



THE DATASHEET OF STM32H725RGV6



Arm[®] Cortex[®]-M7 32-bit 550 MHz MCU, up to 1 MB Flash, 564 KB RAM, Ethernet, USB, 3x FD-CAN, Graphics, 2x 16-bit ADCs

Datasheet - production data

Features

Includes ST state-of-the-art patented technology

Core

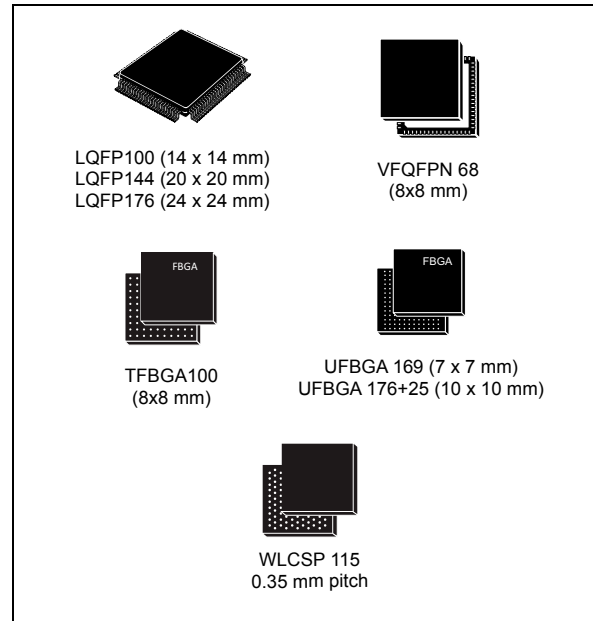
- 32-bit Arm[®] Cortex[®]-M7 CPU with DP-FPU, L1 cache: 32-Kbyte data cache and 32-Kbyte instruction cache allowing 0-wait state execution from embedded Flash memory and external memories, frequency up to 550 MHz, MPU, 1177 DMIPS/2.14 DMIPS/MHz (Dhrystone 2.1), and DSP instructions

Memories

- Up to 1 Mbyte of embedded Flash memory with ECC
- SRAM: total 564 Kbytes all with ECC, including 128 Kbytes of data TCM RAM for critical real-time data + 432 Kbytes of system RAM (up to 256 Kbytes can remap on instruction TCM RAM for critical real time instructions) + 4 Kbytes of backup SRAM (available in the lowest-power modes)
- Flexible external memory controller with up to 24-bit data bus: SRAM, PSRAM, SDRAM/LPSDR SDRAM, NOR/NAND memories
- 2 x Octo-SPI interface with XiP
- 2 x SD/SDIO/MMC interface
- Bootloader

Graphics

- Chrom-ART Accelerator graphical hardware accelerator enabling enhanced graphical user interface to reduce CPU load
- LCD-TFT controller supporting up to XGA resolution



Clock, reset and supply management

- 1.62 V to 3.6 V application supply and I/O
- POR, PDR, PVD and BOR
- Dedicated USB power
- Embedded DCDC and LDO regulator (*VFQFPN68 variant is DCDC only)
- Internal oscillators: 64 MHz HSI, 48 MHz HSI48, 4 MHz CSI, 32 kHz LSI
- External oscillators: 4-50 MHz HSE, 32.768 kHz LSE

Low power

- Sleep, Stop and Standby modes
- V_{BAT} supply for RTC, 32×32-bit backup registers

Analog

- 2×16-bit ADC, up to 3.6 MSPS in 16-bit: up to 22 channels and 7.2 MSPS in double-interleaved mode

- 1 x 12-bit ADC, up to 5 MSPS in 12-bit, up to 12 channels
- 2 x comparators
- 2 x operational amplifier GBW = 8 MHz
- 2x 12-bit D/A converters

Digital filters for sigma delta modulator (DFSDM)

- 8 channels/4 filters

4 DMA controllers to offload the CPU

- 1 x MDMA with linked list support
- 2 x dual-port DMAs with FIFO
- 1 x basic DMA with request router capabilities

24 timers

- Seventeen 16-bit (including 5 x low power 16-bit timer available in stop mode) and four 32-bit timers, each with up to 4 IC/OC/PWM or pulse counter and quadrature (incremental) encoder input
- 2x watchdogs, 1x SysTick timer

Debug mode

- SWD and JTAG interfaces
- 2-Kbyte embedded trace buffer

Up to 128 I/O ports with interrupt capability

Up to 35 communication interfaces

- Up to 5 x I2C FM+ interfaces (SMBus/PMBus™)
- Up to 5 USARTs/5 UARTs (ISO7816 interface, LIN, IrDA, modem control) and 1 x LPUART
- Up to 6 SPIs with 4 with muxed duplex I2S for audio class accuracy via internal audio PLL or

external clock and up to 5 x SPI (from 5 x USART when configured in synchronous mode)

- 2x SAI (serial audio interface)
- 1x FD/TT-CAN and 2x FD-CAN
- 8- to 14-bit camera interface
- 16-bit parallel slave synchronous interface
- SPDIF-IN interface
- HDMI-CEC
- Ethernet MAC interface with DMA controller
- USB 2.0 high-speed/full-speed device/host/OTG controller with dedicated DMA, on-chip FS PHY and ULPI for external HS PHY
- SWPMI single-wire protocol master I/F
- MDIO slave interface

Mathematical acceleration

- CORDIC for trigonometric functions acceleration
- FMAC: Filter mathematical accelerator

Digital temperature sensor

True random number generator

CRC calculation unit

RTC with sub-second accuracy and hardware calendar

ROP, PC-ROP, tamper detection

96-bit unique ID

All packages are ECOPACK2 compliant

Table 1. Device summary

| Reference | Part number |
|-------------|---|
| STM32H725xE | STM32H725ZE, STM32H725VE, STM32H725RE, STM32H725IE, STM32H725AE |
| STM32H725xG | STM32H725ZG, STM32H725VG, STM32H725RG, STM32H725IG, STM32H725AG |

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1 Introduction

This document provides information on STM32H725xE/G microcontrollers, such as description, functional overview, pin assignment and definition, packaging, and ordering information.

This document should be read in conjunction with the STM32H725xE/G reference manual (RM0468), available from the STMicroelectronics website www.st.com.

For information on the device errata with respect to the datasheet and reference manual, refer to the STM32H725 errata sheet (ES0491) available on the STMicroelectronics website www.st.com.

For information on the Arm^{®(a)} Cortex[®]-M7 core, refer to the Cortex[®]-M7 Technical Reference Manual, available from the <http://www.arm.com> website.

The logo for Arm, consisting of the word "arm" in a bold, lowercase, sans-serif font.

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2 Description

STM32H725xE/G devices are based on the high-performance Arm® Cortex®-M7 32-bit RISC core operating at up to 550 MHz. The Cortex® -M7 core features a floating point unit (FPU) which supports Arm® double-precision (IEEE 754 compliant) and single-precision data-processing instructions and data types. The Cortex -M7 core includes 32 Kbytes of instruction cache and 32 Kbytes of data cache. STM32H725xE/G devices support a full set of DSP instructions and a memory protection unit (MPU) to enhance application security.

STM32H725xE/G devices incorporate high-speed embedded memories with up to 1 Mbyte of Flash memory, up to 564 Kbytes of RAM (including 192 Kbytes that can be shared between ITCM and AXI, plus 64 Kbytes exclusively ITCM, plus 128 Kbytes exclusively AXI, 128 Kbyte DTCM, 48 Kbytes AHB and 4 Kbytes of backup RAM), as well as an extensive range of enhanced I/Os and peripherals connected to APB buses, AHB buses, 2x32-bit multi-AHB bus matrix and a multi layer AXI interconnect supporting internal and external memory access. To improve application robustness, all memories feature error code correction (one error correction, two error detections).

The devices embed peripherals allowing mathematical/arithmetic function acceleration (CORDIC coprocessor for trigonometric functions and FMAC unit for filter functions). All the devices offer three ADCs, two DACs, two operational amplifiers, two ultra-low power comparators, a low-power RTC, 4 general-purpose 32-bit timers, 12 general-purpose 16-bit timers including two PWM timers for motor control, five low-power timers, a true random number generator (RNG). The devices support four digital filters for external sigma-delta modulators (DFSDM). They also feature standard and advanced communication interfaces.

- Standard peripherals
 - Five I²Cs
 - Five USARTs, five UARTs and one LPUART
 - Six SPIs, four I²Ss in Half-duplex mode. To achieve audio class accuracy, the I²S peripherals can be clocked by a dedicated internal audio PLL or by an external clock to allow synchronization (note that the five USARTs also provide SPI slave capability).
 - Two SAI serial audio interfaces
 - One SPDIFRX interface with four inputs
 - One SWPMI (Single Wire Protocol Master Interface)
 - Management Data Input/Output (MDIO) slaves
 - Two SDMMC interfaces
 - A USB OTG high-speed interface with full-speed capability (with the ULPI)
 - Two FDCANs plus one TT-FDCAN interface
 - An Ethernet interface
 - Chrom-ART Accelerator
 - HDMI-CEC

- Advanced peripherals including
 - A flexible memory control (FMC) interface
 - Two Octo-SPI memory interfaces
 - A camera interface for CMOS sensors
 - An LCD-TFT display controller

Refer to [Table 2: STM32H725xE/G features and peripheral counts](#) for the list of peripherals available on each part number.

To reduce the power consumption the STM32H725xE/G include an optional step-down converter that can be used either for internal or external supply, or both.

STM32H725xE/G devices operate in the -40 to $+125$ °C ambient temperature range from a 1.62 to 3.6 V power supply. The supply voltage can drop down to 1.62 V by using an external power supervisor (see [Section 3.7.2: Power supply supervisor](#)) and connecting the PDR_ON pin to V_{SS} . Otherwise the supply voltage must stay above 1.71 V with the embedded power voltage detector enabled.

Dedicated supply inputs for USB are available to allow a greater power supply choice.

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

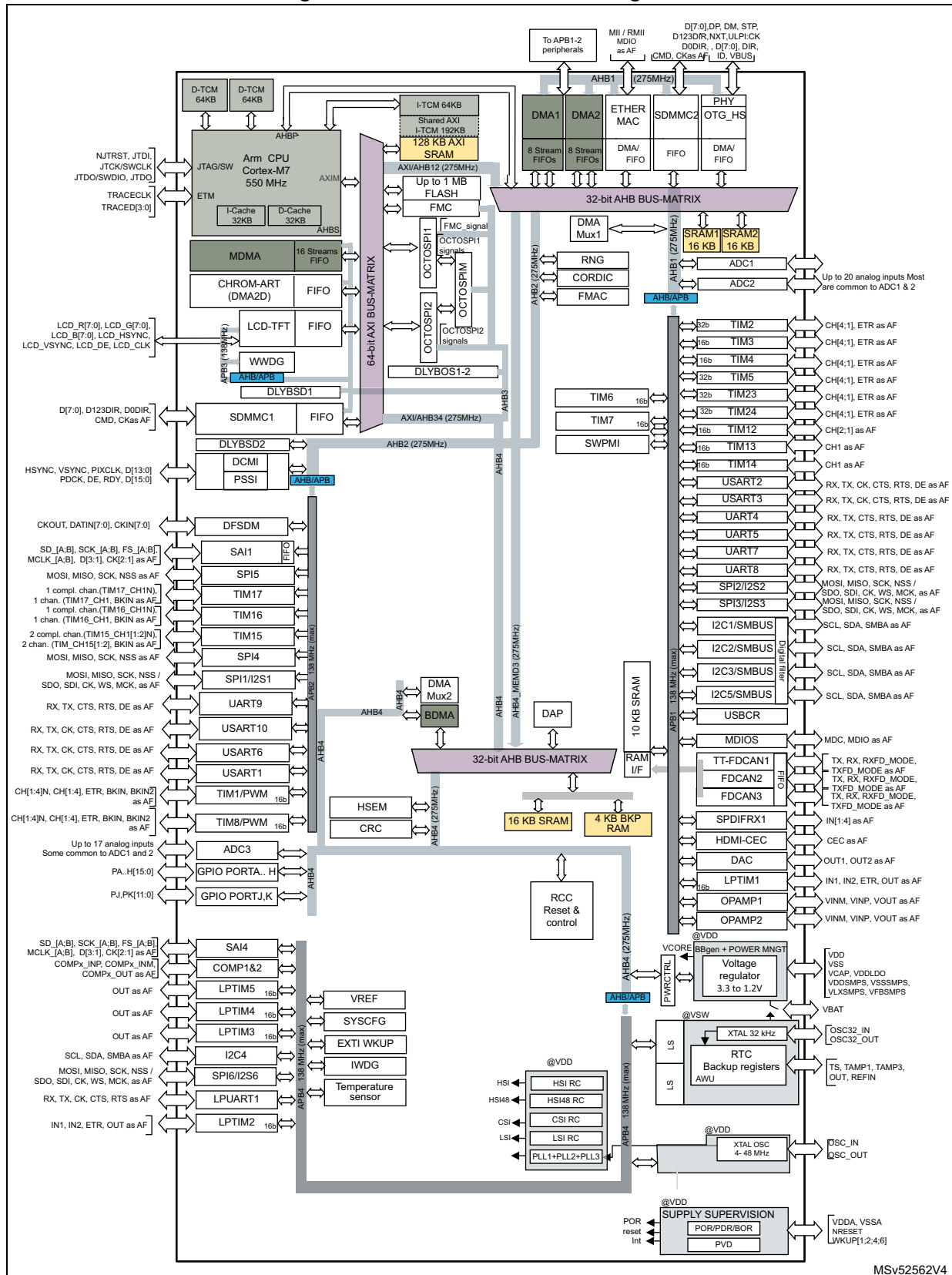
STM32H725xE/G devices are offered in several packages ranging from 68 to 176 pins/balls. The set of included peripherals changes with the device chosen.

These features make STM32H725xE/G 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.

[Figure 1](#) shows the device block diagram.

Figure 1. STM32H725xE/G block diagram



MSv52562V4



Table 2. STM32H725xE/G features and peripheral counts

| Peripherals | | STM32H725REV/RGV | STM32H725VET/VGT | STM32H725VEH/VGH | STM32H725ZET/ZGT | STM32H725VGY | STM32H725AEI/AGI | STM32H725IEK/IGK | STM32H725IET/IGT |
|--|--|------------------|------------------|------------------|------------------|--------------|------------------|------------------|------------------|
| Flash memory (Kbytes) | | 512/1024 | 512/1024 | 512/1024 | 512/1024 | 1024 | 512/1024 | 512/1024 | 512/1024 |
| SRAM (Kbytes) | SRAM mapped onto AXI bus | 128 | | | | | | | |
| | SRAM1 (D2 domain) | 16 | | | | | | | |
| | SRAM2 (D2 domain) | 16 | | | | | | | |
| | SRAM4 (D3 domain) | 16 | | | | | | | |
| RAM shared between ITCM and AXI (Kbytes) | | 192 | | | | | | | |
| TCM RAM in Kbytes | ITCM RAM (instruction) | 64 | | | | | | | |
| | DTCM RAM (data) | 128 | | | | | | | |
| Backup SRAM (Kbytes) | | 4 | | | | | | | |
| FMC | Interface | 1 | | | | | | | |
| | NOR Flash memory/ RAM controller | - | - | - | - | - | yes | yes | yes |
| | Multiplexed I/O NOR Flash memory | - | yes | yes | yes | - | yes | yes | yes |
| | 16-bit NAND Flash memory | - | yes | yes | yes | yes | yes | yes | yes |
| | 16-bit SDRAM controller | - | - | - | - | - | yes | yes | yes |
| | 24-bit SDRAM controller ⁽¹⁾ | - | - | - | - | - | - | yes | - |
| GPIO | | 46 | 67 | 74 | 97 | 67 | 121 | 128 | 119 |
| Octo-SPI interface | | 1 Quad-SPI | 1 Quad-SPI | 1 | 1 | 2 Quad-SPI | 2 | 2 | 2 |
| OTFDEC | | no | | | | | | | |
| Cordic | | yes | | | | | | | |
| FMAC | | yes | | | | | | | |

Table 2. STM32H725xE/G features and peripheral counts (continued)

| Peripherals | | STM32H725REV/RGV | STM32H725VET/VGT | STM32H725VEH/VGH | STM32H725ZET/ZGT | STM32H725VGY | STM32H725AEI/AGI | STM32H725IEK/IGK | STM32H725IET/IGT | |
|---------------------------|--|--------------------|--------------------|--------------------|------------------|--------------------|------------------|------------------|------------------|---------|
| Timers | General purpose 32 bits | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | |
| | General purpose 16 bits | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | |
| | Advanced control (PWM) | 2 ⁽²⁾ | 2 | 2 ⁽²⁾ | 2 | 2 | 2 | 2 | 2 | |
| | Basic | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | |
| | Low-power | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | |
| | RTC | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | Window watchdog / independent watchdog | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | |
| Wakeup pins | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | |
| Tamper pins | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | |
| Random number generator | yes | | | | | | | | | |
| Cryptographic accelerator | no | | | | | | | | | |
| Communication interfaces | SPI / I2S | 4/4 | 5/4 ⁽²⁾ | 5/4 | 6/4 | 4/4 | 6/4 | 6/4 | 6/4 | |
| | I2C | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | |
| | USART/UART/LPUART | 3/4/1 | 4/4/1 | 4/6/1 | 5/5/1 | 4/4/1 | 5/5/1 | 5/5/1 | 5/5/1 | |
| | SAI/PDM | 1/0 ⁽²⁾ | 2/1 ⁽²⁾ | 2/1 ⁽²⁾ | 2/1 | 1/1 ⁽²⁾ | 2/1 | 2/1 | 2/1 | |
| | SPDIFRX | 1 | | | | | | | | |
| | HDMI-CEC | 1 | | | | | | | | |
| | SWPMI | 1 | | | | | | | | |
| | MDIO | 1 | | | | | | | | |
| | SDMMC | 2 | | | | | | | | |
| | FDCAN/TT-FDCAN | 1/1 | 2/1 | 2/1 | 2/1 | 2/1 | 2/1 | 2/1 | 2/1 | 2/1 |
| | USB [OTG_HS (ULPI)/FS(PHY)] | 1 [0/1] | 1 [1/1] | 1 [1/1] | 1 [1/1] | 1 [0/1] | 1 [1/1] | 1 [1/1] | 1 [1/1] | 1 [1/1] |
| | Ethernet [MII/RMII] | - | 1 [1/1] | 1 [1/1] | 1 [1/1] | 1 [0/1] | 1 [1/1] | 1 [1/1] | 1 [1/1] | 1 [1/1] |

Table 2. STM32H725xE/G features and peripheral counts (continued)

| Peripherals | | STM32H725REV/RGV | STM32H725VET/VGT | STM32H725VEH/VGH | STM32H725ZET/ZGT | STM32H725VGY | STM32H725AEI/AGI | STM32H725IEK/IGK | STM32H725IET/IGT |
|-------------------------------|-------------------------------------|--------------------|--------------------|--------------------|------------------|--------------|------------------|------------------|------------------|
| Camera interface/PSSI | | yes | | | | | | | |
| LCD-TFT | | yes ⁽²⁾ | yes ⁽²⁾ | yes ⁽²⁾ | yes | yes | yes | yes | yes |
| Chrom-ART Accelerator (DMA2D) | | yes | | | | | | | |
| 16-bit ADCs | Number of ADCs | 2 | | | | | | | |
| | Number of Direct channels ADC1/ADC2 | 0 | 0 | 2/2 | 0 | 2/2 | 2/2 | 2/2 | 0 |
| | Number of Fast channels ADC1/ADC2 | 3/2 | 3/2 | 3/2 | 4/2 | 3/2 | 6/5 | 6/5 | 4/3 |
| | Number of Slow channels ADC1/ADC2 | 11/10 | 11/10 | 9/8 | 11/11 | 9/8 | 12/11 | 12/11 | 12/11 |
| 12-bit ADCs | Number of ADCs | 1 | | | | | | | |
| | Number of Direct channels | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Number of Fast channels | 0 | 2 | 6 | 4 | 6 | 6 | 6 | 6 |
| | Number of Slow channels | 2 | 0 | 9 | 3 | 9 | 9 | 9 | 4 |
| 12-bit DAC | Present in IC | yes | | | | | | | |
| | Number of channels | 2 | | | | | | | |
| Comparators | | 2 | | | | | | | |
| Operational amplifiers | | 2 | | | | | | | |
| DFSDM | Present in IC | yes | | | | | | | |
| Maximum CPU frequency | | 550 MHz | | | | | | | |
| USB separate supply pad | | - | yes | yes | yes | yes | yes | yes | yes |
| USB internal regulator | | - | - | - | yes | yes | yes | yes | yes |
| LDO | | - | yes | yes | yes | | | | |
| SMPS step-down converter | | yes | | | | | | | |

Table 2. STM32H725xE/G features and peripheral counts (continued)

| Peripherals | | STM32H725REV/RGV | STM32H725VET/VGT | STM32H725VEH/VGH | STM32H725ZET/ZGT | STM32H725V GY | STM32H725AEI/AGI | STM32H725IEK/IGK | STM32H725IET/IGT |
|--|----------------------|------------------|------------------|------------------|--------------------------------|---------------|------------------|------------------|------------------|
| Operating voltage | | 1.71 to 3.6 V | | | 1.62 to 3.6 V 1.62 to 3.6 V | | | | |
| Operating temperatures | Ambient temperature | -40°C to +85°C | | | | | | | |
| | Junction temperature | -40°C to +125°C | | | | | | | |
| Extended operating temperatures ⁽³⁾ | Ambient temperature | -40°C to +125°C | | | | | | | |
| | Junction temperature | -40°C to +140°C | | | | | | | |
| Package | | VFQFPN 68 | LQFP 100 | TFBGA 100 | LQFP 144 | WLCSP 115 | UFBGA 169 | UFBGA 176+25 | LQFP17 6 |

1. The 24-bit SDRAM controller is a 32-bit controller with only a 24-bit data bus and without NBL2-3. It can be used for graphical purposes to access aligned 32-bit words ignoring upper 8 bits.
2. For limitations on peripheral features depending on packages, check the available pins/balls in [Table 8: STM32H725 pin and ball descriptions](#).
3. The extended temperature range is not available on WLCSP115 package.

3 Functional overview

3.1 Arm[®] Cortex[®]-M7 with FPU

The Arm[®] Cortex[®]-M7 with double-precision 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 optimized 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 architecture with L1 caches (32 Kbytes of I-cache and 32 Kbytes of D-cache)
- 64-bit AXI interface
- 64-bit ITCM interface
- 2x32-bit DTCM interfaces

The following memory interfaces are supported:

- Separate Instruction and Data buses (Harvard Architecture) to optimize CPU latency
- Tightly Coupled Memory (TCM) interface designed for fast and deterministic SRAM accesses
- AXI Bus interface to optimize Burst transfers
- Dedicated low-latency AHB-Lite peripheral bus (AHBP) to connect to peripherals.

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

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

[Figure 1](#) shows the general block diagram of the STM32H725xE/G family.

3.2 Memory protection unit (MPU)

The memory protection unit (MPU) manages the CPU access rights and the attributes of the system resources. It has to be programmed and enabled before use. Its main purposes are to prevent an untrusted user program to accidentally corrupt data used by the OS and/or by a privileged task, but also to protect data processes or read-protect memory regions.

The MPU defines access rules for privileged accesses and user program accesses. It allows defining up to 16 protected regions that can in turn be divided into up to 8 independent subregions, where region address, size, and attributes can be configured. The protection area ranges from 32 bytes to 4 Gbytes of addressable memory.

When an unauthorized access is performed, a memory management exception is generated.

3.3 Memories

3.3.1 Embedded Flash memory

The STM32H725xE/G devices embed up to 1 Mbyte of Flash memory that can be used for storing programs and data.

The Flash memory is organized as 266-bit Flash words memory that can be used for storing both code and data constants. Each word consists of:

- one Flash word (8 words, 32 bytes or 256 bits)
- 10 ECC bits (single-error correction and double-error detection).

The Flash memory is organized as follows:

- up to 1 Mbyte of user Flash memory block containing eight user sectors of 128 Kbytes (4 K Flash memory words)
- 128 Kbytes of system Flash memory from which the device can boot
- 2 Kbytes (64 Flash words) of user option bytes for user configuration

3.3.2 Embedded SRAM

All devices feature:

- from 128 to 320 Kbytes of AXI-SRAM mapped onto the AXI bus on D1 domain
- SRAM1 mapped on D2 domain: 16 Kbytes
- SRAM2 mapped on D2 domain: 16 Kbytes
- SRAM4 mapped on D3 domain: 16 Kbytes
- 4 Kbytes of backup SRAM

The content of this area is protected against possible unwanted write accesses, and can be retained in Standby or V_{BAT} mode.

- RAM mapped to TCM interface (ITCM and DTCM):

Both ITCM and DTCM RAMs are 0 wait state memories. They can be accessed either from the CPU or the MDMA (even in Sleep mode) through a specific AHB slave of the Cortex®-M7CPU(AHBSAHBP):

- 64 to 256 Kbytes of ITCM-RAM (instruction RAM)

This RAM is connected to ITCM 64-bit interface designed for execution of critical real-times routines by the CPU.

- 128 Kbytes of DTCM-RAM (2x 64-Kbyte DTCM-RAMs on 2x32-bit DTCM ports)

The DTCM-RAM could be used for critical real-time data, such as interrupt service routines or stack/heap memory. Both DTCM-RAMs can be used in parallel (for load/store operations) thanks to the Cortex®-M7 dual issue capability.

The MDMA can be used to load code or data in ITCM or DTCM RAMs. As reflected above, 192 Kbyte of RAM can be used either for AXI SRAM or ITCM, with a 64Kbyte granularity.

Error code correction (ECC)

Over the product lifetime, and/or due to external events such as radiations, invalid bits in memories may occur. They can be detected and corrected by ECC. This is an expected behavior that has to be managed at final-application software level in order to ensure data integrity through ECC algorithms implementation.

SRAM data are protected by ECC:

- 7 ECC bits are added per 32-bit word.
- 8 ECC bits are added per 64-bit word for AXI-SRAM and ITCM-RAM.

The ECC mechanism is based on the SECDED algorithm. It supports single-error correction and double-error detection.

3.4 Boot modes

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

- All Flash address space
- All RAM address space: ITCM, DTCM RAMs and SRAMs
- The System memory bootloader

The boot loader is located in non-user System memory. It is used to reprogram the Flash memory through a serial interface (USART, I2C, SPI, FDCAN, USB-DFU). Refer to application note AN2606 “*STM32 microcontroller System memory Boot mode*” for details.

3.5 CORDIC co-processor (CORDIC)

The CORDIC co-processor provides hardware acceleration of certain mathematical functions, notably trigonometric, commonly used in motor control, metering, signal processing and many other applications.

It speeds up the calculation of these functions compared to a software implementation, allowing a lower operating frequency, or freeing up processor cycles in order to perform other tasks.

The filter mathematical accelerator unit performs arithmetic operations on vectors. It comprises a multiplier/accumulator (MAC) unit, together with address generation logic, which allows it to index vector elements held in local memory.

The unit includes support for circular buffers on input and output, which allows digital filters to be implemented. Both finite and infinite impulse response filters can be realized.

The unit allows frequent or lengthy filtering operations to be offloaded from the CPU, freeing up the processor for other tasks. In many cases it can accelerate such calculations compared to a software implementation, resulting in a speed-up of time critical tasks.

CORDIC features

- 24-bit CORDIC rotation engine
- Circular and Hyperbolic modes
- Rotation and Vectoring modes
- Functions: Sine, Cosine, Sinh, Cosh, Atan, Atan2, Atanh, Modulus, Square root, Natural logarithm
- Programmable precision up to 20-bit
- Fast convergence: 4 bits per clock cycle
- Supports 16-bit and 32-bit fixed point input and output formats
- Low latency AHB slave interface
- Results can be read as soon as ready without polling or interrupt
- DMA read and write channels

3.6 Filter mathematical accelerator (FMAC)

The filter mathematical accelerator unit performs arithmetic operations on vectors. It comprises a multiplier/accumulator (MAC) unit, together with address generation logic, which allows it to index vector elements held in local memory.

The unit includes support for circular buffers on input and output, which allows digital filters to be implemented. Both finite and infinite impulse response filters can be realized.

The unit allows frequent or lengthy filtering operations to be offloaded from the CPU, freeing up the processor for other tasks. In many cases it can accelerate such calculations compared to a software implementation, resulting in a speed-up of time critical tasks.

FMAC features

- 16 x 16-bit multiplier
- 24+2-bit accumulator with addition and subtraction
- 16-bit input and output data
- 256 x 16-bit local memory
- Up to three areas can be defined in memory for data buffers (two input, one output), defined by programmable base address pointers and associated size registers
- Input and output sample buffers can be circular
- Buffer “watermark” feature reduces overhead in interrupt mode
- Filter functions: FIR, IIR (direct form 1)
- AHB slave interface
- DMA read and write data channels

3.7 Power supply management

3.7.1 Power supply scheme

STM32H725xE/G power supply voltages are the following:

- V_{DD} = 1.62 to 3.6 V: external power supply for I/Os, provided externally through V_{DD} pins.
- V_{DDLDO} = 1.62 to 3.6 V: supply voltage for the internal regulator supplying V_{CORE}
- V_{DDA} = 1.62 to 3.6 V: external analog power supplies for ADC, DAC, COMP and OPAMP.
- $V_{DD33USB}$: allows the support of a V_{DD} supply different from 3.3 V while powering the USB transceiver with 3.3V on $V_{DD33USB}$.
- $V_{DD50USB}$ can be supplied through the USB cable to generate the $V_{DD33USB}$ via the USB internal regulator. This allows support of a V_{DD} supply different to 3.3 V.
The USB regulator can be bypassed to supply directly $V_{DD33USB}$ if $V_{DD} = 3.3$ V.
- V_{BAT} = 1.2 to 3.6 V: power supply for the V_{SW} domain when V_{DD} is not present.
- V_{CAP} : V_{CORE} supply voltage, which values depend on voltage scaling (1.0 V, 1.1 V, 1.2 V or 1.35 V). They are configured through VOS bits in PWR_D3CR register. The

V_{CORE} domain is split into the following power domains that can be independently switch off.

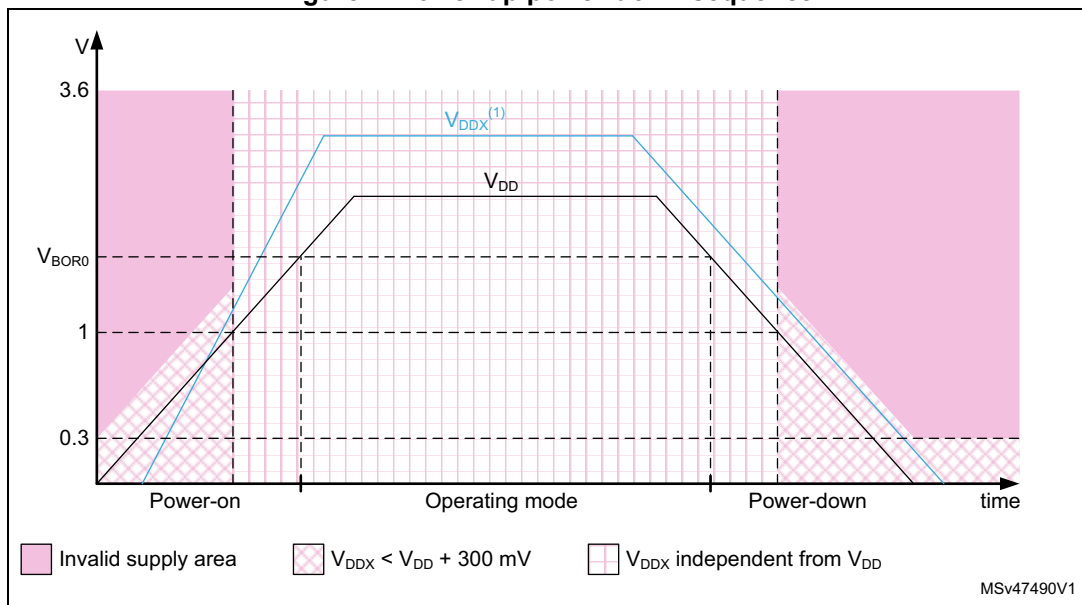
- D1 domain containing some peripherals and the Cortex®-M7 core
- D2 domain containing a large part of the peripherals
- D3 domain containing some peripherals and the system control
- V_{DDSMPS} = 1.62 V to 3.6 V: SMPS step-down converter power supply V_{DDSMPS} must be kept at the same voltage level as V_{DD}
- V_{LXSMPS} = SMPS step-down converter output coupled to an inductor
- V_{FBSMPS} = V_{CORE} or 1.8 V or 2.5 V external SMPS step-down converter feedback voltage sense input.

During power-up and power-down phases, the following power sequence requirements must be respected (see [Figure 2](#)):

- When V_{DD} is below V_{DDmin} , other power supplies (V_{DDA} , $V_{DD33USB}$, $V_{DD50USB}$) must remain below $V_{DD} + 300$ mV.
- When V_{DD} is above V_{DDmin} , all power supplies are independent.

During the power-down phase, V_{DD} can temporarily become lower than other supplies only if the energy provided to the microcontroller remains below 1 mJ. This allows external decoupling capacitors to be discharged with different time constants during the power-down transient phase.

Figure 2. Power-up/power-down sequence



1. V_{DDx} refers to any power supply among V_{DDA} , $V_{DD33USB}$, $V_{DD50USB}$.

3.7.2 Power supply supervisor

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

- Power-on reset (POR)
The POR supervisor monitors V_{DD} power supply and compares it to a fixed threshold. The devices remain in Reset mode when V_{DD} is below this threshold,
- Power-down reset (PDR)
The PDR supervisor monitors V_{DD} power supply. A reset is generated when V_{DD} drops below a fixed threshold.
The PDR supervisor can be enabled/disabled through PDR_ON pin.
- Brownout reset (BOR)
The BOR supervisor monitors V_{DD} power supply. Three BOR thresholds (from 2.1 to 2.7 V) can be configured through option bytes. A reset is generated when V_{DD} drops below this threshold.

3.7.3 Voltage regulator

The same voltage regulator supplies the 3 power domains (D1, D2 and D3). D1 and D2 can be independently switched off.

Voltage regulator output can be adjusted according to application needs through 6 power supply levels:

- Run mode (VOS0 to VOS3)
 - Scale 0: boosted performance
 - Scale 1: high performance
 - Scale 2: medium performance and consumption
 - Scale 3: optimized performance and low-power consumption
- Stop mode (SVOS3 to SVOS5)
 - Scale 3: peripheral with wakeup from Stop mode capabilities (UART, SPI, I2C, LPTIM) are operational
 - Scale 4 and 5 where the peripheral with wakeup from Stop mode is disabled. The peripheral functionality is disabled but wakeup from Stop mode is possible through GPIO or asynchronous interrupt.

3.8 Low-power strategy

There are several ways to reduce power consumption on STM32H725xE/G:

- Decrease the dynamic power consumption by slowing down the system clocks even in Run mode and by individually clock gating the peripherals that are not used.
- Save power when the CPU is idle, by selecting among the available low-power modes according to the user application needs. This allows the best compromise between short startup time and low power consumption to be achieved, according to the available wakeup sources.

The devices feature several low-power modes:

- CSleep (CPU clock stopped)
- CStop (CPU sub-system clock stopped)
- DStop (Domain bus matrix clock stopped)
- Stop (System clock stopped)
- DStandby (Domain powered down)
- Standby (System powered down)

CSleep and CStop low-power modes are entered by the MCU when executing the WFI (Wait for Interrupt) or WFE (Wait for Event) instructions, or when the SLEEPONEXIT bit of the Cortex[®]-Mx core is set after returning from an interrupt service routine.

A domain can enter low-power mode (DStop or DStandby) when the processor, its subsystem and the peripherals allocated in the domain enter low-power mode.

If part of the domain is not in low-power mode, the domain remains in the current mode.

Finally the system can enter Stop or Standby when all EXTI wakeup sources are cleared and the power domains are in DStop or DStandby mode.

Table 3. System versus domain low-power mode

| System power mode | D1 domain power mode | D2 domain power mode | D3 domain power mode |
|-------------------|----------------------|----------------------|----------------------|
| Run | DRun/DStop/DStandby | DRun/DStop/DStandby | DRun |
| Stop | DStop/DStandby | DStop/DStandby | DStop |
| Standby | DStandby | DStandby | DStandby |

3.9 Reset and clock controller (RCC)

The clock and reset controller is located in D3 domain. The RCC manages the generation of all the clocks, as well as the clock gating and the control of the system and peripheral resets. It provides a high flexibility in the choice of clock sources and allows to apply clock ratios to improve the power consumption. In addition, on some communication peripherals that are capable to work with two different clock domains (either a bus interface clock or a kernel peripheral clock), thus the system frequency can be changed without modifying the baudrate.

3.9.1 Clock management

The devices embed four internal oscillators, two oscillators with external crystal or resonator, two internal oscillators with fast startup time and three PLLs.

The RCC receives the following clock source inputs:

- Internal oscillators:
 - 64 MHz HSI clock
 - 48 MHz RC oscillator
 - 4 MHz CSI clock
 - 32 kHz LSI clock
- External oscillators:
 - HSE clock: 4-50 MHz (generated from an external source) or 4-48 MHz (generated from a crystal/ceramic resonator)
 - LSE clock: 32.768 kHz

The RCC provides three PLLs: one for system clock, two for kernel clocks.

The system starts on the HSI clock. The user application can then select the clock configuration.

3.9.2 System reset sources

Power-on reset initializes all registers while system reset reinitializes the system except for the debug, part of the RCC and power controller status registers, as well as the backup power domain.

A system reset is generated in the following cases:

- Power-on reset (pwr_por_rst)
- Brownout reset
- Low level on NRST pin (external reset)
- Window watchdog
- Independent watchdog
- Software reset
- Low-power mode security reset
- Exit from Standby

3.10 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.

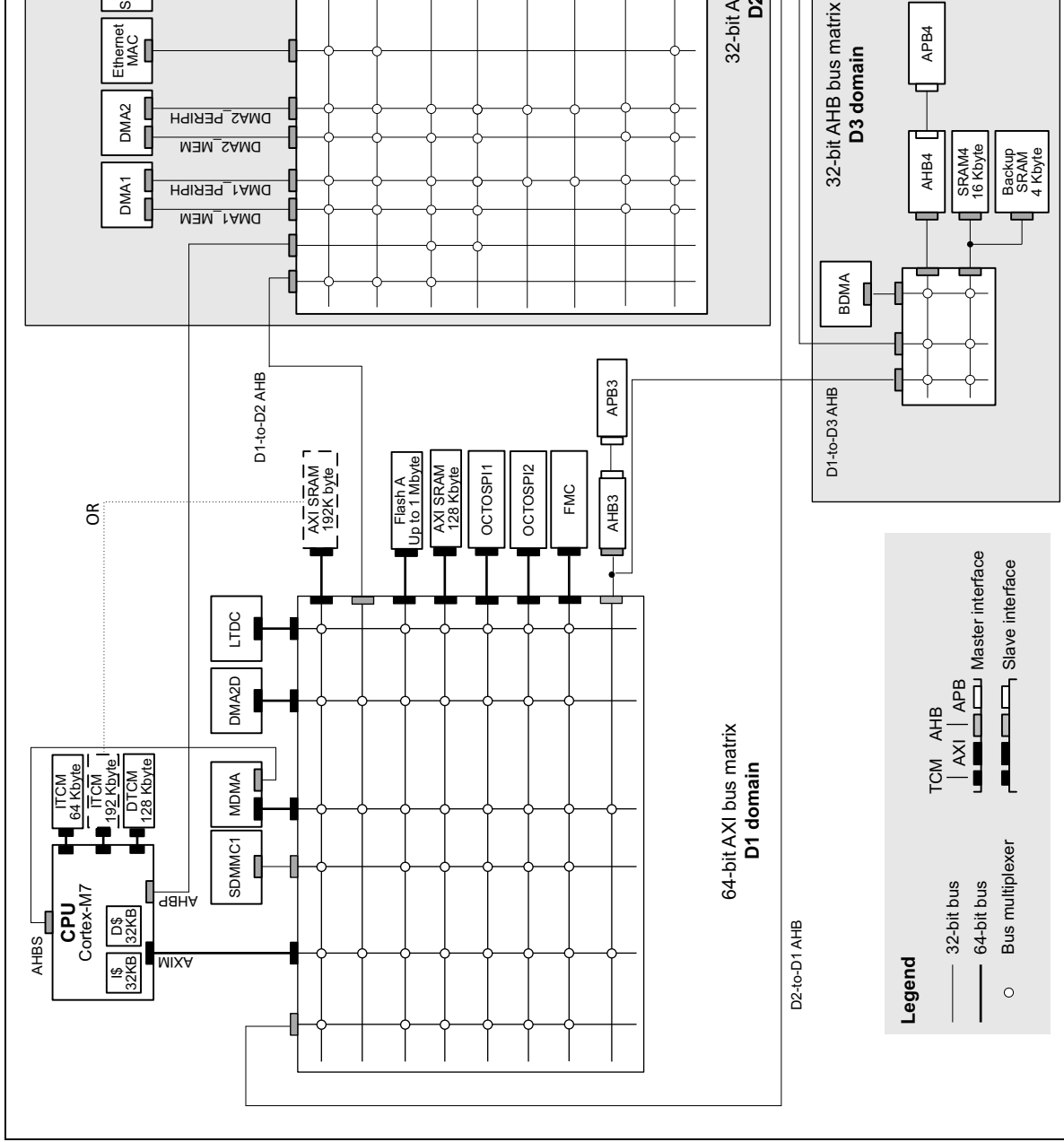
After reset, all GPIOs (except debug pins) are in Analog mode to reduce power consumption (refer to GPIOs register reset values in the device reference manual).

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.

3.11 Bus-interconnect matrix

The devices feature an AXI bus matrix, two AHB bus matrices and bus bridges that allow the interconnection of bus masters with bus slaves (see [Figure 3](#)).

Figure 3. STM32H725xE/G bus matrix



3.12 DMA controllers

The devices feature four DMA instances and a DMA request router to unload CPU activity:

- A master direct memory access (MDMA)

The MDMA is a high-speed DMA controller, which is in charge of all types of memory transfers (peripheral to memory, memory to memory, memory to peripheral), without any CPU action. It features a master AXI interface and a dedicated AHB interface to access Cortex[®]-M7 TCM memories.

The MDMA is located in D1 domain. It is able to interface with the other DMA controllers located in D2 domain to extend the standard DMA capabilities, or can manage peripheral DMA requests directly.

Each of the 16 channels can perform single block transfers, repeated block transfers and linked list transfers.
- Two dual-port DMAs (DMA1, DMA2) located in D2 domain, with FIFO and request router capabilities.
- One basic DMA (BDMA) located in D3 domain, with request router capabilities.
- A DMA request multiplexer (DMAMUX)

The DMA request router could be considered as an extension of the DMA controller. It routes the DMA peripheral requests to the DMA controller itself. This allowing managing the DMA requests with a high flexibility, maximizing the number of DMA requests that run concurrently, as well as generating DMA requests from peripheral output trigger or DMA event.

3.13 Chrom-ART Accelerator (DMA2D)

The Chrom-Art Accelerator (DMA2D) is a specialized DMA dedicated to image manipulation. It can perform the following operations:

- Filling a part or the whole of a destination image with a specific color
- Copying a part or the whole of a source image into a part or the whole of a destination image
- Copying a part or the whole of a source image into a part or the whole of a destination image with a pixel format conversion
- Blending a part and/or two complete source images with different pixel format and copy the result into a part or the whole of a destination image with a different color format.
- All the classical color coding schemes are supported from 4-bit up to 32-bit per pixel with indexed or direct color mode, including block based YCbCr to handle JPEG decoder output.
- The DMA2D has its own dedicated memories for CLUTs (color look-up tables).

An interrupt can be generated when an operation is complete or at a programmed watermark.

All the operations are fully automated and are running independently from the CPU or the DMAs.

3.14 Nested vectored interrupt controller (NVIC)

The devices embed a nested vectored interrupt controller which is able to manage 16 priority levels, and handle up to 140 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 context automatically saved on interrupt entry, and restored on interrupt exit with no instruction overhead

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

3.15 Extended interrupt and event controller (EXTI)

The EXTI controller performs interrupt and event management. In addition, it can wake up the processor, power domains and/or D3 domain from Stop mode.

The EXTI handles up to 80 independent event/interrupt lines split as 26 configurable events and 54 direct events.

Configurable events have dedicated pending flags, active edge selection, and software trigger capable.

Direct events provide interrupts or events from peripherals having a status flag.

3.16 Cyclic redundancy check calculation unit (CRC)

The CRC (cyclic redundancy check) calculation unit is used to get a CRC code using a programmable polynomial.

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

3.17 Flexible memory controller (FMC)

The FMC controller main features are the following:

- Interface with static-memory mapped devices including:
 - Static random access memory (SRAM)
 - NOR Flash memory/OneNAND Flash memory
 - PSRAM (4 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-, 24-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
- The maximum FMC_CLK/FMC_SDCLK frequency for synchronous accesses is the FMC kernel clock divided by 2.

3.18 Octo-SPI memory interface (OCTOSPI)

The OCTOSPI is a specialized communication interface targeting single, dual, quad or octal SPI memories. The STM32H725xE/G embeds two separate Octo-SPI interfaces.

Each OCTOSPI instance supports single/dual/quad/octal SPI formats. Multiplexing of single/dual/quad/octal SPI over the same bus can be achieved using the integrated Octo-SPI I/O manager (OCTOSPIM).

The OCTOSPI can operate in any of the three following modes:

- Indirect mode: all the operations are performed using the OCTOSPI registers
- Status-polling mode: the external memory status register is periodically read and an interrupt can be generated in case of flag setting
- Memory-mapped mode: the external memory is memory mapped and it is seen by the system as if it was an internal memory supporting both read and write operations.

The OCTOSPI supports two frame formats supported by most external serial memories such as serial PSRAMs, serial NAND and serial NOR Flash memories, Hyper RAMs and Hyper Flash memories.

Multi chip package (MCP) combining any of the above mentioned memory types can also be supported.

- The classical frame format with the command, address, alternate byte, dummy cycles and data phase
- The HyperBus™ frame format.

3.19 Analog-to-digital converters (ADCs)

STM32H725xE/G devices embed three analog-to-digital converters, two of 16-bit resolution, and the third of 12-bit resolution. The 16-bit resolution ADCs can be configured as 16, 14, 12, 10 or 8 bits. The 12-bit resolution ADC can be configured to 12, 10 or 8 bits.

Each ADC shares up to 20 external channels, performing conversions in Single-shot or Scan mode. In Scan mode, 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, thus allowing automatic transfer of ADC converted values to a destination location without any software action.

In addition, an analog watchdog feature can accurately monitor 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 the TIM1, TIM2, TIM3, TIM4, TIM6, TIM8, TIM15, TIM23, TIM24, and LPTIM1 timers.

3.20 Temperature sensor

STM32H725xE/G devices embed a temperature sensor that generates a voltage (V_{TS}) that varies linearly with the temperature. This temperature sensor is internally connected to ADC3_IN17. The conversion range is between 1.7 V and 3.6 V. It can measure the device junction temperature ranging from -40 to $+125^{\circ}\text{C}$.

The temperature sensor have a good linearity, but it has to be calibrated to obtain a good overall accuracy of the temperature measurement. As the temperature sensor offset varies from chip to chip due to process variation, the uncalibrated internal temperature sensor is suitable for applications that detect temperature changes only. To improve the accuracy of the temperature sensor measurement, each device is individually factory-calibrated by ST. The temperature sensor factory calibration data are stored by ST in the System memory area, which is accessible in Read-only mode.

3.21 Digital temperature sensor (DTS)

STM32H725xE/G devices embed a sensor that converts the temperature into a square wave the frequency of which is proportional to the temperature. The PCLK or the LSE clock can be used as the reference clock for the measurements. A formula given in the product reference manual allows calculation of the temperature according to the measured frequency stored in the DTS_DR register.

3.22 V_{BAT} operation

The V_{BAT} power domain contains the RTC, the backup registers and the backup SRAM.

To optimize battery duration, this power domain is supplied by V_{DD} when available or by the voltage applied on VBAT pin (when V_{DD} supply is not present). V_{BAT} power is switched when the PDR detects that V_{DD} dropped below the PDR level.

The voltage on the VBAT pin could be provided by an external battery, a supercapacitor or directly by V_{DD}, in which case, the V_{BAT} mode is not functional.

V_{BAT} operation is activated when V_{DD} is not present.

The V_{BAT} pin supplies the RTC, the backup registers and the backup SRAM.

Note: When the microcontroller is supplied from V_{BAT}, external interrupts and RTC alarm/events do not exit it from V_{BAT} operation.

When PDR_ON pin is connected to V_{SS} (Internal Reset OFF), the V_{BAT} functionality is no more available and V_{BAT} pin should be connected to V_{DD}.

3.23 Digital-to-analog converters (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 including DMA underrun error detection
- external triggers for conversion
- input voltage reference V_{REF+} or internal VREFBUF reference.

The DAC channels are triggered through the timer update outputs that are also connected to different DMA streams.

3.24 Ultra-low-power comparators (COMP)

STM32H725xE/G devices embed two rail-to-rail comparators (COMP1 and COMP2). They feature programmable reference voltage (internal or external), hysteresis and speed (low speed for low-power) as well as selectable output polarity.

The reference voltage can be one of the following:

- An external I/O
- A DAC output channel
- An internal reference voltage or submultiple (1/4, 1/2, 3/4).

All comparators can wake up from Stop mode, generate interrupts and breaks for the timers, and be combined into a window comparator.

3.25 Operational amplifiers (OPAMP)

STM32H725xE/G devices embed two rail-to-rail operational amplifiers (OPAMP1 and OPAMP2) with external or internal follower routing and PGA capability.

The operational amplifier main features are:

- PGA with a non-inverting gain ranging of 2, 4, 8 or 16 or inverting gain ranging of -1, -3, -7 or -15
- One positive input connected to DAC
- Output connected to internal ADC
- Low input bias current down to 1 nA
- Low input offset voltage down to 1.5 mV
- Gain bandwidth up to 7.3 MHz

The devices embeds two operational amplifiers (OPAMP1 and OPAMP2) with two inputs and one output each. These three I/Os can be connected to the external pins, thus enabling any type of external interconnections. The operational amplifiers can be configured internally as a follower, as an amplifier with a non-inverting gain ranging from 2 to 16 or with inverting gain ranging from -1 to -15.

3.26 Digital filter for sigma-delta modulators (DFSDM)

The devices embed one DFSDM with 4 digital filters modules and 8 external input serial channels (transceivers) or alternately 8 internal parallel inputs support.

The DFSDM peripheral is dedicated to interface the external $\Sigma\Delta$ modulators to microcontroller and then to perform digital filtering of the received data streams (which represent analog value on $\Sigma\Delta$ modulators inputs). DFSDM can also interface PDM (Pulse Density Modulation) microphones and perform PDM to PCM conversion and filtering in hardware. DFSDM features optional parallel data stream inputs from internal ADC peripherals or microcontroller memory (through DMA/CPU transfers into DFSDM).

DFSDM transceivers support several serial interface formats (to support various $\Sigma\Delta$ modulators). DFSDM digital filter modules perform digital processing according user selected filter parameters with up to 24-bit final ADC resolution.

The DFSDM peripheral supports:

- 8 multiplexed input digital serial channels:
 - configurable SPI interface to connect various SD modulator(s)
 - configurable Manchester coded 1 wire interface support
 - PDM (Pulse Density Modulation) microphone input support
 - maximum input clock frequency up to 20 MHz (10 MHz for Manchester coding)
 - clock output for SD modulator(s): 0..20 MHz
- alternative inputs from 8 internal digital parallel channels (up to 16 bit input resolution):
 - internal sources: ADC data or memory data streams (DMA)
- 4 digital filter modules with adjustable digital signal processing:
 - Sinc^x filter: filter order/type (1..5), oversampling ratio (up to 1..1024)
 - integrator: oversampling ratio (1..256)
- up to 24-bit output data resolution, signed output data format
- automatic data offset correction (offset stored in register by user)
- continuous or single conversion
- start-of-conversion triggered by:
 - software trigger
 - internal timers
 - external events
 - start-of-conversion synchronously with first digital filter module (DFSDM0)
- analog watchdog feature:
 - low value and high value data threshold registers
 - dedicated configurable Sinc^x digital filter (order = 1..3, oversampling ratio = 1..32)
 - input from final output data or from selected input digital serial channels
 - continuous monitoring independently from standard conversion
- short circuit detector to detect saturated analog input values (bottom and top range):
 - up to 8-bit counter to detect 1..256 consecutive 0's or 1's on serial data stream
 - monitoring continuously each input serial channel
- break signal generation on analog watchdog event or on short circuit detector event

- extremes detector:
 - storage of minimum and maximum values of final conversion data
 - refreshed by software
- DMA capability to read the final conversion data
- interrupts: end of conversion, overrun, analog watchdog, short circuit, input serial channel clock absence
- “regular” or “injected” conversions:
 - “regular” conversions can be requested at any time or even in Continuous mode without having any impact on the timing of “injected” conversions
 - “injected” conversions for precise timing and with high conversion priority
- Pulse skipper feature to support beamforming applications (delay-line like behavior).

Table 4. DFSDM implementation

| DFSDM features | DFSDM1 |
|--|---------------|
| Number of filters | 4 |
| Number of input transceivers/channels | 8 |
| Internal ADC parallel input | X |
| Number of external triggers | 16 |
| Regular channel information in identification register | X |

3.27 Digital camera interface (DCMI)

The devices embed a camera interface that can connect with camera modules and CMOS sensors through an 8-bit to 14-bit parallel interface, to receive video data. The camera interface can achieve a data transfer rate up to 140 Mbyte/s using a 80 MHz pixel clock. It features:

- Programmable polarity for the input pixel clock and synchronization signals
- Parallel data communication can be 8-, 10-, 12- or 14-bit
- Supports 8-bit progressive video monochrome or raw bayer format, YCbCr 4:2:2 progressive video, RGB 565 progressive video or compressed data (like JPEG)
- Supports Continuous mode or Snapshot (a single frame) mode
- Capability to automatically crop the image

3.28 PSSI

The PSSI is a generic synchronous 8-/16-bit parallel data input/output slave interface. It allows the transmitter to send a data valid signal to indicate when the data is valid, and the receiver to output a flow control signal to indicate when it is ready to sample the data.

The main PSSI features are:

- Slave mode operation
- 8- or 16-bit parallel data input or output
- 8-word (32-byte) FIFO
- Data enable (DE) alternate function input and Ready (RDY) alternate function output.

When enabled, these signals can either allow the transmitter to indicate when the data is valid or, the receiver to indicate when it is ready to sample the data, or both.

The PSSI shares most of its circuitry with the digital camera interface (DCMI). It therefore cannot be used simultaneously with the DCMI.

3.29 LCD-TFT controller

The LCD-TFT display controller provides a 24-bit parallel digital RGB (Red, Green, Blue) and delivers all signals to interface directly to a broad range of LCD and TFT panels up to XGA (1024 x 768) resolution with the following features:

- 2 display layers with dedicated FIFO (64x64-bit)
- Color Look-Up table (CLUT) up to 256 colors (256x24-bit) per layer
- Up to 8 input color formats selectable per layer
- Flexible blending between two layers using alpha value (per pixel or constant)
- Flexible programmable parameters for each layer
- Color keying (transparency color)
- Up to 4 programmable interrupt events
- AXI master interface with burst of 16 words

3.30 True random number generator (RNG)

The RNG is a true random number generator that provides full entropy outputs to the application as 32-bit samples. It is composed of a live entropy source (analog) and an internal conditioning component.

The RNG can be used to construct a Non-deterministic Random Bit Generator (NDRBG), as a NIST SP 800-90B compliant entropy source.

The RNG true random number generator has been tested using German BSI statistical tests of AIS-31 (T0 to T8), and NIST SP800-90B statistical test suite.

3.31 Timers and watchdogs

The devices include two advanced-control timers, twelve general-purpose timers, two basic timers, five low-power timers, two watchdogs and a SysTick timer.

All timer counters can be frozen in Debug mode.

[Table 5](#) compares the features of the advanced-control, general-purpose and basic timers.

Table 5. 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) ⁽¹⁾ |
|------------------|--------------------------|--------------------|-------------------|---------------------------------|------------------------|--------------------------|----------------------|---------------------------|--------------------------------------|
| Advanced-control | TIM1, TIM8 | 16-bit | Up, Down, Up/down | Any integer between 1 and 65536 | Yes | 4 | Yes | 137.5 | 275 |
| General purpose | TIM2, TIM5, TIM23, TIM24 | 32-bit | Up, Down, Up/down | Any integer between 1 and 65536 | Yes | 4 | No | 137.5 | 275 |
| | TIM3, TIM4 | 16-bit | Up, Down, Up/down | Any integer between 1 and 65536 | Yes | 4 | No | 137.5 | 275 |
| | TIM12 | 16-bit | Up | Any integer between 1 and 65536 | No | 2 | No | 137.5 | 275 |
| | TIM13, TIM14 | 16-bit | Up | Any integer between 1 and 65536 | No | 1 | No | 137.5 | 275 |
| | TIM15 | 16-bit | Up | Any integer between 1 and 65536 | Yes | 2 | 1 | 137.5 | 275 |
| | TIM16, TIM17 | 16-bit | Up | Any integer between 1 and 65536 | Yes | 1 | 1 | 137.5 | 275 |

Table 5. 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) ⁽¹⁾ |
|-----------------|--|--------------------|--------------|---------------------------------|------------------------|--------------------------|----------------------|---------------------------|--------------------------------------|
| Basic | TIM6, TIM7 | 16-bit | Up | Any integer between 1 and 65536 | Yes | 0 | No | 137.5 | 275 |
| Low-power timer | LPTIM1, LPTIM2, LPTIM3, LPTIM4, LPTIM5 | 16-bit | Up | 1, 2, 4, 8, 16, 32, 64, 128 | No | 0 | No | 137.5 | 275 |

1. The maximum timer clock is up to 550 MHz depending on theTIMPRE bit in the RCC_CFGR register and D2PRE1/2 bits in RCC_D2CFGR register.

3.31.1 Advanced-control timers (TIM1, TIM8)

The advanced-control timers (TIM1, TIM8) can be seen as three-phase PWM generators multiplexed on 6 channels. They have complementary PWM outputs with programmable inserted dead times. They can also be considered as complete general-purpose timers. Their 4 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.

TIM1 and TIM8 support independent DMA request generation.

3.31.2 General-purpose timers (TIMx)

There are ten synchronizable general-purpose timers embedded in the STM32H725xE/G devices (see [Table 5: Timer feature comparison](#) for differences).

- **TIM2, TIM3, TIM4, TIM5, TIM23, TIM24**

The devices include 4 full-featured general-purpose timers: TIM2, TIM3, TIM4, TIM5, TIM23 and TIM24. TIM2, TIM5, TIM23 and TIM24 are based on a 32-bit auto-reload up/downcounter and a 16-bit prescaler while TIM3 and TIM4 are based on a 16-bit auto-reload up/downcounter and a 16-bit prescaler. All timers feature 4 independent channels for input capture/output compare, PWM or One-pulse mode output. This gives up to 24 input capture/output compare/PWMs on the largest packages.

TIM2, TIM3, TIM4, TIM5, TIM23 and TIM24 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, TIM23, and TIM24 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.

- **TIM12, TIM13, TIM14, TIM15, TIM16, TIM17**

These timers are based on a 16-bit auto-reload upcounter and a 16-bit prescaler. TIM13, TIM14, TIM16 and TIM17 feature one independent channel, whereas TIM12 and TIM15 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, TIM23, and TIM24 full-featured general-purpose timers or used as simple time bases.

3.31.3 Basic timers TIM6 and TIM7

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

TIM6 and TIM7 support independent DMA request generation.

3.31.4 Low-power timers (LPTIM1, LPTIM2, LPTIM3, LPTIM4, LPTIM5)

The low-power timers have 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

3.31.5 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.

A window option allows the device to be reset when a reload operation is made too early after the previous reload.

3.31.6 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.

3.31.7 SysTick timer

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

- A 24-bit down counter
- Autoreload capability
- Maskable system interrupt generation when the counter reaches 0
- Programmable clock source.

3.32 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_{BAT} 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_{DD} supply when present or from the V_{BAT} pin.

The backup registers are 32-bit registers used to store 128 bytes of user application data when V_{DD} 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_{BAT} 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_{BAT} mode, but is functional in all low-power modes.

All RTC events (Alarm, Wakeup Timer, Timestamp or Tamper) can generate an interrupt and wakeup the device from the low-power modes.

3.33 Inter-integrated circuit interface (I2C)

STM32H725xE/G devices embed five I²C interfaces.

The I²C bus interface handles communications between the microcontroller and the serial I²C bus. It controls all I²C bus-specific sequencing, protocol, arbitration and timing.

The I2C peripheral supports:

- I²C-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 I2C communication speed to be independent from the PCLK reprogramming.
- Wakeup from Stop mode on address match
- Programmable analog and digital noise filters
- 1-byte buffer with DMA capability

3.34 Universal synchronous/asynchronous receiver transmitter (USART)

STM32H725xE/G devices have five embedded universal synchronous receiver transmitters (USART1, USART2, USART3, USART6, and USART10) and five universal asynchronous receiver transmitters (UART4, UART5, UART7, UART8, and UART9). Refer to [Table 6: USART features](#) for a summary of USARTx and UARTx features.

These interfaces provide asynchronous communication, IrDA SIR ENDEC support, multiprocessor communication mode, single-wire Half-duplex communication mode and have LIN Master/Slave capability. They provide hardware management of the CTS and RTS signals, and RS485 Driver Enable. They are able to communicate at speeds of up to 17 Mbit/s.

USART1, USART2, USART3, USART6, and USART10 also provide Smartcard mode (ISO 7816 compliant) and SPI-like communication capability.

The USARTs embed a Transmit FIFO (TXFIFO) and a Receive FIFO (RXFIFO). FIFO mode is enabled by software and is disabled by default.

All USART have a clock domain independent from the CPU clock, allowing the USARTx to wake up the MCU from Stop mode. The wakeup from Stop mode is programmable and can be done on:

- Start bit detection
- Any received data frame
- A specific programmed data frame
- Specific TXFIFO/RXFIFO status when FIFO mode is enabled.

All USART interfaces can be served by the DMA controller.

Table 6. USART features

| USART modes/features ⁽¹⁾ | USART1/2/3/6/10 | UART4/5/7/8/9 |
|--|-----------------|---------------|
| Hardware flow control for modem | X | X |
| Continuous communication using DMA | X | X |
| Multiprocessor communication | X | X |
| Synchronous mode (Master/Slave) | X | - |
| Smartcard mode | X | - |
| Single-wire Half-duplex communication | X | X |
| IrDA SIR ENDEC block | X | X |
| LIN mode | X | X |
| Dual clock domain and wakeup from low power mode | X | X |
| Receiver timeout interrupt | X | X |
| Modbus communication | X | X |
| Auto baud rate detection | X | X |
| Driver Enable | X | X |
| USART data length | 7, 8 and 9 bits | |
| Tx/Rx FIFO | X | X |
| Tx/Rx FIFO size | 16 | |

1. X = supported.

3.35 Low-power universal asynchronous receiver transmitter (LPUART)

The device embeds one Low-Power UART (LPUART1). The LPUART supports asynchronous serial communication with minimum power consumption. It supports half duplex single wire communication and modem operations (CTS/RTS). It allows multiprocessor communication.

The LPUARTs embed a Transmit FIFO (TXFIFO) and a Receive FIFO (RXFIFO). FIFO mode is enabled by software and is disabled by default.

The LPUART has a clock domain independent from the CPU clock, and can wakeup the system from Stop mode. The wakeup from Stop mode are programmable and can be done on:

- Start bit detection
- Any received data frame
- A specific programmed data frame
- Specific TXFIFO/RXFIFO status when FIFO mode is enabled.

Only a 32.768 kHz clock (LSE) is needed to allow LPUART communication up to 9600 baud. Therefore, even in Stop mode, the LPUART can wait for an incoming frame while having an extremely low energy consumption. Higher speed clock can be used to reach higher baudrates.

LPUART interface can be served by the DMA controller.

3.36 Serial peripheral interface (SPI)/inter- integrated sound interfaces (I2S)

The devices feature up to six SPIs (SPI2S1, SPI2S2, SPI2S3, SPI4, SPI5 and SPI2S6) that allow communicating up to 150 Mbits/s in Master and Slave modes, in Half-duplex, Full-duplex and Simplex modes. The 3-bit prescaler gives 8 master mode frequencies and the frame is configurable from 4 to 16 bits. All SPI interfaces support NSS pulse mode, TI mode, Hardware CRC calculation and 8x 8-bit embedded Rx and Tx FIFOs with DMA capability.

Four standard I²S interfaces (multiplexed with SPI1, SPI2, SPI3 and SPI6) are available. They can be operated in Master or Slave mode, in Simplex communication modes, and can be configured to operate as a 16-/32-bit resolution input or output channel (except SPI2S6 which is limited to 16 bits). Audio sampling frequencies from 8 kHz up to 192 kHz are supported. When either or both of the I²S 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 I²S interfaces support 16x 8-bit embedded Rx and Tx FIFOs with DMA capability.

3.37 Serial audio interfaces (SAI)

The devices embed 2 SAIs (SAI1, and SAI4) that allow designing many stereo or mono audio protocols such as I2S, LSB or MSB-justified, PCM/DSP, TDM or AC'97. An SPDIF output is available when the audio block is configured as a transmitter. To bring this level of flexibility and reconfigurability, the SAI contains two independent audio sub-blocks. Each block has its own clock generator and I/O line controller.

Audio sampling frequencies up to 192 kHz are supported.

In addition, up to 8 microphones can be supported thanks to an embedded PDM interface. The SAI can work in master or slave configuration. The audio sub-blocks can be either receiver or transmitter and can work synchronously or asynchronously (with respect to the other one). The SAI can be connected with other SAIs to work synchronously.

3.38 SPDIFRX Receiver Interface (SPDIFRX)

The SPDIFRX peripheral is designed to receive an S/PDIF flow compliant with IEC-60958 and IEC-61937. These standards support simple stereo streams up to high sample rate, and compressed multi-channel surround sound, such as those defined by Dolby or DTS (up to 5.1).

The main SPDIFRX features are the following:

- Up to 4 inputs available
- Automatic symbol rate detection
- Maximum symbol rate: 12.288 MHz
- Stereo stream from 32 to 192 kHz supported
- Supports Audio IEC-60958 and IEC-61937, consumer applications
- Parity bit management
- Communication using DMA for audio samples
- Communication using DMA for control and user channel information
- Interrupt capabilities

The SPDIFRX receiver provides all the necessary features to detect the symbol rate, and decode the incoming data stream. The user can select the wanted SPDIF input, and when a valid signal will be available, the SPDIFRX will re-sample the incoming signal, decode the Manchester stream, recognize frames, sub-frames and blocks elements. It delivers to the CPU decoded data, and associated status flags.

The SPDIFRX also offers a signal named `spdif_frame_sync`, which toggles at the S/PDIF sub-frame rate that will be used to compute the exact sample rate for clock drift algorithms.

3.39 Single wire protocol master interface (SWPMI)

The Single wire protocol master interface (SWPMI) is the master interface corresponding to the Contactless Frontend (CLF) defined in the ETSI TS 102 613 technical specification. The main features are:

- Full-duplex communication mode
- automatic SWP bus state management (active, suspend, resume)
- configurable bitrate up to 2 Mbit/s
- automatic SOF, EOF and CRC handling

SWPMI can be served by the DMA controller.

3.40 Management data input/output (MDIO) slaves

The devices embed an MDIO slave interface it includes the following features:

- 32 MDIO Registers addresses, each of which is managed using separate input and output data registers:
 - 32 x 16-bit firmware read/write, MDIO read-only output data registers
 - 32 x 16-bit firmware read-only, MDIO write-only input data registers
- Configurable slave (port) address
- Independently maskable interrupts/events:
 - MDIO Register write
 - MDIO Register read
 - MDIO protocol error
- Able to operate in and wake up from Stop mode

3.41 SD/SDIO/MMC card host interfaces (SDMMC)

Two SDMMC host interfaces are available. They support *MultiMediaCard System Specification Version 4.51* in three different databus modes: 1 bit (default), 4 bits and 8 bits.

Both interfaces support the *SD memory card specifications version 4.1*. and the *SDIO card specification version 4.0*. in two different databus modes: 1 bit (default) and 4 bits.

Each SDMMC host interface supports only one SD/SDIO/MMC card at any one time and a stack of MMC Version 4.51 or previous.

The SDMMC host interface embeds a dedicated DMA controller allowing high-speed transfers between the interface and the SRAM.

3.42 Controller area network (FDCAN1, FDCAN2, FDCAN3)

The controller area network (CAN) subsystem consists of two CAN modules, a shared message RAM memory and a clock calibration unit.

All CAN modules (FDCAN1, FDCAN2, and FDCAN3) are compliant with ISO 11898-1 (CAN protocol specification version 2.0 part A, B) and CAN FD protocol specification version 1.0.

FDCAN1 supports time triggered CAN (TT-FDCAN) specified in ISO 11898-4, including event synchronized time-triggered communication, global system time, and clock drift compensation. The FDCAN1 contains additional registers, specific to the time triggered feature. The CAN FD option can be used together with event-triggered and time-triggered CAN communication.

A 10-Kbyte message RAM memory implements filters, receive FIFOs, receive buffers, transmit event FIFOs, transmit buffers (and triggers for TT-FDCAN). This message RAM is shared between the three modules - FDCAN1 FDCAN2 and FDCAN3.

The common clock calibration unit is optional. It can be used to generate a calibrated clock for FDCAN1, FDCAN2 and FDCAN3 from the HSI internal RC oscillator and the PLL, by evaluating CAN messages received by the FDCAN1.

3.43 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 that supports both full-speed and high-speed operations. It integrates the transceivers for full-speed operation (12 Mbit/s) and a UTMI low-pin interface (ULPI) for high-speed operation (480 Mbit/s). When using the USB OTG_HS interface in HS mode, an external PHY device connected to the ULPI is required.

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

The main 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
- Battery Charging Specification Revision 1.2 support
- Internal FS OTG PHY support
- 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.
- 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

3.44 Ethernet MAC interface with dedicated DMA controller (ETH)

The devices provide an IEEE-802.3-2002-compliant media access controller (MAC) for ethernet LAN communications through an industry-standard medium-independent interface (MII) or a reduced medium-independent interface (RMII). The microcontroller requires an external physical interface device (PHY) to connect to the physical LAN bus (twisted-pair, fiber, etc.). The PHY is connected to the device MII port using 17 signals for MII or 9 signals for RMII, and can be clocked using the 25 MHz (MII) from the microcontroller.

The devices include the following features:

- Supports 10 and 100 Mbit/s rates
- Dedicated DMA controller allowing high-speed transfers between the dedicated SRAM and the descriptors
- Tagged MAC frame support (VLAN support)
- Half-duplex (CSMA/CD) and full-duplex operation
- MAC control sublayer (control frames) support
- 32-bit CRC generation and removal
- Several address filtering modes for physical and multicast address (multicast and group addresses)
- 32-bit status code for each transmitted or received frame
- Internal FIFOs to buffer transmit and receive frames. The transmit FIFO and the receive FIFO are both 2 Kbytes.
- Supports hardware PTP (precision time protocol) in accordance with IEEE 1588 2008 (PTP V2) with the time stamp comparator connected to the TIM2 input
- Triggers interrupt when system time becomes greater than target time

3.45 High-definition multimedia interface (HDMI) - consumer electronics control (CEC)

The devices embed a HDMI-CEC controller that provides hardware support for the Consumer Electronics Control (CEC) protocol (Supplement 1 to the HDMI standard).

This protocol provides high-level control functions between all audiovisual products in an environment. It is specified to operate at low speeds with minimum processing and memory overhead. It has a clock domain independent from the CPU clock, allowing the HDMI-CEC controller to wakeup the MCU from Stop mode on data reception.

3.46 Debug infrastructure

The devices offer a comprehensive set of debug and trace features to support software development and system integration.

- Breakpoint debugging
- Code execution tracing
- Software instrumentation
- JTAG debug port
- Serial-wire debug port
- Trigger input and output
- Serial-wire trace port
- Trace port
- Arm® CoreSight™ debug and trace components

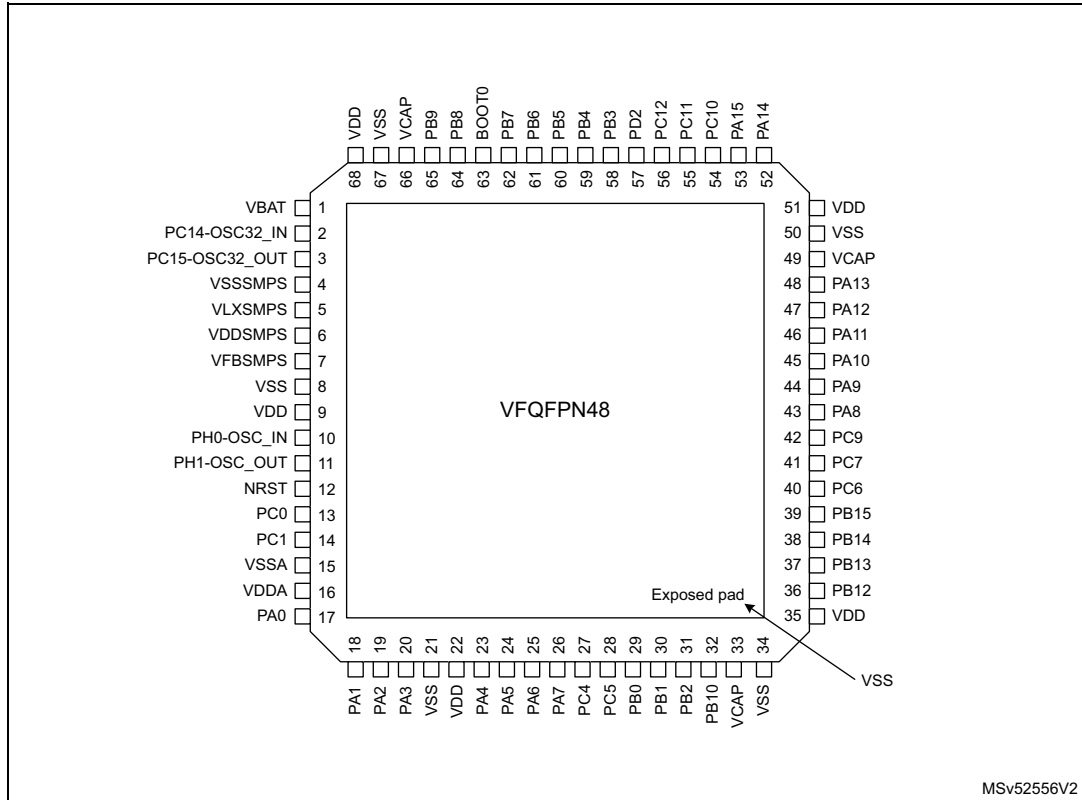
The debug can be controlled via a JTAG/Serial-wire debug access port, using industry standard debugging tools. The trace port performs data capture for logging and analysis.

4 Memory mapping

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

5 Pinouts, pin descriptions and alternate functions

Figure 4. VFQFPN68 pinout



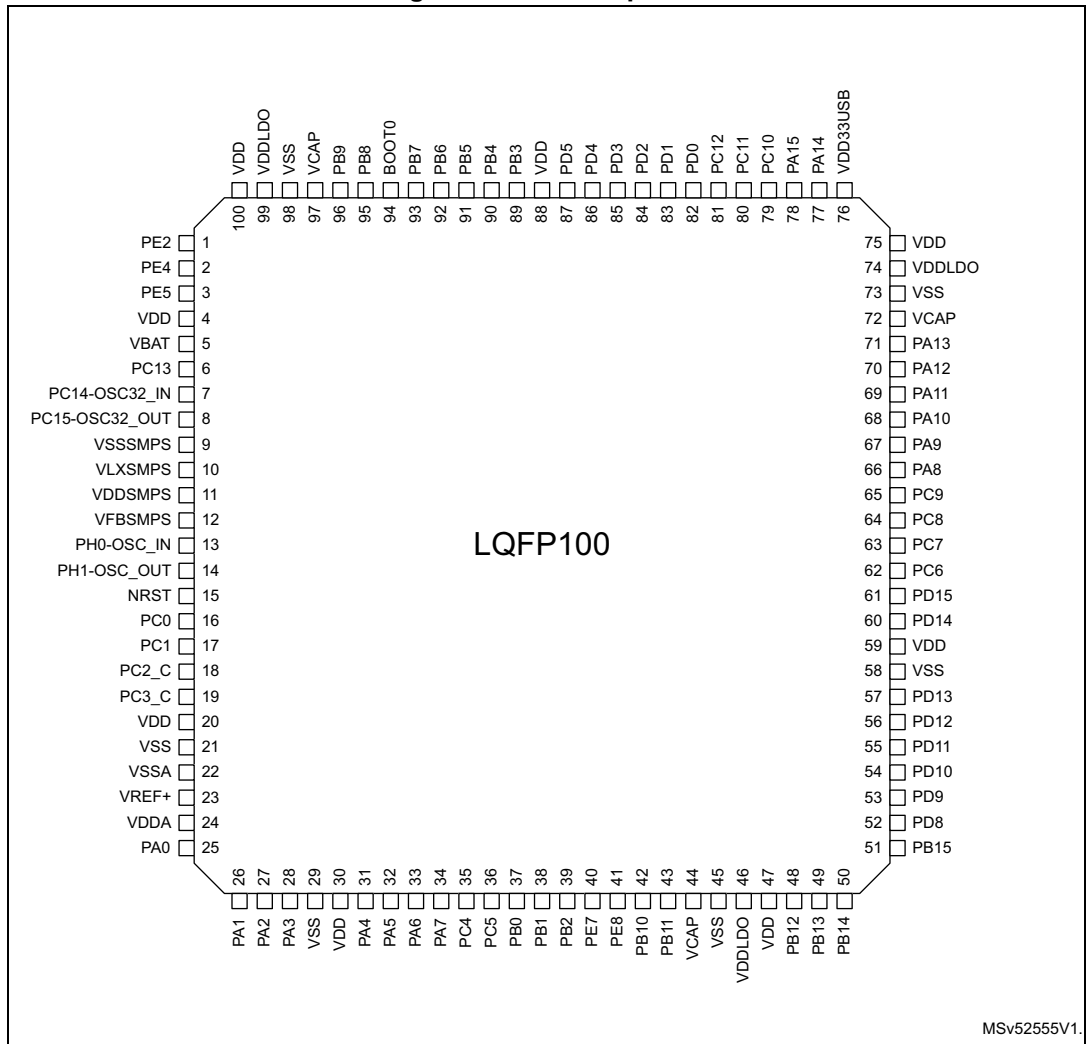
1. The above figure shows the package top view.
2. VSS pads are connected to the exposed pad.

Figure 5. TFBGA100 pinout

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---------------|----------------|--------|-------|-------|--------|--------|----------|------|------|
| A | PE6 | PE5 | PE2 | PB8 | BOOT0 | PB5 | PD6 | PD3 | PD2 | PC12 |
| B | PC14-OSC32_IN | PC15-OSC32_OUT | PE3 | PE0 | PB7 | PB3 | PD4 | PD1 | PC11 | PC10 |
| C | VSS | VBAT | PE4 | PE1 | PB4 | PD7 | PD0 | PA15 | PA14 | PA13 |
| D | VSSMPS | VLXSMPs | PDR_ON | PB6 | VSS | VDD | PD5 | VCAP | PA12 | PA11 |
| E | VDDSMPS | VFBSMPS | PB9 | PC13 | VDD | VDDLDO | VSS | VDD33USB | PA9 | PA10 |
| F | PC1 | NRST | PC0 | PC2_C | VSS | VDD | VDDLDO | PC6 | PC9 | PA8 |
| G | PH0-OSC_IN | PH1-OSC_OUT | PA0 | PC3_C | PA3 | VCAP | PD14 | PD15 | PC7 | PC8 |
| H | VDDA | VSSA | PA2 | PC4 | PE7 | PE10 | PD11 | PD9 | PD12 | PD13 |
| J | VREF+ | PA1 | PA6 | PC5 | PB2 | PE8 | PB11 | PB13 | PD8 | PD10 |
| K | PA4 | PA5 | PA7 | PB0 | PB1 | PE9 | PB10 | PB12 | PB14 | PB15 |

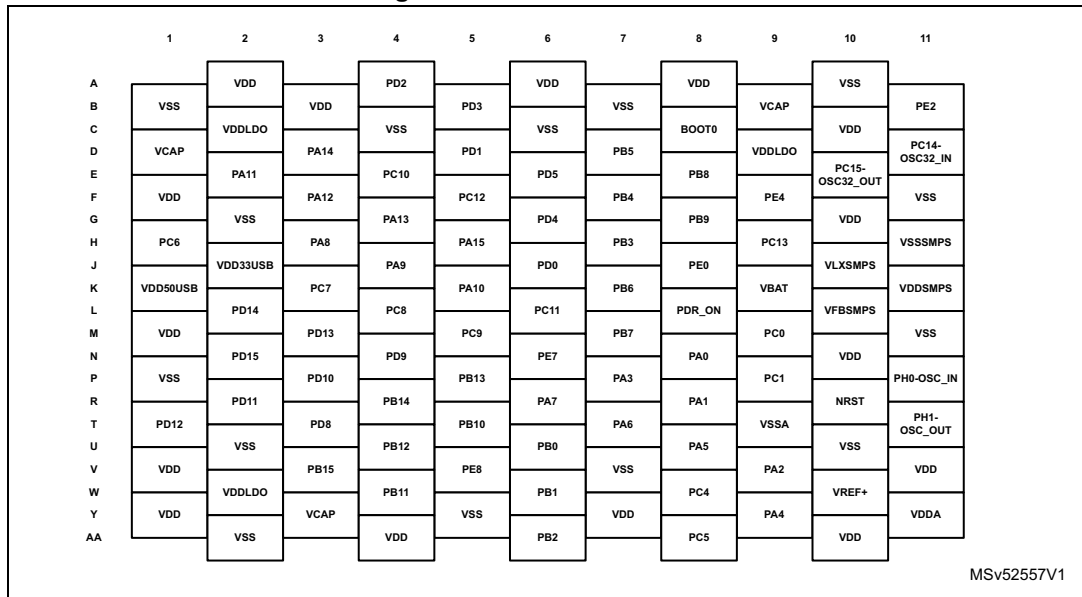
1. The above figure shows the package top view.

Figure 6. LQFP100 pinout



1. The above figure shows the package top view.

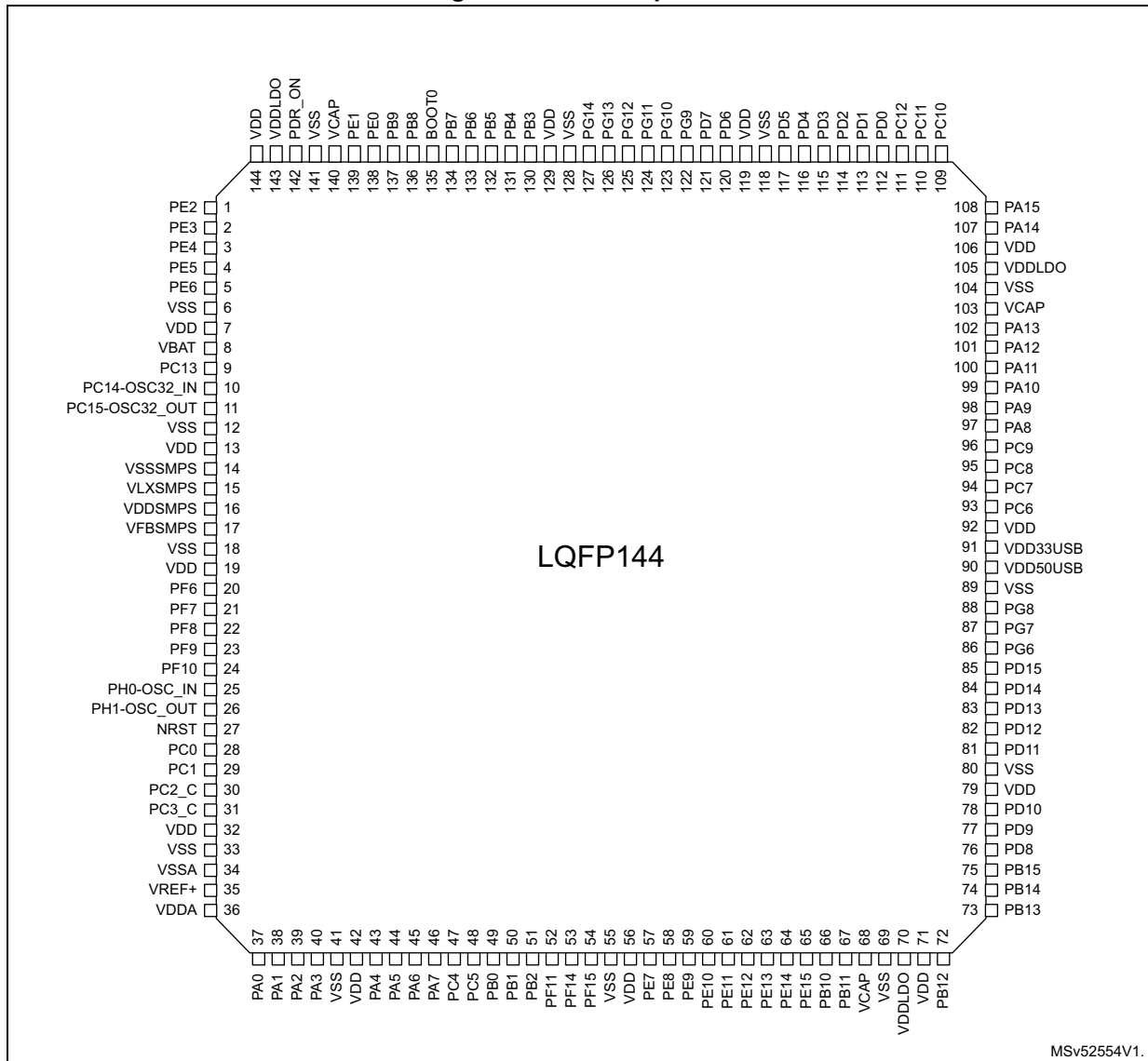
Figure 7. WLCSP115 ballout



MSv52557V1

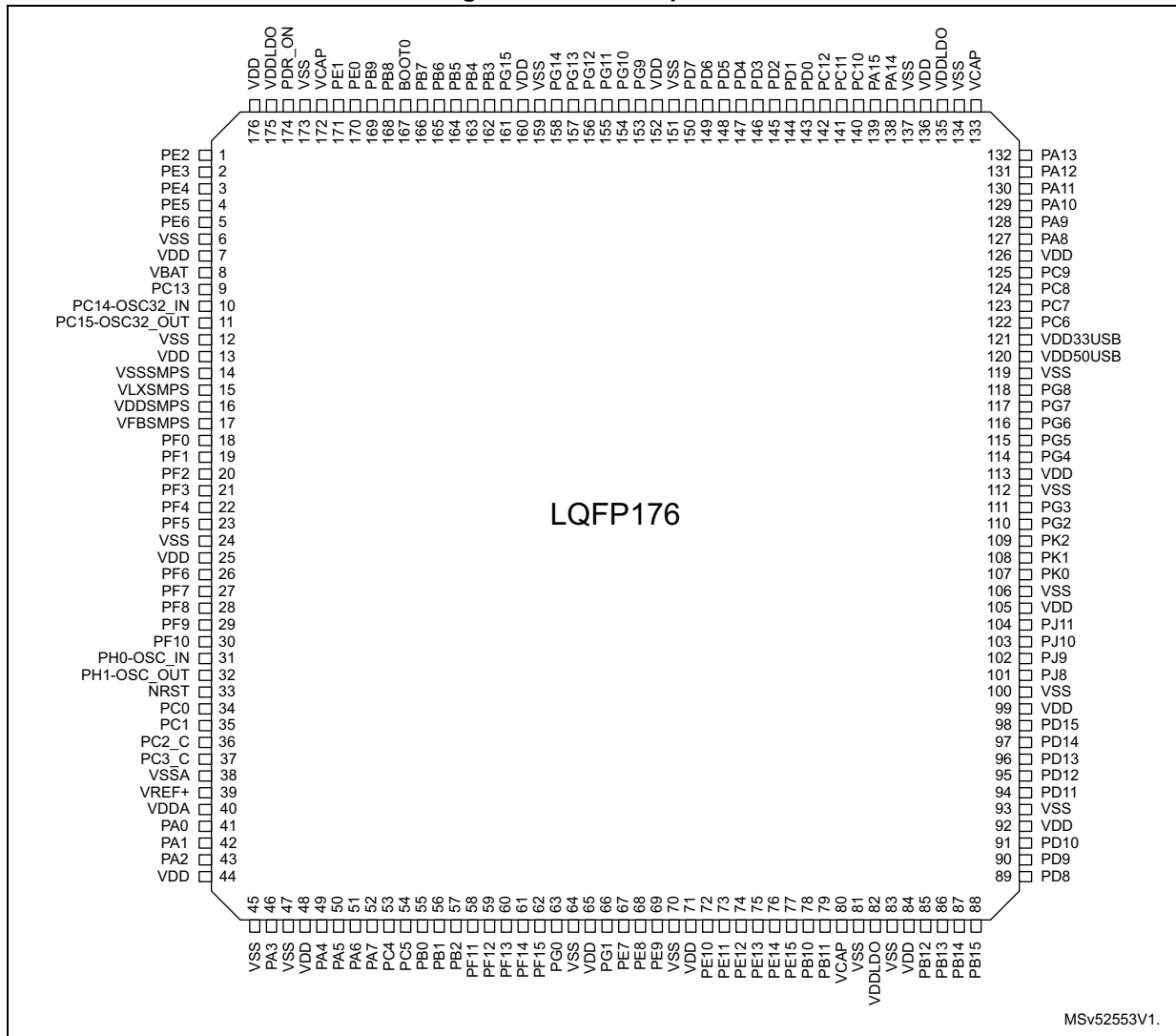
1. The above figure shows the package top view.

Figure 8. LQFP144 pinout



1. The above figure shows the package top view.

Figure 9. LQFP176 pinout



MSv52553V1.

1. The above figure shows the package top view.

Figure 10. UFBGA169 ballout

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|----------------|-------------|-------|--------|-----|-------|------|------|------|--------|------|----------|----------|
| A | PE4 | PE2 | VDD | VCAP | PB6 | VDD | VDD | PG10 | PD5 | VDD | PC12 | PC10 | PH14 |
| B | PC15-OSC32_OUT | PE3 | VSS | VDDLDO | PB8 | PB4 | VSS | PG11 | PD6 | VSS | PC11 | PA14 | PH13 |
| C | PC14-OSC32_IN | PE6 | PE5 | PDR_ON | PB9 | PB5 | PG14 | PG9 | PD4 | PD1 | PA15 | VSS | VDD |
| D | VDD | VSS | PC13 | PE1 | PE0 | PB7 | PG13 | PD7 | PD3 | PD0 | PA13 | VDDLDO | VCAP |
| E | VLXSMPS | VSSMPS | VBAT | PF1 | PF3 | BOOT0 | PG15 | PG12 | PD2 | PA10 | PA9 | PA8 | PA12 |
| F | VDDSMPS | VFBSMPS | PF0 | PF2 | PF5 | PF7 | PB3 | PG4 | PC6 | PC7 | PC9 | PC8 | PA11 |
| G | VDD | VSS | PF4 | PF6 | PF9 | NRST | PF13 | PE7 | PG6 | PG7 | PG8 | VDD50USB | VDD33USB |
| H | PH0-OSC_IN | PH1-OSC_OUT | PF10 | PF8 | PC2 | PA4 | PF14 | PE8 | PG2 | PG3 | PG5 | VSS | VDD |
| J | PC0 | PC1 | VSSA | PC3 | PA0 | PA7 | PF15 | PE9 | PE14 | PD11 | PD13 | PD15 | PD14 |
| K | PC3_C | PC2_C | PA0_C | PA1 | PA6 | PC4 | PG0 | PE13 | PH10 | PH12 | PD9 | PD10 | PD12 |
| L | VDDA | VREF+ | PA1_C | PA5 | PB1 | PB2 | PG1 | PE12 | PB10 | PH11 | PB13 | VSS | VDD |
| M | VDD | VSS | PH3 | VSS | PB0 | PF11 | VSS | PE10 | PB11 | VDDLDO | VSS | PD8 | PB15 |
| N | PA2 | PH2 | PA3 | VDD | PC5 | PF12 | VDD | PE11 | PE15 | VCAP | VDD | PB12 | PB14 |

MSv52551V1.

1. The above figure shows the package top view.

Figure 11. UFBGA176+25 ballout

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----|----------------|---------------|--------|--------|---|-----|------|------|------|------|------|------|--------|--------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|----------|------|----------|
| A | VSS | PB8 | VDDLDO | VCAP | PB6 | PB3 | PG11 | PG9 | PD3 | PD1 | PA15 | PA14 | VDDLDO | VCAP | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | PE4 | PE3 | PB9 | PE0 | PB7 | PB4 | PG13 | PD7 | PD5 | PD2 | PC12 | PH14 | PA13 | PA8 | PA12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | PC13 | VSS | PE2 | PE1 | BOOT0 | PB5 | PG14 | PG10 | PD4 | PD0 | PC11 | PC10 | PH13 | PA10 | PA11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | PC15-OSC32_OUT | PC14-OSC32_IN | PE5 | PDR_ON | VDD | VSS | PG15 | PG12 | PD6 | VSS | VDD | PH15 | PA9 | PC8 | PC7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | VSS | VBAT | PE6 | VDD | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VDD | PC9 | PC6 | VDD50USB |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | VLXSMPS | VSSMPS | PF1 | PF0 | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VDD33USB | PG6 | PG5 |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| G | VDDSMPS | VFBSMPS | PF2 | VDD | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | PG8 | PG7 | PG4 | PG2 |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | PF6 | PF4 | PF5 | PF3 | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VDD | PG3 | PD14 | PD13 |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| J | PH0-OSC_IN | PF8 | PF7 | PF9 | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | PD15 | PD11 | VSS | PD12 |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| K | PH1-OSC_OUT | VSS | PF10 | VDD | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | PD9 | PB15 | PB14 |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L | NRST | PC0 | PC1 | VREF- | <table border="1"> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> <tr><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td><td>VSS</td></tr> </table> | | | | | | | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VSS | VDD | PD10 | PD8 | PB13 |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VSS | VSS | VSS | VSS | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| M | PC2 | PC3 | VREF+ | VDDA | VDD | VSS | PC5 | PB1 | VDD | VSS | PH7 | PE14 | PH11 | PH9 | PB12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| N | PC2_C | PC3_C | VSSA | PH2 | PA3 | PA7 | PF11 | PE8 | PG1 | PF15 | PF13 | PB10 | PH8 | PH10 | PH12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| P | PA0 | PA1 | PA1_C | PH4 | PA4 | PA5 | PB2 | PG0 | PE7 | PB11 | PF12 | PE12 | PE13 | PE15 | PH6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| R | VSS | PA2 | PA0_C | PH3 | PH5 | PC4 | PA6 | PB0 | PE10 | PF14 | PE9 | PE11 | VCAP | VDDLDO | VSS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

MSv52552V1.

1. The above figure shows the package top view.

Table 7. 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 |
| | ANA | | Analog-only Input |
| I/O structure | FT | | 5 V tolerant I/O |
| | TT | | 3.3 V tolerant I/O |
| | B | | Dedicated BOOT0 pin |
| | RST | | Bidirectional reset pin with embedded weak pull-up resistor |
| | Option for TT and FT I/Os | | |
| | _f | | I2C FM+ option |
| | _a | | analog option (supplied by V _{DDA}) |
| | _u | | USB option (supplied by V _{DD33USB}) |
| | _h | | High-speed low-voltage I/O |
| Notes | | Unless otherwise specified by a note, all I/Os are set as floating inputs during and after reset. | |
| Pin functions | Alternate functions | Functions selected through GPIOx_AFR registers | |
| | Additional functions | Functions directly selected/enabled through peripheral registers | |

Table 8. STM32H725 pin and ball descriptions

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | 1 | A3 | 1 | B11 | A2 | C3 | 1 | PE2 | I/O | FT_h | - | TRACECLK, SAI1_CK1, USART10_RX, SPI4_SCK, SAI1_MCLK_A, SAI4_MCLK_A, OCTOSPIM_P1_IO2, SAI4_CK1, ETH_MII_TXD3, FMC_A23, EVENTOUT | - |
| - | - | B3 | 2 | - | B2 | B2 | 2 | PE3 | I/O | FT_h | - | TRACED0, TIM15_BKIN, SAI1_SD_B, SAI4_SD_B, USART10_TX, FMC_A19, EVENTOUT | - |
| - | 2 | C3 | 3 | F9 | A1 | B1 | 3 | PE4 | I/O | FT_h | - | TRACED1, SAI1_D2, DFSDM1_DATIN3, TIM15_CH1N, SPI4_NSS, SAI1_FS_A, SAI4_FS_A, SAI4_D2, FMC_A20, DCMI_D4/PSSI_D4, LCD_B0, EVENTOUT | - |
| - | 3 | A2 | 4 | - | C3 | D3 | 4 | PE5 | I/O | FT_h | - | TRACED2, SAI1_CK2, DFSDM1_CKIN3, TIM15_CH1, SPI4_MISO, SAI1_SCK_A, SAI4_SCK_A, SAI4_CK2, FMC_A21, DCMI_D6/PSSI_D6, LCD_G0, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|--------------------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | A1 | 5 | - | C2 | E3 | 5 | PE6 | I/O | FT_h | - | TRACED3, TIM1_BKIN2, SAI1_D1, TIM15_CH2, SPI4_MOSI, SAI1_SD_A, SAI4_SD_A, SAI4_D1, SAI4_MCLK_B, TIM1_BKIN2_COMP12, FMC_A22, DCMI_D7/PSSI_D7, LCD_G1, EVENTOUT | - |
| - | - | - | 6 | - | - | - | 6 | VSS | S | - | - | - | - |
| - | 4 | - | 7 | - | - | - | 7 | VDD | S | - | - | - | - |
| 1 | 5 | C2 | 8 | K9 | E3 | E2 | 8 | VBAT | S | - | - | - | - |
| - | 6 | E4 | 9 | H9 | D3 | C1 | 9 | PC13 | I/O | FT | - | EVENTOUT | RTC_TAMP1/ RTC_TS, WKUP4 |
| - | - | - | - | F11 | - | - | - | VSS | S | - | - | - | - |
| 2 | 7 | B1 | 10 | D11 | C1 | D2 | 10 | PC14- OSC32_IN | I/O | FT | - | EVENTOUT | OSC32_IN |
| 3 | 8 | B2 | 11 | E10 | B1 | D1 | 11 | PC15- OSC32_OUT | I/O | FT | - | EVENTOUT | OSC32_OUT |
| - | - | - | 12 | F11 | - | - | 12 | VSS | S | - | - | - | - |
| - | - | - | 13 | G10 | - | - | 13 | VDD | S | - | - | - | - |
| 4 | 9 | D1 | 14 | H11 | E2 | F2 | 14 | VSSSMPS | S | - | - | - | - |
| 5 | 10 | D2 | 15 | J10 | E1 | F1 | 15 | VLXSMPS | S | - | - | - | - |
| 6 | 11 | E1 | 16 | K11 | F1 | G1 | 16 | VDDSMPS | S | - | - | - | - |
| 7 | 12 | E2 | 17 | L10 | F2 | G2 | 17 | VFBSMPS | S | - | - | - | - |
| - | - | - | - | - | F3 | F4 | 18 | PF0 | I/O | FT_fh | - | I2C2_SDA(boot), I2C5_SDA, OCTOSPIM_P2_IO0, FMC_A0, TIM23_CH1, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|-------------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | E4 | F3 | 19 | PF1 | I/O | FT_fh | - | I2C2_SCL(boot), I2C5_SCL, OCTOSPIM_P2_IO1, FMC_A1, TIM23_CH2, EVENTOUT | - |
| - | - | - | - | - | F4 | G3 | 20 | PF2 | I/O | FT_h | - | I2C2_SMBA, I2C5_SMBA, OCTOSPIM_P2_IO2, FMC_A2, TIM23_CH3, EVENTOUT | - |
| - | - | - | - | - | E5 | H4 | 21 | PF3 | I/O | FT_ha | - | OCTOSPIM_P2_IO3, FMC_A3, TIM23_CH4, EVENTOUT | ADC3_INP5 |
| - | - | - | - | - | G3 | H2 | 22 | PF4 | I/O | FT_ha | - | OCTOSPIM_P2_CLK, FMC_A4, EVENTOUT | ADC3_INN5, ADC3_INP9 |
| - | - | - | - | - | F5 | H3 | 23 | PF5 | I/O | FT_ha | - | OCTOSPIM_P2_NCL K, FMC_A5, EVENTOUT | ADC3_INP4 |
| 8 | - | - | 18 | M11 | - | - | 24 | VSS | S | - | - | - | - |
| 9 | - | - | 19 | N10 | - | - | 25 | VDD | S | - | - | - | - |
| - | - | - | 20 | - | G4 | H1 | 26 | PF6 | I/O | FT_ha | - | TIM16_CH1, FDCAN3_RX, SPI5_NSS, SAI1_SD_B, UART7_RX, SAI4_SD_B, OCTOSPIM_P1_IO3, TIM23_CH1, EVENTOUT | ADC3_INN4, ADC3_INP8 |
| - | - | - | 21 | - | F6 | J3 | 27 | PF7 | I/O | FT_ha | - | TIM17_CH1, FDCAN3_TX, SPI5_SCK, SAI1_MCLK_B, UART7_TX, SAI4_MCLK_B, OCTOSPIM_P1_IO2, TIM23_CH2, EVENTOUT | ADC3_INP3 |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|-------------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | 22 | - | H4 | J2 | 28 | PF8 | I/O | FT_ha | - | TIM16_CH1N, SPI5_MISO, SAI1_SCK_B, UART7_RTS/UART7_ DE, SAI4_SCK_B, TIM13_CH1, OCTOSPIM_P1_IO0, TIM23_CH3, EVENTOUT | ADC3_INN3, ADC3_INP7 |
| - | - | - | 23 | - | G5 | J4 | 29 | PF9 | I/O | FT_ha | - | TIM17_CH1N, SPI5_MOSI, SAI1_FS_B, UART7_CTS, SAI4_FS_B, TIM14_CH1, OCTOSPIM_P1_IO1, TIM23_CH4, EVENTOUT | ADC3_INP2 |
| - | - | - | 24 | - | H3 | K3 | 30 | PF10 | I/O | FT_ha | - | TIM16_BKIN, SAI1_D3, PSSI_D15, OCTOSPIM_P1_CLK, SAI4_D3, DCMI_D11/PSSI_D11, LCD_DE, EVENTOUT | ADC3_INN2, ADC3_INP6 |
| 10 | 13 | G1 | 25 | P11 | H1 | J1 | 31 | PH0-OSC_IN | I/O | FT | - | EVENTOUT | OSC_IN |
| 11 | 14 | G2 | 26 | T11 | H2 | K1 | 32 | PH1-OSC_OUT | I/O | FT | - | EVENTOUT | OSC_OUT |
| 12 | 15 | F2 | 27 | R10 | G6 | L1 | 33 | NRST | I/O | RST | - | - | - |
| 13 | 16 | F3 | 28 | M9 | J1 | L2 | 34 | PC0 | I/O | FT_ha | - | FMC_D12/FMC_AD12, DFSDM1_CKIN0, DFSDM1_DATIN4, SAI4_FS_B, FMC_A25, OTG_HS_ULPI_STP, LCD_G2, FMC_SDNWE, LCD_R5, EVENTOUT | ADC123_INP10 |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|--|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 14 | 17 | F1 | 29 | P9 | J2 | L3 | 35 | PC1 | I/O | FT_ha | - | TRACED0, SAI4_D1, SAI1_D1, DFSDM1_DATIN0, DFSDM1_CKIN4, SPI2_MOSI/I2S2_SDO, SAI1_SD_A, SAI4_SD_A, SDMMC2_CK, OCTOSPIM_P1_IO4, ETH_MDC, MDIOS_MDC, LCD_G5, EVENTOUT | ADC123_INN10, ADC123_INP11, RTC_TAMP3, WKUP6 |
| - | - | - | - | - | H5 (1) | M1 (1) | - | PC2 | I/O | FT_a | - | PWR_DEEPSLEEP, DFSDM1_CKIN1, OCTOSPIM_P1_IO5, SPI2_MISO/I2S2_SDI, DFSDM1_CKOUT, OCTOSPIM_P1_IO2, OTG_HS_ULPI_DIR, ETH_MII_TXD2, FMC_SDNE0, EVENTOUT | ADC123_INN11, ADC123_INP12 |
| - | 18 (2) | F4 (2) | 30 (2) | - | K2 (1) | N1 (1) | 36 (2) | PC2_C | ANA | TT_a | - | - | ADC3_INN1, ADC3_INP0 |
| - | - | - | - | - | J4 (1) | M2 (1) | - | PC3 | I/O | FT_a | - | PWR_SLEEP, DFSDM1_DATIN1, OCTOSPIM_P1_IO6, SPI2_MOSI/I2S2_SDO, OCTOSPIM_P1_IO0, OTG_HS_ULPI_NXT, ETH_MII_TX_CLK, FMC_SDCKE0, EVENTOUT | ADC12_INN12, ADC12_INP13 |
| - | 19 (2) | G4 (2) | 31 (2) | - | K1 (1) | N2 (1) | 37 (2) | PC3_C | ANA | TT_a | - | - | ADC3_INP1 |
| - | 20 | - | 32 | V11 | - | - | - | VDD | S | - | - | - | - |
| - | 21 | - | 33 | U10 | - | - | - | VSS | S | - | - | - | - |
| 15 | 22 | H2 | 34 | T9 | J3 | N3 | 38 | VSSA | S | - | - | - | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|---------------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | - | L4 | - | VREF- | S | - | - | - | - |
| - | 23 | J1 | 35 | W10 | L2 | M3 | 39 | VREF+ | S | - | - | - | - |
| 16 | 24 | H1 | 36 | Y11 | L1 | M4 | 40 | VDDA | S | - | - | - | - |
| 17 | 25 | G3 | 37 | N8 | J5 (1) | P1 (1) | 41 | PA0 | I/O | FT_ha | - | TIM2_CH1/TIM2_ETR, TIM5_CH1, TIM8_ETR, TIM15_BKIN, SPI6_NSS/I2S6_WS, USART2_CTS/USART 2_NSS, UART4_TX, SDMMC2_CMD, SAI4_SD_B, ETH_MII_CRS, FMC_A19, EVENTOUT | ADC1_INP16, WKUP1 |
| - | - | - | - | - | K3 (1) | R3 (1) | - | PA0_C | ANA | TT_a | - | - | ADC12_INN1, ADC12_INP0 |
| 18 | 26 | J2 | 38 | R8 | K4 (1) | P2 (1) | 42 | PA1 | I/O | FT_ha | - | TIM2_CH2, TIM5_CH2, LPTIM3_OUT, TIM15_CH1N, USART2_RTS/USART 2_DE, UART4_RX, OCTOSPIM_P1_IO3, SAI4_MCLK_B, ETH_MII_RX_CLK/ET H_RMII_REF_CLK, OCTOSPIM_P1_DQS, LCD_R2, EVENTOUT | ADC1_INN16, ADC1_INP17 |
| - | - | - | - | - | L3 (1) | P3 (1) | - | PA1_C | ANA | TT_a | - | - | ADC12_INP1 |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|---------------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 19 | 27 | H3 | 39 | V9 | N1 | R2 | 43 | PA2 | I/O | FT_ha | - | TIM2_CH3, TIM5_CH3, LPTIM4_OUT, TIM15_CH1, OCTOSPIM_P1_IO0, USART2_TX(boot), SAI4_SCK_B, ETH_MDIO, MDIOS_MDIO, LCD_R1, EVENTOUT | ADC12_INP14, WKUP2 |
| - | - | - | - | - | N2 | N4 | - | PH2 | I/O | FT_ha | - | LPTIM1_IN2, OCTOSPIM_P1_IO4, SAI4_SCK_B, ETH_MII_CRS, FMC_SDCKE0, LCD_R0, EVENTOUT | ADC3_INP13 |
| - | - | - | - | AA10 | - | - | 44 | VDD | S | - | - | - | - |
| - | - | - | - | - | - | - | 45 | VSS | S | - | - | - | - |
| - | - | - | - | - | M3 | R4 | - | PH3 | I/O | FT_ha | - | OCTOSPIM_P1_IO5, SAI4_MCLK_B, ETH_MII_COL, FMC_SDNE0, LCD_R1, EVENTOUT | ADC3_INN13, ADC3_INP14 |
| - | - | - | - | - | - | P4 | - | PH4 | I/O | FT_fa | - | I2C2_SCL, LCD_G5, OTG_HS_ULPI_NXT, PSSI_D14, LCD_G4, EVENTOUT | ADC3_INN14, ADC3_INP15 |
| - | - | - | - | - | - | R5 | - | PH5 | I/O | FT_fha | - | I2C2_SDA, SPI5_NSS, FMC_SDNWE, EVENTOUT | ADC3_INN15, ADC3_INP16 |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|---|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 20 | 28 | G5 | 40 | P7 | N3 | N5 | 46 | PA3 | I/O | FT_ha | - | TIM2_CH4, TIM5_CH4, LPTIM5_OUT, TIM15_CH2, I2S6_MCK, OCTOSPIM_P1_IO2, USART2_RX(boot), LCD_B2, OTG_HS_ULPI_D0, ETH_MII_COL, OCTOSPIM_P1_CLK, LCD_B5, EVENTOUT | ADC12_INP15 |
| 21 | 29 | - | 41 | - | - | - | 47 | VSS | S | - | - | - | - |
| 22 | 30 | - | 42 | - | - | - | 48 | VDD | S | - | - | - | - |
| 23 | 31 | K1 | 43 | Y9 | H6 | P5 | 49 | PA4 | I/O | TT_ha | - | D1PWREN, TIM5_ETR, SPI1_NSS(boot)/I2S1_WS, SPI3_NSS/I2S3_WS, USART2_CK, SPI6_NSS/I2S6_WS, FMC_D8/FMC_AD8, DCMI_HSYNC/PSSI_DE, LCD_VSYNC, EVENTOUT | ADC12_INP18, DAC1_OUT1 |
| 24 | 32 | K2 | 44 | U8 | L4 | P6 | 50 | PA5 | I/O | TT_ha | - | D2PWREN, TIM2_CH1/TIM2_ETR, TIM8_CH1N, SPI1_SCK(boot)/I2S1_CK, SPI6_SCK/I2S6_CK, OTG_HS_ULPI_CK, FMC_D9/FMC_AD9, PSSI_D14, LCD_R4, EVENTOUT | ADC12_INN18, ADC12_INP19, DAC1_OUT2 |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|---|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 25 | 33 | J3 | 45 | T7 | K5 | R7 | 51 | PA6 | I/O | FT_ha | - | TIM1_BKIN, TIM3_CH1, TIM8_BKIN, SPI1_MISO(boot)/I2S1_SDI, OCTOSPIM_P1_IO3, SPI6_MISO/I2S6_SDI, TIM13_CH1, TIM8_BKIN_COMP12, MDIOS_MDC, TIM1_BKIN_COMP12, DCMI_PIXCLK/PSSI_PDCK, LCD_G2, EVENTOUT | ADC12_INP3 |
| 26 | 34 | K3 | 46 | R6 | J6 | N6 | 52 | PA7 | I/O | TT_ha | - | TIM1_CH1N, TIM3_CH2, TIM8_CH1N, SPI1_MOSI(boot)/I2S1_SDO, SPI6_MOSI/I2S6_SDO, TIM14_CH1, OCTOSPIM_P1_IO2, ETH_MII_RX_DV/ETH_RMII_CRS_DV, FMC_SDNWE, LCD_VSYNC, EVENTOUT | ADC12_INN3, ADC12_INP7, OPAMP1_VINM |
| 27 | 35 | H4 | 47 | W8 | K6 | R6 | 53 | PC4 | I/O | TT_ha | - | PWR_DEEPSLEEP, FMC_A22, DFSDM1_CKIN2, I2S1_MCK, SPDIFRX1_IN3, SDMMC2_CKIN, ETH_MII_RXD0/ETH_RMII_RXD0, FMC_SDNE0, LCD_R7, EVENTOUT | ADC12_INP4, OPAMP1_VOUT, COMP1_INM |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|---|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 28 | 36 | J4 | 48 | AA8 | N5 | M7 | 54 | PC5 | I/O | TT_ha | - | PWR_SLEEP, SAI4_D3, SAI1_D3, DFSDM1_DATIN2, PSSI_D15, SPDIFRX1_IN4, OCTOSPIM_P1_DQS, ETH_MII_RXD1/ETH_ RMIIXD1, FMC_SDCKE0, COMP1_OUT, LCD_DE, EVENTOUT | ADC12_INN4, ADC12_INP8, OPAMP1_VINM |
| - | - | - | - | V7 | - | - | - | VSS | S | - | - | - | - |
| - | - | - | - | Y7 | - | - | - | VDD | S | - | - | - | - |
| 29 | 37 | K4 | 49 | U6 | M5 | R8 | 55 | PB0 | I/O | TT_ha | - | TIM1_CH2N, TIM3_CH3, TIM8_CH2N, OCTOSPIM_P1_IO1, DFSDM1_CKOUT, UART4_CTS, LCD_R3, OTG_HS_ULPI_D1, ETH_MII_RXD2, LCD_G1, EVENTOUT | ADC12_INN5, ADC12_INP9, OPAMP1_VINP, COMP1_INP |
| 30 | 38 | K5 | 50 | W6 | L5 | M8 | 56 | PB1 | I/O | FT_ha | - | TIM1_CH3N, TIM3_CH4, TIM8_CH3N, OCTOSPIM_P1_IO0, DFSDM1_DATIN1, LCD_R6, OTG_HS_ULPI_D2, ETH_MII_RXD3, LCD_G0, EVENTOUT | ADC12_INP5, COMP1_INM |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 31 | 39 | J5 | 51 | AA6 | L6 | P7 | 57 | PB2 | I/O | FT_ha | - | RTC_OUT, SAI4_D1, SAI1_D1, DFSDM1_CKIN1, SAI1_SD_A, SPI3_MOSI/I2S3_SD O, SAI4_SD_A, OCTOSPIM_P1_CLK, OCTOSPIM_P1_DQS, ETH_TX_ER, TIM23_ETR, EVENTOUT | COMP1_INP |
| - | - | - | 52 | - | M6 | N7 | 58 | PF11 | I/O | FT_ha | - | SPI5_MOSI, OCTOSPIM_P1_NCLK, SAI4_SD_B, FMC_NRAS, DCMI_D12/PSSI_D12, TIM24_CH1, EVENTOUT | ADC1_INP2 |
| - | - | - | - | - | N6 | P11 | 59 | PF12 | I/O | FT_ha | - | OCTOSPIM_P2_DQS, FMC_A6, TIM24_CH2, EVENTOUT | ADC1_INN2, ADC1_INP6 |
| - | - | - | - | - | G7 | N11 | 60 | PF13 | I/O | FT_ha | - | DFSDM1_DATIN6, I2C4_SMBA, FMC_A7, TIM24_CH3, EVENTOUT | ADC2_INP2 |
| - | - | - | 53 | - | H7 | R10 | 61 | PF14 | I/O | FT_fa | - | DFSDM1_CKIN6, I2C4_SCL, FMC_A8, TIM24_CH4, EVENTOUT | ADC2_INN2, ADC2_INP6 |
| - | - | - | 54 | - | J7 | N10 | 62 | PF15 | I/O | FT_fa | - | I2C4_SDA, FMC_A9, EVENTOUT | - |
| - | - | - | - | - | K7 | P8 | 63 | PG0 | I/O | FT_h | - | OCTOSPIM_P2_IO4, UART9_RX, FMC_A10, EVENTOUT | - |
| - | - | - | 55 | - | - | - | 64 | VSS | S | - | - | - | - |
| - | - | - | 56 | - | - | - | 65 | VDD | S | - | - | - | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|---------------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | L7 | N9 | 66 | PG1 | I/O | TT_h | - | OCTOSPIM_P2_IO5, UART9_TX, FMC_A11, EVENTOUT | OPAMP2_VINM |
| - | 40 | H5 | 57 | N6 | G8 | P9 | 67 | PE7 | I/O | TT_ha | - | TIM1_ETR, DFSDM1_DATIN2, UART7_RX, OCTOSPIM_P1_IO4, FMC_D4/FMC_AD4, EVENTOUT | OPAMP2_VOUT, COMP2_INM |
| - | 41 | J6 | 58 | V5 | H8 | N8 | 68 | PE8 | I/O | TT_ha | - | TIM1_CH1N, DFSDM1_CKIN2, UART7_TX, OCTOSPIM_P1_IO5, FMC_D5/FMC_AD5, COMP2_OUT, EVENTOUT | OPAMP2_VINM |
| - | - | K6 | 59 | - | J8 | R11 | 69 | PE9 | I/O | TT_ha | - | TIM1_CH1, DFSDM1_CKOUT, UART7_RTS/UART7_DE, OCTOSPIM_P1_IO6, FMC_D6/FMC_AD6, EVENTOUT | OPAMP2_VINP, COMP2_INP |
| - | - | - | - | Y5 | - | - | 70 | VSS | S | - | - | - | - |
| - | - | - | - | AA4 | - | - | 71 | VDD | S | - | - | - | - |
| - | - | H6 | 60 | - | M8 | R9 | 72 | PE10 | I/O | FT_ha | - | TIM1_CH2N, DFSDM1_DATIN4, UART7_CTS, OCTOSPIM_P1_IO7, FMC_D7/FMC_AD7, EVENTOUT | COMP2_INM |
| - | - | - | 61 | - | N8 | R12 | 73 | PE11 | I/O | FT_ha | - | TIM1_CH2, DFSDM1_CKIN4, SPI4_NSS(boot), SAI4_SD_B, OCTOSPIM_P1_NCS, FMC_D8/FMC_AD8, LCD_G3, EVENTOUT | COMP2_INP |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | 62 | - | L8 | P12 | 74 | PE12 | I/O | FT_h | - | TIM1_CH3N, DFSDM1_DATIN5, SPI4_SCK(boot), SAI4_SCK_B, FMC_D9/FMC_AD9, COMP1_OUT, LCD_B4, EVENTOUT | - |
| - | - | - | 63 | - | K8 | P13 | 75 | PE13 | I/O | FT_h | - | TIM1_CH3, DFSDM1_CKIN5, SPI4_MISO(boot), SAI4_FS_B, FMC_D10/FMC_AD10, COMP2_OUT, LCD_DE, EVENTOUT | - |
| - | - | - | 64 | - | J9 | M12 | 76 | PE14 | I/O | FT_h | - | TIM1_CH4, SPI4_MOSI(boot), SAI4_MCLK_B, FMC_D11/FMC_AD11, LCD_CLK, EVENTOUT | - |
| - | - | - | 65 | - | N9 | P14 | 77 | PE15 | I/O | FT_h | - | TIM1_BKIN, USART10_CK, FMC_D12/FMC_AD12, TIM1_BKIN_COMP12, LCD_R7, EVENTOUT | - |
| 32 | 42 | K7 | 66 | T5 | L9 | N12 | 78 | PB10 | I/O | FT_fh | - | TIM2_CH3, LPTIM2_IN1, I2C2_SCL, SPI2_SCK/I2S2_CK, DFSDM1_DATIN7, USART3_TX(boot), OCTOSPI1_P1_NCS, OTG_HS_ULPI_D3, ETH_MII_RX_ER, LCD_G4, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | 43 | J7 | 67 | W4 | M9 | P10 | 79 | PB11 | I/O | FT_f | - | TIM2_CH4, LPTIM2_ETR, I2C2_SDA, DFSDM1_CKIN7, USART3_RX(boot), OTG_HS_ULPI_D4, ETH_MII_TX_EN/ETH_RMII_TX_EN, LCD_G5, EVENTOUT | - |
| 33 | 44 | G6 | 68 | Y3 | N10 | R13 | 80 | VCAP | S | - | - | - | - |
| 34 | 45 | - | 69 | AA2 | - | - | 81 | VSS | S | - | - | - | - |
| - | 46 | F7 | 70 | W2 | M10 | R14 | 82 | VDDLDO | S | - | - | - | - |
| 35 | 47 | - | 71 | Y1 | - | - | - | VDD | S | - | - | - | - |
| - | - | - | - | - | - | P15 | - | PH6 | I/O | FT_h | - | TIM12_CH1, I2C2_SMBA, SPI5_SCK, ETH_MII_RXD2, FMC_SDNE1, DCMI_D8/PSSI_D8, EVENTOUT | - |
| - | - | - | - | - | - | M11 | - | PH7 | I/O | FT_fh | - | I2C3_SCL, SPI5_MISO, ETH_MII_RXD3, FMC_SDCKE1, DCMI_D9/PSSI_D9, EVENTOUT | - |
| - | - | - | - | - | - | N13 | - | PH8 | I/O | FT_fh | - | TIM5_ETR, I2C3_SDA, FMC_D16, DCMI_HSYNC/PSSI_DE, LCD_R2, EVENTOUT | - |
| - | - | - | - | - | - | M14 | - | PH9 | I/O | FT_h | - | TIM12_CH2, I2C3_SMBA, FMC_D17, DCMI_D0/PSSI_D0, LCD_R3, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | K9 | N14 | - | PH10 | I/O | FT_h | - | TIM5_CH1, I2C4_SMBA, FMC_D18, DCMI_D1/PSSI_D1, LCD_R4, EVENTOUT | - |
| - | - | - | - | - | L10 | M13 | - | PH11 | I/O | FT_fh | - | TIM5_CH2, I2C4_SCL, FMC_D19, DCMI_D2/PSSI_D2, LCD_R5, EVENTOUT | - |
| - | - | - | - | - | - | - | 83 | VSS | S | - | - | - | - |
| - | - | - | - | Y1 | - | - | 84 | VDD | S | - | - | - | - |
| - | - | - | - | - | K10 | N15 | - | PH12 | I/O | FT_fh | - | TIM5_CH3, I2C4_SDA, FMC_D20, DCMI_D3/PSSI_D3, LCD_R6, EVENTOUT | - |
| 36 | 48 | K8 | 72 | U4 | N12 | M15 | 85 | PB12 | I/O | FT_h | - | TIM1_BKIN, OCTOSPIM_P1_NCLK, I2C2_SMBA, SPI2_NSS/I2S2_WS, DFSDM1_DATIN1, USART3_CK, FDCAN2_RX, OTG_HS_ULPI_D5, ETH_MII_TXD0/ETH_RMII_TXD0, OCTOSPIM_P1_IO0, TIM1_BKIN_COMP12, UART5_RX, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 37 | 49 | J8 | 73 | P5 | L11 | L15 | 86 | PB13 | I/O | FT_h | - | TIM1_CH1N, LPTIM2_OUT, OCTOSPIM_P1_IO2, SPI2_SCK/I2S2_CK, DFSDM1_CKIN1, USART3_CTS/USART 3_NSS, FDCAN2_TX, OTG_HS_ULPI_D6, ETH_MII_TXD1/ETH_ RMII_TXD1, SDMMC1_D0, DCMI_D2/PSSI_D2, UART5_TX, EVENTOUT | - |
| 38 | 50 | K9 | 74 | R4 | N13 | K15 | 87 | PB14 | I/O | FT_h | - | TIM1_CH2N, TIM12_CH1, TIM8_CH2N, USART1_TX, SPI2_MISO/I2S2_SDI, DFSDM1_DATIN2, USART3_RTS/USART 3_DE, UART4_RTS/UART4_ DE, SDMMC2_D0, FMC_D10/FMC_AD10 , LCD_CLK, EVENTOUT | - |
| 39 | 51 | K10 | 75 | V3 | M13 | K14 | 88 | PB15 | I/O | FT_h | - | RTC_REFIN, TIM1_CH3N, TIM12_CH2, TIM8_CH3N, USART1_RX, SPI2_MOSI/I2S2_SD O, DFSDM1_CKIN2, UART4_CTS, SDMMC2_D1, FMC_D11/FMC_AD11, LCD_G7, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | 52 | J9 | 76 | T3 | M12 | L14 | 89 | PD8 | I/O | FT_h | - | DFSDM1_CKIN3, USART3_TX(boot), SPDIFRX1_IN2, FMC_D13/FMC_AD13 , EVENTOUT | - |
| - | 53 | H8 | 77 | N4 | K11 | K13 | 90 | PD9 | I/O | FT_h | - | DFSDM1_DATIN3, USART3_RX(boot), FMC_D14/FMC_AD14 , EVENTOUT | - |
| - | 54 | J10 | 78 | P3 | K12 | L13 | 91 | PD10 | I/O | FT_h | - | DFSDM1_CKOUT, USART3_CK, FMC_D15/FMC_AD15 , LCD_B3, EVENTOUT | - |
| - | - | - | 79 | V1 | - | - | 92 | VDD | S | - | - | - | - |
| - | - | - | 80 | U2 | - | - | 93 | VSS | S | - | - | - | - |
| - | 55 | H7 | 81 | R2 | J10 | J13 | 94 | PD11 | I/O | FT_h | - | LPTIM2_IN2, I2C4_SMBA, USART3_CTS/USART 3_NSS, OCTOSPIM_P1_IO0, SAI4_SD_A, FMC_A16/FMC_CLE, EVENTOUT | - |
| - | 56 | H9 | 82 | T1 | K13 | J15 | 95 | PD12 | I/O | FT_fh | - | LPTIM1_IN1, TIM4_CH1, LPTIM2_IN1, I2C4_SCL, FDCAN3_RX, USART3_RTS/USART 3_DE, OCTOSPIM_P1_IO1, SAI4_FS_A, FMC_A17/FMC_ALE, DCMI_D12/PSSI_D12, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | 57 | H10 | 83 | M3 | J11 | H15 | 96 | PD13 | I/O | FT_fh | - | LPTIM1_OUT, TIM4_CH2, I2C4_SDA, FDCAN3_TX, OCTOSPIM_P1_IO3, SAI4_SCK_A, UART9_RTS/UART9_DE, FMC_A18, DCMI_D13/PSSI_D13, EVENTOUT | - |
| - | 58 | - | - | - | - | - | - | VSS | S | - | - | - | - |
| - | 59 | - | - | - | - | - | - | VDD | S | - | - | - | - |
| - | 60 | G7 | 84 | L2 | J13 | H14 | 97 | PD14 | I/O | FT_h | - | TIM4_CH3, UART8_CTS, UART9_RX, FMC_D0/FMC_AD0, EVENTOUT | - |
| - | 61 | G8 | 85 | N2 | J12 | J12 | 98 | PD15 | I/O | FT_h | - | TIM4_CH4, UART8_RTS/UART8_DE, UART9_TX, FMC_D1/FMC_AD1, EVENTOUT | - |
| - | - | - | - | - | - | - | 99 | VDD | S | - | - | - | - |
| - | - | - | - | P1 | - | - | 100 | VSS | S | - | - | - | - |
| - | - | - | - | - | - | - | 101 | PJ8 | I/O | FT | - | TIM1_CH3N, TIM8_CH1, UART8_TX, LCD_G1, EVENTOUT | - |
| - | - | - | - | - | - | - | 102 | PJ9 | I/O | FT | - | TIM1_CH3, TIM8_CH1N, UART8_RX, LCD_G2, EVENTOUT | - |
| - | - | - | - | - | - | - | 103 | PJ10 | I/O | FT | - | TIM1_CH2N, TIM8_CH2, SPI5_MOSI, LCD_G3, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | - | - | 104 | PJ11 | I/O | FT | - | TIM1_CH2, TIM8_CH2N, SPI5_MISO, LCD_G4, EVENTOUT | - |
| - | - | - | - | M1 | - | - | 105 | VDD | S | - | - | - | - |
| - | - | - | - | - | - | - | 106 | VSS | S | - | - | - | - |
| - | - | - | - | - | - | - | 107 | PK0 | I/O | FT | - | TIM1_CH1N, TIM8_CH3, SPI5_SCK, LCD_G5, EVENTOUT | - |
| - | - | - | - | - | - | - | 108 | PK1 | I/O | FT | - | TIM1_CH1, TIM8_CH3N, SPI5_NSS, LCD_G6, EVENTOUT | - |
| - | - | - | - | - | - | - | 109 | PK2 | I/O | FT | - | TIM1_BKIN, TIM8_BKIN, TIM8_BKIN_COMP12, TIM1_BKIN_COMP12, LCD_G7, EVENTOUT | - |
| - | - | - | - | - | H9 | G15 | 110 | PG2 | I/O | FT_h | - | TIM8_BKIN, TIM8_BKIN_COMP12, FMC_A12, TIM24_ETR, EVENTOUT | - |
| - | - | - | - | - | H10 | H13 | 111 | PG3 | I/O | FT_h | - | TIM8_BKIN2, TIM8_BKIN2_COMP1 2, FMC_A13, TIM23_ETR, EVENTOUT | - |
| - | - | - | - | - | - | - | 112 | VSS | S | - | - | - | - |
| - | - | - | - | M1 | - | - | 113 | VDD | S | - | - | - | - |
| - | - | - | - | - | F8 | G14 | 114 | PG4 | I/O | FT_h | - | TIM1_BKIN2, TIM1_BKIN2_COMP1 2, FMC_A14/FMC_BA0, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | H11 | F15 | 115 | PG5 | I/O | FT_h | - | TIM1_ETR, FMC_A15/FMC_BA1, EVENTOUT | - |
| - | - | - | 86 | - | G9 | F14 | 116 | PG6 | I/O | FT_h | - | TIM17_BKIN, OCTOSPIM_P1_NCS, FMC_NE3, DCMI_D12/PSSI_D12, LCD_R7, EVENTOUT | - |
| - | - | - | 87 | - | G10 | G13 | 117 | PG7 | I/O | FT_h | - | SAI1_MCLK_A, USART6_CK, OCTOSPIM_P2_DQS, FMC_INT, DCMI_D13/PSSI_D13, LCD_CLK, EVENTOUT | - |
| - | - | - | 88 | - | G11 | G12 | 118 | PG8 | I/O | FT_h | - | TIM8_ETR, SPI6_NSS/I2S6_WS, USART6_RTS/USART 6_DE, SPDIFRX1_IN3, ETH_PPS_OUT, FMC_SDCLK, LCD_G7, EVENTOUT | - |
| - | - | - | 89 | P1 | - | - | 119 | VSS | S | - | - | - | - |
| - | - | - | 90 | K1 | G12 | E15 | 120 | VDD50 USB | S | - | - | - | - |
| - | - | E8 | 91 | J2 | G13 | F13 | 121 | VDD33 USB | S | - | - | - | - |
| - | - | - | 92 | - | - | - | - | VDD | S | - | - | - | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 40 | 62 | F8 | 93 | H1 | F9 | E14 | 122 | PC6 | I/O | FT_h | - | TIM3_CH1, TIM8_CH1, DFSDM1_CKIN3, I2S2_MCK, USART6_TX, SDMMC1_D0DIR, FMC_NWAIT, SDMMC2_D6, SDMMC1_D6, DCMI_D0/PSSI_D0, LCD_HSYNC, EVENTOUT | SWPMI_IO |
| 41 | 63 | G9 | 94 | K3 | F10 | D15 | 123 | PC7 | I/O | FT_h | - | DBTRGIO, TIM3_CH2, TIM8_CH2, DFSDM1_DATIN3, I2S3_MCK, USART6_RX, SDMMC1_D123DIR, FMC_NE1, SDMMC2_D7, SWPMI_TX, SDMMC1_D7, DCMI_D1/PSSI_D1, LCD_G6, EVENTOUT | - |
| - | 64 | G10 | 95 | L4 | F12 | D14 | 124 | PC8 | I/O | FT_h | - | TRACED1, TIM3_CH3, TIM8_CH3, USART6_CK, UART5_RTS/UART5_ DE, FMC_NE2/FMC_NCE, FMC_INT, SWPMI_RX, SDMMC1_D0, DCMI_D2/PSSI_D2, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 42 | 65 | F9 | 96 | M5 | F11 | E13 | 125 | PC9 | I/O | FT_fh | - | MCO2, TIM3_CH4, TIM8_CH4, I2C3_SDA(boot), I2S_CKIN, I2C5_SDA, UART5_CTS, OCTOSPIM_P1_IO0, LCD_G3, SWPMI_SUSPEND, SDMMC1_D1, DCMI_D3/PSSI_D3, LCD_B2, EVENTOUT | - |
| - | - | - | - | G2 | - | - | - | VSS | S | - | - | - | - |
| - | - | - | - | F1 | - | - | 126 | VDD | S | - | - | - | - |
| 43 | 66 | F10 | 97 | H3 | E12 | B14 | 127 | PA8 | I/O | FT_fh | - | MCO1, TIM1_CH1, TIM8_BKIN2, I2C3_SCL(boot), I2C5_SCL, USART1_CK, OTG_HS_SOF, UART7_RX, TIM8_BKIN2_COMP1 2, LCD_B3, LCD_R6, EVENTOUT | - |
| 44 | 67 | E9 | 98 | J4 | E11 | D13 | 128 | PA9 | I/O | FT_u | - | TIM1_CH2, LPUART1_TX, I2C3_SMBA, SPI2_SCK/I2S2_CK, I2C5_SMBA, USART1_TX(boot), ETH_TX_ER, DCMI_D0/PSSI_D0, LCD_R5, EVENTOUT | OTG_HS_VBUS |
| 45 | 68 | E10 | 99 | K5 | E10 | C14 | 129 | PA10 | I/O | FT_u | - | TIM1_CH3, LPUART1_RX, USART1_RX(boot), OTG_HS_ID, MDIOS_MDIO, LCD_B4, DCMI_D1/PSSI_D1, LCD_B1, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 46 | 69 | D10 | 100 | E2 | F13 | C15 | 130 | PA11 | I/O | FT_u | - | TIM1_CH4, LPUART1_CTS, SPI2_NSS/I2S2_WS, UART4_RX, USART1_CTS/USART1_NSS, FDCAN1_RX, LCD_R4, EVENTOUT | OTG_HS_DM (boot) |
| 47 | 70 | D9 | 101 | F3 | E13 | B15 | 131 | PA12 | I/O | FT_u | - | TIM1_ETR, LPUART1_RTS/LPUART1_DE, SPI2_SCK/I2S2_CK, UART4_TX, USART1_RTS/USART1_DE, SAI4_FS_B, FDCAN1_TX, TIM1_BKIN2, LCD_R5, EVENTOUT | OTG_HS_DP (boot) |
| 48 | 71 | C10 | 102 | G4 | D11 | B13 | 132 | PA13 (JTMS/SWDIO) | I/O | FT | - | JTMS/SWDIO, EVENTOUT | - |
| 49 | 72 | D8 | 103 | D1 | D13 | A14 | 133 | VCAP | S | - | - | - | - |
| 50 | 73 | - | 104 | B1 | - | - | 134 | VSS | S | - | - | - | - |
| - | 74 | E6 | 105 | C2 | D12 | A13 | 135 | VDDLDO | S | - | - | - | - |
| 51 | 75 | - | 106 | A2 | - | - | 136 | VDD | S | - | - | - | - |
| - | 76 | - | - | - | - | - | - | VDD33 USB | S | - | - | - | - |
| - | - | - | - | - | B13 | C13 | - | PH13 | I/O | FT_h | - | TIM8_CH1N, UART4_TX, FDCAN1_TX(boot), FMC_D21, LCD_G2, EVENTOUT | - |
| - | - | - | - | - | A13 | B12 | - | PH14 | I/O | FT_h | - | TIM8_CH2N, UART4_RX, FDCAN1_RX(boot), FMC_D22, DCMI_D4/PSSI_D4, LCD_G3, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | - | D12 | - | PH15 | I/O | FT_h | - | TIM8_CH3N, FMC_D23, DCMI_D11/PSSI_D11, LCD_G4, EVENTOUT | - |
| - | - | - | - | - | - | - | 137 | VSS | S | - | - | - | - |
| - | - | - | - | A2 | - | - | - | VDD | S | - | - | - | - |
| 52 | 77 | C9 | 107 | D3 | B12 | A12 | 138 | PA14 (JTCK/SW CLK) | I/O | FT | - | JTCK/SWCLK, EVENTOUT | - |
| 53 | 78 | C8 | 108 | H5 | C11 | A11 | 139 | PA15(JTDI) | I/O | FT | - | JTDI, TIM2_CH1/TIM2_ETR, CEC, SPI1_NSS/I2S1_WS, SPI3_NSS(boot)/I2S3_WS, SPI6_NSS/I2S6_WS, UART4_RTS/UART4_DE, LCD_R3, UART7_TX, LCD_B6, EVENTOUT | - |
| 54 | 79 | B10 | 109 | E4 | A12 | C12 | 140 | PC10 | I/O | FT_fh | - | DFSDM1_CKIN5, I2C5_SDA, SPI3_SCK(boot)/I2S3_CK, USART3_TX, UART4_TX, OCTOSPIM_P1_IO1, LCD_B1, SWPMI_RX, SDMMC1_D2, DCMI_D8/PSSI_D8, LCD_R2, EVENTOUT | - |
| 55 | 80 | B9 | 110 | L6 | B11 | C11 | 141 | PC11 | I/O | FT_fh | - | DFSDM1_DATIN5, I2C5_SCL, SPI3_MISO(boot)/I2S3_SDI, USART3_RX, UART4_RX, OCTOSPIM_P1_NCS, SDMMC1_D3, DCMI_D4/PSSI_D4, LCD_B4, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 56 | 81 | A10 | 111 | F5 | A11 | B11 | 142 | PC12 | I/O | FT_h | - | TRACED3, FMC_D6/FMC_AD6, TIM15_CH1, I2C5_SMBA, SPI6_SCK/I2S6_CK, SPI3_MOSI(boot)/I2S3_SDO, USART3_CK, UART5_TX, SDMMC1_CK, DCMI_D9/PSSI_D9, LCD_R6, EVENTOUT | - |
| - | - | - | - | B3 | - | - | - | VDD | S | - | - | - | - |
| - | - | - | - | C4 | - | - | - | VSS | S | - | - | - | - |
| - | 82 | C7 | 112 | J6 | D10 | C10 | 143 | PD0 | I/O | FT_h | - | DFSDM1_CKIN6, UART4_RX, FDCAN1_RX(boot), UART9_CTS, FMC_D2/FMC_AD2, LCD_B1, EVENTOUT | - |
| - | 83 | B8 | 113 | D5 | C10 | A10 | 144 | PD1 | I/O | FT_h | - | DFSDM1_DATIN6, UART4_TX, FDCAN1_TX(boot), FMC_D3/FMC_AD3, EVENTOUT | - |
| 57 | 84 | A9 | 114 | A4 | E9 | B10 | 145 | PD2 | I/O | FT_h | - | TRACED2, FMC_D7/FMC_AD7, TIM3_ETR, TIM15_BKIN, UART5_RX, LCD_B7, SDMMC1_CMD, DCMI_D11/PSSI_D11, LCD_B2, EVENTOUT | - |
| - | 85 | A8 | 115 | B5 | D9 | A9 | 146 | PD3 | I/O | FT_h | - | DFSDM1_CKOUT, SPI2_SCK/I2S2_CK, USART2_CTS/USART2_NSS, FMC_CLK, DCMI_D5/PSSI_D5, LCD_G7, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | 86 | B7 | 116 | G6 | C9 | C9 | 147 | PD4 | I/O | FT_h | - | USART2_RTS/USART2_DE, OCTOSPIM_P1_IO4, FMC_NOE, EVENTOUT | - |
| - | 87 | D7 | 117 | E6 | A9 | B9 | 148 | PD5 | I/O | FT_h | - | USART2_TX, OCTOSPIM_P1_IO5, FMC_NWE, EVENTOUT | - |
| - | - | - | 118 | - | - | - | - | VSS | S | - | - | - | - |
| - | 88 | - | 119 | - | - | - | - | VDD | S | - | - | - | - |
| - | - | A7 | 120 | - | B9 | D9 | 149 | PD6 | I/O | FT_h | - | SAI4_D1, SAI1_D1, DFSDM1_CKIN4, DFSDM1_DATIN1, SPI3_MOSI/I2S3_SDO, SAI1_SD_A, USART2_RX, SAI4_SD_A, OCTOSPIM_P1_IO6, SDMMC2_CK, FMC_NWAIT, DCMI_D10/PSSI_D10, LCD_B2, EVENTOUT | - |
| - | - | C6 | 121 | - | D8 | B8 | 150 | PD7 | I/O | FT_h | - | DFSDM1_DATIN4, SPI1_MOSI/I2S1_SDO, DFSDM1_CKIN1, USART2_CK, SPDIFRX1_IN1, OCTOSPIM_P1_IO7, SDMMC2_CMD, FMC_NE1, EVENTOUT | - |
| - | - | - | - | C6 | - | - | 151 | VSS | S | - | - | - | - |
| - | - | - | - | A6 | - | - | 152 | VDD | S | - | - | - | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | 122 | - | C8 | A8 | 153 | PG9 | I/O | FT_h | - | FDCAN3_TX, SPI1_MISO/I2S1_SDI, USART6_RX, SPDIFRX1_IN4, OCTOSPIM_P1_IO6, SAI4_FS_B, SDMMC2_D0, FMC_NE2/FMC_NCE, DCMI_VSYNC/PSSI_RDY, EVENTOUT | - |
| - | - | - | 123 | - | A8 | C8 | 154 | PG10 | I/O | FT_h | - | FDCAN3_RX, OCTOSPIM_P2_IO6, SPI1_NSS/I2S1_WS, LCD_G3, SAI4_SD_B, SDMMC2_D1, FMC_NE3, DCMI_D2/PSSI_D2, LCD_B2, EVENTOUT | - |
| - | - | - | 124 | - | B8 | A7 | 155 | PG11 | I/O | FT_h | - | LPTIM1_IN2, USART10_RX, SPI1_SCK/I2S1_CK, SPDIFRX1_IN1, OCTOSPIM_P2_IO7, SDMMC2_D2, ETH_MII_TX_EN/ETH_RMII_TX_EN, DCMI_D3/PSSI_D3, LCD_B3, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|--|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | 125 | - | E8 | D8 | 156 | PG12 | I/O | FT_h | - | LPTIM1_IN1, OCTOSPIM_P2_NCS, USART10_TX, SPI6_MISO/I2S6_SDI, USART6_RTS/USART6_DE, SPDIFRX1_IN2, LCD_B4, SDMMC2_D3, ETH_MII_TXD1/ETH_RMII_TXD1, FMC_NE4, TIM23_CH1, LCD_B1, EVENTOUT | - |
| - | - | - | 126 | - | D7 | B7 | 157 | PG13 | I/O | FT_h | - | TRACED0, LPTIM1_OUT, USART10_CTS/USART10_NSS, SPI6_SCK/I2S6_CK, USART6_CTS/USART6_NSS, SDMMC2_D6, ETH_MII_TXD0/ETH_RMII_TXD0, FMC_A24, TIM23_CH2, LCD_R0, EVENTOUT | - |
| - | - | - | 127 | - | C7 | C7 | 158 | PG14 | I/O | FT_h | - | TRACED1, LPTIM1_ETR, USART10_RTS/USART10_DE, SPI6_MOSI/I2S6_SDO, USART6_TX, OCTOSPIM_P1_IO7, SDMMC2_D7, ETH_MII_TXD1/ETH_RMII_TXD1, FMC_A25, TIM23_CH3, LCD_B0, EVENTOUT | - |
| - | - | - | 128 | - | - | - | 159 | VSS | S | - | - | - | - |
| - | - | - | 129 | A6 | - | - | 160 | VDD | S | - | - | - | - |



Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | E7 | D7 | 161 | PG15 | I/O | FT_h | - | USART6_CTS/USART6_NSS, OCTOSPIM_P2_DQS, USART10_CK, FMC_NCAS, DCM1_D13/PSSI_D13, EVENTOUT | - |
| 58 | 89 | B6 | 130 | H7 | F7 | A6 | 162 | PB3(JTDO/TRACESWO) | I/O | FT_h | - | JTDO/TRACESWO, TIM2_CH2, SPI1_SCK/I2S1_CK, SPI3_SCK/I2S3_CK, SPI6_SCK/I2S6_CK, SDMMC2_D2, CRS_SYNC, UART7_RX, TIM24_ETR, EVENTOUT | - |
| 59 | 90 | C5 | 131 | F7 | B6 | B6 | 163 | PB4 (NJTRST) | I/O | FT_h | - | NJTRST, TIM16_BKIN, TIM3_CH1, SPI1_MISO/I2S1_SDI, SPI3_MISO/I2S3_SDI, SPI2_NSS/I2S2_WS, SPI6_MISO/I2S6_SDI, SDMMC2_D3, UART7_TX, EVENTOUT | - |
| 60 | 91 | A6 | 132 | D7 | C6 | C6 | 164 | PB5 | I/O | FT_h | - | TIM17_BKIN, TIM3_CH2, LCD_B5, I2C1_SMBA, SPI1_MOSI/I2S1_SDO, I2C4_SMBA, SPI3_MOSI/I2S3_SDO, SPI6_MOSI/I2S6_SDO, FDCAN2_RX, OTG_HS_ULPI_D7, ETH_PPS_OUT, FMC_SDCKE1, DCM1_D10/PSSI_D10, UART5_RX, EVENTOUT | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|---------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VFQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 61 | 92 | D4 | 133 | K7 | A5 | A5 | 165 | PB6 | I/O | FT_fh | - | TIM16_CH1N, TIM4_CH1, I2C1_SCL(boot), CEC, I2C4_SCL, USART1_TX, LPUART1_TX, FDCAN2_TX, OCTOSPIM_P1_NCS, DFSDM1_DATIN5, FMC_SDNE1, DCMI_D5/PSSI_D5, UART5_TX, EVENTOUT | - |
| - | - | - | - | B7 | - | - | - | VSS | S | - | - | - | - |
| - | - | - | - | A8 | - | - | - | VDD | S | - | - | - | - |
| 62 | 93 | B5 | 134 | M7 | D6 | B5 | 166 | PB7 | I/O | FT_fa | - | TIM17_CH1N, TIM4_CH2, I2C1_SDA, I2C4_SDA, USART1_RX, LPUART1_RX, DFSDM1_CKIN5, FMC_NL, DCMI_VSYNC/PSSI_RDY, EVENTOUT | PVD_IN |
| 63 | 94 | A5 | 135 | C8 | E6 | C5 | 167 | BOOT0 | I | B | - | - | VPP |
| 64 | 95 | A4 | 136 | E8 | B5 | A2 | 168 | PB8 | I/O | FT_fh | - | TIM16_CH1, TIM4_CH3, DFSDM1_CKIN7, I2C1_SCL, I2C4_SCL, SDMMC1_CKIN, UART4_RX, FDCAN1_RX, SDMMC2_D4, ETH_MII_TXD3, SDMMC1_D4, DCMI_D6/PSSI_D6, LCD_B6, EVENTOUT | - |



Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| 65 | 96 | E3 | 137 | G8 | C5 | B3 | 169 | PB9 | I/O | FT_fh | - | TIM17_CH1, TIM4_CH4, DFSDM1_DATIN7, I2C1_SDA(boot), SPI2_NSS/I2S2_WS, I2C4_SDA, SDMMC1_CDOR, UART4_TX, FDCAN1_TX, SDMMC2_D5, I2C4_SMBA, SDMMC1_D5, DCMI_D7/PSSI_D7, LCD_B7, EVENTOUT | - |
| - | - | B4 | 138 | J8 | D5 | B4 | 170 | PE0 | I/O | FT_h | - | LPTIM1_ETR, TIM4_ETR, LPTIM2_ETR, UART8_RX, SAI4_MCLK_A, FMC_NBL0, DCMI_D2/PSSI_D2, LCD_R0, EVENTOUT | - |
| - | - | C4 | 139 | - | D4 | C4 | 171 | PE1 | I/O | FT_h | - | LPTIM1_IN2, UART8_TX, FMC_NBL1, DCMI_D3/PSSI_D3, LCD_R6, EVENTOUT | - |
| 66 | 97 | D8 | 140 | B9 | A4 | A4 | 172 | VCAP | S | - | - | - | - |
| 67 | 98 | - | 141 | A10 | - | - | 173 | VSS | S | - | - | - | - |
| - | - | D3 | 142 | L8 | C4 | D4 | 174 | PDR_ON | S | - | - | - | - |
| - | 99 | E6 | 143 | D9 | B4 | A3 | 175 | VDDLDO | S | - | - | - | - |
| 68 | 100 | - | - | C10 | - | - | - | VDD | S | - | - | - | - |
| - | - | - | 144 | C10 | - | - | 176 | VDD | S | - | - | - | - |
| - | - | C1 | - | - | B3 | A1 | - | VSS | S | - | - | - | - |
| - | - | D5 | - | - | B7 | A15 | - | VSS | S | - | - | - | - |
| - | - | E7 | - | - | B10 | C2 | - | VSS | S | - | - | - | - |

Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---------------------|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | F5 | - | - | C12 | D10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | D2 | D6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | G2 | E1 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | H12 | F10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | L12 | F12 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | M2 | F6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | M4 | F7 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | M7 | F8 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | M11 | F9 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | G10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | G6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | G7 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | G8 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | G9 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | H10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | H6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | H7 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | H8 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | H9 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | J10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | J14 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | J6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | J7 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | J8 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | J9 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | K10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | K12 | - | VSS | S | - | - | - | - |



Table 8. STM32H725 pin and ball descriptions (continued)

| Pin number | | | | | | | | Pin name (function after reset) | Pin type | I/O structure | Notes | Alternate functions | Additional functions |
|--------------|--------------|---------------|--------------|---------------|---------------|------------------|--------------|---------------------------------|----------|---------------|-------|---------------------|----------------------|
| VQFPN68 SMPS | LQFP100 SMPS | TFBGA100 SMPS | LQFP144 SMPS | WLCSP115 SMPS | UFBGA169 SMPS | UFBGA176+25 SMPS | LQFP176 SMPS | | | | | | |
| - | - | - | - | - | - | K2 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | K6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | K7 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | K8 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | K9 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | M10 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | M6 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | R1 | - | VSS | S | - | - | - | - |
| - | - | - | - | - | - | R15 | - | VSS | S | - | - | - | - |
| - | - | D6 | - | - | A3 | D5 | - | VDD | S | - | - | - | - |
| - | - | E5 | - | - | A6 | D11 | - | VDD | S | - | - | - | - |
| - | - | F6 | - | - | A7 | E4 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | A10 | E12 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | C13 | G4 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | D1 | H12 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | G1 | K4 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | H13 | L12 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | L13 | M5 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | M1 | M9 | - | VDD | S | - | - | - | - |
| - | - | - | - | - | N4 | - | - | VDD | S | - | - | - | - |
| - | - | - | - | - | N7 | - | - | VDD | S | - | - | - | - |
| - | - | - | - | - | N11 | - | - | VDD | S | - | - | - | - |

1. Pxy_C and Pxy pins/balls are two separate pads (analog switch open). The analog switch is configured through a SYSCFG register. Refer to the product reference manual for a detailed description of the switch configuration bits.
2. There is a direct path between Pxy_C and Pxy pins/balls, through an analog switch. Pxy alternate functions are available on Pxy_C when the analog switch is closed. The analog switch is configured through a SYSCFG register. Refer to the product reference manual for a detailed description of the switch configuration bits.

Table 9. STM32H725 pin alternate functions

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF |
|------|---------|--|--|--|--|---|---|--|--|---|--|---|
| | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CEC/FD CAN3/S P1/2S1/ SP1/2/2S 2/SP1/3/2 SA1/SP1 3/2S3/U ART4 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SA1/SP1 3/2S3/U ART4 | SDMMC 1/SP1/2/2 S2/SP1/3 I2S3/SP1 6/UART 7/USAR T1/2/3/6 | LPUART 1/SA1/4/S DMMC1/ SPDI/FI X1/SP1/6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM P1/2/S TG1_FS/ OTG1_H S/SA1/4/S DMMC2/ TIM8 | CRS/FM C/LCD/O C/TOSPI M_P1/O M_P1/O M_P1/O DMM SWP1/ /TIM1 IM8/U T7/9/ ART | DFSD /ETH/ 4/LCD/O DIOS C/TOSPI M_P1/O M_P1/O DMM SWP1/ /TIM1 IM8/U T7/9/ ART |
| PA0 | - | TIM2_C H1/TIM2 _ETR | TIM5_C H1 | TIM8_ET R | TIM15_B KIN | SPI6_NS S/I2S6_ WS | - | USART2 CTS/U SART2_ NSS | UART4_ TX | SDMMC 2_CMD | SAI4_SD _B | ETH_ _CR |
| PA1 | - | TIM2_C H2 | TIM5_C H2 | LP TIM3_ OUT | TIM15_C H1N | - | - | USART2 RTS/U SART2_ DE | UART4_ RX | OCTOS PIM_P1_ IO3 | SAI4_M CLK_B | ETH_ _RX K/ET RMIL F_C |
| PA2 | - | TIM2_C H3 | TIM5_C H3 | LP TIM4_ OUT | TIM15_C H1 | - | OCTOS PIM_P1_ IO0 | USART2 _TX | SAI4_SC K_B | - | - | ETH_ _IO |
| PA3 | - | TIM2_C H4 | TIM5_C H4 | LP TIM5_ OUT | TIM15_C H2 | I2S6_M CK | OCTOS PIM_P1_ IO2 | USART2 _RX | - | LCD_B2 | OTG_HS _ULPI_D 0 | ETH_ _CC |
| PA4 | D1PWREN | - | TIM5_ET R | - | - | SPI1_NS S/I2S1_ WS | SPI3_NS S/I2S3_ WS | USART2 _CK | SPI6_NS S/I2S6_ WS | - | - | - |
| PA5 | D2PWREN | TIM2_C H1/TIM2 _ETR | - | TIM8_C H1N | - | SPI1_SC K/I2S1_ CK | - | - | SPI6_SC K/I2S6_ CK | - | OTG_HS _ULPI_C K | - |
| PA6 | - | TIM1_B KIN | TIM3_C H1 | TIM8_B KIN | - | SPI1_MI SO/I2S1 _SDI | OCTOS PIM_P1_ IO3 | - | SPI6_MI SO/I2S6 _SDI | TIM13_C H1 | TIM8_B KIN_CO MP12 | MDIC MD |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | | |
|--------|-----|--|--|--|---|--|--|--|---|--|---|--|-----------------------------------|--------------|
| Port A | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /I2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/I2S 2/SPI3/I2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OCTOS PIM_P1/ SA11/SPI 3/I2S3/U ART4 | SDMMC 1/SPI2/I2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART | | |
| | | PA7 | - | TIM1_C H1N | TIM8_C H1N | - | SPI1_M OS/I2S1 _SDO | - | - | SPI6_M OS/I2S6 _SDO | TIM14_C H1 | OCTOS PIM_P1_ IO2 | ETH_ RX _ETH MIL_C _D | |
| | | PA8 | MCO1 | - | TIM8_B KIN2 | I2C3_SC L | - | I2C5_SC L | USART1 _CK | - | - | - | OTG_HS _SOF | UART RX |
| | | PA9 | - | TIM1_C H2 | LPUART 1_TX | I2C3_S MBA | SPI2_SC K/I2S2_ CK | I2C5_S MBA | USART1 _TX | - | - | - | - | ETH _ET |
| | | PA10 | - | TIM1_C H3 | LPUART 1_RX | - | - | - | USART1 _RX | - | - | - | OTG_HS _ID | MDIO MDIO |
| | | PA11 | - | TIM1_C H4 | LPUART 1_CTS | - | SPI2_NS S/I2S2_ WS | UART4_ RX | USART1 CTS/U SART1_ NSS | FDCAN1 _RX | - | - | - | - |
| | | PA12 | - | TIM1_ET R | LPUART 1_RTS/L PUART1 _DE | - | SPI2_SC K/I2S2_ CK | UART4_ TX | USART1 RTS/U SART1_ DE | FDCAN1 _TX | - | - | - | - |
| | | PA13 | JTMS/SWDIO | - | - | - | - | - | - | - | - | - | - | - |
| | | PA14 | JTCK/SWCLK | - | - | - | - | - | - | - | - | - | - | - |
| | | PA15 | JTDI | TIM2_C H1/TIM2 _ETR | - | - | CEC | SPI1_NS S/I2S1_ WS | SPI3_NS S/I2S3_ WS | SPI6_NS S/I2S6_ WS | UART4_ RTS/UA RT4_DE | LCD_R3 | - | UART TX |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | |
|--------|-----|---|--|--|---|--|---|--|---|--|--|---|-----------------------------------|
| Port B | SYS | FMC/LP TIM1/SA /14/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /I2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/2S 2/SPI3/1/2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OCTOS PIM_P1/ SA1/SP1 3/I2S3/U ART4 | SDMMC 1/SPI2/I2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM M_P1/O TG1_FS/ A14/SDM MC2/SP S/SAI4/S DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ A14/SDM MC2/SP S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART | |
| | | PB10 | - | TIM2_C H3 | LPTIM2_ IN1 | I2C2_SC L | SPI2_SC K/I2S2_ CK | DFSDM1 _DATIN7 | USART3 _TX | - | OCTOS PIM_P1_ NCS | OTG_HS _ULPI_D 3 | ETH_ RX_ ETH_ IL_TX N |
| | | PB11 | - | TIM2_C H4 | LPTIM2_ ETR | I2C2_SD A | - | DFSDM1 _CKIN7 | USART3 _RX | - | - | OTG_HS _ULPI_D 4 | ETH_ TX_ ETH_ IL_TX N |
| | | PB12 | - | TIM1_B KIN | OCTOS PIM_P1_ NCLK | I2C2_S MBA | SPI2_NS S/I2S2_ WS | DFSDM1 _DATIN1 | USART3 _CK | - | FDCAN2 _RX | OTG_HS _ULPI_D 5 | ETH_ TXD TH_R _TX |
| | | PB13 | - | TIM1_C H1N | LPTIM2_ OUT | OCTOS PIM_P1_ IO2 | SPI2_SC K/I2S2_ CK | DFSDM1 _CKIN1 | USART3 CTS/U SART3_ NSS | - | FDCAN2 _TX | OTG_HS _ULPI_D 6 | ETH_ TXD TH_R _TX |
| | | PB14 | - | TIM1_C H2N | TIM12_C H1 | USART1 _TX | SPI2_MI SO/I2S2_ SDI | DFSDM1 _DATIN2 | USART3 RTS/U SART3_ DE | UART4_ RTS/UA RT4_DE | SDMMC 2_D0 | - | - |
| | | PB15 | RTC_REFIN | TIM1_C H3N | TIM12_C H2 | USART1 _RX | SPI2_M OS/I2S2_ SDO | DFSDM1 _CKIN2 | - | UART4_ CTS | SDMMC 2_D1 | - | - |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | |
|--------|---------|-------------------|--|--------------------------------------|---|--|--|--|--|---|---|---|--|
| Port C | PC0 | SYS | FMC/LP TIM1/SA /PDM_S /4/TIM3 /4/5/12/1 5 | FDCAN3 A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OCT TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /I2C1/2/3 /4/5/LPTI M2/OCT OSPI_M P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/I2S 2/SPI3/I2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/I2S3/U ART4 | SDMMC 1/SPI2/I2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OCTOS TOSPIM M_P1/O TG1_FS/ A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIO CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART |
| | PC1 | - | FMC_D1 2/FMC AD12 | - | DFSDM1 _CKIN0 | - | - | DFSDM1 _DATIN4 | SAI4_FS _B | FMC_A2 _5 | OTG_HS _ULPI_S _TP | LCD | |
| | PC2 | TRACED0 | SAI4_D1 | SAI1_D1 | DFSDM1 _DATIN0 | DFSDM1 _CKIN4 | SPI2_M OS/I2S2 _SDO | SAI1_SD _A | SAI4_SD _A | SDMMC 2_CK | OCTOS PIM_P1_ IO4 | ETH_ C | |
| | PC3 | PWR_DEEPS LEEP | - | - | DFSDM1 _CKIN1 | OCTOS PIM_P1_ IO5 | SPI2_MI SO/I2S2 _SDI | DFSDM1 _CKOUT | - | OCTOS PIM_P1_ IO2 | OTG_HS _ULPI_D _IR | ETH_ _TX_ _TXI | |
| | PC4 | PWR_SLEEP | - | - | DFSDM1 _DATIN1 | OCTOS PIM_P1_ IO6 | SPI2_M OS/I2S2 _SDO | - | - | OCTOS PIM_P1_ IO0 | OTG_HS _ULPI_N _XT | ETH_ _TX_ _TXI _K | |
| | PC5 | PWR_DEEPS LEEP | FMC_A2 _2 | - | DFSDM1 _CKIN2 | - | I2S1_M CK | - | - | SPDIFR X1_IN3 | SDMMC 2_CKIN | ETH_ _RX_ ETH_ IL_RX | |
| | PC6 | PWR_SLEEP | SAI4_D3 | SAI1_D3 | DFSDM1 _DATIN2 | PSSI_D1 _5 | - | - | - | SPDIFR X1_IN4 | OCTOS PIM_P1_ DQS | ETH_ _RX_ ETH_ IL_RX | |
| | PC7 | - | - | TIM3_C H1 | TIM8_C H1 | DFSDM1 _CKIN3 | I2S2_M CK | - | USART6 _TX | FMC_N WAIT | FMC_N 2_D6 | SDMMC 2_D7 | SWP TX |
| PC8 | DBTRGIO | - | TIM3_C H2 | TIM8_C H2 | DFSDM1 _DATIN3 | - | I2S3_M CK | USART6 _RX | SDMMC 1_D0DIR | FMC_NE 1 | SDMMC 2_D7 | SWP RX | |
| PC8 | TRACED1 | - | TIM3_C H3 | TIM8_C H3 | - | - | - | USART6 _CK | SDMMC 1_D123 DIR | FMC_NE 2/FMC_ NCE | FMC_IN T | SWP RX | |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | |
|--------|---------|---|--|--|---|--|---|--|---|--|--|--|-----------------|
| Port C | SYS | FMC/LP TIM1/SA /14/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /I2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/I2S 2/SPI3/I2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OCTOS PIM_P1/ SA1/SP1 3/I2S3/U ART4 | SDMMC 1/SP12/I2 S2/SP13/ I2S3/SP1 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LCD/O CTOSPI M_P1/O TG1_FS/ OTG1_H SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LCD/ DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART | |
| | | MCO2 | - | TIM3_C H4 | TIM8_C H4 | I2C3_SD A | I2S_CK1 N | I2C5_SD A | - | UART5_ CTS | OCTOS PIM_P1_ IO0 | LCD_G3 | SWP SUS D |
| | | - | - | - | DFSDM1 _CKIN5 | I2C5_SD A | - | SPI3_SC K/I2S3_ CK | USART3 _TX | UART4_ TX | OCTOS PIM_P1_ IO1 | LCD_B1 | SWP RX |
| | - | - | - | DFSDM1 _DATIN5 | I2C5_SC L | - | SPI3_MI SO/I2S3 _SDI | USART3 _RX | UART4_ RX | OCTOS PIM_P1_ NCS | - | - | - |
| | TRACED3 | FMC_D6 /FMC_A D6 | TIM15_C H1 | - | - | I2C5_S MBA | SPI6_SC K/I2S6_ CK | SPI3_M OS/I2S3 _SDO | USART3 _CK | UART5_ TX | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF |
|--------|-----|--|--|---|---|--|--|---|---|--|---|--|
| Port D | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI _M8 | CEC/DC MI/PSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/2S3/U ART4 | SDMMC 1/SPI2/2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART |
| | | - | - | DFSDM1 _CKIN6 | - | - | - | - | UART4_ RX | FDCAN1 _RX | - | UART CT |
| | | - | - | DFSDM1 _DATIN6 | - | - | - | - | UART4_ TX | FDCAN1 _TX | - | - |
| | | TRACED2 | FMC_D7 /FMC_A D7 | TIM3_ET R | - | TIM15_B KIN | - | - | UART5_ RX | LCD_B7 | - | - |
| | | - | - | DFSDM1 _CKOUT | - | - | SPI2_SC K/2S2_ CK | - | USART2 CTS/U SART2_ NSS | - | - | - |
| | | - | - | - | - | - | - | - | USART2 RTS/U SART2_ DE | - | - | OCTOS PIM_P1_ IO4 |
| | | - | - | - | - | - | - | - | USART2 _TX | - | - | OCTOS PIM_P1_ IO5 |
| | | - | SAI4_D1 | SAI1_D1 | DFSDM1 _CKIN4 | DFSDM1 _DATIN1 | SPI3_M OS/2S3 _SDO | SAI1_SD _A | USART2 _RX | SAI4_SD _A | - | OCTOS PIM_P1_ IO6 |
| | | - | - | - | DFSDM1 _DATIN4 | - | SPI1_M OS/2S1 _SDO | DFSDM1 _CKIN1 | USART2 _CK | - | SPDIFR X1_IN1 | OCTOS PIM_P1_ IO7 |
| - | - | - | DFSDM1 _CKIN3 | DFSDM1 _CKIN3 | - | - | USART3 _TX | - | SPDIFR X1_IN2 | - | | |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | | |
|--------|-----|--|--|--|---|--|--|---|---|--|--|---|----------------|---------------------|
| Port D | SYS | FMC/LP TIM1/SA /4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MI/PSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/2S3/U ART4 | SDMMC 1/SPI2/2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LCDIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LCDIO DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART | | |
| | | PD9 | - | DFSDM1 _DATIN3 | - | USART3 _RX | - | USART3 _RX | - | - | - | - | - | |
| | | PD10 | - | DFSDM1 _CKOUT | - | USART3 _CK | - | USART3 _CK | - | - | - | - | - | - |
| | | PD11 | - | LPTIM2_ IN2 | I2C4_S MBA | - | USART3 CTS/U SART3_ NSS | - | USART3 CTS/U SART3_ NSS | - | OCTOS PIM_P1_ IO0 | SAI4_SD _A | - | - |
| | | PD12 | - | LPTIM2_ IN1 | I2C4_SC L | FDCAN3 _RX | - | USART3 RTS/U SART3_ DE | - | USART3 RTS/U SART3_ DE | - | OCTOS PIM_P1_ IO1 | SAI4_FS _A | - |
| | | PD13 | - | - | I2C4_SD A | FDCAN3 _TX | - | - | - | OCTOS PIM_P1_ IO3 | - | OCTOS PIM_P1_ IO3 | SAI4_SC K_A | UART RTS/ RT9 |
| | | PD14 | - | - | - | - | - | - | - | UART8_ CTS | - | - | - | UART RX |
| | | PD15 | - | - | - | - | - | - | - | UART8_ RTS/UA RT8_DE | - | - | - | UART TX |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF11 | | | |
|--------|-----|--|--|---|--|--|--|--|---|--|---|---|-------------------------|---------------------|---|
| Port E | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPI _P1/2/TI M8 | CEC/DC MIIPSSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/1/2S3/U ART4 | SDMMC 1/SPI2/12 S2/SPI3/ I2S3/SPI 6/JART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPI M_P1/O TG1_FS/ A14/SDM OTG1_H S/SAI4/S DMMC2/ TIM8 | CRS/FM C/LCDIO CTOSPI M_P1/O TG1_FS/ A14/SDM OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ DIOS CTO M_P DM SWP /TIM IM8/U T7/9/ ART | | | |
| | | PE0 | - | LPTIM1_ ETR | TIM4_ET R | - | LPTIM2_ ETR | - | - | UART8_ RX | - | SAI4_M CLK_A | - | | |
| | | PE1 | - | LPTIM1_ IN2 | - | - | - | - | - | UART8_ TX | - | - | - | - | |
| | | PE2 | TRACECLK | - | SAI1_CK 1 | - | USART1 0_RX | SP14_SC K | SAI1_M CLK_A | - | SAI4_M CLK_A | OCTOS PIM_P1_ IO2 | SAI4_CK 1 | ETH_ _TX1 | |
| | | PE3 | TRACED0 | - | - | - | TIM15_B KIN | - | SAI1_SD _B | - | SAI4_SD _B | - | - | USAF 0_T | |
| | | PE4 | TRACED1 | - | - | DFSDM1 _DATIN3 | TIM15_C H1N | SP14_NS S | SAI1_FS _A | - | SAI4_FS _A | - | SAI4_D2 | - | - |
| | | PE5 | TRACED2 | - | - | DFSDM1 _CKIN3 | TIM15_C H1 | SP14_MI SO | SAI1_SC K_A | - | SAI4_SC K_A | - | SAI4_CK 2 | - | - |
| | | PE6 | TRACED3 | TIM1_B KIN2 | SAI1_D1 | - | TIM15_C H2 | SP14_M OSI | SAI1_SD _A | - | SAI4_SD _A | SAI4_D1 | SAI4_M CLK_B | TIM1 KIN2 OMP | |
| | | PE7 | - | TIM1_ET R | - | DFSDM1 _DATIN2 | - | - | - | UART7_ RX | - | - | OCTOS PIM_P1_ IO4 | - | - |
| | | PE8 | - | TIM1_C H1N | - | DFSDM1 _CKIN2 | - | - | - | UART7_ TX | - | - | OCTOS PIM_P1_ IO5 | - | - |
| PE9 | - | TIM1_C H1 | - | DFSDM1 _CKOUT | - | - | - | UART7_ RTS/UA RT7_DE | - | - | OCTOS PIM_P1_ IO6 | - | - | | |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF11 | | |
|--------|-----|--|--|---|--|--|--|---|---|---|---|--|---|--------------------|
| Port E | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPI _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPI P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/2S3/U ART4 | SDMMC 1/SPI2/2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPI M_P1/O TG1_FS/ A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART | | |
| | | PE10 | TIM1_C H2N | - | DFSDM1 _DATIN4 | - | - | - | UART7 _CTS | - | - | OCTOS PIM_P1_ IO7 | - | |
| | | PE11 | TIM1_C H2 | - | DFSDM1 _CKIN4 | - | SPI4_NS S | - | - | - | - | SAI4_SD _B | - | OCT PIM_P NC |
| | | PE12 | TIM1_C H3N | - | DFSDM1 _DATIN5 | - | SPI4_SC K | - | - | - | - | SAI4_SC K_B | - | - |
| | | PE13 | TIM1_C H3 | - | DFSDM1 _CKIN5 | - | SPI4_MI SO | - | - | - | - | SAI4_FS _B | - | - |
| | | PE14 | TIM1_C H4 | - | - | - | SPI4_M OSI | - | - | - | - | SAI4_M CLK_B | - | - |
| | | PE15 | TIM1_B KIN | - | - | - | - | - | - | - | - | - | - | USAF 0_C |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF |
|--------|-----|--|--|--|--|--|--|---|---|---|---|---|
| | SYS | FMC/LP TIM1/SA /PDM_S A11/TIM3 /4/5/12/1 5 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MI/PSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OCT OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SA11/SPI 3/2S3/U ART4 | SDMMC 1/SPI2/2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/IOC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART |
| PF0 | - | - | - | I2C2_SD A | I2C5_SD A | - | I2C5_SD A | - | - | OCTOS PIM_P2_ IO0 | - | - |
| PF1 | - | - | - | I2C2_SC L | I2C5_SC L | - | I2C5_SC L | - | - | OCTOS PIM_P2_ IO1 | - | - |
| PF2 | - | - | - | I2C2_S MBA | I2C5_S MBA | - | I2C5_S MBA | - | - | OCTOS PIM_P2_ IO2 | - | - |
| PF3 | - | - | - | - | - | - | - | - | - | OCTOS PIM_P2_ IO3 | - | - |
| PF4 | - | - | - | - | - | - | - | - | - | OCTOS PIM_P2_ CLK | - | - |
| PF5 | - | - | - | - | - | - | - | - | - | OCTOS PIM_P2_ NCLK | - | - |
| PF6 | - | TIM16_C H1 | FDCAN3 _RX | - | - | SPI5_NS S | SAI1_SD _B | UART7_ RX | SAI4_SD _B | - | OCTOS PIM_P1_ IO3 | - |
| PF7 | - | TIM17_C H1 | FDCAN3 _TX | - | - | SPI5_SC K | SAI1_M CLK_B | UART7_ TX | SAI4_M CLK_B | - | OCTOS PIM_P1_ IO2 | - |
| PF8 | - | TIM16_C H1N | - | - | - | SPI5_MI SO | SAI1_SC K_B | UART7_ RTS/UA RT7_DE | SAI4_SC K_B | TIM13_C H1 | OCTOS PIM_P1_ IO0 | - |
| PF9 | - | TIM17_C H1N | - | - | - | SPI5_M OSI | SAI1_FS _B | UART7_ CTS | SAI4_FS _B | TIM14_C H1 | OCTOS PIM_P1_ IO1 | - |
| Port F | | | | | | | | | | | | |





Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF11 | | |
|--------|-----|--|--|--|--|---|--|--|---|--|--|--|---|---|
| Port F | SYS | FMC/LP TIM1/SA /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /I2C1/2/3 /4/5/LPTI M2/OCT OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2/S1/ SPI2/I2S 2/SPI3/I2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/I2S3/U ART4 | SDMMC 1/SPI2/I2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/IFM C/LCDIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/AI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART | | |
| | | PF10 | TIM16_B KIN | SAI1_D3 | - | PSSI_D1 5 | - | - | - | - | OCTOS PIM_P1_ CLK | SAI4_D3 | - | |
| | | PF11 | - | - | - | - | SPI5_M OSI | - | - | - | OCTOS PIM_P1_ NCLK | SAI4_SD _B | - | |
| | | PF12 | - | - | - | - | - | - | - | - | OCTOS PIM_P2_ DQS | - | - | |
| | | PF13 | - | - | - | DFSDM1 _DATIN6 | I2C4_S MBA | - | - | - | - | - | - | - |
| | | PF14 | - | - | - | DFSDM1 _CKIN6 | I2C4_SC L | - | - | - | - | - | - | - |
| PF15 | - | - | - | - | I2C4_SD A | - | - | - | - | - | - | - | | |

Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF |
|------|-----|--|--|--|---|--|--|---|---|--|--|---|
| | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OCT OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/2S3/U ART4 | SDMMC 1/SPI2/2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTSAI4/S /TIM1 DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART |
| PG0 | - | - | - | - | - | - | - | - | - | OCTOS PIM_P2_ IO4 | - | UART RX |
| PG1 | - | - | - | - | - | - | - | - | - | OCTOS PIM_P2_ IO5 | - | UART TX |
| PG2 | - | - | - | TIM8_B KIN | - | - | - | - | - | - | - | TIM8 KIN MP |
| PG3 | - | - | - | TIM8_B KIN2 | - | - | - | - | - | - | - | TIM8 KIN2 OMP |
| PG4 | - | - | - | - | - | - | - | - | - | - | - | TIM1 KIN2 OMP |
| PG5 | - | - | - | - | - | - | - | - | - | - | - | - |
| PG6 | - | - | - | - | - | - | - | - | - | - | - | OCTOS PIM_P1_ NCS |
| PG7 | - | - | - | - | - | - | SAI1_M CLK_A | USART6 _CK | - | OCTOS PIM_P2_ DQS | - | - |
| PG8 | - | - | - | TIM8_ET R | - | SPI6_NS S/2S6_ WS | - | USART6 RTS/U SART6_ DE | SPDIFR X1_IN3 | - | - | ETH S_ O |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | | |
|--------|-----|--|--|--|---|--|---|--|---|--|---|---|-----------------------------------|-----------------------------|
| Port G | SYS | FMC/LP TIM1/SA /4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPIM _P1/2/TI M8 | CEC/DC MI/PSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OCTOS PIM_P1/ SA1/SP1 3/2S3/U ART4 | SDMMC 1/SPI2/2 S2/SPI3/ I2S3/SP1 6/JUART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPIM _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART | | |
| | | PG9 | - | FDCAN3 _TX | - | - | SPI1_MI SO/2S1 _SDI | - | USART6 _RX | SPDIFR X1_IN4 | OCTOS PIM_P1_ IO6 | SAI4_FS _B | SDMMC 2_D | |
| | | PG10 | - | FDCAN3 _RX | OCTOS PIM_P2_ IO6 | - | SPI1_NS S/2S1_ WS | - | - | - | - | LCD_G3 | SAI4_SD _B | SDMMC 2_D |
| | | PG11 | - | LPTIM1_ IN2 | - | USART1 0_RX | SPI1_SC K/2S1_ CK | - | - | SPDIFR X1_IN1 | OCTOS PIM_P2_ IO7 | SDMMC 2_D2 | ETH_ TX_ ETH_ II_TX N | |
| | | PG12 | - | LPTIM1_ IN1 | OCTOS PIM_P2_ NCS | USART1 0_TX | SPI6_MI SO/2S6 _SDI | - | USART6 RTS/U SART6_ DE | SPDIFR X1_IN2 | LCD_B4 | SDMMC 2_D3 | ETH_ TXD TH_R _TXI | |
| | | PG13 | TRACED0 | LPTIM1_ OUT | - | USART1 0_CTS/U SART10 _NSS | SPI6_SC K/2S6_ CK | - | USART6 _CTS/U SART6_ NSS | - | - | - | SDMMC 2_D6 | ETH_ TXD TH_R _TXI |
| | | PG14 | TRACED1 | LPTIM1_ ETR | - | USART1 0_RTS/U SART10 _DE | SPI6_M OS/2S6 _SDO | - | USART6 _TX | - | OCTOS PIM_P1_ IO7 | SDMMC 2_D7 | ETH_ TXD TH_R _TXI | |
| | | PG15 | - | - | - | - | - | - | USART6 _CTS/U SART6_ NSS | - | OCTOS PIM_P2_ DQS | - | USAF 0_C | |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF |
|------|-----|---|--|---|---|--|--|--|---|---|---|---|
| | SYS | FMC/LP TIM1/SA /14/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPI _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /I2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P11/I2S1/ SPI2/I2S 2/SPI3/I2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OCTOS PIM_P1/ SAI1/SPI 3/I2S3/U ART4 | SDMMC 1/SPI2/I2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPI M_P1/O TG1_FS/ M_P1/O A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ M_P1/O A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART |
| PH0 | - | - | - | - | - | - | - | - | - | - | - | - |
| PH1 | - | - | - | - | - | - | - | - | - | - | - | - |
| PH2 | - | LPTIM1_ IN2 | - | - | - | - | - | - | - | OCTOS PIM_P1_ IO4 | SAI4_SC K_B | ETH_ _CR |
| PH3 | - | - | - | - | - | - | - | - | - | OCTOS PIM_P1_ IO5 | SAI4_M CLK_B | ETH_ _CC |
| PH4 | - | - | - | I2C2_SC L | - | - | - | - | - | LCD_G6 | OTG_HS _ULPI_N XT | - |
| PH5 | - | - | - | I2C2_SD A | I2C2_SD NS | - | - | - | - | - | - | - |
| PH6 | - | - | TIM12_C H1 | I2C2_S MBA | SPI5_SC K | - | - | - | - | - | - | ETH_ _RX |
| PH7 | - | - | - | I2C3_SC L | SPI5_MI SO | - | - | - | - | - | - | ETH_ _RX |
| PH8 | - | - | TIM5_ET R | I2C3_SD A | - | - | - | - | - | - | - | - |
| PH9 | - | - | TIM12_C H2 | I2C3_S MBA | - | - | - | - | - | - | - | - |
| PH10 | - | - | TIM5_C H1 | I2C4_S MBA | - | - | - | - | - | - | - | - |

Port H



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | | |
|--------|-----|--|--|---|---|--|--|--|---|---|--|---|---|---|
| Port H | SYS | FMC/LP TIM1/SA I4/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPI _P1/2/TI M8 | CEC/DC MI/PSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S PH1/I2S1/ SPI2/I2S 2/SPI3/I2 S3/SPI4/ 5/6 | DFSDM1 /I2C4/5/ OC/TOS PIM_P1/ SA1/SPI 3/I2S3/U ART4 | SDMMC 1/SPI2/I2 S2/SPI3/ I2S3/SPI 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPI M_P1/O TG1_FS/ A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LCDIO CTOSPI M_P1/O TG1_FS/ OTG1_H SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LCDIO DIOS CTO M_P DM SWP /TIM1 IM8/U T7/9/ ART | | |
| | | PH11 | - | TIM5_C H2 | - | I2C4_SC L | - | - | - | - | - | - | - | |
| | | PH12 | - | TIM5_C H3 | - | I2C4_SD A | - | - | - | - | - | - | - | |
| | | PH13 | - | - | TIM8_C H1N | - | - | - | - | UART4_ TX | FDCAN1 _TX | - | - | |
| | | PH14 | - | - | TIM8_C H2N | - | - | - | - | UART4_ RX | FDCAN1 _RX | - | - | |
| | | PH15 | - | - | TIM8_C H3N | - | - | - | - | - | - | - | - | |
| | | Port J | - | TIM1_C H3N | - | TIM8_C H1 | - | - | - | - | UART8_ TX | - | - | - |
| | | | | TIM1_C H3 | - | TIM8_C H1N | - | - | - | - | UART8_ RX | - | - | - |
| | | | | TIM1_C H2N | - | TIM8_C H2 | - | SPI5_M OSI | - | - | - | - | - | - |
| | | | | TIM1_C H2 | - | TIM8_C H2N | - | SPI5_MI SO | - | - | - | - | - | - |



Table 9. STM32H725 pin alternate functions (continued)

| Port | AF0 | AF1 | AF2 | AF3 | AF4 | AF5 | AF6 | AF7 | AF8 | AF9 | AF10 | AF | |
|--------|-----|---|--|---|--|--|---|--|---|---|---|---|---|
| Port K | SYS | FMC/LP TIM1/SA /14/TIM16 /17/TIM1 x/TIM2x | FDCAN3 /PDM_S A11/TIM3 /4/5/12/1 5 | DFSDM1 /LCD/LP TIM2/3/4 /5/LPUA RT1/OC TOSPI _P1/2/TI M8 | CEC/DC MIP/SSI/ DFSDM1 /2C1/2/3 /4/5/LPTI M2/OC OSPIM_ P1/TIM1 5/USAR T1/10 | CECFD CAN3/S P1/1/2S1/ SPI2/2S 2/SPI3/2 S3/SPI4/ 5/6 | DFSDM1 /2C4/5/ OC/OS PIM_P1/ SA1/SP1 3/2S3/U ART4 | SDMMC 1/SPI2/12 S2/SPI3/ I2S3/SP1 6/UART 7/USAR T1/2/3/6 | LPUART 1/SAI4/S DMMC1/ SPDIFR X1/SPI6/ UART4/ 5/8 | FDCAN1 /2/FMC/ LCD/OC TOSPI M_P1/O _P1/2/S A14/SDM MC2/SP DIFRX1/ TIM13/1 4 | CRS/FM C/LC/DIO CTOSPI M_P1/O TG1_FS/ OTG1_H S/SAI4/S DMMC2/ TIM8 | DFSD /ETH/ 4/LC/DIO DIOS CTO M_P DMM SWP /TIM1 IM8/U T7/9/ ART | |
| | | PK0 | - | TIM8_C H3 | - | SP15_SC K | - | - | - | - | - | - | - |
| | | PK1 | - | TIM8_C H3N | - | SP15_NS S | - | - | - | - | - | - | - |
| PK2 | - | TIM1_B KIN | - | TIM8_B KIN | - | - | - | - | - | - | - | TIM1 KIN_ MP1 | |



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 junction temperature, supply voltage and frequencies by tests in production on 100% of the devices with an junction temperature at $T_J = 25\text{ }^\circ\text{C}$ and $T_J = T_{Jmax}$ (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 $T_J = 25\text{ }^\circ\text{C}$, $V_{DD} = 3.3\text{ V}$ (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

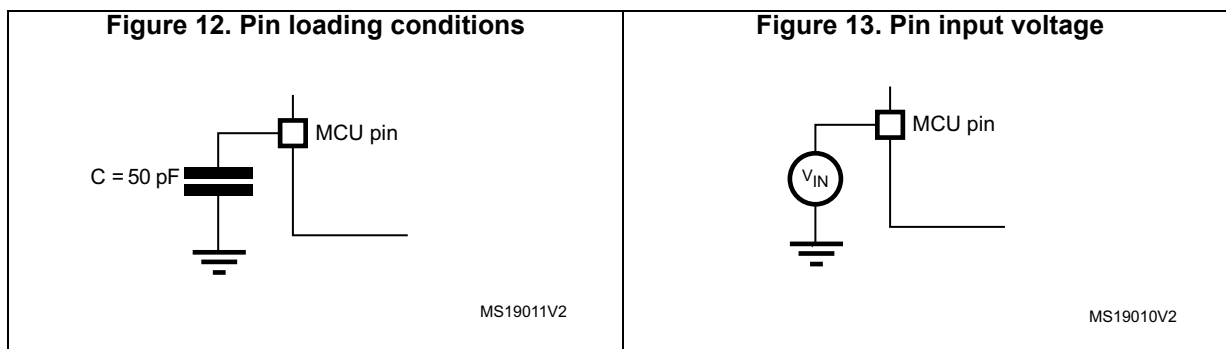
Unless otherwise specified, all typical curves are given only as design guidelines and are not tested.

6.1.4 Loading capacitor

The loading conditions used for pin parameter measurement are shown in [Figure 12](#).

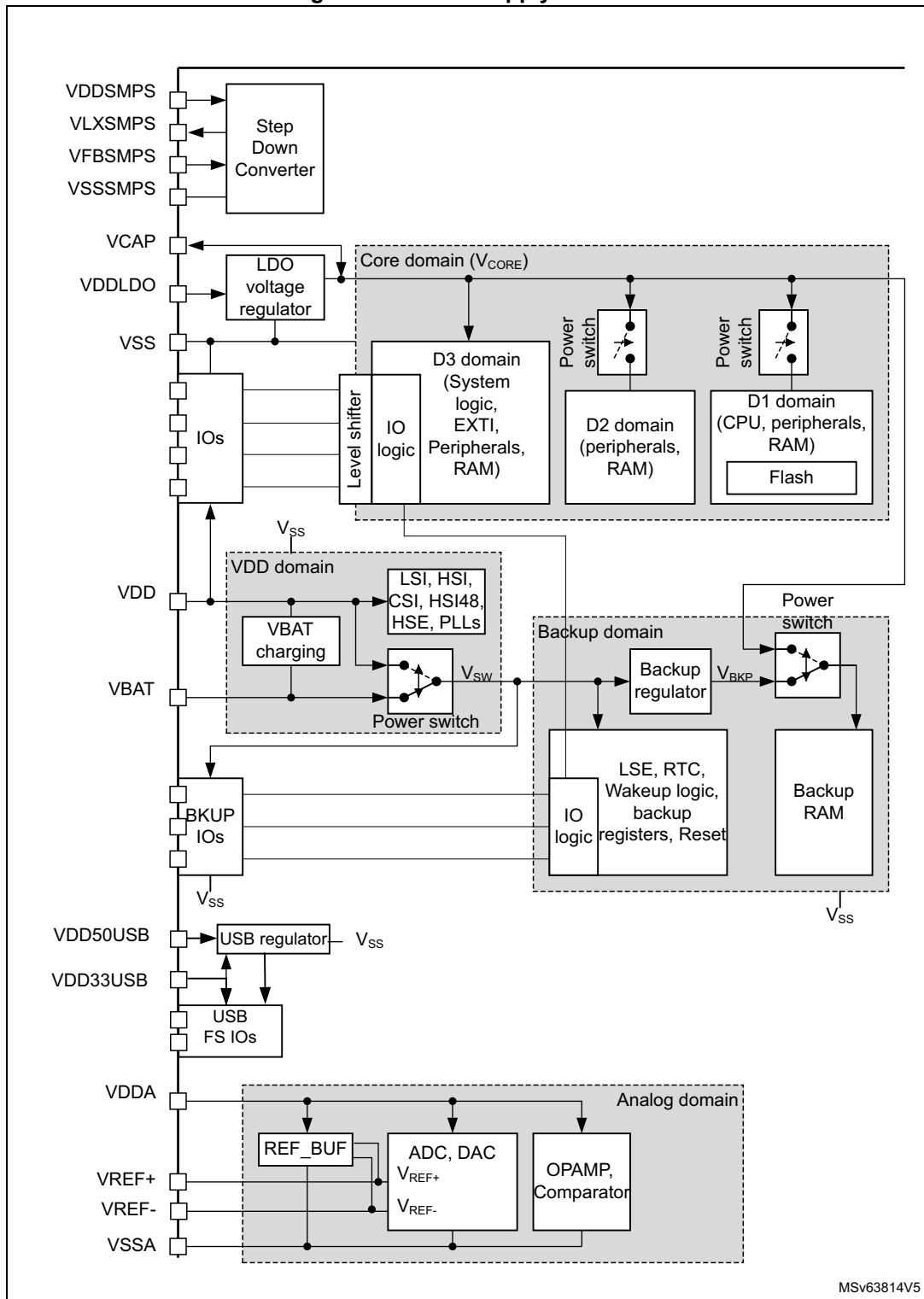
6.1.5 Pin input voltage

The input voltage measurement on a pin of the device is described in [Figure 13](#).



6.1.6 Power supply scheme

Figure 14. Power supply scheme

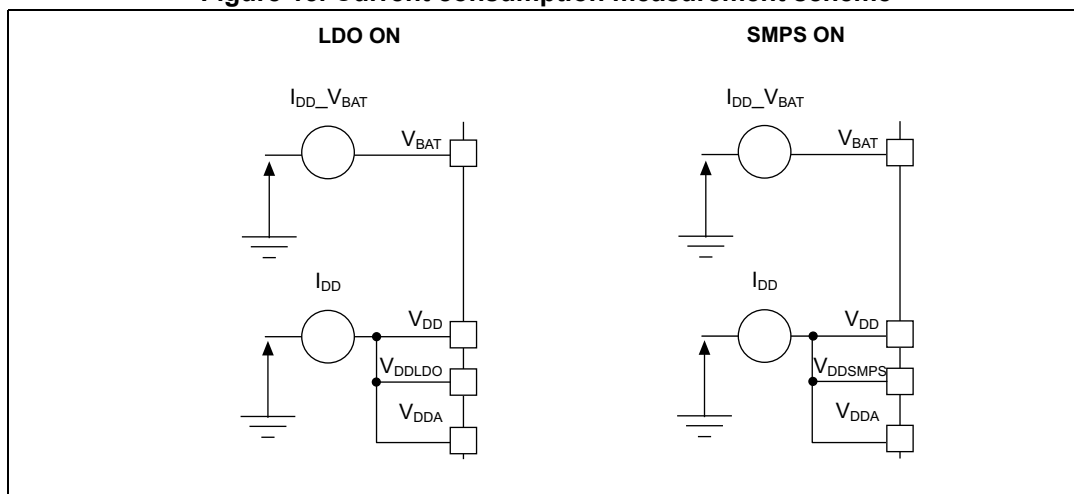


MSv63814V5

1. Refer to application note AN5419 "Getting started with STM32H723/733, STM32H725/735 and STM32H730 Value Line hardware development" for the possible power scheme and connected capacitors.

6.1.7 Current consumption measurement

Figure 15. Current consumption measurement scheme



6.2 Absolute maximum ratings

Stresses above the absolute maximum ratings listed in [Table 10: Voltage characteristics](#), [Table 11: Current characteristics](#), and [Table 12: Thermal characteristics](#) may cause permanent damage to the device. These are stress ratings only and the functional operation of the device at these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability. Device mission profile (application conditions) is compliant with JEDEC JESD47 Qualification Standard, extended mission profiles are available on demand.

Table 10. Voltage characteristics

| Symbols | Ratings | Min | Max | Unit |
|--------------------------|---|----------------|--|------|
| $V_{DDX} - V_{SS}^{(1)}$ | External main supply voltage (including V_{DD} , V_{DDLDO} , V_{DDSMPS} , V_{DDA} , $V_{DD33USB}$, V_{BAT}) | -0.3 | 4.0 | V |
| $V_{IN}^{(2)}$ | Input voltage on FT_XXX pins | $V_{SS} - 0.3$ | $\text{Min}(V_{DD}, V_{DDA}, V_{DD33USB}, V_{BAT}) + 4.0^{(3)(4)}$ | V |
| | Input voltage on TT_XX pins | $V_{SS} - 0.3$ | 4.0 | V |
| | Input voltage on BOOT0 pin | V_{SS} | 9.0 | V |
| | Input voltage on any other pins | $V_{SS} - 0.3$ | 4.0 | V |
| $ \Delta V_{DDX} $ | Variations between different V_{DDX} power pins of the same domain | - | 50 | mV |
| $ V_{SSx} - V_{SS} $ | Variations between all the different ground pins | - | 50 | mV |

- All main power (V_{DD} , V_{DDA} , $V_{DD33USB}$, V_{DDSMPS} , V_{BAT}) and ground (V_{SS} , V_{SSA}) pins must always be connected to the external power supply, in the permitted range.
- V_{IN} maximum must always be respected.
- This formula has to be applied on power supplies related to the IO structure described by the pin definition table.

- To sustain a voltage higher than 4V the internal pull-up/pull-down resistors must be disabled.

Table 11. Current characteristics

| Symbols | Ratings | Max | Unit |
|----------------------------------|---|-------|------|
| $\Sigma I_{V_{DD}}$ | Total current into sum of all V_{DD} power lines (source) ⁽¹⁾ | 620 | mA |
| $\Sigma I_{V_{SS}}$ | Total current out of sum of all V_{SS} ground lines (sink) ⁽¹⁾ | 620 | |
| $I_{V_{DD}}$ | Maximum current into each V_{DD} power pin (source) ⁽¹⁾ | 100 | |
| $I_{V_{SS}}$ | Maximum current out of each V_{SS} ground pin (sink) ⁽¹⁾ | 100 | |
| I_{IO} | Output current sunk by any I/O and control pin, except P _x _C | 20 | |
| | Output current sunk by P _x _C pins | 1 | |
| $\Sigma I_{(PIN)}$ | Total output current sunk by sum of all I/Os and control pins ⁽²⁾ | 140 | |
| | Total output current sourced by sum of all I/Os and control pins ⁽²⁾ | 140 | |
| $I_{INJ(PIN)}$ ⁽³⁾⁽⁴⁾ | Injected current on FT_XXX, TT_XX, RST and B pins except PA4, PA5 | -5/+0 | |
| | Injected current on PA4, PA5 | -0/0 | |
| $\Sigma I_{INJ(PIN)}$ | Total injected current (sum of all I/Os and control pins) ⁽⁵⁾ | ±25 | |

- All main power (V_{DD} , V_{DDA} , $V_{DD33USB}$) and ground (V_{SS} , V_{SSA}) pins must always be connected to the external power supplies, in the permitted range.
- 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 QFP packages.
- Positive injection is not possible on these I/Os and does not occur for input voltages lower than the specified maximum value.
- A positive injection is induced by $V_{IN} > V_{DD}$ while a negative injection is induced by $V_{IN} < V_{SS}$. $I_{INJ(PIN)}$ must never be exceeded. Refer also to [Table 10: Voltage characteristics](#) for the maximum allowed input voltage values.
- 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 12. Thermal characteristics

| Symbol | Ratings | Value | Unit | |
|-----------|------------------------------|---|------|-----|
| T_{STG} | Storage temperature range | - 65 to +150 | °C | |
| T_J | Maximum junction temperature | Industrial temperature range 6 | | 125 |
| | | Extended Industrial temperature range 3 | | 140 |

6.3 Operating conditions

6.3.1 General operating conditions

Table 13. General operating conditions

| Symbol | Parameter | Operating conditions | Min | Typ | Max | Unit |
|----------------------|---|---|---------------------|----------------------|---|------|
| V _{DD} | Standard operating voltage | - | 1.62 ⁽¹⁾ | - | 3.6 | V |
| V _{DDLDO} | Supply voltage for the internal regulator | V _{DDLDO} ≤ V _{DD} | 1.62 ⁽¹⁾ | - | 3.6 | |
| V _{DDSMPS} | Supply voltage for the internal SMPS Step-down converter | V _{DDSMPS} = V _{DD} | 1.62 ⁽¹⁾ | - | 3.6 | |
| V _{DD50USB} | - | USB regulator ON | 4 | 5 | 5.5 | |
| | | USB regulator OFF | - | V _{DD33USB} | - | |
| V _{DD33USB} | Standard operating voltage, USB domain | USB used | 3.0 | - | 3.6 | |
| | | USB not used | 0 | - | 3.6 | |
| V _{DDA} | Analog operating voltage | ADC or COMP used | 1.62 | - | 3.6 | |
| | | DAC used | 1.8 | - | | |
| | | OPAMP used | 2.0 | - | | |
| | | VREFBUF used | 1.8 | - | | |
| | | ADC, DAC, OPAMP, COMP, VREFBUF not used | 0 | - | | |
| V _{BAT} | Supply voltage for Backup domain | - | 1.2 ⁽²⁾ | - | 3.6 | |
| V _{IN} | I/O Input voltage | TT_xx I/O | -0.3 | - | V _{DD} +0.3 | |
| | | BOOT0 | 0 | - | 9 | |
| | | All I/O except BOOT0 and TT_xx | -0.3 | - | Min(V _{DD} , V _{DDA} , V _{DD33USB}) +3.6V < 5.5V ⁽³⁾ | |
| V _{CORE} | Internal regulator ON (LDO or SMPS) ⁽⁴⁾ | VOS3 | 0.95 | 1.0 | 1.05 | V |
| | | VOS2 | 1.05 | 1.10 | 1.15 | |
| | | VOS1 | 1.15 | 1.21 | 1.26 | |
| | | VOS0 | 1.30 | 1.36 | 1.40 | |
| | Regulator OFF: external V _{CORE} voltage must be supplied from external regulator on VCAP pins | VOS3 | 0.98 | 1.03 | 1.08 | |
| | | VOS2 | 1.08 | 1.13 | 1.18 | |
| | | VOS1 | 1.18 | 1.23 | 1.28 | |
| | | VOS0 | 1.33 | 1.38 | 1.40 | |

Table 13. General operating conditions (continued)

| Symbol | Parameter | Operating conditions | Min | Typ | Max | Unit |
|-------------------------------|---|--------------------------------------|-----|-----|---------------------|------|
| f _{CPU} | Arm® Cortex®-M7 clock frequency | VOS3 | - | - | 170 | MHz |
| | | VOS2 | - | - | 300 | |
| | | VOS1 | - | - | 400 | |
| | | VOS0 | - | - | 520 | |
| | | VOS0 and CPU_FREQ_BOOST | - | - | 550 | |
| f _{ACLK} | AXI clock frequency | VOS3 | - | - | 85 | |
| | | VOS2 | - | - | 150 | |
| | | VOS1 | - | - | 200 | |
| | | VOS0 | - | - | 275 | |
| f _{HCLK} | AHB clock frequency | VOS3 | - | - | 85 | |
| | | VOS2 | - | - | 150 | |
| | | VOS1 | - | - | 200 | |
| | | VOS0 | - | - | 275 | |
| f _{PCLK} | APB clock frequency | VOS3 | - | - | 42.5 ⁽⁵⁾ | |
| | | VOS2 | - | - | 75 | |
| | | VOS1 | - | - | 100 | |
| | | VOS0 | - | - | 137.5 | |
| T _A ⁽⁶⁾ | Ambient temperature for temperature range 3 | Maximum power dissipation | -40 | | 125 | °C |
| | Ambient temperature for temperature range 6 | Maximum power dissipation | -40 | | 85 | |
| | | Low-power dissipation ⁽⁷⁾ | -40 | | 105 | |

- When RESET is released, the functionality is guaranteed down to V_{PDRmax} or down to the specified V_{DDmin} when the PDR is OFF. The PDR can only be switched OFF though the PDR_ON pin that not available in all packages.
- V_{BAT} minimum value can be reduced to 0 V if V_{DD} is present.
- This formula has to be applied on power supplies related to the I/O structure described by the pin definition table.
- At startup, the external V_{CORE} voltage must remain higher or equal to 1.10 V before disabling the internal regulator (LDO).
- This value corresponds to the maximum APB clock frequency when at least one peripheral is enabled.
- The device junction temperature must be kept below maximum T_J indicated in [Table 14: Supply voltage and maximum temperature configuration](#) and the maximum temperature.
- In low-power dissipation state, T_A can be extended to this range as long as T_J does not exceed T_{Jmax} (see [Section 7.9: Thermal characteristics](#)).

Table 14. Supply voltage and maximum temperature configuration

| Power scale | V _{CORE} source | Max. T _J (°C) ⁽¹⁾ | Min. V _{DD} (V) | Min. V _{DDLDO} (V) |
|-------------------|--------------------------|---|--------------------------|-----------------------------|
| VOS0 | SMPS | 105 | 2.2 | - |
| | LDO | | 1.7 | 1.7 |
| | SMPS supplies LDO | | 3 ⁽²⁾ | 1.7 |
| | External (Bypass) | | 1.62 | 1.62 |
| VOS1 | SMPS | 140 | 2.2 | - |
| | | 125 | 1.62 | - |
| | LDO | | 1.62 | 1.62 |
| | SMPS supplies LDO | | 2.3 | - |
| External (Bypass) | 1.62 | | - | |
| VOS2 | SMPS | 140 | 1.62 | - |
| | LDO | 125 | 1.62 | 1.62 |
| | SMPS supplies LDO | | 2.3 | - |
| | External (Bypass) | | 1.62 | - |
| VOS3 | SMPS | | 140 | 1.62 |
| | LDO | 125 | 1.62 | 1.62 |
| | SMPS supplies LDO | | 2.3 | - |
| | external (Bypass)E | | 1.62 | - |
| SVOS4/SVOS5 | SMPS | | 140 | 1.62 |
| | LDO | 125 | 2 | 2 |
| | | 105 | 1.62 | 1.62 |
| | SMPS supplies LDO | 125 | 3 ⁽²⁾ | 2 |
| | | 105 | 2.3 | - |
| External (Bypass) | 125 | 1.62 | - | |

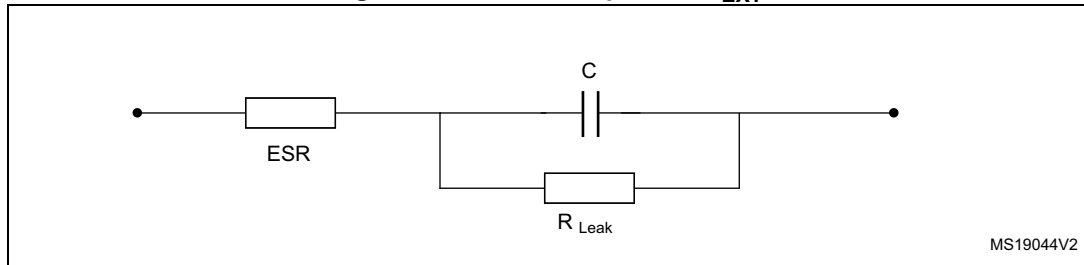
1. 140 °C can be reached only for part numbers in temperature range 3. For part numbers in temperature range 6, this value must be decreased to 125 °C.

2. The SMPS must be configured to output 2,5 V.

6.3.2 VCAP external capacitor

Stabilization for the main regulator is achieved by connecting an external capacitor C_{EXT} to the VCAP pin. C_{EXT} is specified in [Table 15](#). Two external capacitors can be connected to VCAP pins.

Figure 16. External capacitor C_{EXT}



1. Legend: ESR is the equivalent series resistance.

Table 15. VCAP operating conditions⁽¹⁾

| Symbol | Parameter | Conditions |
|------------------|-----------------------------------|-------------------------------|
| C _{EXT} | Capacitance of external capacitor | 2.2 μ F ⁽²⁾⁽³⁾ |
| ESR | ESR of external capacitor | < 100 m Ω |

1. When bypassing the voltage regulator, the two 2.2 μ F V_{CAP} capacitors are not required and should be replaced by two 100 nF decoupling capacitors.
2. This value corresponds to C_{EXT} typical value. A variation of +/-20% is tolerated.
3. If a third VCAP pin is available on the package, it must be connected to the other VCAP pins but no additional capacitor is required.

6.3.3 SMPS step-down converter

The devices embed a high power efficiency SMPS step-down converter. SMPS characteristics for external usage are given in [Table 17](#). The SMPS step-down converter requires external components that are fully described in AN5419 “Getting started with STM32H723/733, STM32H725/735 and STM32H730 Value Line hardware development”, The components used for datasheet characterization are specified in [Figure 17](#) and [Table 16](#).

Figure 17. External components for SMPS step-down converter

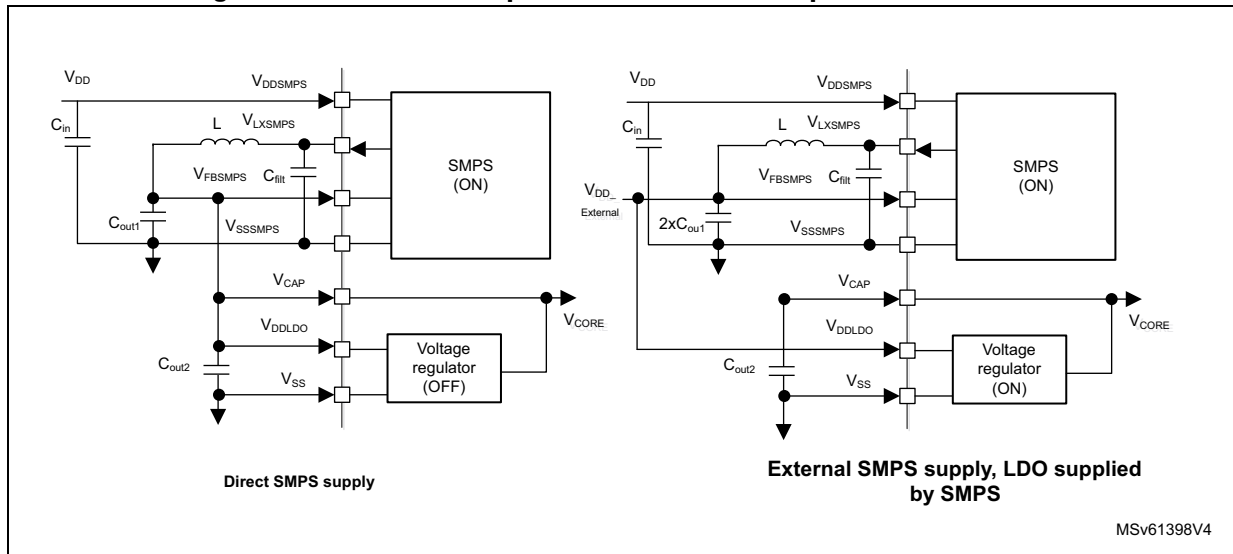


Table 16. Characteristics of SMPS step-down converter external components

| Symbol | Parameter | Conditions |
|------------|--|----------------|
| C_{in} | Capacitance of external capacitor on V_{DDSMPS} | 4.7 μF |
| | ESR of external capacitor | 100 m Ω |
| C_{filt} | Capacitance of external capacitor on V_{LXSMPS} pin | 220 pF |
| C_{OUT} | Capacitance of external capacitor on V_{FB_SMP} pin | 10 μF |
| | ESR of external capacitor | 20 m Ω |
| L | Inductance of external Inductor on V_{LXSMPS} pin | 2.2 μH |
| - | Serial DC resistor | 150 m Ω |
| I_{SAT} | DC current at which the inductance drops 30% from its value without current. | 1.7 A |
| I_{RMS} | Average current for a 40 °C rise: rated current for which the temperature of the inductor is raised 40°C by DC current | 1.4 A |

Table 17. SMPS step-down converter characteristics for external usage

| Parameters | Conditions | Min | Typ | Max | Unit |
|--------------------|------------------------------------|------|-----|------|------------|
| $V_{DDSMPS}^{(1)}$ | $V_{OUT} = 1.8 V$ | 2.3 | - | 3.6 | V |
| | $V_{OUT} = 2.5 V$ | 3 | - | 3.6 | |
| $V_{OUT}^{(2)}$ | $I_{out}=600 mA$ | 2.25 | 2.5 | 2.75 | V |
| | | 1.62 | 1.8 | 1.98 | |
| I_{OUT} | internal and external usage | - | - | 600 | mA |
| | External usage only ⁽³⁾ | - | - | 600 | |
| RDS_{ON} | - | - | 100 | 120 | m Ω |

Table 17. SMPS step-down converter characteristics for external usage (continued)

| Parameters | Conditions | Min | Typ | Max | Unit |
|-------------------|-------------------|-----|-----|-----|---------|
| I_{DDSMPS_Q} | Quiescent current | - | 220 | - | μA |
| T_{SMPS_START} | $V_{OUT} = 1.8 V$ | - | 270 | 405 | μs |
| | $V_{OUT} = 2.5 V$ | - | 360 | 540 | |

1. The switching frequency is 2.4 MHz±10%
2. Including line transient and load transient.
3. These characteristics are given for SDEXTHP bit is set in the PWR_CR3 register.

Table 18. Inrush current and inrush electric charge characteristics for LDO and SMPS⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | - | Min | Typ | Max | Unit |
|------------|---|-----------------------|---|-----|-----|--------------------|------|
| I_{RUSH} | Inrush current on voltage regulator power-on (POR or wakeup from Standby) | on $V_{DDLDO}^{(3)}$ | - | - | 55 | 96 ⁽⁴⁾ | mA |
| | | on $V_{DDSMPS}^{(5)}$ | SMPS supplies the V_{DDCORE} | - | 100 | 420 ⁽⁶⁾ | |
| | Inrush current on voltage regulator power-on (POR) | on $V_{DDSMPS}^{(5)}$ | SMPS supplies internal LDO, $V_{OUT} = 1.8 V^{(7)}$ | - | 130 | 400 ⁽⁶⁾ | |
| | | | SMPS supplies internal LDO, $V_{OUT} = 2.5 V^{(7)}$ | - | - | 300 ⁽⁶⁾ | |
| | | | SMPS supplies external circuit, $V_{OUT} = 1.8 V^{(7)}$ | - | 100 | 320 ⁽⁶⁾ | |
| | | | SMPS supplies external circuit, $V_{OUT} = 2.5 V^{(7)}$ | - | - | 240 ⁽⁶⁾ | |
| | Inrush current on voltage regulator power-on (wakeup from Standby) | on $V_{DDSMPS}^{(5)}$ | SMPS supplies internal LDO, $V_{OUT} = 1.8 V$ | - | 170 | 530 ⁽⁶⁾ | |
| | | | SMPS supplies internal LDO, $V_{OUT} = 2.5 V$ | - | 240 | 550 ⁽⁶⁾ | |

Table 18. Inrush current and inrush electric charge characteristics for LDO and SMPS⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | - | Min | Typ | Max | Unit |
|-------------------|---|---------------------------------------|---|-----|------|---------------------|------|
| Q _{RUSH} | Inrush current on voltage regulator power-on (POR or wakeup from Standby) | on V _{DDLDO} ⁽³⁾ | - | - | 4.4 | 5.3 ⁽⁴⁾ | μC |
| | | on V _{DDSMPS} ⁽⁵⁾ | SMPS supplies the V _{DDCORE} | - | 7.3 | 18 ⁽⁶⁾ | |
| | Inrush current on voltage regulator power-on (POR) | on V _{DDSMPS} ⁽⁵⁾ | SMPS supplies internal LDO, V _{OUT} = 1.8 V ⁽⁷⁾ | - | 8.8 | 17 ⁽⁶⁾ | |
| | | | SMPS supplies internal LDO, V _{OUT} = 2.5 V ⁽⁷⁾ | - | | 13 ⁽⁶⁾ | |
| | | | SMPS supplies external circuit, V _{OUT} = 1.8 V ⁽⁷⁾ | - | 7.3 | 13.7 ⁽⁶⁾ | |
| | | | SMPS supplies external circuit, V _{OUT} = 2.5 V ⁽⁷⁾ | - | | 10.5 ⁽⁶⁾ | |
| | Inrush current on voltage regulator power-on (wakeup from Standby) | on V _{DDSMPS} ⁽⁵⁾ | SMPS supplies internal LDO, V _{OUT} = 1.8 V | - | 15.0 | 28 ⁽⁶⁾ | |
| | | | SMPS supplies internal LDO, V _{OUT} = 2.5 V | - | 28.0 | 39 ⁽⁶⁾ | |

1. The typical values are given for V_{DDLDO} = V_{DDSMPS} = 3.3 V and for typical decoupling capacitor values of C_{EXT} and C_{OUT}.
2. The product consumption (on V_{DDCORE}) is not taken into account in the inrush current and inrush electric charges.
3. The inrush current and inrush electric charge on V_{DDLDO} are not present in Bypass mode or when the SMPS supplies the V_{DDCORE}.
4. The maximum value is given for the maximum decoupling capacitor C_{EXT}.
5. The inrush current and inrush electric charges on V_{DDSMPS} are not present if the external component (L or C_{OUT}) is not present that is if the SMPS is not used.
6. The maximum value is given for the maximum decoupling capacitor C_{OUT} and the minimum V_{DDSMPS} voltage.
7. The inrush current due to transition from 1.2 V to the final V_{OUT} Value (1.8 V or 2.5 V) is not taken into account.

6.3.4 Operating conditions at power-up / power-down

Subject to general operating conditions for T_A .

Table 19. Operating conditions at power-up/power-down

| Symbol | Parameter | Min | Max | Unit |
|----------------------|--|-----|----------|-----------------|
| t_{VDD} | V_{DD} rise time rate | 0 | ∞ | $\mu\text{s/V}$ |
| | V_{DD} fall time rate | 10 | ∞ | |
| t_{VDDA} | V_{DDA} rise time rate | 0 | ∞ | |
| | V_{DDA} fall time rate | 10 | ∞ | |
| t_{VDDUSB} | V_{DDUSB} rise time rate | 0 | ∞ | |
| | V_{DDUSB} fall time rate | 10 | ∞ | |
| $t_{V_{CORE}}^{(1)}$ | V_{CORE} rise time rate ⁽²⁾ | 0 | 285 | |
| | V_{CORE} fall time rate | 10 | ∞ | |

- $t_{V_{CORE}}$ should be achieved when V_{CORE} is provided by an external supply voltage (bypass with $V_{DDLDO} = V_{CORE}$).
- V_{CORE} rising slope must respect the above constraints. There are no constraints on the delay between V_{DD} rising and V_{CORE} rising.

6.3.5 Embedded reset and power control block characteristics

The parameters given in [Table 20](#) are derived from tests performed under ambient temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 20. Reset and power control block characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------|--|----------------------------|------|-------|-------|---------|
| $t_{RSTTEMPO}^{(1)}$ | Reset temporization after BOR0 released | - | - | 377 | 550 | μs |
| $V_{POR/PDR}$ | Power-on/power-down reset threshold | Rising edge ⁽¹⁾ | 1.62 | 1.67 | 1.71 | V |
| | | Falling edge | 1.58 | 1.62 | 1.68 | |
| V_{BOR1} | Brown-out reset threshold 1 | Rising edge | 2.04 | 2.10 | 2.15 | |
| | | Falling edge | 1.95 | 2.00 | 2.06 | |
| V_{BOR2} | Brown-out reset threshold 2 | Rising edge | 2.34 | 2.41 | 2.47 | |
| | | Falling edge | 2.25 | 2.31 | 2.37 | |
| V_{BOR3} | Brown-out reset threshold 3 | Rising edge | 2.63 | 2.70 | 2.78 | |
| | | Falling edge | 2.54 | 2.61 | 2.68 | |
| V_{PVD0} | Programmable Voltage Detector threshold 0 | Rising edge | 1.90 | 1.96 | 2.01 | |
| | | Falling edge | 1.81 | 1.86 | 1.91 | |
| V_{PVD1} | Programmable Voltage Detector threshold 1 | Rising edge | 2.05 | 2.10 | 2.16 | |
| | | Falling edge | 1.96 | 2.01 | 2.06 | |
| V_{PVD2} | Programmable Voltage Detector threshold 2 | Rising edge | 2.19 | 2.26 | 2.32 | |
| | | Falling edge | 2.10 | 2.15 | 2.21 | |
| V_{PVD3} | Programmable Voltage Detector threshold 3 | Rising edge | 2.35 | 2.41 | 2.47 | |
| | | Falling edge | 2.25 | 2.31 | 2.37 | |
| V_{PVD4} | Programmable Voltage Detector threshold 4 | Rising edge | 2.49 | 2.56 | 2.62 | |
| | | Falling edge | 2.39 | 2.45 | 2.51 | |
| V_{PVD5} | Programmable Voltage Detector threshold 5 | Rising edge | 2.64 | 2.71 | 2.78 | |
| | | Falling edge | 2.55 | 2.61 | 2.68 | |
| V_{PVD6} | Programmable Voltage Detector threshold 6 | Rising edge | 2.78 | 2.86 | 2.94 | |
| | | Falling edge in Run mode | 2.69 | 2.76 | 2.83 | |
| $V_{POR/PDR}$ | Hysteresis voltage for Power-on/power-down reset | Hysteresis in Run mode | - | 43.00 | - | mV |
| $V_{hyst_BOR_PVD}$ | Hysteresis voltage for BOR | Hysteresis in Run mode | - | 100 | - | |
| $I_{DD_BOR_PVD}^{(1)}$ | BOR and PVD consumption from V_{DD} | - | - | - | 0.630 | μA |
| $I_{DD_POR_PVD}$ | POR and PVD consumption from V_{DD} | - | 0.8 | - | 1.200 | |

Table 20. Reset and power control block characteristics (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|------------------------|---|-----------------|------|------|------|------|----|
| V _{AVM_0} | Analog voltage detector for V _{DDA} threshold 0 | Rising edge | 1.66 | 1.71 | 1.76 | V | |
| | | Falling edge | 1.56 | 1.61 | 1.66 | | |
| V _{AVM_1} | Analog voltage detector for V _{DDA} threshold 1 | Rising edge | 2.06 | 2.12 | 2.19 | | |
| | | Falling edge | 1.96 | 2.02 | 2.08 | | |
| V _{AVM_2} | Analog voltage detector for V _{DDA} threshold 2 | Rising edge | 2.42 | 2.50 | 2.58 | | |
| | | Falling edge | 2.35 | 2.42 | 2.49 | | |
| V _{AVM_3} | Analog voltage detector for V _{DDA} threshold 3 | Rising edge | 2.74 | 2.83 | 2.91 | | |
| | | Falling edge | 2.64 | 2.72 | 2.80 | | |
| V _{hyst_VDDA} | Hysteresis of V _{DDA} voltage detector | - | - | 100 | - | | mV |
| I _{DD_PVM} | PVM consumption from V _{DD(1)} | - | - | - | 0.25 | | μA |
| I _{DD_VDDA} | Voltage detector consumption on V _{DDA} ⁽¹⁾ | Resistor bridge | - | - | 2.5 | μA | |

1. Guaranteed by design.

6.3.6 Embedded reference voltage characteristics

The parameters given in [Table 21](#) are derived from tests performed under ambient temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 21. Embedded reference voltage

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|--|-------|-------|-------|--------|
| V _{REFINT} | Internal reference voltages | -40°C < T _J < T _{Jmax} | 1.180 | 1.216 | 1.255 | V |
| t _{S_vrefint} ⁽¹⁾⁽²⁾⁽³⁾ | ADC sampling time when reading the internal reference voltage | - | 4.3 | - | - | μs |
| t _{S_vbat} ⁽²⁾ | VBAT sampling time when reading the internal VBAT reference voltage | - | 9 | - | - | |
| t _{start_vrefint} ⁽²⁾ | Start time of reference voltage buffer when ADC is enable | - | - | - | 4.4 | |
| I _{refbuf} ⁽²⁾ | Reference Buffer consumption for ADC | V _{DD} = 3.3 V | 9 | 13.5 | 23 | μA |
| ΔV _{REFINT} ⁽²⁾ | Internal reference voltage spread over the temperature range | -40°C < T _J < T _{Jmax} | - | 5 | 15 | mV |
| T _{coeff} ⁽²⁾ | Average temperature coefficient | Average temperature coefficient | - | 20 | 70 | ppm/°C |
| V _{DDcoeff} ⁽²⁾ | Average Voltage coefficient | 3.0 V < V _{DD} < 3.6 V | - | 10 | 1370 | ppm/V |

Table 21. Embedded reference voltage (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------|-----------------------|------------|-----|-----|-----|--------------------------|
| V _{REFINT_DIV1} | 1/4 reference voltage | - | - | 25 | - | % V _{REFINT} |
| V _{REFINT_DIV2} | 1/2 reference voltage | - | - | 50 | - | |
| V _{REFINT_DIV3} | 3/4 reference voltage | - | - | 75 | - | |

1. The shortest sampling time for the application can be determined by multiple iterations.
2. Guaranteed by design.
3. Guaranteed by design. and tested in production at 3.3 V.

Table 22. Internal reference voltage calibration values

| Symbol | Parameter | Memory address |
|------------------------|---|-----------------------|
| V _{REFIN_CAL} | Raw data acquired at temperature of 30 °C, V _{DDA} = 3.3 V | 1FF1 E860 - 1FF1 E861 |

6.3.7 Embedded USB regulator characteristics

The parameters given in [Table 23](#) are derived from tests performed under ambient temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 23. USB regulator characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------|---|------------|-----|-----|-----|------|
| V _{DD50USB} | Supply voltage | - | 4 | 5 | 5.5 | V |
| I _{DD50USB} | Current consumption | - | - | 14 | - | μA |
| V _{REGOUTV33V} | Regulated output voltage | - | 3 | - | 3.6 | V |
| I _{OUT} | Output current load sinked by USB block | - | - | - | 20 | mA |
| T _{WKUP} | Wakeup time | - | - | 120 | 170 | us |

6.3.8 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 15: Current consumption measurement scheme](#).

All the run-mode current consumption measurements given in this section are performed with a CoreMark code.

Typical and maximum current consumption

The MCU is placed under the following conditions:

- All I/O pins are in analog input mode.
- All peripherals are disabled except when explicitly mentioned.
- The Flash memory access time is adjusted with the minimum wait states number, depending on the f_{ACLK} frequency (refer to the table “Number of wait states according to CPU clock ($f_{\text{rcc_c_ck}}$) frequency and V_{CORE} range” available in the reference manual).
- When the peripherals are enabled, the AHB clock frequency is the CPU frequency divided by 2 and the APB clock frequency is AHB clock frequency divided by 2.
- For typical values, the power supply is 3 V unless otherwise specified.

The parameters given in the below tables are derived from tests performed under ambient temperature and supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 24. Typical and maximum current consumption in Run mode, code with data processing running from ITCM⁽¹⁾

| Symbol | Parameter | Conditions | f _{rcc_c_ck} (MHz) | Typ LDO regulator ON | Typ SMPS ON | Max LDO regulator ON ⁽²⁾ | | | | Max SMPS ON ⁽³⁾ | Unit | |
|-----------------|----------------------------|--------------------------|-----------------------------|----------------------|-------------|-------------------------------------|------------------------|-------------------------|-------------------------|----------------------------|------|----|
| | | | | | | T _J = 25 °C | T _J = 85 °C | T _J = 105 °C | T _J = 125 °C | T _J = 140 °C | | |
| I _{DD} | Supply current in Run mode | All peripherals disabled | VOS0 ⁽⁴⁾ | 550 | 145 | 81 | 170 | 260 | 330 | - | - | mA |
| | | | | 520 | 135 | 76 | 160 | 260 | 320 | - | - | |
| | | | VOS0 | 520 | 135 | 76 | 160 | 260 | 320 | - | - | |
| | | | | 480 | 125 | 72.5 | 150 | 250 | 310 | - | - | |
| | | | | 450 | 115 | 67.5 | 150 | 240 | 300 | - | - | |
| | | | VOS1 | 400 | 105 | 60 | 130 | 230 | 290 | - | - | |
| | | | | 400 | 90.5 | 47 | 110 | 170 | 220 | 280 | 160 | |
| | | | VOS2 | 300 | 69.5 | 36.5 | 84 | 150 | 200 | 260 | 150 | |
| | | | | 300 | 63 | 31.5 | 74 | 130 | 170 | 220 | 110 | |
| | | | VOS3 | 280 | 58 | 29 | 69 | 120 | 160 | 210 | 110 | |
| | | | | 216 | 45.5 | 22.5 | 56 | 110 | 150 | 200 | 110 | |
| | | | | 200 | 42 | 21 | 53 | 110 | 140 | 200 | 110 | |
| | | | | 170 | 32.5 | 15 | 40 | 80 | 110 | 160 | 74 | |
| | | | VOS3 | 168 | 32 | 15 | 40 | 79 | 110 | 160 | 74 | |
| | | | | 144 | 28 | 13.5 | 36 | 75 | 110 | 150 | 74 | |
| | | 60 | | 13.5 | 6.7 | 21 | 61 | 90 | 140 | 67 | | |
| | | 25 | | 6.9 | 3.6 | 14 | 54 | 83 | 130 | 67 | | |
| | | 25 | | 6.9 | 3.6 | 14 | 54 | 83 | 130 | 67 | | |
| | | All peripherals enabled | VOS0 ⁽⁴⁾ | 550 | 215 | 125 | 250 | 360 | 430 | - | - | |
| | | | | 520 | 205 | 120 | 240 | 350 | 420 | - | - | |
| | | | VOS0 | 520 | 205 | 120 | 240 | 350 | 420 | - | - | |
| | | | | 400 | 160 | 92.5 | 190 | 300 | 370 | - | - | |
| | | | VOS1 | 400 | 135 | 72 | 160 | 230 | 290 | 360 | 200 | |
| | | | | 300 | 105 | 54.5 | 130 | 200 | 250 | 330 | 180 | |
| | | | VOS2 | 300 | 95 | 46.5 | 110 | 170 | 210 | 280 | 140 | |
| | | | | 280 | 88 | 43 | 100 | 160 | 210 | 270 | 140 | |
| | | | VOS3 | 170 | 49 | 22.5 | 58 | 110 | 140 | 190 | 93 | |

1. Data are in DTCM for best computation performance, the cache has no influence on consumption in this case.
2. Guaranteed by characterization results, unless otherwise specified. Refer to [Section 6.3.3: SMPS step-down converter](#) for the SMPS maximum consumption.
3. The parameter values given in the above table for the SMPS regulator are extrapolated from the LDO consumption and typical SMPS efficiency factors.
4. CPU_FREQ_BOOST is enabled.

Table 25. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory, cache ON⁽¹⁾

| Symbol | Parameter | Conditions | f _{rcc_c_ck} (MHz) | Typ LDO regulator ON | Typ SMPS ON | Max LDO regulator ON ⁽²⁾ | | | | Max SMPS ON ⁽³⁾ | Unit | |
|-----------------|----------------------------------|--------------------------------|--------------------------------|-------------------------------|-------------------|-------------------------------------|---------------------------|----------------------------|----------------------------|----------------------------------|------|----------------------------|
| | | | | | | T _J = 25 °C | T _J = 85 °C | T _J = 105 °C | T _J = 125 °C | | | T _J = 140 °C |
| I _{DD} | Supply current in Run mode | All peripherals disabled | VOS0 ⁽⁴⁾ | 550 | 145 | 83.5 | 170 | 270 | 330 | - | - | mA |
| | | | | 520 | 140 | 78.5 | 170 | 260 | 320 | - | - | |
| | | | VOS0 | 520 | 140 | 78.5 | 170 | 260 | 320 | - | - | |
| | | | | 400 | 110 | 62 | 140 | 230 | 290 | - | - | |
| | | | VOS1 | 400 | 92 | 48.5 | 110 | 180 | 220 | 290 | 160 | |
| | | | | 300 | 71 | 37.5 | 86 | 150 | 200 | 260 | 150 | |
| | | | VOS2 | 300 | 64 | 32 | 75 | 130 | 170 | 220 | 110 | |
| | | | | 280 | 59 | 29.5 | 70 | 120 | 160 | 210 | 110 | |
| | | | | 216 | 46.5 | 23 | - | - | - | - | - | |
| | | | | 200 | 42.5 | 21.5 | 53 | 110 | 140 | 200 | 110 | |
| | | | VOS3 | 180 | 36 | 17 | 43 | 83 | 120 | 160 | 85 | |
| | | | | 170 | 33.5 | 15.5 | 41 | 81 | 110 | 160 | 74 | |
| | | | | 168 | 33 | 15.5 | - | - | - | - | - | |
| | | | | 144 | 29 | 13.5 | - | - | - | - | - | |
| | | 60 | | 14 | 6.85 | - | - | - | - | - | | |
| | | All peripherals enabled | VOS0 ⁽⁴⁾ | 550 | 220 | 130 | 250 | 360 | 430 | - | - | |
| | | | | 520 | 210 | 120 | 240 | 350 | 420 | - | - | |
| | | | VOS0 | 520 | 210 | 120 | 240 | 350 | 420 | - | - | |
| | | | | 400 | 160 | 94.5 | 190 | 300 | 370 | - | - | |
| | | | VOS1 | 400 | 140 | 73 | 160 | 240 | 290 | 360 | 200 | |
| | | | | 300 | 105 | 55.5 | 130 | 200 | 250 | 330 | 180 | |
| | | | VOS2 | 300 | 96 | 47 | 110 | 170 | 210 | 280 | 140 | |
| | | | | 280 | 89 | 43.5 | 110 | 160 | 210 | 270 | 140 | |
| | | | VOS3 | 170 | 50 | 23 | 59 | 110 | 140 | 190 | 93 | |

1. Data are in DTCM for best computation performance, the cache has no influence on consumption in this case.
2. Guaranteed by characterization results, unless otherwise specified. Refer to [Section 6.3.3: SMPS step-down converter](#) for the SMPS maximum consumption.
3. The parameter values given in the above table for the SMPS regulator are extrapolated from the LDO consumption and typical SMPS efficiency factors.
4. CPU_FREQ_BOOST is enabled.

Table 26. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory, cache OFF⁽¹⁾

| Symbol | Parameter | Conditions | f _{rcc_c_ck} (MHz) | Typ LDO regulator ON | Typ SMPS ON | Unit | |
|-----------------|-------------------------------|-----------------------------|--------------------------------|-------------------------------|-------------------|------|----|
| I _{DD} | Supply current in Run mode | All peripherals disabled | VOS0 ⁽²⁾ | 550 | 99 | 59.5 | mA |
| | | | | 520 | 95 | 56 | |
| | | | VOS0 | 520 | 95 | 56 | |
| | | | | 400 | 76.5 | 47 | |
| | | | VOS1 | 400 | 66.5 | 38 | |
| | | | | 300 | 51.5 | 30 | |
| | | | VOS2 | 300 | 47.5 | 26 | |
| | | | | 280 | 43.5 | 24 | |
| | | VOS3 | 170 | 24.5 | 13 | | |
| | | All peripherals enabled | VOS0 ⁽²⁾ | 550 | 170 | 100 | |
| | | | | 520 | 165 | 95.5 | |
| | | | VOS0 | 520 | 165 | 95.5 | |
| | | | | 400 | 130 | 77.5 | |
| | | | VOS1 | 400 | 115 | 62 | |
| | | | | 300 | 87 | 47.5 | |
| | | | VOS2 | 300 | 79 | 41.5 | |
| 280 | 73.5 | | | 38 | | | |
| VOS3 | 170 | 41 | 20.5 | | | | |

1. Data are in DTCM for best computation performance, the cache has no influence on consumption in this case.
2. CPU_FREQ_BOOST is enabled.

Table 27. Typical consumption in Run mode and corresponding performance versus code position

| Symbol | Parameter | Conditions | | f _{rcc_c_ck} (MHz) | Coremark | Typ LDO regulator ON | Typ SMPS ON | Unit | LDO I _{DD} /Coremark | SMPS I _{DD} /Coremark | Unit |
|-----------------|----------------------------|------------------------------------|----------|--------------------------------|----------|----------------------|-------------|------|-------------------------------|--------------------------------|-----------------|
| | | Peripheral | Code | | | | | | | | |
| I _{DD} | Supply current in Run mode | All peripherals disabled, cache ON | ITCM | 550 | 2777 | 145 | 81 | mA | 52.2 | 29.2 | μA/ Coremark |
| | | | FLASH | 550 | 2777 | 145 | 83.5 | | 52.2 | 30.1 | |
| | | | AXI SRAM | 550 | 2777 | 145 | 83.5 | | 52.2 | 30.1 | |
| | | | SRAM 1 | 550 | 2777 | 150 | 86 | | 54.0 | 31.0 | |
| | | | SRAM 4 | 550 | 2777 | 145 | 83.5 | | 52.2 | 30.1 | |
| | | All peripherals disabled cache OFF | FLASH | 550 | 923 | 99 | 59.5 | | 107.3 | 64.5 | |
| | | | AXI SRAM | 550 | 1271 | 105 | 60.5 | | 82.6 | 47.6 | |
| | | | SRAM 1 | 550 | 790 | 96.5 | 54.5 | | 122.2 | 69.0 | |
| | | | SRAM 4 | 550 | 723 | 89.5 | 50.5 | | 123.8 | 69.8 | |

Table 28. Typical current consumption in Autonomous mode

| Symbol | Parameter | Conditions | f _{rcc_c_ck} (MHz) | Typ LDO regulator ON | Typ SMPS ON | Unit | |
|-----------------|-----------------------------------|---------------------------|--------------------------------|----------------------|-------------|------|----|
| I _{DD} | Supply current in Autonomous mode | Run, D1Stop, D2Stop | VOS3 | 64 | 3.6 | 2.2 | mA |
| | | Run, D1Standby, D2Standby | VOS3 | 64 | 2.6 | 1.6 | |

Table 29. Typical and maximum current consumption in Sleep mode

| Symbol | Parameter | Conditions | f _{rcc_c_ck} (MHz) | Typ LDO regulator ON | Typ SMPS ON | Max LDO regulator ON ⁽¹⁾⁽²⁾ | | | | | Max SMPS ON ⁽³⁾ | Unit |
|------------------------|------------------------------|--------------------------|--------------------------------|----------------------|-------------|--|------------------------|-------------------------|-------------------------|-------------------------|----------------------------|------|
| | | | | | | T _J = 25 °C | T _J = 85 °C | T _J = 105 °C | T _J = 125 °C | T _J = 140 °C | | |
| I _{DD(Sleep)} | Supply current in Sleep mode | All peripherals disabled | VOS0 ⁽⁴⁾ | 550 | 36 | 20.5 | - | - | - | - | - | mA |
| | | | | 520 | 33.5 | 19.5 | 60 | 170 | 240 | - | - | |
| | | | VOS0 | 520 | 33.5 | 19.5 | 60 | 170 | 240 | - | - | |
| | | | | 400 | 27 | 16 | 52 | 160 | 230 | - | - | |
| | | | VOS1 | 400 | 22.5 | 12.5 | 39 | 110 | 170 | 240 | 140 | |
| | | | | 300 | 18.5 | 10.5 | 34 | 110 | 160 | 240 | 140 | |
| | | | VOS2 | 300 | 16.5 | 8.75 | 28 | 85 | 130 | 190 | 110 | |
| | | | | 170 | 9.7 | 5.2 | 21 | 78 | 120 | 190 | 110 | |
| | | | VOS3 | 170 | 8.5 | 4.35 | 17 | 61 | 96 | 150 | 74 | |

1. Guaranteed by characterization results.
2. Refer to [Section 6.3.3: SMPS step-down converter](#) for the SMPS maximum consumption.
3. The parameter values given in the above table for the SMPS regulator are extrapolated from the LDO consumption and typical SMPS efficiency factors.
4. CPU_FREQ_BOOST is enabled.

Table 30. Typical and maximum current consumption in System Stop mode

| Symbol | Parameter | Conditions | Typ LDO regulator ON | Typ SMPS ON ⁽³⁾ | Max LDO regulator ON ⁽¹⁾⁽²⁾ | | | | Max SMPS ON ⁽³⁾ | Unit | |
|-----------------------|---|--|----------------------|----------------------------|--|------------------------|-------------------------|-------------------------|----------------------------|-------|-------------------------|
| | | | | | T _J = 25 °C | T _J = 85 °C | T _J = 105 °C | T _J = 125 °C | | | T _J = 140 °C |
| I _{DD(Stop)} | D1, D2 and D3 domains in DStop mode | Flash memory in low-power mode | SVOS5 | 0.52 | 0.2 | 3.7 | 26.0 | 44.0 | 72.0 | 50.0 | mA |
| | | | SVOS4 | 0.81 | 0.34 | 6.1 | 39.0 | 64.0 | 110.0 | 70.0 | |
| | | | SVOS3 | 1.15 | 0.51 | 8.6 | 51.0 | 83.0 | 130.0 | 100.0 | |
| | | Flash memory in normal mode, IWDG OFF | SVOS5 | 0.535 | 0.2 | 3.7 | 26.0 | 44.0 | 72.0 | 50.0 | |
| | | | SVOS4 | 0.96 | 0.4 | 6.2 | 39.0 | 64.0 | 110.0 | 75.0 | |
| | | | SVOS3 | 1.45 | 0.65 | 8.8 | 51.0 | 83.0 | 130.0 | 100.0 | |
| | D1 and D3 domains in DStop mode, D2 domain in DStandby mode | Flash memory in low-power mode, IWDG OFF | SVOS5 | 0.48 | 0.19 | 3.3 | 23.0 | 39.0 | 63.0 | 43.0 | |
| | | | SVOS4 | 0.73 | 0.31 | 5.4 | 34.0 | 56.0 | 88.0 | 58.0 | |
| | | | SVOS3 | 1 | 0.46 | 7.7 | 45.0 | 72.0 | 120.0 | 71.0 | |
| | | Flash memory in normal mode, IWDG OFF | SVOS5 | 0.46 | 0.18 | 3.3 | 23.0 | 39.0 | 63.0 | 43.0 | |
| | | | SVOS4 | 0.9 | 0.38 | 5.6 | 34.0 | 56.0 | 89.0 | 58.0 | |
| | | | SVOS3 | 1.17 | 0.52 | 7.8 | 45.0 | 72.0 | 120.0 | 71.0 | |
| | D1 domain in DStandby mode, D2 and D3 domains in DStop mode | Flash memory in low-power mode, IWDG OFF | SVOS5 | 0.15 | 0.069 | 0.8 | 5.4 | 9.2 | 16.0 | 9.8 | |
| | | | SVOS4 | 0.21 | 0.098 | 1.3 | 7.9 | 14.0 | 22.0 | 14.0 | |
| | | | SVOS3 | 0.275 | 0.15 | 1.8 | 11.0 | 18.0 | 28.0 | 17.0 | |
| | D1 and D2 domains in DStandby mode, D3 domain in DStop mode | | SVOS5 | 0.095 | 0.055 | 0.3 | 2.1 | 3.6 | 5.9 | 3.8 | |
| | | | SVOS4 | 0.12 | 0.064 | 0.5 | 3.2 | 5.2 | 8.3 | 5.1 | |
| | | | SVOS3 | 0.15 | 0.084 | 0.8 | 4.2 | 6.8 | 11.0 | 6.3 | |

1. Guaranteed by characterization results.
2. Refer to [Section 6.3.3: SMPS step-down converter](#) for the SMPS maximum consumption.
3. The parameter values given in the above table for the SMPS regulator are extrapolated from the LDO consumption and typical SMPS efficiency factors.

Table 31. Typical and maximum current consumption in Standby mode

| Symbol | Parameter | Conditions | | Typ ⁽¹⁾ | | | | Max at 3.6 V with LDO regulator ON ⁽²⁾ | | | | Max at 3.6 V with SMPS ON ⁽³⁾ | Unit |
|------------------------------|--|-------------|----------------------------|--------------------|-------|------|-------|---|------------------------|-------------------------|-------------------------|--|------|
| | | Backup SRAM | RTC and LSE ⁽⁴⁾ | 1.65 V | 2.4 V | 3 V | 3.3 V | T _J = 25 °C | T _J = 85 °C | T _J = 105 °C | T _J = 125 °C | T _J = 140 °C | |
| I _{DD} (Standby) | Supply current in Standby mode, IWDG OFF | OFF | OFF | 2.2 | 2.35 | 2.5 | 2.8 | - | - | - | - | - | µA |
| | | ON | OFF | 3.5 | 3.7 | 4 | 4.3 | - | - | - | - | | |
| | | OFF | ON | 2.2 | 2.4 | 2.85 | 3.25 | 4.5 | 15 | 30 | 64 | 96 | |
| | | ON | ON | 3.5 | 3.8 | 4.35 | 4.75 | 8.3 | 39 | 75 | 140 | 180 | |

1. These values are given for PDR OFF. When the PDR is ON, the typical current consumption is increased (refer to [Table 20: Reset and power control block characteristics](#)).
2. Guaranteed by characterization results.
3. The parameter values given in the above table for the SMPS regulator are extrapolated from the LDO consumption and typical SMPS efficiency factors.
4. The LSE is in Low-drive mode.

Table 32. Typical and maximum current consumption in V_{BAT} mode

| Symbol | Parameter | Conditions | | Typ | | | | Max at 3.6 V with LDO regulator ON ⁽¹⁾⁽²⁾ | | | | Max at 3.6 V with SMPS ON ⁽¹⁾⁽²⁾ | Unit |
|---------------------------|-----------------------------|--------------|----------------------------|-------|------|-------|-------|--|------------------------|-------------------------|-------------------------|---|------|
| | | Back-up SRAM | RTC and LSE ⁽³⁾ | 1.2 V | 2 V | 3 V | 3.3 V | T _J = 25 °C | T _J = 85 °C | T _J = 105 °C | T _J = 125 °C | T _J = 140 °C | |
| I _{DD} (VBAT) | Supply current in VBAT mode | OFF | OFF | 0.008 | 0.01 | 0.025 | 0.05 | 0.3 | 3.1 | 7.4 | 18 | 34 | µA |
| | | ON | OFF | 1.5 | 1.7 | 1.9 | 1.9 | 4 | 28 | 53 | 91 | 110 | |
| | | OFF | ON | 0.4 | 0.5 | 0.75 | 0.8 | - | - | - | - | - | |
| | | ON | ON | 1.8 | 2.1 | 2.8 | 3.2 | - | - | - | - | - | |

1. Guaranteed by characterization results.
2. The LDO regulator is used before switching to V_{BAT} mode.
3. The LSE is in Low-drive mode.

Typical SMPS efficiency versus load current and temperature

Figure 18. Typical SMPS efficiency (%) vs load current (A) in Run mode at $T_J = 30\text{ }^\circ\text{C}$

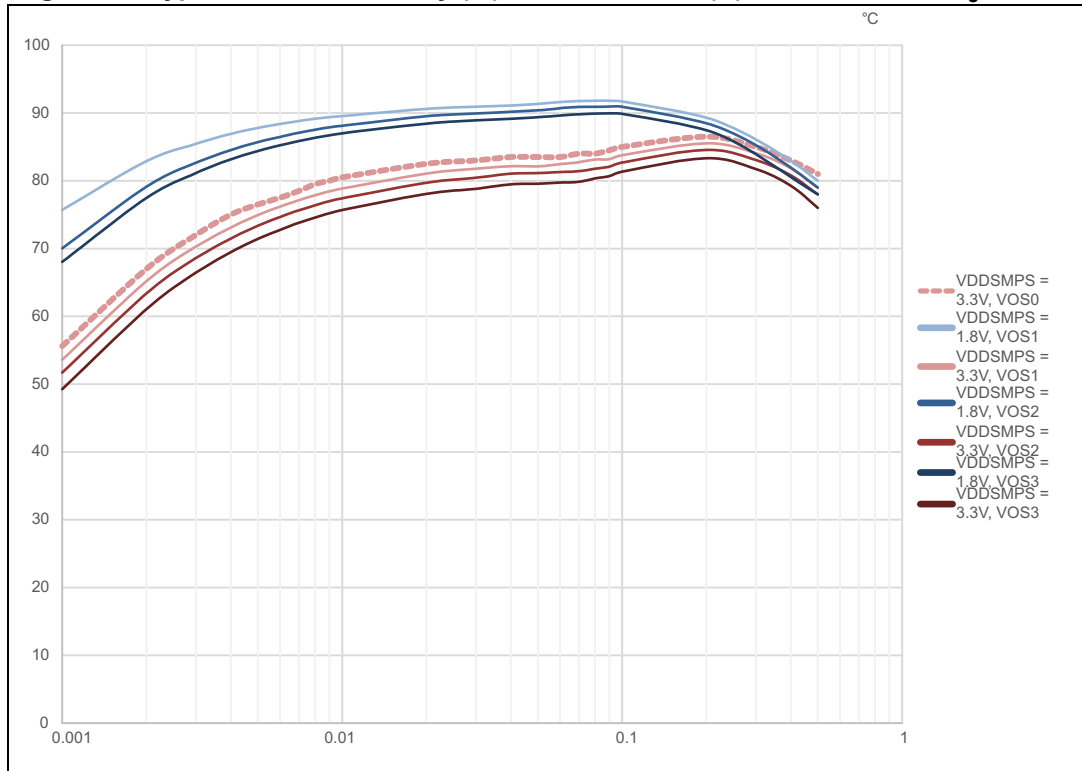


Figure 19. Typical SMPS efficiency (%) vs load current (A) in Run mode at $T_J = T_{Jmax}$

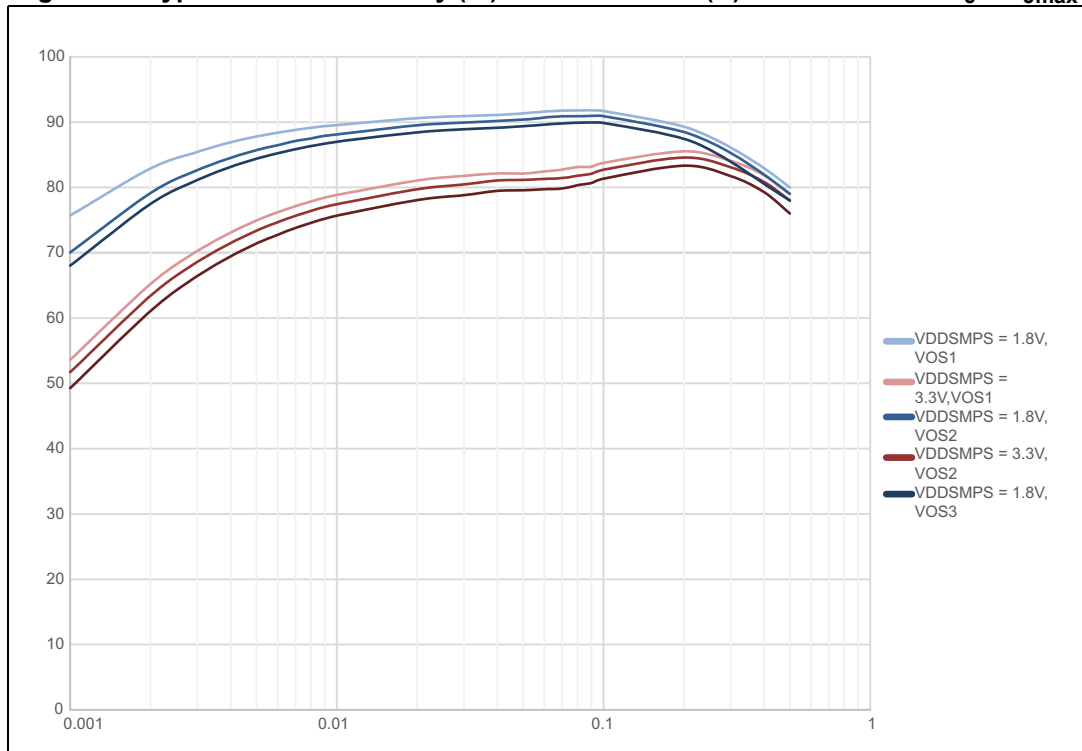


Figure 20. Typical SMPS efficiency (%) vs load current (A) in Stop and DStop modes at $T_J = 30\text{ }^\circ\text{C}$

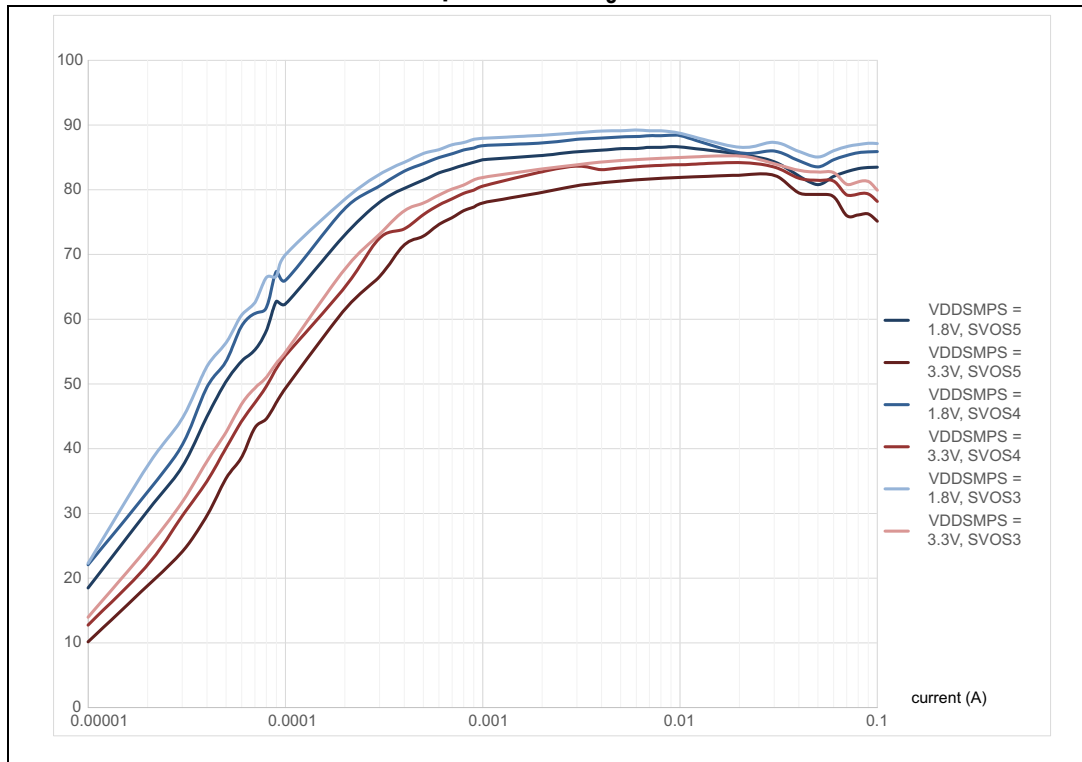
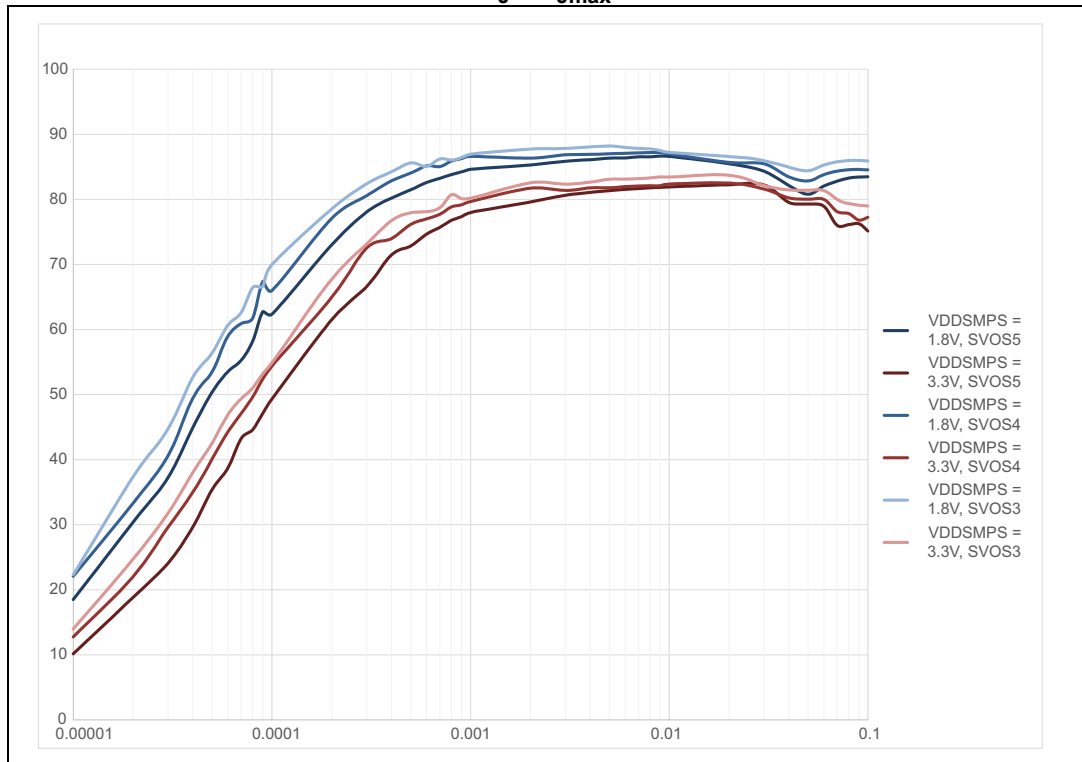


Figure 21. Typical SMPS efficiency (%) vs load current (A) in low-power mode at $T_J = T_{Jmax}$



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 a 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 55: I/O static characteristics](#).

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

An 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 should 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 a 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 33: Peripheral current consumption in Run mode](#)), 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:

$$I_{SW} = V_{DDx} \times f_{SW} \times C_L$$

where

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

V_{DDx} is the MCU supply voltage

f_{SW} is the I/O switching frequency

C_L 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.

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.
- The I/O compensation cell is enabled.
- $f_{rcc_c_ck}$ is the CPU clock. $f_{PCLK} = f_{rcc_c_ck}/4$, and $f_{HCLK} = f_{rcc_c_ck}/2$.
 The given value is calculated by measuring the difference of current consumption
 - with all peripherals clocked off
 - with only one peripheral clocked on
 - $f_{rcc_c_ck} = 550$ MHz (Scale 0), $f_{rcc_c_ck} = 400$ MHz (Scale 1), $f_{rcc_c_ck} = 300$ MHz (Scale 2), $f_{rcc_c_ck} = 170$ MHz (Scale 3)
- The ambient operating temperature is 25 °C and $V_{DD}=3.3$ V
- The LDO regulator supplies V_{CORE} .

Table 33. Peripheral current consumption in Run mode

| Peripheral | | $I_{DD(Typ)}$ | | | | Unit |
|------------|--------------------|---------------|-------|-------|-------|--------|
| | | VOS0 | VOS1 | VOS2 | VOS3 | |
| AHB3 | MDMA | 3.70 | 3.10 | 2.90 | 2.60 | µA/MHz |
| | DMA2D | 2.70 | 2.30 | 2.10 | 1.90 | |
| | Flash memory | 15.20 | 14.00 | 12.00 | 10.90 | |
| | FMC registers | 0.90 | 0.90 | 0.80 | 0.70 | |
| | FMC kernel | 7.00 | 6.10 | 5.60 | 5.40 | |
| | OCTOSPI1 registers | 1.40 | 1.30 | 0.50 | 0.40 | |
| | OCTOSPI1 kernel | 3.10 | 1.20 | 0.50 | 0.20 | |
| | SDMMC1 registers | 8.70 | 7.60 | 6.90 | 6.10 | |
| | SDMMC1 kernel | 2.10 | 1.80 | 1.40 | 1.20 | |
| | OCTOSPI2 registers | 1.40 | 1.30 | 0.90 | 0.60 | |
| | OCTOSPI2 kernel | 2.50 | 1.50 | 1.40 | 0.50 | |
| | AXI SRAM | 8.50 | 7.50 | 6.90 | 6.00 | |
| AHB1 | DMA1 | 0.70 | 0.60 | 0.50 | 0.40 | µA/MHz |
| | DMA2 | 1.00 | 0.80 | 0.70 | 0.70 | |
| | DMAMUX1 | 0.10 | 0.10 | 0.10 | 0.10 | |
| | ADC1/2 registers | 4.50 | 4.00 | 3.60 | 2.30 | |
| | ADC1/2 kernel | 0.90 | 0.80 | 0.60 | 0.40 | |
| | USB1 registers | 20.80 | 17.50 | 16.50 | 14.80 | |
| | USB1 kernel | 1.20 | 0.90 | 0.90 | 0.90 | |
| | USB1 ULPI kernel | 31.00 | 30.00 | 29.50 | 27.00 | |
| Ethernet | 17.30 | 14.40 | 13.70 | 12.30 | | |

Table 33. Peripheral current consumption in Run mode (continued)

| Peripheral | | I _{DD(Typ)} | | | | Unit |
|------------|------------------|----------------------|-------|-------|-------|--------|
| | | VOS0 | VOS1 | VOS2 | VOS3 | |
| AHB2 | DCMI | 4.80 | 4.00 | 3.80 | 3.40 | μA/MHz |
| | HSEM | 0.60 | 0.60 | 0.10 | 0.10 | |
| | RNG1 registers | 1.20 | 1.00 | 0.90 | 0.70 | |
| | RNG1 kernel | 15.00 | 13.60 | 10.00 | 9.00 | |
| | SDMMC2 registers | 15.00 | 12.20 | 11.70 | 10.40 | |
| | SDMMC2 kernel | 2.10 | 1.80 | 1.40 | 1.20 | |
| | BDMA | 6.50 | 5.90 | 4.80 | 4.30 | |
| | SRAM1 | 2.40 | 2.00 | 1.80 | 1.60 | |
| | SRAM2 | 2.70 | 2.30 | 2.00 | 1.80 | |
| | CORDIC | 0.80 | 0.60 | 0.50 | 0.50 | |
| FMAC | 2.40 | 2.10 | 1.90 | 1.60 | | |
| AHB4 | GPIOA | 0.10 | 0.10 | 0.10 | 0.10 | μA/MHz |
| | GPIOB | 0.90 | 0.80 | 0.10 | 0.10 | |
| | GPIOC | 0.50 | 0.10 | 0.10 | 0.10 | |
| | GPIOD | 0.90 | 0.80 | 0.10 | 0.10 | |
| | GPIOE | 0.90 | 0.80 | 0.10 | 0.10 | |
| | GPIOF | 0.30 | 0.10 | 0.10 | 0.10 | |
| | GPIOG | 0.90 | 0.80 | 0.30 | 0.20 | |
| | GPIOH | 0.10 | 0.10 | 0.10 | 0.10 | |
| | GPIOJ | 0.90 | 0.80 | 0.30 | 0.20 | |
| | GPIOK | 0.80 | 0.80 | 0.10 | 0.10 | |
| | HSEM | 0.60 | 0.60 | 0.10 | 0.10 | |
| | BDMA | 6.50 | 5.90 | 4.80 | 4.30 | |
| | CRC | 0.90 | 0.30 | 0.30 | 0.30 | |
| | ADC3 registers | 2.10 | 1.40 | 1.30 | 1.20 | |
| | ADC3 kernel | 0.40 | 0.30 | 0.30 | 0.20 | |
| | Backup SRAM | 1.80 | 1.00 | 1.00 | 0.80 | |
| APB3 | LTDC | 9.00 | 7.90 | 7.70 | 6.40 | |
| | WWDG1 | 0.60 | 0.50 | 0.50 | 0.50 | |

Table 33. Peripheral current consumption in Run mode (continued)

| Peripheral | | I _{DD(Typ)} | | | | Unit |
|----------------|-------------------|----------------------|------|------|------|--------|
| | | VOS0 | VOS1 | VOS2 | VOS3 | |
| APB1 | TIM2 | 4.50 | 4.40 | 3.30 | 3.00 | μA/MHz |
| | TIM3 | 3.80 | 3.20 | 2.90 | 2.70 | |
| | TIM4 | 3.60 | 3.10 | 2.60 | 2.50 | |
| | TIM5 | 4.10 | 3.40 | 3.10 | 2.90 | |
| | TIM6 | 1.50 | 1.10 | 1.00 | 1.00 | |
| | TIM7 | 1.40 | 1.10 | 0.90 | 0.90 | |
| | TIM12 | 2.30 | 1.80 | 1.60 | 1.60 | |
| | TIM13 | 1.90 | 1.40 | 1.30 | 1.20 | |
| | TIM14 | 1.60 | 1.20 | 1.10 | 1.10 | |
| | TIM23 | 4.60 | 3.90 | 3.60 | 3.40 | |
| | TIM24 | 4.40 | 3.80 | 3.50 | 3.30 | |
| | LPTIM1 registers | 3.50 | 2.90 | 2.70 | 2.60 | |
| | LPTIM1 kernel | 2.60 | 2.30 | 2.00 | 1.80 | |
| | SPI2 registers | 2.10 | 1.60 | 0.90 | 0.80 | |
| | SPI2 kernel | 1.50 | 1.20 | 1.10 | 1.00 | |
| | SPI3 registers | 2.40 | 2.00 | 1.90 | 1.80 | |
| | SPDIFRX registers | 0.60 | 0.50 | 0.50 | 0.50 | |
| | SPDIFRX kernel | 3.50 | 2.80 | 2.40 | 2.20 | |
| | USART2 registers | 6.60 | 5.70 | 5.20 | 4.90 | |
| | USART2 kernel | 4.80 | 4.80 | 4.60 | 3.80 | |
| | USART3 registers | 5.90 | 5.40 | 4.60 | 4.30 | |
| | USART3 kernel | 4.00 | 3.40 | 3.00 | 2.90 | |
| | UART4 registers | 5.60 | 4.80 | 3.50 | 3.10 | |
| | UART4 kernel | 3.80 | 3.20 | 3.00 | 2.40 | |
| | UART5 registers | 5.60 | 4.60 | 4.40 | 4.00 | |
| | UART5 kernel | 3.90 | 3.40 | 3.30 | 3.20 | |
| | UART7 registers | 5.40 | 4.60 | 4.20 | 3.90 | |
| | UART7 kernel | 3.80 | 3.30 | 3.00 | 3.00 | |
| | UART8 registers | 5.60 | 4.10 | 3.50 | 3.40 | |
| | UART8 kernel | 3.60 | 3.20 | 3.20 | 3.10 | |
| | I2C1 registers | 0.90 | 0.60 | 0.60 | 0.50 | |
| | I2C1 kernel | 2.30 | 2.00 | 1.80 | 1.60 | |
| I2C2 registers | 1.00 | 0.70 | 0.60 | 0.60 | | |

Table 33. Peripheral current consumption in Run mode (continued)

| Peripheral | | I _{DD(Typ)} | | | | Unit |
|------------|----------------------|----------------------|-------|-------|-------|--------|
| | | VOS0 | VOS1 | VOS2 | VOS3 | |
| APB1 | I2C2 kernel | 2.30 | 1.90 | 1.70 | 1.20 | μA/MHz |
| | I2C3 registers | 0.90 | 0.60 | 0.50 | 0.50 | |
| | I2C3 kernel | 2.30 | 2.00 | 1.00 | 1.00 | |
| | I2C5 registers | 0.90 | 0.60 | 0.50 | 0.50 | |
| | I2C5 kernel | 2.20 | 2.10 | 1.90 | 1.80 | |
| | CEC registers | 0.60 | 0.30 | 0.20 | 0.20 | |
| | CEC kernel | 0.10 | 0.10 | 0.10 | 0.10 | |
| | DAC1 | 1.60 | 1.30 | 1.10 | 1.10 | |
| | FDCAN1/2/3 registers | 24.10 | 20.90 | 18.20 | 17.40 | |
| | FDCAN1/2/3 kernel | 9.90 | 9.90 | 9.00 | 8.00 | |
| | CRS | 4.90 | 3.90 | 3.50 | 3.20 | |
| | SWPMI registers | 1.10 | 0.80 | 0.80 | 0.80 | |
| | SWPMI kernel | 1.50 | 1.10 | 1.00 | 1.00 | |
| | OPAMP | 0.50 | 0.40 | 0.30 | 0.20 | |

Table 33. Peripheral current consumption in Run mode (continued)

| Peripheral | | I _{DD(Typ)} | | | | Unit |
|------------|-------------------|----------------------|------|------|------|--------|
| | | VOS0 | VOS1 | VOS2 | VOS3 | |
| APB2 | TIM1 | 5.30 | 4.40 | 4.20 | 3.80 | µA/MHz |
| | TIM8 | 5.60 | 5.40 | 5.20 | 3.90 | |
| | USART1 registers | 1.80 | 1.60 | 1.40 | 1.10 | |
| | USART1 kernel | 3.00 | 2.90 | 2.80 | 2.70 | |
| | USART6 registers | 1.90 | 1.70 | 1.50 | 1.20 | |
| | USART6 kernel | 4.50 | 4.00 | 3.60 | 3.10 | |
| | UART9 registers | 1.70 | 1.70 | 1.60 | 1.10 | |
| | UART9 kernel | 3.80 | 3.30 | 2.90 | 2.90 | |
| | USART10 registers | 1.80 | 1.70 | 1.40 | 1.10 | |
| | USART10 kernel | 3.80 | 3.30 | 2.90 | 2.90 | |
| | SPI1 registers | 1.90 | 1.80 | 1.40 | 1.20 | |
| | SPI1 kernel | 1.50 | 1.20 | 1.10 | 1.00 | |
| | SPI4 registers | 1.80 | 1.60 | 1.40 | 1.10 | |
| | SPI4 kernel | 1.50 | 1.20 | 1.10 | 1.00 | |
| | SPI5 registers | 1.60 | 1.60 | 1.40 | 1.10 | |
| | SPI5 kernel | 1.50 | 1.20 | 1.10 | 1.00 | |
| | TIM15 | 2.80 | 2.50 | 2.30 | 1.90 | |
| | TIM16 | 2.00 | 1.90 | 1.60 | 1.30 | |
| | TIM17 | 2.10 | 2.00 | 1.70 | 1.40 | |
| | SAI1 registers | 1.40 | 1.40 | 1.20 | 0.90 | |
| | SAI1 kernel | 0.80 | 0.70 | 0.70 | 0.70 | |
| | DFSDM1 registers | 5.60 | 5.40 | 5.30 | 4.00 | |
| | DFSDM1 kernel | 0.30 | 0.20 | 0.20 | 0.10 | |
| SYSCFG | 1.20 | 1.10 | 1.10 | 1.10 | | |

Table 33. Peripheral current consumption in Run mode (continued)

| Peripheral | | I _{DD(Typ)} | | | | Unit |
|------------|-------------------|----------------------|------|------|------|--------|
| | | VOS0 | VOS1 | VOS2 | VOS3 | |
| APB4 | LPUART1 registers | 1.80 | 0.90 | 0.80 | 0.60 | μA/MHz |
| | LPUART1 kernel | 2.40 | 2.30 | 2.00 | 1.90 | |
| | SPI6 registers | 2.60 | 2.30 | 2.10 | 1.80 | |
| | SPI6 kernel | 1.20 | 1.10 | 1.00 | 0.90 | |
| | I2C4 registers | 0.70 | 0.70 | 0.60 | 0.40 | |
| | I2C4 kernel | 2.00 | 1.70 | 1.70 | 1.40 | |
| | LPTIM2 registers | 1.50 | 0.70 | 0.50 | 0.30 | |
| | LPTIM2 kernel | 2.50 | 2.10 | 2.00 | 1.90 | |
| | LPTIM3 registers | 2.90 | 2.60 | 2.30 | 1.90 | |
| | LPTIM3 kernel | 2.40 | 2.00 | 1.90 | 1.70 | |
| | LPTIM4 registers | 2.60 | 2.30 | 2.10 | 1.80 | |
| | LPTIM4 kernel | 2.10 | 1.80 | 1.70 | 1.60 | |
| | LPTIM5 registers | 2.60 | 2.30 | 2.00 | 1.70 | |
| | LPTIM5 kernel | 2.10 | 1.80 | 1.60 | 1.50 | |
| | COMP1/2 | 0.70 | 0.30 | 0.20 | 0.10 | |
| | VREF | 0.10 | 0.10 | 0.10 | 0.10 | |
| | RTC | 0.10 | 0.10 | 0.10 | 0.10 | |
| | WWDG1 | 0.60 | 0.50 | 0.50 | 0.50 | |
| | SAI4 registers | 2.40 | 2.20 | 2.10 | 1.70 | |
| | SAI4 kernel | 0.90 | 0.90 | 0.90 | 0.70 | |
| DTS | 2.90 | 2.60 | 2.30 | 2.00 | | |

6.3.9 Wakeup time from low-power modes

The wakeup times given in [Table 34](#) 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 (PC1) 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 34. Low-power mode wakeup timings

| Symbol | Parameter | Conditions | Typ ⁽¹⁾ | Max ⁽¹⁾ (2) | Unit |
|---------------------|--------------------------|--|--------------------|---------------------------|------------------|
| $t_{WUSLEEP}^{(3)}$ | Wakeup from Sleep | - | 14.00 | 15.00 | CPU clock cycles |
| $t_{WUSTOP}^{(3)}$ | Wakeup from Stop mode | SVOS3, HSI, Flash memory in Normal mode | 4.6 | 6.2 | μs |
| | | SVOS3, HSI, Flash memory in low-power mode | 12.4 | 17.4 | |
| | | SVOS4, HSI, Flash memory in Normal mode | 15.5 | 21.1 | |
| | | SVOS4, HSI, Flash memory in low-power mode | 23.3 | 31.8 | |
| | | SVOS5, HSI, Flash memory in Normal mode | 39.1 | 52.6 | |
| | | SVOS5, HSI, Flash memory in low-power mode | 39.1 | 52.7 | |
| | | SVOS3, CSI, Flash memory in Normal mode | 30.0 | 41.6 | |
| | | SVOS3, CSI, Flash memory in low-power mode | 40.6 | 55.0 | |
| | | SVOS4, CSI, Flash memory in Normal mode | 41.0 | 55.4 | |
| | | SVOS4, CSI, Flash memory in low-power mode | 51.5 | 68.8 | |
| | | SVOS5, CSI, Flash memory in Normal mode | 67.3 | 89.5 | |
| | | SVOS5, CSI, Flash memory in low-power mode | 67.2 | 89.5 | |
| $t_{WUSTDBY}^{(3)}$ | Wakeup from Standby mode | - | 400.0 | 504.3 | |

1. Guaranteed by characterization results.
2. The maximum values have been measured at -40 °C, in worst conditions.
3. The wakeup times are measured from the wakeup event to the point in which the application code reads the first

6.3.10 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.

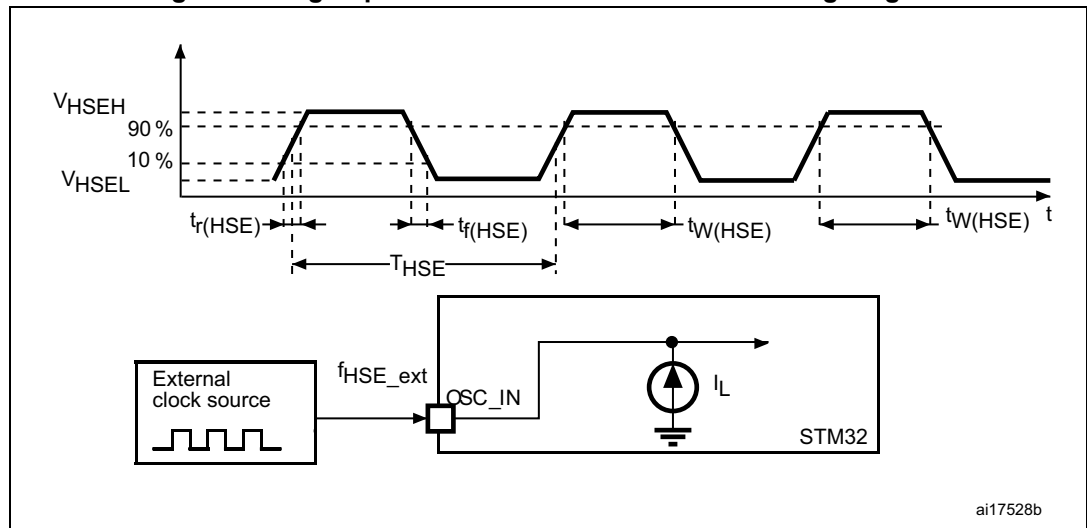
The external clock signal has to respect the [Table 55: I/O static characteristics](#). However, the recommended clock input waveform is shown in [Figure 22](#).

Table 35. High-speed external user clock characteristics⁽¹⁾

| Symbol | Parameter | Min | Typ | Max | Unit |
|----------------|---|--------------|-----|--------------|------|
| f_{HSE_ext} | User external clock source frequency | 4 | 25 | 50 | MHz |
| V_{HSEH} | Digital OSC_IN input high-level voltage | $0.7 V_{DD}$ | - | V_{DD} | V |
| V_{HSEL} | Digital OSC_IN input low-level voltage | V_{SS} | - | $0.3 V_{DD}$ | |
| $t_{W(HSE)}$ | OSC_IN high or low time | 7 | - | - | ns |

1. Guaranteed by design.

Figure 22. High-speed external clock source AC timing diagram



Low-speed external user clock generated from an external source

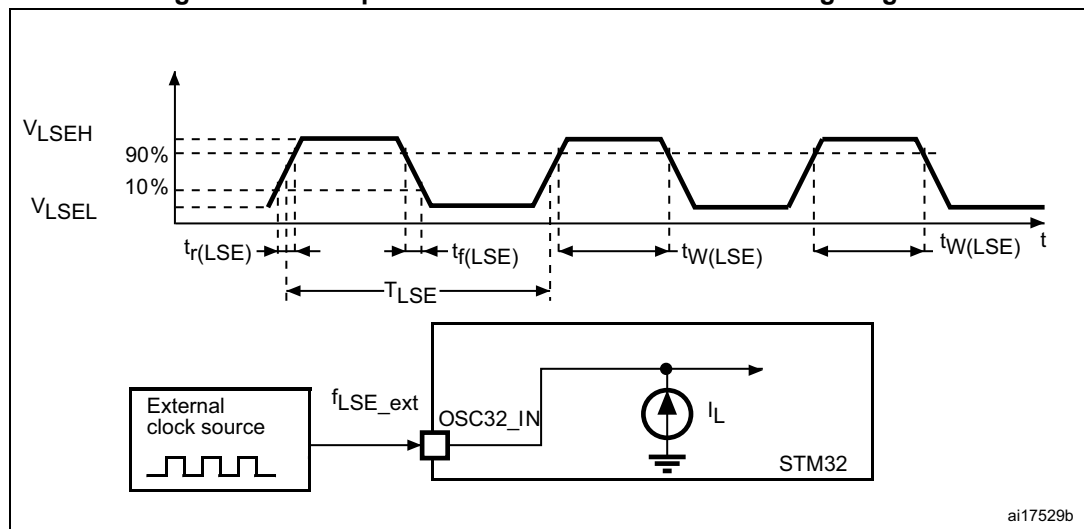
In bypass mode the LSE oscillator is switched off and the input pin is a standard I/O. The external clock signal has to respect the [Table 55: I/O static characteristics](#). However, the recommended clock input waveform is shown in [Figure 23](#).

Table 36. Low-speed external user clock characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|---------------------------------------|------------|--------------|--------|--------------|------|
| f_{LSE_ext} | User external clock source frequency | - | - | 32.768 | 1000 | kHz |
| V_{LSEH} | OSC32_IN input pin high-level voltage | - | $0.7 V_{DD}$ | - | V_{DD} | V |
| V_{LSEL} | OSC32_IN input pin low-level voltage | - | V_{SS} | - | $0.3 V_{DD}$ | |
| $t_{w(LSEH)}$ $t_{w(LSEL)}$ | OSC32_IN high or low time | - | 250 | - | - | ns |

1. Guaranteed by design.

Figure 23. Low-speed external clock source AC timing diagram



ai17529b

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

The high-speed external (HSE) clock can be supplied with a 4 to 50 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 37](#). 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 37. 4-50 MHz HSE oscillator characteristics⁽¹⁾

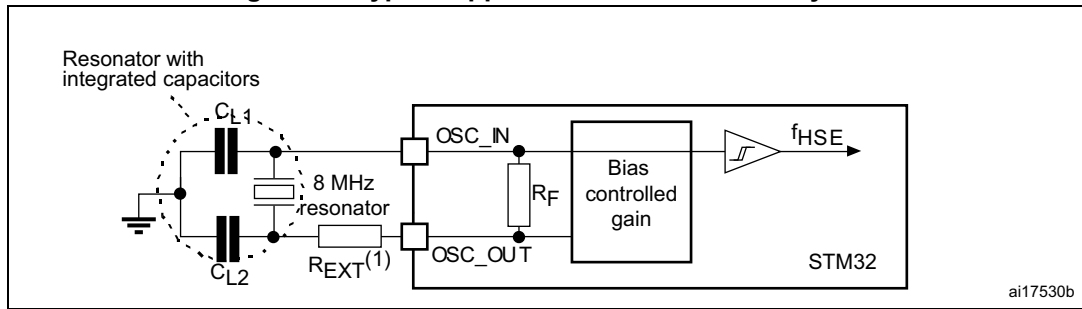
| Symbol | Parameter | Operating conditions ⁽²⁾ | Min | Typ | Max | Unit |
|-----------------------------------|-----------------------------|---|-----|------|-----|------|
| F | Oscillator frequency | - | 4 | - | 50 | MHz |
| R _F | Feedback resistor | - | - | 200 | - | kΩ |
| I _{DD(HSE)} | HSE current consumption | During startup ⁽³⁾ | - | - | 4 | mA |
| | | V _{DD} =3 V, R _m =30 Ω C _L =10 pF at 4 MHz | - | 0.35 | - | |
| | | V _{DD} =3 V, R _m =30 Ω C _L =10 pF at 8 MHz | - | 0.40 | - | |
| | | V _{DD} =3 V, R _m =30 Ω C _L =10 pF at 16 MHz | - | 0.45 | - | |
| | | V _{DD} =3 V, R _m =30 Ω C _L =10 pF at 32 MHz | - | 0.65 | - | |
| | | V _{DD} =3 V, R _m =30 Ω C _L =10 pF at 48 MHz | - | 0.95 | - | |
| G _m _{critmax} | Maximum critical crystal gm | Startup | - | - | 1.5 | mA/V |
| t _{SU} ⁽⁴⁾ | Start-up time | V _{DD} is stabilized | - | 2 | - | ms |

1. Guaranteed by design.
2. Resonator characteristics given by the crystal/ceramic resonator manufacturer.
3. This consumption level occurs during the first 2/3 of the t_{SU(HSE)} startup time.
4. 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 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 (typical), designed for high-frequency applications, and selected to match the requirements of the crystal or resonator (see [Figure 24](#)). 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}. The 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 application note AN2867 "Oscillator design guide for ST microcontrollers" available from the ST website www.st.com.

Figure 24. 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 38](#). 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).

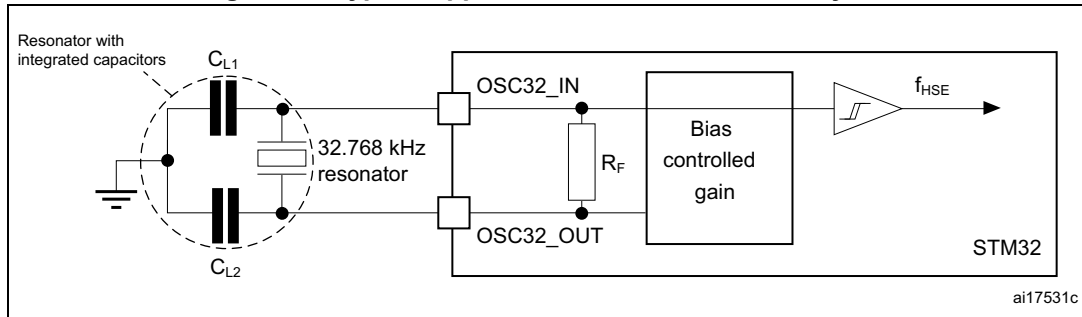
Table 38. Low-speed external user clock characteristics⁽¹⁾

| Symbol | Parameter | Operating conditions ⁽²⁾ | Min | Typ | Max | Unit |
|-------------------|-----------------------------|---|-----|--------|------|-----------|
| F | Oscillator frequency | - | - | 32.768 | - | kHz |
| I_{DD} | LSE current consumption | LSEDRV[1:0] = 00, Low drive capability | - | 290 | - | nA |
| | | LSEDRV[1:0] = 01, Medium Low drive capability | - | 390 | - | |
| | | LSEDRV[1:0] = 10, Medium high drive capability | - | 550 | - | |
| | | LSEDRV[1:0] = 11, High drive capability | - | 900 | - | |
| $G_{m_{critmax}}$ | Maximum critical crystal gm | LSEDRV[1:0] = 00, Low drive capability | - | - | 0.5 | $\mu A/V$ |
| | | LSEDRV[1:0] = 01, Medium Low drive capability | - | - | 0.75 | |
| | | LSEDRV[1:0] = 10, Medium high drive capability | - | - | 1.7 | |
| | | LSEDRV[1:0] = 11, High drive capability | - | - | 2.7 | |
| $t_{SU}^{(3)}$ | Startup time | VDD is stabilized | - | 2 | - | s |

1. Guaranteed by design.
2. Refer to the note and caution paragraphs below the table, and to the application note AN2867 "Oscillator design guide for ST microcontrollers".
3. t_{SU} is the startup time measured from the moment it is enabled (by software) to a stabilized 32.768k Hz 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 website www.st.com.

Figure 25. Typical application with a 32.768 kHz crystal



1. An external resistor is not required between OSC32_IN and OSC32_OUT and it is forbidden to add one.

6.3.11 Internal clock source characteristics

The parameters given in [Table 39](#) to [Table 41](#) are derived from tests performed under ambient temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#).

48 MHz high-speed internal RC oscillator (HSI48)

Table 39. HSI48 oscillator characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---|---|---------------------|------------|---------------------|---------------|
| f_{HSI48} | HSI48 frequency | $V_{DD}=3.3\text{ V}$, $T_J=30\text{ }^\circ\text{C}$ | 47.5 ⁽¹⁾ | 48 | 48.5 ⁽¹⁾ | MHz |
| TRIM ⁽²⁾ | USER trimming step | - | - | 0.175 | 0.250 | % |
| USER TRIM COVERAGE ⁽³⁾ | USER TRIMMING coverage | ± 32 steps | ± 4.70 | ± 5.6 | - | % |
| DuCy(HSI48) ⁽²⁾ | Duty Cycle | - | 45 | - | 55 | % |
| ACCHSI48_REL ⁽³⁾ | Accuracy of the HSI48 oscillator over temperature (factory calibrated) | $T_J=-40\text{ to }125\text{ }^\circ\text{C}$ | -4.5 | - | 3.5 | % |
| | | $T_J=-40\text{ to }140\text{ }^\circ\text{C}$ | -4.5 | - | 4 | |
| $\Delta V_{DD}(\text{HSI48})^{(2)(4)}$ | HSI48 oscillator frequency drift with $V_{DD}^{(5)}$ (the reference is 3.3 V) | $V_{DD}=3\text{ to }3.6\text{ V}$ | - | 0.025 | 0.05 | % |
| | | $V_{DD}=1.62\text{ V to }3.6\text{ V}$ | - | 0.05 | 0.1 | |
| $t_{su}(\text{HSI48})^{(2)}$ | HSI48 oscillator start-up time | - | - | 2.1 | 4.0 | μs |
| $I_{DD}(\text{HSI48})^{(2)}$ | HSI48 oscillator power consumption | - | - | 350 | 400 | μA |
| N_T jitter ⁽²⁾ | Next transition jitter Accumulated jitter on 28 cycles ⁽⁶⁾ | - | - | ± 0.15 | - | ns |
| P_T jitter ⁽²⁾ | Paired transition jitter Accumulated jitter on 56 cycles ⁽⁶⁾ | - | - | ± 0.25 | - | ns |

1. Guaranteed by test in production.
2. Guaranteed by design.
3. Guaranteed by characterization results.
4. $\Delta f_{HSI} = \text{ACCHSI48_REL} + \Delta V_{DD}$.

- 5. These values are obtained by using the formula: $(\text{Freq}(3.6\text{ V}) - \text{Freq}(3.0\text{ V})) / \text{Freq}(3.0\text{ V})$ or $(\text{Freq}(3.6\text{ V}) - \text{Freq}(1.62\text{ V})) / \text{Freq}(1.62\text{ V})$.
- 6. Jitter measurements are performed without clock source activated in parallel.

64 MHz high-speed internal RC oscillator (HSI)

Table 40. HSI oscillator characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------|--|--|---------------------|-------|---------------------|------|
| f _{HSI} | HSI frequency | V _{DD} =3.3 V, T _J =30 °C | 63.7 ⁽²⁾ | 64 | 64.3 ⁽²⁾ | MHz |
| TRIM | HSI user trimming step | Trimming is not a multiple of 32 | - | 0.24 | 0.32 | % |
| | | Trimming is 128, 256 and 384 | -5.2 | -1.8 | - | |
| | | Trimming is 64, 192, 320 and 448 | -1.4 | -0.8 | - | |
| | | Other trimming are a multiple of 32 (not including multiple of 64 and 128) | -0.6 | -0.25 | - | |
| DuCy(HSI) | Duty cycle | - | 45 | - | 55 | % |
| ΔV _{DD} (HSI) | HSI oscillator frequency drift over V _{DD} (the reference is 3.3 V) | V _{DD} =1.62 to 3.6 V | -0.12 | - | 0.03 | % |
| ΔT _{EMP} (HSI) | HSI oscillator frequency drift over temperature (the reference is 64 MHz) | T _J =-20 to 105 °C | -1 ⁽³⁾ | - | 1 ⁽³⁾ | % |
| | | T _J =-40 to T _J max °C | -2 ⁽³⁾ | - | 1 ⁽³⁾ | |
| t _{su} (HSI) | HSI oscillator start-up time | - | - | 1.4 | 2 | μs |
| t _{stab} (HSI) | HSI oscillator stabilization time | at 1% of target frequency | - | 4 | 8 | |
| | | at 5% of target frequency | - | - | 4 | |
| I _{DD} (HSI) | HSI oscillator power consumption | - | - | 300 | 400 | μA |

- 1. Guaranteed by design unless otherwise specified.
- 2. Guaranteed by test in production.
- 3. Guaranteed by characterization results.

4 MHz low-power internal RC oscillator (CSI)

Table 41. CSI oscillator characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|---|---|---------------------|-------|---------------------|---------------|
| f_{CSI} | CSI frequency | $V_{\text{DD}}=3.3\text{ V}$, $T_{\text{J}}=30\text{ °C}$ | 3.96 ⁽²⁾ | 4 | 4.04 ⁽²⁾ | MHz |
| TRIM | CSI trimming step | Trimming is not a multiple of 16 | - | 0.40 | 0.75 | % |
| | | Trimming is a multiple of 32 | -4.75 | -2.75 | 0.75 | |
| | | Other trimming values not multiple of 16 (excluding multiple of 32) | -0.43 | 0.00 | 0.75 | |
| DuCy(CSI) | Duty cycle | - | 45 | - | 55 | % |
| Δ_{TEMP} (CSI) | CSI oscillator frequency drift over temperature | $T_{\text{J}} = 0\text{ to }85\text{ °C}$ | -3.7 ⁽³⁾ | - | 4.5 ⁽³⁾ | % |
| | | $T_{\text{J}} = -40\text{ to }125\text{ °C}$ | -11 ⁽³⁾ | - | 7.5 ⁽³⁾ | |
| Δ_{VDD} (CSI) | CSI oscillator frequency drift over V_{DD} | $V_{\text{DD}} = 1.62\text{ to }3.6\text{ V}$ | -0.06 | - | 0.06 | % |
| $t_{\text{su}}(\text{CSI})$ | CSI oscillator startup time | - | - | 1 | 2 | μs |
| $t_{\text{stab}}(\text{CSI})$ | CSI oscillator stabilization time (to reach $\pm 3\%$ of f_{CSI}) | - | - | - | 4 | cycle |
| $I_{\text{DD}}(\text{CSI})$ | CSI oscillator power consumption | - | - | 23 | 30 | μA |

1. Guaranteed by design, unless otherwise specified.
2. Guaranteed by test in production.
3. Guaranteed by characterization results.

Low-speed internal (LSI) RC oscillator

Table 42. LSI oscillator characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---|---|----------------------|-----|---------------------|---------------|
| f_{LSI} | LSI frequency | $V_{\text{DD}} = 3.3\text{ V}$, $T_{\text{J}} = 25\text{ °C}$ | 31.4 ⁽¹⁾ | 32 | 32.6 ⁽¹⁾ | kHz |
| | | $T_{\text{J}} = -40\text{ to }110\text{ °C}$, $V_{\text{DD}} = 1.62\text{ to }3.6\text{ V}$ | 29.76 ⁽²⁾ | - | 33.6 ⁽²⁾ | |
| | | $T_{\text{J}} = -40\text{ to }125\text{ °C}$, $V_{\text{DD}} = 1.62\text{ to }3.6\text{ V}$ | 29.4 ⁽²⁾ | - | 33.6 ⁽²⁾ | |
| $t_{\text{su}}(\text{LSI})$ ⁽³⁾ | LSI oscillator startup time | - | - | 80 | 130 | μs |
| $t_{\text{stab}}(\text{LSI})$ ⁽³⁾ | LSI oscillator stabilization time (5% of final value) | - | - | 120 | 170 | |
| $I_{\text{DD}}(\text{LSI})$ ⁽³⁾ | LSI oscillator power consumption | - | - | 130 | 280 | nA |

1. Guaranteed by test in production.
2. Guaranteed by characterization results.
3. Guaranteed by design.

6.3.12 PLL characteristics

The parameters given in [Table 43](#), [Table 46](#) are derived from tests performed under temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 43. PLL1 characteristics (wide VCO frequency range)⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | | | |
|----------------------------------|--------------------------------------|--|--------------------------------|--------------------------------|--------------------|------|----|---|---|
| f _{PLL_IN} | PLL input clock | - | 2 | - | 16 | MHz | | | |
| | PLL input clock duty cycle | - | 10 | - | 90 | % | | | |
| f _{PLL_P_OUT} | PLL multiplier output clock P | VOS0 | 1.5 | - | 550 ⁽²⁾ | MHz | | | |
| | | VOS1 | 1.5 | - | 400 ⁽²⁾ | | | | |
| | | VOS2 | 1.5 | - | 300 ⁽²⁾ | | | | |
| | | VOS3 | 1.5 | - | 170 ⁽²⁾ | | | | |
| f _{VCO_OUT} | PLL VCO output | - | 192 | - | 836 ⁽³⁾ | | | | |
| t _{LOCK} | PLL lock time | Normal mode | 15 | 50 | 150 ⁽³⁾ | µs | | | |
| | | Sigma-delta mode (CKIN ≥ 8 MHz) | 25 | 65 | 170 | | | | |
| Jitter | Cycle-to-cycle jitter ⁽⁴⁾ | f _{PLL_OUT} = f _{VCO_OUT} /100 | f _{VCO_OUT} = 192 MHz | - | 51 | - | ps | | |
| | | | f _{VCO_OUT} = 400 MHz | - | 19 | - | | | |
| | | | f _{VCO_OUT} = 560 MHz | - | 10 | - | | | |
| | | | f _{VCO_OUT} = 800 MHz | - | 9 | - | | | |
| | Period jitter | | f _{VCO_OUT} = 192 MHz | - | 38 | - | | | |
| | | | f _{VCO_OUT} = 560 MHz | - | 8 | - | | | |
| | | | f _{VCO_OUT} = 800 MHz | - | 7 | - | | | |
| | Long term jitter | | Normal mode (CKIN = 2 MHz) | f _{VCO_OUT} = 192 MHz | - | 0.15 | | - | % |
| | | | | f _{VCO_OUT} = 400 MHz | - | 0.14 | | - | |
| | | | | f _{VCO_OUT} = 832 MHz | - | 0.16 | | - | |
| Sigma-delta mode (CKIN = 16 MHz) | | f _{VCO_OUT} = 192 MHz | - | 0.17 | - | | | | |
| | | f _{VCO_OUT} = 500 MHz | - | 0.08 | - | | | | |
| | | f _{VCO_OUT} = 836 MHz | - | 0.06 | - | | | | |

Table 43. PLL1 characteristics (wide VCO frequency range)⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|----------------------|-----------------------|--------------------------------|-------------------|------|------|------|----|
| I _{DD(PLL)} | PLL power consumption | f _{VCO_OUT} = 560 MHz | V _{DDA} | 530 | 557 | 670 | μA |
| | | | V _{CORE} | 1190 | 1285 | 6300 | |
| | | f _{VCO_OUT} = 192 MHz | V _{DDA} | 260 | 286 | 513 | |
| | | | V _{CORE} | 309 | 377 | 5700 | |

1. Guaranteed by design unless otherwise specified.
2. This value must be limited to the maximum frequency due to the product limitation.
3. Guaranteed by characterization results.
4. Integer mode only.

Table 44. PLL1 characteristics (medium VCO frequency range)⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|----------------------|--|--------------------------------|--------------------------------|-------------------|--------------------|------|-----|
| f _{PLL_IN} | PLL input clock | - | 1 | - | 2 | MHz | |
| | PLL input clock duty cycle | - | 10 | - | 90 | % | |
| f _{PLL_OUT} | PLL multiplier output clock P, Q, R | VOS0 | 1.17 | - | 210 | MHz | |
| | | VOS1 | 1.17 | - | 210 | | |
| | | VOS2 | 1.17 | - | 210 | | |
| | | VOS3 | 1.17 | - | 200 | | |
| f _{VCO_OUT} | PLL VCO output | - | 150 | - | 420 | | |
| t _{LOCK} | PLL lock time | Normal mode | - | 60 ⁽²⁾ | 100 ⁽²⁾ | μs | |
| | | Sigma-delta mode | forbidden | | | | |
| Jitter | Cycle-to-cycle jitter ⁽³⁾ | - | f _{VCO_OUT} = 150 MHz | - | 145 | - | ±ps |
| | | | f _{VCO_OUT} = 300 MHz | - | 91 | - | |
| | | | f _{VCO_OUT} = 400 MHz | - | 64 | - | |
| | | | f _{VCO_OUT} = 420 MHz | - | 63 | - | |
| | Period jitter | f _{PLL_OUT} = 50 MHz | f _{VCO_OUT} = 150 MHz | - | 55 | - | ±ps |
| | | | f _{VCO_OUT} = 400 MHz | - | 30 | - | |
| Long term jitter | Normal mode | f _{VCO_OUT} = 400 MHz | - | ±0.3 | - | % | |
| I(PLL) | PLL power consumption on V _{DD} | f _{VCO_OUT} = 420 MHz | VDD | - | 440 | 1150 | μA |
| | | | VCORE | - | 530 | - | |
| | | f _{VCO_OUT} = 150 MHz | VDD | - | 180 | 500 | |
| | | | VCORE | - | 200 | - | |

1. Guaranteed by design unless otherwise specified.
2. Guaranteed by characterization results.
3. Integer mode only.

Table 45. PLL2 and PLL3 characteristics (wide VCO frequency range)⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|-------------------------------------|--------------------------------------|---|--------------------------------|-----|--------------------|------|----|
| f _{PLL_IN} | PLL input clock | - | 2 | - | 16 | MHz | |
| | PLL input clock duty cycle | - | 10 | - | 90 | % | |
| f _{PLL_OUT} | PLL multiplier output clock P, Q, R | VOS0 | 1.5 | - | 550 ⁽²⁾ | MHz | |
| | | VOS1 | 1.5 | - | 400 ⁽²⁾ | | |
| | | VOS2 | 1.5 | - | 300 ⁽²⁾ | | |
| | | VOS3 | 1.5 | - | 170 ⁽²⁾ | | |
| f _{VCO_OUT} | PLL VCO output | - | 192 | - | 960 ⁽³⁾ | | |
| t _{LOCK} | PLL lock time | Normal mode | - | 50 | 150 ⁽³⁾ | µs | |
| | | Sigma-delta mode (f _{PLL_IN} ≥ 8 MHz) | - | 58 | 166 ⁽³⁾ | | |
| Jitter | Cycle-to-cycle jitter ⁽⁴⁾ | f _{VCO_OUT} = 192 MHz | - | 134 | - | ±ps | |
| | | f _{VCO_OUT} = 200 MHz | - | 134 | - | | |
| | | f _{VCO_OUT} = 400 MHz | - | 76 | - | | |
| | | f _{VCO_OUT} = 800 MHz | - | 39 | - | | |
| | Long term jitter | Normal mode (f _{PLL_IN} = 2 MHz) | f _{VCO_OUT} = 560 MHz | - | ±0.2 | - | % |
| | | Normal mode (f _{PLL_IN} = 16 MHz) | f _{VCO_OUT} = 560 MHz | - | ±0.8 | - | |
| | | Sigma-delta mode (f _{PLL_IN} = 2 MHz) | f _{VCO_OUT} = 560 MHz | - | ±0.2 | - | |
| | | Sigma-delta mode (f _{PLL_IN} = 16 MHz) | f _{VCO_OUT} = 560 MHz | - | ±0.8 | - | |
| I _{DD(PLL)} ⁽³⁾ | PLL power consumption | f _{VCO_OUT} = 836 MHz | V _{DD} | - | 590 | 1500 | µA |
| | | | V _{CORE} | - | 720 | - | |
| | | f _{VCO_OUT} = 192 MHz | V _{DD} | - | 180 | 600 | |
| | | | V _{CORE} | - | 280 | - | |

1. Guaranteed by design unless otherwise specified.
2. This value must be limited to the maximum frequency due to the product limitation.

- 3. Guaranteed by characterization results.
- 4. Integer mode only.

Table 46. PLL2 and PLL3 characteristics (medium VCO frequency range)⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|----------------------|--|--------------------------------|--------------------------------|------|--------------------|------|-----|
| f _{PLL_IN} | PLL input clock | - | 1 | - | 2 | MHz | |
| | PLL input clock duty cycle | - | 10 | - | 90 | % | |
| f _{PLL_OUT} | PLL multiplier output clock P, Q, R | VOS0 | 1.17 | - | 210 | MHz | |
| | | VOS1 | 1.17 | - | 210 | - | |
| | | VOS2 | 1.17 | - | 210 | - | |
| | | VOS3 | 1.17 | - | 200 | - | |
| f _{VCO_OUT} | PLL VCO output | - | 150 | - | 420 | - | |
| t _{LOCK} | PLL lock time | Normal mode | - | 60 | 100 ⁽²⁾ | μs | |
| | | Sigma-delta mode | forbidden | | | | |
| Jitter | Cycle-to-cycle jitter ⁽³⁾ | f _{VCO_OUT} = 150 MHz | - | 145 | - | ±ps | |
| | | f _{VCO_OUT} = 200 MHz | - | 91 | - | | |
| | | f _{VCO_OUT} = 400 MHz | - | 64 | - | | |
| | | f _{VCO_OUT} = 420 MHz | - | 63 | - | | |
| | Period jitter | f _{PLL_OUT} = 50 MHz | f _{VCO_OUT} = 150 MHz | - | 55 | - | ±ps |
| | | f _{VCO_OUT} = 400 MHz | | - | 30 | - | |
| Long term jitter | Normal mode | f _{VCO_OUT} = 400 MHz | - | ±0.3 | - | % | |
| I _{DD(PLL)} | PLL power consumption on V _{DD} | f _{VCO_OUT} = 420 MHz | V _{DD} | - | 440 | 1150 | μA |
| | | | V _{CORE} | - | 530 | - | |
| | | f _{VCO_OUT} = 150 MHz | V _{DD} | - | 180 | 500 | |
| | | | V _{CORE} | - | 200 | - | |

- 1. Guaranteed by design unless otherwise specified.
- 2. Guaranteed by characterization results.
- 3. Integer mode only.

6.3.13 Memory characteristics

Flash memory

The characteristics are given at $T_J = -40$ to 125 °C unless otherwise specified.

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

Table 47. Flash memory characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------|----------------|---------------------------|-----|------|-----|------|
| I_{DD} | Supply current | Write / Erase 8-bit mode | - | 6.5 | - | mA |
| | | Write / Erase 16-bit mode | - | 11.5 | - | |
| | | Write / Erase 32-bit mode | - | 20 | - | |
| | | Write / Erase 64-bit mode | - | 35 | - | |

Table 48. Flash memory programming

| Symbol | Parameter | Conditions | Min ⁽¹⁾ | Typ | Max ⁽¹⁾ | Unit |
|-------------|----------------------------------|--------------------------------|--------------------|-----|--------------------|---------|
| t_{prog} | Word (266 bits) programming time | Program/erase parallelism x 8 | - | 290 | 580 ⁽²⁾ | μ s |
| | | Program/erase parallelism x 16 | - | 180 | 360 | |
| | | Program/erase parallelism x 32 | - | 130 | 260 | |
| | | Program/erase parallelism x 64 | - | 100 | 200 | |
| t_{ERASE} | Sector (128 Kbytes) erase time | Program/erase parallelism x 8 | - | 2 | 4 | s |
| | | Program/erase parallelism x 16 | - | 1.8 | 3.6 | |
| | | Program/erase parallelism x 32 | - | - | - | |
| t_{ME} | Mass erase time (1 Mbyte) | Program/erase parallelism x 8 | - | 3 | 26 | s |
| | | Program/erase parallelism x 16 | - | 8 | 16 | |
| | | Program/erase parallelism x 32 | - | 6 | 12 | |
| | | Program/erase parallelism x 64 | - | 5 | 10 | |
| V_{prog} | Programming voltage | Program parallelism x 8 | 1.62 | - | 3.6 | V |
| | | Program parallelism x 16 | | | | |
| | | Program parallelism x 32 | | | | |
| | | Program parallelism x 64 | 1.8 | - | 3.6 | |

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

Table 49. Flash memory endurance and data retention

| Symbol | Parameter | Conditions | Min ⁽¹⁾ | Unit |
|-----------|----------------|-----------------------------|--------------------|---------|
| N_{END} | Endurance | $T_J = -40$ to $+125$ °C | 10 | kcycles |
| t_{RET} | Data retention | 1 kcycle at $T_A = 85$ °C | 30 | Years |
| | | 10 kcycles at $T_A = 55$ °C | 20 | |

1. Guaranteed by characterization results.

6.3.14 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_{DD} and V_{SS} 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 50](#). They are based on the EMS levels and classes defined in application note AN1709 “*EMC design guide for STM8, STM32 and Legacy MCUs*”.

Table 50. EMS characteristics

| Symbol | Parameter | Conditions | Level/Class |
|------------|---|---|-------------|
| V_{FESD} | Voltage limits to be applied on any I/O pin to induce a functional disturbance | $V_{DD} = 3.3\text{ V}$, $T_A = 25\text{ °C}$, LQFP176, conforming to IEC 61000-4-2 | 3B |
| V_{FTB} | Fast transient voltage burst limits to be applied through 100 pF on V_{DD} and V_{SS} pins to induce a functional disturbance | $V_{DD} = 3.3\text{ V}$, $T_A = 25\text{ °C}$, LQFP176, conforming to IEC 61000-4-4 | 5A |

As a consequence, it is recommended to add a serial resistor (1 k Ω) 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 “Software techniques for improving microcontrollers EMC performance”).

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 51. EMI characteristics

| Symbol | Parameter | Conditions | Monitored frequency band | Max vs. [f _{HSE} /f _{CPU}] | Unit |
|------------------|------------|--|--------------------------|---|------|
| | | | | 8/550 MHz | |
| S _{EMI} | Peak level | V _{DD} = 3.6 V, T _A = 25 °C, LQFP176 package, conforming to IEC61967-2 | 0.1 to 30 MHz | 14 | dBμV |
| | | | 30 to 130 MHz | 20 | |
| | | | 130 MHz to 1 GHz | 27 | |
| | | | 1 GHz to 2 GHz | 17 | |
| | | | EMI Level | 4 | - |

6.3.15 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) are applied to the pins of each sample according to each pin combination. This test conforms to the ANSI/ESDA/JEDEC JS-001 and ANSI/ESDA/JEDEC JS-002 standards.

Table 52. ESD absolute maximum ratings

| Symbol | Ratings | Conditions | Packages | Class | Maximum value ⁽¹⁾ | Unit |
|-----------------------|---|--|----------------------------|-------|------------------------------|------|
| V _{ESD(HBM)} | Electrostatic discharge voltage (human body model) | T _A = 25 °C conforming to ANSI/ESDA/JEDEC JS-001 | All packages | 1C | 1000 ⁽²⁾ | V |
| V _{ESD(CDM)} | Electrostatic discharge voltage (charge device model) | T _A = +25 °C conforming to ANSI/ESDA/JEDEC JS-002 | All LQFP packages | C1 | 250 | |
| | | | All BGA and WLCSP packages | C2a | 500 | |

1. Guaranteed by characterization results.

2. Excluding V_{FBSMPS} , the maximum value is 2000 V.

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 JESD78 IC latchup standard.

Table 53. Electrical sensitivities

| Symbol | Parameter | Conditions | Class |
|--------|----------------------|---|------------|
| LU | Static latchup class | Conforming to JESD78, $T_J = T_{JMax}$ | II level A |

6.3.16 I/O current injection characteristics

As a general rule, a current injection to the I/O pins, due to external voltage below V_{SS} or above V_{DD} (for standard, 3.3 V-capable I/O pins) should be avoided during the normal product operation. However, in order to give an indication of the robustness of the microcontroller in cases when an abnormal injection accidentally happens, susceptibility tests are performed on a sample basis during the 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 (higher than 5 LSB TUE), out of conventional limits of induced leakage current on adjacent pins (out of $-5 \mu A/+0 \mu A$ range), or other functional failure (for example reset, oscillator frequency deviation).

The following tables are the compilation of the SIC1/SIC2 and functional ESD results.

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

Table 54. I/O current injection susceptibility⁽¹⁾

| Symbol | Description | Functional susceptibility | | Unit |
|-----------|---|---------------------------|--------------------|------|
| | | Negative injection | Positive injection | |
| I_{INJ} | PA12, PE8 | 5 | 0 | mA |
| | PC4, PE12, PF15, PH0 | 0 | NA | |
| | PA0, PA0_C, PA1, PA1_C, PC2, PC2_C, PC3, PC3_C, PA4, PA5, PE7, PG1, PH4, PH5, BOOT0 | 0 | 0 | |
| | All other I/Os | 5 | NA | |

1. Guaranteed by characterization results.

6.3.17 I/O port characteristics

General input/output characteristics

Unless otherwise specified, the parameters given in [Table 55: I/O static characteristics](#) are derived from tests performed under the conditions summarized in [Table 13: General operating conditions](#). All I/Os are CMOS and TTL compliant (except for BOOT0).

Note: For information on GPIO configuration, refer to application note AN4899 “STM32 GPIO configuration for hardware settings and low-power consumption”, available from the ST website www.st.com.

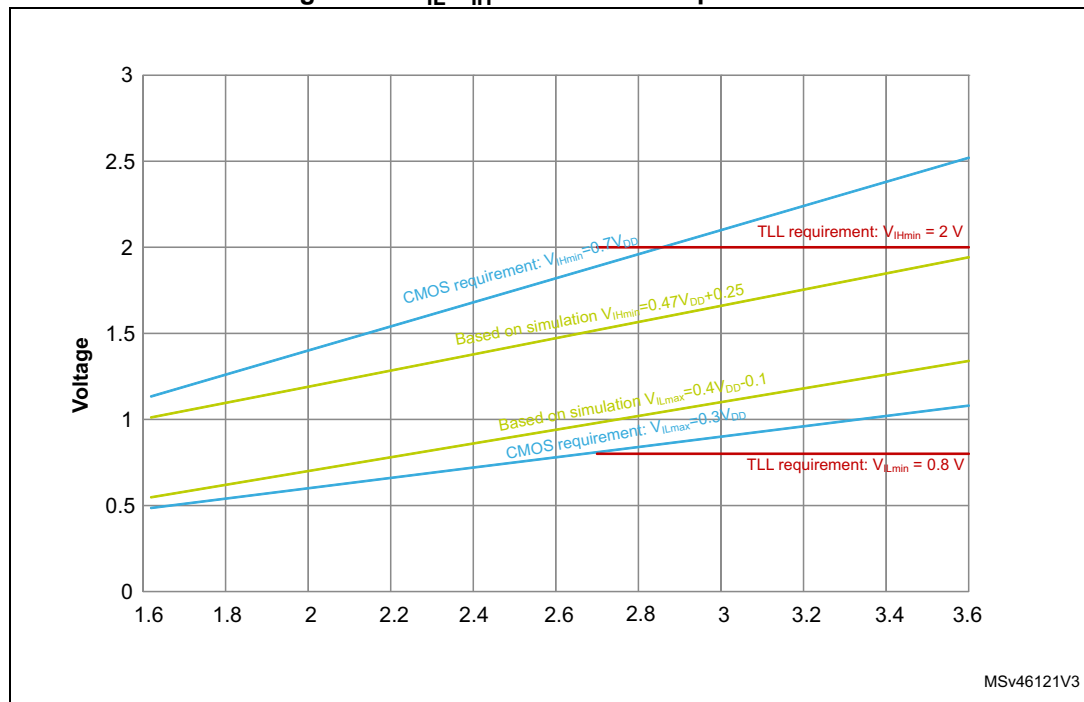
Table 55. I/O static characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---------------------------------|---|---|--|-----|---|------|
| V _{IL} | I/O input low level voltage except BOOT0 | 1.62 V < V _{DD} < 3.6 V | - | - | 0.3V _{DD} ⁽¹⁾ | V |
| | I/O input low level voltage except BOOT0 | | - | - | 0.4V _{DD} -0.1 ⁽²⁾ | |
| | BOOT0 I/O input low level voltage | | - | - | 0.19V _{DD} +0.1 ⁽²⁾ | |
| V _{IH} | I/O input high level voltage except BOOT0 | 1.62 V < V _{DD} < 3.6 V | 0.7V _{DD} ⁽¹⁾ | - | - | V |
| | I/O input high level voltage except BOOT0 | | 0.47V _{DD} +0.25 ⁽²⁾ | - | - | |
| | BOOT0 I/O input high level voltage | | 0.17V _{DD} +0.6 ⁽²⁾ | - | - | |
| V _{HYS} ⁽²⁾ | TT_xx, FT_XXX and NRST I/O input hysteresis | 1.62 V < V _{DD} < 3.6 V | - | 250 | - | mV |
| | BOOT0 I/O input hysteresis | | - | 200 | - | |
| I _{lkg} ⁽³⁾ | FT_xx Input leakage current ⁽²⁾ | 0 < V _{IN} ≤ Max(V _{DDXXX}) ⁽⁸⁾ | - | - | +/-250 | nA |
| | | Max(V _{DDXXX}) < V _{IN} ≤ 5.5 V ⁽⁴⁾⁽⁵⁾⁽⁸⁾ | - | - | 1500 | |
| | FT_u IO | 0 < V _{IN} ≤ Max(V _{DDXXX}) ⁽⁸⁾ | - | - | +/- 350 | |
| | | Max(V _{DDXXX}) < V _{IN} ≤ 5.5 V ⁽⁴⁾⁽⁵⁾⁽⁸⁾ | - | - | 5000 ⁽⁶⁾ | |
| | TT_xx Input leakage current | 0 < V _{IN} ≤ Max(V _{DDXXX}) ⁽⁸⁾ | - | - | +/-250 | |
| | VPP (BOOT0 alternate function) | 0 < V _{IN} ≤ V _{DD} | - | - | 15 | |
| | V _{DD} < V _{IN} ≤ 9 V | - | - | 35 | | |
| R _{PU} | Weak pull-up equivalent resistor ⁽⁷⁾ | V _{IN} =V _{SS} | 30 | 40 | 50 | kΩ |
| R _{PD} | Weak pull-down equivalent resistor ⁽⁷⁾ | V _{IN} =V _{DD} ⁽⁸⁾ | 30 | 40 | 50 | |
| C _{IO} | I/O pin capacitance | - | - | 5 | - | pF |

1. Compliant with CMOS requirements.
2. Guaranteed by design.
3. This parameter represents the pad leakage of the I/O itself. The total product pad leakage is provided by the following formula: $I_{Total_leak_max} = 10 \mu A + [number\ of\ I/Os\ where\ V_{IN}\ is\ applied\ on\ the\ pad] \times I_{kg(Max)}$
4. All FT_xx IO except FT_lu, FT_u and PC3.
5. V_{IN} must be less than $Max(VDDXXX) + 3.6 V$.
6. To sustain a voltage higher than $MIN(V_{DD}, V_{DDA}, V_{DD33USB}) + 0.3 V$, the internal pull-up and pull-down resistors must be disabled.
7. The pull-up and pull-down resistors are designed with a true resistance in series with a switchable PMOS/NMOS. This PMOS/NMOS contribution to the series resistance is minimal (~10% order).
8. $Max(VDDXXX)$ is the maximum value of all the I/O supplies.

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 26](#).

Figure 26. V_{IL}/V_{IH} for all I/Os except BOOT0



Output driving current

The GPIOs (general purpose input/outputs) can sink or source up to ± 8 mA, and sink or source up to ± 20 mA (with a relaxed V_{OL}/V_{OH}).

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 ΣI_{VDD} (see [Table 11](#)).
- 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 ΣI_{VSS} (see [Table 11](#)).

Output voltage levels

Unless otherwise specified, the parameters given in [Table 56: Output voltage characteristics for all I/Os except PC13, PC14 and PC15](#) and [Table 57: Output voltage characteristics for PC13, PC14 and PC15](#) are derived from tests performed under ambient temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#). All I/Os are CMOS and TTL compliant.

Table 56. Output voltage characteristics for all I/Os except PC13, PC14 and PC15⁽¹⁾

| Symbol | Parameter | Conditions ⁽³⁾ | Min | Max | Unit |
|-------------------|---|--|--------------|-----|------|
| V_{OL} | Output low level voltage | CMOS port ⁽²⁾ $I_{IO} = 8 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | V |
| V_{OH} | Output high level voltage | CMOS port ⁽²⁾ $I_{IO} = -8 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | $V_{DD}-0.4$ | - | |
| $V_{OL}^{(3)}$ | Output low level voltage | TTL port ⁽²⁾ $I_{IO} = 8 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | |
| $V_{OH}^{(3)}$ | Output high level voltage | TTL port ⁽²⁾ $I_{IO} = -8 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | 2.4 | - | |
| $V_{OL}^{(3)}$ | Output low level voltage | $I_{IO} = 20 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 1.3 | |
| $V_{OH}^{(3)}$ | Output high level voltage | $I_{IO} = -20 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | $V_{DD}-1.3$ | - | |
| $V_{OL}^{(3)}$ | Output low level voltage | $I_{IO} = 4 \text{ mA}$ $1.62 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | |
| $V_{OH}^{(3)}$ | Output high level voltage | $I_{IO} = -4 \text{ mA}$ $1.62 \text{ V} \leq V_{DD} < 3.6 \text{ V}$ | $V_{DD}-0.4$ | - | |
| $V_{OLFM+}^{(3)}$ | Output low level voltage for an FTf I/O pin in FM+ mode | $I_{IO} = 20 \text{ mA}$ $2.3 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | |
| | | $I_{IO} = 10 \text{ mA}$ $1.62 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | |

1. The IIO current sourced or sunk by the device must always respect the absolute maximum rating specified in [Table 10: Voltage characteristics](#), and the sum of the currents sourced or sunk by all the I/Os (I/O ports and control pins) must always respect the absolute maximum ratings ΣIIO .
2. TTL and CMOS outputs are compatible with JEDEC standards JESD36 and JESD52.
3. Guaranteed by design.

Table 57. Output voltage characteristics for PC13, PC14 and PC15⁽¹⁾

| Symbol | Parameter | Conditions ⁽³⁾ | Min | Max | Unit |
|----------------|---------------------------|--|--------------|-----|------|
| V_{OL} | Output low level voltage | CMOS port ⁽²⁾ $I_{IO} = 3 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | V |
| V_{OH} | Output high level voltage | CMOS port ⁽²⁾ $I_{IO} = -3 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | $V_{DD}-0.4$ | - | |
| $V_{OL}^{(3)}$ | Output low level voltage | TTL port ⁽²⁾ $I_{IO} = 3 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | |
| $V_{OH}^{(2)}$ | Output high level voltage | TTL port ⁽²⁾ $I_{IO} = -3 \text{ mA}$ $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | 2.4 | - | |
| $V_{OL}^{(2)}$ | Output low level voltage | $I_{IO} = 1.5 \text{ mA}$ $1.62 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | - | 0.4 | |
| $V_{OH}^{(2)}$ | Output high level voltage | $I_{IO} = -1.5 \text{ mA}$ $1.62 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$ | $V_{DD}-0.4$ | - | |

1. The I/O current sourced or sunk by the device must always respect the absolute maximum rating specified in [Table 10: Voltage characteristics](#), and the sum of the currents sourced or sunk by all the I/Os (I/O ports and control pins) must always respect the absolute maximum ratings $\Sigma I/O$.
2. TTL and CMOS outputs are compatible with JEDEC standards JESD36 and JESD52.
3. Guaranteed by design.

Output buffer timing characteristics (HSLV option disabled)

The HSLV bit of SYSCFG_CCCSR register can be used to optimize the I/O speed when the product voltage is below 2.7 V.

Table 58. Output timing characteristics (HSLV OFF)⁽¹⁾

| Speed | Symbol | Parameter | conditions | Min | Max | Unit |
|-------|------------------|---|---|-----|------|------|
| 00 | $F_{\max}^{(2)}$ | Maximum frequency | C=50 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 12 | MHz |
| | | | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 3 | |
| | | | C=30 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 12 | |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 3 | |
| | | | C=10 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 16 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 4 | |
| | $t_r/t_f^{(3)}$ | Output high to low level fall time and output low to high level rise time | C=50 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 16.6 | ns |
| | | | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 33.3 | |
| | | | C=30 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 13.3 | |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 25 | |
| | | | C=10 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 10 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 20 | |
| 01 | $F_{\max}^{(2)}$ | Maximum frequency | C=50 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 60 | MHz |
| | | | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 15 | |
| | | | C=30 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 80 | |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 15 | |
| | | | C=10 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 110 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 20 | |
| | $t_r/t_f^{(3)}$ | Output high to low level fall time and output low to high level rise time | C=50 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 5.2 | ns |
| | | | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 10 | |
| | | | C=30 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 4.2 | |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 7.5 | |
| | | | C=10 pF, 2.7 V ≤ V _{DD} ≤ 3.6 V | - | 2.8 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 5.2 | |

Table 58. Output timing characteristics (HSLV OFF)⁽¹⁾ (continued)

| Speed | Symbol | Parameter | conditions | Min | Max | Unit |
|-------|---|---|---|-----|-----|------|
| 10 | F _{max} ⁽²⁾ | Maximum frequency | C=50 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 85 | MHz |
| | | | C=50 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 35 | |
| | | | C=30 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 110 | |
| | | | C=30 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 40 | |
| | | | C=10 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 166 | |
| | | | C=10 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 100 | |
| | t _r /t _f ⁽³⁾ | Output high to low level fall time and output low to high level rise time | C=50 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 3.8 | ns |
| | | | C=50 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 6.9 | |
| | | | C=30 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 2.8 | |
| | | | C=30 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 5.2 | |
| | | | C=10 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 1.8 | |
| | | | C=10 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 3.3 | |
| 11 | F _{max} ⁽²⁾ | Maximum frequency | C=50 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 100 | MHz |
| | | | C=50 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 50 | |
| | | | C=30 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 133 | |
| | | | C=30 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 66 | |
| | | | C=10 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 220 | |
| | | | C=10 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 85 | |
| | t _r /t _f ⁽³⁾ | Output high to low level fall time and output low to high level rise time | C=50 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 3.3 | ns |
| | | | C=50 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 6.6 | |
| | | | C=30 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 2.4 | |
| | | | C=30 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 4.5 | |
| | | | C=10 pF, 2.7 V≤V _{DD} ≤3.6 V ⁽⁴⁾ | - | 1.5 | |
| | | | C=10 pF, 1.62 V≤V _{DD} ≤2.7 V ⁽⁴⁾ | - | 2.7 | |

1. Guaranteed by design.
2. The maximum frequency is defined with the following conditions:
 (t_r+t_f) ≤ 2/3 T
 Skew ≤ 1/20 T
 45%<Duty cycle<55%
3. The fall and rise times are defined between 90% and 10% and between 10% and 90% of the output waveform, respectively.
4. Compensation system enabled.

Output buffer timing characteristics (HSLV option enabled)

Table 59. Output timing characteristics (HSLV ON)⁽¹⁾

| Speed | Symbol | Parameter | conditions | Min | Max | Unit |
|-------|---|---|--|-----|-----|------|
| 00 | F _{max} ⁽²⁾ | Maximum frequency | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 10 | MHz |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 10 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 10 | |
| | t _r /t _f ⁽³⁾ | Output high to low level fall time and output low to high level rise time | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 11 | ns |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 9 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 6.6 | |
| 01 | F _{max} ⁽²⁾ | Maximum frequency | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 50 | MHz |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 58 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 66 | |
| | t _r /t _f ⁽³⁾ | Output high to low level fall time and output low to high level rise time | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 6.6 | ns |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 4.8 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V | - | 3 | |
| 10 | F _{max} ⁽²⁾ | Maximum frequency | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 55 | MHz |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 80 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 133 | |
| | t _r /t _f ⁽³⁾ | Output high to low level fall time and output low to high level rise time | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 5.8 | ns |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 4 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 2.4 | |
| 11 | F _{max} ⁽²⁾ | Maximum frequency | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 60 | MHz |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 90 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 175 | |
| | t _r /t _f ⁽³⁾ | Output high to low level fall time and output low to high level rise time | C=50 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 5.3 | ns |
| | | | C=30 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 3.6 | |
| | | | C=10 pF, 1.62 V ≤ V _{DD} ≤ 2.7 V ⁽⁴⁾ | - | 1.9 | |

1. Guaranteed by design.

2. The maximum frequency is defined with the following conditions:
 $(t_r + t_f) \leq 2/3 T$
 Skew $\leq 1/20 T$
 $45\% < \text{Duty cycle} < 55\%$

3. The fall and rise times are defined between 90% and 10% and between 10% and 90% of the output waveform, respectively.

4. Compensation system enabled.

Analog switch between ports Pxy_C and Pxy

PA0_C, PA1_C, PC2_C and PC3_C can be connected internally to PA0, PA1, PC2 and PC3, respectively (refer to SYSCFG_PMCR register in RM0468 reference manual). The switch is controlled by $V_{DDSWITCH}$ voltage level. It is defined through BOOSTVDDSEL bit of SYSCFG_PMCR. If the switch is closed the switch characteristics are given in the table below.

Table 60. Pxy_C and Pxy analog switch characteristics

| Parameter | Conditions | Min | Typ | Max | Unit | |
|------------------|----------------------------|--------------------------------|-----|-----|----------|-----|
| Switch impedance | Switch control boosted | - | - | 315 | Ω | |
| | Switch control not boosted | $V_{DDSWITCH} > 2.7\text{ V}$ | - | - | | 315 |
| | | $V_{DDSWITCH} > 2.4\text{ V}$ | - | - | | 335 |
| | | $V_{DDSWITCH} > 2.0\text{ V}$ | - | - | | 390 |
| | | $V_{DDSWITCH} > 1.8\text{ V}$ | - | - | | 445 |
| | | $V_{DDSWITCH} > 1.62\text{ V}$ | - | - | | 550 |

6.3.18 NRST pin characteristics

The NRST pin input driver uses CMOS technology. It is connected to a permanent pull-up resistor, R_{PU} (see [Table 55: I/O static characteristics](#)).

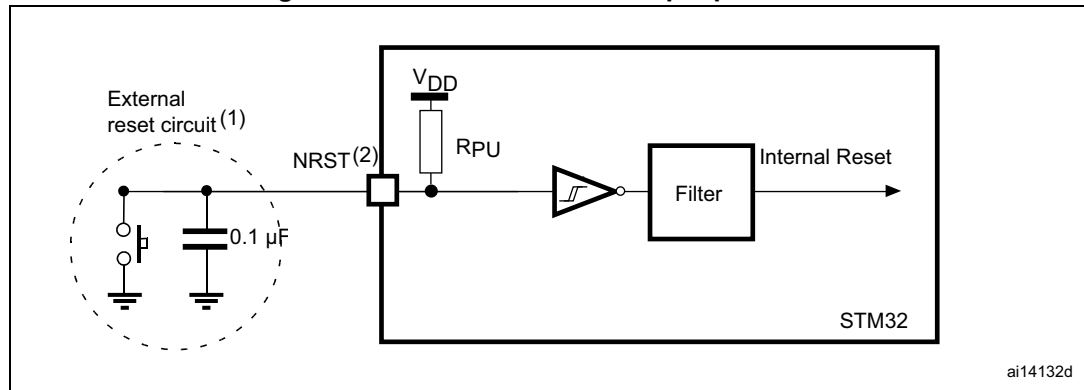
Unless otherwise specified, the parameters given in [Table 61](#) are derived from tests performed under the ambient temperature and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 61. NRST pin characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------------|---|---|------|-----|-----|-----------|
| $R_{PU}^{(2)}$ | Weak pull-up equivalent resistor ⁽¹⁾ | $V_{IN} = V_{SS}$ | 30 | 40 | 50 | $k\Omega$ |
| $V_{F(NRST)}^{(2)}$ | NRST Input filtered pulse | $1.71\text{ V} < V_{DD} < 3.6\text{ V}$ | - | - | 50 | ns |
| $V_{NF(NRST)}^{(2)}$ | NRST Input not filtered pulse | $1.71\text{ V} < V_{DD} < 3.6\text{ V}$ | 350 | - | - | |
| | | $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | 1000 | - | - | |

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 27. Recommended NRST pin protection



1. The reset network protects the device against parasitic resets.
2. The user must ensure that the level on the NRST pin can go below the $V_{IL(NRST)}$ max level specified in [Table 55](#). Otherwise the reset is not taken into account by the device.

6.3.19 FMC characteristics

Unless otherwise specified, the parameters given in [Table 62](#) to [Table 75](#) 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 13: General operating conditions](#), with the following configuration:

- Output speed is set to $OSPEEDRy[1:0] = 11$
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- HSLV activated when $V_{DD} \leq 2.7$ V
- VOS level set to VOS0.

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics.

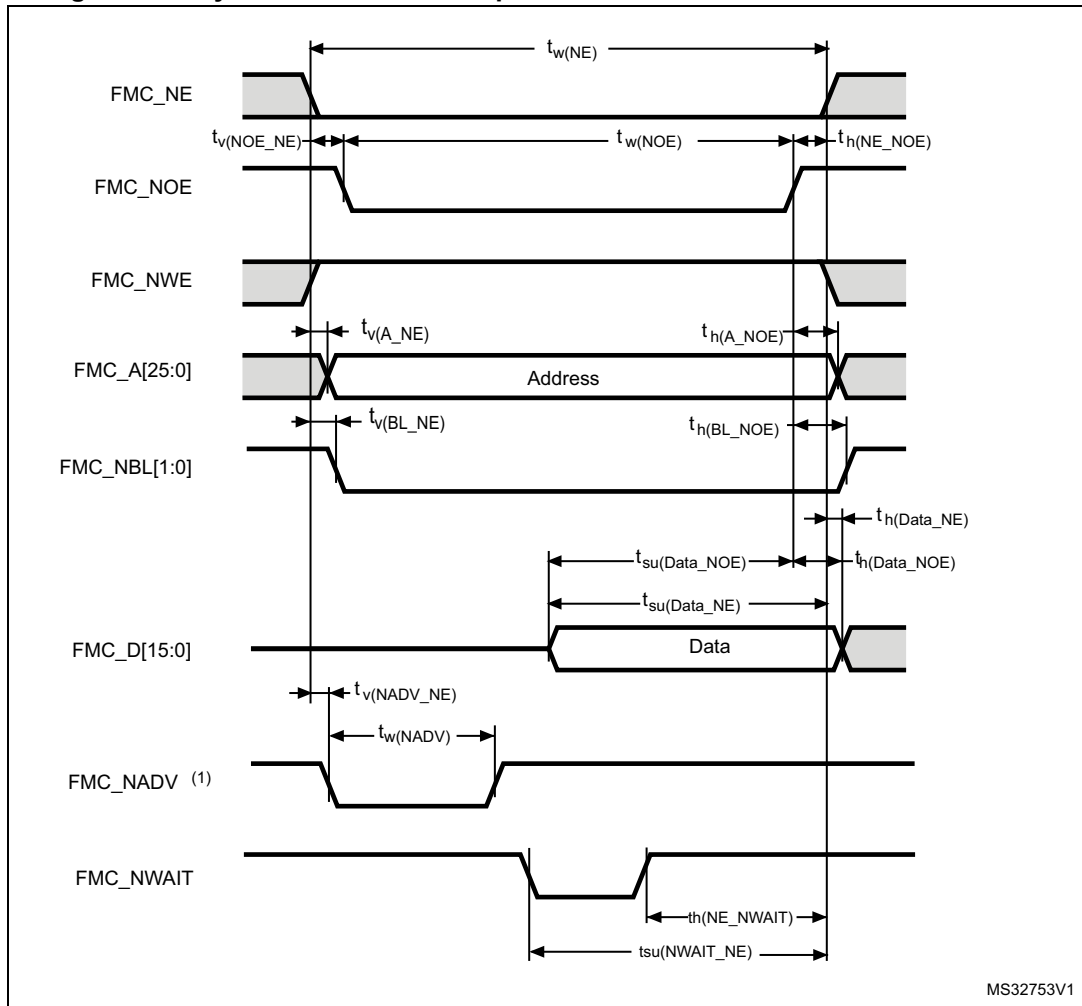
Asynchronous waveforms and timings

[Figure 28](#) through [Figure 30](#) represent asynchronous waveforms and [Table 62](#) through [Table 69](#) 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 $C_L = 30$ pF

In all timing tables, the T_{KERCK} is the $f_{mc_ker_ck}$ clock period.

Figure 28. Asynchronous non-multiplexed SRAM/PSRAM/NOR read waveforms



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1. Mode 2/B, C and D only. In Mode 1, FMC_NADV is not used.

Table 62. Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|----------------------|---------------------------------------|-----------------------|-----------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $3T_{fmc_ker_ck}-1$ | $3T_{fmc_ker_ck}+1$ | ns |
| $t_{v(NOEN_NE)}$ | FMC_NEx low to FMC_NOE low | 0 | 0.5 | |
| $t_{w(NOEN)}$ | FMC_NOE low time | $2T_{fmc_ker_ck}-1$ | $2T_{fmc_ker_ck}+1$ | |
| $t_{h(NE_NOEN)}$ | FMC_NOE high to FMC_NE high hold time | $T_{fmc_ker_ck}$ | - | |
| $t_{v(A_NE)}$ | FMC_NEx low to FMC_A valid | - | 0.5 | |
| $t_{h(A_NOEN)}$ | Address hold time after FMC_NOE high | $2T_{fmc_ker_ck}$ | - | |
| $t_{su(Data_NE)}$ | Data to FMC_NEx high setup time | $T_{fmc_ker_ck}+14$ | - | |
| $t_{su(Data_NOEN)}$ | Data to FMC_NOEx high setup time | 13 | - | |
| $t_{h(Data_NOEN)}$ | 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 | - | 4 | |
| $t_{w(NADV)}$ | FMC_NADV low time | - | $T_{fmc_ker_ck}+1$ | |

1. Guaranteed by characterization results.

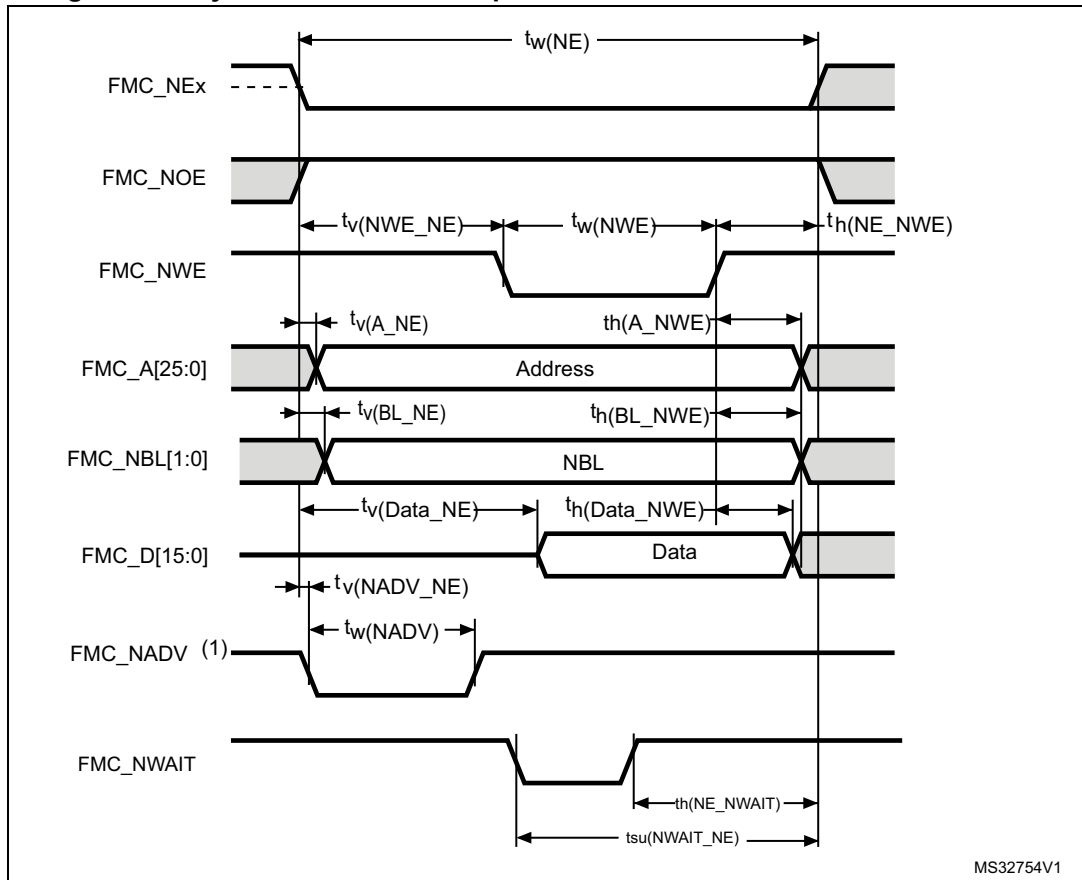
Table 63. Asynchronous non-multiplexed SRAM/PSRAM/NOR read-NWAIT timings⁽¹⁾⁽²⁾

| Symbol | Parameter | Min | Max | Unit |
|---------------------|---|------------------------|-----------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $7T_{fmc_ker_ck}-1$ | $7T_{fmc_ker_ck}+1$ | ns |
| $t_{w(NOEN)}$ | FMC_NOE low time | $5T_{fmc_ker_ck}-1$ | $5T_{fmc_ker_ck}+1$ | |
| $t_{w(NWAIT)}$ | FMC_NWAIT low time | $T_{fmc_ker_ck}-0.5$ | - | |
| $t_{su(NWAIT_NE)}$ | FMC_NWAIT valid before FMC_NEx high | $4T_{fmc_ker_ck}+9$ | - | |
| $t_{h(NE_NWAIT)}$ | FMC_NEx hold time after FMC_NWAIT invalid | $3T_{fmc_ker_ck}+12$ | - | |

1. Guaranteed by characterization results.

2. N_{WAIT} pulse width is equal to 1 fmc_ker_ck cycle.

Figure 29. Asynchronous non-multiplexed SRAM/PSRAM/NOR write waveforms



1. Mode 2/B, C and D only. In Mode 1, FMC_NADV is not used.

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Table 64. Asynchronous non-multiplexed SRAM/PSRAM/NOR write timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|--------------------|---------------------------------------|--------------------------|--------------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $3T_{fmc_ker_ck} - 1$ | $3T_{fmc_ker_ck} + 1$ | ns |
| $t_{v(NWE_NE)}$ | FMC_NEx low to FMC_NWE low | $T_{fmc_ker_ck} - 1$ | $T_{fmc_ker_ck}$ | |
| $t_{w(NWE)}$ | FMC_NWE low time | $T_{fmc_ker_ck} - 0.5$ | $T_{fmc_ker_ck} + 0.5$ | |
| $t_{h(NE_NWE)}$ | FMC_NWE high to FMC_NE high hold time | $T_{fmc_ker_ck}$ | - | |
| $t_{v(A_NE)}$ | FMC_NEx low to FMC_A valid | - | 1 | |
| $t_{h(A_NWE)}$ | Address hold time after FMC_NWE high | $T_{fmc_ker_ck} - 0.5$ | - | |
| $t_{v(BL_NE)}$ | FMC_NEx low to FMC_BL valid | - | 0.5 | |
| $t_{h(BL_NWE)}$ | FMC_BL hold time after FMC_NWE high | $T_{fmc_ker_ck} - 0.5$ | - | |
| $t_{v(Data_NE)}$ | Data to FMC_NEx low to Data valid | - | $T_{fmc_ker_ck} + 2$ | |
| $t_{h(Data_NWE)}$ | Data hold time after FMC_NWE high | $T_{fmc_ker_ck}$ | - | |
| $t_{v(NADV_NE)}$ | FMC_NEx low to FMC_NADV low | - | 5 | |
| $t_{w(NADV)}$ | FMC_NADV low time | - | $T_{fmc_ker_ck} + 1$ | |

1. Guaranteed by characterization results.

Table 65. Asynchronous non-multiplexed SRAM/PSRAM/NOR write-NWAIT timings⁽¹⁾⁽²⁾

| Symbol | Parameter | Min | Max | Unit |
|---------------------|---|--------------------------|-------------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $8T_{fmc_ker_ck} - 1$ | $8T_{fmc_ker_ck} + 1$ | ns |
| $t_{w(NWE)}$ | FMC_NWE low time | $6T_{fmc_ker_ck} - 1$ | $6T_{fmc_ker_ck} + 1$ | |
| $t_{su(NWAIT_NE)}$ | FMC_NWAIT valid before FMC_NEx high | $5T_{fmc_ker_ck} + 13$ | - | |
| $t_{h(NE_NWAIT)}$ | FMC_NEx hold time after FMC_NWAIT invalid | $4T_{fmc_ker_ck} + 12$ | - | |

1. Guaranteed by characterization results.

2. N_{WAIT} pulse width is equal to 1 fmc_ker_ck cycle.

Figure 30. Asynchronous multiplexed PSRAM/NOR read waveforms

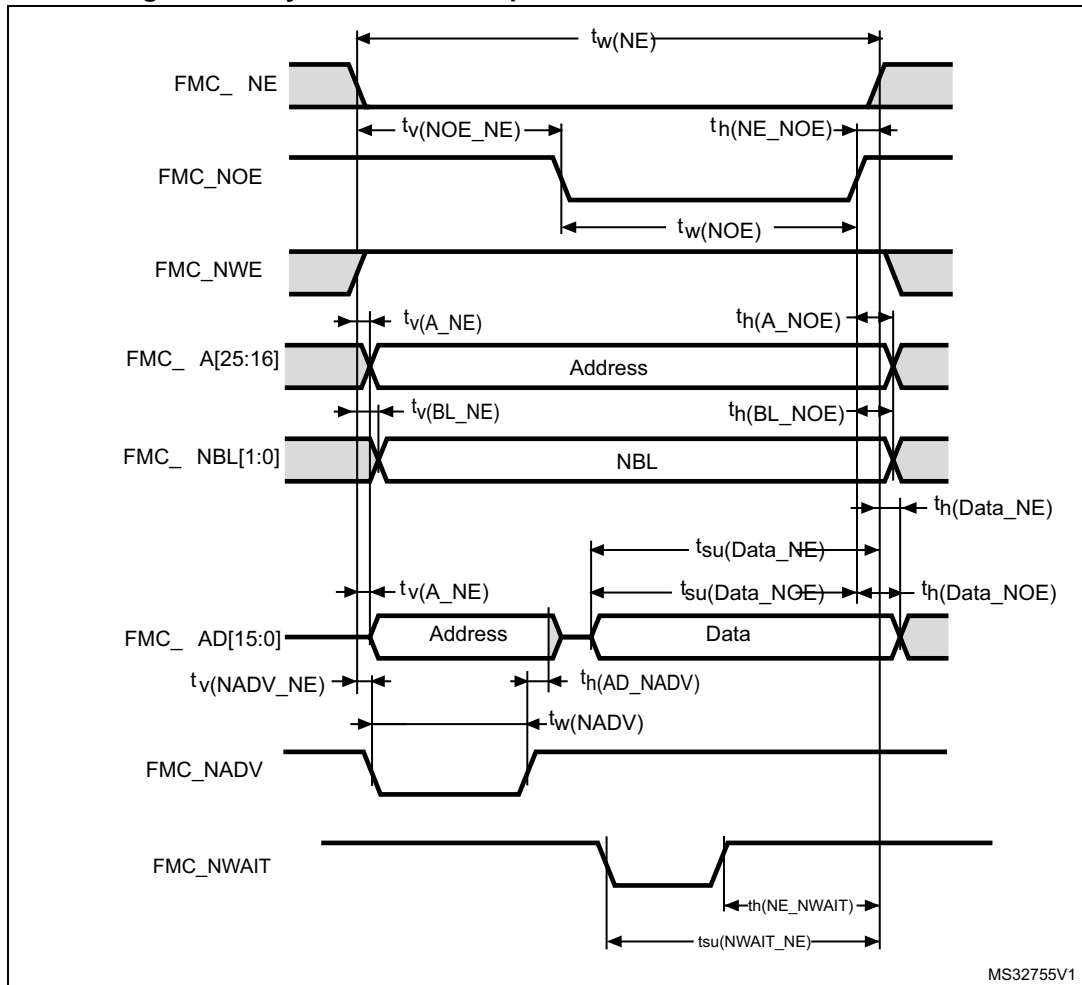


Table 66. Asynchronous multiplexed PSRAM/NOR read timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|---------------------|---|--------------------------|---------------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $4T_{fmc_ker_ck} - 1$ | $4T_{fmc_ker_ck} + 1$ | ns |
| $t_{v(NOE_NE)}$ | FMC_NEx low to FMC_NOE low | $2T_{fmc_ker_ck}$ | $2T_{fmc_ker_ck} + 0.5$ | |
| $t_{tw(NOE)}$ | FMC_NOE low time | $T_{fmc_ker_ck} - 1$ | $T_{fmc_ker_ck} + 1$ | |
| $t_{h(NE_NOE)}$ | FMC_NOE high to FMC_NE high hold time | $T_{fmc_ker_ck}$ | - | |
| $t_{v(A_NE)}$ | FMC_NEx low to FMC_A valid | - | 0.5 | |
| $t_{v(NADV_NE)}$ | FMC_NEx low to FMC_NADV low | 0 | 4.0 | |
| $t_{w(NADV)}$ | FMC_NADV low time | $T_{fmc_ker_ck} - 0.5$ | $T_{fmc_ker_ck} + 1$ | |
| $t_{h(AD_NADV)}$ | FMC_AD(address) valid hold time after FMC_NADV high | $T_{fmc_ker_ck} - 4$ | - | |
| $t_{h(A_NOE)}$ | Address hold time after FMC_NOE high | $T_{fmc_ker_ck} - 0.5$ | - | |
| $t_{su(Data_NE)}$ | Data to FMC_NEx high setup time | $T_{fmc_ker_ck} + 14$ | - | |
| $t_{su(Data_NOE)}$ | Data to FMC_NOE high setup time | 13 | - | |
| $t_{h(Data_NE)}$ | 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 67. Asynchronous multiplexed PSRAM/NOR read-NWAIT timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|---------------------|---|--------------------------|-------------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $8T_{fmc_ker_ck} - 1$ | $8T_{fmc_ker_ck} + 1$ | ns |
| $t_{w(NOE)}$ | FMC_NWE low time | $5T_{fmc_ker_ck} - 1$ | $5T_{fmc_ker_ck} + 1$ | |
| $t_{su(NWAIT_NE)}$ | FMC_NWAIT valid before FMC_NEx high | $4T_{fmc_ker_ck} + 9$ | - | |
| $t_{h(NE_NWAIT)}$ | FMC_NEx hold time after FMC_NWAIT invalid | $3T_{fmc_ker_ck} + 12$ | - | |

1. Guaranteed by characterization results.

Table 68. Asynchronous multiplexed PSRAM/NOR write timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|---------------------|---|---------------------------|---------------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $4T_{fmc_ker_ck} - 1$ | $4T_{fmc_ker_ck}$ | ns |
| $t_{v(NWE_NE)}$ | FMC_NEx low to FMC_NWE low | $T_{fmc_ker_ck} - 1$ | $T_{fmc_ker_ck} + 0.5$ | |
| $t_{w(NWE)}$ | FMC_NWE low time | $2T_{fmc_ker_ck} - 0.5$ | $2T_{fmc_ker_ck} + 0.5$ | |
| $t_{h(NE_NWE)}$ | FMC_NWE high to FMC_NE high hold time | $T_{fmc_ker_ck} - 0.5$ | - | |
| $t_{v(A_NE)}$ | FMC_NEx low to FMC_A valid | - | 1 | |
| $t_{v(NADV_NE)}$ | FMC_NEx low to FMC_NADV low | 0 | 5.0 | |
| $t_{w(NADV)}$ | FMC_NADV low time | $T_{fmc_ker_ck} - 0.5$ | $T_{fmc_ker_ck} + 1$ | |
| $t_{h(AD_NADV)}$ | FMC_AD(address) valid hold time after FMC_NADV high | $T_{fmc_ker_ck} - 4.5$ | - | |
| $t_{h(A_NWE)}$ | Address hold time after FMC_NWE high | $T_{fmc_ker_ck} - 0.5$ | - | |
| $t_{h(BL_NWE)}$ | FMC_BL hold time after FMC_NWE high | $T_{fmc_ker_ck} - 0.5$ | - | |
| $t_{v(BL_NE)}$ | FMC_NEx low to FMC_BL valid | - | 0.5 | |
| $t_{v(Data_NADV)}$ | FMC_NADV high to Data valid | - | $T_{fmc_ker_ck} + 2$ | |
| $t_{h(Data_NWE)}$ | Data hold time after FMC_NWE high | $T_{fmc_ker_ck}$ | - | |

1. Guaranteed by characterization results.

Table 69. Asynchronous multiplexed PSRAM/NOR write-NWAIT timings⁽¹⁾⁽²⁾

| Symbol | Parameter | Min | Max | Unit |
|---------------------|---|---------------------------|---------------------------|------|
| $t_{w(NE)}$ | FMC_NE low time | $9T_{fmc_ker_ck} - 1$ | $9T_{fmc_ker_ck}$ | ns |
| $t_{w(NWE)}$ | FMC_NWE low time | $7T_{fmc_ker_ck} - 0.5$ | $7T_{fmc_ker_ck} + 0.5$ | |
| $t_{su(NWAIT_NE)}$ | FMC_NWAIT valid before FMC_NEx high | $5T_{fmc_ker_ck} + 9$ | - | |
| $t_{h(NE_NWAIT)}$ | FMC_NEx hold time after FMC_NWAIT invalid | $4T_{fmc_ker_ck} + 12$ | - | |

1. Guaranteed by characterization results.

2. N_{WAIT} pulse width is equal to 1 fmc_ker_ck cycle.

Synchronous waveforms and timings

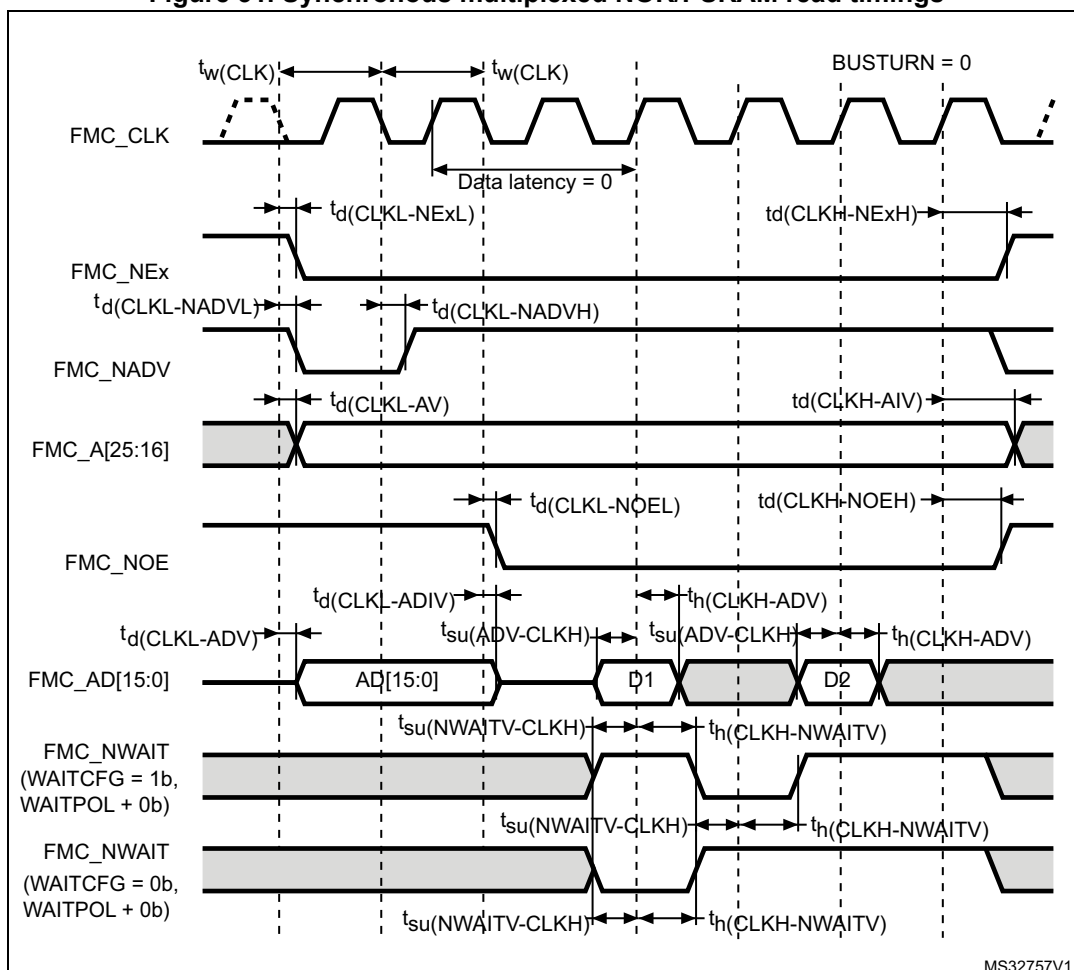
Figure 31 through Figure 34 represent synchronous waveforms and Table 70 through Table 73 provide the corresponding timings. The results shown in these tables are obtained with the following FMC configuration:

- BurstAccessMode = FMC_BurstAccessMode_Enable
- MemoryType = FMC_MemoryType_CRAM
- WriteBurst = FMC_WriteBurst_Enable
- CLKDivision = 1
- DataLatency = 1 for NOR Flash, DataLatency = 0 for PSRAM, $C_L = 30$ pF

In all the timing tables, the $T_{fmc_ker_ck}$ is the $f_{mc_ker_ck}$ clock period, with the following FMC_CLK maximum values:

- For $2.7 V < V_{DD} < 3.6 V$: maximum FMC_CLK = 137 MHz at $C_L = 20$ pF
- For $1.8 V < V_{DD} < 1.9 V$: maximum FMC_CLK = 100 MHz at $C_L = 20$ pF
- For $1.62 V < V_{DD} < 1.8 V$: maximum FMC_CLK = 88 MHz at $C_L = 15$ pF

Figure 31. Synchronous multiplexed NOR/PSRAM read timings



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Table 70. Synchronous multiplexed NOR/PSRAM read timings⁽¹⁾

| Symbol | Parameter | | Min | Max | Unit |
|-----------------------------|--|----------------------------------|----------------------------------|-----|------|
| $t_w(\text{CLK})$ | FMC_CLK period | | $2T_{\text{fmc_ker_ck}} - 0.5$ | - | ns |
| $t_d(\text{CLKL-NEXL})$ | FMC_CLK low to FMC_NEx low (x=0..2) | | - | 3 | |
| $t_d(\text{CLKH-NExH})$ | FMC_CLK high to FMC_NEx high (x= 0...2) | | $T_{\text{fmc_ker_ck}} + 1.5$ | - | |
| $t_d(\text{CLKL-NADV})$ | FMC_CLK low to FMC_NADV low | 1.62 V < V _{DD} < 3.6 V | - | 5.5 | |
| | | 2.7 V < V _{DD} < 3.6 V | | 2 | |
| $t_d(\text{CLKL-NADVH})$ | FMC_CLK low to FMC_NADV high | 1.62 V < V _{DD} < 3.6 V | 1 | - | |
| | | 2.7 V < V _{DD} < 3.6 V | | - | |
| $t_d(\text{CLKL-AV})$ | FMC_CLK low to FMC_Ax valid (x=16...25) | | - | 3 | |
| $t_d(\text{CLKH-AIV})$ | FMC_CLK high to FMC_Ax invalid (x=16...25) | | $T_{\text{fmc_ker_ck}}$ | - | |
| $t_d(\text{CLKL-NOEL})$ | FMC_CLK low to FMC_NOE low | | - | 2.5 | |
| $t_d(\text{CLKH-NOEH})$ | FMC_CLK high to FMC_NOE high | | $T_{\text{fmc_ker_ck}} + 1$ | - | |
| $t_d(\text{CLKL-ADV})$ | FMC_CLK low to FMC_AD[15:0] valid | | - | 3 | |
| $t_d(\text{CLKL-ADIV})$ | FMC_CLK low to FMC_AD[15:0] invalid | | 0 | - | |
| $t_{su}(\text{ADV-CLKH})$ | FMC_A/D[15:0] valid data before FMC_CLK high | | 3 | - | |
| $t_h(\text{CLKH-ADV})$ | FMC_A/D[15:0] valid data after FMC_CLK high | | 0 | - | |
| $t_{su}(\text{NWAIT-CLKH})$ | FMC_NWAIT valid before FMC_CLK high | | 3 | - | |
| $t_h(\text{CLKH-NWAIT})$ | FMC_NWAIT valid after FMC_CLK high | | 2.5 | - | |

1. Guaranteed by characterization results.

Figure 32. Synchronous multiplexed PSRAM write timings

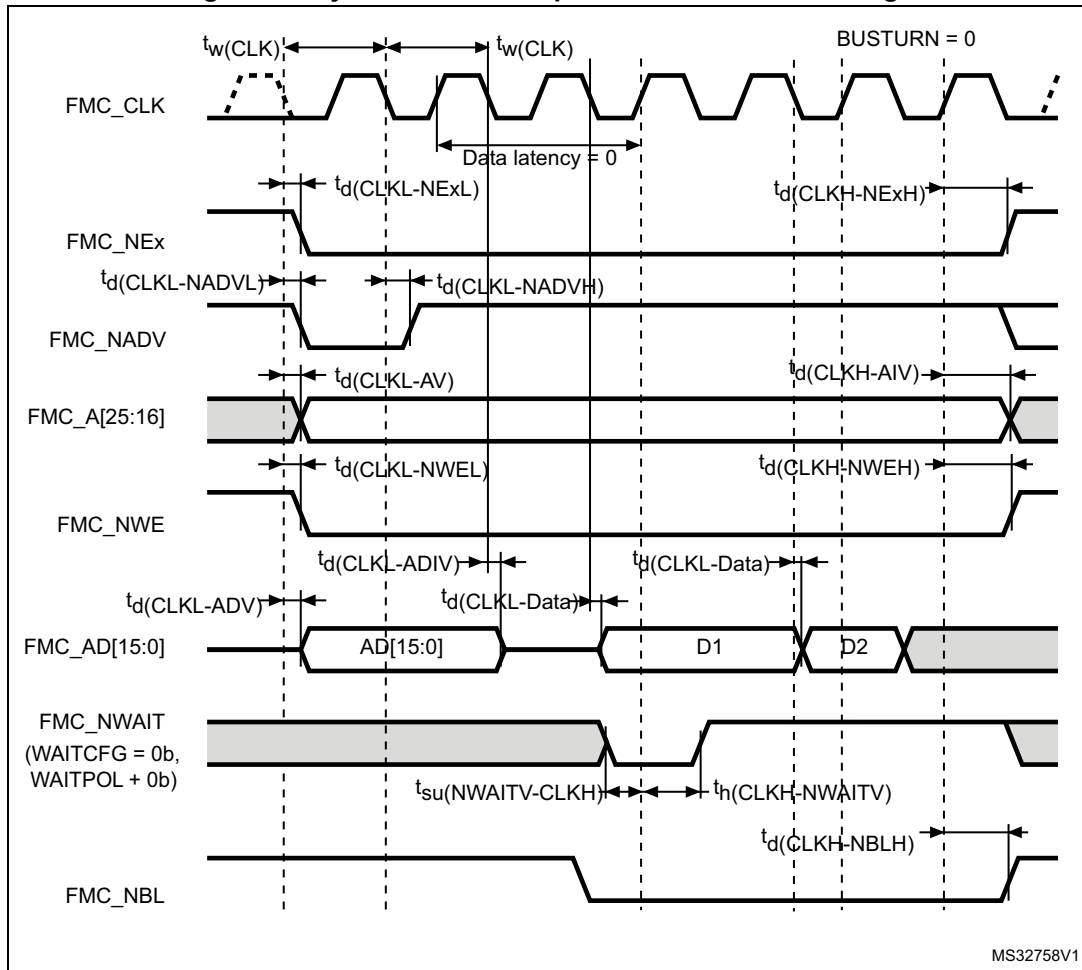


Table 71. Synchronous multiplexed PSRAM write timings⁽¹⁾

| Symbol | Parameter | | Min | Max | Unit |
|-----------------------------|---|---|---------------------------|-----|------|
| $t_w(\text{CLK})$ | FMC_CLK period, $V_{DD} = 2.7$ to 3.6 V | | $2T_{fmc_ker_ck} - 0.5$ | - | ns |
| $t_d(\text{CLKL-NExL})$ | FMC_CLK low to FMC_NEx low ($x = 0..2$) | | - | 3 | |
| $t_d(\text{CLKH-NExH})$ | FMC_CLK high to FMC_NEx high ($x = 0..2$) | | $T_{fmc_ker_ck} + 1.5$ | - | |
| $t_d(\text{CLKL-NADV})$ | FMC_CLK low to FMC_NADV low | $1.62 \text{ V} < V_{DD} < 3.6 \text{ V}$ | - | 5.5 | |
| | | $2.7 \text{ V} < V_{DD} < 3.6 \text{ V}$ | | 2.0 | |
| $t_d(\text{CLKL-NADVH})$ | FMC_CLK low to FMC_NADV high | $1.62 \text{ V} < V_{DD} < 3.6 \text{ V}$ | 1 | - | |
| | | $2.7 \text{ V} < V_{DD} < 3.6 \text{ V}$ | | - | |
| $t_d(\text{CLKL-AV})$ | FMC_CLK low to FMC_Ax valid ($x = 16..25$) | | - | 3 | |
| $t_d(\text{CLKH-AIV})$ | FMC_CLK high to FMC_Ax invalid ($x = 16..25$) | | $T_{fmc_ker_ck}$ | - | |
| $t_d(\text{CLKL-NWEL})$ | FMC_CLK low to FMC_NWE low | | - | 2.5 | |
| $t_d(\text{CLKH-NWEH})$ | FMC_CLK high to FMC_NWE high | | $T_{fmc_ker_ck} + 1$ | - | |
| $t_d(\text{CLKL-ADV})$ | FMC_CLK low to FMC_AD[15:0] valid | | - | 2.5 | |
| $t_d(\text{CLKL-ADIV})$ | FMC_CLK low to FMC_AD[15:0] invalid | | 0 | - | |
| $t_d(\text{CLKL-DATA})$ | FMC_A/D[15:0] valid data after FMC_CLK low | | - | 3.5 | |
| $t_d(\text{CLKL-NBLL})$ | FMC_CLK low to FMC_NBL low | | - | 2 | |
| $t_d(\text{CLKH-NBLH})$ | FMC_CLK high to FMC_NBL high | | $T_{fmc_ker_ck} + 0.5$ | - | |
| $t_{su}(\text{NWAIT-CLKH})$ | FMC_NWAIT valid before FMC_CLK high | | 3 | - | |
| $t_h(\text{CLKH-NWAIT})$ | FMC_NWAIT valid after FMC_CLK high | | 2.5 | - | |

1. Guaranteed by characterization results.

Figure 33. Synchronous non-multiplexed NOR/PSRAM read timings

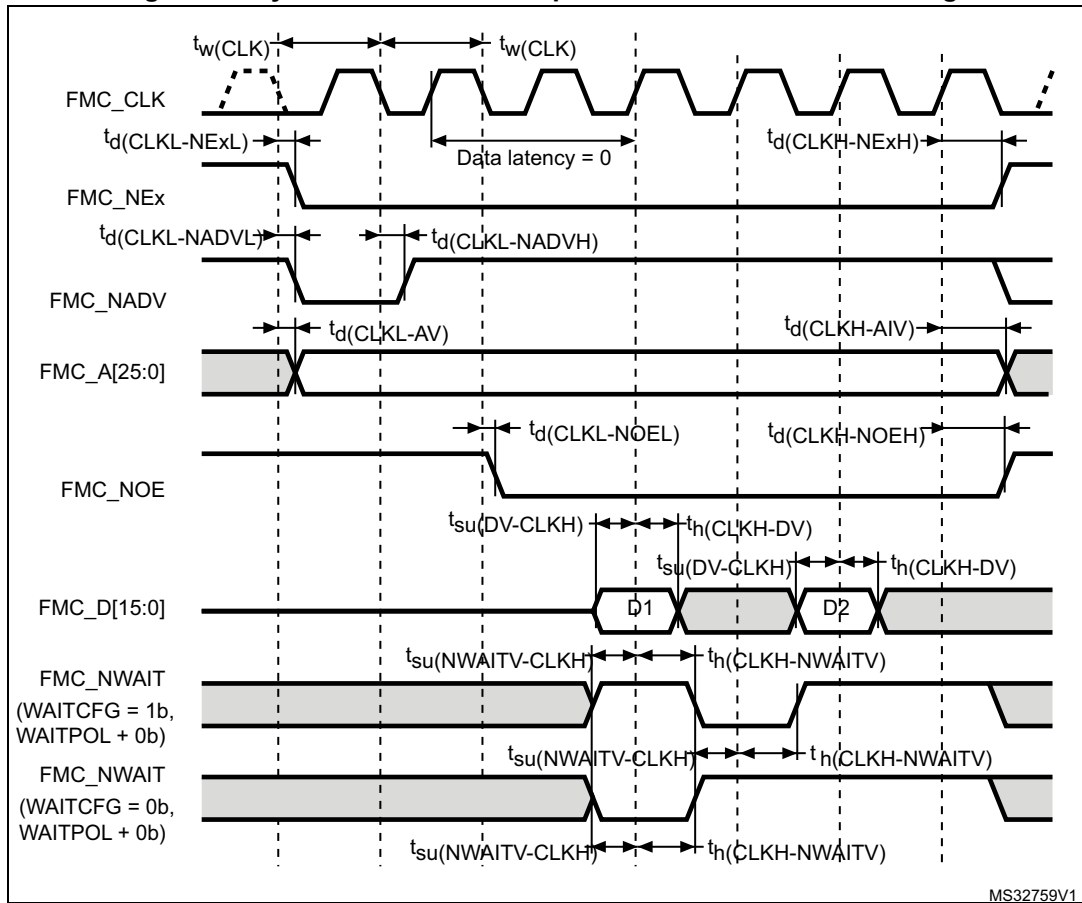


Table 72. Synchronous non-multiplexed NOR/PSRAM read timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit | |
|------------------------------------|--|--|-----|------|-----|
| $t_w(\text{CLK})$ | FMC_CLK period | $2T_{\text{fmc_ker_ck}} - 0.5$ | - | ns | |
| $t_{(\text{CLKL-NE}x\text{L})}$ | FMC_CLK low to FMC_NEx low (x=0..2) | - | 3 | | |
| $t_{d(\text{CLKH-NE}x\text{H})}$ | FMC_CLK high to FMC_NEx high (x= 0..2) | $T_{\text{fmc_ker_ck}} + 1.5$ | - | | |
| $t_{d(\text{CLKL-NADV}x\text{L})}$ | FMC_CLK low to FMC_NADV low | $1.62 \text{ V} < V_{\text{DD}} < 3.6 \text{ V}$ | - | | 5.5 |
| | | $2.7 \text{ V} < V_{\text{DD}} < 3.6 \text{ V}$ | - | | 2.0 |
| $t_{d(\text{CLKL-NADV}x\text{H})}$ | FMC_CLK low to FMC_NADV high | $1.62 \text{ V} < V_{\text{DD}} < 3.6 \text{ V}$ | 1 | | - |
| | | $2.7 \text{ V} < V_{\text{DD}} < 3.6 \text{ V}$ | - | | - |
| $t_{d(\text{CLKL-AV})}$ | FMC_CLK low to FMC_Ax valid (x=16...25) | - | 3 | | |
| $t_{d(\text{CLKH-AIV})}$ | FMC_CLK high to FMC_Ax invalid (x=16...25) | $T_{\text{fmc_ker_ck}}$ | - | | |
| $t_{d(\text{CLKL-NOEL})}$ | FMC_CLK low to FMC_NOE low | - | 2.5 | | |
| $t_{d(\text{CLKH-NOEH})}$ | FMC_CLK high to FMC_NOE high | $T_{\text{fmc_ker_ck}} + 1$ | - | | |
| $t_{\text{su}(\text{DV-CLKH})}$ | FMC_D[15:0] valid data before FMC_CLK high | 3 | - | | |
| $t_{\text{h}(\text{CLKH-DV})}$ | FMC_D[15:0] valid data after FMC_CLK high | 0 | - | | |
| $t_{(\text{NWAIT-CLKH})}$ | FMC_NWAIT valid before FMC_CLK high | 3 | - | | |
| $t_{\text{h}(\text{CLKH-NWAIT})}$ | FMC_NWAIT valid after FMC_CLK high | 2.5 | - | | |

1. Guaranteed by characterization results.

Figure 34. Synchronous non-multiplexed PSRAM write timings

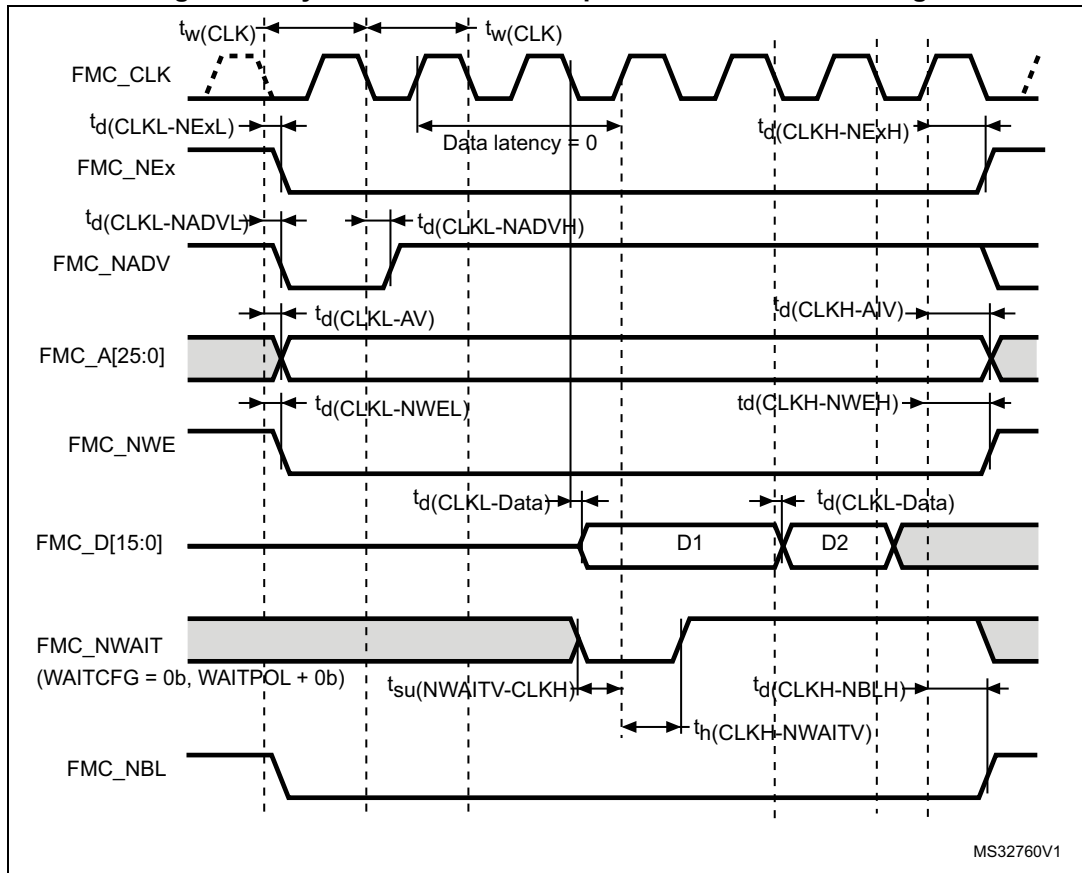


Table 73. Synchronous non-multiplexed PSRAM write timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit | |
|----------------------|--|---|-----|------|-----|
| $t_{(CLK)}$ | FMC_CLK period | $2T_{fmc_ker_ck} - 0.5$ | - | ns | |
| $t_{d(CLKL-NExL)}$ | FMC_CLK low to FMC_NEx low (x=0..2) | - | 3 | | |
| $t_{(CLKH-NExH)}$ | FMC_CLK high to FMC_NEx high (x= 0...2) | $T_{fmc_ker_ck} + 1.5$ | - | | |
| $t_{d(CLKL-NADV)}$ | FMC_CLK low to FMC_NADV low | $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | - | | 5.5 |
| | | $2.7\text{ V} < V_{DD} < 3.6\text{ V}$ | - | | 2 |
| $t_{d(CLKL-NADV)}$ | FMC_CLK low to FMC_NADV high | $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | 1 | | - |
| | | $2.7\text{ V} < V_{DD} < 3.6\text{ V}$ | - | | - |
| $t_{d(CLKL-AV)}$ | 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) | $T_{fmc_ker_ck}$ | - | | |
| $t_{d(CLKL-NWEL)}$ | FMC_CLK low to FMC_NWE low | - | 2.5 | | |
| $t_{d(CLKH-NWEH)}$ | FMC_CLK high to FMC_NWE high | $T_{fmc_ker_ck} + 1$ | - | | |
| $t_{d(CLKL-Data)}$ | FMC_D[15:0] valid data after FMC_CLK low | - | 3.5 | | |
| $t_{d(CLKL-NBLL)}$ | FMC_CLK low to FMC_NBL low | - | 2 | | |
| $t_{d(CLKH-NBLH)}$ | FMC_CLK high to FMC_NBL high | $T_{fmc_ker_ck} + 0.5$ | - | | |
| $t_{su(NWAIT-CLKH)}$ | FMC_NWAIT valid before FMC_CLK high | 3 | - | | |
| $t_{h(CLKH-NWAIT)}$ | FMC_NWAIT valid after FMC_CLK high | 2.5 | - | | |

1. Guaranteed by characterization results.

NAND controller waveforms and timings

Figure 35 through Figure 38 represent synchronous waveforms, and Table 74 and Table 75 provide the corresponding timings. The results shown in this table are obtained with the following FMC configuration and a capacitive load (C_L) of 30 pF:

- 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 $T_{fmc_ker_ck}$ is the `fmc_ker_ck` clock period.

Figure 35. NAND controller waveforms for read access

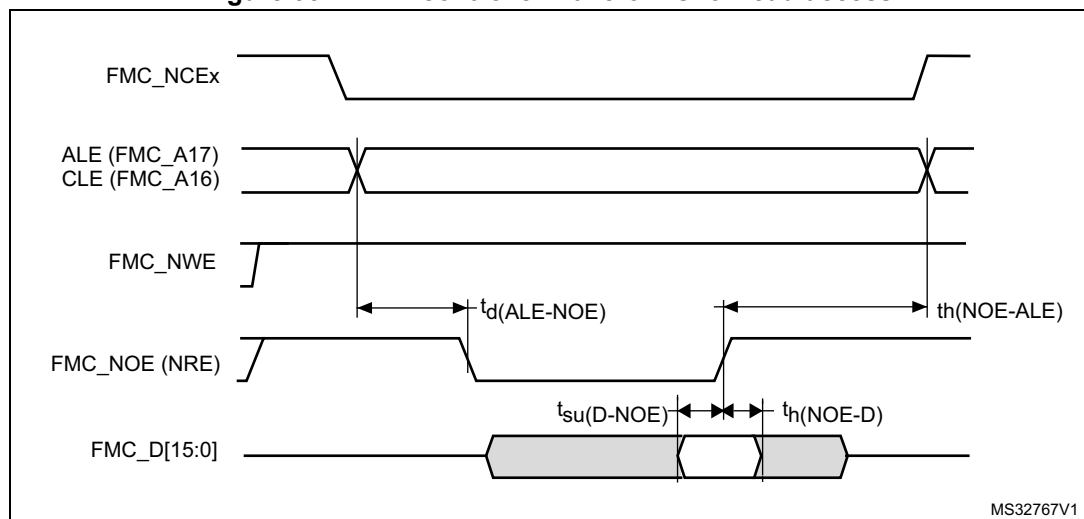


Figure 36. NAND controller waveforms for write access

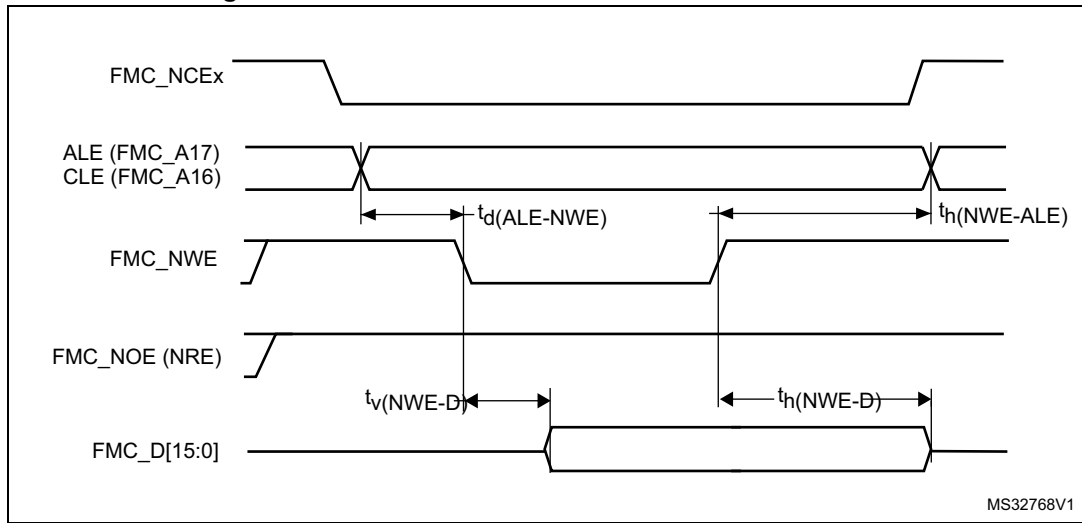


Figure 37. NAND controller waveforms for common memory read access

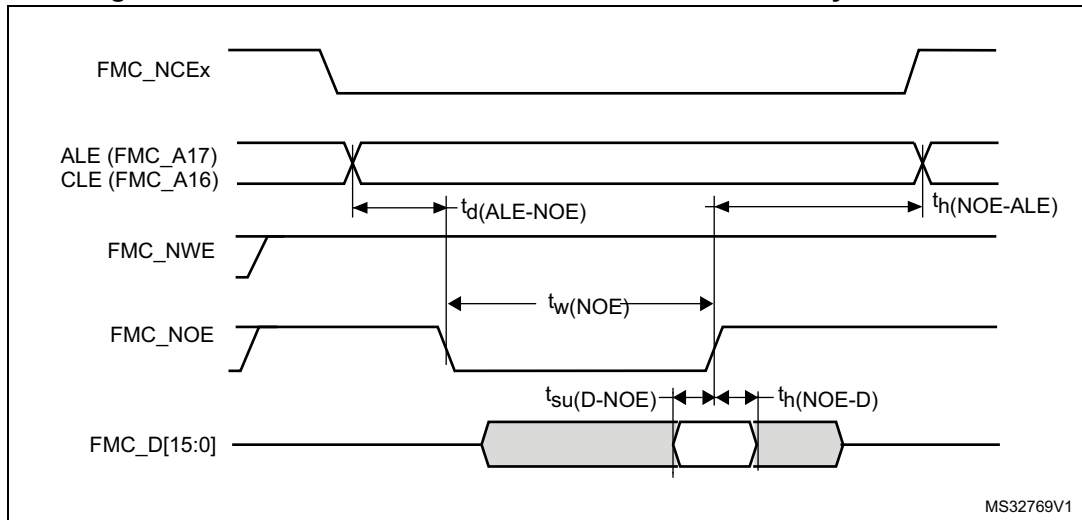


Figure 38. NAND controller waveforms for common memory write access

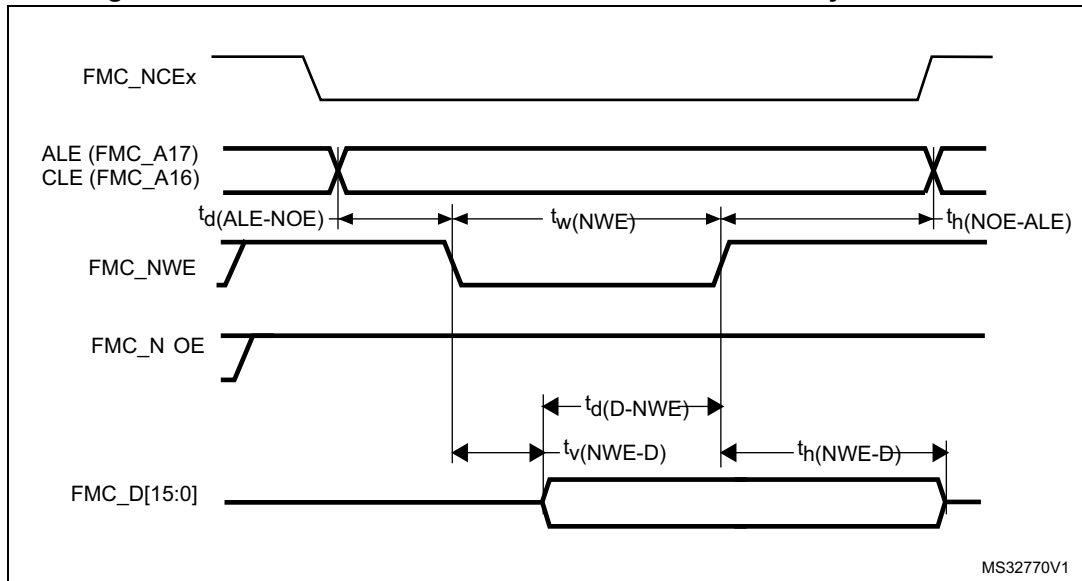


Table 74. Switching characteristics for NAND Flash read cycles⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|-------------------------------|--|----------------------------------|----------------------------------|------|
| $t_w(\text{NOE})$ | FMC_NOE low width | $4T_{\text{fmc_ker_ck}} - 0.5$ | $4T_{\text{fmc_ker_ck}} + 0.5$ | ns |
| $t_{\text{su}}(\text{D-NOE})$ | FMC_D[15-0] valid data before FMC_NOE high | 11 | - | |
| $t_h(\text{NOE-D})$ | FMC_D[15-0] valid data after FMC_NOE high | 0 | - | |
| $t_d(\text{ALE-NOE})$ | FMC_ALE valid before FMC_NOE low | - | $3T_{\text{fmc_ker_ck}} + 0.5$ | |
| $t_h(\text{NOE-ALE})$ | FMC_NWE high to FMC_ALE invalid | $4T_{\text{fmc_ker_ck}} - 1$ | - | |

1. Guaranteed by characterization results.

Table 75. Switching characteristics for NAND Flash write cycles⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|-----------------------|---------------------------------------|----------------------------------|----------------------------------|------|
| $t_w(\text{NWE})$ | FMC_NWE low width | $4T_{\text{fmc_ker_ck}} - 0.5$ | $4T_{\text{fmc_ker_ck}} + 0.5$ | ns |
| $t_v(\text{NWE-D})$ | FMC_NWE low to FMC_D[15-0] valid | 0 | - | |
| $t_h(\text{NWE-D})$ | FMC_NWE high to FMC_D[15-0] invalid | $2T_{\text{fmc_ker_ck}} + 1.5$ | - | |
| $t_d(\text{D-NWE})$ | FMC_D[15-0] valid before FMC_NWE high | $5T_{\text{fmc_ker_ck}} - 5$ | - | |
| $t_d(\text{ALE-NWE})$ | FMC_ALE valid before FMC_NWE low | - | $3T_{\text{fmc_ker_ck}} + 0.5$ | |
| $t_h(\text{NWE-ALE})$ | FMC_NWE high to FMC_ALE invalid | $2T_{\text{fmc_ker_ck}} - 0.5$ | - | |

1. Guaranteed by characterization results.

SDRAM waveforms and timings

In all timing tables, the TKERCK is the `fmc_ker_ck` clock period, with the following FMC_SDCLK maximum values:

- For $2.7\text{ V} < V_{DD} < 3.6\text{ V}$: maximum FMC_CLK = 95 MHz at 20 pF
- For $1.8\text{ V} < V_{DD} < 1.9\text{ V}$: maximum FMC_CLK = 90 MHz at 20 pF
- For $1.62\text{ V} < V_{DD} < 1.8\text{ V}$: maximum FMC_CLK = 85 MHz at 15 pF

Figure 39. SDRAM read access waveforms (CL = 1)

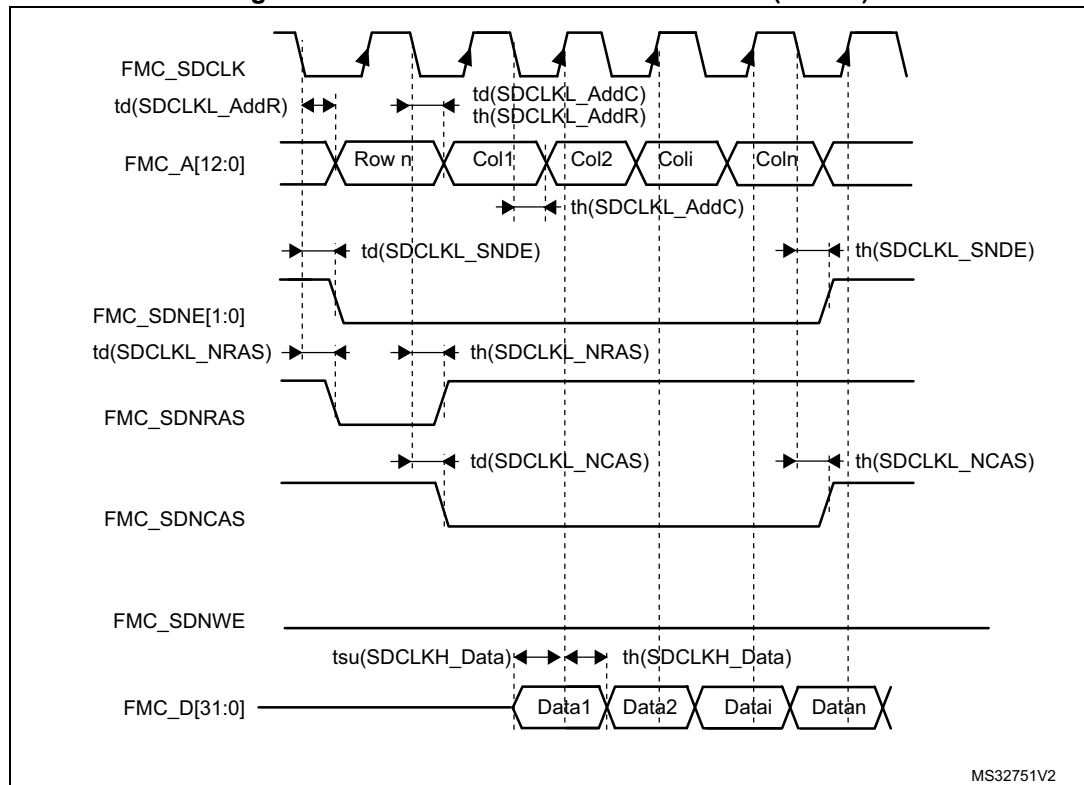


Table 76. SDRAM read timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|-------------------------|------------------------|---------------------------|---------------------------|------|
| $t_{w(SDCLK)}$ | FMC_SDCLK period | $2T_{fmc_ker_ck} - 0.5$ | $2T_{fmc_ker_ck} + 0.5$ | ns |
| $t_{su(SDCLKH_Data)}$ | Data input setup time | 3 | - | |
| $t_{h(SDCLKH_Data)}$ | Data input hold time | 1.5 | - | |
| $t_{d(SDCLKL_Add)}$ | Address valid time | - | 2.0 | |
| $t_{d(SDCLKL_SDNE)}$ | Chip select valid time | - | 1.5 ⁽²⁾ | |
| $t_{h(SDCLKL_SDNE)}$ | Chip select hold time | 0 | - | |
| $t_{d(SDCLKL_SDNRAS)}$ | SDNRAS valid time | - | 1 | |
| $t_{h(SDCLKL_SDNRAS)}$ | SDNRAS hold time | 0 | - | |
| $t_{d(SDCLKL_SDNCAS)}$ | SDNCAS valid time | - | 2.0 | |
| $t_{h(SDCLKL_SDNCAS)}$ | SDNCAS hold time | 0.5 | - | |

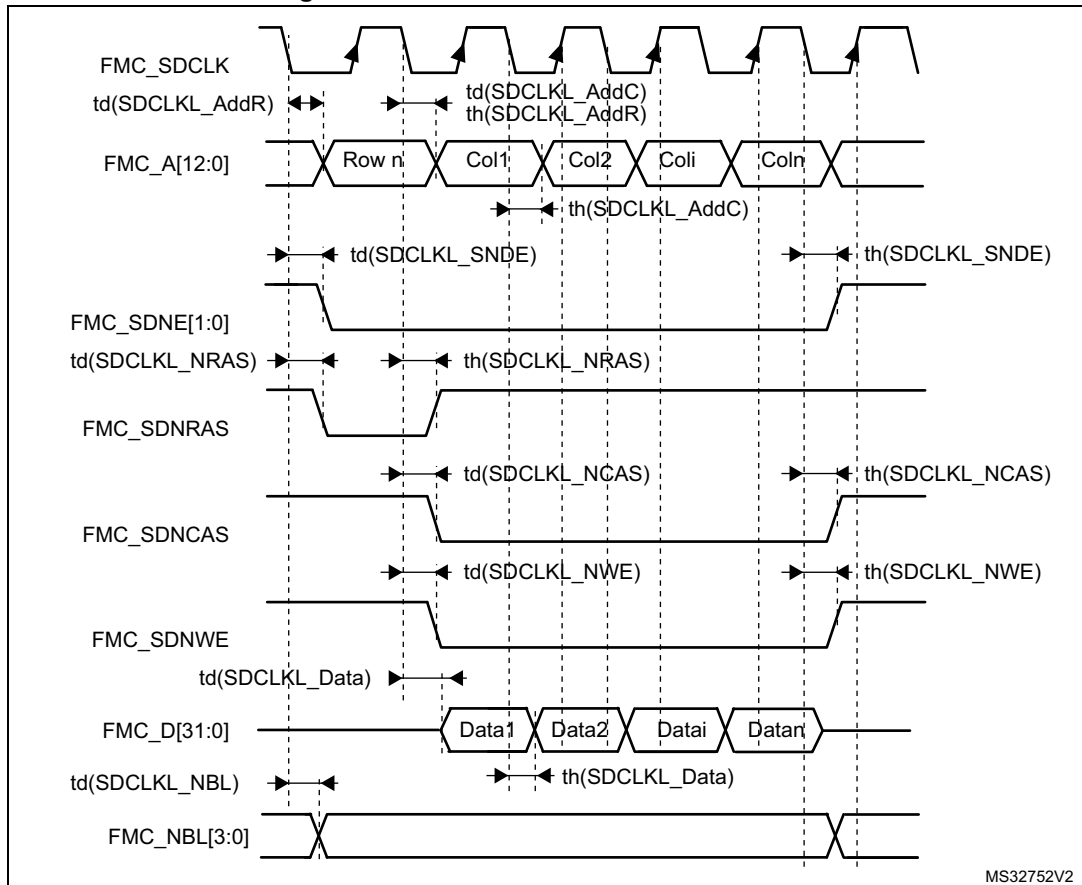
1. Guaranteed by characterization results.
2. Using PC2_C I/O adds 4.5 ns to this timing.

Table 77. LPDDR SDRAM read timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|-------------------------|------------------------|---------------------------|---------------------------|------|
| $t_{w(SDCLK)}$ | FMC_SDCLK period | $2T_{fmc_ker_ck} - 0.5$ | $2T_{fmc_ker_ck} + 0.5$ | ns |
| $t_{su(SDCLKH_Data)}$ | Data input setup time | 3 | - | |
| $t_{h(SDCLKH_Data)}$ | Data input hold time | 2.5 | - | |
| $t_{d(SDCLKL_Add)}$ | Address valid time | - | 2 | |
| $t_{d(SDCLKL_SDNE)}$ | Chip select valid time | - | 1.5 ⁽²⁾⁽³⁾ | |
| $t_{h(SDCLKL_SDNE)}$ | Chip select hold time | 0 | - | |
| $t_{d(SDCLKL_SDNRAS)}$ | SDNRAS valid time | - | 1 | |
| $t_{h(SDCLKL_SDNRAS)}$ | SDNRAS hold time | 0 | - | |
| $t_{d(SDCLKL_SDNCAS)}$ | SDNCAS valid time | - | 2 | |
| $t_{h(SDCLKL_SDNCAS)}$ | SDNCAS hold time | 0.5 | - | |

1. Guaranteed by characterization results.
2. Using PC2 I/O adds 4 ns to this timing.
3. Using PC2_C I/O adds 16.5 ns to this timing.

Figure 40. SDRAM write access waveforms



MS32752V2

Table 78. SDRAM Write timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|------------------------------|------------------------|----------------------------------|----------------------------------|------|
| $t_w(\text{SDCLK})$ | FMC_SDCLK period | $2T_{\text{fmc_ker_ck}} - 0.5$ | $2T_{\text{fmc_ker_ck}} + 0.5$ | ns |
| $t_d(\text{SDCLKL_Data})$ | Data output valid time | - | 2 | |
| $t_h(\text{SDCLKL_Data})$ | Data output hold time | 0.5 | - | |
| $t_d(\text{SDCLKL_Add})$ | Address valid time | - | 2 | |
| $t_d(\text{SDCLKL_SDNWE})$ | SDNWE valid time | - | 2 | |
| $t_h(\text{SDCLKL_SDNWE})$ | SDNWE hold time | 0 | - | |
| $t_d(\text{SDCLKL_SDNE})$ | Chip select valid time | - | 1.5 ⁽²⁾ | |
| $t_h(\text{SDCLKL_SDNE})$ | Chip select hold time | 0 | - | |
| $t_d(\text{SDCLKL_SDNRAS})$ | SDNRAS valid time | - | 1 | |
| $t_h(\text{SDCLKL_SDNRAS})$ | SDNRAS hold time | 0 | - | |
| $t_d(\text{SDCLKL_SDNCAS})$ | SDNCAS valid time | - | 2 | |
| $t_d(\text{SDCLKL_SDNCAS})$ | SDNCAS hold time | 0.5 | - | |

1. Guaranteed by characterization results.
2. Using PC2_C I/O adds 4.5 ns to this timing.

Table 79. LPSDR SDRAM Write timings⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|------------------------|------------------------|---------------------------|---------------------------|------|
| $t_{w(SDCLK)}$ | FMC_SDCLK period | $2T_{fmc_ker_ck} - 0.5$ | $2T_{fmc_ker_ck} + 0.5$ | 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 | - | 2.5 | |
| $t_{d(SDCLKL-SDNWE)}$ | SDNWE valid time | - | 2 | |
| $t_{h(SDCLKL-SDNWE)}$ | SDNWE hold time | 0 | - | |
| $t_{d(SDCLKL-SDNE)}$ | Chip select valid time | - | $1.5^{(2)(3)}$ | |
| $t_{h(SDCLKL-SDNE)}$ | Chip select hold time | 0 | - | |
| $t_{d(SDCLKL-SDNRAS)}$ | SDNRAS valid time | - | 1 | |
| $t_{h(SDCLKL-SDNRAS)}$ | SDNRAS hold time | 0 | - | |
| $t_{d(SDCLKL-SDNCAS)}$ | SDNCAS valid time | - | 2 | |
| $t_{d(SDCLKL-SDNCAS)}$ | SDNCAS hold time | 0.5 | - | |

1. Guaranteed by characterization results.
2. Using PC2 I/O adds 4 ns to this timing.
3. Using PC2_C I/O adds 16.5 ns to this timing.

6.3.20 Octo-SPI interface characteristics

Unless otherwise specified, the parameters given in [Table 80](#) and [Table 82](#) for OCTOSPI are derived from tests performed under the ambient temperature, f_{HCLK} frequency and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- HSLV activated when $V_{DD} \leq 2.5$ V
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics.

Table 80. OCTOSPI characteristics in SDR mode⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------|-------------------------|---|-----|-----|-----|------|
| $F_{(CLK)}$ | OCTOSPI clock frequency | $1.71\text{ V} < V_{DD} < 3.6\text{ V}$, VOS0, $C_{LOAD} = 15\text{ pF}$ | - | - | 92 | MHz |
| | | $1.71\text{ V} < V_{DD} < 3.6\text{ V}$, VOS0, $C_{LOAD} = 20\text{ pF}$ | - | - | 90 | |
| | | $2.7\text{ V} < V_{DD} < 3.6\text{ V}$, VOS0, $C_{LOAD} = 20\text{ pF}$ | - | - | 140 | |

Table 80. OCTOSPI characteristics in SDR mode⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------|--|------------------------------|----------------------------|-----|--------------------------|------|
| $t_{w(CKH)}$ | OCTOSPI clock high and low time, even division | PRESCALER[7:0] = n = 0,1,3,5 | $t_{(CK)}/2$ | - | $t_{(CK)}/2+1$ | ns |
| $t_{w(CKL)}$ | | | $t_{(CK)}/2-1$ | - | $t_{(CK)}/2$ | |
| $t_{w(CKH)}$ | OCTOSPI clock high and low time, odd division | PRESCALER[7:0] = n = 2,4,6,8 | $(n/2)*t_{(CK)}/(n+1)$ | - | $(n/2)*t_{(CK)}/(n+1)+1$ | |
| $t_{w(CKL)}$ | | | $(n/2+1)*t_{(CK)}/(n+1)-1$ | - | $(n/2+1)*t_{(CK)}/(n+1)$ | |
| $t_{s(IN)}^{(3)}$ | Data input setup time | - | 3.0 | - | - | |
| $t_{h(IN)}^{(3)}$ | Data input hold time | - | 1.5 | - | - | |
| $t_{v(OUT)}$ | Data output valid time | - | - | 0.5 | 1 ⁽⁴⁾ | |
| $t_{h(OUT)}$ | Data output hold time | - | 0 | - | - | |

1. All values apply to Octal and Quad-SPI mode.
2. Guaranteed by characterization results.
3. Delay block bypassed.
4. Using PC2 or PC3 I/O in the data bus adds 4 ns to this timing value.

Figure 41. OCTOSPI SDR read/write timing diagram

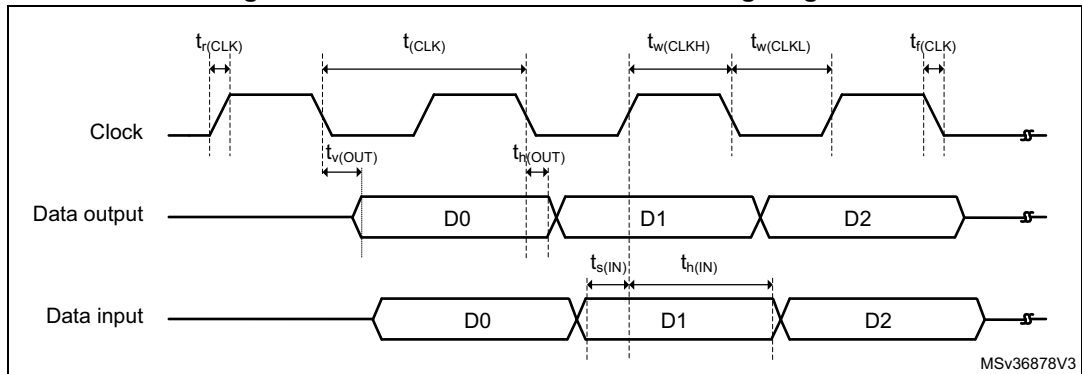


Table 81. OCTOSPI characteristics in DTR mode (no DQS)⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|--|--|---|------------------------------|---|------|
| F _{CK} ⁽³⁾ | OCTOSPI clock frequency | 1.71 V < V _{DD} < 3.6 V, VOS0, C _{LOAD} = 15 pF | - | - | 90 ⁽⁴⁾ | MHz |
| | | 1.71 V < V _{DD} < 3.6 V, VOS0, C _{LOAD} = 20 pF | - | - | 87 ⁽⁴⁾ | |
| | | 2.7 V < V _{DD} < 3.6 V, VOS0, C _{LOAD} = 20 pF | - | - | 110 | |
| t _{w(CLKH)} t _{w(CLKL)} | OCTOSPI clock high and low time, even division | PRESCALER[7:0] = n = 0,1,3,5 | t _{(CK)/2} | - | t _{(CK)/2+1} | ns |
| t _{w(CLKH)} t _{w(CLKL)} | | | OCTOSPI clock high and low time, odd division | PRESCALER[7:0] = n = 2,4,6,8 | (n/2)*t _{(CK)/(n+1)} | |
| t _{sr(IN)} t _{sf(IN)} ⁽⁵⁾ | Data input setup time | - | | | 3.0 | |
| t _{hr(IN)} t _{hf(IN)} ⁽⁵⁾ | Data input hold time | - | 1.50 | - | - | |
| t _{vr(OUT)} t _{vf(OUT)} | Data output valid time | DHQC = 0 | - | 6 | 7 ⁽⁶⁾ | |
| | | DHQC = 1, Prescaler = 1,2 ... | - | t _{pclk/4+1} | t _{pclk/4+1.25} ⁽⁶⁾ | |
| t _{hr(OUT)} t _{hf(OUT)} | Data output hold time | DHQC = 0 | 4.5 | - | - | |
| | | DHQC = 1, Prescaler = 1,2 ... | t _{pclk/4} | - | - | |

1. All values apply to Octal and Quad-SPI mode.
2. Guaranteed by characterization results.
3. DHQC must be set to reach the mentioned frequency.
4. Using PC2 or PC3 I/O in the data bus decreases the frequency to 47 MHz.
5. Delay block bypassed.
6. Using PC2 or PC3 I/O in the data bus adds 4 ns to this timing value.

Figure 42. OCTOSPI DTR mode timing diagram

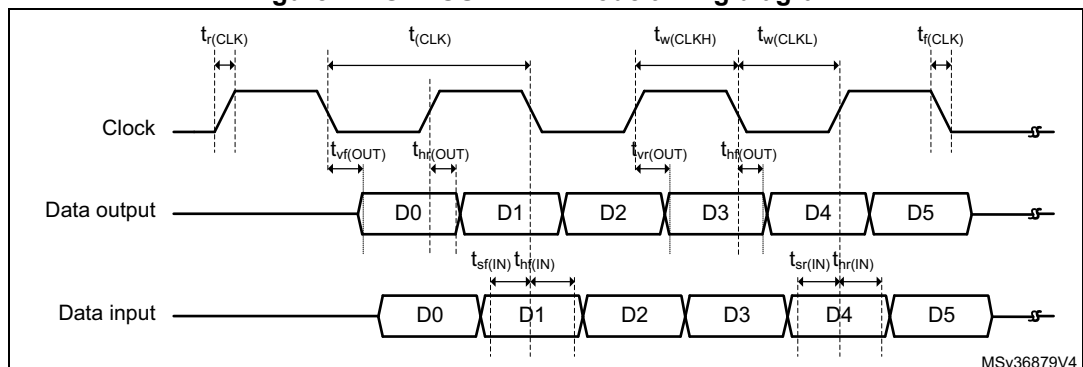


Table 82. OCTOSPI characteristics in DTR mode (with DQS)/Octal and Hyperbus⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------------------------|---|--|-----------------------------------|--------------------------|--|------|
| F _{CK} ⁽²⁾⁽³⁾ | OCTOSPI clock frequency | 2,7 V < V _{DD} < 3.6 V, VOS0, C _{LOAD} = 20 pF | - | - | 100 | MHz |
| | | 1.71 V < V _{DD} < 3.6 V, VOS0, C _{LOAD} = 20 pF | - | - | 100 ⁽⁴⁾ | |
| t _{w(CKH)} | OCTOSPI clock high and low time, even division | PRESCALER[7:0] = n = 0,1,3,5 | t _{(CK)/2} | - | t _{(CK)/2+1} | ns |
| t _{w(CKL)} | | | t _{(CK)/2-1} | - | t _{(CK)/2} | |
| t _{w(CKH)} | OCTOSPI clock high and low time, odd division | PRESCALER[7:0] = n = 2,4,6,8 | (n/2)*t _{(CK)/(n+1)} | - | (n/2)*t _{(CK)/(n+1)+1} | ns |
| t _{w(CKL)} | | | (n/2+1)*t _{(CK)/(n+1)-1} | - | (n/2+1)*t _{(CK)/(n+1)} | |
| t _{v(CK)} | Clock valid time | - | - | - | t _{(CK)+1} | |
| t _{h(CK)} | Clock hold time | - | t _{(CK)/2} | - | - | |
| V _{ODr(CK)} | CK, \overline{CK} crossing level on CK rising edge | VDD = 1.8 V | 922 | - | 1229 | mV |
| V _{ODf(CK)} | CK, \overline{CK} crossing level on CK falling edge | VDD = 1.8 V | 1000 | - | 1277 | |
| t _{w(CS)} | Chip select high time | - | 3*t _(CK) | - | - | ns |
| t _{v(DQ)} | Data input valid time | - | 0 | - | - | |
| t _{v(DS)} | Data strobe input valid time | - | 0 | - | - | |
| t _{h(DS)} | Data strobe input hold time | - | 0 | - | - | |
| t _{v(RWDS)} | Data strobe output valid time | - | - | - | 3 x t _(CK) | |
| t _{sr(DQ)} | Data input setup time | Rising edge | 0 | - | - | |
| t _{sf(DQ)} | | Falling edge | 0 | - | - | |
| t _{hr(DQ)} | Data input hold time | Rising edge | 1 | - | - | |
| t _{hf(DQ)} | | Falling edge | 1 | - | - | |
| t _{vr(OUT)} | Data output valid time rising edge | DHQC = 0 | - | 6 | 7 ⁽⁵⁾ | |
| | | DHQC = 1, Prescaler = 1,2... | - | t _{pclk} /4+1 | t _{pclk} /4+1.25 ⁽⁵⁾ | |
| t _{vf(OUT)} | Data output valid time falling edge | DHQC = 0 | - | 5.5 | 6 ⁽⁵⁾ | |
| | | DHQC = 1, Prescaler = 1,2... | - | t _{pclk} /4+0.5 | t _{pclk} /4+0.75 ⁽⁵⁾ | |
| t _{hr(OUT)} | Data output hold time rising edge | DHQC = 0 | 4.5 | - | - | |
| | | DHQC = 1, Prescaler = 1,2... | t _{pclk} /4 | - | - | |
| t _{hf(OUT)} | Data output hold time falling edge | DHQC = 0 | 4.5 | - | - | |
| | | DHQC = 1, Prescaler = 1,2... | t _{pclk} /4 | - | - | |

1. Guaranteed by characterization results.

2. Maximum frequency values are given for a RWDS to DQ skew of maximum +/-1.0 ns.
3. Activating DHQC is mandatory to reach this frequency
4. Using PC2 or PC3 I/O on data bus decreases the frequency to 47 MHz.
5. Using PC2 or PC3 I/O on the data bus adds 4 ns to this timing value.

Figure 43. OCTOSPI Hyperbus clock timing diagram

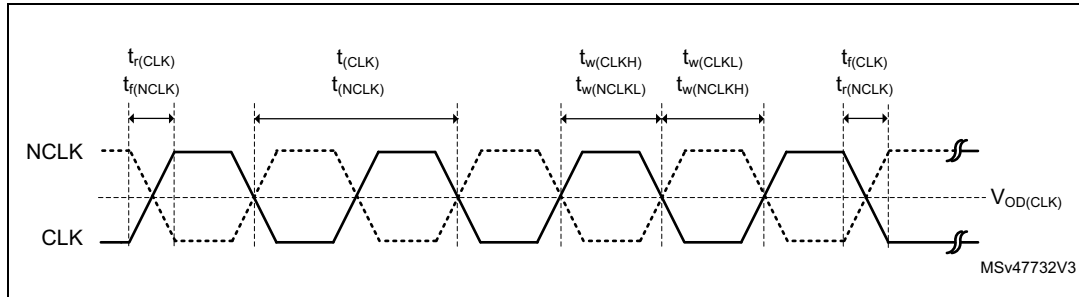


Figure 44. OCTOSPI Hyperbus read timing diagram

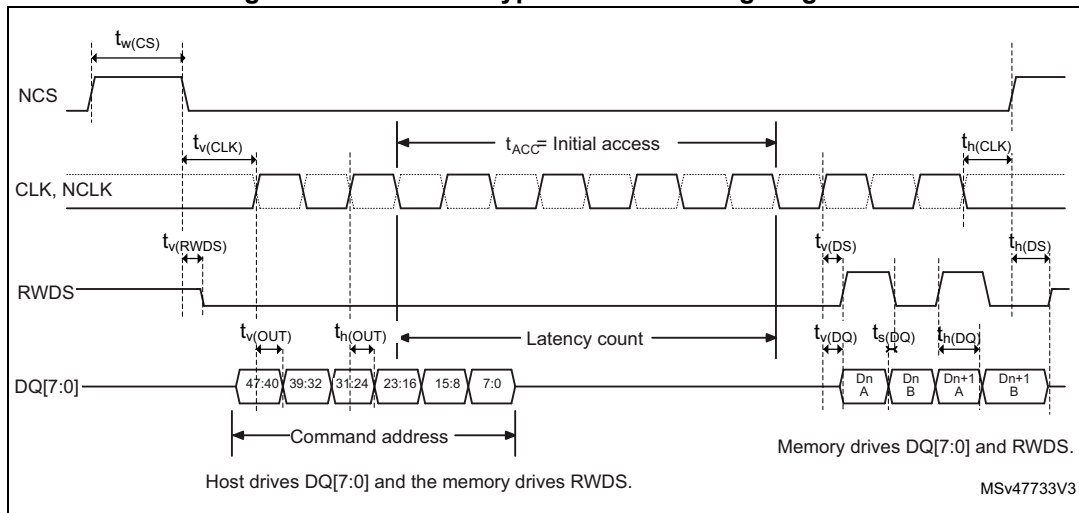
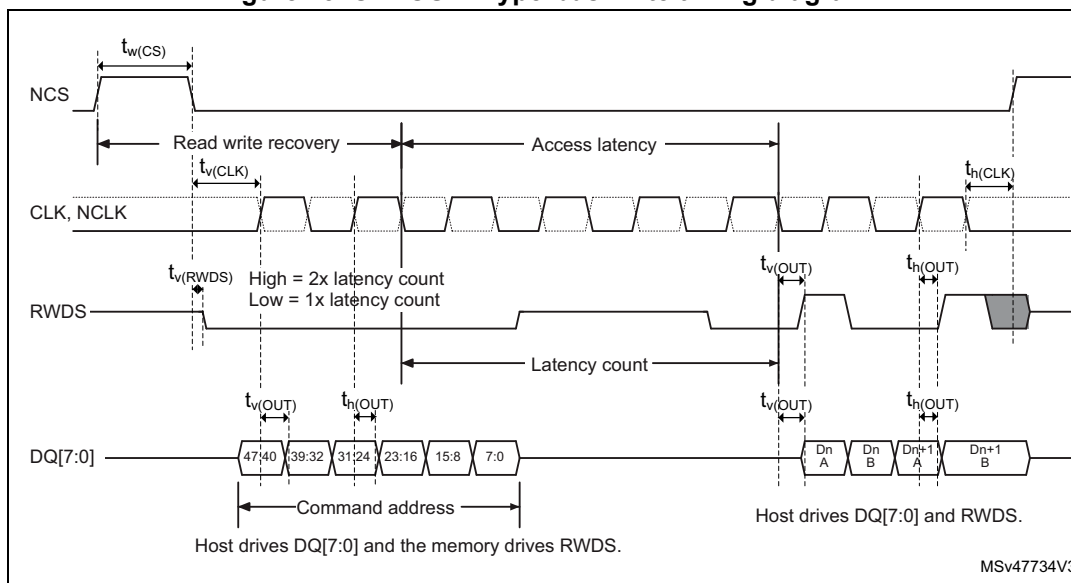


Figure 45. OCTOSPI Hyperbus write timing diagram



6.3.21 Delay block (DLYB) characteristics

Unless otherwise specified, the parameters given in [Table 83](#) for Delay Block are derived from tests performed under the ambient temperature, $f_{\text{RCC_C_ck}}$ frequency and V_{DD} supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

Table 83. Delay Block characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------|---------------|------------|-----|------|------|------|
| t_{init} | Initial delay | - | 900 | 1300 | 1900 | ps |
| t_{Δ} | Unit Delay | - | 28 | 33 | 41 | - |

6.3.22 16-bit ADC characteristics

Unless otherwise specified, the parameters given in [Table 84](#), [Table 85](#) and [Table 86](#) are derived from tests performed under the ambient temperature, f_{PCLK2} frequency and V_{DDA} supply voltage conditions summarized in [Table 13: General operating conditions](#).

Table 84. 16-bit ADC characteristics⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------|----------------------------------|-----------------------------------|------------------|-----|------------------|------|
| V_{DDA} | Analog supply voltage for ADC ON | - | 1.62 | - | 3.6 | V |
| $V_{\text{REF+}}$ | Positive reference voltage | $V_{\text{DDA}} \geq 2 \text{ V}$ | 1.62 | - | V_{DDA} | |
| | | $V_{\text{DDA}} < 2 \text{ V}$ | V_{DDA} | | | |
| $V_{\text{REF-}}$ | Negative reference voltage | - | V_{SSA} | | | |

Table 84. 16-bit ADC characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | | | | Min | Typ | Max | Unit | |
|---------------------------------|--|--|--|---------------------------|---------------------------|---------------------------|---------------------|---------------------------|--------------------|------|
| f _{ADC} | ADC clock frequency | 1.62 V ≤ V _{DDA} ≤ 3.6 V | | | | BOOST = 11 | 0.12 | - | 50 | MHz |
| | | | | | | BOOST = 10 | 0.12 | - | 25 | |
| | | | | | | BOOST = 01 | 0.12 | - | 12.5 | |
| | | | | | | BOOST = 00 | - | - | 6.25 | |
| f _s ⁽³⁾ | Sampling rate for Direct channels | Resolution = 16 bits, V _{DDA} > 2.5 V | T _J = 90 °C | f _{ADC} = 36 MHz | SMP = 1.5 | - | - | 3.60 | MSps | |
| | | Resolution = 16 bits | | f _{ADC} = 37 MHz | SMP = 2.5 | - | - | 3.35 | | |
| | | Resolution = 14 bits | T _J = 125 °C | f _{ADC} = 50 MHz | SMP = 2.5 | - | - | 5.00 | | |
| | | Resolution = 12 bits | | f _{ADC} = 50 MHz | SMP = 2.5 | - | - | 5.50 | | |
| | | Resolution = 10 bits | | f _{ADC} = 50 MHz | SMP = 1.5 | - | - | 7.10 | | |
| | | Resolution = 8 bits | | f _{ADC} = 50 MHz | SMP = 1.5 | - | - | 8.30 | | |
| | | Resolution = 14 bits | T _J = 140 °C | f _{ADC} = 49 MHz | SMP = 1.5 | - | - | 4.90 | | |
| | | Resolution = 12 bits | | f _{ADC} = 50 MHz | SMP = 1.5 | - | - | 5.50 | | |
| | | Resolution = 10 bits | | f _{ADC} = 50 MHz | SMP = 1.5 | - | - | 6.70 | | |
| | | Resolution = 8 bits | | f _{ADC} = 50 MHz | SMP = 1.5 | - | - | 8.30 | | |
| | | Sampling rate for Fast channels | Resolution = 16 bits, V _{DDA} > 2.5 V | T _J = 90 °C | f _{ADC} = 32 MHz | SMP = 2.5 | - | - | | 2.90 |
| | | | Resolution = 16 bits | | f _{ADC} = 31 MHz | SMP = 2.5 | - | - | | 2.80 |
| | Resolution = 14 bits | | T _J = 125 °C | f _{ADC} = 33 MHz | SMP = 2.5 | - | - | 3.30 | | |
| | Resolution = 12 bits | | | f _{ADC} = 39 MHz | SMP = 2.5 | - | - | 4.30 | | |
| | Resolution = 10 bits | | | f _{ADC} = 48 MHz | SMP = 2.5 | - | - | 6.00 | | |
| | Resolution = 8 bits | | | f _{ADC} = 50 MHz | SMP = 2.5 | - | - | 7.10 | | |
| | Resolution = 12 bits | | T _J = 140 °C | f _{ADC} = 37 MHz | SMP = 2.5 | - | - | 4.10 | | |
| | Resolution = 10 bits | | | f _{ADC} = 46 MHz | SMP = 2.5 | - | - | 5.70 | | |
| | Resolution = 8 bits | f _{ADC} = 50 MHz | | SMP = 2.5 | - | - | 7.10 | | | |
| | Sampling rate for Slow channels ⁽⁴⁾ | resolution = 16 bits | T _J = 90 °C | | | - | - | 1.00 | | |
| | | resolution = 14 bits | | | | - | - | | | |
| | | resolution = 12 bits | | T _J = 125 °C | | | - | | | - |
| | | resolution = 10 bits | | | | | - | | | - |
| | | resolution = 8 bits | | | | - | - | | | |
| resolution = 12 bits | | T _J = 140 °C | | | | - | - | | | |
| resolution = 10 bits | | | | | - | - | | | | |
| resolution = 8 bits | | | | | - | - | | | | |
| resolution = 8 bits | | | | - | - | | | | | |
| t _{TRIG} | External trigger period | Resolution = 16 bits | | | | - | - | 10 | 1/f _{ADC} | |
| V _{AIN} ⁽⁵⁾ | Conversion voltage range | - | | | | 0 | - | V _{REF+} | V | |
| V _{CMIV} | Common mode input voltage | - | | | | V _{REF} /2 - 10% | V _{REF} /2 | V _{REF} /2 + 10% | V | |

Table 84. 16-bit ADC characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | | | Min | Typ | Max | Unit |
|---------------------------------|--|---|---|---|----------------|-----|--------|--------------------|
| R _{AIN} ⁽⁶⁾ | External input impedance | Resolution = 16 bits, T _J = 140 °C | | | - | - | 50 | Ω |
| | | Resolution = 16 bits, T _J = 125 °C | - | - | - | - | 170 | |
| | | Resolution = 14 bits, T _J = 140 °C | | | - | - | 200 | |
| | | Resolution = 14 bits, T _J = 125 °C | - | - | - | - | 435 | |
| | | Resolution = 12 bits, T _J = 140 °C | | | - | - | 700 | |
| | | Resolution = 12 bits, T _J = 125 °C | - | - | - | - | 1,150 | |
| | | Resolution = 10 bits, T _J = 140 °C | | | - | - | 3,700 | |
| | | Resolution = 10 bits, T _J = 125 °C | - | - | - | - | 5,650 | |
| | | Resolution = 8 bits, T _J = 140 °C | | | - | - | 18,000 | |
| | | Resolution = 8 bits, T _J = 125 °C | - | - | - | - | 26,500 | |
| C _{ADC} | Internal sample and hold capacitor | - | | | - | 4 | - | pF |
| t _{ADCVREG_STUP} | ADC LDO startup time | - | | | - | 5 | 10 | us |
| t _{STAB} | ADC Power-up time | LDO already started | | | 1 | - | - | conversion cycle |
| t _{CAL} | Offset and linearity calibration time | - | | | 16,5010 | | | 1/f _{ADC} |
| t _{OFF_CAL} | Offset calibration time | - | | | 1,280 | | | 1/f _{ADC} |
| t _{LATR} | Trigger conversion latency regular and injected channels without conversion abort | CKMODE = 00 | | | 1.5 | 2 | 2.5 | 1/f _{ADC} |
| | | CKMODE = 01 | | | - | - | 2.5 | |
| | | CKMODE = 10 | | | - | - | 2.5 | |
| | | CKMODE = 11 | | | - | - | 2.25 | |
| t _{LATRINJ} | Trigger conversion latency regular injected channels aborting a regular conversion | CKMODE = 00 | | | 2.5 | 3 | 3.5 | 1/f _{ADC} |
| | | CKMODE = 01 | | | - | - | 3.5 | |
| | | CKMODE = 10 | | | - | - | 3.5 | |
| | | CKMODE = 11 | | | - | - | 3.25 | |
| t _S | Sampling time | - | | | 1.5 | - | 810.5 | 1/f _{ADC} |
| t _{CONV} | Total conversion time (including sampling time) | Resolution = N bits | | | ts + 0.5 + N/2 | - | - | 1/f _{ADC} |

Table 84. 16-bit ADC characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | | | Min | Typ | Max | Unit |
|------------------------------|--|---|---|---|-----|-------|-----|------|
| I _{DDA-D} (ADC) | ADC consumption on V _{DDA} , BOOST=11, Differential mode | Resolution = 16 bits, f _{ADC} = 25 MHz | - | - | - | 1,440 | - | μA |
| | | Resolution = 14 bits, f _{ADC} = 30 MHz | - | - | - | 1,350 | - | |
| | | Resolution = 12 bits, f _{ADC} = 40 MHz | - | - | - | 990 | - | |
| | ADC consumption on V _{DDA} , BOOST=10, Differential mode, f _{ADC} = 25 MHz | Resolution = 16 bits | - | - | - | 1,080 | - | |
| | | Resolution = 14 bits | - | - | - | 810 | - | |
| | | Resolution = 12 bits | - | - | - | 585 | - | |
| | ADC consumption on V _{DDA} , BOOST=01, Differential mode, f _{ADC} = 12.5 MHz | Resolution = 16 bits | - | - | - | 630 | - | |
| | | Resolution = 14 bits | - | - | - | 432 | - | |
| | | Resolution = 12 bits | - | - | - | 315 | - | |
| | ADC consumption on V _{DDA} , BOOST=00, Differential mode, f _{ADC} = 6.25 MHz | Resolution = 16 bits | - | - | - | 360 | - | |
| | | Resolution = 14 bits | - | - | - | 270 | - | |
| | | Resolution = 12 bits | - | - | - | 225 | - | |
| I _{DDA-SE} (ADC) | ADC consumption on V _{DDA} , BOOST=11, Single-ended mode | Resolution = 16 bits, f _{ADC} =25 MHz | - | - | - | 720 | - | |
| | | Resolution = 14 bits, f _{ADC} =30 MHz | - | - | - | 675 | - | |
| | | Resolution = 12 bits, f _{ADC} =40 MHz | - | - | - | 495 | - | |
| | ADC consumption on V _{DDA} , BOOST=10, Single-ended mode, f _{ADC} = 25 MHz | Resolution = 16 bits | - | - | - | 540 | - | |
| | | Resolution = 14 bits | - | - | - | 405 | - | |
| | | Resolution = 12 bits | - | - | - | 292.5 | - | |
| | ADC consumption on V _{DDA} , BOOST=01, Single-ended mode, f _{ADC} = 12.5 MHz | Resolution = 16 bits | - | - | - | 315 | - | |
| | | Resolution = 14 bits | - | - | - | 216 | - | |
| | | Resolution = 12 bits | - | - | - | 157.5 | - | |
| | ADC consumption on V _{DDA} , BOOST=00, Single-ended mode, f _{ADC} =6.25 MHz | Resolution = 16 bits | - | - | - | 180 | - | |
| | | Resolution = 14 bits | - | - | - | 135 | - | |
| | | Resolution = 12 bits | - | - | - | 112.5 | - | |
| I _{DD} (ADC) | ADC consumption on V _{DD} | f _{ADC} =50 MHz | - | - | - | 400 | - | |
| | | f _{ADC} =25 MHz | - | - | - | 220 | - | |
| | | f _{ADC} =12.5 MHz | - | - | - | 180 | - | |
| | | f _{ADC} =6.25 MHz | - | - | - | 120 | - | |
| | | f _{ADC} =3.125 MHz | - | - | - | 80 | - | |

1. Guaranteed by design.
2. The voltage booster on ADC switches must be used for V_{DDA} < 2.4 V (embedded I/O switches).
3. These values are valid for TFBGA100, UFBGA169 and UFBGA176+25 packages and one ADC. The values for other packages and multiple ADCs may be different.
4. For slow channels, the performance should be limited to 1 Msps what ever the value of f_{ADC}.

- 5. Depending on the package, V_{REF+} can be internally connected to V_{DDA} and V_{REF-} to V_{SSA} .
- 6. The tolerance is 10 LSBs for 16-bit resolution, 4 LSBs for 14-bit resolution, and 2 LSBs for 12-bit, 10-bit and 8-bit resolutions.

Table 85. Minimum sampling time vs R_{AIN} (16-bit ADC)⁽¹⁾⁽²⁾

| Resolution | R_{AIN} (Ω) | Minimum sampling time (s) | | |
|------------|------------------------|--------------------------------|------------------------------|------------------------------|
| | | Direct channels ⁽³⁾ | Fast channels ⁽⁴⁾ | Slow channels ⁽⁵⁾ |
| 16 bits | 47 | 7.37E-08 | 1.14E-07 | 1.72E-07 |
| 14 bits | 47 | 6.29E-08 | 9.74E-08 | 1.55E-07 |
| | 68 | 6.84E-08 | 1.02E-07 | 1.58E-07 |
| | 100 | 7.80E-08 | 1.12E-07 | 1.62E-07 |
| | 150 | 9.86E-08 | 1.32E-07 | 1.80E-07 |
| | 220 | 1.32E-07 | 1.61E-07 | 2.01E-07 |
| 12 bits | 47 | 5.32E-08 | 8.00E-08 | 1.29E-07 |
| | 68 | 5.74E-08 | 8.50E-08 | 1.32E-07 |
| | 100 | 6.58E-08 | 9.31E-08 | 1.40E-07 |
| | 150 | 8.37E-08 | 1.10E-07 | 1.51E-07 |
| | 220 | 1.11E-07 | 1.34E-07 | 1.73E-07 |
| | 330 | 1.56E-07 | 1.78E-07 | 2.14E-07 |
| | 470 | 2.16E-07 | 2.39E-07 | 2.68E-07 |
| | 680 | 3.01E-07 | 3.29E-07 | 3.54E-07 |
| 10 bits | 47 | 4.34E-08 | 6.51E-08 | 1.08E-07 |
| | 68 | 4.68E-08 | 6.89E-08 | 1.11E-07 |
| | 100 | 5.35E-08 | 7.55E-08 | 1.16E-07 |
| | 150 | 6.68E-08 | 8.77E-08 | 1.26E-07 |
| | 220 | 8.80E-08 | 1.08E-07 | 1.40E-07 |
| | 330 | 1.24E-07 | 1.43E-07 | 1.71E-07 |
| | 470 | 1.69E-07 | 1.89E-07 | 2.13E-07 |
| | 680 | 2.38E-07 | 2.60E-07 | 2.80E-07 |
| | 1000 | 3.45E-07 | 3.66E-07 | 3.84E-07 |
| | 1500 | 5.15E-07 | 5.35E-07 | 5.48E-07 |
| | 2200 | 7.42E-07 | 7.75E-07 | 7.78E-07 |
| | 3300 | 1.10E-06 | 1.14E-06 | 1.14E-06 |

Table 85. Minimum sampling time vs R_{AIN} (16-bit ADC)⁽¹⁾⁽²⁾ (continued)

| Resolution | R _{AIN} (Ω) | Minimum sampling time (s) | | |
|------------|----------------------|--------------------------------|------------------------------|------------------------------|
| | | Direct channels ⁽³⁾ | Fast channels ⁽⁴⁾ | Slow channels ⁽⁵⁾ |
| 8 bits | 47 | 3.32E-08 | 5.10E-08 | 8.61E-08 |
| | 68 | 3.59E-08 | 5.35E-08 | 8.83E-08 |
| | 100 | 4.10E-08 | 5.83E-08 | 9.22E-08 |
| | 150 | 5.06E-08 | 6.76E-08 | 9.95E-08 |
| | 220 | 6.61E-08 | 8.22E-08 | 1.11E-07 |
| | 330 | 9.17E-08 | 1.08E-07 | 1.32E-07 |
| | 470 | 1.24E-07 | 1.40E-07 | 1.63E-07 |
| | 680 | 1.74E-07 | 1.91E-07 | 2.12E-07 |
| | 1000 | 2.53E-07 | 2.70E-07 | 2.85E-07 |
| | 1500 | 3.73E-07 | 3.93E-07 | 4.05E-07 |
| | 2200 | 5.39E-07 | 5.67E-07 | 5.75E-07 |
| | 3300 | 8.02E-07 | 8.36E-07 | 8.38E-07 |
| | 4700 | 1.13E-06 | 1.18E-06 | 1.18E-06 |
| | 6800 | 1.62E-06 | 1.69E-06 | 1.68E-06 |
| | 10000 | 2.36E-06 | 2.47E-06 | 2.45E-06 |
| 15000 | 3.50E-06 | 3.69E-06 | 3.65E-06 | |

1. Guaranteed by design.
2. Data valid at up to 130 °C, with a 47 pF PCB capacitor, and V_{DDA}=1.6 V.
3. Direct channels are connected to analog I/Os (PA0_C, PA1_C, PC2_C and PC3_C) to optimize ADC performance.
4. Fast channels correspond to PA6, PB1, PC4, PF11, PF13 for ADCx_INPx, and to PA7, PB0, PC5, PF12, PF14 for ADCx_INNx.
5. Slow channels correspond to all ADC inputs except for the Direct and Fast channels.

Table 86. 16-bit ADC accuracy⁽¹⁾⁽²⁾

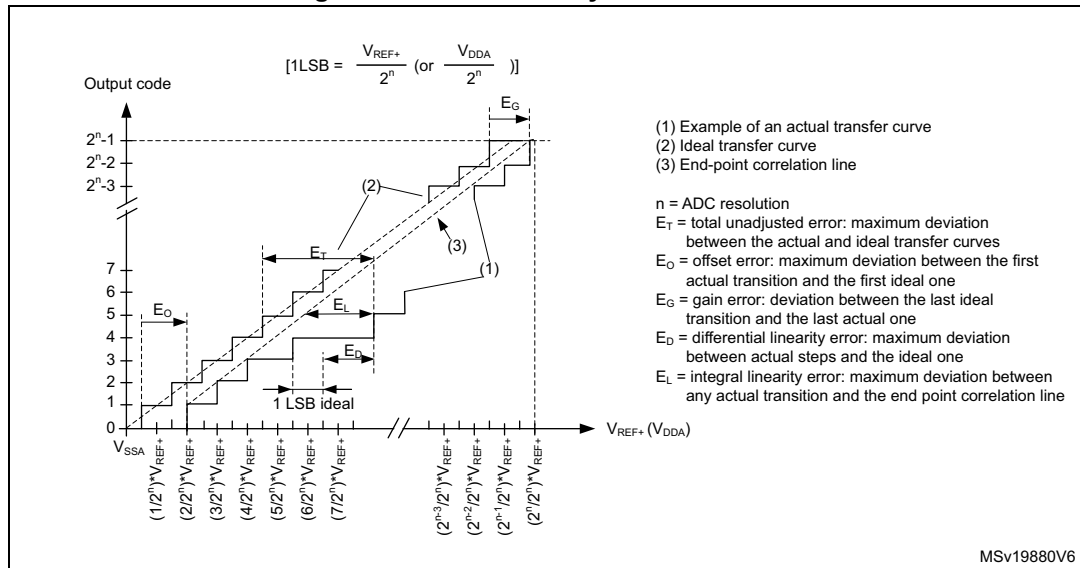
| Symbol | Parameter | Conditions ⁽³⁾ | | Min | Typ | Max | Unit |
|--------|--------------------------------------|---------------------------|--------------|-----|---------|-----|------|
| ET | Total undadjusted error | Direct channel | Single ended | - | +10/-20 | - | LSB |
| | | | Differential | - | ±15 | - | |
| | | Fast channel | Single ended | - | +10/-20 | - | |
| | | | Differential | - | ±15 | - | |
| | | Slow channel | Single ended | - | ±10 | - | |
| | | | Differential | - | ±10 | - | |
| EO | Offset error | - | | - | ±10 | - | |
| EG | Gain error | - | | - | ±15 | - | |
| ED | Differential linearity error | Single ended | | - | +3/-1 | - | |
| | | Differential | | - | +4.5/-1 | - | |
| EL | Integral linearity error | Direct channel | Single ended | - | ±11 | - | |
| | | | Differential | - | ±7 | - | |
| | | Fast channel | Single ended | - | ±13 | - | |
| | | | Differential | - | ±7 | - | |
| | | Slow channel | Single ended | - | ±10 | - | |
| | | | Differential | - | ±6 | - | |
| ENOB | Effective number of bits | Single ended | | - | 12.2 | - | Bits |
| | | Differential | | - | 13.2 | - | |
| SINAD | Signal-to-noise and distortion ratio | Single ended | | - | 75.2 | - | dB |
| | | Differential | | - | 81.2 | - | |
| SNR | Signal-to-noise ratio | Single ended | | - | 77.0 | - | |
| | | Differential | | - | 81.0 | - | |
| THD | Total harmonic distortion | Single ended | | - | 87 | - | |
| | | Differential | | - | 90 | - | |

1. Guaranteed by characterization results for BGA packages. The values for LQFP packages might differ.
2. ADC DC accuracy values are measured after internal calibration.
3. ADC clock frequency = 25 MHz, ADC resolution = 16 bits, $V_{DDA}=V_{REF+}=3.3$ V, BOOST=11 and 16-bit mode.

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.

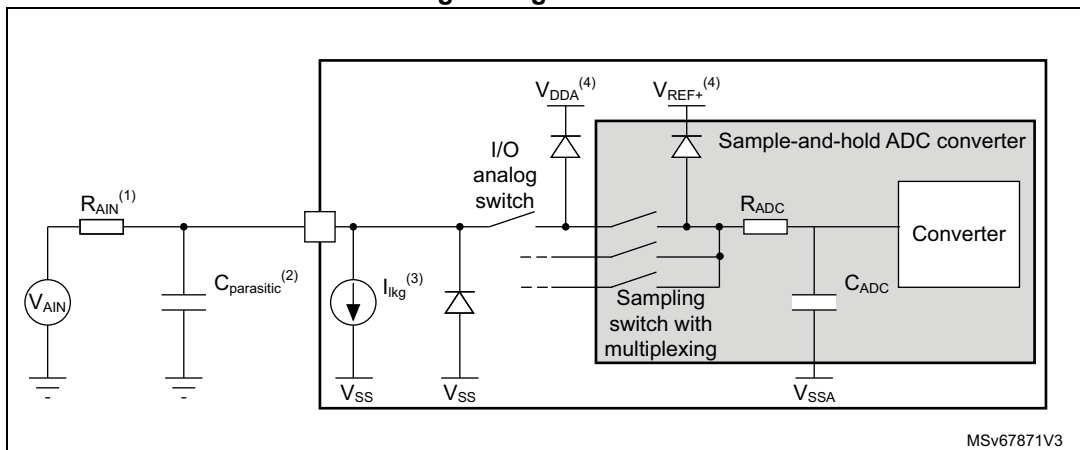
Any positive injection current within the limits specified for $I_{INJ(PIN)}$ and $\Sigma I_{INJ(PIN)}$ does not affect the ADC accuracy.

Figure 46. ADC accuracy characteristics



1. Example of an actual transfer curve.
2. Ideal transfer curve.
3. End point correlation line.
4. 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 47. Typical connection diagram when using the ADC with FT/TT pins featuring analog switch function

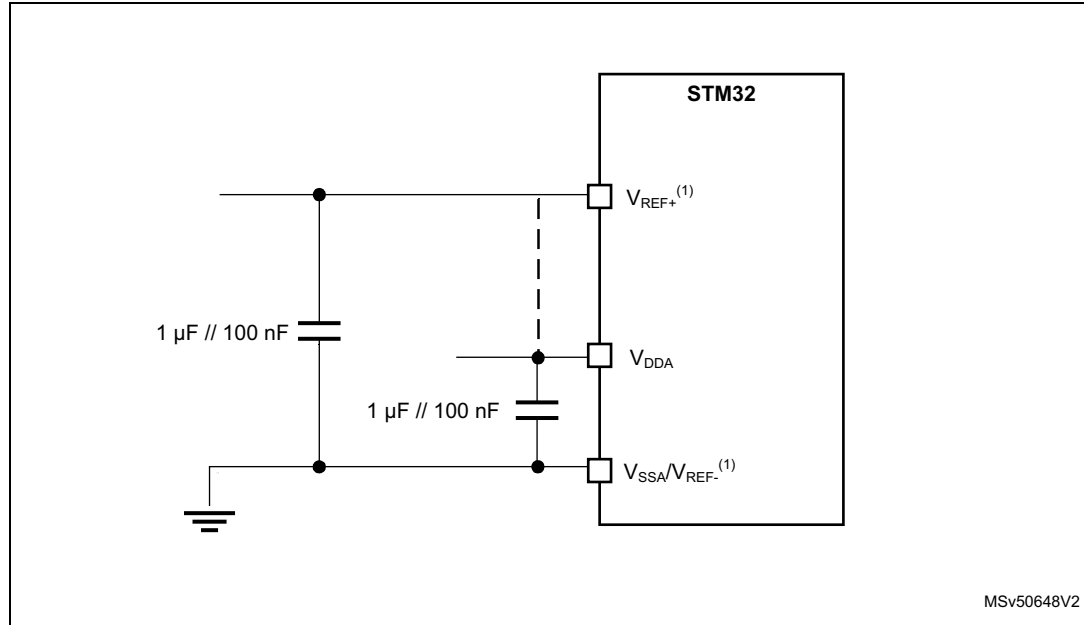


1. Refer to [Table 84: 16-bit ADC characteristics](#) for the values of R_{AIN} , R_{ADC} and C_{ADC} .
2. $C_{\text{parasitic}}$ represents the capacitance of the PCB (dependent on soldering and PCB layout quality) plus the pad capacitance (refer to [Table 55: I/O static characteristics](#)). A high $C_{\text{parasitic}}$ value downgrades conversion accuracy. To remedy this, f_{ADC} should be reduced.
3. Refer to [Table 55: I/O static characteristics](#) for the value of I_{kg} .
4. Refer to [Figure 14: Power supply scheme](#).

General PCB design guidelines

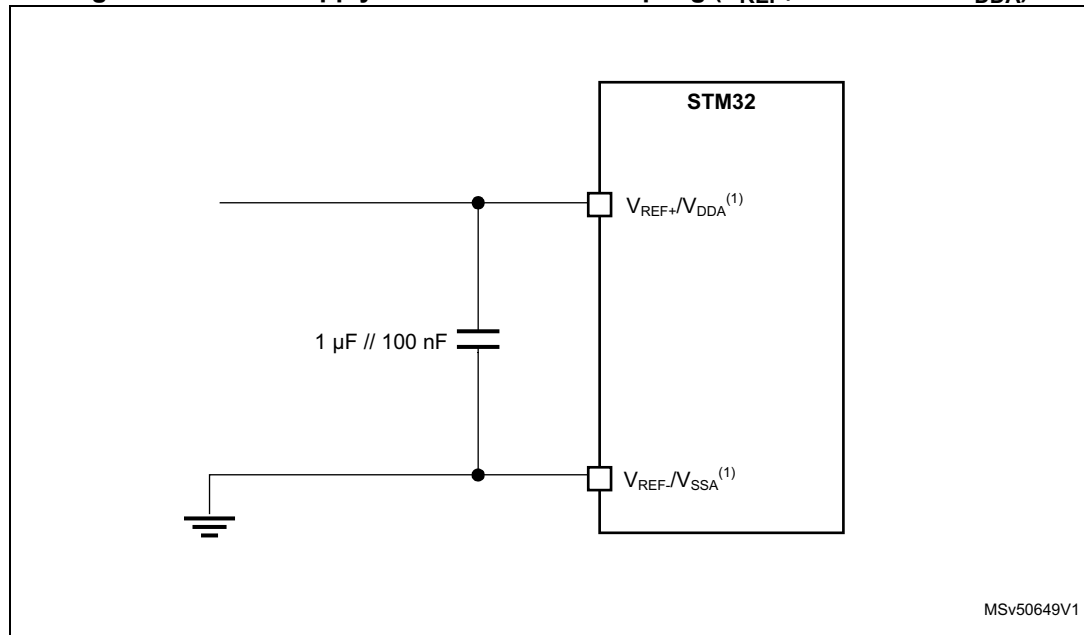
Power supply decoupling should be performed as shown in [Figure 48](#) or [Figure 49](#), depending on whether V_{REF+} is connected to V_{DDA} or not. The 100 nF capacitors should be ceramic (good quality). They should be placed them as close as possible to the chip.

Figure 48. Power supply and reference decoupling (V_{REF+} not connected to V_{DDA})



1. When V_{REF+} and V_{REF-} inputs are not available, they are internally connected to V_{DDA} and V_{SSA} , respectively.

Figure 49. Power supply and reference decoupling (V_{REF+} connected to V_{DDA})



1. When V_{REF+} and V_{REF-} inputs are not available, they are internally connected to V_{DDA} and V_{SSA} , respectively.

6.3.23 12-bit ADC characteristics

Unless otherwise specified, the parameters given in [Table 87](#), [Table 88](#) and [Table 89](#) are derived from tests performed under the ambient temperature and V_{DDA} supply voltage conditions summarized in [Table 13: General operating conditions](#). In [Table 87](#), [Table 88](#) and [Table 89](#), f_{ADC} refers to f_{adc_ker_ck}.

Table 87. 12-bit ADC characteristics⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | | | | Min | Typ | Max | Unit | | |
|----------------------------------|-----------------------------------|--|--|--|--|--|---------------------------|----------------------------------|---------------------------|-----------|------|
| V _{DDA} | Analog power supply for ADC ON | - | | | | 1.62 | - | 3.6 | V | | |
| V _{REF+} ⁽³⁾ | Positive reference voltage | V _{DDA} ≥ V _{REF+} | | | | 1.62 | - | V _{DDA} | | | |
| V _{REF-} | Negative reference voltage | - | | | | V _{SSA} | - | - | | | |
| f _{ADC} | ADC clock frequency | 1,62 V ≤ V _{DDA} ≤ 3.6 V | | | | 1.5 | - | 75 | MHz | | |
| f _S ⁽⁴⁾ | Sampling rate for Direct channels | Resolution = 12 bits | Continuous and Discontinuous mode ⁽⁵⁾ | 2.4 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | SMP = 2.5 | - | - | 5 | MSPS |
| | | | | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 60 MHz | | - | - | 4 | |
| | | | Single mode | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 50 MHz ⁽⁶⁾ | | - | - | 3.33 | |
| | | | | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 38 MHz ⁽⁶⁾ | | - | - | 2.53 | |
| | | Resolution = 10 bits | Continuous and Discontinuous mode ⁽⁵⁾ | 1.6 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | SMP = 2.5 | - | - | 5.77 | |
| | | | | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 58 MHz ⁽⁶⁾ | | - | - | 4.46 | |
| | | | Single mode | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 42 MHz ⁽⁶⁾ | | - | - | 3.23 | |
| | | | | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 75 MHz | | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | SMP = 2.5 | |
| | | Continuous and Discontinuous mode ⁽⁵⁾ | 2.4 V ≤ V _{DDA} ≤ 3.6 V | f _{ADC} = 67 MHz ⁽⁶⁾ | - | - | 6.09 | | | | |
| | | | Single mode | 1.6 V ≤ V _{DDA} ≤ 3.6 V | f _{ADC} = 48 MHz ⁽⁶⁾ | - | - | | 4.36 | | |
| | | Resolution = 8 bits | | Continuous and Discontinuous mode ⁽⁵⁾ | 1.6 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | | SMP = 2.5 | | |
| | | | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 75 MHz ⁽⁶⁾ | | - | - | | 8.33 | |
| | | | Single mode | 1.6 V ≤ V _{DDA} ≤ 3.6 V | f _{ADC} = 55 MHz ⁽⁶⁾ | | - | - | | 6.11 | |
| | | | | 1.6 V ≤ V _{DDA} ≤ 3.6 V | f _{ADC} = 75 MHz | | - | - | | 8.33 | |

Table 87. 12-bit ADC characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | | | | | Min | Typ | Max | Unit | |
|--|--|---------------------------------|--|----------------------------------|----------------------------------|--|---------------------------|---------------------|---------------------------|--------------------|------|
| f _S ⁽⁴⁾ (continued) | Sampling rate for fast channels (VIN[0:5]) | Resolution = 12 bits | Continuous and Discontinuous mode ⁽⁵⁾ | 2.4 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 65 MHz | SMP = 2.5 | - | - | 4.33 | MSPS |
| | | | | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 58 MHz | | - | - | 3.87 | |
| | | | Single mode | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 32 MHz ⁽⁶⁾ | | - | - | 2.13 | |
| | | | | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 26 MHz ⁽⁶⁾ | | - | - | 1.73 | |
| | | Resolution = 10 bits | Continuous and Discontinuous mode ⁽⁵⁾ | 1.6 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | SMP = 2.5 | - | - | 5.77 | |
| | | | | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 36 MHz ⁽⁶⁾ | | - | - | 2.77 | |
| | | | Single mode | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 30 MHz ⁽⁶⁾ | | - | - | 2.31 | |
| | | Resolution = 8 bits | Continuous and Discontinuous mode ⁽⁵⁾ | 1.6 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | SMP = 2.5 | - | - | 6.82 | |
| | | | | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 44 MHz ⁽⁶⁾ | | - | - | 4.00 | |
| | | | Single mode | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 35 MHz ⁽⁶⁾ | | - | - | 3.18 | |
| | | Resolution = 6 bits | Continuous and Discontinuous mode ⁽⁵⁾ | 1.6 V ≤ V _{DDA} ≤ 3.6 V | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 75 MHz | SMP = 2.5 | - | - | 8.33 | |
| | | | | 2.4 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 56 MHz ⁽⁶⁾ | | - | - | 6.22 | |
| | | | Single mode | 1.6 V ≤ V _{DDA} ≤ 3.6 V | | f _{ADC} = 42 MHz ⁽⁶⁾ | | - | - | 4.66 | |
| | | Sampling rate for slow channels | Resolution = 12 bits | - | -40 °C ≤ T _J ≤ 130 °C | f _{ADC} = 15 MHz ⁽⁶⁾ | SMP = 2.5 | - | - | 1.00 | |
| | | | Resolution = 10 bits | - | | | | - | - | 1.28 | |
| | | | Resolution = 8 bits | - | | | | - | - | 1.63 | |
| Resolution = 6 bits | - | | - | - | | | | 2.08 | | | |
| t _{TRIG} | External trigger period | Resolution = 12 bits | | | | | - | - | 15 | 1/f _{ADC} | |
| V _{AIN} | Conversion voltage range | - | | | | | 0 | - | V _{REF+} | V | |
| V _{CMIV} | Common mode input voltage | - | | | | | V _{REF} /2 - 10% | V _{REF} /2 | V _{REF} /2 + 10% | | |

Table 87. 12-bit ADC characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------------------------|---|--|--------------------------|-----|-------|--------------------|
| R _{AIN} (7) | External input impedance | Resolution = 12 bits, T _J = 140 °C (tolerance 4 LSBs) | - | - | 321 | Ω |
| | | Resolution = 12 bits, T _J = 125 °C | - | - | 220 | |
| | | Resolution = 10 bits, T _J = 140 °C | - | - | 1039 | |
| | | Resolution = 10 bits, T _J = 125 °C | - | - | 2100 | |
| | | Resolution = 8 bits, T _J = 140 °C | - | - | 6327 | |
| | | Resolution = 8 bits, T _J = 125 °C | - | - | 12000 | |
| | | Resolution = 6 bits, T _J = 140 °C | - | - | 47620 | |
| | | Resolution = 6 bits, T _J = 125 °C | - | - | 80000 | |
| C _{ADC} | Internal sample and hold capacitor | - | - | 5 | - | pF |
| t _{ADCV} REG_ STUP | ADC LDO startup time | - | - | 5 | 10 | μs |
| t _{STAB} | ADC power-up time | LDO already started | 1 | - | - | conversion cycle |
| t _{OFF} CAL | Offset calibration time | - | 135 | - | - | 1/f _{ADC} |
| t _{LATR} | Trigger conversion latency for regular and injected channels without aborting the conversion | CKMODE = 00 | 1.5 | 2 | 2.5 | |
| | | CKMODE = 01 | - | - | 2.5 | |
| | | CKMODE = 10 | - | - | 2.5 | |
| | | CKMODE = 11 | - | - | 2.25 | |
| t _{LATR} INJ | Trigger conversion latency for regular and injected channels when a regular conversion is aborted | CKMODE = 00 | 2.5 | 3 | 3.5 | |
| | | CKMODE = 01 | - | - | 3.5 | |
| | | CKMODE = 10 | - | - | 3.5 | |
| | | CKMODE = 11 | - | - | 3.25 | |
| t _s | Sampling time | - | 2.5 | - | 640.5 | |
| t _{CONV} | Total conversion time (including sampling time) | N-bits resolution | t _s + 0.5 + N | - | - | |

Table 87. 12-bit ADC characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---|---------------------------|-----|-----|-----|--------|
| I _{D_{DA}} _{D(ADC)} | ADC consumption on V _{D_{DA}} and V _{REF} , Differential mode | f _S = 5 MSPS | - | 430 | - | µA |
| | | f _S = 1 MSPS | - | 133 | - | |
| | | f _S = 0.1 MSPS | - | 51 | - | |
| I _{D_{DA}} _{SE(ADC)} | ADC consumption on V _{D_{DA}} and V _{REF} , Single-ended mode | f _S = 5 MSPS | - | 350 | - | |
| | | f _S = 1 MSPS | - | 122 | - | |
| | | f _S = 0.1 MSPS | - | 47 | - | |
| I _{DD} (ADC) | ADC consumption on V _{DD} per f _{ADC} | - | - | 2.4 | - | µA/MHz |

1. Guaranteed by design.
2. The voltage booster on ADC switches must be used for V_{D_{DA}} < 2.4 V (embedded I/O switches).
3. Depending on the package, VREF+ can be internally connected to V_{D_{DA}} and VREF- to V_{SSA}.
4. Guaranteed by characterization for BGA and CSP packages. The values for LQFP packages may be different.
5. The conversion of the first element in the group is excluded.
6. f_{ADC} value corresponds to the maximum frequency that can be reached considering a 2.5 sampling period. For other SMPy sampling periods, the maximum frequency is f_{ADC} value * SMPy / 2.5 with a limitation to 75 MHz.
7. The tolerance is 2 LSBs for 12-bit, 10-bit and 8-bit resolutions. It is otherwise specified.

Table 88. Minimum sampling time vs R_{AIN} (12-bit ADC)⁽¹⁾⁽²⁾

| Resolution | R _{AIN} (Ω) | Minimum sampling time (s) | | |
|------------|----------------------|--------------------------------|------------------------------|------------------------------|
| | | Direct channels ⁽³⁾ | Fast channels ⁽⁴⁾ | Slow channels ⁽⁵⁾ |
| 12 bits | 47 | 5.55E-08 | 7.04E-08 | 1.03E-07 |
| | 68 | 5.76E-08 | 7.22E-08 | 1.05E-07 |
| | 100 | 6.17E-08 | 7.65E-08 | 1.07E-07 |
| | 150 | 7.02E-08 | 8.45E-08 | 1.13E-07 |
| | 220 | 8.59E-08 | 1.00E-07 | 1.22E-07 |
| | 330 | 1.11E-07 | 1.26E-07 | 1.41E-07 |
| | 470 | 1.46E-07 | 1.61E-07 | 1.69E-07 |
| | 680 | 1.98E-07 | 2.17E-07 | 2.25E-07 |

Table 88. Minimum sampling time vs R_{AIN} (12-bit ADC)⁽¹⁾⁽²⁾ (continued)

| Resolution | R _{AIN} (Ω) | Minimum sampling time (s) | | |
|------------|----------------------|--------------------------------|------------------------------|------------------------------|
| | | Direct channels ⁽³⁾ | Fast channels ⁽⁴⁾ | Slow channels ⁽⁵⁾ |
| 10 bits | 47 | 4.90E-08 | 6.06E-08 | 8.77E-08 |
| | 68 | 5.07E-08 | 6.27E-08 | 8.95E-08 |
| | 100 | 5.41E-08 | 6.67E-08 | 9.22E-08 |
| | 150 | 6.18E-08 | 7.50E-08 | 9.59E-08 |
| | 220 | 7.51E-08 | 8.70E-08 | 1.04E-07 |
| | 330 | 9.46E-08 | 1.07E-07 | 1.17E-07 |
| | 470 | 1.22E-07 | 1.34E-07 | 1.42E-07 |
| | 680 | 1.63E-07 | 1.77E-07 | 1.86E-07 |
| | 1000 | 2.27E-07 | 2.42E-07 | 2.43E-07 |
| | 1500 | 3.27E-07 | 3.40E-07 | 3.35E-07 |
| | 2200 | 4.53E-07 | 4.86E-07 | 4.73E-07 |
| | 3300 | 6.56E-07 | 6.93E-07 | 6.72E-07 |
| 8 bits | 47 | 4.35E-08 | 5.31E-08 | 7.36E-08 |
| | 68 | 4.47E-08 | 5.48E-08 | 7.47E-08 |
| | 100 | 4.72E-08 | 5.79E-08 | 7.63E-08 |
| | 150 | 5.33E-08 | 6.35E-08 | 7.88E-08 |
| | 220 | 6.26E-08 | 7.26E-08 | 8.47E-08 |
| | 330 | 7.84E-08 | 8.80E-08 | 9.48E-08 |
| | 470 | 9.80E-08 | 1.07E-07 | 1.14E-07 |
| | 680 | 1.28E-07 | 1.39E-07 | 1.43E-07 |
| | 1000 | 1.76E-07 | 1.88E-07 | 1.90E-07 |
| | 1500 | 2.49E-07 | 2.66E-07 | 2.64E-07 |
| | 2200 | 3.50E-07 | 3.63E-07 | 3.63E-07 |
| | 3300 | 5.09E-07 | 5.27E-07 | 5.24E-07 |
| | 4700 | 7.00E-07 | 7.28E-07 | 7.09E-07 |
| | 6800 | 9.84E-07 | 1.03E-06 | 1.00E-06 |
| | 10000 | 1.43E-06 | 1.48E-06 | 1.44E-06 |
| 15000 | 2.10E-06 | 2.18E-06 | 2.11E-06 | |

Table 88. Minimum sampling time vs R_{AIN} (12-bit ADC)⁽¹⁾⁽²⁾ (continued)

| Resolution | R_{AIN} (Ω) | Minimum sampling time (s) | | |
|------------|------------------------|--------------------------------|------------------------------|------------------------------|
| | | Direct channels ⁽³⁾ | Fast channels ⁽⁴⁾ | Slow channels ⁽⁵⁾ |
| 6 bits | 47 | 3.79E-08 | 4.58E-08 | 5.74E-08 |
| | 68 | 3.88E-08 | 4.69E-08 | 5.81E-08 |
| | 100 | 4.09E-08 | 4.89E-08 | 5.93E-08 |
| | 150 | 4.48E-08 | 5.25E-08 | 6.14E-08 |
| | 220 | 5.07E-08 | 5.81E-08 | 6.58E-08 |
| | 330 | 6.04E-08 | 6.79E-08 | 7.46E-08 |
| | 470 | 7.37E-08 | 8.10E-08 | 8.60E-08 |
| | 680 | 9.31E-08 | 1.01E-07 | 1.04E-07 |
| | 1000 | 1.23E-07 | 1.32E-07 | 1.34E-07 |
| | 1500 | 1.71E-07 | 1.82E-07 | 1.82E-07 |
| | 2200 | 2.39E-07 | 2.50E-07 | 2.49E-07 |
| | 3300 | 3.43E-07 | 3.57E-07 | 3.49E-07 |
| | 4700 | 4.72E-07 | 4.92E-07 | 4.81E-07 |
| | 6800 | 6.65E-07 | 6.89E-07 | 6.68E-07 |
| | 10000 | 9.54E-07 | 9.88E-07 | 9.54E-07 |
| 15000 | 1.40E-06 | 1.45E-06 | 1.39E-06 | |

1. Guaranteed by design.
2. Data valid up to 130 °C, with a 22 pF PCB capacitor and $V_{DDA} = 1.62$ V.
3. Direct channels are connected to analog I/Os (PA0_C, PA1_C, PC2_C and PC3_C) to optimize ADC performance.
4. Fast channels correspond to ADCx_INx[0:5].
5. Slow channels correspond to all ADC inputs except for the Direct and Fast channels.

Table 89. 12-bit ADC accuracy⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|--------|--------------------------------------|----------------|--------------|-----|--------------------|----------|------|
| ET | Total unadjusted error | Direct channel | Single ended | - | 3.5 | 5 | ±LSB |
| | | | Differential | - | 2.5 | 3 | |
| | | Fast channel | Single ended | - | 3.5 | 5 | |
| | | | Differential | - | 2.5 | 3 | |
| | | Slow channel | Single ended | - | 3.5 | 5 | |
| | | | Differential | - | 2.5 | 3 | |
| EO | Offset error | - | | - | +/-2 | +/-5 | |
| EG | Gain error | - | | - | TBD ⁽³⁾ | - | |
| ED | Differential linearity error | Single ended | | - | +/-0.75 | +1.5/-1 | ±LSB |
| | | Differential | | - | +/-0.5 | +1.25/-1 | |
| EL | Integral linearity error | Direct channel | Single ended | - | +/-1 | +/-2.5 | ±LSB |
| | | | Differential | - | +/-1 | +/-2 | |
| | | Fast channel | Single ended | - | +/-1 | +/-2.5 | |
| | | | Differential | - | +/-1 | +/-2 | |
| | | Slow channel | Single ended | - | +/-1 | +/-2.5 | |
| | | | Differential | - | +/-1 | +/-2 | |
| ENOB | Effective number of bits | Single ended | | - | 11.2 | - | bits |
| | | Differential | | - | 11.5 | - | |
| SINAD | Signal-to-noise and distortion ratio | Single ended | | - | 68.9 | - | dB |
| | | Differential | | - | 71.1 | - | |
| SNR | Signal-to-noise ratio | Single ended | | - | 69.1 | - | dB |
| | | Differential | | - | 71.4 | - | |
| THD | Total harmonic distortion | Single ended | | - | -79.6 | - | dB |
| | | Differential | | - | -81.8 | - | |

1. Guaranteed by characterization for BGA packages. The maximum values are preliminary data. The values for LQFP packages may be different.
2. ADC DC accuracy values are measured after internal calibration in Continuous and Discontinuous mode.
3. TBD stands for "to be defined".

6.3.24 DAC characteristics

Table 90. DAC characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|------------------------------------|---|--|-------------------------------|------------------|------------------|------------------------|----|
| V _{DDA} | Analog supply voltage | - | 1.8 | 3.3 | 3.6 | V | |
| V _{REF+} | Positive reference voltage | - | 1.80 | - | V _{DDA} | | |
| V _{REF-} | Negative reference voltage | - | - | V _{SSA} | - | | |
| R _L | Resistive Load | DAC output buffer ON | connected to V _{SSA} | 5 | - | - | kΩ |
| | | | connected to V _{DDA} | 25 | - | - | |
| R _O | Output Impedance | DAC output buffer OFF | | 10.3 | 13 | 16 | |
| R _{BON} | Output impedance sample and hold mode, output buffer ON | DAC output buffer ON | V _{DD} = 2.7 V | - | - | 1.6 | kΩ |
| | | | V _{DD} = 2.0 V | - | - | 2.6 | |
| R _{BOFF} | Output impedance sample and hold mode, output buffer OFF | DAC output buffer OFF | V _{DD} = 2.7 V | - | - | 17.8 | kΩ |
| | | | V _{DD} = 2.0 V | - | - | 18.7 | |
| C _L | Capacitive Load | DAC output buffer OFF | | - | - | 50 | pF |
| C _{SH} | | Sample and Hold mode | | - | 0.1 | 1 | μF |
| V _{DAC_OUT} | Voltage on DAC_OUT output | DAC output buffer ON | | 0.2 | - | V _{DDA} - 0.2 | V |
| | | DAC output buffer OFF | | 0 | - | V _{REF+} | |
| t _{SETTLING} | Settling time (full scale: for a 12-bit code transition between the lowest and the highest input codes when DAC_OUT reaches the final value of ±0.5LSB, ±1LSB, ±2LSB, ±4LSB, ±8LSB) | Normal mode, DAC output buffer ON, C _L ≤ 50 pF, R _L ≥ 5 kΩ | ±0.5 LSB | - | 2.05 | 3 | μs |
| | | | ±1 LSB | - | 1.97 | 2.87 | |
| | | | ±2 LSB | - | 1.67 | 2.84 | |
| | | | ±4 LSB | - | 1.66 | 2.78 | |
| | | | ±8 LSB | - | 1.65 | 2.7 | |
| | | Normal mode, DAC output buffer OFF, ±1LSB C _L =10 pF | | - | 1.7 | 2 | |
| t _{WAKEUP} ⁽²⁾ | Wakeup time from off state (setting the ENx bit in the DAC Control register) until the final value of ±1LSB is reached | Normal mode, DAC output buffer ON, C _L ≤ 50 pF, R _L = 5 kΩ | | - | 5 | 7.5 | μs |
| | | Normal mode, DAC output buffer OFF, C _L ≤ 10 pF | | - | 2 | 5 | |
| PSRR | DC V _{DDA} supply rejection ratio | Normal mode, DAC output buffer ON, C _L ≤ 50 pF, R _L = 5 kΩ | | - | -80 | -28 | dB |

Table 90. DAC characteristics⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|-----------------------|--|--|------------------------------------|---|------|------|----|
| t _{SAMP} | Sampling time in Sample and Hold mode C _L =100 nF (code transition between the lowest input code and the highest input code when DAC_OUT reaches the ±1LSB final value) | MODE<2:0>_V12=100/101 (BUFFER ON) | - | 0.7 | 2.6 | ms | |
| | | MODE<2:0>_V12=110 (BUFFER OFF) | - | 11.5 | 18.7 | | |
| | | MODE<2:0>_V12=111 (INTERNAL BUFFER OFF) | - | 0.3 | 0.6 | µs | |
| I _{leak} | Output leakage current | - | (3) | | | nA | |
| C _{lint} | Internal sample and hold capacitor | - | 1.8 | 2.2 | 2.6 | pF | |
| t _{TRIM} | Middle code offset trim time | Minimum time to verify the each code | 50 | - | - | µs | |
| V _{offset} | Middle code offset for 1 trim code step | V _{REF+} = 3.6 V | - | 850 | - | µV | |
| | | V _{REF+} = 1.8 V | - | 425 | - | | |
| I _{DDA(DAC)} | DAC quiescent consumption from V _{DDA} | DAC output buffer ON | No load, middle code (0x800) | - | 360 | - | µA |
| | | | No load, worst code (0xF1C) | - | 490 | - | |
| | | DAC output buffer OFF | No load, middle/worst code (0x800) | - | 20 | - | |
| | | Sample and Hold mode, C _{SH} =100 nF | - | 360*T _{ON} / (T _{ON} +T _{OFF}) ⁽⁴⁾ | - | | |
| I _{DDV(DAC)} | DAC consumption from V _{REF+} | DAC output buffer ON | No load, middle code (0x800) | - | 170 | - | µA |
| | | | No load, worst code (0xF1C) | - | 170 | - | |
| | | DAC output buffer OFF | No load, middle/worst code (0x800) | - | 160 | - | |
| | | Sample and Hold mode, Buffer ON, C _{SH} =100 nF (worst code) | - | 170*T _{ON} / (T _{ON} +T _{OFF}) ⁽⁴⁾ | - | | |
| | | Sample and Hold mode, Buffer OFF, C _{SH} =100 nF (worst code) | - | 160*T _{ON} / (T _{ON} +T _{OFF}) ⁽⁴⁾ | - | | |

1. Guaranteed by design unless otherwise specified.

2. In buffered mode, the output can overshoot above the final value for low input code (starting from the minimum value).
3. Refer to [Table 55: I/O static characteristics](#).
4. T_{ON} is the refresh phase duration, while T_{OFF} is the hold phase duration. Refer to the product reference manual for more details.

Table 91. DAC accuracy⁽¹⁾

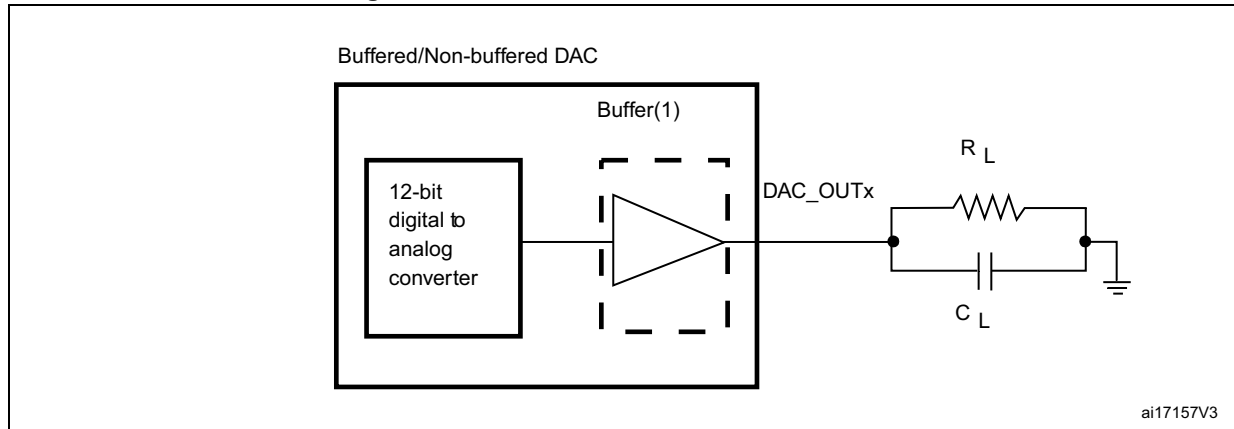
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|-----------|--|---|--------------------|------|----------|----------|-----|
| DNL | Differential non linearity ⁽²⁾ | DAC output buffer ON | -2 | - | 2 | LSB | |
| | | DAC output buffer OFF | -2 | - | 2 | | |
| - | Monotonicity | 10 bits | - | - | - | - | |
| INL | Integral non linearity ⁽³⁾ | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω | -4 | - | 4 | LSB | |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L | -4 | - | 4 | | |
| Offset | Offset error at code 0x800 ⁽³⁾ | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω | $V_{REF+} = 3.6$ V | - | - | ± 12 | LSB |
| | | | $V_{REF+} = 1.8$ V | - | - | ± 25 | |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L | - | - | ± 8 | | |
| Offset1 | Offset error at code 0x001 ⁽⁴⁾ | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L | - | - | ± 5 | LSB | |
| OffsetCal | Offset error at code 0x800 after factory calibration | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω | $V_{REF+} = 3.6$ V | - | - | ± 5 | LSB |
| | | | $V_{REF+} = 1.8$ V | - | - | ± 7 | |
| Gain | Gain error ⁽⁵⁾ | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω | - | - | ± 1 | % | |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L | - | - | ± 1 | | |
| TUE | Total unadjusted error | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω | - | - | ± 30 | LSB | |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L | - | - | ± 12 | | |
| TUECal | Total unadjusted error after calibration | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω | - | - | ± 23 | | |
| SNR | Signal-to-noise ratio ⁽⁶⁾ | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω , 1 kHz, BW = 500 KHz | - | 67.8 | - | dB | |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L , 1 kHz, BW = 500 KHz | - | 67.8 | - | | |

Table 91. DAC accuracy⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|---|---|-----|-------|-----|------|
| THD | Total harmonic distortion ⁽⁶⁾ | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω , 1 kHz | - | -78.6 | - | dB |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L , 1 kHz | - | -78.6 | - | |
| SINAD | Signal-to-noise and distortion ratio ⁽⁶⁾ | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω , 1 kHz | - | 67.5 | - | dB |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L , 1 kHz | - | 67.5 | - | |
| ENOB | Effective number of bits | DAC output buffer ON, $C_L \leq 50$ pF, $R_L \geq 5$ k Ω , 1 kHz | - | 10.9 | - | bits |
| | | DAC output buffer OFF, $C_L \leq 50$ pF, no R_L , 1 kHz | - | 10.9 | - | |

1. Guaranteed by characterization results.
2. Difference between two consecutive codes minus 1 LSB.
3. Difference between the value measured at Code *i* and the value measured at Code *i* on a line drawn between Code 0 and last Code 4095.
4. Difference between the value measured at Code (0x001) and the ideal value.
5. Difference between the ideal slope of the transfer function and the measured slope computed from code 0x000 and 0xFFFF when the buffer is OFF, and from code giving 0.2 V and ($V_{REF+} - 0.2$ V) when the buffer is ON.
6. Signal is -0.5dBFS with $F_{sampling}=1$ MHz.

Figure 50. 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.

6.3.25 Voltage reference buffer characteristics

Table 92. VREFBUF characteristics⁽¹⁾

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|-------------------------|--|---|----------------------------|---------------------------|--------|--|--------|
| V _{DDA} | Analog supply voltage | Normal mode, V _{DDA} = 3.3 V | VSCALE = 000 | 2.8 | 3.3 | 3.6 | V |
| | | | VSCALE = 001 | 2.4 | - | 3.6 | |
| | | | VSCALE = 010 | 2.1 | - | 3.6 | |
| | | | VSCALE = 011 | 1.8 | - | 3.6 | |
| | | Degraded mode ⁽²⁾ | VSCALE = 000 | 1.62 | - | 2.80 | |
| | | | VSCALE = 001 | 1.62 | - | 2.40 | |
| | | | VSCALE = 010 | 1.62 | - | 2.10 | |
| | | | VSCALE = 011 | 1.62 | - | 1.80 | |
| V _{REFBUF_OUT} | Voltage Reference Buffer Output, at 30 °C, I _{load} = 100 µA | Normal mode at 30 °C, I _{load} = 100 µA | VSCALE = 000 | 2.4980 | 2.5000 | 2.5035 | |
| | | | VSCALE = 001 | 2.0460 | 2.0490 | 2.0520 | |
| | | | VSCALE = 010 | 1.8010 | 1.8040 | 1.8060 | |
| | | | VSCALE = 011 | 1.4995 | 1.5015 | 1.5040 | |
| | | Degraded mode ⁽²⁾ | VSCALE = 000 | V _{DDA} - 150 mV | - | V _{DDA} | |
| | | | VSCALE = 001 | V _{DDA} - 150 mV | - | V _{DDA} | |
| | | | VSCALE = 010 | V _{DDA} - 150 mV | - | V _{DDA} | |
| | | | VSCALE = 011 | V _{DDA} - 150 mV | - | V _{DDA} | |
| TRIM | Trim step resolution | - | - | - | ±0.05 | ±0.1 | % |
| C _L | Load capacitor | - | - | 0.5 | 1 | 1.50 | µF |
| esr | Equivalent Serial Resistor of C _L | - | - | - | - | 2 | Ω |
| I _{LOAD} | Static load current | - | - | - | - | 4 | mA |
| I _{line_reg} | Line regulation | 2.8 V ≤ V _{DDA} ≤ 3.6 V | I _{load} = 500 µA | - | 200 | - | ppm/V |
| | | | I _{load} = 4 mA | - | 100 | - | |
| I _{load_reg} | Load regulation | 500 µA ≤ I _{LOAD} ≤ 4 mA | Normal mode | - | 50 | - | ppm/mA |
| T _{coeff} | Temperature coefficient | -40 °C < T _J < +130 °C | | - | - | T _{coeff} V _{REFINT} + 100 | ppm/°C |
| PSRR | Power supply rejection | DC | - | - | 60 | - | dB |
| | | 100KHZ | - | - | 40 | - | |

Table 92. VREFBUF characteristics⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|-------------------------------|--|----------------------------|---|-----|-----|-----|------|
| t _{START} | Start-up time | C _L =0.5 μF | - | - | 300 | - | μs |
| | | C _L =1 μF | - | - | 500 | - | |
| | | C _L =1.5 μF | - | - | 650 | - | |
| I _{INRUSH} | Control of maximum DC current drive on V _{REFBUF_OUT} during startup phase ⁽³⁾ | - | | - | 8 | - | mA |
| I _{DDA} (VREFBUF) | VREFBUF consumption from V _{DDA} | I _{LOAD} = 0 μA | - | - | 15 | 25 | μA |
| | | I _{LOAD} = 500 μA | - | - | 16 | 30 | |
| | | I _{LOAD} = 4 mA | - | - | 32 | 50 | |

1. Guaranteed by design, unless otherwise specified.
2. In degraded mode, the voltage reference buffer cannot accurately maintain the output voltage (V_{DDA}-drop voltage).
3. To properly control VREFBUF I_{INRUSH} current during the startup phase and the change of scaling, V_{DDA} voltage should be in the range of 1.8 V-3.6 V, 2.1 V-3.6 V, 2.4 V-3.6 V and 2.8 V-3.6 V for VSCALE = 011, 010, 001 and 000, respectively.

6.3.26 Analog temperature sensor characteristics

Table 93. Temperature sensor characteristics

| Symbol | Parameter | Min | Typ | Max | Unit |
|-------------------------------------|--|-----|------|------|-------|
| T _L ⁽¹⁾ | V _{SENSE} linearity with temperature | - | - | ±3 | °C |
| Avg_Slope ⁽²⁾ | Average slope | - | 2 | - | mV/°C |
| V ₃₀ ⁽³⁾ | Voltage at 30°C ± 5 °C | - | 0.62 | - | V |
| t _{start_run} | Startup time in Run mode (buffer startup) | - | - | 25.2 | μs |
| t _{S_temp} ⁽¹⁾ | ADC sampling time when reading the temperature | 9 | - | - | |
| I _{sens} ⁽¹⁾ | Sensor consumption | - | 0.18 | 0.31 | μA |
| I _{sensbuf} ⁽¹⁾ | Sensor buffer consumption | - | 3.8 | 6.5 | |

1. Guaranteed by design.
2. Guaranteed by characterization results.
3. Measured at V_{DDA} = 3.3 V ± 10 mV. The V₃₀ ADC conversion result is stored in the TS_CAL1 byte.

Table 94. Temperature sensor calibration values

| Symbol | Parameter | Memory address |
|---------|---|---------------------------|
| TS_CAL1 | Temperature sensor raw data acquired value at 30 °C, V _{DDA} =3.3 V | 0x1FF1 E820 - 0x1FF1 E821 |
| TS_CAL2 | Temperature sensor raw data acquired value at 130 °C, V _{DDA} =3.3 V | 0x1FF1 E840 - 0x1FF1 E841 |

6.3.27 Digital temperature sensor characteristics

Table 95. Digital temperature sensor characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------|--|---|------|------|--------|-------|
| $f_{DTS}^{(2)}$ | Output Clock frequency | - | 500 | 750 | 1150 | kHz |
| $T_{LC}^{(2)}$ | Temperature linearity coefficient | VOS2 | 1660 | 2100 | 2750 | Hz/°C |
| $T_{TOTAL_ERROR}^{(2)}$ | Temperature offset measurement, all VOS | $T_J = -40^{\circ}\text{C}$ to 30°C | -13 | - | 4 | °C |
| | | $T_J = 30^{\circ}\text{C}$ to T_{jmax} | -7 | - | 2 | |
| T_{VDD_CORE} | Additional error due to supply variation | VOS2 | 0 | - | 0 | °C |
| | | VOS0, VOS1, VOS3 | -1 | - | 1 | |
| t_{TRIM} | Calibration time | - | - | - | 2 | ms |
| t_{WAKE_UP} | Wake-up time from off state until DTS ready bit is set | - | - | 67 | 116.00 | μs |
| I_{DDCORE_DTS} | DTS consumption on VDD_CORE | - | 8.5 | 30 | 70.0 | μA |

1. Guaranteed by design, unless otherwise specified.
2. Guaranteed by characterization results.

6.3.28 Temperature and V_{BAT} monitoring

Table 96. V_{BAT} monitoring characteristics

| Symbol | Parameter | Min | Typ | Max | Unit |
|---------------------|--|-----|------|-----|------|
| R | Resistor bridge for V_{BAT} | - | 26 | - | KΩ |
| Q | Ratio on V_{BAT} measurement | - | 4 | - | - |
| $Er^{(1)}$ | Error on Q | -10 | - | +10 | % |
| $t_{S_vbat}^{(1)}$ | ADC sampling time when reading V_{BAT} input | 9 | - | - | μs |
| $V_{BAThigh}$ | High supply monitoring | - | 3.55 | - | V |
| V_{BATlow} | Low supply monitoring | - | 1.36 | - | |

1. Guaranteed by design.

Table 97. V_{BAT} charging characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|----------|---------------------------|--------------------|-----|-----|-----|------|
| R_{BC} | Battery charging resistor | VBRS in PWR_CR3= 0 | - | 5 | - | KΩ |
| | | VBRS in PWR_CR3= 1 | | 1.5 | - | |

Table 98. Temperature monitoring characteristics

| Symbol | Parameter | Min | Typ | Max | Unit |
|----------------------|-----------------------------|-----|-----|-----|------|
| TEMP _{high} | High temperature monitoring | - | 117 | - | °C |
| TEMP _{low} | Low temperature monitoring | - | -25 | - | |

6.3.29 Voltage booster for analog switch

Table 99. Voltage booster for analog switch characteristics⁽¹⁾

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|------------------------|----------------------|----------------------------------|------|-----|-----|------|
| V _{DD} | Supply voltage | - | 1.62 | 2.6 | 3.6 | V |
| t _{SU(BOOST)} | Booster startup time | - | - | - | 50 | µs |
| I _{DD(BOOST)} | Booster consumption | 1.62 V ≤ V _{DD} ≤ 2.7 V | - | - | 125 | µA |
| | | 2.7 V < V _{DD} < 3.6 V | - | - | 250 | |

1. Guaranteed by characterization results.

6.3.30 Comparator characteristics

Table 100. COMP characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|---|---------------------------|------|-----|------------------|------|
| V _{DDA} | Analog supply voltage | - | 1.62 | 3.3 | 3.6 | V |
| V _{IN} | Comparator input voltage range | - | 0 | - | V _{DDA} | |
| V _{BG} | Scaler input voltage | - | (2) | | | |
| V _{SC} | Scaler offset voltage | - | - | ±5 | ±10 | mV |
| I _{DDA(SCALER)} | Scaler static consumption from V _{DDA} | BRG_EN=0 (bridge disable) | - | 0.2 | 0.3 | µA |
| | | BRG_EN=1 (bridge enable) | - | 0.8 | 1 | |
| t _{START_SCALER} | Scaler startup time | - | - | 140 | 250 | µs |
| t _{START} | Comparator startup time to reach propagation delay specification | High-speed mode | - | 2 | 5 | µs |
| | | Medium mode | - | 5 | 20 | |
| | | Ultra-low-power mode | - | 15 | 80 | |
| t _D ⁽³⁾ | Propagation delay for 200 mV step with 100 mV overdrive | High-speed mode | - | 50 | 80 | ns |
| | | Medium mode | - | 0.5 | 0.9 | µs |
| | | Ultra-low-power mode | - | 2.5 | 7 | |
| | Propagation delay for step > 200 mV with 100 mV overdrive only on positive inputs | High-speed mode | - | 50 | 120 | µs |
| | | Medium mode | - | 0.5 | 1.2 | |
| | | Ultra-low-power mode | - | 2.5 | 7 | |
| V _{offset} | Comparator offset error | Full common mode range | - | ±5 | ±20 | mV |

Table 100. COMP characteristics⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|-----------------|---------------------------------------|----------------------|--|-----|-----|------|---------|
| V_{hys} | Comparator hysteresis | No hysteresis | - | 0 | - | mV | |
| | | Low hysteresis | 4 | 10 | 22 | | |
| | | Medium hysteresis | 8 | 20 | 37 | | |
| | | High hysteresis | 16 | 30 | 52 | | |
| $I_{DDA}(COMP)$ | Comparator consumption from V_{DDA} | Ultra-low-power mode | Static | - | 400 | 600 | nA |
| | | | With 50 kHz ± 100 mV overdrive square signal | - | 800 | - | |
| | | Medium mode | Static | - | 5 | 7 | μA |
| | | | With 50 kHz ± 100 mV overdrive square signal | - | 6 | - | |
| | | High-speed mode | Static | - | 70 | 100 | |
| | | | With 50 kHz ± 100 mV overdrive square signal | - | 75 | - | |

1. Guaranteed by design, unless otherwise specified.
2. Refer to [Table 21: Embedded reference voltage](#).
3. Guaranteed by characterization results.

6.3.31 Operational amplifier characteristics

Table 101. Operational amplifier characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|------------------------------|---|---------------------------------------|-----|-----------|-----------|-------------------|
| V_{DDA} | Analog supply voltage Range | - | 2 | 3.3 | 3.6 | V |
| CMIR | Common Mode Input Range | - | 0 | - | V_{DDA} | |
| V_{I_OFFSET} | Input offset voltage | 25°C, no load on output | - | - | ± 1.5 | mV |
| | | All voltages and temperature, no load | - | - | ± 2.5 | |
| ΔV_{I_OFFSET} | Input offset voltage drift | - | - | ± 3.0 | - | $\mu V/^{\circ}C$ |
| TRIMOFFSETP TRIMLPOFFSETP | Offset trim step at low common input voltage ($0.1 \cdot V_{DDA}$) | - | - | 1.1 | 1.5 | mV |
| TRIMOFFSETN TRIMLPOFFSETN | Offset trim step at high common input voltage ($0.9 \cdot V_{DDA}$) | - | - | 1.1 | 1.5 | |
| I_{LOAD} | Drive current | - | - | - | 500 | μA |
| I_{LOAD_PGA} | Drive current in PGA mode | - | - | - | 270 | |

Table 101. Operational amplifier characteristics⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|---------------------|--|--|--|-----|------|------|----|
| C _{LOAD} | Capacitive load | - | - | - | 50 | pF | |
| CMRR | Common mode rejection ratio | - | - | 80 | - | dB | |
| PSRR | Power supply rejection ratio | C _{LOAD} ≤ 50pf / R _{LOAD} ≥ 4 kΩ ⁽²⁾ at 1 kHz, V _{com} =V _{DDA} /2 | 50 | 66 | - | dB | |
| GBW | Gain bandwidth for high supply range | 200 mV ≤ Output dynamic range ≤ V _{DDA} - 200 mV | 4 | 7.3 | 12.3 | MHz | |
| SR | Slew rate (from 10% and 90% of output voltage) | Normal mode | - | 3 | - | V/μs | |
| | | High-speed mode | - | 24 | - | | |
| AO | Open loop gain | 200 mV ≤ Output dynamic range ≤ V _{DDA} - 200 mV | 59 | 90 | 129 | dB | |
| φ _m | Phase margin | - | - | 55 | - | ° | |
| GM | Gain margin | - | - | 12 | - | dB | |
| V _{OHSAT} | High saturation voltage | I _{load} =max or R _{LOAD} =min, Input at V _{DDA} | V _{DDA} -100 mV | - | - | mV | |
| V _{OLSAT} | Low saturation voltage | I _{load} =max or R _{LOAD} =min, Input at 0 V | - | - | 100 | | |
| t _{WAKEUP} | Wake up time from OFF state | Normal mode | C _{LOAD} ≤ 50pf, R _{LOAD} ≥ 4 kΩ, follower configuration | - | 0.8 | 3.2 | μs |
| | | High speed mode | C _{LOAD} ≤ 50pf, R _{LOAD} ≥ 4 kΩ, follower configuration | - | 0.9 | 2.8 | |
| PGA gain | Non inverting gain error value | PGA gain = 2 | -1 | - | 1 | % | |
| | | PGA gain = 4 | -2 | - | 2 | | |
| | | PGA gain = 8 | -2.5 | - | 2.5 | | |
| | | PGA gain = 16 | -3 | - | 3 | | |
| | Inverting gain error value | PGA gain = 2 | -1 | - | 1 | | |
| | | PGA gain = 4 | -1 | - | 1 | | |
| | | PGA gain = 8 | -2 | - | 2 | | |
| | | PGA gain = 16 | -3 | - | 3 | | |
| | External non-inverting gain error value | PGA gain = 2 | -1 | - | 1 | | |
| | | PGA gain = 4 | -3 | - | 3 | | |
| | | PGA gain = 8 | -3.5 | - | 3.5 | | |
| | | PGA gain = 16 | -4 | - | 4 | | |

Table 101. Operational amplifier characteristics⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|-------------------------|---|-----------------|-----------------------------------|--------|-----|-----------|------------|
| R _{network} | R2/R1 internal resistance values in non-inverting PGA mode ⁽³⁾ | PGA Gain=2 | - | 10/10 | - | kΩ/ kΩ | |
| | | PGA Gain=4 | - | 30/10 | - | | |
| | | PGA Gain=8 | - | 70/10 | - | | |
| | | PGA Gain=16 | - | 150/10 | - | | |
| | R2/R1 internal resistance values in inverting PGA mode ⁽³⁾ | PGA Gain = -1 | - | 10/10 | - | | |
| | | PGA Gain = -3 | - | 30/10 | - | | |
| | | PGA Gain = -7 | - | 70/10 | - | | |
| | | PGA Gain = -15 | - | 150/10 | - | | |
| Delta R | Resistance variation (R1 or R2) | - | -15 | - | 15 | % | |
| PGA BW | PGA bandwidth for different non inverting gain | Gain=2 | - | GBW/2 | - | MHz | |
| | | Gain=4 | - | GBW/4 | - | | |
| | | Gain=8 | - | GBW/8 | - | | |
| | | Gain=16 | - | GBW/16 | - | | |
| | PGA bandwidth for different inverting gain | Gain = -1 | - | 5.00 | - | MHz | |
| | | Gain = -3 | - | 3.00 | - | | |
| | | Gain = -7 | - | 1.50 | - | | |
| | | Gain = -15 | - | 0.80 | - | | |
| en | Voltage noise density | at 1 KHz | output loaded with 4 kΩ | - | 140 | - | nV/√ Hz |
| | | at 10 KHz | | - | 55 | - | |
| I _{DDA(OPAMP)} | OPAMP consumption from V _{DDA} | Normal mode | no Load, quiescent mode, follower | - | 570 | 1000 | μA |
| | | High-speed mode | | - | 610 | 1200 | |

1. Guaranteed by design, unless otherwise specified.
2. R_{LOAD} is the resistive load connected to V_{SSA} or to V_{DDA}.
3. R2 is the internal resistance between the OPAMP output and th OPAMP inverting input. R1 is the internal resistance between the OPAMP inverting input and ground. PGA gain = 1 + R2/R1.

6.3.32 Digital filter for Sigma-Delta Modulators (DFSDM) characteristics

Unless otherwise specified, the parameters given in [Table 102](#) for DFSDM are derived from tests performed under the ambient temperature, fCLKx frequency and supply voltage conditions summarized in [Table 13: General operating conditions](#).

- Output speed is set to OSPEEDRy[1:0] = 10
- Capacitive load C_L = 30 pF
- Measurement points are done at CMOS levels: 0.5V_{DD}
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics (DIFSDM_CKINx, DFSDM_DATINx, DFSDM_CKOUT for DFSDM).

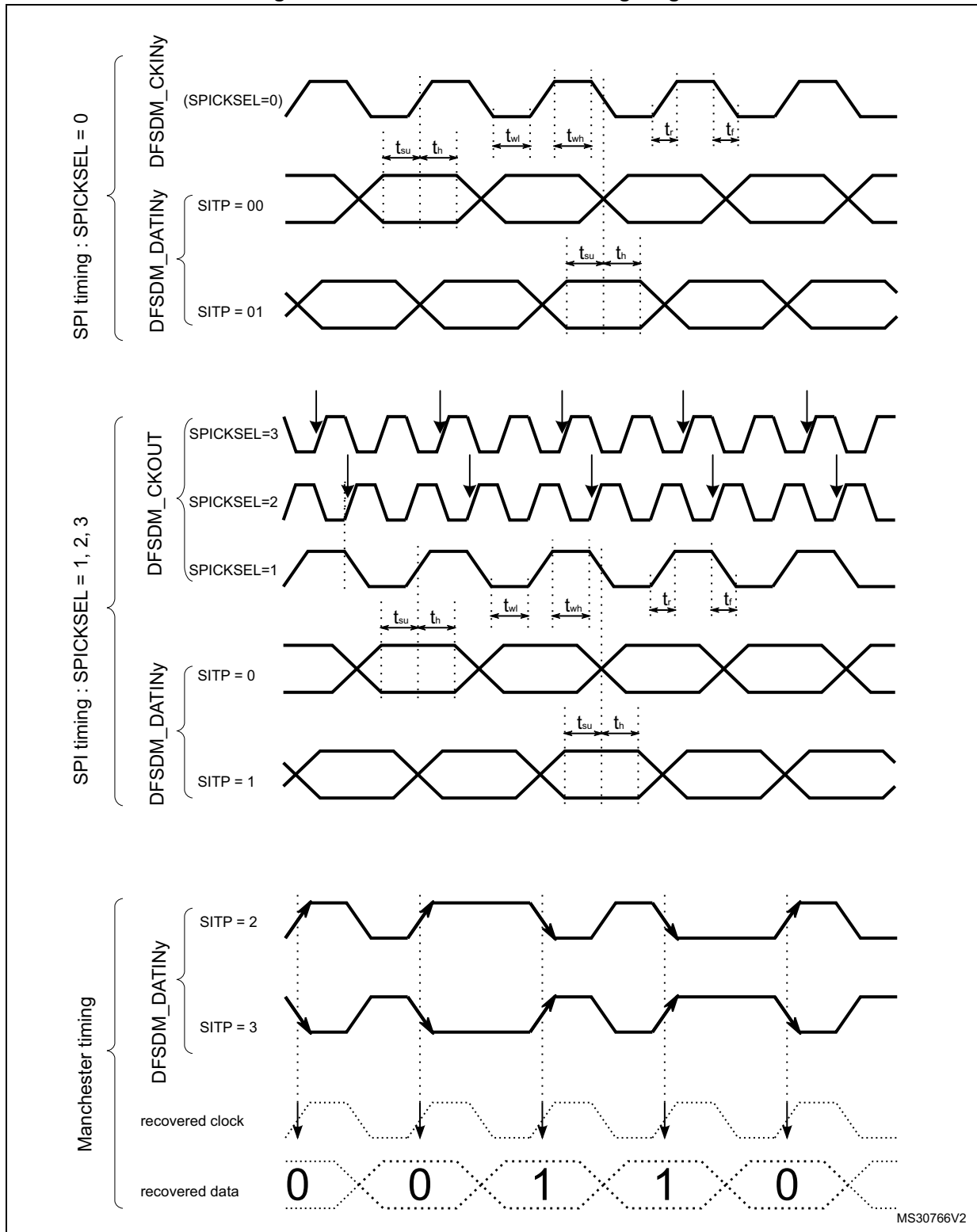
Table 102. DFSDM measured timing

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|-----------------------------------|--|---|----------------------------------|--------------------------------|----------------------------------|------|
| f _{DFSDMCLK} | DFSDM clock | 1.62 < V _{DD} < 3.6 V | | - | - | f _{SYSCLK} | MHz |
| f _{CKIN} (1/T _{CKIN}) | Input clock frequency | SPI mode (SITP[1:0] = 0,1), External clock mode (SPICKSEL[1:0] = 0) | | - | - | 20 | |
| | | SPI mode (SITP[1:0] = 0,1), Internal clock mode (SPICKSEL[1:0] ≠ 0) | | - | - | 20 | |
| f _{CKOUT} | Output clock frequency | 1.62 < V _{DD} < 3.6 V | | - | - | 20 | |
| DuCy _{CKOUT} | Output clock frequency duty cycle | 1.62 < V _{DD} < 3.6 V | Even division, CKOUTDIV = n, 1, 3, 5.. | 45 | 50 | 55 | % |
| | | | Odd division, CKOUTDIV = n, 2, 4, 6.. | $\frac{((n/2+1)/(n+1))}{*100}-5$ | $\frac{((n/2+1)/(n+1))}{*100}$ | $\frac{((n/2+1)/(n+1))}{*100}+5$ | |

Table 102. DFSDM measured timing (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------------------------|---|---|-------------------------------|--------------|-------------------------------|------|
| $t_{wh(CKIN)}$ $t_{wl(CKIN)}$ | Input clock high and low time | SPI mode (SITP[1:0] = 0,1), External clock mode (SPICKSEL[1:0] = 0) | $T_{CKIN}/2-0.5$ | $T_{CKIN}/2$ | - | ns |
| t_{su} | Data input setup time | SPI mode (SITP[1:0] = 0,1), External clock mode (SPICKSEL[1:0] = 0) | 2 | - | - | |
| t_h | Data input hold time | SPI mode (SITP[1:0] = 0,1), External clock mode (SPICKSEL[1:0] = 0) | 1 | - | - | |
| $T_{Manchester}$ | Manchester data period (recovered clock period) | Manchester mode (SITP[1:0] = 2,3), Internal clock mode (SPICKSEL[1:0] ≠ 0) | $(CKOUTDIV+1) * T_{DFSDMCLK}$ | - | $(2*CKOUTDIV) * T_{DFSDMCLK}$ | |

Figure 51. Channel transceiver timing diagrams



6.3.33 Camera interface (DCMI) timing specifications

Unless otherwise specified, the parameters given in [Table 103](#) for DCMI are derived from tests performed under the ambient temperature, f_{HCLK} frequency and VDD supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

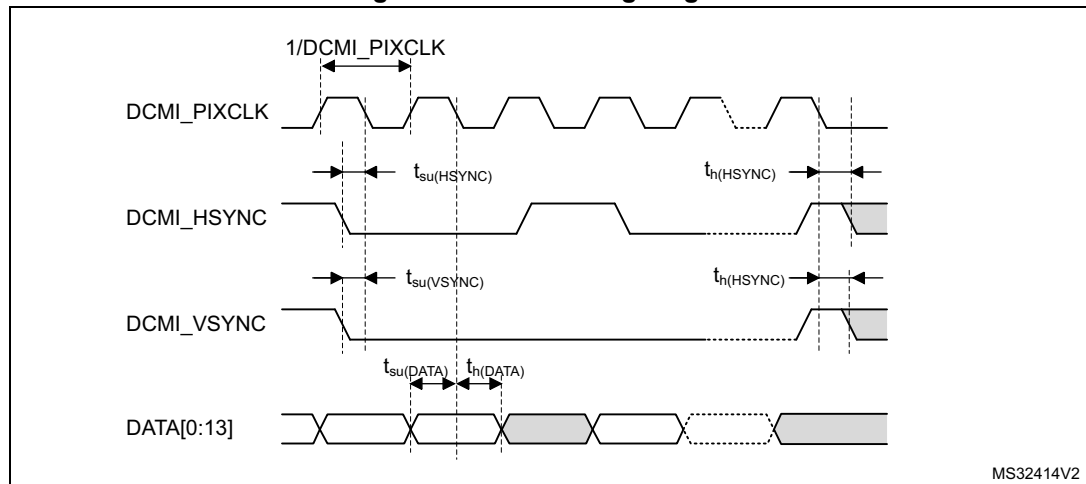
- DCMI_PIXCLK polarity: falling
- DCMI_VSYNC and DCMI_HSYNC polarity: high
- Data formats: 14 bits
- Capacitive load $C_L=30$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- VOS level set to VOS0

Table 103. DCMI characteristics⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|--------------------------------------|---|-----|-----|------|
| - | Frequency ratio DCMI_PIXCLK/ f_{HCLK} | - | 0.4 | - |
| DCMI_PIXCLK | Pixel Clock input | - | 110 | MHz |
| D_{pixel} | Pixel Clock input duty cycle | 30 | 70 | % |
| $t_{su}(DATA)$ | Data input setup time | 2 | - | ns |
| $t_h(DATA)$ | Data hold time | 1 | - | |
| $t_{su}(HSYNC)$, $t_{su}(VSYNC)$ | DCMI_HSYNC/ DCMI_VSYNC input setup time | 2 | - | |
| $t_h(HSYNC)$, $t_h(VSYNC)$ | DCMI_HSYNC/ DCMI_VSYNC input hold time | 1 | - | |

1. Guaranteed by characterization results.

Figure 52. DCMI timing diagram



6.3.34 Parallel synchronous slave interface (PSSI) characteristics

Unless otherwise specified, the parameters given in [Table 104](#) and [Table 105](#) for PSSI are derived from tests performed under the ambient temperature, f_{HCLK} frequency and VDD supply voltage summarized in [Table 13: General operating conditions](#).

Table 104. PSSI transmit characteristics⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|----------------|--|-----|-------------------|------|
| - | Frequency ratio PSSI_PDCK/ f_{HCLK} | - | 0.4 | - |
| PSSI_PDCK | PSSI Clock input | - | 50 | MHz |
| | | - | 35 ⁽²⁾ | |
| D_{pixel} | PSSI Clock input duty cycle | 30 | 70 | % |
| $t_{ov}(DATA)$ | Data output valid time | - | 10 | ns |
| - | - | - | 14 ⁽²⁾ | |
| $t_{oh}(DATA)$ | Data output hold time | 4.5 | - | |
| $t_{ov}(DE)$ | DE output valid time | - | 10 | |
| $t_{oh}(DE)$ | DE output hold time | 4 | - | |
| $t_{su}(RDY)$ | RDY input setup time | 0 | - | |
| $t_h(RDY)$ | RDY input hold time | 0 | - | |

1. Guaranteed by characterization results.
2. This value is obtained by using PA9, PA10 or PH4 I/O.

Table 105. PSSI receive characteristics⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|----------------|--|-----|-----|------|
| - | Frequency ratio PSSI_PDCK/ f_{HCLK} | - | 0.4 | - |
| PSSI_PDCK | PSSI Clock input | - | 110 | MHz |
| D_{pixel} | PSSI Clock input duty cycle | 30 | 70 | % |
| $t_{su}(DATA)$ | Data input setup time | 1.5 | - | ns |
| $t_h(DATA)$ | Data input hold time | 0.5 | - | |
| $t_{su}(DE)$ | DE input setup time | 2 | - | |
| $t_h(DE)$ | DE input hold time | 1 | - | |
| $t_{ov}(RDY)$ | RDY output valid time | - | 15 | |
| $t_{oh}(RDY)$ | RDY output hold time | 5.5 | - | |

1. Guaranteed by characterization results.

6.3.35 LCD-TFT controller (LTDC) characteristics

Unless otherwise specified, the parameters given in [Table 106](#) for LCD-TFT are derived from tests performed under the ambient temperature, f_{HCLK} frequency and VDD supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

- LCD_CLK polarity: high
- LCD_DE polarity: low
- LCD_VSYNC and LCD_HSYNC polarity: high
- Pixel formats: 24 bits
- Output speed is set to OSPEEDRy[1:0] = 11
- Capacitive load $C_L=30$ pF
- Measurement points are done at CMOS levels: 0.5VDD
- IO Compensation cell activated.
- HSLV activated when $V_{DD} \leq 2.7$ V
- VOS level set to VOS0

Table 106. LTDC characteristics⁽¹⁾

| Symbol | Parameter | | Min | Max | Unit |
|---|----------------------------------|-------------------------------|--------------------|------------------------|------|
| f_{CLK} | LTDC clock output frequency | $2.7 < V_{DD} < 3.6$ V, 20 pF | - | 150 | MHz |
| | | $2.7 < V_{DD} < 3.6$ V | | 133 | |
| | | $1.62 < V_{DD} < 3.6$ V | | 90/76.5 ⁽²⁾ | |
| D_{CLK} | LTDC clock output duty cycle | | 45 | 55 | % |
| $t_{w(CLKH)}$, $t_{w(CLKL)}$ | Clock High time, low time | | $t_{w(CLK)}/2-0.5$ | $t_{w(CLK)}/2+0.5$ | ns |
| $t_{v(DATA)}$ | Data output valid time | $2.7 < V_{DD} < 3.6$ V | - | 2.0 | |
| | | $1.62 < V_{DD} < 3.6$ V | | 2.5/6.5 ⁽²⁾ | |
| $t_{h(DATA)}$ | Data output hold time | | 0 | - | |
| $t_{v(HSYNC)}$, $t_{v(VSYNC)}$, $t_{v(DE)}$ | HSYNC/VSYNC/DE output valid time | $2.7 < V_{DD} < 3.6$ V | - | 1.5 | |
| | | $1.62 < V_{DD} < 3.6$ V | - | 2.0 | |
| $t_{h(HSYNC)}$, $t_{h(VSYNC)}$, $t_{h(DE)}$ | HSYNC/VSYNC/DE output hold time | | 0 | - | |

1. Guaranteed by characterization results.
2. This value is valid when PA[9], PA[10], PA[11], PA[12], PA[15], PB[11], PH[4], PJ[8], PJ[9], PJ[10], PJ[11], PK[0], PK[1] or PK[2] is used.

Figure 53. LCD-TFT horizontal timing diagram

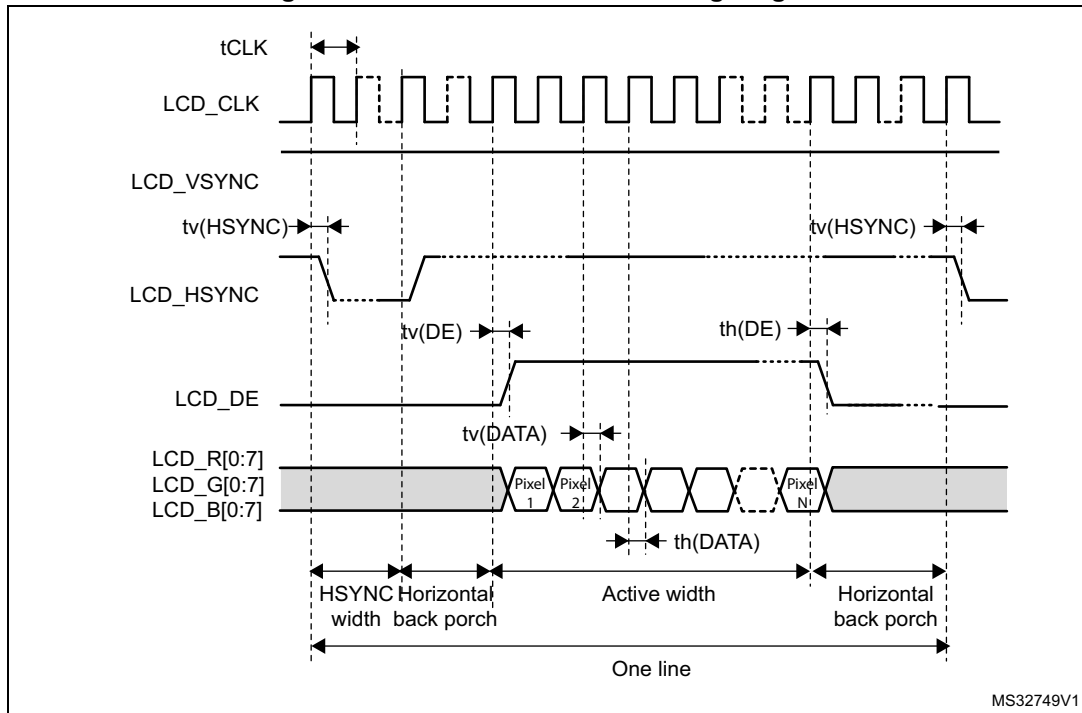
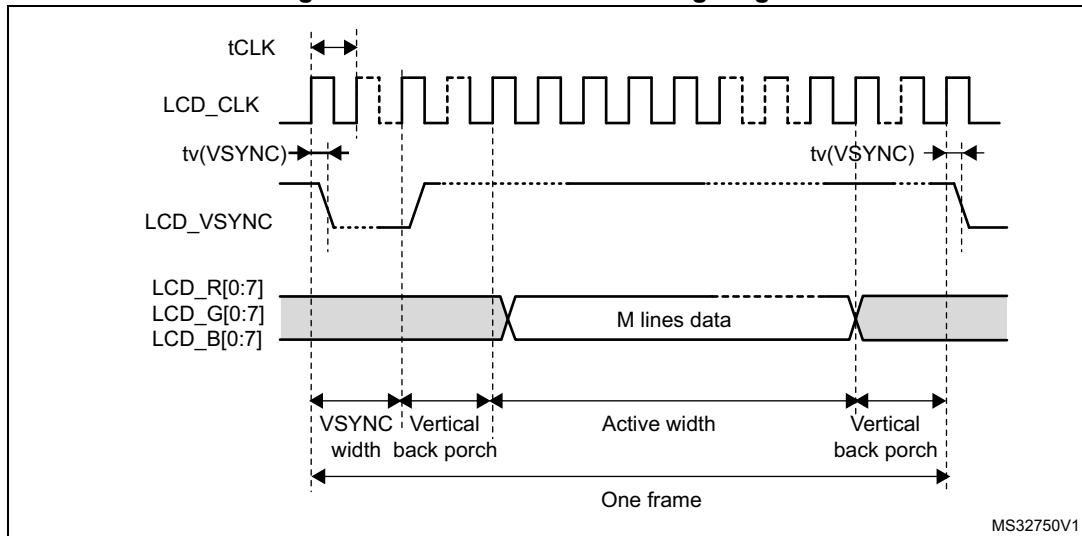


Figure 54. LCD-TFT vertical timing diagram



6.3.36 Timer characteristics

The parameters given in [Table 107](#) are guaranteed by design.

Refer to [Section 6.3.17: I/O port characteristics](#) for details on the input/output alternate function characteristics (output compare, input capture, external clock, PWM output).

Table 107. TIMx characteristics⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions ⁽³⁾ | Min | Max | Unit |
|------------------------|--|--|-----|-------------------------|----------------------|
| t _{res(TIM)} | Timer resolution time | AHB/APBx prescaler=1 or 2 or 4, f _{TIMxCLK} = 275 MHz | 1 | - | t _{TIMxCLK} |
| | | AHB/APBx prescaler>4, f _{TIMxCLK} = 137.5 MHz | 1 | - | t _{TIMxCLK} |
| f _{EXT} | Timer external clock frequency on CH1 to CH4 | f _{TIMxCLK} = 240 MHz | 0 | f _{TIMxCLK} /2 | MHz |
| Res _{TIM} | Timer resolution | | - | 16/32 | bit |
| t _{MAX_COUNT} | Maximum possible count with 32-bit counter | - | - | 65536 × 65536 | t _{TIMxCLK} |

1. TIMx is used as a general term to refer to the TIM1 to TIM17 timers.
2. Guaranteed by design.
3. The maximum timer frequency on APB1 or APB2 is up to 275 MHz, by setting the TIMPRE bit in the RCC_CFGR register, if APBx prescaler is 1 or 2 or 4, then TIMxCLK = rcc_hclk1, otherwise TIMxCLK = 4 × F_{rcc_pclkx1} or TIMxCLK = 4 × F_{rcc_pclkx2}.

6.3.37 Low-power timer characteristics

The parameters given in [Table 108](#) are guaranteed by design.

Refer to [Section 6.3.17: I/O port characteristics](#) for details on the input/output alternate function characteristics (output compare, input capture, external clock, PWM output).

Table 108. LPTIMx characteristics⁽¹⁾⁽²⁾

| Symbol | Parameter | Min | Max | Unit |
|------------------------|---|-----|---------------------------|----------------------|
| t _{res(TIM)} | Timer resolution time | 1 | - | t _{TIMxCLK} |
| f _{LPTIMxCLK} | Timer kernel clock | 0 | 137.5 | MHz |
| f _{EXT} | Timer external clock frequency on Input1 and Input2 | 0 | f _{LPTIMxCLK} /2 | |
| Res _{TIM} | Timer resolution | - | 16 | bit |
| t _{MAX_COUNT} | Maximum possible count | - | 65536 | t _{TIMxCLK} |

1. LPTIMx is used as a general term to refer to the LPTIM1 to LPTIM5 timers.
2. Guaranteed by design.

6.3.38 Communication interfaces

I²C interface characteristics

The I²C interface meets the timings requirements of the I2C-bus specification and user manual revision 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 1 Mbit/s.

The I²C timings requirements are guaranteed by design when the I²C peripheral is properly configured (refer to RM0399 reference manual) and when the i2c_ker_ck frequency is greater than the minimum shown in the table below:

Table 109. Minimum i2c_ker_ck frequency in all I²C modes

| Symbol | Parameter | Condition | | Min | Unit |
|-----------|------------------|----------------|----------------------------|-----|------|
| f(I2CCLK) | I2CCLK frequency | Standard-mode | - | 2 | MHz |
| | | Fast-mode | Analog Filtre ON DNF=0 | 8 | |
| | | | Analog Filtre OFF DNF=1 | 9 | |
| | | Fast-mode Plus | Analog Filtre ON DNF=0 | 17 | |
| | | | Analog Filtre OFF 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 still present.
- The 20 mA 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:

$$t_{r(SDA/SCL)} = 0.8473 \times R_P \times C_{Load}$$

$$R_{P(min)} = (V_{DD} - V_{OL(max)}) / I_{OL(max)}$$

Where R_P is the I2C lines pull-up. Refer to [Section 6.3.17: I/O port characteristics](#) for the I²C I/Os characteristics.

All I²C SDA and SCL I/Os embed an analog filter. Refer to the table below for the analog filter characteristics:

Table 110. I²C analog filter characteristics⁽¹⁾

| Symbol | Parameter | Min | Max | Unit |
|-----------------|--|-------------------|-------------------|------|
| t _{AF} | Maximum pulse width of spikes that are suppressed by analog filter | 50 ⁽²⁾ | 80 ⁽³⁾ | 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.

USART interface characteristics

Unless otherwise specified, the parameters given in [Table 111](#) for USART are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Capacitive load $C_L = 30$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- VOS level set to VOS0

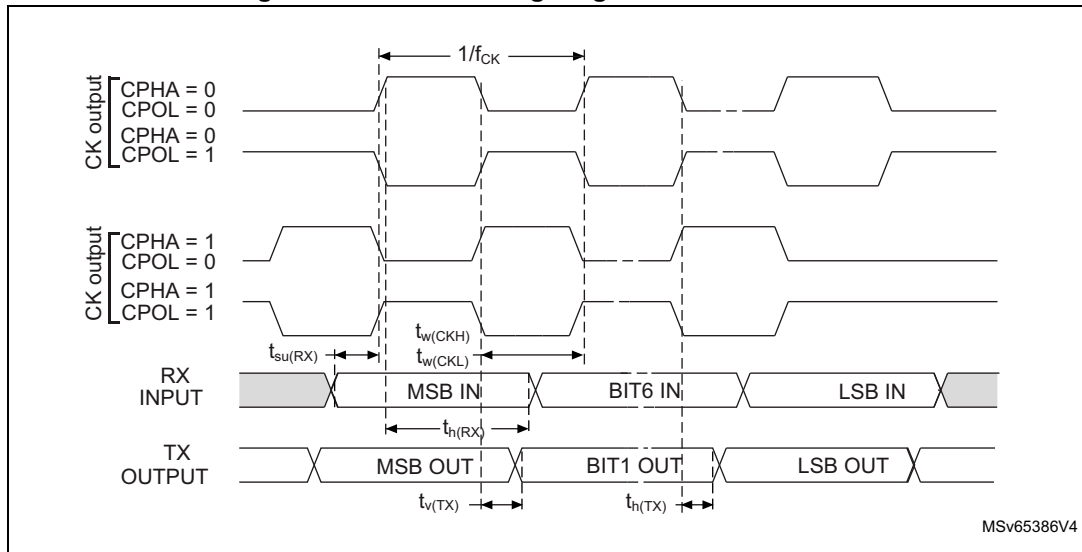
Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics (NSS, CK, TX, RX for USART).

Table 111. USART characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------------------------|------------------------|--|----------------|--------------|----------------|------|
| f_{CK} | USART clock frequency | Master mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | - | - | 17.0 | MHz |
| | | Slave receiver mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | | | 45.0 | |
| | | Slave transmitter mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | - | - | 27.0 | |
| | | Slave transmitter mode, $2.5\text{ V} < V_{DD} < 3.6\text{ V}$ | | | 37.0 | |
| $t_{su(NSS)}$ | NSS setup time | Slave mode | $t_{ker}+1$ | - | - | ns |
| $t_{h(NSS)}$ | NSS hold time | Slave mode | 2 | - | - | |
| $t_{w(SCKH)}$, $t_{w(SCKL)}$ | CK high and low time | Master mode | $1/f_{CK}/2-2$ | $1/f_{CK}/2$ | $1/f_{CK}/2+2$ | |
| $t_{su(RX)}$ | Data input setup time | Master mode | 16 | - | - | |
| | | Slave mode | 1.0 | - | - | |
| $t_{h(RX)}$ | Data input hold time | Master mode | 0 | - | - | |
| | | Slave mode | 2.0 | - | - | |
| $t_{v(TX)}$ | Data output valid time | Slave mode, , $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | - | 12.0 | 18 | |
| | | Slave mode, , $2.5\text{ V} < V_{DD} < 3.6\text{ V}$ | - | 12.0 | 13.5 | |
| | | Master mode | - | 0.5 | 1 | |
| $t_{h(TX)}$ | Data output hold time | Slave mode | 9 | - | - | |
| | | Master mode | 0 | - | - | |

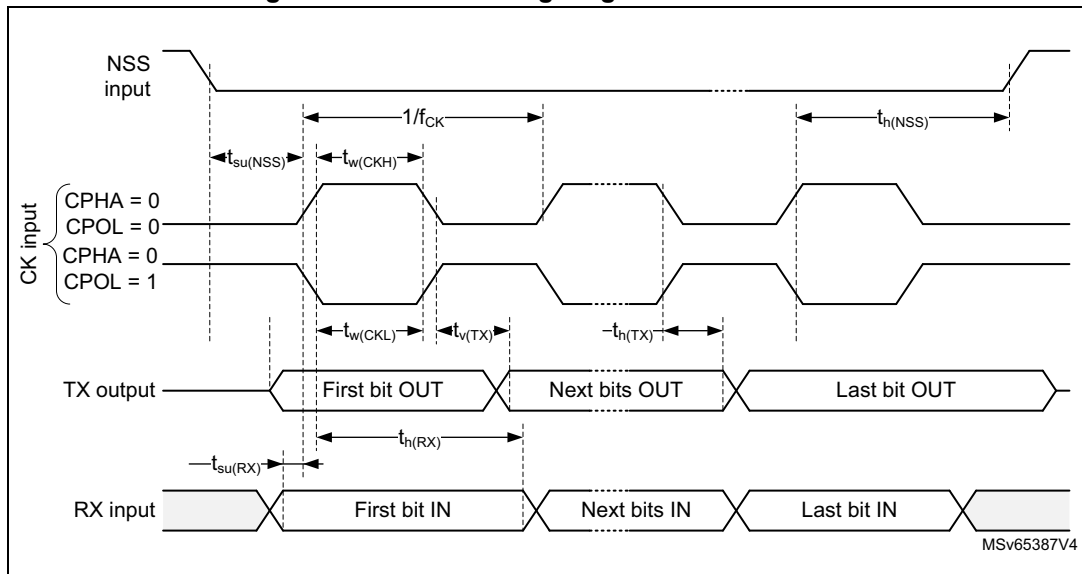
1. Guaranteed by characterization results.

Figure 55. USART timing diagram in Master mode



1. Measurement points are done at $0.5V_{DD}$ and with external $C_L = 30\text{ pF}$.

Figure 56. USART timing diagram in Slave mode



SPI interface characteristics

Unless otherwise specified, the parameters given in [Table 112](#) for SPI are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to $OSPEEDRy[1:0] = 11$
- Capacitive load $C_L = 30$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- HSLV activated when $V_{DD} \leq 2.7$ V
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics (NSS, SCK, MOSI, MISO for SPI).

Table 112. SPI characteristics⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|------------------------------|-----------------------|--|---------------------|-------------------|------------------------|------|
| f_{SCK} | SPI clock frequency | Master mode, $2.7\text{ V} < V_{DD} < 3.6\text{ V}$, SPI1, 2, 3 | - | - | 125 | MHz |
| | | Master mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$, SPI1, 2, 3 | | | 80/66 ⁽³⁾ | |
| | | Master mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$, SPI4, 5, 6 | | | 68.5 | |
| | | Slave receiver mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$, SPI1, 2, 3 | | | 100 | |
| | | Slave receiver mode, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$, SPI4, 5, 6 | | | 68.5 | |
| | | Slave mode transmitter/full duplex, $2.7\text{ V} < V_{DD} < 3.6\text{ V}$ | | | 45 | |
| | | Slave mode transmitter/full duplex, $1.62\text{ V} < V_{DD} < 3.6\text{ V}$ | | | 42.5/31 ⁽⁴⁾ | |
| $t_{su(NSS)}$ | NSS setup time | Slave mode | 2 | - | - | - |
| $t_h(NSS)$ | NSS hold time | Slave mode | 1 | - | - | |
| $t_w(SCKH)$, $t_w(SCKL)$ | SCK high and low time | Master mode | $t_{SCK}/2-1^{(5)}$ | $t_{SCK}/2^{(5)}$ | $t_{SCK}/2+1^{(5)}$ | |

Table 112. SPI characteristics⁽¹⁾⁽²⁾ (continued)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------|--------------------------|---|-----|-----|------------------------|------|
| $t_{su(MI)}$ | Data input setup time | Master mode | 2.5 | - | - | ns |
| $t_{su(SI)}$ | | Slave mode | 1 | - | - | |
| $t_{h(MI)}$ | Data input hold time | Master mode | 3 | - | - | |
| $t_{h(SI)}$ | | Slave mode | 1.5 | - | - | |
| $t_{a(SO)}$ | Data output access time | Slave mode | 9 | 13 | 27 | |
| $t_{dis(SO)}$ | Data output disable time | Slave mode | 0 | 1 | 5 | |
| $t_{v(SO)}$ | Data output valid time | Slave mode, 2.7 V < V_{DD} < 3.6 V | - | 7.5 | 11 | |
| | | Slave mode, 1.62 V < V_{DD} < 3.6 V | - | 7.5 | 12/16 ⁽⁴⁾ | |
| $t_{v(MO)}$ | | Master mode, 1.62 V < V_{DD} < 3.6 V | - | 1 | 1.5/5.5 ⁽⁶⁾ | |
| $t_{h(SO)}$ | Data output hold time | Slave mode | 7 | - | - | |
| $t_{h(MO)}$ | | Master mode | 0.5 | - | - | |

1. Guaranteed by characterization results.
2. The values given in the above table might be degraded when PC3_C/PC2_C I/Os are used (not available on all packages).
3. This value is obtained by using PA9 or PA12 I/O.
4. This value is obtained by using PC2 or PJ11 I/O.
5. $t_{SCK} = t_{ker_ck} * \text{baud rate prescaler}$.
6. This value is obtained by using PC3 or PJ10 I/O.

Figure 57. SPI timing diagram - slave mode and CPHA = 0

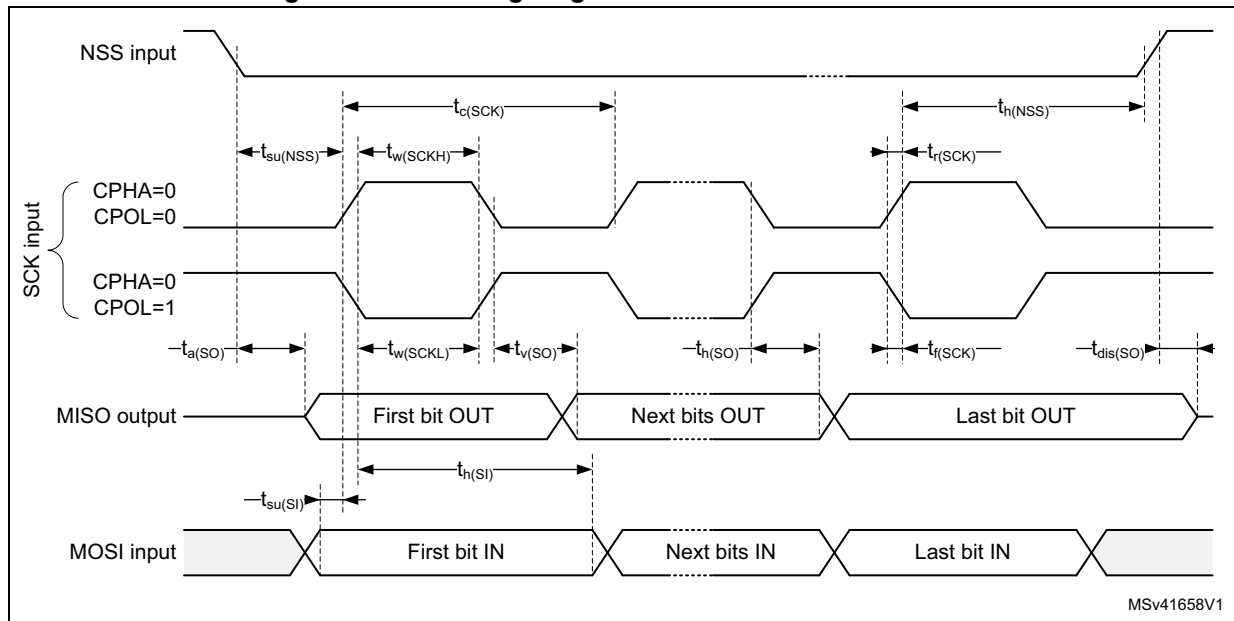
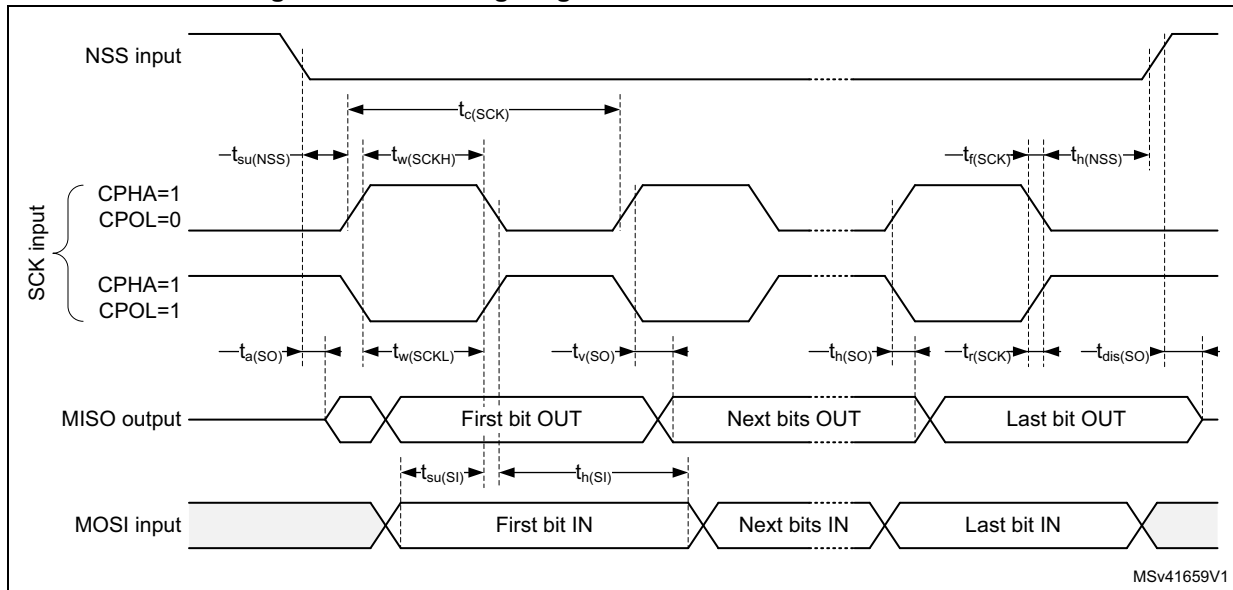
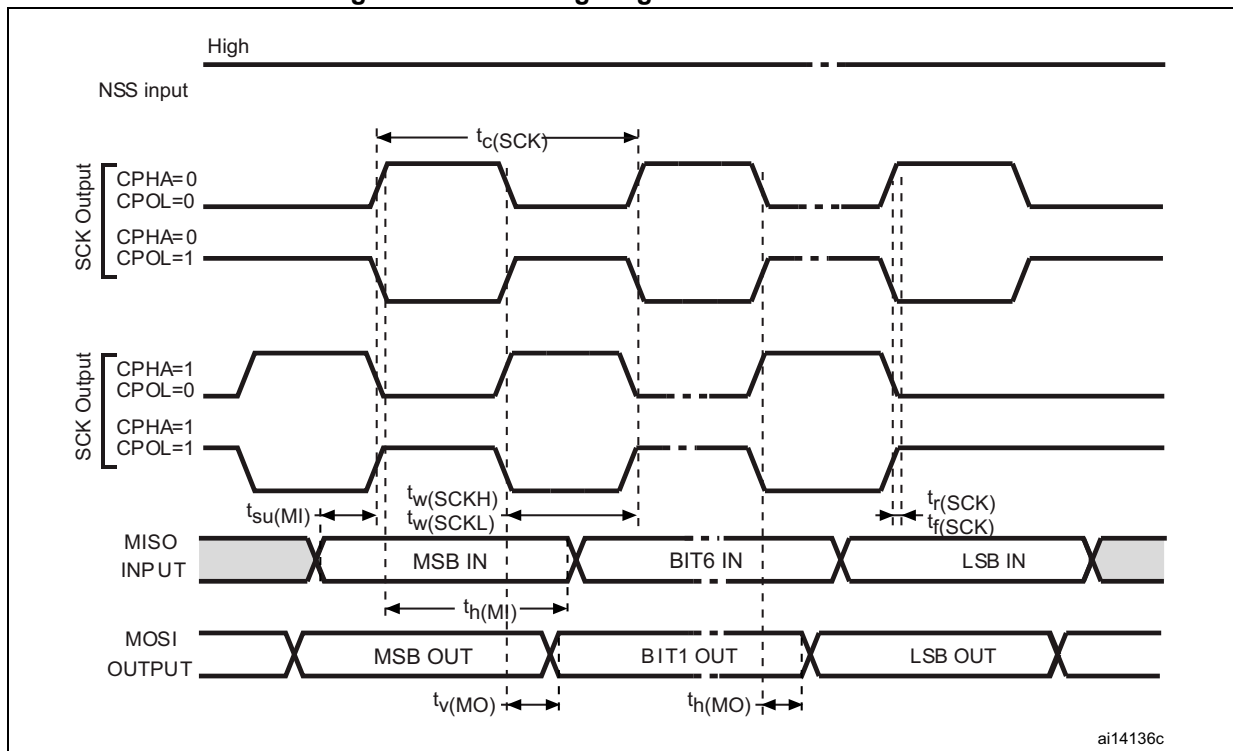


Figure 58. SPI timing diagram - slave mode and CPHA = 1⁽¹⁾



1. Measurement points are done at 0.5V_{DD} and with external C_L = 30 pF.

Figure 59. SPI timing diagram - master mode⁽¹⁾



1. Measurement points are done at 0.5V_{DD} and with external C_L = 30 pF.

I²S Interface characteristics

Unless otherwise specified, the parameters given in [Table 113](#) for I²S are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Capacitive load $C_L = 30$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- HSLV activated when $V_{DD} \leq 2.7$ V
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics (CK,SD,WS).

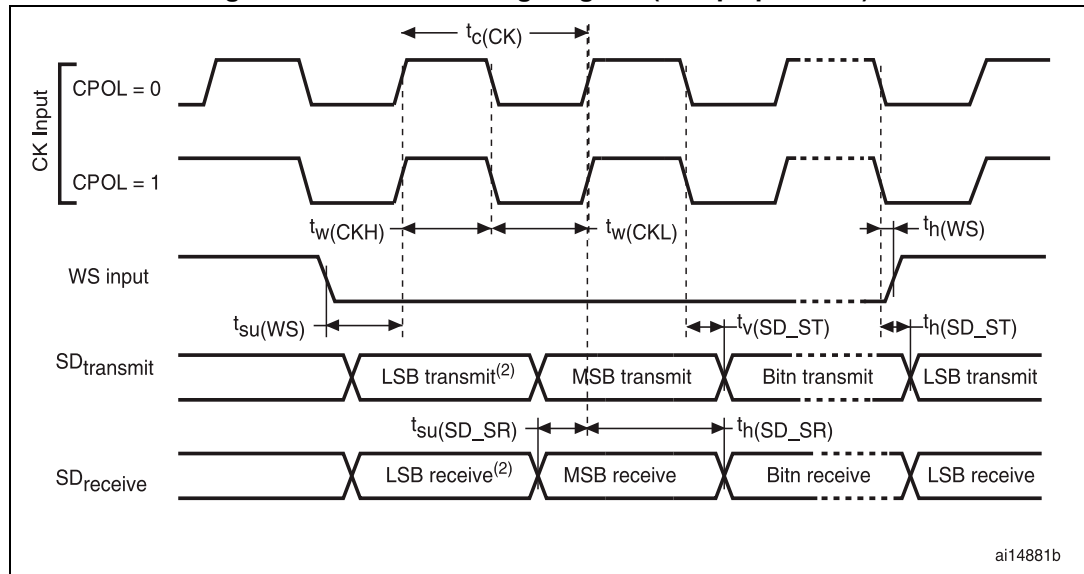
Table 113. I²S dynamic characteristics⁽¹⁾

| Symbol | Parameter | Conditions | Min | Max | Unit |
|------------------|------------------------------------|--|-----|------------------------|------|
| f_{MCK} | I ² S main clock output | - | - | 50 | MHz |
| | | Master transmitter | - | 50/40 ⁽²⁾ | |
| | | Master receiver | - | 50/40 ⁽²⁾ | |
| | | Slave transmitter | - | 41.5/31 ⁽³⁾ | |
| | | Slave receiver | - | 50 | |
| $t_{v(WS)}$ | WS valid time | Master mode | - | 2/6 ⁽⁴⁾ | ns |
| $t_{h(WS)}$ | WS hold time | | 1 | - | |
| $t_{su(WS)}$ | WS setup time | Slave mode | 3 | - | |
| $t_{h(WS)}$ | WS hold time | | 1 | - | |
| $t_{su(SD_MR)}$ | Data input setup time | Master receiver | 2.5 | - | |
| $t_{su(SD_SR)}$ | | Slave receiver | 1 | - | |
| $t_{h(SD_MR)}$ | Data input hold time | Master receiver | 3 | - | |
| $t_{h(SD_SR)}$ | | Slave receiver | 1.5 | - | |
| $t_{v(SD_ST)}$ | Data output valid time | Slave transmitter (after enable edge) | - | 12/16 ⁽³⁾ | |
| $t_{v(SD_MT)}$ | | Master transmitter (after enable edge) | - | 2/6 ⁽⁵⁾ | |
| $t_{h(SD_ST)}$ | Data output hold time | Slave transmitter (after enable edge) | 6.5 | - | |
| $t_{h(SD_MT)}$ | | Master transmitter (after enable edge) | 0.5 | - | |

1. Guaranteed by characterization results.
2. This value is obtained when PA9 or PA12 are used.
3. This value is obtained when PC2 is used.
4. This value is obtained when PA11 or PA15 are used.

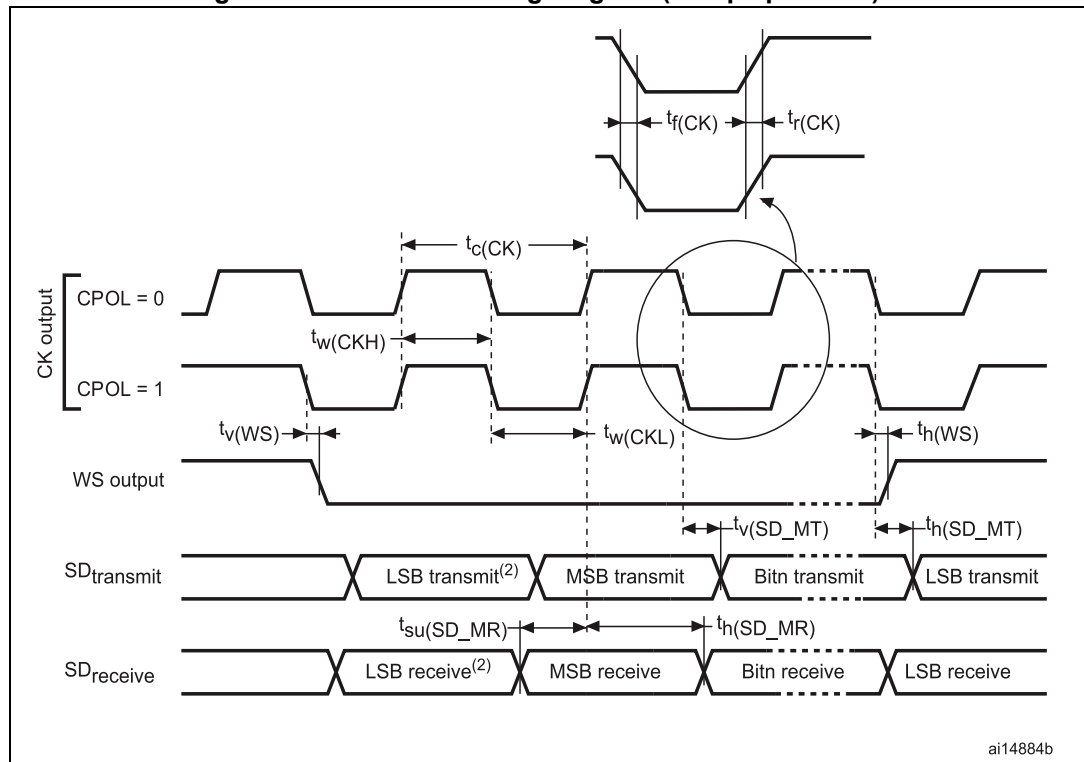
- This value is obtained when PC3 is used.

Figure 60. I²S slave timing diagram (Philips protocol)⁽¹⁾



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

Figure 61. I²S master timing diagram (Philips protocol)⁽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 114](#) for SAI are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and VDD supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 10
- Capacitive load $C_L = 30$ pF
- IO Compensation cell activated.
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output alternate function characteristics (SCK,SD,WS).

Table 114. SAI characteristics⁽¹⁾

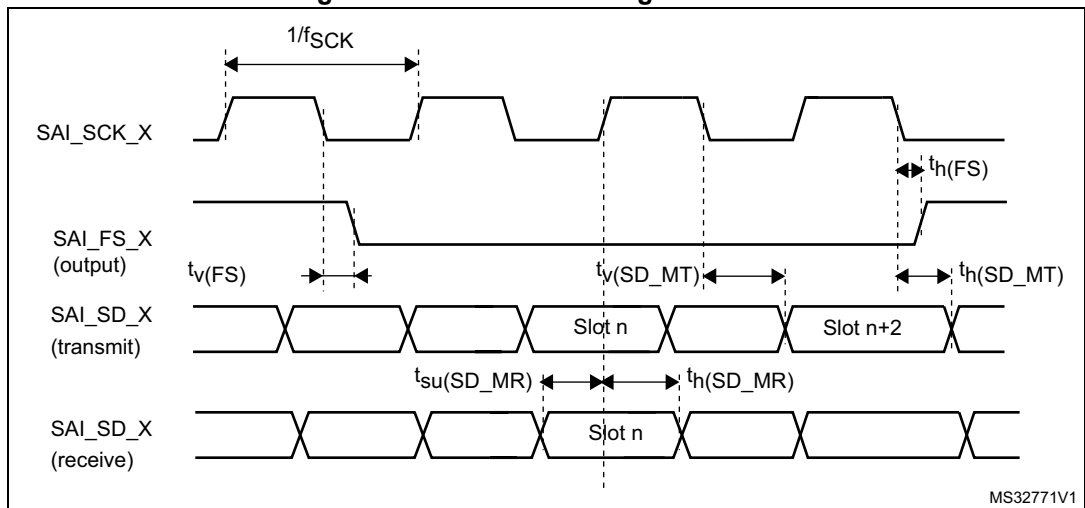
| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|------------------------------------|---|-----|------|------|
| f_{MCK} | SAI Main clock output | - | - | 50 | MHz |
| f_{CK} | SAI clock frequency ⁽²⁾ | Master transmitter, $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 45 | |
| | | Master transmitter, $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 32 | |
| | | Master receiver, $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 32 | |
| | | Slave transmitter, $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 47.5 | |
| | | Slave transmitter, $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 41.5 | |
| | | Slave receiver, $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 50 | |

Table 114. SAI characteristics⁽¹⁾ (continued)

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---------------------|------------------------|--|-----|------|------|
| $t_{v(FS)}$ | F_S valid time | Master mode, $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 11 | ns |
| | | Master mode, $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 15.5 | |
| $t_{su(FS)}$ | F_S setup time | Slave mode | 2.5 | - | |
| $t_{h(FS)}$ | F_S hold time | Master mode | 6 | - | |
| | | Slave mode | 0.5 | - | |
| $t_{su(SD_A_MR)}$ | Data input setup time | Master receiver | 3 | - | |
| $t_{su(SD_B_SR)}$ | | Slave receiver | 3.5 | - | |
| $t_{h(SD_A_MR)}$ | Data input hold time | Master receiver | 3.5 | - | |
| $t_{h(SD_B_SR)}$ | | Slave receiver | 0 | - | |
| $t_{v(SD_B_ST)}$ | Data output valid time | Slave transmitter (after enable edge), $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 10.5 | |
| | | Slave transmitter (after enable edge), $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 12 | |
| $t_{h(SD_B_ST)}$ | Data output hold time | Slave transmitter (after enable edge) | 6.5 | - | |
| $t_{v(SD_A_MT)}$ | Data output valid time | Master transmitter (after enable edge), $2.7\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 10.5 | |
| | | Master transmitter (after enable edge), $1.62\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ | - | 14.5 | |
| $t_{h(SD_A_MT)}$ | Data output hold time | Master transmitter (after enable edge) | 6 | - | |

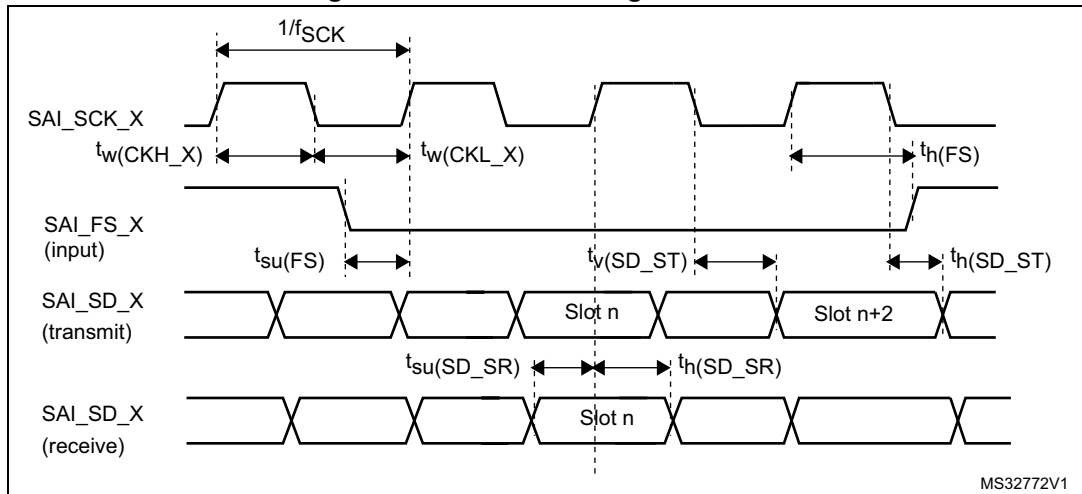
1. Guaranteed by characterization results.
2. APB clock frequency must be at least twice SAI clock frequency.

Figure 62. SAI master timing waveforms



MS32771V1

Figure 63. SAI slave timing waveforms



MDIO characteristics

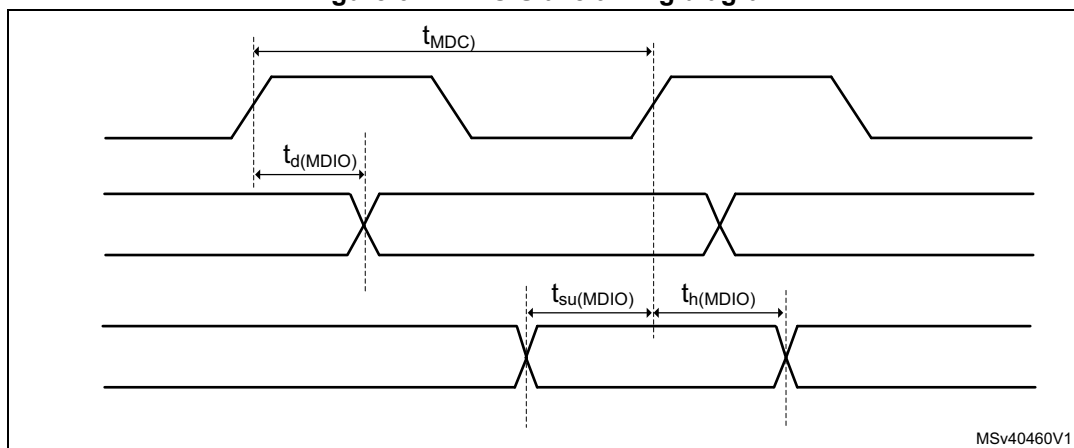
Unless otherwise specified, the parameters given in [Table 115](#) for the MDIO are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and VDD supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 10
- I/O Compensation cell activated.
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- HSLV activated when $V_{DD} \leq 2.7 V$
- VOS level set to VOS0

Table 115. MDIO Slave timing parameters

| Symbol | Parameter | Min | Typ | Max | Unit |
|----------------|--|-----|-----|-----|------|
| F_{MDC} | Management Data Clock | - | - | 30 | MHz |
| $t_d(MDIO)$ | Management Data Input/output output valid time | 8 | 10 | 18 | ns |
| $t_{su}(MDIO)$ | Management Data Input/output setup time | 1 | - | - | |
| $t_h(MDIO)$ | Management Data Input/output hold time | 1 | - | - | |

Figure 64. MDIO Slave timing diagram



MSv40460V1

SD/SDIO MMC card host interface (SDMMC) characteristics

Unless otherwise specified, the parameters given in [Table 116](#) and [Table 117](#) for SDIO are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and VDD supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Capacitive load $C_L=30$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- HSLV activated when $V_{DD} \leq 2.7$ V
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output characteristics.

Table 116. Dynamics characteristics: SD / MMC characteristics, $V_{DD} = 2.7$ to 3.6 V⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|---------------------------------------|-------------------------|-----|-----|-----|------|
| f_{PP} | Clock frequency in data transfer mode | - | 0 | - | 120 | MHz |
| - | SDIO_CK/fPCLK2 frequency ratio | - | - | - | 8/3 | - |
| $t_{W(CKL)}$ | Clock low time | $f_{PP} = 52\text{MHz}$ | 8.5 | 9.5 | - | ns |
| $t_{W(CKH)}$ | Clock high time | | 8.5 | 9.5 | - | |
| CMD, D inputs (referenced to CK) in eMMC legacy/SDR/DDR and SD HS/SDR/DDR mode | | | | | | |
| t_{ISU} | Input setup time HS | - | 2.5 | - | - | ns |
| t_{IH} | Input hold time HS | - | 0.5 | - | - | |
| $t_{IDW}^{(3)}$ | Input valid window (variable window) | - | 1.5 | - | - | |
| CMD, D outputs (referenced to CK) in eMMC legacy/SDR/DDR and SD HS/SDR/DDR mode | | | | | | |
| t_{OV} | Output valid time HS | - | - | 5.5 | 6 | ns |
| t_{OH} | Output hold time HS | - | 4.5 | - | - | |

Table 116. Dynamics characteristics: SD / MMC characteristics, $V_{DD} = 2.7$ to 3.6 V⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|------------------------------|------------|-----|-----|-----|------|
| CMD, D inputs (referenced to CK) in SD default mode | | | | | | |
| t_{ISUD} | Input setup time SD | - | 1.5 | | - | ns |
| t_{IHD} | Input hold time SD | - | 0.5 | | - | |
| CMD, D outputs (referenced to CK) in SD default mode | | | | | | |
| t_{OVD} | Output valid default time SD | - | - | 1 | 1 | ns |
| t_{OHD} | Output hold default time SD | - | 0 | - | - | |

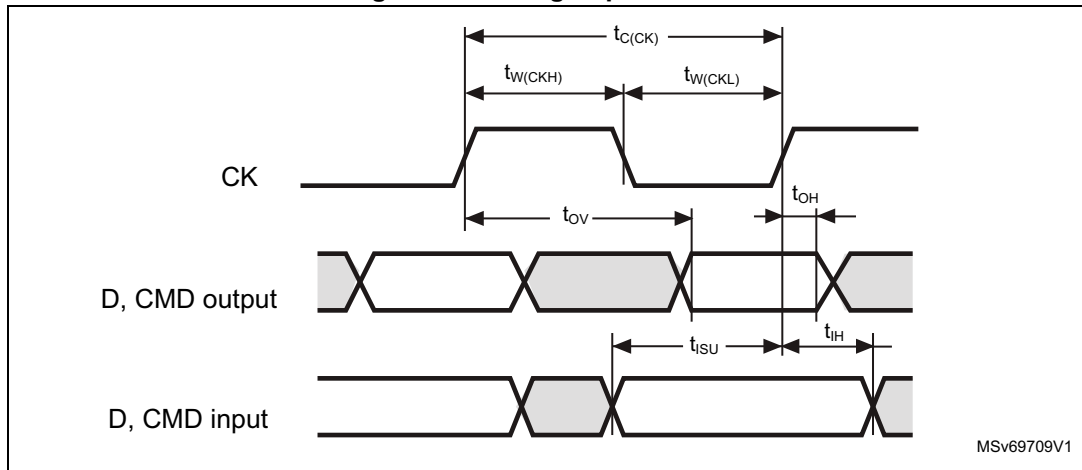
1. Guaranteed by characterization results.
2. Above 100 MHz, $C_L = 20$ pF.
3. The minimum window of time where the data needs to be stable for proper sampling in tuning mode.

Table 117. Dynamics characteristics: eMMC characteristics $V_{DD} = 1.71$ V to 1.9 V⁽¹⁾⁽²⁾

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---------------------------------------|-------------------|-----|-----|-----|------|
| f_{PP} | Clock frequency in data transfer mode | - | 0 | - | 85 | MHz |
| - | SDIO_CK/fPCLK2 frequency ratio | - | - | - | 8/3 | - |
| $t_{W(CKL)}$ | Clock low time | $f_{PP} = 52$ MHz | 8.5 | 9.5 | - | ns |
| $t_{W(CKH)}$ | Clock high time | | 8.5 | 9.5 | - | |
| CMD, D inputs (referenced to CK) in eMMC mode | | | | | | |
| t_{ISU} | Input setup time HS | - | 1.5 | - | - | ns |
| t_{IH} | Input hold time HS | - | 1.5 | - | - | |
| $t_{IDW}^{(3)}$ | Input valid window (variable window) | - | 3.5 | - | - | |
| CMD, D outputs (referenced to CK) in eMMC mode | | | | | | |
| t_{OVD} | Output valid time HS | - | - | 6 | 6.5 | ns |
| t_{OHD} | Output hold time HS | - | 5.5 | - | - | |

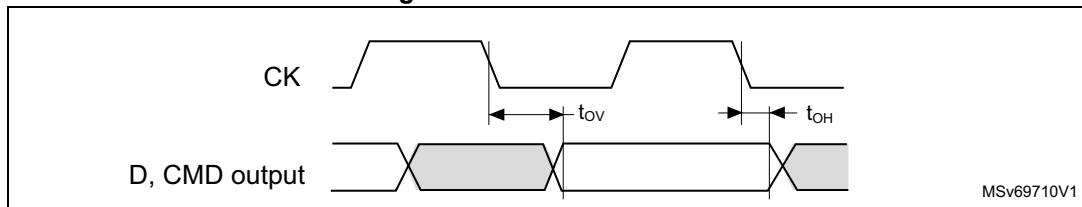
1. Guaranteed by characterization results.
2. $C_L = 20$ pF.
3. The minimum window of time where the data needs to be stable for proper sampling in tuning mode.

Figure 65. SD high-speed mode



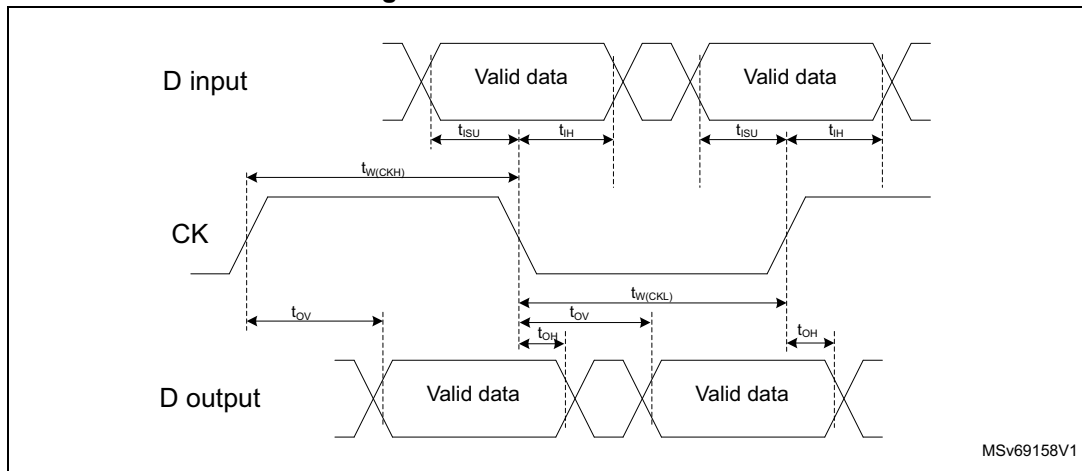
MSv69709V1

Figure 66. SD default mode



MSv69710V1

Figure 67. SDRAM DDR mode



MSv69158V1

USB OTG_FS characteristics

Unless otherwise specified, the parameters given in [Table 119](#) for ULPI are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and V_{DD} supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to $OSPEEDRy[1:0] = 11$
- Capacitive load $C_L = 20$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output characteristics.

Table 118. USB OTG_FS electrical characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---------------|--|---------------------|--------------------|------|------|------|
| $V_{DD33USB}$ | USB transceiver operating voltage | - | 3.0 ⁽¹⁾ | - | 3.6 | V |
| R_{PUI} | Embedded USB_DP pull-up value during idle | - | 900 | 1250 | 1600 | Ω |
| R_{PUR} | Embedded USB_DP pull-up value during reception | - | 1400 | 2300 | 3200 | |
| Z_{DRV} | Output driver impedance ⁽²⁾ | Driver high and low | 28 | 36 | 44 | |

- The USB functionality is ensured down to 2.7 V. However, not all USB electrical characteristics are degraded in the 2.7 to 3.0 V voltage range.
- No external termination series resistors are required on USB_DP (D+) and USB_DM (D-); the matching impedance is already included in the embedded driver.

USB OTG_HS characteristics

Unless otherwise specified, the parameters given in [Table 119](#) for ULPI are derived from tests performed under the ambient temperature, f_{PCLKx} frequency and V_{DD} supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Capacitive load $C_L=20$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- VOS level set to VOS0

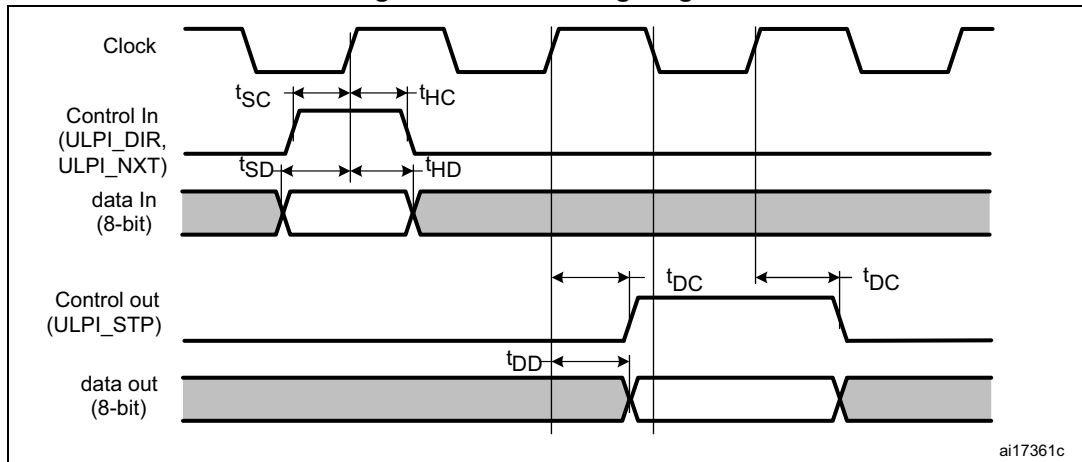
Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output characteristics.

Table 119. Dynamics characteristics: USB ULPI⁽¹⁾

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|-----------------|--|---|-----|-----|-----|------|
| t_{SC} | Control in (ULPI_DIR, ULPI_NXT) setup time | - | 5.5 | - | - | ns |
| t_{HC} | Control in (ULPI_DIR, ULPI_NXT) hold time | - | 0 | - | - | |
| t_{SD} | Data in setup time | - | 2.5 | - | - | |
| t_{HD} | Data in hold time | - | 0 | - | - | |
| t_{DC}/t_{DD} | Control/Data output delay | $2.7\text{ V} < V_{DD} < 3.6\text{ V}$, $C_L = 20\text{ pF}$ | - | 6.0 | 8.0 | |
| | | $1.71\text{ V} < V_{DD} < 3.6\text{ V}$, $C_L = 15\text{ pF}$ | - | 6.0 | 12 | |

- Guaranteed by characterization results.

Figure 68. ULPI timing diagram



Ethernet interface characteristics

Unless otherwise specified, the parameters given in [Table 120](#), [Table 121](#) and [Table 122](#) for SMI, RMII and MII are derived from tests performed under the ambient temperature, $f_{rcc_c_ck}$ frequency and V_{DD} supply voltage conditions summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 10
- Capacitive load $C_L=20$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- IO Compensation cell activated.
- HSLV activated when $VDD \leq 2.7$ V
- VOS level set to VOS1

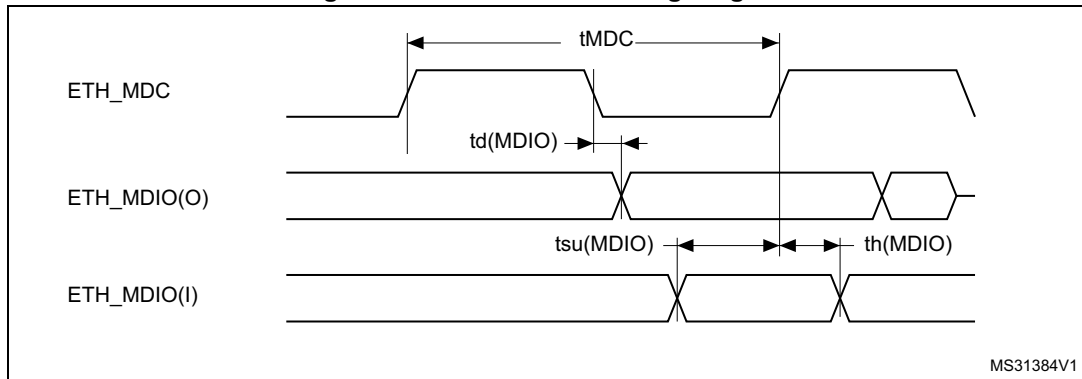
Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output characteristics:

Table 120. Dynamics characteristics: Ethernet MAC signals for SMI ⁽¹⁾

| Symbol | Parameter | Min | Typ | Max | Unit |
|----------------|--------------------------|------|-----|-----|------|
| t_{MDC} | MDC cycle time(2.5 MHz) | 400 | 400 | 403 | ns |
| $T_d(MDIO)$ | Write data valid time | 0.5 | 1.5 | 4 | |
| $t_{su}(MDIO)$ | Read data setup time | 12.5 | - | - | |
| $t_h(MDIO)$ | Read data hold time | 0 | - | - | |

1. Guaranteed by characterization results.

Figure 69. Ethernet SMI timing diagram



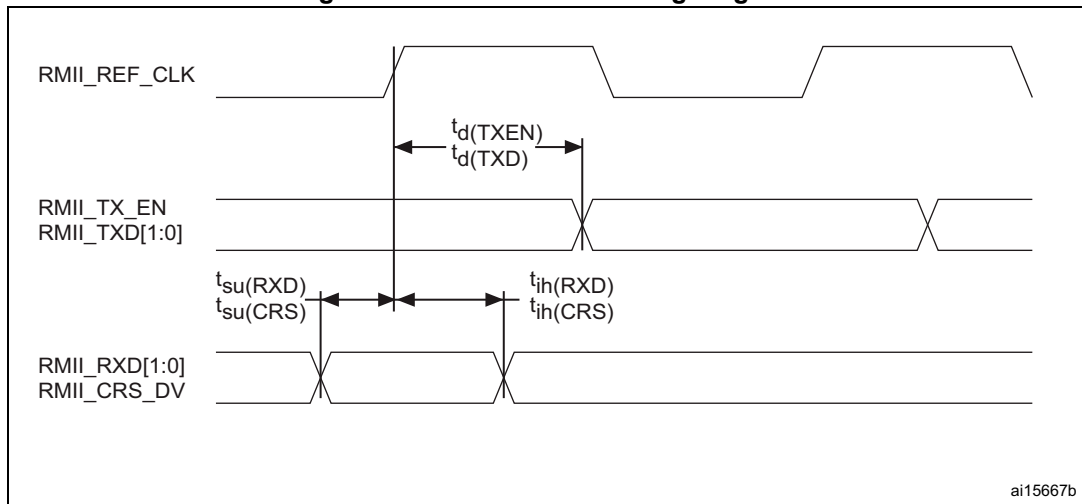
MS31384V1

Table 121. Dynamics characteristics: Ethernet MAC signals for RMII ⁽¹⁾

| Symbol | Parameter | Min | Typ | Max | Unit |
|---------------|----------------------------------|-----|-----|------|------|
| $t_{su}(RXD)$ | Receive data setup time | 2 | - | - | ns |
| $t_{th}(RXD)$ | Receive data hold time | 2 | - | - | |
| $t_{su}(CRS)$ | Carrier sense setup time | 1.5 | - | - | |
| $t_{th}(CRS)$ | Carrier sense hold time | 1.5 | - | - | |
| $t_d(TXEN)$ | Transmit enable valid delay time | 8 | 0 | 10.5 | |
| $t_d(TXD)$ | Transmit data valid delay time | 7 | 8 | 9.5 | |

1. Guaranteed by characterization results.

Figure 70. Ethernet RMII timing diagram



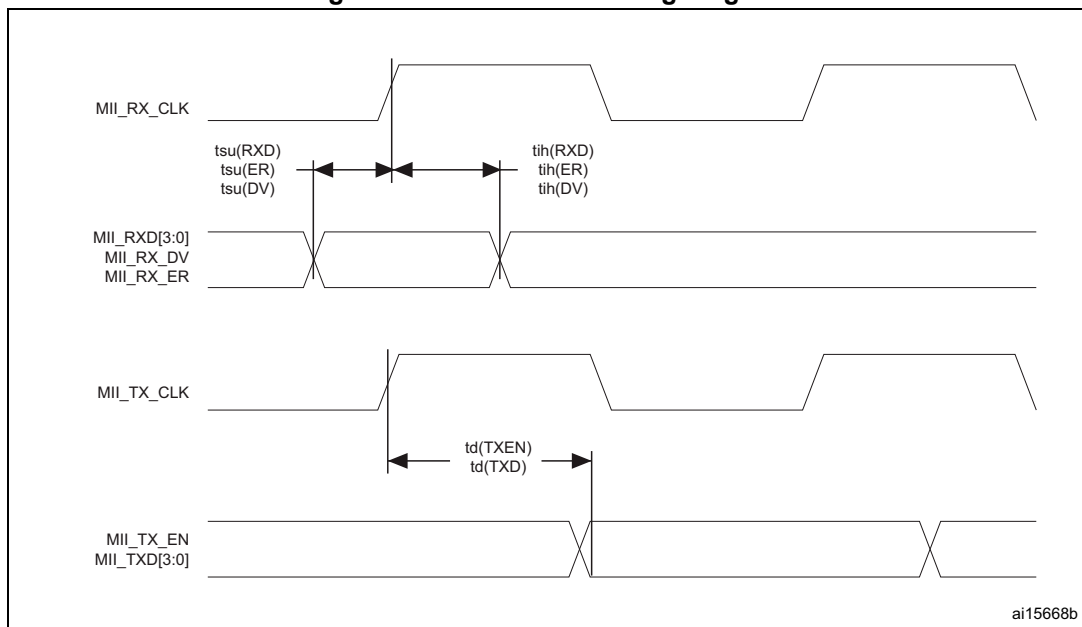
ai15667b

Table 122. Dynamics characteristics: Ethernet MAC signals for MII ⁽¹⁾

| Symbol | Parameter | Min | Typ | Max | Unit |
|---------------|----------------------------------|-----|-----|-----|------|
| $t_{su}(RXD)$ | Receive data setup time | 2.0 | - | - | ns |
| $t_{ih}(RXD)$ | Receive data hold time | 2.0 | - | - | |
| $t_{su}(DV)$ | Data valid setup time | 1.5 | - | - | |
| $t_{ih}(DV)$ | Data valid hold time | 1.5 | - | - | |
| $t_{su}(ER)$ | Error setup time | 1.5 | - | - | |
| $t_{ih}(ER)$ | Error hold time | 0.5 | - | - | |
| $t_d(TXEN)$ | Transmit enable valid delay time | 9.0 | 11 | 19 | |
| $t_d(TXD)$ | Transmit data valid delay time | 8.5 | 10 | 19 | |

1. Guaranteed by characterization results.

Figure 71. Ethernet MII timing diagram



JTAG/SWD interface characteristics

Unless otherwise specified, the parameters given in [Table 123](#) and [Table 124](#) for JTAG/SWD are derived from tests performed under the ambient temperature, $f_{rcc_c_ck}$ frequency and V_{DD} supply voltage summarized in [Table 13: General operating conditions](#), with the following configuration:

- Output speed is set to OSPEEDRy[1:0] = 11
- Capacitive load $C_L=30$ pF
- Measurement points are done at CMOS levels: $0.5V_{DD}$
- VOS level set to VOS0

Refer to [Section 6.3.17: I/O port characteristics](#) for more details on the input/output characteristics:

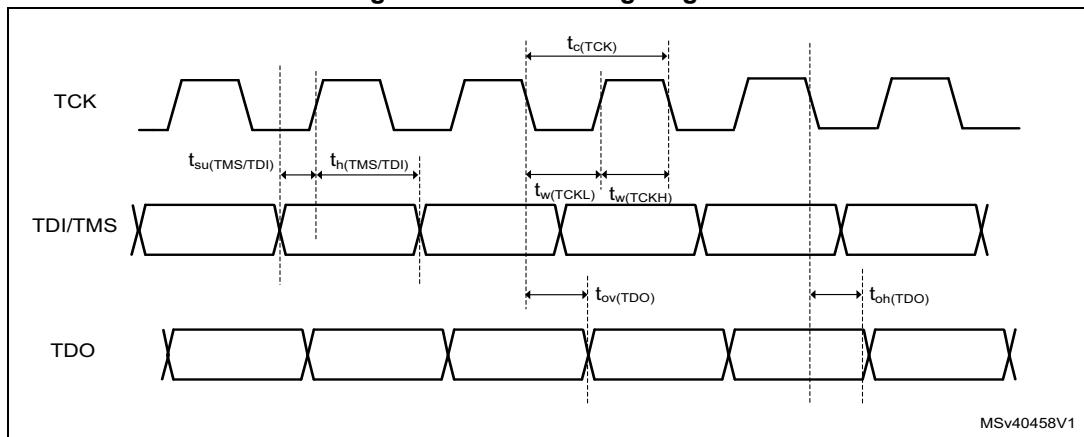
Table 123. Dynamics JTAG characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|------------------------|---------------------------------|-------------------------------|-----|-----|------|------|
| F_{pp} | T _{CK} clock frequency | 2.7V <V _{DD} < 3.6 V | - | - | 37 | MHz |
| 1/t _c (TCK) | | 1.62 <V _{DD} < 3.6 V | - | - | 27.5 | |
| t _{su} (TMS) | TMS input setup time | - | 2.5 | - | - | - |
| t _h (TMS) | TMS input hold time | - | 1 | - | - | - |
| t _{su} (TDI) | TDI input setup time | - | 1.5 | - | - | - |
| t _h (TDI) | TDI input hold time | - | 1 | - | - | - |
| t _{ov} (TDO) | TDO output valid time | 2.7V <V _{DD} < 3.6 V | - | 8 | 13.5 | - |
| | | 1.62 <V _{DD} < 3.6 V | - | 8 | 18 | - |
| t _{oh} (TDO) | TDO output hold time | - | 7 | - | - | - |

Table 124. Dynamics SWD characteristics

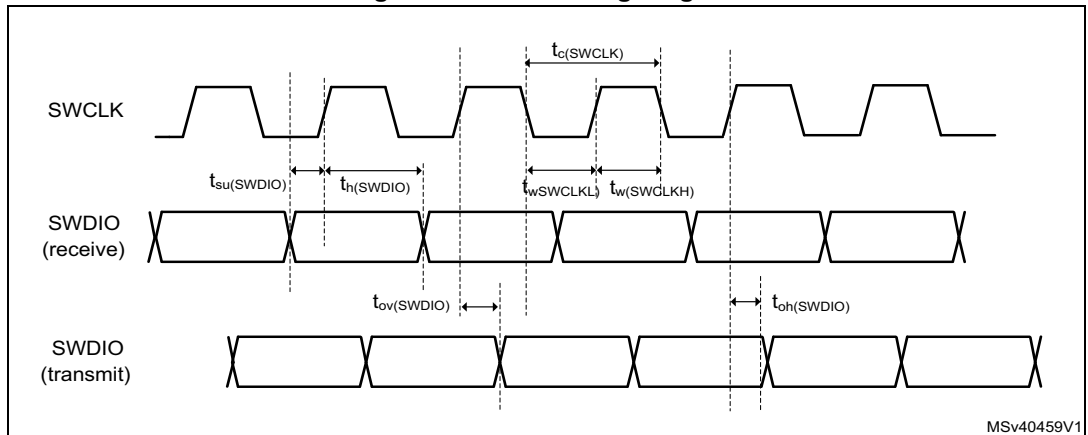
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------|-------------------------|-------------------------------|-----|-----|------|------|
| F_{pp} | SWCLK clock frequency | 2.7V <V _{DD} < 3.6 V | - | - | 71 | MHz |
| 1/t _c (SWCLK) | | 1.62 <V _{DD} < 3.6 V | - | - | 52.5 | |
| t _{su} (SWDIO) | SWDIO input setup time | - | 2.5 | - | - | - |
| t _h (SWDIO) | SWDIO input hold time | - | 1 | - | - | - |
| t _{ov} (SWDIO) | SWDIO output valid time | 2.7V <V _{DD} < 3.6 V | - | 8.5 | 14 | - |
| | | 1.62 <V _{DD} < 3.6 V | - | 8.5 | 19 | - |
| t _{oh} (SWDIO) | SWDIO output hold time | - | 8 | - | - | - |

Figure 72. JTAG timing diagram



MSv40458V1

Figure 73. SWD timing diagram



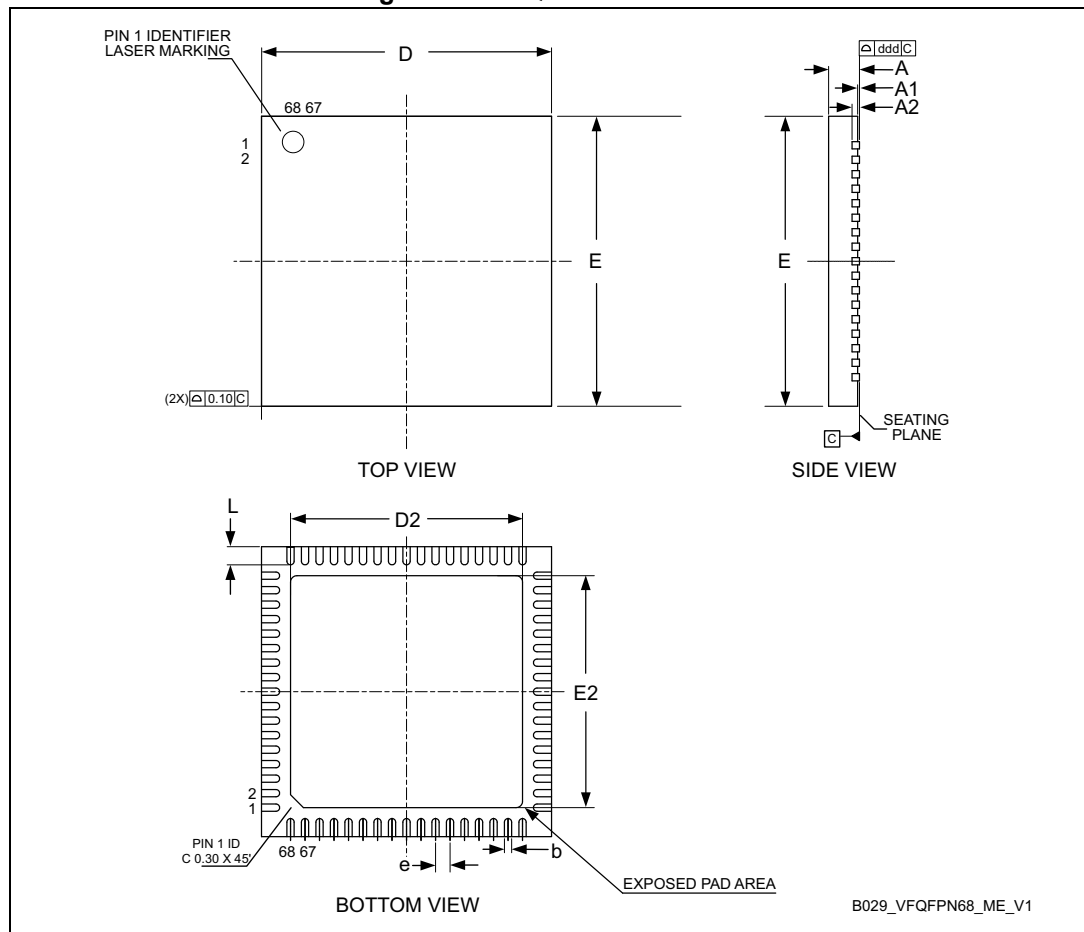
7 Package information

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*. ECOPACK is an ST trademark.

7.1 VFQFPN68 package information

This VFQFPN68 is a 68-pin, 8 x 8 mm, 0.4 mm pitch, very thin fine pitch quad flat package.

Figure 74. VFQFPN68 - Outline



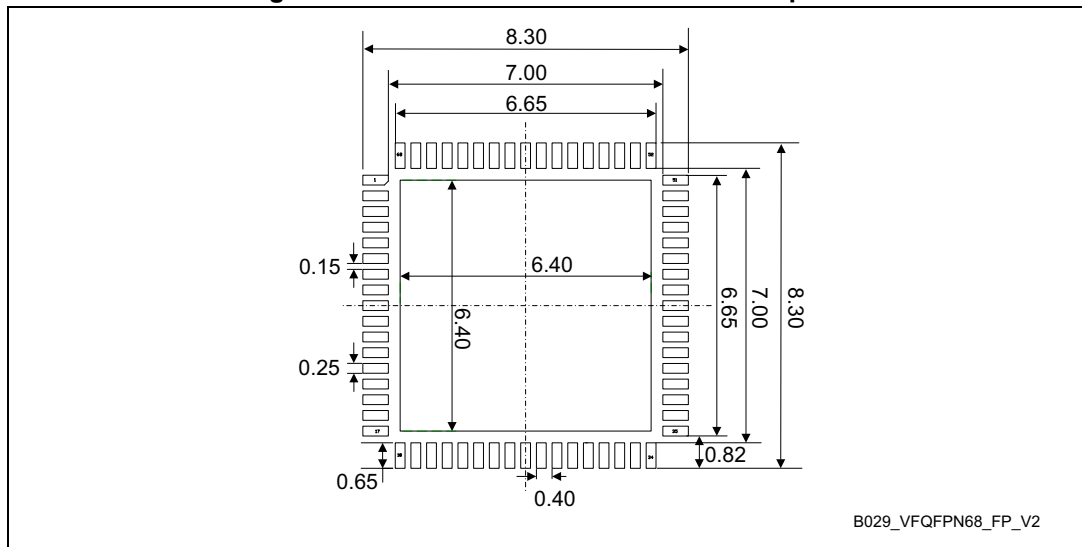
1. VFQFPN stands for Thermally Enhanced Very thin Fine pitch Quad Flat Packages No lead. Sawed version. Very thin profile: $0.80 < A \leq 1.00\text{mm}$.
2. The pin #1 identifier must be existed on the top surface of the package by using indentation mark or other feature of package body. Exact shape and size of this feature is optional.

Table 125. VFQFPN68 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|------|------|-----------------------|--------|--------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.80 | 0.90 | 1.00 | 0.0315 | 0.0354 | 0.0394 |
| A1 | 0 | 0.02 | 0.05 | 0 | 0.0008 | 0.0020 |
| A3 | - | 0.20 | - | - | 0.0008 | - |
| b | 0.15 | 0.20 | 0.25 | 0.0059 | 0.0079 | 0.0098 |
| D | 7.85 | 8.00 | 8.15 | 0.3091 | 0.3150 | 0.3209 |
| D2 | 6.30 | 6.40 | 6.50 | 0.2480 | 0.2520 | 0.2559 |
| E | 7.85 | 8.00 | 8.15 | 0.3091 | 0.3150 | 0.3209 |
| E2 | 6.30 | 6.40 | 6.50 | 0.2480 | 0.2520 | 0.2559 |
| e | - | 0.40 | - | - | 0.0157 | - |
| L | 0.40 | 0.50 | 0.60 | 0.0157 | 0.0197 | 0.0236 |
| ddd | - | - | 0.08 | - | - | 0.0031 |

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

Figure 75. VFQFPN68 - Recommended footprint



1. Dimensions are expressed in millimeters.

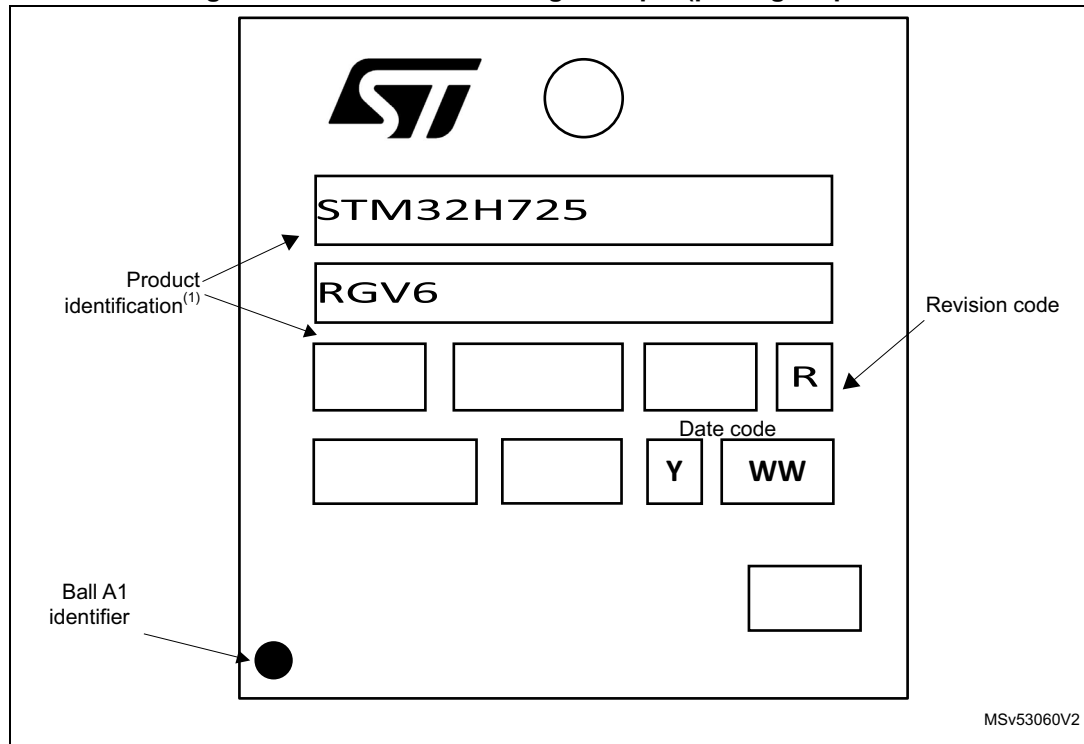
Device marking for VFQFPN68

The following figure gives an example of topside marking versus ball A1 position identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 76. VFQFPN68 marking example (package top view)

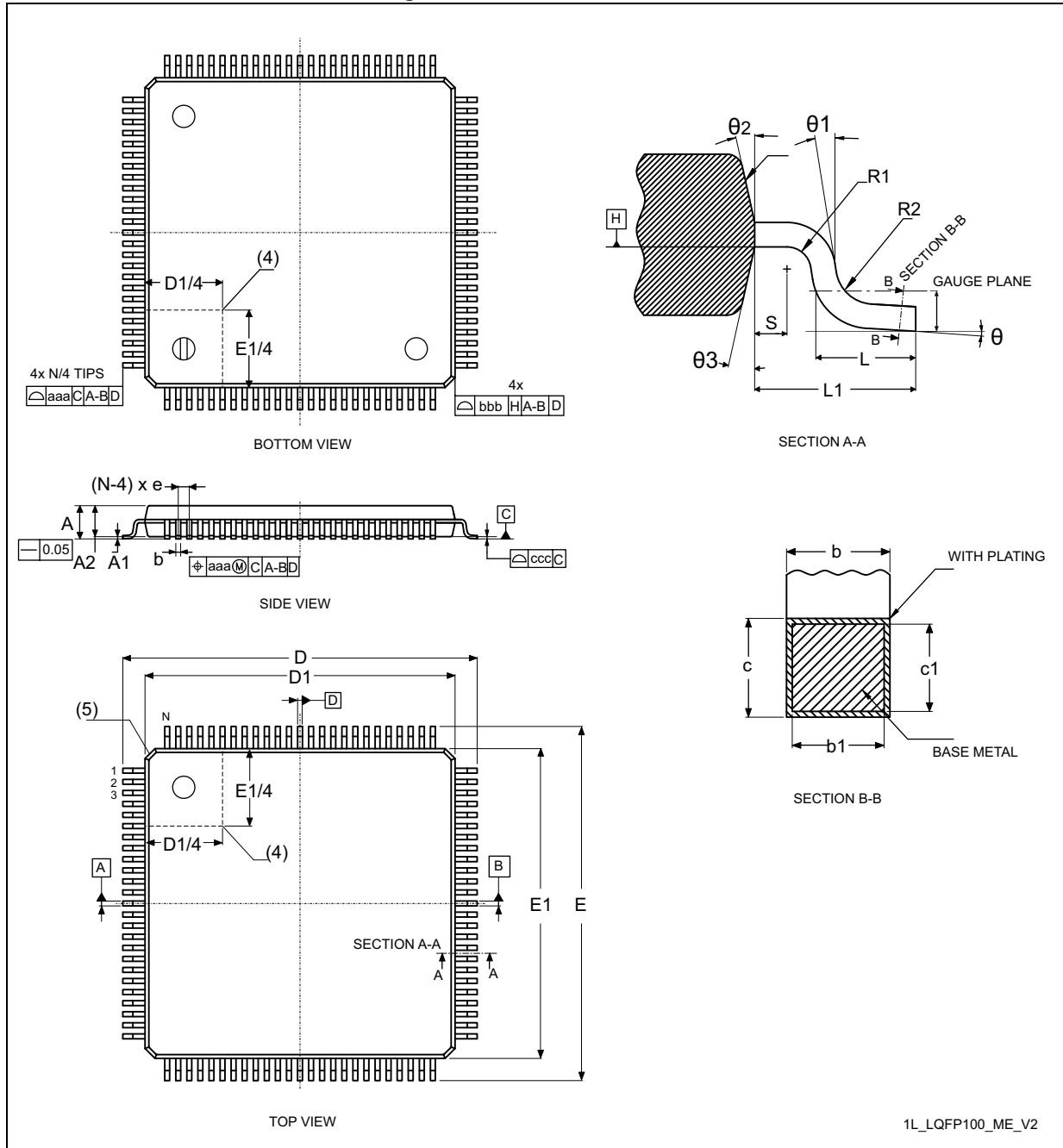


1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering 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 package information

This LQFP100 is a 100-pin, 14 x 14 mm low-profile quad flat package.

Figure 77. LQFP100- Outline



1. Drawing is not to scale.

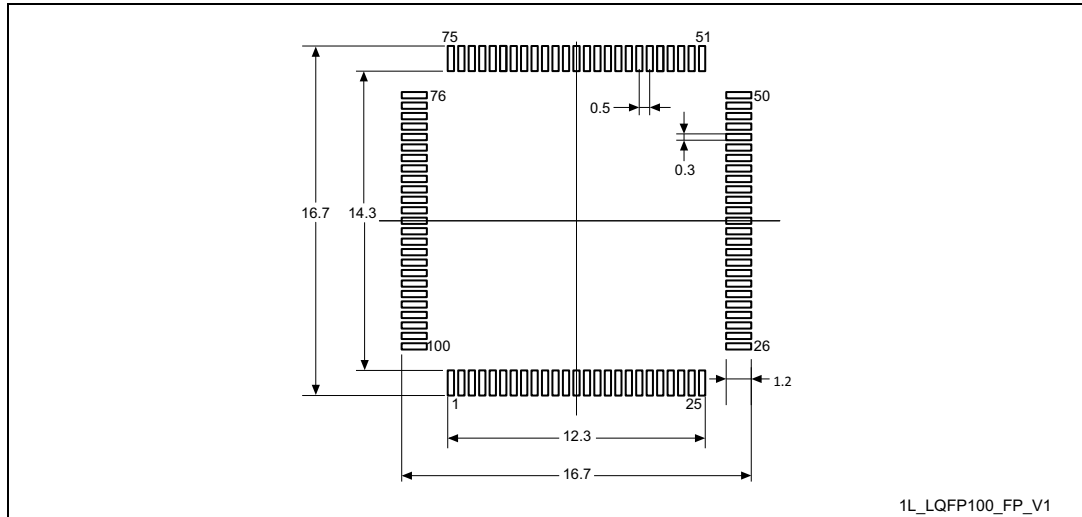
Table 126. LQFP100 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|----------------------|-------------|------|------|-----------------------|--------|--------|
| | Min | Typ | Max | Min | Typ | Max |
| A | - | 1.50 | 1.60 | - | 0.0590 | 0.0630 |
| A1 ⁽²⁾ | 0.05 | - | 0.15 | 0.0019 | - | 0.0059 |
| A2 | 1.35 | 1.40 | 1.45 | 0.0531 | 0.0551 | 0.0570 |
| b ⁽³⁾⁽⁴⁾ | 0.17 | 0.22 | 0.27 | 0.0067 | 0.0087 | 0.0106 |
| b1 ⁽⁴⁾ | 0.17 | 0.20 | 0.23 | 0.0067 | 0.0079 | 0.0090 |
| c ⁽⁴⁾ | 0.09 | - | 0.20 | 0.0035 | - | 0.0079 |
| c1 ⁽⁴⁾ | 0.09 | - | 0.16 | 0.0035 | - | 0.0063 |
| D ⁽⁵⁾ | 16.00 | | | 0.6299 | | |
| D1 ⁽⁶⁾⁽⁷⁾ | 14.00 | | | 0.5512 | | |
| E ⁽⁵⁾ | 16.00 | | | 0.6299 | | |
| E1 ⁽⁶⁾⁽⁷⁾ | 14.00 | | | 0.5512 | | |
| e | - | 0.50 | - | - | 0.0197 | - |
| L | 0.45 | 0.60 | 0.75 | 0.177 | 0.0236 | 0.0295 |
| L1 ⁽⁴⁾ | 1.00 | | | - | 0.0394 | - |
| N ⁽⁸⁾ | 100 | | | | | |
| 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 | 0.08 | - | - | 0.0031 | - | - |
| R2 | 0.08 | - | 0.20 | 0.0031 | - | 0.0079 |
| S | 0.20 | - | - | 0.0079 | - | - |
| aaa ⁽⁹⁾ | 0.20 | | | 0.0079 | | |
| bbb ⁽⁹⁾ | 0.20 | | | 0.0079 | | |
| ccc ⁽⁹⁾ | 0.08 | | | 0.0031 | | |
| ddd ⁽⁹⁾ | 0.08 | | | 0.0031 | | |

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

LQFP100 - Recommended footprint



Dimensions are expressed in millimeters.

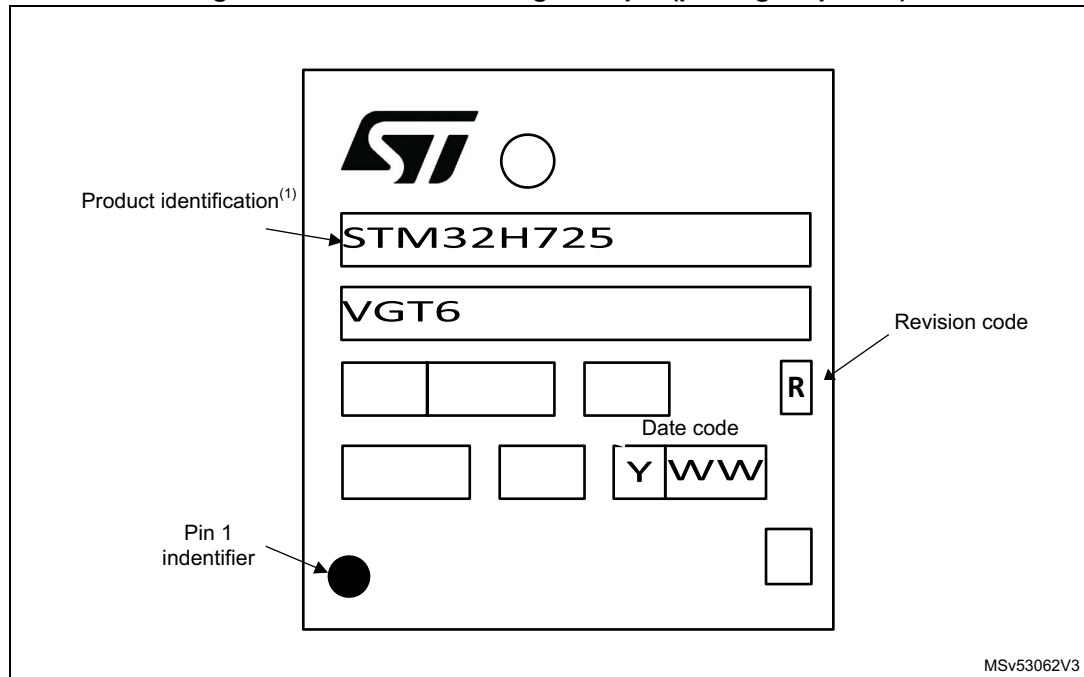
Device marking for LQFP100

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

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 78. LQFP100 marking example (package top view)

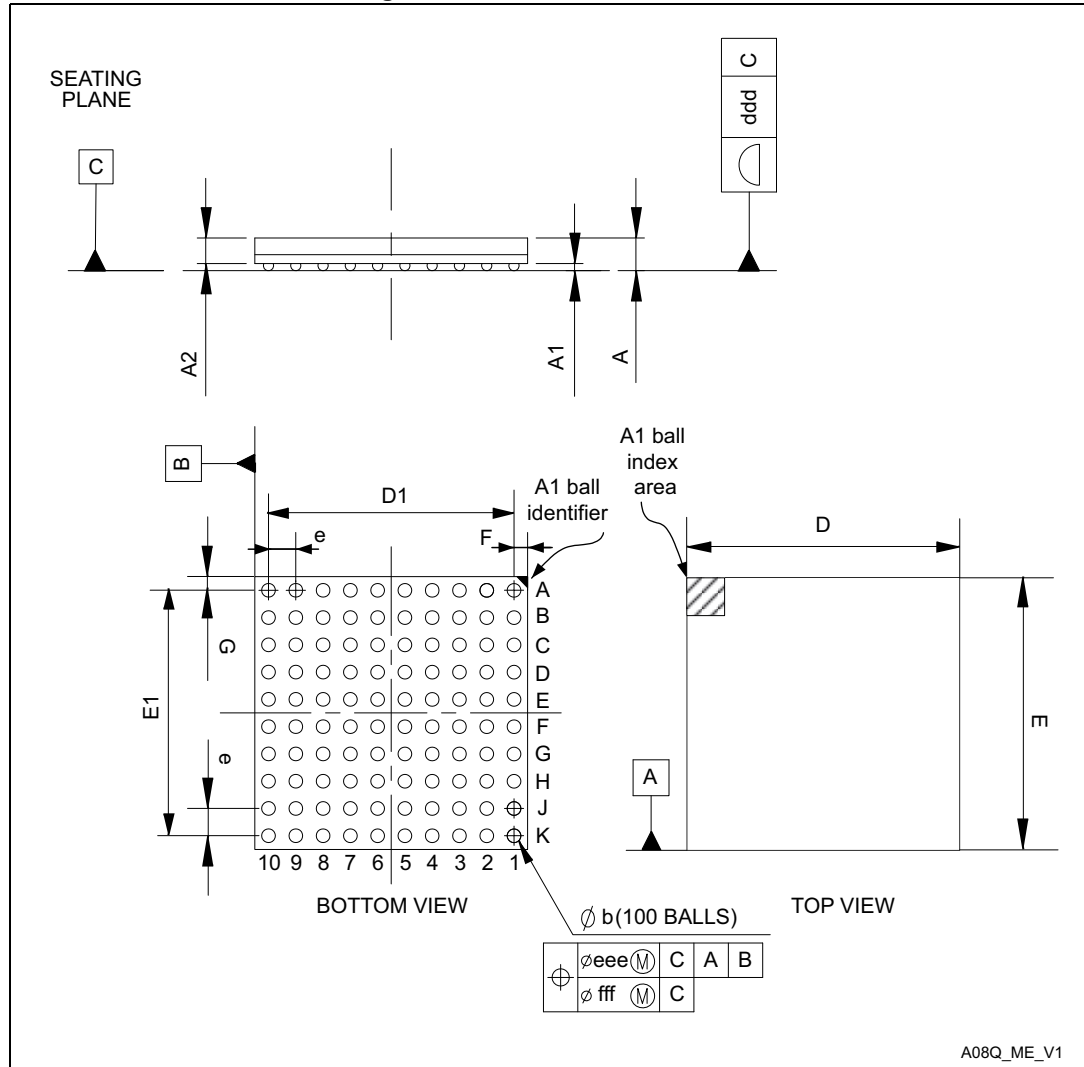


1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering 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 TFBGA100 package information

This TFBGA is 100 - ball, 8X8 mm, 0.8 mm pitch fine pitch ball grid array package.

Figure 79. TFBGA100 - Outline



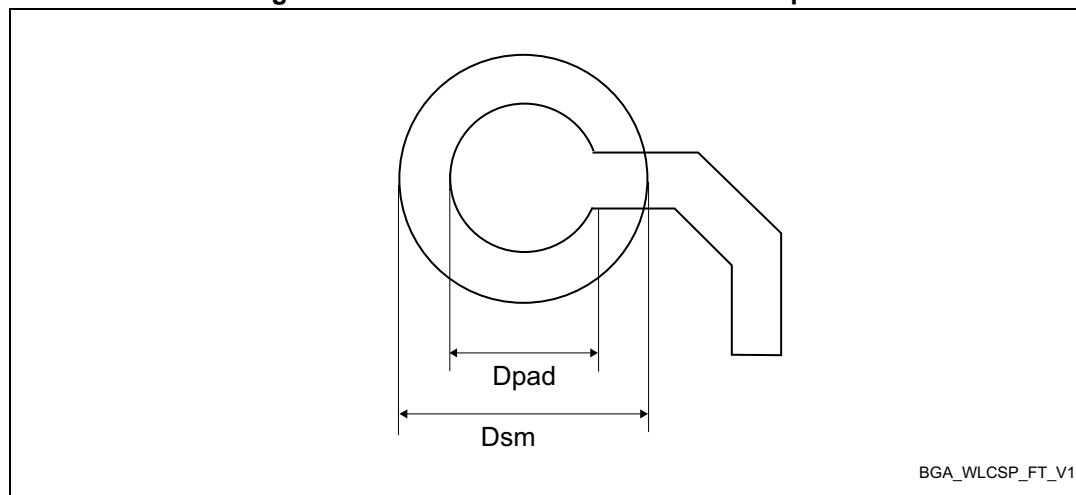
1. Drawing is not to scale.

Table 127. TFBGA100 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|-------|-------|-----------------------|--------|--------|
| | Min | Typ | Max | Min | Typ | Max |
| A | - | - | 1.100 | - | - | 0.0433 |
| A1 | 0.150 | - | - | 0.0059 | - | - |
| A2 | - | 0.760 | - | - | 0.0299 | - |
| b | 0.350 | 0.400 | 0.450 | 0.0138 | 0.0157 | 0.0177 |
| D | 7.850 | 8.000 | 8.150 | 0.3091 | 0.3150 | 0.3209 |
| D1 | - | 7.200 | - | - | 0.2835 | - |
| E | 7.850 | 8.000 | 8.150 | 0.3091 | 0.3150 | 0.3209 |
| E1 | - | 7.200 | - | - | 0.2835 | - |
| e | - | 0.800 | - | - | 0.0315 | - |
| F | - | 0.400 | - | - | 0.0157 | - |
| G | - | 0.400 | - | - | 0.0157 | - |
| ddd | - | - | 0.100 | - | - | 0.0039 |
| eee | - | - | 0.150 | - | - | 0.0059 |
| fff | - | - | 0.080 | - | - | 0.0031 |

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

Figure 80. TFBGA100 - Recommended footprint



1. Dimensions are expressed in millimeters.

Table 128. TFBGA100 - Recommended PCB design rules (0.8 mm pitch BGA)

| Dimension | Recommended values |
|-------------------|---|
| Pitch | 0.8 |
| Dpad | 0.400 mm |
| Dsm | 0.470 mm typ (depends on the soldermask registration tolerance) |
| Stencil opening | 0.400 mm |
| Stencil thickness | Between 0.100 mm and 0.125 mm |
| Pad trace width | 0.120 mm |

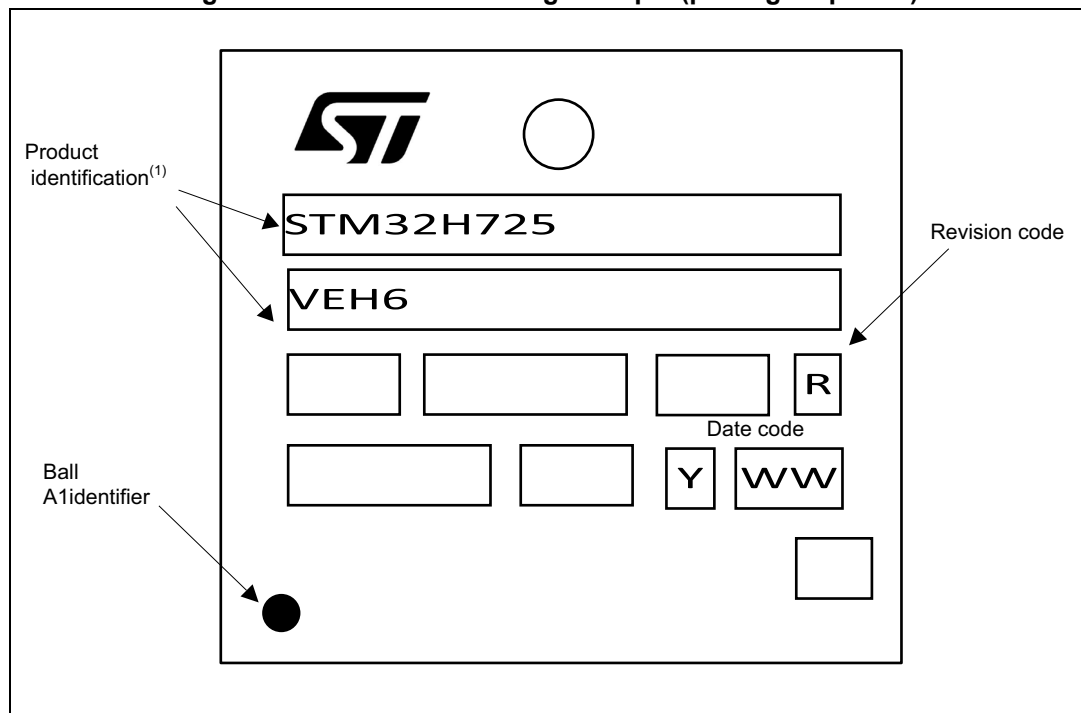
Device marking for TFBGA100

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

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 81. TFBGA100 marking example (package top view)

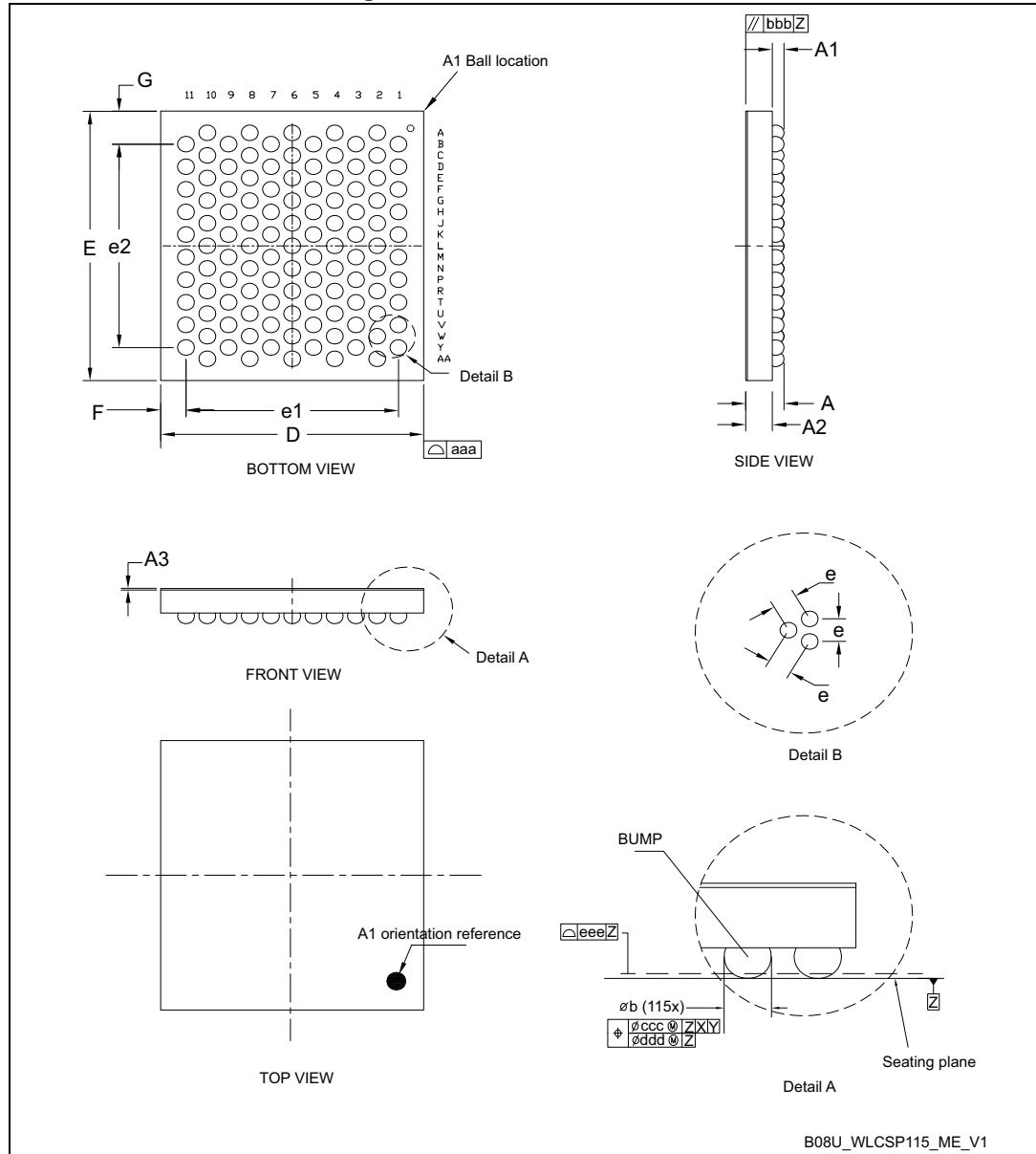


1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering 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 WLCSP115 package information

This WLCSP is a 115-ball, 3.73 x 4.15 mm, 0.35 mm pitch, wafer level chip scale package.

Figure 82. WLCSP115 - Outline



1. Drawing is not to scale.
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 129. WLCSP115 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|-------------------|-------------|-------|------|-----------------------|-------|-------|
| | Min | Typ | Max | Min | Typ | Max |
| A ⁽²⁾ | - | - | 0.58 | - | - | 0.023 |
| A1 | - | 0.17 | - | - | 0.007 | - |
| A2 | - | 0.38 | - | - | 0.015 | - |
| A3 ⁽³⁾ | - | 0.025 | - | - | 0.001 | - |
| b | 0.21 | 0.24 | 0.27 | 0.008 | 0.009 | 0.011 |
| D | 3.71 | 3.73 | 3.75 | 0.146 | 0.147 | 0.148 |
| E | 4.13 | 4.15 | 4.17 | 0.163 | 0.163 | 0.164 |
| e | - | 0.35 | - | - | 0.014 | - |
| e1 | - | 3.03 | - | - | 0.119 | - |
| e2 | - | 3.15 | - | - | 0.124 | - |
| F ⁽⁴⁾ | - | 0.36 | - | - | 0.014 | - |
| G ⁽⁴⁾ | - | 0.51 | - | - | 0.020 | - |
| aaa | - | - | 0.10 | - | - | 0.004 |
| bbb | - | - | 0.10 | - | - | 0.004 |
| ccc | - | - | 0.10 | - | - | 0.004 |
| ddd | - | - | 0.05 | - | - | 0.002 |
| eee | - | - | 0.05 | - | - | 0.002 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.
2. The maximum total package height is calculated by the RSS method (Root Sum Square) using nominal and tolerances values of A1 and A2.
3. Back side coating. Nominal dimension is rounded to the 3rd decimal place resulting from process capability.
4. Calculated dimensions are rounded to the 3rd decimal place

Figure 83. WLCSP115 - Recommended footprint

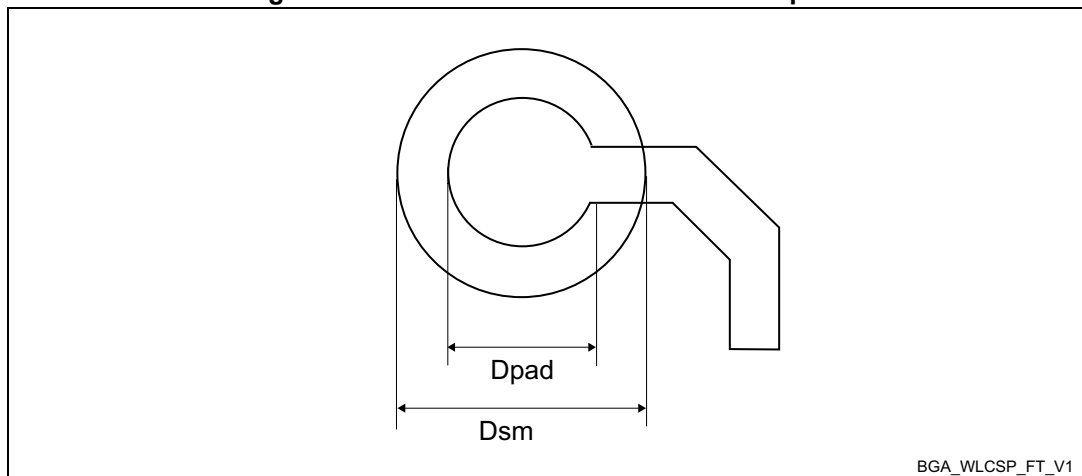


Table 130. WLCSP115 - Recommended PCB design rules

| Dimension | Recommended values |
|-------------------|--|
| Pitch | 0.35 mm |
| Dpad | 0,225 mm |
| Dsm | 0.250 mm typ. (depends on soldermask registration tolerance) |
| Stencil opening | 0.250 mm |
| Stencil thickness | 0.080 mm |

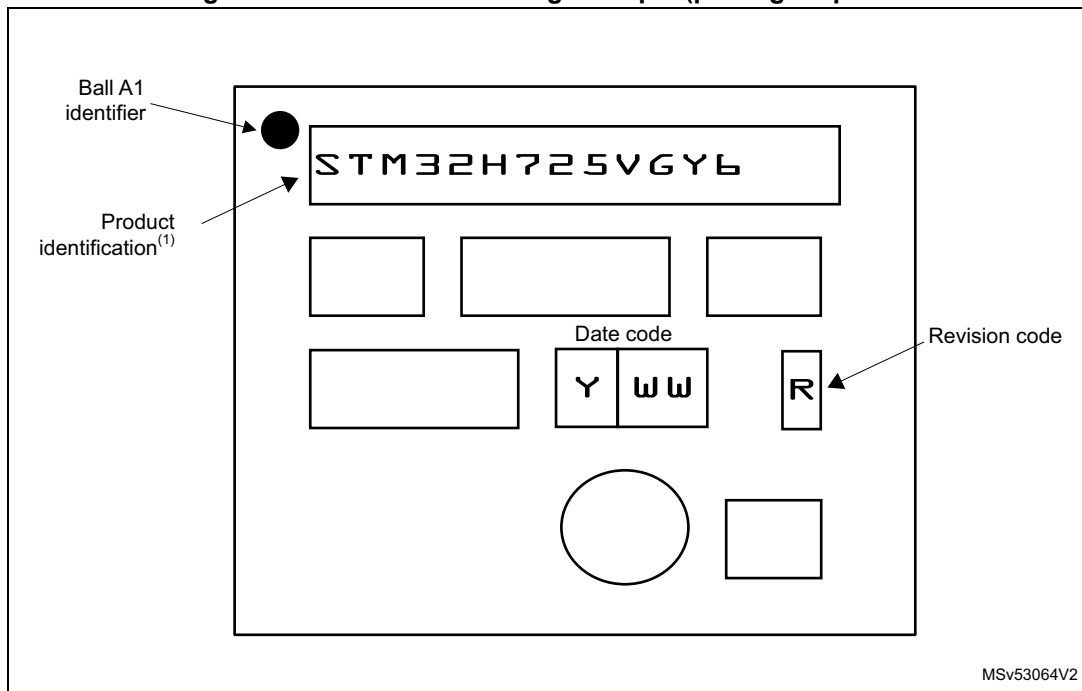
Device marking for WLSCP115

The following figure gives an example of topside marking versus ball A1 position identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 84. WLCSP115 marking example (package top view)

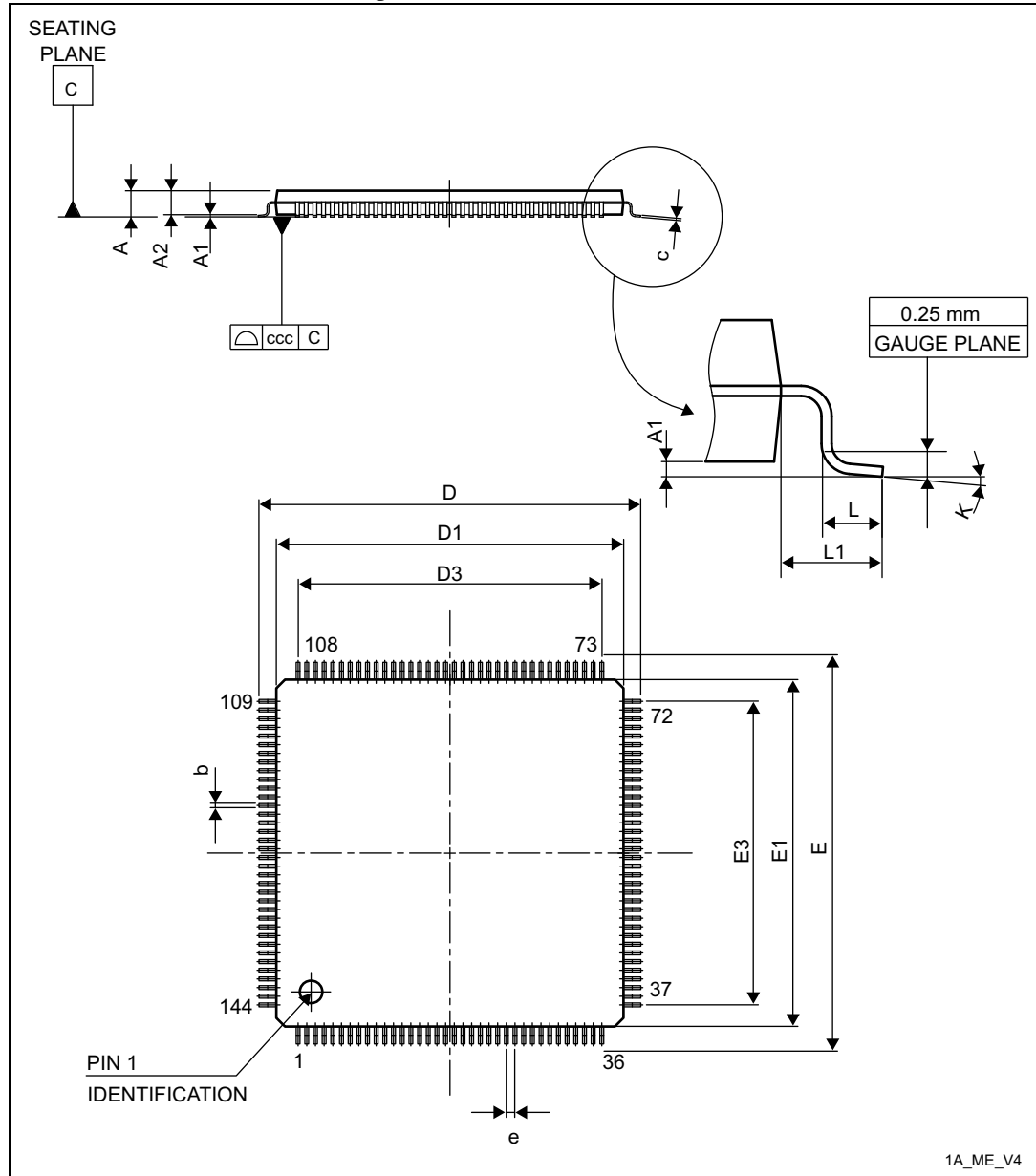


1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering 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 LQFP144 package information

This LQFP is a 144-pin, 20 x 20 mm low-profile quad flat package.

Figure 85. LQFP144 - Outline



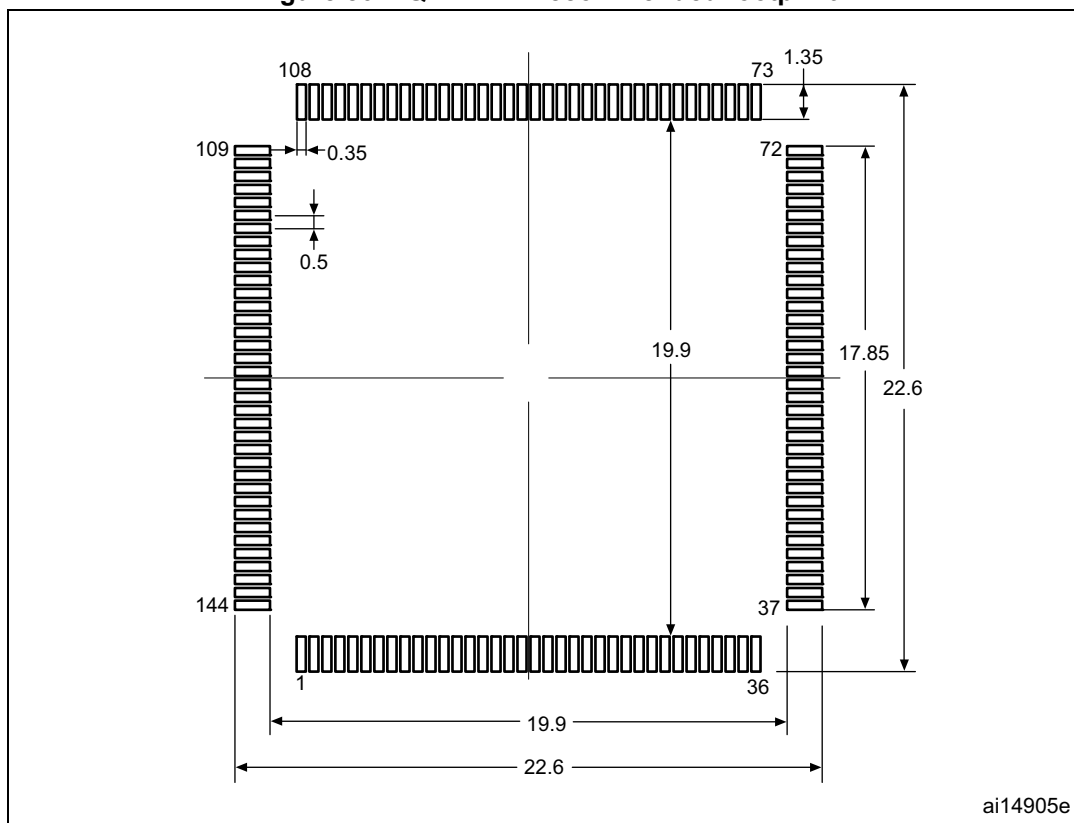
1. Drawing is not to scale.

Table 131. LQFP144 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|--------|--------|-----------------------|--------|--------|
| | 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 | 0.8740 |
| D1 | 19.800 | 20.000 | 20.200 | 0.7795 | 0.7874 | 0.7953 |
| D3 | - | 17.500 | - | - | 0.6890 | - |
| 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 86. LQFP144 - Recommended footprint



ai14905e

1. Dimensions are expressed in millimeters.

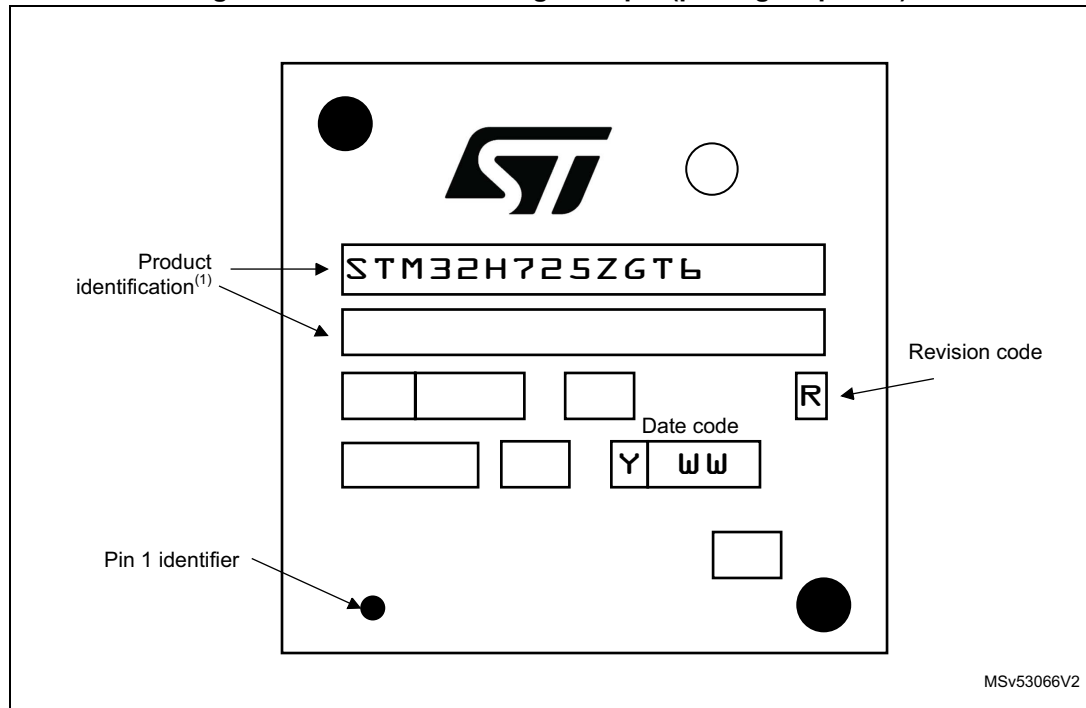
Device marking for LQFP144

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

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 87. LQFP144 marking example (package top view)

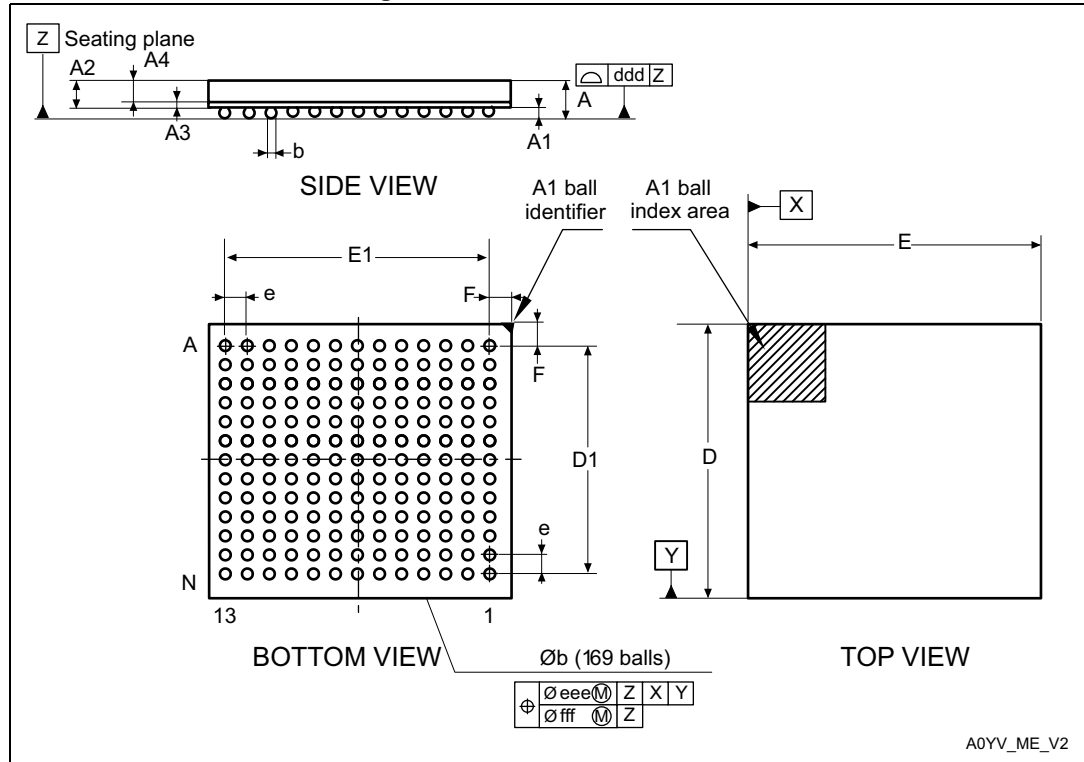


1. Parts marked as "ES", "E" or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering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

7.6 UFBGA169 package information

This UFBGA is a 169-pin, 7 x 7 mm, 0.50 mm pitch, ultra fine pitch ball grid array package.

Figure 88. UFBGA169 - Outline



1. Drawing is not in scale.

Table 132. UFBGA169 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|-------|-------|-----------------------|--------|--------|
| | 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 | 0.330 | 0.0091 | 0.0110 | 0.0130 |
| D | 6.950 | 7.000 | 7.050 | 0.2736 | 0.2756 | 0.2776 |
| D1 | 5.950 | 6.000 | 6.050 | 0.2343 | 0.2362 | 0.2382 |
| E | 6.950 | 7.000 | 7.050 | 0.2736 | 0.2756 | 0.2776 |
| E1 | 5.950 | 6.000 | 6.050 | 0.2343 | 0.2362 | 0.2382 |
| e | - | 0.500 | - | - | 0.0197 | - |
| F | 0.450 | 0.500 | 0.550 | 0.0177 | 0.0197 | 0.0217 |

Table 132. UFBGA169 - Mechanical data (continued)

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|------|-------|-----------------------|------|--------|
| | 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 89. UFBGA169 - Recommended footprint

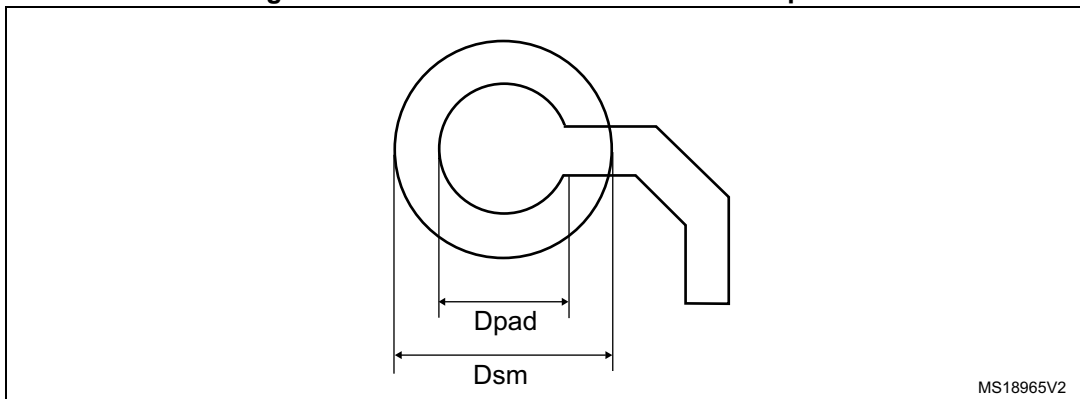


Table 133. UFBGA169 - Recommended PCB design rules (0.5 mm pitch BGA)

| Dimension | Recommended values |
|--------------|---|
| Pitch | 0.5 |
| D_{pad} | 0.27 mm |
| D_{sm} | 0.35 mm typ. (depends on the soldermask registration tolerance) |
| Solder paste | 0.27 mm aperture diameter. |

*Note: Non-solder mask defined (NSMD) pads are recommended.
4 to 6 mils solder paste screen printing process.*

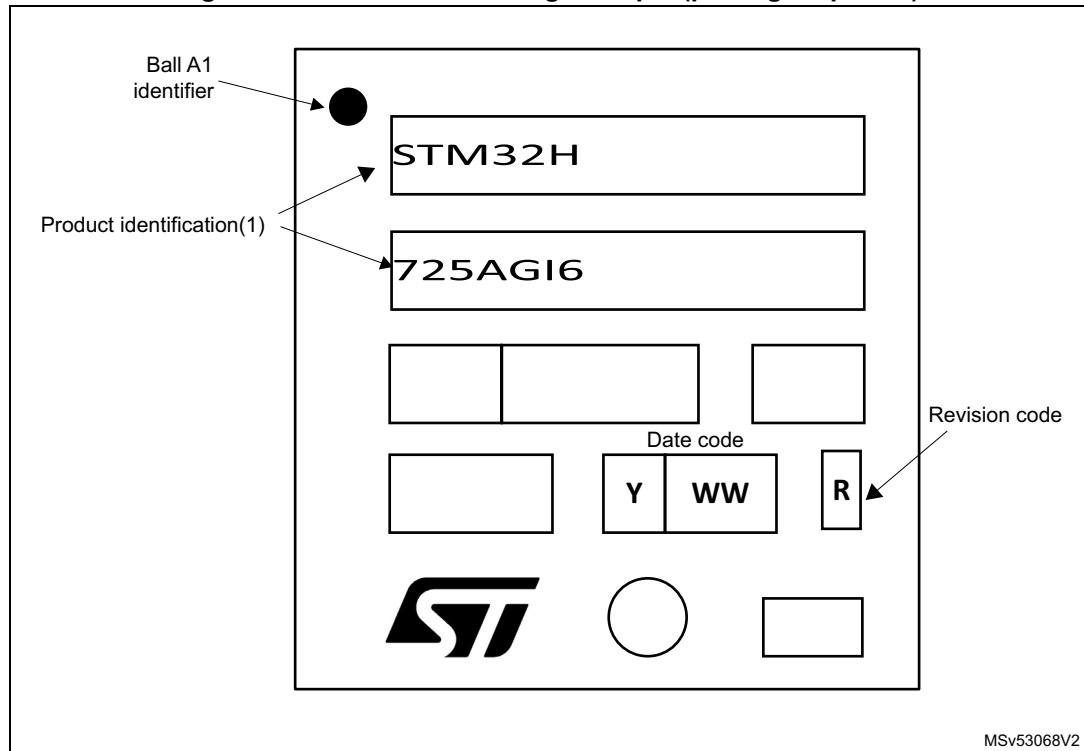
Device marking for UFBGA169

The following figure gives an example of topside marking versus ball A1 position identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 90. UFBGA169 marking example (package top view)

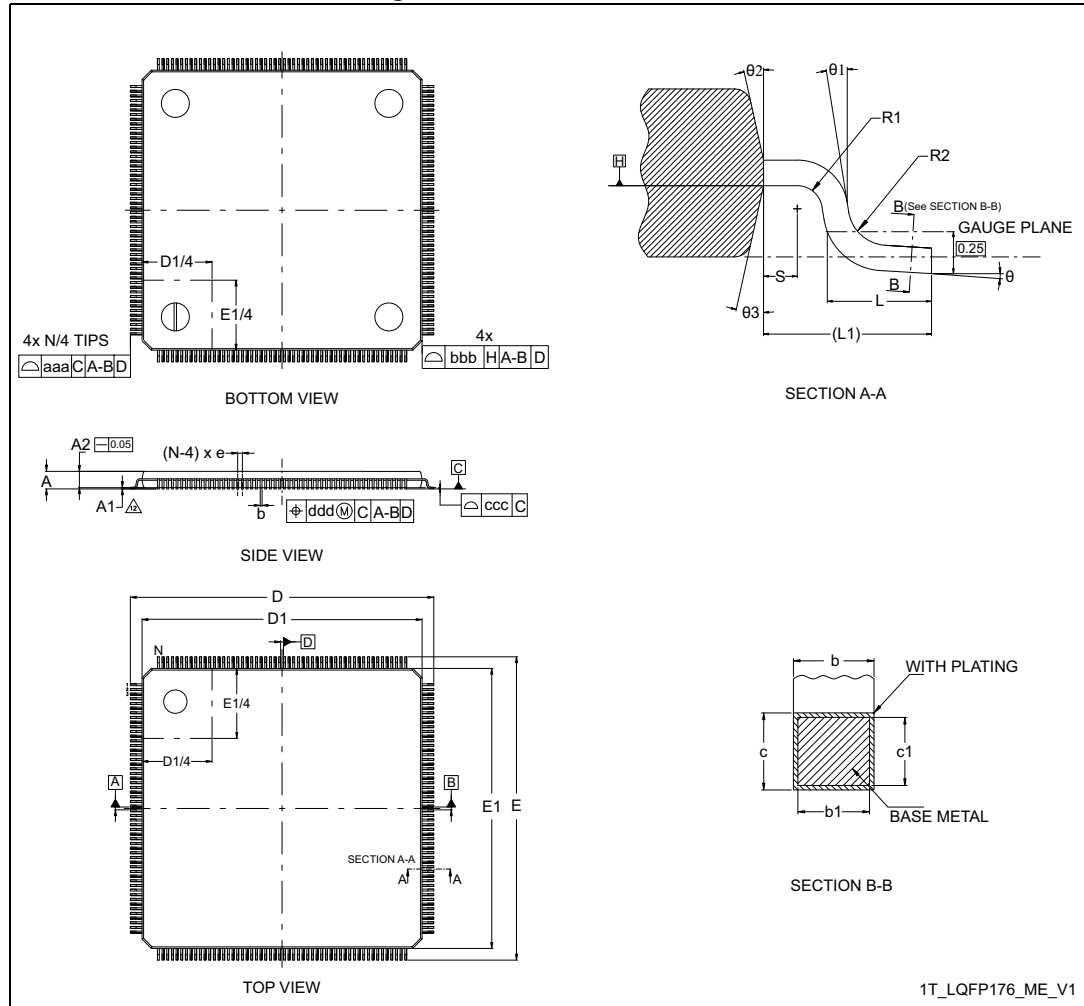


1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering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

7.7 LQFP176 package information

This LQFP is a 176-pin, 24 x 24 mm low profile quad flat package.

Figure 91. LQFP176 - Outline



1. Drawing is not to scale.
2. Dimensioning and tolerancing 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 134. LQFP176 - Mechanical data

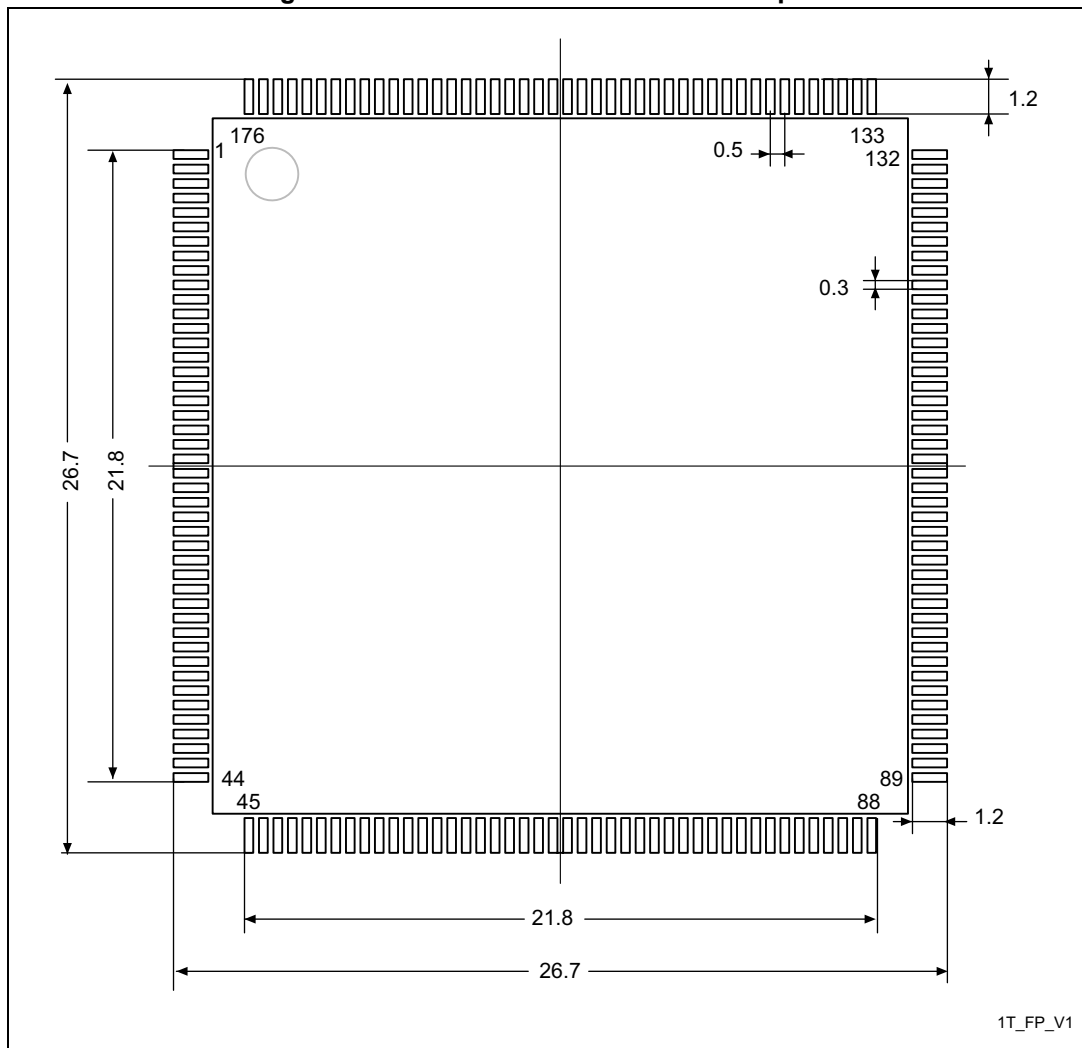
| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|---------------------|-------------|-------|-------|-----------------------|--------|--------|
| | Min | Typ | Max | Min | Typ | Max |
| A | - | - | 1.600 | - | - | 0.0630 |
| A1 ⁽²⁾ | 0.050 | - | 0.150 | 0.0020 | - | 0.0059 |
| A2 | 1.350 | 1.400 | 1.450 | 0.0531 | 0.0551 | 0.0571 |
| b ⁽³⁾⁽⁴⁾ | 0.170 | 0.220 | 0.270 | 0.0067 | 0.0087 | 0.0106 |

Table 134. LQFP176 - Mechanical data (continued)

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|----------------------|-------------|-------|-------|-----------------------|--------|--------|
| | Min | Typ | Max | Min | Typ | Max |
| b1 ⁽⁴⁾ | 0.170 | 0.200 | 0.230 | 0.0067 | 0.0079 | 0.0091 |
| c ⁽⁴⁾ | 0.090 | - | 0.200 | 0.0035 | - | 0.0079 |
| c1 ⁽⁴⁾ | 0.090 | - | 0.160 | 0.0035 | - | 0.063 |
| D ⁽⁵⁾ | 26.000 | | | 1.0236 | | |
| D1 ⁽⁶⁾⁽⁷⁾ | 24.000 | | | 0.9449 | | |
| E ⁽⁵⁾ | 26.000 | | | 0.0197 | | |
| E1 ⁽⁶⁾⁽⁷⁾ | 24.000 | | | 0.9449 | | |
| e | 0.500 | | | 0.1970 | | |
| L | 0.450 | 0.600 | 0.750 | 0.0177 | 0.0236 | 0.0295 |
| L1 ⁽⁴⁾ | 1 | | | 0.0394 REF | | |
| N ⁽⁸⁾ | 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 ⁽⁹⁾ | 0.200 | | | 0.0079 | | |
| bbb ⁽⁹⁾ | 0.200 | | | 0.0079 | | |
| ccc ⁽⁹⁾ | 0.080 | | | 0.0031 | | |
| ddd ⁽⁹⁾ | 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 92. LQFP176 - Recommended footprint



1. Dimensions are expressed in millimeters.

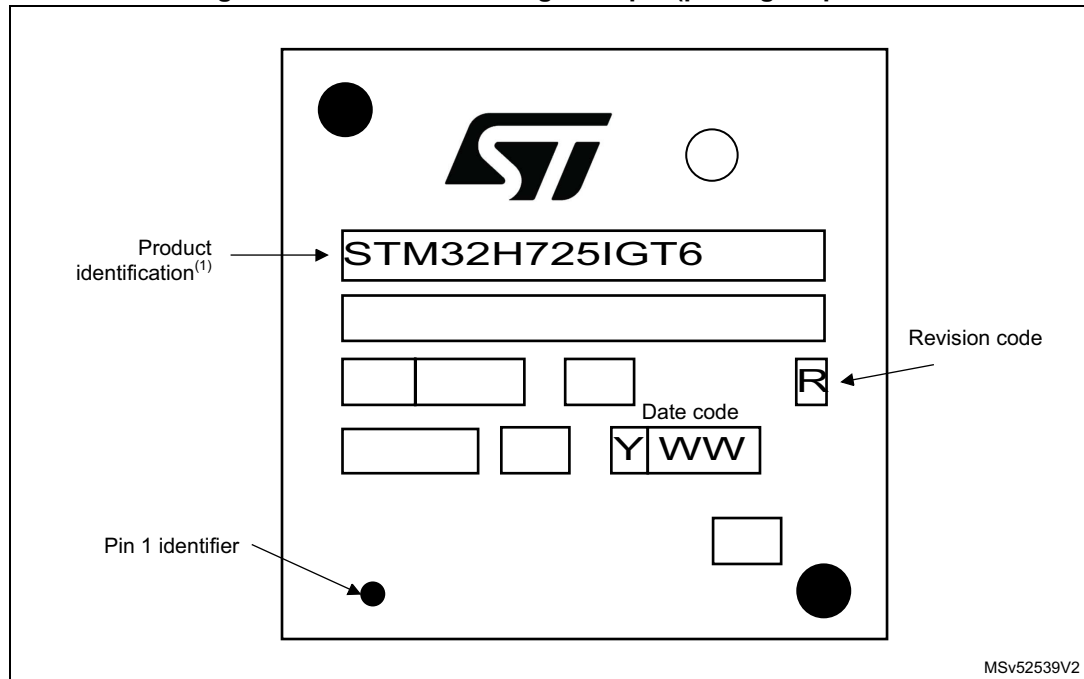
Device marking for LQFP176

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

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 93. LQFP176 marking example (package top view)

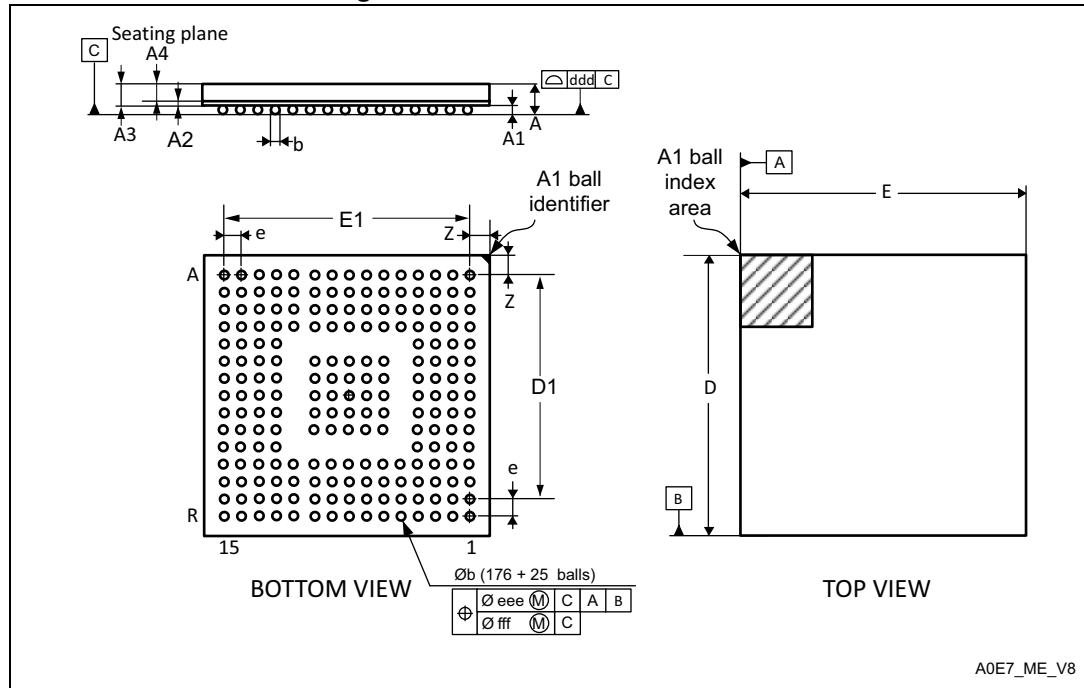


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7.8 UFBGA176+25 package information

This UFBGA176+25 is a 201-ball, 10 x 10 mm, 0.65 mm pitch, ultra fine pitch ball grid array package.

Figure 94. UFBGA176+25 - Outline



1. Drawing is not to scale.

Table 135. UFBGA176+25 - Mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|--------|--------|-----------------------|--------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | - | - | 0.600 | - | - | 0.0236 |
| A1 | - | - | 0.110 | - | - | 0.0043 |
| A2 | - | 0.130 | - | - | 0.0051 | - |
| A3 | - | 0.450 | - | - | 0.0177 | - |
| 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 | - |
| Z | - | 0.450 | - | - | 0.0177 | - |
| ddd | - | - | 0.080 | - | - | 0.0031 |

Table 135. UFBGA176+25 - Mechanical data (continued)

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|------|-------|-----------------------|------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| 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 95. UFBGA176+25 - Recommended footprint

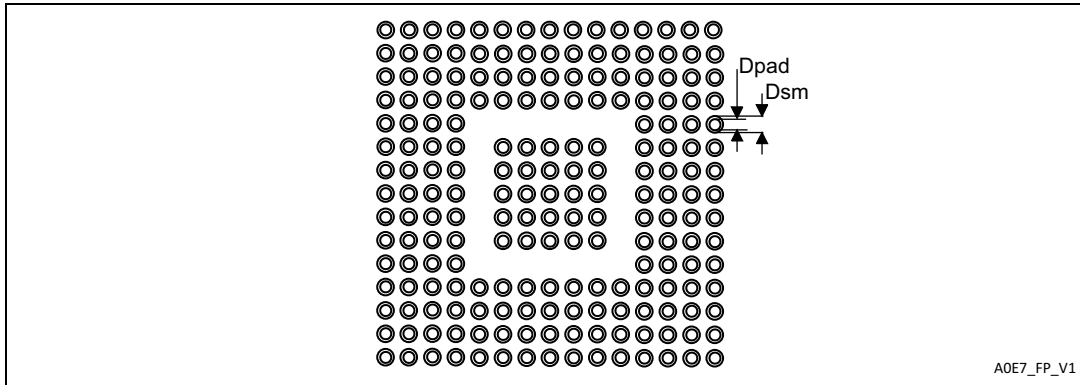


Table 136. UFBGA176+25 - Recommended PCB design rules (0.65 mm pitch BGA)

| 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 |

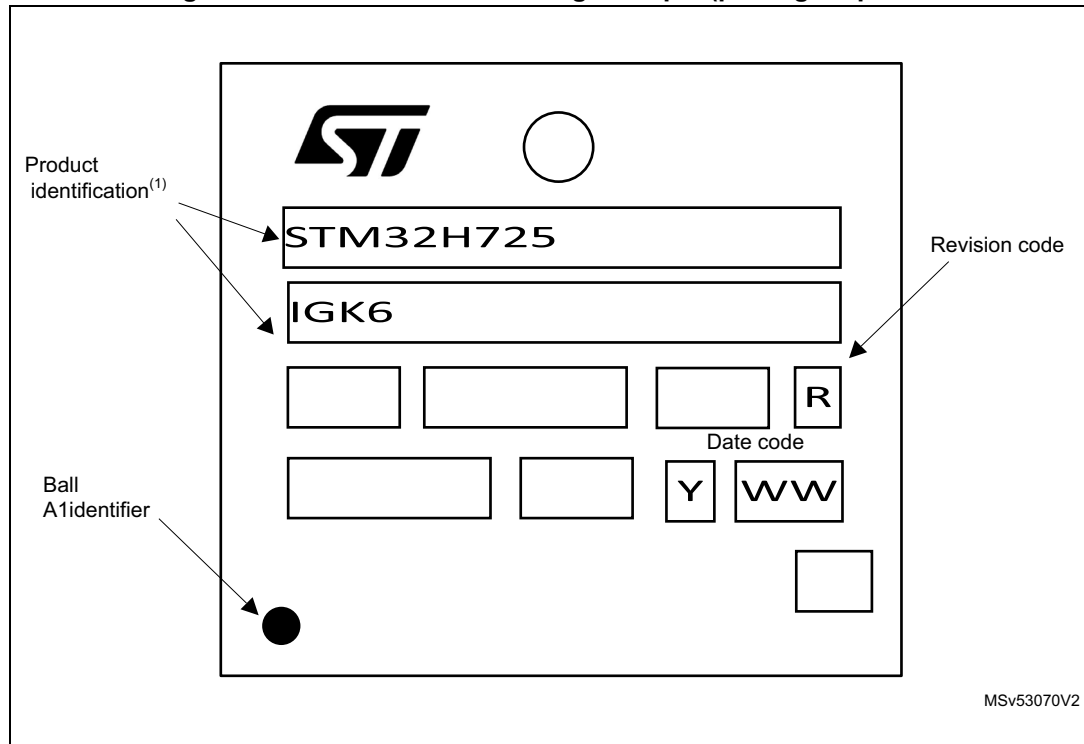
Device marking for UFBGA176+25

The following figure gives an example of topside marking versus ball A1 position identifier location.

The printed markings may differ depending on the supply chain.

Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 96. UFBGA176+25 marking example (package top view)



1. Parts marked as “ES”, “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.

7.9 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,
- Θ_{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 137. Thermal characteristics

| Symbol | Definition | Parameter | Value | Unit |
|---------------|-------------------------------------|---|-------|------|
| Θ_{JA} | Thermal resistance junction-ambient | Thermal resistance junction-ambient VFQFPN68 - 8 x 8 mm / 0.4 mm pitch | 26.1 | °C/W |
| | | Thermal resistance junction-ambient LQFP100 - 14 x 14 mm | 43.8 | |
| | | Thermal resistance junction-ambient TFBGA100 - 8 x 8 mm / 0.8 mm pitch | 43.2 | |
| | | Thermal resistance junction-ambient WLCSP115 3.73 x 4.15 mm, 0.35 mm pitch | 44.2 | |
| | | Thermal resistance junction-ambient LQFP144 - 20 x 20 mm / 0.5 mm pitch | 44.8 | |
| | | Thermal resistance junction-ambient UFBGA169 - 7 x 7 mm / 0.5 mm pitch | 38 | |
| | | Thermal resistance junction-ambient LQFP176 - 24 x 24 mm / 0.5 mm pitch | 48.3 | |
| | | Thermal resistance junction-ambient UFBGA176+25 - 10 x 10 mm / 0.65 mm pitch | 38 | |

Table 137. Thermal characteristics (continued)

| Symbol | Definition | Parameter | Value | Unit |
|---------------|-----------------------------------|---|-------|------|
| Θ_{JB} | Thermal resistance junction-board | Thermal resistance junction-board VFQFPN68 - 8 x 8 mm / 0.4 mm pitch | 5.6 | °C/W |
| | | Thermal resistance junction-board LQFP100 - 14 x 14 mm | 19.8 | |
| | | Thermal resistance junction-ambient TFBGA100 - 8 x 8 mm /0.8 mm pitch | 24.8 | |
| | | Thermal resistance junction-ambient WLCSP115 3.73 x 4.15 mm, 0.35 mm pitch | 17.6 | |
| | | Thermal resistance junction-board LQFP144 - 20 x 20 mm /0.5 mm pitch | 24.4 | |
| | | Thermal resistance junction-board UFBGA169 - 7 x 7 mm /0.5 mm pitch | 18 | |
| | | Thermal resistance junction-board LQFP176 - 24 x 24 mm /0.5 mm pitch | 29.1 | |
| | | Thermal resistance junction-board UFBGA176+25 - 10 x 10 mm /0.65 mm pitch | 20 | |
| Θ_{JC} | Thermal resistance junction-case | Thermal resistance junction-case VFQFPN68 - 8 x 8 mm / 0.4 mm pitch | 3.1 | °C/W |
| | | Thermal resistance junction-case LQFP100 - 14 x 14 mm | 7.3 | |
| | | Thermal resistance junction-ambient TFBGA100 - 8 x 8 mm /0.8 mm pitch | 13.2 | |
| | | Thermal resistance junction-ambient WLCSP115 3.73 x 4.15 mm / 0.35 mm pitch | 1.7 | |
| | | Thermal resistance junction-case LQFP144 - 20 x 20 mm /0.5 mm pitch | 7.4 | |
| | | Thermal resistance junction-case UFBGA169 - 7 x 7 mm / 0.5 mm pitch | 11 | |
| | | Thermal resistance junction-case LQFP176 - 24 x 24 mm / 0.5 mm pitch | 7.9 | |
| | | Thermal resistance junction-case UFBGA176+25 - 10 x 10 mm / 0.65 mm pitch | 24 | |

7.9.1 Reference documents

- JESD51-2 Integrated Circuits Thermal Test Method Environment Conditions - Natural Convection (Still Air). Available from www.jedec.org.
- For information on thermal management, refer to application note “*Thermal management guidelines for STM32 applications*” (AN5036) available from www.st.com.

8 Ordering information

| Example: | STM32 | H | 725 | V | G | T | 6 | TR |
|---|--|---|-----|---|---|---|---|----|
| Device family | <div style="border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; height: 500px; margin: 0 5px;"></div> | | | | | | | |
| STM32 = Arm-based 32-bit microcontroller | | | | | | | | |
| Product type | | | | | | | | |
| H = High performance | | | | | | | | |
| Device subfamily | | | | | | | | |
| 725 = STM32H725 | | | | | | | | |
| Pin count | | | | | | | | |
| R = 68 pins V = 100/115 pins Z = 144 pins A = 169 pins I = 176 pins/balls | | | | | | | | |
| Flash memory size | <div style="border-left: 1px solid black; border-right: 1px solid black; border-bottom: 1px solid black; height: 500px; margin: 0 5px;"></div> | | | | | | | |
| E = 512 Kbytes G = 1024 Kbytes | | | | | | | | |
| Package | | | | | | | | |
| T = LQFP ECOPACK2 K = UFBGA pitch 0.65 mm ECOPACK2 I = UFBGA pitch 0.5 mm ECOPACK2 H = TFBGA ECOPACK2 V = VFQFPN ECOPACK [®] 2 Y = WLCSP ECOPACK [®] 2 | | | | | | | | |
| Temperature range | | | | | | | | |
| 3 = Extended industrial temperature range, -40 to 125 °C 6 = Industrial temperature range -40 to 85 °C | | | | | | | | |
| Packing | | | | | | | | |
| TR = tape and reel No character = tray or tube | | | | | | | | |

For a list of available options (speed, package, etc.) or for further information on any aspect of this device, please contact your nearest ST sales office.

9 Revision history

Table 138. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 10-Jul-2020 | 1 | Initial release. |
| 03-Sep-2020 | 2 | <p>Distinction made between LQFP100 (STM32H725VGT) and TFBGA100 (STM32H725VGH) packages in Table 2: STM32H725xE/G features and peripheral counts.</p> <p>Renamed Section 3.30 into <i>True random number generator (RNG)</i>.</p> <p>Replaced V_{DDIOx} by V_{DD} in Section 6: Electrical characteristics.</p> <p>Updated I_{IO} in Table 11: Current characteristics and Table 18: Inrush current and inrush electric charge characteristics for LDO and SMPS.</p> <p>Removed Table 14: Supply voltage and maximum temperature configuration.</p> <p>Updated Table 28: Typical current consumption in Autonomous mode, Table 31: Typical and maximum current consumption in Standby mode and Table 32: Typical and maximum current consumption in VBAT mode.</p> <p>Added Section 6.3.16: I/O current injection characteristics.</p> <p>Removed reference to PI8 in Table 56: Output voltage characteristics for all I/Os except PC13, PC14 and PC15 and Table 57: Output voltage characteristics for PC13, PC14 and PC15.</p> <p>Added Section : Analog switch between ports Pxy_C and Pxy.</p> <p>Added Figure 92: LQFP176 - Recommended footprint and Table 133: UFBGA169 - Recommended PCB design rules (0.5 mm pitch BGA).</p> |
| 07-Dec-2021 | 3 | <p>Added indication that patents apply to the devices in Section : Features.</p> <p>Added reference to errata sheet in Section 1: Introduction.</p> <p>Table 2: STM32H725xE/G features and peripheral counts:</p> <ul style="list-style-type: none"> – Changed number of general-purpose 32-bit timers to 4. – For LQFP100, LQFP144 and TFBGA100 packages, replaced 2 Octo-SPI/Quad-SPI interfaces by 1 and remove note. – Changed number of SPI/I2S from 4/4 to 6/4 for UFBGA169, and 6/4 to 4/4 for WLCSP115. <p>In Section 3.7.1: Power supply scheme, changed V_{DD} power supply requirements.</p> <p>In Section 3.34: Universal synchronous/asynchronous receiver transmitter (USART), changed USART communication speed to 17 Mbit/s</p> <p>Updated Figure 4: VFQFPN68 pinout to show exposed pad.</p> <p>Changed F7 signal to VDDLDO in Figure 5: TFBGA100 pinout.</p> <p>Table 8: STM32H725 pin and ball descriptions:</p> <ul style="list-style-type: none"> – Added Note 1 and Note 2 to the package pin/balls corresponding to Pxy and Pxy_C. – For PA15(JTDI), replaced SPI3_NSS/I2S3_WS alternate function by SPI3_NSS(boot)/I2S3_WS. |

Table 138. Document revision history

| Date | Revision | Changes |
|-------------|---------------|---|
| 07-Dec-2021 | 3 (continued) | <p>Moved LSI clock from backup domain to VDD domain in Figure 14: Power supply scheme.</p> <p>Added V_{BAT} in Table 13: General operating conditions.</p> <p>Updated Table 19: Operating conditions at power-up/power-down title and added $t_{V_{CORE}}$.</p> <p>Modified Section 6.3.3: SMPS step-down converter including Figure 17: External components for SMPS step-down converter. Updated Figure 18: Typical SMPS efficiency (%) vs load current (A) in Run mode at $T_J = 30\text{ }^\circ\text{C}$.</p> <p>Updated measurement conditions for Typical and maximum current consumption, Table 30: Typical and maximum current consumption in System Stop mode.</p> <p>Section : On-chip peripheral current consumption: updated measurement conditions and Table 33: Peripheral current consumption in Run mode.</p> <p>Updated Table 35: High-speed external user clock characteristics.</p> <p>Changed unit for PLL long-term jitter in Table 43: PLL1 characteristics (wide VCO frequency range).</p> <p>Renamed I_{LEAK} into I_{lkg} in Table 55: I/O static characteristics.</p> <p>Table 59: Output timing characteristics (HSLV ON): updated load capacitance condition for t_r/t_f and speed 10 and 11.</p> <p>Updated Figure 41: OCTOSPI SDR read/write timing diagram, Figure 42: OCTOSPI DTR mode timing diagram, Figure 43: OCTOSPI Hyperbus clock timing diagram, Figure 44: OCTOSPI Hyperbus read timing diagram and Figure 45: OCTOSPI Hyperbus write timing diagram.</p> <p>Updated sampling rate for slow channels in Table 84: 16-bit ADC characteristics.</p> <p>Updated Figure 46: ADC accuracy characteristics and Figure 47: Typical connection diagram when using the ADC with FT/TT pins featuring analog switch function plus notes below.</p> <p>Updated T_L max value in Table 93: Temperature sensor characteristics.</p> <p>Changed temperature condition to $130\text{ }^\circ\text{C}$ for TS_CAL2 in Table 94: Temperature sensor calibration values.</p> <p>Updated Figure 48: Power supply and reference decoupling (V_{REF+} not connected to V_{DDA}).</p> <p>Updated Figure 55: USART timing diagram in Master mode and Figure 56: USART timing diagram in Slave mode.</p> <p>Updated Figure 65: SD high-speed mode, Figure 66: SD default mode and Figure 67: SDMMC DDR mode.</p> <p>Updated Figure 71: Ethernet MII timing diagram.</p> <p>Updated Figure 77: LQFP100- Outline, Table 126: LQFP100 - Mechanical data, Figure 80: TFBGA100 - Recommended footprint, Figure 91: LQFP176 - Outline and Table 134: LQFP176 - Mechanical data.</p> |

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