

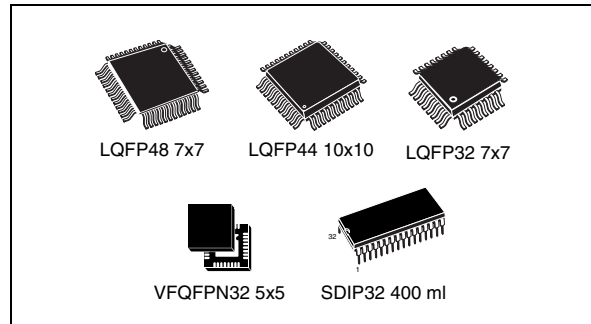


# STM8S105xx

Access line, 16 MHz STM8S 8-bit MCU, up to 32 Kbytes Flash, integrated EEPROM, 10-bit ADC, timers, UART, SPI, I<sup>2</sup>C

## Features

- Core
  - 16 MHz advanced STM8 core with Harvard architecture and 3-stage pipeline
  - Extended instruction set
- Memories
  - Medium-density Flash/EEPROM:
    - Program memory up to 32 Kbytes; data retention 20 years at 55°C after 10 kcycles
    - Data memory up to 1 Kbytes true data EEPROM; endurance 300 kcycles
  - RAM: Up to 2 Kbytes
- Clock, reset and supply management
  - 2.95 V to 5.5 V operating voltage
  - Flexible clock control, 4 master clock sources:
    - Low power crystal resonator oscillator
    - External clock input
    - Internal, user-trimmable 16 MHz RC
    - Internal low power 128 kHz RC
  - Clock security system with clock monitor
  - Power management:
    - Low power modes (wait, active-halt, halt)
    - Switch-off peripheral clocks individually
  - Permanently active, low consumption power-on and power-down reset
- Interrupt management
  - Nested interrupt controller with 32 interrupts
  - Up to 37 external interrupts on 6 vectors
- Timers
  - 2x 16-bit general purpose timers, with 2+3 CAPCOM channels (IC, OC or PWM)
  - Advanced control timer: 16-bit, 4 CAPCOM channels, 3 complementary outputs, dead-time insertion and flexible synchronization
  - 8-bit basic timer with 8-bit prescaler
  - Auto wake-up timer



- Two watchdog timers: Window watchdog and independent watchdog
- Communications interfaces
  - UART with clock output for synchronous operation, Smartcard, IrDA, LIN
  - SPI interface up to 8 Mbit/s
  - I<sup>2</sup>C interface up to 400 Kbit/s
- Analog-to-digital converter (ADC)
  - 10-bit,  $\pm 1$  LSB ADC with up to 10 multiplexed channels, scan mode and analog watchdog
- I/Os
  - Up to 38 I/Os on a 48-pin package including 16 high sink outputs
  - Highly robust I/O design, immune against current injection
- Development support
  - Embedded single wire interface module (SWIM) for fast on-chip programming and non intrusive debugging

Table 1. Device summary

Reference	Part number
STM8S105xx	STM8S105K4, STM8S105K6, STM8S105S4, STM8S105S6, STM8S105C4, STM8S105C6

# Contents

- 1 Introduction ..... 9**
- 2 Description ..... 10**
- 3 Block diagram ..... 11**
- 4 Product overview ..... 12**
  - 4.1 Central processing unit STM8 ..... 12
  - 4.2 Single wire interface module (SWIM) and debug module (DM) ..... 13
  - 4.3 Interrupt controller ..... 13
  - 4.4 Flash program and data EEPROM memory ..... 14
  - 4.5 Clock controller ..... 15
  - 4.6 Power management ..... 17
  - 4.7 Watchdog timers ..... 17
  - 4.8 Auto wakeup counter ..... 18
  - 4.9 Beeper ..... 18
  - 4.10 TIM1 - 16-bit advanced control timer ..... 18
  - 4.11 TIM2, TIM3 - 16-bit general purpose timers ..... 18
  - 4.12 TIM4 - 8-bit basic timer ..... 19
  - 4.13 Analog-to-digital converter (ADC1) ..... 19
  - 4.14 Communication interfaces ..... 19
    - 4.14.1 UART2 ..... 20
    - 4.14.2 SPI ..... 21
    - 4.14.3 I<sup>2</sup>C ..... 21
- 5 Pinouts and pin description ..... 22**
  - 5.1 Alternate function remapping ..... 29
- 6 Memory and register map ..... 30**
  - 6.1 Memory map ..... 30
  - 6.2 Register map ..... 31
- 7 Interrupt vector mapping ..... 42**

<b>8</b>	<b>Option bytes</b> .....	<b>43</b>
<b>9</b>	<b>Electrical characteristics</b> .....	<b>46</b>
9.1	Parameter conditions .....	46
9.1.1	Minimum and maximum values .....	46
9.1.2	Typical values .....	46
9.1.3	Typical curves .....	46
9.1.4	Typical current consumption .....	46
9.1.5	Pin loading conditions .....	47
9.1.6	Loading capacitor .....	47
9.1.7	Pin input voltage .....	47
9.2	Absolute maximum ratings .....	48
9.3	Operating conditions .....	50
9.3.1	VCAP external capacitor .....	51
9.3.2	Supply current characteristics .....	52
9.3.3	External clock sources and timing characteristics .....	61
9.3.4	Internal clock sources and timing characteristics .....	63
9.3.5	Memory characteristics .....	65
9.3.6	I/O port pin characteristics .....	66
9.3.7	Reset pin characteristics .....	73
9.3.8	SPI serial peripheral interface .....	75
9.3.9	I <sup>2</sup> C interface characteristics .....	78
9.3.10	10-bit ADC characteristics .....	80
9.3.11	EMC characteristics .....	83
<b>10</b>	<b>Package characteristics</b> .....	<b>86</b>
10.1	Package mechanical data .....	87
10.1.1	LQFP package mechanical data .....	87
10.1.2	VFQFPN package mechanical data .....	90
10.1.3	SDIP32 package mechanical data .....	91
10.2	Thermal characteristics .....	92
10.2.1	Reference document .....	92
10.2.2	Selecting the product temperature range .....	93
<b>11</b>	<b>Ordering information</b> .....	<b>94</b>
<b>12</b>	<b>STM8 development tools</b> .....	<b>95</b>

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12.1	Emulation and in-circuit debugging tools .....	95
12.2	Software tools .....	96
12.2.1	STM8 toolset .....	96
12.2.2	C and assembly toolchains .....	96
12.3	Programming tools .....	96
<b>13</b>	<b>Revision history .....</b>	<b>97</b>

## List of tables

Table 1.	Device summary . . . . .	1
Table 2.	STM8S105xx access line features . . . . .	10
Table 3.	Peripheral clock gating bit assignments in CLK_PCKENR1/2 registers . . . . .	16
Table 4.	TIM timer features . . . . .	19
Table 5.	Legend/abbreviations . . . . .	25
Table 6.	Pin description for STM8S105 microcontrollers . . . . .	26
Table 7.	Flash, Data EEPROM and RAM boundary addresses . . . . .	31
Table 8.	I/O port hardware register map . . . . .	31
Table 9.	General hardware register map . . . . .	33
Table 10.	CPU/SWIM/debug module/interrupt controller registers . . . . .	40
Table 11.	Interrupt mapping . . . . .	42
Table 12.	Option bytes . . . . .	43
Table 13.	Option byte description . . . . .	44
Table 14.	Description of alternate function remapping bits [7:0] of OPT2 . . . . .	45
Table 15.	Voltage characteristics . . . . .	48
Table 16.	Current characteristics . . . . .	49
Table 17.	Thermal characteristics . . . . .	49
Table 18.	General operating conditions . . . . .	50
Table 19.	Operating conditions at power-up/power-down . . . . .	51
Table 20.	Total current consumption with code execution in run mode at $V_{DD} = 5\text{ V}$ . . . . .	52
Table 21.	Total current consumption with code execution in run mode at $V_{DD} = 3.3\text{ V}$ . . . . .	53
Table 22.	Total current consumption in wait mode at $V_{DD} = 5\text{ V}$ . . . . .	54
Table 23.	Total current consumption in wait mode at $V_{DD} = 3.3\text{ V}$ . . . . .	54
Table 24.	Total current consumption in active halt mode at $V_{DD} = 5\text{ V}$ . . . . .	55
Table 25.	Total current consumption in active halt mode at $V_{DD} = 3.3\text{ V}$ . . . . .	55
Table 26.	Total current consumption in halt mode at $V_{DD} = 5\text{ V}$ . . . . .	56
Table 27.	Total current consumption in halt mode at $V_{DD} = 3.3\text{ V}$ . . . . .	56
Table 28.	Wakeup times . . . . .	57
Table 29.	Total current consumption and timing in forced reset state . . . . .	57
Table 30.	Peripheral current consumption . . . . .	58
Table 31.	HSE user external clock characteristics . . . . .	61
Table 32.	HSE oscillator characteristics . . . . .	62
Table 33.	HSI oscillator characteristics . . . . .	63
Table 34.	LSI oscillator characteristics . . . . .	64
Table 35.	RAM and hardware registers . . . . .	65
Table 36.	Flash program memory/data EEPROM memory . . . . .	65
Table 37.	I/O static characteristics . . . . .	66
Table 38.	Output driving current (standard ports) . . . . .	68
Table 39.	Output driving current (true open drain ports) . . . . .	68
Table 40.	Output driving current (high sink ports) . . . . .	68
Table 41.	NRST pin characteristics . . . . .	73
Table 42.	SPI characteristics . . . . .	75
Table 43.	I <sup>2</sup> C characteristics . . . . .	78
Table 44.	ADC characteristics . . . . .	80
Table 45.	ADC accuracy with $R_{AIN} < 10\text{ k}\Omega$ , $V_{DDA} = 5\text{ V}$ . . . . .	81
Table 46.	ADC accuracy with $R_{AIN} < 10\text{ k}\Omega$ , $R_{AIN}$ , $V_{DDA} = 3.3\text{ V}$ . . . . .	81
Table 47.	EMS data . . . . .	83
Table 48.	EMI data . . . . .	84

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Table 49.	ESD absolute maximum ratings . . . . .	84
Table 50.	Electrical sensitivities . . . . .	85
Table 51.	48-pin low profile quad flat package mechanical data . . . . .	87
Table 52.	44-pin low profile quad flat package mechanical data . . . . .	88
Table 53.	32-pin low profile quad flat package mechanical data . . . . .	89
Table 54.	32-lead very thin fine pitch quad flat no-lead package mechanical data . . . . .	90
Table 55.	32-lead shrink plastic DIP (400 ml) package mechanical data . . . . .	91
Table 56.	Thermal characteristics . . . . .	92
Table 57.	Document revision history . . . . .	97

## List of figures

Figure 1.	STM8S105xx access line block diagram	11
Figure 2.	Flash memory organisation	15
Figure 3.	LQFP 48-pin pinout	22
Figure 4.	LQFP 44-pin pinout	23
Figure 5.	VFQFPN32/LQFP 32-pin pinout	24
Figure 6.	SDIP32-pin pinout	25
Figure 7.	Memory map	30
Figure 8.	Supply current measurement conditions	46
Figure 9.	Pin loading conditions	47
Figure 10.	Pin input voltage	47
Figure 11.	$f_{CPUmax}$ versus $V_{DD}$	51
Figure 12.	External capacitor $C_{EXT}$	51
Figure 13.	Typ. $I_{DD(RUN)}$ vs. $V_{DD}$ , HSE user external clock, $f_{CPU} = 16$ MHz	59
Figure 14.	Typ. $I_{DD(RUN)}$ vs. $f_{CPU}$ , HSE user external clock, $V_{DD} = 5$ V	59
Figure 15.	Typ. $I_{DD(RUN)}$ vs. $V_{DD}$ , HSI RC osc, $f_{CPU} = 16$ MHz	59
Figure 16.	Typ. $I_{DD(WFI)}$ vs. $V_{DD}$ , HSE user external clock, $f_{CPU} = 16$ MHz	60
Figure 17.	Typ. $I_{DD(WFI)}$ vs. $f_{CPU}$ , HSE user external clock, $V_{DD} = 5$ V	60
Figure 18.	Typ. $I_{DD(WFI)}$ vs. $V_{DD}$ , HSI RC osc, $f_{CPU} = 16$ MHz	60
Figure 19.	HSE external clock source	61
Figure 20.	HSE oscillator circuit diagram	62
Figure 21.	Typical HSI accuracy at $V_{DD} = 5$ V vs 5 temperatures	63
Figure 22.	Typical HSI accuracy vs $V_{DD}$ @ 4 temperatures	64
Figure 23.	Typical LSI accuracy vs $V_{DD}$ @ 4 temperatures	64
Figure 24.	Typical $V_{IL}$ and $V_{IH}$ vs $V_{DD}$ @ 4 temperatures	67
Figure 25.	Typical pull-up resistance vs $V_{DD}$ @ 4 temperatures	67
Figure 26.	Typical pull-up current vs $V_{DD}$ @ 4 temperatures	67
Figure 27.	Typ. $V_{OL}$ @ $V_{DD} = 5$ V (standard ports)	69
Figure 28.	Typ. $V_{OL}$ @ $V_{DD} = 3.3$ V (standard ports)	69
Figure 29.	Typ. $V_{OL}$ @ $V_{DD} = 5$ V (true open drain ports)	69
Figure 30.	Typ. $V_{OL}$ @ $V_{DD} = 3.3$ V (true open drain ports)	70
Figure 31.	Typ. $V_{OL}$ @ $V_{DD} = 5$ V (high sink ports)	70
Figure 32.	Typ. $V_{OL}$ @ $V_{DD} = 3.3$ V (high sink ports)	70
Figure 33.	Typ. $V_{DD} - V_{OH}$ @ $V_{DD} = 5$ V (standard ports)	71
Figure 34.	Typ. $V_{DD} - V_{OH}$ @ $V_{DD} = 3.3$ V (standard ports)	71
Figure 35.	Typ. $V_{DD} - V_{OH}$ @ $V_{DD} = 5$ V (high sink ports)	71
Figure 36.	Typ. $V_{DD} - V_{OH}$ @ $V_{DD} = 3.3$ V (high sink ports)	72
Figure 37.	Typical NRST $V_{IL}$ and $V_{IH}$ vs $V_{DD}$ @ 4 temperatures	73
Figure 38.	Typical NRST pull-up resistance vs $V_{DD}$ @ 4 temperatures	73
Figure 39.	Typical NRST pull-up current vs $V_{DD}$ @ 4 temperatures	74
Figure 40.	Recommended reset pin protection	74
Figure 41.	SPI timing diagram - slave mode and $CPHA = 0$	76
Figure 42.	SPI timing diagram - slave mode and $CPHA = 1^{(1)}$	76
Figure 43.	SPI timing diagram - master mode <sup>(1)</sup>	77
Figure 44.	Typical application with I2C bus and timing diagram 1)	79
Figure 45.	ADC accuracy characteristics	82
Figure 46.	Typical application with ADC	82
Figure 47.	48-pin low profile quad flat package (7 x 7)	87
Figure 48.	44-pin low profile quad flat package (10 x 10)	88

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Figure 49.	32-pin low profile quad flat package (7 x 7) .....	89
Figure 50.	32-lead very thin fine pitch quad flat no-lead package (5 x 5) .....	90
Figure 51.	32-lead shrink plastic DIP (400 ml) package .....	91
Figure 52.	STM8S105xx access line ordering information scheme .....	94



# 1 Introduction

This datasheet contains the description of the STM8S105xx access line features, pinout, electrical characteristics, mechanical data and ordering information.

- For complete information on the STM8S microcontroller memory, registers and peripherals, please refer to the STM8S microcontroller family reference manual (RM0016).
- For information on programming, erasing and protection of the internal Flash memory please refer to the STM8S Flash programming manual (PM0051).
- For information on the debug 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, please refer to the STM8 CPU programming manual (PM0044).

## 2 Description

The STM8S105xx access line 8-bit microcontrollers offer from 16 to 32 Kbytes Flash program memory, plus integrated true data EEPROM. They are referred to as medium-density devices in the STM8S microcontroller family reference manual (RM0016).

All devices of the STM8S105xx access line provide the following benefits:

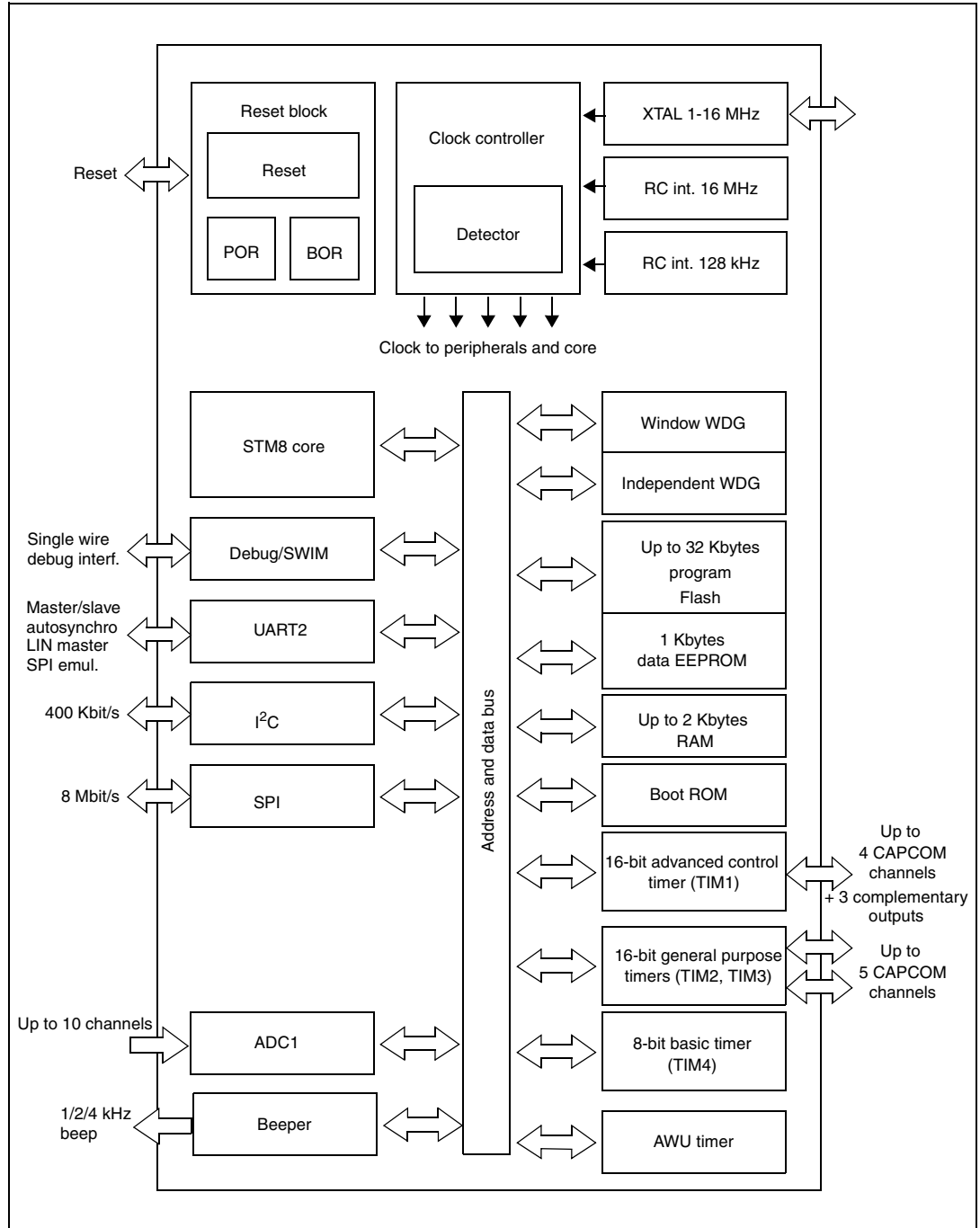
- Reduced system cost
  - Integrated true data EEPROM for up to 300 k write/erase cycles
  - High system integration level with internal clock oscillators, watchdog and brown-out reset.
- Performance and robustness
  - 16 MHz CPU clock frequency
  - Robust I/O, independent watchdogs with separate clock source
  - Clock security system
- Short development cycles
  - Applications scalability across a common family product architecture with compatible pinout, memory map and modular peripherals.
  - Full documentation and a wide choice of development tools
- Product longevity
  - Advanced core and peripherals made in a state-of-the art technology
  - A family of products for applications with 2.95 V to 5.5 V operating supply

**Table 2. STM8S105xx access line features**

Device	Pin count	No. of maximum GPIO (I/O)	Ext. Interrupt pins	Timer CAPCOM channels	Timer complementary outputs	A/D Converter channels	High sink I/Os	Medium density Flash Program memory (bytes)	Data EEPROM (bytes)	RAM (bytes)	Peripheral set
STM8S105C6	48	38	35	9	3	10	16	32K	1024	2K	Advanced control timer (TIM1), General-purpose timers (TIM2 and TIM3), Basic timer (TIM4) SPI, I <sup>2</sup> C, UART, Window WDG, Independent WDG, ADC
STM8S105C4	48	38	35	9	3	10	16	16K	1024	2K	
STM8S105S6	44	34	31	8	3	9	15	32K	1024	2K	
STM8S105S4	44	34	31	8	3	9	15	16K	1024	2K	
STM8S105K6	32	25	23	8	3	7	12	32K	1024	2K	
STM8S105K4	32	25	23	8	3	7	12	16K	1024	2K	

### 3 Block diagram

Figure 1. STM8S105xx access line block diagram



## 4 Product overview

The following section intends to give an overview of the basic features of the STM8S105xx access line functional modules and peripherals.

For more detailed information please refer to the corresponding family reference manual (RM0016).

### 4.1 Central processing unit STM8

The 8-bit STM8 core is designed for code efficiency and performance.

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 for 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 K-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 look-up 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

## 4.2 Single wire interface module (SWIM) and debug module (DM)

The single wire interface module and debug module permits non-intrusive, real-time in-circuit debugging and fast memory programming.

### SWIM

Single wire interface module for direct access to the debug module and memory programming. The interface can be activated in all device operation modes. The maximum data transmission speed is 145 bytes/ms.

### Debug module

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

- R/W to RAM and peripheral registers in real-time
- R/W access to all resources by stalling the CPU
- Breakpoints on all program-memory instructions (software breakpoints)
- Two advanced breakpoints, 23 predefined configurations

## 4.3 Interrupt controller

- Nested interrupts with three software priority levels
- 32 interrupt vectors with hardware priority
- Up to 37 external interrupts on six vectors including TLI
- Trap and reset interrupts

## 4.4 Flash program and data EEPROM memory

- Up to 32 Kbytes of Flash program single voltage Flash memory
- Up to 1 K bytes true data EEPROM
- Read while write: Writing in data memory possible while executing code in program memory.
- User option byte area

### Write protection (WP)

Write protection of Flash program memory and data EEPROM is provided to avoid unintentional overwriting of memory that could result from a user software malfunction.

There are two levels of write protection. The first level is known as MASS (memory access security system). MASS is always enabled and protects the main Flash program memory, data EEPROM and option bytes.

To perform in-application programming (IAP), this write protection can be removed by writing a MASS key sequence in a control register. This allows the application to write to data EEPROM, modify the contents of main program memory or the device option bytes.

A second level of write protection, can be enabled to further protect a specific area of memory known as UBC (user boot code). Refer to [Figure 2](#).

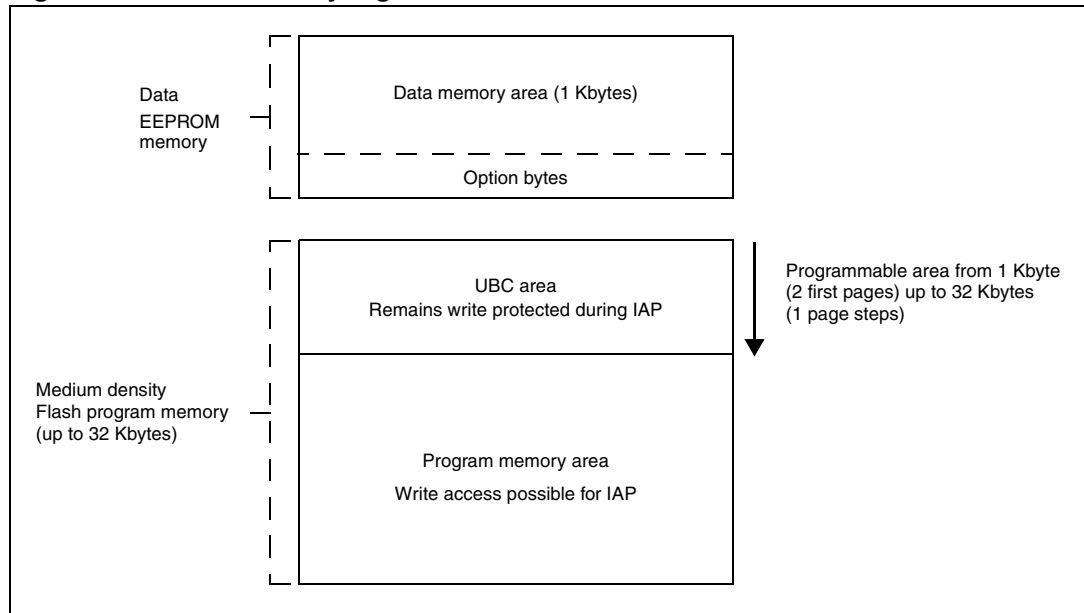
The size of the UBC is programmable through the UBC option byte ([Table 13](#)), in increments of 1 page (512 bytes) by programming the UBC option byte in ICP mode.

This divides the program memory into two areas:

- Main program memory: Up to 32 Kbytes minus UBC
- User-specific boot code (UBC): Configurable up to 32 Kbytes

The UBC area remains write-protected during in-application programming. This means that the MASS keys do not unlock the UBC area. It protects the memory used to store the boot program, specific code libraries, reset and interrupt vectors, the reset routine and usually the IAP and communication routines.

**Figure 2. Flash memory organisation**



**Read-out protection (ROP)**

The read-out protection blocks reading and writing the Flash program memory and data EEPROM memory in ICP mode (and debug mode). Once the read-out protection is activated, any attempt to toggle its status triggers a global erase of the program and data memory. Even if no protection can be considered as totally unbreakable, the feature provides a very high level of protection for a general purpose microcontroller.

**4.5 Clock controller**

The clock controller distributes the system clock ( $f_{MASTER}$ ) 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 run mode through a configuration register. The clock signal is not switched until the new clock source is ready. The design guarantees glitch-free switching.
- **Clock management:** To reduce power consumption, the clock controller can stop the clock to the core, individual peripherals or memory.
- **Master clock sources:** Four different clock sources can be used to drive the master clock:
  - 1-16 MHz high-speed external crystal (HSE)
  - Up to 16 MHz high-speed user-external clock (HSE user-ext)
  - 16 MHz high-speed internal RC oscillator (HSI)
  - 128 kHz low-speed internal RC (LSI)
- **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 an HSE clock failure occurs, the internal RC (16 MHz/8) is automatically selected by the CSS and an interrupt can optionally be generated.
- **Configurable main clock output (CCO):** This outputs an external clock for use by the application.

**Table 3. Peripheral clock gating bit assignments in CLK\_PCKENR1/2 registers**

Bit	Peripheral clock	Bit	Peripheral clock	Bit	Peripheral clock	Bit	Peripheral clock
PCKEN17	TIM1	PCKEN13	UART2	PCKEN27	Reserved	PCKEN23	ADC
PCKEN16	TIM2	PCKEN12	Reserved	PCKEN26	Reserved	PCKEN22	AWU
PCKEN15	TIM3	PCKEN11	SPI	PCKEN25	Reserved	PCKEN21	Reserved
PCKEN14	TIM4	PCKEN10	I <sup>2</sup> C	PCKEN24	Reserved	PCKEN20	Reserved



## 4.6 Power management

For efficient power management, the application can be put in one of four different low-power modes. You can configure each mode to obtain the best compromise between lowest power consumption, fastest start-up time and available wakeup sources.

- **Wait mode:** In this mode, the CPU is stopped, but peripherals are kept running. The wakeup is performed by an internal or external interrupt or reset.
- **Active halt mode with regulator on:** In this mode, the CPU and peripheral clocks are stopped. An internal wakeup is generated at programmable intervals by the auto wake up unit (AWU). The main voltage regulator is kept powered on, so current consumption is higher than in active halt mode with regulator off, but the wakeup time is faster. Wakeup is triggered by the internal AWU interrupt, external interrupt or reset.
- **Active halt mode with regulator off:** This mode is the same as active halt with regulator on, except that the main voltage regulator is powered off, so the wake up time is slower.
- **Halt mode:** In this mode the microcontroller uses the least power. The CPU and peripheral clocks are stopped, the main voltage regulator is powered off. Wakeup is triggered by external event or reset.

## 4.7 Watchdog timers

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

Activation of the watchdog timers is controlled by option bytes or by software. Once activated, the watchdogs cannot be disabled by the user program without performing a reset.

### Window watchdog timer

The window watchdog 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.

The window function can be used to trim the watchdog behavior to match the application perfectly.

The application software must refresh the counter before time-out and during a limited time window.

A reset is generated in two situations:

1. Timeout: At 16 MHz CPU clock the time-out period can be adjusted between 75  $\mu$ s up to 64 ms.
2. Refresh out of window: The downcounter is refreshed before its value is lower than the one stored in the window register.

### Independent watchdog timer

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

It is clocked by the 128 kHz LSI internal RC clock source, and thus stays active even in case of a CPU clock failure

The IWDG time base spans from 60  $\mu$ s to 1 s.

## 4.8 Auto wakeup counter

- Used for auto wakeup from active halt mode
- Clock source: Internal 128 kHz internal low frequency RC oscillator or external clock
- LSI clock can be internally connected to TIM3 input capture channel 1 for calibration

## 4.9 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.

## 4.10 TIM1 - 16-bit advanced control timer

This is a high-end timer designed for a wide range of control applications. With its complementary outputs, dead-time control and center-aligned PWM capability, the field of applications is extended to motor control, lighting and half-bridge driver.

- 16-bit up, down and up/down autoreload counter with 16-bit prescaler
- Four independent capture/compare channels (CAPCOM) configurable as input capture, output compare, PWM generation (edge and center aligned mode) and single pulse mode output
- Synchronization module to control the timer with external signals
- Break input to force the timer outputs into a defined state
- Three complementary outputs with adjustable dead time
- Encoder mode
- Interrupt sources: 3 x input capture/output compare, 1 x overflow/update, 1 x break

## 4.11 TIM2, TIM3 - 16-bit general purpose timers

- 16-bit autoreload (AR) up-counter
- 15-bit prescaler adjustable to fixed power of 2 ratios 1...32768
- Timers with 3 or 2 individually configurable capture/compare channels
- PWM mode
- Interrupt sources: 2 or 3 x input capture/output compare, 1 x overflow/update

## 4.12 TIM4 - 8-bit basic timer

- 8-bit autoreload, adjustable prescaler ratio to any power of 2 from 1 to 128
- Clock source: CPU clock
- Interrupt source: 1 x overflow/update

Table 4. TIM timer features

Timer	Counter size (bits)	Prescaler	Counting mode	CAPCOM channels	Complem. outputs	Ext. trigger	Timer synchronization/chaining
TIM1	16	Any integer from 1 to 65536	Up/down	4	3	Yes	No
TIM2	16	Any power of 2 from 1 to 32768	Up	3	0	No	
TIM3	16	Any power of 2 from 1 to 32768	Up	2	0	No	
TIM4	8	Any power of 2 from 1 to 128	Up	0	0	No	

## 4.13 Analog-to-digital converter (ADC1)

STM8S105xx products contain a 10-bit successive approximation A/D converter (ADC1) with up to 10 multiplexed input channels and the following main features:

- Input voltage range: 0 to  $V_{DDA}$
- Conversion time: 14 clock cycles
- Single and continuous and buffered continuous conversion modes
- Buffer size ( $n \times 10$  bits) where  $x$  = number of input channels
- Scan mode for single and continuous conversion of a sequence of channels
- Analog watchdog capability with programmable upper and lower thresholds
- Analog watchdog interrupt
- External trigger input
- Trigger from TIM1 TRGO
- End of conversion (EOC) interrupt

## 4.14 Communication interfaces

The following communication interfaces are implemented:

- UART2: Full feature UART, synchronous mode, SPI master mode, Smartcard mode, IrDA mode, LIN2.1 master/slave capability
- SPI : Full and half-duplex, 8 Mbit/s
- I<sup>2</sup>C: Up to 400 Kbit/s

### 4.14.1 UART2

#### Main features

- One Mbit/s full duplex SCI
- SPI emulation
- High precision baud rate generator
- Smartcard emulation
- IrDA SIR encoder decoder
- LIN master mode
- LIN slave mode

#### Asynchronous communication (UART mode)

- Full duplex communication - NRZ standard format (mark/space)
- Programmable transmit and receive baud rates up to 1 Mbit/s ( $f_{CPU}/16$ ) and capable of following any standard baud rate regardless of the input frequency
- Separate enable bits for transmitter and receiver
- Two receiver wakeup modes:
  - Address bit (MSB)
  - Idle line (interrupt)
- Transmission error detection with interrupt generation
- Parity control

#### Synchronous communication

- Full duplex synchronous transfers
- SPI master operation
- 8-bit data communication
- Maximum speed: 1 Mbit/s at 16 MHz ( $f_{CPU}/16$ )

#### LIN master mode

- Emission: Generates 13-bit synch break frame
- Reception: Detects 11-bit break frame

#### LIN slave mode

- Autonomous header handling - one single interrupt per valid message header
- Automatic baud rate synchronization - maximum tolerated initial clock deviation  $\pm 15\%$
- Synch delimiter checking
- 11-bit LIN synch break detection - break detection always active
- Parity check on the LIN identifier field
- LIN error management
- Hot plugging support

#### 4.14.2 SPI

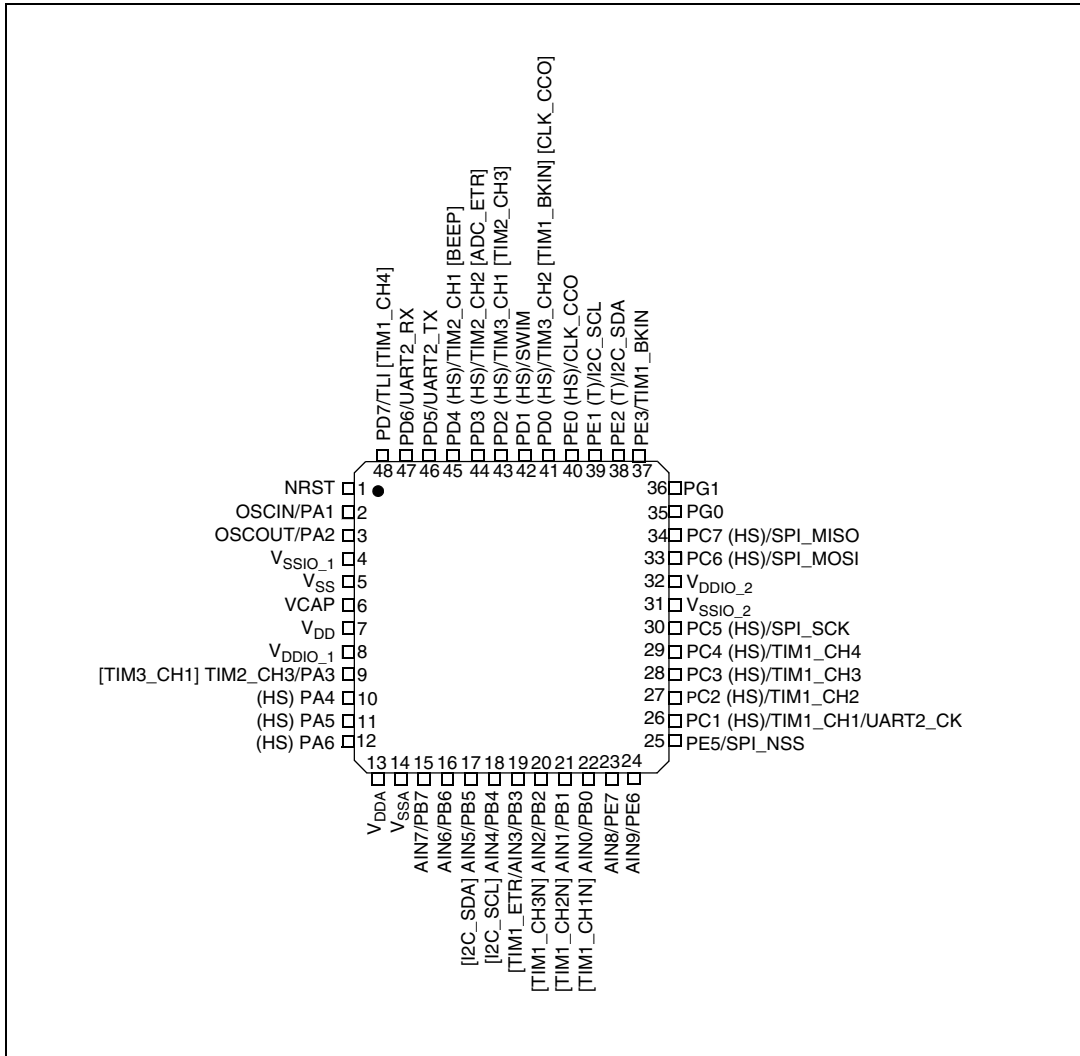
- Maximum speed: 8 Mbit/s ( $f_{\text{MASTER}}/2$ ) both for master and slave
- Full duplex synchronous transfers
- Simplex synchronous transfers on two lines with a possible bidirectional data line
- Master or slave operation - selectable by hardware or software
- CRC calculation
- 1 byte Tx and Rx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

#### 4.14.3 I<sup>2</sup>C

- I<sup>2</sup>C master features:
  - Clock generation
  - Start and stop generation
- I<sup>2</sup>C slave features:
  - Programmable I<sup>2</sup>C address detection
  - Stop bit detection
- Generation and detection of 7-bit/10-bit addressing and general call
- Supports different communication speeds:
  - Standard speed (up to 100 kHz)
  - Fast speed (up to 400 kHz)

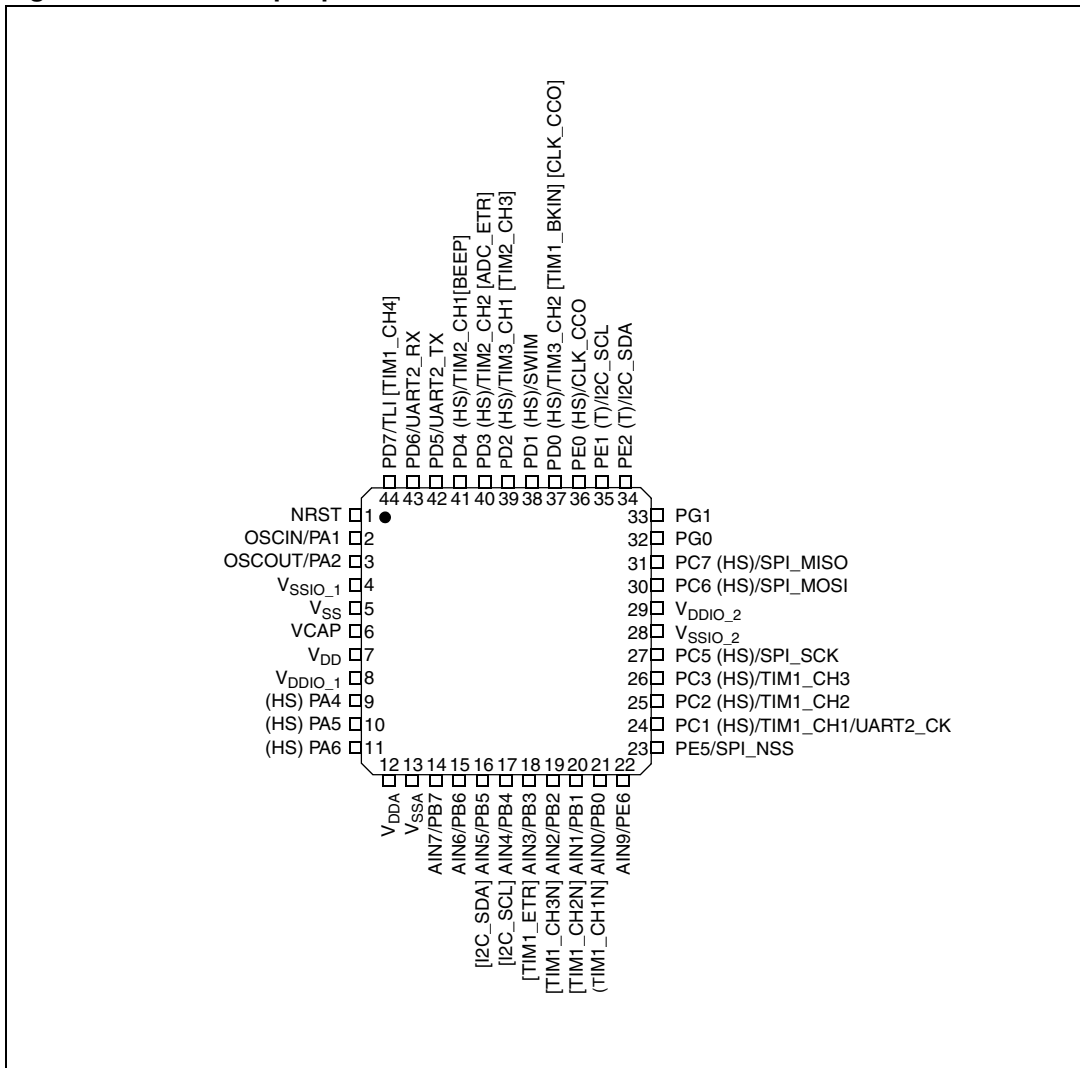
# 5 Pinouts and pin description

Figure 3. LQFP 48-pin pinout



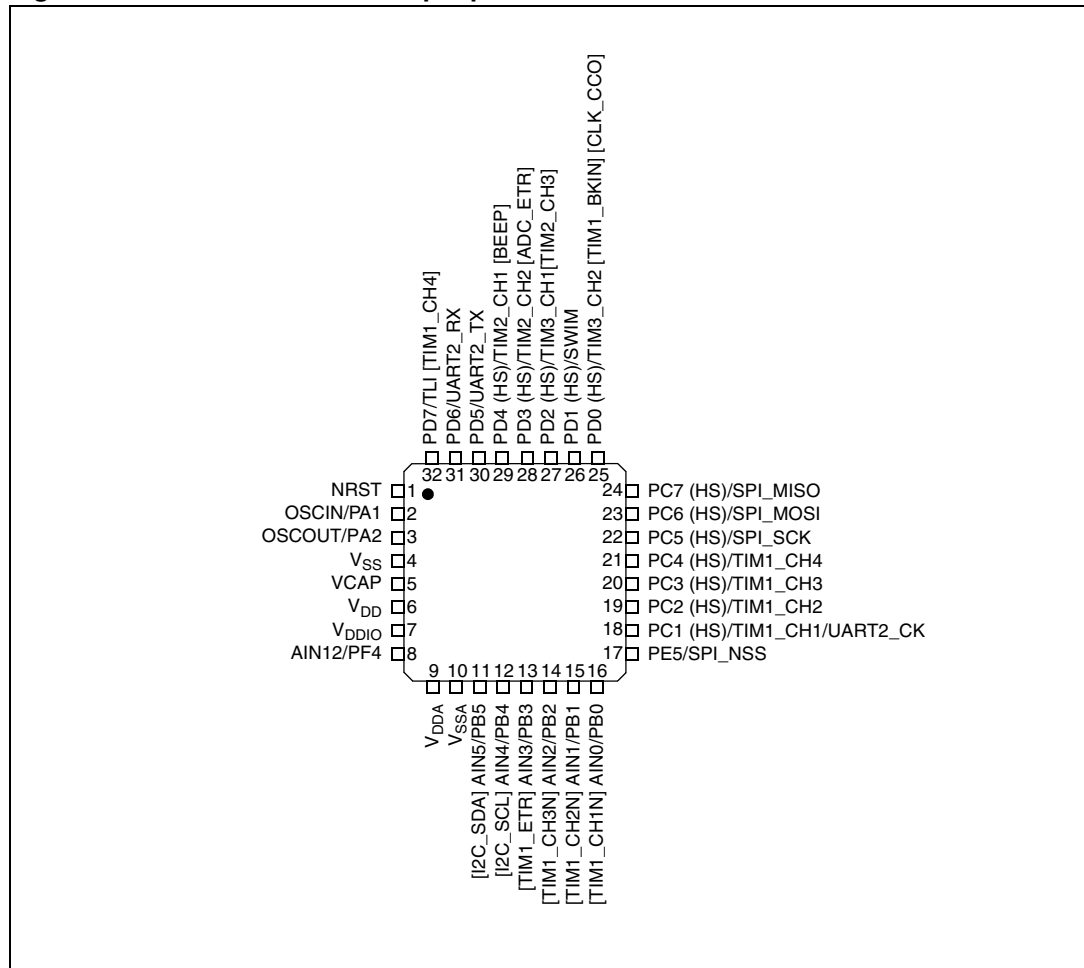
1. (HS) high sink capability.
2. (T) True open drain (P-buffer and protection diode to V<sub>DD</sub> not implemented).
3. [ ] alternate function remapping option (If the same alternate function is shown twice, it indicates an exclusive choice not a duplication of the function).

Figure 4. LQFP 44-pin pinout



- 1. (HS) high sink capability.
- 2. (T) True open drain (P-buffer and protection diode to V<sub>DD</sub> not implemented).
- 3. [ ] alternate function remapping option (If the same alternate function is shown twice, it indicates an exclusive choice not a duplication of the function).

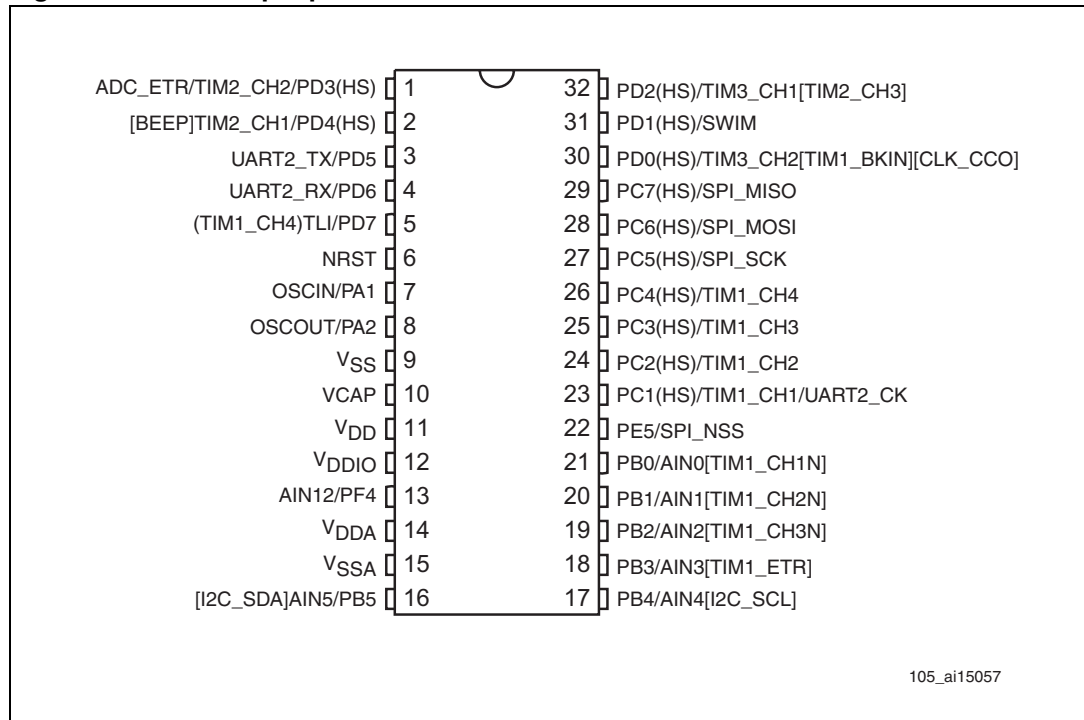
Figure 5. VFQFPN32/LQFP 32-pin pinout



1. (HS) high sink capability.
2. [ ] alternate function remapping option (If the same alternate function is shown twice, it indicates an exclusive choice not a duplication of the function).



**Figure 6. SDIP32-pin pinout**



105\_ai15057

1. (HS) high sink capability.
2. (T) True open drain (P-buffer and protection diode to V<sub>DD</sub> not implemented).
3. [ ] alternate function remapping option (If the same alternate function is shown twice, it indicates an exclusive choice not a duplication of the function).

**Table 5. Legend/abbreviations**

<b>Type</b>	I= Input, O = Output, S = Power supply	
<b>Level</b>	Input	CM = CMOS
	Output	HS = High sink
<b>Output speed</b>	O1 = Slow (up to 2 MHz) O2 = Fast (up to 10 MHz) O3 = Fast/slow programmability with slow as default state after reset O4 = Fast/slow programmability with fast as default state after reset	
<b>Port and control configuration</b>	Input	float = floating, wpu = weak pull-up
	Output	T = True open drain, OD = Open drain, PP = Push pull
<b>Reset state</b>	Bold X	

Table 6. Pin description for STM8S105 microcontrollers

Pin number				Pin name	Type	Input			Output				Main function (after reset)	Default alternate function	Alternate function after remap [option bit]
LQFP48	LQFP44	VFQFPN32/LQFP32	SDIP32			floating	wpu	Ext. interrupt	High sink	Speed	OD	PP			
1	1	1	6	NRST	I/O		X						Reset		
2	2	2	7	PA1/OSCIN	I/O	X	X		O1	X	X	Port A1	Resonator/crystal in		
3	3	3	8	PA2/OSCOOUT	I/O	X	X	X	O1	X	X	Port A2	Resonator/crystal out		
4	4	-	-	V <sub>SSIO_1</sub>	S								I/O ground		
5	5	4	9	V <sub>SS</sub>	S								Digital ground		
6	6	5	10	VCAP	S								1.8 V regulator capacitor		
7	7	6	11	V <sub>DD</sub>	S								Digital power supply		
8	8	7	12	V <sub>DDIO_1</sub>	S								I/O power supply		
9	-	-	-	PA3/TIM2_CH3 [TIM3_CH1]	I/O	X	X	X	O1	X	X	Port A3	Timer 2 - channel3	TIM3_CH1 [AFR1]	
10	9	-	-	PA4	I/O	X	X	X	HS	O3	X	X	Port A4		
11	10	-	-	PA5	I/O	X	X	X	HS	O3	X	X	Port A5		
12	11	-	-	PA6	I/O	X	X	X	HS	O3	X	X	Port A6		
-	-	8	13	PF4/AIN12	I/O	X	X		O1	X	X	Port F4	Analog input 12 <sup>(1)</sup>		
13	12	9	14	V <sub>DDA</sub>	S								Analog power supply		
14	13	10	15	V <sub>SSA</sub>	S								Analog ground		
15	14	-	-	PB7/AIN7	I/O	X	X	X	O1	X	X	Port B7	Analog input 7		
16	15	-	-	PB6/AIN6	I/O	X	X	X	O1	X	X	Port B6	Analog input 6		
17	16	11	16	PB5/AIN5 [I <sup>2</sup> C_SDA]	I/O	X	X	X	O1	X	X	Port B5	Analog input 5	I <sup>2</sup> C_SDA [AFR6]	
18	17	12	17	PB4/AIN4 [I <sup>2</sup> C_SCL]	I/O	X	X	X	O1	X	X	Port B4	Analog input 4	I <sup>2</sup> C_SCL [AFR6]	
19	18	13	18	PB3/AIN3 [TIM1_ETR]	I/O	X	X	X	O1	X	X	Port B3	Analog input 3	TIM1_ETR [AFR5]	
20	19	14	19	PB2/AIN2 [TIM1_CH3N]	I/O	X	X	X	O1	X	X	Port B2	Analog input	TIM1_CH3N [AFR5]	
21	20	15	20	PB1/AIN1 [TIM1_CH2N]	I/O	X	X	X	O1	X	X	Port B1	Analog input 1	TIM1_CH2N [AFR5]	

Table 6. Pin description for STM8S105 microcontrollers (continued)

Pin number				Pin name	Type	Input			Output				Main function (after reset)	Default alternate function	Alternate function after remap [option bit]
LQFP48	LQFP44	VFQFPN32/LQFP32	SDIP32			floating	wpu	Ext. interrupt	High sink	Speed	OD	PP			
22	21	16	21	PB0/AIN0 [TIM1_CH1N]	I/O	X	X	X		O1	X	X	Port B0	Analog input 0	TIM1_CH1N [AFR5]
23	-	-	-	PE7/AIN8	I/O	X	X	X		O1	X	X	Port E7	Analog input 8	
24	22	-	-	PE6/AIN9	I/O	X	X	X		O1	X	X	Port E6	Analog input 9 <sup>(2)</sup>	
25	23	17	22	PE5/SPI_NSS	I/O	X	X	X		O1	X	X	Port E5	SPI master/slave select	
26	24	18	23	PC1/TIM1_CH1/ UART2_CK	I/O	X	X	X	HS	O3	X	X	Port C1	Timer 1 - channel 1/ UART2 synchronous clock	
27	25	19	24	PC2/TIM1_CH2	I/O	X	X	X	HS	O3	X	X	Port C2	Timer 1 - channel 2	
28	26	20	25	PC3/TIM1_CH3	I/O	X	X	X	HS	O3	X	X	Port C3	Timer 1 - channel 3	
29	-	21	26	PC4/TIM1_CH4	I/O	X	X	X	HS	O3	X	X	Port C4	Timer 1 - channel 4	
30	27	22	27	PC5/SPI_SCK	I/O	X	X	X	HS	O3	X	X	Port C5	SPI clock	
31	28	-	-	V <sub>SSIO_2</sub>	S									I/O ground	
32	29	-	-	V <sub>DDIO_2</sub>	S									I/O power supply	
33	30	23	28	PC6/SPI_MOSI	I/O	X	X	X	HS	O3	X	X	Port C6	SPI master out/ slave in	
34	31	24	29	PC7/SPI_MISO	I/O	X	X	X	HS	O3	X	X	Port C7	SPI master in/ slave out	
35	32	-	-	PG0	I/O	X	X			O1	X	X	Port G0		
36	33	-	-	PG1	I/O	X	X			O1	X	X	Port G1		
37	-	-	-	PE3/TIM1_BKIN	I/O	X	X	X		O1	X	X	Port E3	Timer 1 - break input	
38	34	-	-	PE2/I <sup>2</sup> C_SDA	I/O	X		X		O1	T <sup>(3)</sup>		Port E2	I <sup>2</sup> C data	
39	35	-	-	PE1/I <sup>2</sup> C_SCL	I/O	X		X		O1	T <sup>(3)</sup>		Port E1	I <sup>2</sup> C clock	
40	36	-	-	PE0/CLK_CCO	I/O	X	X	X	HS	O3	X	X	Port E0	Configurable clock output	

Table 6. Pin description for STM8S105 microcontrollers (continued)

Pin number				Pin name	Type	Input			Output				Main function (after reset)	Default alternate function	Alternate function after remap [option bit]
LQFP48	LQFP44	VQFPN32/LQFP32	SDIP32			floating	wpu	Ext. interrupt	High sink	Speed	OD	PP			
41	37	25	30	PD0/TIM3_CH2 [TIM1_BKIN] [CLK_CCO]	I/O	X	X	X	HS	O3	X	X	Port D0	Timer 3 - channel 2	TIM1_BKIN [AFR3]/ CLK_CCO [AFR2]
42	38	26	31	PD1/SWIM	I/O	X	X	X	HS	O4	X	X	Port D1	SWIM data interface	
43	39	27	32	PD2/TIM3_CH1 [TIM2_CH3]	I/O	X	X	X	HS	O3	X	X	Port D2	Timer 3 - channel 1	TIM2_CH3 [AFR1]
44	40	28	1	PD3/TIM2_CH2 [ADC_ETR]	I/O	X	X	X	HS	O3	X	X	Port D3	Timer 2 - channel 2	ADC_ETR [AFR0]
45	41	29	2	PD4/TIM2_CH1 [BEEP]	I/O	X	X	X	HS	O3	X	X	Port D4	Timer 2 - channel 1	BEEP output [AFR7]
46	42	30	3	PD5/UART2_TX	I/O	X	X	X		O1	X	X	Port D5	UART2 data transmit	
47	43	31	4	PD6/UART2_RX	I/O	X	X	X		O1	X	X	Port D6	UART2 data receive	
48	44	32	5	PD7/TLI [TIM1_CH4]	I/O	X	X	X		O1	X	X	Port D7	Top level interrupt	TIM1_CH4 [AFR4]

1. AIN12 is not selectable in ADC scan mode or with analog watchdog.
2. In 44-pin package, AIN9 cannot be used by ADC scan mode.
3. 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).

## 5.1 Alternate function remapping

As shown in the rightmost column of the pin description table, some alternate functions can be remapped at different I/O ports by programming one of eight AFR (alternate function remap) option bits. Refer to [Section 8: Option bytes](#). When the remapping option is active, the default alternate function is no longer available.

To use an alternate function, the corresponding peripheral must be enabled in the peripheral registers.

Alternate function remapping does not effect GPIO capabilities of the I/O ports (see the GPIO section of the family reference manual, RM0016).

## 6 Memory and register map

### 6.1 Memory map

Figure 7. Memory map

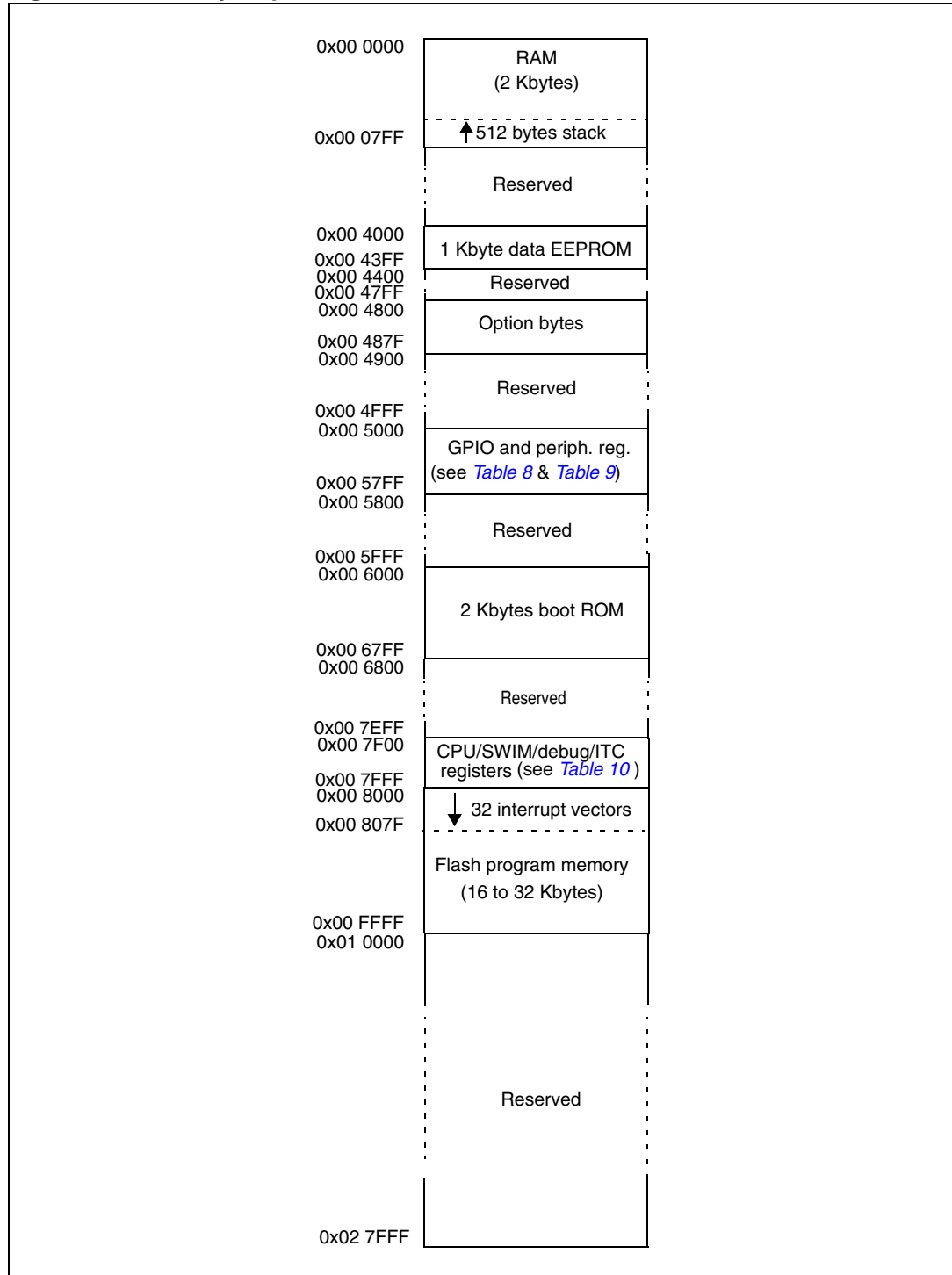


Table 7 lists the boundary addresses for each memory size. The top of the stack is at the RAM end address in each case.

**Table 7. Flash, Data EEPROM and RAM boundary addresses**

Memory area	Size (bytes)	Start address	End address
Flash program memory	32K	0x00 8000	0x00 FFFF
	16K	0x00 8000	0x00 BFFF
RAM	2K	<b>0x00 0000</b>	0x00 07FF
Data EEPROM	1024	0x00 4000	<b>0x00 43FF</b>

## 6.2 Register map

**Table 8. 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	0x00
0x00 5002		PA_DDR	Port A data direction register	0x00
0x00 5003		PA_CR1	Port A control register 1	0x00
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	0x00
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	0x00
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	0x00
0x00 5011		PD_DDR	Port D data direction register	0x00
0x00 5012		PD_CR1	Port D control register 1	0x02
0x00 5013		PD_CR2	Port D control register 2	0x00

Table 8. I/O port hardware register map (continued)

Address	Block	Register label	Register name	Reset status
0x00 5014	Port E	PE_ODR	Port E data output latch register	0x00
0x00 5015		PE_IDR	Port E input pin value register	0x00
0x00 5016		PE_DDR	Port E data direction register	0x00
0x00 5017		PE_CR1	Port E control register 1	0x00
0x00 5018		PE_CR2	Port E control register 2	0x00
0x00 5019	Port F	PF_ODR	Port F data output latch register	0x00
0x00 501A		PF_IDR	Port F input pin value register	0x00
0x00 501B		PF_DDR	Port F data direction register	0x00
0x00 501C		PF_CR1	Port F control register 1	0x00
0x00 501D		PF_CR2	Port F control register 2	0x00
0x00 501E	Port G	PG_ODR	Port G data output latch register	0x00
0x00 501F		PG_IDR	Port G input pin value register	0x00
0x00 5020		PG_DDR	Port G data direction register	0x00
0x00 5021		PG_CR1	Port G control register 1	0x00
0x00 5022		PG_CR2	Port G control register 2	0x00
0x00 5023	Port H	PH_ODR	Port H data output latch register	0x00
0x00 5024		PH_IDR	Port H input pin value register	0x00
0x00 5025		PH_DDR	Port H data direction register	0x00
0x00 5026		PH_CR1	Port H control register 1	0x00
0x00 5027		PH_CR2	Port H control register 2	0x00
0x00 5028	Port I	PI_ODR	Port I data output latch register	0x00
0x00 5029		PI_IDR	Port I input pin value register	0x00
0x00 502A		PI_DDR	Port I data direction register	0x00
0x00 502B		PI_CR1	Port I control register 1	0x00
0x00 502C		PI_CR2	Port I control register 2	0x00



**Table 9. General hardware register map**

Address	Block	Register label	Register name	Reset status
0x00 5050 to 0x00 5059	Reserved area (10 bytes)			
0x00 505A	Flash	FLASH_CR1	Flash control register 1	0x00
0x00 505B		FLASH_CR2	Flash control register 2	0x00
0x00 505C		FLASH_NCR2	Flash complementary control register 2	0xFF
0x00 505D		FLASH_FPR	Flash protection register	0x00
0x00 505E		FLASH_NFPR	Flash complementary protection register	0xFF
0x00 505F		FLASH_IAPSR	Flash in-application programming status register	0x00
0x00 5060 to 0x00 5061	Reserved area (2 bytes)			
0x00 5062	Flash	FLASH_PUKR	Flash program memory unprotection register	0x00
0x00 5063	Reserved area (1 byte)			
0x00 5064	Flash	FLASH_DUKR	Data EEPROM unprotection register	0x00
0x00 5065 to 0x00 509F	Reserved area (59 bytes)			
0x00 50A0	ITC - EXTI	EXTI_CR1	External interrupt control register 1	0x00
0x00 50A1		EXTI_CR2	External interrupt control register 2	0x00
0x00 50A2 to 0x00 50B2	Reserved area (17 bytes)			
0x00 50B3	RST	RST_SR	Reset status register	xx
0x00 50B4 to 0x00 50BF	Reserved area (12 bytes)			
0x00 50C0	CLK	CLK_ICKR	Internal clock control register	0x01
0x00 50C1		CLK_ECKR	External clock control register	0x00
0x00 50C2	Reserved area (1 byte)			

**Table 9. General hardware register map (continued)**

Address	Block	Register label	Register name	Reset status
0x00 50C3	CLK	CLK_CMSR	Clock master status register	0xE1
0x00 50C4		CLK_SWR	Clock master switch register	0xE1
0x00 50C5		CLK_SWCR	Clock switch control register	0bxxxx 0000
0x00 50C6		CLK_CKDIVR	Clock divider register	0x18
0x00 50C7		CLK_PCKENR1	Peripheral clock gating register 1	0xFF
0x00 50C8		CLK_CSSR	Clock security system register	0x00
0x00 50C9		CLK_CCOR	Configurable clock control register	0x00
0x00 50CA		CLK_PCKENR2	Peripheral clock gating register 2	0xFF
0x00 50CB		CLK_CANCCR	CAN clock control register	0x00
0x00 50CC		CLK_HSITRIMR	HSI clock calibration trimming register	xx
0x00 50CD		CLK_SWIMCCR	SWIM clock control register	x0
0x00 50CE to 0x00 50D0		Reserved area (3 bytes)		
0x00 50D1	WWDG	WWDG_CR	WWDG control register	0x7F
0x00 50D2		WWDG_WR	WWDG window register	0x7F
0x00 50D3 to 0x00 50DF	Reserved area (13 bytes)			
0x00 50E0	IWDG	IWDG_KR	IWDG key register	-
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	AWU	AWU_CSR1	AWU control/status register 1	0x00
0x00 50F1		AWU_APR	AWU asynchronous prescaler buffer register	0x3F
0x00 50F2		AWU_TBR	AWU timebase selection register	0x00
0x00 50F3	BEEP	BEEP_CSR	BEEP control/status register	0x1F
0x00 50F4 to 0x00 50FF	Reserved area (12 bytes)			

**Table 9. General hardware register map (continued)**

Address	Block	Register label	Register name	Reset status	
00 5200h	SPI	SPI_CR1	SPI control register 1	0x00	
00 5201h		SPI_CR2	SPI control register 2	0x00	
00 5202h		SPI_ICR	SPI interrupt control register	0x00	
00 5203h		SPI_SR	SPI status register	0x02	
00 5204h		SPI_DR	SPI data register	0x00	
00 5205h		SPI_CRCPR	SPI CRC polynomial register	0x07	
00 5206h		SPI_RXCR	SPI Rx CRC register	0xFF	
00 5207h		SPI_TXCR	SPI Tx CRC register	0xFF	
00 5208h to 00 520Fh	Reserved area (8 bytes)				
00 5210h	I <sup>2</sup> C	I2C_CR1	I <sup>2</sup> C control register 1	0x00	
00 5211h		I2C_CR2	I <sup>2</sup> C control register 2	0x00	
00 5212h		I2C_FREQR	I <sup>2</sup> C frequency register	0x00	
00 5213h		I2C_OARL	I <sup>2</sup> C Own address register low	0x00	
00 5214h		I2C_OARH	I <sup>2</sup> C own address register high	0x00	
00 5215h		Reserved			
00 5216h		I2C_DR	I <sup>2</sup> C data register	0x00	
00 5217h		I2C_SR1	I <sup>2</sup> C status register 1	0x00	
00 5218h		I2C_SR2	I <sup>2</sup> C status register 2	0x00	
00 5219h		I2C_SR3	I <sup>2</sup> C status register 3	0x00	
00 521Ah		I2C_ITR	I <sup>2</sup> C interrupt control register	0x00	
00 521Bh		I2C_CCRL	I <sup>2</sup> C clock control register low	0x00	
00 521Ch		I2C_CCRH	I <sup>2</sup> C clock control register high	0x00	
00 521Dh		I2C_TRISER	I <sup>2</sup> C TRISE register	0x02	
00 521Eh		I2C_PECR	I <sup>2</sup> C packet error checking register	0x00	
00 521Fh to 00 522Fh		Reserved area (17 bytes)			
0x00 5230 to 0x00 523F	Reserved area (6 bytes)				

**Table 9. General hardware register map (continued)**

Address	Block	Register label	Register name	Reset status	
0x00 5240	UART2	UART2_SR	UART2 status register	C0h	
0x00 5241		UART2_DR	UART2 data register	xx	
0x00 5242		UART2_BRR1	UART2 baud rate register 1	0x00	
0x00 5243		UART2_BRR2	UART2 baud rate register 2	0x00	
0x00 5244		UART2_CR1	UART2 control register 1	0x00	
0x00 5245		UART2_CR2	UART2 control register 2	0x00	
0x00 5246		UART2_CR3	UART2 control register 3	0x00	
005247		UART2_CR4	UART2 control register 4	0x00	
0x00 5248		Reserved			
0x00 5249		UART2_CR6	UART2 control register 6	0x00	
0x00 524A		UART2_GTR	UART2 guard time register	0x00	
0x00 524B		UART2_PSCR	UART2 prescaler register	0x00	
0x00 524C to 0x00 524F		Reserved area (4 bytes)			
0x00 5250		TIM1	TIM1_CR1	TIM1 control register 1	0x00
0x00 5251	TIM1_CR2		TIM1 control register 2	0x00	
0x00 5252	TIM1_SMCR		TIM1 slave mode control register	0x00	
0x00 5253	TIM1_ETR		TIM1 external trigger register	0x00	
0x00 5254	TIM1_IER		TIM1 interrupt enable register	0x00	
0x00 5255	TIM1_SR1		TIM1 status register 1	0x00	
0x00 5256	TIM1_SR2		TIM1 status register 2	0x00	
0x00 5257	TIM1_EGR		TIM1 event generation register	0x00	
0x00 5258	TIM1_CCMR1		TIM1 capture/compare mode register 1	0x00	
0x00 5259	TIM1_CCMR2		TIM1 capture/compare mode register 2	0x00	
0x00 525A	TIM1_CCMR3		TIM1 capture/compare mode register 3	0x00	
0x00 525B	TIM1_CCMR4		TIM1 capture/compare mode register 4	0x00	
0x00 525C	TIM1_CCER1		TIM1 capture/compare enable register 1	0x00	
0x00 525D	TIM1_CCER2		TIM1 capture/compare enable register 2	0x00	
0x00 525E	TIM1_CNTRH		TIM1 counter high	0x00	
0x00 525F	TIM1_CNTRL		TIM1 counter low	0x00	
0x00 5260	TIM1_PSCRH		TIM1 prescaler register high	0x00	
0x00 5261	TIM1_PSCRL		TIM1 prescaler register low	0x00	
0x00 5262	TIM1_ARRH		TIM1 auto-reload register high	0xFF	
0x00 5263	TIM1_ARRL		TIM1 auto-reload register low	0xFF	

**Table 9. General hardware register map (continued)**

Address	Block	Register label	Register name	Reset status
0x00 5264	TIM1 cont'd	TIM1_RCR	TIM1 repetition counter register	0x00
0x00 5265		TIM1_CCR1H	TIM1 capture/compare register 1 high	0x00
0x00 5266		TIM1_CCR1L	TIM1 capture/compare register 1 low	0x00
0x00 5267		TIM1_CCR2H	TIM1 capture/compare register 2 high	0x00
0x00 5268		TIM1_CCR2L	TIM1 capture/compare register 2 low	0x00
0x00 5269		TIM1_CCR3H	TIM1 capture/compare register 3 high	0x00
0x00 526A		TIM1_CCR3L	TIM1 capture/compare register 3 low	0x00
0x00 526B		TIM1_CCR4H	TIM1 capture/compare register 4 high	0x00
0x00 526C		TIM1_CCR4L	TIM1 capture/compare register 4 low	0x00
0x00 526D		TIM1_BKR	TIM1 break register	0x00
0x00 526E		TIM1_DTR	TIM1 dead-time register	0x00
0x00 526F		TIM1_OISR	TIM1 output idle state register	0x00
0x00 5270 to 0x00 52FF		Reserved area (147 bytes)		
0x00 5300	TIM2	TIM2_CR1	TIM2 control register 1	0x00
0x00 5301		TIM2_IER	TIM2 interrupt enable register	0x00
0x00 5302		TIM2_SR1	TIM2 status register 1	0x00
0x00 5303		TIM2_SR2	TIM2 status register 2	0x00
0x00 5304		TIM2_EGR	TIM2 event generation register	0x00
0x00 5305		TIM2_CCMR1	TIM2 capture/compare mode register 1	0x00
0x00 5306		TIM2_CCMR2	TIM2 capture/compare mode register 2	0x00
0x00 5307		TIM2_CCMR3	TIM2 capture/compare mode register 3	0x00
0x00 5308		TIM2_CCER1	TIM2 capture/compare enable register 1	0x00
0x00 5309		TIM2_CCER2	TIM2 capture/compare enable register 2	0x00
0x00 530A		TIM2_CNTRH	TIM2 counter high	0x00
0x00 530B		TIM2_CNTRL	TIM2 counter low	0x00
0x00 530C		TIM2_PSCR	TIM2 prescaler register	0x00
0x00 530D		TIM2_ARRH	TIM2 auto-reload register high	0xFF
0x00 530E		TIM2_ARRL	TIM2 auto-reload register low	0xFF
0x00 530F		TIM2_CCR1H	TIM2 capture/compare register 1 high	0x00
0x00 5310		TIM2_CCR1L	TIM2 capture/compare register 1 low	0x00
0x00 5311		TIM2_CCR2H	TIM2 capture/compare reg. 2 high	0x00
0x00 5312		TIM2_CCR2L	TIM2 capture/compare register 2 low	0x00
0x00 5313		TIM2_CCR3H	TIM2 capture/compare register 3 high	0x00

**Table 9. General hardware register map (continued)**

Address	Block	Register label	Register name	Reset status
0x00 5314	TIM2 cont'd	TIM2_CCR3L	TIM2 capture/compare register 3 low	0x00
0x00 5315 to 0x00 531F	Reserved area (11 bytes)			
0x00 5320	TIM3	TIM3_CR1	TIM3 control register 1	0x00
0x00 5321		TIM3_IER	TIM3 interrupt enable register	0x00
0x00 5322		TIM3_SR1	TIM3 status register 1	0x00
0x00 5323		TIM3_SR2	TIM3 status register 2	0x00
0x00 5324		TIM3_EGR	TIM3 event generation register	0x00
0x00 5325		TIM3_CCMR1	TIM3 capture/compare mode register 1	0x00
0x00 5326		TIM3_CCMR2	TIM3 capture/compare mode register 2	0x00
0x00 5327		TIM3_CCER1	TIM3 capture/compare enable register 1	0x00
0x00 5328		TIM3_CNTRH	TIM3 counter high	0x00
0x00 5329		TIM3_CNTRL	TIM3 counter low	0x00
0x00 532A		TIM3_PSCR	TIM3 prescaler register	0x00
0x00 532B		TIM3_ARRH	TIM3 auto-reload register high	0xFF
0x00 532C		TIM3_ARRL	TIM3 auto-reload register low	0xFF
0x00 532D		TIM3_CCR1H	TIM3 capture/compare register 1 high	0x00
0x00 532E		TIM3_CCR1L	TIM3 capture/compare register 1 low	0x00
0x00 532F		TIM3_CCR2H	TIM3 capture/compare register 2 high	0x00
0x00 5330		TIM3_CCR2L	TIM3 capture/compare register 2 low	0x00
0x00 5331 to 0x00 533F	Reserved area (15 bytes)			
0x00 5340	TIM4	TIM4_CR1	TIM4 control register 1	0x00
0x00 5341		TIM4_IER	TIM4 interrupt enable register	0x00
0x00 5342		TIM4_SR	TIM4 status register	0x00
0x00 5343		TIM4_EGR	TIM4 event generation register	0x00
0x00 5344		TIM4_CNTR	TIM4 counter	0x00
0x00 5345		TIM4_PSCR	TIM4 prescaler register	0x00
0x00 5346		TIM4_ARR	TIM4 auto-reload register	0xFF
0x00 5347 to 0x00 53DF	Reserved area (153 bytes)			

**Table 9. General hardware register map (continued)**

Address	Block	Register label	Register name	Reset status
0x00 53E0 to 0x00 53F3	ADC1	ADC_DBxR	ADC data buffer registers	0x00
0x00 53F4 to 0x00 53FF	Reserved area (12 bytes)			
0x00 5400	ADC1	ADC_CSR	ADC control/status register	0x00
0x00 5401		ADC_CR1	ADC configuration register 1	0x00
0x00 5402		ADC_CR2	ADC configuration register 2	0x00
0x00 5403		ADC_CR3	ADC configuration register 3	0x00
0x00 5404		ADC_DRH	ADC data register high	0x00
0x00 5405		ADC_DRL	ADC data register low	0x00
0x00 5406		ADC_TDRH	ADC Schmitt trigger disable register high	0x00
0x00 5407		ADC_TDRL	ADC Schmitt trigger disable register low	0x00
0x00 5408		ADC_HTRH	ADC high threshold register high	0x03
0x00 5409		ADC_HTRL	ADC high threshold register low	0xFF
0x00 540A		ADC_LTRH	ADC low threshold register high	0x00
0x00 540B		ADC_LTRL	ADC low threshold register low	0x00
0x00 540C		ADC_AWSRH	ADC analog watchdog status register high	0x00
0x00 540D		ADC_AWSRL	ADC analog watchdog status register low	0x00
0x00 540E		ADC_AWCRH	ADC analog watchdog control register high	0x00
0x00 540F		ADC_AWCRL	ADC analog watchdog control register low	0x00
0x00 5410 to 0x00 57FF	Reserved area (1008 bytes)			

Table 10. 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	0x07
0x00 7F09		SPL	Stack pointer low	0xFF
0x00 7F0A		CCR	Condition code register	0x28
0x00 7F0B to 0x00 7F5F	Reserved area (85 bytes)			
0x00 7F60	CPU	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 to 0x00 7F79	Reserved area (2 bytes)			
0x00 7F80	SWIM	SWIM_CSR	SWIM control status register	0x00
0x00 7F81 to 0x00 7F8F	Reserved area (15 bytes)			



Table 10. CPU/SWIM/debug module/interrupt controller registers (continued)

Address	Block	Register label	Register name	Reset status
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
0x00 7F97		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 to 0x00 7F9F	Reserved area (5 bytes)			

1. Accessible by debug module only

## 7 Interrupt vector mapping

Table 11. Interrupt mapping

IRQ no.	Source block	Description	Wakeup from halt mode	Wakeup from active-halt mode	Vector address
	RESET	Reset	Yes	Yes	0x00 8000
	TRAP	Software interrupt	-	-	0x00 8004
0	TLI	External top level interrupt	-	-	0x00 8008
1	AWU	Auto wake up from halt	-	Yes	0x00 800C
2	CLK	Clock controller	-	-	0x00 8010
3	EXTI0	Port A external interrupts	Yes <sup>(1)</sup>	Yes <sup>(1)</sup>	0x00 8014
4	EXTI1	Port B external interrupts	Yes	Yes	0x00 8018
5	EXTI2	Port C external interrupts	Yes	Yes	0x00 801C
6	EXTI3	Port D external interrupts	Yes	Yes	0x00 8020
7	EXTI4	Port E external interrupts	Yes	Yes	0x00 8024
8		Reserved	-	-	0x00 8028
9		Reserved	-	-	0x00 802C
10	SPI	End of transfer	Yes	Yes	0x00 8030
11	TIM1	TIM1 update/overflow/underflow/ trigger/break	-	-	0x00 8034
12	TIM1	TIM1 capture/compare	-	-	0x00 8038
13	TIM2	TIM2 update /overflow	-	-	0x00 803C
14	TIM2	TIM2 capture/compare	-	-	0x00 8040
15	TIM3	Update/overflow	-	-	0x00 8044
16	TIM3	Capture/compare	-	-	0x00 8048
17		Reserved	-	-	0x00 804C
18		Reserved	-	-	0x00 8050
19	I <sup>2</sup> C	I <sup>2</sup> C interrupt	Yes	Yes	0x00 8054
20	UART2	Tx complete	-	-	0x00 8058
21	UART2	Receive register DATA FULL	-	-	0x00 805C
22	ADC1	ADC1 end of conversion/analog watchdog interrupt	-	-	0x00 8060
23	TIM4	TIM4 update/overflow	-	-	0x00 8064
24	Flash	EOP/WR_PG_DIS	-	-	0x00 8068
Reserved					0x00 806C to 0x00 807C

1. Except PA1

## 8 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 block of the memory. Except for the ROP (read-out protection) byte, each option byte has to be stored twice, in a regular form (OPTx) and a complemented one (NOPTx) for redundancy.

Option bytes can be modified in ICP mode (via SWIM) by accessing the EEPROM address shown in [Table 12: Option bytes](#) below.

Option bytes can also be modified ‘on the fly’ by the application in IAP mode, except the ROP option that can only be modified in ICP mode (via SWIM).

Refer to the STM8S Flash programming manual (PM0051) and STM8 SWIM communication protocol and debug module user manual (UM0470) for information on SWIM programming procedures.

**Table 12. Option bytes**

Addr.	Option name	Option byte no.	Option bits								Factory default setting
			7	6	5	4	3	2	1	0	
4800h	Read-out protection (ROP)	OPT0	ROP[7:0]								00h
4801h	User boot code(UBC)	OPT1	UBC[7:0]								00h
4802h		NOPT1	NUBC[7:0]								FFh
4803h	Alternate function remapping (AFR)	OPT2	AFR7	AFR6	AFR5	AFR4	AFR3	AFR2	AFR1	AFR0	00h
4804h		NOPT2	NAFR7	NAFR6	NAFR5	NAFR4	NAFR3	NAFR2	NAFR1	NAFR0	FFh
4805h	Miscellaneous option	OPT3	Reserved			HSITRIM	LSI_EN	IWDG_HW	WWDG_HW	WWDG_HALT	00h
4806h		NOPT3	Reserved			NHSI-TRIM	NLSI_EN	NIWDG_HW	NWWDG_HW	NWWDG_HALT	FFh
4807h	Clock option	OPT4	Reserved			EXT_CLK	CKAWU_SEL	PRS_C1	PRS_C0	00h	
4808h		NOPT4	Reserved			NEXT_CLK	NCKAWUS_EL	NPR_SC1	NPR_SC0	FFh	
4809h	HSE clock startup	OPT5	HSECNT[7:0]								00h
480Ah		NOPT5	NHSECNT[7:0]								FFh
480Bh	Reserved	OPT6	Reserved								00h
480Ch		NOPT6	Reserved								FFh
480Dh	Reserved	OPT7	Reserved								00h
480Eh		NOPT7	Reserved								FFh
487Eh	Bootloader	OPTBL	BL[7:0]								00h
487Fh		NOPTBL	NBL[7:0]								FFh

Table 13. Option byte description

Option byte no.	Description
OPT0	<p><b>ROP[7:0]</b> <i>Memory readout protection (ROP)</i>            AAh: Enable readout protection (write access via SWIM protocol)  <i>Note: Refer to the family reference manual (RM0016) section on Flash/EEPROM memory readout protection for details.</i></p>
OPT1	<p><b>UBC[7:0]</b> <i>User boot code area</i>            0x00: no UBC, no write-protection            0x01: Pages 0 to 1 defined as UBC, memory write-protected            0x02: Pages 0 to 3 defined as UBC, memory write-protected            0x03: Pages 0 to 4 defined as UBC, memory write-protected            ...            0x3E: Pages 0 to 63 defined as UBC, memory write-protected            Other values: Reserved  <i>Note: Refer to the family reference manual (RM0016) section on Flash write protection for more details.</i></p>
OPT2	<p><b>AFR[7:0]</b>            Refer to <a href="#">Table 14</a> for the alternate function remapping descriptions of bits [7:0].</p>
OPT3	<p><b>HSITRIM:</b> <i>High speed internal clock trimming register size</i>            0: 3-bit trimming supported in CLK_HSITRIMR register            1: 4-bit trimming supported in CLK_HSITRIMR register</p>
	<p><b>LSI_EN:</b> <i>Low speed internal clock enable</i>            0: LSI clock is not available as CPU clock source            1: LSI clock is available as CPU clock source</p>
	<p><b>IWDG_HW:</b> <i>Independent watchdog</i>            0: IWDG Independent watchdog activated by software            1: IWDG Independent watchdog activated by hardware</p>
	<p><b>WWDG_HW:</b> <i>Window watchdog activation</i>            0: WWDG window watchdog activated by software            1: WWDG window watchdog activated by hardware</p>
	<p><b>WWDG_HALT:</b> <i>Window watchdog reset on halt</i>            0: No reset generated on halt if WWDG active            1: Reset generated on halt if WWDG active</p>
OPT4	<p><b>EXTCLK:</b> <i>External clock selection</i>            0: External crystal connected to OSCIN/OSCOUT            1: External clock signal on OSCIN</p>
	<p><b>CKAWUSEL:</b> <i>Auto wake-up unit/clock</i>            0: LSI clock source selected for AWU            1: HSE clock with prescaler selected as clock source for for AWU</p>
	<p><b>PRSC[1:0]</b> <i>AWU clock prescaler</i>            0x: 16 MHz to 128 kHz prescaler            10: 8 MHz to 128 kHz prescaler            11: 4 MHz to 128 kHz prescaler</p>

**Table 13. Option byte description (continued)**

Option byte no.	Description
OPT5	<b>HSECNT[7:0]: HSE crystal oscillator stabilization time</b> 0x00: 2048 HSE cycles 0xB4: 128 HSE cycles 0xD2: 8 HSE cycles 0xE1: 0.5 HSE cycles
OPT6	Reserved.
OPT7	Reserved.
OPTBL	<b>BL[7:0] Bootloader option byte</b> This option is checked by the boot ROM code after reset. Depending on content of addresses 0x487E, 0x487F and 0x8000 (reset vector) the CPU jumps to the bootloader or to the reset vector. Refer to the STM8S bootloader manual for more details.

**Table 14. Description of alternate function remapping bits [7:0] of OPT2**

Option byte no.	Description <sup>(1)</sup>
OPT2	<p><b>AFR7 Alternate function remapping option 7</b>                      0: AFR7 remapping option inactive: Default alternate function<sup>(2)</sup>.                      1: Port D4 alternate function = BEEP.</p> <p><b>AFR6 Alternate function remapping option 6</b>                      0: AFR6 remapping option inactive: Default alternate functions<sup>(2)</sup>.                      1: Port B5 alternate function = I<sup>2</sup>C_SDA; port B4 alternate function = I<sup>2</sup>C_SCL.</p> <p><b>AFR5 Alternate function remapping option 5</b>                      0: AFR5 remapping option inactive: Default alternate functions<sup>(2)</sup>.                      1: Port B3 alternate function = TIM1_ETR; port B2 alternate function = TIM1_NCC3; port B1 alternate function = TIM1_CH2N; port B0 alternate function = TIM1_CH1N.</p> <p><b>AFR4 Alternate function remapping option 4</b>                      0: AFR4 remapping option inactive: Default alternate function<sup>(2)</sup>.                      1: Port D7 alternate function = TIM1_CH4.</p> <p><b>AFR3 Alternate function remapping option 3</b>                      0: AFR3 remapping option inactive: Default alternate function<sup>(2)</sup>.                      1: Port D0 alternate function = TIM1_BKIN.</p> <p><b>AFR2 Alternate function remapping option 2</b>                      0: AFR2 remapping option inactive: Default alternate function<sup>(2)</sup>.                      1: Port D0 alternate function = CLK_CCO.  <i>Note: AFR2 option has priority over AFR3 if both are activated.</i></p> <p><b>AFR1 Alternate function remapping option 1</b>                      0: AFR1 remapping option inactive: Default alternate functions<sup>(2)</sup>.                      1: Port A3 alternate function = TIM3_CH1; port D2 alternate function TIM2_CH3.</p> <p><b>AFR0 Alternate function remapping option 0</b>                      0: AFR0 remapping option inactive: Default alternate function<sup>(2)</sup>.                      1: Port D3 alternate function = ADC_ETR.</p>

1. Do not use more than one remapping option in the same port.
2. Refer to pinout description.

## 9 Electrical characteristics

### 9.1 Parameter conditions

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

#### 9.1.1 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  $T_A = 25\text{ °C}$  and  $T_A = T_{Amax}$  (given by the selected temperature range).

Data based on characterization results, design simulation and/or technology characteristics are 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 (mean  $\pm 3\sigma$ ).

#### 9.1.2 Typical values

Unless otherwise specified, typical data are based on  $T_A = 25\text{ °C}$ ,  $V_{DD} = 5\text{ V}$ . They are given only as design guidelines and are not tested.

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

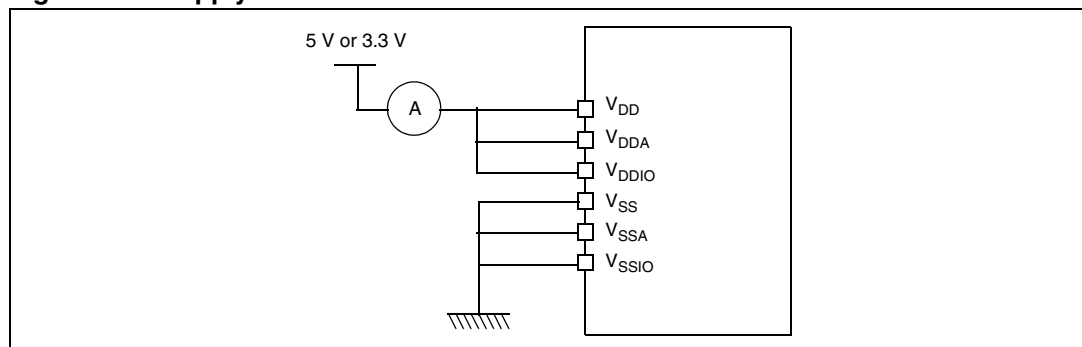
#### 9.1.3 Typical curves

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

#### 9.1.4 Typical current consumption

For typical current consumption measurements,  $V_{DD}$ ,  $V_{DDIO}$  and  $V_{DDA}$  are connected together in the configuration shown in [Figure 8](#).

**Figure 8. Supply current measurement conditions**

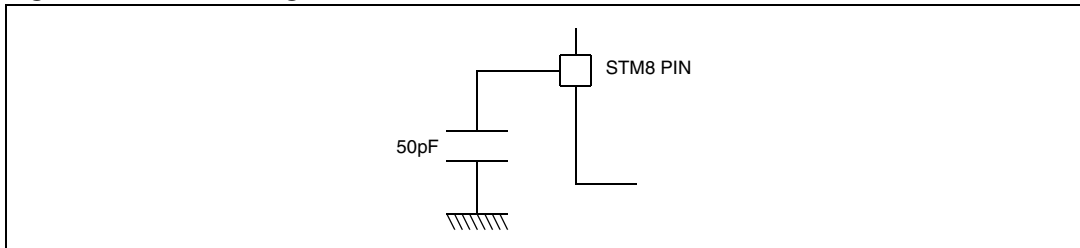


### 9.1.5 Pin loading conditions

### 9.1.6 Loading capacitor

The loading conditions used for pin parameter measurement are shown in [Figure 9](#).

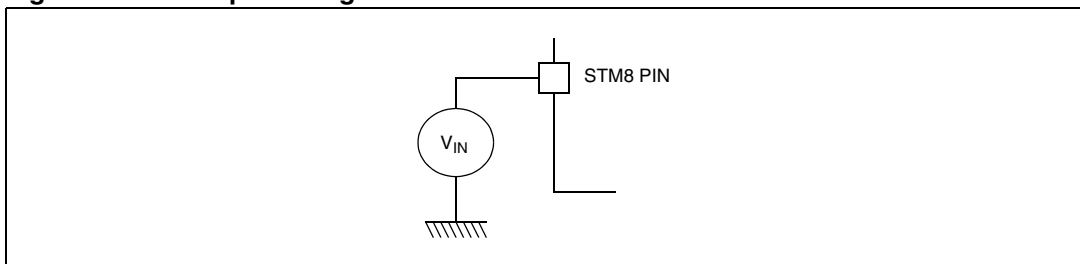
**Figure 9. Pin loading conditions**



### 9.1.7 Pin input voltage

The input voltage measurement on a pin of the device is described in [Figure 10](#).

**Figure 10. Pin input voltage**



## 9.2 Absolute maximum ratings

Stresses above those listed as ‘absolute maximum ratings’ may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**Table 15. Voltage characteristics**

Symbol	Ratings	Min	Max	Unit
$V_{DDX} - V_{SS}$	Supply voltage (including $V_{DDA}$ and $V_{DDIO}$ ) <sup>(1)</sup>	-0.3	6.5	V
$V_{IN}$	Input voltage on true open drain pins (PE1, PE2) <sup>(2)</sup>	$V_{SS} - 0.3$	6.5	
	Input voltage on any other pin <sup>(2)</sup>	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
$ V_{DDX} - V_{DD} $	Variations between different power pins		50	mV
$ V_{SSX} - V_{SS} $	Variations between all the different ground pins		50	
$V_{ESD}$	Electrostatic discharge voltage	see <a href="#">Absolute maximum ratings (electrical sensitivity) on page 84</a>		

1. All power ( $V_{DD}$ ,  $V_{DDIO}$ ,  $V_{DDA}$ ) and ground ( $V_{SS}$ ,  $V_{SSIO}$ ,  $V_{SSA}$ ) pins must always be connected to the external power supply
2.  $I_{INJ(PIN)}$  must never be exceeded. This is implicitly insured if  $V_{IN}$  maximum is respected. If  $V_{IN}$  maximum cannot be respected, the injection current must be limited externally to the  $I_{INJ(PIN)}$  value. A positive injection is induced by  $V_{IN} > V_{DD}$  while a negative injection is induced by  $V_{IN} < V_{SS}$ . For true open-drain pads, there is no positive injection current, and the corresponding  $V_{IN}$  maximum must always be respected



**Table 16. Current characteristics**

Symbol	Ratings	Max. <sup>(1)</sup>	Unit
$I_{VDD}$	Total current into $V_{DD}$ power lines (source) <sup>(2)</sup>	60	mA
$I_{VSS}$	Total current out of $V_{SS}$ ground lines (sink) <sup>(2)</sup>	60	
$I_{IO}$	Output current sunk by any I/O and control pin	20	
	Output current source by any I/Os and control pin	20	
$\Sigma I_{IO}$	Total output current sourced (sum of all I/O and control pins) for devices with two $V_{DDIO}$ pins <sup>(3)</sup>	200	
	Total output current sourced (sum of all I/O and control pins) for devices with one $V_{DDIO}$ pin <sup>(3)</sup>	100	
	Total output current sunk (sum of all I/O and control pins) for devices with two $V_{SSIO}$ pins <sup>(3)</sup>	160	
	Total output current sunk (sum of all I/O and control pins) for devices with one $V_{SSIO}$ pin <sup>(3)</sup>	80	
$I_{INJ(PIN)}^{(4)(5)}$	Injected current on NRST pin	±4	
	Injected current on OSCIN pin	±4	
	Injected current on any other pin <sup>(6)</sup>	±4	
$\Sigma I_{INJ(PIN)}^{(4)}$	Total injected current (sum of all I/O and control pins) <sup>(6)</sup>	±20	

1. Data based on characterization results, not tested in production.
2. All power ( $V_{DD}$ ,  $V_{DDIO}$ ,  $V_{DDA}$ ) and ground ( $V_{SS}$ ,  $V_{SSIO}$ ,  $V_{SSA}$ ) pins must always be connected to the external supply.
3. I/O pins used simultaneously for high current source/sink must be uniformly spaced around the package between the  $V_{DDIO}/V_{SSIO}$  pins.
4.  $I_{INJ(PIN)}$  must never be exceeded. This is implicitly insured if  $V_{IN}$  maximum is respected. If  $V_{IN}$  maximum cannot be respected, the injection current must be limited externally to the  $I_{INJ(PIN)}$  value. A positive injection is induced by  $V_{IN} > V_{DD}$  while a negative injection is induced by  $V_{IN} < V_{SS}$ . For true open-drain pads, there is no positive injection current, and the corresponding  $V_{IN}$  maximum must always be respected
5. Negative injection disturbs the analog performance of the device. See note in [Section Figure 44.: Typical application with I2C bus and timing diagram 1\) on page 79.](#)
6. 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). These results are based on characterization with  $\Sigma I_{INJ(PIN)}$  maximum current injection on four I/O port pins of the device.

**Table 17. Thermal characteristics**

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

### 9.3 Operating conditions

**Table 18. General operating conditions**

Symbol	Parameter	Conditions	Min	Max	Unit
$f_{CPU}$	Internal CPU clock frequency		0	16	MHz
$V_{DD}/V_{DD\_IO}$	Standard operating voltage		2.95	5.5	V
$C_{EXT}$	VCAP external capacitor <sup>(1)</sup>	$0.05 \leq ESR \leq 0.2\Omega$ at 1 MHz	470	3300	nF
$P_D^{(2)}$	Power dissipation at TA = 85 °C for suffix 6 or TA= 125° C for suffix 3	44 and 48-pin devices, with output on eight standard ports, two high sink ports and two open drain ports simultaneously <sup>(3)</sup>		443	mW
		32-pin package, with output on eight standard ports and two high sink ports simultaneously <sup>(3)</sup>		360	
$T_A$	Ambient temperature for 6 suffix version	Maximum power dissipation	-40	85	°C
		Low power dissipation <sup>(4)</sup>	-40	105	
	Ambient temperature for 3 suffix version	Maximum power dissipation	-40	125	
		Low power dissipation <sup>(4)</sup>	-40	140	
$T_J$	Junction temperature range	6 suffix version	-40	105	
		3 suffix version	-40	130 <sup>(5)</sup>	

- Care should be taken when selecting the capacitor, due to its tolerance, as well as its dependency on temperature, DC bias and frequency in addition to other factors.
- To calculate  $P_{Dmax}(T_A)$ , use the formula  $P_{Dmax} = (T_{Jmax} - T_A)/\Theta_{JA}$  (see [Section 10.2: Thermal characteristics](#)) with the value for  $T_{Jmax}$  given in [Table 18](#) and the value for  $\Theta_{JA}$  given in [Table 56: Thermal characteristics](#).
- Refer to [Section 10.2: Thermal characteristics on page 92](#) for the calculation method.
- In low power dissipation state,  $T_A$  can be extended to this range as long as  $T_J$  does not exceed  $T_{Jmax}$  (see [Section 10.2: Thermal characteristics on page 92](#)).
- $T_{Jmax}$  is given by the test limit. Above this value the product behavior is not guaranteed.

Figure 11.  $f_{CPUmax}$  versus  $V_{DD}$

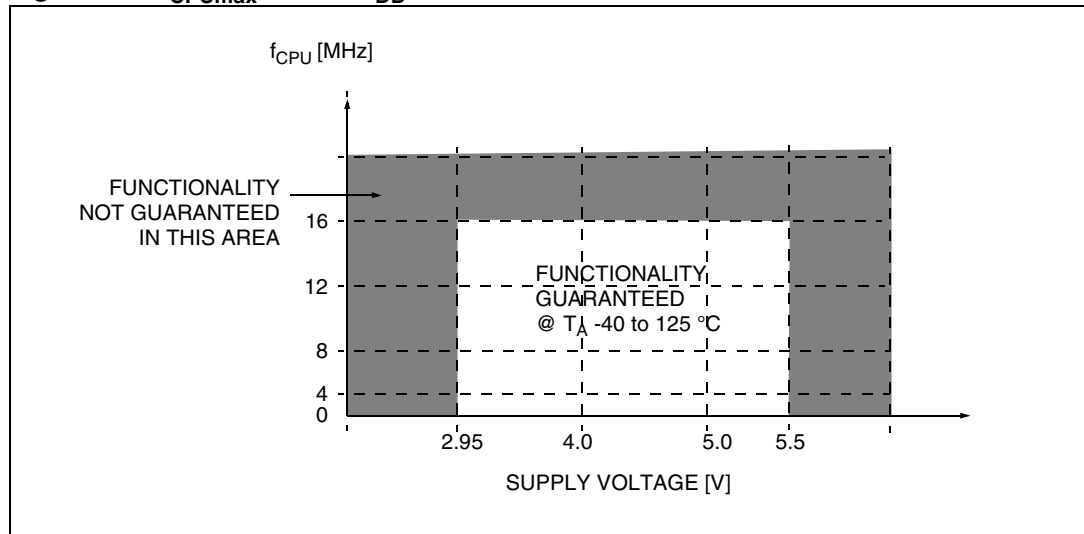


Table 19. Operating conditions at power-up/power-down

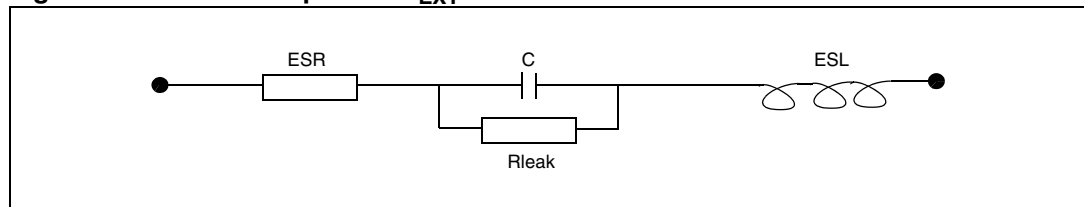
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$t_{VDD}$	$V_{DD}$ rise time rate		2 <sup>(1)</sup>		$\infty$	$\mu\text{s/V}$
	$V_{DD}$ fall time rate		2 <sup>(1)</sup>		$\infty$	
$t_{TEMP}$	Reset release delay	$V_{DD}$ rising			1.7 <sup>(1)</sup>	ms
$V_{IT+}$	Power-on reset threshold		2.65	2.8	2.95	V
$V_{IT-}$	Brown-out reset threshold		2.58	2.7	2.88	
$V_{HYS(BOR)}$	Brown-out reset hysteresis			70		mV

1. Guaranteed by design, not tested in production.

### 9.3.1 VCAP external capacitor

Stabilization for the main regulator is achieved connecting an external capacitor  $C_{EXT}$  to the  $V_{CAP}$  pin.  $C_{EXT}$  is specified in [Table 18](#). Care should be taken to limit the series inductance to less than 15 nH.

Figure 12. External capacitor  $C_{EXT}$



1. ESR is the equivalent series resistance and ESL is the equivalent inductance.

### 9.3.2 Supply current characteristics

The current consumption is measured as described in [Figure 8 on page 46](#).

#### Total current consumption in run mode

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 (clock stopped by Peripheral Clock Gating registers) except if explicitly mentioned.

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

**Table 20. Total current consumption with code execution in run mode at  $V_{DD} = 5\text{ V}$**

Symbol	Parameter	Conditions	Typ	Max <sup>(1)</sup>	Unit		
$I_{DD(RUN)}$	Supply current in run mode, code executed from RAM	$f_{CPU} = f_{MASTER} = 16\text{ MHz}$	HSE crystal osc. (16 MHz)	3.2		mA	
			HSE user ext. clock (16 MHz)	2.6	3.2		
			HSI RC osc. (16 MHz)	2.5	3.2		
		$f_{CPU} = f_{MASTER}/128 = 125\text{ kHz}$	HSE user ext. clock (16 MHz)	1.6	2.2		
			HSI RC osc. (16 MHz)	1.3	2.0		
		$f_{CPU} = f_{MASTER}/128 = 15.625\text{ kHz}$	HSI RC osc. (16 MHz/8)	0.75			
	Supply current in run mode, code executed from Flash	$f_{CPU} = f_{MASTER} = 16\text{ MHz}$	LSI RC osc. (128 kHz)	0.55			
			$f_{CPU} = f_{MASTER} = 2\text{ MHz}$	HSE crystal osc. (16 MHz)	7.7		
				HSE user ext. clock (16 MHz)	7.0		8
		HSI RC osc.(16 MHz)		7.0	8.0		
		$f_{CPU} = f_{MASTER} = 125\text{ kHz}$	HSI RC osc. (16 MHz/8) <sup>(2)</sup>	1.5			
		$f_{CPU} = f_{MASTER}/128 = 125\text{ kHz}$	HSI RC osc. (16 MHz)	1.35	2.0		
		$f_{CPU} = f_{MASTER}/128 = 15.625\text{ kHz}$	HSI RC osc. (16 MHz/8)	0.75			
		$f_{CPU} = f_{MASTER} = 128\text{ kHz}$	LSI RC osc. (128 kHz)	0.6			

1. Data based on characterization results, not tested in production.
2. Default clock configuration measured with all peripherals off.

**Table 21. Total current consumption with code execution in run mode at V<sub>DD</sub> = 3.3 V**

Symbol	Parameter	Conditions	Typ	Max <sup>(1)</sup>	Unit	
I <sub>DD(RUN)</sub>	Supply current in run mode, code executed from RAM	f <sub>CPU</sub> = f <sub>MASTER</sub> = 16 MHz	HSE crystal osc. (16 MHz)	2.8		mA
			HSE user ext. clock (16 MHz)	2.6	3.2	
			HSI RC osc. (16 MHz)	2.5	3.2	
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 125 kHz	HSE user ext. clock (16 MHz)	1.6	2.2	
			HSI RC osc. (16 MHz)	1.3	2.0	
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 15.625 kHz	HSI RC osc. (16 MHz/8)	0.75		
	f <sub>CPU</sub> = f <sub>MASTER</sub> = 128 kHz	LSI RC osc. (128 kHz)	0.55			
	Supply current in run mode, code executed from Flash	f <sub>CPU</sub> = f <sub>MASTER</sub> = 16 MHz	HSE crystal osc. (16 MHz)	7.3		
			HSE user ext. clock (16 MHz)	7.0	8	
			HSI RC osc.(16 MHz)	7.0	8.0	
		f <sub>CPU</sub> = f <sub>MASTER</sub> = 2 MHz.	HSI RC osc. (16 MHz/8) <sup>(2)</sup>	1.5		
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 125 kHz	HSI RC osc. (16 MHz)	1.35	2.0	
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 15.625 kHz	HSI RC osc. (16 MHz/8)	0.75		
	f <sub>CPU</sub> = f <sub>MASTER</sub> = 128 kHz	LSI RC osc. (128 kHz)	0.6			

1. Data based on characterization results, not tested in production.
2. Default clock configuration measured with all peripherals off.

**Total current consumption in wait mode**

**Table 22. Total current consumption in wait mode at V<sub>DD</sub> = 5 V**

Symbol	Parameter	Conditions		Typ	Max <sup>(1)</sup>	Unit
I <sub>DD(WFI)</sub>	Supply current in wait mode	f <sub>CPU</sub> = f <sub>MASTER</sub> = 16 MHz	HSE crystal osc. (16 MHz)	2.15		mA
			HSE user ext. clock (16 MHz)	1.55	2.0	
			HSI RC osc. (16 MHz)	1.5	1.9	
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 125 kHz	HSI RC osc. (16 MHz)	1.3		
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 15.625 kHz	HSI RC osc. (16 MHz/8) <sup>(2)</sup>	0.7		
f <sub>CPU</sub> = f <sub>MASTER</sub> = 128 kHz	LSI RC osc. (128 kHz)	0.5				

1. Data based on characterization results, not tested in production.
2. Default clock configuration measured with all peripherals off.

**Table 23. Total current consumption in wait mode at V<sub>DD</sub> = 3.3 V**

Symbol	Parameter	Conditions		Typ	Max <sup>(1)</sup>	Unit
I <sub>DD(WFI)</sub>	Supply current in wait mode	f <sub>CPU</sub> = f <sub>MASTER</sub> = 16 MHz	HSE crystal osc. (16 MHz)	1.75		mA
			HSE user ext. clock (16 MHz)	1.55	2.0	
			HSI RC osc. (16 MHz)	1.5	1.9	
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 125 kHz	HSI RC osc. (16 MHz)	1.3		
		f <sub>CPU</sub> = f <sub>MASTER</sub> /128 = 15.625 kHz	HSI RC osc. (16 MHz/8) <sup>(2)</sup>	0.7		
f <sub>CPU</sub> = f <sub>MASTER</sub> = 128 kHz	LSI RC osc. (128 kHz)	0.5				

1. Data based on characterization results, not tested in production.
2. Default clock configuration measured with all peripherals off.

**Total current consumption in active halt mode**

**Table 24. Total current consumption in active halt mode at V<sub>DD</sub> = 5 V**

Symbol	Parameter	Conditions			Typ	Max at 85 °C <sup>(1)</sup>	Max at 125 °C <sup>(1)</sup>	Unit
		Main voltage regulator (MVR) <sup>(2)</sup>	Flash mode <sup>(3)</sup>	Clock source				
I <sub>DD(AH)</sub>	Supply current in active halt mode	On	Operating mode	HSE crystal osc. (16 MHz)	1080			µA
				LSI RC osc. (128 kHz)	200	320	400	
			Power-down mode	HSE crystal osc. (16 MHz)	1030			
				LSI RC osc. (128 kHz)	140	270	350	
		Off	Operating mode	LSI RC osc. (128 kHz)	68	120	220	
			Power-down mode	LSI RC osc. (128 kHz)	12	60	150	

1. Data based on characterization results, not tested in production
2. Configured by the REGAH bit in the CLK\_ICKR register.
3. Configured by the AHALT bit in the FLASH\_CR1 register.

**Table 25. Total current consumption in active halt mode at V<sub>DD</sub> = 3.3 V**

Symbol	Parameter	Conditions			Typ	Max at 85 °C <sup>(1)</sup>	Max at 125 °C <sup>(1)</sup>	Unit
		Main voltage regulator (MVR) <sup>(2)</sup>	Flash mode <sup>(3)</sup>	Clock source				
I <sub>DD(AH)</sub>	Supply current in active halt mode	On	Operating mode	HSE crystal osc. (16 MHz)	680			µA
				LSI RC osc. (128 kHz)	200	320	400	
			Power-down mode	HSE crystal osc. (16 MHz)	630			
				LSI RC osc. (128 kHz)	140	270	350	
		Off	Operating mode	LSI RC osc. (128 kHz)	66	120	220	
			Power-down mode	LSI RC osc. (128 kHz)	10	60	150	

1. Data based on characterization results, not tested in production.
2. Configured by the REGAH bit in the CLK\_ICKR register.
3. Configured by the AHALT bit in the FLASH\_CR1 register.

**Total current consumption in halt mode**

**Table 26. Total current consumption in halt mode at V<sub>DD</sub> = 5 V**

Symbol	Parameter	Conditions	Typ	Max at 85 °C <sup>(1)</sup>	Max at 125 °C <sup>(1)</sup>	Unit
I <sub>DD(H)</sub>	Supply current in halt mode	Flash in operating mode, HSI clock after wakeup	62	90	150	μA
		Flash in powerdown mode, HSI clock after wakeup	6.5	20	80	

1. Data based on characterization results, not tested in production.

**Table 27. Total current consumption in halt mode at V<sub>DD</sub> = 3.3 V**

Symbol	Parameter	Conditions	Typ	Max at 85 °C <sup>(1)</sup>	Max at 125 °C <sup>(1)</sup>	Unit
I <sub>DD(H)</sub>	Supply current in halt mode	Flash in operating mode, HSI clock after wakeup	60	90	150	μA
		Flash in powerdown mode, HSI clock after wakeup	4.5	20	80	

1. Data based on characterization results, not tested in production.



Low power mode wakeup times

Table 28. Wakeup times

Symbol	Parameter	Conditions		Typ	Max <sup>(1)</sup>	Unit	
$t_{WU(WFI)}$	Wakeup time from wait mode to run mode <sup>(3)</sup>				See note <sup>(2)</sup>		
		$f_{CPU} = f_{MASTER} = 16 \text{ MHz}$		0.56			
$t_{WU(AH)}$	Wakeup time active halt mode to run mode <sup>(3)</sup>	MVR voltage regulator on <sup>(4)</sup>	Flash in operating mode <sup>(5)</sup>	HSI (after wakeup)	1 <sup>(6)</sup>	2 <sup>(6)</sup>	$\mu\text{s}$
			Flash in power-down mode <sup>(5)</sup>		3 <sup>(6)</sup>		
		MVR voltage regulator off <sup>(4)</sup>	Flash in operating mode <sup>(5)</sup>		48 <sup>(6)</sup>		
			Flash in power-down mode <sup>(5)</sup>		50 <sup>(6)</sup>		
$t_{WU(H)}$	Wakeup time from halt mode to run mode <sup>(3)</sup>	Flash in operating mode <sup>(5)</sup>		52			
		Flash in power-down mode <sup>(5)</sup>		54			

1. Data guaranteed by design, not tested in production.
2.  $t_{WU(WFI)} = 2 \times 1/f_{master} + 7 \times 1/f_{CPU}$
3. Measured from interrupt event to interrupt vector fetch.
4. Configured by the REGAH bit in the CLK\_ICR register.
5. Configured by the AHALT bit in the FLASH\_CR1 register.
6. Plus 1 LSI clock depending on synchronization.

Total current consumption and timing in forced reset state

Table 29. Total current consumption and timing in forced reset state

Symbol	Parameter	Conditions	Typ	Max <sup>(1)</sup>	Unit
$I_{DD(R)}$	Supply current in reset state <sup>(2)</sup>	$V_{DD} = 5 \text{ V}$	500		$\mu\text{A}$
		$V_{DD} = 3.3 \text{ V}$	400		
$t_{RESETBL}$	Reset release to bootloader vector fetch			150	$\mu\text{s}$

1. Data guaranteed by design, not tested in production.
2. Characterized with all I/Os tied to  $V_{SS}$ .

### Current consumption of on-chip peripherals

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

HSI internal  $RC/f_{CPU} = f_{MASTER} = 16$  MHz.

**Table 30. Peripheral current consumption**

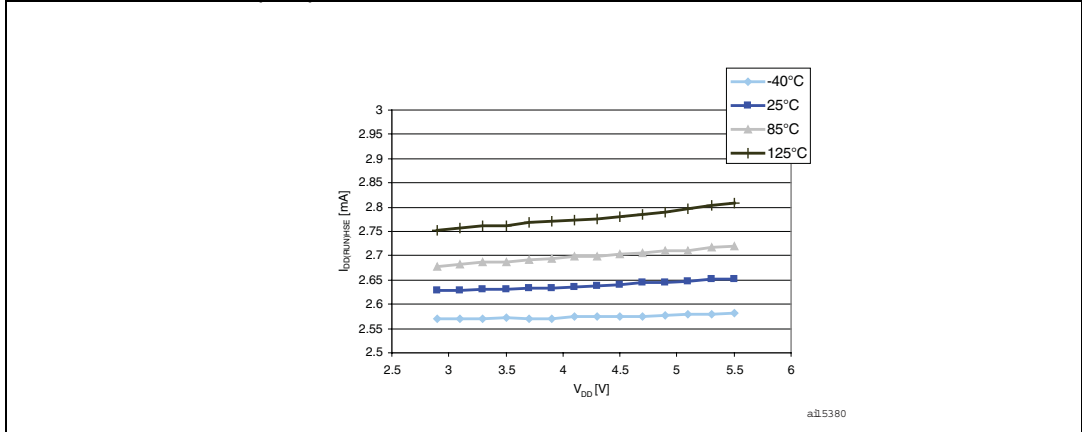
Symbol	Parameter	Typ.	Unit
$I_{DD(TIM1)}$	TIM1 supply current <sup>(1)</sup>	230	μA
$I_{DD(TIM2)}$	TIM2 supply current <sup>(1)</sup>	115	
$I_{DD(TIM3)}$	TIM3 timer supply current <sup>(1)</sup>	90	
$I_{DD(TIM4)}$	TIM4 timer supply current <sup>(1)</sup>	30	
$I_{DD(UART2)}$	UART2 supply current <sup>(2)</sup>	110	
$I_{DD(SPI)}$	SPI supply current <sup>(2)</sup>	45	
$I_{DD(I^2C)}$	I <sup>2</sup> C supply current <sup>(2)</sup>	65	
$I_{DD(ADC1)}$	ADC1 supply current when converting <sup>(3)</sup>	955	

1. Data based on a differential  $I_{DD}$  measurement between reset configuration and timer counter running at 16 MHz. No IC/OC programmed (no I/O pads toggling). Not tested in production.
2. Data based on a differential  $I_{DD}$  measurement between the on-chip peripheral when kept under reset and not clocked and the on-chip peripheral when clocked and not kept under reset. No I/O pads toggling. Not tested in production.
3. Data based on a differential  $I_{DD}$  measurement between reset configuration and continuous A/D conversions. Not tested in production.

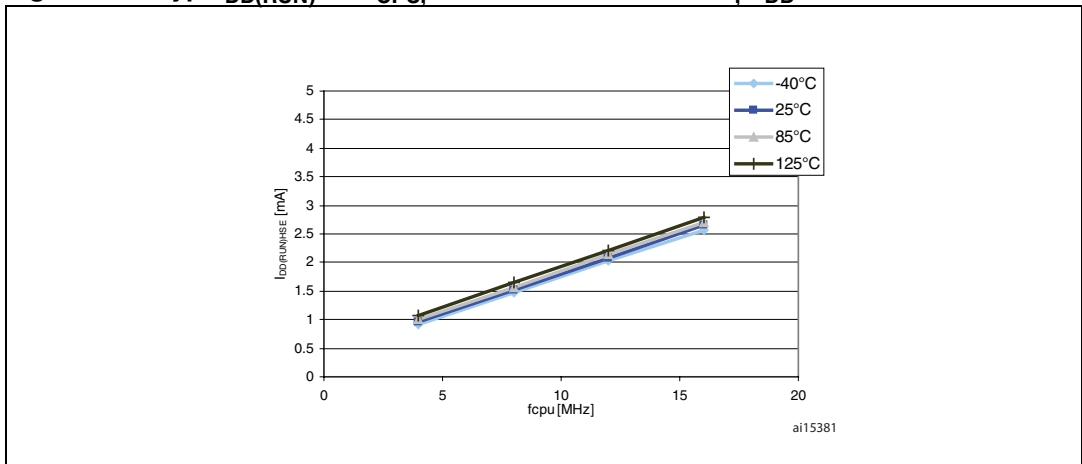
**Current consumption curves**

Figure 15 to Figure 18 show typical current consumption measured with code executing in RAM.

**Figure 13. Typ.  $I_{DD(RUN)}$  vs.  $V_{DD}$ , HSE user external clock,  $f_{CPU} = 16$  MHz**



**Figure 14. Typ.  $I_{DD(RUN)}$  vs.  $f_{CPU}$ , HSE user external clock,  $V_{DD} = 5$  V**



**Figure 15. Typ.  $I_{DD(RUN)}$  vs.  $V_{DD}$ , HSI RC osc,  $f_{CPU} = 16$  MHz**

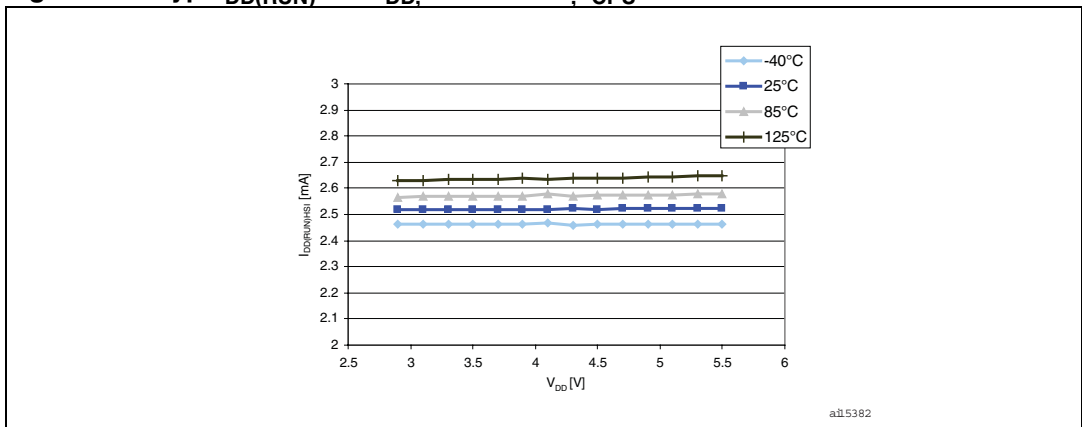


Figure 16. Typ.  $I_{DD(WFI)}$  vs.  $V_{DD}$ , HSE user external clock,  $f_{CPU} = 16$  MHz

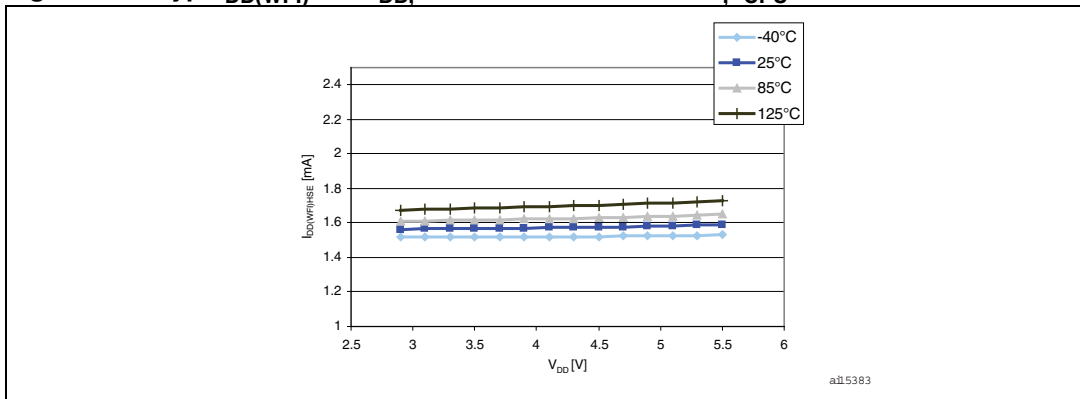


Figure 17. Typ.  $I_{DD(WFI)}$  vs.  $f_{CPU}$ , HSE user external clock  $V_{DD} = 5$  V

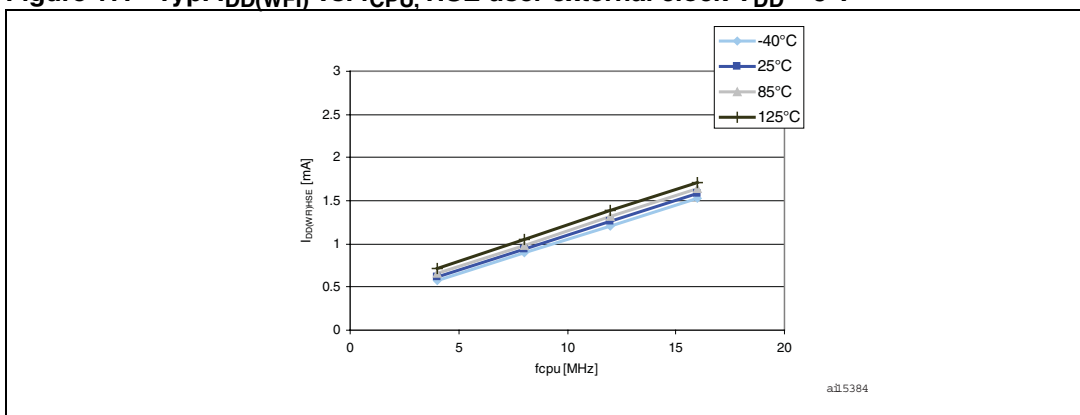
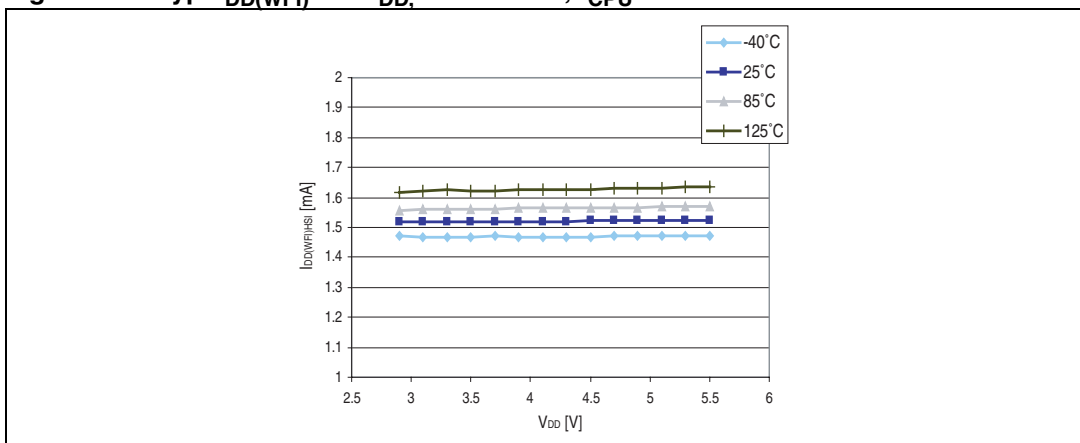


Figure 18. Typ.  $I_{DD(WFI)}$  vs.  $V_{DD}$ , HSI RC osc,  $f_{CPU} = 16$  MHz



### 9.3.3 External clock sources and timing characteristics

#### HSE user external clock

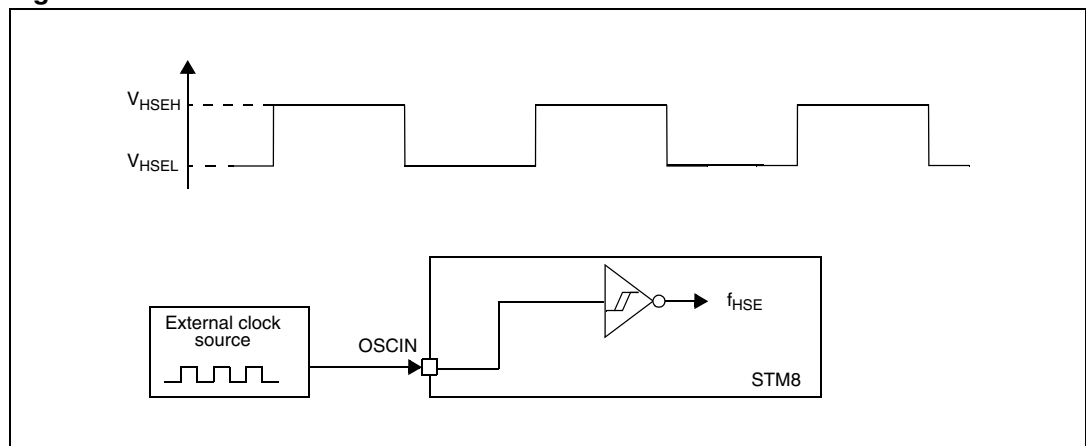
Subject to general operating conditions for  $V_{DD}$  and  $T_A$ .

**Table 31. HSE user external clock characteristics**

Symbol	Parameter	Conditions	Min	Max	Unit
$f_{HSE\_ext}$	User external clock source frequency		0	16	MHz
$V_{HSEH}^{(1)}$	OSCIN input pin high level voltage		$0.7 \times V_{DD}$	$V_{DD} + 0.3 V$	V
$V_{HSEL}^{(1)}$	OSCIN input pin low level voltage		$V_{SS}$	$0.3 \times V_{DD}$	
$I_{LEAK\_HSE}$	OSCIN input leakage current	$V_{SS} < V_{IN} < V_{DD}$	-1	+1	$\mu A$

1. Data based on characterization results, not tested in production.

**Figure 19. HSE external clock source**



#### HSE crystal/ceramic resonator oscillator

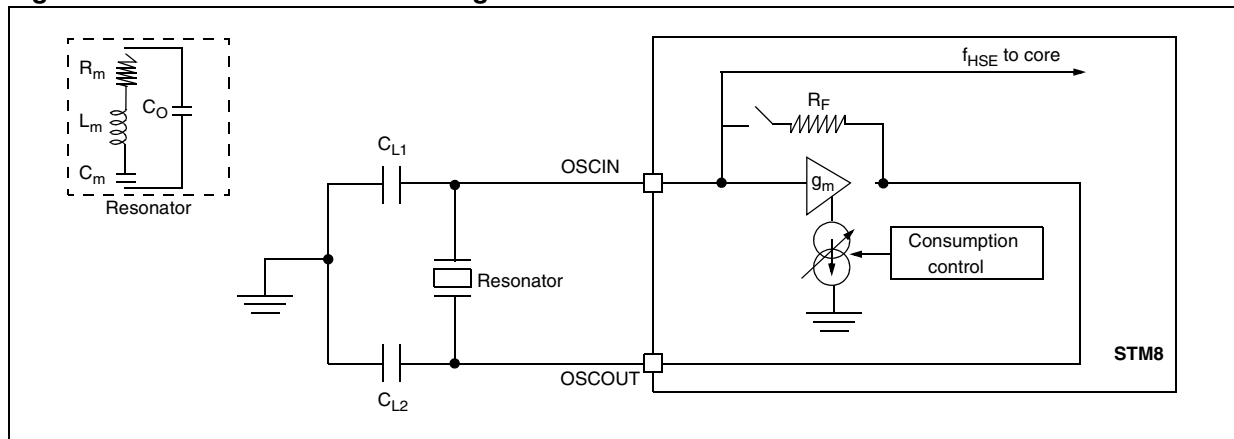
The HSE clock can be supplied with a 1 to 16 MHz crystal/ceramic resonator oscillator. All the information given in this paragraph is based on characterization results with specified typical external components. In the application, the resonator and the load capacitors have to be placed as close as possible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

**Table 32. HSE oscillator characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{HSE}$	External high speed oscillator frequency		1		16	MHz
$R_F$	Feedback resistor			220		k $\Omega$
$C^{(1)}$	Recommended load capacitance <sup>(2)</sup>				20	pF
$I_{DD(HSE)}$	HSE oscillator power consumption	$C = 20$ pF, $f_{OSC} = 16$ MHz			6 (startup) 1.6 (stabilized) <sup>(3)</sup>	mA
		$C = 10$ pF, $f_{OSC} = 16$ MHz			6 (startup) 1.2 (stabilized) <sup>(3)</sup>	
$g_m$	Oscillator transconductance		5			mA/V
$t_{SU(HSE)}^{(4)}$	Startup time	$V_{DD}$ is stabilized		1		ms

1. C is approximately equivalent to 2 x crystal Cload.
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. Data based on characterization results, not tested in production.
4.  $t_{SU(HSE)}$  is the start-up time measured from the moment it is enabled (by software) to a stabilized 16 MHz oscillation is reached. This value is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.

**Figure 20. HSE oscillator circuit diagram**



**HSE oscillator critical  $g_m$  formula**

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

$R_m$ : Notional resistance (see crystal specification),  $L_m$ : Notional inductance (see crystal specification),

$C_m$ : Notional capacitance (see crystal specification),  $C_o$ : Shunt capacitance (see crystal specification),

$C_{L1}=C_{L2}=C$ : Grounded external capacitance

$g_m \gg g_{m_{crit}}$

### 9.3.4 Internal clock sources and timing characteristics

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

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

**Table 33. HSI oscillator characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{HSI}$	Frequency			16		MHz
$ACC_{HSI}$	Accuracy of HSI oscillator	User-trimmed with CLK_HSITRIMR register for given $V_{DD}$ and $T_A$ conditions <sup>(1)</sup>			1 <sup>(2)</sup>	%
	Accuracy of HSI oscillator (factory calibrated)	$V_{DD} = 5\text{ V}, T_A = 25^\circ\text{C}^{(3)}$	-2.5 <sup>(4)</sup>		1.3 <sup>(4)</sup>	
		$V_{DD} = 5\text{ V}, 25^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	-2.5 <sup>(4)</sup>		2 <sup>(4)</sup>	
		$2.95 \leq V_{DD} \leq 5.5\text{ V}, -40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$	-4.5 <sup>(3)(4)</sup>		3 <sup>(3)(4)</sup>	
$t_{su(HSI)}$	HSI oscillator wakeup time including calibration				1 <sup>(2)</sup>	$\mu\text{s}$
$I_{DD(HSI)}$	HSI oscillator power consumption			170	250 <sup>(3)</sup>	$\mu\text{A}$

1. Refer to application note.
2. Guaranteed by design, not tested in production.
3. Data based on characterization results, not tested in production.
4. Subject to further characterization to give better results.

**Figure 21. Typical HSI accuracy at  $V_{DD} = 5\text{ V}$  vs 5 temperatures**

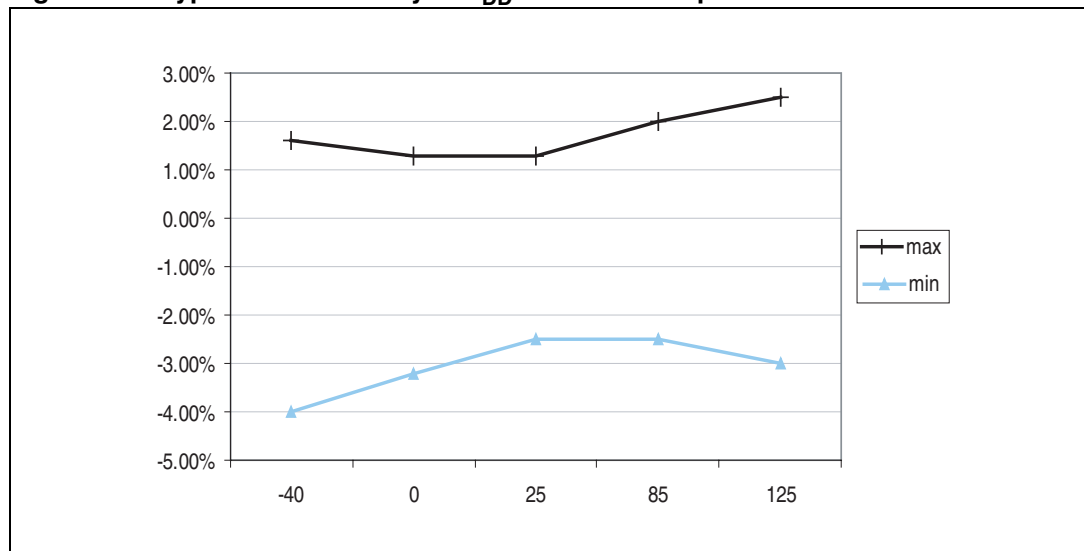
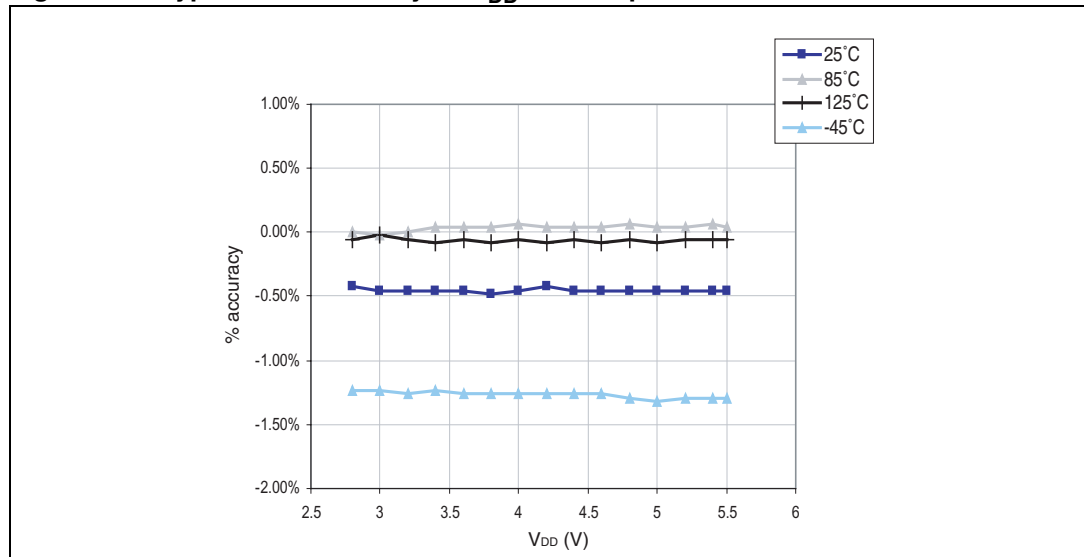


Figure 22. Typical HSI accuracy vs V<sub>DD</sub> @ 4 temperatures



Low speed internal RC oscillator (LSI)

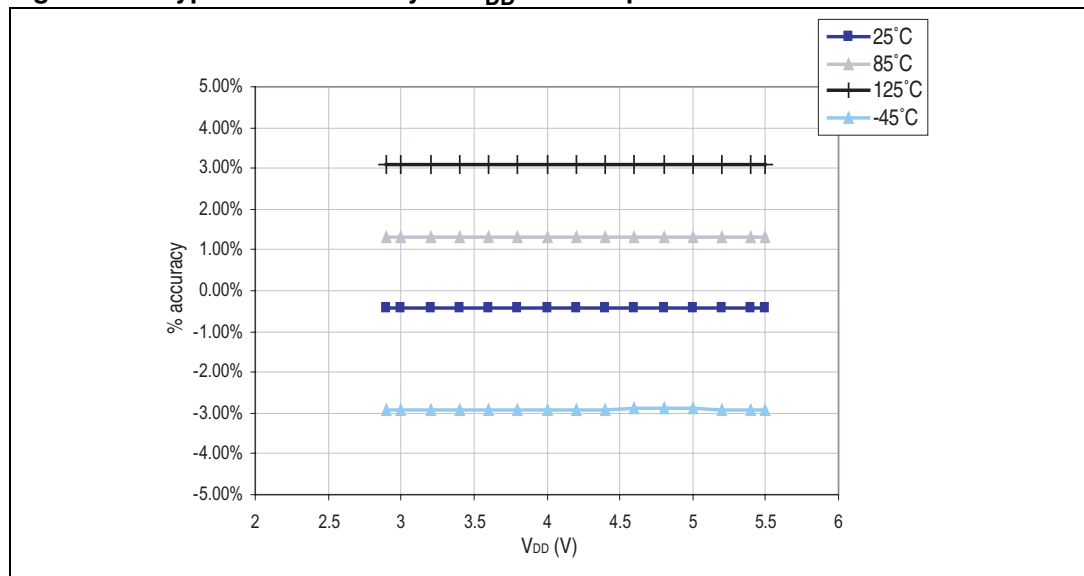
Subject to general operating conditions for V<sub>DD</sub> and T<sub>A</sub>.

Table 34. LSI oscillator characteristics

Symbol	Parameter	Min	Typ	Max	Unit
f <sub>LSI</sub>	Frequency	110	128	146	kHz
t <sub>su(LSI)</sub>	LSI oscillator wakeup time			7 <sup>(1)</sup>	μs
I <sub>DD(LSI)</sub>	LSI oscillator power consumption		5		μA

1. Guaranteed by design, not tested in production.

Figure 23. Typical LSI accuracy vs V<sub>DD</sub> @ 4 temperatures





### 9.3.5 Memory characteristics

#### RAM and hardware registers

**Table 35. RAM and hardware registers**

Symbol	Parameter	Conditions	Min	Unit
V <sub>RM</sub>	Data retention mode <sup>(1)</sup>	Halt mode (or reset)	V <sub>IT-max</sub> <sup>(2)</sup>	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 design, not tested in production.

2. Refer to [Table 19 on page 51](#) for the value of V<sub>IT-max</sub>.

#### Flash program memory/data EEPROM memory

General conditions: T<sub>A</sub> = -40 to 125 °C.

**Table 36. Flash program memory/data EEPROM memory**

Symbol	Parameter	Conditions	Min <sup>(1)</sup>	Typ	Max	Unit
V <sub>DD</sub>	Operating voltage (all modes, execution/write/erase)	f <sub>CPU</sub> ≤16 MHz	2.95		5.5	V
t <sub>prog</sub>	Standard programming time (including erase) for byte/word/block (1 byte/4 bytes/128 bytes)			6	6.6	ms
	Fast programming time for 1 block (128 bytes)			3	3.3	ms
t <sub>erase</sub>	Erase time for 1 block (128 bytes)			3	3.3	ms
N <sub>RW</sub>	Erase/write cycles <sup>(2)</sup> (program memory)	T <sub>A</sub> = +85 °C	10 k			cycles
	Erase/write cycles (data memory) <sup>(2)</sup>	T <sub>A</sub> = +125 °C	300 k	1M		
t <sub>RET</sub>	Data retention (program memory) after 10k erase/write cycles at T <sub>A</sub> = +85 °C	T <sub>RET</sub> = 55° C	20			years
	Data retention (data memory) after 10k erase/write cycles at T <sub>A</sub> = +85 °C	T <sub>RET</sub> = 55° C	20			
	Data retention (data memory) after 300 k erase/write cycles at T <sub>A</sub> = +125 °C	T <sub>RET</sub> = 85° C	1			
I <sub>DD</sub>	Supply current (Flash programming or erasing for 1 to 128 bytes)			2		mA

1. Data based on characterization results, not tested in production.

2. 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.

### 9.3.6 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 37. I/O static characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{IL}$	Input low level voltage	$V_{DD} = 5\text{ V}$	-0.3		$0.3 \times V_{DD}$	V
$V_{IH}$	Input high level voltage		$0.7 \times V_{DD}$		$V_{DD} + 0.3\text{ V}$	V
$V_{hys}$	Hysteresis <sup>(1)</sup>			700		mV
$R_{pu}$	Pull-up resistor	$V_{DD} = 5\text{ V}, V_{IN} = V_{SS}$	30	45	60	k $\Omega$
$t_R, t_F$	Rise and fall time (10 % - 90 %)	Fast I/Os Load = 50 pF			20 <sup>(2)</sup>	ns
		Standard and high sink I/Os Load = 50 pF			125 <sup>(2)</sup>	ns
$I_{lkg}$	Input leakage current, analog and digital	$V_{SS} \leq V_{IN} \leq V_{DD}$			$\pm 1$ <sup>(2)</sup>	$\mu\text{A}$
$I_{lkg\text{ ana}}$	Analog input leakage current	$V_{SS} \leq V_{IN} \leq V_{DD}$			$\pm 250$ <sup>(2)</sup>	nA
$I_{lkg(inj)}$	Leakage current in adjacent I/O <sup>(2)</sup>	Injection current $\pm 4\text{ mA}$			$\pm 1$ <sup>(2)</sup>	$\mu\text{A}$

1. Hysteresis voltage between Schmitt trigger switching levels. Based on characterization results, not tested in production.
2. Data based on characterization results, not tested in production.

Figure 24. Typical  $V_{IL}$  and  $V_{IH}$  vs  $V_{DD}$  @ 4 temperatures

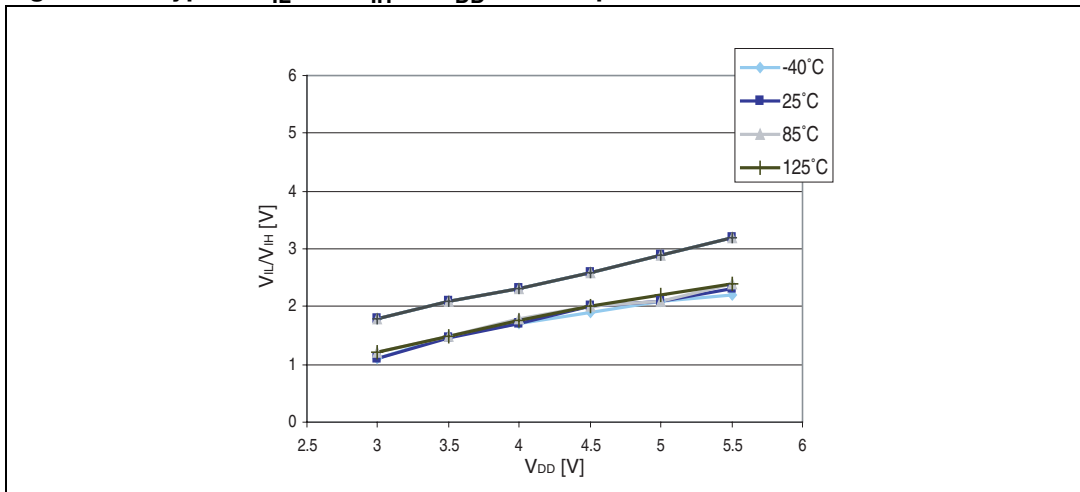


Figure 25. Typical pull-up resistance vs  $V_{DD}$  @ 4 temperatures

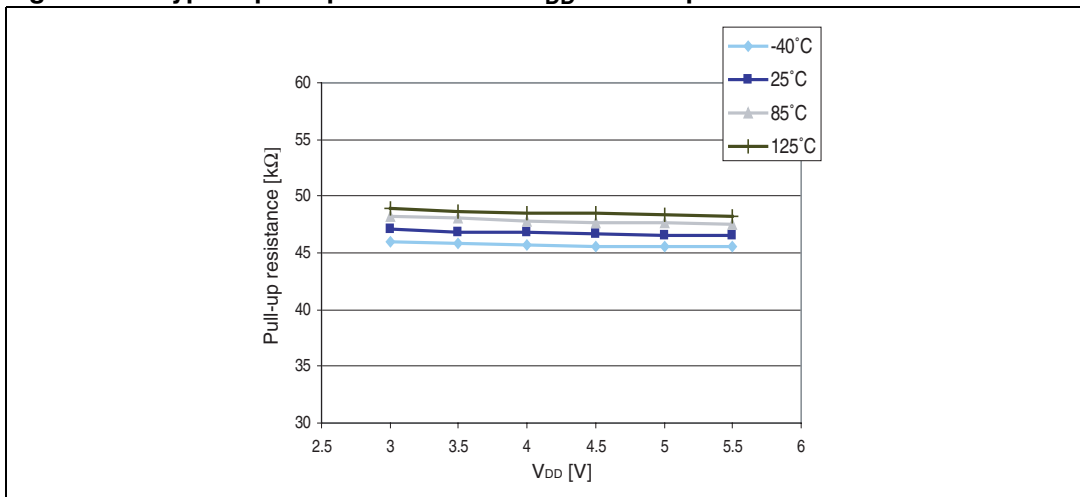
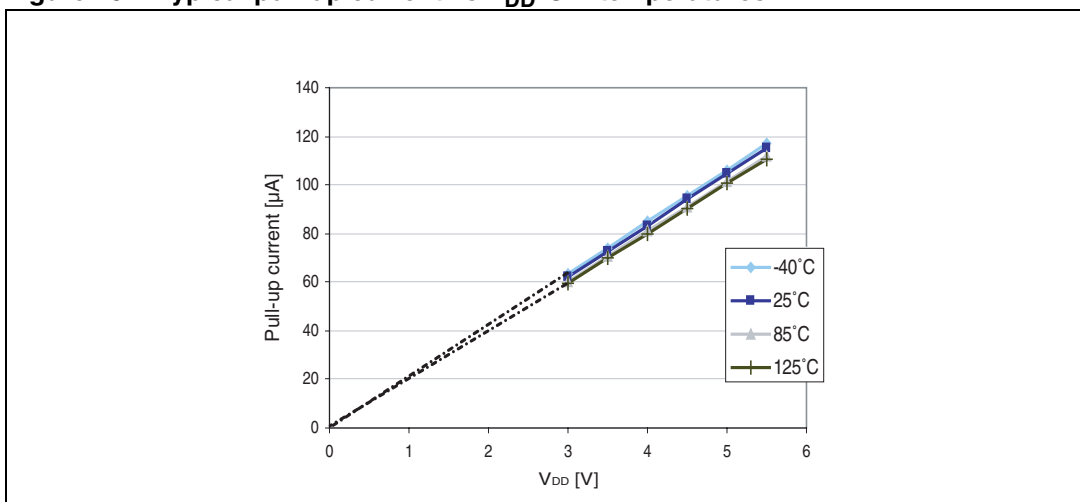


Figure 26. Typical pull-up current vs  $V_{DD}$  @ 4 temperatures



1. The pull-up is a pure resistor (slope goes through 0).

**Table 38. Output driving current (standard ports)**

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>OL</sub>	Output low level with eight pins sunk	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 5 V		2	V
	Output low level with four pins sunk	I <sub>IO</sub> = 4 mA, V <sub>DD</sub> = 3.3 V		1 <sup>(1)</sup>	
V <sub>OH</sub>	Output high level with eight pins sourced	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 5 V	2.4		V
	Output high level with four pins sourced	I <sub>IO</sub> = 4 mA, V <sub>DD</sub> = 3.3 V	2 <sup>(1)</sup>		

1. Data based on characterization results, not tested in production

**Table 39. Output driving current (true open drain ports)**

Symbol	Parameter	Conditions	Max	Unit
V <sub>OL</sub>	Output low level with two pins sunk	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 5 V	1	V
		I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 3.3 V	1.5 <sup>(1)</sup>	
		I <sub>IO</sub> = 20 mA, V <sub>DD</sub> = 5 V	2 <sup>(1)</sup>	

1. Data based on characterization results, not tested in production

**Table 40. Output driving current (high sink ports)**

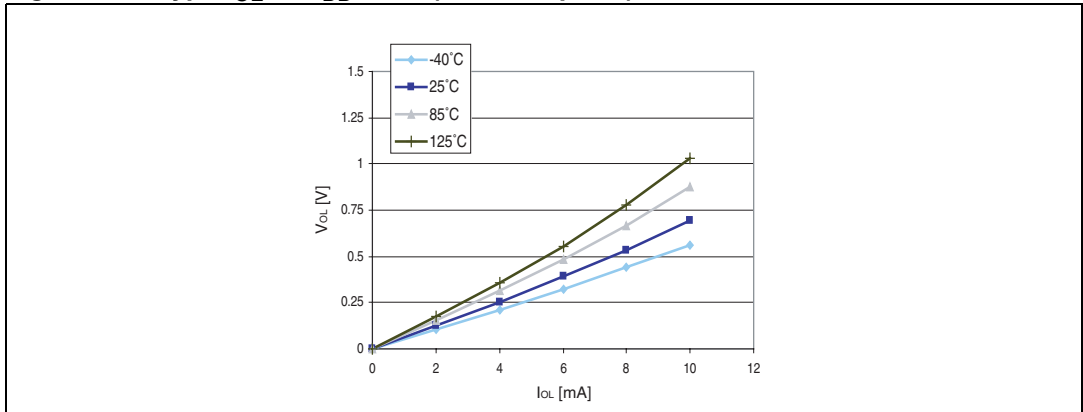
Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>OL</sub>	Output low level with eight pins sunk	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 5 V		0.9	V
	Output low level with four pins sunk	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 3.3 V		1.1 <sup>(1)</sup>	
	Output low level with four pins sunk	I <sub>IO</sub> = 20 mA, V <sub>DD</sub> = 5 V		1.6 <sup>(1)</sup>	
V <sub>OH</sub>	Output high level with eight pins sourced	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 5 V	3.8		
	Output high level with four pins sourced	I <sub>IO</sub> = 10 mA, V <sub>DD</sub> = 3.3 V	1.9 <sup>(1)</sup>		
	Output high level with four pins sourced	I <sub>IO</sub> = 20 mA, V <sub>DD</sub> = 5 V	2.9 <sup>(1)</sup>		

1. Data based on characterization results, not tested in production

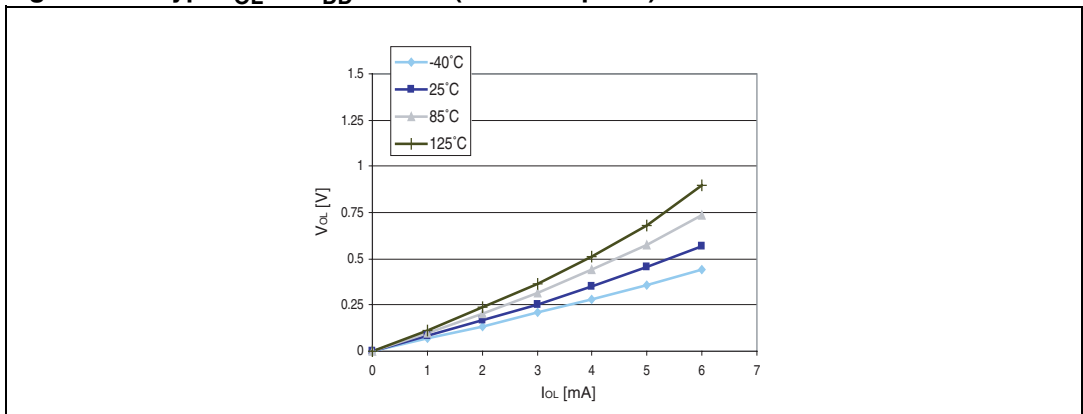
**Typical output level curves**

Figure 28 to Figure 35 show typical output level curves measured with output on a single pin.

**Figure 27. Typ.  $V_{OL}$  @  $V_{DD} = 5\text{ V}$  (standard ports)**



**Figure 28. Typ.  $V_{OL}$  @  $V_{DD} = 3.3\text{ V}$  (standard ports)**



**Figure 29. Typ.  $V_{OL}$  @  $V_{DD} = 5\text{ V}$  (true open drain ports)**

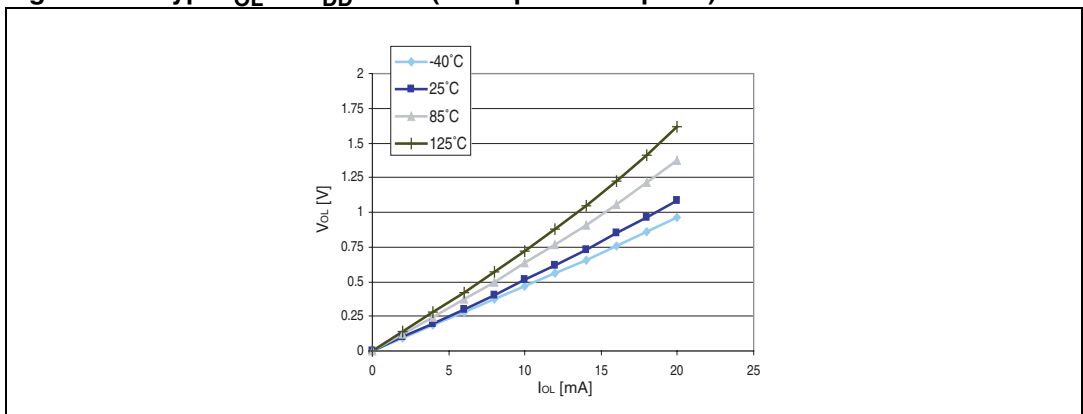


Figure 30. Typ.  $V_{OL}$  @  $V_{DD} = 3.3\text{ V}$  (true open drain ports)

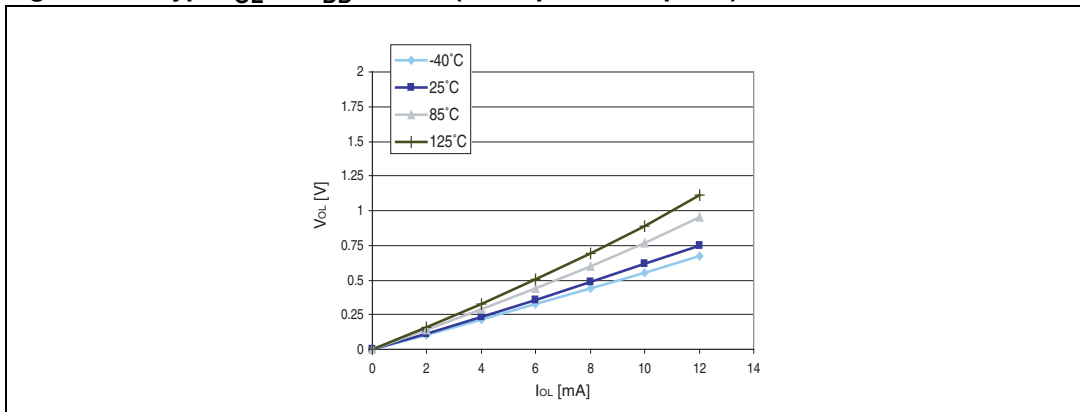


Figure 31. Typ.  $V_{OL}$  @  $V_{DD} = 5\text{ V}$  (high sink ports)

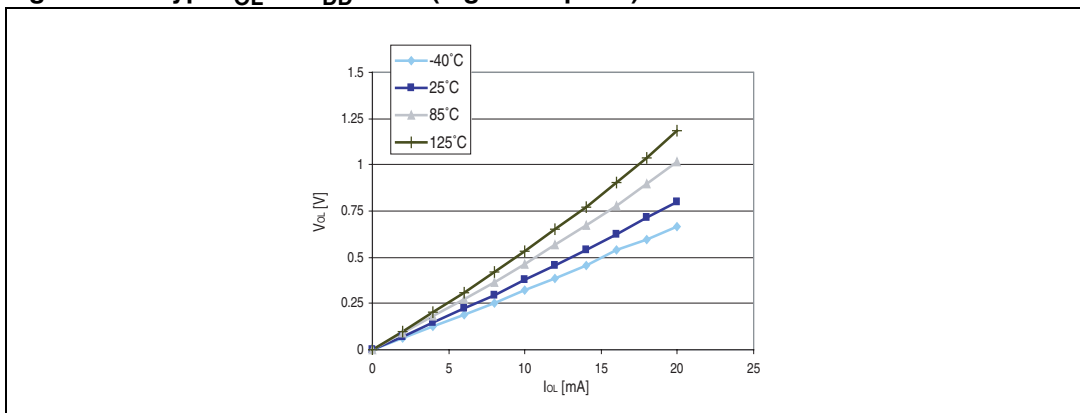


Figure 32. Typ.  $V_{OL}$  @  $V_{DD} = 3.3\text{ V}$  (high sink ports)

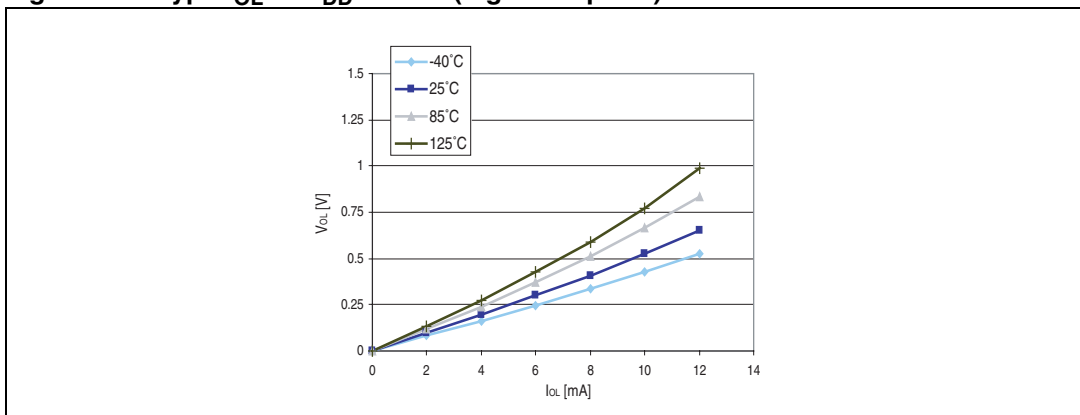


Figure 33. Typ.  $V_{DD} - V_{OH}$  @  $V_{DD} = 5\text{ V}$  (standard ports)

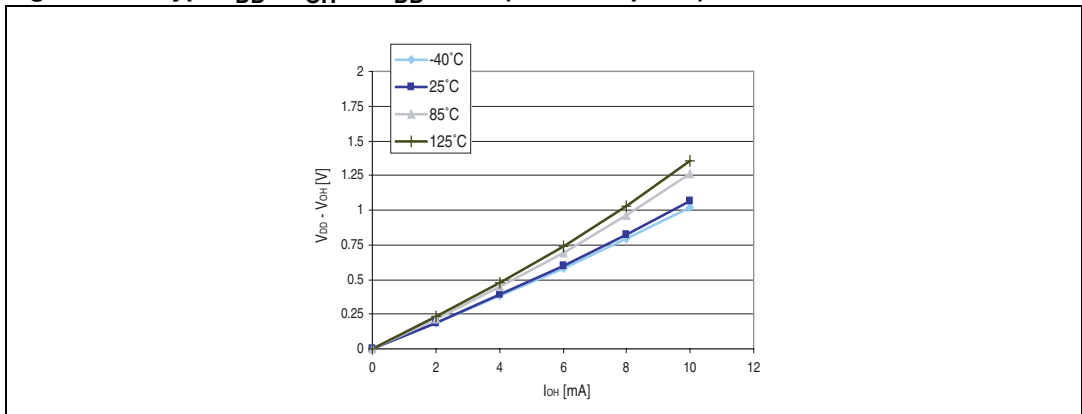


Figure 34. Typ.  $V_{DD} - V_{OH}$  @  $V_{DD} = 3.3\text{ V}$  (standard ports)

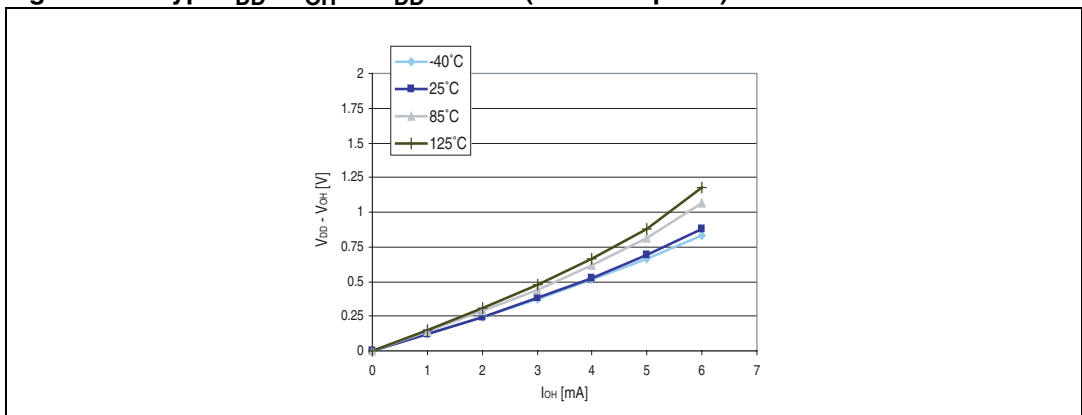


Figure 35. Typ.  $V_{DD} - V_{OH}$  @  $V_{DD} = 5\text{ V}$  (high sink ports)

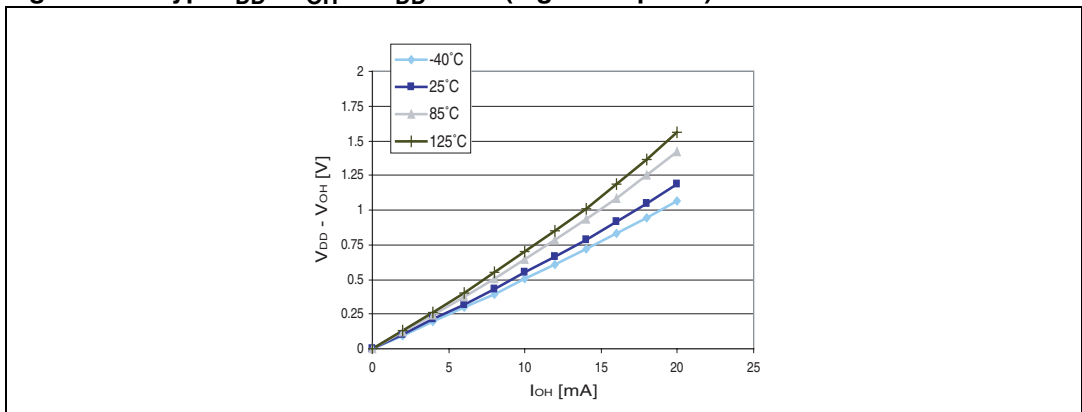
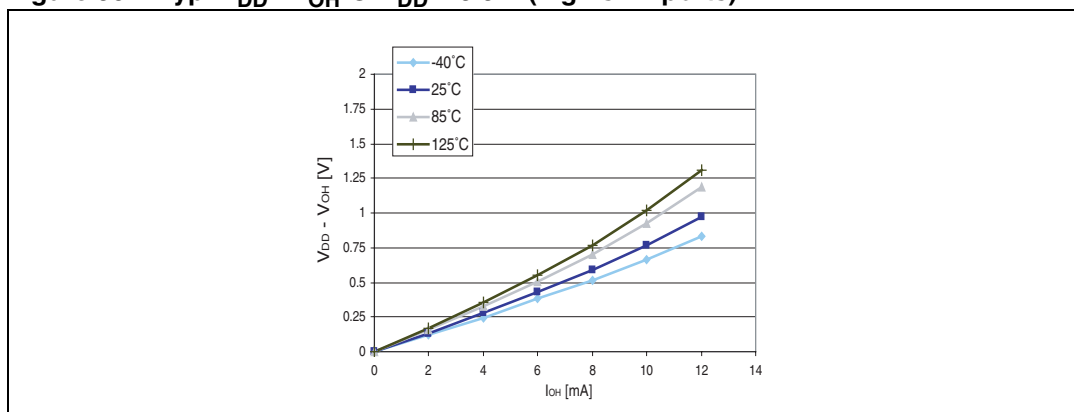


Figure 36. Typ.  $V_{DD} - V_{OH}$  @  $V_{DD} = 3.3$  V (high sink ports)





### 9.3.7 Reset pin characteristics

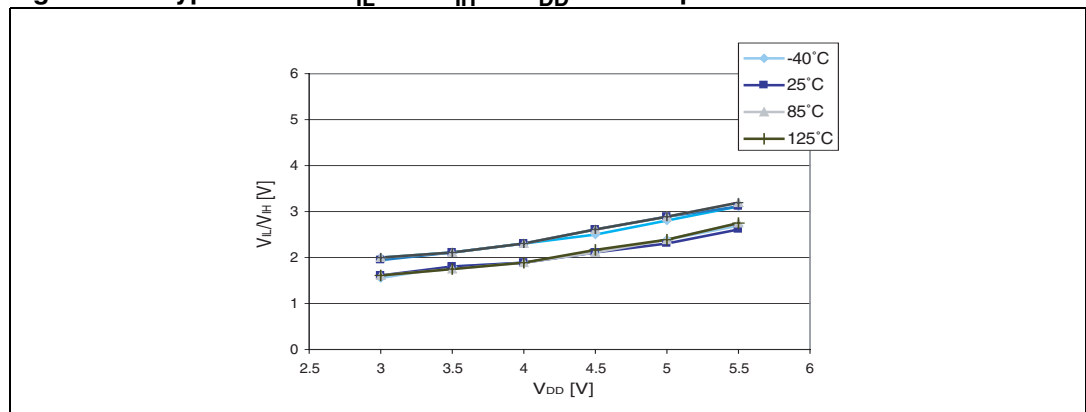
Subject to general operating conditions for  $V_{DD}$  and  $T_A$  unless otherwise specified.

**Table 41. NRST pin characteristics**

Symbol	Parameter	Conditions	Min	Typ <sup>1)</sup>	Max	Unit
$V_{IL(NRST)}$	NRST Input low level voltage <sup>(1)</sup>		-0.3 V		$0.3 \times V_{DD}$	V
$V_{IH(NRST)}$	NRST Input high level voltage <sup>(1)</sup>		$0.7 \times V_{DD}$		$V_{DD} + 0.3$	
$V_{OL(NRST)}$	NRST Output low level voltage <sup>(1)</sup>	$I_{OL}=2 \text{ mA}$			0.5	
$R_{PU(NRST)}$	NRST Pull-up resistor <sup>(2)</sup>		30	40	60	k $\Omega$
$t_{IFP(NRST)}$	NRST Input filtered pulse <sup>(3)</sup>				75	ns
$t_{INFP(NRST)}$	NRST Input not filtered pulse <sup>(3)</sup>		500			ns
$t_{OP(NRST)}$	NRST output pulse <sup>(1)</sup>		15			$\mu\text{s}$

1. Data based on characterization results, not tested in production.
2. The  $R_{PU}$  pull-up equivalent resistor is based on a resistive transistor
3. Data guaranteed by design, not tested in production.

**Figure 37. Typical NRST  $V_{IL}$  and  $V_{IH}$  vs  $V_{DD}$  @ 4 temperatures**



**Figure 38. Typical NRST pull-up resistance vs  $V_{DD}$  @ 4 temperatures**

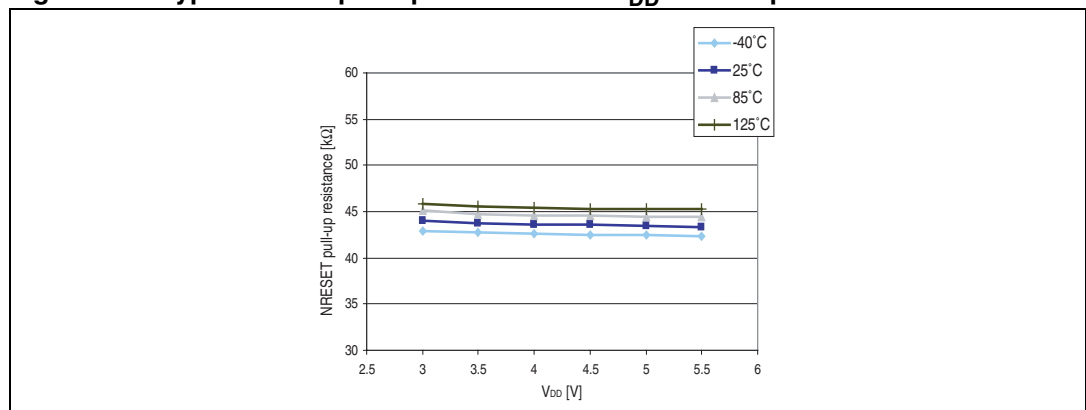
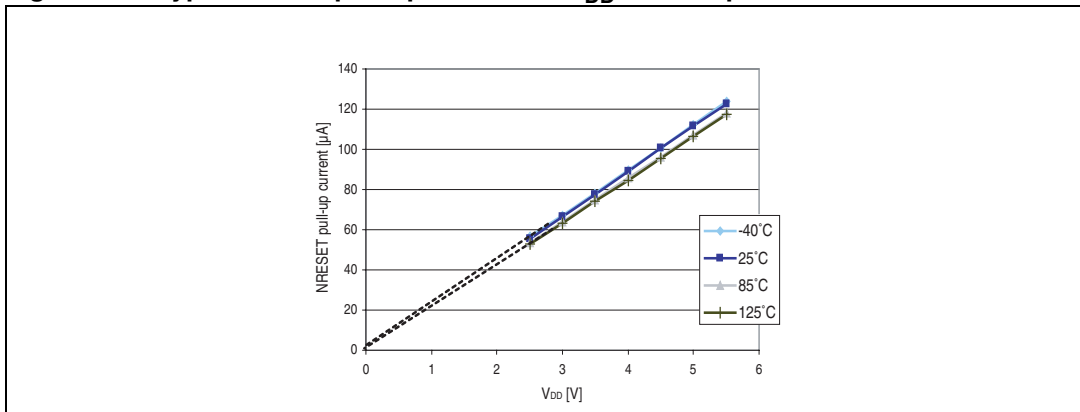
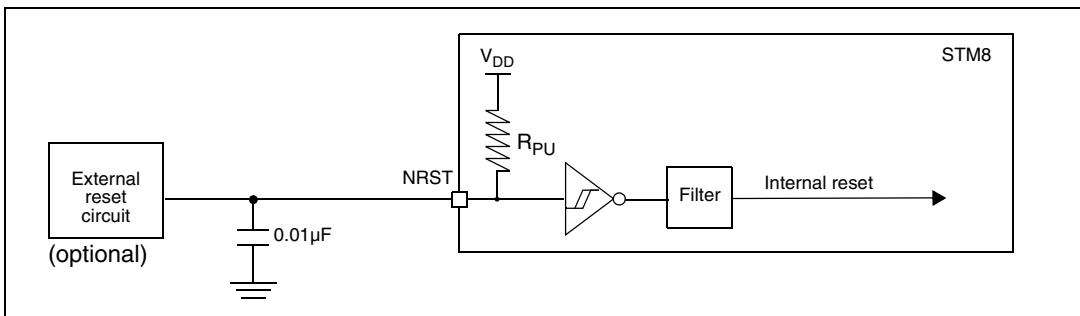


Figure 39. Typical NRST pull-up current vs  $V_{DD}$  @ 4 temperatures



The reset network shown in [Figure 40](#) protects the device against parasitic resets. The user must ensure that the level on the NRST pin can go below the  $V_{IL}$  max. level specified in [Table 37](#). Otherwise the reset is not taken into account internally.

Figure 40. Recommended reset pin protection



### 9.3.8 SPI serial peripheral interface

Unless otherwise specified, the parameters given in [Table 42](#) are derived from tests performed under ambient temperature,  $f_{\text{MASTER}}$  frequency and  $V_{\text{DD}}$  supply voltage conditions.  $t_{\text{MASTER}} = 1/f_{\text{MASTER}}$ .

Refer to I/O port characteristics for more details on the input/output alternate function characteristics (NSS, SCK, MOSI, MISO).

**Table 42. SPI characteristics**

Symbol	Parameter	Conditions	Min	Max	Unit
$f_{\text{SCK}}$ $1/t_{\text{c(SCK)}}$	SPI clock frequency	Master mode	0	8	MHz
		Slave mode	0	6	
$t_{\text{r(SCK)}}$ $t_{\text{f(SCK)}}$	SPI clock rise and fall time	Capacitive load: C = 30 pF		25	ns
$t_{\text{su(NSS)}}^{(1)}$	NSS setup time	Slave mode	$4 \times t_{\text{MASTER}}$		
$t_{\text{h(NSS)}}^{(1)}$	NSS hold time	Slave mode	70		
$t_{\text{w(SCKH)}}^{(1)}$ $t_{\text{w(SCKL)}}^{(1)}$	SCK high and low time	Master mode	$t_{\text{SCK}}/2 - 15$	$t_{\text{SCK}}/2 + 15$	
$t_{\text{su(MI)}}^{(1)}$ $t_{\text{su(SI)}}^{(1)}$	Data input setup time	Master mode	5		
		Slave mode	5		
$t_{\text{h(MI)}}^{(1)}$ $t_{\text{h(SI)}}^{(1)}$	Data input hold time	Master mode	7		
		Slave mode	10		
$t_{\text{a(SO)}}^{(1)(2)}$	Data output access time	Slave mode		$3 \times t_{\text{MASTER}}$	
$t_{\text{dis(SO)}}^{(1)(3)}$	Data output disable time	Slave mode	25		
$t_{\text{v(SO)}}^{(1)}$	Data output valid time	Slave mode (after enable edge)		73	
$t_{\text{v(MO)}}^{(1)}$	Data output valid time	Master mode (after enable edge)		36	
$t_{\text{h(SO)}}^{(1)}$ $t_{\text{h(MO)}}^{(1)}$	Data output hold time	Slave mode (after enable edge)	28		
		Master mode (after enable edge)	12		

1. Values based on design simulation and/or characterization results, and not tested in production.
2. Min time is for the minimum time to drive the output and the max time is for the maximum time to validate the data.
3. Min time is for the minimum time to invalidate the output and the max time is for the maximum time to put the data in Hi-Z.

Figure 41. SPI timing diagram - slave mode and CPHA = 0

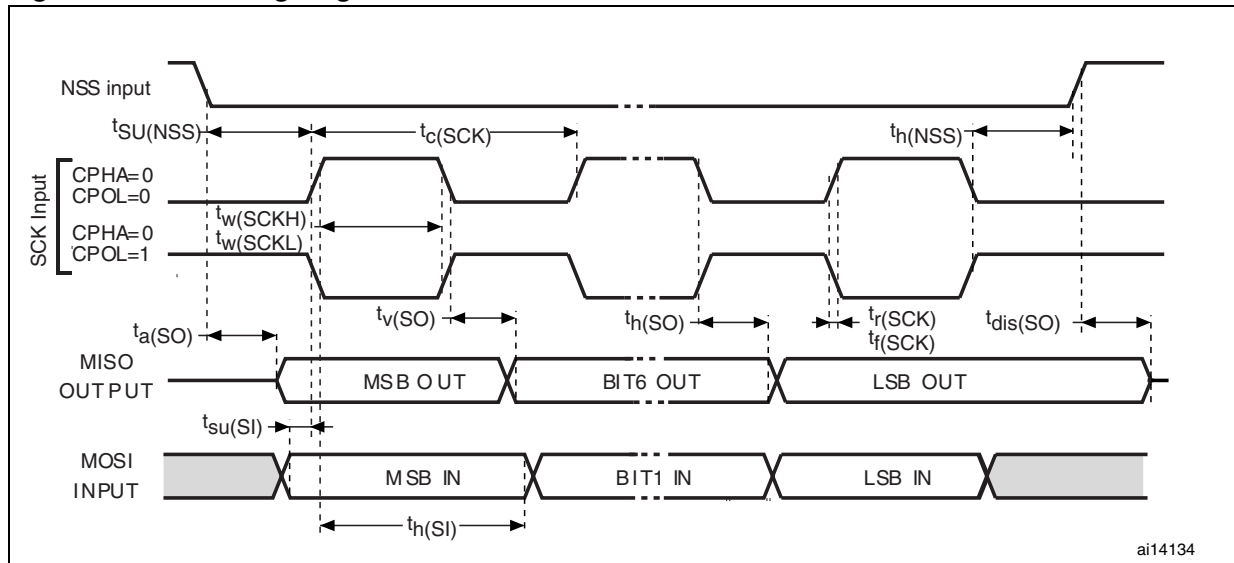
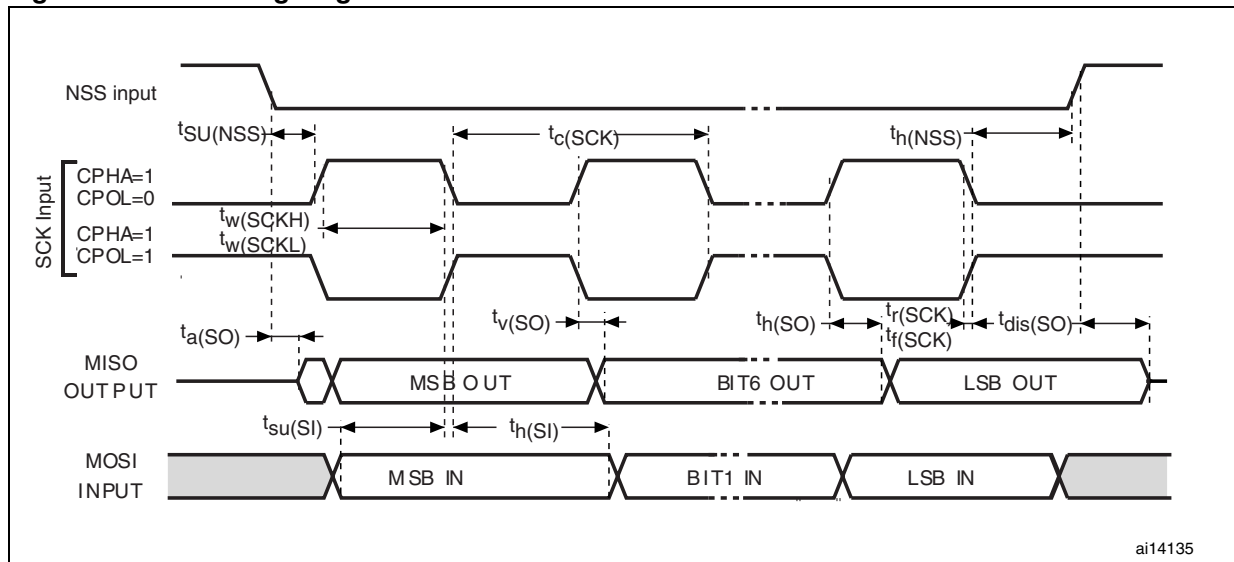
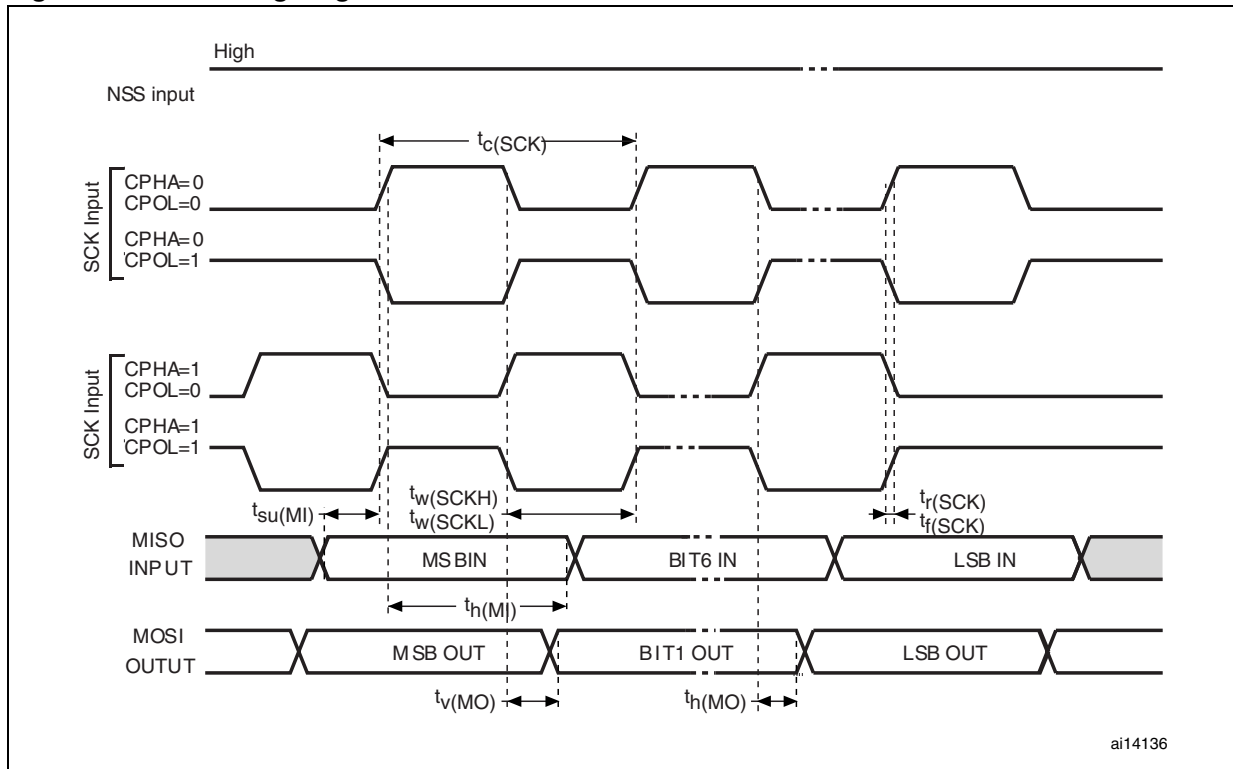


Figure 42. SPI timing diagram - slave mode and CPHA = 1<sup>(1)</sup>



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

Figure 43. SPI timing diagram - master mode<sup>(1)</sup>



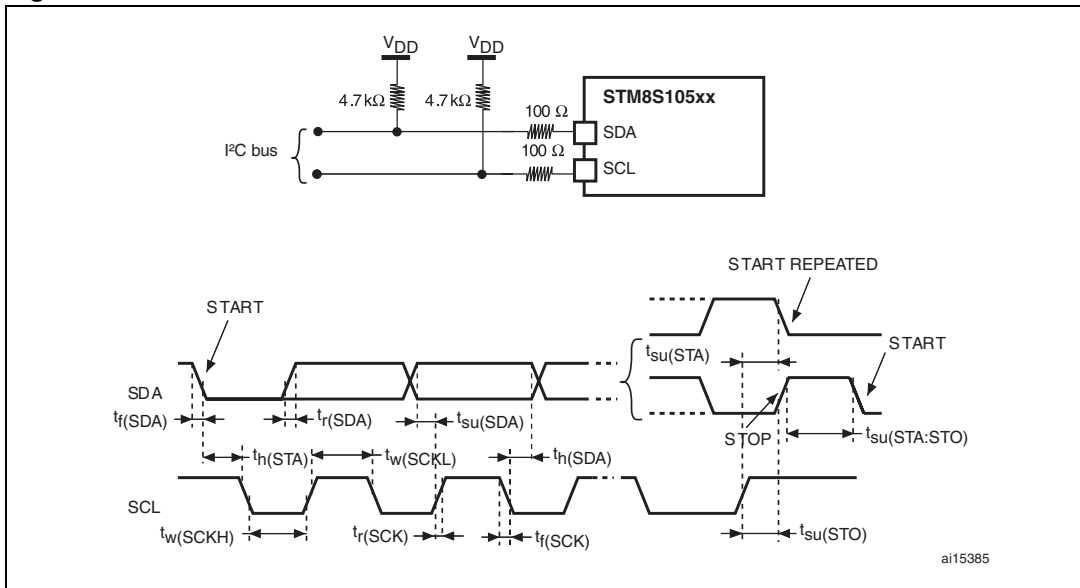
1. Measurement points are done at CMOS levels: 0.3 V<sub>DD</sub> and 0.7 V<sub>DD</sub>.

9.3.9 I<sup>2</sup>C interface characteristicsTable 43. I<sup>2</sup>C characteristics

Symbol	Parameter	Standard mode I <sup>2</sup> C		Fast mode I <sup>2</sup> C <sup>(1)</sup>		Unit
		Min <sup>(2)</sup>	Max <sup>(2)</sup>	Min <sup>(2)</sup>	Max <sup>(2)</sup>	
t <sub>w(SCLL)</sub>	SCL clock low time	4.7		1.3		μs
t <sub>w(SCLH)</sub>	SCL clock high time	4.0		0.6		
t <sub>su(SDA)</sub>	SDA setup time	250		100		ns
t <sub>h(SDA)</sub>	SDA data hold time	0 <sup>(3)</sup>		0 <sup>(4)</sup>	900 <sup>(3)</sup>	
t <sub>r(SDA)</sub> t <sub>r(SCL)</sub>	SDA and SCL rise time		1000		300	
t <sub>f(SDA)</sub> t <sub>f(SCL)</sub>	SDA and SCL fall time		300		300	
t <sub>h(STA)</sub>	START condition hold time	4.0		0.6		μs
t <sub>su(STA)</sub>	Repeated START condition setup time	4.7		0.6		
t <sub>su(STO)</sub>	STOP condition setup time	4.0		0.6		μs
t <sub>w(STO:STA)</sub>	STOP to START condition time (bus free)	4.7		1.3		μs
C <sub>b</sub>	Capacitive load for each bus line		400		400	pF

1. f<sub>MASTER</sub> must be at least 8 MHz to achieve max fast I<sup>2</sup>C speed (400 kHz).
2. Data based on standard I<sup>2</sup>C protocol requirement, not tested in production.
3. The maximum hold time of the start condition has only to be met if the interface does not stretch the low time.
4. The device must internally provide a hold time of at least 300 ns for the SDA signal in order to bridge the undefined region of the falling edge of SCL.

Figure 44. Typical application with I<sup>2</sup>C bus and timing diagram <sup>1)</sup>



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

9.3.10 10-bit ADC characteristics

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

Table 44. ADC characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{ADC}$	ADC clock frequency	$V_{DDA} = 2.95$ to $5.5$ V	1		4	MHz
		$V_{DDA} = 4.5$ to $5.5$ V	1		6	
$V_{DDA}$	Analog supply		3		5.5	V
$V_{REF+}$	Positive reference voltage		2.75 <sup>(1)</sup>		$V_{DDA}$	V
$V_{REF-}$	Negative reference voltage		$V_{SSA}$		0.5 <sup>(1)</sup>	V
$V_{AIN}$	Conversion voltage range <sup>(2)</sup>		$V_{SSA}$		$V_{DDA}$	V
		Devices with external $V_{REF+}/V_{REF-}$ pins	$V_{REF-}$		$V_{REF+}$	V
$C_{ADC}$	Internal sample and hold capacitor			3		pF
$t_S^{(2)}$	Sampling time	$f_{ADC} = 4$ MHz	0.75			$\mu$ s
		$f_{ADC} = 6$ MHz	0.5			
$t_{STAB}$	Wakeup time from standby			7		$\mu$ s
$t_{CONV}$	Total conversion time (including sampling time, 10-bit resolution)	$f_{ADC} = 4$ MHz	3.5			$\mu$ s
		$f_{ADC} = 6$ MHz	2.33			$\mu$ s
			14			$1/f_{ADC}$

1. Data guaranteed by design, not tested in production..
2. During the sample time the input capacitance  $C_{AIN}$  (3 pF max) can be charged/discharged by the external source. The internal resistance of the analog source must allow the capacitance to reach its final voltage level within  $t_S$ . After the end of the sample time  $t_S$ , changes of the analog input voltage have no effect on the conversion result. Values for the sample clock  $t_S$  depend on programming.



**Table 45. ADC accuracy with  $R_{AIN} < 10\text{ k}\Omega$ ,  $V_{DDA} = 5\text{ V}$**

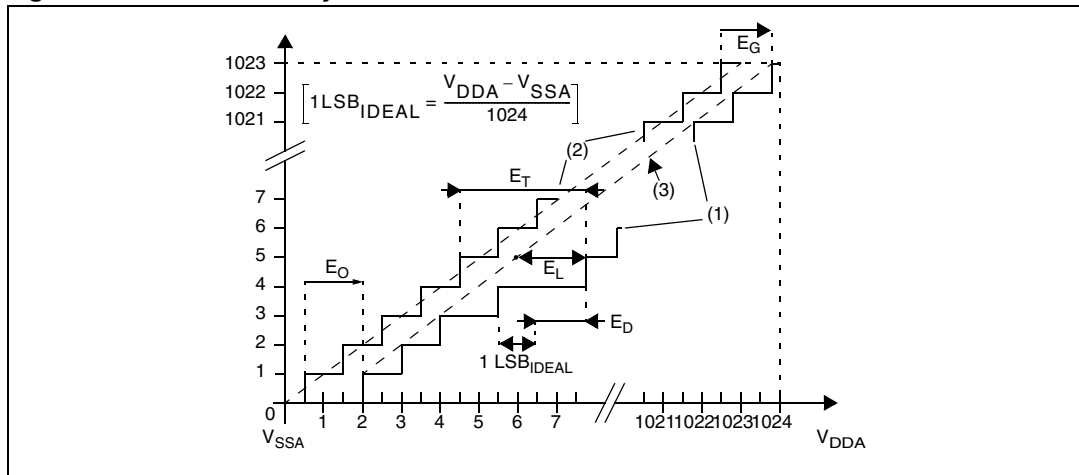
Symbol	Parameter	Conditions	Typ	Max <sup>(1)</sup>	Unit
E <sub>T</sub>	Total unadjusted error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	1	2.5	LSB
		f <sub>ADC</sub> = 4 MHz	1.4	3	
		f <sub>ADC</sub> = 6 MHz	1.6	3.5	
E <sub>O</sub>	Offset error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.6	2	
		f <sub>ADC</sub> = 4 MHz	1.1	2.5	
		f <sub>ADC</sub> = 6 MHz	1.2	2.5	
E <sub>G</sub>	Gain error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.2	2	
		f <sub>ADC</sub> = 4 MHz	0.6	2.5	
		f <sub>ADC</sub> = 6 MHz	0.8	2.5	
E <sub>D</sub>	Differential linearity error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.7	1.5	
		f <sub>ADC</sub> = 4 MHz	0.7	1.5	
		f <sub>ADC</sub> = 6 MHz	0.8	1.5	
E <sub>L</sub>	Integral linearity error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.6	1.5	
		f <sub>ADC</sub> = 4 MHz	0.6	1.5	
		f <sub>ADC</sub> = 6 MHz	0.6	1.5	

1. Data based on characterisation results for LQFP80 device with V<sub>REF+</sub>/V<sub>REF-</sub>, not tested in production.
2. ADC accuracy vs. negative injection current: Injecting negative current on any of the analog input pins should be avoided as this significantly reduces the accuracy of the conversion being performed on another analog input. It is recommended to add a Schottky diode (pin to ground) to standard analog pins which may potentially inject negative current. Any positive injection current within the limits specified for I<sub>INJ(PIN)</sub> and ΣI<sub>INJ(PIN)</sub> in [Section 9.3.6](#) does not affect the ADC accuracy.

**Table 46. ADC accuracy with  $R_{AIN} < 10\text{ k}\Omega$ ,  $R_{AIN}$ ,  $V_{DDA} = 3.3\text{ V}$**

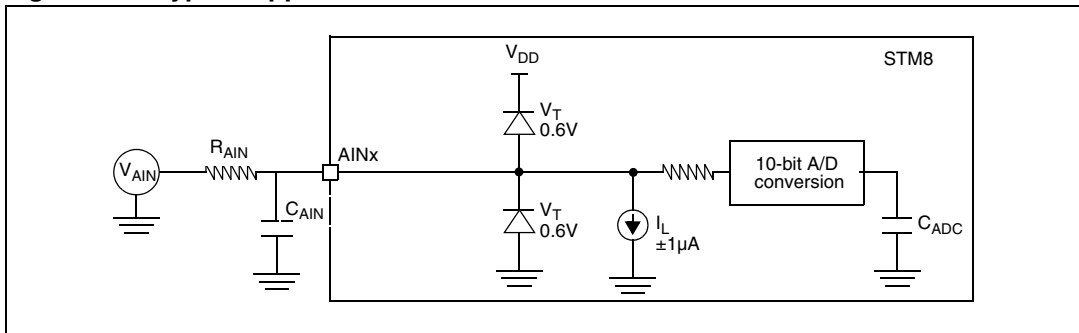
Symbol	Parameter	Conditions	Typ	Max <sup>(1)</sup>	Unit
E <sub>T</sub>	Total unadjusted error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	1.1	2	LSB
		f <sub>ADC</sub> = 4 MHz	1.6	2.5	
E <sub>O</sub>	Offset error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.7	1.5	
		f <sub>ADC</sub> = 4 MHz	1.3	2	
E <sub>G</sub>	Gain error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.2	1.5	
		f <sub>ADC</sub> = 4 MHz	0.5	2	
E <sub>D</sub>	Differential linearity error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.7	1	
		f <sub>ADC</sub> = 4 MHz	0.7	1	
E <sub>L</sub>	Integral linearity error <sup>(2)</sup>	f <sub>ADC</sub> = 2 MHz	0.6	1.5	
		f <sub>ADC</sub> = 4 MHz	0.6	1.5	

Figure 45. ADC accuracy characteristics



1. Example of an actual transfer curve.
  2. The ideal transfer curve
  3. End point correlation line
- $E_T$  = Total unadjusted error: maximum deviation between the actual and the ideal transfer curves.  
 $E_o$  = Offset error: deviation between the first actual transition and the first ideal one.  
 $E_G$  = Gain error: deviation between the last ideal transition and the last actual one.  
 $E_D$  = Differential linearity error: maximum deviation between actual steps and the ideal one.  
 $E_L$  = Integral linearity error: maximum deviation between any actual transition and the end point correlation line.

Figure 46. Typical application with ADC



**9.3.11 EMC characteristics**

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

**Functional EMS (electromagnetic susceptibility)**

While executing a simple application (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 1000-4-2 standard.
- **FTB:** A burst of fast transient voltage (positive and negative) is applied to V<sub>DD</sub> and V<sub>SS</sub> through a 100 pF capacitor, until a functional disturbance occurs. This test conforms with the IEC 1000-4-4 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.

Software recommendations

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

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

Prequalification trials

Most of the common failures (unexpected reset and program counter corruption) can be recovered by applying 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 47. EMS data**

Symbol	Parameter	Conditions	Level/class
V <sub>FESD</sub>	Voltage limits to be applied on any I/O pin to induce a functional disturbance	V <sub>DD</sub> = 5 V, T <sub>A</sub> = +25 °C, f <sub>MASTER</sub> = 16 MHz, conforming to IEC 1000-4-2	2B
V <sub>EFTB</sub>	Fast transient voltage burst limits to be applied through 100pF on V <sub>DD</sub> and V <sub>SS</sub> pins to induce a functional disturbance	V <sub>DD</sub> = 5 V, T <sub>A</sub> = +25 °C, f <sub>MASTER</sub> = 16 MHz, conforming to IEC 1000-4-4	4A

**Electromagnetic interference (EMI)**

Emission tests conform to the SAE J 1752/3 standard for test software, board layout and pin loading.

**Table 48. EMI data**

Symbol	Parameter	Conditions				Unit
		General conditions	Monitored frequency band	Max $f_{HSE}/f_{CPU}^{(1)}$		
				8 MHz/8 MHz	8 MHz/16 MHz	
$S_{EMI}$	Peak level	$V_{DD} = 5 V$ , $T_A = +25\text{ }^\circ\text{C}$ , LQFP48 package conforming to SAE J 1752/3	0.1MHz to 30 MHz	13	14	dB $\mu$ V
			30 MHz to 130 MHz	23	19	
			130 MHz to 1 GHz	-4	-4	
	SAE EMI level		2	1.5	—	

1. Data based on characterization results, 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 (3 positive then 3 negative pulses 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). This test conforms to the JESD22-A114A/A115A standard. For more details, refer to the application note AN1181.

**Table 49. ESD absolute maximum ratings**

Symbol	Ratings	Conditions	Class	Maximum value <sup>(1)</sup>	Unit
$V_{ESD(HBM)}$	Electrostatic discharge voltage (Human body model)	$T_A = +25\text{ }^\circ\text{C}$ , conforming to JESD22-A114	A	2000	V
$V_{ESD(CDM)}$	Electrostatic discharge voltage (Charge device model)	$T_A = +25\text{ }^\circ\text{C}$ , conforming to JESD22-C101	IV	1000	V

1. Data based on characterization results, not tested in production

### Static latch-up

Two complementary static tests are required on 10 parts to assess the latch-up performance:

- A supply overvoltage (applied to each power supply pin)
- 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 50. Electrical sensitivities**

Symbol	Parameter	Conditions	Class <sup>(1)</sup>
LU	Static latch-up class	$T_A = +25\text{ °C}$	A
		$T_A = +85\text{ °C}$	A
		$T_A = +125\text{ °C}$	A

1. Class description: A Class is an STMicroelectronics internal specification. All its limits are higher than the JEDEC specifications, that means when a device belongs to class A it exceeds the JEDEC standard. B class strictly covers all the JEDEC criteria (international standard).

## 10 Package characteristics

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

## 10.1 Package mechanical data

### 10.1.1 LQFP package mechanical data

Figure 47. 48-pin low profile quad flat package (7 x 7)

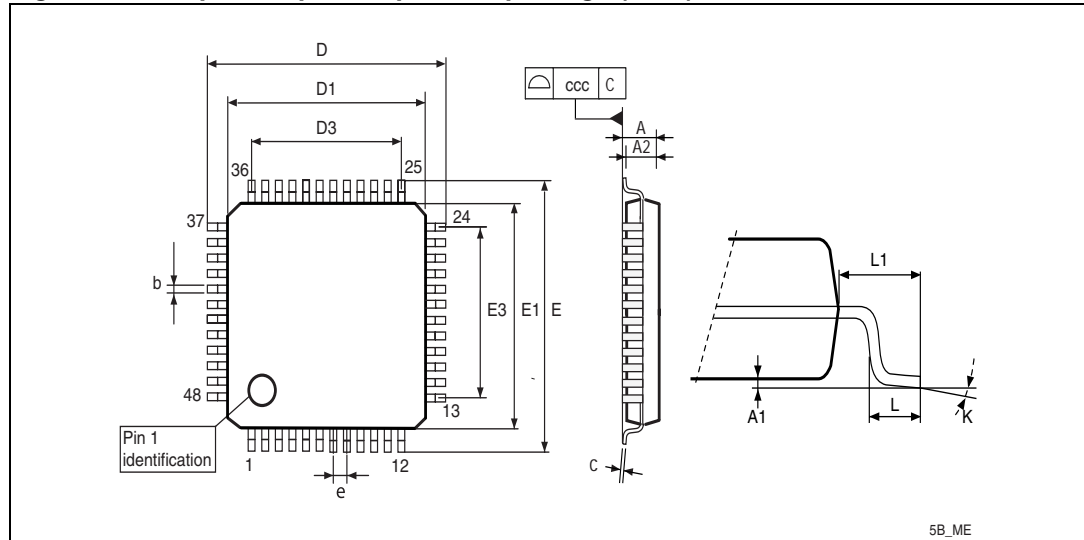


Table 51. 48-pin low profile quad flat package mechanical data

Dim.	mm			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A			1.600			0.0630
A1	0.050		0.150	0.0020		0.0059
A2	1.350	1.400	1.450	0.0531	0.0551	0.0571
b	0.170	0.220	0.270	0.0067	0.0087	0.0106
c	0.090		0.200	0.0035		0.0079
D	8.800	9.000	9.200	0.3465	0.3543	0.3622
D1	6.800	7.000	7.200	0.2677	0.2756	0.2835
D3		5.500			0.2165	
E	8.800	9.000	9.200	0.3465	0.3543	0.3622
E1	6.800	7.000	7.200	0.2677	0.2756	0.2835
E3		5.500			0.2165	
e		0.500			0.0197	
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1		1.000			0.0394	
k	0.0°	3.5°	7.0°	0.0°	3.5°	7.0°
ccc			0.080			0.0031

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

Figure 48. 44-pin low profile quad flat package (10 x 10)

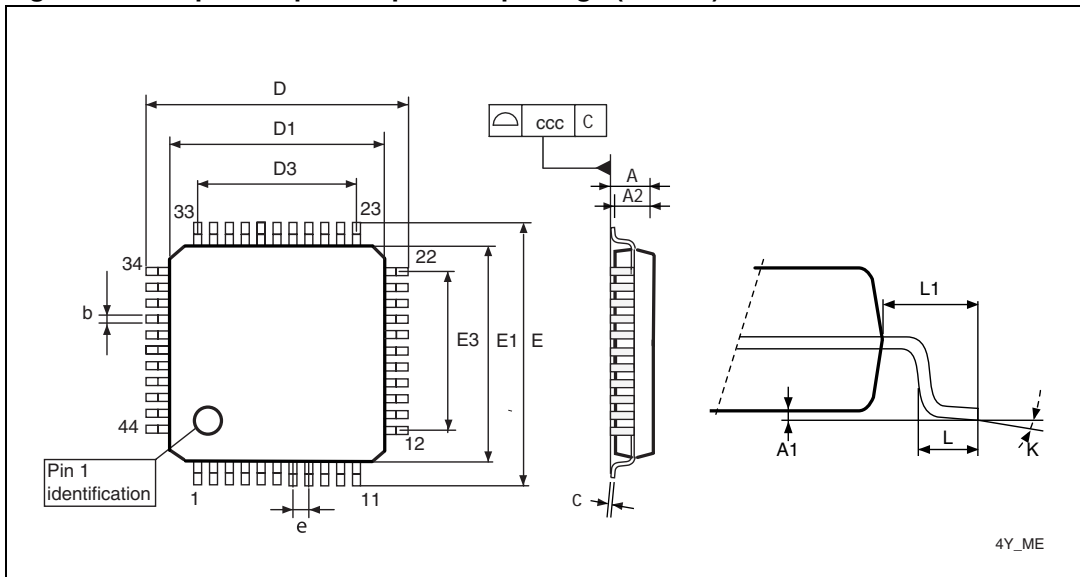


Table 52. 44-pin low profile quad flat package mechanical data

Dim.	mm			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A			1.600			0.0630
A1	0.050		0.150	0.0020		0.0059
A2	1.350	1.400	1.450	0.0531	0.0551	0.0571
b	0.300	0.370	0.450	0.0118	0.0146	0.0177
c	0.090		0.200	0.0035		0.0079
D	11.800	12.000	12.200	0.4646	0.4724	0.4803
D1	9.800	10.000	10.200	0.3858	0.3937	0.4016
D3		8.000			0.3150	
E	11.800	12.000	12.200	0.4646	0.4724	0.4803
E1	9.800	10.000	10.200	0.3858	0.3937	0.4016
E3		8.000			0.3150	
e		0.800			0.0315	
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1		1.000			0.0394	
k	0.0°	3.5°	7.0°	0.0°	3.5°	7.0°
ccc			0.100			0.0039

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



Figure 49. 32-pin low profile quad flat package (7 x 7)

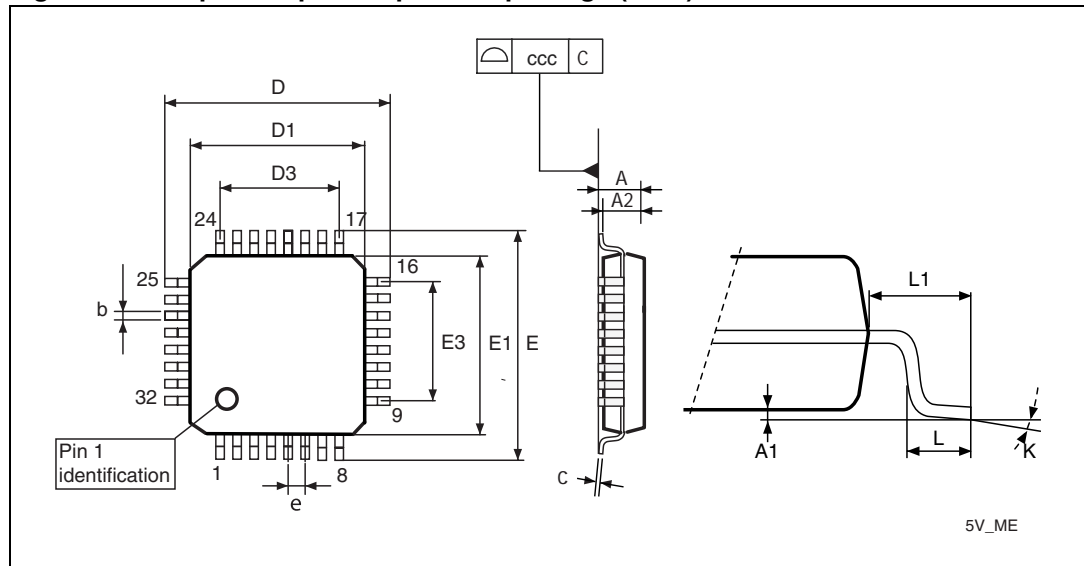


Table 53. 32-pin low profile quad flat package mechanical data

Dim.	mm			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A			1.600			0.0630
A1	0.050		0.150	0.0020		0.0059
A2	1.350	1.400	1.450	0.0531	0.0551	0.0571
b	0.300	0.370	0.450	0.0118	0.0146	0.0177
c	0.090		0.200	0.0035		0.0079
D	8.800	9.000	9.200	0.3465	0.3543	0.3622
D1	6.800	7.000	7.200	0.2677	0.2756	0.2835
D3		5.600			0.2205	
E	8.800	9.000	9.200	0.3465	0.3543	0.3622
E1	6.800	7.000	7.200	0.2677	0.2756	0.2835
E3		5.600			0.2205	
e		0.800			0.0315	
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1		1.000			0.0394	
k	0.0°	3.5°	7.0°	0.0°	3.5°	7.0°
ccc			0.100			0.0039

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

10.1.2 VFQFPN package mechanical data

Figure 50. 32-lead very thin fine pitch quad flat no-lead package (5 x 5)

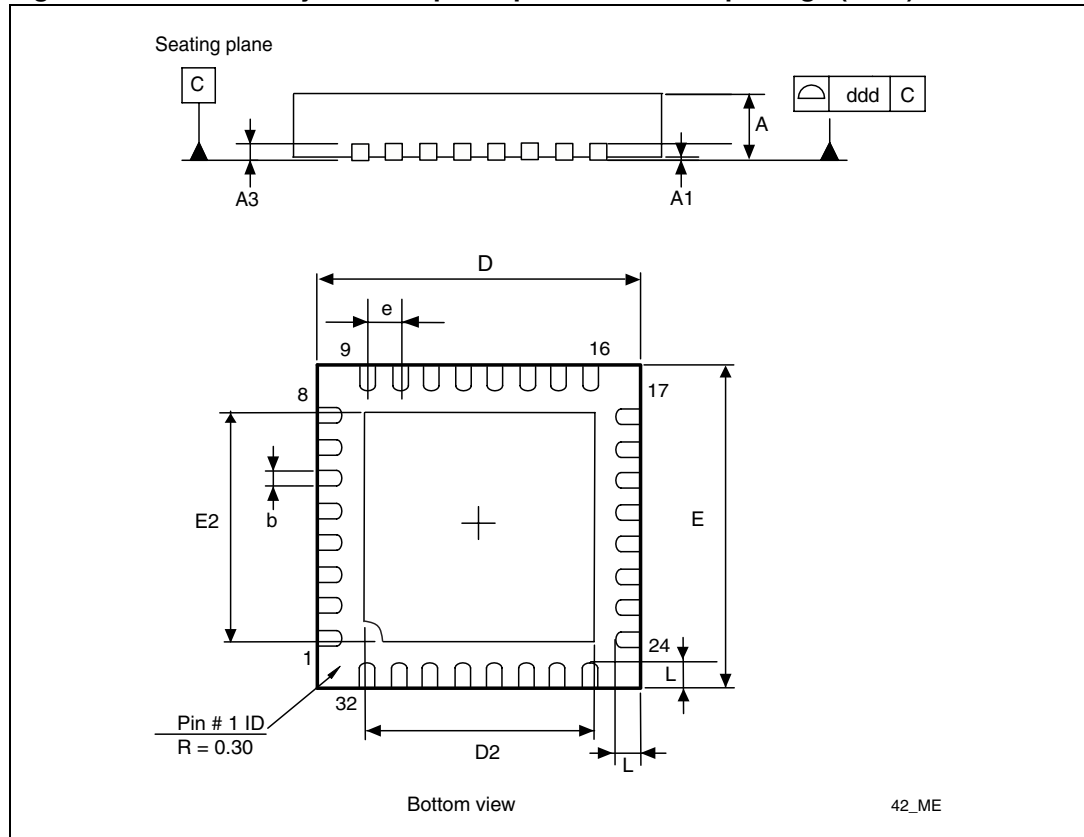


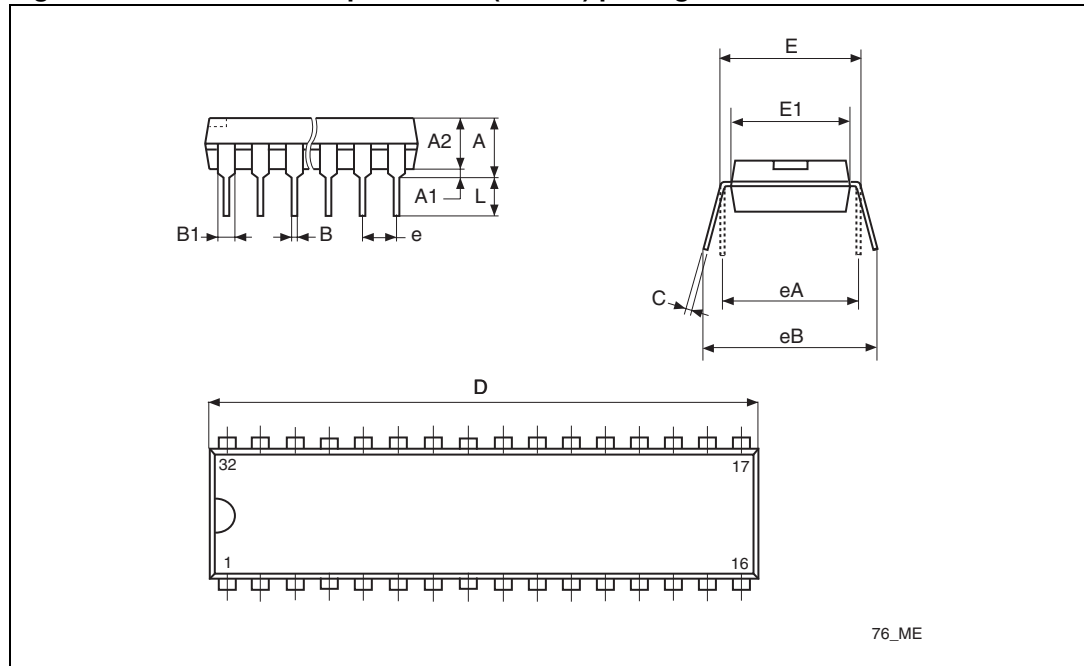
Table 54. 32-lead very thin fine pitch quad flat no-lead package mechanical data

Dim.	mm			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A	0.80	0.90	1.00	0.0315	0.0354	0.0394
A1	0	0.02	0.05		0.0008	0.0020
A3		0.20			0.0079	
b	0.18	0.25	0.30	0.0071	0.0098	0.0118
D	4.85	5.00	5.15	0.1909	0.1969	0.2028
D2	3.20	3.45	3.70	0.1260		0.1457
E	4.85	5.00	5.15	0.1909	0.1969	0.2028
E2	3.20	3.45	3.70	0.1260	0.1358	0.1457
e		0.50			0.0197	
L	0.30	0.40	0.50	0.0118	0.0157	0.0197
ddd			0.08			0.0031

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

10.1.3 SDIP32 package mechanical data

Figure 51. 32-lead shrink plastic DIP (400 ml) package



76\_ME

Table 55. 32-lead shrink plastic DIP (400 ml) package mechanical data

Dim.	mm			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A	3.556	3.759	5.080	0.1400	0.1480	0.2000
A1	0.508			0.0200		
A2	3.048	3.556	4.572	0.1200	0.1400	0.1800
B	0.356	0.457	0.584	0.0140	0.0180	0.0230
B1	0.762	1.016	1.397	0.0300	0.0400	0.0550
C	0.203	0.254	0.356	0.0079	0.0100	0.0140
D	27.430	27.940	28.450	1.0799	1.1000	1.1201
E	9.906	10.410	11.050	0.3900	0.4098	0.4350
E1	7.620	8.890	9.398	0.3000	0.3500	0.3700
e		1.778			0.0700	
eA		10.160			0.4000	
eB			12.700			0.5000
L	2.540	3.048	3.810	0.1000	0.1200	0.1500

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

## 10.2 Thermal characteristics

The maximum chip junction temperature ( $T_{Jmax}$ ) must never exceed the values given in [Table 18: General operating conditions on page 50](#).

The maximum chip-junction temperature,  $T_{Jmax}$ , in degrees 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:

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

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 56. Thermal characteristics<sup>(1)</sup>**

Symbol	Parameter	Value	Unit
$\Theta_{JA}$	Thermal resistance junction-ambient LQFP 48 - 7 x 7 mm	57	°C/W
$\Theta_{JA}$	Thermal resistance junction-ambient LQFP 44 - 10 x 10 mm	54	°C/W
$\Theta_{JA}$	Thermal resistance junction-ambient LQFP 32 - 7 x 7 mm	59	°C/W
$\Theta_{JA}$	Thermal resistance junction-ambient VFQFPN 32 - 5 x 5 mm	22	°C/W

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

### 10.2.1 Reference document

JESD51-2 integrated circuits thermal test method environment conditions - natural convection (still air). Available from [www.jedec.org](http://www.jedec.org).

## 10.2.2 Selecting the product temperature range

When ordering the microcontroller, the temperature range is specified in the order code (see [Figure 52: STM8S105xx access line ordering information scheme on page 94](#)).

The following example shows how to calculate the temperature range needed for a given application.

Assuming the following application conditions:

- Maximum ambient temperature  $T_{Ambaz} = 82\text{ °C}$  (measured according to JESD51-2)
- $I_{DDmax} = 15\text{ mA}$ ,  $V_{DD} = 5.5\text{ V}$
- Maximum 8 standard I/Os used at the same time in output at low level with  $I_{OL} = 10\text{ mA}$ ,  $V_{OL} = 2\text{ V}$
- Maximum 4 high sink I/Os used at the same time in output at low level with  $I_{OL} = 20\text{ mA}$ ,  $V_{OL} = 1.5\text{ V}$
- Maximum 2 true open drain I/Os used at the same time in output at low level with  $I_{OL} = 20\text{ mA}$ ,  $V_{OL} = 2\text{ V}$

$$P_{INTmax} = 15\text{ mA} \times 5.5\text{ V} = 82.5\text{ mW}$$

$$P_{IOmax} = (10\text{ mA} \times 2\text{ V} \times 8) + (20\text{ mA} \times 2\text{ V} \times 2) + (20\text{ mA} \times 1.5\text{ V} \times 4) = 360\text{ mW}$$

This gives:  $P_{INTmax} = 82.5\text{ mW}$  and  $P_{IOmax} = 360\text{ mW}$ :

$$P_{Dmax} = 82.5\text{ mW} + 360\text{ mW}$$

$$\text{Thus: } P_{Dmax} = 443\text{ mW}$$

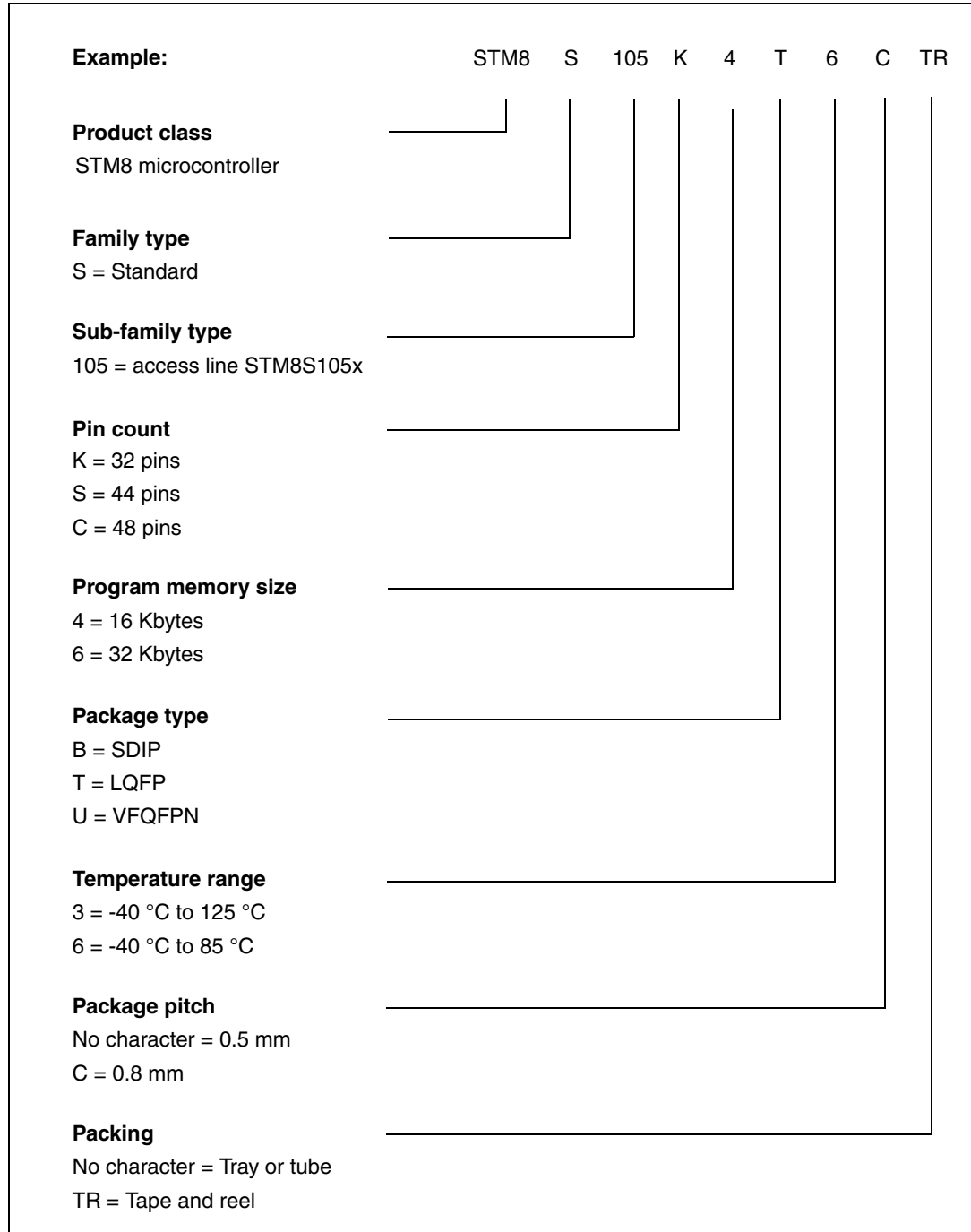
Using the values obtained in [Table 56: Thermal characteristics on page 92](#)  $T_{Jmax}$  is calculated as follows for LQFP32 59°C/W:

$$T_{Jmax} = 75\text{ °C} + (59\text{ °C/W} \times 464\text{ mW}) = 75\text{ °C} + 27\text{ °C} = 102\text{ °C}$$

This is within the range of the suffix 6 version parts ( $-40 < T_J < 106\text{ °C}$ ). In this case, parts must be ordered at least with the temperature range suffix 6.

# 11 Ordering information

Figure 52. STM8S105xx access line ordering information scheme



1. For a list of available options (e.g. memory size, package) and orderable part numbers or for further information on any aspect of this device, please go to [www.st.com](http://www.st.com) or contact the ST sales office nearest to you.

## 12 STM8 development tools

Development tools for the STM8 microcontrollers include the full-featured STice emulation system supported by a complete software tool package including C compiler, assembler and integrated development environment with high-level language debugger. In addition, the STM8 is to be supported by a complete range of tools including starter kits, evaluation boards and a low-cost in-circuit debugger/programmer.

### 12.1 Emulation and in-circuit debugging tools

The STice emulation system offers a complete range of emulation and in-circuit debugging features on a platform that is designed for versatility and cost-effectiveness. In addition, STM8 application development is supported by a low-cost in-circuit debugger/programmer.

The STice is the fourth generation of full featured emulators from STMicroelectronics. It offers new advanced debugging capabilities including profiling and coverage to help detect and eliminate bottlenecks in application execution and dead code when fine tuning an application.

In addition, STice offers in-circuit debugging and programming of STM8 microcontrollers via the STM8 single wire interface module (SWIM), which allows non-intrusive debugging of an application while it runs on the target microcontroller.

For improved cost effectiveness, STice is based on a modular design that allows you to order exactly what you need to meet your development requirements and to adapt your emulation system to support existing and future ST microcontrollers.

#### STice key features

- Occurrence and time profiling and code coverage (new features)
- Advanced breakpoints with up to 4 levels of conditions
- Data breakpoints
- Program and data trace recording up to 128 KB records
- Read/write on the fly of memory during emulation
- In-circuit debugging/programming via SWIM protocol
- 8-bit probe analyzer
- 1 input and 2 output triggers
- Power supply follower managing application voltages between 1.62 to 5.5 V
- Modularity that allows you to specify the components you need to meet your development requirements and adapt to future requirements
- Supported by free software tools that include integrated development environment (IDE), programming software interface and assembler for STM8.

## 12.2 Software tools

STM8 development tools are supported by a complete, free software package from STMicroelectronics that includes ST Visual Develop (STVD) IDE and the ST Visual Programmer (STVP) software interface. STVD provides seamless integration of the Cosmic and Raisonance C compilers for STM8, which are available in a free version that outputs up to 16 Kbytes of code.

### 12.2.1 STM8 toolset

**STM8 toolset** with STVD integrated development environment and STVP programming software is available for free download at [www.st.com/mcu](http://www.st.com/mcu). This package includes:

**ST Visual Develop** – Full-featured integrated development environment from ST, featuring

- Seamless integration of C and ASM toolsets
- Full-featured debugger
- Project management
- Syntax highlighting editor
- Integrated programming interface
- Support of advanced emulation features for STIce such as code profiling and coverage

**ST Visual Programmer (STVP)** – Easy-to-use, unlimited graphical interface allowing read, write and verify of your STM8 microcontroller's Flash program memory, data EEPROM and option bytes. STVP also offers project mode for saving programming configurations and automating programming sequences.

### 12.2.2 C and assembly toolchains

Control of C and assembly toolchains is seamlessly integrated into the STVD integrated development environment, making it possible to configure and control the building of your application directly from an easy-to-use graphical interface.

Available toolchains include:

- **Cosmic C compiler for STM8** – Available in a free version that outputs up to 16 Kbytes of code. For more information, see [www.cosmic-software.com](http://www.cosmic-software.com).
- **Raisonance C compiler for STM8** – Available in a free version that outputs up to 16 Kbytes of code. For more information, see [www.raisonance.com](http://www.raisonance.com).
- **STM8 assembler linker** – Free assembly toolchain included in the STVD toolset, which allows you to assemble and link your application source code.

## 12.3 Programming tools

During the development cycle, STIce provides in-circuit programming of the STM8 Flash microcontroller on your application board via the SWIM protocol. Additional tools are to include a low-cost in-circuit programmer as well as ST socket boards, which provide dedicated programming platforms with sockets for programming your STM8.

For production environments, programmers will include a complete range of gang and automated programming solutions from third-party tool developers already supplying programmers for the STM8 family.



## 13 Revision history

**Table 57. Document revision history**

Date	Revision	Changes
05-Jun-2008	1	Initial release.
23-Jun-2008	2	Corrected number of high sink outputs to 9 in <i>I/Os on page 1</i> . Updated part numbers in <i>Table 2: STM8S105xx access line features on page 10</i> .
12-Aug-2008	3	Updated part numbers in <i>Table 2: STM8S105xx access line features on page 10</i> . USART renamed UART1, LINUART renamed UART2. Added <i>Table 7: Pin-to-pin comparison of pin 7 to 12 in 32-pin access line devices</i> .
17-Sep-2008	4	Removed STM8S102xx and STM8S104xx root part numbers corresponding to devices without data EEPROM. Updated STM8S103 pinout in <i>Section 5.2 on page 29</i> . Added low and medium density Flash memory categories. Added <i>Note 1</i> in <i>Table 16: Current characteristics</i> . Updated <i>Table 6: Option bytes on page 39</i> .
05-Feb-2009	5	Updated STM8S103 pinout in <i>Section 5.2 on page 29</i> Updated number of High Sink I/Os in pinout. TSSOP20 pinout modified (PD4 moved to pin 1 etc.) Added WFQFN20 package Updated <i>Section 6: Option bytes on page 39</i> Added <i>Section 7: Memory and register map on page 44</i>
27-Feb-2009	6	Removed STM8S103x products (separate STM8S103 datasheet created) Updated <i>Section 9: Electrical characteristics</i>
12-May-2009	7	Added SDIP32 silhouette and package to the <i>Features</i> and <i>Section 10.1.3: SDIP32 package mechanical data</i> ; added <i>Figure 6: SDIP32-pin pinout</i> ; updated <i>Table 6: Pin description for STM8S105 microcontrollers</i> and <i>Figure 52: STM8S105xx access line ordering information scheme</i> for the SDIP. Updated $V_{DD}$ range (2.95 V to 5.5 V) <i>on page 1</i> . Amended name of package VQFPN32 Added <i>Table 3 on page 16</i> . Updated <i>Section 4.8: Auto wakeup counter on page 18</i> . Updated pins 25, 30, and 31 in <i>Figure 5</i> . Removed <i>Table 7: Pin-to-pin comparison of pin 7 to 12 in 32-pin access line devices</i> . Added <i>Table 14: Description of alternate function remapping bits [7:0] of OPT2</i> .

Table 57. Document revision history (continued)

Date	Revision	Changes
12-May-2009	7 cont'd	<p><i>Section 9: Electrical characteristics:</i> Updated VCAP specifications; updated <a href="#">Table 15</a>, <a href="#">Table 18</a>, <a href="#">Table 20</a>, <a href="#">Table 21</a>, <a href="#">Table 22</a>, <a href="#">Table 23</a>, <a href="#">Table 24</a>, <a href="#">Table 25</a>, <a href="#">Table 26</a>, <a href="#">Table 27</a>, <a href="#">Table 29</a>, <a href="#">Table 35</a>, and <a href="#">Table 42</a>; added current consumption curves <a href="#">Figure 13</a> to <a href="#">Figure 18</a>; removed <a href="#">figure 20: typical HSE frequency vs <math>f_{cpu}</math> @ 4 temperatures</a>; updated <a href="#">Figure 13</a>, <a href="#">Figure 14</a>, <a href="#">Figure 15</a>, <a href="#">Figure 16</a> and <a href="#">Figure 17 on page 60</a>; modified HSI accuracy in <a href="#">Table 33: HSI oscillator characteristics on page 63</a>; added <a href="#">Figure 44: Typical application with I2C bus and timing diagram 1) on page 79</a>; modified <math>f_{SCK}</math>, <math>t_{V(SO)}</math> and <math>t_{V(MO)}</math> in <a href="#">Table 42: SPI characteristics on page 75</a>; updated figures and tables of <a href="#">High speed internal RC oscillator (HSI) on page 63</a>; replaced <a href="#">Figure 23</a>, <a href="#">Figure 24</a>, <a href="#">Figure 26</a>, and <a href="#">Figure 39 on page 74</a>.</p> <p><i>Section 10: Package characteristics:</i> Updated <a href="#">Table 56: Thermal characteristics</a> and removed <a href="#">Table 57: Junction temperature range</a>. Updated <a href="#">Figure 52: STM8S105xx access line ordering information scheme</a>.</p>
10-Jun-2009	8	<p>Document status changed from “preliminary data” to “datasheet”. Standardized name of the VFQFPN package.</p> <p>Removed ‘wpu’ from I<sup>2</sup>C pins in <a href="#">Table 6: Pin description for STM8S105 microcontrollers</a>.</p>

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