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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M4
Core Size	32-Bit Single-Core
Speed	80MHz
Connectivity	CANbus, EBI/EMI, I²C, IrDA, LINbus, MMC/SD, QSPI, SAI, SPI, SWPMI, UART/USART, USB OTG
Peripherals	Brown-out Detect/Reset, DMA, LCD, PWM, WDT
Number of I/O	83
Program Memory Size	1MB (1M x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	320K x 8
Voltage - Supply (Vcc/Vdd)	1.71V ~ 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	100-UFBGA, WLCSP
Supplier Device Package	100-WLCSP (4.62x4.14)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32l4a6vgy6ptr

Table 5. Functionalities depending on the working mode[1]

Peripheral	Run	Sleep	Low-power run	Low-power sleep	Stop 0/1		Stop 2		Standby		Shutdown		VBAT
					-	Wakeup capability	-	Wakeup capability	-	Wakeup capability	-	Wakeup capability	
CPU	Y	-	Y	-	-	-	-	-	-	-	-	-	-
Flash memory (1 MB)	O[2]	O[2]	O[2]	O[2]	-	-	-	-	-	-	-	-	-
SRAM1 (256 KB)	Y	Y[3]	Y	Y[3]	Y	-	Y	-	-	-	-	-	-
SRAM2 (64 KB)	Y	Y[3]	Y	Y[3]	Y	-	Y	-	O[4]	-	-	-	-
FSMC	O	O	O	O	-	-	-	-	-	-	-	-	-
Quad SPI	O	O	O	O	-	-	-	-	-	-	-	-	-
Backup Registers	Y	Y	Y	Y	Y	-	Y	-	Y	-	Y	-	Y
Brown-out reset (BOR)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	-
Programmable Voltage Detector (PVD)	O	O	O	O	O	O	O	O	-	-	-	-	-
Peripheral Voltage Monitor (PVMx; x=1,2,3,4)	O	O	O	O	O	O	O	O	-	-	-	-	-
DMA	O	O	O	O	-	-	-	-	-	-	-	-	-
DMA2D	O	O	O	O	-	-	-	-	-	-	-	-	-
High Speed Internal (HSI16)	O	O	O	O	(5)	-	(5)	-	-	-	-	-	-
Oscillator HSI48	O	O	-	-	-	-	-	-	-	-	-	-	-
High Speed External (HSE)	O	O	O	O	-	-	-	-	-	-	-	-	-
Low Speed Internal (LSI)	O	O	O	O	O	-	O	-	O	-	-	-	-
Low Speed External (LSE)	O	O	O	O	O	-	O	-	O	-	O	-	O
Multi-Speed Internal (MSI)	O	O	O	O	-	-	-	-	-	-	-	-	-
Clock Security System (CSS)	O	O	O	O	-	-	-	-	-	-	-	-	-
Clock Security System on LSE	O	O	O	O	O	O	O	O	O	O	-	-	-
RTC / Auto wakeup	O	O	O	O	O	O	O	O	O	O	O	O	O

Table 5. Functionalities depending on the working mode(1) (continued)

Peripheral	Run	Sleep	Low-power run	Low-power sleep	Stop 0/1		Stop 2		Standby		Shutdown		VBAT
					-	Wakeup capability	-	Wakeup capability	-	Wakeup capability	-	Wakeup capability	
SysTick timer	O	O	O	O	-	-	-	-	-	-	-	-	-
Touch sensing controller (TSC)	O	O	O	O	-	-	-	-	-	-	-	-	-
Random number generator (RNG)	O(8)	O(8)	-	-	-	-	-	-	-	-	-	-	-
AES hardware accelerator	O	O	O	O	-	-	-	-	-	-	-	-	-
HASH hardware accelerator	O	O	O	O	-	-	-	-	-	-	-	-	-
CRC calculation unit	O	O	O	O	-	-	-	-	-	-	-	-	-
GPIOs	O	O	O	O	O	O	O	O	(9)	5 pins (10)	(11)	5 pins (10)	-

1. Legend: Y = Yes (Enable). O = Optional (Disable by default. Can be enabled by software). - = Not available.
2. The Flash can be configured in power-down mode. By default, it is not in power-down mode.
3. The SRAM clock can be gated on or off.
4. SRAM2 content is preserved when the bit RRS is set in PWR_CR3 register.
5. Some peripherals with wakeup from Stop capability can request HSI16 to be enabled. In this case, HSI16 is woken up by the peripheral, and only feeds the peripheral which requested it. HSI16 is automatically put off when the peripheral does not need it anymore.
6. UART and LPUART reception is functional in Stop mode, and generates a wakeup interrupt on Start, address match or received frame event.
7. I2C address detection is functional in Stop mode, and generates a wakeup interrupt in case of address match.
8. Voltage scaling Range 1 only.
9. I/Os can be configured with internal pull-up, pull-down or floating in Standby mode.
10. The I/Os with wakeup from Standby/Shutdown capability are: PA0, PC13, PE6, PA2, PC5.
11. I/Os can be configured with internal pull-up, pull-down or floating in Shutdown mode but the configuration is lost when exiting the Shutdown mode.

3.10.5 Reset mode

In order to improve the consumption under reset, the I/Os state under and after reset is “analog state” (the I/O schmitt trigger is disable). In addition, the internal reset pull-up is deactivated when the reset source is internal.

3.10.6 VBAT operation

The VBAT pin allows to power the device VBAT domain from an external battery, an external supercapacitor, or from V_{DD} when no external battery and an external supercapacitor are

3.17 Analog to digital converter (ADC)

The device embeds 3 successive approximation analog-to-digital converters with the following features:

- 12-bit native resolution, with built-in calibration
- 5.33 Msps maximum conversion rate with full resolution
  - Down to 18.75 ns sampling time
  - Increased conversion rate for lower resolution (up to 8.88 Msps for 6-bit resolution)
- Up to 24 external channels, some of them shared between ADC1 and ADC2, or ADC1, ADC2 and ADC3.
- 5 internal channels: internal reference voltage, temperature sensor, VBAT/3, DAC1_OUT1 and DAC1_OUT2.
- One external reference pin is available on some package, allowing the input voltage range to be independent from the power supply
- Single-ended and differential mode inputs
- Low-power design
  - Capable of low-current operation at low conversion rate (consumption decreases linearly with speed)
  - Dual clock domain architecture: ADC speed independent from CPU frequency
- Highly versatile digital interface
  - Single-shot or continuous/discontinuous sequencer-based scan mode: 2 groups of analog signals conversions can be programmed to differentiate background and high-priority real-time conversions
  - Handles two ADC converters for dual mode operation (simultaneous or interleaved sampling modes)
  - Each ADC support multiple trigger inputs for synchronization with on-chip timers and external signals
  - Results stored into 3 data register or in RAM with DMA controller support
  - Data pre-processing: left/right alignment and per channel offset compensation
  - Built-in oversampling unit for enhanced SNR
  - Channel-wise programmable sampling time
  - Three analog watchdog for automatic voltage monitoring, generating interrupts and trigger for selected timers
  - Hardware assistant to prepare the context of the injected channels to allow fast context switching

3.17.1 Temperature sensor

The temperature sensor (TS) generates a voltage V_{TS} that varies linearly with temperature.

The temperature sensor is internally connected to the ADC1_IN17 and ADC3_IN17 input channels which is used to convert the sensor output voltage into a digital value.

The sensor provides good linearity but it has to be calibrated to obtain good overall accuracy of the temperature measurement. As the offset of the temperature sensor varies from chip to chip due to process variation, the uncalibrated internal temperature sensor is suitable for applications that detect temperature changes only.

The main features of the touch sensing controller are the following:

- Proven and robust surface charge transfer acquisition principle
- Supports up to 24 capacitive sensing channels
- Up to 3 capacitive sensing channels can be acquired in parallel offering a very good response time
- Spread spectrum feature to improve system robustness in noisy environments
- Full hardware management of the charge transfer acquisition sequence
- Programmable charge transfer frequency
- Programmable sampling capacitor I/O pin
- Programmable channel I/O pin
- Programmable max count value to avoid long acquisition when a channel is faulty
- Dedicated end of acquisition and max count error flags with interrupt capability
- One sampling capacitor for up to 3 capacitive sensing channels to reduce the system components
- Compatible with proximity, touchkey, linear and rotary touch sensor implementation
- Designed to operate with STMTouch touch sensing firmware library

Note: The number of capacitive sensing channels is dependent on the size of the packages and subject to I/O availability.

3.23 Liquid crystal display controller (LCD)

The LCD drives up to 8 common terminals and 44 segment terminals to drive up to 320 pixels.

- Internal step-up converter to guarantee functionality and contrast control irrespective of V_{DD}. This converter can be deactivated, in which case the VLCD pin is used to provide the voltage to the LCD
- Supports static, 1/2, 1/3, 1/4 and 1/8 duty
- Supports static, 1/2, 1/3 and 1/4 bias
- Phase inversion to reduce power consumption and EMI
- Integrated voltage output buffers for higher LCD driving capability
- Up to 8 pixels can be programmed to blink
- Unneeded segments and common pins can be used as general I/O pins
- LCD RAM can be updated at any time owing to a double-buffer
- The LCD controller can operate in Stop mode

3.24 Digital filter for Sigma-Delta Modulators (DFSDM)

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

The DFSDM peripheral is dedicated to interface the external ΣΔ modulators to microcontroller and then to perform digital filtering of the received data streams (which represent analog value on ΣΔ modulators inputs). DFSDM can also interface PDM (Pulse Density Modulation) microphones and perform PDM to PCM conversion and filtering in

3.29.4 Low-power timer (LPTIM1 and LPTIM2)

The devices embed two low-power timers. These timers have an independent clock and are running in Stop mode if they are clocked by LSE, LSI or an external clock. They are able to wakeup the system from Stop mode.

LPTIM1 is active in Stop 0, Stop 1 and Stop 2 modes.

LPTIM2 is active in Stop 0 and Stop 1 mode.

This low-power timer supports the following features:

- 16-bit up counter with 16-bit autoreload register
- 16-bit compare register
- Configurable output: pulse, PWM
- Continuous/ one shot mode
- Selectable software/hardware input trigger
- Selectable clock source
  - Internal clock sources: LSE, LSI, HSI16 or APB clock
  - External clock source over LPTIM input (working even with no internal clock source running, used by pulse counter application).
- Programmable digital glitch filter
- Encoder mode (LPTIM1 only)

3.29.5 Infrared interface (IRTIM)

The STM32L4A6xG includes one infrared interface (IRTIM). It can be used with an infrared LED to perform remote control functions. It uses TIM16 and TIM17 output channels to generate output signal waveforms on IR_OUT pin.

3.29.6 Independent watchdog (IWDG)

The independent watchdog is based on a 12-bit downcounter and 8-bit prescaler. It is clocked from an independent 32 kHz internal RC (LSI) 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.

3.29.7 System window watchdog (WWDG)

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.

Table 15. STM32L4A6xG pin definitions (continued)

Pin Number										Pin name (function after reset)	Pin type	I/O structure	Notes	Pin functions	
LQFP64	WLCSP100	WLCSP100_SMPS	LQFP100	UFBGA132	UFBGA132_SMPS	LQFP144	LQFP144_SMPS	UFBGA169	UFBGA169_SMPS					Alternate functions	Additional functions
-	-	-	-	-	-	21	21	-	-	PF9	I/O	FT_a	-	TIM5_CH4, QUADSPI_BK1_IO1, SAI1_FS_B, TIM15_CH1, EVENTOUT	ADC3_IN12
-	-	-	-	-	-	22	22	H4	H4	PF10	I/O	FT_a	-	QUADSPI_CLK, DCMI_D11, TIM15_CH2, EVENTOUT	ADC3_IN13
5	F10	F10	12	F1	F1	23	23	H1	H1	PH0-OSC_IN (PH0)	I/O	FT	-	EVENTOUT	OSC_IN
6	G10	F9	13	G1	G1	24	24	J1	J1	PH1-OSC_OUT (PH1)	I/O	FT	-	EVENTOUT	OSC_OUT
7	E8	F8	14	H2	H2	25	25	H3	H3	NRST	I/O	RST	-	-	-
8	F9	G10	15	H1	H1	26	26	J2	J2	PC0	I/O	FT_fla	-	LPTIM1_IN1, I2C4_SCL, I2C3_SCL, DFSDM1_DATIN4, LPUART1_RX, LCD_SEG18, LPTIM2_IN1, EVENTOUT	ADC123_IN1
9	F8	F7	16	J2	J2	27	27	J3	J3	PC1	I/O	FT_fla	-	TRACED0, LPTIM1_OUT, I2C4_SDA, SPI2_MOSI, I2C3_SDA, DFSDM1_CKIN4, LPUART1_TX, QUADSPI_BK2_IO0, LCD_SEG19, SAI1_SD_A, EVENTOUT	ADC123_IN2
10	H10	G9	17	J3	J3	28	28	J4	J4	PC2	I/O	FT_la	-	LPTIM1_IN2, SPI2_MISO, DFSDM1_CKOUT, QUADSPI_BK2_IO1, LCD_SEG20, EVENTOUT	ADC123_IN3
11	F7	F6	18	K2	K2	29	29	K1	K1	PC3	I/O	FT_la	-	LPTIM1_ETR, SPI2_MOSI, QUADSPI_BK2_IO2, LCD_VLCD, SAI1_SD_A, LPTIM2_ETR, EVENTOUT	ADC123_IN4

Table 15. STM32L4A6xG pin definitions (continued)

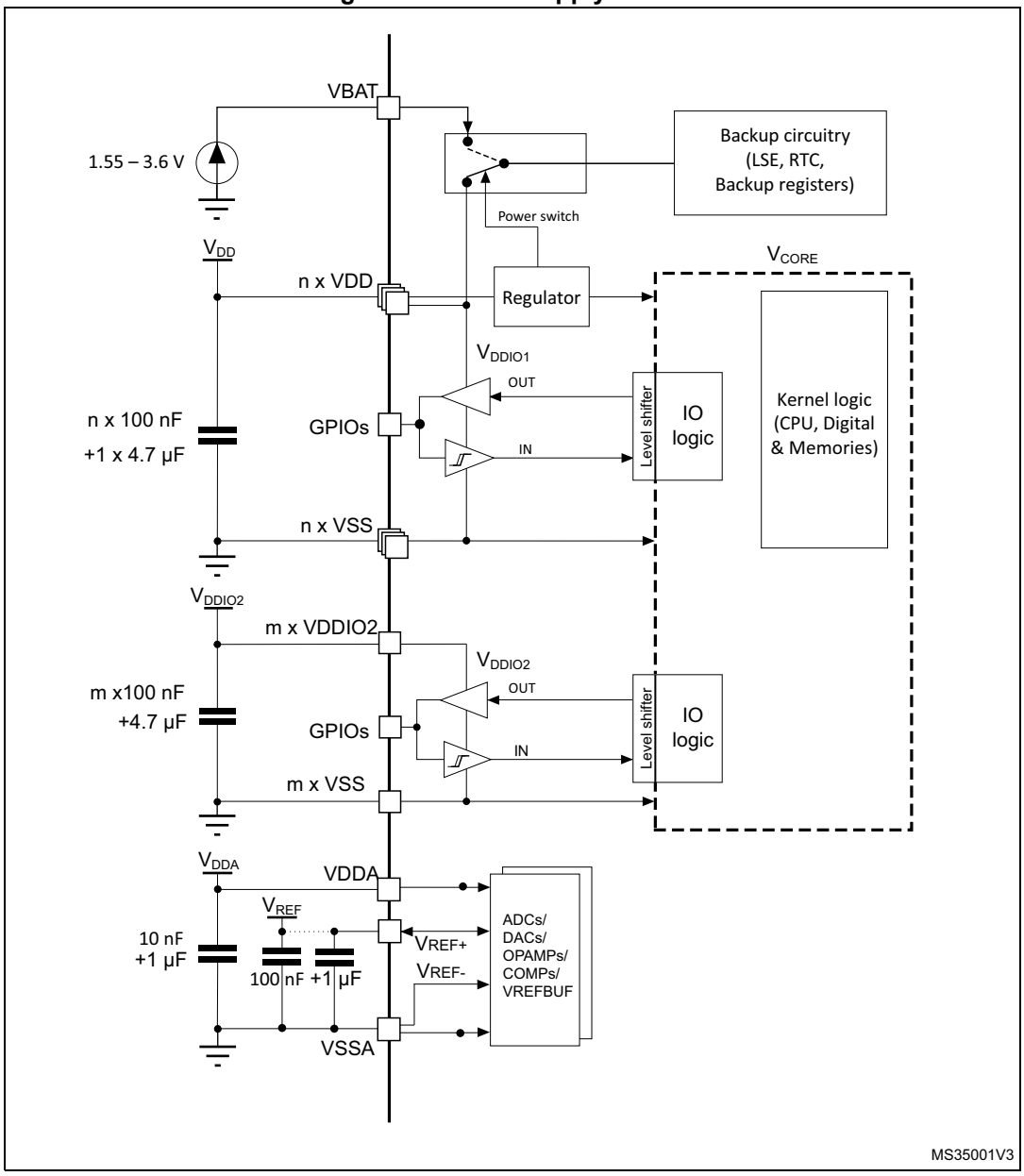
Pin Number										Pin name (function after reset)	Pin type	I/O structure	Notes	Pin functions	
LQFP64	WLCSP100	WLCSP100_SMPS	LQFP100	UFBGA132	UFBGA132_SMPS	LQFP144	LQFP144_SMPS	UFBGA169	UFBGA169_SMPS					Alternate functions	Additional functions
44	D1	D1	70	B12	B12	103	103	E13	E13	PA11	I/O	FT_u	-	TIM1_CH4, TIM1_BKIN2, SPI1_MISO, USART1_CTS, CAN1_RX, OTG_FS_DM, TIM1_BKIN2_COMP1, EVENTOUT	-
45	C1	C1	71	A12	A12	104	104	D13	D13	PA12	I/O	FT_u	-	TIM1_ETR, SPI1_MOSI, USART1_RTS_DE, CAN1_TX, OTG_FS_DP, EVENTOUT	-
46	C2	C2	72	A11	A11	105	105	A11	A11	PA13 (JTMS/SWDIO)	I/O	FT	(4)	JTMS/SWDIO, IR_OUT, OTG_FS_NOE, SWPMI1_TX, SAI1_SD_B, EVENTOUT	-
47	B1	B1	-	-	-	-	-	-	-	VSS	S	-	-	-	-
48	A1	A1	73	C11	C11	106	106	E12	E12	VDDUSB	S	-	-	-	-
-	-	-	74	F11	F11	107	107	C12	C12	VSS	S	-	-	-	-
-	-	-	75	G11	G11	108	108	C13	C13	VDD	S	-	-	-	-
-	-	-	-	-	-	-	-	E11	E11	PH6	I/O	FT	-	I2C2_SMBA, DCMI_D8, EVENTOUT	-
-	-	-	-	-	-	-	-	D12	D12	PH7	I/O	FT_f	-	I2C3_SCL, DCMI_D9, EVENTOUT	-
-	-	-	-	-	-	-	-	D11	D11	PH9	I/O	FT	-	I2C3_SMBA, DCMI_D0, EVENTOUT	-
-	-	-	-	-	-	-	-	B13	B13	PH12	I/O	FT	-	TIM5_CH3, DCMI_D3, EVENTOUT	-

Table 18. STM32L4A6xG memory map and peripheral register boundary addresses(1) (continued)

Bus	Boundary address	Size (bytes)	Peripheral
AHB1	0x4002 B000 - 0x4002 BBFF	3 KB	DMA2D
	0x4002 4400 - 0x4002 AFFF	26 KB	Reserved
	0x4002 4000 - 0x4002 43FF	1 KB	TSC
	0x4002 3400 - 0x4002 3FFF	1 KB	Reserved
	0x4002 3000 - 0x4002 33FF	1 KB	CRC
	0x4002 2400 - 0x4002 2FFF	3 KB	Reserved
	0x4002 2000 - 0x4002 23FF	1 KB	FLASH registers
	0x4002 1400 - 0x4002 1FFF	3 KB	Reserved
	0x4002 1000 - 0x4002 13FF	1 KB	RCC
	0x4002 0800 - 0x4002 0FFF	2 KB	Reserved
	0x4002 0400 - 0x4002 07FF	1 KB	DMA2
	0x4002 0000 - 0x4002 03FF	1 KB	DMA1
APB2	0x4001 6400 - 0x4001 FFFF	39 KB	Reserved
	0x4001 6000 - 0x4001 63FF	1 KB	DFSDM1
	0x4001 5C00 - 0x4001 5FFF	1 KB	Reserved
	0x4001 5800 - 0x4001 5BFF	1 KB	SAI2
	0x4001 5400 - 0x4001 57FF	1 KB	SAI1
	0x4001 4C00 - 0x4001 53FF	2 KB	Reserved
	0x4001 4800 - 0x4001 4BFF	1 KB	TIM17
	0x4001 4400 - 0x4001 47FF	1 KB	TIM16
	0x4001 4000 - 0x4001 43FF	1 KB	TIM15
	0x4001 3C00 - 0x4001 3FFF	1 KB	Reserved
	0x4001 3800 - 0x4001 3BFF	1 KB	USART1
	0x4001 3400 - 0x4001 37FF	1 KB	TIM8
	0x4001 3000 - 0x4001 33FF	1 KB	SPI1
	0x4001 2C00 - 0x4001 2FFF	1 KB	TIM1
	0x4001 2800 - 0x4001 2BFF	1 KB	SDMMC1
	0x4001 2000 - 0x4001 27FF	2 KB	Reserved
	0x4001 1C00 - 0x4001 1FFF	1 KB	FIREWALL
	0x4001 0800- 0x4001 1BFF	5 KB	Reserved
	0x4001 0400 - 0x4001 07FF	1 KB	EXTI

6.1.6 Power supply scheme

Figure 20. Power supply scheme



Caution: Each power supply pair (V_{DD}/V_{SS}, V_{DDA}/V_{SSA} etc.) must be decoupled with filtering ceramic capacitors as shown above. These capacitors must be placed as close as possible to, or below, the appropriate pins on the underside of the PCB to ensure the good functionality of the device.

Table 40. Typical current consumption in Run, with different codesrunning from SRAM1 and power supplied by external SMPS (V_{DD12} = 1.05 V)

Symbol	Parameter	Conditions(1)			TYP	Unit	TYP	Unit
		-	Voltage scaling	Code	25 °C		25 °C	
I_{DD_ALL} (Run)	Supply current in Run mode	f_{HCLK} = f_{HSE} up to 48 MHz included, bypass mode PLL ON above 48 MHz all peripherals disable	f_{HCLK} = 26 MHz	Reduced code(2)	1.07	mA	41	µA/MHz
				Coremark	1.07		41	
				Dhrystone 2.1	1.04		40	
				Fibonacci	0.97		37	
				While(1)	0.93		36	

1. All values are obtained by calculation based on measurements done without SMPS and using following parameters: SMPS input = 3.3 V, SMPS efficiency = 85%, V_{DD12} = 1.05 V
2. Reduced code used for characterization results provided in *Table 26*, *Table 28*, *Table 30*.

Table 41. Current consumption in Sleep and Low-power sleep modes, Flash ON

Symbol	Parameter	Conditions			TYP					MAX(1)					Unit
		-	Voltage scaling	f_{HCLK}	25 °C	55 °C	85 °C	105 °C	125 °C	25 °C	55 °C	85 °C	105 °C	125 °C	
I_{DD_ALL} (Sleep)	Supply current in sleep mode,	$f_{HCLK} = f_{HSE}$ up to 48 MHz included, bypass mode pll ON above 48 MHz all peripherals disable	Range 2	26 MHz	0.79	0.82	0.95	1.17	1.63	0.9	1.0	1.2	1.7	2.7	mA
				16 MHz	0.54	0.57	0.7	0.92	1.38	0.6	0.7	1.0	1.4	2.4	
				8 MHz	0.33	0.37	0.49	0.71	1.17	0.4	0.5	0.7	1.2	2.2	
				4 MHz	0.23	0.26	0.39	0.61	1.06	0.3	0.4	0.6	1.1	2.1	
				2 MHz	0.18	0.21	0.34	0.56	1.01	0.2	0.3	0.5	1.0	1.0	
				1 MHz	0.16	0.19	0.31	0.53	0.99	0.2	0.3	0.5	1.0	1.0	
				100 kHz	0.13	0.17	0.29	0.51	0.96	0.1	0.3	0.5	1.0	1.9	
			Range 1	80 MHz	2.57	2.62	2.76	3.01	3.53	2.8	2.9	3.2	3.8	4.9	
				72 MHz	2.34	2.38	2.53	2.78	3.29	2.6	2.7	3.0	3.5	4.6	
				64 MHz	2.1	2.15	2.29	2.54	3.05	2.3	2.4	2.7	3.3	4.4	
				48 MHz	1.58	1.63	1.78	2.03	2.54	1.8	1.9	2.2	2.7	3.8	
				32 MHz	1.11	1.15	1.3	1.54	2.05	1.2	1.4	1.7	2.2	3.3	
				24 MHz	0.87	0.91	1.06	1.3	1.81	1.0	1.1	1.4	1.9	3.0	
				16 MHz	0.63	0.67	0.82	1.06	1.56	0.7	0.8	1.1	1.6	2.7	
I_{DD_ALL} (LPSleep)	Supply current in low-power sleep mode	$f_{HCLK} = f_{MSI}$ all peripherals disable		2 MHz	103	140	270	506	985	130	247	500	990	2025	µA
				1 MHz	74.2	111	245	476	955	100	215	467	963	1999	
				400 kHz	60	89.8	224	457	937	79	194	444	941	1975	
				100 kHz	53.7	84.1	216	448	928	70	185	434	933	1967	

1. Guaranteed by characterization results, unless otherwise specified.

Table 45. Current consumption in Stop 1 mode

Symbol	Parameter	Conditions			TYP					MAX(1)					Unit
		-	-	V_{DD}	25 °C	55 °C	85 °C	105 °C	125 °C	25 °C	55 °C	85 °C	105 °C	125 °C	
I_{DD_ALL} (Stop 1)	Supply current in Stop 1 mode, RTC disabled	-	LCD disabled	1.8 V	11.2	30.7	107	243	523	25.4	79.6	287	651	1395	µA
				2.4 V	11.3	30.8	108	244	526	25.5	79.8	288	655	1403	
				3 V	11.6	31	108	245	530	25.9	80.5	290	659	1413	
				3.6 V	11.9	31.5	109	248	536	28.6	81.4	293	665	1428	
		-	LCD enabled(2) clocked by LSI	1.8 V	11.7	29.7	102	234	504	27.1	81.1	288.5	653	1397	
				2.4 V	11.7	29.9	102	234	506	27.2	81.0	289	656	1405	
				3 V	12.1	29.9	103	234	508	27.4	81.6	291	660	1415	
				3.6 V	12.2	30.1	103	235	510	28.8	82.4	294	667	1429	
I_{DD_ALL} (Stop 1 with RTC)	Supply current in stop 1 mode, RTC enabled	RTC clocked by LSI	LCD disabled	1.8 V	11.9	31.1	108	244	524	26.6	80.5	288	652	1396	µA
				2.4 V	12.1	31.4	109	245	528	26.7	80.9	289	656	1404	
				3 V	12.4	31.7	109	246	531	27.7	81.6	291	660	1415	
				3.6 V	12.6	32.3	110	249	537	28.9	82.8	295	667	1429	
			LCD enabled(2)	1.8 V	11.7	30.1	104	235	510	26.7	80.6	288	653	1397	
				2.4 V	11.8	30.2	104	238	511	26.7	81.1	290	657	1406	
				3 V	11.8	30.5	104	238	515	28.3	81.8	2912	661	1416	
				3.6 V	12.3	31	105	239	519	30.9	83.0	295	668	1430	
		RTC clocked by LSE bypassed at 32768 Hz	LCD disabled	1.8 V	11.6	31.3	108	244	524	-	-	-	-	-	
				2.4 V	11.8	31.6	109	245	527	-	-	-	-	-	
				3 V	12.3	31.9	109	246	531	-	-	-	-	-	
				3.6 V	12.7	32.5	111	249	537	-	-	-	-	-	
		RTC clocked by LSE quartz(3) in low drive mode	LCD disabled	1.8 V	11.5	31.1	108	244	-	-	-	-	-	-	
				2.4 V	11.5	31.4	109	246	-	-	-	-	-	-	
				3 V	12	31.7	109	247	-	-	-	-	-	-	
				3.6 V	12.4	32.3	110	250	-	-	-	-	-	-	

Table 49. Current consumption in VBAT mode

Symbol	Parameter	Conditions		TYP					MAX(1)					Unit
		-	V_{BAT}	25 °C	55 °C	85 °C	105 °C	125 °C	25 °C	55 °C	85 °C	105 °C	125 °C	
$I_{VDD\_VBAT}(V_{BAT})$	Backup domain supply current	RTC disabled	1.8 V	2	18	110	329	908	-	-	-	-	-	nA
			2.4 V	2	20	125	371	1016	-	-	-	-	-	
			3 V	3	25	154	546	1965	-	-	-	-	-	
			3.6 V	10	57	324	963	2688	-	-	-	-	-	
		RTC enabled and clocked by LSE bypassed at 32768 Hz	1.8 V	198	216	312	535	-	-	-	-	-	-	
			2.4 V	280	300	411	664	-	-	-	-	-	-	
			3 V	375	402	544	943	-	-	-	-	-	-	
			3.6 V	488	529	791	1459	-	-	-	-	-	-	
		RTC enabled and clocked by LSE quartz(2)	1.8 V	320	347	448	856	1432	-	-	-	-	-	
			2.4 V	405	436	550	921	1567	-	-	-	-	-	
			3 V	512	545	686	1128	2529	-	-	-	-	-	
			3.6 V	648	705	976	1588	3293	-	-	-	-	-	

1. Guaranteed by characterization results, unless otherwise specified.
2. Based on characterization done with a 32.768 kHz crystal (MC306-G-06Q-32.768, manufacturer JFVNY) with two 6.8 pF loading capacitors.

Prequalification trials

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

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

Electromagnetic Interference (EMI)

The electromagnetic field emitted by the device are monitored while a simple application is executed (toggling 2 LEDs through the I/O ports). This emission test is compliant with IEC 61967-2 standard which specifies the test board and the pin loading.

Table 66. EMI characteristics

Symbol	Parameter	Conditions	Monitored frequency band	Max vs. [f_{HSE}/f_{HCLK}]	Unit
				8 MHz / 80 MHz	
S_{EMI}	Peak level	V_{DD} = 3.6 V, T_A = 25 °C, BGA169 package compliant with IEC 61967-2	0.1 MHz to 30 MHz	3	dBµV
			30 MHz to 130 MHz	-2	
			130 MHz to 1 GHz	0	
			1 GHz to 2 GHz	8	
			EMI Level	1.5	-

6.3.12 Electrical sensitivity characteristics

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

Electrostatic discharge (ESD)

Electrostatic discharges (a positive then a negative pulse separated by 1 second) are applied to the pins of each sample according to each pin combination. The sample size depends on the number of supply pins in the device (3 parts × (n+1) supply pins). This test conforms to the ANSI/JEDEC standard.

Table 67. ESD absolute maximum ratings

Symbol	Ratings	Conditions	Class	Maximum value(1)	Unit
$V_{ESD(HBM)}$	Electrostatic discharge voltage (human body model)	T_A = +25 °C, conforming to ANSI/ESDA/JEDEC JS-001	2	2000	V
$V_{ESD(CDM)}$	Electrostatic discharge voltage (charge device model)	T_A = +25 °C, conforming to ANSI/ESD STM5.3.1	C3	250	

1. Guaranteed by characterization results.

6.3.14 I/O port characteristics

General input/output characteristics

Unless otherwise specified, the parameters given in *Table 70* are derived from tests performed under the conditions summarized in *Table 22: General operating conditions*. All I/Os are designed as CMOS- and TTL-compliant (except BOOT0).

Table 70. I/O static characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}(1)	I/O input low level voltage except BOOT0	1.62 V<V_{DDIOx}<3.6 V	-	-	0.3xV_{DDIOx} (2)	V
	I/O input low level voltage except BOOT0	1.62 V<V_{DDIOx}<3.6 V	-	-	0.39xV_{DDIOx} - 0.06 (3)	
	I/O input low level voltage except BOOT0	1.08 V<V_{DDIOx}<1.62 V	-	-	0.43xV_{DDIOx} - 0.1 (3)	
	BOOT0 I/O input low level voltage	1.62 V<V_{DDIOx}<3.6 V	-	-	0.17xV_{DDIOx} (3)	
V_{IH}(1)	I/O input high level voltage except BOOT0	1.62 V<V_{DDIOx}<3.6 V	0.7xV_{DDIOx} (2)	-	-	V
	I/O input high level voltage except BOOT0	1.62 V<V_{DDIOx}<3.6 V	0.49xV_{DDIOX} + 0.26 (3)	-	-	
	I/O input high level voltage except BOOT0	1.08 V<V_{DDIOx}<1.62 V	0.61xV_{DDIOX} + 0.05 (3)	-	-	
	BOOT0 I/O input high level voltage	1.62 V<V_{DDIOx}<3.6 V	0.77xV_{DDIOX} (3)	-	-	
V_{hys}(3)	TT_xx, FT_xxx and NRST I/O input hysteresis	1.62 V<V_{DDIOx}<3.6 V	-	200	-	mV
	FT_sx	1.08 V<V_{DDIOx}<1.62 V	-	150	-	
	BOOT0 I/O input hysteresis	1.62 V<V_{DDIOx}<3.6 V	-	200	-	

Table 79. ADC accuracy - limited test conditions 2(1)(2)(3) (continued)

Symbol	Parameter	Conditions(4)			Min	Typ	Max	Unit
THD	Total harmonic distortion	ADC clock frequency ≤ 80 MHz, Sampling rate ≤ 5.33 Msps, 2 V ≤ V_{DDA}	Single ended	Fast channel (max speed)	-	-74	-65	dB
				Slow channel (max speed)	-	-74	-67	
			Differential	Fast channel (max speed)	-	-79	-70	
				Slow channel (max speed)	-	-79	-71	

1. Guaranteed by design.
2. ADC DC accuracy values are measured after internal calibration.
3. ADC accuracy vs. negative Injection Current: Injecting negative current on any analog input pins should be avoided as this significantly reduces the accuracy of the conversion being performed on another analog input. It is recommended to add a Schottky diode (pin to ground) to analog pins which may potentially inject negative current.
4. The I/O analog switch voltage booster is enable when V_{DDA} < 2.4 V (BOOSTEN = 1 in the SYSCFG_CFGR1 when V_{DDA} < 2.4 V). It is disable when V_{DDA} ≥ 2.4 V. No oversampling.

Table 86. OPAMP characteristics(1) (continued)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
en	Voltage noise density	Normal mode	at 1 kHz, Output loaded with 4 kΩ	-	500	-	nV/√Hz
		Low-power mode	at 1 kHz, Output loaded with 20 kΩ	-	600	-	
		Normal mode	at 10 kHz, Output loaded with 4 kΩ	-	180	-	
		Low-power mode	at 10 kHz, Output loaded with 20 kΩ	-	290	-	
I_{DDA}(OPAMP)(2)	OPAMP consumption from V_{DDA}	Normal mode	no Load, quiescent mode	-	120	260	µA
		Low-power mode		-	45	100	

1. Guaranteed by design, unless otherwise specified.
2. Guaranteed by characterization results.
3. Mostly I/O leakage, when used in analog mode. Refer to I_{lkg} parameter in *Table 70: I/O static characteristics*.
4. R2 is the internal resistance between OPAMP output and OPAMP inverting input. R1 is the internal resistance between OPAMP inverting input and ground. The PGA gain =1+R2/R1

6.3.28 Communication interfaces characteristics

I²C interface characteristics

The I2C interface meets the timings requirements of the I²C-bus specification and user manual rev. 03 for:

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

The I2C timings requirements are guaranteed by design when the I2C peripheral is properly configured (refer to RM0351 reference manual).

The SDA and SCL I/O requirements are met with the following restrictions: the SDA and SCL I/O pins are not “true” open-drain. When configured as open-drain, the PMOS connected between the I/O pin and V_{DDIOx} is disabled, but is still present. Only FT_f I/O pins support Fm+ low level output current maximum requirement. Refer to *Section 6.3.14: I/O port characteristics* for the I2C I/Os characteristics.

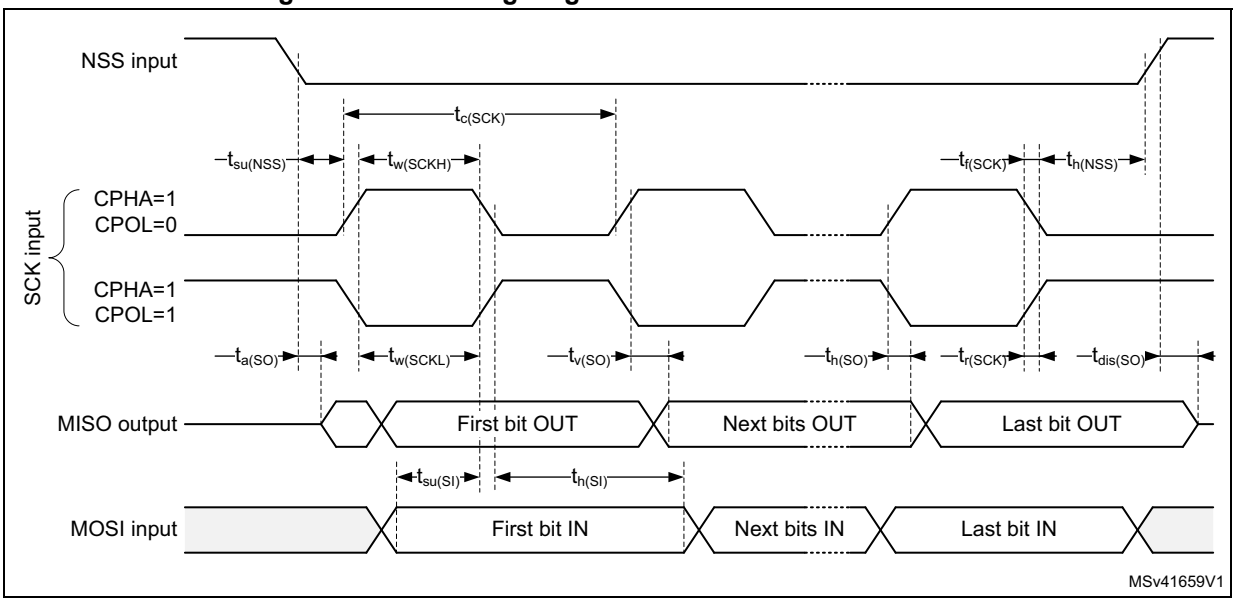
All I2C SDA and SCL I/Os embed an analog filter. Refer to the table below for the analog filter characteristics:

Table 95. I2C analog filter characteristics(1)

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

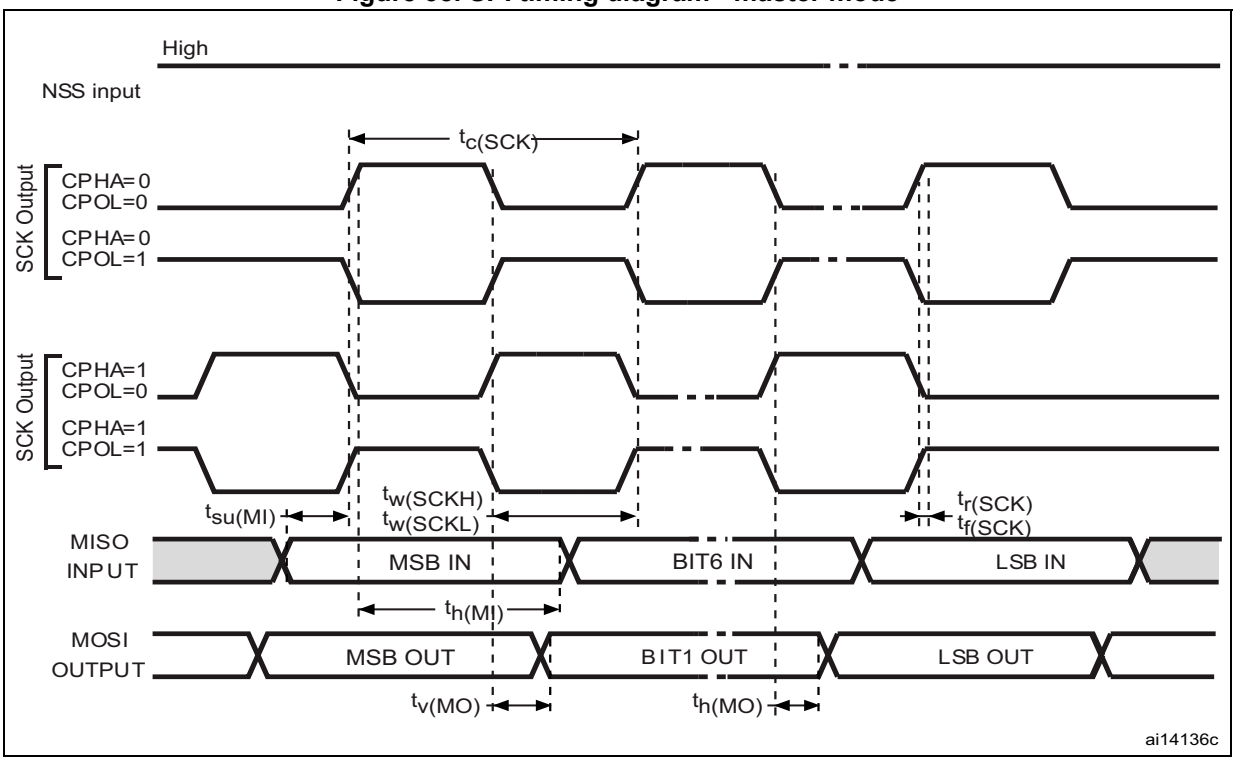
1. Guaranteed by design.
2. Spikes with widths below $t_{AF(min)}$ are filtered.
3. Spikes with widths above $t_{AF(max)}$ are not filtered

Figure 37. SPI timing diagram - slave mode and CPHA = 1



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

Figure 38. SPI timing diagram - master mode



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