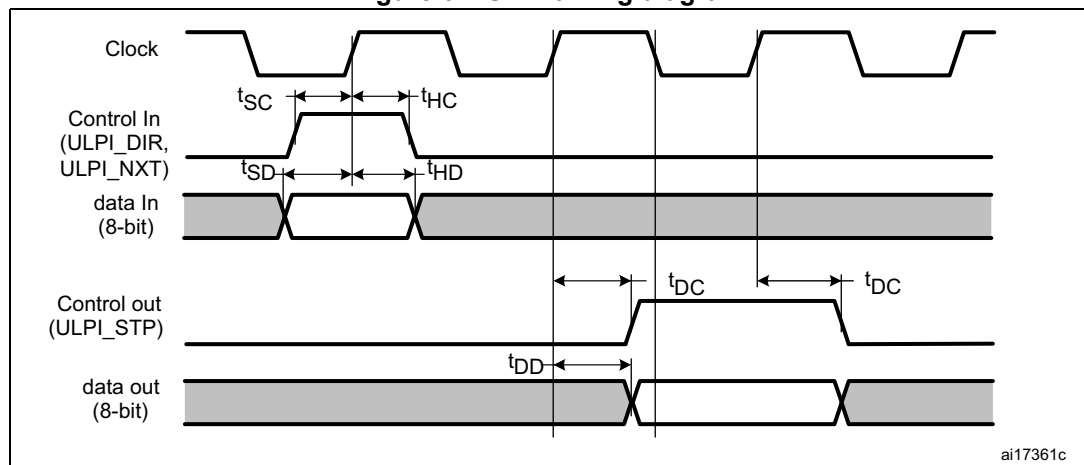


Table 89. Dynamic characteristics: USB ULPI<sup>(1)</sup>

| Symbol                           | Parameter                                  | Conditions                                                                           | Min. | Typ. | Max. | Unit |
|----------------------------------|--------------------------------------------|--------------------------------------------------------------------------------------|------|------|------|------|
| t <sub>SC</sub>                  | Control in (ULPI_DIR, ULPI_NXT) setup time | -                                                                                    | 1.5  | -    | -    | ns   |
| t <sub>HC</sub>                  | Control in (ULPI_DIR, ULPI_NXT) hold time  | -                                                                                    | 1    | -    | -    |      |
| t <sub>SD</sub>                  | Data in setup time                         | -                                                                                    | 1.5  | -    | -    |      |
| t <sub>HD</sub>                  | Data in hold time                          | -                                                                                    | 1    | -    | -    |      |
| t <sub>DC</sub> /t <sub>DD</sub> | Data/control output delay                  | 2.7 V < V <sub>DD</sub> < 3.6 V,<br>C <sub>L</sub> = 20 pF and<br>OSPEEDRy[1:0] = 11 | -    | 6    | 7.5  |      |
|                                  |                                            | -                                                                                    | -    | 9.5  | 11   |      |
|                                  |                                            | 1.7 V < V <sub>DD</sub> < 3.6 V,<br>C <sub>L</sub> = 15 pF and<br>OSPEEDRy[1:0] = 11 | -    |      |      |      |

1. Guaranteed by characterization results.

### USB high speed (HS) characteristics (embedded PHY High speed on STM32F723xx devices)

Table 90. USB OTG high speed DC electrical characteristics

| Symbol       | Parameter                                           | Conditions | Min  | Typ | Max  | Unit |
|--------------|-----------------------------------------------------|------------|------|-----|------|------|
| $V_{hssq}$   | High speed squelch detection threshold              | -          | 100  | -   | 150  | mV   |
| $V_{hdsdc}$  | High speed disconnect detection threshold           | -          | 525  | -   | 625  | mV   |
| $V_{hstdif}$ | High speed differential detection threshold         | -          | 100  | -   | -    | mV   |
| $V_{hscm}$   | High speed data signaling common mode voltage range | -          | -50  | -   | 500  | mV   |
| $V_{hsoi}$   | High speed idle level                               | -          | -10  | -   | 10   | mV   |
| $V_{hsoh}$   | High speed data signaling high                      | -          | 360  | -   | 440  | mV   |
| $V_{hsol}$   | High speed data signaling low                       | -          | -10  | -   | 10   | mV   |
| $V_{chirpj}$ | Chirp J level                                       | -          | 700  | -   | 1100 | mV   |
| $V_{chirpk}$ | Chirp K level                                       | -          | -900 | -   | -500 | mV   |

Table 91. USB OTG high speed electrical characteristics

| Parameter  | Comments                                                                    | Conditions | Min  | Typ | Max  | Unit     |
|------------|-----------------------------------------------------------------------------|------------|------|-----|------|----------|
| $t_{ir}$   | Rise time                                                                   | -          | 0.5  | -   | -    | ns       |
| $t_{if}$   | Fall time                                                                   | -          | 0.5  | -   | -    | ns       |
| $t_{lrfm}$ | Setup time from INHSDRIVERENABLE=1 to the transition on INHSDATAP/INHSDATAN | -          | 10   | -   | -    | ns       |
| $Z_{drv}$  | Driver output impedance                                                     | -          | 40.5 | -   | 49.5 | $\Omega$ |

Table 92. USB FS PHY BCD electrical characteristics

| Symbol               | Parameter                                       | Conditions | Min  | Typ | Max | Unit |
|----------------------|-------------------------------------------------|------------|------|-----|-----|------|
| I <sub>DDUSB</sub>   | Primary detection mode consumption              | -          | -    | -   | 300 | μA   |
|                      | Secondary detection mode consumption            | -          | -    | -   | 300 |      |
| R <sub>DAT_LKG</sub> | Data line leakage resistance                    | -          | 300  | -   | -   | kΩ   |
| V <sub>DAT_LKG</sub> | Data line leakage voltage                       | -          | 0.0  | -   | 3.6 | V    |
| R <sub>DCP_DAT</sub> | Dedicated charging port resistance across D+/D- | -          | -    | -   | 200 | Ω    |
| V <sub>LGC_HI</sub>  | Logic high                                      | -          | 2.0  | -   | 3.6 | V    |
| V <sub>LGC_LOW</sub> | Logic low                                       | -          | -    | -   | 0.8 |      |
| V <sub>LGC</sub>     | Logic threshold                                 | -          | 0.8  | -   | 2.0 |      |
| V <sub>DAT_REF</sub> | Data detect voltage                             | -          | 0.25 | -   | 3.6 |      |
| V <sub>DP_SRC</sub>  | D+ source voltage                               | -          | 0.5  | -   | 3.6 |      |
| V <sub>DM_SRC</sub>  | D- source voltage                               | -          | 0.5  | -   | 3.6 |      |
| I <sub>DM_SINK</sub> | D- sink current                                 | -          | 25   | -   | 175 | μA   |
| I <sub>DP_SINK</sub> | D+ sink current                                 | -          | 25   | -   | 175 |      |
| I <sub>DP_SRC</sub>  | Data contact detect current source              | -          | 7    | -   | 30  |      |

### CAN (controller area network) interface

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output alternate function characteristics (CANx\_TX and CANx\_RX).

### 6.3.30 FMC characteristics

Unless otherwise specified, the parameters given in [Table 93](#) to [Table 106](#) for the FMC interface are derived from tests performed under the ambient temperature,  $f_{HCLK}$  frequency and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Measurement points are done at CMOS levels:  $0.5V_{DD}$

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output characteristics.

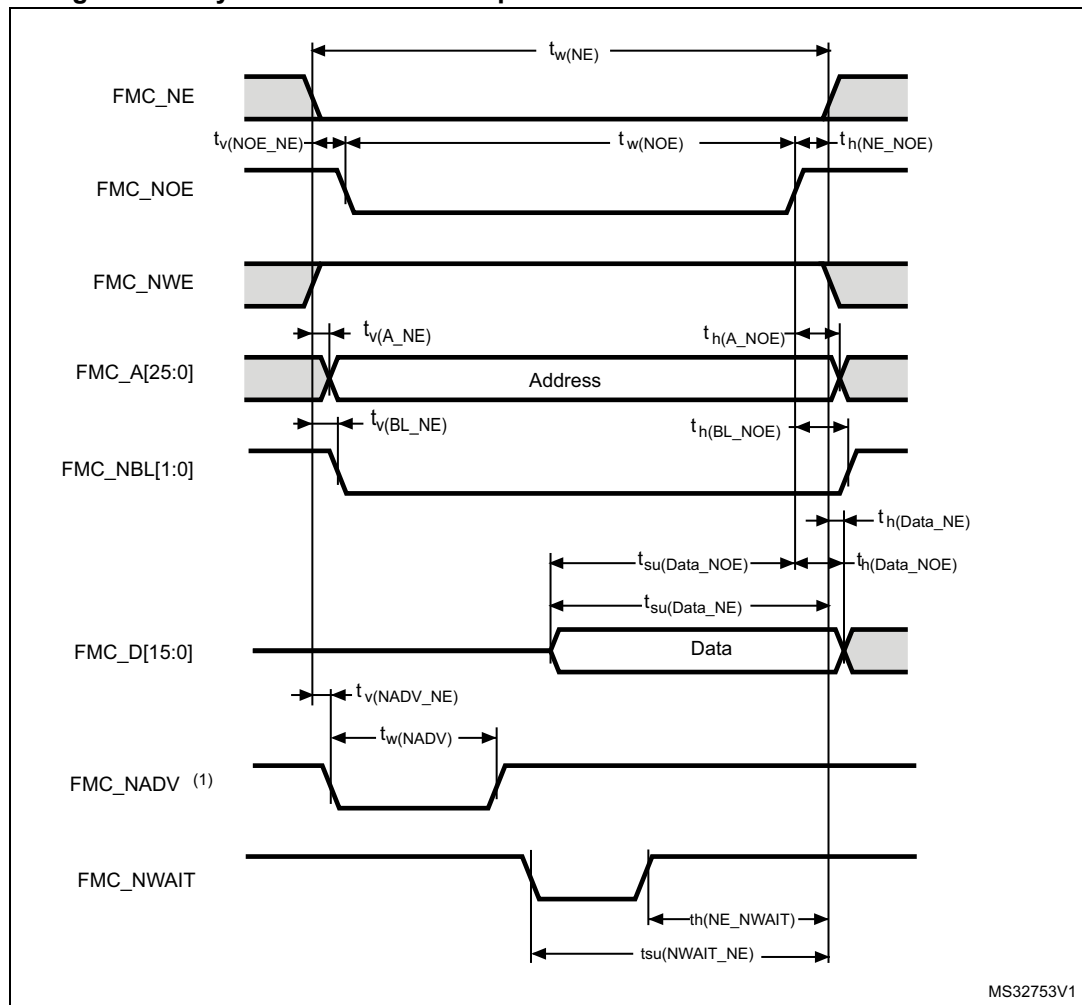
### Asynchronous waveforms and timings

[Figure 62](#) through [Figure 65](#) represent asynchronous waveforms and [Table 93](#) through [Table 100](#) provide the corresponding timings. The results shown in these tables are obtained with the following FMC configuration:

- AddressSetupTime = 0x1
- AddressHoldTime = 0x1
- DataSetupTime = 0x1 (except for asynchronous NWAIT mode, DataSetupTime = 0x5)
- BusTurnAroundDuration = 0x0
- Capacitive load CL = 30 pF

In all timing tables, the  $T_{HCLK}$  is the HCLK clock period

Figure 62. Asynchronous non-multiplexed SRAM/PSRAM/NOR read waveforms



1. Mode 2/B, C and D only. In Mode 1, FMC\_NADV is not used.

**Table 93. Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings<sup>(1)</sup>**

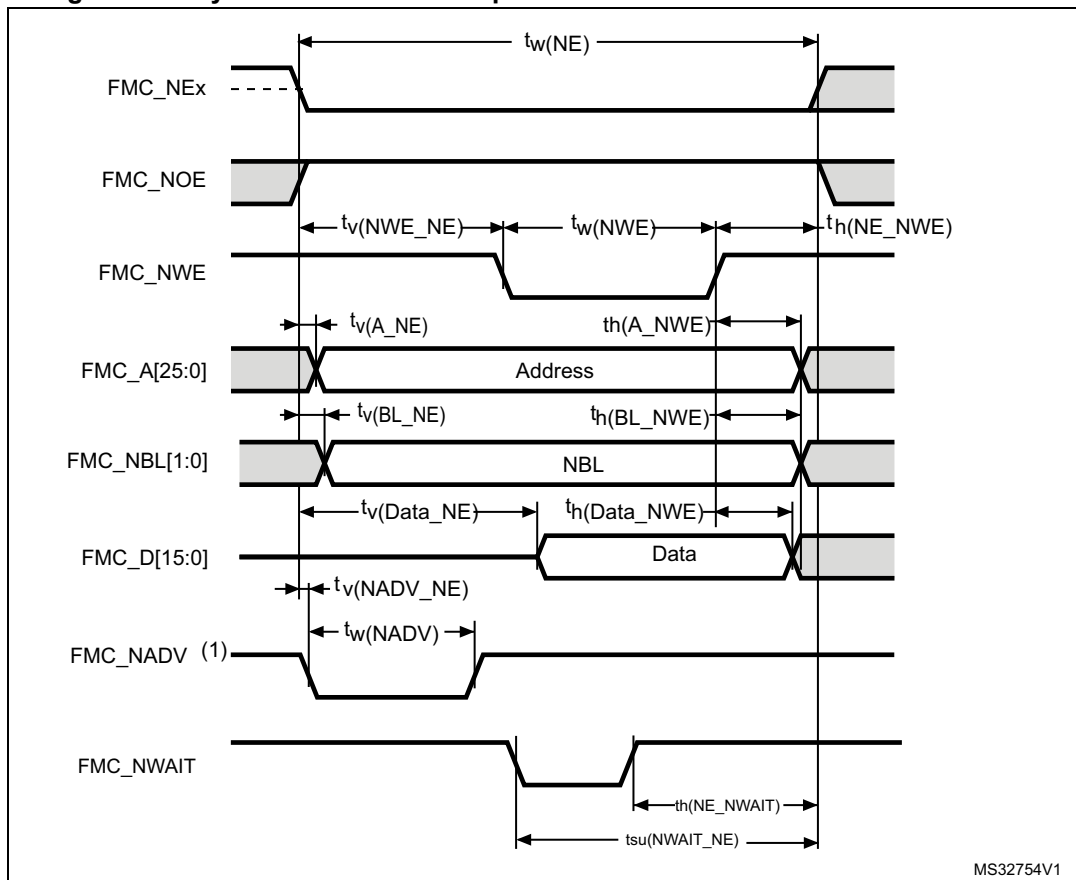
| Symbol              | Parameter                             | Min        | Max        | Unit |
|---------------------|---------------------------------------|------------|------------|------|
| $t_{w(NE)}$         | FMC_NE low time                       | 2Thclk -1  | 2Thclk +1  | ns   |
| $t_{v(NOE\_NE)}$    | FMC_NEx low to FMC_NOE low            | 0          | 0.5        |      |
| $t_{w(NOE)}$        | FMC_NOE low time                      | 2Thclk -1  | 2Thclk +1  |      |
| $t_{h(NE\_NOE)}$    | FMC_NOE high to FMC_NE high hold time | 0          | -          |      |
| $t_{v(A\_NE)}$      | FMC_NEx low to FMC_A valid            | -          | 0.5        |      |
| $t_{h(A\_NOE)}$     | Address hold time after FMC_NOE high  | 0          | -          |      |
| $t_{v(BL\_NE)}$     | FMC_NEx low to FMC_BL valid           | -          | 0.5        |      |
| $t_{h(BL\_NOE)}$    | FMC_BL hold time after FMC_NOE high   | 0          | -          |      |
| $t_{su(Data\_NE)}$  | Data to FMC_NEx high setup time       | Thclk -1.5 | -          |      |
| $t_{su(Data\_NOE)}$ | Data to FMC_NOEx high setup time      | Thclk -1.5 | -          |      |
| $t_{h(Data\_NOE)}$  | Data hold time after FMC_NOE high     | 0          | -          |      |
| $t_{h(Data\_NE)}$   | Data hold time after FMC_NEx high     | 0          | -          |      |
| $t_{v(NADV\_NE)}$   | FMC_NEx low to FMC_NADV low           | -          | 0          |      |
| $t_{w(NADV)}$       | FMC_NADV low time                     | -          | Thclk -0.5 |      |

1.  $C_L = 30$  pF.

**Table 94. Asynchronous non-multiplexed SRAM/PSRAM/NOR read - NWAIT timings<sup>(1)</sup>**

| Symbol              | Parameter                                 | Min         | Max       | Unit |
|---------------------|-------------------------------------------|-------------|-----------|------|
| $t_{w(NE)}$         | FMC_NE low time                           | 7Thclk +1   | 7Thclk +1 | ns   |
| $t_{w(NOE)}$        | FMC_NWE low time                          | 5Thclk -1   | 5Thclk +1 |      |
| $t_{w(NWAIT)}$      | FMC_NWAIT low time                        | Thclk -0.5  | -         |      |
| $t_{su(NWAIT\_NE)}$ | FMC_NWAIT valid before FMC_NEx high       | 5Thclk +1.5 | -         |      |
| $t_{h(NE\_NWAIT)}$  | FMC_NEx hold time after FMC_NWAIT invalid | 4Thclk +1   | -         |      |

1. Guaranteed by characterization results.

**Figure 63. Asynchronous non-multiplexed SRAM/PSRAM/NOR write waveforms**

1. Mode 2/B, C and D only. In Mode 1, FMC\_NADV is not used.

**Table 95. Asynchronous non-multiplexed SRAM/PSRAM/NOR write timings<sup>(1)</sup>**

| Symbol             | Parameter                             | Min         | Max         | Unit |
|--------------------|---------------------------------------|-------------|-------------|------|
| $t_{w(NE)}$        | FMC_NE low time                       | 3Thclk + 1  | 3Thclk + 1  | ns   |
| $t_{v(NWE\_NE)}$   | FMC_NEx low to FMC_NWE low            | Thclk - 0.5 | Thclk + 0.5 |      |
| $t_{w(NWE)}$       | FMC_NWE low time                      | Thclk - 1.5 | Thclk + 0.5 |      |
| $t_{h(NE\_NWE)}$   | FMC_NWE high to FMC_NE high hold time | Thclk       | -           |      |
| $t_{v(A\_NE)}$     | FMC_NEx low to FMC_A valid            | -           | 0           |      |
| $t_{h(A\_NWE)}$    | Address hold time after FMC_NWE high  | Thclk - 0.5 | -           |      |
| $t_{v(BL\_NE)}$    | FMC_NEx low to FMC_BL valid           | -           | 0.5         |      |
| $t_{h(BL\_NWE)}$   | FMC_BL hold time after FMC_NWE high   | Thclk - 0.5 | -           |      |
| $t_{v(Data\_NE)}$  | Data to FMC_NEx low to Data valid     | -           | Thclk + 1.5 |      |
| $t_{h(Data\_NWE)}$ | Data hold time after FMC_NWE high     | Thclk + 0.5 | -           |      |
| $t_{v(NADV\_NE)}$  | FMC_NEx low to FMC_NADV low           | -           | 0           |      |
| $t_{w(NADV)}$      | FMC_NADV low time                     | -           | Thclk - 0.5 |      |

1. Guaranteed by characterization results.

**Table 96. Asynchronous non-multiplexed SRAM/PSRAM/NOR write - NWAIT timings<sup>(1)</sup>**

| Symbol              | Parameter                                 | Min          | Max          | Unit |
|---------------------|-------------------------------------------|--------------|--------------|------|
| $t_{w(NE)}$         | FMC_NE low time                           | 8Thclk - 1   | 8Thclk + 1   | ns   |
| $t_{w(NWE)}$        | FMC_NWE low time                          | 6Thclk - 1.5 | 6Thclk + 0.5 |      |
| $t_{su(NWAIT\_NE)}$ | FMC_NWAIT valid before FMC_NEx high       | 6Thclk - 1   | -            |      |
| $t_{h(NE\_NWAIT)}$  | FMC_NEx hold time after FMC_NWAIT invalid | 4Thclk + 2   | -            |      |

1. Guaranteed by characterization results.

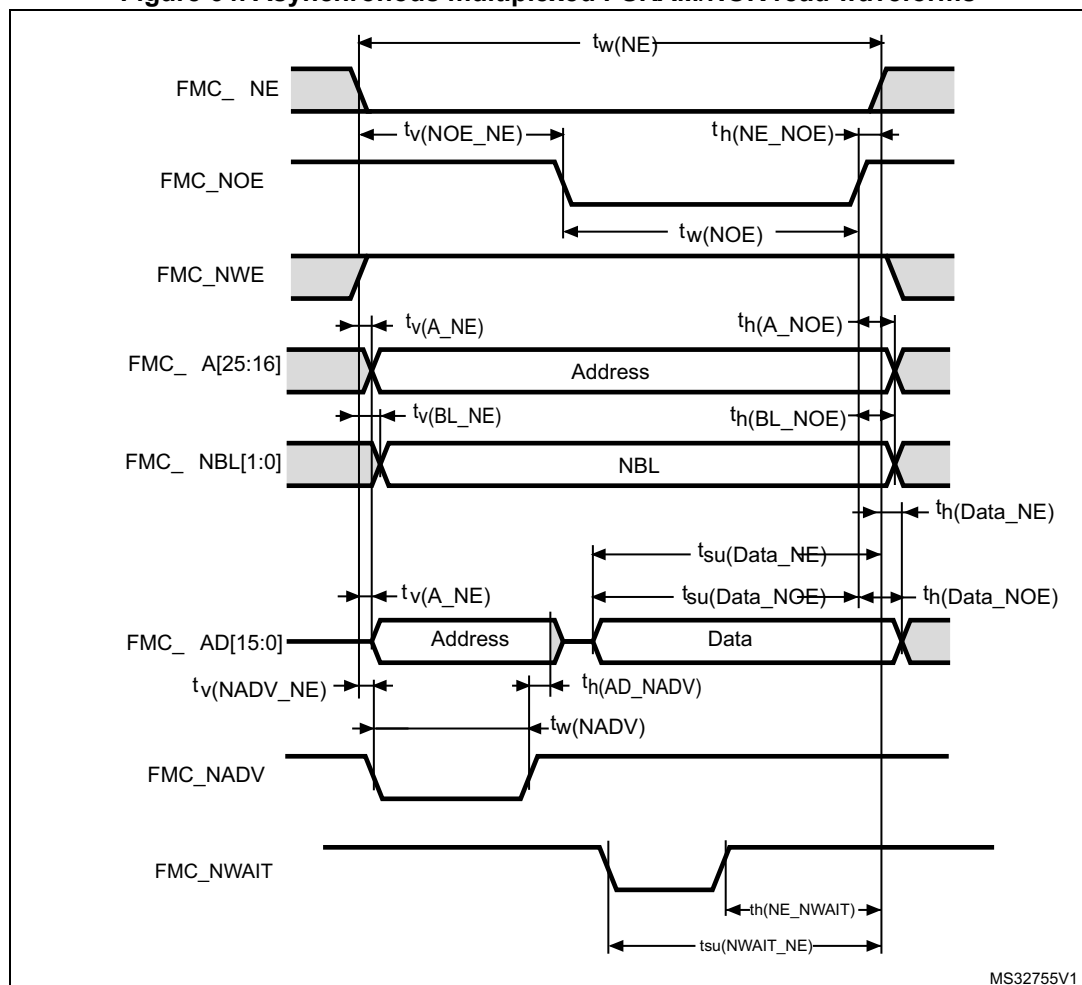
**Figure 64. Asynchronous multiplexed PSRAM/NOR read waveforms**



Table 97. Asynchronous multiplexed PSRAM/NOR read timings<sup>(1)</sup>

| Symbol              | Parameter                                           | Min        | Max         | Unit |
|---------------------|-----------------------------------------------------|------------|-------------|------|
| $t_{w(NE)}$         | FMC_NE low time                                     | 3Thclk -1  | 3Thclk +1   | ns   |
| $t_{v(NOE\_NE)}$    | FMC_NEx low to FMC_NOE low                          | 2Thclk     | 2Thclk +0.5 |      |
| $t_{tw(NOE)}$       | FMC_NOE low time                                    | Thclk -1   | Thclk +1    |      |
| $t_{h(NE\_NOE)}$    | FMC_NOE high to FMC_NE high hold time               | 0          | -           |      |
| $t_{v(A\_NE)}$      | FMC_NEx low to FMC_A valid                          | -          | 0.5         |      |
| $t_{v(NADV\_NE)}$   | FMC_NEx low to FMC_NADV low                         | 0          | 0.5         |      |
| $t_{w(NADV)}$       | FMC_NADV low time                                   | Thclk -0.5 | Thclk +1    |      |
| $t_{h(AD\_NADV)}$   | FMC_AD(address) valid hold time after FMC_NADV high | Thclk +0.5 | -           |      |
| $t_{h(A\_NOE)}$     | Address hold time after FMC_NOE high                | Thclk -0.5 | -           |      |
| $t_{h(BL\_NOE)}$    | FMC_BL time after FMC_NOE high                      | 0          | -           |      |
| $t_{v(BL\_NE)}$     | FMC_NEx low to FMC_BL valid                         | -          | 0.5         |      |
| $t_{su(Data\_NE)}$  | Data to FMC_NEx high setup time                     | Thclk -1.5 | -           |      |
| $t_{su(Data\_NOE)}$ | Data to FMC_NOE high setup time                     | Thclk -1.5 | -           |      |
| $t_{h(Data\_NE)}$   | Data hold time after FMC_NEx high                   | 0          | -           |      |
| $t_{h(Data\_NOE)}$  | Data hold time after FMC_NOE high                   | 0          | -           |      |

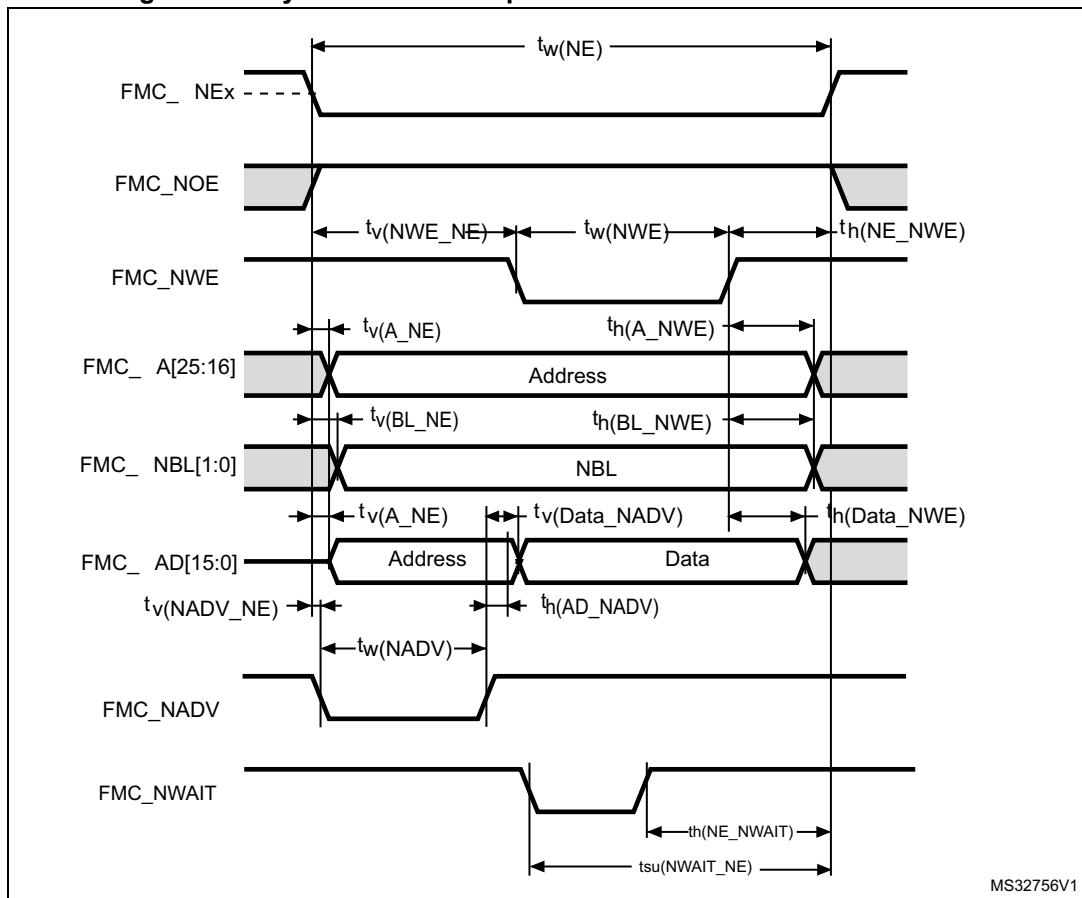
1. Guaranteed by characterization results.

Table 98. Asynchronous multiplexed PSRAM/NOR read-NWAIT timings<sup>(1)</sup>

| Symbol              | Parameter                                 | Min         | Max         | Unit |
|---------------------|-------------------------------------------|-------------|-------------|------|
| $t_{w(NE)}$         | FMC_NE low time                           | 8Thclk -1   | 8Thclk +1   | ns   |
| $t_{w(NOE)}$        | FMC_NWE low time                          | 5Thclk -1.5 | 8Thclk +0.5 |      |
| $t_{su(NWAIT\_NE)}$ | FMC_NWAIT valid before FMC_NEx high       | 5Thclk +1.5 | -           |      |
| $t_{h(NE\_NWAIT)}$  | FMC_NEx hold time after FMC_NWAIT invalid | 4Thclk +1   | -           |      |

1. Guaranteed by characterization results.

Figure 65. Asynchronous multiplexed PSRAM/NOR write waveforms

Table 99. Asynchronous multiplexed PSRAM/NOR write timings<sup>(1)</sup>

| Symbol              | Parameter                                           | Min         | Max         | Unit |
|---------------------|-----------------------------------------------------|-------------|-------------|------|
| $t_{w(NE)}$         | FMC_NE low time                                     | 4Thclk -1   | 4Thclk +1   | ns   |
| $t_{v(NWE\_NE)}$    | FMC_NEx low to FMC_NWE low                          | Thclk -0.5  | Thclk +0.5  |      |
| $t_{w(NWE)}$        | FMC_NWE low time                                    | 2Thclk -0.5 | 2Thclk +0.5 |      |
| $t_{h(NE\_NWE)}$    | FMC_NWE high to FMC_NE high hold time               | Thclk -0.5  | -           |      |
| $t_{v(A\_NE)}$      | FMC_NEx low to FMC_A valid                          | -           | 0           |      |
| $t_{v(NADV\_NE)}$   | FMC_NEx low to FMC_NADV low                         | 0           | 0.5         |      |
| $t_{w(NADV)}$       | FMC_NADV low time                                   | Thclk       | Thclk +1    |      |
| $t_{h(AD\_NADV)}$   | FMC_AD(address) valid hold time after FMC_NADV high | Thclk +0.5  | -           |      |
| $t_{h(A\_NWE)}$     | Address hold time after FMC_NWE high                | Thclk +0.5  | -           |      |
| $t_{h(BL\_NWE)}$    | FMC_BL hold time after FMC_NWE high                 | Thclk -0.5  | -           |      |
| $t_{v(BL\_NE)}$     | FMC_NEx low to FMC_BL valid                         | -           | 0.5         |      |
| $t_{v(Data\_NADV)}$ | FMC_NADV high to Data valid                         | -           | Thclk +1.5  |      |
| $t_{h(Data\_NWE)}$  | Data hold time after FMC_NWE high                   | Thclk +0.5  | -           |      |

1. Guaranteed by characterization results.

**Table 100. Asynchronous multiplexed PSRAM/NOR write-NWAIT timings<sup>(1)</sup>**

| Symbol              | Parameter                                 | Min          | Max          | Unit |
|---------------------|-------------------------------------------|--------------|--------------|------|
| $t_{w(NE)}$         | FMC_NE low time                           | 9Thclk - 1   | 9Thclk + 1   | ns   |
| $t_{w(NWE)}$        | FMC_NWE low time                          | 7Thclk - 0.5 | 7Thclk + 0.5 |      |
| $t_{su(NWAIT\_NE)}$ | FMC_NWAIT valid before FMC_NEx high       | 6Thclk + 2   | -            |      |
| $t_{h(NE\_NWAIT)}$  | FMC_NEx hold time after FMC_NWAIT invalid | 4Thclk - 1   | -            |      |

1. Guaranteed by characterization results.

### Synchronous waveforms and timings

*Figure 66* through *Figure 69* represent synchronous waveforms and *Table 101* through *Table 104* provide the corresponding timings. The results shown in these tables are obtained with the following FMC configuration:

- BurstAccessMode = FMC\_BurstAccessMode\_Enable;
- MemoryType = FMC\_MemoryType\_CRAM;
- WriteBurst = FMC\_WriteBurst\_Enable;
- CLKDivision = 1;
- DataLatency = 1 for NOR Flash; DataLatency = 0 for PSRAM
- CL = 30 pF on data and address lines. CL = 10 pF on FMC\_CLK unless otherwise specified.

In all timing tables, the  $T_{HCLK}$  is the HCLK clock period.

- For  $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ , maximum FMC\_CLK = 108 MHz at CL=20 pF or 90 MHz at CL=30 pF (on FMC\_CLK).
- For  $1.71\text{ V} \leq V_{DD} < 2.7\text{ V}$ , maximum FMC\_CLK = 70 MHz at CL=10 pF (on FMC\_CLK).

The diagram illustrates the timing relationships for FMC signals. Key parameters shown include:

- $t_w(\text{CLK})$ : Clock pulse width.
- $t_d(\text{CLKL-NEXL})$ ,  $t_d(\text{CLKH-NEXH})$ : Data setup and hold times for FMC\_NEX.
- $t_d(\text{CLKL-NADVL})$ ,  $t_d(\text{CLKL-NADVH})$ : Data setup and hold times for FMC\_NADV.
- $t_d(\text{CLKL-AV})$ ,  $t_d(\text{CLKH-AIV})$ : Data setup and hold times for FMC\_A[25:16].
- $t_d(\text{CLKL-NOEL})$ ,  $t_d(\text{CLKH-NOEH})$ : Data setup and hold times for FMC\_NOE.
- $t_d(\text{CLKL-ADIV})$ ,  $t_d(\text{CLKH-ADV})$ : Data setup and hold times for FMC\_AD[15:0].
- $t_{su}(\text{ADV-CLKH})$ ,  $t_h(\text{CLKH-ADV})$ : Address setup and hold times for FMC\_AD[15:0].
- $t_{su}(\text{NWAIT-TV-CLKH})$ ,  $t_h(\text{CLKH-NWAITTV})$ : Wait setup and hold times for FMC\_NWAIT.

Additional labels include  $\text{BUSTURN} = 0$  and  $\text{Data latency} = 0$ .

Table 101. Synchronous multiplexed NOR/PSRAM read timings<sup>(1)</sup>

| Symbol               | Parameter                                     | Min               | Max | Unit |
|----------------------|-----------------------------------------------|-------------------|-----|------|
| $t_{w(CLK)}$         | FMC_CLK period                                | $2T_{hclk} - 0.5$ | -   | ns   |
| $t_{d(CLKL-NEXL)}$   | FMC_CLK low to FMC_NEx low ( $x=0..2$ )       | -                 | 2   |      |
| $t_{d(CLKH-NEXH)}$   | FMC_CLK high to FMC_NEx high ( $x=0..2$ )     | $T_{hclk} + 0.5$  | -   |      |
| $t_{d(CLKL-NADV L)}$ | FMC_CLK low to FMC_NADV low                   | -                 | 1   |      |
| $t_{d(CLKL-NADV H)}$ | FMC_CLK low to FMC_NADV high                  | 0                 | -   |      |
| $t_{d(CLKL-AV)}$     | FMC_CLK low to FMC_Ax valid ( $x=16..25$ )    | -                 | 3   |      |
| $t_{d(CLKH-AIV)}$    | FMC_CLK high to FMC_Ax invalid ( $x=16..25$ ) | $T_{hclk}$        | -   |      |
| $t_{d(CLKL-NOEL)}$   | FMC_CLK low to FMC_NOE low                    | -                 | 2   |      |
| $t_{d(CLKH-NOEH)}$   | FMC_CLK high to FMC_NOE high                  | $T_{hclk} - 0.5$  | -   |      |
| $t_{d(CLKL-ADV)}$    | FMC_CLK low to FMC_AD[15:0] valid             | -                 | 2   |      |
| $t_{d(CLKL-ADIV)}$   | FMC_CLK low to FMC_AD[15:0] invalid           | 0                 | -   |      |
| $t_{su(ADV-CLKH)}$   | FMC_A/D[15:0] valid data before FMC_CLK high  | 0.5               | -   |      |
| $t_h(CLKH-ADV)$      | FMC_A/D[15:0] valid data after FMC_CLK high   | 4                 | -   |      |
| $t_{su(NWAIT-CLKH)}$ | FMC_NWAIT valid before FMC_CLK high           | 2                 | -   |      |
| $t_h(CLKH-NWAIT)$    | FMC_NWAIT valid after FMC_CLK high            | 3                 | -   |      |

1. Guaranteed by characterization results.

Figure 67. Synchronous multiplexed PSRAM write timings

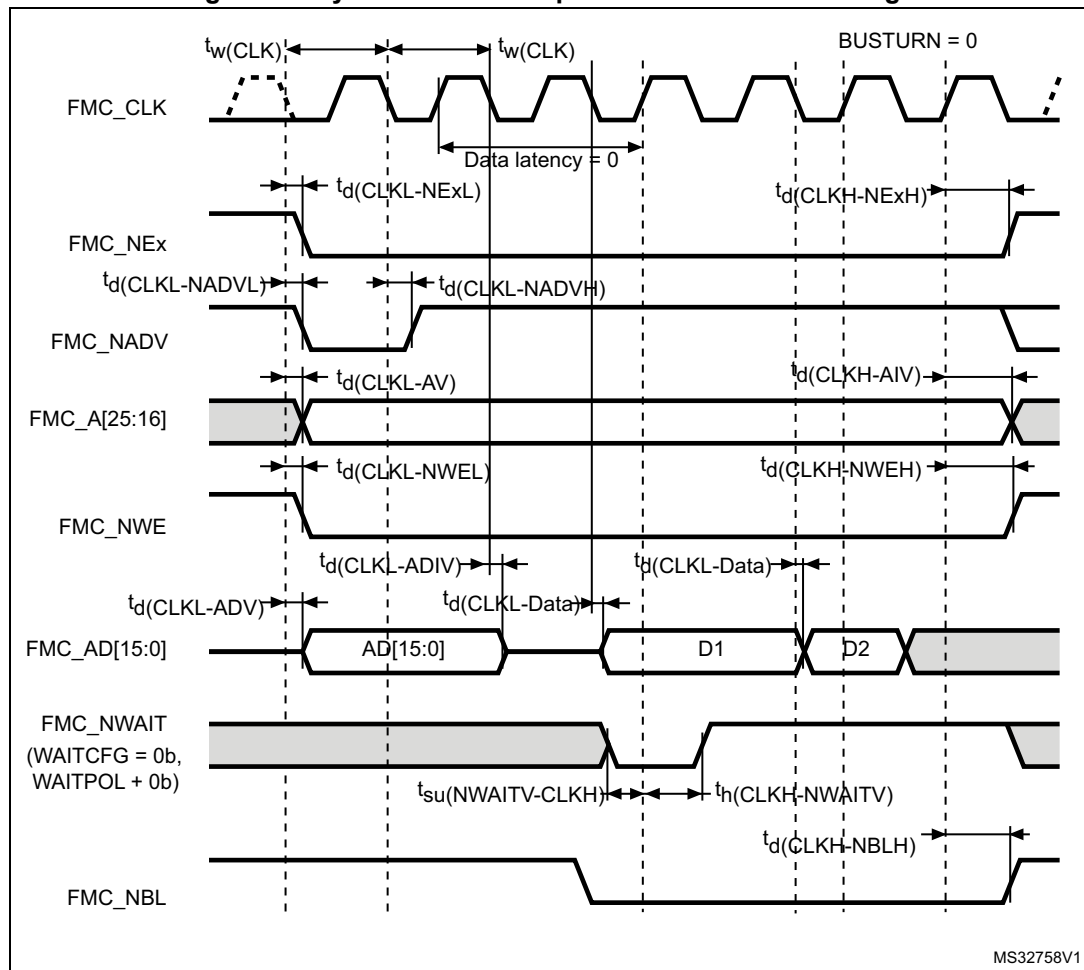
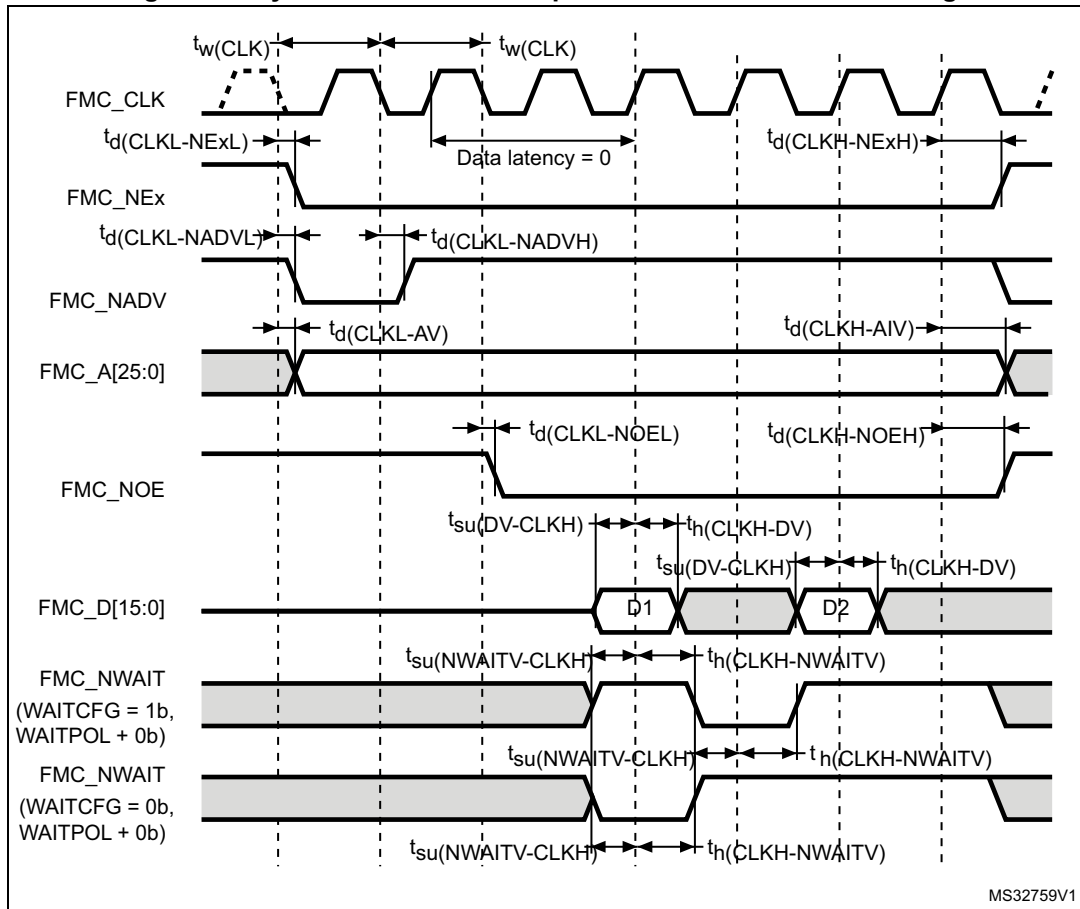


Table 102. Synchronous multiplexed PSRAM write timings<sup>(1)</sup>

| Symbol               | Parameter                                     | Min            | Max | Unit |
|----------------------|-----------------------------------------------|----------------|-----|------|
| $t_{w(CLK)}$         | FMC_CLK period                                | $2Thclk - 0.5$ | -   | ns   |
| $t_{d(CLKL-NExL)}$   | FMC_CLK low to FMC_NEx low ( $x=0..2$ )       | -              | 2   |      |
| $t_{d(CLKH-NExH)}$   | FMC_CLK high to FMC_NEx high ( $x=0..2$ )     | $Thclk + 0.5$  | -   |      |
| $t_{d(CLKL-NADV_L)}$ | FMC_CLK low to FMC_NADV low                   | -              | 1   |      |
| $t_{d(CLKL-NADV_H)}$ | FMC_CLK low to FMC_NADV high                  | 0              | -   |      |
| $t_{d(CLKL-AV)}$     | FMC_CLK low to FMC_Ax valid ( $x=16..25$ )    | -              | 3   |      |
| $t_{d(CLKH-AIV)}$    | FMC_CLK high to FMC_Ax invalid ( $x=16..25$ ) | $Thclk$        | -   |      |
| $t_{d(CLKL-NWEL)}$   | FMC_CLK low to FMC_NWE low                    | -              | 1.5 |      |
| $t_{d(CLKH-NWEH)}$   | FMC_CLK high to FMC_NWE high                  | $Thclk + 0.5$  | -   |      |
| $t_{d(CLKL-ADV)}$    | FMC_CLK low to FMC_AD[15:0] valid             | -              | 3   |      |
| $t_{d(CLKL-ADIV)}$   | FMC_CLK low to FMC_AD[15:0] invalid           | 0              | -   |      |
| $t_{d(CLKL-DATA)}$   | FMC_A/D[15:0] valid data after FMC_CLK low    | -              | 3   |      |
| $t_{d(CLKL-NBL_L)}$  | FMC_CLK low to FMC_NBL low                    | -              | 2   |      |
| $t_{d(CLKH-NBL_H)}$  | FMC_CLK high to FMC_NBL high                  | $Thclk + 0.5$  | -   |      |
| $t_{su(NWAIT-CLKH)}$ | FMC_NWAIT valid before FMC_CLK high           | 2              | -   |      |
| $t_h(CLKH-NWAIT)$    | FMC_NWAIT valid after FMC_CLK high            | 3              | -   |      |

1. Guaranteed by characterization results.

Figure 68. Synchronous non-multiplexed NOR/PSRAM read timings

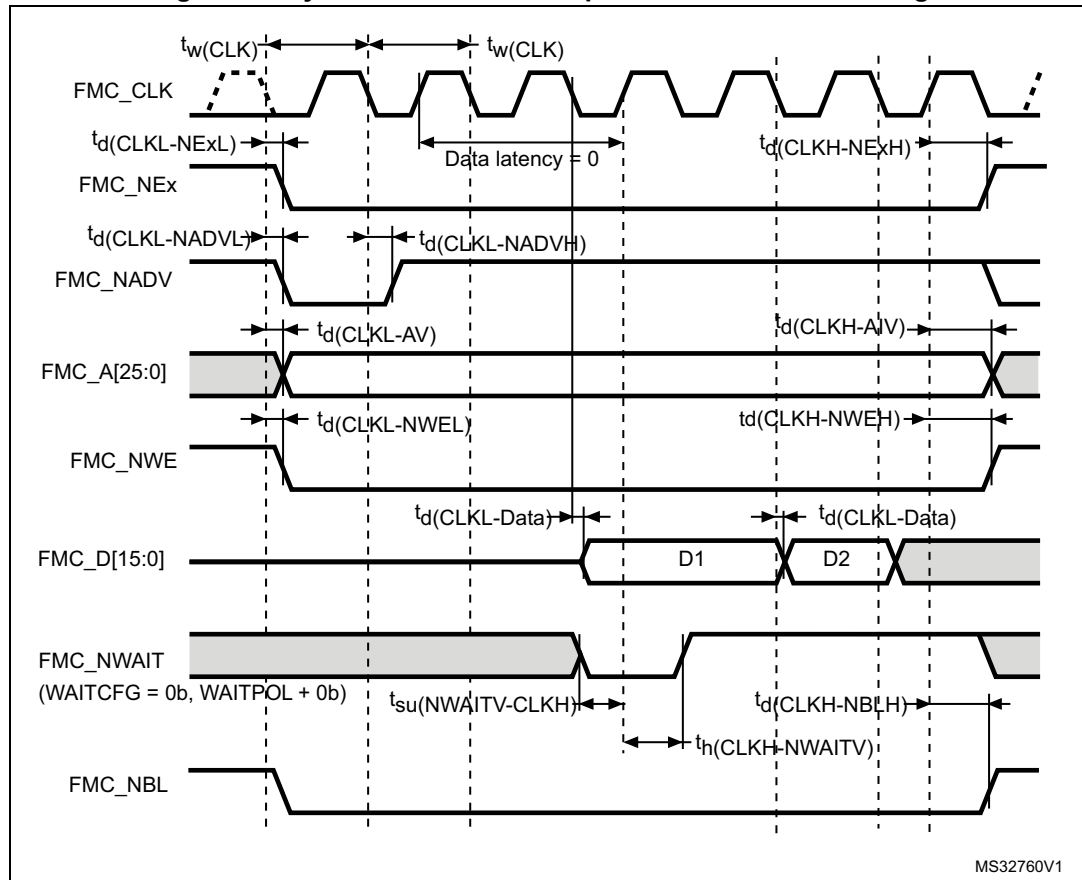
Table 103. Synchronous non-multiplexed NOR/PSRAM read timings<sup>(1)</sup>

| Symbol                              | Parameter                                     | Min                      | Max | Unit |
|-------------------------------------|-----------------------------------------------|--------------------------|-----|------|
| $t_w(\text{CLK})$                   | FMC_CLK period                                | $2T_{\text{HCLK}} - 0.5$ | -   | ns   |
| $t_{\text{d}}(\text{CLKL-NExL})$    | FMC_CLK low to FMC_NEx low ( $x=0..2$ )       | -                        | 2   |      |
| $t_{\text{d}}(\text{CLKH-NExH})$    | FMC_CLK high to FMC_NEx high ( $x=0..2$ )     | $T_{\text{HCLK}} + 0.5$  | -   |      |
| $t_{\text{d}}(\text{CLKL-NADV})$    | FMC_CLK low to FMC_NADV low                   | -                        | 0.5 |      |
| $t_{\text{d}}(\text{CLKL-NADVH})$   | FMC_CLK low to FMC_NADV high                  | 0                        | -   |      |
| $t_{\text{d}}(\text{CLKL-AV})$      | FMC_CLK low to FMC_Ax valid ( $x=16..25$ )    | -                        | 3   |      |
| $t_{\text{d}}(\text{CLKH-AIV})$     | FMC_CLK high to FMC_Ax invalid ( $x=16..25$ ) | $T_{\text{HCLK}}$        | -   |      |
| $t_{\text{d}}(\text{CLKL-NOEL})$    | FMC_CLK low to FMC_NOE low                    | -                        | 2   |      |
| $t_{\text{d}}(\text{CLKH-NOEH})$    | FMC_CLK high to FMC_NOE high                  | $T_{\text{HCLK}} - 0.5$  | -   |      |
| $t_{\text{su}}(\text{DV-CLKH})$     | FMC_D[15:0] valid data before FMC_CLK high    | 0.5                      | -   |      |
| $t_{\text{h}}(\text{CLKH-DV})$      | FMC_D[15:0] valid data after FMC_CLK high     | 4                        | -   |      |
| $t_{\text{su}}(\text{NWAITV-CLKH})$ | FMC_NWAIT valid before FMC_CLK high           | 2                        | -   |      |
| $t_{\text{h}}(\text{CLKH-NWAITV})$  | FMC_NWAIT valid after FMC_CLK high            | 3                        | -   |      |



1. Guaranteed by characterization results.

**Figure 69. Synchronous non-multiplexed PSRAM write timings**



**Table 104. Synchronous non-multiplexed PSRAM write timings<sup>(1)</sup>**

| Symbol                      | Parameter                                     | Min                      | Max | Unit |
|-----------------------------|-----------------------------------------------|--------------------------|-----|------|
| $t_{\text{CLK}}$            | FMC_CLK period                                | $2T_{\text{HCLK}} - 0.5$ | -   | ns   |
| $t_{\text{d(CLKL-NExL)}}$   | FMC_CLK low to FMC_NEx low ( $x=0..2$ )       | -                        | 2   |      |
| $t_{\text{d(CLKH-NExH)}}$   | FMC_CLK high to FMC_NEx high ( $x=0..2$ )     | $T_{\text{HCLK}} + 0.5$  | -   |      |
| $t_{\text{d(CLKL-NADV L)}}$ | FMC_CLK low to FMC_NADV low                   | -                        | 0.5 |      |
| $t_{\text{d(CLKL-NADV H)}}$ | FMC_CLK low to FMC_NADV high                  | 0                        | -   |      |
| $t_{\text{d(CLKL-AV)}}$     | FMC_CLK low to FMC_Ax valid ( $x=16..25$ )    | -                        | 3   |      |
| $t_{\text{d(CLKH-AIV)}}$    | FMC_CLK high to FMC_Ax invalid ( $x=16..25$ ) | $T_{\text{HCLK}}$        | -   |      |
| $t_{\text{d(CLKL-NWEL)}}$   | FMC_CLK low to FMC_NWE low                    | -                        | 1.5 |      |
| $t_{\text{d(CLKH-NWEH)}}$   | FMC_CLK high to FMC_NWE high                  | $T_{\text{HCLK}} + 1$    | -   |      |
| $t_{\text{d(CLKL-Data)}}$   | FMC_D[15:0] valid data after FMC_CLK low      | -                        | 3   |      |
| $t_{\text{d(CLKL-NBLL)}}$   | FMC_CLK low to FMC_NBL low                    | -                        | 2   |      |
| $t_{\text{d(CLKH-NBLH)}}$   | FMC_CLK high to FMC_NBL high                  | $T_{\text{HCLK}} + 1$    | -   |      |
| $t_{\text{su(NWAIT-CLKH)}}$ | FMC_NWAIT valid before FMC_CLK high           | 2                        | -   |      |
| $t_{\text{h(CLKH-NWAIT)}}$  | FMC_NWAIT valid after FMC_CLK high            | 3.5                      | -   |      |

1. Guaranteed by characterization results.

### NAND controller waveforms and timings

Figure 70 through Figure 73 represent synchronous waveforms, and Table 105 and Table 106 provide the corresponding timings. The results shown in this table are obtained with the following FMC configuration:

- COM.FMC\_SetupTime = 0x01
- COM.FMC\_WaitSetupTime = 0x03
- COM.FMC\_HoldSetupTime = 0x02
- COM.FMC\_HiZSetupTime = 0x01
- ATT.FMC\_SetupTime = 0x01
- ATT.FMC\_WaitSetupTime = 0x03
- ATT.FMC\_HoldSetupTime = 0x02
- ATT.FMC\_HiZSetupTime = 0x01
- Bank = FMC\_Bank\_NAND
- MemoryDataWidth = FMC\_MemoryDataWidth\_16b
- ECC = FMC\_ECC\_Enable
- ECCPageSize = FMC\_ECCPageSize\_512Bytes
- TCLRSetupTime = 0
- TARSetupTime = 0

In all timing tables, the  $T_{\text{HCLK}}$  is the HCLK clock period.

Figure 70. NAND controller waveforms for read access

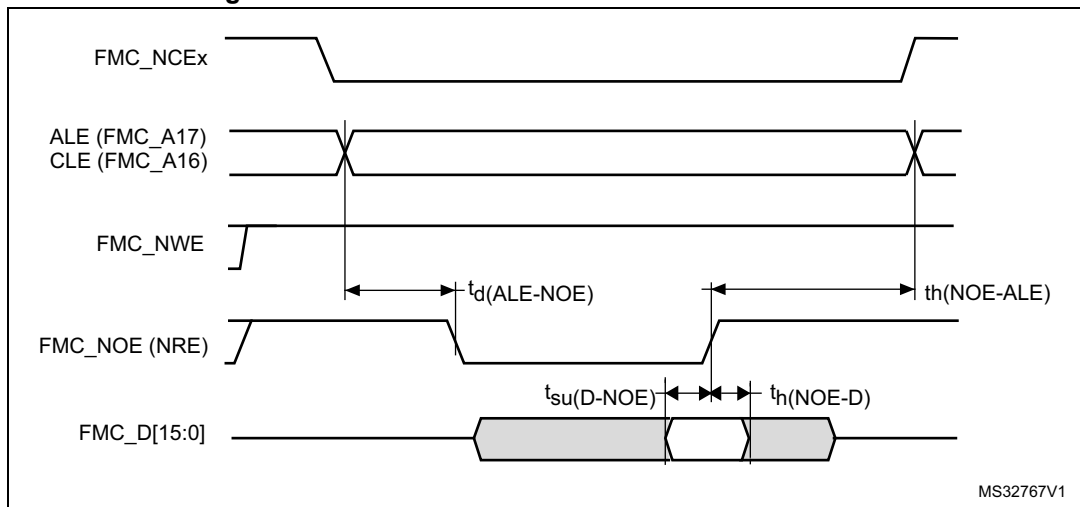


Figure 71. NAND controller waveforms for write access

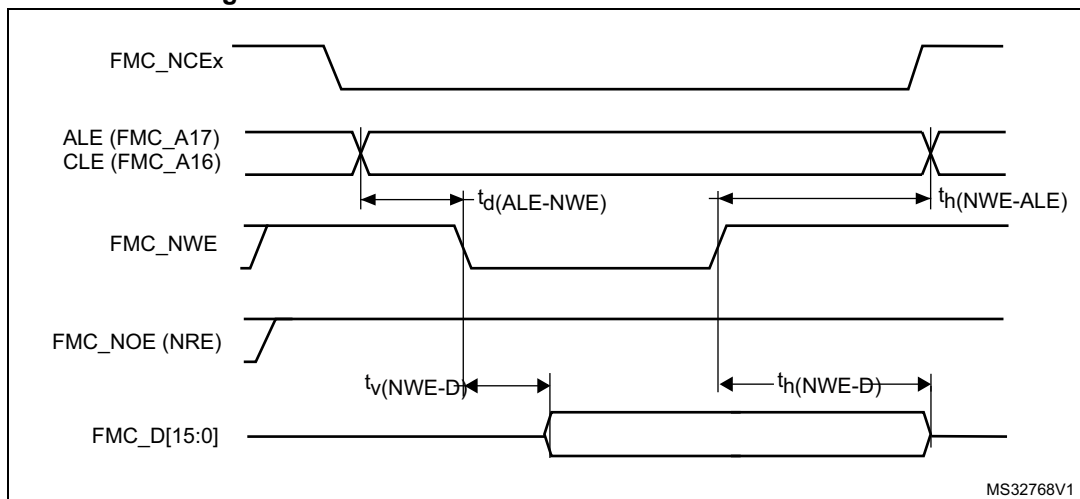
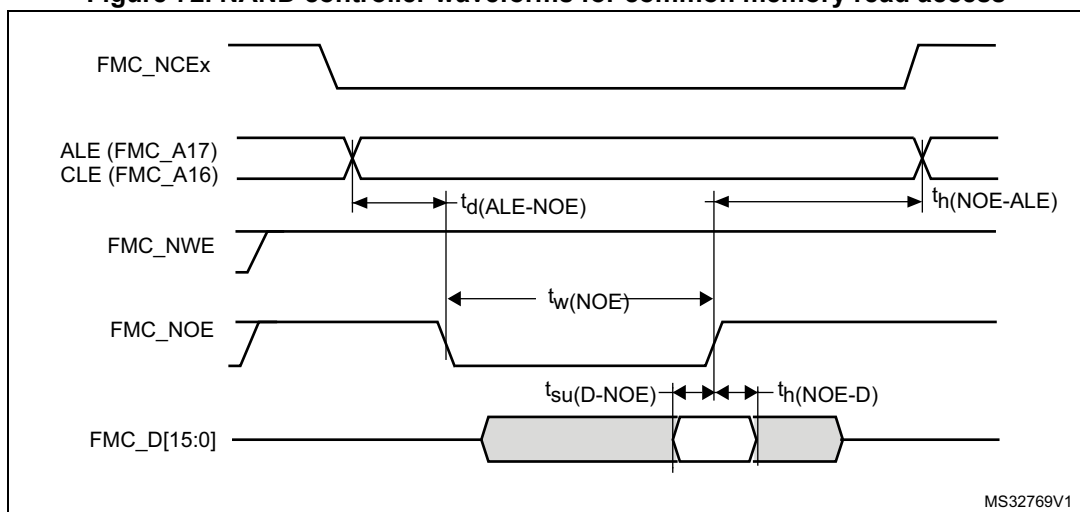
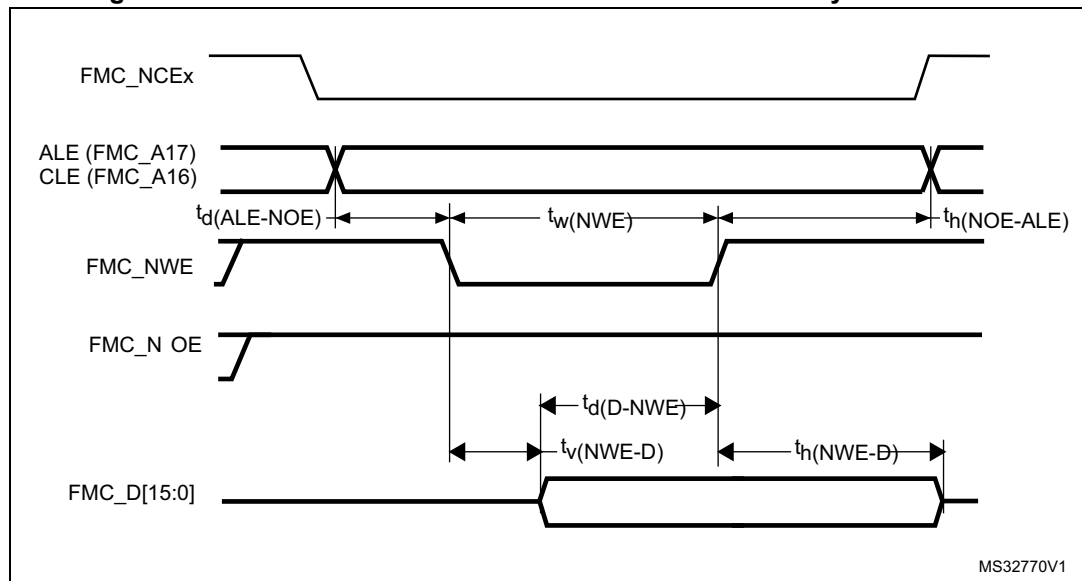


Figure 72. NAND controller waveforms for common memory read access



**Figure 73. NAND controller waveforms for common memory write access****Table 105. Switching characteristics for NAND Flash read cycles<sup>(1)</sup>**

| Symbol           | Parameter                                  | Min          | Max          | Unit |
|------------------|--------------------------------------------|--------------|--------------|------|
| $t_{w(NOE)}$     | FMC_NOE low width                          | 4Thclk - 0.5 | 4Thclk + 0.5 | ns   |
| $t_{su(D-NOE)}$  | FMC_D[15-0] valid data before FMC_NOE high | 11           | -            |      |
| $t_{h(NOE-D)}$   | FMC_D[15-0] valid data after FMC_NOE high  | 0            | -            |      |
| $t_d(ALE-NOE)$   | FMC_ALE valid before FMC_NOE low           | -            | 3Thclk + 1.5 |      |
| $t_{h(NOE-ALE)}$ | FMC_NWE high to FMC_ALE invalid            | 4Thclk - 2   | -            |      |

1. Guaranteed by characterization results.

**Table 106. Switching characteristics for NAND Flash write cycles<sup>(1)</sup>**

| Symbol           | Parameter                             | Min          | Max          | Unit |
|------------------|---------------------------------------|--------------|--------------|------|
| $t_{w(NWE)}$     | FMC_NWE low width                     | 4Thclk - 0.5 | 4Thclk + 0.5 | ns   |
| $t_{v(NWE-D)}$   | FMC_NWE low to FMC_D[15-0] valid      | 0            | -            |      |
| $t_{h(NWE-D)}$   | FMC_NWE high to FMC_D[15-0] invalid   | 2Thclk - 1   | -            |      |
| $t_d(D-NWE)$     | FMC_D[15-0] valid before FMC_NWE high | 5Thclk - 1   | -            |      |
| $t_d(ALE-NWE)$   | FMC_ALE valid before FMC_NWE low      | -            | 3Thclk + 1.5 |      |
| $t_{h(NWE-ALE)}$ | FMC_NWE high to FMC_ALE invalid       | 2Thclk - 2   | -            |      |

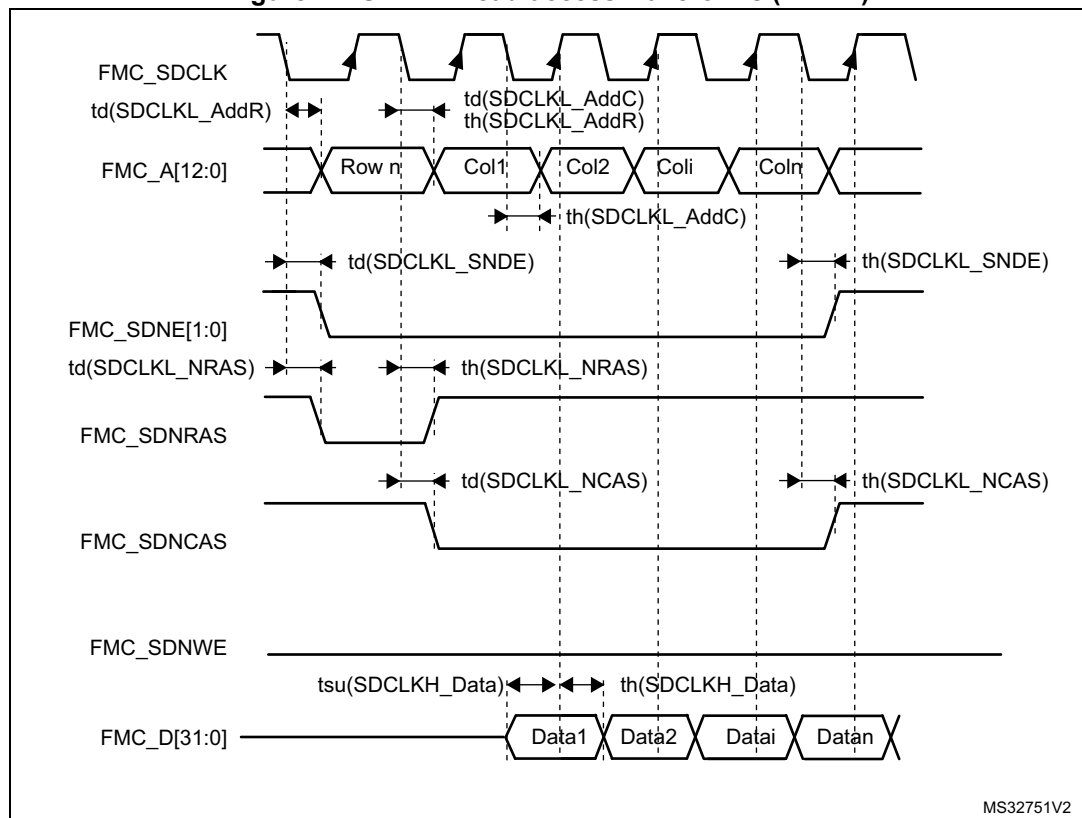
1. Guaranteed by characterization results.

**SDRAM waveforms and timings**

- CL = 30 pF on data and address lines. CL = 10 pF on FMC\_SDCLK unless otherwise specified.

In all timing tables, the  $T_{HCLK}$  is the HCLK clock period.

- For  $3.0\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ , maximum FMC\_SDCLK = 100 MHz at CL=20 pF (on FMC\_SDCLK).
- For  $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ , maximum FMC\_SDCLK = 90 MHz at CL=30 pF (on FMC\_SDCLK).
- For  $1.71\text{ V} \leq V_{DD} < 1.9\text{ V}$ , maximum FMC\_SDCLK = 70 MHz at CL=10 pF (on FMC\_SDCLK).

**Figure 74. SDRAM read access waveforms (CL = 1)**

**Table 107. SDRAM read timings<sup>(1)</sup>**

| Symbol                  | Parameter              | Min         | Max         | Unit |
|-------------------------|------------------------|-------------|-------------|------|
| $t_{w(SDCLK)}$          | FMC_SDCLK period       | 2Thclk -0.5 | 2Thclk +0.5 | ns   |
| $t_{su(SDCLKH\_Data)}$  | Data input setup time  | 1.5         | -           |      |
| $t_{h(SDCLKH\_Data)}$   | Data input hold time   | 2           | -           |      |
| $t_{d(SDCLKL\_Add)}$    | Address valid time     | -           | 1.5         |      |
| $t_{d(SDCLKL\_SDNE)}$   | Chip select valid time | -           | 1.5         |      |
| $t_{h(SDCLKL\_SDNE)}$   | Chip select hold time  | 0.5         | -           |      |
| $t_{d(SDCLKL\_SDNRAS)}$ | SDNRAS valid time      | -           | 1           |      |
| $t_{h(SDCLKL\_SDNRAS)}$ | SDNRAS hold time       | 0.5         | -           |      |
| $t_{d(SDCLKL\_SDNCAS)}$ | SDNCAS valid time      | -           | 1.5         |      |
| $t_{h(SDCLKL\_SDNCAS)}$ | SDNCAS hold time       | 0           | -           |      |

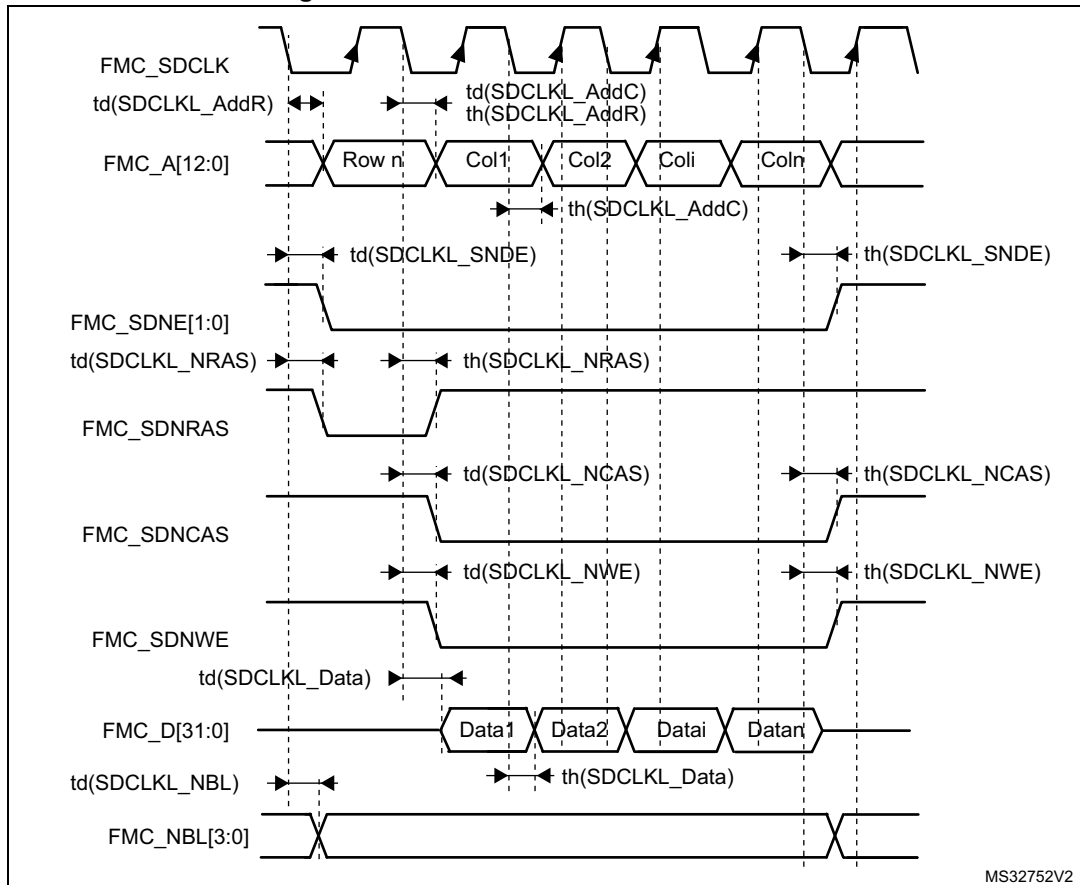
1. Guaranteed by characterization results.

**Table 108. LPSPDR SDRAM read timings<sup>(1)</sup>**

| Symbol                  | Parameter              | Min         | Max         | Unit |
|-------------------------|------------------------|-------------|-------------|------|
| $t_{w(SDCLK)}$          | FMC_SDCLK period       | 2Thclk -0.5 | 2Thclk +0.5 | ns   |
| $t_{su(SDCLKH\_Data)}$  | Data input setup time  | 0           | -           |      |
| $t_{h(SDCLKH\_Data)}$   | Data input hold time   | 4.5         | -           |      |
| $t_{d(SDCLKL\_Add)}$    | Address valid time     | -           | 1.5         |      |
| $t_{d(SDCLKL\_SDNE)}$   | Chip select valid time | -           | 1.5         |      |
| $t_{h(SDCLKL\_SDNE)}$   | Chip select hold time  | 0           | -           |      |
| $t_{d(SDCLKL\_SDNRAS)}$ | SDNRAS valid time      | -           | 0.5         |      |
| $t_{h(SDCLKL\_SDNRAS)}$ | SDNRAS hold time       | 0           | -           |      |
| $t_{d(SDCLKL\_SDNCAS)}$ | SDNCAS valid time      | -           | 1.5         |      |
| $t_{h(SDCLKL\_SDNCAS)}$ | SDNCAS hold time       | 0           | -           |      |

1. Guaranteed by characterization results.

Figure 75. SDRAM write access waveforms

Table 109. SDRAM write timings<sup>(1)</sup>

| Symbol                       | Parameter              | Min               | Max               | Unit |
|------------------------------|------------------------|-------------------|-------------------|------|
| $t_w(\text{SDCLK})$          | FMC_SDCLK period       | $2T_{hclk} - 0.5$ | $2T_{hclk} + 0.5$ | ns   |
| $t_d(\text{SDCLKL\_Data})$   | Data output valid time | -                 | 1.5               |      |
| $t_h(\text{SDCLKL\_Data})$   | Data output hold time  | 0                 | -                 |      |
| $t_d(\text{SDCLKL\_Add})$    | Address valid time     | -                 | 1.5               |      |
| $t_d(\text{SDCLKL\_SDNWE})$  | SDNWE valid time       | -                 | 1.5               |      |
| $t_h(\text{SDCLKL\_SDNWE})$  | SDNWE hold time        | 0.5               | -                 |      |
| $t_d(\text{SDCLKL\_SDNE})$   | Chip select valid time | -                 | 1.5               |      |
| $t_h(\text{SDCLKL\_SDNE})$   | Chip select hold time  | 0.5               | -                 |      |
| $t_d(\text{SDCLKL\_SDNRAS})$ | SDNRAS valid time      | -                 | 1                 |      |
| $t_h(\text{SDCLKL\_SDNRAS})$ | SDNRAS hold time       | 0.5               | -                 |      |
| $t_d(\text{SDCLKL\_SDNCAS})$ | SDNCAS valid time      | -                 | 1.5               |      |
| $t_d(\text{SDCLKL\_SDNCAS})$ | SDNCAS hold time       | 0.5               | -                 |      |

1. Guaranteed by characterization results.

Table 110. LPDDR SDRAM write timings<sup>(1)</sup>

| Symbol                 | Parameter              | Min               | Max               | Unit |
|------------------------|------------------------|-------------------|-------------------|------|
| $t_{w(SDCLK)}$         | FMC_SDCLK period       | $2T_{hclk} - 0.5$ | $2T_{hclk} + 0.5$ | ns   |
| $t_{d(SDCLKL\_Data)}$  | Data output valid time | -                 | 2                 |      |
| $t_{h(SDCLKL\_Data)}$  | Data output hold time  | 0                 | -                 |      |
| $t_{d(SDCLKL\_Add)}$   | Address valid time     | -                 | 1.5               |      |
| $t_{d(SDCLKL-SDNWE)}$  | SDNWE valid time       | -                 | 1.5               |      |
| $t_{h(SDCLKL-SDNWE)}$  | SDNWE hold time        | 0                 | -                 |      |
| $t_{d(SDCLKL-SDNE)}$   | Chip select valid time | -                 | 0.5               |      |
| $t_{h(SDCLKL-SDNE)}$   | Chip select hold time  | 0.                | -                 |      |
| $t_{d(SDCLKL-SDNRAS)}$ | SDNRAS valid time      | -                 | 2                 |      |
| $t_{h(SDCLKL-SDNRAS)}$ | SDNRAS hold time       | 0                 | -                 |      |
| $t_{d(SDCLKL-SDNCAS)}$ | SDNCAS valid time      | -                 | 2                 |      |
| $t_{d(SDCLKL-SDNCAS)}$ | SDNCAS hold time       | 0                 | -                 |      |

1. Guaranteed by characterization results.

### 6.3.31 Quad-SPI interface characteristics

Unless otherwise specified, the parameters given in [Table 111](#) and [Table 112](#) for Quad-SPI are derived from tests performed under the ambient temperature,  $f_{AHB}$  frequency and  $V_{DD}$  supply voltage conditions summarized in [Table 16: General operating conditions](#), with the following configuration:

- Output speed is set to  $OSPEEDRy[1:0] = 11$
- Capacitive load  $C = 20$  pF
- Measurement points are done at CMOS levels:  $0.5 \times V_{DD}$

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output alternate function characteristics.

Table 111. Quad-SPI characteristics in SDR mode<sup>(1)</sup>

| Symbol          | Parameter                | Conditions                              | Min | Typ | Max | Unit |
|-----------------|--------------------------|-----------------------------------------|-----|-----|-----|------|
| $F_{ck1/t(CK)}$ | Quad-SPI clock frequency | $2.7 V \leq V_{DD} < 3.6 V$<br>CL=20 pF | -   | -   | 108 | MHz  |
|                 |                          | $1.71 V < V_{DD} < 3.6 V$<br>CL=15 pF   | -   | -   | 100 |      |



Table 111. Quad-SPI characteristics (continued) in SDR mode<sup>(1)</sup> (continued)

| Symbol  | Parameter                        | Conditions                | Min             | Typ | Max             | Unit |
|---------|----------------------------------|---------------------------|-----------------|-----|-----------------|------|
| tw(CKH) | Quad-SPI clock high and low time | -                         | $t(CK)/2 - 0.5$ | -   | $t(CK)/2 + 0.5$ | ns   |
| tw(CKL) |                                  |                           | $t(CK)/2 - 0.5$ | -   | $t(CK)/2 + 0.5$ |      |
| ts(IN)  | Data input setup time            | $2.7 V < V_{DD} < 3.6 V$  | 2               | -   | -               |      |
|         |                                  | $1.71 V < V_{DD} < 3.6 V$ | 2               | -   | -               |      |
| th(IN)  | Data input hold time             | $2.7 V < V_{DD} < 3.6 V$  | 1               | -   | -               |      |
|         |                                  | $1.71 V < V_{DD} < 3.6 V$ | 2               | -   | -               |      |
| tv(OUT) | Data output valid time           | $2.7 V < V_{DD} < 3.6 V$  | -               | 1.5 | 3               |      |
|         |                                  | $1.71 V < V_{DD} < 3.6 V$ | -               | 1.5 | 2.5             |      |
| th(OUT) | Data output hold time            | -                         | 0.5             | -   | -               |      |

1. Guaranteed by characterization results.

Table 112. Quad-SPI characteristics in DDR mode<sup>(1)</sup>

| Symbol                | Parameter                        | Conditions                            | Min             | Typ         | Max             | Unit |
|-----------------------|----------------------------------|---------------------------------------|-----------------|-------------|-----------------|------|
| Fck1/t(CK)            | Quad-SPI clock frequency         | $2.7 V < V_{DD} < 3.6 V$<br>CL=20 pF  | -               | -           | 80              | MHz  |
|                       |                                  | $1.8 V < V_{DD} < 3.6 V$<br>CL=15 pF  | -               | -           | 80              |      |
|                       |                                  | $1.71 V < V_{DD} < 3.6 V$<br>CL=10 pF | -               | -           | 80              |      |
| tw(CKH)               | Quad-SPI clock high and low time | -                                     | $t(CK)/2 - 0.5$ | -           | $t(CK)/2 + 0.5$ | ns   |
| tw(CKL)               |                                  |                                       | $t(CK)/2 - 0.5$ | -           | $t(CK)/2 + 0.5$ |      |
| ts(IN),<br>tsf(IN)    | Data input setup time            | $2.7 V < V_{DD} < 3.6 V$              | 1               | -           | -               |      |
|                       |                                  | $1.71 V < V_{DD} < 2 V$               | 0.5             | -           | -               |      |
| thr(IN),<br>thf(IN)   | Data input hold time             | $2.7 V < V_{DD} < 3.6 V$              | 2.25            | -           | -               |      |
|                       |                                  | $1.71 V < V_{DD} < 2 V$               | 2.75            | -           | -               |      |
| tvr(OUT),<br>tvf(OUT) | Data output valid time           | $2.7 V < V_{DD} < 3.6 V$              | -               | 9.5         | 11.5            |      |
|                       |                                  | $1.71 V < V_{DD} < 3.6 V$<br>DHHC=0   | -               | 9.5         | 12.25           |      |
|                       |                                  | DHHC=1<br>Pres=1, 2...                | -               | Thclk/2 + 2 | Thclk/2 + 2.5   |      |
| thr(OUT),<br>thf(OUT) | Data output hold time            | DHHC=0                                | 5.5             | -           | -               |      |
|                       |                                  | DHHC=1<br>Pres=1, 2...                | Thclk/2 + 0.75  | -           | -               |      |

1. Guaranteed by characterization results.

Figure 76. Quad-SPI timing diagram - SDR mode

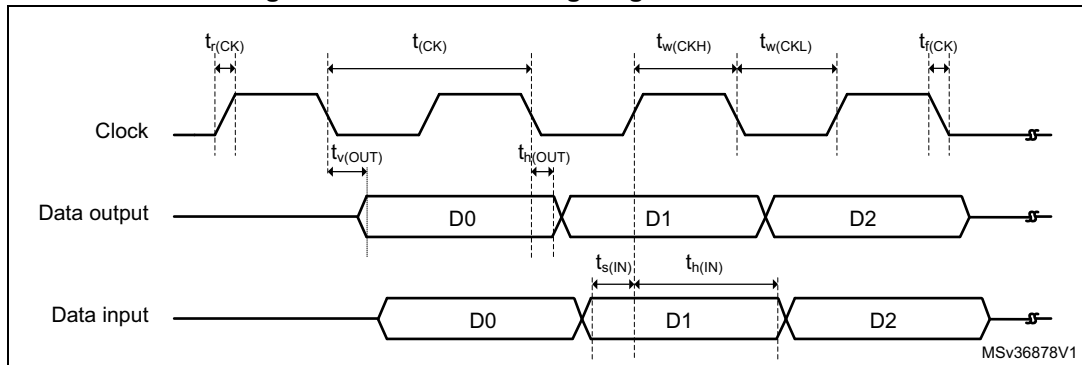
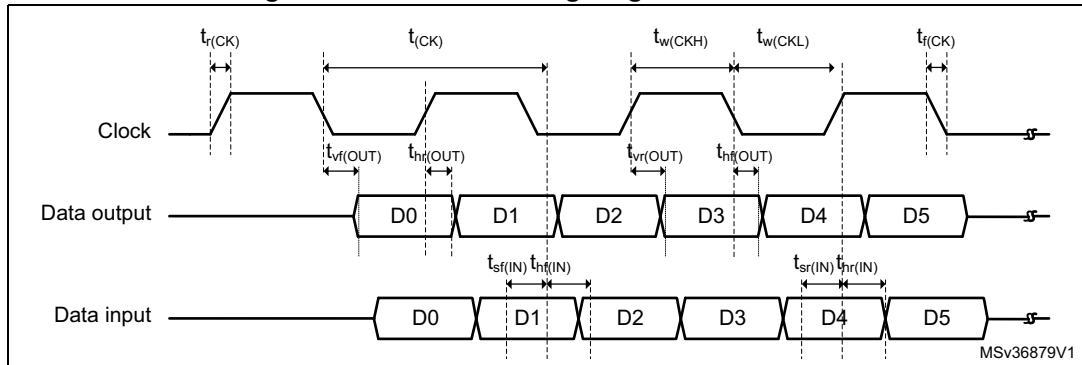


Figure 77. Quad-SPI timing diagram - DDR mode



### 6.3.32 SD/SDIO MMC card host interface (SDMMC) characteristics

Unless otherwise specified, the parameters given in [Table 113](#) for the SDIO/MMC interface are derived from tests performed under the ambient temperature,  $f_{PCLK2}$  frequency and  $V_{DD}$  supply voltage conditions summarized in [Table 16](#), with the following configuration:

- Output speed is set to  $OSPEEDRy[1:0] = 11$
- Capacitive load  $C = 30$  pF
- Measurement points are done at CMOS levels:  $0.5V_{DD}$

Refer to [Section 6.3.20: I/O port characteristics](#) for more details on the input/output characteristics.

Figure 78. SDIO high-speed mode

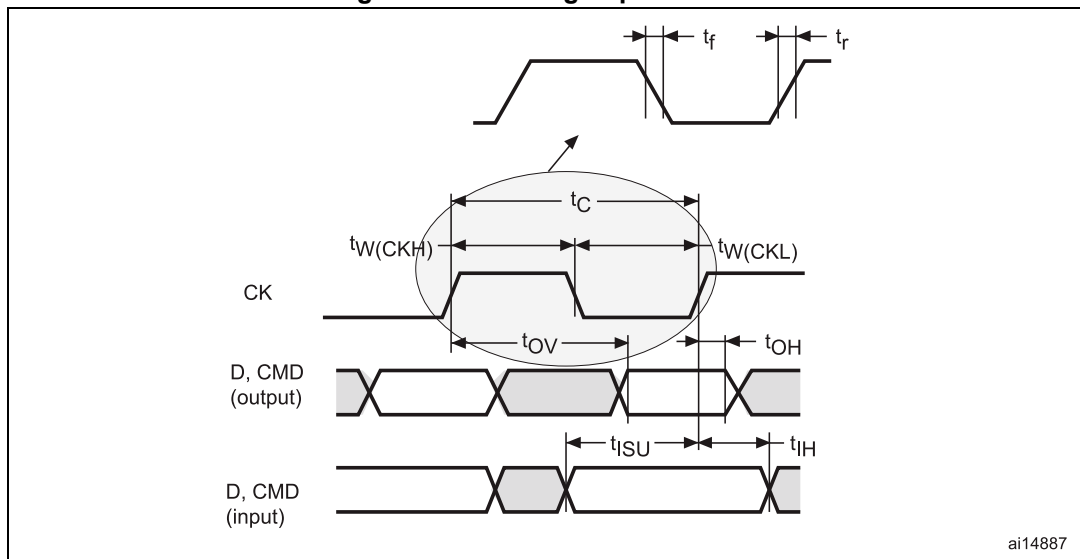
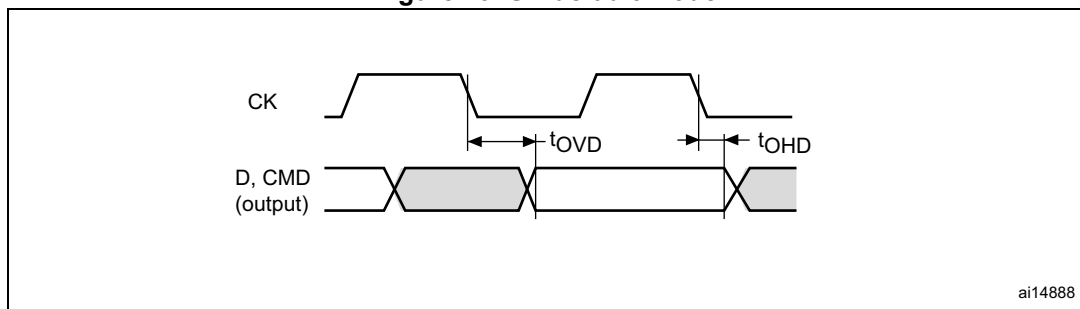


Figure 79. SD default mode

Table 113. Dynamic characteristics: SD / MMC characteristics,  $V_{DD}=2.7V$  to  $3.6V^{(1)}$ 

| Symbol                                                  | Parameter                             | Conditions              | Min | Typ | Max | Unit |
|---------------------------------------------------------|---------------------------------------|-------------------------|-----|-----|-----|------|
| f <sub>PP</sub>                                         | Clock frequency in data transfer mode | -                       | 0   | -   | 50  | MHz  |
| -                                                       | SDMMC_CK/fPCLK2 frequency ratio       | -                       | -   | -   | 8/3 | -    |
| t <sub>W(CKL)</sub>                                     | Clock low time                        | f <sub>pp</sub> =50 MHz | 9   | 10  | -   | ns   |
| t <sub>W(CKH)</sub>                                     | Clock high time                       | f <sub>pp</sub> =50 MHz | 9   | 10  | -   |      |
| CMD, D inputs (referenced to CK) in MMC and SD HS mode  |                                       |                         |     |     |     |      |
| t <sub>ISU</sub>                                        | Input setup time HS                   | f <sub>pp</sub> =50 MHz | 1   | -   | -   | ns   |
| t <sub>IH</sub>                                         | Input hold time HS                    | f <sub>pp</sub> =50 MHz | 3   | -   | -   |      |
| CMD, D outputs (referenced to CK) in MMC and SD HS mode |                                       |                         |     |     |     |      |
| t <sub>OV</sub>                                         | Output valid time HS                  | f <sub>pp</sub> =50 MHz | -   | 11  | 12  | ns   |
| t <sub>OH</sub>                                         | Output hold time HS                   | f <sub>pp</sub> =50 MHz | 9   | -   | -   |      |

**Table 113. Dynamic characteristics: SD / MMC characteristics,  $V_{DD}=2.7V$  to  $3.6V^{(1)}$  (continued)**

| Symbol                                               | Parameter                    | Conditions  | Min | Typ | Max | Unit |
|------------------------------------------------------|------------------------------|-------------|-----|-----|-----|------|
| CMD, D inputs (referenced to CK) in SD default mode  |                              |             |     |     |     |      |
| t <sub>ISUD</sub>                                    | Input setup time SD          | fpp =25 MHz | 1   | -   | -   | ns   |
| t <sub>IHD</sub>                                     | Input hold time SD           | fpp =25 MHz | 3   | -   | -   |      |
| CMD, D outputs (referenced to CK) in SD default mode |                              |             |     |     |     |      |
| t <sub>OVD</sub>                                     | Output valid default time SD | fpp =25 MHz | -   | 2   | 2.5 | ns   |
| t <sub>OHD</sub>                                     | Output hold default time SD  | fpp =25 MHz | 0.5 | -   | -   |      |

1. Guaranteed by characterization results,.

**Table 114. Dynamic characteristics: eMMC characteristics,  $V_{DD}=1.71V$  to  $1.9V^{(1)(2)}$** 

| Symbol                                         | Parameter                             | Conditions  | Min  | Typ  | Max | Unit |
|------------------------------------------------|---------------------------------------|-------------|------|------|-----|------|
| f <sub>PP</sub>                                | Clock frequency in data transfer mode | -           | 0    | -    | 50  | MHz  |
| -                                              | SDMMC_CK/fPCLK2 frequency ratio       | -           | -    | -    | 8/3 | -    |
| t <sub>W(CKL)</sub>                            | Clock low time                        | fpp =50 MHz | 9.5  | 10.5 | -   | ns   |
| t <sub>W(CKH)</sub>                            | Clock high time                       | fpp =50 MHz | 8.5  | 9.5  | -   |      |
| CMD, D inputs (referenced to CK) in eMMC mode  |                                       |             |      |      |     |      |
| t <sub>ISU</sub>                               | Input setup time HS                   | fpp =50 MHz | 0    | -    | -   | ns   |
| t <sub>IH</sub>                                | Input hold time HS                    | fpp =50 MHz | 4.5  | -    | -   |      |
| CMD, D outputs (referenced to CK) in eMMC mode |                                       |             |      |      |     |      |
| t <sub>OV</sub>                                | Output valid time HS                  | fpp =50 MHz | -    | 12   | 14  | ns   |
| t <sub>OH</sub>                                | Output hold time HS                   | fpp =50 MHz | 10.5 | -    | -   |      |

1. Guaranteed by characterization results.

2.  $C_{load} = 20$  pF.

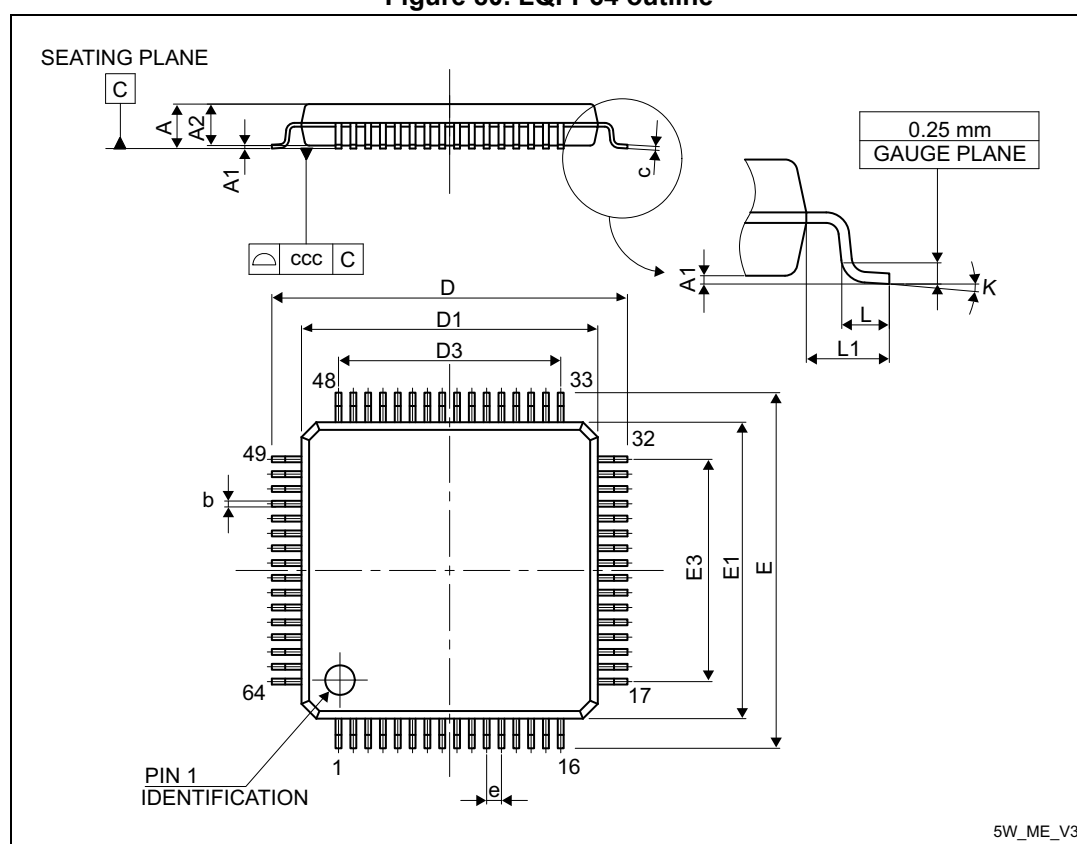
## 7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

### 7.1 LQFP64 – 10 x 10 mm, low-profile quad flat package information

LQFP64 is a 64-pin, 10 x 10 mm low-profile quad flat package.

Figure 80. LQFP64 outline



1. Drawing is not to scale.

Table 115. LQFP64 mechanical data

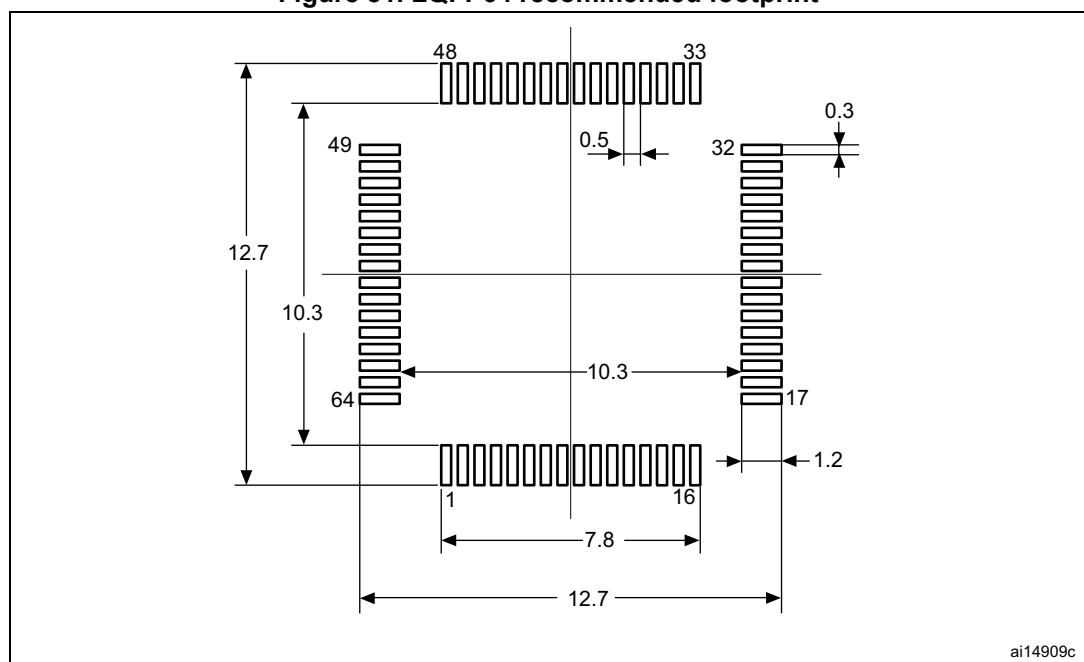
| Symbol | millimeters |      |      | inches <sup>(1)</sup> |        |        |
|--------|-------------|------|------|-----------------------|--------|--------|
|        | Min         | Typ  | Max  | Min                   | Typ    | Max    |
| A      | -           | -    | 1.60 | -                     | -      | 0.0630 |
| A1     | 0.05        | -    | 0.15 | 0.0020                | -      | 0.0059 |
| A2     | 1.350       | 1.40 | 1.45 | 0.0531                | 0.0551 | 0.0571 |

Table 115. LQFP64 mechanical data (continued)

| Symbol | millimeters |       |      | inches <sup>(1)</sup> |        |        |
|--------|-------------|-------|------|-----------------------|--------|--------|
|        | Min         | Typ   | Max  | Min                   | Typ    | Max    |
| b      | 0.17        | 0.22  | 0.27 | 0.0067                | 0.0087 | 0.0106 |
| c      | 0.09        | -     | 0.20 | 0.0035                | -      | 0.0079 |
| D      | -           | 12.00 | -    | -                     | 0.4724 | -      |
| D1     | -           | 10.00 | -    | -                     | 0.3937 | -      |
| D3     | -           | 7.50  | -    | -                     | 0.2953 | -      |
| E      | -           | 12.00 | -    | -                     | 0.4724 | -      |
| E1     | -           | 10.00 | -    | -                     | 0.3937 | -      |
| E3     | -           | 7.50  | -    | -                     | 0.2953 | -      |
| e      | -           | 0.50  | -    | -                     | 0.0197 | -      |
| K      | 0°          | 3.5°  | 7°   | 0°                    | 3.5°   | 7°     |
| L      | 0.45        | 0.60  | 0.75 | 0.0177                | 0.0236 | 0.0295 |
| L1     | -           | 1.00  | -    | -                     | 0.0394 | -      |
| ccc    | -           | -     | 0.08 | -                     | -      | 0.0031 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 81. LQFP64 recommended footprint



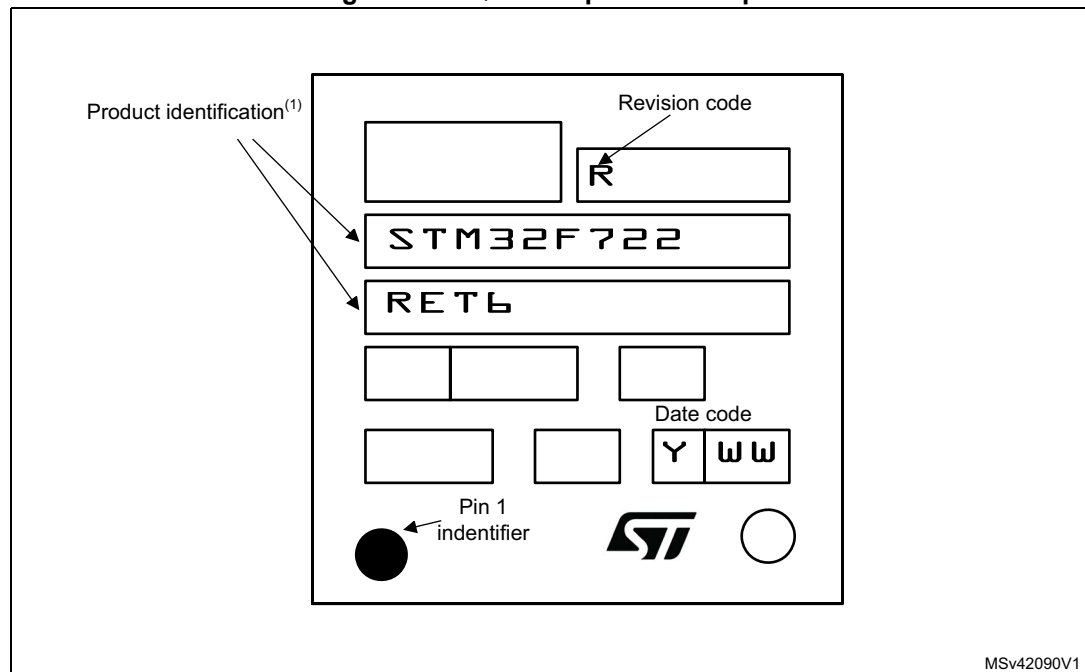
### LQFP64 device marking

The following figure gives an example of topside marking orientation versus pin 1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 82. LQFP64 top view example**

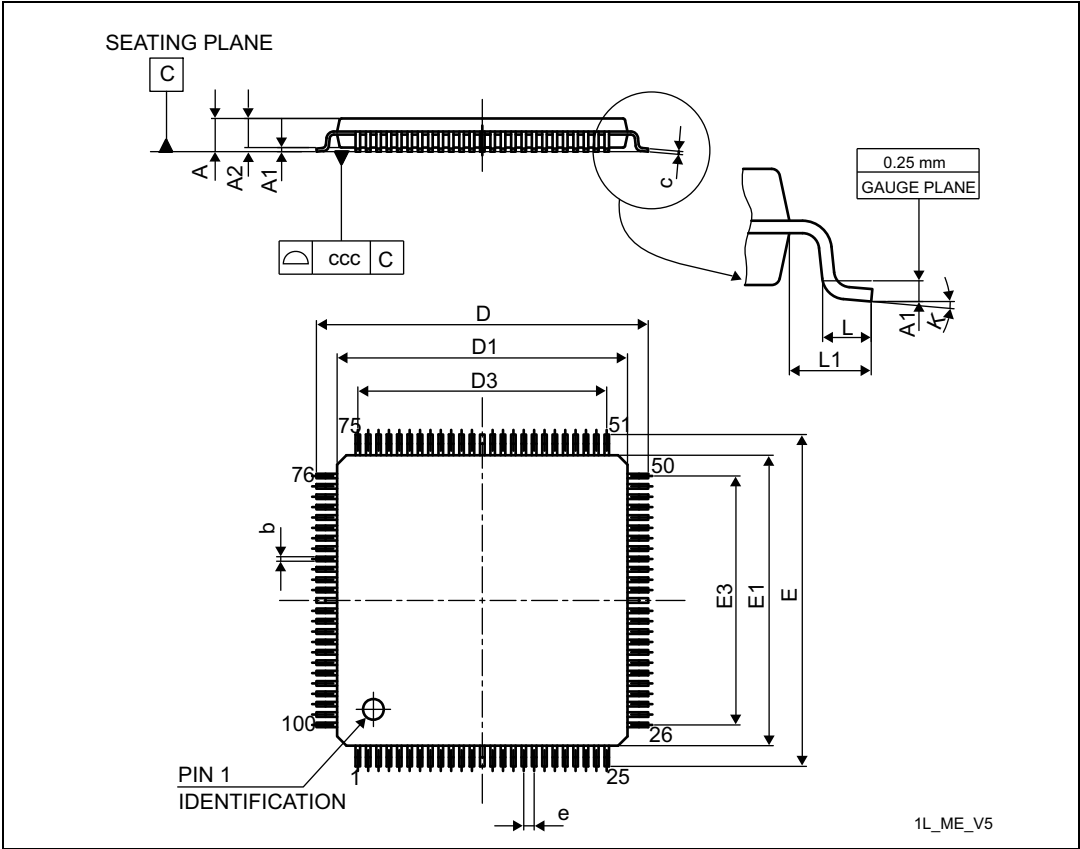


1. Parts marked as ES or E or accompanied by an engineering sample notification letter are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

## 7.2 LQFP100, 14 x 14 mm low-profile quad flat package information

LQFP100 is a 100-pin, 14 x 14 mm low-profile quad flat package.

Figure 83. LQFP100 outline



1. Drawing is not to scale.

Table 116. LQFP100 mechanical data

| Symbol | millimeters |        |        | inches <sup>(1)</sup> |        |        |
|--------|-------------|--------|--------|-----------------------|--------|--------|
|        | Min         | Typ    | Max    | Min                   | Typ    | Max    |
| A      | -           | -      | 1.600  | -                     | -      | 0.0630 |
| A1     | 0.050       | -      | 0.150  | 0.0020                | -      | 0.0059 |
| A2     | 1.350       | 1.400  | 1.450  | 0.0531                | 0.0551 | 0.0571 |
| b      | 0.170       | 0.220  | 0.270  | 0.0067                | 0.0087 | 0.0106 |
| c      | 0.090       | -      | 0.200  | 0.0035                | -      | 0.0079 |
| D      | 15.800      | 16.000 | 16.200 | 0.6220                | 0.6299 | 0.6378 |
| D1     | 13.800      | 14.000 | 14.200 | 0.5433                | 0.5512 | 0.5591 |
| D3     | -           | 12.000 | -      | -                     | 0.4724 | -      |
| E      | 15.800      | 16.000 | 16.200 | 0.6220                | 0.6299 | 0.6378 |

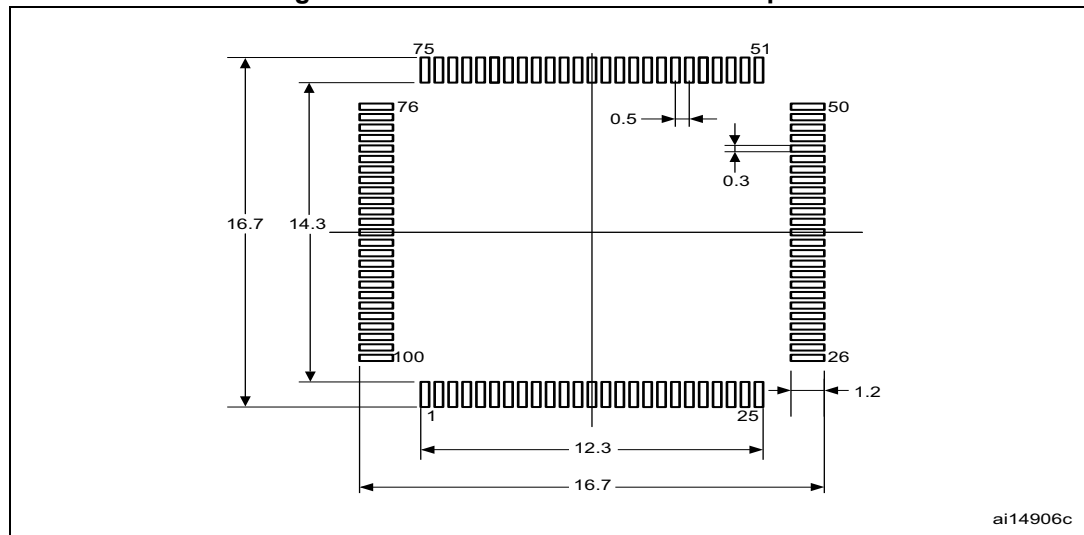


Table 116. LQPF100 mechanical data (continued)

| Symbol | millimeters |        |        | inches <sup>(1)</sup> |        |        |
|--------|-------------|--------|--------|-----------------------|--------|--------|
|        | Min         | Typ    | Max    | Min                   | Typ    | Max    |
| E1     | 13.800      | 14.000 | 14.200 | 0.5433                | 0.5512 | 0.5591 |
| E3     | -           | 12.000 | -      | -                     | 0.4724 | -      |
| e      | -           | 0.500  | -      | -                     | 0.0197 | -      |
| L      | 0.450       | 0.600  | 0.750  | 0.0177                | 0.0236 | 0.0295 |
| L1     | -           | 1.000  | -      | -                     | 0.0394 | -      |
| k      | 0°          | 3.5°   | 7°     | 0°                    | 3.5°   | 7°     |
| ccc    | -           | -      | 0.080  | -                     | -      | 0.0031 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 84. LQFP100 recommended footprint



1. Dimensions are expressed in millimeters.

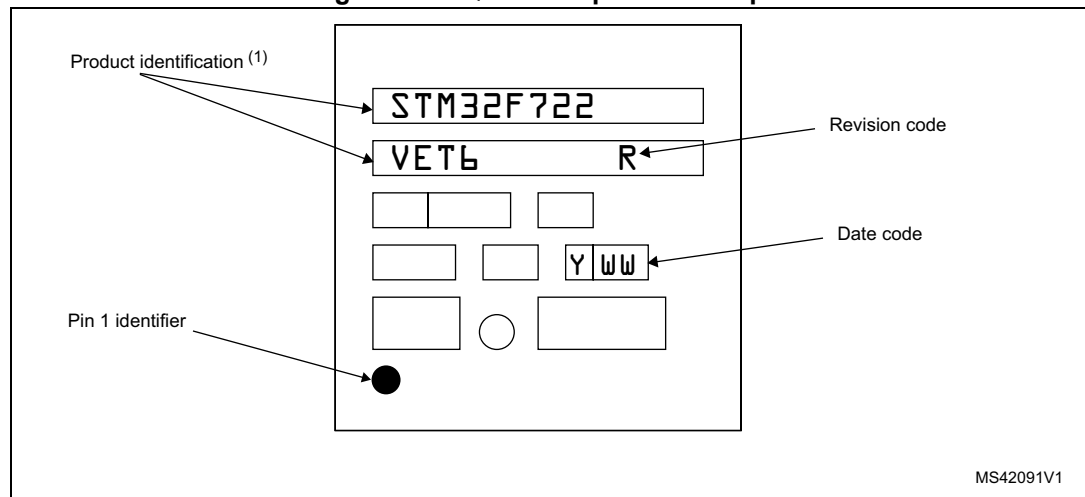
### LQFP100 device marking

The following figure gives an example of topside marking orientation versus pin 1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 85. LQFP100 top view example**



1. Parts marked as ES or E or accompanied by an engineering sample notification letter are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

## 7.3 LQFP144, 20 x 20 mm low-profile quad flat package information

LQFP144 is a 144-pin, 20 x 20 mm low-profile quad flat package.

Figure 86. LQFP144 outline

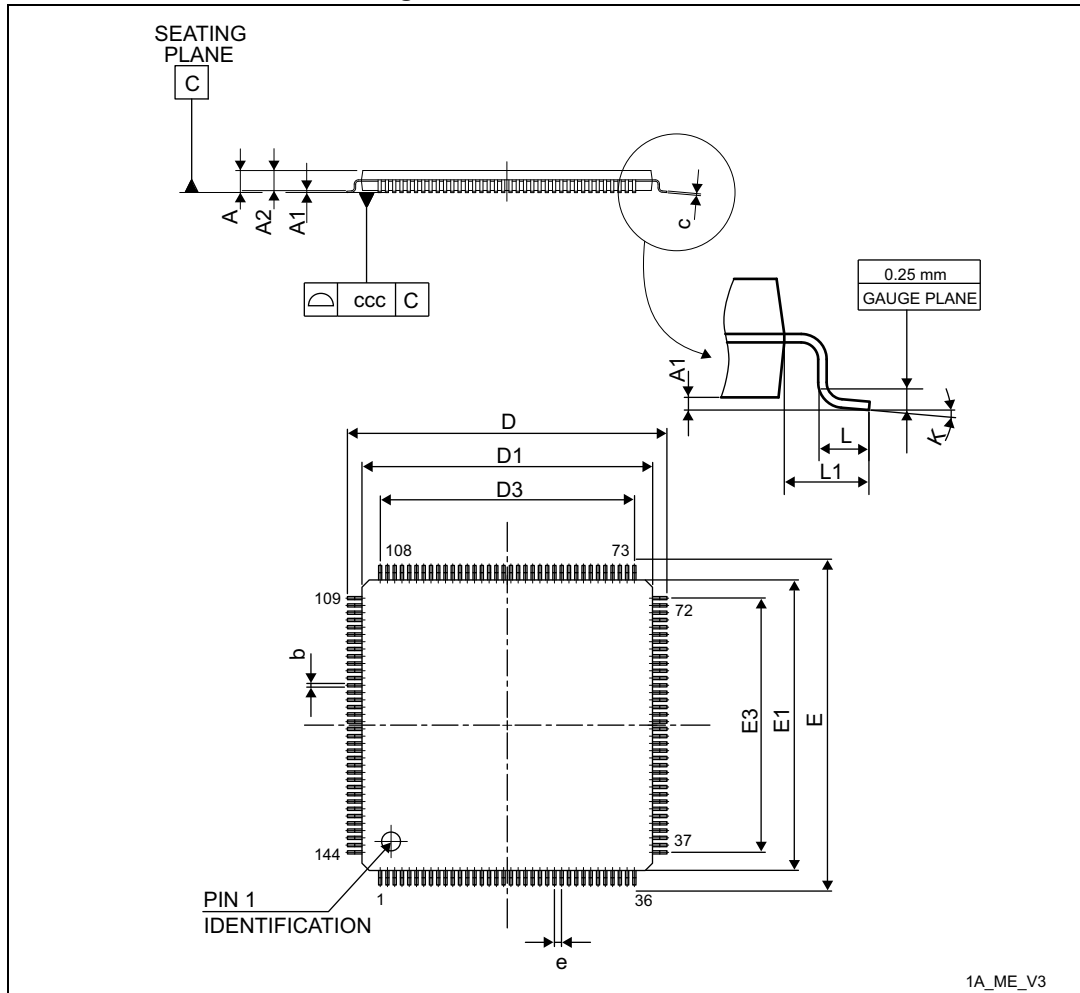


Table 117. LQFP144 mechanical data

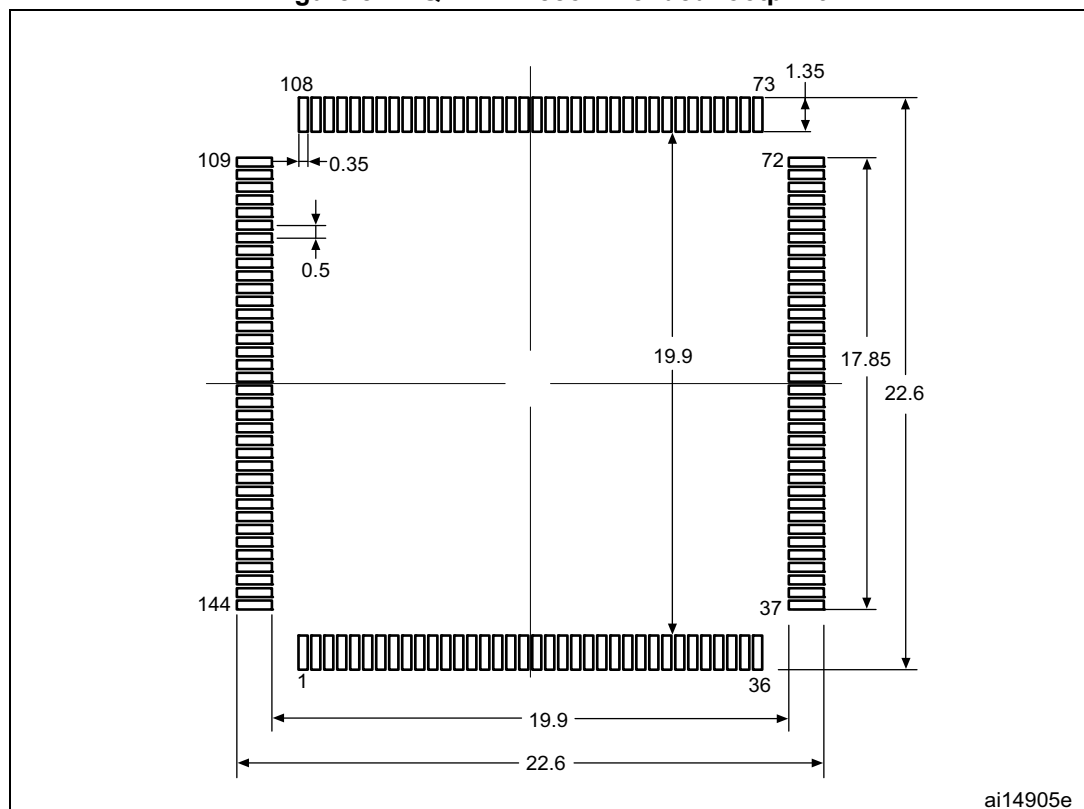
| Symbol | millimeters |        |        | inches <sup>(1)</sup> |        |        |
|--------|-------------|--------|--------|-----------------------|--------|--------|
|        | Min         | Typ    | Max    | Min                   | Typ    | Max    |
| A      | -           | -      | 1.600  | -                     | -      | 0.0630 |
| A1     | 0.050       | -      | 0.150  | 0.0020                | -      | 0.0059 |
| A2     | 1.350       | 1.400  | 1.450  | 0.0531                | 0.0551 | 0.0571 |
| b      | 0.170       | 0.220  | 0.270  | 0.0067                | 0.0087 | 0.0106 |
| c      | 0.090       | -      | 0.200  | 0.0035                | -      | 0.0079 |
| D      | 21.800      | 22.000 | 22.200 | 0.8583                | 0.8661 | 0.874  |

**Table 117. LQFP144 mechanical data (continued)**

| Symbol | millimeters |        |        | inches <sup>(1)</sup> |        |        |
|--------|-------------|--------|--------|-----------------------|--------|--------|
|        | Min         | Typ    | Max    | Min                   | Typ    | Max    |
| D1     | 19.800      | 20.000 | 20.200 | 0.7795                | 0.7874 | 0.7953 |
| D3     | -           | 17.500 | -      | -                     | 0.689  | -      |
| E      | 21.800      | 22.000 | 22.200 | 0.8583                | 0.8661 | 0.8740 |
| E1     | 19.800      | 20.000 | 20.200 | 0.7795                | 0.7874 | 0.7953 |
| E3     | -           | 17.500 | -      | -                     | 0.6890 | -      |
| e      | -           | 0.500  | -      | -                     | 0.0197 | -      |
| L      | 0.450       | 0.600  | 0.750  | 0.0177                | 0.0236 | 0.0295 |
| L1     | -           | 1.000  | -      | -                     | 0.0394 | -      |
| k      | 0°          | 3.5°   | 7°     | 0°                    | 3.5°   | 7°     |
| ccc    | -           | -      | 0.080  | -                     | -      | 0.0031 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

**Figure 87. LQFP144 recommended footprint**



1. Dimensions are expressed in millimeters.

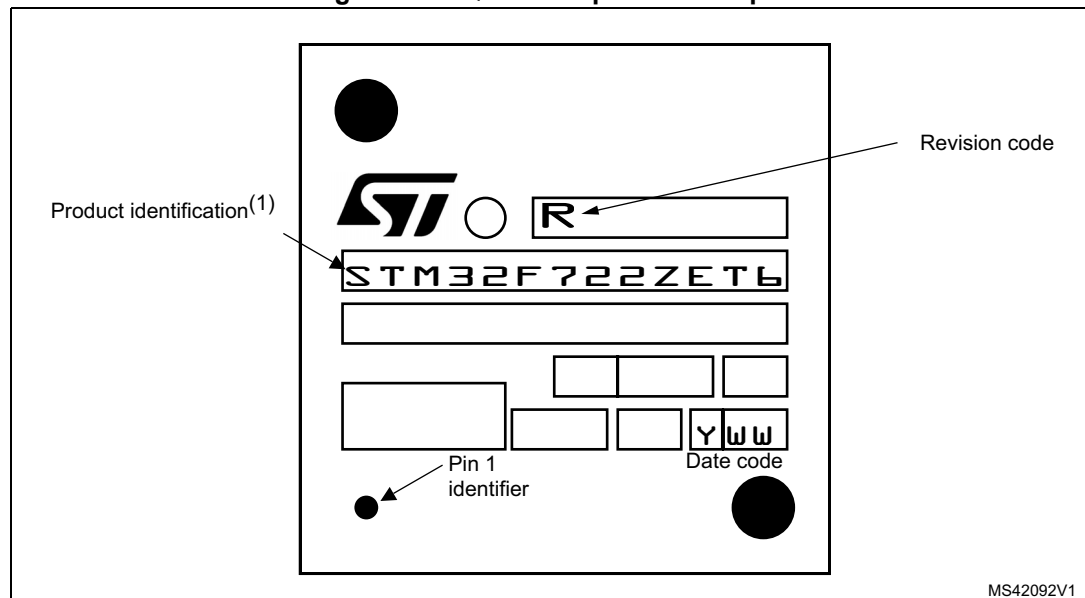
### LQP144 device marking

The following figure gives an example of topside marking orientation versus pin 1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 88. LQFP144 top view example**

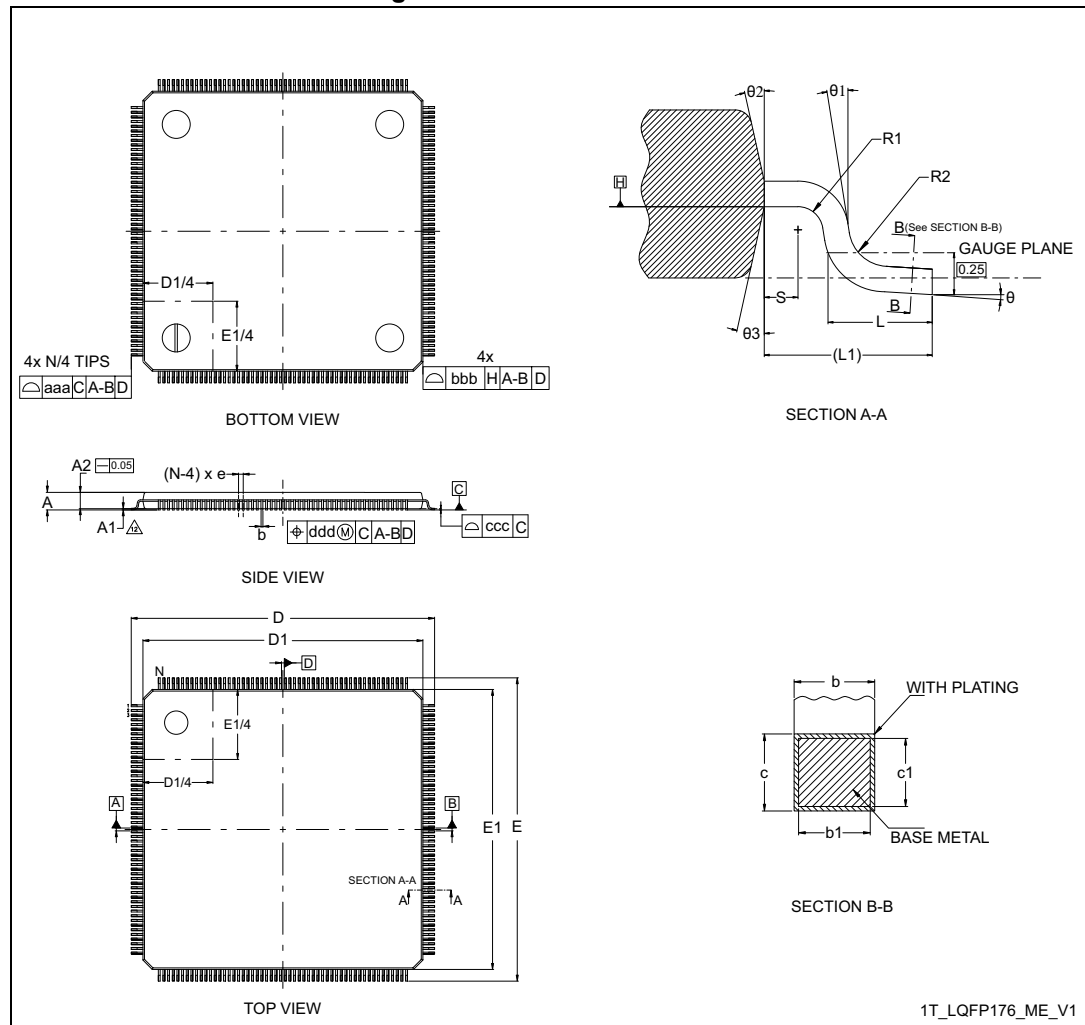


1. Parts marked as ES or E or accompanied by an engineering sample notification letter are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

## 7.4 LQFP176 24 x 24 mm low-profile quad flat package information

This LQFP is a 176-pin, 24 x 24 mm, 0.5 mm pitch, low profile quad flat package.

Figure 89. LQFP176 - Outline



1. Drawing is not to scale.
2. Dimensioning and tolerance schemes conform to ASME Y14.5M-1994.
3. Datums A-B and D to be determined at datum plane H.
4. Detail of pin 1 identifier are optional but must be located within the zone indicated.
5. Exact shape of each corner is optional.

Table 118. LQFP176 - Mechanical data

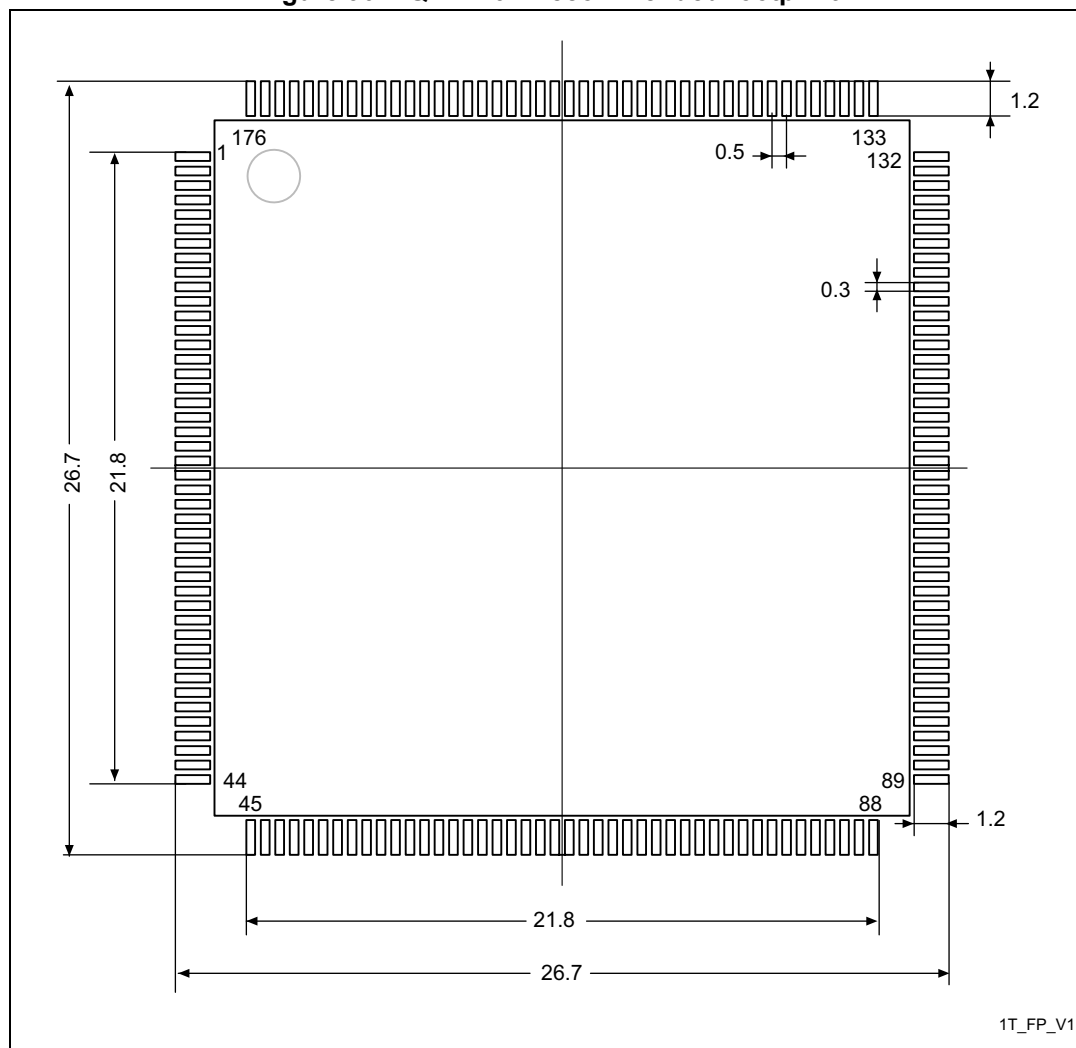
| Symbol            | millimeters |     |       | inches <sup>(1)</sup> |     |        |
|-------------------|-------------|-----|-------|-----------------------|-----|--------|
|                   | Min         | Typ | Max   | Min                   | Typ | Max    |
| A                 | -           | -   | 1.600 | -                     | -   | 0.0630 |
| A1 <sup>(2)</sup> | 0.050       | -   | 0.150 | 0.0020                | -   | 0.0059 |

Table 118. LQFP176 - Mechanical data (continued)

| Symbol               | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|----------------------|-------------|-------|-------|-----------------------|--------|--------|
|                      | Min         | Typ   | Max   | Min                   | Typ    | Max    |
| A2                   | 1.350       | 1.400 | 1.450 | 0.0531                | 0.0551 | 0.0571 |
| b <sup>(3)(4)</sup>  | 0.170       | 0.220 | 0.270 | 0.0067                | 0.0087 | 0.0106 |
| b1 <sup>(4)</sup>    | 0.170       | 0.200 | 0.230 | 0.0067                | 0.0079 | 0.0091 |
| c <sup>(4)</sup>     | 0.090       | -     | 0.200 | 0.0035                | -      | 0.0079 |
| c1 <sup>(4)</sup>    | 0.090       | -     | 0.160 | 0.0035                | -      | 0.063  |
| D <sup>(5)</sup>     | 26.000      |       |       | 1.0236                |        |        |
| D1 <sup>(6)(7)</sup> | 24.000      |       |       | 0.9449                |        |        |
| E <sup>(5)</sup>     | 26.000      |       |       | 0.0197                |        |        |
| E1 <sup>(6)(7)</sup> | 24.000      |       |       | 0.9449                |        |        |
| e                    | 0.500       |       |       | 0.1970                |        |        |
| L                    | 0.450       | 0.600 | 0.750 | 0.0177                | 0.0236 | 0.0295 |
| L1 <sup>(4)</sup>    | 1           |       |       | 0.0394 REF            |        |        |
| N <sup>(8)</sup>     | 176         |       |       |                       |        |        |
| θ                    | 0°          | 3.5°  | 7°    | 0°                    | 3.5°   | 7°     |
| θ1                   | 0°          | -     | -     | 0°                    | -      | -      |
| θ2                   | 10°         | 12°   | 14°   | 10°                   | 12°    | 14°    |
| θ3                   | 10°         | 12°   | 14°   | 10°                   | 12°    | 14°    |
| R1                   | 0.080       | -     | -     | 0.0031                | -      | -      |
| R2                   | 0.080       | -     | 0.200 | 0.0031                | -      | 0.0079 |
| S                    | 0.200       | -     | -     | 0.0079                | -      | -      |
| aaa <sup>(9)</sup>   | 0.200       |       |       | 0.0079                |        |        |
| bbb <sup>(9)</sup>   | 0.200       |       |       | 0.0079                |        |        |
| ccc <sup>(9)</sup>   | 0.080       |       |       | 0.0031                |        |        |
| ddd <sup>(9)</sup>   | 0.080       |       |       | 0.0031                |        |        |

1. Values in inches are converted from mm and rounded to four decimal digits.
2. A1 is defined as the distance from the seating plane to the lowest point on the package body.
3. Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum "b" dimension by more than 0.08 mm. Dambar cannot be located on the lower radius or the foot. Minimum space between protrusion and an adjacent lead is 0.07 mm for 0.4 mm and 0.5 mm pitch packages.
4. These dimensions apply to the flat section of the lead between 0.10 mm and 0.25 mm from the lead tip.
5. To be determined at seating datum plane C.
6. The Top package body size may be smaller than the bottom package size by as much as 0.15 mm.
7. Dimensions D1 and E1 do not include mold flash or protrusions. Allowable mold flash or protrusions is "0.25 mm" per side. D1 and E1 are Maximum plastic body size dimensions including mold mismatch.
8. "N" is the max number of terminal positions for the specified body size.
9. Dimensioning and tolerancing schemes conform to ASME Y14.5M-1994.

Figure 90. LQFP176 - Recommended footprint



1. Dimensions are expressed in millimeters.
1. Dimensions are expressed in millimeters.



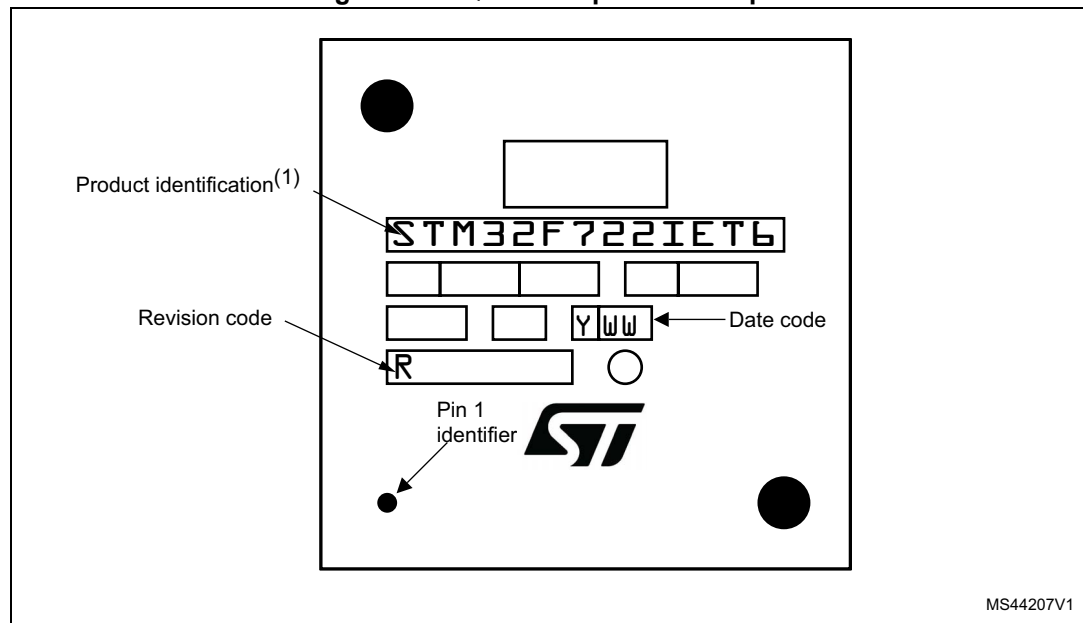
### LQFP176 device marking

The following figure gives an example of topside marking orientation versus pin 1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 91. LQFP176 top view example**

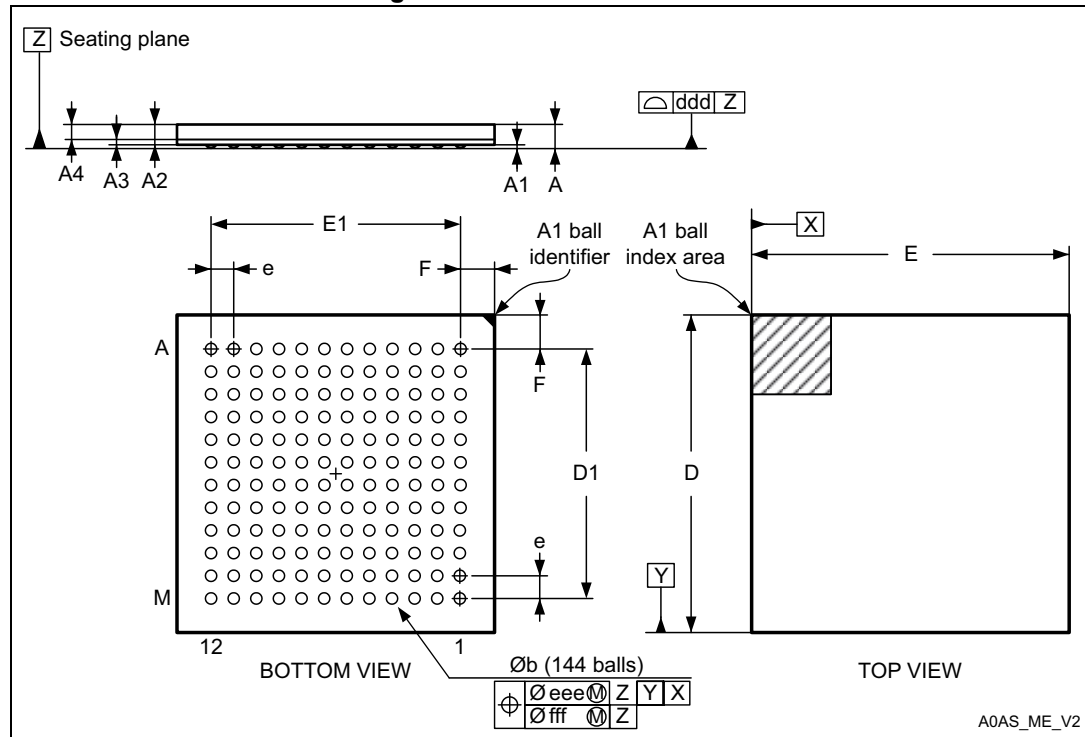


1. Parts marked as ES or E or accompanied by an engineering sample notification letter are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

## 7.5 UFBGA144 package information

UFBGA144 is a 144-ball, 7 x 7 mm, 0.50 mm pitch, ultra fine pitch ball grid array package.

Figure 92. UFBGA144 outline



1. Drawing is not to scale.

Table 119. UFBGA144 mechanical data

| Symbol | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|--------|-------------|-------|-------|-----------------------|--------|--------|
|        | Min.        | Typ.  | Max.  | Min.                  | Typ.   | Max.   |
| A      | 0.460       | 0.530 | 0.600 | 0.0181                | 0.0209 | 0.0236 |
| A1     | 0.050       | 0.080 | 0.110 | 0.0020                | 0.0031 | 0.0043 |
| A2     | 0.400       | 0.450 | 0.500 | 0.0157                | 0.0177 | 0.0197 |
| A3     | -           | 0.130 | -     | -                     | 0.0051 | -      |
| A4     | 0.270       | 0.320 | 0.370 | 0.0106                | 0.0126 | 0.0146 |
| b      | 0.230       | 0.280 | 0.320 | 0.0091                | 0.0110 | 0.0126 |
| D      | 6.950       | 7.000 | 7.050 | 0.2736                | 0.2756 | 0.2776 |
| D1     | 5.450       | 5.500 | 5.550 | 0.2146                | 0.2165 | 0.2185 |
| E      | 6.950       | 7.000 | 7.050 | 0.2736                | 0.2756 | 0.2776 |
| E1     | 5.450       | 5.500 | 5.550 | 0.2146                | 0.2165 | 0.2185 |
| e      | -           | 0.500 | -     | -                     | 0.0197 | -      |
| F      | 0.700       | 0.750 | 0.800 | 0.0276                | 0.0295 | 0.0315 |

Table 119. UFBGA144 mechanical data (continued)

| Symbol | millimeters |      |       | inches <sup>(1)</sup> |      |        |
|--------|-------------|------|-------|-----------------------|------|--------|
|        | Min.        | Typ. | Max.  | Min.                  | Typ. | Max.   |
| ddd    | -           | -    | 0.100 | -                     | -    | 0.0039 |
| eee    | -           | -    | 0.150 | -                     | -    | 0.0059 |
| fff    | -           | -    | 0.050 | -                     | -    | 0.0020 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 93. UFBGA144 recommended footprint

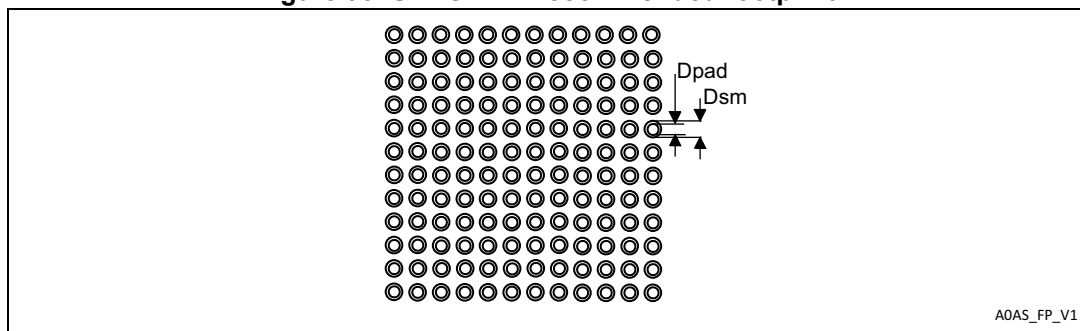


Table 120. UFBGA144 recommended PCB design rules (0.50 mm pitch BGA)

| Dimension         | Recommended values                                               |
|-------------------|------------------------------------------------------------------|
| Pitch             | 0.50 mm                                                          |
| Dpad              | 0.280 mm                                                         |
| Dsm               | 0.370 mm typ. (depends on the soldermask registration tolerance) |
| Stencil opening   | 0.280 mm                                                         |
| Stencil thickness | Between 0.100 mm and 0.125 mm                                    |
| Pad trace width   | 0.120 mm                                                         |

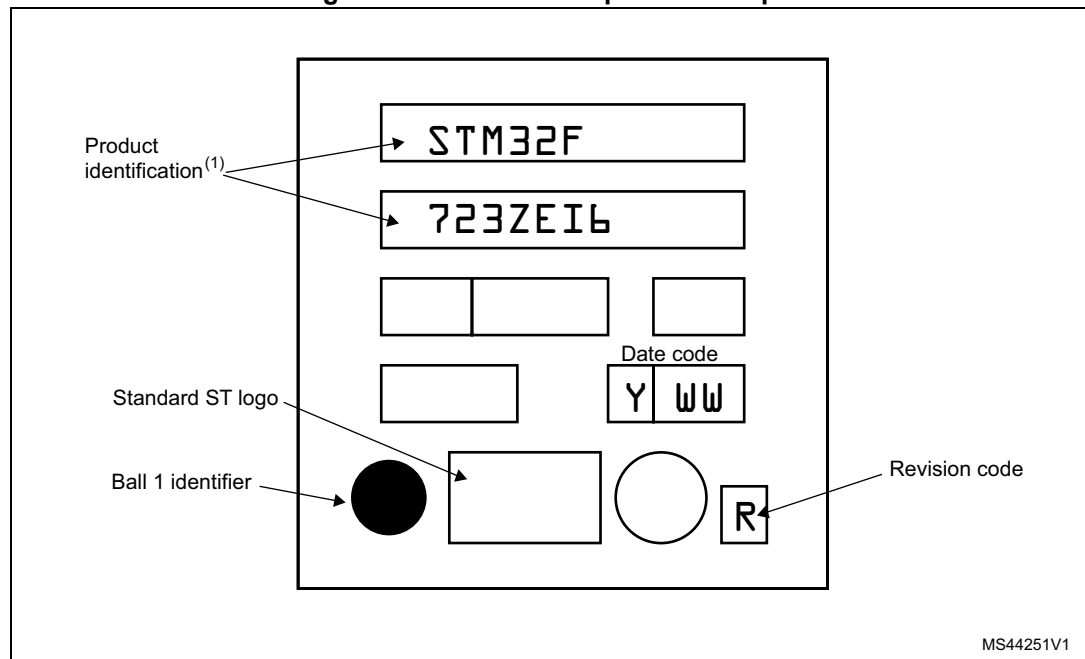
### UFBGA144 device marking

The following figure gives an example of topside marking orientation versus ball A1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 94. UFBGA144 top view example**

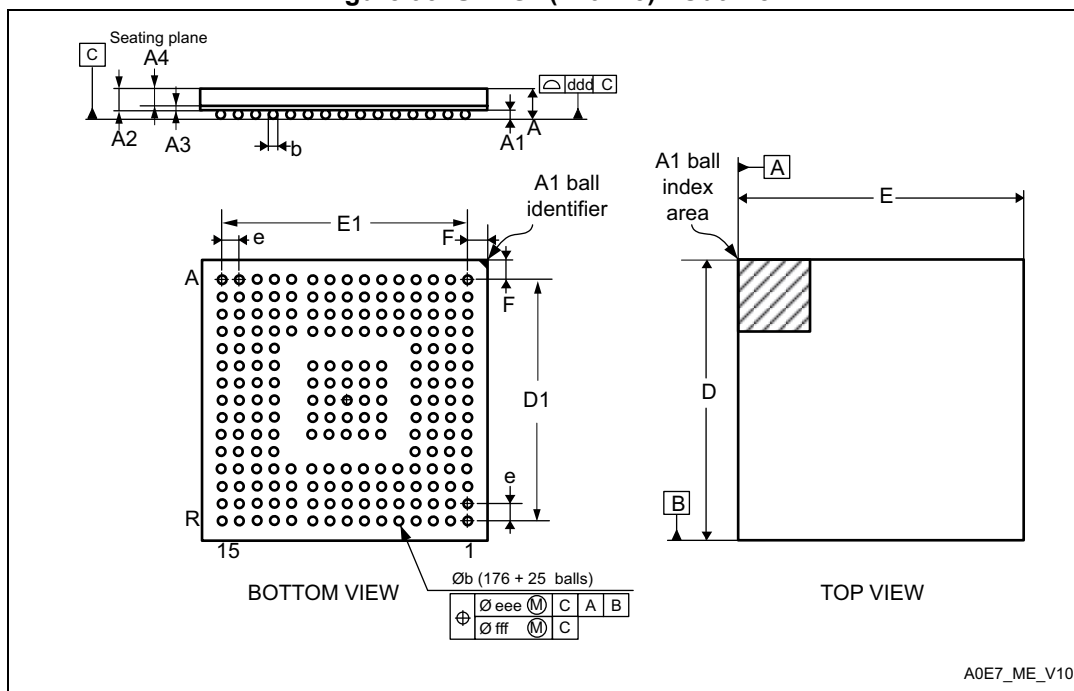


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## 7.6 UFBGA176+25, 10 x 10, 0.65 mm ultra thin-pitch ball grid array package information

This UFBGA is a 176+25 - ball, 10 x 10 mm, 0.65 mm pitch, ultra fine pitch ball grid array package

Figure 95. UFBGA(176+25) - Outline



1. Drawing is not to scale.

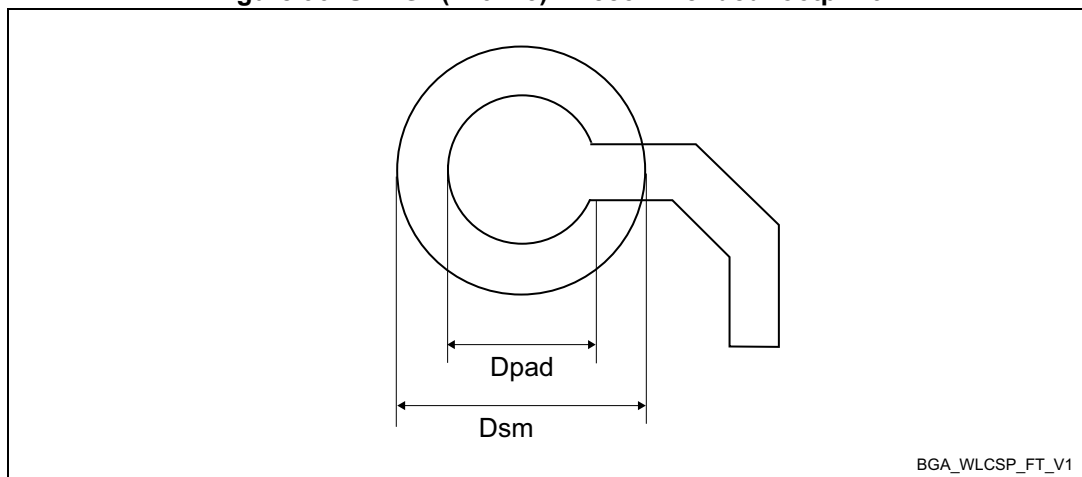
Table 121. UFBGA(176+25) - Mechanical data

| Symbol | millimeters |        |        | inches <sup>(1)</sup> |        |        |
|--------|-------------|--------|--------|-----------------------|--------|--------|
|        | Min.        | Typ.   | Max.   | Min.                  | Typ.   | Max.   |
| A      | -           | -      | 0.600  | -                     | -      | 0.0236 |
| A1     | 0.050       | 0.080  | 0.110  | 0.0020                | 0.0031 | 0.0043 |
| A2     | -           | 0.450  | -      | -                     | 0.0177 | -      |
| A3     | -           | 0.130  | -      | -                     | 0.0051 | -      |
| A4     | -           | 0.320  | -      | -                     | 0.0126 | -      |
| b      | 0.240       | 0.290  | 0.340  | 0.0094                | 0.0114 | 0.0134 |
| D      | 9.850       | 10.000 | 10.150 | 0.3878                | 0.3937 | 0.3996 |
| D1     | -           | 9.100  | -      | -                     | 0.3583 | -      |
| E      | 9.850       | 10.000 | 10.150 | 0.3878                | 0.3937 | 0.3996 |
| E1     | -           | 9.100  | -      | -                     | 0.3583 | -      |
| e      | -           | 0.650  | -      | -                     | 0.0256 | -      |
| F      | -           | 0.450  | -      | -                     | 0.0177 | -      |

**Table 121. UFBGA(176+25) - Mechanical data (continued)**

| Symbol | millimeters |      |       | inches <sup>(1)</sup> |      |        |
|--------|-------------|------|-------|-----------------------|------|--------|
|        | Min.        | Typ. | Max.  | Min.                  | Typ. | Max.   |
| ddd    | -           | -    | 0.080 | -                     | -    | 0.0031 |
| eee    | -           | -    | 0.150 | -                     | -    | 0.0059 |
| fff    | -           | -    | 0.050 | -                     | -    | 0.0020 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

**Figure 96. UFBGA(176+25) - Recommended footprint****Table 122. UFBGA(176+25) - Recommended PCB design rules (0.65 mm pitch BGA)**

| Dimension         | Recommended values                                               |
|-------------------|------------------------------------------------------------------|
| Pitch             | 0.65 mm                                                          |
| Dpad              | 0.300 mm                                                         |
| Dsm               | 0.400 mm typ. (depends on the soldermask registration tolerance) |
| Stencil opening   | 0.300 mm                                                         |
| Stencil thickness | Between 0.100 mm and 0.125 mm                                    |
| Pad trace width   | 0.100 mm                                                         |

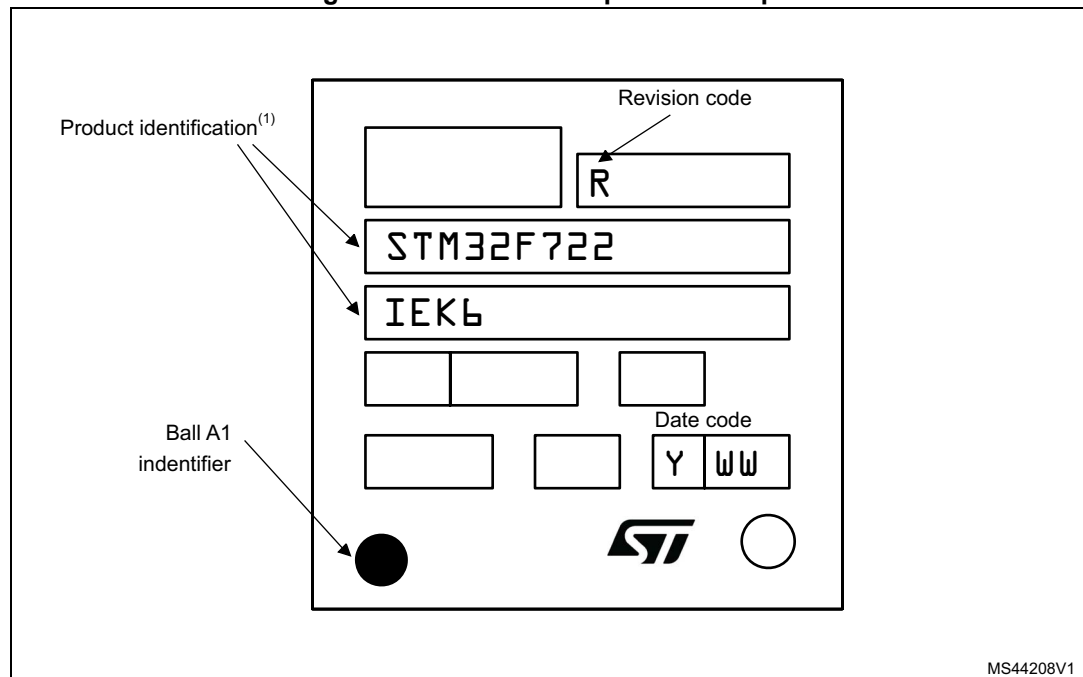
### UFBGA176+25 device marking

The following figure gives an example of topside marking orientation versus ball A1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 97. UFBGA176 top view example**

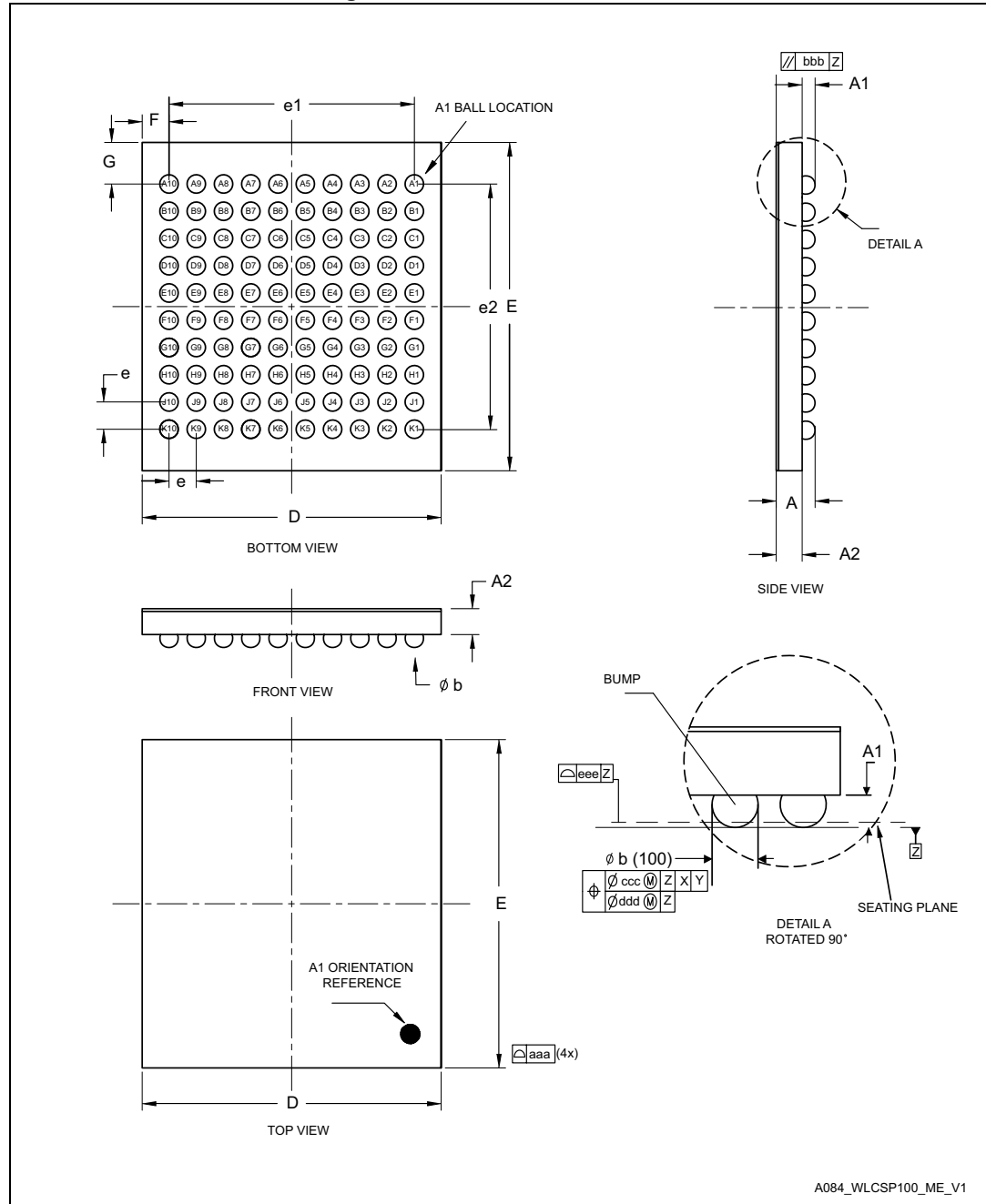


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## 7.7 WLCSP100 package information

This WLCSP is a 100-ball, 4.341x4.775 mm, 0.4 mm pitch, wafer level chip scale package.

**Figure 98. WLCSP100 - Outline**



2. Dimension is measured at the maximum bump diameter parallel to primary datum Z.
3. Primary datum Z and seating plane are defined by the spherical crowns of the bump.
4. Bump position designation per JESD 95-1, SPP-010.



Table 123. WLCSP100 - Mechanical data

| Symbol            | millimeters |                      |       | inches <sup>(1)</sup> |        |        |
|-------------------|-------------|----------------------|-------|-----------------------|--------|--------|
|                   | Min         | Typ                  | Max   | Min                   | Typ    | Max    |
| A                 | 0.525       | 0.555                | 0.585 | 0.0207                | 0.0219 | 0.0230 |
| A1                | -           | 0.175                | -     | -                     | 0.0069 | -      |
| A2 <sup>(2)</sup> | -           | 0.380                | -     | -                     | 0.0150 | -      |
| A3                | -           | 0.025 <sup>(3)</sup> | -     | -                     | 0.0010 | -      |
| b                 | 0.220       | 0.250                | 0.280 | 0.0087                | 0.0098 | 0.0110 |
| D                 | 4.306       | 4.341                | 4.376 | 0.1695                | 0.1709 | 0.1723 |
| E                 | 4.740       | 4.775                | 4.810 | 0.1866                | 0.1880 | 0.1894 |
| e                 | -           | 0.400                | -     | -                     | 0.0157 | -      |
| e1                | -           | 3.600                | -     | -                     | 0.1417 | -      |
| e2                | -           | 3.600                | -     | -                     | 0.1417 | -      |
| F <sup>(4)</sup>  | -           | 0.3705               | -     | -                     | 0.0146 | -      |
| G <sup>(4)</sup>  | -           | 0.5875               | -     | -                     | 0.0231 | -      |
| N                 | 100         |                      |       |                       |        |        |
| aaa               | -           | -                    | 0.100 | -                     | -      | 0.0039 |
| bbb               | -           | -                    | 0.100 | -                     | -      | 0.0039 |
| ccc               | -           | -                    | 0.100 | -                     | -      | 0.0039 |
| ddd               | -           | -                    | 0.050 | -                     | -      | 0.0020 |
| eee               | -           | -                    | 0.050 | -                     | -      | 0.0020 |

1. Values in inches are converted from mm and rounded to the 4rd decimal place.
2. Back side coating.
3. Nominal dimension rounded to the 3rd decimal place results from process capability.
4. Calculated dimensions are rounded to 3rd decimal place.

Figure 99. WLCSP100 - Recommended footprint

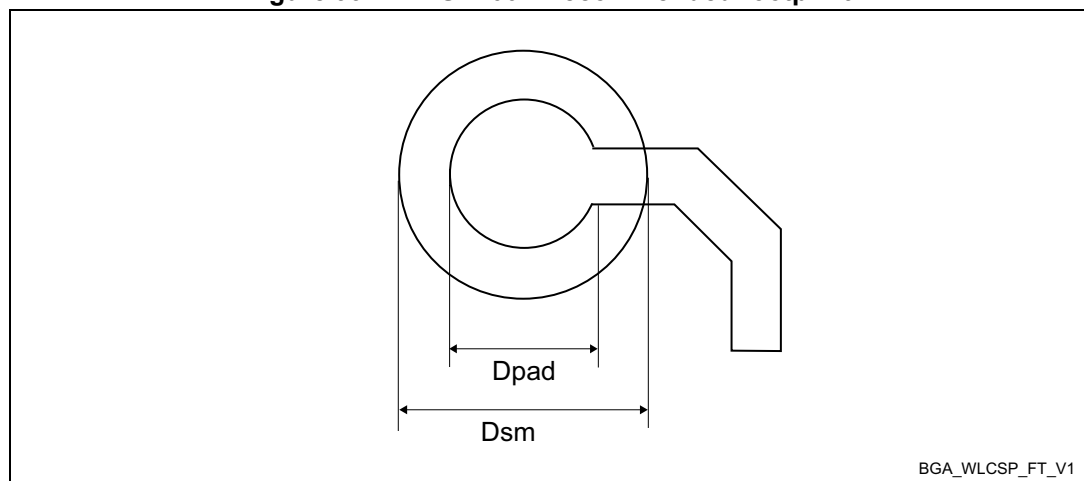


Table 124. WLCSP100 - Recommended PCB design rules

| Dimension         | Recommended values                                               |
|-------------------|------------------------------------------------------------------|
| Pitch             | 0.4 mm                                                           |
| Dpad              | 0.250 mm                                                         |
| Dsm               | 0.290 mm typ. (depends on the soldermask registration tolerance) |
| Stencil opening   | 0.325 mm                                                         |
| Stencil thickness | 0.100 mm                                                         |

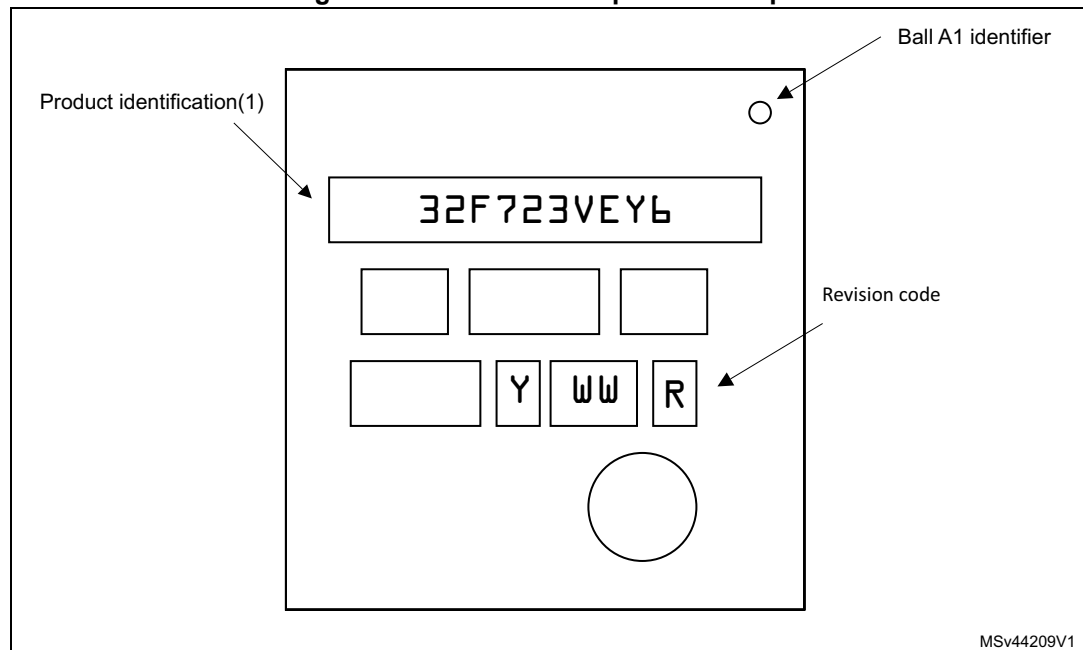
### WLCSP100 device marking

The following figure gives an example of topside marking orientation versus ball A1 identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

**Figure 100. WLCSP100 top view example**



1. Parts marked as ES or E or accompanied by an engineering sample notification letter are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

## 7.8 Thermal characteristics

The maximum chip-junction temperature,  $T_J \text{ max}$ , in degrees Celsius, may be calculated using the following equation:

$$T_J \text{ max} = T_A \text{ max} + (P_D \text{ max} \times \Theta_{JA})$$

Where:

- $T_A \text{ max}$  is the maximum ambient temperature in °C,
- $\Theta_{JA}$  is the package junction-to-ambient thermal resistance, in °C/W,
- $P_D \text{ max}$  is the sum of  $P_{INT} \text{ max}$  and  $P_{I/O} \text{ max}$  ( $P_D \text{ max} = P_{INT} \text{ max} + P_{I/O} \text{ max}$ ),
- $P_{INT} \text{ max}$  is the product of  $I_{DD}$  and  $V_{DD}$ , expressed in Watts. This is the maximum chip internal power.

$P_{I/O} \text{ max}$  represents the maximum power dissipation on output pins where:

$$P_{I/O} \text{ max} = \Sigma (V_{OL} \times I_{OL}) + \Sigma (V_{DD} - V_{OH}) \times I_{OH},$$

taking into account the actual  $V_{OL} / I_{OL}$  and  $V_{OH} / I_{OH}$  of the I/Os at low and high level in the application.

**Table 125. Package thermal characteristics**

| Symbol        | Parameter                                                                    | Value | Unit |
|---------------|------------------------------------------------------------------------------|-------|------|
| $\Theta_{JA}$ | Thermal resistance junction-ambient<br>LQFP64 - 10 × 10 mm / 0.5 mm pitch    | 48.5  | °C/W |
|               | Thermal resistance junction-ambient<br>LQFP100 - 14 × 14 mm / 0.5 mm pitch   | 47.1  |      |
|               | Thermal resistance junction-ambient<br>WLCSP100 - 0.4 mm pitch               | 35.85 |      |
|               | Thermal resistance junction-ambient<br>LQFP144 - 20 × 20 mm / 0.5 mm pitch   | 45.6  |      |
|               | Thermal resistance junction-ambient<br>LQFP176 - 24 × 24 mm / 0.5 mm pitch   | 43.9  |      |
|               | Thermal resistance junction-ambient<br>UFBGA144 - 7 × 7 mm / 0.5 mm pitch    | 42    |      |
|               | Thermal resistance junction-ambient<br>UFBGA176 - 10 × 10 mm / 0.65 mm pitch | 41.2  |      |

### Reference document

JESD51-2 Integrated Circuits Thermal Test Method Environment Conditions - Natural Convection (Still Air). Available from [www.jedec.org](http://www.jedec.org).

## 8 Ordering information

**Table 126. Ordering information scheme**

|                                                                                                     |       |   |     |   |   |   |   |     |
|-----------------------------------------------------------------------------------------------------|-------|---|-----|---|---|---|---|-----|
| Example:                                                                                            | STM32 | F | 722 | V | C | T | 6 | xxx |
| <b>Device family</b>                                                                                |       |   |     |   |   |   |   |     |
| STM32 = Arm-based 32-bit microcontroller                                                            |       |   |     |   |   |   |   |     |
| <b>Product type</b>                                                                                 |       |   |     |   |   |   |   |     |
| F = general-purpose                                                                                 |       |   |     |   |   |   |   |     |
| <b>Device subfamily</b>                                                                             |       |   |     |   |   |   |   |     |
| 722 = STM32F722xx, no OTG PHY HS<br>723 = STM32F723xx, with OTG PHY HS                              |       |   |     |   |   |   |   |     |
| <b>Pin count</b>                                                                                    |       |   |     |   |   |   |   |     |
| R = 64 pins<br>V = 100 pins<br>Z = 144 pins<br>I = 176 pins                                         |       |   |     |   |   |   |   |     |
| <b>Flash memory size</b>                                                                            |       |   |     |   |   |   |   |     |
| C = 256 Kbytes of Flash memory<br>E = 512 Kbytes of Flash memory                                    |       |   |     |   |   |   |   |     |
| <b>Package</b>                                                                                      |       |   |     |   |   |   |   |     |
| T = LQFP<br>K = UFBGA (10 x 10 mm)<br>I = UFBGA (7 x 7 mm)<br>Y = WLCSP                             |       |   |     |   |   |   |   |     |
| <b>Temperature range</b>                                                                            |       |   |     |   |   |   |   |     |
| 6 = Industrial temperature range, –40 to 85 °C.<br>7 = Industrial temperature range, –40 to 105 °C. |       |   |     |   |   |   |   |     |
| <b>Options</b>                                                                                      |       |   |     |   |   |   |   |     |
| xxx = programmed parts<br>TR = tape and reel                                                        |       |   |     |   |   |   |   |     |

For a list of available options (such as speed or package) or for further information on any aspect of this device, contact the nearest ST sales office.

## Appendix A Recommendations when using internal reset OFF

When the internal reset is OFF, the following integrated features are no longer supported:

- The integrated power-on reset (POR) / power-down reset (PDR) circuitry is disabled.
- The brownout reset (BOR) circuitry must be disabled.
- The embedded programmable voltage detector (PVD) is disabled.
- $V_{BAT}$  functionality is no more available and VBAT pin should be connected to  $V_{DD}$ .
- The over-drive mode is not supported.

### A.1 Operating conditions

Table 127. Limitations depending on the operating power supply range

| Operating power supply range    | ADC operation                  | Maximum Flash memory access frequency with no wait states ( $f_{Flashmax}$ ) | Maximum Flash memory access frequency with wait states <sup>(1)(2)</sup> | I/O operation         | Possible Flash memory operations        |
|---------------------------------|--------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------|-----------------------------------------|
| $V_{DD} = 1.7$ to $2.1 V^{(3)}$ | Conversion time up to 1.2 Msps | 20 MHz                                                                       | 180 MHz with 8 wait states and over-drive OFF                            | – No I/O compensation | 8-bit erase and program operations only |

1. Applicable only when the code is executed from Flash memory. When the code is executed from RAM, no wait state is required.
2. Thanks to the ART accelerator on ITCM interface and L1-cache on AXI interface, the number of wait states given here does not impact the execution speed from the Flash memory since the ART accelerator or L1-cache is used to achieve a performance equivalent to 0-wait state program execution.
3.  $V_{DD}/V_{DDA}$  minimum value of 1.7 V, with the use of an external power supply supervisor (refer to [Section 3.15.1: Internal reset ON](#)).

## 9 Revision history

**Table 128. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 03-Feb-2017 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 30-Mar-2017 | 2        | Updated cover with the maximum SPI speed at 54 Mbit/s.<br>Updated <i>Figure 14: STM32F732xx LQFP64 pinout</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 01-Jun-2017 | 3        | Updated <i>Figure 16: STM32F733xx WLCSP100 ballout (with OTG PHY HS)</i> .<br>Updated note 1 below all the package device marking figures.<br>Updated <i>Section 1: Introduction</i> .<br>Updated <i>Table 60: I/O current injection susceptibility</i> note by 'injection is not possible'.<br>Updated <i>Table 67: ADC characteristics</i> $R_{ADC}$ min at 1.5 k $\Omega$<br>Updated <i>Figure 45: Recommended NRST pin protection</i> note about the 0.1uF capacitor.<br>Updated <i>Table 78: DAC characteristics</i> $R_{LOAD}$ feature.<br>Updated <i>Figure 39: ACCHSI versus temperature</i> .                                                                                                                                                                                                                                                            |
| 10-Apr-2018 | 4        | Added <i>Section 1: Introduction</i> .<br>Removed memory mapping, transferred in the reference manual (RM0431).<br>Updated <i>Table 10: STM32F732xx and STM32F733xx pin and ball definition</i> footnote 5 only for PC14, PC15, PH0, PH1.<br>Updated <i>Table 125: Package thermal characteristics</i> thermal values for LQFP packages.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 23-Mar-2020 | 5        | Updated <i>Table 1: Device summary</i> adding STM32F723VC.<br>Added LQFP100 package for STM32F723xx devices:<br>– Updated <i>Table 2: STM32F722xx and STM32F723xx features and peripheral counts</i> .<br>– Updated <i>Section 2.2: STM32F723xx versus STM32F722xx LQFP100/ LQFP144/ LQFP176 packages</i> .<br>– Added <i>Figure 3: Compatible board design for LQFP100 package</i> .<br>– Added <i>Figure 17: STM32F723xx LQFP100 pinout</i> .<br>– Updated <i>Table 10: STM32F722xx and STM32F723xx pin and ball definition</i><br>Added VDDPHYS<br>– Updated <i>Figure 6: STM32F722xx and STM32F723xx block diagram</i> .<br>– Updated <i>Figure 29: STM32F723xx power supply scheme</i> .<br>– Updated <i>Table 13: Voltage characteristics</i><br>– Updated <i>Table 16: General operating conditions</i><br>Updated <i>Section 7: Package information</i> . |
| 04-Apr-2020 | 6        | Updated <i>Table 53: Flash memory programming</i> maximum programming voltage ( $V_{prog}$ ) for 32-bit Flash program operation at 3.6V (instead of 3V).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 05-Nov-2020 | 7        | Updated<br>– <i>Section 2: Description</i><br>– <i>Section 2.1: Full compatibility throughout the family</i><br>– Note 1 of <i>Table 42: HSI oscillator characteristics</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3-Feb-2022  | 8        | Updated:<br>– <a href="#">Section 7.7: WLCSP100 package information</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

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