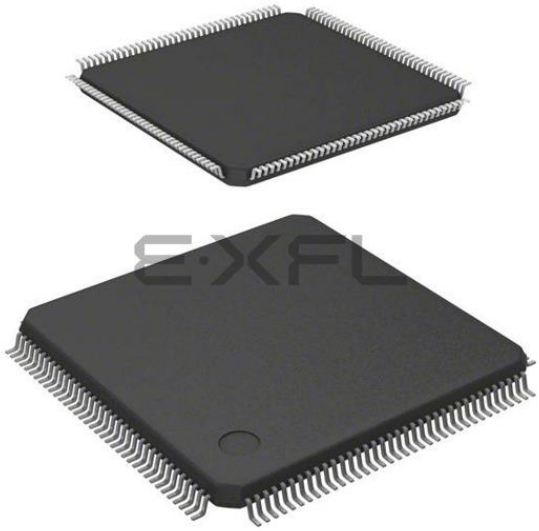

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M3
Core Size	32-Bit Single-Core
Speed	36MHz
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	DMA, PDR, POR, PVD, PWM, Temp Sensor, WDT
Number of I/O	112
Program Memory Size	1MB (1M x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	80K x 8
Voltage - Supply (Vcc/Vdd)	2V ~ 3.6V
Data Converters	A/D 16x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	144-LQFP
Supplier Device Package	144-LQFP (20x20)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32f101zgt6

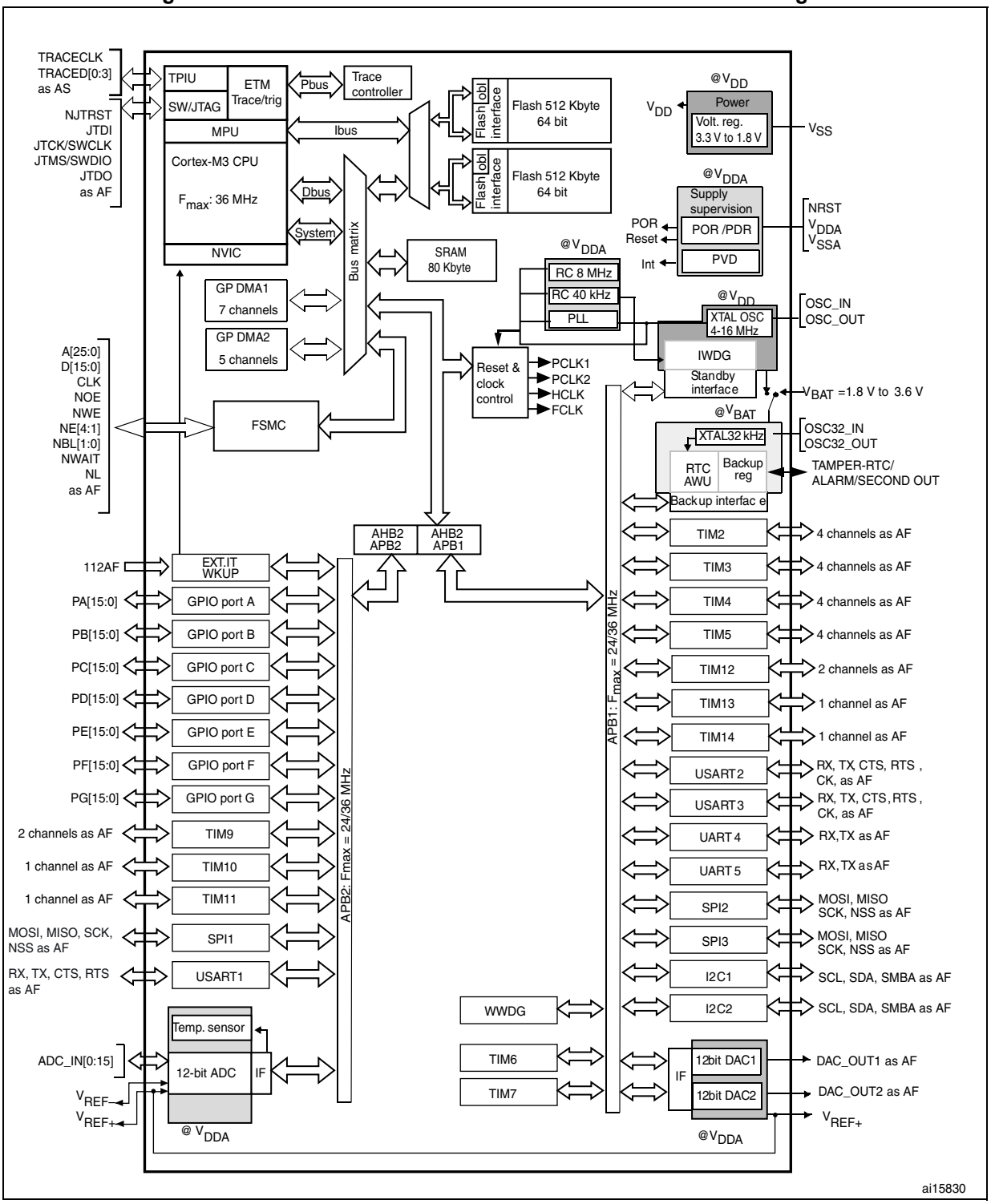
1 Introduction

This datasheet provides the ordering information and mechanical device characteristics of the STM32F101xF and STM32F101xG XL-density access line microcontrollers. For more details on the whole STMicroelectronics STM32F101xx family, please refer to *Section 2.2: Full compatibility throughout the family*.

The XL-density STM32F101xx datasheet should be read in conjunction with the STM32F10xxx reference manual.
For information on programming, erasing and protection of the internal Flash memory please refer to the *STM32F10xxx Flash programming manual.*
The reference and Flash programming manuals are both available from the STMicroelectronics website *www.st.com*.

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

Figure 1. STM32F101xF and STM32F101xG access line block diagram



1. T_A = –40 °C to +85 °C (junction temperature up to 105 °C).
2. AF = alternate function on I/O port pin.

one-pulse mode output. This gives up to 16 input captures / output compares / PWMs on the largest packages.

Their counter can be frozen in debug mode. Any of the general-purpose timers can be used to generate PWM outputs. They all have independent DMA request generation.

These timers are capable of handling quadrature (incremental) encoder signals and the digital outputs from 1 to 3 hall-effect sensors.

- **TIM10, TIM11 and TIM9**

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

- **TIM13, TIM14 and TIM12**

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

Basic timers TIM6 and TIM7

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

Independent watchdog

The independent watchdog is based on a 12-bit downcounter and 8-bit prescaler. It is clocked from an independent 40 kHz internal RC and as it operates independently from the main clock, it can operate in Stop and Standby modes. It can be used either as a watchdog to reset the device when a problem occurs, or as a free running timer for application timeout management. It is hardware or software configurable through the option bytes. The counter can be frozen in debug mode.

Window watchdog

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

SysTick timer

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

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

Table 5. STM32F101xF/STM32F101xG pin definitions (continued)

Pins			Pin name	Type[1]	I / O level[2]	Main function[3] (after reset)	Alternate functions[4]	
LQFP144	LQFP64	LQFP100					Default	Remap
12	-	-	PF2	I/O	FT	PF2	FSMC_A2	-
13	-	-	PF3	I/O	FT	PF3	FSMC_A3	-
14	-	-	PF4	I/O	FT	PF4	FSMC_A4	-
15	-	-	PF5	I/O	FT	PF5	FSMC_A5	-
16	-	10	V_{SS_5}	S	-	V_{SS_5}	-	-
17	-	11	V_{DD_5}	S	-	V_{DD_5}	-	-
18	-	-	PF6	I/O	-	PF6	FSMC_NIORD	TIM10_CH1
19	-	-	PF7	I/O	-	PF7	FSMC_NREG	TIM11_CH1
20	-	-	PF8	I/O	-	PF8	FSMC_NIOWR	TIM13_CH1
21	-	-	PF9	I/O	-	PF9	FSMC_CD	TIM14_CH1
22	-	-	PF10	I/O	-	PF10	FSMC_INTR	-
23	5	12	OSC_IN	I	-	OSC_IN	-	PD0[7]
24	6	13	OSC_OUT	O	-	OSC_OUT	-	PD1[7]
25	7	14	NRST	I/O	-	NRST	-	-
26	8	15	PC0	I/O	-	PC0	ADC_IN10	-
27	9	16	PC1	I/O	-	PC1	ADC_IN11	-
28	10	17	PC2	I/O	-	PC2	ADC_IN12	-
29	11	18	PC3	I/O	-	PC3	ADC_IN13	-
30	12	19	V_{SSA}	S	-	V_{SSA}	-	-
31	-	20	V_{REF-}	S	-	V_{REF-}	-	-
32	-	21	V_{REF+}	S	-	V_{REF+}	-	-
33	13	22	V_{DDA}	S	-	V_{DDA}	-	-
34	14	23	PA0-WKUP	I/O	-	PA0	WKUP/ USART2_CTS[8]/ ADC_IN0 / TIM5_CH1/ TIM2_CH1_ETR[8]	-
35	15	24	PA1	I/O	-	PA1	USART2_RTS[8]/ ADC_IN1 / TIM5_CH2 TIM2_CH2[8]	-
36	16	25	PA2	I/O	-	PA2	USART2_TX[8]/ TIM5_CH3 / ADC_IN2/ TIM2_CH3[8] / TIM9_CH1	-

Figure 11. Typical current consumption in Run mode versus frequency (at 3.6 V) - code with data processing running from RAM, peripherals enabled

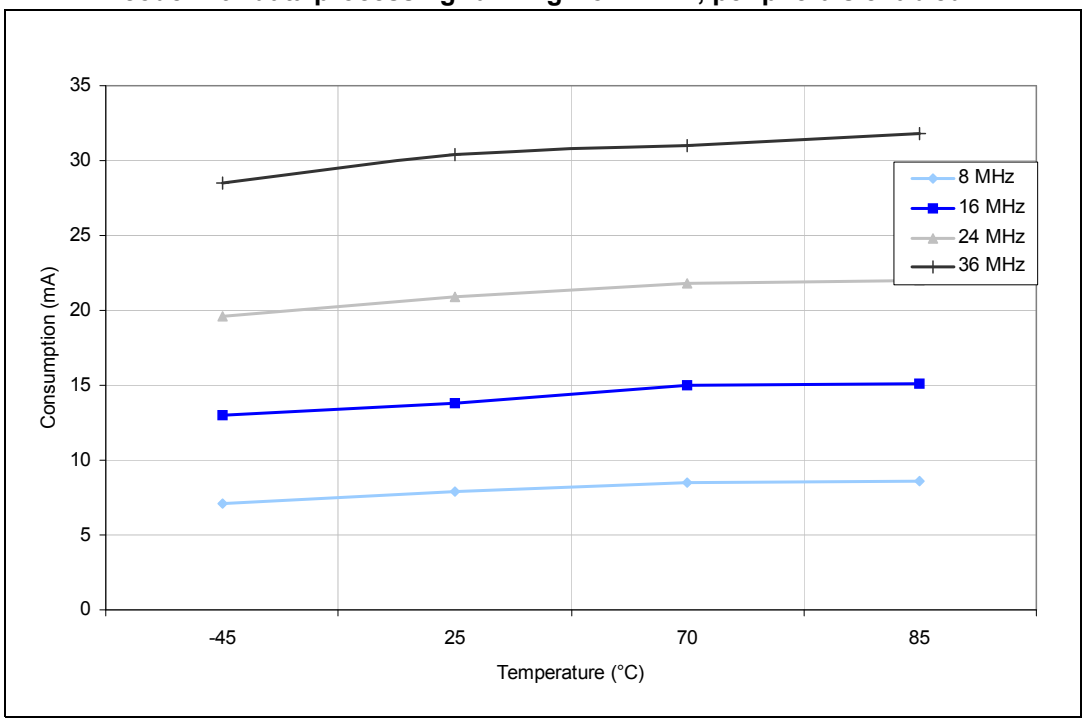


Figure 12. Typical current consumption in Run mode versus frequency (at 3.6 V) - code with data processing running from RAM, peripherals disabled

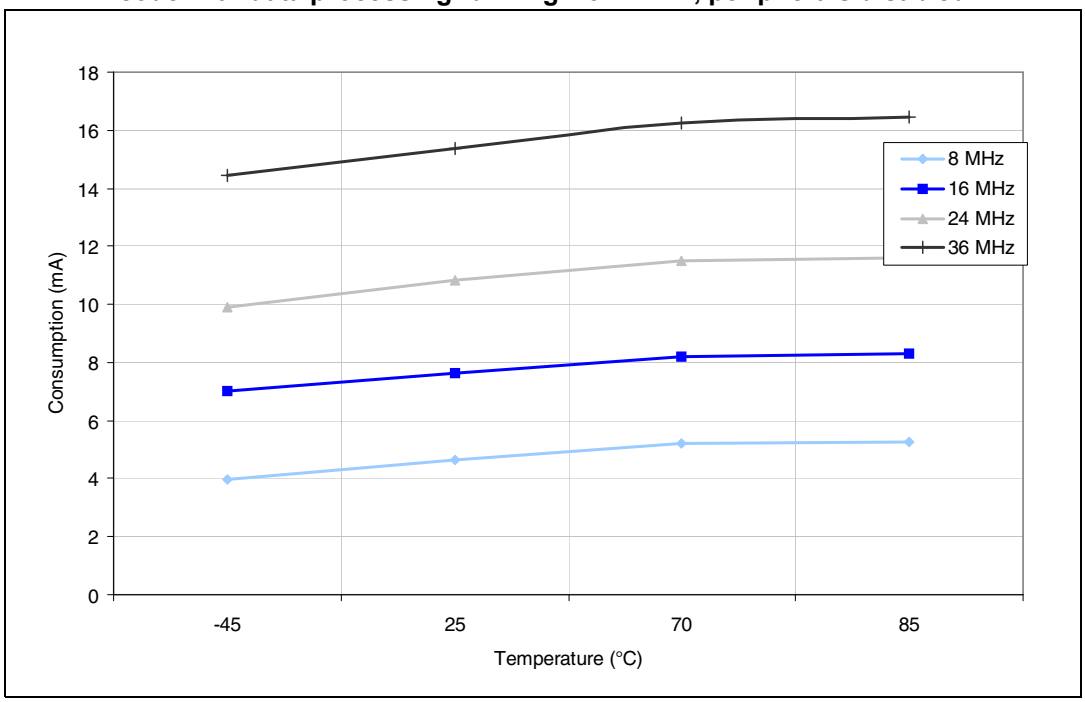


Table 19. Typical current consumption in Sleep mode, code running from Flash or RAM

Symbol	Parameter	Conditions	f_{HCLK}	Typ(1)	Typ(1)	Unit
				All peripherals enabled(2)	All peripherals disabled	
I_{DD}	Supply current in Sleep mode	External clock(3)	36 MHz	17.7	4	mA
			24 MHz	12.2	3.1	
			16 MHz	8.4	2.3	
			8 MHz	4.6	1.5	
			4 MHz	3	1.3	
			2 MHz	2.15	1.25	
			1 MHz	1.7	1.2	
			500 kHz	1.5	1.15	
			125 kHz	1.35	1.15	
		Running on High Speed Internal RC (HSI), AHB prescaler used to reduce the frequency	36 MHz	17	3.35	
			24 MHz	11.6	2.3	
			16 MHz	7.7	1.6	
			8 MHz	3.9	0.8	
			4 MHz	2.3	0.7	
			2 MHz	1.5	0.6	
			1 MHz	1.1	0.5	
			500 kHz	0.9	0.5	
			125 kHz	0.7	0.5	

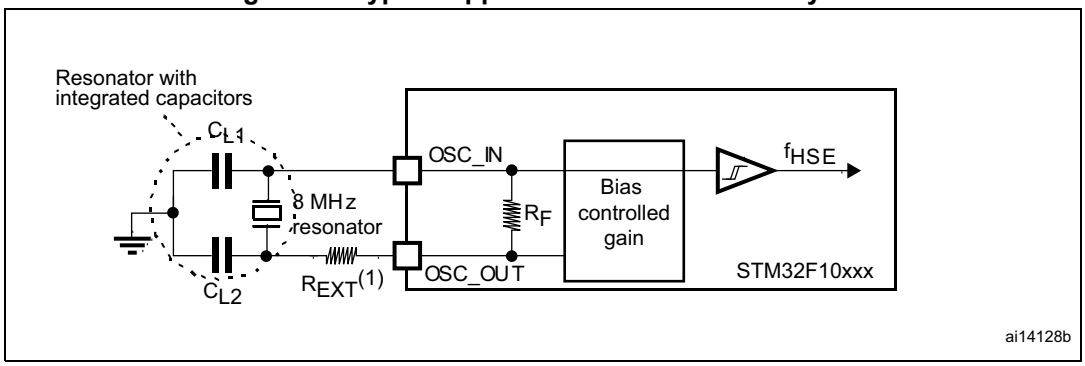
1. Typical values are measures at T_A = 25 °C, V_{DD} = 3.3 V.
2. Add an additional power consumption of 0.8 mA per ADC for the analog part. In applications, this consumption occurs only while the ADC is on (ADON bit is set in the ADC_CR2 register).
3. External clock is 8 MHz and PLL is on when f_{HCLK} > 8 MHz.

On-chip peripheral current consumption

The current consumption of the on-chip peripherals is given in *Table 20*. The MCU is placed under the following conditions:

- all I/O pins are in input mode with a static value at V_{DD} or V_{SS} (no load)
- all peripherals are disabled unless otherwise mentioned
- the given value is calculated by measuring the current consumption
  - with all peripherals clocked off
  - with only one peripheral clocked on
- ambient operating temperature and V_{DD} supply voltage conditions summarized in *Table 7*.

Figure 17. Typical application with an 8 MHz crystal



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

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

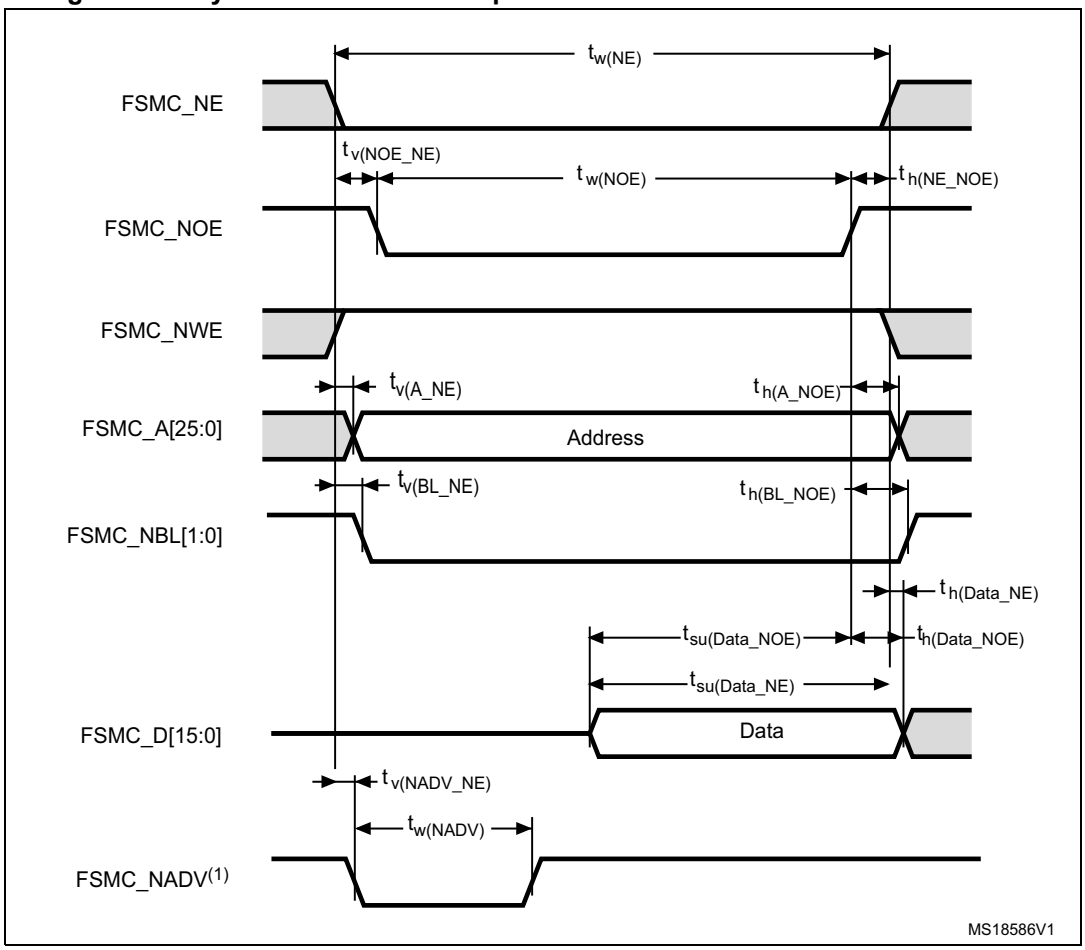
The low-speed external (LSE) clock can be supplied with a 32.768 kHz crystal/ceramic resonator oscillator. All the information given in this paragraph are based on characterization results obtained with typical external components specified in *Table 24*. In the application, the resonator and the load capacitors have to be placed as close as possible to the oscillator pins in order to minimize output distortion and startup stabilization time. Refer to the crystal resonator manufacturer for more details on the resonator characteristics (frequency, package, accuracy).

Table 24. LSE oscillator characteristics (f_{LSE} = 32.768 kHz)(1) (2)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
R_F	Feedback resistor	-	-	-	5	-	MΩ
C	Recommended load capacitance versus equivalent serial resistance of the crystal (R_S)	R_S = 30 KΩ	-	-	-	15	pF
I_2	LSE driving current	V_{DD} = 3.3 V V_{IN} = V_{SS}	-	-	-	1.4	µA
g_m	Oscillator transconductance	-	-	5	-	-	µA/V
$t_{SU(LSE)}$(3)	Startup time	V_{DD} is stabilized	T_A = 50 °C	-	1.5	-	s
			T_A = 25 °C	-	2.5	-	
			T_A = 10 °C	-	4	-	
			T_A = 0 °C	-	6	-	
			T_A = -10 °C	-	10	-	
			T_A = -20 °C	-	17	-	
			T_A = -30 °C	-	32	-	
			T_A = -40 °C	-	60	-	

1. Guaranteed by characterization results.
2. Refer to the note and caution paragraphs below the table, and to the application note AN2867 “Oscillator design guide for ST microcontrollers”.
3. $t_{SU(LSE)}$ is the startup time measured from the moment it is enabled (by software) to a stabilized 32.768 kHz oscillation is reached. This value is measured for a standard crystal and it can vary significantly with the crystal manufacturer

Figure 19. Asynchronous non-multiplexed SRAM/PSRAM/NOR read waveforms



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

Note: FSMC_BusTurnAroundDuration = 0.

Table 31. Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings(1) (2)

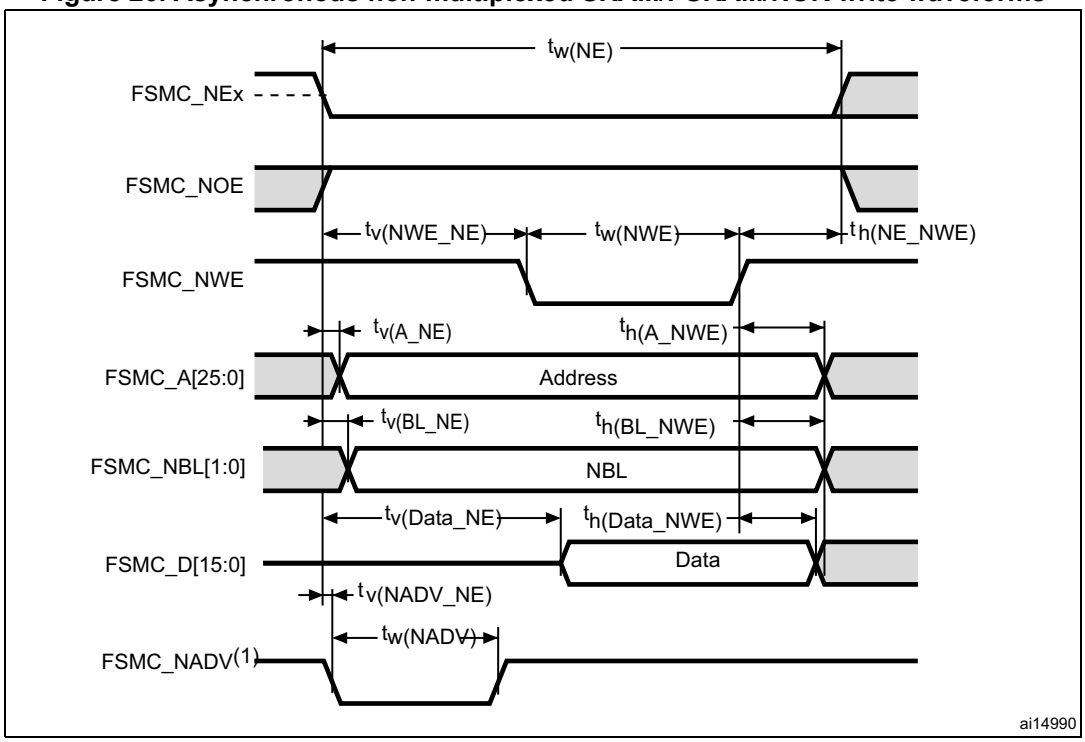
Symbol	Parameter	Min	Max	Unit
$t_{w(NE)}$	FSMC_NE low time	$5t_{HCLK}$ + 0.5	$5t_{HCLK}$ + 2	ns
$t_{v(NOE\_NE)}$	FSMC_NEx low to FSMC_NOE low	0.5	1.5	ns
$t_{w(NOE)}$	FSMC_NOE low time	$5t_{HCLK}$ – 1	$5t_{HCLK}$ + 1	ns
$t_{h(NE\_NOE)}$	FSMC_NOE high to FSMC_NE high hold time	0	-	ns
$t_{v(A\_NE)}$	FSMC_NEx low to FSMC_A valid	-	3	ns
$t_{h(A\_NOE)}$	Address hold time after FSMC_NOE high	0	-	ns
$t_{v(BL\_NE)}$	FSMC_NEx low to FSMC_BL valid	-	0	ns
$t_{h(BL\_NOE)}$	FSMC_BL hold time after FSMC_NOE high	0.5	-	ns
$t_{su(Data\_NE)}$	Data to FSMC_NEx high setup time	$2t_{HCLK}$ - 1	-	ns
$t_{su(Data\_NOE)}$	Data to FSMC_NOEx high setup time	$2t_{HCLK}$ - 1	-	ns
$t_{h(Data\_NOE)}$	Data hold time after FSMC_NOE high	0	-	ns

Table 31. Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings(1) (2)

Symbol	Parameter	Min	Max	Unit
$t_{h(Data\_NE)}$	Data hold time after FSMC_NEx high	0	-	ns
$t_{v(NADV\_NE)}$	FSMC_NEx low to FSMC_NADV low	-	0	ns
$t_{w(NADV)}$	FSMC_NADV low time	-	t_{HCLK} + 2	ns

1. C_L = 15 pF.
2. Guaranteed by characterization results.

Figure 20. Asynchronous non-multiplexed SRAM/PSRAM/NOR write waveforms



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

Table 32. Asynchronous non-multiplexed SRAM/PSRAM/NOR write timings(1)(2)

Symbol	Parameter	Min	Max	Unit
$t_{w(NE)}$	FSMC_NE low time	$3t_{HCLK}$ + 0.5	$3t_{HCLK}$ + 1.5	ns
$t_{v(NWE\_NE)}$	FSMC_NEx low to FSMC_NWE low	t_{HCLK} + 0.5	t_{HCLK} + 1.5	ns
$t_{w(NWE)}$	FSMC_NWE low time	t_{HCLK} – 0.5	t_{HCLK} + 1	ns
$t_{h(NE\_NWE)}$	FSMC_NWE high to FSMC_NE high hold time	t_{HCLK} – 0.5	-	ns
$t_{v(A\_NE)}$	FSMC_NEx low to FSMC_A valid	-	0	ns
$t_{h(A\_NWE)}$	Address hold time after FSMC_NWE high	t_{HCLK}	-	ns
$t_{v(BL\_NE)}$	FSMC_NEx low to FSMC_BL valid	-	1.5	ns
$t_{h(BL\_NWE)}$	FSMC_BL hold time after FSMC_NWE high	t_{HCLK} – 1.5	-	ns
$t_{v(Data\_NE)}$	FSMC_NEx low to Data valid	-	t_{HCLK}	ns

Table 32. Asynchronous non-multiplexed SRAM/PSRAM/NOR write timings(1)(2)

Symbol	Parameter	Min	Max	Unit
$t_{h(Data\_NWE)}$	Data hold time after FSMC_NWE high	t_{HCLK}	-	ns
$t_{v(NADV\_NE)}$	FSMC_NEx low to FSMC_NADV low	-	0	ns
$t_{w(NADV)}$	FSMC_NADV low time	-	t_{HCLK} + 1.5	ns

1. C_L = 15 pF.
2. Guaranteed by characterization results.

Figure 21. Asynchronous multiplexed NOR/PSRAM read waveforms

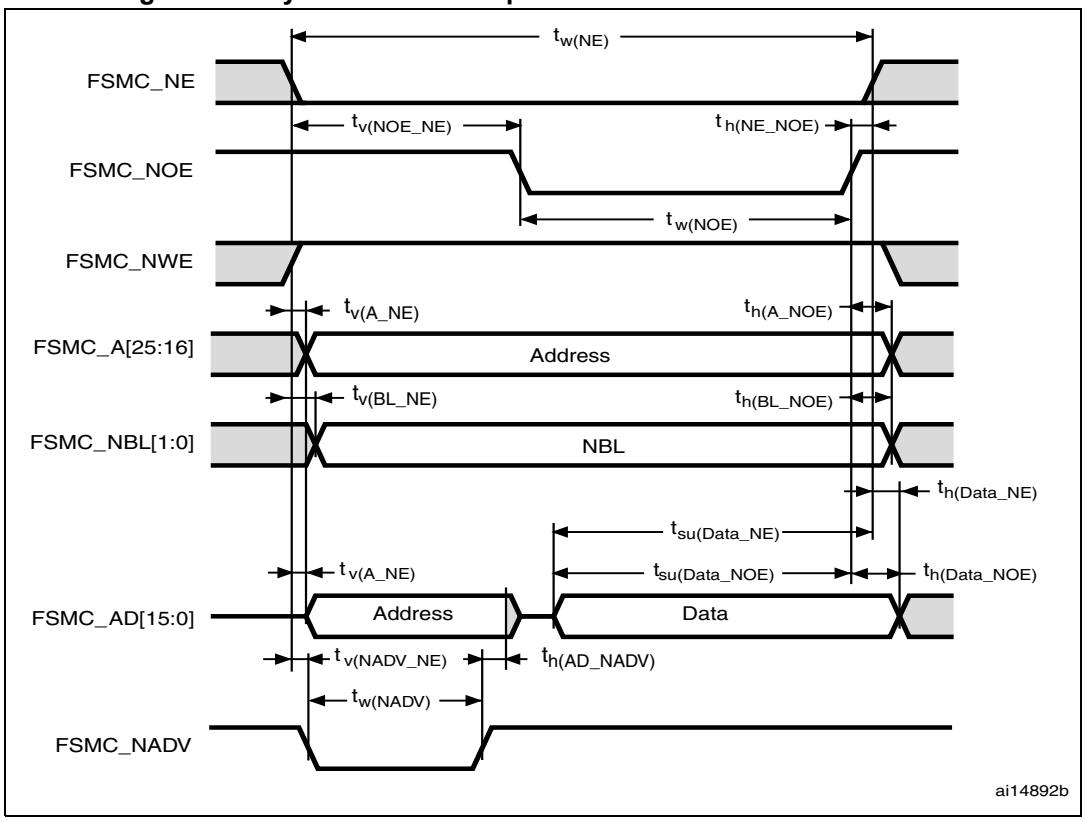


Table 33. Asynchronous multiplexed NOR/PSRAM read timings(1)(2)

Symbol	Parameter	Min	Max	Unit
$t_{w(NE)}$	FSMC_NE low time	$7t_{HCLK}$ + 0.5	$7t_{HCLK}$ + 2	ns
$t_{v(NOE\_NE)}$	FSMC_NEx low to FSMC_NOE low	$3t_{HCLK}$ + 0.5	$3t_{HCLK}$ + 1.5	ns
$t_{w(NOE)}$	FSMC_NOE low time	$4t_{HCLK}$ – 1	$4t_{HCLK}$ + 1	ns
$t_{h(NE\_NOE)}$	FSMC_NOE high to FSMC_NE high hold time	0.5	-	ns
$t_{v(A\_NE)}$	FSMC_NEx low to FSMC_A valid	-	0	ns
$t_{v(NADV\_NE)}$	FSMC_NEx low to FSMC_NADV low	0	1	ns
$t_{w(NADV)}$	FSMC_NADV low time	t_{HCLK} + 0.5	t_{HCLK} + 2	ns
$t_{h(AD\_NADV)}$	FSMC_AD (address) valid hold time after FSMC_NADV high	t_{HCLK}	-	ns

Table 38. Synchronous non-multiplexed PSRAM write timings(1)(2) (continued)

Symbol	Parameter	Min	Max	Unit
$t_{su(NWAITV-CLKH)}$	FSMC_NWAIT valid before FSMC_CLK high	7	-	ns
$t_{h(CLKH-NWAITV)}$	FSMC_NWAIT valid after FSMC_CLK high	2	-	ns

1. C_L = 15 pF.
2. Guaranteed by characterization results.

PC Card/CompactFlash controller waveforms and timings

Figure 27 through *Figure 32* represent synchronous waveforms and *Table 40* and *Table 41* provide the corresponding timings. The results shown in this table are obtained with the following FSMC configuration:

- COM.FSMC_SetupTime = 0x04;
- COM.FSMC_WaitSetupTime = 0x07;
- COM.FSMC_HoldSetupTime = 0x04;
- COM.FSMC_HiZSetupTime = 0x00;
- ATT.FSMC_SetupTime = 0x04;
- ATT.FSMC_WaitSetupTime = 0x07;
- ATT.FSMC_HoldSetupTime = 0x04;
- ATT.FSMC_HiZSetupTime = 0x00;
- IO.FSMC_SetupTime = 0x04;
- IO.FSMC_WaitSetupTime = 0x07;
- IO.FSMC_HoldSetupTime = 0x04;
- IO.FSMC_HiZSetupTime = 0x00;
- TCLRSetupTime = 0;
- TARSetupTime = 0;

Figure 32. PC Card/CompactFlash controller waveforms for I/O space write access

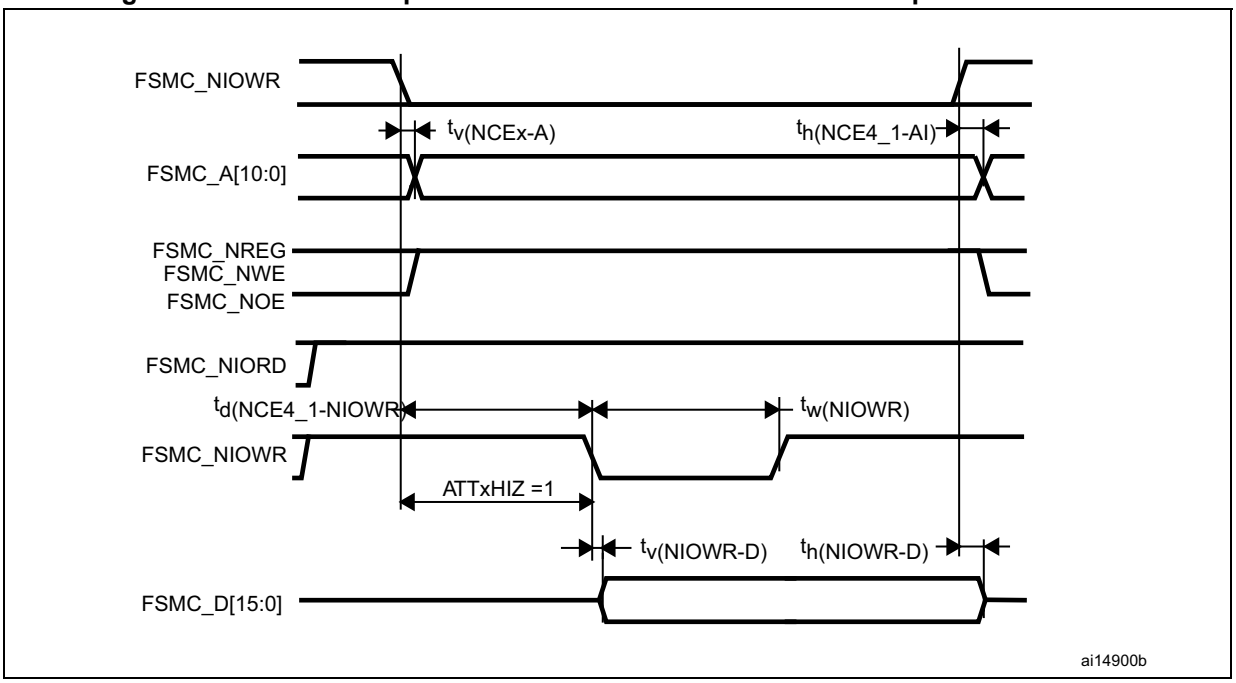


Table 39. Switching characteristics for PC Card/CF read and write cycles in attribute/common space

Symbol	Parameter	Min	Max	Unit
$t_{v(NCEx-A)}$	FSMC_NCEx low to FSMC_Ay valid	-	0	ns
$t_{h(NCEx-AI)}$	FSMC_NCEx high to FSMC_Ax invalid	0	-	
$t_{d(NREG-NCEx)}$	FSMC_NCEx low to FSMC_NREG valid	-	2	
$t_{h(NCEx-NREG)}$	FSMC_NCEx high to FSMC_NREG invalid	t_{HCLK} + 4	-	
$t_{d(NCEx\_NWE)}$	FSMC_NCEx low to FSMC_NWE low	-	$5t_{HCLK}$ + 1	
$t_{d(NCEx\_NOE)}$	FSMC_NCEx low to FSMC_NOE low	-	$5t_{HCLK}$ + 1	
$t_{w(NOE)}$	FSMC_NOE low width	$8t_{HCLK}$ - 0.5	$8t_{HCLK}$ + 1	
$t_{d(NOE-NCEx}$	FSMC_NOE high to FSMC_NCEx high	$5t_{HCLK}$ - 0.5	-	
$t_{su(D-NOE)}$	FSMC_D[15:0] valid data before FSMC_NOE high	32	-	
$t_{h(NOE-D)}$	FSMC_NOE high to FSMC_D[15:0] invalid	t_{HCLK}	-	
$t_{w(NWE)}$	FSMC_NWE low width	$8t_{HCLK}$ – 1	$8t_{HCLK}$ + 4	
$t_{d(NWE\_NCEx)}$	FSMC_NWE high to FSMC_NCEx high	$5t_{HCLK}$ + 1.5	-	
$t_{d(NCEx-NWE)}$	FSMC_NCEx low to FSMC_NWE low	-	$5t_{HCLK}$ + 1	
$t_{v(NWE-D)}$	FSMC_NWE low to FSMC_D[15:0] valid	-	0	
$t_{h(NWE-D)}$	FSMC_NWE high to FSMC_D[15:0] invalid	$11t_{HCLK}$	-	
$t_{d(D-NWE)}$	FSMC_D[15:0] valid before FSMC_NWE high	$13t_{HCLK}$ + 2.5	-	

Output voltage levels

Unless otherwise specified, the parameters given in *Table 48* are derived from tests performed under ambient temperature and V_{DD} supply voltage conditions summarized in *Table 10*. All I/Os are CMOS and TTL compliant.

Table 48. Output voltage characteristics

Symbol	Parameter	Conditions	Min	Max	Unit
V_{OL}(1)	Output Low level voltage for an I/O pin when 8 pins are sunk at the same time	CMOS port(2), I_{IO} = +8 mA, 2.7 V < V_{DD} < 3.6 V	-	0.4	V
V_{OH}(3)	Output High level voltage for an I/O pin when 8 pins are sourced at the same time		V_{DD}–0.4	-	
V_{OL}(1)	Output low level voltage for an I/O pin when 8 pins are sunk at the same time	TTL port(2) I_{IO} = +8 mA 2.7 V < V_{DD} < 3.6 V	-	0.4	V
V_{OH}(3)	Output high level voltage for an I/O pin when 8 pins are sourced at the same time		2.4	-	
V_{OL}(1)	Output low level voltage for an I/O pin when 8 pins are sunk at the same time	I_{IO} = +20 mA(4) 2.7 V < V_{DD} < 3.6 V	-	1.3	V
V_{OH} (3)	Output high level voltage for an I/O pin when 8 pins are sourced at the same time		V_{DD}–1.3	-	
V_{OL}(1)	Output low level voltage for an I/O pin when 8 pins are sunk at the same time	I_{IO} = +6 mA(4) 2 V < V_{DD} < 2.7 V	-	0.4	V
V_{OH}(3)	Output high level voltage for an I/O pin when 8 pins are sourced at the same time		V_{DD}–0.4	-	

1. The I_{IO} current sunk by the device must always respect the absolute maximum rating specified in *Table 8* and the sum of I_{IO} (I/O ports and control pins) must not exceed I_{VSS}.
2. TTL and CMOS outputs are compatible with JEDEC standards JESD36 and JESD52.
3. The I_{IO} current sourced by the device must always respect the absolute maximum rating specified in *Table 8* and the sum of I_{IO} (I/O ports and control pins) must not exceed I_{VDD}.
4. Guaranteed by characterization results.

5.3.17 Communications interfaces

I²C interface characteristics

The STM32F101xF and STM32F101xG access line I²C interface meets the requirements of the standard I²C communication protocol with the following restrictions: the I/O pins SDA and SCL are mapped to are not “true” open-drain. When configured as open-drain, the PMOS connected between the I/O pin and V_{DD} is disabled, but is still present.

The I²C characteristics are described in *Table 52*. Refer also to *Section 5.3.13: I/O current injection characteristics* for more details on the input/output alternate function characteristics (SDA and SCL).

Table 52. I²C characteristics

Symbol	Parameter	Standard mode I²C(1)(2)		Fast mode I²C(1)(2)		Unit
		Min	Max	Min	Max	
$t_{w(SCLL)}$	SCL clock low time	4.7	-	1.3	-	µs
$t_{w(SCLH)}$	SCL clock high time	4.0	-	0.6	-	
$t_{su(SDA)}$	SDA setup time	250	-	100	-	ns
$t_{h(SDA)}$	SDA data hold time	-	3450(3)	-	900(3)	
$t_{r(SDA)}$ $t_{r(SCL)}$	SDA and SCL rise time	-	1000	-	300	
$t_{f(SDA)}$ $t_{f(SCL)}$	SDA and SCL fall time	-	300	-	300	
$t_{h(STA)}$	Start condition hold time	4.0	-	0.6	-	µs
$t_{su(STA)}$	Repeated Start condition setup time	4.7	-	0.6	-	
$t_{su(STO)}$	Stop condition setup time	4.0	-	0.6	-	µs
$t_{w(STO:STA)}$	Stop to Start condition time (bus free)	4.7	-	1.3	-	µs
C_b	Capacitive load for each bus line	-	400	-	400	pF
t_{SP}	Pulse width of the spikes that are suppressed by the analog filter for standard and fast mode	0	50(4)	0	50(4)	µs

1. Guaranteed by design.
2. f_{PCLK1} must be at least 2 MHz to achieve standard mode I²C frequencies. It must be at least 4 MHz to achieve the fast mode I²C frequencies and it must be a multiple of 10 MHz in order to reach the I2C fast mode maximum clock speed of 400 kHz.
3. The maximum data hold time has only to be met if the interface does not stretch the low period of SCL signal.
4. The minimum width of the spikes filtered by the analog filter is above t_{SP}(max).

SPI interface characteristics

Unless otherwise specified, the parameters given in *Table 54Table 55* are derived from tests performed under ambient temperature, f_{PCLKx} frequency and V_{DD} supply voltage conditions summarized in *Table 10*.
Refer to *Section 5.3.13: I/O current injection characteristics* for more details on the input/output alternate function characteristics (NSS, SCK, MOSI, MISO).

Table 54. STM32F10xxx SPI characteristics

Symbol	Parameter	Conditions	Min	Max	Unit
f_{SCK} $1/t_{c(SCK)}$	SPI clock frequency	Master mode	-	10	MHz
		Slave mode	-	10	
$t_{r(SCK)}$ $t_{f(SCK)}$	SPI clock rise and fall time	Capacitive load: C = 30 pF	-	8	ns
$t_{su(NSS)}$ (1)	NSS setup time	Slave mode	$4t_{PCLK}$	-	
$t_{h(NSS)}$ (1)	NSS hold time	Slave mode	73	-	
$t_{w(SCKH)}$ (1) $t_{w(SCKL)}$ (1)	SCK high and low time	Master mode, f_{PCLK} = 36 MHz, presc = 4	50	60	
$t_{su(MI)}$ (1) $t_{su(SI)}$ (1)	Data input setup time	Master mode - SPI1	3	-	
		Master mode - SPI2	5	-	
		Slave mode	4	-	
$t_{h(MI)}$ (1)	Data input hold time	Master mode - SPI1	4	-	
		Master mode - SPI2	6	-	
$t_{h(SI)}$ (1)		Slave mode	5	-	
$t_{a(SO)}$ (1)(2)	Data output access time	Slave mode, f_{PCLK} = 36 MHz, presc = 4	0	55	
		Slave mode, f_{PCLK} = 20 MHz	-	$4t_{PCLK}$	
$t_{dis(SO)}$ (1)(3)	Data output disable time	Slave mode	10	-	
$t_{v(SO)}$ (1)	Data output valid time	Slave mode (after enable edge)	-	25	
$t_{v(MO)}$ (1)	Data output valid time	Master mode (after enable edge)	-	6	
$t_{h(SO)}$ (1)	Data output hold time	Slave mode (after enable edge)	25	-	
$t_{h(MO)}$ (1)		Master mode (after enable edge)	6	-	

1. Guaranteed by characterization results.
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

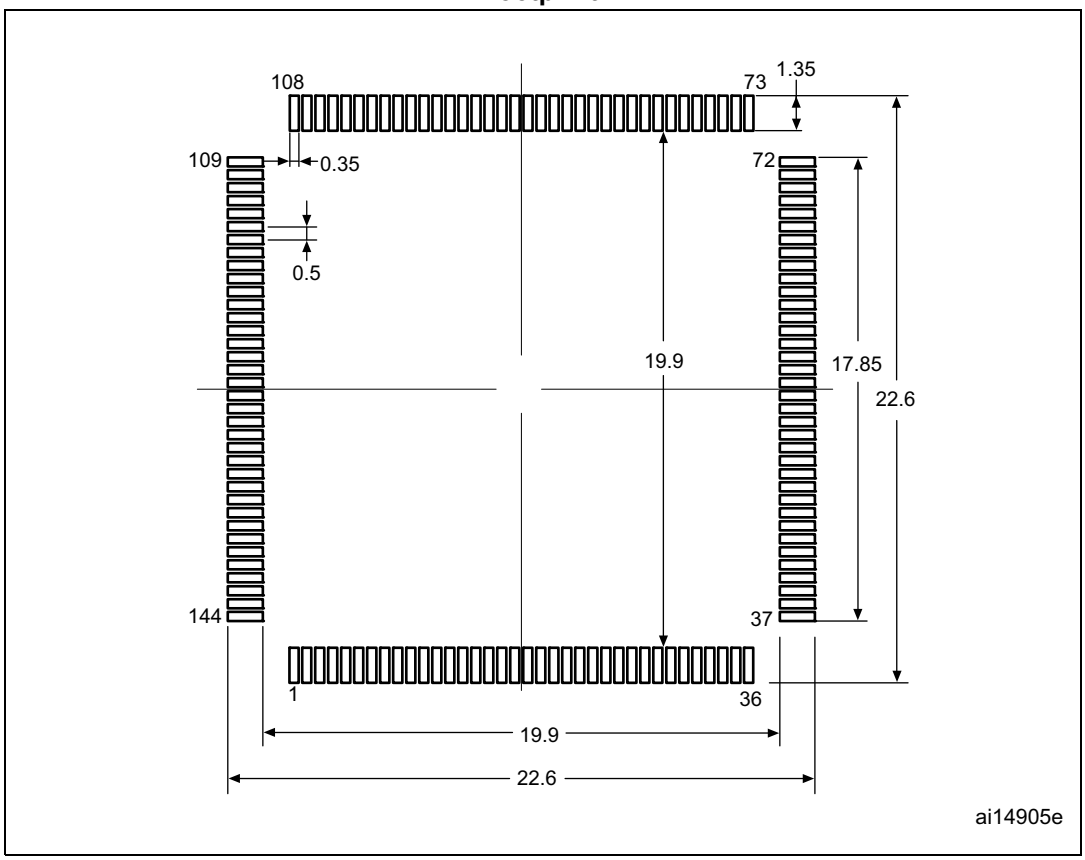
5.3.20 Temperature sensor characteristics

Table 61. TS characteristics

Symbol	Parameter	Min	Typ	Max	Unit
T_L(1)	V_{SENSE} linearity with temperature	-	±1	±2	°C
Avg_Slope(1)	Average slope	4.0	4.3	4.6	mV/°C
V_{25}(1)	Voltage at 25°C	1.34	1.43	1.52	V
t_{START}(2)	Startup time	4	-	10	µs
T_{S_temp}(3)(2)	ADC sampling time when reading the temperature	-	-	17.1	µs

1. Preliminary values.
2. Guaranteed by design.
3. Shortest sampling time can be determined in the application by multiple iterations.

Figure 53. LQFP144 - 144-pin, 20 x 20 mm low-profile quad flat package footprint



1. Dimensions are expressed in millimeters.

6.4.2 Evaluating the maximum junction temperature for an application

When ordering the microcontroller, the temperature range is specified in the ordering information scheme shown in *Table 66: STM32F101xF and STM32F101xG ordering information scheme*.

Each temperature range suffix corresponds to a specific guaranteed ambient temperature at maximum dissipation and, to a specific maximum junction temperature. Here, only temperature range 6 is available (–40 to 85 °C).

The following example shows how to calculate the temperature range needed for a given application, making it possible to check whether the required temperature range is compatible with the STM32F10xxx junction temperature range.

Example: High-performance application

Assuming the following application conditions:

Maximum ambient temperature T_{Amax} = 82 °C (measured according to JESD51-2), I_{DDmax} = 50 mA, V_{DD} = 3.5 V, maximum 20 I/Os used at the same time in output at low level with I_{OL} = 8 mA, V_{OL}= 0.4 V and maximum 8 I/Os used at the same time in output mode at low level with I_{OL} = 20 mA, V_{OL}= 1.3 V

P_{INTmax} = 50 mA × 3.5 V= 175 mW

P_{IOmax} = 20 × 8 mA × 0.4 V + 8 × 20 mA × 1.3 V = 272 mW

This gives: P_{INTmax} = 175 mW and P_{IOmax} = 272 mW

P_{Dmax} = 175 + 272 = 447 mW

Thus: P_{Dmax} = 447 mW

Using the values obtained in *Table 66* T_{Jmax} is calculated as follows:

– For LQFP64, 45 °C/W

T_{Jmax} = 82 °C + (45 °C/W × 447 mW) = 82 °C + 20.1 °C = 102.1 °C

This is within the junction temperature range of the STM32F10xxx (–40 < T_J < 105 °C).

Figure 61. LQFP64 P_D max vs. T_A