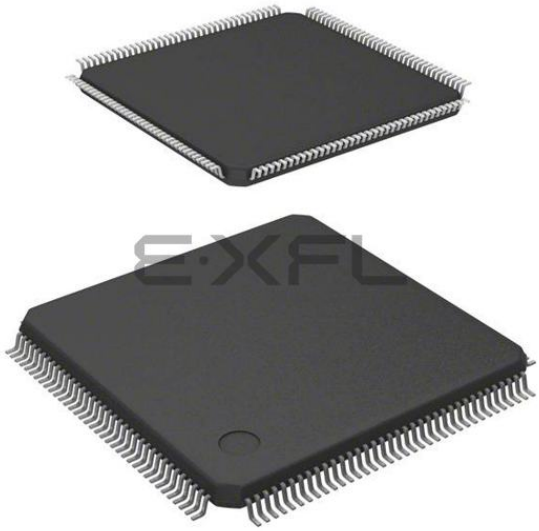

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What is "Embedded - Microcontrollers"?

"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	115
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	16K x 8
RAM Size	80K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 3.6V
Data Converters	A/D 40x12b; 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/stm32l151zet6

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2.1 Device overview

Table 2. Ultra-low-power STM32L151xE and STM32L152xE device features and peripheral counts

Peripheral		STM32L15xRE	STM32L15xVE	STM32L15xQE	STM32L15xZE
Flash (Kbytes)		512			
Data EEPROM (Kbytes)		16			
RAM (Kbytes)		80			
Timers	32 bit	1			
	General-purpose	6			
	Basic	2			
Communication interfaces	SPI	8(3)(1)			
	I^2S	2			
	I^2C	2			
	USART	5			
	USB	1			
GPIOs		51	83	109	115
Operational amplifiers		2			
12-bit synchronized ADC Number of channels		1 21	1 25	1 40	1 40
12-bit DAC Number of channels		2 2			
LCD (2) COM x SEG		1 4x32 or 8x28	1 4x44 or 8x40		
Comparators		2			
Capacitive sensing channels		23		33	34
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 temperature: -40 °C to 85 °C / -40 °C to 105 °C Junction temperature: –40 to + 110 °C			
Packages		LQFP64	LQFP100, WLCSP104	UFBGA132	LQFP144

1. 5 SPIs are USART configured in synchronous mode emulating SPI master.
2. STM32L152xx devices only.

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 STM32L151xE and STM32L152xE devices are compatible with all ARM tools and software.

Nested vectored interrupt controller (NVIC)

The ultra-low-power STM32L151xE and STM32L152xE devices embed a nested vectored interrupt controller able to handle up to 56 maskable interrupt channels (not including the 16 interrupt lines of ARM® Cortex®-M3) and 16 priority levels.

- Closely coupled NVIC gives low-latency interrupt processing
- Interrupt entry vector table address passed directly to the core
- Closely coupled NVIC core interface
- Allows early processing of interrupts
- Processing of *late arriving*, higher-priority interrupts
- Support for tail-chaining
- Processor state automatically saved
- Interrupt entry restored on interrupt exit with no instruction overhead

This hardware block provides flexible interrupt management features with minimal interrupt latency.

3.3 Reset and supply management

3.3.1 Power supply schemes

- V_{DD} = 1.65 to 3.6 V: external power supply for I/Os and the internal regulator. Provided externally through V_{DD} pins.
- V_{SSA}, V_{DDA} = 1.65 to 3.6 V: external analog power supplies for ADC, reset blocks, RCs and PLL (minimum voltage to be applied to V_{DDA} is 1.8 V when the ADC is used). V_{DDA} and V_{SSA} must be connected to V_{DD} and V_{SS}, respectively.

3.3.2 Power supply supervisor

The device has an integrated ZEROPOWER power-on reset (POR)/power-down reset (PDR) that can be coupled with a brownout reset (BOR) circuitry.

The device exists in two versions:

- The version with BOR activated at power-on operates between 1.8 V and 3.6 V.
- The other version without BOR operates between 1.65 V and 3.6 V.

After the V_{DD} threshold is reached (1.65 V or 1.8 V depending on the BOR which is active or not at power-on), the option byte loading process starts, either to confirm or modify default thresholds, or to disable the BOR permanently: in this case, the V_{DD} min value becomes 1.65 V (whatever the version, BOR active or not, at power-on).

When BOR is active at power-on, it ensures proper operation starting from 1.8 V whatever the power ramp-up phase before it reaches 1.8 V. When BOR is not active at power-up, the

3.5 Low-power real-time clock and backup registers

The real-time clock (RTC) is an independent BCD timer/counter. Dedicated registers contain the sub-second, second, minute, hour (12/24 hour), week day, date, month, year, in BCD (binary-coded decimal) format. Correction for 28, 29 (leap year), 30, and 31 day of the month are made automatically. The RTC provides two programmable alarms and programmable periodic interrupts with wakeup from Stop and Standby modes.

The programmable wakeup time ranges from 120 µs to 36 hours.

The RTC can be calibrated with an external 512 Hz output, and a digital compensation circuit helps reduce drift due to crystal deviation.

The RTC can also be automatically corrected with a 50/60Hz stable powerline.

The RTC calendar can be updated on the fly down to sub second precision, which enables network system synchronization.

A time stamp can record an external event occurrence, and generates an interrupt.

There are thirty-two 32-bit backup registers provided to store 128 bytes of user application data. They are cleared in case of tamper detection.

Three pins can be used to detect tamper events. A change on one of these pins can reset backup register and generate an interrupt. To prevent false tamper event, like ESD event, these three tamper inputs can be digitally filtered.

3.6 GPIOs (general-purpose inputs/outputs)

Each of the GPIO pins can be configured by software as output (push-pull or open-drain), as input (with or without pull-up or pull-down) or as peripheral alternate function. Most of the GPIO pins are shared with digital or analog alternate functions, and can be individually remapped using dedicated AFIO registers. All GPIOs are high current capable. The alternate function configuration of I/Os can be locked if needed following a specific sequence in order to avoid spurious writing to the I/O registers. The I/O controller is connected to the AHB with a toggling speed of up to 16 MHz.

External interrupt/event controller (EXTI)

The external interrupt/event controller consists of 24 edge detector lines used to generate interrupt/event requests. Each line can be individually configured to select the trigger event (rising edge, falling edge, both) and can be masked independently. A pending register maintains the status of the interrupt requests. The EXTI can detect an external line with a pulse width shorter than the Internal APB2 clock period. Up to 115 GPIOs can be connected to the 16 external interrupt lines. The 8 other lines are connected to RTC, PVD, USB, comparator events or capacitive sensing acquisition.

3.13 Ultra-low-power comparators and reference voltage

The STM32L151xE and STM32L152xE devices embed two comparators sharing the same current bias and reference voltage. The reference voltage can be internal or external (coming from an I/O).

- One comparator with fixed threshold
- One comparator with rail-to-rail inputs, fast or slow mode. The threshold can be one of the following:
  - DAC output
  - External I/O
  - Internal reference voltage (V_{REFINT}) or a sub-multiple (1/4, 1/2, 3/4)

Both comparators can wake up from Stop mode, and be combined into a window comparator.

The internal reference voltage is available externally via a low-power / low-current output buffer (driving current capability of 1 µA typical).

3.14 System configuration controller and routing interface

The system configuration controller provides the capability to remap some alternate functions on different I/O ports.

The highly flexible routing interface allows the application firmware to control the routing of different I/Os to the TIM2, TIM3 and TIM4 timer input captures. It also controls the routing of internal analog signals to ADC1, COMP1 and COMP2 and the internal reference voltage V_{REFINT}.

3.15 Touch sensing

The STM32L151xE and STM32L152xE devices provide a simple solution for adding capacitive sensing functionality to any application. These devices offer up to 34 capacitive sensing channels distributed over 11 analog I/O groups. Both software and timer capacitive sensing acquisition modes are supported.

Capacitive sensing technology is able to detect the presence of a finger near a sensor which is protected from direct touch by a dielectric (glass, plastic...). The capacitive variation introduced by the finger (or any conductive object) is measured using a proven implementation based on a surface charge transfer acquisition principle. It consists of charging the sensor capacitance and then transferring a part of the accumulated charges into a sampling capacitor until the voltage across this capacitor has reached a specific threshold. The capacitive sensing acquisition only requires few external components to operate. This acquisition is managed directly by the GPIOs, timers and analog I/O groups (see *Section 3.14: System configuration controller and routing interface*).

Reliable touch sensing functionality can be quickly and easily implemented using the free STM32L1xx STMTouch touch sensing firmware library.

Table 8. STM32L151xE and STM32L152xE pin definitions (continued)

Pins					Pin name	Pin Type(1)	I / O structure	Main function(2) (after reset)	Pin functions	
LQFP144	UFBGA132	LQFP100	LQFP64	WLCSP104					Alternate functions	Additional functions
16	F2	10	-	E8	V_{SS_5}	S		V_{SS_5}	-	-
17	G2	11	-	E9	V_{DD_5}	S		V_{DD_5}	-	-
18	G3	-	-	-	PF6	I/O	FT	PF6	TIM5_CH1/TIM5_ETR	ADC_IN27
19	G4	-	-	-	PF7	I/O	FT	PF7	TIM5_CH2	ADC_IN28/ COMP1_INP
20	H4	-	-	-	PF8	I/O	FT	PF8	TIM5_CH3	ADC_IN29/ COMP1_INP
21	J6	-	-	-	PF9	I/O	FT	PF9	TIM5_CH4	ADC_IN30/ COMP1_INP
22	-	-	-	-	PF10	I/O	FT	PF10	-	ADC_IN31/ COMP1_INP
23	F1	12	5	F8	PH0-OSC_IN(5)	I/O	TC	PH0	-	OSC_IN
24	G1	13	6	F9	PH1-OSC_OUT(5)	I/O	TC	PH1	-	OSC_OUT
25	H2	14	7	F7	NRST	I/O	RST	NRST	-	-
26	H1	15	8	F6	PC0	I/O	FT	PC0	LCD_SEG18	ADC_IN10/ COMP1_INP
27	J2	16	9	H9	PC1	I/O	FT	PC1	LCD_SEG19	ADC_IN11/ COMP1_INP
28	-	17	10	G9	PC2	I/O	FT	PC2	LCD_SEG20	ADC_IN12/ COMP1_INP
-	J3	-	-	-	PC2	I/O	FT	PC2	LCD_SEG20	ADC_IN12/ COMP1_INP
-	K1	-	-	-	NC	I		NC	-	-
29	K2	18	11	G8	PC3	I/O	TC	PC3	LCD_SEG21	ADC_IN13/ COMP1_INP
30	J1	19	12	J9	V_{SSA}	S	-	V_{SSA}	-	-
31	-	20	-	H8	V_{REF-}	S	-	V_{REF-}	-	-
32	L1	21	-	G7	V_{REF+}	S	-	V_{REF+}	-	-
33	M1	22	13	G6	V_{DDA}	S	-	V_{DDA}	-	-

Alternate functions

Table 9. Alternate function input/output

Port name	Digital alternate function number														
	AFIO0	AFIO1	AFIO2	AFIO3	AFIO4	AFIO5	AFIO6	AFIO7	AFIO8	...	AFIO11	...	AFIO14	AFIO15
	Alternate function														
	SYSTEM	TIM2	TIM3/4/5	TIM9/10/11	I2C1/2	SPI1/2	SPI3	USART1/2/3	UART4/5	-	LCD	-	CPRI	SYSTEM
BOOT0	BOOT0	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
NRST	NRST	-	-	-	-	-	-	-	-	-	-	-	-	-
PA0-WKUP1	-	TIM2_CH1_ETR	TIM5_CH1	-	-	-	-	USART2_CTS	-	-	-	-	TIMx_IC1	EVENT OUT
PA1	-	TIM2_CH2	TIM5_CH2	-	-	-	-	USART2_RTS	-	-	SEG0	-	TIMx_IC2	EVENT OUT
PA2	-	TIM2_CH3	TIM5_CH3	TIM9_CH1	-	-	-	USART2_TX	-	-	SEG1	-	TIMx_IC3	EVENT OUT
PA3	-	TIM2_CH4	TIM5_CH4	TIM9_CH2	-	-	-	USART2_RX	-	-	SEG2	-	TIMx_IC4	EVENT OUT
PA4	-	-	-	-	-	SPI1_NSS	SPI3_NSS I2S3_WS	USART2_CK	-	-	-	-	TIMx_IC1	EVENT OUT
PA5	-	TIM2_CH1_ETR	-	-	-	SPI1_SCK	-	-	-	-	-	-	TIMx_IC2	EVENT OUT
PA6	-	-	TIM3_CH1	TIM10_CH1	-	SPI1_MISO	-	-	-	-	SEG3	-	TIMx_IC3	EVENT OUT
PA7	-	-	TIM3_CH2	TIM11_CH1	-	SPI1_MOSI	-	-	-	-	SEG4	-	TIMx_IC4	EVENT OUT
PA8	MCO	-	-	-	-	-	-	USART1_CK	-	-	COM0	-	TIMx_IC1	EVENT OUT
PA9	-	-	-	-	-	-	-	USART1_TX	-	-	COM1	-	TIMx_IC2	EVENT OUT
PA10	-	-	-	-	-	-	-	USART1_RX	-	-	COM2	-	TIMx_IC3	EVENT OUT

Table 9. Alternate function input/output (continued)

Port name	Digital alternate function number														
	AFIO0	AFIO1	AFIO2	AFIO3	AFIO4	AFIO5	AFIO6	AFIO7	AFIO8	. .	AFIO11	. .	AFIO14	AFIO15
	Alternate function													
	SYSTEM	TIM2	TIM3/4/5	TIM9/10/11	I2C1/2	SPI1/2	SPI3	USART1/2/3	UART4/5	-	LCD	-	CPRI	SYSTEM
PD4	-	-	-	-	-	SPI2_MOSI I2S2_SD	-	USART2_RTS	-	-	-	-	TIMx_IC1	EVENT OUT
PD5	-	-	-	-	-	-	-	USART2_TX	-	-	-	-	TIMx_IC2	EVENT OUT
PD6	-	-	-	-	-	-	-	USART2_RX	-	-	-	-	TIMx_IC3	EVENT OUT
PD7	-	-	-	TIM9_CH2	-	-	-	USART2_CK	-	-	-	-	TIMx_IC4	EVENT OUT
PD8	-	-	-	-	-	-	-	USART3_TX	-	-	SEG28	-	TIMx_IC1	EVENT OUT
PD9	-	-	-	-	-	-	-	USART3_RX	-	-	SEG29	-	TIMx_IC2	EVENT OUT
PD10	-	-	-	-	-	-	-	USART3_CK	-	-	SEG30	-	TIMx_IC3	EVENT OUT
PD11	-	-	-	-	-	-	-	USART3_CTS	-	-	SEG31	-	TIMx_IC4	EVENT OUT
PD12	-	-	TIM4_CH1	-	-	-	-	USART3_RTS	-	-	SEG32	-	TIMx_IC1	EVENT OUT
PD13	-	-	TIM4_CH2	-	-	-	-	-	-	-	SEG33	-	TIMx_IC2	EVENT OUT
PD14	-	-	TIM4_CH3	-	-	-	-	-	-	-	SEG34	-	TIMx_IC3	EVENT OUT
PD15	-	-	TIM4_CH4	-	-	-	-	-	-	-	SEG35	-	TIMx_IC4	EVENT OUT
PE0	-	-	TIM4_ETR	TIM10_CH1	-	-	-	-	-	-	SEG36	-	TIMx_IC1	EVENT OUT
PE1	-	-	-	TIM11_CH1	-	-	-	-	-	-	SEG37	-	TIMx_IC2	EVENT OUT

Table 9. Alternate function input/output (continued)

Port name	Digital alternate function number														
	AFIO0	AFIO1	AFIO2	AFIO3	AFIO4	AFIO5	AFIO6	AFIO7	AFIO8	. .	AFIO11	. .	AFIO14	AFIO15
	Alternate function													
	SYSTEM	TIM2	TIM3/4/5	TIM9/10/11	I2C1/2	SPI1/2	SPI3	USART1/2/3	UART4/5	-	LCD	-	CPRI	SYSTEM
PE2	TRACECK	-	TIM3_ETR	-	-	-	-	-	-	-	SEG 38	-	TIMx_IC3	EVENT OUT
PE3	TRACED0	-	TIM3_CH1	-	-	-	-	-	-	-	SEG 39	-	TIMx_IC4	EVENT OUT
PE4	TRACED1	-	TIM3_CH2	-	-	-	-	-	-	-	-	-	TIMx_IC1	EVENT OUT
PE5	TRACED2	-	-	TIM9_CH1	-	-	-	-	-	-	-	-	TIMx_IC2	EVENT OUT
PE6-WKUP3	TRACED3	-	-	TIM9_CH2	-	-	-	-	-	-	-	-	TIMx_IC3	EVENT OUT
PE7	-	-	-	-	-	-	-	-	-	-	-	-	TIMx_IC4	EVENT OUT
PE8	-	-	-	-	-	-	-	-	-	-	-	-	TIMx_IC1	EVENT OUT
PE9	-	TIM2_CH1_ETR	-	-	-	-	-	-	-	-	-	-	TIMx_IC2	EVENT OUT
PE10	-	TIM2_CH2	-	-	-	-	-	-	-	-	-	-	TIMx_IC3	EVENT OUT
PE11	-	TIM2_CH3	-	-	-	-	-	-	-	-	-	-	TIMx_IC4	EVENT OUT
PE12	-	TIM2_CH4	-	-	-	SPI1_NSS	-	-	-	-	-	-	TIMx_IC1	EVENT OUT
PE13	-	-	-	-	-	SPI1_SCK	-	-	-	-	-	-	TIMx_IC2	EVENT OUT
PE14	-	-	-	-	-	SPI1_MISO	-	-	-	-	-	-	TIMx_IC3	EVENT OUT
PE15	-	-	-	-	-	SPI1_MOSI	-	-	-	-	-	-	TIMx_IC4	EVENT OUT

Low-speed external user clock generated from an external source

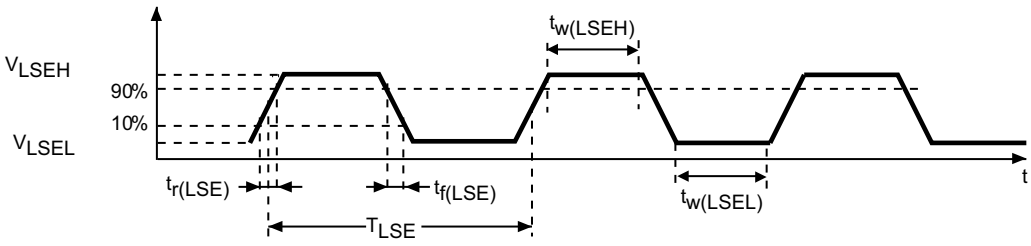
The characteristics given in the following table result from tests performed using a low-speed external clock source, and under the conditions summarized in *Table 13*.

Table 27. Low-speed external user clock characteristics(1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{LSE_ext}	User external clock source frequency	-	1	32.768	1000	kHz
V_{LSEH}	OSC32_IN input pin high level voltage		$0.7V_{DD}$	-	V_{DD}	V
V_{LSEL}	OSC32_IN input pin low level voltage		V_{SS}	-	$0.3V_{DD}$	
$t_{w(LSEH)}$ $t_{w(LSEL)}$	OSC32_IN high or low time		465	-	-	ns
$t_{r(LSE)}$ $t_{f(LSE)}$	OSC32_IN rise or fall time		-	-	10	
$C_{IN(LSE)}$	OSC32_IN input capacitance	-	-	0.6	-	pF

1. Guaranteed by design.

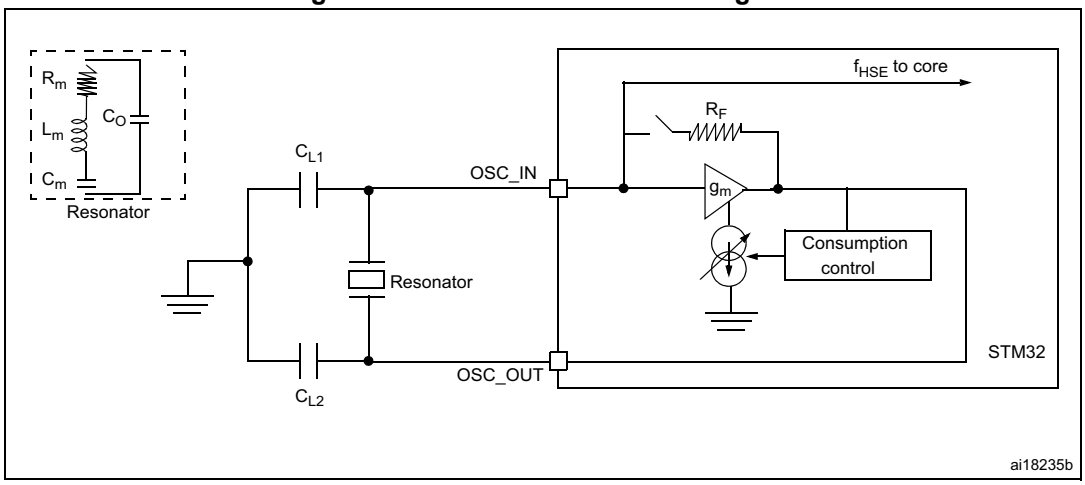
Figure 15. Low-speed external clock source AC timing diagram



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

The high-speed external (HSE) clock can be supplied with a 1 to 24 MHz crystal/ceramic resonator oscillator. All the information given in this paragraph are based on characterization results obtained with typical external components specified in *Table 28*. 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).

Figure 16. 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 29*. 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 29. 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.

Input/output AC characteristics

The definition and values of input/output AC characteristics are given in *Figure 18* and *Table 44*, respectively.

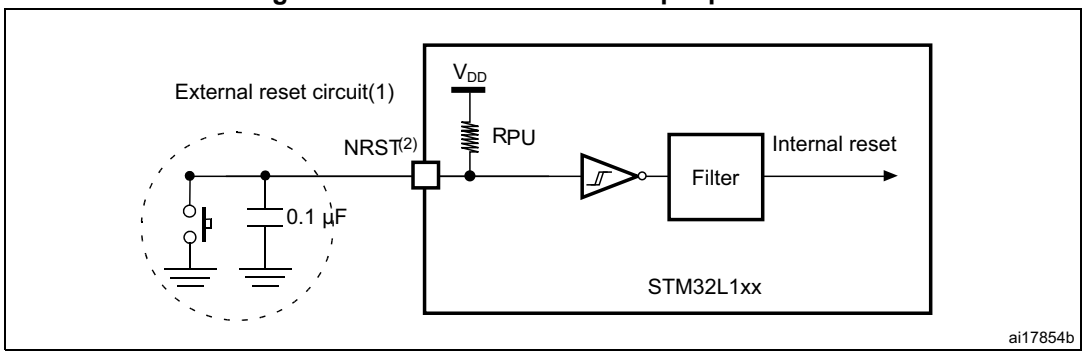
Unless otherwise specified, the parameters given in *Table 44* are derived from tests performed under the conditions summarized in *Table 13*.

Table 44. I/O AC characteristics(1)

OSPEEDRx [1:0] bit value(1)	Symbol	Parameter	Conditions	Min	Max(2)	Unit
00	$f_{max(IO)out}$	Maximum frequency(3)	C_L = 50 pF, V_{DD} = 2.7 V to 3.6 V	-	400	kHz
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	400	
	$t_{f(IO)out}$ $t_{r(IO)out}$	Output rise and fall time	C_L = 50 pF, V_{DD} = 2.7 V to 3.6 V	-	625	ns
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	625	
01	$f_{max(IO)out}$	Maximum frequency(3)	C_L = 50 pF, V_{DD} = 2.7 V to 3.6 V	-	2	MHz
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	1	
	$t_{f(IO)out}$ $t_{r(IO)out}$	Output rise and fall time	C_L = 50 pF, V_{DD} = 2.7 V to 3.6 V	-	125	ns
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	250	
10	$F_{max(IO)out}$	Maximum frequency(3)	C_L = 50 pF, V_{DD} = 2.7 V to 3.6 V	-	10	MHz
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	2	
	$t_{f(IO)out}$ $t_{r(IO)out}$	Output rise and fall time	C_L = 50 pF, V_{DD} = 2.7 V to 3.6 V	-	25	ns
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	125	
11	$F_{max(IO)out}$	Maximum frequency(3)	C_L = 30 pF, V_{DD} = 2.7 V to 3.6 V	-	50	MHz
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	8	
	$t_{f(IO)out}$ $t_{r(IO)out}$	Output rise and fall time	C_L = 30 pF, V_{DD} = 2.7 V to 3.6 V	-	5	ns
			C_L = 50 pF, V_{DD} = 1.65 V to 2.7 V	-	30	
-	t_{EXTIpw}	Pulse width of external signals detected by the EXTI controller	-	8	-	

1. The I/O speed is configured using the OSPEEDRx[1:0] bits. Refer to the STM32L151xx, STM32L152xx and STM32L162xx reference manual for a description of GPIO Port configuration register.
2. Guaranteed by design.
3. The maximum frequency is defined in *Figure 18*.

Figure 19. Recommended NRST pin protection



1. The reset network protects the device against parasitic resets.
2. The user must ensure that the level on the NRST pin can go below the $V_{IL(NRST)}$ max level specified in *Table 45*. Otherwise the reset will not be taken into account by the device.

6.3.15 TIM timer characteristics

The parameters given in the *Table 46* are guaranteed by design.

Refer to *Section 6.3.13: I/O port characteristics* for details on the input/output ction characteristics (output compare, input capture, external clock, PWM output).

Table 46. TIMx(1) characteristics

Symbol	Parameter	Conditions	Min	Max	Unit
$t_{res(TIM)}$	Timer resolution time	-	1	-	$t_{TIMxCLK}$
		$f_{TIMxCLK}$ = 32 MHz	31.25	-	ns
f_{EXT}	Timer external clock frequency on CH1 to CH4	-	0	$f_{TIMxCLK}/2$	MHz
		$f_{TIMxCLK}$ = 32 MHz	0	16	MHz
Res_{TIM}	Timer resolution	-		16	bit
$t_{COUNTER}$	16-bit counter clock period when internal clock is selected (timer's prescaler disabled)	-	1	65536	$t_{TIMxCLK}$
		$f_{TIMxCLK}$ = 32 MHz	0.0312	2048	µs
t_{MAX_COUNT}	Maximum possible count	-	-	65536 × 65536	$t_{TIMxCLK}$
		$f_{TIMxCLK}$ = 32 MHz	-	134.2	s

1. TIMx is used as a general term to refer to the TIM2, TIM3 and TIM4 timers.

Figure 27. ADC accuracy characteristics

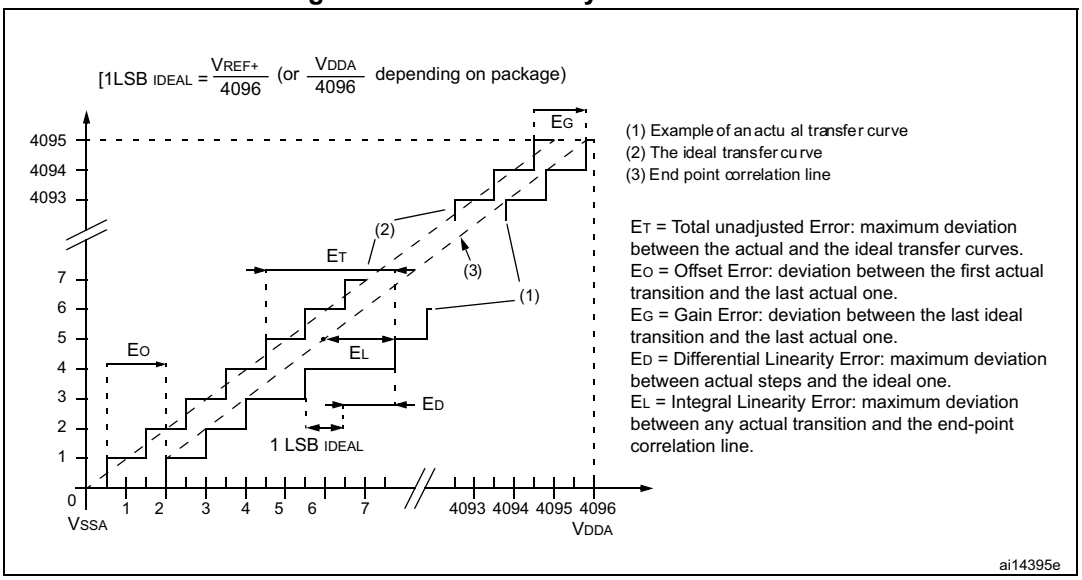
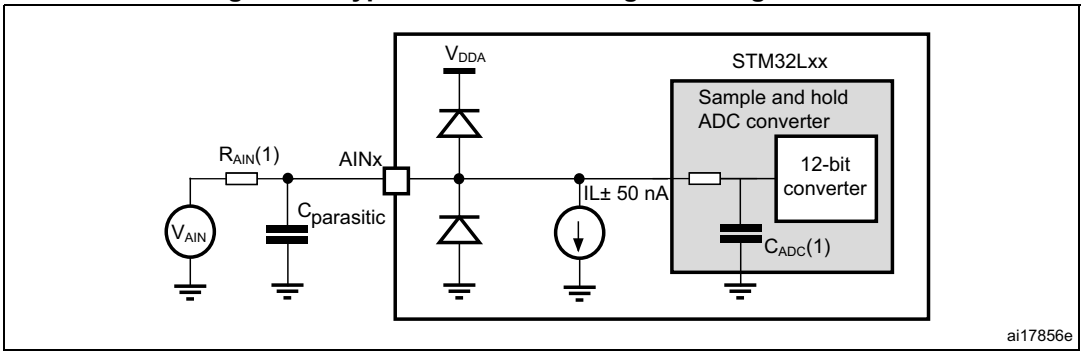


Figure 28. Typical connection diagram using the ADC



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 C_{ADC}.
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.

6.3.22 LCD controller

The device embeds a built-in step-up converter to provide a constant LCD reference voltage independently from the V_{DD} voltage. An external capacitor C_{ext} must be connected to the V_{LCD} pin to decouple this converter.

Table 64. LCD controller characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_{LCD}	LCD external voltage	-	-	3.6	V
V_{LCD0}	LCD internal reference voltage 0	-	2.6	-	
V_{LCD1}	LCD internal reference voltage 1	-	2.73	-	
V_{LCD2}	LCD internal reference voltage 2	-	2.86	-	
V_{LCD3}	LCD internal reference voltage 3	-	2.98	-	
V_{LCD4}	LCD internal reference voltage 4	-	3.12	-	
V_{LCD5}	LCD internal reference voltage 5	-	3.26	-	
V_{LCD6}	LCD internal reference voltage 6	-	3.4	-	
V_{LCD7}	LCD internal reference voltage 7	-	3.55	-	
C_{ext}	V_{LCD} external capacitance	0.1	-	2	µF
I_{LCD}(1)	Supply current at V_{DD} = 2.2 V	-	3.3	-	µA
	Supply current at V_{DD} = 3.0 V	-	3.1	-	
R_{Htot}(2)	Low drive resistive network overall value	5.28	6.6	7.92	MΩ
R_L(2)	High drive resistive network total value	192	240	288	kΩ
V_{44}	Segment/Common highest level voltage	-	-	V_{LCD}	V
V_{34}	Segment/Common 3/4 level voltage	-	3/4 V_{LCD}	-	V
V_{23}	Segment/Common 2/3 level voltage	-	2/3 V_{LCD}	-	
V_{12}	Segment/Common 1/2 level voltage	-	1/2 V_{LCD}	-	
V_{13}	Segment/Common 1/3 level voltage	-	1/3 V_{LCD}	-	
V_{14}	Segment/Common 1/4 level voltage	-	1/4 V_{LCD}	-	
V_0	Segment/Common lowest level voltage	0	-	-	
ΔVxx(3)	Segment/Common level voltage error T_A = -40 to 105 °C	-	-	±50	mV

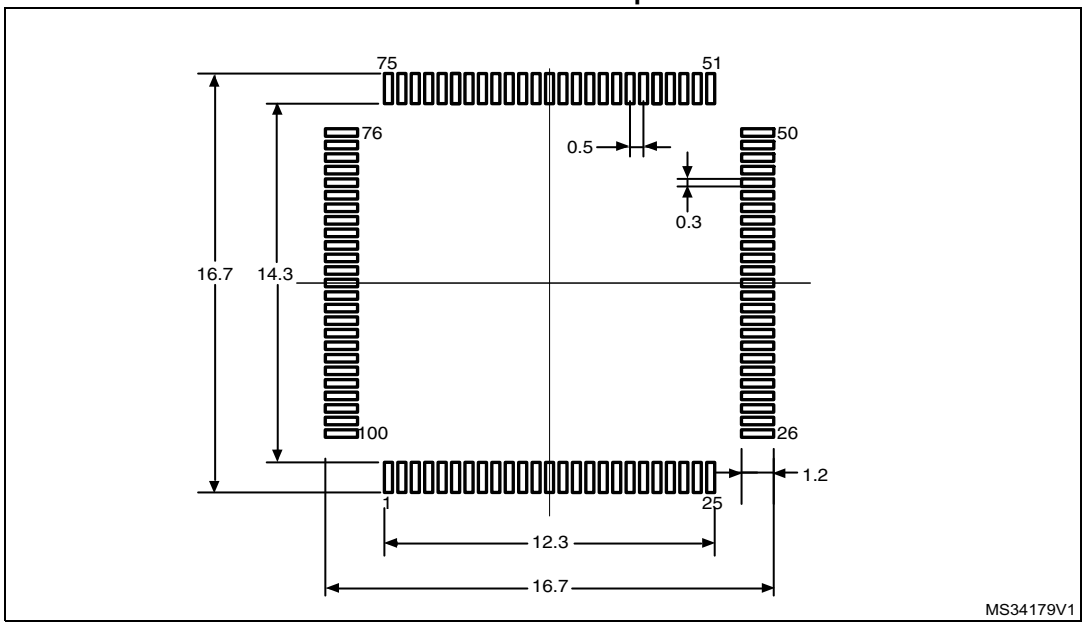
1. LCD enabled with 3 V internal step-up active, 1/8 duty, 1/4 bias, division ratio= 64, all pixels active, no LCD connected.
2. Guaranteed by design.
3. Guaranteed by characterization results.

Table 66. LQPF100, 14 x 14 mm, 100-pin low-profile quad flat package mechanical data (continued)

Symbol	millimeters			inches[1]		
	Min	Typ	Max	Min	Typ	Max
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.

Figure 35. LQFP100, 14 x 14 mm, 100-pin low-profile quad flat package recommended footprint



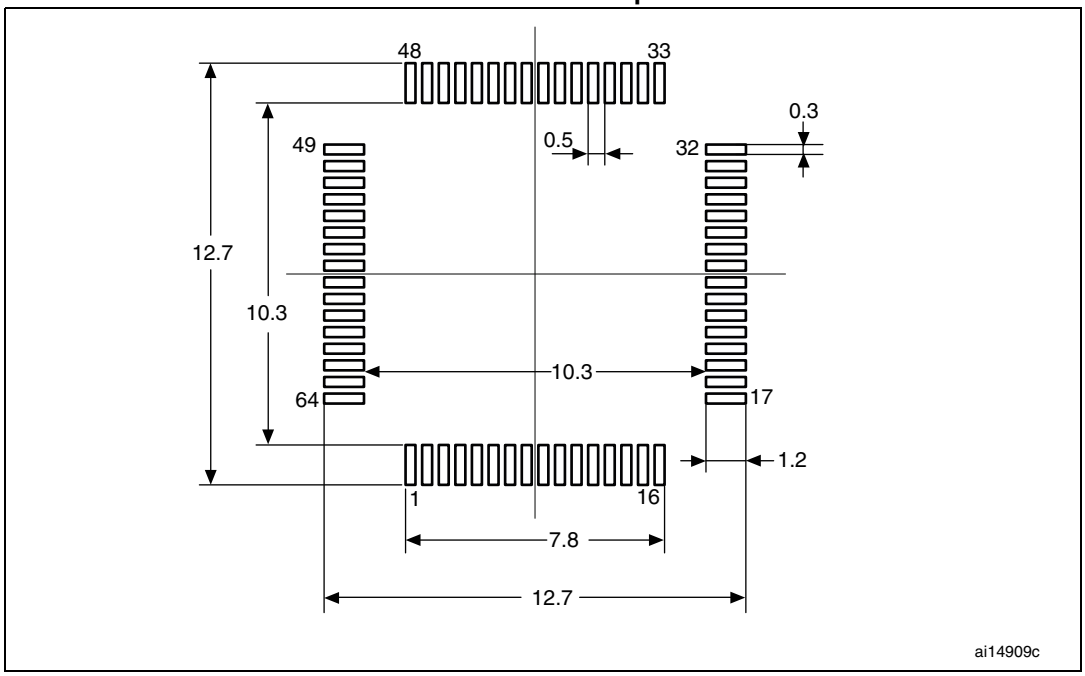
1. Dimensions are in millimeters.

Table 67. LQFP64, 10 x 10 mm 64-pin low-profile quad flat package mechanical data (continued)

Symbol	millimeters			inches[1]		
	Min	Typ	Max	Min	Typ	Max
E3	-	7.500	-	-	0.2953	-
e	-	0.500	-	-	0.0197	-
K	0°	3.5°	7°	0°	3.5°	7°
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1	-	1.000	-	-	0.0394	-
ccc	-	-	0.080	-	-	0.0031

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

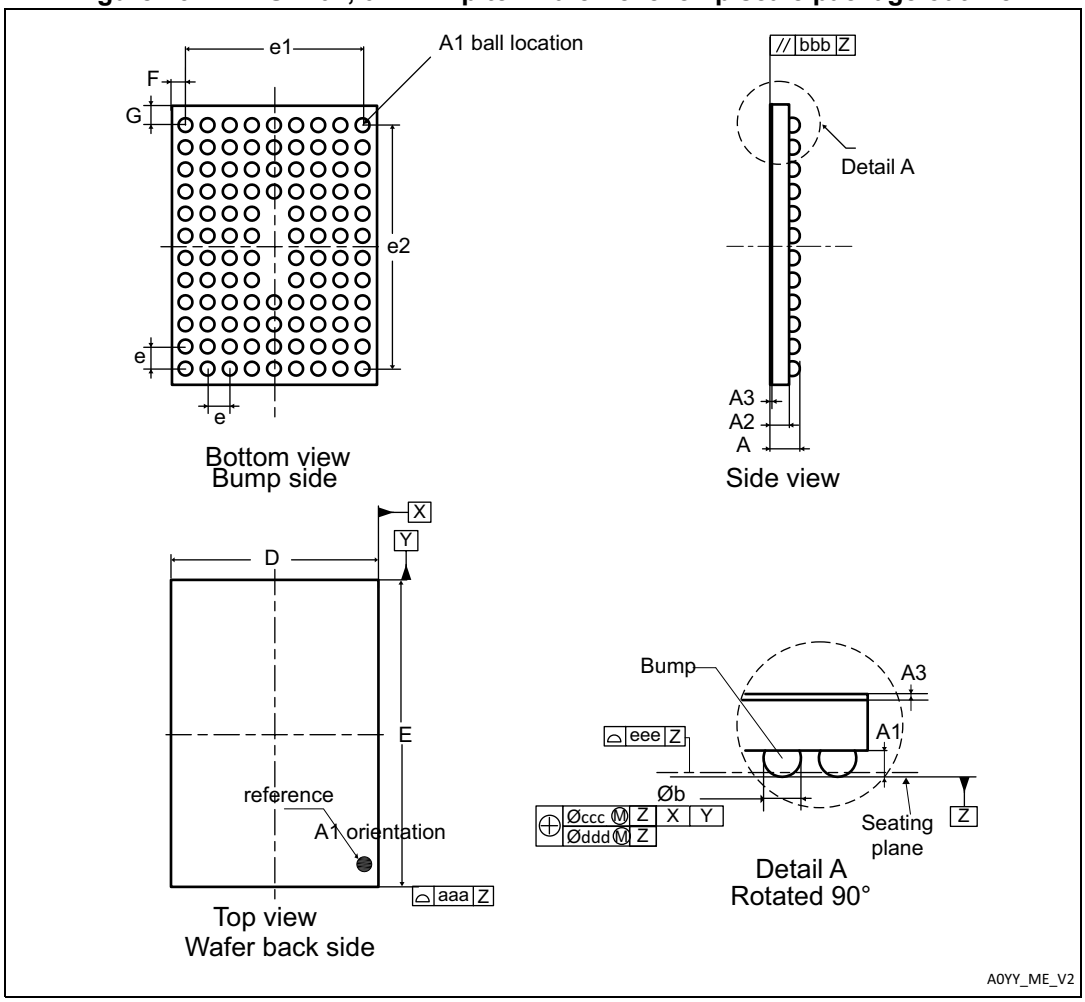
Figure 38. LQFP64, 10 x 10 mm, 64-pin low-profile quad flat package recommended footprint



1. Dimensions are in millimeters.

7.5 WLCSP104, 0.4 mm pitch wafer level chip scale package information

Figure 43. WLCSP104, 0.4 mm pitch wafer level chip scale package outline



1. Drawing is not to scale.