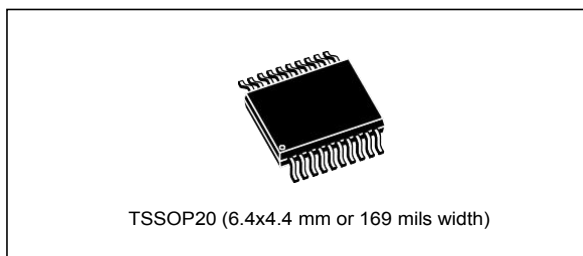


8-bit ultra-low-power MCU, 8-Kbyte Flash memory,  
256-byte data EEPROM, RTC, timers, USART, I2C, SPI, ADC

Datasheet - production data

## Features

- Operating conditions
  - Operating power supply: 1.8 V to 3.6 V
  - Temperature range: -40°C to 85 °C
- Low-power features
  - 5 low-power modes: Wait, Low-power run (5.1 µA), Low-power wait (3 µA), Active-halt with RTC (1.3 µA), Halt (350 nA)
  - Ultra-low leakage per I/O: 50 nA
  - Fast wakeup from Halt: 5 µs
- Advanced STM8 core
  - Harvard architecture and 3-stage pipeline
  - Max freq: 16 MHz, 16 CISC MIPS peak
  - Up to 40 external interrupt sources
- Reset and supply management
  - Low power, ultra-safe BOR reset with 5 selectable thresholds
  - Ultra-low power POR/PDR
  - Programmable voltage detector (PVD)
- Clock management
  - 32 kHz and 1 to 16 MHz crystal oscillators
  - Internal 16 MHz factory-trimmed RC
  - Internal 38 kHz low consumption RC
  - Clock security system
- Low-power RTC
  - BCD calendar with alarm interrupt
  - Digital calibration with +/- 0.5 ppm accuracy
  - LSE security system
  - Auto-wakeup from Halt w/ periodic interrupt
- Memories
  - 8 Kbytes of Flash program memory and 256 bytes of data EEPROM with ECC
  - Flexible write and read protection modes
  - 1 Kbyte of RAM



- DMA
  - 4 channels supporting ADC, SPI, I2C, USART, timers
  - 1 channel for memory-to-memory
- 12-bit ADC up to 1 Msps/10 channels
  - Internal reference voltage
- Timers
  - Two 16-bit timers with 2 channels (used as IC, OC, PWM), quadrature encoder
  - One 8-bit timer with 7-bit prescaler
  - 2 watchdogs: 1 Window, 1 Independent
  - Beeper timer with 1, 2 or 4 kHz frequencies
- Communication interfaces
  - Synchronous serial interface (SPI)
  - Fast I2C 400 kHz SMBus and PMBus
  - USART
- Up to 18 I/Os, all mappable on interrupt vectors
- Development support
  - Fast on-chip programming and non-intrusive debugging with SWIM
  - Bootloader using USART



# Contents

|          |                                                            |           |
|----------|------------------------------------------------------------|-----------|
| <b>1</b> | <b>Introduction.....</b>                                   | <b>8</b>  |
| <b>2</b> | <b>Description.....</b>                                    | <b>9</b>  |
| 2.1      | Device overview.....                                       | 10        |
| 2.2      | Ultra-low-power continuum.....                             | 11        |
| <b>3</b> | <b>Functional overview.....</b>                            | <b>12</b> |
| 3.1      | Low-power modes.....                                       | 13        |
| 3.2      | Central processing unit STM8.....                          | 14        |
| 3.2.1    | Advanced STM8 Core.....                                    | 14        |
| 3.2.2    | Interrupt controller.....                                  | 14        |
| 3.3      | Reset and supply management.....                           | 15        |
| 3.3.1    | Power supply scheme.....                                   | 15        |
| 3.3.2    | Power supply supervisor.....                               | 15        |
| 3.3.3    | Voltage regulator.....                                     | 15        |
| 3.4      | Clock management.....                                      | 16        |
| 3.5      | Low power real-time clock.....                             | 18        |
| 3.6      | Memories.....                                              | 18        |
| 3.7      | DMA.....                                                   | 18        |
| 3.8      | Analog-to-digital converter.....                           | 18        |
| 3.9      | System configuration controller and routing interface..... | 19        |
| 3.10     | Timers.....                                                | 19        |
| 3.10.1   | 16-bit general purpose timers (TIM2, TIM3).....            | 19        |
| 3.10.2   | 8-bit basic timer (TIM4).....                              | 19        |
| 3.11     | Watchdog timers.....                                       | 19        |
| 3.11.1   | Window watchdog timer.....                                 | 20        |
| 3.11.2   | Independent watchdog timer.....                            | 20        |
| 3.12     | Beeper.....                                                | 20        |
| 3.13     | Communication interfaces.....                              | 20        |
| 3.13.1   | SPI.....                                                   | 20        |
| 3.13.2   | I2C.....                                                   | 20        |
| 3.13.3   | USART.....                                                 | 21        |

|          |                                                             |           |
|----------|-------------------------------------------------------------|-----------|
| <b>4</b> | <b>Pin description.....</b>                                 | <b>23</b> |
| 4.1      | System configuration options.....                           | 25        |
| <b>5</b> | <b>Memory and register map.....</b>                         | <b>26</b> |
| 5.1      | Memory mapping.....                                         | 26        |
| 5.2      | Register map.....                                           | 27        |
| <b>6</b> | <b>Interrupt vector mapping.....</b>                        | <b>40</b> |
| <b>7</b> | <b>Option bytes.....</b>                                    | <b>42</b> |
| <b>8</b> | <b>Electrical parameters.....</b>                           | <b>45</b> |
| 8.1      | Parameter conditions.....                                   | 45        |
| 8.1.1    | Minimum and maximum values.....                             | 45        |
| 8.1.2    | Typical values.....                                         | 45        |
| 8.1.3    | Typical curves.....                                         | 45        |
| 8.1.4    | Loading capacitor.....                                      | 45        |
| 8.1.5    | Pin input voltage.....                                      | 46        |
| 8.2      | Absolute maximum ratings.....                               | 46        |
| 8.3      | Operating conditions.....                                   | 48        |
| 8.3.1    | General operating conditions.....                           | 48        |
| 8.3.2    | Embedded reset and power control block characteristics..... | 49        |
| 8.3.3    | Supply current characteristics.....                         | 50        |
| 8.3.4    | Clock and timing characteristics.....                       | 60        |
| 8.3.5    | Memory characteristics.....                                 | 65        |
| 8.3.6    | I/O current injection characteristics.....                  | 66        |
| 8.3.7    | I/O port pin characteristics.....                           | 66        |
| 8.3.8    | Communication interfaces.....                               | 74        |
| 8.3.9    | Embedded reference voltage.....                             | 79        |
| 8.3.10   | 12-bit ADC1 characteristics.....                            | 79        |
| 8.3.11   | EMC characteristics.....                                    | 85        |
| <b>9</b> | <b>Package characteristics.....</b>                         | <b>88</b> |
| 9.1      | ECOPACK®.....                                               | 88        |
| 9.2      | Package mechanical data.....                                | 89        |
| 9.3      | TSSOP20 package information.....                            | 89        |



|     |                              |    |
|-----|------------------------------|----|
| 9.4 | Thermal characteristics..... | 92 |
| 10  | Ordering information.....    | 93 |
| 11  | Revision history.....        | 94 |

## List of tables

|           |                                                                                            |    |
|-----------|--------------------------------------------------------------------------------------------|----|
| Table 1.  | STM8L051F3 features and peripheral counts.....                                             | 10 |
| Table 2.  | Timer feature comparison.....                                                              | 19 |
| Table 3.  | Legend/abbreviation for <a href="#">Table 4</a> .....                                      | 23 |
| Table 4.  | STM8L051F3 pin description.....                                                            | 24 |
| Table 5.  | Flash and RAM boundary addresses.....                                                      | 27 |
| Table 6.  | I/O port hardware register map.....                                                        | 27 |
| Table 7.  | General hardware register map.....                                                         | 28 |
| Table 8.  | CPU/SWIM/debug module/interrupt controller registers.....                                  | 38 |
| Table 9.  | Interrupt mapping.....                                                                     | 40 |
| Table 10. | Option byte addresses.....                                                                 | 42 |
| Table 11. | Option byte description.....                                                               | 43 |
| Table 12. | Voltage characteristics.....                                                               | 46 |
| Table 13. | Current characteristics.....                                                               | 46 |
| Table 14. | Thermal characteristics.....                                                               | 47 |
| Table 15. | General operating conditions.....                                                          | 48 |
| Table 16. | Embedded reset and power control block characteristics.....                                | 49 |
| Table 17. | Total current consumption in Run mode.....                                                 | 51 |
| Table 18. | Total current consumption in Wait mode.....                                                | 53 |
| Table 19. | Total current consumption and timing in Low power run mode<br>at VDD = 1.8 V to 3.6 V..... | 55 |
| Table 20. | Total current consumption in Low power wait mode at VDD = 1.8 V to 3.6 V.....              | 56 |
| Table 21. | Total current consumption and timing in Active-halt mode at VDD = 1.8 V to 3.6 V.....      | 57 |
| Table 22. | Typical current consumption in Active-halt mode, RTC clocked by LSE external crystal.....  | 57 |
| Table 23. | Total current consumption and timing in Halt mode at VDD = 1.8 to 3.6 V.....               | 58 |
| Table 24. | Peripheral current consumption.....                                                        | 59 |
| Table 25. | Current consumption under external reset.....                                              | 60 |
| Table 26. | HSE external clock characteristics.....                                                    | 60 |
| Table 27. | LSE external clock characteristics.....                                                    | 60 |
| Table 28. | HSE oscillator characteristics.....                                                        | 61 |
| Table 29. | LSE oscillator characteristics.....                                                        | 62 |
| Table 30. | HSI oscillator characteristics.....                                                        | 63 |
| Table 31. | LSI oscillator characteristics.....                                                        | 64 |
| Table 32. | RAM and hardware registers.....                                                            | 65 |
| Table 33. | Flash program and data EEPROM memory.....                                                  | 65 |
| Table 34. | I/O current injection susceptibility.....                                                  | 66 |
| Table 35. | I/O static characteristics.....                                                            | 67 |
| Table 36. | Output driving current (high sink ports).....                                              | 70 |
| Table 37. | Output driving current (true open drain ports).....                                        | 70 |
| Table 38. | Output driving current (PA0 with high sink LED driver capability).....                     | 70 |
| Table 39. | NRST pin characteristics.....                                                              | 72 |
| Table 40. | SPI1 characteristics.....                                                                  | 74 |
| Table 41. | I2C characteristics.....                                                                   | 77 |
| Table 42. | Reference voltage characteristics.....                                                     | 79 |
| Table 43. | ADC1 characteristics.....                                                                  | 80 |
| Table 44. | ADC1 accuracy with VDDA = 3.3 V to 2.5 V.....                                              | 82 |
| Table 45. | ADC1 accuracy with VDDA = 2.4 V to 3.6 V.....                                              | 82 |
| Table 46. | ADC1 accuracy with VDDA = VREF <sub>+</sub> = 1.8 V to 2.4 V.....                          | 82 |
| Table 47. | R <sub>AIN</sub> max for f <sub>ADC</sub> = 16 MHz.....                                    | 84 |

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|           |                                                                                                           |    |
|-----------|-----------------------------------------------------------------------------------------------------------|----|
| Table 48. | EMS data.....                                                                                             | 86 |
| Table 49. | EMI data.....                                                                                             | 86 |
| Table 50. | ESD absolute maximum ratings.....                                                                         | 87 |
| Table 51. | Electrical sensitivities.....                                                                             | 87 |
| Table 52. | TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch,<br>package mechanical data..... | 89 |
| Table 53. | Thermal characteristics.....                                                                              | 92 |
| Table 54. | Document revision history.....                                                                            | 94 |

## List of figures

|            |                                                                                                          |    |
|------------|----------------------------------------------------------------------------------------------------------|----|
| Figure 1.  | STM8L051F3 block diagram.....                                                                            | 12 |
| Figure 2.  | STM8L051F3 clock tree diagram.....                                                                       | 17 |
| Figure 3.  | STM8L051F3 20-pin TSSOP20 package pinout.....                                                            | 23 |
| Figure 4.  | Memory map.....                                                                                          | 26 |
| Figure 5.  | Pin loading conditions.....                                                                              | 45 |
| Figure 6.  | Pin input voltage.....                                                                                   | 46 |
| Figure 7.  | POR/BOR thresholds.....                                                                                  | 50 |
| Figure 8.  | Typ. $I_{DD}(RUN)$ vs. $V_{DD}$ , $f_{CPU} = 16\text{ MHz}$ .....                                        | 52 |
| Figure 9.  | Typ. $I_{DD}(Wait)$ vs. $V_{DD}$ , $f_{CPU} = 16\text{ MHz}$ 1).....                                     | 54 |
| Figure 10. | Typ. $I_{DD}(LPR)$ vs. $V_{DD}$ (LSI clock source).....                                                  | 55 |
| Figure 11. | Typ. $I_{DD}(LPW)$ vs. $V_{DD}$ (LSI clock source).....                                                  | 56 |
| Figure 12. | HSE oscillator circuit diagram.....                                                                      | 61 |
| Figure 13. | LSE oscillator circuit diagram.....                                                                      | 62 |
| Figure 14. | Typical HSI frequency vs $V_{DD}$ .....                                                                  | 63 |
| Figure 15. | Typical LSI frequency vs. $V_{DD}$ .....                                                                 | 64 |
| Figure 16. | Typical $V_{IL}$ and $V_{IH}$ vs $V_{DD}$ (high sink I/Os).....                                          | 68 |
| Figure 17. | Typical $V_{IL}$ and $V_{IH}$ vs $V_{DD}$ (true open drain I/Os).....                                    | 68 |
| Figure 18. | Typical pull-up resistance $R_{PU}$ vs $V_{DD}$ with $V_{IN}=V_{SS}$ .....                               | 69 |
| Figure 19. | Typical pull-up current $I_{PU}$ vs $V_{DD}$ with $V_{IN}=V_{SS}$ .....                                  | 69 |
| Figure 20. | Typ. $V_{OL}$ @ $V_{DD} = 3.0\text{ V}$ (high sink ports).....                                           | 71 |
| Figure 21. | Typ. $V_{OL}$ @ $V_{DD} = 1.8\text{ V}$ (high sink ports).....                                           | 71 |
| Figure 22. | Typ. $V_{OL}$ @ $V_{DD} = 3.0\text{ V}$ (true open drain ports).....                                     | 71 |
| Figure 23. | Typ. $V_{OL}$ @ $V_{DD} = 1.8\text{ V}$ (true open drain ports).....                                     | 71 |
| Figure 24. | Typ. $V_{DD} - V_{OH}$ @ $V_{DD} = 3.0\text{ V}$ (high sink ports).....                                  | 71 |
| Figure 25. | Typ. $V_{DD} - V_{OH}$ @ $V_{DD} = 1.8\text{ V}$ (high sink ports).....                                  | 71 |
| Figure 26. | Typical NRST pull-up resistance $R_{PU}$ vs $V_{DD}$ .....                                               | 72 |
| Figure 27. | Typical NRST pull-up current $I_{PU}$ vs $V_{DD}$ .....                                                  | 73 |
| Figure 28. | Recommended NRST pin configuration.....                                                                  | 73 |
| Figure 29. | SPI1 timing diagram - slave mode and $CPHA=0$ .....                                                      | 75 |
| Figure 30. | SPI1 timing diagram - slave mode and $CPHA=1$ <sup>(1)</sup> .....                                       | 75 |
| Figure 31. | SPI1 timing diagram - master mode <sup>(1)</sup> .....                                                   | 76 |
| Figure 32. | Typical application with I2C bus and timing diagram 1).....                                              | 78 |
| Figure 33. | ADC1 accuracy characteristics.....                                                                       | 83 |
| Figure 34. | Typical connection diagram using the ADC.....                                                            | 83 |
| Figure 35. | Maximum dynamic current consumption on $V_{REF+}$ supply pin during ADC conversion.....                  | 83 |
| Figure 36. | Power supply and reference decoupling ( $V_{REF+}$ not connected to $V_{DDA}$ ).....                     | 84 |
| Figure 37. | Power supply and reference decoupling ( $V_{REF+}$ connected to $V_{DDA}$ ).....                         | 85 |
| Figure 38. | TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package outline.....           | 89 |
| Figure 39. | TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package footprint.....         | 90 |
| Figure 40. | Device marking for TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch example..... | 91 |
| Figure 41. | Low density value line STM8L051F3 ordering information scheme.....                                       | 93 |

# 1 Introduction

This document describes the features, pinout, mechanical data and ordering information for the low density STM8L051F3 microcontroller with 8-Kbyte Flash memory density.

For further details on the whole STMicroelectronics low density family please refer to [Section 2.2: Ultra-low-power continuum](#).

For detailed information on device operation and registers, refer to the *STM8L050J3, STM8L051F3, STM8L052C6, STM8L052R8 MCUs and STM8L151/L152, STM8L162, STM8AL31, STM8AL3L lines* reference manual (RM0031).

For information on to the Flash program memory and data EEPROM, refer to the *How to program STM8L and STM8AL Flash program memory and data EEPROM* programming manual (PM0054).

For information on the debug module and SWIM (single wire interface module), refer to the *STM8 SWIM communication protocol and debug module* user manual (UM0470).

For information on the STM8 core, refer to the *STM8 CPU programming manual* (PM0044).

The low density value line devices, including STM8L051F3, provide the following benefits:

- Integrated system
  - 8 Kbytes of low-density embedded Flash program memory
  - 256 bytes of data EEPROM
  - 1 Kbyte of RAM
  - Internal high-speed and low-power low speed RC
  - Embedded reset
- Ultra-low-power consumption
  - 1  $\mu$ A in Active-halt mode
  - Clock gated system and optimized power management
  - Capability to execute from RAM for Low-power wait mode and Low-power run mode
- Advanced features
  - Up to 16 MIPS at 16 MHz CPU clock frequency
  - Direct memory access (DMA) for memory-to-memory or peripheral-to-memory access
- Short development cycles
  - Application scalability across a common family product architecture with compatible pinout, memory map and modular peripherals
  - Wide choice of development tools

These features make STM8L051F3 suitable for a wide range of consumer and mass market applications.

Refer to [Table 1: STM8L051F3 features and peripheral counts](#) and [Section 3: Functional overview](#) for an overview of the complete range of peripherals proposed in this family.

[Figure 1](#) shows the block diagram of the low density STM8L051F3 device.



## 2 Description

STM8L051F3 is member of the STM8L ultra-low-power 8-bit family.

STM8L051F3 features an enhanced STM8 CPU core providing increased processing power (up to 16 MIPS at 16 MHz) while maintaining the advantages of a CISC architecture with improved code density, a 24-bit linear addressing space and an optimized architecture for low-power operations.

The STM8L051F3 MCU includes an integrated debug module with a hardware interface (SWIM) which allows non-intrusive In-Application debugging and ultra-fast Flash programming. It features an embedded data EEPROM and low-power, low-voltage, single-supply program Flash memory.

The device incorporates an extensive range of enhanced I/Os and peripherals, a 12-bit ADC, a real-time clock, two 16-bit timers, one 8-bit timer, as well as standard communication interfaces such as an SPI, an I2C interface, and one USART.

The modular design of the peripheral set allows this device to have the same peripherals that can be found in different ST microcontroller families including 32-bit families. This makes any transition to a different family very easy, supported also by the use of a common set of development tools.

STM8L051F3 as all the value line STM8L ultra-low-power products are based on the same architecture with the same memory mapping and a coherent pinout.

## 2.1 Device overview

**Table 1. STM8L051F3 features and peripheral counts**

| Features                                     |                 | STM8L051F3                                                                                                                   |
|----------------------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------|
| Flash (Kbytes)                               |                 | 8                                                                                                                            |
| Data EEPROM (Bytes)                          |                 | 256                                                                                                                          |
| RAM (Kbytes)                                 |                 | 1                                                                                                                            |
| Timers                                       | Basic           | 1<br>(8-bit)                                                                                                                 |
|                                              | General purpose | 2<br>(16-bit)                                                                                                                |
| Communication interfaces                     | SPI             | 1                                                                                                                            |
|                                              | I2C             | 1                                                                                                                            |
|                                              | USART           | 1                                                                                                                            |
| GPIOs                                        |                 | 18 <sup>(1)</sup>                                                                                                            |
| 12-bit synchronized ADC (number of channels) |                 | 1<br>(10)                                                                                                                    |
| Others                                       |                 | RTC, window watchdog, independent watchdog,<br>16-MHz and 32-kHz internal RC,<br>1- to 16-MHz and 32-kHz external oscillator |
| CPU frequency                                |                 | 16 MHz                                                                                                                       |
| Operating voltage                            |                 | 1.8 to 3.6 V                                                                                                                 |
| Operating temperature                        |                 | −40 to +85 °C                                                                                                                |
| Package                                      |                 | TSSOP20                                                                                                                      |

1. The number of GPIOs given in this table includes the NRST/PA1 pin but the application can use the NRST/PA1 pin as general purpose output only (PA1).

## 2.2 Ultra-low-power continuum

STM8L051F3 is part of STM8's ultra-low-power value line on which all the devices are pin-to-pin, software and feature compatible. Besides the full compatibility within the STM8L family, the devices are part of STMicroelectronics microcontrollers ultra-low-power strategy which also includes the STM8L001xx, STM8L101xx and STM32L15xxx devices. The STM8L and STM32L families allow a continuum of performance, peripherals, system architecture, and features.

They are all based on STMicroelectronics 0.13  $\mu\text{m}$  ultra-low leakage process.

- Note:*
- 1 *STM8L051F3 is pin-to-pin compatible with STM8L101xx devices.*
  - 2 *The STM32L family is pin-to-pin compatible with the general purpose STM32F family. Please refer to STM32L15x documentation for more information on these devices.*

### Performance

All the STMicroelectronics ultra-low-power families incorporate highly energy-efficient cores with both Harvard architecture and pipelined execution: advanced STM8 core for STM8L families and ARM® 32-bit Cortex®-M3 core for STM32L family. In addition specific care for the design architecture has been taken to optimize the mA/DMIPS and mA/MHz ratios.

This allows the ultra-low-power performance to range from 5 up to 33.3 DMIPs.

### Shared peripherals

The STM8L05xxx, STM8L15xxx and STM32L15xxx devices share identical peripherals which ensure a very easy migration from one family to another:

- Analog peripheral: ADC1
- Digital peripherals: RTC and some communication interfaces

### Common system strategy

To offer flexibility and optimize performance, the STM8L and STM32L devices use a common architecture:

- Same power supply range from 1.8 to 3.6 V
- Architecture optimized to reach ultra-low consumption both in low-power modes and Run mode
- Fast startup strategy from low-power modes
- Flexible system clock
- Ultra-safe reset: same reset strategy for both STM8L and STM32L including power-on reset, power-down reset, brownout reset and programmable voltage detector.

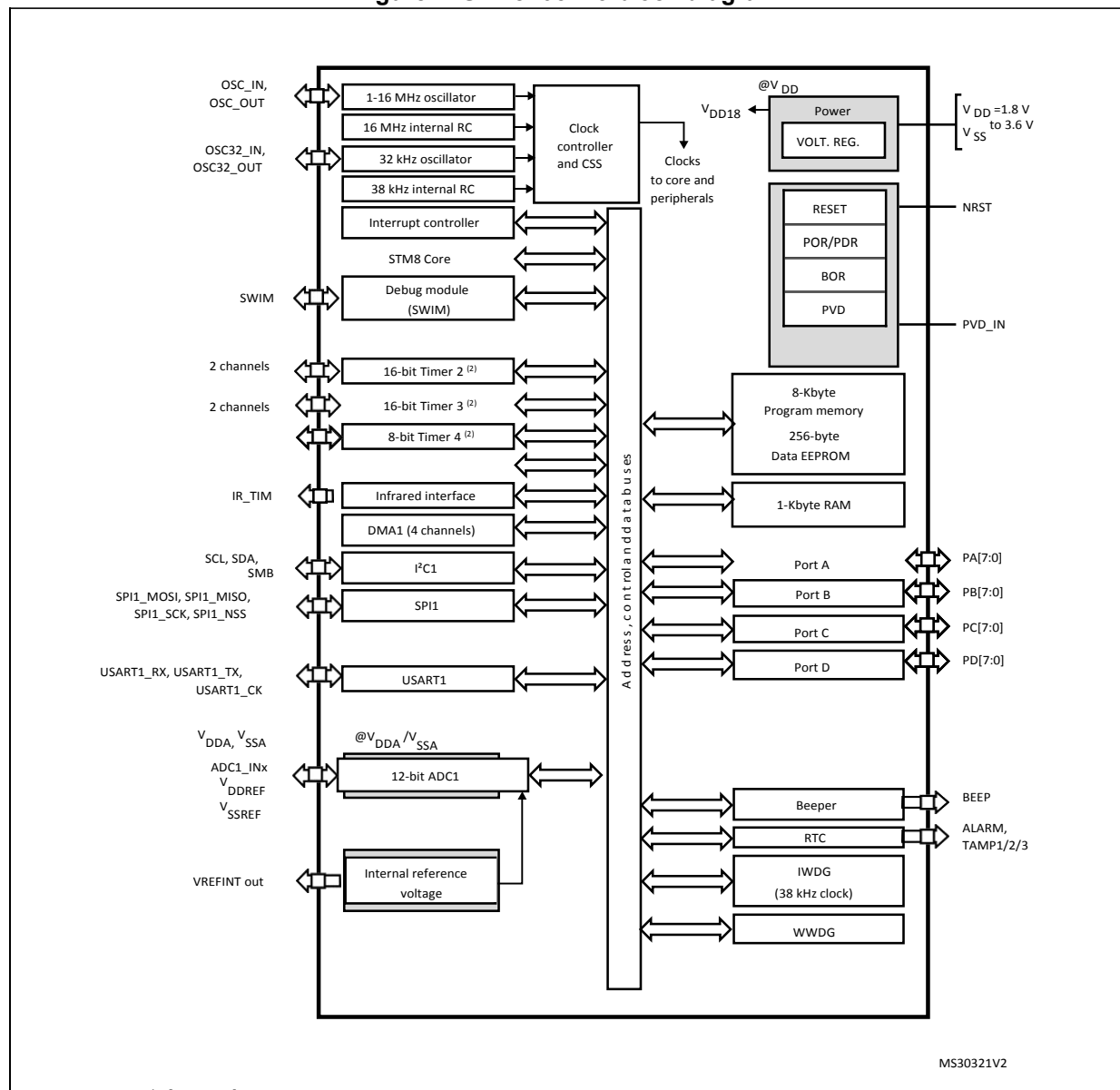
### Features

ST ultra-low-power continuum also lies in feature compatibility:

- More than 10 packages with pin count from 20 to 100 pins and size down to 3 x 3 mm
- Memory density ranging from 4 to 128 Kbytes

### 3 Functional overview

Figure 1. STM8L051F3 block diagram



#### 1. Legend:

ADC: Analog-to-digital converter  
 BOR: Brownout reset  
 DMA: Direct memory access  
 I<sup>2</sup>C: Inter-integrated circuit multimaster interface  
 IWDG: Independent watchdog  
 POR/PDR: Power-on reset / power-down reset  
 RTC: Real-time clock  
 SPI: Serial peripheral interface  
 SWIM: Single wire interface module  
 USART: Universal synchronous asynchronous receiver transmitter  
 WWDG: Window watchdog

### 3.1 Low-power modes

STM8L051F3 as well as all the low density value line STM8L05xxx devices support five low-power modes to achieve the best compromise between low power consumption, short startup time and available wakeup sources:

- **Wait mode:** The CPU clock is stopped, but selected peripherals keep running. An internal or external interrupt or a Reset can be used to exit the microcontroller from Wait mode (WFE or WFI mode).
- **Low-power run mode:** The CPU and the selected peripherals are running. Execution is done from RAM with a low speed oscillator (LSI or LSE). Flash memory and data EEPROM are stopped and the voltage regulator is configured in ultra-low-power mode. The microcontroller enters Low-power run mode by software and can exit from this mode by software or by a reset.  
All interrupts must be masked. They cannot be used to exit the microcontroller from this mode.
- **Low-power wait mode:** This mode is entered when executing a Wait for event in Low-power run mode. It is similar to Low-power run mode except that the CPU clock is stopped. The wakeup from this mode is triggered by a Reset or by an internal or external event (peripheral event generated by the timers, serial interfaces, DMA controller (DMA1) and I/O ports). When the wakeup is triggered by an event, the system goes back to Low-power run mode.  
All interrupts must be masked. They cannot be used to exit the microcontroller from this mode.
- **Active-halt mode:** CPU and peripheral clocks are stopped, except RTC. The wakeup can be triggered by RTC interrupts, external interrupts or reset.
- **Halt mode:** CPU and peripheral clocks are stopped, the device remains powered on. The RAM content is preserved. The wakeup is triggered by an external interrupt or reset. A few peripherals have also a wakeup from Halt capability. Switching off the internal reference voltage reduces power consumption. Through software configuration it is also possible to wake up the device without waiting for the internal reference voltage wakeup time to have a fast wakeup time of 5  $\mu$ s.

## 3.2 Central processing unit STM8

The central processing unit represents the core of the microcontroller; it executes code and controls the peripherals.

### 3.2.1 Advanced STM8 Core

The 8-bit STM8 core is designed for code efficiency and performance with an Harvard architecture and a 3-stage pipeline.

It contains 6 internal registers which are directly addressable in each execution context, 20 addressing modes including indexed indirect and relative addressing, and 80 instructions.

#### Architecture and registers

- Harvard architecture
- 3-stage pipeline
- 32-bit wide program memory bus - single cycle fetching most instructions
- X and Y 16-bit index registers - enabling indexed addressing modes with or without offset and read-modify-write type data manipulations
- 8-bit accumulator
- 24-bit program counter - 16-Mbyte linear memory space
- 16-bit stack pointer - access to a 64-Kbyte level stack
- 8-bit condition code register - 7 condition flags for the result of the last instruction

#### Addressing

- 20 addressing modes
- Indexed indirect addressing mode for lookup tables located anywhere in the address space
- Stack pointer relative addressing mode for local variables and parameter passing

#### Instruction set

- 80 instructions with 2-byte average instruction size
- Standard data movement and logic/arithmetic functions
- 8-bit by 8-bit multiplication
- 16-bit by 8-bit and 16-bit by 16-bit division
- Bit manipulation
- Data transfer between stack and accumulator (push/pop) with direct stack access
- Data transfer using the X and Y registers or direct memory-to-memory transfers

### 3.2.2 Interrupt controller

STM8L051F3 and all the low density value line STM8L05xxx feature a nested vectored interrupt controller:

- Nested interrupts with 3 software priority levels
- 32 interrupt vectors with hardware priority
- Up to 17 external interrupt sources on 11 vectors
- Trap and reset interrupts

### 3.3 Reset and supply management

The power supplies requirements must be defined in order to have a correct microcontroller operation. The reset and supply management controls the microcontroller operation under defined conditions.

#### 3.3.1 Power supply scheme

The device requires a 1.8 V to 3.6 V operating supply voltage ( $V_{DD}$ ). The external power supply pins must be connected as follows:

- $V_{SS1}$ ;  $V_{DD1}$  = 1.8 to 3.6 V: external power supply for I/Os and for the internal regulator. Provided externally through  $V_{DD1}$  pins, the corresponding ground pin is  $V_{SS1}$ .
- $V_{SSA}$ ;  $V_{DDA}$  = 1.8 to 3.6 V: external power supplies for analog peripherals.  $V_{DDA}$  and  $V_{SSA}$  must be connected to  $V_{DD1}$  and  $V_{SS1}$ , respectively.
- $V_{SS2}$ ;  $V_{DD2}$  = 1.8 to 3.6 V: external power supplies for I/Os.  $V_{DD2}$  and  $V_{SS2}$  must be connected to  $V_{DD1}$  and  $V_{SS1}$ , respectively.
- $V_{REF+}$ ,  $V_{REF-}$  (for ADC1): external reference voltage for ADC1. Must be provided externally through  $V_{REF+}$  and  $V_{REF-}$  pin.

#### 3.3.2 Power supply supervisor

The device has an integrated ZEROPOWER power-on reset (POR)/power-down reset (PDR), coupled with a brownout reset (BOR) circuitry. When the microcontroller operates between 1.8 and 3.6 V, BOR is always active and ensures proper operation starting from 1.8 V. After the 1.8 V BOR threshold is reached, the option byte loading process starts, either to confirm or modify default thresholds, or to disable BOR permanently.

Five BOR thresholds are available through option bytes, starting from 1.8 V to 3 V. To reduce the power consumption in Halt mode, it is possible to automatically switch off the internal reference voltage (and consequently the BOR) in Halt mode. The device remains in reset state when  $V_{DD}$  is below a specified threshold,  $V_{POR/PDR}$  or  $V_{BOR}$ , without the need for any external reset circuit.

The device features an embedded programmable voltage detector (PVD) that monitors the  $V_{DD}/V_{DDA}$  power supply and compares it to the  $V_{PVD}$  threshold. This PVD offers 7 different levels between 1.85 V and 3.05 V, chosen by software, with a step around 200 mV. An interrupt can be generated when  $V_{DD}/V_{DDA}$  drops below the  $V_{PVD}$  threshold and/or when  $V_{DD}/V_{DDA}$  is higher than the  $V_{PVD}$  threshold. The interrupt service routine can then generate a warning message and/or put the MCU into a safe state. The PVD is enabled by software.

#### 3.3.3 Voltage regulator

STM8L051F3 as all the low density value line STM8L05xxx embeds an internal voltage regulator for generating the 1.8 V power supply for the core and peripherals.

This regulator has two different modes:

- Main voltage regulator mode (MVR) for Run, Wait for interrupt (WFI) and Wait for event (WFE) modes.
- Low-power voltage regulator mode (LPVR) for Halt, Active-halt, Low-power run and Low-power wait modes.

When entering Halt or Active-halt modes, the system automatically switches from the MVR to the LPVR in order to reduce current consumption.

## 3.4 Clock management

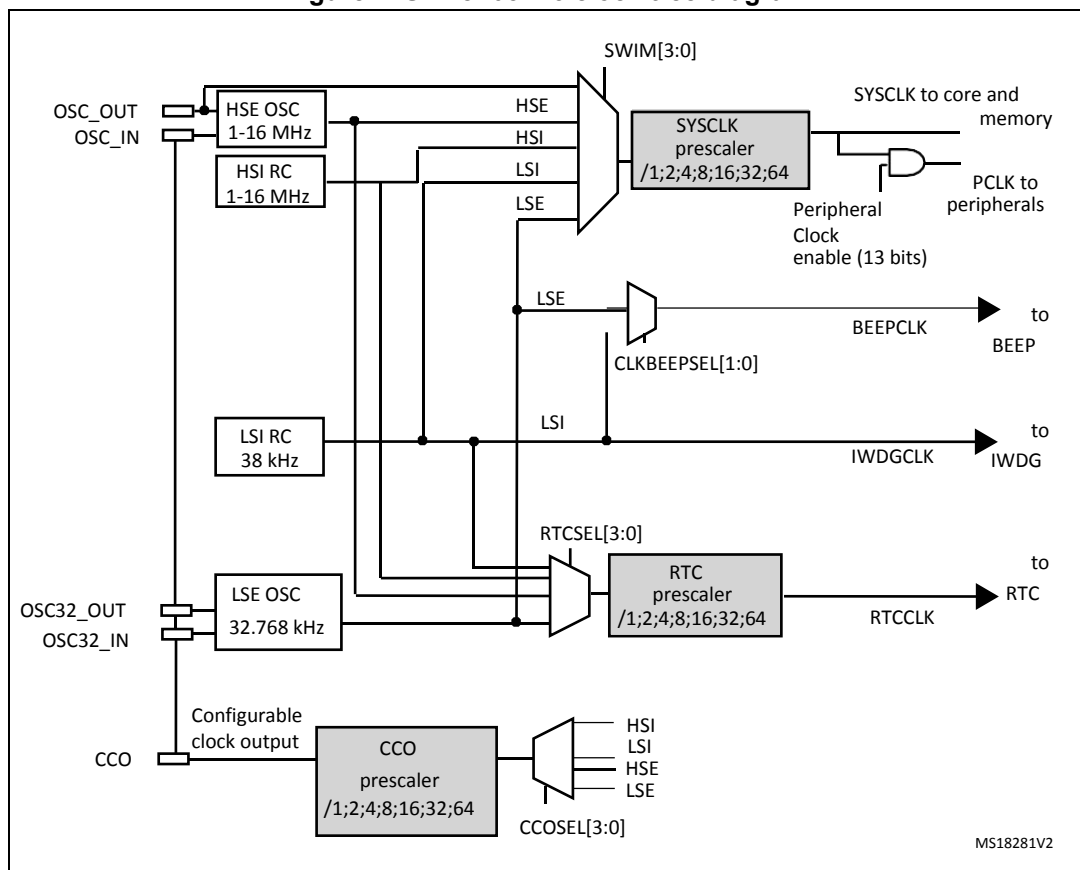
The clock controller distributes the system clock (SYSCLK) coming from different oscillators to the core and the peripherals. It also manages clock gating for low-power modes and ensures clock robustness.

### Features

- **Clock prescaler:** to get the best compromise between speed and current consumption the clock frequency to the CPU and peripherals can be adjusted by a programmable prescaler.
- **Safe clock switching:** Clock sources can be changed safely on the fly in runmode through a configuration register.
- **Clock management:** To reduce power consumption, the clock controller can stop the clock to the core, individual peripherals or memory.
- **System clock sources:** four different clock sources can be used to drive the system clock:
  - 1-16 MHz High speed external crystal (HSE)
  - 16 MHz High speed internal RC oscillator (HSI)
  - 32.768 Low speed external crystal (LSE)
  - 38 kHz Low speed internal RC (LSI)
- **RTC clock sources:** the above four sources can be chosen to clock the RTC whatever the system clock.
- **Startup clock:** After reset, the microcontroller restarts by default with an internal 2 MHz clock (HSI/8). The prescaler ratio and clock source can be changed by the application program as soon as the code execution starts.
- **Clock security system (CSS):** This feature can be enabled by software. If a HSE clock failure occurs, it is automatically switched to HSI.
- **Configurable main clock output (CCO):** This outputs an external clock for use by the application.



Figure 2. STM8L051F3 clock tree diagram



1. The HSE clock source can be either an external crystal/ceramic resonator or an external source (HSE bypass). Refer to Section HSE clock in the *STM8L050J3*, *STM8L051F3*, *STM8L052C6*, *STM8L052R8* MCUs and *STM8L151/L152*, *STM8L162*, *STM8AL31*, *STM8AL3L* lines reference manual (RM0031).
2. The LSE clock source can be either an external crystal/ceramic resonator or a external source (LSE bypass). Refer to Section LSE clock in the *STM8L050J3*, *STM8L051F3*, *STM8L052C6*, *STM8L052R8* MCUs and *STM8L151/L152*, *STM8L162*, *STM8AL31*, *STM8AL3L* lines reference manual (RM0031).

### 3.5 Low power real-time clock

The real-time clock (RTC) is an independent binary coded decimal (BCD) timer/counter.

Six byte locations contain the second, minute, hour (12/24 hour), week day, date, month, year, in BCD (binary coded decimal) format. Correction for 28, 29 (leap year), 30, and 31 day months are made automatically.

It provides a programmable alarm and programmable periodic interrupts with wakeup from Halt capability.

- Periodic wakeup time using the 32.768 kHz LSE with the lowest resolution (of 61  $\mu$ s) is from min. 122  $\mu$ s to max. 3.9 s. With a different resolution, the wakeup time can reach 36 hours
- Periodic alarms based on the calendar can also be generated from every second to every year

### 3.6 Memories

STM8L051F3 as all the low density value line STM8L05xxx devices have the following main features:

- Up to 1 Kbyte of RAM
- The non-volatile memory is divided into three arrays:
  - 8 Kbytes of low-density embedded Flash program memory
  - 256 bytes of Data EEPROM
  - Option bytes

The EEPROM embeds the error correction code (ECC) feature.

The option byte protects part of the Flash program memory from write and readout piracy.

### 3.7 DMA

A 4-channel direct memory access controller (DMA1) offers a memory-to-memory and peripherals-from/to-memory transfer capability. The 4 channels are shared between the following IPs with DMA capability: ADC1, I2C1, SPI1, USART1, and the three timers.

### 3.8 Analog-to-digital converter

- 12-bit analog-to-digital converter (ADC1) with 10 channels (no fast channel) and internal reference voltage
- Conversion time down to 1  $\mu$ s with  $f_{\text{SYSCLK}} = 16$  MHz
- Programmable resolution
- Programmable sampling time
- Single and continuous mode of conversion
- Scan capability: automatic conversion performed on a selected group of analog inputs
- Analog watchdog
- Triggered by timer

*Note:* ADC1 can be served by DMA1.

### 3.9 System configuration controller and routing interface

The system configuration controller provides the capability to remap some alternate functions on different I/O ports. TIM4 and ADC1 DMA channels can also be remapped.

The highly flexible routing interface controls the routing of internal analog signals to ADC1 and the internal reference voltage  $V_{REFINT}$ .

### 3.10 Timers

STM8L051F3 contains two 16-bit general purpose timers (TIM2 and TIM3) and one 8-bit basic timer (TIM4).

All the timers can be served by DMA1.

[Table 2](#) compares the features of the advanced control, general-purpose and basic timers.

**Table 2. Timer feature comparison**

| Timer | Counter resolution | Counter type | Prescaler factor               | DMA1 request generation | Capture/compare channels | Complementary outputs |
|-------|--------------------|--------------|--------------------------------|-------------------------|--------------------------|-----------------------|
| TIM2  | 16-bit             | up/down      | Any power of 2 from 1 to 128   | Yes                     | 2                        | None                  |
| TIM3  |                    |              |                                |                         | 2                        |                       |
| TIM4  | 8-bit              | up           | Any power of 2 from 1 to 32768 |                         | 0                        |                       |

#### 3.10.1 16-bit general purpose timers (TIM2, TIM3)

- 16-bit autoreload (AR) up/down-counter
- 7-bit prescaler adjustable to fixed power of 2 ratios (1...128)
- 2 individually configurable capture/compare channels
- PWM mode
- Interrupt capability on various events (capture, compare, overflow, break, trigger)
- Synchronization with other timers or external signals (external clock, reset, trigger and enable)

#### 3.10.2 8-bit basic timer (TIM4)

The 8-bit timer consists of an 8-bit up auto-reload counter driven by a programmable prescaler. It can be used for timebase generation with interrupt generation on timer overflow.

### 3.11 Watchdog timers

The watchdog system is based on two independent timers providing maximum security to the applications.

### 3.11.1 Window watchdog timer

The window watchdog (WWDG) is used to detect the occurrence of a software fault, usually generated by external interferences or by unexpected logical conditions, which cause the application program to abandon its normal sequence.

### 3.11.2 Independent watchdog timer

The independent watchdog peripheral (IWDG) can be used to resolve processor malfunctions due to hardware or software failures.

It is clocked by the internal LSI RC clock source, and thus stays active even in case of a CPU clock failure.

## 3.12 Beeper

The beeper function outputs a signal on the BEEP pin for sound generation. The signal is in the range of 1, 2 or 4 kHz.

## 3.13 Communication interfaces

This section describes the three communication interfaces of STM8L050J3: SPI, I2C and USART.

### 3.13.1 SPI

The serial peripheral interfaces (SPI1) provide half/ full duplex synchronous serial communication with external devices.

- Maximum speed: 8 Mbit/s ( $f_{\text{SYSCLK}}/2$ ) both for master and slave
- Full duplex synchronous transfers
- Simplex synchronous transfers on 2 lines with a possible bidirectional data line
- Master or slave operation - selectable by hardware or software
- Hardware CRC calculation
- Slave/master selection input pin

*Note:* SPI1 can be served by the DMA1 Controller.

### 3.13.2 I2C

The I2C bus interface (I2C1) provides multi-master capability, and controls all I2C bus-specific sequencing, protocol, arbitration and timing.

- Master, slave and multi-master capability
- Standard mode up to 100 kHz and fast speed modes up to 400 kHz
- 7-bit and 10-bit addressing modes
- SMBus 2.0 and PMBus support
- Hardware CRC calculation

*Note:* I2C1 can be served by the DMA1 Controller.

### 3.13.3 USART

The USART interface (USART1) allows full duplex, asynchronous communications with external devices requiring an industry standard NRZ asynchronous serial data format. It offers a very wide range of baud rates.

- 1 Mbit/s full duplex SCI
- SPI1 emulation
- High precision baud rate generator
- Smartcard emulation
- IrDA SIR encoder decoder
- Single wire half duplex mode

*Note:* USART1 can be served by the DMA1 Controller.

## 3.14 Infrared (IR) interface

The low density STM8L05xxx devices contain an infrared interface which can be used with an IR LED for remote control functions. Two timer output compare channels are used to generate the infrared remote control signals.

## 3.15 Development support

### Development tools

Development tools for the STM8 microcontrollers include:

- The STice emulation system offering tracing and code profiling
- The STVD high-level language debugger including C compiler, assembler and integrated development environment
- The STVP Flash programming software

The STM8 also comes with starter kits, evaluation boards and low-cost in-circuit debugging/programming tools.

### Single wire data interface (SWIM) and debug module

The debug module with its single wire data interface (SWIM) permits non-intrusive real-time in-circuit debugging and fast memory programming.

The Single wire interface is used for direct access to the debugging module and memory programming. The interface can be activated in all device operation modes.

The non-intrusive debugging module features a performance close to a full-featured emulator. Beside memory and peripherals, CPU operation can also be monitored in real-time by means of shadow registers.

If the initial delay is not acceptable for the application there is the option that the firmware reenables the SWIM pin functionality under specific conditions such as during firmware startup or during application run. Once that this procedure is done, the SWIM interface can be used for device debug/programming.

**Bootloader**

STM8L051F3 features a built-in bootloader. See *STM8 bootloader* user manual (UM0560).

The bootloader is used to download application software into the device memories, including RAM, program and data memory, using standard serial interfaces. It is a complementary solution to programming via the SWIM debugging interface.

4 Pin description

Figure 3. STM8L051F3 20-pin TSSOP20 package pinout

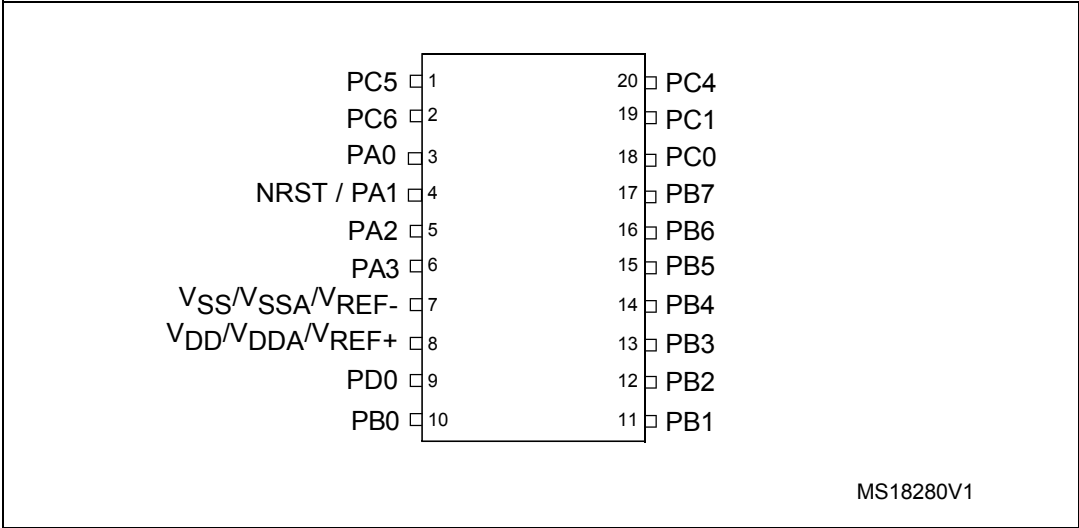


Table 3. Legend/abbreviation for [Table 4](#)

|                                |                                                                                                                                                                                                      |                                                      |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| Type                           | I= input, O = output, S = power supply                                                                                                                                                               |                                                      |
| Level                          | Output                                                                                                                                                                                               | HS = high sink/source (20 mA)                        |
|                                | Input                                                                                                                                                                                                | FT - five volt tolerant                              |
| Port and control configuration | Input                                                                                                                                                                                                | float = floating, wpu = weak pull-up                 |
|                                | Output                                                                                                                                                                                               | T = true open drain, OD = open drain, PP = push pull |
| Reset state                    | Bold X (pin state after reset release).<br>Unless otherwise specified, the pin state is the same during the reset phase (i.e. "under reset") and after internal reset release (i.e. at reset state). |                                                      |

Table 4. STM8L051F3 pin description

| pin<br>n° | Pin name                                                             | Type | I/O level | Input    |     |                | Output           |                  |    | Main function<br>(after reset) | Default alternate function                                                                   |
|-----------|----------------------------------------------------------------------|------|-----------|----------|-----|----------------|------------------|------------------|----|--------------------------------|----------------------------------------------------------------------------------------------|
|           |                                                                      |      |           | floating | wpu | Ext. interrupt | High sink/source | OD               | PP |                                |                                                                                              |
| TSSOP20   |                                                                      |      |           |          |     |                |                  |                  |    |                                |                                                                                              |
| 4         | NRST/PA1 <sup>(1)</sup>                                              | I/O  | -         | -        | X   | -              | HS               | -                | X  | Reset                          | PA1                                                                                          |
| 5         | PA2/OSC_IN/[USART_TX] <sup>(2)</sup> /<br>[SPI_MISO] <sup>(2)</sup>  | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>A2                     | HSE oscillator input / [USART<br>transmit] / [SPI master in- slave out]                      |
| 6         | PA3/OSC_OUT/[USART_RX] <sup>(2)</sup> /<br>[SPI_MOSI] <sup>(2)</sup> | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>A3                     | HSE oscillator output / [USART<br>receive] / [SPI master out/slave in]                       |
| 10        | PB0 <sup>(3)</sup> /TIM2_CH1/ADC1_IN18                               | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B0                     | Timer 2 - channel 1 / ADC1_IN18                                                              |
| 11        | PB1/TIM3_CH1/ADC1_IN17                                               | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B1                     | Timer 3 - channel 1 / ADC1_IN17                                                              |
| 12        | PB2/TIM2_CH2/ADC1_IN16                                               | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B2                     | Timer 2 - channel 2 ADC1_IN16                                                                |
| 13        | PB3/TIM2_ETR/<br>ADC1_IN15/RTC_ALARM                                 | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B3                     | Timer 2 - external trigger /<br>ADC1_IN15 / RTC_ALARM                                        |
| 14        | PB4 <sup>(3)</sup> /SPI1_NSS/ADC1_IN14                               | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B4                     | SPI master/slave select /<br>ADC1_IN14                                                       |
| 15        | PB5/SPI_SCK/<br>ADC1_IN13                                            | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B5                     | [SPI clock] / ADC1_IN13                                                                      |
| 16        | PB6/SPI1_MOSI/<br>ADC1_IN12                                          | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B6                     | SPI master out/<br>slave in / ADC1_IN12                                                      |
| 17        | PB7/SPI1_MISO/ADC1_IN11                                              | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>B7                     | SPI1 master in- slave out/<br>ADC1_IN11                                                      |
| 18        | PC0/I2C_SDA                                                          | I/O  | FT        | X        | -   | X              | -                | T <sup>(4)</sup> |    | Port<br>C0                     | I2C data                                                                                     |
| 19        | PC1/I2C_SCL                                                          | I/O  | FT        | X        | -   | X              | -                | T <sup>(3)</sup> |    | Port<br>C1                     | I2C clock                                                                                    |
| 20        | PC4/USART_CK/<br>I2C_SMB/CCO/ADC1_IN4                                | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>C4                     | USART synchronous clock /<br>I2C1_SMB / Configurable clock<br>output / ADC1_IN4              |
| 1         | PC5/OSC32_IN/[SPI1_NSS] <sup>(2)</sup> /<br>[USART_TX]/[TIM2_CH1]    | I/O  | -         | X        | X   | X              | HS               | X                | X  | Port<br>C5                     | LSE oscillator input / [SPI<br>master/slave select] / [USART<br>transmit]/Timer 2 -channel 1 |



Table 4. STM8L051F3 pin description (continued)

| pin<br>n° | Pin name                                                                           | Type | I/O level | Input    |     |                | Output            |    |    | Main function<br>(after reset) | Default alternate function                                                                                    |
|-----------|------------------------------------------------------------------------------------|------|-----------|----------|-----|----------------|-------------------|----|----|--------------------------------|---------------------------------------------------------------------------------------------------------------|
|           |                                                                                    |      |           | floating | wpu | Ext. interrupt | High sink/source  | OD | PP |                                |                                                                                                               |
| 2         | PC6/OSC32_OUT/[SPI_SCK] <sup>(2)</sup> /<br>[USART_RX]/[TIM2_CH2]                  | I/O  | -         | X        | X   | X              | HS                | X  | X  | Port<br>C6                     | LSE oscillator output / [SPI clock] /<br>[USART receive] /<br>Timer 2 -channel 2                              |
| 9         | PD0/TIM3_CH2/[ADC1_TRIG] <sup>(2)</sup> /<br>ADC1_IN22                             | I/O  | -         | X        | X   | X              | HS                | X  | X  | Port<br>D0                     | Timer 3 - channel 2 /<br>[ADC1_Trigger] / ADC1_IN22                                                           |
| 8         | V <sub>DD</sub> / V <sub>DDA</sub> / V <sub>REF+</sub>                             | S    |           |          |     |                |                   |    |    |                                | Digital supply voltage /<br>ADC1 positive voltage reference                                                   |
| 7         | V <sub>SS</sub> / V <sub>REF-</sub> / V <sub>SSA</sub>                             |      |           |          |     |                |                   |    |    |                                | Ground voltage / ADC1 negative voltage<br>reference / Analog ground voltage                                   |
| 3         | PA0 <sup>(5)</sup> /[USART_CK] <sup>(2)</sup> /<br>SWIM/BEEP/IR_TIM <sup>(6)</sup> | I/O  | -         | X        | X   | X              | HS <sup>(6)</sup> | X  | X  | Port<br>A0                     | [USART1 synchronous clock] <sup>(2)</sup> /<br>SWIM input and output /<br>Beep output / Infrared timer output |

- At power-up, the PA1/NRST pin is a reset input pin with pull-up. To be used as a general purpose pin (PA1), it can be configured only as output open-drain or push-pull, not as a general purpose input. Refer to Section *Configuring NRST/PA1 pin as general purpose output* in the *STM8L051/L052 Value Line, STM8L151/L152, STM8L162, STM8AL31, STM8AL3L MCU lines* reference manual (RM0031).
- [ ] Alternate function remapping option (if the same alternate function is shown twice, it indicates an exclusive choice not a duplication of the function).
- A pull-up is applied to PB0 and PB4 during the reset phase. These two pins are input floating after reset release.
- In the open-drain output column, 'T' defines a true open-drain I/O (P-buffer and protection diode to V<sub>DD</sub> are not implemented).
- The PA0 pin is in input pull-up during the reset phase and after reset release.
- High Sink LED driver capability available on PA0.

**Note:** 1 The slope control of all GPIO pins, except true open drain pins, can be programmed. By default, the slope control is limited to 2 MHz.

## 4.1 System configuration options

As shown in [Table 4: STM8L051F3 pin description](#), some alternate functions can be remapped on different I/O ports by programming one of the two remapping registers described in the “Routing interface (RI) and system configuration controller” section in the *STM8L050J3, STM8L051F3, STM8L052C6, STM8L052R8 MCUs and STM8L151/L152, STM8L162, STM8AL31, STM8AL3L lines* reference manual (RM0031).

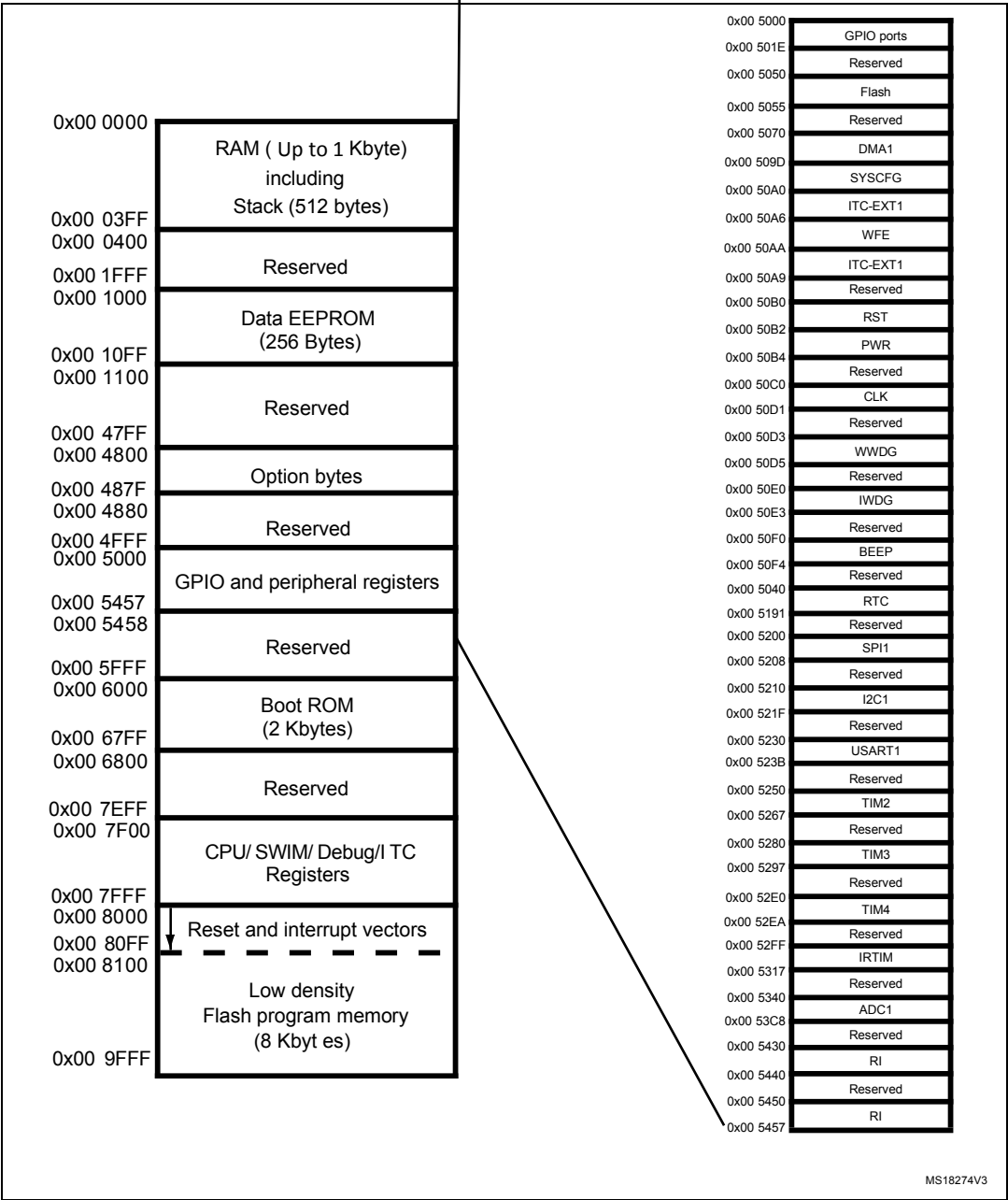
5 Memory and register map

The following sections describe the mapping of the device's memory and peripherals.

5.1 Memory mapping

The memory map is shown in [Figure 4](#).

Figure 4. Memory map



1. [Table 5](#) lists the boundary addresses for each memory size. The top of the stack is at the RAM end

address.

2. Refer to [Table 7](#) for an overview of hardware register mapping, to [Table 6](#) for details on I/O port hardware registers, and to [Table 8](#) for information on CPU/SWIM/debug module controller registers.

**Table 5. Flash and RAM boundary addresses**

| Memory area          | Size     | Start address | End address |
|----------------------|----------|---------------|-------------|
| RAM                  | 1 Kbyte  | 0x00 0000     | 0x00 03FF   |
| Flash program memory | 8 Kbytes | 0x00 8000     | 0x00 9FFF   |

## 5.2 Register map

**Table 6. I/O port hardware register map**

| Address                      | Block                   | Register label | Register name                     | Reset status |
|------------------------------|-------------------------|----------------|-----------------------------------|--------------|
| 0x00 5000                    | Port A                  | PA_ODR         | Port A data output latch register | 0x00         |
| 0x00 5001                    |                         | PA_IDR         | Port A input pin value register   | 0xFF         |
| 0x00 5002                    |                         | PA_DDR         | Port A data direction register    | 0x00         |
| 0x00 5003                    |                         | PA_CR1         | Port A control register 1         | 0x01         |
| 0x00 5004                    |                         | PA_CR2         | Port A control register 2         | 0x00         |
| 0x00 5005                    | Port B                  | PB_ODR         | Port B data output latch register | 0x00         |
| 0x00 5006                    |                         | PB_IDR         | Port B input pin value register   | 0xFF         |
| 0x00 5007                    |                         | PB_DDR         | Port B data direction register    | 0x00         |
| 0x00 5008                    |                         | PB_CR1         | Port B control register 1         | 0x00         |
| 0x00 5009                    |                         | PB_CR2         | Port B control register 2         | 0x00         |
| 0x00 500A                    | Port C                  | PC_ODR         | Port C data output latch register | 0x00         |
| 0x00 500B                    |                         | PC_IDR         | Port C input pin value register   | 0xFF         |
| 0x00 500C                    |                         | PC_DDR         | Port C data direction register    | 0x00         |
| 0x00 500D                    |                         | PC_CR1         | Port C control register 1         | 0x00         |
| 0x00 500E                    |                         | PC_CR2         | Port C control register 2         | 0x00         |
| 0x00 500F                    | Port D                  | PD_ODR         | Port D data output latch register | 0x00         |
| 0x00 5010                    |                         | PD_IDR         | Port D input pin value register   | 0xFF         |
| 0x00 5011                    |                         | PD_DDR         | Port D data direction register    | 0x00         |
| 0x00 5012                    |                         | PD_CR1         | Port D control register 1         | 0x00         |
| 0x00 5013                    |                         | PD_CR2         | Port D control register 2         | 0x00         |
| 0x00 5014<br>to<br>0x00 501D | Reserved area (0 bytes) |                |                                   |              |

Table 7. General hardware register map

| Address                      | Block                    | Register label          | Register name                                        | Reset status |
|------------------------------|--------------------------|-------------------------|------------------------------------------------------|--------------|
| 0x00 502E<br>to<br>0x00 5049 | Reserved area (44 bytes) |                         |                                                      |              |
| 0x00 5050                    | Flash                    | FLASH_CR1               | Flash control register 1                             | 0x00         |
| 0x00 5051                    |                          | FLASH_CR2               | Flash control register 2                             | 0x00         |
| 0x00 5052                    |                          | FLASH_PUKR              | Flash program memory unprotection key register       | 0x00         |
| 0x00 5053                    |                          | FLASH_DUKR              | Data EEPROM unprotection key register                | 0x00         |
| 0x00 5054                    |                          | FLASH_IAPSR             | Flash in-application programming status register     | 0x00         |
| 0x00 5055<br>to<br>0x00 506F | Reserved area (27 bytes) |                         |                                                      |              |
| 0x00 5070                    | DMA1                     | DMA1_GCSR               | DMA1 global configuration & status register          | 0xFC         |
| 0x00 5071                    |                          | DMA1_GIR1               | DMA1 global interrupt register 1                     | 0x00         |
| 0x00 5072 to<br>0x00 5074    |                          | Reserved area (3 bytes) |                                                      |              |
| 0x00 5075                    |                          | DMA1_C0CR               | DMA1 channel 0 configuration register                | 0x00         |
| 0x00 5076                    |                          | DMA1_C0SPR              | DMA1 channel 0 status & priority register            | 0x00         |
| 0x00 5077                    |                          | DMA1_C0NDTR             | DMA1 number of data to transfer register (channel 0) | 0x00         |
| 0x00 5078                    |                          | DMA1_C0PARH             | DMA1 peripheral address high register (channel 0)    | 0x52         |
| 0x00 5079                    |                          | DMA1_C0PARL             | DMA1 peripheral address low register (channel 0)     | 0x00         |
| 0x00 507A                    |                          | Reserved area (1 byte)  |                                                      |              |
| 0x00 507B                    |                          | DMA1_C0M0ARH            | DMA1 memory 0 address high register (channel 0)      | 0x00         |
| 0x00 507C                    |                          | DMA1_C0M0ARL            | DMA1 memory 0 address low register (channel 0)       | 0x00         |

Table 7. General hardware register map (continued)

| Address                | Block | Register label          | Register name                                        | Reset status |
|------------------------|-------|-------------------------|------------------------------------------------------|--------------|
| 0x00 507D to 0x00 507E | DMA1  | Reserved area (2 bytes) |                                                      |              |
| 0x00 507F              |       | DMA1_C1CR               | DMA1 channel 1 configuration register                | 0x00         |
| 0x00 5080              |       | DMA1_C1SPR              | DMA1 channel 1 status & priority register            | 0x00         |
| 0x00 5081              |       | DMA1_C1NDTR             | DMA1 number of data to transfer register (channel 1) | 0x00         |
| 0x00 5082              |       | DMA1_C1PARH             | DMA1 peripheral address high register (channel 1)    | 0x52         |
| 0x00 5083              |       | DMA1_C1PARL             | DMA1 peripheral address low register (channel 1)     | 0x00         |
| 0x00 5084              |       | Reserved area (1 byte)  |                                                      |              |
| 0x00 5085              |       | DMA1_C1M0ARH            | DMA1 memory 0 address high register (channel 1)      | 0x00         |
| 0x00 5086              |       | DMA1_C1M0ARL            | DMA1 memory 0 address low register (channel 1)       | 0x00         |
| 0x00 5087<br>0x00 5088 |       | Reserved area (2 bytes) |                                                      |              |
| 0x00 5089              |       | DMA1_C2CR               | DMA1 channel 2 configuration register                | 0x00         |
| 0x00 508A              |       | DMA1_C2SPR              | DMA1 channel 2 status & priority register            | 0x00         |
| 0x00 508B              |       | DMA1_C2NDTR             | DMA1 number of data to transfer register (channel 2) | 0x00         |
| 0x00 508C              |       | DMA1_C2PARH             | DMA1 peripheral address high register (channel 2)    | 0x52         |
| 0x00 508D              |       | DMA1_C2PARL             | DMA1 peripheral address low register (channel 2)     | 0x00         |
| 0x00 508E              |       | Reserved area (1 byte)  |                                                      |              |
| 0x00 508F              |       | DMA1_C2M0ARH            | DMA1 memory 0 address high register (channel 2)      | 0x00         |
| 0x00 5090              |       | DMA1_C2M0ARL            | DMA1 memory 0 address low register (channel 2)       | 0x00         |
| 0x00 5091<br>0x00 5092 |       | Reserved area (2 bytes) |                                                      |              |
| 0x00 5093              |       | DMA1_C3CR               | DMA1 channel 3 configuration register                | 0x00         |
| 0x00 5094              |       | DMA1_C3SPR              | DMA1 channel 3 status & priority register            | 0x00         |
| 0x00 5095              |       | DMA1_C3NDTR             | DMA1 number of data to transfer register (channel 3) | 0x00         |
| 0x00 5096              |       | DMA1_C3PARH_<br>C3M1ARH | DMA1 peripheral address high register (channel 3)    | 0x40         |
| 0x00 5097              |       | DMA1_C3PARL_<br>C3M1ARL | DMA1 peripheral address low register (channel 3)     | 0x00         |

Table 7. General hardware register map (continued)

| Address                | Block                    | Register label          | Register name                                    | Reset status        |
|------------------------|--------------------------|-------------------------|--------------------------------------------------|---------------------|
| 0x00 5098              | DMA1                     | DMA_C3M0EAR             | DMA channel 3 memory 0 extended address register | 0x00                |
| 0x00 5099              |                          | DMA1_C3M0ARH            | DMA1 memory 0 address high register (channel 3)  | 0x00                |
| 0x00 509A              |                          | DMA1_C3M0ARL            | DMA1 memory 0 address low register (channel 3)   | 0x00                |
| 0x00 509B to 0x00 509C |                          | Reserved area (3 bytes) |                                                  |                     |
| 0x00 509D              | SYSCFG                   | SYSCFG_RMPCR3           | Remapping register 3                             | 0x00                |
| 0x00 509E              |                          | SYSCFG_RMPCR1           | Remapping register 1                             | 0x00                |
| 0x00 509F              |                          | SYSCFG_RMPCR2           | Remapping register 2                             | 0x00                |
| 0x00 50A0              | ITC - EXTI               | EXTI_CR1                | External interrupt control register 1            | 0x00                |
| 0x00 50A1              |                          | EXTI_CR2                | External interrupt control register 2            | 0x00                |
| 0x00 50A2              |                          | EXTI_CR3                | External interrupt control register 3            | 0x00                |
| 0x00 50A3              |                          | EXTI_SR1                | External interrupt status register 1             | 0x00                |
| 0x00 50A4              |                          | EXTI_SR2                | External interrupt status register 2             | 0x00                |
| 0x00 50A5              |                          | EXTI_CONF1              | External interrupt port select register 1        | 0x00                |
| 0x00 50A6              | WFE                      | WFE_CR1                 | WFE control register 1                           | 0x00                |
| 0x00 50A7              |                          | WFE_CR2                 | WFE control register 2                           | 0x00                |
| 0x00 50A8              |                          | WFE_CR3                 | WFE control register 3                           | 0x00                |
| 0x00 50A9              |                          | WFE_CR4                 | WFE control register 4                           | 0x00                |
| 0x00 50AA              | ITC - EXTI               | EXTI_CR4                | External interrupt control register 4            | 0x00                |
| 0x00 50AB              |                          | EXTI_CONF2              | External interrupt port select register 2        | 0x00                |
| 0x00 50A9 to 0x00 50AF | Reserved area (7 bytes)  |                         |                                                  |                     |
| 0x00 50B0              | RST                      | RST_CR                  | Reset control register                           | 0x00                |
| 0x00 50B1              |                          | RST_SR                  | Reset status register                            | 0x01                |
| 0x00 50B2              | PWR                      | PWR_CSR1                | Power control and status register 1              | 0x00                |
| 0x00 50B3              |                          | PWR_CSR2                | Power control and status register 2              | 0x00                |
| 0x00 50B4 to 0x00 50BF | Reserved area (12 bytes) |                         |                                                  |                     |
| 0x00 50C0              | CLK                      | CLK_CKDIVR              | CLK Clock master divider register                | 0x03                |
| 0x00 50C1              |                          | CLK_CRTCR               | CLK Clock RTC register                           | 0x00 <sup>(1)</sup> |
| 0x00 50C2              |                          | CLK_ICKCR               | CLK Internal clock control register              | 0x11                |
| 0x00 50C3              |                          | CLK_PCKENR1             | CLK Peripheral clock gating register 1           | 0x00                |

Table 7. General hardware register map (continued)

| Address                | Block                    | Register label          | Register name                               | Reset status |
|------------------------|--------------------------|-------------------------|---------------------------------------------|--------------|
| 0x00 50C4              | CLK                      | CLK_PCKENR2             | CLK Peripheral clock gating register 2      | 0x00         |
| 0x00 50C5              |                          | CLK_CCOR                | CLK Configurable clock control register     | 0x00         |
| 0x00 50C6              |                          | CLK_ECKCR               | CLK External clock control register         | 0x00         |
| 0x00 50C7              |                          | CLK_SCSR                | CLK System clock status register            | 0x01         |
| 0x00 50C8              |                          | CLK_SWR                 | CLK System clock switch register            | 0x01         |
| 0x00 50C9              |                          | CLK_SWCR                | CLK Clock switch control register           | 0xX0         |
| 0x00 50CA              |                          | CLK_CSSR                | CLK Clock security system register          | 0x00         |
| 0x00 50CB              |                          | CLK_CBEEPFR             | CLK Clock BEEP register                     | 0x00         |
| 0x00 50CC              |                          | CLK_HSICALR             | CLK HSI calibration register                | 0xXX         |
| 0x00 50CD              |                          | CLK_HSIETRMR            | CLK HSI clock calibration trimming register | 0x00         |
| 0x00 50CE              |                          | CLK_HSIUNLCKR           | CLK HSI unlock register                     | 0x00         |
| 0x00 50CF              |                          | CLK_REGCSR              | CLK Main regulator control status register  | 0bxx11 100X  |
| 0x00 50D0              |                          | CLK_PCKENR3             | CLK Peripheral clock gating register 3      | 0x00         |
| 0x00 50D1 to 0x00 50D2 | Reserved area (2 bytes)  |                         |                                             |              |
| 0x00 50D3              | WWDG                     | WWDG_CR                 | WWDG control register                       | 0x7F         |
| 0x00 50D4              |                          | WWDG_WR                 | WWDG window register                        | 0x7F         |
| 0x00 50D5 to 00 50DF   | Reserved area (11 bytes) |                         |                                             |              |
| 0x00 50E0              | IWDG                     | IWDG_KR                 | IWDG key register                           | 0x01         |
| 0x00 50E1              |                          | IWDG_PR                 | IWDG prescaler register                     | 0x00         |
| 0x00 50E2              |                          | IWDG_RLR                | IWDG reload register                        | 0xFF         |
| 0x00 50E3 to 0x00 50EF | Reserved area (13 bytes) |                         |                                             |              |
| 0x00 50F0              | BEEP                     | BEEP_CSR1               | BEEP control/status register 1              | 0x00         |
| 0x00 50F1<br>0x00 50F2 |                          | Reserved area (2 bytes) |                                             |              |
| 0x00 50F3              |                          | BEEP_CSR2               | BEEP control/status register 2              | 0x1F         |
| 0x00 50F4 to 0x00 513F | Reserved area (76 bytes) |                         |                                             |              |
| 0x00 5140              | RTC                      | RTC_TR1                 | RTC Time register 1                         | 0x00         |
| 0x00 5141              |                          | RTC_TR2                 | RTC Time register 2                         | 0x00         |
| 0x00 5142              |                          | RTC_TR3                 | RTC Time register 3                         | 0x00         |

Table 7. General hardware register map (continued)

| Address                   | Block | Register label          | Register name                            | Reset status        |
|---------------------------|-------|-------------------------|------------------------------------------|---------------------|
| 0x00 5143                 | RTC   | Reserved area (1 byte)  |                                          |                     |
| 0x00 5144                 |       | RTC_DR1                 | RTC Date register 1                      | 0x01                |
| 0x00 5145                 |       | RTC_DR2                 | RTC Date register 2                      | 0x21                |
| 0x00 5146                 |       | RTC_DR3                 | RTC Date register 3                      | 0x00                |
| 0x00 5147                 |       | Reserved area (1 byte)  |                                          |                     |
| 0x00 5148                 |       | RTC_CR1                 | RTC Control register 1                   | 0x00 <sup>(1)</sup> |
| 0x00 5149                 |       | RTC_CR2                 | RTC Control register 2                   | 0x00 <sup>(1)</sup> |
| 0x00 514A                 |       | RTC_CR3                 | RTC Control register 3                   | 0x00 <sup>(1)</sup> |
| 0x00 514B                 |       | Reserved area (1 byte)  |                                          |                     |
| 0x00 514C                 |       | RTC_ISR1                | RTC Initialization and status register 1 | 0x01                |
| 0x00 514D                 |       | RTC_ISR2                | RTC Initialization and Status register 2 | 0x00                |
| 0x00 514E<br>0x00 514F    |       | Reserved area (2 bytes) |                                          |                     |
| 0x00 5150                 |       | RTC_SPRERH              | RTC Synchronous prescaler register high  | 0x00 <sup>(1)</sup> |
| 0x00 5151                 |       | RTC_SPRERL              | RTC Synchronous prescaler register low   | 0xFF <sup>(1)</sup> |
| 0x00 5152                 |       | RTC_APRER               | RTC Asynchronous prescaler register      | 0x7F <sup>(1)</sup> |
| 0x00 5153                 |       | Reserved area (1 byte)  |                                          |                     |
| 0x00 5154                 |       | RTC_WUTRH               | RTC Wakeup timer register high           | 0xFF <sup>(1)</sup> |
| 0x00 5155                 |       | RTC_WUTRL               | RTC Wakeup timer register low            | 0xFF <sup>(1)</sup> |
| 0x00 5156                 |       | Reserved area (1 byte)  |                                          |                     |
| 0x00 5157                 |       | RTC_SSRL                | RTC Subsecond register low               | 0x00                |
| 0x00 5158                 |       | RTC_SSRH                | RTC Subsecond register high              | 0x00                |
| 0x00 5159                 |       | RTC_WPR                 | RTC Write protection register            | 0x00                |
| 0x00 5158                 |       | RTC_SSRH                | RTC Subsecond register high              | 0x00                |
| 0x00 5159                 |       | RTC_WPR                 | RTC Write protection register            | 0x00                |
| 0x00 515A                 |       | RTC_SHIFTRH             | RTC Shift register high                  | 0x00                |
| 0x00 515B                 |       | RTC_SHIFTRL             | RTC Shift register low                   | 0x00                |
| 0x00 515C                 |       | RTC_ALRMAR1             | RTC Alarm A register 1                   | 0x00 <sup>(1)</sup> |
| 0x00 515D                 |       | RTC_ALRMAR2             | RTC Alarm A register 2                   | 0x00 <sup>(1)</sup> |
| 0x00 515E                 |       | RTC_ALRMAR3             | RTC Alarm A register 3                   | 0x00 <sup>(1)</sup> |
| 0x00 515F                 |       | RTC_ALRMAR4             | RTC Alarm A register 4                   | 0x00 <sup>(1)</sup> |
| 0x00 5160 to<br>0x00 5163 |       | Reserved area (4 bytes) |                                          |                     |
| 0x00 5164                 |       | RTC_ALRMASSRH           | RTC Alarm A subsecond register high      | 0x00 <sup>(1)</sup> |
| 0x00 5165                 |       | RTC_ALRMASSSL           | RTC Alarm A subsecond register low       | 0x00 <sup>(1)</sup> |



Table 7. General hardware register map (continued)

| Address                | Block                     | Register label           | Register name                           | Reset status        |
|------------------------|---------------------------|--------------------------|-----------------------------------------|---------------------|
| 0x00 5166              | RTC                       | RTC_ALRMASKSKR           | RTC Alarm A masking register            | 0x00 <sup>(1)</sup> |
| 0x00 5167 to 0x00 5169 |                           | Reserved area (3 bytes)  |                                         |                     |
| 0x00 516A              |                           | RTC_CALRH                | RTC Calibration register high           | 0x00 <sup>(1)</sup> |
| 0x00 516B              |                           | RTC_CALRL                | RTC Calibration register low            | 0x00 <sup>(1)</sup> |
| 0x00 516C              |                           | RTC_TCR1                 | RTC Tamper control register 1           | 0x00 <sup>(1)</sup> |
| 0x00 516D              |                           | RTC_TCR2                 | RTC Tamper control register 2           | 0x00 <sup>(1)</sup> |
| 0x00 516E to 0x00 518A |                           | Reserved area (36 bytes) |                                         |                     |
| 0x00 5190              |                           | CSSLSE_CSR               | CSS on LSE control and status register  | 0x00 <sup>(1)</sup> |
| 0x00 519A to 0x00 51FF | Reserved area (111 bytes) |                          |                                         |                     |
| 0x00 5200              | SPI1                      | SPI1_CR1                 | SPI1 control register 1                 | 0x00                |
| 0x00 5201              |                           | SPI1_CR2                 | SPI1 control register 2                 | 0x00                |
| 0x00 5202              |                           | SPI1_ICR                 | SPI1 interrupt control register         | 0x00                |
| 0x00 5203              |                           | SPI1_SR                  | SPI1 status register                    | 0x02                |
| 0x00 5204              |                           | SPI1_DR                  | SPI1 data register                      | 0x00                |
| 0x00 5205              |                           | SPI1_CRCPR               | SPI1 CRC polynomial register            | 0x07                |
| 0x00 5206              |                           | SPI1_RXCRCR              | SPI1 Rx CRC register                    | 0x00                |
| 0x00 5207              |                           | SPI1_TXCRCR              | SPI1 Tx CRC register                    | 0x00                |
| 0x00 5208 to 0x00 520F | Reserved area (8 bytes)   |                          |                                         |                     |
| 0x00 5210              | I2C1                      | I2C1_CR1                 | I2C1 control register 1                 | 0x00                |
| 0x00 5211              |                           | I2C1_CR2                 | I2C1 control register 2                 | 0x00                |
| 0x00 5212              |                           | I2C1_FREQR               | I2C1 frequency register                 | 0x00                |
| 0x00 5213              |                           | I2C1_OARL                | I2C1 own address register low           | 0x00                |
| 0x00 5214              |                           | I2C1_OARH                | I2C1 own address register high          | 0x00                |
| 0x00 5215              |                           | I2C1_OAR2                | I2C1 own address register for dual mode | 0x00                |
| 0x00 5216              |                           | I2C1_DR                  | I2C1 data register                      | 0x00                |
| 0x00 5217              |                           | I2C1_SR1                 | I2C1 status register 1                  | 0x00                |
| 0x00 5218              |                           | I2C1_SR2                 | I2C1 status register 2                  | 0x00                |
| 0x00 5219              |                           | I2C1_SR3                 | I2C1 status register 3                  | 0x0X                |
| 0x00 521A              |                           | I2C1_ITR                 | I2C1 interrupt control register         | 0x00                |
| 0x00 521B              |                           | I2C1_CCRL                | I2C1 clock control register low         | 0x00                |
| 0x00 521C              |                           | I2C1_CCRH                | I2C1 clock control register high        | 0x00                |

Table 7. General hardware register map (continued)

| Address                      | Block                    | Register label | Register name                          | Reset status |
|------------------------------|--------------------------|----------------|----------------------------------------|--------------|
| 0x00 521D                    | I2C1                     | I2C1_TRISER    | I2C1 TRISE register                    | 0x02         |
| 0x00 521E                    |                          | I2C1_PECR      | I2C1 packet error checking register    | 0x00         |
| 0x00 521F<br>to<br>0x00 522F | Reserved area (17 bytes) |                |                                        |              |
| 0x00 5230                    | USART1                   | USART1_SR      | USART1 status register                 | 0xC0         |
| 0x00 5231                    |                          | USART1_DR      | USART1 data register                   | 0xFF         |
| 0x00 5232                    |                          | USART1_BRR1    | USART1 baud rate register 1            | 0x00         |
| 0x00 5233                    |                          | USART1_BRR2    | USART1 baud rate register 2            | 0x00         |
| 0x00 5234                    |                          | USART1_CR1     | USART1 control register 1              | 0x00         |
| 0x00 5235                    |                          | USART1_CR2     | USART1 control register 2              | 0x00         |
| 0x00 5236                    |                          | USART1_CR3     | USART1 control register 3              | 0x00         |
| 0x00 5237                    |                          | USART1_CR4     | USART1 control register 4              | 0x00         |
| 0x00 5238                    |                          | USART1_CR5     | USART1 control register 5              | 0x00         |
| 0x00 5239                    |                          | USART1_GTR     | USART1 guard time register             | 0x00         |
| 0x00 523A                    |                          | USART1_PSCR    | USART1 prescaler register              | 0x00         |
| 0x00 523B<br>to<br>0x00 524F | Reserved area (21 bytes) |                |                                        |              |
| 0x00 5250                    | TIM2                     | TIM2_CR1       | TIM2 control register 1                | 0x00         |
| 0x00 5251                    |                          | TIM2_CR2       | TIM2 control register 2                | 0x00         |
| 0x00 5252                    |                          | TIM2_SMCR      | TIM2 Slave mode control register       | 0x00         |
| 0x00 5253                    |                          | TIM2_ETR       | TIM2 external trigger register         | 0x00         |
| 0x00 5254                    |                          | TIM2_DER       | TIM2 DMA1 request enable register      | 0x00         |
| 0x00 5255                    |                          | TIM2_IER       | TIM2 interrupt enable register         | 0x00         |
| 0x00 5256                    |                          | TIM2_SR1       | TIM2 status register 1                 | 0x00         |
| 0x00 5257                    |                          | TIM2_SR2       | TIM2 status register 2                 | 0x00         |
| 0x00 5258                    |                          | TIM2_EGR       | TIM2 event generation register         | 0x00         |
| 0x00 5259                    |                          | TIM2_CCMR1     | TIM2 capture/compare mode register 1   | 0x00         |
| 0x00 525A                    |                          | TIM2_CCMR2     | TIM2 capture/compare mode register 2   | 0x00         |
| 0x00 525B                    |                          | TIM2_CCER1     | TIM2 capture/compare enable register 1 | 0x00         |
| 0x00 525C                    |                          | TIM2_CNTRH     | TIM2 counter high                      | 0x00         |
| 0x00 525D                    |                          | TIM2_CNTRL     | TIM2 counter low                       | 0x00         |
| 0x00 525E                    |                          | TIM2_PSCR      | TIM2 prescaler register                | 0x00         |
| 0x00 525F                    |                          | TIM2_ARRH      | TIM2 auto-reload register high         | 0xFF         |

Table 7. General hardware register map (continued)

| Address                | Block                    | Register label | Register name                          | Reset status |
|------------------------|--------------------------|----------------|----------------------------------------|--------------|
| 0x00 5260              | TIM2                     | TIM2_ARRL      | TIM2 auto-reload register low          | 0xFF         |
| 0x00 5261              |                          | TIM2_CCR1H     | TIM2 capture/compare register 1 high   | 0x00         |
| 0x00 5262              |                          | TIM2_CCR1L     | TIM2 capture/compare register 1 low    | 0x00         |
| 0x00 5263              |                          | TIM2_CCR2H     | TIM2 capture/compare register 2 high   | 0x00         |
| 0x00 5264              |                          | TIM2_CCR2L     | TIM2 capture/compare register 2 low    | 0x00         |
| 0x00 5265              |                          | TIM2_BKR       | TIM2 break register                    | 0x00         |
| 0x00 5266              |                          | TIM2_OISR      | TIM2 output idle state register        | 0x00         |
| 0x00 5267 to 0x00 527F | Reserved area (25 bytes) |                |                                        |              |
| 0x00 5280              | TIM3                     | TIM3_CR1       | TIM3 control register 1                | 0x00         |
| 0x00 5281              |                          | TIM3_CR2       | TIM3 control register 2                | 0x00         |
| 0x00 5282              |                          | TIM3_SMCR      | TIM3 Slave mode control register       | 0x00         |
| 0x00 5283              |                          | TIM3_ETR       | TIM3 external trigger register         | 0x00         |
| 0x00 5284              |                          | TIM3_DER       | TIM3 DMA1 request enable register      | 0x00         |
| 0x00 5285              |                          | TIM3_IER       | TIM3 interrupt enable register         | 0x00         |
| 0x00 5286              |                          | TIM3_SR1       | TIM3 status register 1                 | 0x00         |
| 0x00 5287              |                          | TIM3_SR2       | TIM3 status register 2                 | 0x00         |
| 0x00 5288              |                          | TIM3_EGR       | TIM3 event generation register         | 0x00         |
| 0x00 5289              |                          | TIM3_CCMR1     | TIM3 Capture/Compare mode register 1   | 0x00         |
| 0x00 528A              |                          | TIM3_CCMR2     | TIM3 Capture/Compare mode register 2   | 0x00         |
| 0x00 528B              |                          | TIM3_CCER1     | TIM3 Capture/Compare enable register 1 | 0x00         |
| 0x00 528C              |                          | TIM3_CNTRH     | TIM3 counter high                      | 0x00         |
| 0x00 528D              |                          | TIM3_CNTRL     | TIM3 counter low                       | 0x00         |
| 0x00 528E              |                          | TIM3_PSCR      | TIM3 prescaler register                | 0x00         |
| 0x00 528F              |                          | TIM3_ARRH      | TIM3 Auto-reload register high         | 0xFF         |
| 0x00 5290              |                          | TIM3_ARRL      | TIM3 Auto-reload register low          | 0xFF         |
| 0x00 5291              |                          | TIM3_CCR1H     | TIM3 Capture/Compare register 1 high   | 0x00         |
| 0x00 5292              |                          | TIM3_CCR1L     | TIM3 Capture/Compare register 1 low    | 0x00         |
| 0x00 5293              |                          | TIM3_CCR2H     | TIM3 Capture/Compare register 2 high   | 0x00         |
| 0x00 5294              |                          | TIM3_CCR2L     | TIM3 Capture/Compare register 2 low    | 0x00         |
| 0x00 5295              |                          | TIM3_BKR       | TIM3 break register                    | 0x00         |
| 0x00 5296              |                          | TIM3_OISR      | TIM3 output idle state register        | 0x00         |
| 0x00 5297 to 0x00 52DF | Reserved area (72 bytes) |                |                                        |              |

Table 7. General hardware register map (continued)

| Address                      | Block                    | Register label | Register name                     | Reset status |
|------------------------------|--------------------------|----------------|-----------------------------------|--------------|
| 0x00 52E0                    | TIM4                     | TIM4_CR1       | TIM4 control register 1           | 0x00         |
| 0x00 52E1                    |                          | TIM4_CR2       | TIM4 control register 2           | 0x00         |
| 0x00 52E2                    |                          | TIM4_SMCR      | TIM4 Slave mode control register  | 0x00         |
| 0x00 52E3                    |                          | TIM4_DER       | TIM4 DMA1 request enable register | 0x00         |
| 0x00 52E4                    |                          | TIM4_IER       | TIM4 Interrupt enable register    | 0x00         |
| 0x00 52E5                    |                          | TIM4_SR1       | TIM4 status register 1            | 0x00         |
| 0x00 52E6                    |                          | TIM4_EGR       | TIM4 Event generation register    | 0x00         |
| 0x00 52E7                    |                          | TIM4_CNTR      | TIM4 counter                      | 0x00         |
| 0x00 52E8                    |                          | TIM4_PSCR      | TIM4 prescaler register           | 0x00         |
| 0x00 52E9                    |                          | TIM4_ARR       | TIM4 Auto-reload register         | 0x00         |
| 0x00 52EA<br>to<br>0x00 52FE | Reserved area (21 bytes) |                |                                   |              |
| 0x00 52FF                    | IRTIM                    | IR_CR          | Infrared control register         | 0x00         |
| 0x00 5317<br>to<br>0x00 533F | Reserved area (41 bytes) |                |                                   |              |
| 0x00 5340                    | ADC1                     | ADC1_CR1       | ADC1 configuration register 1     | 0x00         |
| 0x00 5341                    |                          | ADC1_CR2       | ADC1 configuration register 2     | 0x00         |
| 0x00 5342                    |                          | ADC1_CR3       | ADC1 configuration register 3     | 0x1F         |
| 0x00 5343                    |                          | ADC1_SR        | ADC1 status register              | 0x00         |
| 0x00 5344                    |                          | ADC1_DRH       | ADC1 data register high           | 0x00         |
| 0x00 5345                    |                          | ADC1_DRL       | ADC1 data register low            | 0x00         |
| 0x00 5346                    |                          | ADC1_HTRH      | ADC1 high threshold register high | 0x0F         |
| 0x00 5347                    |                          | ADC1_HTRL      | ADC1 high threshold register low  | 0xFF         |
| 0x00 5348                    |                          | ADC1_LTRH      | ADC1 low threshold register high  | 0x00         |
| 0x00 5349                    |                          | ADC1_LTRL      | ADC1 low threshold register low   | 0x00         |
| 0x00 534A                    |                          | ADC1_SQR1      | ADC1 channel sequence 1 register  | 0x00         |
| 0x00 534B                    |                          | ADC1_SQR2      | ADC1 channel sequence 2 register  | 0x00         |
| 0x00 534C                    |                          | ADC1_SQR3      | ADC1 channel sequence 3 register  | 0x00         |
| 0x00 534D                    |                          | ADC1_SQR4      | ADC1 channel sequence 4 register  | 0x00         |
| 0x00 534E                    |                          | ADC1_TRIGR1    | ADC1 trigger disable 1            | 0x00         |
| 0x00 534F                    |                          | ADC1_TRIGR2    | ADC1 trigger disable 2            | 0x00         |
| 0x00 5350                    |                          | ADC1_TRIGR3    | ADC1 trigger disable 3            | 0x00         |
| 0x00 5351                    |                          | ADC1_TRIGR4    | ADC1 trigger disable 4            | 0x00         |

Table 7. General hardware register map (continued)

| Address                | Block                    | Register label         | Register name                  | Reset status |
|------------------------|--------------------------|------------------------|--------------------------------|--------------|
| 0x00 53C8 to 0x00 542F | Reserved area(104 bytes) |                        |                                |              |
| 0x00 5430              | RI                       | Reserved area (1 byte) |                                | 0x00         |
| 0x00 5433              |                          | RI_IOIR1               | RI I/O input register 1        | 0xXX         |
| 0x00 5434              |                          | RI_IOIR2               | RI I/O input register 2        | 0xXX         |
| 0x00 5435              |                          | RI_IOIR3               | RI I/O input register 3        | 0xXX         |
| 0x00 5436              |                          | RI_IOC MR1             | RI I/O control mode register 1 | 0x00         |
| 0x00 5437              |                          | RI_IOC MR2             | RI I/O control mode register 2 | 0x00         |
| 0x00 5438              |                          | RI_IOC MR3             | RI I/O control mode register 3 | 0x00         |
| 0x00 5439              |                          | RI_IOSR1               | RI I/O switch register 1       | 0x00         |
| 0x00 543A              |                          | RI_IOSR2               | RI I/O switch register 2       | 0x00         |
| 0x00 543B              |                          | RI_IOSR3               | RI I/O switch register 3       | 0x00         |
| 0x00 543C              |                          | RI_I OGCR              | RI I/O group control register  | 0xFF         |
| 0x00 543D              |                          | RI_A SCR1              | Analog switch register 1       | 0x00         |
| 0x00 543E              |                          | RI_A SCR2              | RI Analog switch register 2    | 0x00         |
| 0x00 543F              |                          | RI_RCR                 | RI Resistor control register   | 0x00         |
| 0x00 5440 to 0x00 544F | Reserved area (16 bytes) |                        |                                |              |
| 0x00 5450              | RI                       | RI_CR                  | RI I/O control register        | 0x00         |
| 0x00 5451              |                          | RI_MASKR1              | RI I/O mask register 1         | 0x00         |
| 0x00 5452              |                          | RI_MASKR2              | RI I/O mask register 2         | 0x00         |
| 0x00 5453              |                          | RI_MASKR3              | RI I/O mask register 3         | 0x00         |
| 0x00 5454              |                          | RI_MASKR4              | RI I/O mask register 4         | 0x00         |
| 0x00 5455              |                          | RI_IOIR4               | RI I/O input register 4        | 0xXX         |
| 0x00 5456              |                          | RI_IOC MR4             | RI I/O control mode register 4 | 0x00         |
| 0x00 5457              |                          | RI_IOSR4               | RI I/O switch register 4       | 0x00         |

1. These registers are not impacted by a system reset. They are reset at power-on.

Table 8. CPU/SWIM/debug module/interrupt controller registers

| Address                      | Block                    | Register label           | Register name                          | Reset status |
|------------------------------|--------------------------|--------------------------|----------------------------------------|--------------|
| 0x00 7F00                    | CPU <sup>(1)</sup>       | A                        | Accumulator                            | 0x00         |
| 0x00 7F01                    |                          | PCE                      | Program counter extended               | 0x00         |
| 0x00 7F02                    |                          | PCH                      | Program counter high                   | 0x00         |
| 0x00 7F03                    |                          | PCL                      | Program counter low                    | 0x00         |
| 0x00 7F04                    |                          | XH                       | X index register high                  | 0x00         |
| 0x00 7F05                    |                          | XL                       | X index register low                   | 0x00         |
| 0x00 7F06                    |                          | YH                       | Y index register high                  | 0x00         |
| 0x00 7F07                    |                          | YL                       | Y index register low                   | 0x00         |
| 0x00 7F08                    |                          | SPH                      | Stack pointer high                     | 0x03         |
| 0x00 7F09                    |                          | SPL                      | Stack pointer low                      | 0xFF         |
| 0x00 7F0A                    |                          | CCR                      | Condition code register                | 0x28         |
| 0x00 7F0B to<br>0x00 7F5F    | CPU                      | Reserved area (85 bytes) |                                        |              |
| 0x00 7F60                    |                          | CFG_GCR                  | Global configuration register          | 0x00         |
| 0x00 7F70                    | ITC-SPR                  | ITC_SPR1                 | Interrupt Software priority register 1 | 0xFF         |
| 0x00 7F71                    |                          | ITC_SPR2                 | Interrupt Software priority register 2 | 0xFF         |
| 0x00 7F72                    |                          | ITC_SPR3                 | Interrupt Software priority register 3 | 0xFF         |
| 0x00 7F73                    |                          | ITC_SPR4                 | Interrupt Software priority register 4 | 0xFF         |
| 0x00 7F74                    |                          | ITC_SPR5                 | Interrupt Software priority register 5 | 0xFF         |
| 0x00 7F75                    |                          | ITC_SPR6                 | Interrupt Software priority register 6 | 0xFF         |
| 0x00 7F76                    |                          | ITC_SPR7                 | Interrupt Software priority register 7 | 0xFF         |
| 0x00 7F77                    |                          | ITC_SPR8                 | Interrupt Software priority register 8 | 0xFF         |
| 0x00 7F78<br>to<br>0x00 7F79 | Reserved area (2 bytes)  |                          |                                        |              |
| 0x00 7F80                    | SWIM                     | SWIM_CSR                 | SWIM control status register           | 0x00         |
| 0x00 7F81<br>to<br>0x00 7F8F | Reserved area (15 bytes) |                          |                                        |              |
| 0x00 7F90                    | DM                       | DM_BK1RE                 | DM breakpoint 1 register extended byte | 0xFF         |
| 0x00 7F91                    |                          | DM_BK1RH                 | DM breakpoint 1 register high byte     | 0xFF         |
| 0x00 7F92                    |                          | DM_BK1RL                 | DM breakpoint 1 register low byte      | 0xFF         |
| 0x00 7F93                    |                          | DM_BK2RE                 | DM breakpoint 2 register extended byte | 0xFF         |
| 0x00 7F94                    |                          | DM_BK2RH                 | DM breakpoint 2 register high byte     | 0xFF         |
| 0x00 7F95                    |                          | DM_BK2RL                 | DM breakpoint 2 register low byte      | 0xFF         |
| 0x00 7F96                    |                          | DM_CR1                   | DM Debug module control register 1     | 0x00         |

Table 8. CPU/SWIM/debug module/interrupt controller registers (continued)

| Address                      | Block                   | Register label | Register name                             | Reset status |
|------------------------------|-------------------------|----------------|-------------------------------------------|--------------|
| 0x00 7F97                    | DM                      | DM_CR2         | DM Debug module control register 2        | 0x00         |
| 0x00 7F98                    |                         | DM_CSR1        | DM Debug module control/status register 1 | 0x10         |
| 0x00 7F99                    |                         | DM_CSR2        | DM Debug module control/status register 2 | 0x00         |
| 0x00 7F9A                    |                         | DM_ENFCTR      | DM enable function register               | 0xFF         |
| 0x00 7F9B<br>to<br>0x00 7F9F | Reserved area (5 bytes) |                |                                           |              |

1. Accessible by debug module only

## 6 Interrupt vector mapping

The interrupt vector mapping is described in [Table 9](#).

**Table 9. Interrupt mapping**

| IRQ No. | Source block       | Description                                                                | Wakeup from Halt mode | Wakeup from Active-halt mode | Wakeup from Wait (WFI mode) | Wakeup from Wait (WFE mode) <sup>(1)</sup> | Vector address |
|---------|--------------------|----------------------------------------------------------------------------|-----------------------|------------------------------|-----------------------------|--------------------------------------------|----------------|
|         | RESET              | Reset                                                                      | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8000      |
|         | TRAP               | Software interrupt                                                         | -                     | -                            | -                           | -                                          | 0x00 8004      |
| 0       | TLI <sup>(2)</sup> | External Top level Interrupt                                               | -                     | -                            | -                           | -                                          | 0x00 8008      |
| 1       | FLASH              | FLASH end of programing/<br>write attempted to<br>protected page interrupt | -                     | -                            | Yes                         | Yes                                        | 0x00 800C      |
| 2       | DMA1 0/1           | DMA1 channels 0/1 half<br>transaction/transaction<br>complete interrupt    | -                     | -                            | Yes                         | Yes                                        | 0x00 8010      |
| 3       | DMA1 2/3           | DMA1 channels 2/3 half<br>transaction/transaction<br>complete interrupt    | -                     | -                            | Yes                         | Yes                                        | 0x00 8014      |
| 4       | RTC                | RTC alarm A/wakeup/<br>tamper 1/tamper 2/tamper 3                          | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8018      |
| 5       | PVD                | PVD interrupt                                                              | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 801C      |
| 6       | EXTIB              | External interrupt port B                                                  | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8020      |
| 7       | EXTID              | External interrupt port D                                                  | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8024      |
| 8       | EXTI0              | External interrupt 0                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8028      |
| 9       | EXTI1              | External interrupt 1                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 802C      |
| 10      | EXTI2              | External interrupt 2                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8030      |
| 11      | EXTI3              | External interrupt 3                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8034      |
| 12      | EXTI4              | External interrupt 4                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8038      |
| 13      | EXTI5              | External interrupt 5                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 803C      |
| 14      | EXTI6              | External interrupt 6                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8040      |
| 15      | EXTI7              | External interrupt 7                                                       | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8044      |
| 16      | Reserved           |                                                                            |                       |                              |                             |                                            | 0x00 8048      |
| 17      | CLK                | CLK system clock<br>switch/CSS interrupt                                   | -                     | -                            | Yes                         | Yes                                        | 0x00 804C      |
| 18      | ADC1               | ACD1 end of conversion/<br>analog watchdog/<br>overrun interrupt           | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8050      |



Table 9. Interrupt mapping (continued)

| IRQ No. | Source block | Description                                                                                      | Wakeup from Halt mode | Wakeup from Active-halt mode | Wakeup from Wait (WFI mode) | Wakeup from Wait (WFE mode) <sup>(1)</sup> | Vector address |
|---------|--------------|--------------------------------------------------------------------------------------------------|-----------------------|------------------------------|-----------------------------|--------------------------------------------|----------------|
| 19      | TIM2         | TIM2 update /overflow/trigger/break interrupt                                                    | -                     | -                            | Yes                         | Yes                                        | 0x00 8054      |
| 20      | TIM2         | TIM2 Capture/Compare interrupt                                                                   | -                     | -                            | Yes                         | Yes                                        | 0x00 8058      |
| 21      | TIM3         | TIM3 Update /Overflow/Trigger/Break interrupt                                                    | -                     | -                            | Yes                         | Yes                                        | 0x00 805C      |
| 22      | TIM3         | TIM3 Capture/Compare interrupt                                                                   | -                     | -                            | Yes                         | Yes                                        | 0x00 8060      |
| 23      | RI           | RI trigger interrupt                                                                             | -                     | -                            | Yes                         | -                                          | 0x00 8064      |
| 24      | Reserved     |                                                                                                  |                       |                              |                             |                                            | 0x00 8068      |
| 25      | TIM4         | TIM4 update/overflow/trigger interrupt                                                           | -                     | -                            | Yes                         | Yes                                        | 0x00 806C      |
| 26      | SPI1         | SPI1 TX buffer empty/ RX buffer not empty/ error/wakeup interrupt                                | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 8070      |
| 27      | USART 1      | USART1 transmit data register empty/ transmission complete interrupt                             | -                     | -                            | Yes                         | Yes                                        | 0x00 8074      |
| 28      | USART 1      | USART1 received data ready/overrun error/ idle line detected/parity error/global error interrupt | -                     | -                            | Yes                         | Yes                                        | 0x00 8078      |
| 29      | I2C1         | I2C1 interrupt <sup>(3)</sup>                                                                    | Yes                   | Yes                          | Yes                         | Yes                                        | 0x00 807C      |

1. The Low-power wait mode is entered when executing a WFE instruction in Low-power run mode. In WFE mode, the interrupt is served if it has been previously enabled. After processing the interrupt, the processor goes back to WFE mode. When the interrupt is configured as a wakeup event, the CPU wakes up and resumes processing.
2. The TLI interrupt is the logic OR between TIM2 overflow interrupt, and TIM4 overflow interrupts.
3. The device is woken up from Halt or Active-halt mode only when the address received matches the interface address.

## 7 Option bytes

Option bytes contain configurations for device hardware features as well as the memory protection of the device. They are stored in a dedicated memory block.

All option bytes can be modified in ICP mode (with SWIM) by accessing the EEPROM address. See [Table 10](#) for details on option byte addresses.

The option bytes can also be modified 'on the fly' by the application in IAP mode, except for the ROP and UBC values which can only be taken into account when they are modified in ICP mode (with the SWIM).

Refer to the *How to program STM8L and STM8AL Flash program memory and data EEPROM* programming manual (PM0054) and the *STM8 SWIM communication protocol and debug module* user manual (UM0470) for information on SWIM programming procedures.

**Table 10. Option byte addresses**

| Addr.     | Option name                                                      | Option byte No. | Option bits |   |   |   |             |         |             |         | Factory default setting |
|-----------|------------------------------------------------------------------|-----------------|-------------|---|---|---|-------------|---------|-------------|---------|-------------------------|
|           |                                                                  |                 | 7           | 6 | 5 | 4 | 3           | 2       | 1           | 0       |                         |
| 0x00 4800 | Read-out protection (ROP)                                        | OPT0            | ROP[7:0]    |   |   |   |             |         |             |         | 0xAA                    |
| 0x00 4802 | UBC (User Boot code size)                                        | OPT1            | UBC[7:0]    |   |   |   |             |         |             |         | 0x00                    |
| 0x00 4807 | Reserved                                                         |                 |             |   |   |   |             |         |             | 0x00    |                         |
| 0x00 4808 | Independent watchdog option                                      | OPT3 [3:0]      | Reserved    |   |   |   | WWDG_HALT   | WWDG_HW | IWDG_HALT   | IWDG_HW | 0x00                    |
| 0x00 4809 | Number of stabilization clock cycles for HSE and LSE oscillators | OPT4            | Reserved    |   |   |   | LSECNT[1:0] |         | HSECNT[1:0] |         | 0x00                    |
| 0x00 480A | Brownout reset (BOR)                                             | OPT5 [3:0]      | Reserved    |   |   |   | BOR_TH      |         |             | BOR_ON  | 0x00                    |
| 0x00 480B | Bootloader option bytes (OPTBL)                                  | OPTBL [15:0]    | OPTBL[15:0] |   |   |   |             |         |             |         | 0x00                    |
| 0x00 480C |                                                                  |                 |             |   |   |   |             |         |             |         | 0x00                    |

Table 11. Option byte description

| Option byte No. | Option description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OPT0            | <b>ROP[7:0]</b> Memory readout protection (ROP)<br>0xAA: Disable readout protection (write access via SWIM protocol)<br>Refer to the “Readout protection” section in the <i>STM8L050J3, STM8L051F3, STM8L052C6, STM8L052R8 MCUs and STM8L151/L152, STM8L162, STM8AL31, STM8AL3L</i> lines reference manual (RM0031).                                                                                                                                                                                                                                                                                                                                  |
| OPT1            | <b>UBC[7:0]</b> Size of the user boot code area<br>0x00: UBC is not protected.<br>0x01: Page 0 is write protected.<br>0x02: Page 0 and 1 reserved for the UBC and write protected. It covers only the interrupt vectors.<br>0x03: Page 0 to 2 reserved for UBC and write protected.<br>0x7F to 0xFF - All 128 pages reserved for UBC and write protected.<br>The protection of the memory area not protected by the UBC is enabled through the MASS keys.<br>Refer to the “User boot code” section in the <i>STM8L050J3, STM8L051F3, STM8L052C6, STM8L052R8 MCUs and STM8L151/L152, STM8L162, STM8AL31, STM8AL3L</i> lines reference manual (RM0031). |
| OPT2            | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| OPT3            | <b>IWDG_HW</b> : Independent watchdog<br>0: Independent watchdog activated by software<br>1: Independent watchdog activated by hardware                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                 | <b>IWDG_HALT</b> : Independent window watchdog off on Halt/Active-halt<br>0: Independent watchdog continues running in Halt/Active-halt mode<br>1: Independent watchdog stopped in Halt/Active-halt mode                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                 | <b>WWDG_HW</b> : Window watchdog<br>0: Window watchdog activated by software<br>1: Window watchdog activated by hardware                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                 | <b>WWDG_HALT</b> : Window window watchdog reset on Halt/Active-halt<br>0: Window watchdog stopped in Halt mode<br>1: Window watchdog generates a reset when MCU enters Halt mode                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| OPT4            | <b>HSECNT</b> : Number of HSE oscillator stabilization clock cycles<br>0x00 - 1 clock cycle<br>0x01 - 16 clock cycles<br>0x10 - 512 clock cycles<br>0x11 - 4096 clock cycles                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                 | <b>LSECNT</b> : Number of LSE oscillator stabilization clock cycles<br>0x00 - 1 clock cycle<br>0x01 - 16 clock cycles<br>0x10 - 512 clock cycles<br>0x11 - 4096 clock cycles<br>Refer to <a href="#">Table 29: LSE oscillator characteristics on page 62</a> .                                                                                                                                                                                                                                                                                                                                                                                        |

Table 11. Option byte description (continued)

| Option byte No. | Option description                                                                                                                                                                                                                                                                        |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OPT5            | <b>BOR_ON:</b><br>0: Brownout reset off<br>1: Brownout reset on                                                                                                                                                                                                                           |
|                 | <b>BOR_TH[3:1]:</b> Brownout reset thresholds. Refer to for details on the thresholds according to the value of BOR_TH bits.                                                                                                                                                              |
| OPTBL           | <b>OPTBL[15:0]:</b><br>This option is checked by the boot ROM code after reset. Depending on content of addresses 00 480B, 00 480C and 0x8000 (reset vector) the CPU jumps to the bootloader or to the reset vector.<br>Refer to the UM0560 STM8 bootloader user manual for more details. |

## 8 Electrical parameters

This section describes the quantification of the given device's parameters.

### 8.1 Parameter conditions

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

#### 8.1.1 Minimum and maximum values

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

Data based on characterization results, design simulation and/or technology characteristics is indicated in the table footnotes and are not tested in production. 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 ( $\text{mean} \pm 3\Sigma$ ).

#### 8.1.2 Typical values

Unless otherwise specified, typical data is based on  $T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 3\text{ V}$ . It is given only as design guidelines and is 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 ( $\text{mean} \pm 2\Sigma$ ).

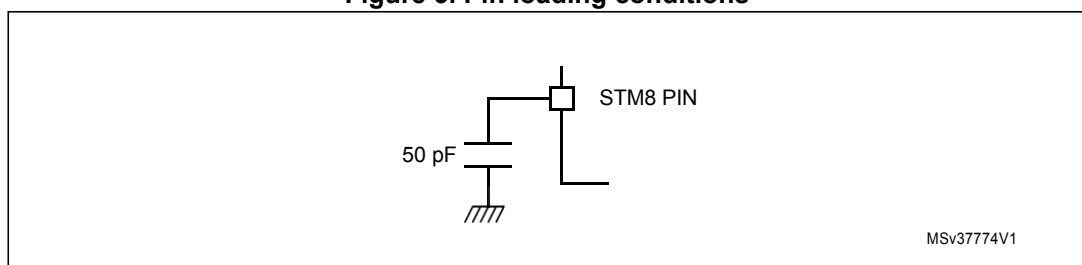
#### 8.1.3 Typical curves

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

#### 8.1.4 Loading capacitor

The loading conditions used for pin parameter measurement are shown in [Figure 5](#).

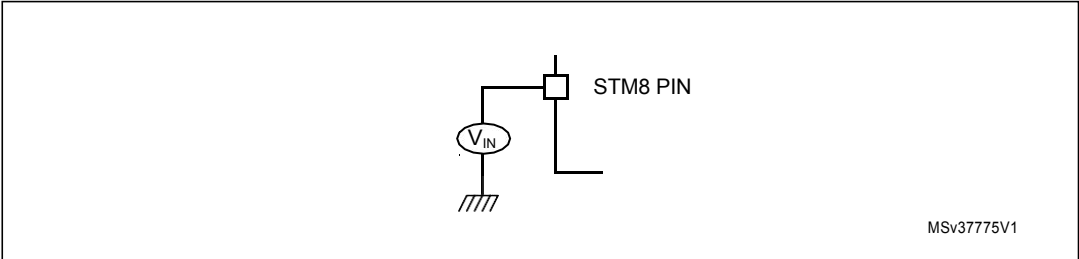
Figure 5. Pin loading conditions



### 8.1.5 Pin input voltage

The input voltage measurement on a pin of the device is described in [Figure 6](#).

Figure 6. Pin input voltage



## 8.2 Absolute maximum ratings

Stresses above the absolute maximum ratings listed in [Table 12: Voltage characteristics](#), [Table 13: Current characteristics](#), and [Table 14: Thermal characteristics](#) may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect the device's reliability.

The device's mission profile (application conditions) is compliant with the JEDEC JESD47 Qualification Standard, extended mission profiles are available on demand.

Table 12. Voltage characteristics

| Symbol            | Ratings                                                                     | Min                                                                              | Max            | Unit |
|-------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------|------|
| $V_{DD} - V_{SS}$ | External supply voltage (including $V_{DDA}$ and $V_{DD2}$ ) <sup>(1)</sup> | - 0.3                                                                            | 4.0            | V    |
| $V_{IN}^{(2)}$    | Input voltage on true open-drain pins (PC0 and PC1)                         | $V_{SS} - 0.3$                                                                   | $V_{DD} + 4.0$ | V    |
|                   | Input voltage on five-volt tolerant (FT) pins (PA7 and PE0)                 | $V_{SS} - 0.3$                                                                   | $V_{DD} + 4.0$ |      |
|                   | Input voltage on 3.6 V tolerant (TT) pins                                   | $V_{SS} - 0.3$                                                                   | 4.0            |      |
|                   | Input voltage on any other pin                                              | $V_{SS} - 0.3$                                                                   | 4.0            |      |
| $V_{ESD}$         | Electrostatic discharge voltage                                             | see <a href="#">Absolute maximum ratings (electrical sensitivity)</a> on page 86 |                |      |

1. All power ( $V_{DD1}$ ,  $V_{DD2}$ ,  $V_{DDA}$ ) and ground ( $V_{SS1}$ ,  $V_{SS2}$ ,  $V_{SSA}$ ) pins must always be connected to the external power supply.
2.  $V_{IN}$  maximum must always be respected. Refer to [Table 13: Current characteristics](#) for maximum allowed injected current values.

Table 13. Current characteristics

| Symbol    | Ratings                                          | Max. | Unit |
|-----------|--------------------------------------------------|------|------|
| $I_{VDD}$ | Total current into $V_{DD}$ power line (source)  | 80   | mA   |
| $I_{VSS}$ | Total current out of $V_{SS}$ ground line (sink) | 80   |      |

Table 13. Current characteristics (continued)

| Symbol                | Ratings                                                                       | Max.     | Unit |
|-----------------------|-------------------------------------------------------------------------------|----------|------|
| $I_{IO}$              | Output current sunk by IR_TIM pin (with high sink LED driver capability)      | 80       |      |
|                       | Output current sunk by any other I/O and control pin                          | 25       |      |
|                       | Output current sourced by any I/Os and control pin                            | - 25     |      |
| $I_{INJ(PIN)}$        | Injected current on true open-drain pins (PC0 and PC1) <sup>(1)</sup>         | - 5 / +0 |      |
|                       | Injected current on five-volt tolerant (FT) pins (PA7 and PE0) <sup>(1)</sup> | - 5 / +0 |      |
|                       | Injected current on 3.6 V tolerant (TT) pins <sup>(1)</sup>                   | - 5 / +0 |      |
|                       | Injected current on any other pin <sup>(2)</sup>                              | - 5 / +5 |      |
| $\Sigma I_{INJ(PIN)}$ | Total injected current (sum of all I/O and control pins) <sup>(3)</sup>       | ± 25     |      |

1. Positive injection is not possible on these I/Os. A negative injection is induced by  $V_{IN} < V_{SS}$ .  $I_{INJ(PIN)}$  must never be exceeded. Refer to [Table 13: Current characteristics](#) for maximum allowed input voltage values.
2. 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 to [Table 13: Current characteristics](#) for maximum allowed input voltage values.
3. 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 14. Thermal characteristics

| Symbol    | Ratings                      | Value       | Unit |
|-----------|------------------------------|-------------|------|
| $T_{STG}$ | Storage temperature range    | -65 to +150 | ° C  |
| $T_J$     | Maximum junction temperature | 150         |      |

## 8.3 Operating conditions

Subject to general operating conditions for  $V_{DD}$  and  $T_A$ .

### 8.3.1 General operating conditions

The operating conditions define the conditions under which the device operates correctly according to its specification (see [Table 15](#)).

**Table 15. General operating conditions**

| Symbol                    | Parameter                                     | Conditions                                      | Min. | Max.               | Unit             |
|---------------------------|-----------------------------------------------|-------------------------------------------------|------|--------------------|------------------|
| $f_{\text{SYSCLK}}^{(1)}$ | System clock frequency                        | $1.8 \text{ V} \leq V_{DD} < 3.6 \text{ V}$     | 0    | 16                 | MHz              |
| $V_{DD}$                  | Standard operating voltage                    | -                                               | 1.8  | 3.6                | V                |
| $V_{DDA}$                 | Analog operating voltage                      | Must be at the same potential as $V_{DD}$       | 1.8  | 3.6                | V                |
| $P_D^{(2)}$               | Power dissipation at $T_A = 85^\circ\text{C}$ | TSSOP20                                         | -    | 181                | mW               |
| $T_A$                     | Temperature range                             | $1.8 \text{ V} \leq V_{DD} < 3.6 \text{ V}$     | -40  | 85                 | $^\circ\text{C}$ |
| $T_J$                     | Junction temperature range                    | $-40^\circ\text{C} \leq T_A < 85^\circ\text{C}$ | -40  | 105 <sup>(3)</sup> | $^\circ\text{C}$ |

1.  $f_{\text{SYSCLK}} = f_{\text{CPU}}$

2. To calculate  $P_{D\text{max}}(T_A)$ , use the formula  $P_{D\text{max}} = (T_{J\text{max}} - T_A) / \Theta_{JA}$  with  $T_{J\text{max}}$  in this table and  $\Theta_{JA}$  in "Thermal characteristics" table.

3.  $T_{J\text{max}}$  is given by the test limit. Above this value, the product behavior is not guaranteed.



### 8.3.2 Embedded reset and power control block characteristics

The reset and power block parameters are described in [Table 16](#) and are derived from tests performed under the ambient temperature conditions summarized in [Table 15: General operating conditions](#).

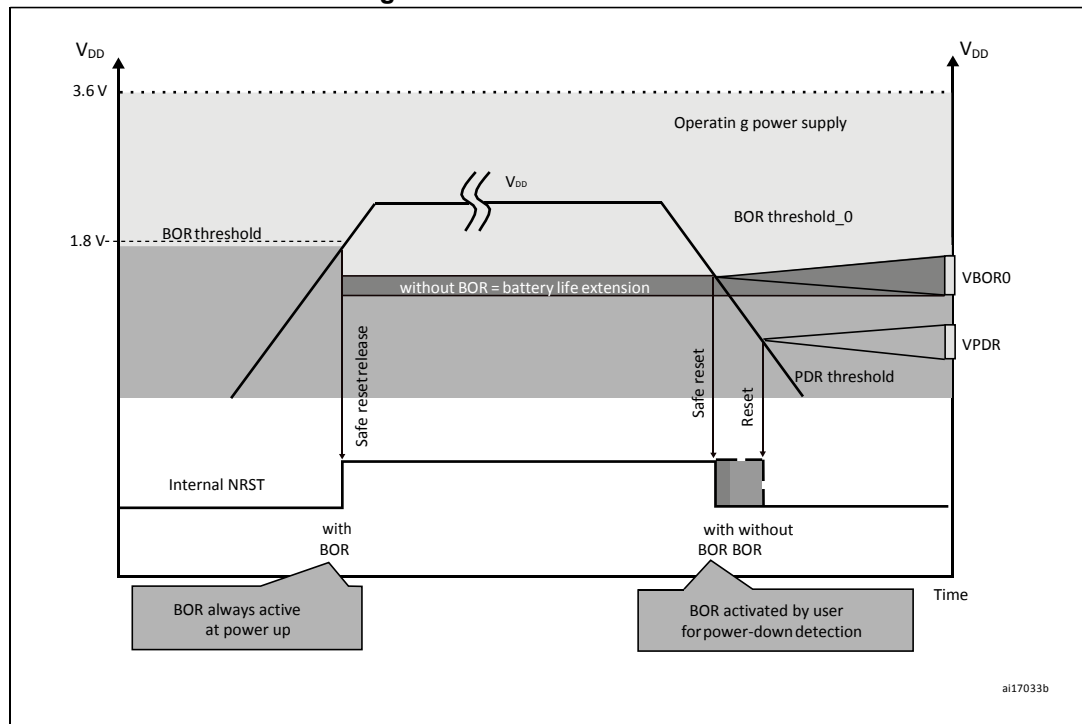
**Table 16. Embedded reset and power control block characteristics**

| Symbol     | Parameter                                     | Conditions           | Min                 | Typ  | Max                     | Unit            |
|------------|-----------------------------------------------|----------------------|---------------------|------|-------------------------|-----------------|
| $t_{VDD}$  | $V_{DD}$ rise time rate                       | BOR detector enabled | 0 <sup>(1)</sup>    | -    | $\infty$ <sup>(1)</sup> | $\mu\text{s/V}$ |
|            | $V_{DD}$ fall time rate                       | BOR detector enabled | 20 <sup>(1)</sup>   | -    | $\infty$ <sup>(1)</sup> |                 |
| $t_{TEMP}$ | Reset release delay                           | $V_{DD}$ rising      | -                   | 3    | -                       | ms              |
| $V_{PDR}$  | Power-down reset threshold                    | Falling edge         | 1.30 <sup>(2)</sup> | 1.50 | 1.65                    | V               |
| $V_{BOR0}$ | Brown-out reset threshold 0 (BOR_TH[2:0]=000) | Falling edge         | 1.67                | 1.70 | 1.74                    | V               |
|            |                                               | Rising edge          | 1.69                | 1.75 | 1.80                    |                 |
| $V_{BOR1}$ | Brown-out reset threshold 1 (BOR_TH[2:0]=001) | Falling edge         | 1.87                | 1.93 | 1.97                    |                 |
|            |                                               | Rising edge          | 1.96                | 2.04 | 2.07                    |                 |
| $V_{BOR2}$ | Brown-out reset threshold 2 (BOR_TH[2:0]=010) | Falling edge         | 2.22                | 2.3  | 2.35                    |                 |
|            |                                               | Rising edge          | 2.31                | 2.41 | 2.44                    |                 |
| $V_{BOR3}$ | Brown-out reset threshold 3 (BOR_TH[2:0]=011) | Falling edge         | 2.45                | 2.55 | 2.60                    |                 |
|            |                                               | Rising edge          | 2.54                | 2.66 | 2.7                     |                 |
| $V_{BOR4}$ | Brown-out reset threshold 4 (BOR_TH[2:0]=100) | Falling edge         | 2.68                | 2.80 | 2.85                    |                 |
|            |                                               | Rising edge          | 2.78                | 2.90 | 2.95                    |                 |
| $V_{PVD0}$ | PVD threshold 0                               | Falling edge         | 1.80                | 1.84 | 1.88                    | V               |
|            |                                               | Rising edge          | 1.88                | 1.94 | 1.99                    |                 |
| $V_{PVD1}$ | PVD threshold 1                               | Falling edge         | 1.98                | 2.04 | 2.09                    |                 |
|            |                                               | Rising edge          | 2.08                | 2.14 | 2.18                    |                 |
| $V_{PVD2}$ | PVD threshold 2                               | Falling edge         | 2.2                 | 2.24 | 2.28                    |                 |
|            |                                               | Rising edge          | 2.28                | 2.34 | 2.38                    |                 |
| $V_{PVD3}$ | PVD threshold 3                               | Falling edge         | 2.39                | 2.44 | 2.48                    |                 |
|            |                                               | Rising edge          | 2.47                | 2.54 | 2.58                    |                 |
| $V_{PVD4}$ | PVD threshold 4                               | Falling edge         | 2.57                | 2.64 | 2.69                    |                 |
|            |                                               | Rising edge          | 2.68                | 2.74 | 2.79                    |                 |
| $V_{PVD5}$ | PVD threshold 5                               | Falling edge         | 2.77                | 2.83 | 2.88                    |                 |
|            |                                               | Rising edge          | 2.87                | 2.94 | 2.99                    |                 |
| $V_{PVD6}$ | PVD threshold 6                               | Falling edge         | 2.97                | 3.05 | 3.09                    |                 |
|            |                                               | Rising edge          | 3.08                | 3.15 | 3.20                    |                 |

1. Guaranteed by design.

2. Guaranteed by characterization results.

### Figure 7. POR/BOR thresholds



### 8.3.3 Supply current characteristics

### Total current consumption

The MCU is placed under the following conditions:

- All I/O pins in input mode with a static value at  $V_{DD}$  or  $V_{SS}$  (no load)
- All peripherals are disabled except if explicitly mentioned.

In the following table, data is based on characterization results, unless otherwise specified.

Subject to general operating conditions for  $V_{DD}$  and  $T_A$ .

Table 17. Total current consumption in Run mode

| Symbol               | Parameter                                 | Conditions <sup>(1)</sup>                                                          |                                                                         |                                     | Typ   | Max   |                      | Unit |
|----------------------|-------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------|-------|-------|----------------------|------|
|                      |                                           |                                                                                    |                                                                         |                                     |       | 55 °C | 85 °C                |      |
| I <sub>DD(RUN)</sub> | Supply current in run mode <sup>(2)</sup> | All peripherals OFF, code executed from RAM, V <sub>DD</sub> from 1.8 V to 3.6 V   | HSI RC osc. (16 MHz) <sup>(3)</sup>                                     | f <sub>CPU</sub> = 125 kHz          | 0.39  | 0.47  | 0.49                 | mA   |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 1 MHz            | 0.48  | 0.56  | 0.58                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 4 MHz            | 0.75  | 0.84  | 0.86                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 8 MHz            | 1.10  | 1.20  | 1.25                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 16 MHz           | 1.85  | 1.93  | 2.12 <sup>(5)</sup>  |      |
|                      |                                           |                                                                                    | HSE external clock (f <sub>CPU</sub> =f <sub>HSE</sub> ) <sup>(4)</sup> | f <sub>CPU</sub> = 125 kHz          | 0.05  | 0.06  | 0.09                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 1 MHz            | 0.18  | 0.19  | 0.20                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 4 MHz            | 0.55  | 0.62  | 0.64                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 8 MHz            | 0.99  | 1.20  | 1.21                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 16 MHz           | 1.90  | 2.22  | 2.23 <sup>(5)</sup>  |      |
|                      |                                           |                                                                                    | LSI RC osc. (typ. 38 kHz)                                               | f <sub>CPU</sub> = f <sub>LSI</sub> | 0.040 | 0.045 | 0.046                |      |
|                      |                                           |                                                                                    | LSE external clock (32.768 kHz)                                         | f <sub>CPU</sub> = f <sub>LSE</sub> | 0.035 | 0.040 | 0.048 <sup>(5)</sup> |      |
| I <sub>DD(RUN)</sub> | Supply current in Run mode                | All peripherals OFF, code executed from Flash, V <sub>DD</sub> from 1.8 V to 3.6 V | HSI RC osc. <sup>(6)</sup>                                              | f <sub>CPU</sub> = 125 kHz          | 0.43  | 0.55  | 0.56                 | mA   |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 1 MHz            | 0.60  | 0.77  | 0.80                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 4 MHz            | 1.11  | 1.34  | 1.37                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 8 MHz            | 1.90  | 2.20  | 2.23                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 16 MHz           | 3.8   | 4.60  | 4.75                 |      |
|                      |                                           |                                                                                    | HSE external clock (f <sub>CPU</sub> =f <sub>HSE</sub> ) <sup>(4)</sup> | f <sub>CPU</sub> = 125 kHz          | 0.30  | 0.36  | 0.39                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 1 MHz            | 0.40  | 0.50  | 0.52                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 4 MHz            | 1.15  | 1.31  | 1.40                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 8 MHz            | 2.17  | 2.33  | 2.44                 |      |
|                      |                                           |                                                                                    |                                                                         | f <sub>CPU</sub> = 16 MHz           | 4.0   | 4.46  | 4.52                 |      |
|                      |                                           |                                                                                    | LSI RC osc.                                                             | f <sub>CPU</sub> = f <sub>LSI</sub> | 0.110 | 0.123 | 0.130                |      |
|                      |                                           |                                                                                    | LSE ext. clock (32.768 kHz) <sup>(7)</sup>                              | f <sub>CPU</sub> = f <sub>LSE</sub> | 0.100 | 0.101 | 0.104                |      |

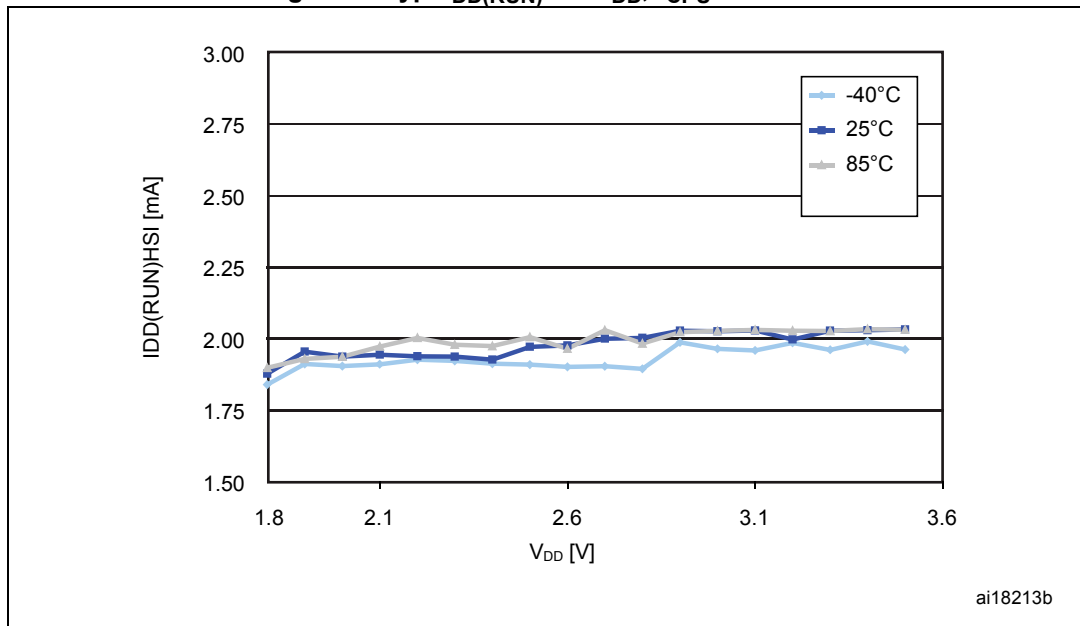
1. All peripherals OFF, V<sub>DD</sub> from 1.8 V to 3.6 V, HSI internal RC osc. , f<sub>CPU</sub>=f<sub>SYSCCLK</sub>

2. CPU executing typical data processing

3. The run from RAM consumption can be approximated with the linear formula:  
 $I_{DD(run\_from\_RAM)} = \text{Freq} * 90 \mu\text{A}/\text{MHz} + 380 \mu\text{A}$

4. Oscillator bypassed (HSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the HSE consumption ( $I_{DD\ HSE}$ ) must be added. Refer to [Table 28](#).
5. Tested in production.
6. The run from Flash consumption can be approximated with the linear formula:  
 $I_{DD(run\_from\_Flash)} = Freq * 195\ \mu A/MHz + 440\ \mu A$
7. Oscillator bypassed (LSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the LSE consumption ( $I_{DD\ LSE}$ ) must be added. Refer to [Table 29](#).

**Figure 8. Typ.  $I_{DD(RUN)}$  vs.  $V_{DD}$ ,  $f_{CPU} = 16\ MHz$**



1. Typical current consumption measured with code executed from RAM

In the following table, data is based on characterization results, unless otherwise specified.

**Table 18. Total current consumption in Wait mode**

| Symbol                                                    | Parameter                                      | Conditions <sup>(1)</sup>                                                                                                                             |                                                                         |                                                | Typ                                                                                                 | Max   |                            | Unit  |
|-----------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------|----------------------------|-------|
|                                                           |                                                |                                                                                                                                                       |                                                                         |                                                |                                                                                                     | 55°C  | 85°C                       |       |
| I <sub>DD(Wait)</sub>                                     | Supply current in Wait mode                    | CPU not clocked, all peripherals OFF, code executed from RAM with Flash in I <sub>DDQ</sub> mode <sup>(2)</sup> , V <sub>DD</sub> from 1.8 V to 3.6 V | HSI                                                                     | f <sub>CPU</sub> = 125 kHz                     | 0.33                                                                                                | 0.39  | 0.41                       | mA    |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 1 MHz                       | 0.35                                                                                                | 0.41  | 0.44                       |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 4 MHz                       | 0.42                                                                                                | 0.51  | 0.52                       |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 8 MHz                       | 0.52                                                                                                | 0.57  | 0.58                       |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 16 MHz                      | 0.68                                                                                                | 0.76  | 0.79                       |       |
|                                                           |                                                |                                                                                                                                                       | HSE external clock (f <sub>CPU</sub> =f <sub>HSE</sub> ) <sup>(3)</sup> | f <sub>CPU</sub> = 125 kHz                     | 0.032                                                                                               | 0.056 | 0.068                      |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 1 MHz                       | 0.078                                                                                               | 0.121 | 0.144                      |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 4 MHz                       | 0.218                                                                                               | 0.26  | 0.30                       |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | f <sub>CPU</sub> = 8 MHz                       | 0.40                                                                                                | 0.52  | 0.57                       |       |
|                                                           |                                                |                                                                                                                                                       | LSI                                                                     | f <sub>CPU</sub> = f <sub>LSI</sub>            | 0.035                                                                                               | 0.044 | 0.046                      |       |
|                                                           |                                                |                                                                                                                                                       |                                                                         | LSE <sup>(4)</sup> external clock (32.768 kHz) | f <sub>CPU</sub> = f <sub>LSE</sub>                                                                 | 0.032 | 0.036                      |       |
|                                                           |                                                |                                                                                                                                                       | I <sub>DD(Wait)</sub>                                                   | Supply current in Wait mode                    | CPU not clocked, all peripherals OFF, code executed from Flash, V <sub>DD</sub> from 1.8 V to 3.6 V | HSI   | f <sub>CPU</sub> = 125 kHz |       |
| f <sub>CPU</sub> = 1 MHz                                  | 0.41                                           | 0.49                                                                                                                                                  |                                                                         |                                                |                                                                                                     |       | 0.51                       |       |
| f <sub>CPU</sub> = 4 MHz                                  | 0.50                                           | 0.57                                                                                                                                                  |                                                                         |                                                |                                                                                                     |       | 0.58                       |       |
| f <sub>CPU</sub> = 8 MHz                                  | 0.60                                           | 0.66                                                                                                                                                  |                                                                         |                                                |                                                                                                     |       | 0.68                       |       |
| f <sub>CPU</sub> = 16 MHz                                 | 0.79                                           | 0.84                                                                                                                                                  |                                                                         |                                                |                                                                                                     |       | 0.86                       |       |
| HSE <sup>(3)</sup> external clock (f <sub>CPU</sub> =HSE) | f <sub>CPU</sub> = 125 kHz                     | 0.06                                                                                                                                                  |                                                                         |                                                |                                                                                                     | 0.08  | 0.09                       |       |
|                                                           | f <sub>CPU</sub> = 1 MHz                       | 0.10                                                                                                                                                  |                                                                         |                                                |                                                                                                     | 0.17  | 0.18                       |       |
|                                                           | f <sub>CPU</sub> = 4 MHz                       | 0.24                                                                                                                                                  |                                                                         |                                                |                                                                                                     | 0.36  | 0.39                       |       |
|                                                           | f <sub>CPU</sub> = 8 MHz                       | 0.50                                                                                                                                                  |                                                                         |                                                |                                                                                                     | 0.58  | 0.61                       |       |
| LSI                                                       | f <sub>CPU</sub> = f <sub>LSI</sub>            | 0.055                                                                                                                                                 |                                                                         |                                                |                                                                                                     | 0.058 | 0.065                      |       |
|                                                           | LSE <sup>(4)</sup> external clock (32.768 kHz) | f <sub>CPU</sub> = f <sub>LSE</sub>                                                                                                                   |                                                                         |                                                |                                                                                                     | 0.051 | 0.056                      | 0.060 |

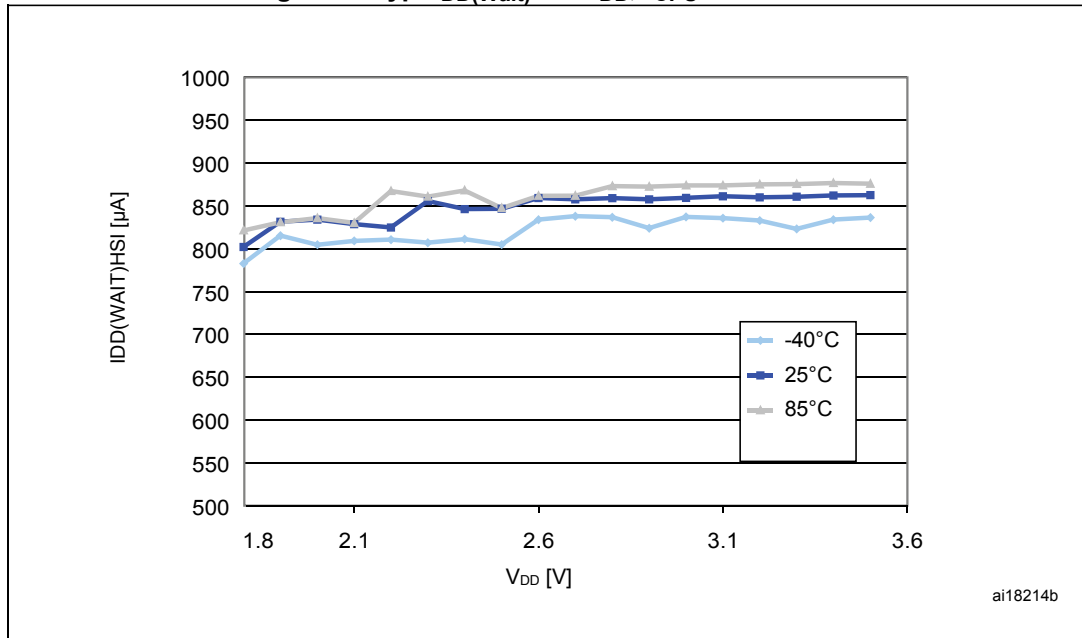
1. All peripherals OFF,  $V_{DD}$  from 1.8 V to 3.6 V, HSI internal RC osc. ,  $f_{CPU} = f_{SYSCLK}$

2. Flash is configured in  $I_{DDQ}$  mode in Wait mode by setting the EPM or WAITM bit in the Flash\_CR1 register.

3. Oscillator bypassed (HSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the HSE consumption ( $I_{DD HSE}$ ) must be added. Refer to [Table 28](#).

4. Oscillator bypassed (LSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the LSE consumption ( $I_{DD\ HSE}$ ) must be added. Refer to [Table 29](#).

**Figure 9. Typ.  $I_{DD(Wait)}$  vs.  $V_{DD}$ ,  $f_{CPU} = 16\text{ MHz}$  <sup>1)</sup>**



1. Typical current consumption measured with code executed from Flash memory.

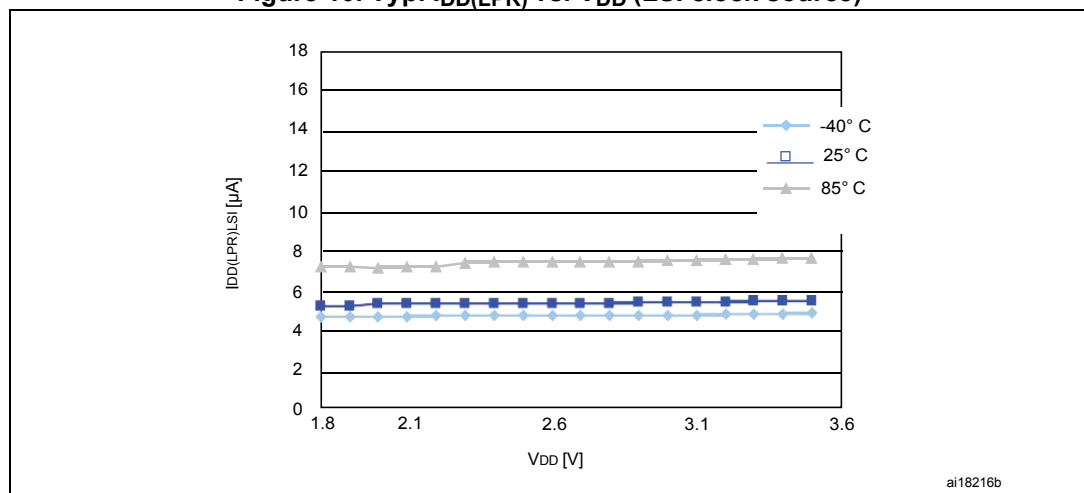
In the following table, data is based on characterization results, unless otherwise specified.

**Table 19. Total current consumption and timing in Low power run mode  
at  $V_{DD} = 1.8\text{ V}$  to  $3.6\text{ V}$**

| Symbol        | Parameter                            | Conditions <sup>(1)</sup>                            |                                 |                                                                     | Typ  | Max | Unit          |
|---------------|--------------------------------------|------------------------------------------------------|---------------------------------|---------------------------------------------------------------------|------|-----|---------------|
| $I_{DD(LPR)}$ | Supply current in Low power run mode | LSI RC osc.<br>(at 38 kHz)                           | all peripherals OFF             | $T_A = -40\text{ }^{\circ}\text{C}$ to $25\text{ }^{\circ}\text{C}$ | 5.1  | 5.4 | $\mu\text{A}$ |
|               |                                      |                                                      |                                 | $T_A = 55\text{ }^{\circ}\text{C}$                                  | 5.7  | 6   |               |
|               |                                      |                                                      |                                 | $T_A = 85\text{ }^{\circ}\text{C}$                                  | 6.8  | 7.5 |               |
|               |                                      |                                                      | with TIM2 active <sup>(2)</sup> | $T_A = -40\text{ }^{\circ}\text{C}$ to $25\text{ }^{\circ}\text{C}$ | 5.4  | 5.7 |               |
|               |                                      |                                                      |                                 | $T_A = 55\text{ }^{\circ}\text{C}$                                  | 6.0  | 6.3 |               |
|               |                                      |                                                      |                                 | $T_A = 85\text{ }^{\circ}\text{C}$                                  | 7.2  | 7.8 |               |
|               |                                      | LSE <sup>(3)</sup> external<br>clock<br>(32.768 kHz) | all peripherals OFF             | $T_A = -40\text{ }^{\circ}\text{C}$ to $25\text{ }^{\circ}\text{C}$ | 5.25 | 5.6 |               |
|               |                                      |                                                      |                                 | $T_A = 55\text{ }^{\circ}\text{C}$                                  | 5.67 | 6.1 |               |
|               |                                      |                                                      |                                 | $T_A = 85\text{ }^{\circ}\text{C}$                                  | 5.85 | 6.3 |               |
|               |                                      |                                                      | with TIM2 active <sup>(2)</sup> | $T_A = -40\text{ }^{\circ}\text{C}$ to $25\text{ }^{\circ}\text{C}$ | 5.59 | 6   |               |
|               |                                      |                                                      |                                 | $T_A = 55\text{ }^{\circ}\text{C}$                                  | 6.10 | 6.4 |               |
|               |                                      |                                                      |                                 | $T_A = 85\text{ }^{\circ}\text{C}$                                  | 6.30 | 7   |               |

1. No floating I/Os
2. Timer 2 clock enabled and counter running
3. Oscillator bypassed (LSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the LSE consumption ( $I_{DD\text{ LSE}}$ ) must be added. Refer to [Table 29](#)

**Figure 10. Typ.  $I_{DD(LPR)}$  vs.  $V_{DD}$  (LSI clock source)**



In the following table, data is based on characterization results, unless otherwise specified.

**Table 20. Total current consumption in Low power wait mode at  $V_{DD} = 1.8\text{ V}$  to  $3.6\text{ V}$**

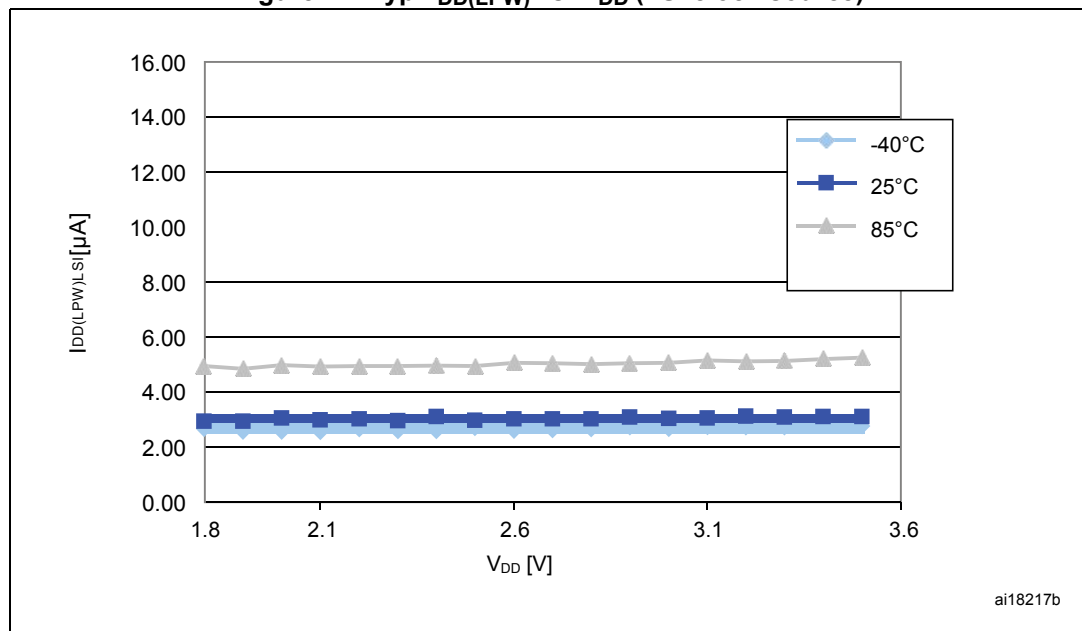
| Symbol        | Parameter                             | Conditions <sup>(1)</sup>                            |                                 |                                         | Typ  | Max  | Unit          |
|---------------|---------------------------------------|------------------------------------------------------|---------------------------------|-----------------------------------------|------|------|---------------|
| $I_{DD(LPW)}$ | Supply current in Low power wait mode | LSI RC osc.<br>(at 38 kHz)                           | all peripherals OFF             | $T_A = -40\text{ °C}$ to $25\text{ °C}$ | 3    | 3.3  | $\mu\text{A}$ |
|               |                                       |                                                      |                                 | $T_A = 55\text{ °C}$                    | 3.3  | 3.6  |               |
|               |                                       |                                                      |                                 | $T_A = 85\text{ °C}$                    | 4.4  | 5    |               |
|               |                                       |                                                      | with TIM2 active <sup>(2)</sup> | $T_A = -40\text{ °C}$ to $25\text{ °C}$ | 3.4  | 3.7  |               |
|               |                                       |                                                      |                                 | $T_A = 55\text{ °C}$                    | 3.7  | 4    |               |
|               |                                       |                                                      |                                 | $T_A = 85\text{ °C}$                    | 4.8  | 5.4  |               |
|               |                                       | LSE external<br>clock <sup>(3)</sup><br>(32.768 kHz) | all peripherals OFF             | $T_A = -40\text{ °C}$ to $25\text{ °C}$ | 2.35 | 2.7  |               |
|               |                                       |                                                      |                                 | $T_A = 55\text{ °C}$                    | 2.42 | 2.82 |               |
|               |                                       |                                                      |                                 | $T_A = 85\text{ °C}$                    | 3.10 | 3.71 |               |
|               |                                       |                                                      | with TIM2 active <sup>(2)</sup> | $T_A = -40\text{ °C}$ to $25\text{ °C}$ | 2.46 | 2.75 |               |
|               |                                       |                                                      |                                 | $T_A = 55\text{ °C}$                    | 2.50 | 2.81 |               |
|               |                                       |                                                      |                                 | $T_A = 85\text{ °C}$                    | 3.16 | 3.82 |               |

1. No floating I/Os.

2. Timer 2 clock enabled and counter is running.

3. Oscillator bypassed (LSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the LSE consumption ( $I_{DD\text{ LSE}}$ ) must be added. Refer to [Table 29](#).

**Figure 11. Typ.  $I_{DD(LPW)}$  vs.  $V_{DD}$  (LSI clock source)**





In the following table, data is based on characterization results, unless otherwise specified.

**Table 21. Total current consumption and timing in Active-halt mode at  $V_{DD} = 1.8\text{ V}$  to  $3.6\text{ V}$**

| Symbol                     | Parameter                                                           | Conditions <sup>(1)</sup>                      |                                         | Typ  | Max | Unit          |
|----------------------------|---------------------------------------------------------------------|------------------------------------------------|-----------------------------------------|------|-----|---------------|
| $I_{DD(AH)}$               | Supply current in Active-halt mode                                  | LSI RC (at 38 kHz)                             | $T_A = -40\text{ °C}$ to $25\text{ °C}$ | 0.9  | 2.1 | $\mu\text{A}$ |
|                            |                                                                     |                                                | $T_A = 55\text{ °C}$                    | 1.2  | 3   |               |
|                            |                                                                     |                                                | $T_A = 85\text{ °C}$                    | 1.5  | 3.4 |               |
|                            |                                                                     | LSE external clock (32.768 kHz) <sup>(2)</sup> | $T_A = -40\text{ °C}$ to $25\text{ °C}$ | 0.5  | 1.2 |               |
|                            |                                                                     |                                                | $T_A = 55\text{ °C}$                    | 0.62 | 1.4 |               |
|                            |                                                                     |                                                | $T_A = 85\text{ °C}$                    | 0.88 | 2.1 |               |
| $I_{DD(WUFAH)}$            | Supply current during wakeup time from Active-halt mode (using HSI) | -                                              | -                                       | 2.4  | -   | mA            |
| $t_{WU\_HSI(AH)}^{(3)(4)}$ | Wakeup time from Active-halt mode to Run mode (using HSI)           | -                                              | -                                       | 4.7  | 7   | $\mu\text{s}$ |
| $t_{WU\_LSI(AH)}^{(3)(4)}$ | Wakeup time from Active-halt mode to Run mode (using LSI)           | -                                              | -                                       | 150  | -   | $\mu\text{s}$ |

1. No floating I/O, unless otherwise specified.
2. Oscillator bypassed (LSEBYP = 1 in CLK\_ECKCR). When configured for external crystal, the LSE consumption ( $I_{DD\text{ LSE}}$ ) must be added. Refer to [Table 29](#).
3. Wakeup time until start of interrupt vector fetch.  
The first word of interrupt routine is fetched 4 CPU cycles after  $t_{WU}$ .
4. ULP=0 or ULP=1 and FWU=1 in the PWR\_CSR2 register.

**Table 22. Typical current consumption in Active-halt mode, RTC clocked by LSE external crystal**

| Symbol             | Parameter                          | Condition <sup>(1)</sup> |                       | Typ  | Unit          |
|--------------------|------------------------------------|--------------------------|-----------------------|------|---------------|
| $I_{DD(AH)}^{(2)}$ | Supply current in Active-halt mode | $V_{DD} = 1.8\text{ V}$  | LSE                   | 1.15 | $\mu\text{A}$ |
|                    |                                    |                          | LSE/32 <sup>(3)</sup> | 1.05 |               |
|                    |                                    | $V_{DD} = 3\text{ V}$    | LSE                   | 1.30 |               |
|                    |                                    |                          | LSE/32 <sup>(3)</sup> | 1.20 |               |
|                    |                                    | $V_{DD} = 3.6\text{ V}$  | LSE                   | 1.45 |               |
|                    |                                    |                          | LSE/32 <sup>(3)</sup> | 1.35 |               |

1. No floating I/O, unless otherwise specified.
2. Based on measurements on bench with 32.768 kHz external crystal oscillator.
3. RTC clock is LSE divided by 32.

In the following table, data is based on characterization results, unless otherwise specified.

**Table 23. Total current consumption and timing in Halt mode at  $V_{DD} = 1.8$  to  $3.6$  V**

| Symbol                       | Parameter                                                                         | Condition <sup>(1)</sup>                                            | Typ  | Max                 | Unit          |
|------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------|------|---------------------|---------------|
| $I_{DD(Halt)}$               | Supply current in Halt mode (Ultra-low-power ULP bit =1 in the PWR_CSR2 register) | $T_A = -40\text{ }^{\circ}\text{C}$ to $25\text{ }^{\circ}\text{C}$ | 350  | 1400 <sup>(2)</sup> | nA            |
|                              |                                                                                   | $T_A = 55\text{ }^{\circ}\text{C}$                                  | 580  | 2000                |               |
|                              |                                                                                   | $T_A = 85\text{ }^{\circ}\text{C}$                                  | 1160 | 2800 <sup>(2)</sup> |               |
| $I_{DD(WUHalt)}$             | Supply current during wakeup time from Halt mode (using HSI)                      | -                                                                   | 2.4  | -                   | mA            |
| $t_{WU\_HSI(Halt)}^{(3)(4)}$ | Wakeup time from Halt to Run mode (using HSI)                                     | -                                                                   | 4.7  | 7                   | $\mu\text{s}$ |
| $t_{WU\_LSI(Halt)}^{(3)(4)}$ | Wakeup time from Halt mode to Run mode (using LSI)                                | -                                                                   | 150  | -                   | $\mu\text{s}$ |

- $T_A = -40$  to  $85\text{ }^{\circ}\text{C}$ , no floating I/O, unless otherwise specified.
- Tested in production.
- ULP=0 or ULP=1 and FWU=1 in the PWR\_CSR2 register.
- Wakeup time until start of interrupt vector fetch.  
The first word of interrupt routine is fetched 4 CPU cycles after  $t_{WU}$ .

## Current consumption of on-chip peripherals

Table 24. Peripheral current consumption

| Symbol                    | Parameter                                                                    |                              | Typ.<br>V <sub>DD</sub> = 3.0 V | Unit   |
|---------------------------|------------------------------------------------------------------------------|------------------------------|---------------------------------|--------|
| I <sub>DD</sub> (TIM2)    | TIM2 supply current <sup>(1)</sup>                                           |                              | 8                               | μA/MHz |
| I <sub>DD</sub> (TIM3)    | TIM3 supply current <sup>(1)</sup>                                           |                              | 8                               |        |
| I <sub>DD</sub> (TIM4)    | TIM4 timer supply current <sup>(1)</sup>                                     |                              | 3                               |        |
| I <sub>DD</sub> (USART1)  | USART1 supply current <sup>(2)</sup>                                         |                              | 6                               |        |
| I <sub>DD</sub> (SPI1)    | SPI1 supply current <sup>(2)</sup>                                           |                              | 3                               |        |
| I <sub>DD</sub> (I2C1)    | I2C1 supply current <sup>(2)</sup>                                           |                              | 5                               |        |
| I <sub>DD</sub> (DMA1)    | DMA1 supply current <sup>(2)</sup>                                           |                              | 3                               |        |
| I <sub>DD</sub> (WWDG)    | WWDG supply current <sup>(2)</sup>                                           |                              | 2                               | μA/MHz |
| I <sub>DD</sub> (ALL)     | Peripherals ON <sup>(3)</sup>                                                |                              | 44                              |        |
| I <sub>DD</sub> (ADC1)    | ADC1 supply current <sup>(4)</sup>                                           |                              | 1500                            | μA     |
| I <sub>DD</sub> (COMP1)   | Comparator 1 supply current <sup>(5)</sup>                                   |                              | 0.160                           |        |
| I <sub>DD</sub> (COMP2)   | Comparator 2 supply current <sup>(5)</sup>                                   | Slow mode                    | 2                               |        |
|                           |                                                                              | Fast mode                    | 5                               |        |
| I <sub>DD</sub> (PVD/BOR) | Power voltage detector and brownout Reset unit supply current <sup>(6)</sup> |                              | 2.6                             |        |
| I <sub>DD</sub> (BOR)     | Brownout Reset unit supply current <sup>(6)</sup>                            |                              | 2.4                             |        |
| I <sub>DD</sub> (IDWDG)   | Independent watchdog supply current                                          | including LSI supply current | 0.45                            |        |
|                           |                                                                              | excluding LSI supply current | 0.05                            |        |

1. Data based on a differential I<sub>DD</sub> measurement between all peripherals OFF and a timer counter running at 16 MHz. The CPU is in Wait mode in both cases. No IC/OC programmed, no I/O pins toggling. Not tested in production.
2. Data based on a differential I<sub>DD</sub> measurement between the on-chip peripheral in reset configuration and not clocked and the on-chip peripheral when clocked and not kept under reset. The CPU is in Wait mode in both cases. No I/O pins toggling. Not tested in production.
3. Peripherals listed above the I<sub>DD</sub>(ALL) parameter ON: TIM1, TIM2, TIM3, TIM4, USART1, SPI1, I2C1, DMA1, WWDG.
4. Data based on a differential I<sub>DD</sub> measurement between ADC in reset configuration and continuous ADC conversion.
5. Data based on a differential I<sub>DD</sub> measurement between COMP1 or COMP2 in reset configuration and COMP1 or COMP2 enabled with static inputs. Supply current of internal reference voltage excluded.
6. Including supply current of internal reference voltage.

Table 25. Current consumption under external reset

| Symbol               | Parameter                                          | Conditions                                      |                         | Typ | Unit |
|----------------------|----------------------------------------------------|-------------------------------------------------|-------------------------|-----|------|
| I <sub>DD(RST)</sub> | Supply current under external reset <sup>(1)</sup> | All pins are externally tied to V <sub>DD</sub> | V <sub>DD</sub> = 1.8 V | 48  | μA   |
|                      |                                                    |                                                 | V <sub>DD</sub> = 3 V   | 76  |      |
|                      |                                                    |                                                 | V <sub>DD</sub> = 3.6 V | 91  |      |

1. All pins except PA0, PB0 and PB4 are floating under reset. PA0, PB0 and PB4 are configured with pull-up under reset.

### 8.3.4 Clock and timing characteristics

#### HSE external clock (HSEBYP = 1 in CLK\_ECKCR)

Subject to general operating conditions for  $V_{DD}$  and  $T_A$ .

Table 26. HSE external clock characteristics

| Symbol          | Parameter                                      | Conditions                 | Min                 | Typ | Max                 | Unit          |
|-----------------|------------------------------------------------|----------------------------|---------------------|-----|---------------------|---------------|
| $f_{HSE\_ext}$  | External clock source frequency <sup>(1)</sup> | -                          | 1                   | -   | 16                  | MHz           |
| $V_{HSEH}$      | OSC_IN input pin high level voltage            | -                          | $0.7 \times V_{DD}$ | -   | $V_{DD}$            | V             |
| $V_{HSEL}$      | OSC_IN input pin low level voltage             | -                          | $V_{SS}$            | -   | $0.3 \times V_{DD}$ |               |
| $C_{in(HSE)}$   | OSC_IN input capacitance <sup>(1)</sup>        | -                          | -                   | 2.6 | -                   | pF            |
| $I_{LEAK\_HSE}$ | OSC_IN input leakage current                   | $V_{SS} < V_{IN} < V_{DD}$ | -                   | -   | $\pm 1$             | $\mu\text{A}$ |

1. Guaranteed by design.

#### LSE external clock (LSEBYP=1 in CLK\_ECKCR)

Subject to general operating conditions for  $V_{DD}$  and  $T_A$ .

Table 27. LSE external clock characteristics

| Symbol           | Parameter                                      | Min                 | Typ    | Max                 | Unit          |
|------------------|------------------------------------------------|---------------------|--------|---------------------|---------------|
| $f_{LSE\_ext}$   | External clock source frequency <sup>(1)</sup> | -                   | 32.768 | -                   | kHz           |
| $V_{LSEH}^{(2)}$ | OSC32_IN input pin high level voltage          | $0.7 \times V_{DD}$ | -      | $V_{DD}$            | V             |
| $V_{LSEL}^{(2)}$ | OSC32_IN input pin low level voltage           | $V_{SS}$            | -      | $0.3 \times V_{DD}$ |               |
| $C_{in(LSE)}$    | OSC32_IN input capacitance <sup>(1)</sup>      | -                   | 0.6    | -                   | pF            |
| $I_{LEAK\_LSE}$  | OSC32_IN input leakage current                 | -                   | -      | $\pm 1$             | $\mu\text{A}$ |

1. Guaranteed by design.

2. Guaranteed by characterization results.

### HSE crystal/ceramic resonator oscillator

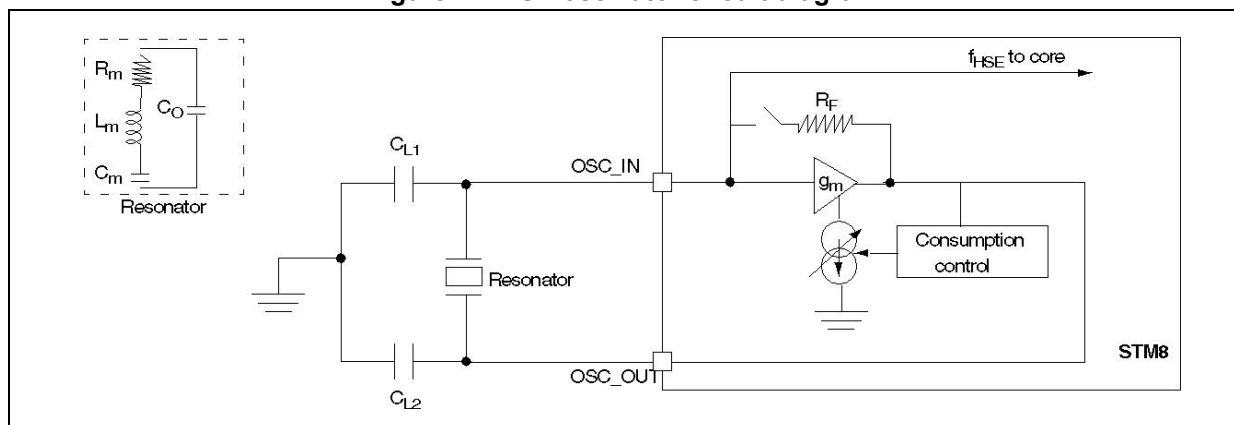
The HSE clock can be supplied with a 1 to 16 MHz crystal/ceramic resonator oscillator. All the information given in this paragraph is based on characterization results with specified typical external components. In the application, the resonator and the load capacitors have to be placed as close as possible to the oscillator pins in order to minimize output distortion and startup stabilization time. Refer to the crystal resonator manufacturer for more details (frequency, package, accuracy...).

**Table 28. HSE oscillator characteristics**

| Symbol              | Parameter                                   | Conditions                         | Min                | Typ | Max                                               | Unit       |
|---------------------|---------------------------------------------|------------------------------------|--------------------|-----|---------------------------------------------------|------------|
| $f_{HSE}$           | High speed external oscillator frequency    | -                                  | 1                  | -   | 16                                                | MHz        |
| $R_F$               | Feedback resistor                           | -                                  | -                  | 200 | -                                                 | k $\Omega$ |
| $C^{(1)}$           | Recommended load capacitance <sup>(2)</sup> | -                                  | -                  | 20  | -                                                 | pF         |
| $I_{DD(HSE)}$       | HSE oscillator power consumption            | $C = 20$ pF,<br>$f_{OSC} = 16$ MHz | -                  | -   | 2.5 (startup)<br>0.7 (stabilized) <sup>(3)</sup>  | mA         |
|                     |                                             | $C = 10$ pF,<br>$f_{OSC} = 16$ MHz | -                  | -   | 2.5 (startup)<br>0.46 (stabilized) <sup>(3)</sup> |            |
| $g_m$               | Oscillator transconductance                 | -                                  | 3.5 <sup>(3)</sup> | -   | -                                                 | mA/V       |
| $t_{SU(HSE)}^{(4)}$ | Startup time                                | $V_{DD}$ is stabilized             | -                  | 1   | -                                                 | ms         |

1.  $C=C_{L1}=C_{L2}$  is approximately equivalent to  $2 \times$  crystal  $C_{LOAD}$ .
2. The oscillator selection can be optimized in terms of supply current using a high quality resonator with small  $R_m$  value. Refer to crystal manufacturer for more details
3. Guaranteed by design.
4.  $t_{SU(HSE)}$  is the startup time measured from the moment it is enabled (by software) to a stabilized 16 MHz oscillation. This value is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.

**Figure 12. HSE oscillator circuit diagram**



### HSE oscillator critical $g_m$ formula

$$g_{mcrit} = (2 \times \pi \times f_{HSE})^2 \times R_m(2C_o + C)^2$$

$R_m$ : Motional resistance (see crystal specification),  $L_m$ : Motional inductance (see crystal specification),  
 $C_m$ : Motional capacitance (see crystal specification),  $C_o$ : Shunt capacitance (see crystal specification),  
 $C_{L1}=C_{L2}=C$ : Grounded external capacitance  
 $g_m \gg g_{mcrit}$

### LSE crystal/ceramic resonator oscillator

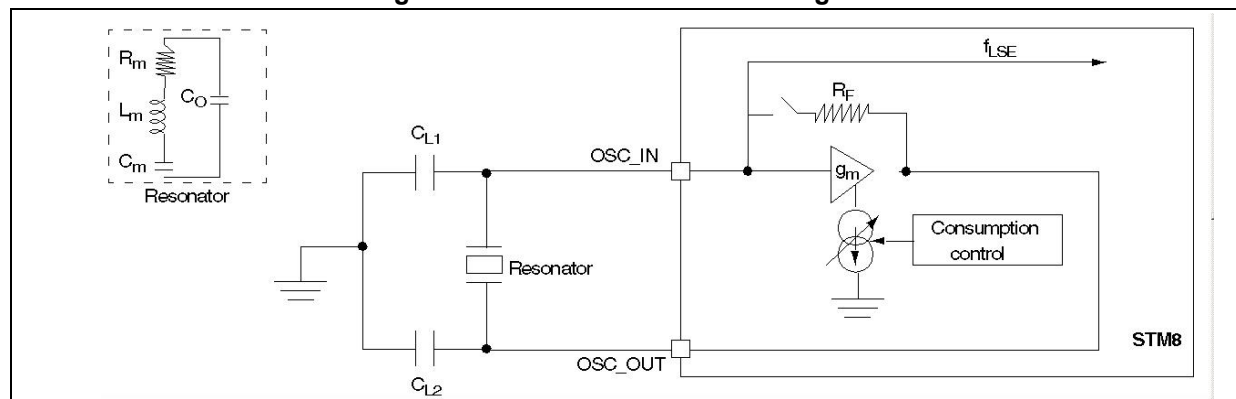
The LSE clock can be supplied with a 32.768 kHz crystal/ceramic resonator oscillator. All the information given in this paragraph is based on characterization results with specified typical external components. In the application, the resonator and the load capacitors have to be placed as close as possible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

**Table 29. LSE oscillator characteristics**

| Symbol              | Parameter                                   | Conditions                  | Min              | Typ    | Max                | Unit            |
|---------------------|---------------------------------------------|-----------------------------|------------------|--------|--------------------|-----------------|
| $f_{LSE}$           | Low speed external oscillator frequency     | -                           | -                | 32.768 | -                  | kHz             |
| $R_F$               | Feedback resistor                           | $\Delta V = 200 \text{ mV}$ | -                | 1.2    | -                  | M $\Omega$      |
| $C^{(1)}$           | Recommended load capacitance <sup>(2)</sup> | -                           | -                | 8      | -                  | pF              |
| $I_{DD(LSE)}$       | LSE oscillator power consumption            | -                           | -                | -      | 1.4 <sup>(3)</sup> | $\mu\text{A}$   |
|                     |                                             | $V_{DD} = 1.8 \text{ V}$    | -                | 450    | -                  | nA              |
|                     |                                             | $V_{DD} = 3 \text{ V}$      | -                | 600    | -                  |                 |
|                     |                                             | $V_{DD} = 3.6 \text{ V}$    | -                | 750    | -                  |                 |
| $g_m$               | Oscillator transconductance                 | -                           | 3 <sup>(3)</sup> | -      | -                  | $\mu\text{A/V}$ |
| $t_{SU(LSE)}^{(4)}$ | Startup time                                | $V_{DD}$ is stabilized      | -                | 1      | -                  | s               |

1.  $C=C_{L1}=C_{L2}$  is approximately equivalent to  $2 \times \text{crystal } C_{LOAD}$ .
2. The oscillator selection can be optimized in terms of supply current using a high quality resonator with a small  $R_m$  value. Refer to crystal manufacturer for more details.
3. Guaranteed by design.
4.  $t_{SU(LSE)}$  is the startup time measured from the moment it is enabled (by software) to a stabilized 32.768 kHz oscillation. This value is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.

**Figure 13. LSE oscillator circuit diagram**



### Internal clock sources

Subject to general operating conditions for  $V_{DD}$ , and  $T_A$ .

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

In the following table, data is based on characterization results, not tested in production, unless otherwise specified.

**Table 30. HSI oscillator characteristics**

| Symbol        | Parameter                                       | Conditions <sup>(1)</sup>                                                                                                | Min                       | Typ | Max                | Unit          |
|---------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------|-----|--------------------|---------------|
| $f_{HSI}$     | Frequency                                       | $V_{DD} = 3.0\text{ V}$                                                                                                  | -                         | 16  | -                  | MHz           |
| $ACC_{HSI}$   | Accuracy of HSI oscillator (factory calibrated) | $V_{DD} = 3.0\text{ V}$ , $T_A = 25\text{ }^{\circ}\text{C}$                                                             | -1 <sup>(2)</sup><br>-2.5 | -   | 1 <sup>(2)</sup>   | %             |
|               |                                                 | $1.8\text{ V} \leq V_{DD} \leq 3.6\text{ V}$ ,<br>$-40\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$ | -5                        | -   | 5                  | %             |
| TRIM          | HSI user trimming step <sup>(3)</sup>           | Trimming code $\neq$ multiple of 16                                                                                      | -                         | 0.4 | 0.7                | %             |
|               |                                                 | Trimming code = multiple of 16                                                                                           | -                         | -   | $\pm 1.5$          | %             |
| $t_{su(HSI)}$ | HSI oscillator setup time (wakeup time)         | -                                                                                                                        | -                         | 3.7 | 6 <sup>(4)</sup>   | $\mu\text{s}$ |
| $I_{DD(HSI)}$ | HSI oscillator power consumption                | -                                                                                                                        | -                         | 100 | 140 <sup>(4)</sup> | $\mu\text{A}$ |

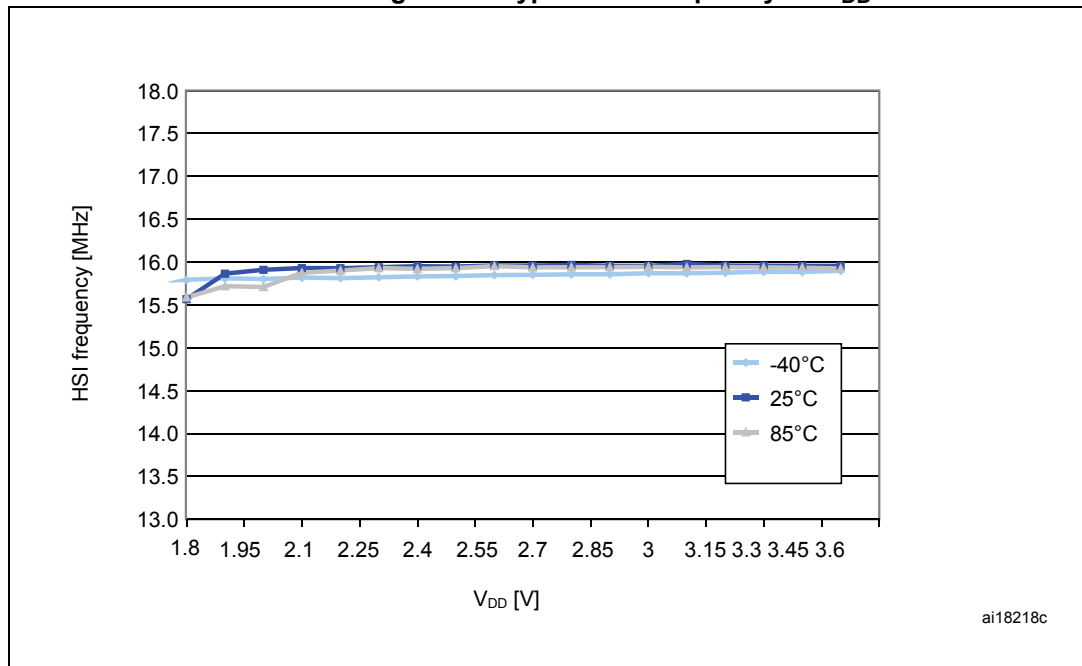
1.  $V_{DD} = 3.0\text{ V}$ ,  $T_A = -40\text{ to }85\text{ }^{\circ}\text{C}$  unless otherwise specified.

2. Tested in production.

3. The trimming step differs depending on the trimming code. It is usually negative on the codes which are multiples of 16 (0x00, 0x10, 0x20, 0x30...0xE0). Refer to the AN3101 "STM8L15x internal RC oscillator calibration" application note for more details.

4. Guaranteed by design.

**Figure 14. Typical HSI frequency vs  $V_{DD}$**



**Low speed internal RC oscillator (LSI)**

In the following table, data is based on characterization results, not tested in production.

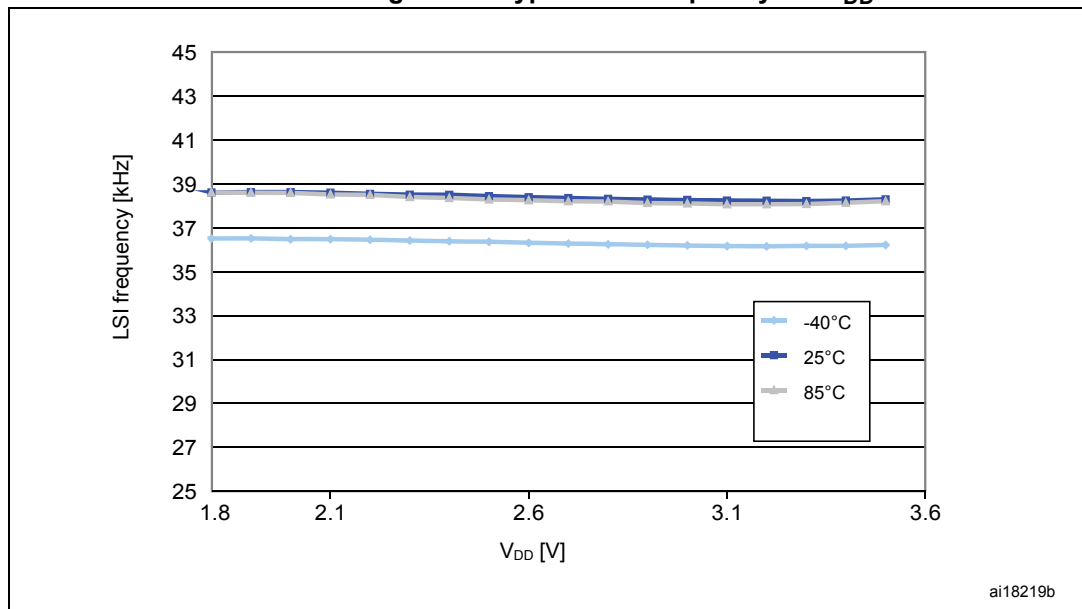
**Table 31. LSI oscillator characteristics**

| Symbol               | Parameter <sup>(1)</sup>                      | Conditions <sup>(1)</sup>                                            | Min | Typ | Max                | Unit          |
|----------------------|-----------------------------------------------|----------------------------------------------------------------------|-----|-----|--------------------|---------------|
| $f_{\text{LSI}}$     | Frequency                                     | -                                                                    | 26  | 38  | 56                 | kHz           |
| $t_{\text{su(LSI)}}$ | LSI oscillator wakeup time                    | -                                                                    | -   | -   | 200 <sup>(2)</sup> | $\mu\text{s}$ |
| $I_{\text{DD(LSI)}}$ | LSI oscillator frequency drift <sup>(3)</sup> | $0\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$ | -12 | -   | 11                 | %             |

1.  $V_{\text{DD}} = 1.8\text{ V to }3.6\text{ V}$ ,  $T_A = -40\text{ to }85\text{ }^{\circ}\text{C}$  unless otherwise specified.

2. Guaranteed by design.

3. This is a deviation for an individual part, once the initial frequency has been measured.

**Figure 15. Typical LSI frequency vs.  $V_{\text{DD}}$** 



### 8.3.5 Memory characteristics

$T_A = -40$  to  $85\text{ }^{\circ}\text{C}$  unless otherwise specified.

**Table 32. RAM and hardware registers**

| Symbol   | Parameter                          | Conditions           | Min | Typ | Max | Unit |
|----------|------------------------------------|----------------------|-----|-----|-----|------|
| $V_{RM}$ | Data retention mode <sup>(1)</sup> | Halt mode (or Reset) | 1.8 | -   | -   | V    |

1. Minimum supply voltage without losing data stored in RAM (in Halt mode or under Reset) or in hardware registers (only in Halt mode). Guaranteed by characterization.

### Flash memory

**Table 33. Flash program and data EEPROM memory**

| Symbol          | Parameter                                                                                                       | Conditions                                                    | Min                       | Typ | Max<br>(1) | Unit    |
|-----------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------------|-----|------------|---------|
| $V_{DD}$        | Operating voltage<br>(all modes, read/write/erase)                                                              | $f_{SYSCLK} = 16\text{ MHz}$                                  | 1.8                       |     | 3.6        | V       |
| $t_{prog}$      | Programming time for 1 or 64 bytes (block)<br>erase/write cycles (on programmed byte)                           |                                                               |                           | 6   |            | ms      |
|                 | Programming time for 1 to 64 bytes (block)<br>write cycles (on erased byte)                                     |                                                               |                           | 3   |            | ms      |
| $I_{prog}$      | Programming/ erasing consumption                                                                                | $T_A = +25\text{ }^{\circ}\text{C}$ , $V_{DD} = 3.0\text{ V}$ |                           | 0.7 |            | mA      |
|                 |                                                                                                                 | $T_A = +25\text{ }^{\circ}\text{C}$ , $V_{DD} = 1.8\text{ V}$ |                           |     |            |         |
| $t_{RET}^{(2)}$ | Data retention (program memory) after 100<br>erase/write cycles at $T_A = -40$ to $+85\text{ }^{\circ}\text{C}$ | $T_{RET} = +85\text{ }^{\circ}\text{C}$                       | 30 <sup>(1)</sup>         |     |            | years   |
|                 | Data retention (data memory) after 100000<br>erase/write cycles at $T_A = -40$ to $+85\text{ }^{\circ}\text{C}$ | $T_{RET} = +85\text{ }^{\circ}\text{C}$                       | 30 <sup>(1)</sup>         |     |            |         |
| $N_{RW}^{(3)}$  | Erase/write cycles (program memory)                                                                             | $T_A = -40$ to $+85\text{ }^{\circ}\text{C}$                  | 100 <sup>(1)</sup>        |     |            | cycles  |
|                 | Erase/write cycles (data memory)                                                                                |                                                               | 100 <sup>(1)</sup><br>(4) |     |            | kcycles |

1. Guaranteed by characterization results.

2. Conforming to JEDEC JESD22a117

3. The physical granularity of the memory is 4 bytes, so cycling is performed on 4 bytes even when a write/erase operation addresses a single byte.

4. Data based on characterization performed on the whole data memory.

### 8.3.6 I/O current injection characteristics

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

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

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

The failure is indicated by an out of range parameter: ADC error, out of spec current injection on adjacent pins or other functional failure (for example reset, oscillator frequency deviation, LCD levels, etc.).

The test results are given in the following table.

**Table 34. I/O current injection susceptibility**

| Symbol    | Description                                            | Functional susceptibility |                    | Unit |
|-----------|--------------------------------------------------------|---------------------------|--------------------|------|
|           |                                                        | Negative injection        | Positive injection |      |
| $I_{INJ}$ | Injected current on true open-drain pins (PC0 and PC1) | -5                        | +0                 | mA   |
|           | Injected current on all five-volt tolerant (FT) pins   | -5                        | +0                 |      |
|           | Injected current on all 3.6 V tolerant (TT) pins       | -5                        | +0                 |      |
|           | Injected current on any other pin                      | -5                        | +5                 |      |

### 8.3.7 I/O port pin characteristics

#### General characteristics

Subject to general operating conditions for  $V_{DD}$  and  $T_A$  unless otherwise specified. All unused pins must be kept at a fixed voltage: using the output mode of the I/O for example or an external pull-up or pull-down resistor.

Table 35. I/O static characteristics

| Symbol    | Parameter                                          | Conditions <sup>(1)</sup>                                                          | Min                  | Typ | Max                 | Unit       |
|-----------|----------------------------------------------------|------------------------------------------------------------------------------------|----------------------|-----|---------------------|------------|
| $V_{IL}$  | Input low level voltage <sup>(2)</sup>             | Input voltage on true open-drain pins (PC0 and PC1)                                | $V_{SS}-0.3$         |     | $0.3 \times V_{DD}$ | V          |
|           |                                                    | Input voltage on five-volt tolerant (FT) pins (PA7 and PE0)                        | $V_{SS}-0.3$         |     | $0.3 \times V_{DD}$ |            |
|           |                                                    | Input voltage on 3.6 V tolerant (TT) pins                                          | $V_{SS}-0.3$         |     | $0.3 \times V_{DD}$ |            |
|           |                                                    | Input voltage on any other pin                                                     | $V_{SS}-0.3$         |     | $0.3 \times V_{DD}$ |            |
| $V_{IH}$  | Input high level voltage <sup>(2)</sup>            | Input voltage on true open-drain pins (PC0 and PC1) with $V_{DD} < 2$ V            | $0.70 \times V_{DD}$ |     | 5.2                 | V          |
|           |                                                    | Input voltage on true open-drain pins (PC0 and PC1) with $V_{DD} \geq 2$ V         |                      |     | 5.5                 |            |
|           |                                                    | Input voltage on five-volt tolerant (FT) pins (PA7 and PE0) with $V_{DD} < 2$ V    | $0.70 \times V_{DD}$ |     | 5.2                 |            |
|           |                                                    | Input voltage on five-volt tolerant (FT) pins (PA7 and PE0) with $V_{DD} \geq 2$ V |                      |     | 5.5                 |            |
|           |                                                    | Input voltage on 3.6 V tolerant (TT) pins                                          |                      |     | 3.6                 |            |
|           |                                                    | Input voltage on any other pin                                                     | $0.70 \times V_{DD}$ |     | $V_{DD}+0.3$        |            |
| $V_{hys}$ | Schmitt trigger voltage hysteresis <sup>(3)</sup>  | I/Os                                                                               |                      | 200 |                     | mV         |
|           |                                                    | True open drain I/Os                                                               |                      | 200 |                     |            |
| $I_{lkg}$ | Input leakage current <sup>(4)</sup>               | $V_{SS} \leq V_{IN} \leq V_{DD}$<br>High sink I/Os                                 | -                    | -   | 50 <sup>(5)</sup>   | nA         |
|           |                                                    | $V_{SS} \leq V_{IN} \leq V_{DD}$<br>True open drain I/Os                           | -                    | -   | 200 <sup>(5)</sup>  |            |
|           |                                                    | $V_{SS} \leq V_{IN} \leq V_{DD}$<br>PA0 with high sink LED driver capability       | -                    | -   | 200 <sup>(5)</sup>  |            |
| $R_{PU}$  | Weak pull-up equivalent resistor <sup>(2)(6)</sup> | $V_{IN} = V_{SS}$                                                                  | 30                   | 45  | 60                  | k $\Omega$ |
| $C_{IO}$  | I/O pin capacitance                                |                                                                                    |                      | 5   |                     | pF         |

1.  $V_{DD} = 3.0$  V,  $T_A = -40$  to  $85$  °C unless otherwise specified.

2. Guaranteed by characterization results.

3. Hysteresis voltage between Schmitt trigger switching levels. Based on characterization results, not tested.

4. The max. value may be exceeded if negative current is injected on adjacent pins.

5. Not tested in production.

6.  $R_{PU}$  pull-up equivalent resistor based on a resistive transistor (corresponding  $I_{PU}$  current characteristics described in [Figure 19](#)).

Figure 16. Typical  $V_{IL}$  and  $V_{IH}$  vs  $V_{DD}$  (high sink I/Os)

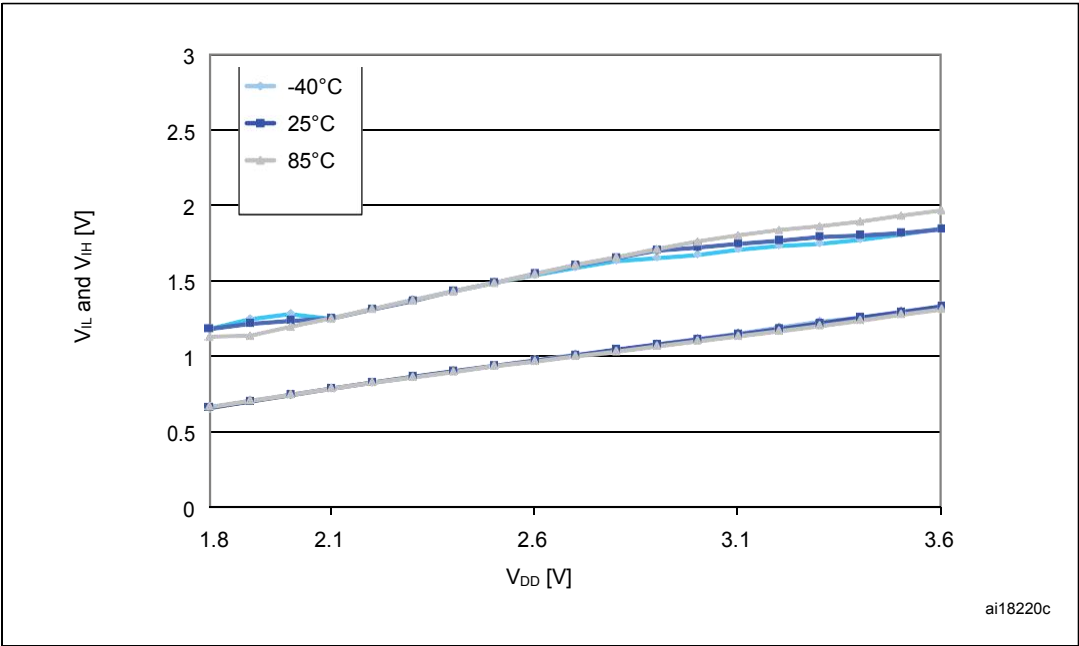


Figure 17. Typical  $V_{IL}$  and  $V_{IH}$  vs  $V_{DD}$  (true open drain I/Os)

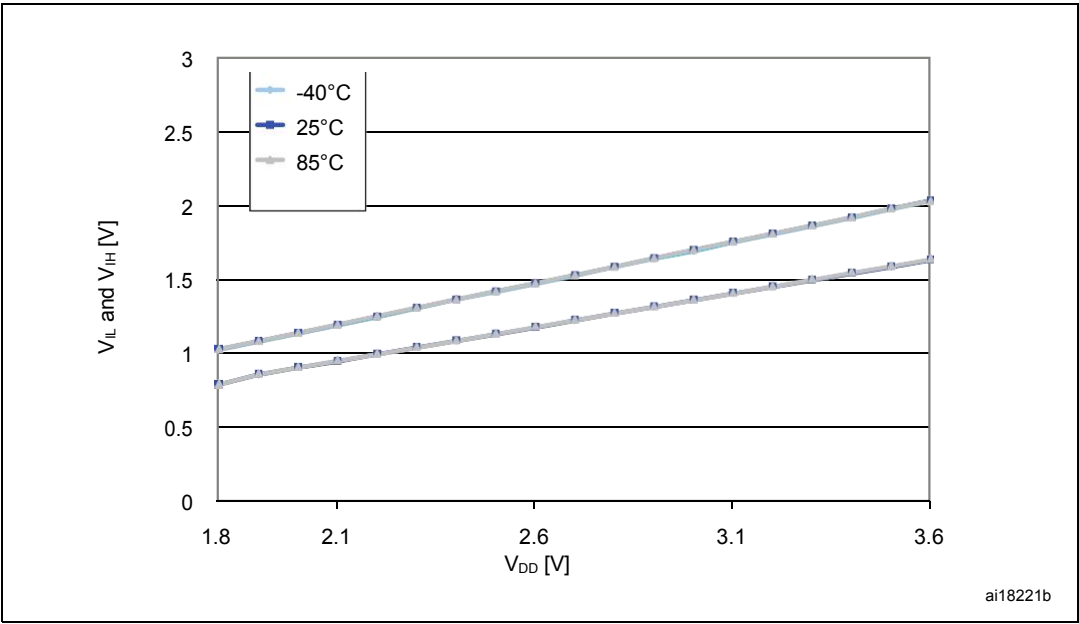


Figure 18. Typical pull-up resistance  $R_{PU}$  vs  $V_{DD}$  with  $V_{IN}=V_{SS}$

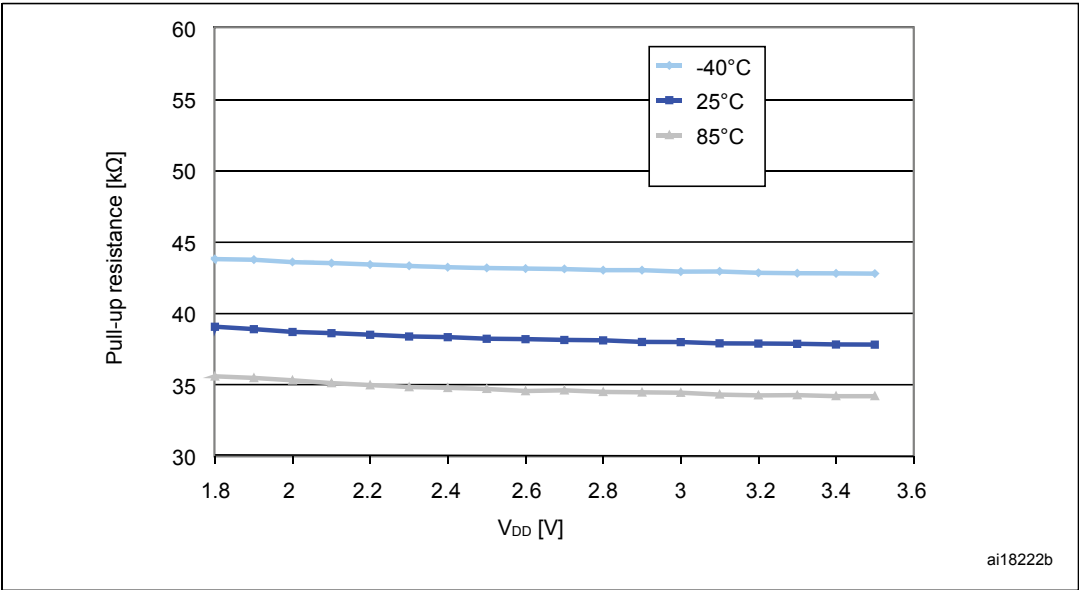
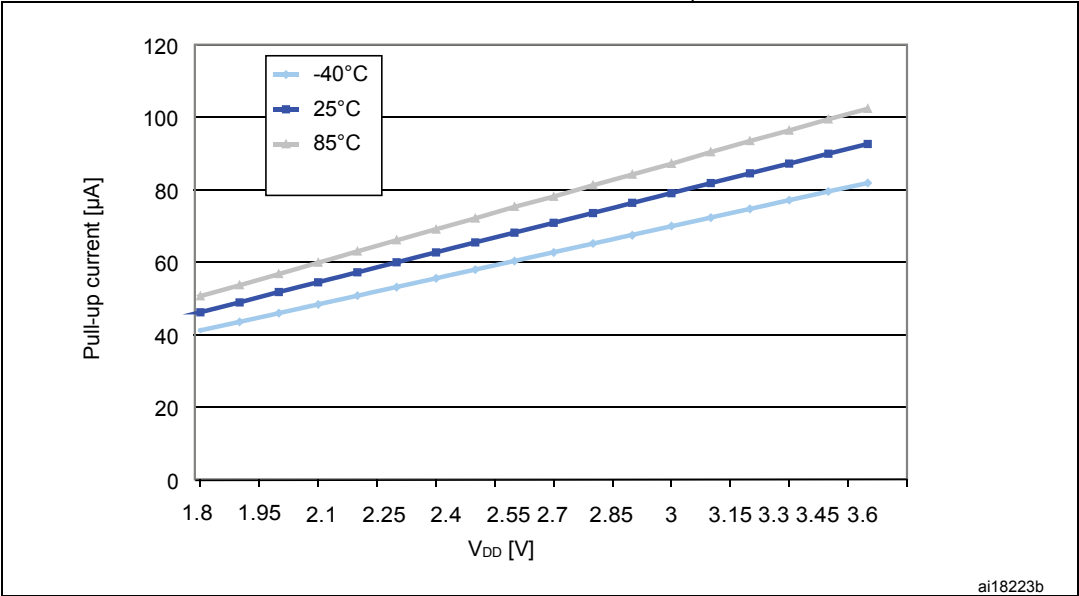


Figure 19. Typical pull-up current  $I_{pu}$  vs  $V_{DD}$  with  $V_{IN}=V_{SS}$



**Output driving current**

Subject to general operating conditions for  $V_{DD}$  and  $T_A$  unless otherwise specified.

**Table 36. Output driving current (high sink ports)**

| I/O Type  | Symbol         | Parameter                                | Conditions                                              | Min           | Max  | Unit |
|-----------|----------------|------------------------------------------|---------------------------------------------------------|---------------|------|------|
| High sink | $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin  | $I_{IO} = +2 \text{ mA}$ ,<br>$V_{DD} = 3.0 \text{ V}$  | -             | 0.45 | V    |
|           |                |                                          | $I_{IO} = +2 \text{ mA}$ ,<br>$V_{DD} = 1.8 \text{ V}$  | -             | 0.45 | V    |
|           |                |                                          | $I_{IO} = +10 \text{ mA}$ ,<br>$V_{DD} = 3.0 \text{ V}$ | -             | 0.7  | V    |
|           | $V_{OH}^{(2)}$ | Output high level voltage for an I/O pin | $I_{IO} = -2 \text{ mA}$ ,<br>$V_{DD} = 3.0 \text{ V}$  | $V_{DD}-0.45$ | -    | V    |
|           |                |                                          | $I_{IO} = -1 \text{ mA}$ ,<br>$V_{DD} = 1.8 \text{ V}$  | $V_{DD}-0.45$ | -    | V    |
|           |                |                                          | $I_{IO} = -10 \text{ mA}$ ,<br>$V_{DD} = 3.0 \text{ V}$ | $V_{DD}-0.7$  | -    | V    |

1. The  $I_{IO}$  current sunk must always respect the absolute maximum rating specified in [Table 13: Current characteristics](#) and the sum of  $I_{IO}$  (I/O ports and control pins) must not exceed  $I_{VSS}$ .
2. The  $I_{IO}$  current sourced must always respect the absolute maximum rating specified in [Table 13: Current characteristics](#) and the sum of  $I_{IO}$  (I/O ports and control pins) must not exceed  $I_{VDD}$ .

**Table 37. Output driving current (true open drain ports)**

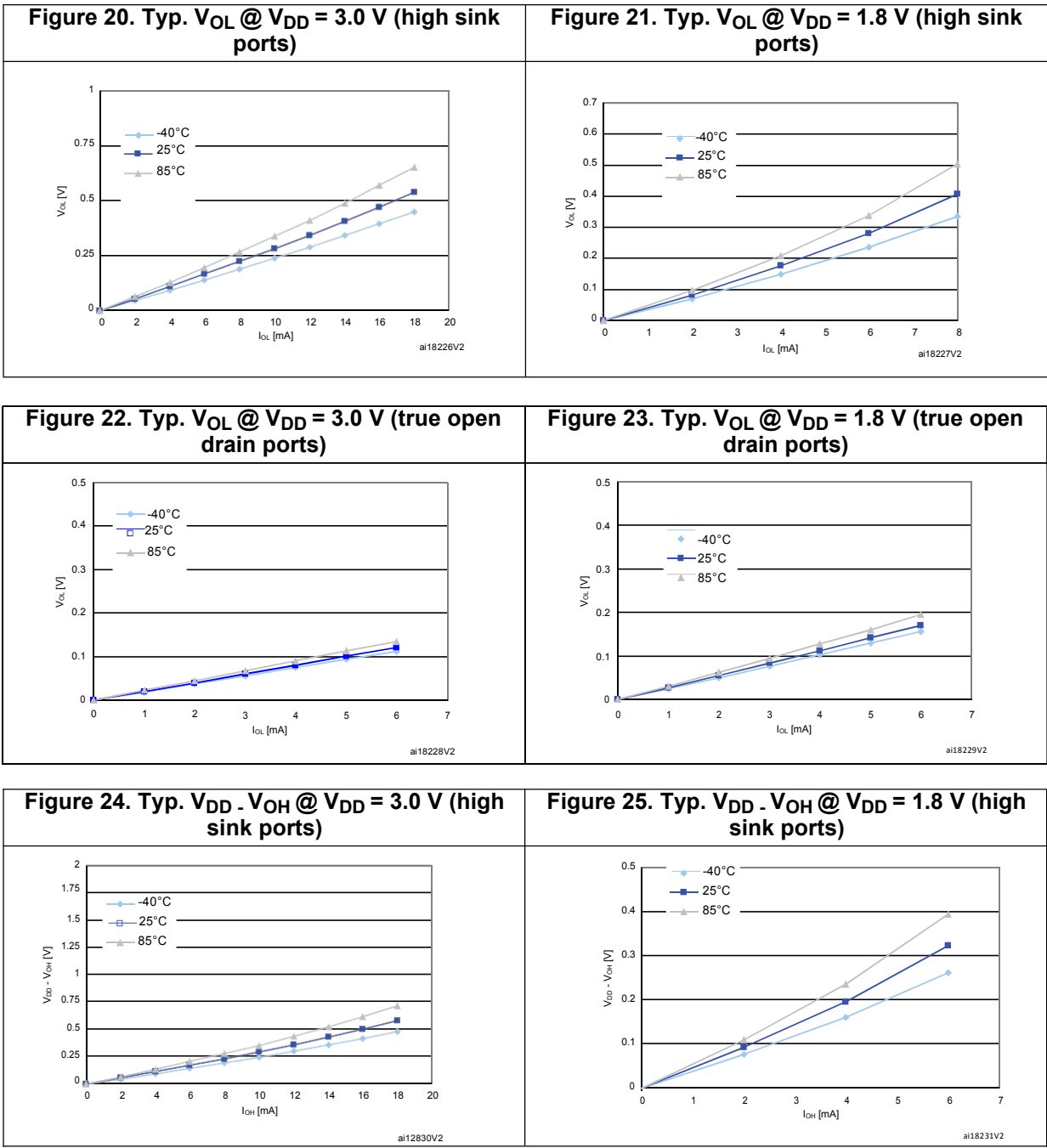
| I/O Type   | Symbol         | Parameter                               | Conditions                                             | Min | Max  | Unit |
|------------|----------------|-----------------------------------------|--------------------------------------------------------|-----|------|------|
| Open drain | $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin | $I_{IO} = +3 \text{ mA}$ ,<br>$V_{DD} = 3.0 \text{ V}$ | -   | 0.45 | V    |
|            |                |                                         | $I_{IO} = +1 \text{ mA}$ ,<br>$V_{DD} = 1.8 \text{ V}$ | -   | 0.45 |      |

1. The  $I_{IO}$  current sunk must always respect the absolute maximum rating specified in [Table 13: Current characteristics](#) and the sum of  $I_{IO}$  (I/O ports and control pins) must not exceed  $I_{VSS}$ .

**Table 38. Output driving current (PA0 with high sink LED driver capability)**

| I/O Type | Symbol         | Parameter                               | Conditions                                              | Min | Max  | Unit |
|----------|----------------|-----------------------------------------|---------------------------------------------------------|-----|------|------|
| LED      | $V_{OL}^{(1)}$ | Output low level voltage for an I/O pin | $I_{IO} = +20 \text{ mA}$ ,<br>$V_{DD} = 2.0 \text{ V}$ | -   | 0.45 | V    |

1. The  $I_{IO}$  current sunk must always respect the absolute maximum rating specified in [Table 13: Current characteristics](#) and the sum of  $I_{IO}$  (I/O ports and control pins) must not exceed  $I_{VSS}$ .



**NRST pin**

Subject to general operating conditions for  $V_{DD}$  and  $T_A$  unless otherwise specified.

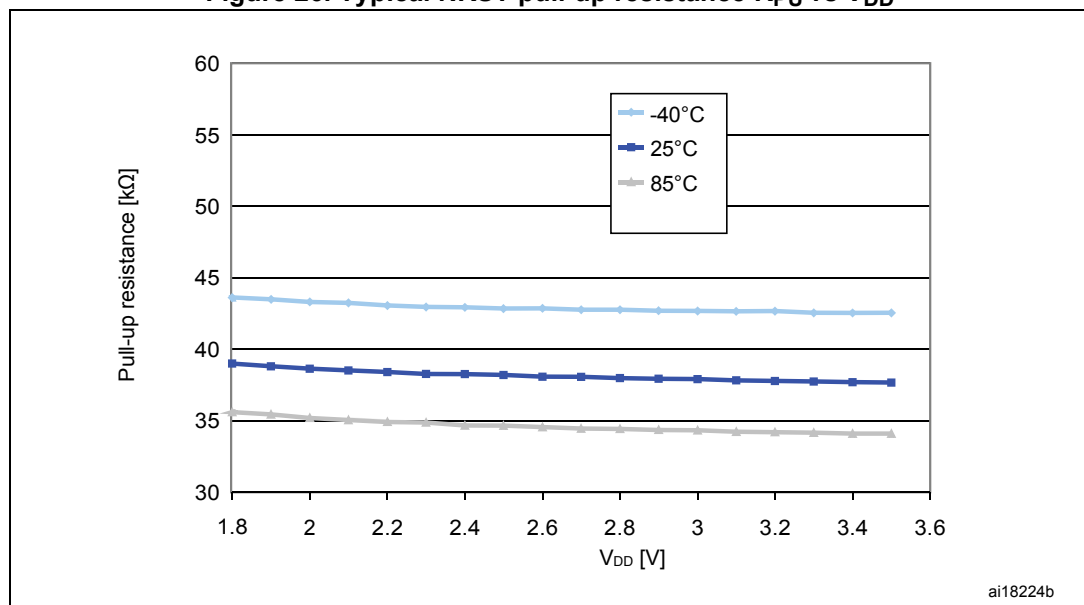
**Table 39. NRST pin characteristics**

| Symbol         | Parameter                                       | Conditions                                                                                                                                 | Min                 | Typ | Max      | Unit       |
|----------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----|----------|------------|
| $V_{IL(NRST)}$ | NRST input low level voltage <sup>(1)</sup>     | -                                                                                                                                          | $V_{SS}$            | -   | 0.8      | V          |
| $V_{IH(NRST)}$ | NRST input high level voltage <sup>(1)</sup>    | -                                                                                                                                          | 1.4                 | -   | $V_{DD}$ |            |
| $V_{OL(NRST)}$ | NRST output low level voltage <sup>(1)</sup>    | $I_{OL} = 2 \text{ mA}$<br>for $2.7 \text{ V} \leq V_{DD} \leq 3.6 \text{ V}$<br>$I_{OL} = 1.5 \text{ mA}$<br>for $V_{DD} < 2.7 \text{ V}$ | -                   | -   | 0.4      |            |
| $V_{HYST}$     | NRST input hysteresis <sup>(3)</sup>            | -                                                                                                                                          | $10\%V_{DD}$<br>(2) | -   | -        | mV         |
| $R_{PU(NRST)}$ | NRST pull-up equivalent resistor <sup>(1)</sup> | -                                                                                                                                          | 30                  | 45  | 60       | k $\Omega$ |
| $V_{F(NRST)}$  | NRST input filtered pulse <sup>(3)</sup>        | -                                                                                                                                          | -                   | -   | 50       | ns         |
| $V_{NF(NRST)}$ | NRST input not filtered pulse <sup>(3)</sup>    | -                                                                                                                                          | 300                 | -   | -        |            |

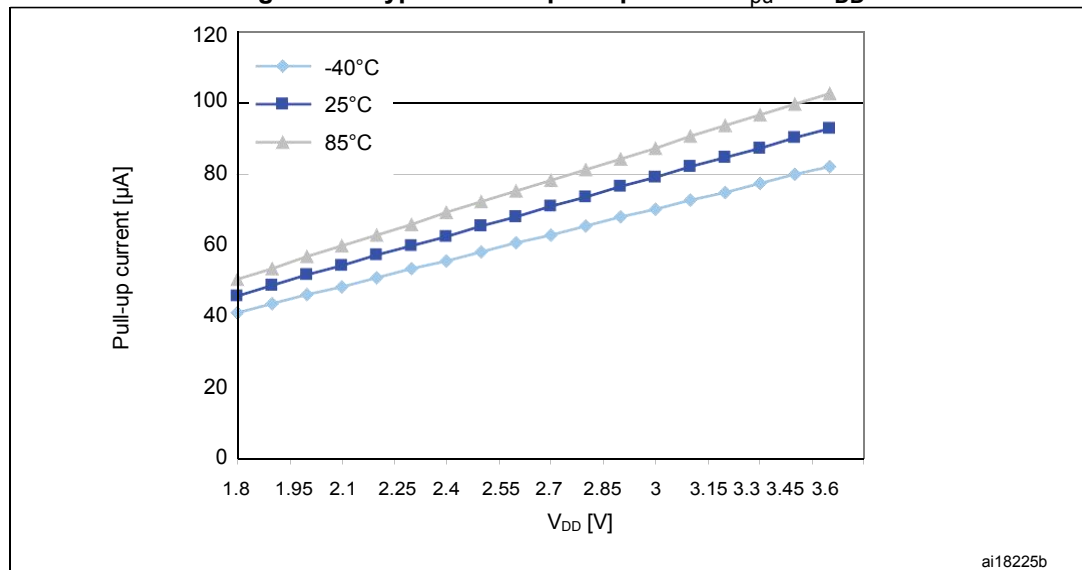
1. Guaranteed by characterization results.

2. 200 mV min.

3. Data guaranteed by design, not tested in production.

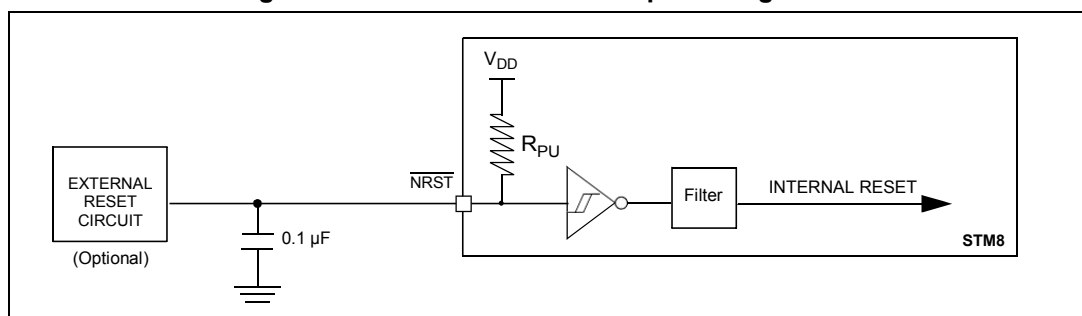
**Figure 26. Typical NRST pull-up resistance  $R_{PU}$  vs  $V_{DD}$** 



**Figure 27. Typical NRST pull-up current  $I_{PU}$  vs  $V_{DD}$** 

The reset network shown in [Figure 28](#) protects the device against parasitic resets. The user must ensure that the level on the NRST pin can go below the  $V_{IL(NRST)}$  max. level specified in [Table 39](#). Otherwise the reset is not taken into account internally.

For power consumption sensitive applications, the external reset capacitor value can be reduced to limit the charge/discharge current. If the NRST signal is used to reset the external circuitry, attention must be paid to the charge/discharge time of the external capacitor to fulfill the external devices reset timing conditions. The minimum recommended capacity is 10 nF.

**Figure 28. Recommended NRST pin configuration**

### 8.3.8 Communication interfaces

#### SPI1 - Serial peripheral interface

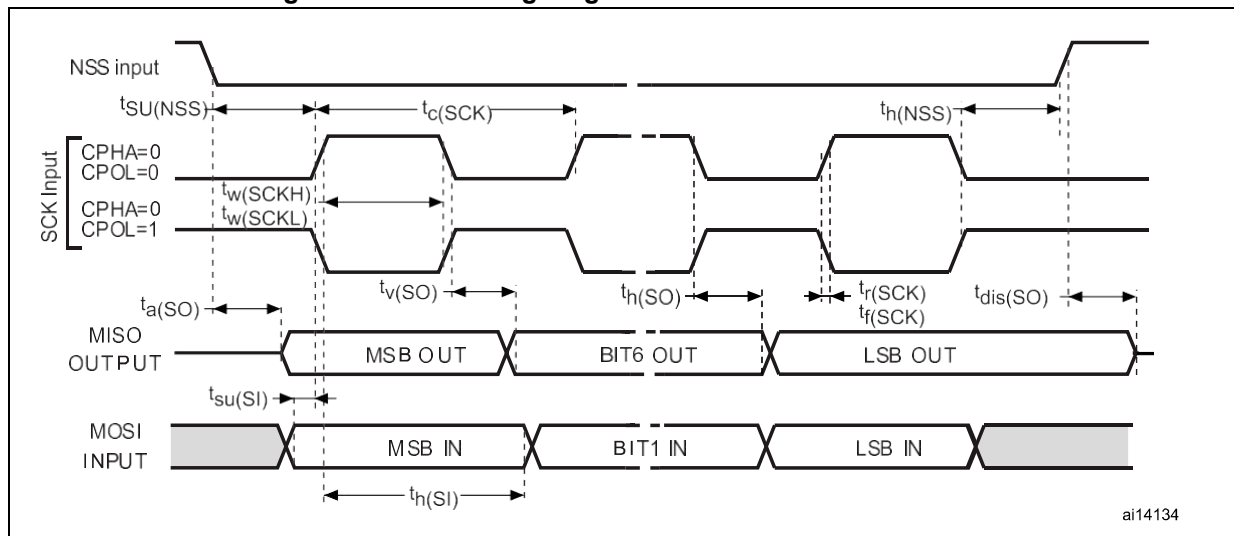
Unless otherwise specified, the parameters given in [Table 40](#) are derived from tests performed under ambient temperature,  $f_{\text{SYSCLK}}$  frequency and  $V_{\text{DD}}$  supply voltage conditions summarized in [Section 8.3.1](#). Refer to I/O port characteristics for more details on the input/output alternate function characteristics (NSS, SCK, MOSI, MISO).

**Table 40. SPI1 characteristics**

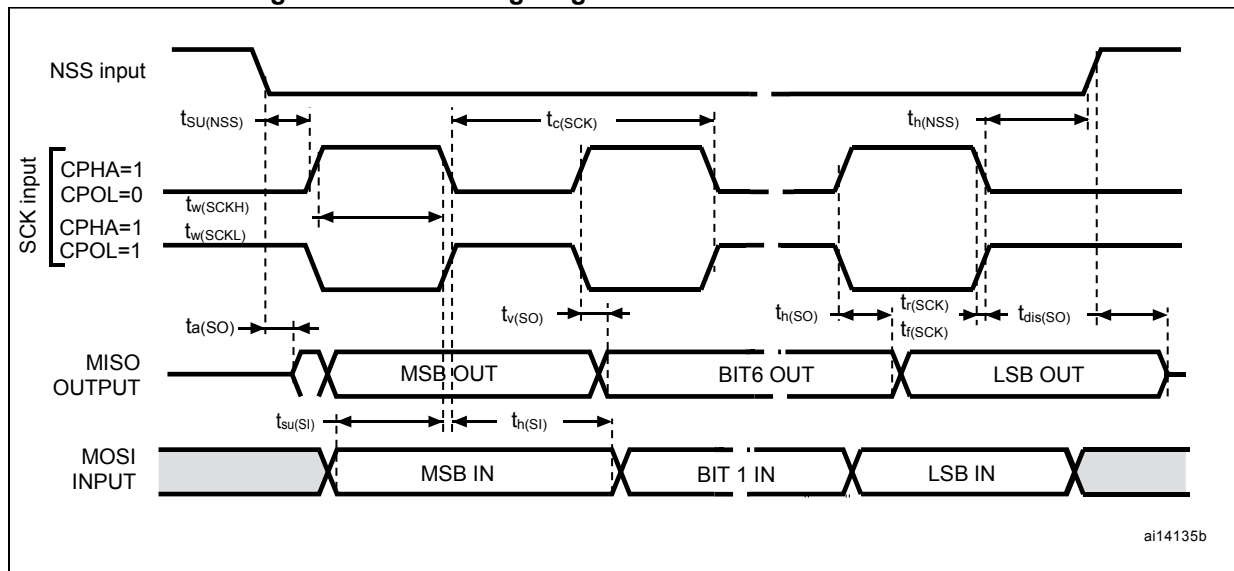
| Symbol                                                   | Parameter                     | Conditions <sup>(1)</sup>                                                              | Min                            | Max                            | Unit |
|----------------------------------------------------------|-------------------------------|----------------------------------------------------------------------------------------|--------------------------------|--------------------------------|------|
| $f_{\text{SCK}}$<br>$1/t_{\text{c(SCK)}}$                | SPI1 clock frequency          | Master mode                                                                            | 0                              | 8                              | MHz  |
|                                                          |                               | Slave mode                                                                             | 0                              | 8                              |      |
| $t_{\text{r(SCK)}}$<br>$t_{\text{f(SCK)}}$               | SPI1 clock rise and fall time | Capacitive load: C = 30 pF                                                             | -                              | 30                             | ns   |
| $t_{\text{su(NSS)}}^{(2)}$                               | NSS setup time                | Slave mode                                                                             | $4 \times 1/f_{\text{SYSCLK}}$ | -                              |      |
| $t_{\text{h(NSS)}}^{(2)}$                                | NSS hold time                 | Slave mode                                                                             | 80                             | -                              |      |
| $t_{\text{w(SCKH)}}^{(2)}$<br>$t_{\text{w(SCKL)}}^{(2)}$ | SCK high and low time         | Master mode,<br>$f_{\text{MASTER}} = 8 \text{ MHz}$ , $f_{\text{SCK}} = 4 \text{ MHz}$ | 105                            | 145                            |      |
| $t_{\text{su(MI)}}^{(2)}$<br>$t_{\text{su(SI)}}^{(2)}$   | Data input setup time         | Master mode                                                                            | 30                             | -                              |      |
|                                                          |                               | Slave mode                                                                             | 3                              | -                              |      |
| $t_{\text{h(MI)}}^{(2)}$<br>$t_{\text{h(SI)}}^{(2)}$     | Data input hold time          | Master mode                                                                            | 15                             | -                              |      |
|                                                          |                               | Slave mode                                                                             | 0                              | -                              |      |
| $t_{\text{a(SO)}}^{(2)(3)}$                              | Data output access time       | Slave mode                                                                             | -                              | $3 \times 1/f_{\text{SYSCLK}}$ |      |
| $t_{\text{dis(SO)}}^{(2)(4)}$                            | Data output disable time      | Slave mode                                                                             | 30                             | -                              |      |
| $t_{\text{v(SO)}}^{(2)}$                                 | Data output valid time        | Slave mode (after enable edge)                                                         | -                              | 60                             |      |
| $t_{\text{v(MO)}}^{(2)}$                                 | Data output valid time        | Master mode (after enable edge)                                                        | -                              | 20                             |      |
| $t_{\text{h(SO)}}^{(2)}$                                 | Data output hold time         | Slave mode (after enable edge)                                                         | 15                             | -                              |      |
| $t_{\text{h(MO)}}^{(2)}$                                 |                               | Master mode (after enable edge)                                                        | 1                              | -                              |      |

- Parameters are given by selecting 10 MHz I/O output frequency.
- Values based on design simulation and/or characterization results, and not tested in production.
- Min time is for the minimum time to drive the output and max time is for the maximum time to validate the data.
- Min time is for the minimum time to invalidate the output and max time is for the maximum time to put the data in Hi-Z.

Figure 29. SPI1 timing diagram - slave mode and CPHA=0

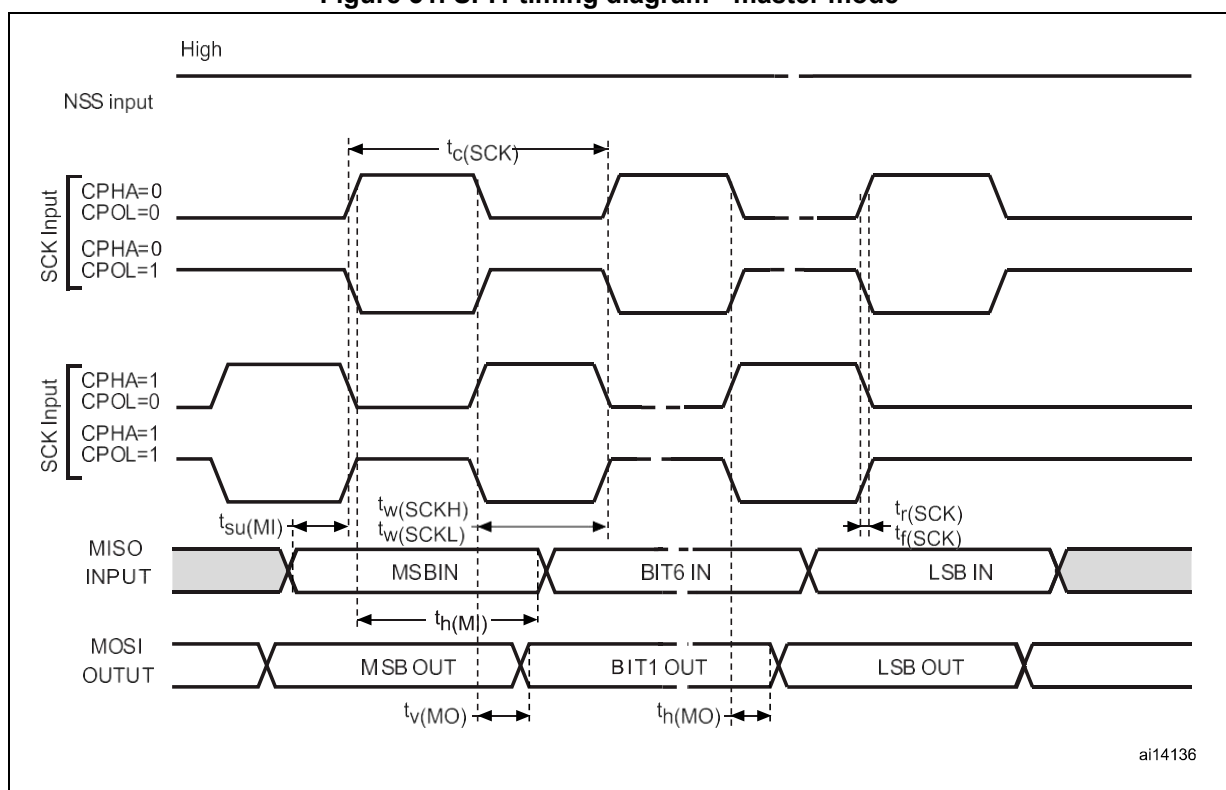


ai14134

Figure 30. SPI1 timing diagram - slave mode and CPHA=1<sup>(1)</sup>

ai14135b

1. Measurement points are done at CMOS levels: 0.3V<sub>DD</sub> and 0.7V<sub>DD</sub>.

Figure 31. SPI1 timing diagram - master mode<sup>(1)</sup>

1. Measurement points are done at CMOS levels:  $0.3V_{DD}$  and  $0.7V_{DD}$ .

**I2C - Inter IC control interface**

Subject to general operating conditions for  $V_{DD}$ ,  $f_{SYSCLK}$ , and  $T_A$  unless otherwise specified.

The STM8L I2C interface (I2C1) meets the requirements of the Standard I2C communication protocol described in the following table with the restriction mentioned below:

Refer to I/O port characteristics for more details on the input/output alternate function characteristics (SDA and SCL).

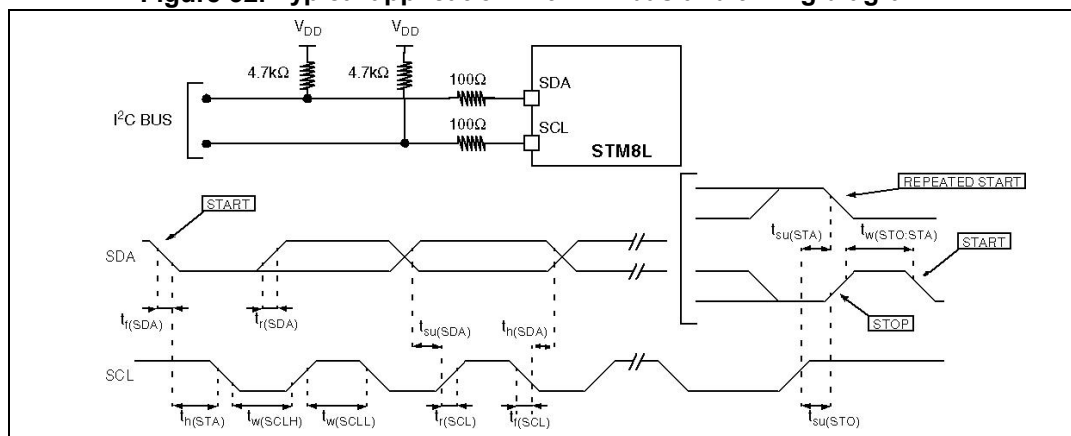
**Table 41. I2C characteristics**

| Symbol                   | Parameter                               | Standard mode I2C  |                    | Fast mode I2C <sup>(1)</sup> |                    | Unit    |
|--------------------------|-----------------------------------------|--------------------|--------------------|------------------------------|--------------------|---------|
|                          |                                         | Min <sup>(2)</sup> | Max <sup>(2)</sup> | Min <sup>(2)</sup>           | Max <sup>(2)</sup> |         |
| $t_{w(SCLL)}$            | SCL clock low time                      | 4.7                | -                  | 1.3                          | -                  | $\mu s$ |
| $t_{w(SCLH)}$            | SCL clock high time                     | 4.0                | -                  | 0.6                          | -                  |         |
| $t_{su(SDA)}$            | SDA setup time                          | 250                | -                  | 100                          | -                  | ns      |
| $t_h(SDA)$               | SDA data hold time                      | 0                  | -                  | 0                            | 900                |         |
| $t_r(SDA)$<br>$t_r(SCL)$ | SDA and SCL rise time                   | -                  | 1000               | -                            | 300                |         |
| $t_f(SDA)$<br>$t_f(SCL)$ | SDA and SCL fall time                   | -                  | 300                | -                            | 300                |         |
| $t_h(STA)$               | START condition hold time               | 4.0                | -                  | 0.6                          | -                  | $\mu s$ |
| $t_{su(STA)}$            | Repeated START condition setup time     | 4.7                | -                  | 0.6                          | -                  |         |
| $t_{su(STO)}$            | STOP condition setup time               | 4.0                | -                  | 0.6                          | -                  | $\mu s$ |
| $t_{w(STO:STA)}$         | STOP to START condition time (bus free) | 4.7                | -                  | 1.3                          | -                  | $\mu s$ |
| $C_b$                    | Capacitive load for each bus line       | -                  | 400                | -                            | 400                | pF      |

1.  $f_{SYSCLK}$  must be at least equal to 8 MHz to achieve max fast I2C speed (400 kHz).

2. Data based on standard I2C protocol requirement, not tested in production.

**Note:** For speeds around 200 kHz, the achieved speed can have  $\pm 5\%$  tolerance  
 For other speed ranges, the achieved speed can have  $\pm 2\%$  tolerance  
 The above variations depend on the accuracy of the external components used.

Figure 32. Typical application with I2C bus and timing diagram <sup>1)</sup>

1. Measurement points are done at CMOS levels:  $0.3 \times V_{DD}$  and  $0.7 \times V_{DD}$

### 8.3.9 Embedded reference voltage

In the following table, data is based on characterization results, not tested in production, unless otherwise specified.

**Table 42. Reference voltage characteristics**

| Symbol                    | Parameter                                                                           | Conditions                                 | Min                  | Typ   | Max.                 | Unit            |
|---------------------------|-------------------------------------------------------------------------------------|--------------------------------------------|----------------------|-------|----------------------|-----------------|
| $I_{REFINT}$              | Internal reference voltage consumption                                              | -                                          | -                    | 1.4   | -                    | $\mu A$         |
| $T_{S\_VREFINT}^{(1)(2)}$ | ADC sampling time when reading the internal reference voltage                       | -                                          | -                    | 5     | 10                   | $\mu s$         |
| $I_{BUF}^{(2)}$           | Internal reference voltage buffer consumption (used for ADC)                        | -                                          | -                    | 13.5  | 25                   | $\mu A$         |
| $V_{REFINT\ out}$         | Reference voltage output                                                            | -                                          | 1.202 <sup>(3)</sup> | 1.224 | 1.242 <sup>(3)</sup> | V               |
| $I_{LPBU_F}^{(2)}$        | Internal reference voltage low-power buffer consumption                             | -                                          | -                    | 730   | 1200                 | nA              |
| $I_{REFOUT}^{(2)}$        | Buffer output current <sup>(4)</sup>                                                | -                                          | -                    | -     | 1                    | $\mu A$         |
| $C_{REFOUT}$              | Reference voltage output load                                                       | -                                          | -                    | -     | 50                   | pF              |
| $t_{VREFINT}$             | Internal reference voltage startup time                                             | -                                          | -                    | 2     | 3                    | ms              |
| $t_{BUFEN}^{(2)}$         | Internal reference voltage buffer startup time once enabled <sup>(1)</sup>          | -                                          | -                    | -     | 10                   | $\mu s$         |
| $ACC_{VREFINT}$           | Accuracy of $V_{REFINT}$ stored in the $VREFINT\_Factory\_CONV$ byte <sup>(5)</sup> | -                                          | -                    | -     | $\pm 5$              | mV              |
| $STAB_{VREFINT}$          | Stability of $V_{REFINT}$ over temperature                                          | $-40\ ^\circ C \leq T_A \leq 85\ ^\circ C$ | -                    | 20    | 50                   | ppm/ $^\circ C$ |
|                           | Stability of $V_{REFINT}$ over temperature                                          | $0\ ^\circ C \leq T_A \leq 50\ ^\circ C$   | -                    | -     | 20                   | ppm/ $^\circ C$ |
| $STAB_{VREFINT}$          | Stability of $V_{REFINT}$ after 1000 hours                                          | -                                          | -                    | -     | TBD                  | ppm             |

1. Defined when ADC output reaches its final value  $\pm 1/2LSB$

2. Data guaranteed by design.

3. Tested in production at  $V_{DD} = 3\ V \pm 10\ mV$ .

4. To guaranty less than 1%  $V_{REFOUT}$  deviation.

5. Measured at  $V_{DD} = 3\ V \pm 10\ mV$ . This value takes into account  $V_{DD}$  accuracy and ADC conversion accuracy.

### 8.3.10 12-bit ADC1 characteristics

In the following table, data is guaranteed by design, not tested in production.

Table 43. ADC1 characteristics

| Symbol           | Parameter                               | Conditions                                                                  | Min                 | Typ  | Max                               | Unit               |
|------------------|-----------------------------------------|-----------------------------------------------------------------------------|---------------------|------|-----------------------------------|--------------------|
| $V_{DDA}$        | Analog supply voltage                   | -                                                                           | 1.8                 | -    | 3.6                               | V                  |
| $V_{REF+}$       | Reference supply voltage                | $2.4\text{ V} \leq V_{DDA} \leq 3.6\text{ V}$                               | 2.4                 | -    | $V_{DDA}$                         | V                  |
|                  |                                         | $1.8\text{ V} \leq V_{DDA} \leq 2.4\text{ V}$                               | $V_{DDA}$           |      |                                   | V                  |
| $V_{REF-}$       | Lower reference voltage                 | -                                                                           | $V_{SSA}$           |      |                                   | V                  |
| $I_{VDDA}$       | Current on the $V_{DDA}$ input pin      | -                                                                           | -                   | 1000 | 1450                              | $\mu\text{A}$      |
| $I_{VREF+}$      | Current on the $V_{REF+}$ input pin     | -                                                                           | -                   | 400  | 700 (peak) <sup>(1)</sup>         | $\mu\text{A}$      |
|                  |                                         | -                                                                           | -                   |      | 450 (average) <sup>(1)</sup>      | $\mu\text{A}$      |
| $V_{AIN}$        | Conversion voltage range                | -                                                                           | 0 <sup>(2)</sup>    | -    | $V_{REF+}$                        | -                  |
| $T_A$            | Temperature range                       | -                                                                           | -40                 | -    | 85                                | $^{\circ}\text{C}$ |
| $R_{AIN}$        | External resistance on $V_{AIN}$        | -                                                                           | -                   | -    | 50 <sup>(3)</sup>                 | $\text{k}\Omega$   |
|                  |                                         | -                                                                           | -                   | -    |                                   |                    |
| $C_{ADC}$        | Internal sample and hold capacitor      | -                                                                           | -                   | 16   | -                                 | $\text{pF}$        |
|                  |                                         | -                                                                           | -                   |      | -                                 |                    |
| $f_{ADC}$        | ADC sampling clock frequency            | $2.4\text{ V} \leq V_{DDA} \leq 3.6\text{ V}$ without zooming               | 0.320               | -    | 16                                | MHz                |
|                  |                                         | $1.8\text{ V} \leq V_{DDA} \leq 2.4\text{ V}$ with zooming                  | 0.320               | -    | 8                                 | MHz                |
| $f_{CONV}$       | 12-bit conversion rate                  | $V_{AIN}$ on all slow channels                                              | -                   | -    | 760 <sup>(4)</sup>                | kHz                |
| $f_{TRIG}$       | External trigger frequency              | -                                                                           | -                   | -    | $t_{conv}$                        | $1/f_{ADC}$        |
| $t_{LAT}$        | External trigger latency                | -                                                                           | -                   | -    | 3.5                               | $1/f_{SYSCLK}$     |
| $t_S$            | Sampling time                           | $V_{AIN}$ on slow channels<br>$V_{DDA} < 2.4\text{ V}$                      | 0.86 <sup>(4)</sup> | -    | -                                 | $\mu\text{s}$      |
|                  |                                         | $V_{AIN}$ on slow channels<br>$2.4\text{ V} \leq V_{DDA} \leq 3.6\text{ V}$ | 0.41 <sup>(4)</sup> | -    | -                                 | $\mu\text{s}$      |
| $t_{conv}$       | 12-bit conversion time                  | -                                                                           | $12 + t_S$          |      |                                   | $1/f_{ADC}$        |
|                  |                                         | 16 MHz                                                                      | 1 <sup>(4)</sup>    |      |                                   | $\mu\text{s}$      |
| $t_{WKUP}$       | Wakeup time from OFF state              | -                                                                           | -                   | -    | 3                                 | $\mu\text{s}$      |
| $t_{IDLE}^{(5)}$ | Time before a new conversion            | $T_A = +25\text{ }^{\circ}\text{C}$                                         | -                   | -    | 1 <sup>(6)</sup>                  | s                  |
|                  |                                         | $T_A = +70\text{ }^{\circ}\text{C}$                                         | -                   | -    | 20 <sup>(6)</sup>                 | ms                 |
| $t_{VREFINT}$    | Internal reference voltage startup time | -                                                                           | -                   | -    | refer to <a href="#">Table 42</a> | ms                 |



1. The current consumption through  $V_{REF}$  is composed of two parameters:
  - one constant (max 300  $\mu A$ )
  - one variable (max 400  $\mu A$ ), only during sampling time + 2 first conversion pulses.So, peak consumption is  $300+400 = 700 \mu A$  and average consumption is  $300 + [(4 \text{ sampling} + 2) / 16] \times 400 = 450 \mu A$  at 1Msps
2.  $V_{REF-}$  or  $V_{DDA}$  must be tied to ground.
3. Guaranteed by design.
4. Minimum sampling and conversion time is reached for maximum  $R_{ext} = 0.5 k\Omega$ .
5. The time between 2 conversions, or between ADC ON and the first conversion must be lower than  $t_{DLE}$ .
6. The  $t_{DLE}$  maximum value is  $\infty$  on the "Z" revision code of the device.

In the following three tables, data is guaranteed by characterization result, not tested in production.

**Table 44. ADC1 accuracy with  $V_{DDA} = 3.3\text{ V}$  to  $2.5\text{ V}$**

| Symbol | Parameter                  | Conditions                | Typ | Max | Unit |
|--------|----------------------------|---------------------------|-----|-----|------|
| DNL    | Differential non linearity | f <sub>ADC</sub> = 16 MHz | 1   | 1.6 | LSB  |
|        |                            | f <sub>ADC</sub> = 8 MHz  | 1   | 1.6 |      |
|        |                            | f <sub>ADC</sub> = 4 MHz  | 1   | 1.5 |      |
| INL    | Integral non linearity     | f <sub>ADC</sub> = 16 MHz | 1.2 | 2   |      |
|        |                            | f <sub>ADC</sub> = 8 MHz  | 1.2 | 1.8 |      |
|        |                            | f <sub>ADC</sub> = 4 MHz  | 1.2 | 1.7 |      |
| TUE    | Total unadjusted error     | f <sub>ADC</sub> = 16 MHz | 2.2 | 3.0 |      |
|        |                            | f <sub>ADC</sub> = 8 MHz  | 1.8 | 2.5 |      |
|        |                            | f <sub>ADC</sub> = 4 MHz  | 1.8 | 2.3 |      |
| Offset | Offset error               | f <sub>ADC</sub> = 16 MHz | 1.5 | 2   | LSB  |
|        |                            | f <sub>ADC</sub> = 8 MHz  | 1   | 1.5 |      |
|        |                            | f <sub>ADC</sub> = 4 MHz  | 0.7 | 1.2 |      |
| Gain   | Gain error                 | f <sub>ADC</sub> = 16 MHz | 1   | 1.5 |      |
|        |                            | f <sub>ADC</sub> = 8 MHz  |     |     |      |
|        |                            | f <sub>ADC</sub> = 4 MHz  |     |     |      |

**Table 45. ADC1 accuracy with  $V_{DDA} = 2.4\text{ V}$  to  $3.6\text{ V}$**

| Symbol | Parameter                  | Typ | Max | Unit |
|--------|----------------------------|-----|-----|------|
| DNL    | Differential non linearity | 1   | 2   | LSB  |
| INL    | Integral non linearity     | 1.7 | 3   | LSB  |
| TUE    | Total unadjusted error     | 2   | 4   | LSB  |
| Offset | Offset error               | 1   | 2   | LSB  |
| Gain   | Gain error                 | 1.5 | 3   | LSB  |

**Table 46. ADC1 accuracy with  $V_{DDA} = V_{\text{REF}+} = 1.8\text{ V}$  to  $2.4\text{ V}$**

| Symbol | Parameter                  | Typ | Max | Unit |
|--------|----------------------------|-----|-----|------|
| DNL    | Differential non linearity | 1   | 2   | LSB  |
| INL    | Integral non linearity     | 2   | 3   | LSB  |
| TUE    | Total unadjusted error     | 3   | 5   | LSB  |
| Offset | Offset error               | 2   | 3   | LSB  |
| Gain   | Gain error                 | 2   | 3   | LSB  |

Figure 33. ADC1 accuracy characteristics

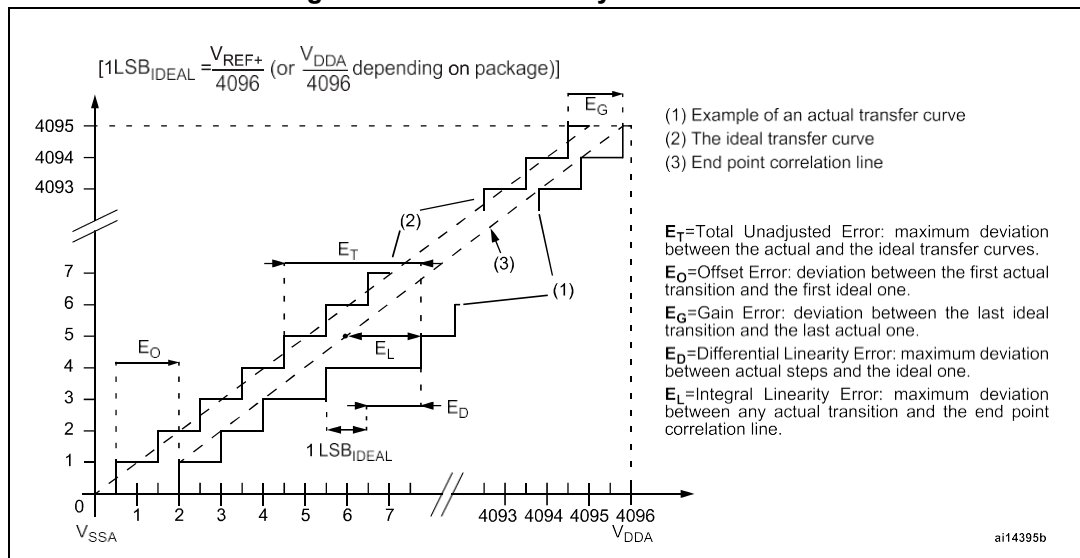
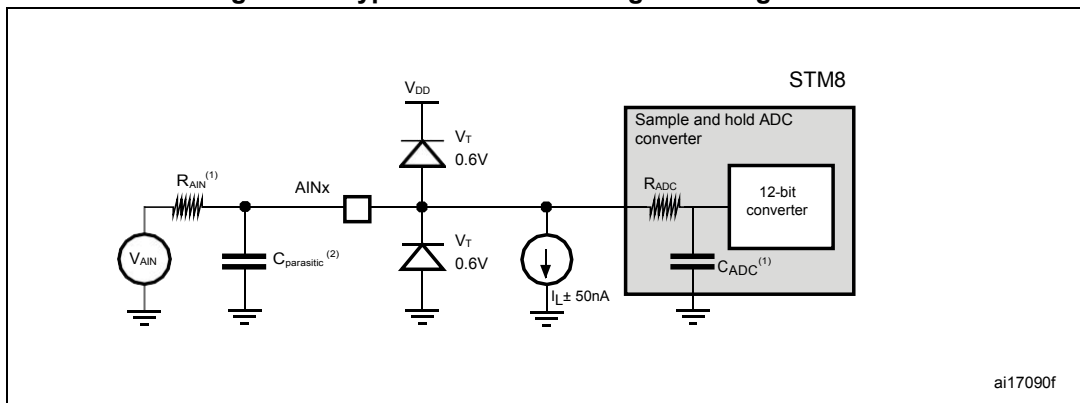


Figure 34. Typical connection diagram using the ADC



1. Refer to [Table 47](#) for the values of  $R_{\text{AIN}}$  and  $C_{\text{ADC}}$ .
2.  $C_{\text{parasitic}}$  represents the capacitance of the PCB (dependent on soldering and PCB layout quality) plus the pad capacitance (roughly 7 pF). A high  $C_{\text{parasitic}}$  value will downgrade conversion accuracy. To remedy this,  $f_{\text{ADC}}$  should be reduced.

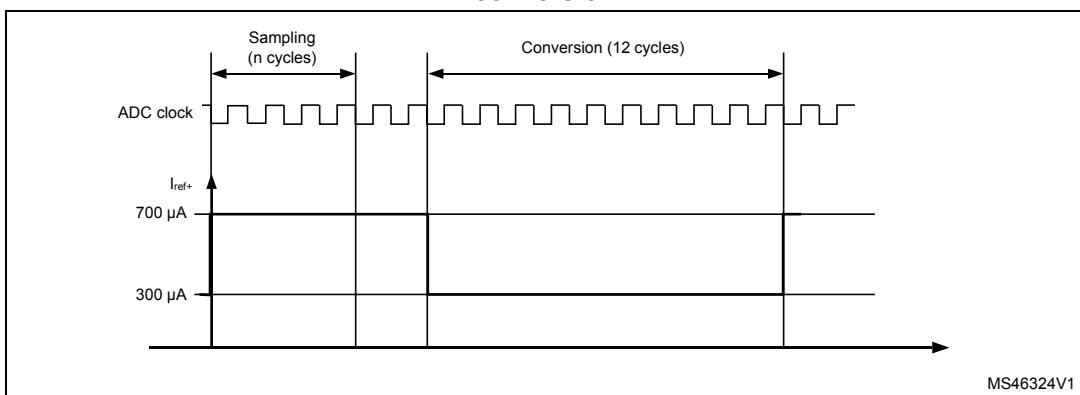
Figure 35. Maximum dynamic current consumption on  $V_{\text{REF}+}$  supply pin during ADC conversion

Table 47.  $R_{AIN}$  max for  $f_{ADC} = 16 \text{ MHz}^{(1)}$ 

| Ts (cycles) | Ts ( $\mu\text{s}$ ) | $R_{AIN}$ max (kohm)                      |                                           |
|-------------|----------------------|-------------------------------------------|-------------------------------------------|
|             |                      | Slow channels                             |                                           |
|             |                      | $2.4 \text{ V} < V_{DDA} < 3.6 \text{ V}$ | $1.8 \text{ V} < V_{DDA} < 2.4 \text{ V}$ |
| 4           | 0.25                 | Not allowed                               | Not allowed                               |
| 9           | 0.5625               | 0.8                                       | Not allowed                               |
| 16          | 1                    | 2.0                                       | 0.8                                       |
| 24          | 1.5                  | 3.0                                       | 1.8                                       |
| 48          | 3                    | 6.8                                       | 4.0                                       |
| 96          | 6                    | 15.0                                      | 10.0                                      |
| 192         | 12                   | 32.0                                      | 25.0                                      |
| 384         | 24                   | 50.0                                      | 50.0                                      |

1. Guaranteed by design.

### General PCB design guidelines

Power supply decoupling should be performed as shown in [Figure 36](#) or [Figure 37](#), depending on whether  $V_{REF+}$  is connected to  $V_{DDA}$  or not. Good quality ceramic 10 nF capacitors should be used. They should be placed as close as possible to the chip.

**Figure 36. Power supply and reference decoupling ( $V_{REF+}$  not connected to  $V_{DDA}$ )**

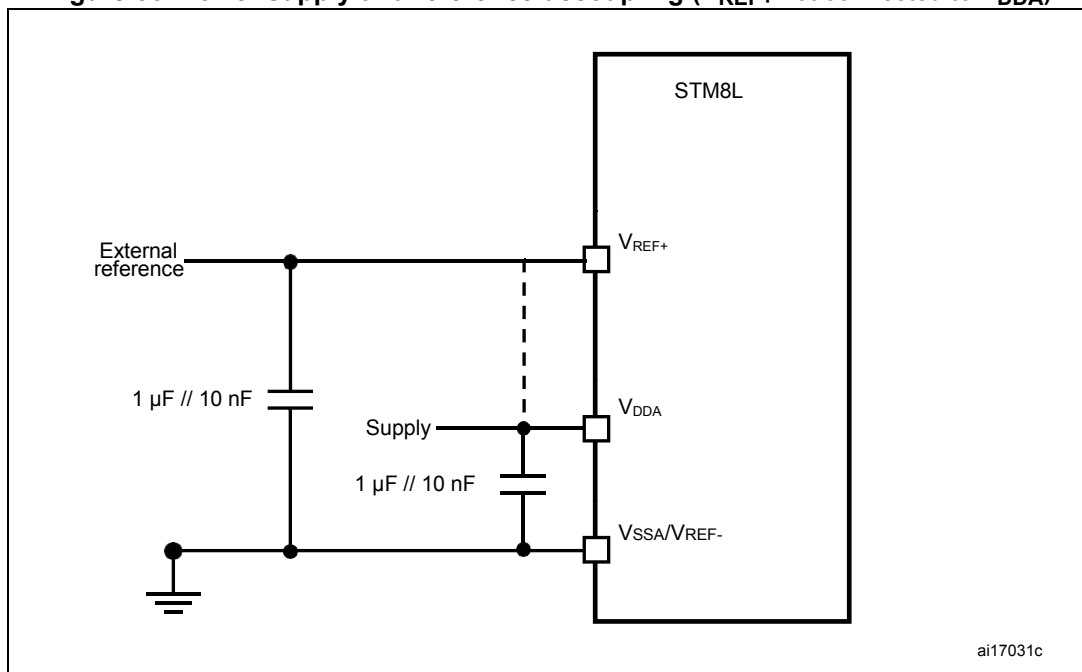
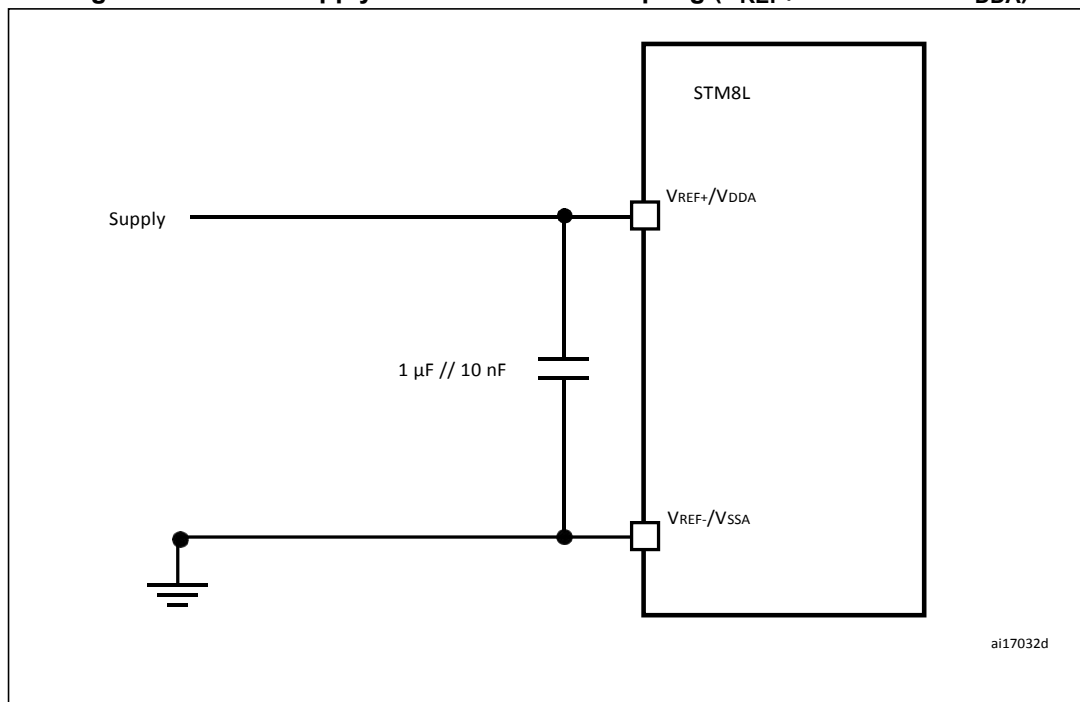


Figure 37. Power supply and reference decoupling ( $V_{REF+}$  connected to  $V_{DDA}$ )

### 8.3.11 EMC characteristics

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

#### Functional EMS (electromagnetic susceptibility)

Based on a simple running application on the product (toggling 2 LEDs through I/O ports), the product is stressed by two electromagnetic events until a failure occurs (indicated by the LEDs).

- **ESD:** Electrostatic discharge (positive and negative) is applied on all pins of the device until a functional disturbance occurs. This test conforms with the IEC 61000 standard.
- **FTB:** A burst of fast transient voltage (positive and negative) is applied to  $V_{DD}$  and  $V_{SS}$  through a  $100\ \text{pF}$  capacitor, until a functional disturbance occurs. This test conforms with the IEC 61000 standard.

A device reset allows normal operations to be resumed. The test results are given in the table below based on the EMS levels and classes defined in application note AN1709.

#### 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.

#### 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).

Table 48. EMS data

| Symbol     | Parameter                                                                                                                         | Conditions                                                                                                              | Level/Class     |
|------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------|
| $V_{FESD}$ | Voltage limits to be applied on any I/O pin to induce a functional disturbance                                                    | $V_{DD} = 3.3\text{ V}$ , $T_A = +25\text{ }^{\circ}\text{C}$ ,<br>$f_{CPU} = 16\text{ MHz}$ ,<br>conforms to IEC 61000 | 3B              |
| $V_{EFTB}$ | Fast transient voltage burst limits to be applied through 100 pF on $V_{DD}$ and $V_{SS}$ pins to induce a functional disturbance | $V_{DD} = 3.3\text{ V}$ , $T_A = +25\text{ }^{\circ}\text{C}$ ,<br>$f_{CPU} = 16\text{ MHz}$ ,<br>conforms to IEC 61000 | Using HSI<br>4A |
|            |                                                                                                                                   |                                                                                                                         | Using HSE<br>2B |

### Electromagnetic interference (EMI)

Based on a simple application running on the product (toggling 2 LEDs through the I/O ports), the product is monitored in terms of emission. This emission test is in line with the norm IEC61967-2 which specifies the board and the loading of each pin.

Table 49. EMI data <sup>(1)</sup>

| Symbol    | Parameter  | Conditions                                                                                                  | Monitored frequency band | Max vs. | Unit       |
|-----------|------------|-------------------------------------------------------------------------------------------------------------|--------------------------|---------|------------|
|           |            |                                                                                                             |                          | 16 MHz  |            |
| $S_{EMI}$ | Peak level | $V_{DD} = 3.6\text{ V}$ ,<br>$T_A = +25\text{ }^{\circ}\text{C}$ ,<br>LQFP32<br>conforming to<br>IEC61967-2 | 0.1 MHz to 30 MHz        | -3      | dB $\mu$ V |
|           |            |                                                                                                             | 30 MHz to 130 MHz        | 9       |            |
|           |            |                                                                                                             | 130 MHz to 1 GHz         | 4       |            |
|           |            |                                                                                                             | SAE EMI Level            | 2       | -          |

1. Not tested in production.

### Absolute maximum ratings (electrical sensitivity)

Based on two different tests (ESD and LU) using specific measurement methods, the product is stressed in order to determine its performance in terms of electrical sensitivity. For more details, refer to the application note AN1181.

### Electrostatic discharge (ESD)

Electrostatic discharges (a positive then a negative pulse separated by 1 second) are applied to the pins of each sample according to each pin combination. The sample size depends on the number of supply pins in the device (3 parts\*(n+1) supply pin). Two models can be simulated: human body model and charge device model. This test conforms to the JESD22-A114A/A115A standard.

Table 50. ESD absolute maximum ratings

| Symbol                | Ratings                                               | Conditions              | Maximum value <sup>(1)</sup> | Unit |
|-----------------------|-------------------------------------------------------|-------------------------|------------------------------|------|
| V <sub>ESD(HBM)</sub> | Electrostatic discharge voltage (human body model)    | T <sub>A</sub> = +25 °C | 2000                         | V    |
| V <sub>ESD(CDM)</sub> | Electrostatic discharge voltage (charge device model) |                         | 500                          |      |

1. Guaranteed by characterization results.

### Static latch-up

- **LU:** 3 complementary static tests are required on 6 parts to assess the latch-up performance. A supply overvoltage (applied to each power supply pin) and a current injection (applied to each input, output and configurable I/O pin) are performed on each sample. This test conforms to the EIA/JESD 78 IC latch-up standard. For more details, refer to the application note AN1181.

Table 51. Electrical sensitivities

| Symbol | Parameter             | Class |
|--------|-----------------------|-------|
| LU     | Static latch-up class | II    |

## 9 Package characteristics

### 9.1 ECOPACK®

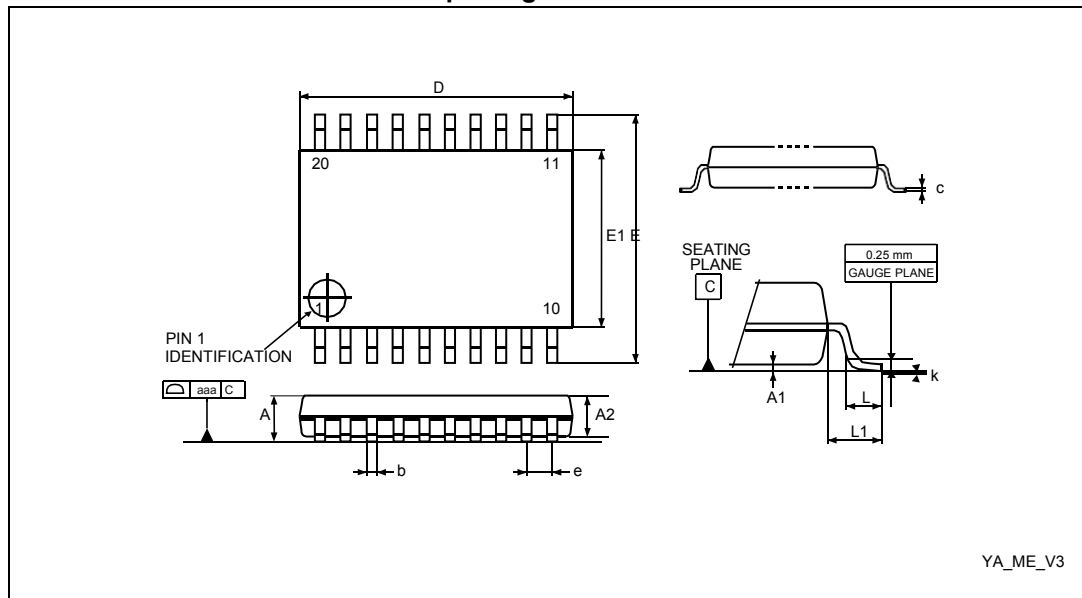
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.



## 9.2 Package mechanical data

### 9.3 TSSOP20 package information

Figure 38. TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package outline



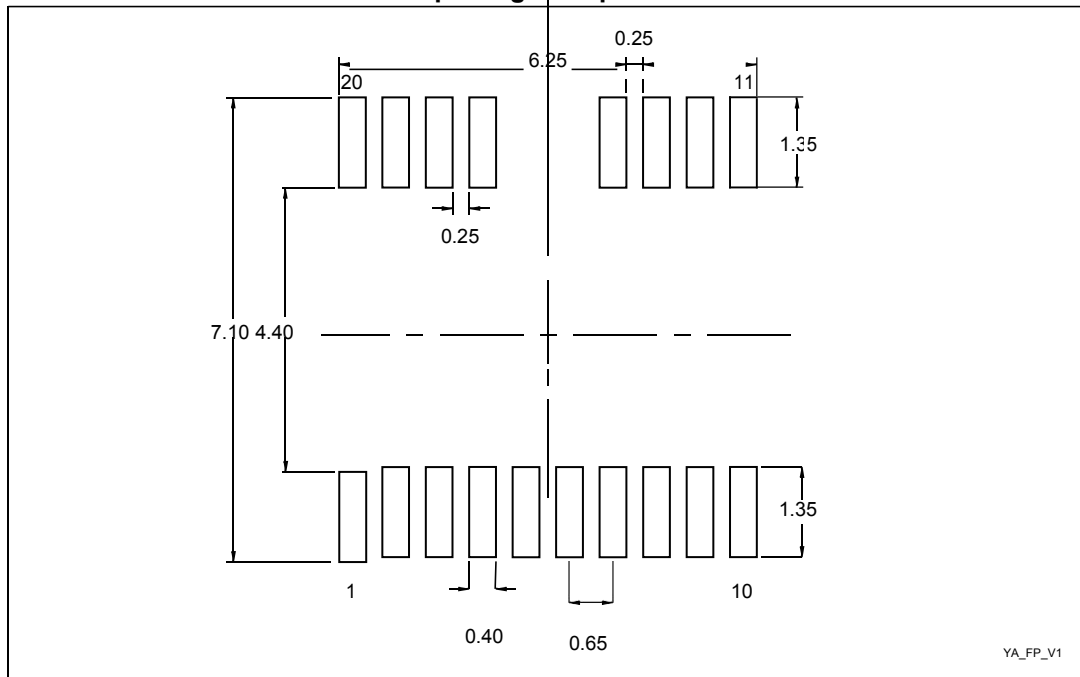
1. Drawing is not to scale.

Table 52. TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package mechanical data

| Symbol            | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|-------------------|-------------|-------|-------|-----------------------|--------|--------|
|                   | Min.        | Typ.  | Max.  | Min.                  | Typ.   | Max.   |
| A                 | -           | -     | 1.200 | -                     | -      | 0.0472 |
| A1                | 0.050       | -     | 0.150 | 0.0020                | -      | 0.0059 |
| A2                | 0.800       | 1.000 | 1.050 | 0.0315                | 0.0394 | 0.0413 |
| b                 | 0.190       | -     | 0.300 | 0.0075                | -      | 0.0118 |
| c                 | 0.090       | -     | 0.200 | 0.0035                | -      | 0.0079 |
| D <sup>(2)</sup>  | 6.400       | 6.500 | 6.600 | 0.2520                | 0.2559 | 0.2598 |
| E                 | 6.200       | 6.400 | 6.600 | 0.2441                | 0.2520 | 0.2598 |
| E1 <sup>(3)</sup> | 4.300       | 4.400 | 4.500 | 0.1693                | 0.1732 | 0.1772 |
| e                 | -           | 0.650 | -     | -                     | 0.0256 | -      |
| L                 | 0.450       | 0.600 | 0.750 | 0.0177                | 0.0236 | 0.0295 |
| L1                | -           | 1.000 | -     | -                     | 0.0394 | -      |
| k                 | 0°          | -     | 8°    | 0°                    | -      | 8°     |
| aaa               | -           | -     | 0.100 | -                     | -      | 0.0039 |

1. Values in inches are converted from mm and rounded to four decimal digits.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15mm per side.
3. Dimension "E1" does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25mm per side.

**Figure 39. TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package footprint**



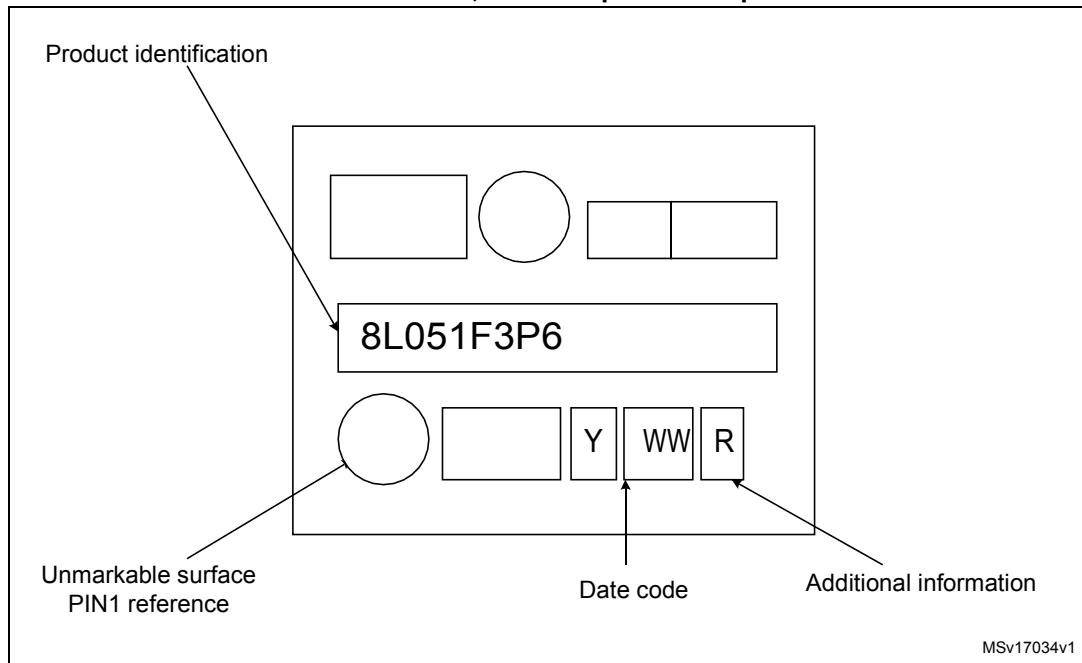
1. Dimensions are expressed in millimeters.

### Device marking for TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch

The following figure gives an example of topside marking orientation versus pin 1/ball A1 identifier location.

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

**Figure 40. Device marking for TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch example**



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

## 9.4 Thermal characteristics

The maximum chip junction temperature ( $T_{Jmax}$ ) must never exceed the values given in [Table 15: General operating conditions on page 48](#).

The maximum chip-junction temperature,  $T_{Jmax}$ , in degree Celsius, may be calculated using the following equation:

$$T_{Jmax} = T_{Amax} + (P_{Dmax} \times \Theta_{JA})$$

Where:

- $T_{Amax}$  is the maximum ambient temperature in °C
- $\Theta_{JA}$  is the package junction-to-ambient thermal resistance in °C/W
- $P_{Dmax}$  is the sum of  $P_{INTmax}$  and  $P_{I/Omax}$  ( $P_{Dmax} = P_{INTmax} + P_{I/Omax}$ )
- $P_{INTmax}$  is the product of  $I_{DD}$  and  $V_{DD}$ , expressed in Watts. This is the maximum chip internal power.
- $P_{I/Omax}$  represents the maximum power dissipation on output pins

Where:

$$P_{I/Omax} = \Sigma (V_{OL} \times I_{OL}) + \Sigma ((V_{DD} - V_{OH}) \times I_{OH}),$$

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.

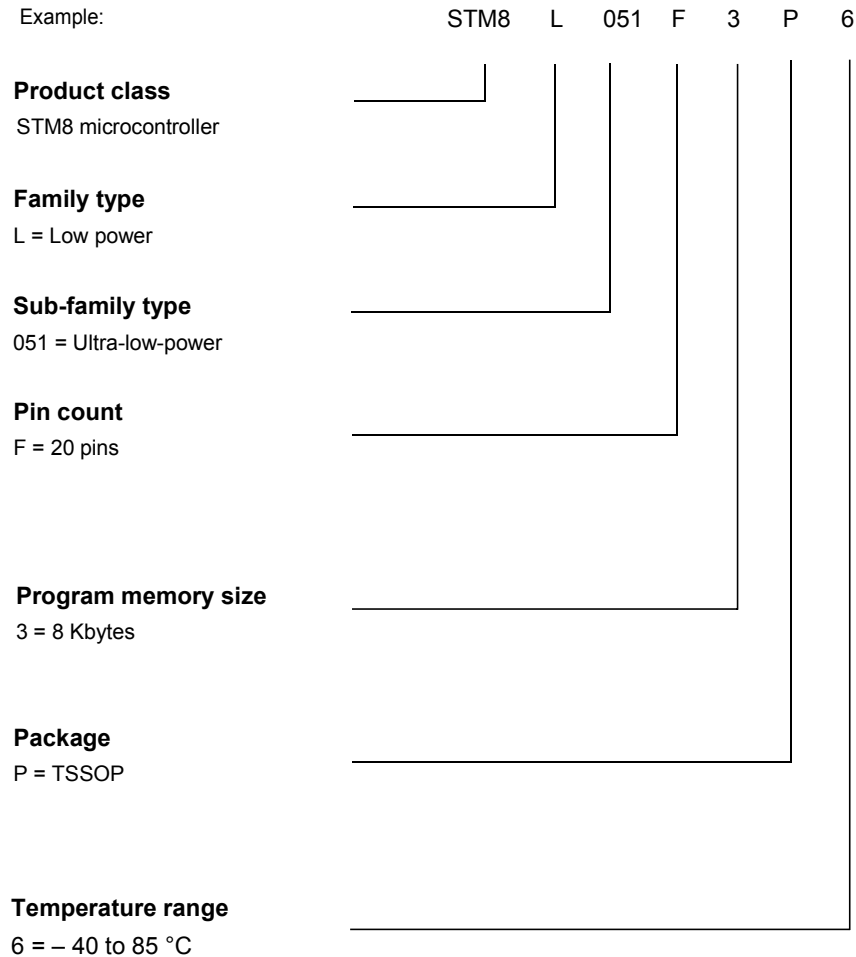
**Table 53. Thermal characteristics<sup>(1)</sup>**

| Symbol        | Parameter                                      | Value | Unit |
|---------------|------------------------------------------------|-------|------|
| $\Theta_{JA}$ | Thermal resistance junction-ambient<br>TSSOP20 | 110   | °C/W |

1. Thermal resistances are based on JEDEC JESD51-2 with 4-layer PCB in a natural convection environment.

## 10 Ordering information

**Figure 41. Low density value line STM8L051F3 ordering information scheme**



For a list of available options (such as memory size, package) and orderable part numbers or for further information on any aspect of this device, please contact the ST sales office nearest to you.

# 11 Revision history

**Table 54. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01-Aug-2012 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 26-Mar-2014 | 2        | Updated TSSOP20 package information<br>Updated pin name related to pin1 and 2 inside <a href="#">Table 4: STM8L051F3 pin description</a><br>Updated inside <a href="#">Table 10: Option byte addresses</a> OPT5 default factory of BOR to 0x00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 04-Jul-2017 | 3        | Updated <ul style="list-style-type: none"> <li>– All document to refer to specific RPN instead to the whole Value line when relevant to make content clearer</li> <li>– Document's title</li> <li>– Footnotes were standardized on <a href="#">Section 8: Electrical parameters</a></li> <li>– Figure on <a href="#">Features</a> on the cover page</li> <li>– <a href="#">Section 1: Introduction</a></li> <li>– <a href="#">Section 2: Description</a></li> <li>– <a href="#">Section 2.2: Ultra-low-power continuum</a></li> <li>– <a href="#">Section 8.2: Absolute maximum ratings</a></li> <li>– <a href="#">Section 9.3: TSSOP20 package information</a></li> <li>– <a href="#">Figure 1: STM8L051F3 block diagram</a></li> <li>– <a href="#">Figure 2: STM8L051F3 clock tree diagram</a></li> <li>– <a href="#">Figure 5: Pin loading conditions</a></li> <li>– <a href="#">Figure 6: Pin input voltage</a></li> <li>– <a href="#">Figure 8: Typ. IDD(RUN) vs. VDD, fCPU = 16 MHz</a></li> <li>– <a href="#">Figure 9: Typ. IDD(Wait) vs. VDD, fCPU = 16 MHz 1)</a></li> <li>– <a href="#">Figure 10: Typ. IDD(LPR) vs. VDD (LSI clock source)</a></li> <li>– <a href="#">Figure 11: Typ. IDD(LPW) vs. VDD (LSI clock source)</a></li> <li>– <a href="#">Figure 13: LSE oscillator circuit diagram</a></li> <li>– <a href="#">Figure 15: Typical LSI frequency vs. VDD</a></li> <li>– <a href="#">Figure 16: Typical VIL and VIH vs VDD (high sink I/Os)</a></li> <li>– <a href="#">Figure 17: Typical VIL and VIH vs VDD (true open drain I/Os)</a></li> <li>– <a href="#">Figure 18: Typical pull-up resistance <math>R_{PU}</math> vs <math>V_{DD}</math> with <math>V_{IN}=V_{SS}</math></a></li> <li>– <a href="#">Figure 19: Typical pull-up current <math>I_{PU}</math> vs <math>V_{DD}</math> with <math>V_{IN}=V_{SS}</math></a></li> <li>– <a href="#">Figure 29: SPI1 timing diagram - slave mode and CPHA=0</a></li> <li>– <a href="#">Figure 30: SPI1 timing diagram - slave mode and CPHA=1<sup>(1)</sup></a></li> <li>– <a href="#">Figure 34: Typical connection diagram using the ADC</a></li> <li>– <a href="#">Figure 35: Maximum dynamic current consumption on <math>V_{REF+}</math> supply pin during ADC conversion</a></li> </ul> |

Table 54. Document revision history

| Date        | Revision     | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 04-Jul-2017 | 3<br>(Cont.) | <p>Updated (continuation):</p> <ul style="list-style-type: none"> <li>– <a href="#">Figure 37: Power supply and reference decoupling (VREF+ connected to VDDA)</a></li> <li>– <a href="#">Figure 38: TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package outline</a></li> <li>– <a href="#">Figure 39: TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch, package footprint</a></li> <li>– <a href="#">Table 25: Current consumption under external reset</a></li> </ul> <p>Added</p> <ul style="list-style-type: none"> <li>– <a href="#">Section : Device marking for TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch</a></li> <li>– <a href="#">Figure 40: Device marking for TSSOP20 – 20-lead thin shrink small outline, 6.5 x 4.4 mm, 0.65 mm pitch example</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                     |
| 07-Sep-2018 | 4            | <p>Updated:</p> <ul style="list-style-type: none"> <li>– <a href="#">12-bit ADC up to 1 Msps/10 channels</a> feature on cover page</li> <li>– <a href="#">Section 3.8: Analog-to-digital converter</a></li> <li>– <a href="#">Table 4: STM8L051F3 pin description</a></li> <li>– <a href="#">Table 7: General hardware register map</a></li> <li>– <a href="#">Table 43: ADC1 characteristics</a></li> <li>– <a href="#">Table 47: <math>R_{AIN}</math> max for <math>f_{ADC} = 16</math> MHz</a></li> <li>– Added introduction to following sections: <ul style="list-style-type: none"> <li><a href="#">Section 3.2: Central processing unit STM8</a></li> <li><a href="#">Section 3.3: Reset and supply management</a></li> <li><a href="#">Section 3.13: Communication interfaces</a></li> <li><a href="#">Section 3.15: Development support</a></li> <li><a href="#">Section 5: Memory and register map</a></li> <li><a href="#">Section 6: Interrupt vector mapping</a></li> <li><a href="#">Section 8: Electrical parameters</a></li> <li><a href="#">Section 8.3.1: General operating conditions</a></li> <li><a href="#">Section 8.3.2: Embedded reset and power control block characteristics</a></li> </ul> </li> </ul> |

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