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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®-M3
Core Size	32-Bit Single-Core
Speed	32MHz
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART, USB
Peripherals	Brown-out Detect/Reset, Cap Sense, DMA, I²S, POR, PWM, WDT
Number of I/O	37
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 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	48-LQFP
Supplier Device Package	48-LQFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32l151cbt6a

1 Introduction

This datasheet provides the ordering information and mechanical device characteristics of the STM32L151x6/8/B-A and STM32L152x6/8/B-A ultra-low-power ARM® Cortex®-M3 based microcontrollers product line.

The ultra-low-power STM32L151x6/8/B-A and STM32L152x6/8/B-A microcontroller family includes devices in 3 different package types: from 48 to 100 pins. Depending on the device chosen, different sets of peripherals are included, the description below gives an overview of the complete range of peripherals proposed in this family.

These features make the ultra-low-power STM32L151x6/8/B-A and STM32L152x6/8/B-A microcontroller family suitable for a wide range of applications:

- Medical and handheld equipment
- Application control and user interface
- PC peripherals, gaming, GPS and sport equipment
- Alarm systems, Wired and wireless sensors, Video intercom
- Utility metering

This STM32L151x6/8/B-A and STM32L152x6/8/B-A datasheet should be read in conjunction with the STM32L1xxxx reference manual (RM0038). The document "Getting started with STM32L1xxxx hardware development" AN3216 gives a hardware implementation overview.

Both documents are available from the STMicroelectronics website *www.st.com*.

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

Figure 1 shows the general block diagram of the device family.

Caution: This datasheet does not apply to:

– STM32L15xx6/8/B

covered by a separate datasheet.

2.1 Device overview

Table 2. Ultra-low-power STM32L151x6/8/B-A and STM32L152x6/8/B-A device features and peripheral counts

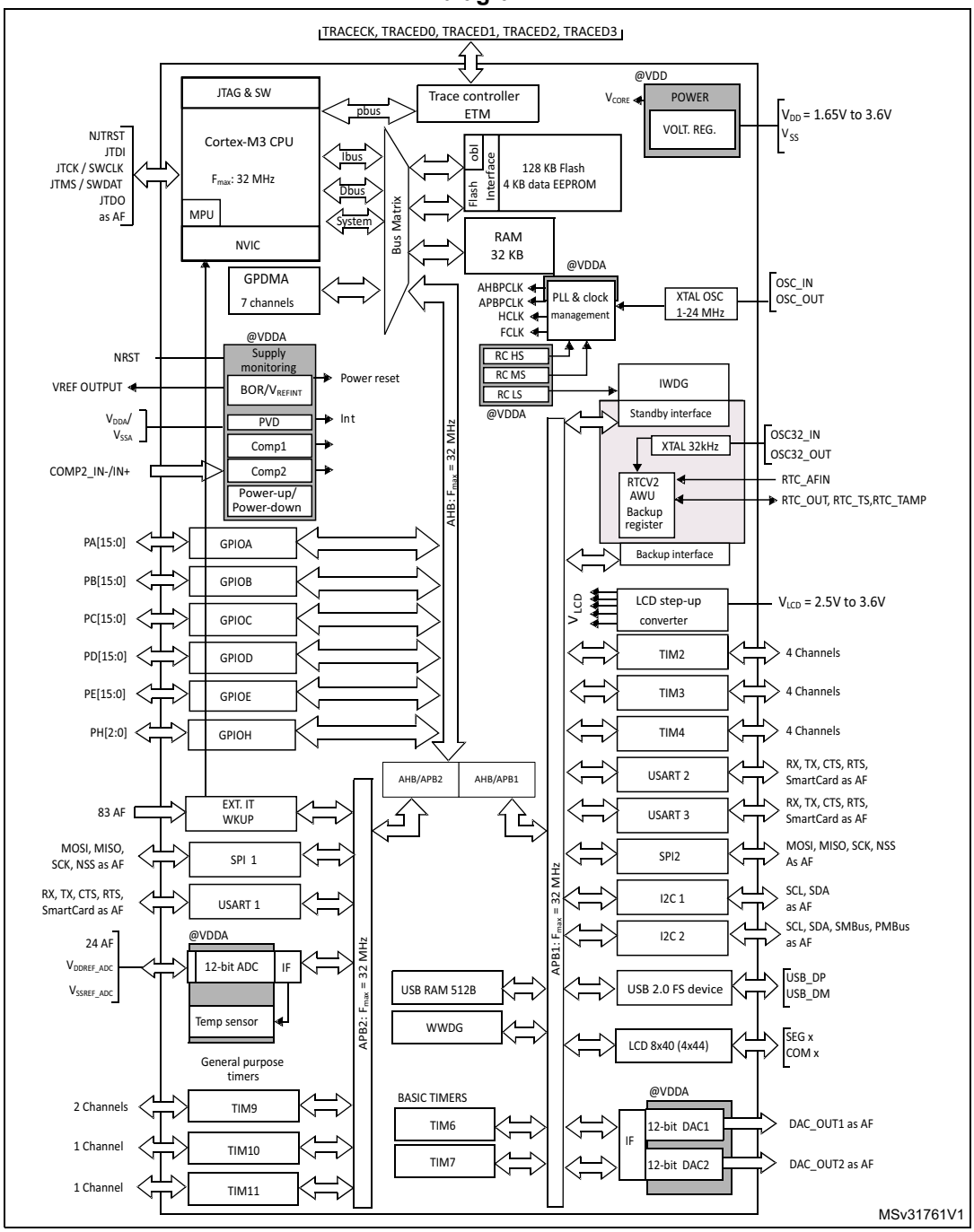
Peripheral		STM32L15xCxxxA			STM32L15xRxxxA			STM32L15xVxxxA	
Flash (Kbytes)		32	64	128	32	64	128	64	128
Data EEPROM (Kbytes)		4							
RAM (Kbytes)		16	32	32	16	32	32	32	32
Timers	General-purpose	6							
	Basic	2							
Communication interfaces	SPI	2							
	I^2C	2							
	USART	3							
	USB	1							
GPIOs		37			51/50(1)			83	
12-bit synchronized ADC Number of channels		1 14 channels			1 20/19 channels(1)			1 24 channels	
12-bit DAC Number of channels		2 2							
LCD (STM32L152xxxxA Only) COM x SEG		4x16			4x32/4x31(1) 8x28/8x27(1)			4x44 8x40	
Comparator		2							
Capacitive sensing channels		13			20				
Max. CPU frequency		32 MHz							
Operating voltage		1.8 V to 3.6 V (down to 1.65 V at power-down) with BOR option 1.65 V to 3.6 V without BOR option							
Operating temperatures		Ambient operating temperatures: –40 to +85 °C / –40 to + 105 °C Junction temperature: -40 to +110°C							
Packages		LQFP48, UFQFPN48			LQFP64, TFBGA64			LQFP100, UFBGA100	

1. For TFBGA64 package (instead of PC3 pin there is V_{REF+} pin).

3 Functional overview

Figure 1 shows the block diagram.

Figure 1. Ultra-low-power STM32L151x6/8/B-A and STM32L152x6/8/B-A block diagram



1. AF = alternate function on I/O port pin.

Table 5. Working mode-dependent functionalities (from Run/active down to standby) (continued)

Ips	Run/Active	Sleep	Low-power Run	Low-power Sleep	Stop		Standby	
						Wakeup capability		Wakeup capability
DAC	Y	Y	Y	Y	Y	-	-	-
Temperature sensor	Y	Y	Y	Y	Y	-	-	-
Comparators	Y	Y	Y	Y	Y	Y	-	-
16-bit Timers	Y	Y	Y	Y	-	-	-	-
IWDG	Y	Y	Y	Y	Y	Y	Y	Y
WWDG	Y	Y	Y	Y	-	-	-	-
Touch sensing	Y	-	-	-	-	-	-	-
Systick Timer	Y	Y	Y	Y	-	-	-	-
GPIOs	Y	Y	Y	Y	Y	Y	-	3 pins
Wakeup time to Run mode	0 µs	0.4 µs	3 µs	46 µs	< 8 µs		58 µs	
Consumption V_{DD}=1.8V to 3.6V (Typ)	Down to 185 µA/MHz (from Flash)	Down to 36.9 µA/MHz (from Flash)	Down to 10.9 µA	Down to 5.5 µA	0.43 µA (No RTC) V_{DD}=1.8 V		0.27 µA (No RTC) V_{DD}=1.8 V	
					1.13 µA (with RTC) V_{DD}=1.8 V		0.87 µA (with RTC) V_{DD}=1.8 V	
					0.44 µA (No RTC) V_{DD}=3.0 V		0.28 µA (No RTC) V_{DD}=3.0 V	
					1.38 µA (with RTC) V_{DD}=3.0 V		1.11 µA (with RTC) V_{DD}=3.0 V	

1. The startup on communication line wakes the CPU which was made possible by an EXTI, this induces a delay before entering run mode.

3.2 ARM® Cortex®-M3 core with MPU

The ARM® Cortex®-M3 processor is the industry leading processor for embedded systems. It has been developed to provide a low-cost platform that meets the needs of MCU implementation, with a reduced pin count and low-power consumption, while delivering outstanding computational performance and an advanced system response to interrupts.

The ARM® Cortex®-M3 32-bit RISC processor features exceptional code-efficiency, delivering the high-performance expected from an ARM core in the memory size usually associated with 8- and 16-bit devices.

The memory protection unit (MPU) improves system reliability by defining the memory attributes (such as read/write access permissions) for different memory regions. It provides up to eight different regions and an optional predefined background region.

Owing to its embedded ARM core, the STM32L151x6/8/B-A and STM32L152x6/8/B-A devices are compatible with all ARM tools and software.

Table 9. STM32L151x6/8/B-A and STM32L152x6/8/B-A pin definitions (continued)

Pins					Pin name	Pin type(1)	I/O structure	Main function(2) (after reset)	Pins functions	
LQFP100	LQFP64	TFBGA64	UFBGA100	LQFP48 or UFQFPN48					Alternate functions	Additional functions
82	-	-	B9	-	PD1	I/O	FT	PD1	SPI2_SCK	-
83	54	B5	C8	-	PD2	I/O	FT	PD2	TIM3_ETR/LCD_SEG31 /LCD_SEG43/ LCD_COM7	-
84	-	-	B8	-	PD3	I/O	FT	PD3	USART2_CTS/ SPI2_MISO	-
85	-	-	B7	-	PD4	I/O	FT	PD4	USART2_RTS/ SPI2_MOSI	-
86	-	-	A6	-	PD5	I/O	FT	PD5	USART2_TX	-
87	-	-	B6	-	PD6	I/O	FT	PD6	USART2_RX	-
88	-	-	A5	-	PD7	I/O	FT	PD7	USART2_CK/ TIM9_CH2	-
89	55	A5	A8	39	PB3	I/O	FT	JTDO	TIM2_CH2/PB3/ SPI1_SCK/ LCD_SEG7/JTDO	COMP2_INM
90	56	A4	A7	40	PB4	I/O	FT	NJTRST	TIM3_CH1/PB4/ SPI1_MISO/LCD_SEG8 /NJTRST	COMP2_INP
91	57	C4	C5	41	PB5	I/O	FT	PB5	I2C1_SMBA/TIM3_CH2/ SPI1_MOSI/LCD_SEG9	COMP2_INP
92	58	D3	B5	42	PB6	I/O	FT	PB6	I2C1_SCL/TIM4_CH1/ USART1_TX	-
93	59	C3	B4	43	PB7	I/O	FT	PB7	I2C1_SDA/TIM4_CH2/ USART1_RX	PVD_IN
94	60	B4	A4	44	BOOT0	I	B	BOOT0	-	-
95	61	B3	A3	45	PB8	I/O	FT	PB8	TIM4_CH3/I2C1_SCL/ LCD_SEG16/ TIM10_CH1	-
96	62	A3	B3	46	PB9	I/O	FT	PB9	TIM4_CH4/I2C1_SDA/ LCD_COM3/ TIM11_CH1	-
97	-	-	C3	-	PE0	I/O	FT	PE0	TIM4_ETR/LCD_SEG36 / TIM10_CH1	-

Table 10. Alternate function input/output (continued)

Port name	Digital alternate function number														
	AFIO0	AFIO1	AFIO2	AFIO3	AFIO4	AFIO5	AFOI6	AFIO7	AFIO8	AFIO9	AFIO11	AFIO12	AFIO13	AFIO14	AFIO15
	Alternate function														
	SYSTEM	TIM2	TIM3/4	TIM9/10/11	I2C1/2	SPI1/2	N/A	USART 1/2/3	N/A	N/A	LCD	N/A	N/A	RI	SYSTEM
PC10	-	-	-	-	-	-	-	USART3_TX	-	-	COM4 / SEG28 / SEG40	-	-	TIMx_IC3	EVENTOUT
PC11	-	-	-	-	-	-	-	USART3_RX	-	-	COM5 / SEG29 / SEG41	-	-	TIMx_IC4	EVENTOUT
PC12	-	-	-	-	-	-	-	USART3_CK	-	-	COM6 / SEG30 / SEG42	-	-	TIMx_IC1	EVENTOUT
PC13-WKUP2	-	-	-	-	-	-	-	-	-	-	-	-	-	TIMx_IC2	EVENTOUT
PC14-OSC32_IN	-	-	-	-	-	-	-	-	-	-	-	-	-	TIMx_IC3	EVENTOUT
PC15-OSC32_OUT	-	-	-	-	-	-	-	-	-	-	-	-	-	TIMx_IC4	EVENTOUT
PD0	-	-	-	TIM9_CH1	-	SPI2_NSS	-	-	-	-	-	-	-	TIMx_IC1	EVENTOUT
PD1	-	-	-	-	-	SPI2_SCK	-	-	-	-	-	-	-	TIMx_IC2	EVENTOUT
PD2	-	-	TIM3_ETR	-	-	-	-	-	-	-	COM7 / SEG31 / SEG43	-	-	TIMx_IC3	EVENTOUT
PD3	-	-	-	-	-	SPI2_MISO	-	USART2_CTS	-	-	-	-	-	TIMx_IC4	EVENTOUT
PD4	-	-	-	-	-	SPI2_MOSI	-	USART2_RTS	-	-	-	-	-	TIMx_IC1	EVENTOUT
PD5	-	-	-	-	-	-	-	USART2_TX	-	-	-	-	-	TIMx_IC2	EVENTOUT
PD6	-	-	-	-	-	-	-	USART2_RX	-	-	-	-	-	TIMx_IC3	EVENTOUT
PD7	-	-	-	TIM9_CH2	-	-	-	USART2_CK	-	-	-	-	-	TIMx_IC4	EVENTOUT
PD8	-	-	-	-	-	-	-	USART3_TX	-	-	-	-	-	TIMx_IC1	EVENTOUT
PD9	-	-	-	-	-	-	-	USART3_RX	-	-	-	-	-	TIMx_IC2	EVENTOUT

5 Memory mapping

The memory map is shown in the following figure.

Figure 9. Memory map

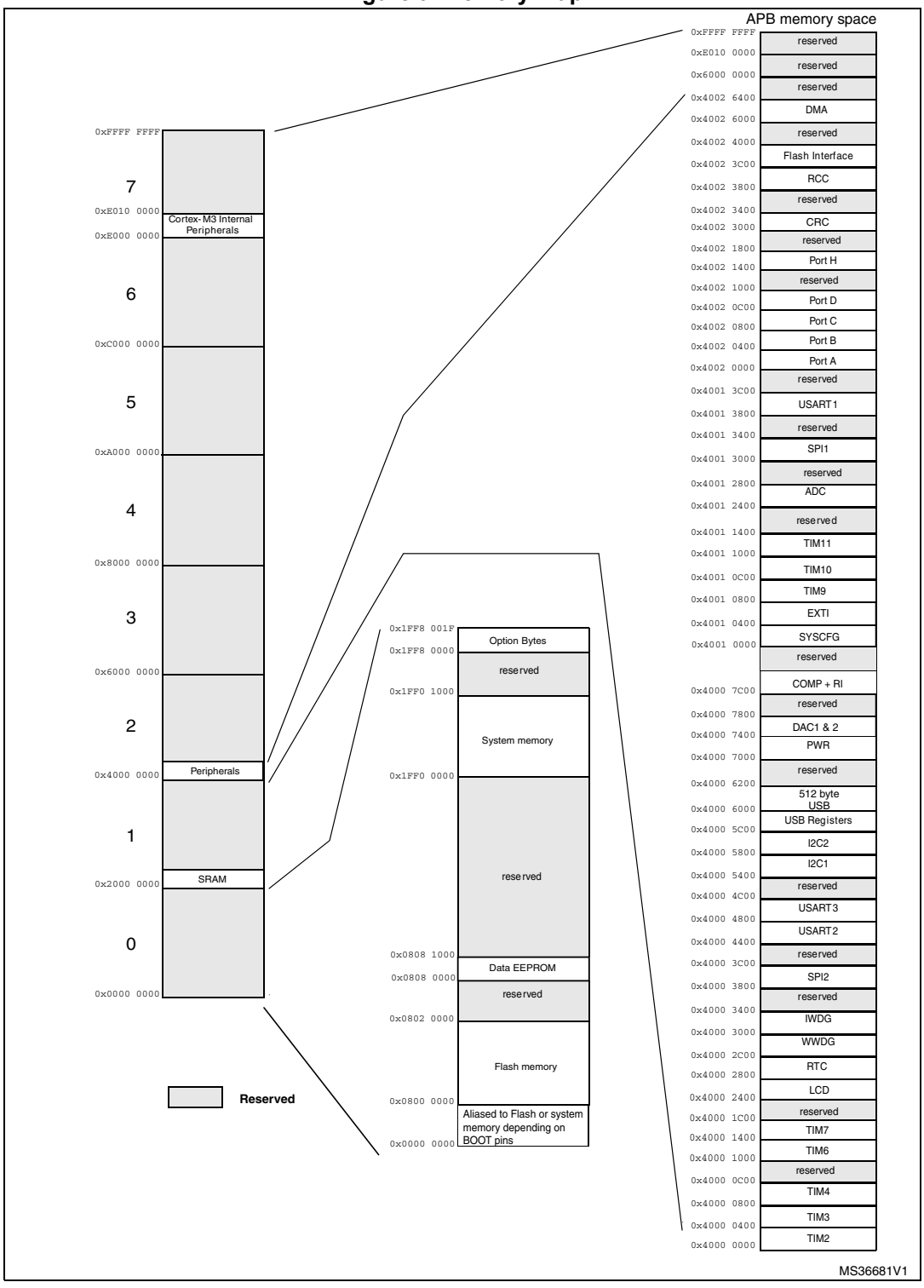


Table 15. Embedded reset and power control block characteristics (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{BOR0}	Brown-out reset threshold 0	Falling edge	1.67	1.7	1.74	V
		Rising edge	1.69	1.76	1.8	
V_{BOR1}	Brown-out reset threshold 1	Falling edge	1.87	1.93	1.97	
		Rising edge	1.96	2.03	2.07	
V_{BOR2}	Brown-out reset threshold 2	Falling edge	2.22	2.30	2.35	
		Rising edge	2.31	2.41	2.44	
V_{BOR3}	Brown-out reset threshold 3	Falling edge	2.45	2.55	2.60	
		Rising edge	2.54	2.66	2.7	
V_{BOR4}	Brown-out reset threshold 4	Falling edge	2.68	2.8	2.85	
		Rising edge	2.78	2.9	2.95	
V_{PVD0}	Programmable voltage detector threshold 0	Falling edge	1.8	1.85	1.88	V
		Rising edge	1.88	1.94	1.99	
V_{PVD1}	PVD threshold 1	Falling edge	1.98	2.04	2.09	
		Rising edge	2.08	2.14	2.18	
V_{PVD2}	PVD threshold 2	Falling edge	2.20	2.24	2.28	
		Rising edge	2.28	2.34	2.38	
V_{PVD3}	PVD threshold 3	Falling edge	2.39	2.44	2.48	
		Rising edge	2.47	2.54	2.58	
V_{PVD4}	PVD threshold 4	Falling edge	2.57	2.64	2.69	
		Rising edge	2.68	2.74	2.79	
V_{PVD5}	PVD threshold 5	Falling edge	2.77	2.83	2.88	
		Rising edge	2.87	2.94	2.99	
V_{PVD6}	PVD threshold 6	Falling edge	2.97	3.05	3.09	
		Rising edge	3.08	3.15	3.20	
V_{hyst}	Hysteresis voltage	BOR0 threshold	-	40	-	mV
		All BOR and PVD thresholds excepting BOR0	-	100	-	

1. Guaranteed by characterization.
2. Valid for device version without BOR at power up. Please see option "D" in Ordering information scheme for more details.

6.3.3 Embedded internal reference voltage

The parameters given in the following table are based on characterization results, unless otherwise specified.

Table 16. Embedded internal reference voltage calibration values

Calibration value name	Description	Memory address
VREFINT_CAL	Raw data acquired at temperature of 30 °C ±5 °C, V_{DDA}= 3 V ±10 mV	0x1FF8 0078-0x1FF8 0079

Table 17. Embedded internal reference voltage

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{REFINT\ out}$(1)	Internal reference voltage	– 40 °C < T_J < +110 °C	1.202	1.224	1.242	V
I_{REFINT}	Internal reference current consumption	-	-	1.4	2.3	µA
$T_{VREFINT}$	Internal reference startup time	-	-	2	3	ms
V_{VREF_MEAS}	V_{DDA} and V_{REF+} voltage during V_{REFINT} factory measure	-	2.99	3	3.01	V
A_{VREF_MEAS}	Accuracy of factory-measured V_{REF} value (2)	Including uncertainties due to ADC and V_{DDA}/V_{REF+} values	-	-	±5	mV
T_{Coeff}(3)	Temperature coefficient	–40 °C < T_J < +110 °C	-	25	100	ppm/°C
A_{Coeff}(3)	Long-term stability	1000 hours, T= 25 °C	-	-	1000	ppm
$V_{DDCoeff}$(3)(4)	Voltage coefficient	3.0 V < V_{DDA} < 3.6 V	-	-	2000	ppm/V
$T_{S\_vrefint}$(3)	ADC sampling time when reading the internal reference voltage	-	4	-	-	µs
T_{ADC_BUF}(3)	Startup time of reference voltage buffer for ADC	-	-	-	10	µs
I_{BUF_ADC}(3)	Consumption of reference voltage buffer for ADC	-	-	13.5	25	µA
I_{VREF_OUT}(3)	VREF_OUT output current(5)	-	-	-	1	µA
C_{VREF_OUT}(3)	VREF_OUT output load	-	-	-	50	pF
I_{LPBUF}(3)	Consumption of reference voltage buffer for VREF_OUT and COMP	-	-	730	1200	nA
V_{REFINT_DIV1}(3)	1/4 reference voltage	-	24	25	26	% V_{REFINT}
V_{REFINT_DIV2}(3)	1/2 reference voltage	-	49	50	51	
V_{REFINT_DIV3}(3)	3/4 reference voltage	-	74	75	76	

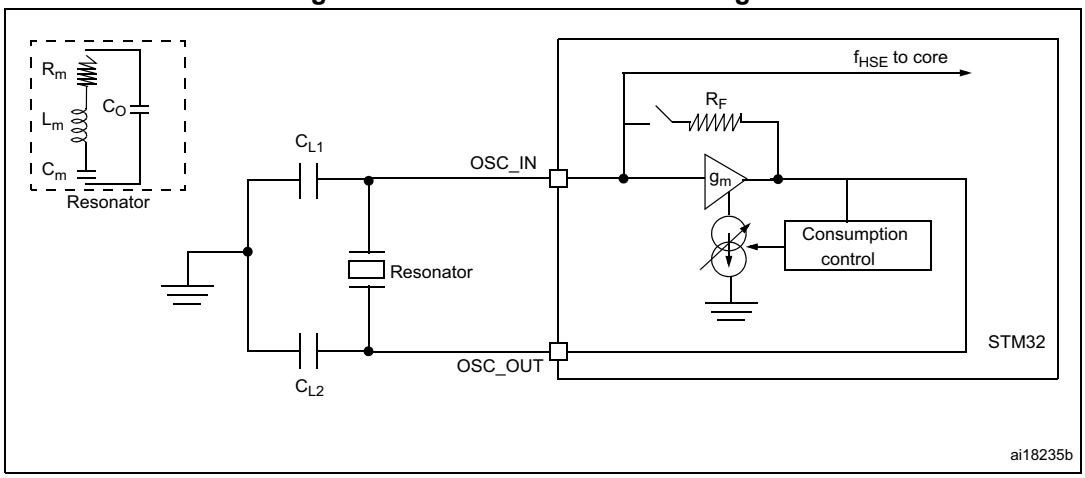
1. Guaranteed by test in production.
2. The internal V_{REF} value is individually measured in production and stored in dedicated EEPROM bytes.
3. Guaranteed by characterization results.
4. Shortest sampling time can be determined in the application by multiple interactions.
5. To guarantee less than 1% VREF_OUT deviation.

Table 23. Typical and maximum current consumptions in Stop mode (continued)

Symbol	Parameter	Conditions		Typ(1)	Max (1)(2)	Unit
$I_{DD\ (Stop)}$	Supply current in Stop mode (RTC disabled)	Regulator in LP mode, HSI and HSE OFF, independent watchdog and LSI enabled	T_A = -40°C to 25°C	1.80	2.2	µA
		Regulator in LP mode, LSI, HSI and HSE OFF (no independent watchdog)	T_A = -40°C to 25°C	0.434	1	
			T_A = 55°C	0.735	3	
			T_A= 85°C	2.350	9	
			T_A = 105°C	6.84	22(6)	
$I_{DD\ (WU\ from\ Stop)}$	RMS (root mean square) supply current during wakeup time when exiting from Stop mode	MSI = 4.2 MHz	V_{DD} = 3.0 V T_A = -40°C to 25°C	2	-	mA
		MSI = 1.05 MHz		1.45	-	
		MSI = 65 kHz(7)		1.45	-	

1. The typical values are given for V_{DD} = 3.0 V and max values are given for V_{DD} = 3.6 V, unless otherwise specified.
2. Guaranteed by characterization results, unless otherwise specified.
3. LCD enabled with external VLCD, static duty, division ratio = 256, all pixels active, no LCD connected.
4. LCD enabled with external VLCD, 1/8 duty, 1/3 bias, division ratio = 64, all pixels active, no LCD connected.
5. Based on characterization done with a 32.768 kHz crystal (MC306-G-06Q-32.768, manufacturer JFVNY) with two 6.8pF loading capacitors.
6. Guaranteed by test in production.
7. When MSI = 64 kHz, the RMS current is measured over the first 15 µs following the wakeup event. For the remaining time of the wakeup period, the current is similar to the Run mode current.

Figure 17. HSE oscillator circuit diagram



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 14*. 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 30. LSE oscillator characteristics (f_{LSE} = 32.768 kHz)(1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{LSE}	Low speed external oscillator frequency	-	-	32.768	-	kHz
R_F	Feedback resistor	-	-	1.2	-	MΩ
C(2)	Recommended load capacitance versus equivalent serial resistance of the crystal (R_S)(3)	R_S = 30 kΩ	-	8	-	pF
I_{LSE}	LSE driving current	V_{DD} = 3.3 V, V_{IN} = V_{SS}	-	-	1.1	µA
$I_{DD\ (LSE)}$	LSE oscillator current consumption	V_{DD} = 1.8 V	-	450	-	nA
		V_{DD} = 3.0 V	-	600	-	
		V_{DD} = 3.6V	-	750	-	
g_m	Oscillator transconductance	-	3	-	-	µA/V
$t_{SU(LSE)}$(4)	Startup time	V_{DD} is stabilized	-	1	-	s

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. The oscillator selection can be optimized in terms of supply current using an high quality resonator with small R_S value for example MSIV-TIN32.768kHz. Refer to crystal manufacturer for more details.
4. $t_{SU(LSE)}$ 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 resonator and it can vary significantly with the crystal manufacturer.

Note: For CL1 and CL2, it is recommended to use high-quality ceramic capacitors in the 5 pF to 15 pF range selected to match the requirements of the crystal or resonator (see Figure 18). CL1 and CL2, are usually the same size. The crystal manufacturer typically specifies a load capacitance which is the series combination of CL1 and CL2.
Load capacitance CL has the following formula: CL = CL1 x CL2 / (CL1 + CL2) + Cstray where Cstray is the pin capacitance and board or trace PCB-related capacitance. Typically, it is between 2 pF and 7 pF.

Caution: To avoid exceeding the maximum value of CL1 and CL2 (15 pF) it is strongly recommended to use a resonator with a load capacitance CL ≤ 7 pF. Never use a resonator with a load capacitance of 12.5 pF.
Example: if you choose a resonator with a load capacitance of CL = 6 pF and Cstray = 2 pF, then CL1 = CL2 = 8 pF.

Figure 18. Typical application with a 32.768 kHz crystal

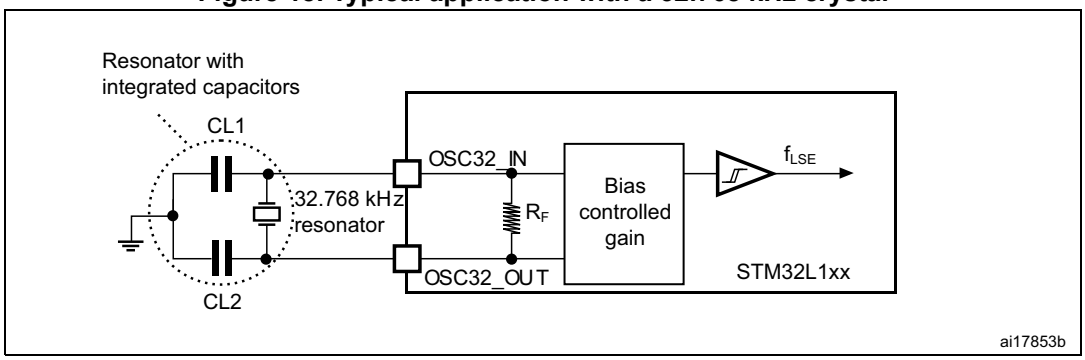


Table 52. USB DC electrical characteristics

Symbol	Parameter	Conditions	Min.(1)	Max.(1)	Unit
Input levels					
V_{DD}	USB operating voltage(2)	-	3.0	3.6	V
V_{DI}(3)	Differential input sensitivity	I(USB_DP, USB_DM)	0.2	-	V
V_{CM}(3)	Differential common mode range	Includes V_{DI} range	0.8	2.5	
V_{SE}(3)	Single ended receiver threshold	-	1.3	2.0	
Output levels					
V_{OL}(4)	Static output level low	R_L of 1.5 kΩ to 3.6 V(5)	-	0.3	V
V_{OH}(4)	Static output level high	R_L of 15 kΩ to V_{SS}(5)	2.8	3.6	

1. All the voltages are measured from the local ground potential.
2. To be compliant with the USB 2.0 full speed electrical specification, the USB_DP (D+) pin should be pulled up with a 1.5 kΩ resistor to a 3.0-to-3.6 V voltage range.
3. Guaranteed by characterization results.
4. Guaranteed by test in production.
5. R_L is the load connected on the USB drivers.

Figure 25. USB timings: definition of data signal rise and fall time

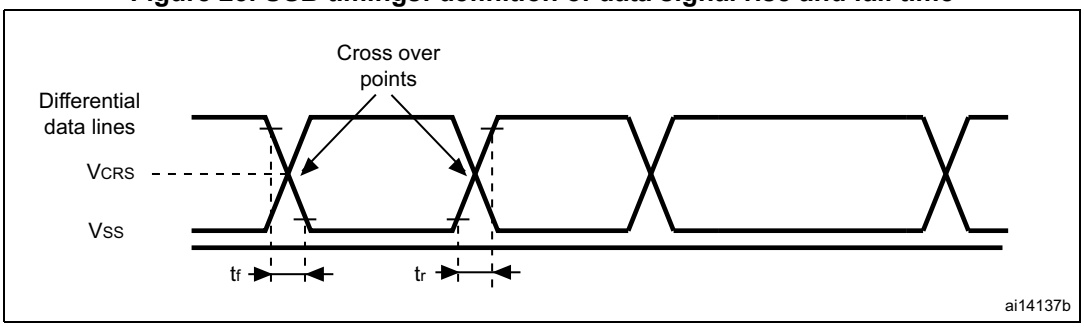


Table 53. USB: full speed electrical characteristics

Driver characteristics(1)					
Symbol	**Parameter**	**Conditions**	**Min**	**Max**	**Unit**
t_r	Rise time(2)	C_L = 50 pF	4	20	ns
t_f	Fall Time(2)	C_L = 50 pF	4	20	ns
t_{rfm}	Rise/ fall time matching	t_r/t_f	90	110	%
V_{CRS}	Output signal crossover voltage	-	1.3	2.0	V

1. Guaranteed by design.
2. Measured from 10% to 90% of the data signal. For more detailed informations, please refer to USB Specification section 7 (version 2.0).

6.3.17 12-bit ADC characteristics

Unless otherwise specified, the parameters given in *Table 55* are guaranteed by design.

Table 54. ADC clock frequency

Symbol	Parameter	Conditions			Min	Max	Unit
f_{ADC}	ADC clock frequency	Voltage Range 1 & 2	2.4 V ≤V_{DDA} ≤3.6 V	V_{REF+} = V_{DDA}	0.480	16	MHz
				V_{REF+} < V_{DDA} V_{REF+} > 2.4 V		8	
				V_{REF+} < V_{DDA} V_{REF+} ≤2.4 V		4	
			1.8 V ≤V_{DDA} ≤2.4 V	V_{REF+} = V_{DDA}		8	
				V_{REF+} < V_{DDA}		4	
		Voltage Range 3				4	

Table 55. ADC characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DDA}	Power supply	-	1.8	-	3.6	V
V_{REF+}	Positive reference voltage	2.4 V ≤V_{DDA} ≤3.6 V V_{REF+} must be below or equal to V_{DDA}	1.8(1)	-	V_{DDA}	V
V_{REF-}	Negative reference voltage	-	-	V_{SSA}	-	V
I_{VDDA}	Current on the V_{DDA} input pin	-	-	1000	1450	µA
I_{VREF}(2)	Current on the V_{REF} input pin	Peak	-	400	700	µA
		Average	-		450	µA
V_{AIN}	Conversion voltage range(3)	-	0(4)	-	V_{REF+}	V
f_S	12-bit sampling rate	Direct channels	-	-	1	Msps
		Multiplexed channels	-	-	0.76	
	10-bit sampling rate	Direct channels	-	-	1.07	Msps
		Multiplexed channels	-	-	0.8	
	8-bit sampling rate	Direct channels	-	-	1.23	Msps
		Multiplexed channels	-	-	0.89	
	6-bit sampling rate	Direct channels	-	-	1.45	Msps
		Multiplexed channels	-	-	1	

Table 56. ADC accuracy(1)(2)

Symbol	Parameter	Test conditions	Min(3)	Typ	Max(3)	Unit
ET	Total unadjusted error	$2.4\ V \le V_{DDA} \le 3.6\ V$ $2.4\ V \le V_{REF+} \le 3.6\ V$ $f_{ADC} = 8\ MHz$, $R_{AIN} = 50\ \Omega$ $T_A = -40$ to $105\ °C$	-	2.5	4	LSB
EO	Offset error		-	1	2	
EG	Gain error		-	1.5	3.5	
ED	Differential linearity error		-	1	2	
EL	Integral linearity error		-	2	3	
ENOB	Effective number of bits	$2.4\ V \le V_{DDA} \le 3.6\ V$ $V_{DDA} = V_{REF+}$ $f_{ADC} = 16\ MHz$, $R_{AIN} = 50\ \Omega$ $T_A = -40$ to $105\ °C$ F_{input} =10 kHz	9.5	10	-	bits
SINAD	Signal-to-noise and distortion ratio		59	62	-	dB
SNR	Signal-to-noise ratio		60	62	-	
THD	Total harmonic distortion		-	-72	-69	
ENOB	Effective number of bits	$1.8\ V \le V_{DDA} \le 2.4\ V$ $V_{DDA} = V_{REF+}$ $f_{ADC} = 8\ MHz$ or $4\ MHz$, $R_{AIN} = 50\ \Omega$ $T_A = -40$ to $105\ °C$ F_{input} =10 kHz	9.5	10	-	bits
SINAD	Signal-to-noise and distortion ratio		59	62	-	dB
SNR	Signal-to-noise ratio		60	62	-	
THD	Total harmonic distortion		-	-72	-69	
ET	Total unadjusted error	$2.4\ V \le V_{DDA} \le 3.6\ V$ $1.8\ V \le V_{REF+} \le 2.4\ V$ $f_{ADC} = 4\ MHz$, $R_{AIN} = 50\ \Omega$ $T_A = -40$ to $105\ °C$	-	4	6.5	LSB
EO	Offset error		-	1.5	3.5	
EG	Gain error		-	3.5	6	
ED	Differential linearity error		-	1	2	
EL	Integral linearity error		-	2.5	3.5	
ET	Total unadjusted error	$1.8\ V \le V_{DDA} \le 2.4\ V$ $1.8\ V \le V_{REF+} \le 2.4\ V$ $f_{ADC} = 4\ MHz$, $R_{AIN} = 50\ \Omega$ $T_A = -40$ to $105\ °C$	-	2	3	LSB
EO	Offset error		-	1	1.5	
EG	Gain error		-	1.5	2.5	
ED	Differential linearity error		-	1	2	
EL	Integral linearity error		-	2	3	

1. ADC DC accuracy values are measured after internal calibration.
2. ADC accuracy vs. negative injection current: Injecting a negative current on any analog input pins should be avoided as this significantly reduces the accuracy of the conversion being performed on another analog input. It is recommended to add a Schottky diode (pin to ground) to analog pins which may potentially inject negative currents.
   Any positive injection current within the limits specified for $I_{INJ(PIN)}$ and $\Sigma I_{INJ(PIN)}$ in *Section 6.3.12* does not affect the ADC accuracy.
3. Guaranteed by characterization results.

Figure 26. ADC accuracy characteristics

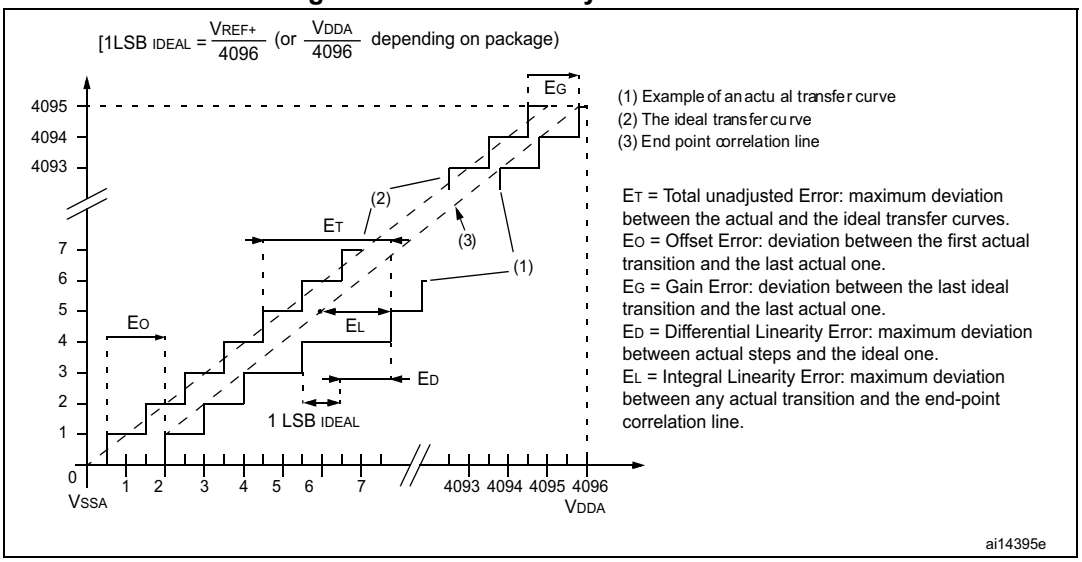
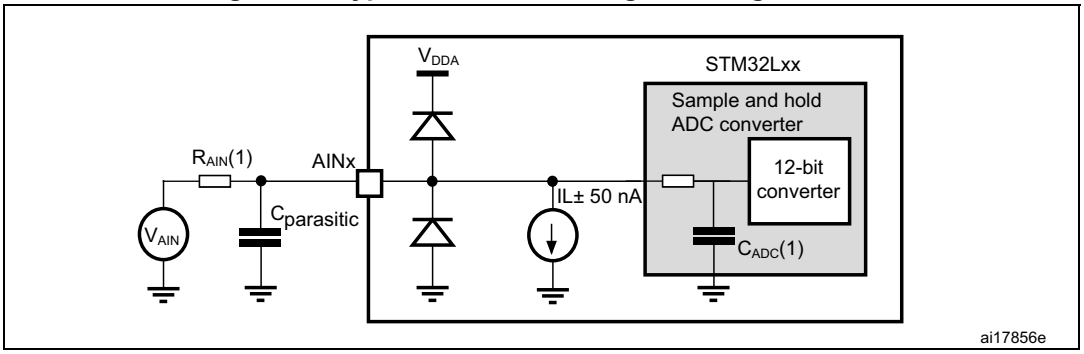


Figure 27. Typical connection diagram using the ADC



1. Refer to *Table 57: Maximum source impedance RAIN max* for the value of R_{AIN} and *Table 55: ADC characteristics* for the value of CADC
2. $C_{parasitic}$ represents the capacitance of the PCB (dependent on soldering and PCB layout quality) plus the pad capacitance (roughly 7 pF). A high $C_{parasitic}$ value will downgrade conversion accuracy. To remedy this, f_{ADC} should be reduced.

Table 62. Comparator 2 characteristics

Symbol	Parameter	Conditions	Min	Typ	Max(1)	Unit
V_{DDA}	Analog supply voltage	-	1.65	-	3.6	V
V_{IN}	Comparator 2 input voltage range	-	0	-	V_{DDA}	V
t_{START}	Comparator startup time	Fast mode	-	15	20	µs
		Slow mode	-	20	25	
$t_{d\ slow}$	Propagation delay(2) in slow mode	1.65 V ≤V_{DDA} ≤2.7 V	-	1.8	3.5	
		2.7 V ≤V_{DDA} ≤3.6 V	-	2.5	6	
$t_{d\ fast}$	Propagation delay(2) in fast mode	1.65 V ≤V_{DDA} ≤2.7 V	-	0.8	2	
		2.7 V ≤V_{DDA} ≤3.6 V	-	1.2	4	
V_{offset}	Comparator offset error	-	-	±4	±20	mV
dThreshold/ dt	Threshold voltage temperature coefficient	V_{DDA} = 3.3V T_A = 0 to 50 °C V- = V_{REFINT}, 3/4 V_{REFINT}, 1/2 V_{REFINT}, 1/4 V_{REFINT}	-	15	100	ppm /°C
I_{COMP2}	Current consumption(3)	Fast mode	-	3.5	5	µA
		Slow mode	-	0.5	2	

1. Guaranteed by characterization results.
2. The delay is characterized for 100 mV input step with 10 mV overdrive on the inverting input, the non-inverting input set to the reference.
3. Comparator consumption only. Internal reference voltage (necessary for comparator operation) is not included.

Table 64. LQPF100 14 x 14 mm, 100-pin low-profile quad flat package mechanical data

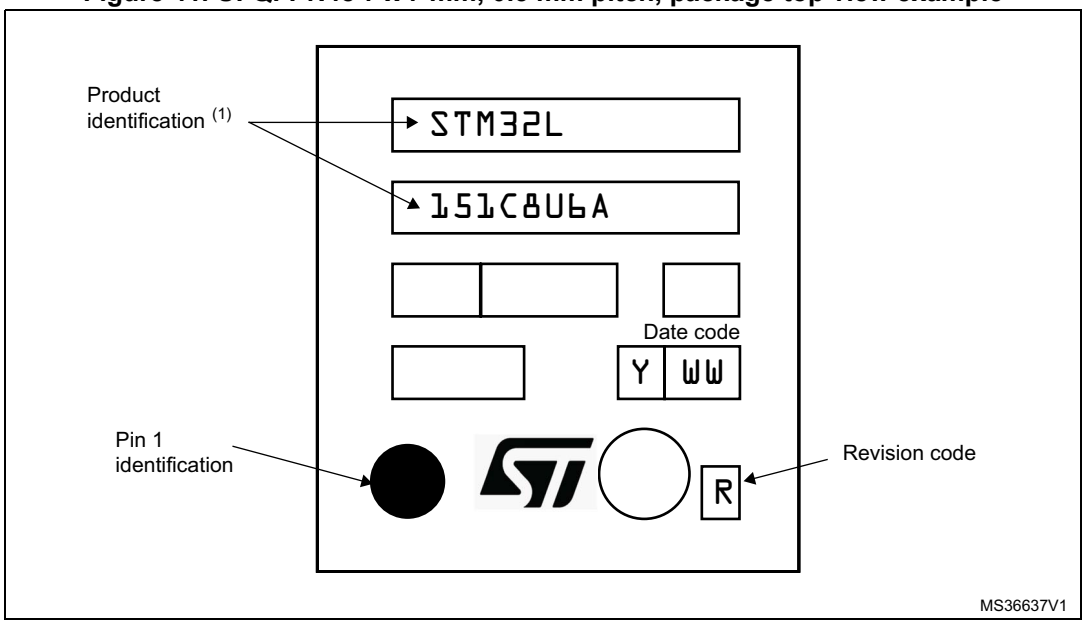
Symbol	millimeters			inches[1]		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.600	-	-	0.0630
A1	0.050	-	0.150	0.0020	-	0.0059
A2	1.350	1.400	1.450	0.0531	0.0551	0.0571
b	0.170	0.220	0.270	0.0067	0.0087	0.0106
c	0.090	-	0.200	0.0035	-	0.0079
D	15.800	16.000	16.200	0.6220	0.6299	0.6378
D1	13.800	14.000	14.200	0.5433	0.5512	0.5591
D3	-	12.000	-	-	0.4724	-
E	15.800	16.000	16.200	0.6220	0.6299	0.6378
E1	13.800	14.000	14.200	0.5433	0.5512	0.5591
E3	-	12.000	-	-	0.4724	-
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.

UFQFPN48 device marking

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

Figure 41. UFQFPN48 7 x 7 mm, 0.5 mm pitch, package top view example



1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not yet ready to be used in production and any consequences deriving from such usage will not be at ST charge. In no event, ST will be liable for any customer usage of these engineering samples in production. ST Quality has to be contacted prior to any decision to use these Engineering samples to run qualification activity.