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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	Cap Sense, DMA, I²S, POR, PWM, WDT
Number of I/O	83
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)	1.65V ~ 3.6V
Data Converters	A/D 25x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-LQFP
Supplier Device Package	100-LQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32l151vet6d

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3.7 Memories

The STM32L151xE and STM32L152xE devices have the following features:

- 80 Kbytes of embedded RAM accessed (read/write) at CPU clock speed with 0 wait states. With the enhanced bus matrix, operating the RAM does not lead to any performance penalty during accesses to the system bus (AHB and APB buses).
- The non-volatile memory is divided into three arrays:
  - 512 Kbytes of embedded Flash program memory
  - 16 Kbytes of data EEPROM
  - Options bytes

  Flash program and data EEPROM are divided into two banks, this enables writing in one bank while running code or reading data in the other bank.

  The options bytes are used to write-protect or read-out protect the memory (with 4 Kbytes granularity) and/or readout-protect the whole memory with the following options:
  - Level 0: no readout protection
  - Level 1: memory readout protection, the Flash memory cannot be read from or written to if either debug features are connected or boot in RAM is selected
  - Level 2: chip readout protection, debug features (ARM Cortex-M3 JTAG and serial wire) and boot in RAM selection disabled (JTAG fuse)

  The whole non-volatile memory embeds the error correction code (ECC) feature.

3.8 DMA (direct memory access)

The flexible 12-channel, general-purpose DMA is able to manage memory-to-memory, peripheral-to-memory and memory-to-peripheral transfers. The DMA controller supports circular buffer management, avoiding the generation of interrupts when the controller reaches the end of the buffer.

Each channel is connected to dedicated hardware DMA requests, with software trigger support for each channel. Configuration is done by software and transfer sizes between source and destination are independent.

The DMA can be used with the main peripherals: SPI, I^2C, USART, general-purpose timers, DAC and ADC.

They can also be used as simple time bases and be clocked by the LSE clock source (32.768 kHz) to provide time bases independent from the main CPU clock.

3.16.2 Basic timers (TIM6 and TIM7)

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

3.16.3 SysTick timer

This timer is dedicated to the OS, but could also be used as a standard downcounter. It is based on a 24-bit downcounter with autoreload capability and a programmable clock source. It features a maskable system interrupt generation when the counter reaches 0.

3.16.4 Independent watchdog (IWDG)

The independent watchdog is based on a 12-bit downcounter and 8-bit prescaler. It is clocked from an independent 37 kHz internal RC and, as it operates independently of 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.

3.16.5 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.

3.17 Communication interfaces

3.17.1 I²C bus

Up to two I²C bus interfaces can operate in multimaster and slave modes. They can support standard and fast modes.

They support dual slave addressing (7-bit only) and both 7- and 10-bit addressing in master mode. A hardware CRC generation/verification is embedded.

They can be served by DMA and they support SM Bus 2.0/PM Bus.

3.17.2 Universal synchronous/asynchronous receiver transmitter (USART)

The three USART and two UART interfaces are able to communicate at speeds of up to 4 Mbit/s. They support IrDA SIR ENDEC and have LIN Master/Slave capability. The three USARTs provide hardware management of the CTS and RTS signals and are ISO 7816 compliant.

All USART/UART interfaces can be served by the DMA controller.

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
34	L2	23	14	K9	PA0-WKUP1	I/O	FT	PA0	TIM2_CH1_ETR/ TIM5_CH1/ USART2_CTS	WKUP1/RTC_TAMP2/ADC_IN0/ COMP1_INP
35	M2	24	15	L9	PA1	I/O	FT	PA1	TIM2_CH2/TIM5_CH2/ USART2_RTS/ LCD_SEG0	ADC_IN1/ COMP1_INP/ OPAMP1_VINP
36	-	25	16	J8	PA2	I/O	FT	PA2	TIM2_CH3/TIM5_CH3/ TIM9_CH1/ USART2_TX/LCD_SEG1	ADC_IN2/ COMP1_INP/ OPAMP1_VINM
-	K3	-	-	-	PA2	I/O	FT	PA2	TIM2_CH3/TIM5_CH3/ TIM9_CH1/ USART2_TX/LCD_SEG1	ADC_IN2/ COMP1_INP
-	M3	-	-		OPAMP1_VINM	I	TC	OPAMP1_ VINM	-	-
37	L3	26	17	H7	PA3	I/O	TC	PA3	TIM2_CH4/TIM5_CH4/ TIM9_CH2/ USART2_RX/LCD_SEG2	ADC_IN3/ COMP1_INP/ OPAMP1_VOUT
38	-	27	18	K8	V_{SS_4}	S	-	V_{SS_4}	-	-
39	-	28	19	L8, M9	V_{DD_4}	S	-	V_{DD_4}	-	-
40	J4	29	20	J7	PA4	I/O	TC	PA4	SPI1_NSS/SPI3_NSS/ I2S3_WS/ USART2_CK	ADC_IN4/ DAC_OUT1/ COMP1_INP
41	K4	30	21	M8	PA5	I/O	TC	PA5	TIM2_CH1_ETR/ SPI1_SCK	ADC_IN5/ DAC_OUT2/ COMP1_INP
42	L4	31	22	H6	PA6	I/O	FT	PA6	TIM3_CH1/TIM10_CH1/SPI1_MISO/ LCD_SEG3	ADC_IN6/ COMP1_INP/ OPAMP2_VINP
43	-	32	23	K7	PA7	I/O	FT	PA7	TIM3_CH2/TIM11_CH1/ SPI1_MOSI/ LCD_SEG4	ADC_IN7/ COMP1_INP/ OPAMP2_VINM
-	J5	-	-	-	PA7	I/O	FT	PA7	TIM3_CH2/TIM11_CH1/ SPI1_MOSI/ LCD_SEG4	ADC_IN7/ COMP1_INP

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
116	C8	83	54	C3	PD2	I/O	FT	PD2	TIM3_ETR/UART5_RX/ LCD_SEG31/ LCD_SEG43/LCD_COM7	-
117	B8	84	-	C4	PD3	I/O	FT	PD3	SPI2_MISO/ USART2_CTS	-
118	B7	85	-	A3	PD4	I/O	FT	PD4	SPI2_MOSI/I2S2_SD/ USART2_RTS	-
119	A6	86	-	B3	PD5	I/O	FT	PD5	USART2_TX	-
120	F7	-	-	-	V_{SS_10}	S	-	V_{SS_10}	-	-
121	G7	-	-	-	V_{DD_10}	S	-	V_{DD_10}	-	-
122	B6	87	-	B4	PD6	I/O	FT	PD6	USART2_RX	-
123	A5	88	-	A4	PD7	I/O	FT	PD7	TIM9_CH2/USART2_CK	-
124	D9	-	-	-	PG9	I/O	FT	PG9	-	-
125	D8	-	-	-	PG10	I/O	FT	PG10	-	-
126	-	-	-	-	PG11	I/O	FT	PG11	-	-
127	D7	-	-	-	PG12	I/O	FT	PG12	-	-
128	C7	-	-	-	PG13	I/O	FT	PG13	-	-
129	C6	-	-	-	PG14	I/O	FT	PG14	-	-
130	-	-	-	-	V_{SS_11}	S	-	V_{SS_11}	-	-
131	-	-	-	-	V_{DD_11}	S	-	V_{DD_11}	-	-
132	-	-	-	-	PG15	I/O	FT	PG15	-	-
133	A8	89	55	B5	PB3	I/O	FT	JTDO	TIM2_CH2/SPI1_SCK/ SPI3_SCK/ I2S3_CK/ LCD_SEG7/JTDO	COMP2_INM
134	A7	90	56	A5	PB4	I/O	FT	NJTRST	TIM3_CH1/SPI1_MISO/ SPI3_MISO/ LCD_SEG8/NJTRST	COMP2_INP
135	C5	91	57	A6	PB5	I/O	FT	PB5	TIM3_CH2/I2C1_SMBA/ SPI1_MOSI/ SPI3_MOSI/I2S3_SD/ LCD_SEG9	COMP2_INP

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
136	B5	92	58	C5	PB6	I/O	FT	PB6	TIM4_CH1/I2C1_SCL/ USART1_TX	COMP2_INP
137	B4	93	59	B6	PB7	I/O	FT	PB7	TIM4_CH2/I2C1_SDA/ USART1_RX	COMP2_INP/ PVD_IN
138	A4	94	60	A7	BOOT0	I	B	BOOT0	-	-
139	A3	95	61	D5	PB8	I/O	FT	PB8	TIM4_CH3/TIM10_CH1/ I2C1_SCL/ LCD_SEG16	-
140	B3	96	62	C6	PB9	I/O	FT	PB9	TIM4_CH4/ TIM11_CH1/I2C1_SDA/ LCD_COM3	-
141	C3	97	-	B7	PE0	I/O	FT	PE0	TIM4_ETR/TIM10_CH1/ LCD_SEG36	-
142	A2	98	-	A8	PE1	I/O	FT	PE1	TIM11_CH1/LCD_SEG37	-
143	D3	99	63	C7	V_{SS_3}	S	-	V_{SS_3}	-	-
144	C4	100	64	B8, A9	V_{DD_3}	S	-	V_{DD_3}	-	-

1. I = input, O = output, S = supply.
2. Function availability depends on the chosen device.
3. Applicable to STM32L152xE devices only. In STM32L151xE devices, this pin should be connected to V_{DD}.
4. The PC14 and PC15 I/Os are only configured as OSC32_IN/OSC32_OUT when the LSE oscillator is ON (by setting the LSEON bit in the RCC_CSR register). The LSE oscillator pins OSC32_IN/OSC32_OUT can be used as general-purpose PH0/PH1 I/Os, respectively, when the LSE oscillator is off (after reset, the LSE oscillator is off). The LSE has priority over the GPIO function. For more details, refer to Using the OSC32_IN/OSC32_OUT pins as GPIO PC14/PC15 port pins section in the STM32L151xx, STM32L152xx and STM32L162xx reference manual (RM0038).
5. The PH0 and PH1 I/Os are only configured as OSC_IN/OSC_OUT when the HSE oscillator is ON (by setting the HSEON bit in the RCC_CR register). The HSE oscillator pins OSC_IN/OSC_OUT can be used as general-purpose PH0/PH1 I/Os, respectively, when the HSE oscillator is off (after reset, the HSE oscillator is off). The HSE has priority over the GPIO function.

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
PF14	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PF15	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG0	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG1	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG2	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG3	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG4	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG5	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG6	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG7	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG8	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG9	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG10	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT
PG11	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENT OUT

6 Electrical characteristics

6.1 Parameter conditions

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

6.1.1 Minimum and maximum values

Unless otherwise specified the minimum and maximum values are guaranteed in the worst conditions of ambient temperature, supply voltage and frequencies by tests in production on 100% of the devices with an ambient temperature at T_A = 25 °C and T_A = $T_A$max (given by the selected temperature range).

Data based on characterization results, design simulation and/or technology characteristics are indicated in the table footnotes. Based on characterization, the minimum and maximum values refer to sample tests and represent the mean value plus or minus three times the standard deviation (mean ±3σ).

6.1.2 Typical values

Unless otherwise specified, typical data are based on T_A = 25 °C, V_{DD} = 3.6 V (for the 1.65 V ≤V_{DD} ≤3.6 V voltage range). They are given only as design guidelines and are not tested.

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

6.1.3 Typical curves

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

6.1.4 Loading capacitor

The loading conditions used for pin parameter measurement are shown in *Figure 9*.

6.1.5 Pin input voltage

The input voltage measurement on a pin of the device is described in *Figure 10*.

Figure 9. Pin loading conditions

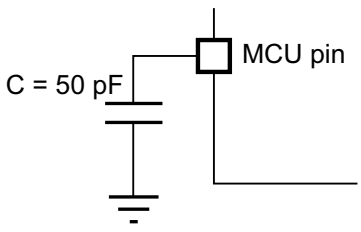
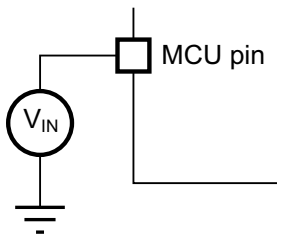


Figure 10. Pin input voltage



6.2 Absolute maximum ratings

Stresses above the absolute maximum ratings listed in *Table 10: Voltage characteristics*, *Table 11: Current characteristics*, and *Table 12: Thermal characteristics* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Table 10. Voltage characteristics

Symbol	Ratings	Min	Max	Unit
V_{DD}–V_{SS}	External main supply voltage (including V_{DDA} and V_{DD})(1)	–0.3	4.0	V
V_{IN}(2)	Input voltage on five-volt tolerant pin	V_{SS} –0.3	V_{DD}+4.0	
	Input voltage on any other pin	V_{SS} –0.3	4.0	
$\lvert\Delta V_{DDx}\rvert$	Variations between different V_{DD} power pins	-	50	mV
$\lvert V_{SSX} - V_{SS}\rvert$	Variations between all different ground pins(3)	-	50	
V_{REF+} –V_{DDA}	Allowed voltage difference for V_{REF+} > V_{DDA}	-	0.4	V
$V_{ESD(HBM)}$	Electrostatic discharge voltage (human body model)	see *Section 6.3.11*		

1. All main power (V_{DD}, V_{DDA}) and ground (V_{SS}, V_{SSA}) pins must always be connected to the external power supply, in the permitted range.
2. V_{IN} maximum must always be respected. Refer to *Table 11* for maximum allowed injected current values.
3. Include V_{REF-} pin.

Table 11. Current characteristics

Symbol	Ratings	Max.	Unit
$I_{VDD(\Sigma)}$	Total current into sum of all V_{DD_x} power lines (source)(1)	100	mA
$I_{VSS(\Sigma)}$(2)	Total current out of sum of all V_{SS_x} ground lines (sink)(1)	100	
$I_{VDD(PIN)}$	Maximum current into each V_{DD_x} power pin (source)(1)	70	
$I_{VSS(PIN)}$	Maximum current out of each VSS_x ground pin (sink)(1)	-70	
I_{IO}	Output current sunk by any I/O and control pin	25	
	Output current sourced by any I/O and control pin	- 25	
$\Sigma I_{IO(PIN)}$	Total output current sunk by sum of all IOs and control pins(2)	60	
	Total output current sourced by sum of all IOs and control pins(2)	-60	
$I_{INJ(PIN)}$ (3)	Injected current on five-volt tolerant I/O(4), RST and B pins	-5/+0	
	Injected current on any other pin (5)	± 5	
$\Sigma I_{INJ(PIN)}$	Total injected current (sum of all I/O and control pins)(6)	± 25	

1. All main power (V_{DD}, V_{DDA}) and ground (V_{SS}, V_{SSA}) pins must always be connected to the external power supply, in the permitted range.
2. This current consumption must be correctly distributed over all I/Os and control pins. The total output current must not be sunk/sourced between two consecutive power supply pins referring to high pin count LQFP packages.
3. Negative injection disturbs the analog performance of the device. See note in *Section 6.3.17*.

Table 17. Current consumption in Run mode, code with data processing running from Flash

Symbol	Parameter	Conditions		f_{HCLK}	Typ	Max(1)	Unit
I_{DD} (Run from Flash)	Supply current in Run mode, code executed from Flash	$f_{HSE} = f_{HCLK}$ up to 16 MHz included, $f_{HSE} = f_{HCLK}/2$ above 16 MHz (PLL ON)(2)	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	1 MHz	225	500	µA
				2 MHz	420	750	
				4 MHz	780	1200	
			Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	4 MHz	0.98	1.6	mA
				8 MHz	1.85	2.9	
				16 MHz	3.6	5.2	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	8 MHz	2.2	3.5	
				16 MHz	4.4	6.5	
				32 MHz	8.6	12	
		HSI clock source (16 MHz)	Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	16 MHz	3.6	5.2	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	32 MHz	8.7	12.3	
		MSI clock, 65 kHz	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	65 kHz	42	145	µA
		MSI clock, 524 kHz		524 kHz	135	250	
		MSI clock, 4.2 MHz		4.2 MHz	820	1200	

1. Guaranteed by characterization results, unless otherwise specified.
2. Oscillator bypassed (HSEBYP = 1 in RCC_CR register).

Table 19. Current consumption in Sleep mode

Symbol	Parameter	Conditions		f_{HCLK}	Typ	Max(1)	Unit
I_{DD} (Sleep)	Supply current in Sleep mode, Flash OFF	f_{HSE} = f_{HCLK} up to 16 MHz included, f_{HSE} = f_{HCLK}/2 above 16 MHz (PLL ON)(2)	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	1 MHz	51	220	µA
				2 MHz	81	300	
				4 MHz	140	380	
			Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	4 MHz	175	500	
				8 MHz	330	700	
				16 MHz	625	1100	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	8 MHz	395	800	
				16 MHz	760	1250	
				32 MHz	1700	2700	
		HSI clock source (16 MHz)	Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	16 MHz	670	1100	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	32 MHz	1750	2700	
		MSI clock, 65 kHz	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	65 kHz	19	92	
		MSI clock, 524 kHz		524 kHz	33	110	
		MSI clock, 4.2 MHz		4.2 MHz	150	273	
	Supply current in Sleep mode, Flash ON	f_{HSE} = f_{HCLK} up to 16 MHz included, f_{HSE} = f_{HCLK}/2 above 16 MHz (PLL ON)(2)	Range 3, V_{CORE}=1.2 V VOS[1:0] = 11	1 MHz	63	250	
				2 MHz	93	300	
				4 MHz	155	380	
			Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	4 MHz	190	500	
				8 MHz	340	700	
				16 MHz	640	1120	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	8 MHz	410	800	
				16 MHz	770	1300	
				32 MHz	1750	2700	
		HSI clock source (16 MHz)	Range 2, V_{CORE}=1.5 V VOS[1:0] = 10	16 MHz	690	1160	
			Range 1, V_{CORE}=1.8 V VOS[1:0] = 01	32 MHz	1750	2800	
	Supply current in Sleep mode, Flash ON	MSI clock, 65 kHz	Range 3, V_{CORE}=1.2V VOS[1:0] = 11	65 kHz	31	105	
		MSI clock, 524 kHz		524 kHz	45	125	
		MSI clock, 4.2 MHz		4.2 MHz	160	290	

1. Guaranteed by characterization results, unless otherwise specified.
2. Oscillator bypassed (HSEBYP = 1 in RCC_CR register)

Table 23. Typical and maximum current consumptions in Standby mode

Symbol	Parameter	Conditions		Typ	Max(1)	Unit
I_{DD} (Standby with RTC)	Supply current in Standby mode with RTC enabled	RTC clocked by LSI (no independent watchdog)	T_A = -40 °C to 25 °C V_{DD} = 1.8 V	0.865	-	µA
			T_A = -40 °C to 25 °C	1.11	1.9	
			T_A = 55 °C	1.72	2.2	
			T_A= 85 °C	2.12	4	
			T_A = 105 °C	2.54	8.3(2)	
		RTC clocked by LSE external quartz (no independent watchdog)(3)	T_A = -40 °C to 25 °C V_{DD} = 1.8 V	0.97	-	
			T_A = -40 °C to 25 °C	1.28	-	
			T_A = 55 °C	2.01	-	
			T_A= 85 °C	2.5	-	
			T_A = 105 °C	2.98	-	
I_{DD} (Standby)	Supply current in Standby mode (RTC disabled)	Independent watchdog and LSI enabled	T_A = -40 °C to 25 °C	1	1.7	
		Independent watchdog and LSI OFF	T_A = -40 °C to 25 °C	0.29	1	
			T_A = 55 °C	0.96	1.3	
			T_A = 85 °C	1.38	3	
			T_A = 105 °C	1.98	7(2)	
I_{DD} (WU from Standby)	Supply current during wakeup time from Standby mode	-	T_A = -40 °C to 25 °C	1	-	mA

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

On-chip peripheral current consumption

The current consumption of the on-chip peripherals is given in the following table. 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

6.3.6 External clock source characteristics

High-speed external user clock generated from an external source

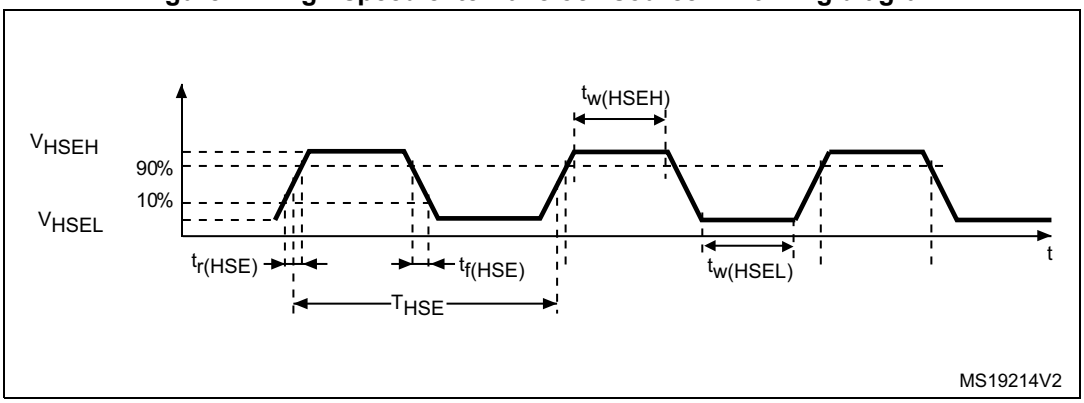
In bypass mode the HSE oscillator is switched off and the input pin is a standard GPIO.The external clock signal has to respect the I/O characteristics in *Section 6.3.12*. However, the recommended clock input waveform is shown in *Figure 14*.

Table 26. High-speed external user clock characteristics(1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{HSE_ext}	User external clock source frequency	CSS is on or PLL is used	1	8	32	MHz
		CSS is off, PLL not used	0	8	32	MHz
V_{HSEH}	OSC_IN input pin high level voltage	-	$0.7V_{DD}$	-	V_{DD}	V
V_{HSEL}	OSC_IN input pin low level voltage		V_{SS}	-	$0.3V_{DD}$	
$t_{w(HSEH)}$ $t_{w(HSEL)}$	OSC_IN high or low time		12	-	-	ns
$t_{r(HSE)}$ $t_{f(HSE)}$	OSC_IN rise or fall time		-	-	20	
$C_{in(HSE)}$	OSC_IN input capacitance		-	2.6	-	pF

1. Guaranteed by design.

Figure 14. High-speed external clock source AC timing diagram



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 C_{L1} and C_{L2}, 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 17). C_{L1} and C_{L2}, are usually the same size. The crystal manufacturer typically specifies a load capacitance which is the series combination of C_{L1} and C_{L2}.
Load capacitance C_L has the following formula: $C_L = C_{L1} \times C_{L2} / (C_{L1} + C_{L2}) + C_{stray}$ where C_{stray} 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 C_{L1} and C_{L2} (15 pF) it is strongly recommended to use a resonator with a load capacitance $C_L \leq 7$ pF. Never use a resonator with a load capacitance of 12.5 pF.
Example: if the user chooses a resonator with a load capacitance of C_L = 6 pF and C_{stray} = 2 pF, then $C_{L1} = C_{L2}$ = 8 pF.

Figure 17. Typical application with a 32.768 kHz crystal

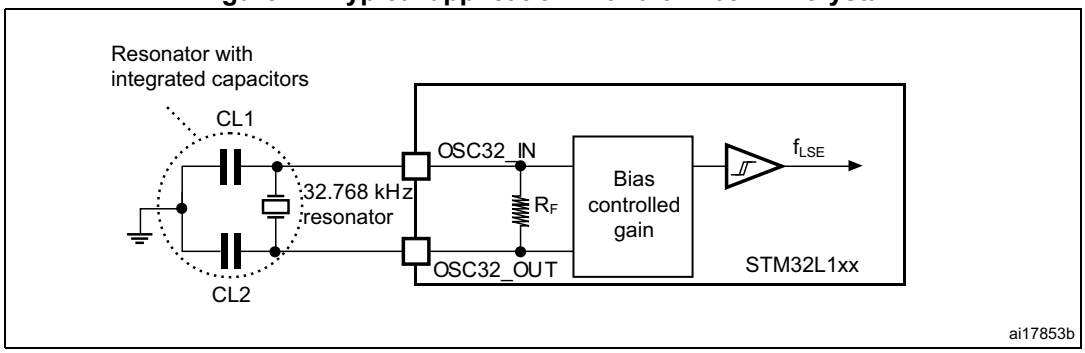


Table 52. USB: full speed electrical characteristics (continued)

Driver characteristics[1]					
Symbol	**Parameter**	**Conditions**	**Min**	**Max**	**Unit**
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 - Chapter 7 (version 2.0).

I2S characteristics

Table 53. I2S characteristics

Symbol	Parameter	Conditions	Min	Max	Unit
f_{MCK}	I2S Main Clock Output		256 x 8K	256xFs (1)	MHz
f_{CK}	I2S clock frequency	Master data: 32 bits	-	64xFs	MHz
		Slave data: 32 bits	-	64xFs	
D_{CK}	I2S clock frequency duty cycle	Slave receiver, 48KHz	30	70	%
$t_{r(CK)}$	I2S clock rise time	Capacitive load CL=30pF	-	8	ns
$t_{f(CK)}$	I2S clock fall time			8	
$t_{v(WS)}$	WS valid time	Master mode	4	24	
$t_{h(WS)}$	WS hold time	Master mode	0	-	
$t_{su(WS)}$	WS setup time	Slave mode	15	-	
$t_{h(WS)}$	WS hold time	Slave mode	0	-	
$t_{su(SD\_MR)}$	Data input setup time	Master receiver	8	-	
$t_{su(SD\_SR)}$	Data input setup time	Slave receiver	9	-	
$t_{h(SD\_MR)}$	Data input hold time	Master receiver	5	-	
$t_{h(SD\_SR)}$		Slave receiver	4	-	
$t_{v(SD\_ST)}$	Data output valid time	Slave transmitter (after enable edge)	-	64	
$t_{h(SD\_ST)}$	Data output hold time	Slave transmitter (after enable edge)	22	-	
$t_{v(SD\_MT)}$	Data output valid time	Master transmitter (after enable edge)	-	12	
$t_{h(SD\_MT)}$	Data output hold time	Master transmitter (after enable edge)	8	-	

1. The maximum for 256xFs is 8 MHz

Note: Refer to the I2S section of the product reference manual for more details about the sampling frequency (Fs), f_{MCK}, f_{CK} and D_{CK} values. These values reflect only the digital peripheral behavior, source clock precision might slightly change them. DCK depends mainly on the

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 not included.

Table 63. 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	

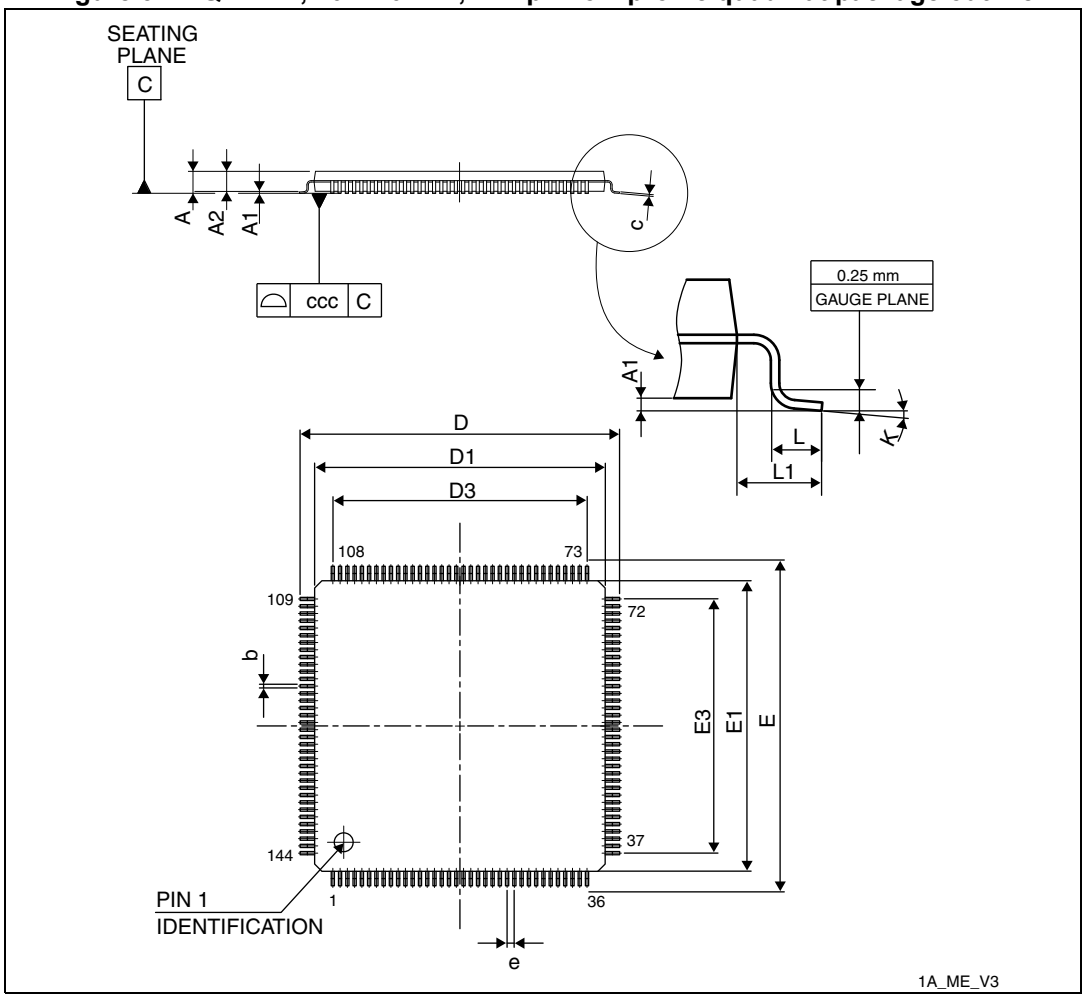
1. Guaranteed by characterization results.
2. The delay is characterized for 100 mV input step with 10 mV overdrive on the inverting input, the non-inverting input set to the reference.
3. Comparator consumption only. Internal reference voltage (necessary for comparator operation) is not included.

7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

7.1 LQFP144, 20 x 20 mm, 144-pin low-profile quad flat package information

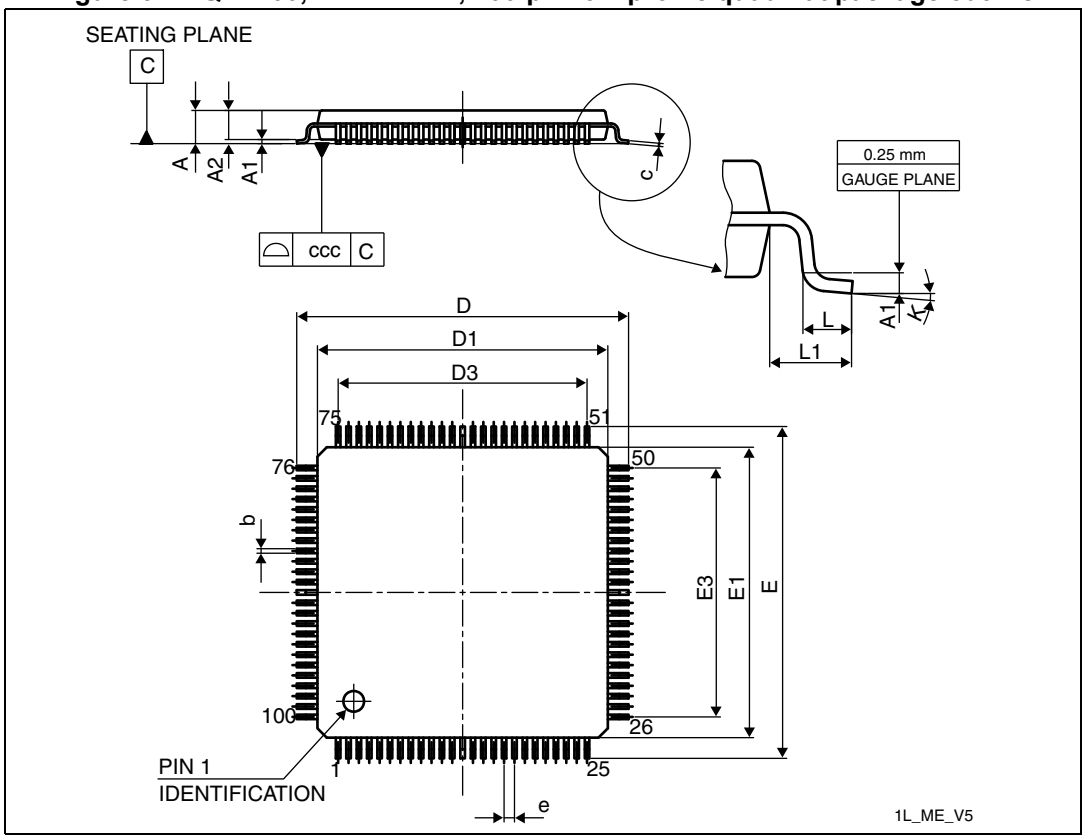
Figure 31. LQFP144, 20 x 20 mm, 144-pin low-profile quad flat package outline



1. Drawing is not to scale.

7.2 LQFP100, 14 x 14 mm, 100-pin low-profile quad flat package information

Figure 34. LQFP100, 14 x 14 mm, 100-pin low-profile quad flat package outline



1. Drawing is not to scale.

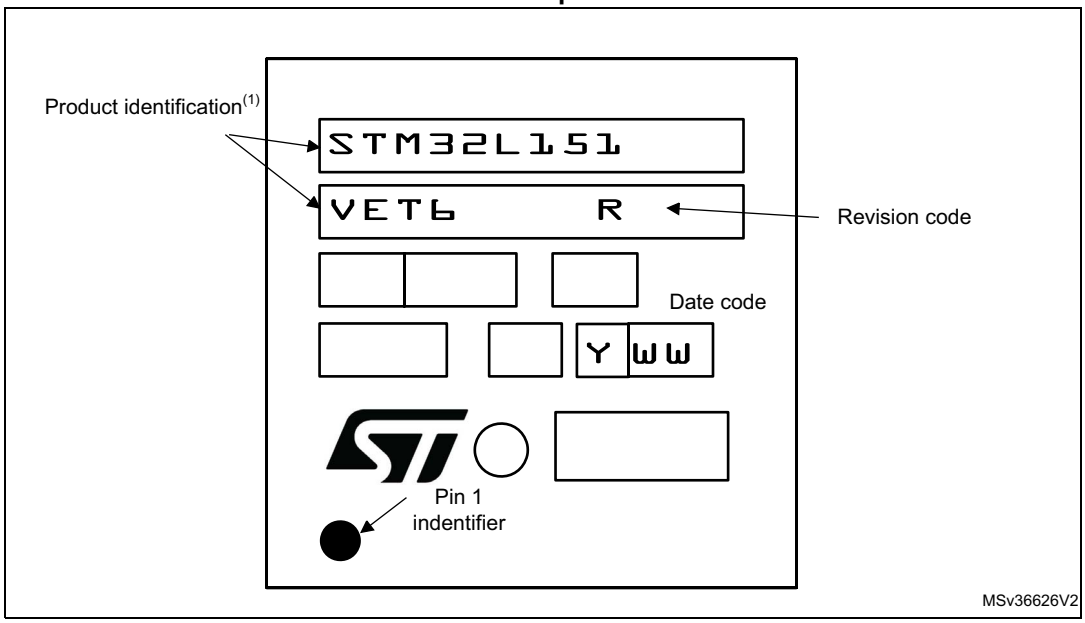
Table 66. LQPF100, 14 x 14 mm, 100-pin low-profile quad flat package mechanical data

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

Marking of engineering samples

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

Figure 36. LQFP100, 14 x 14 mm, 100-pin low-profile quad flat 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

8 Part numbering

Table 72. STM32L151xE and STM32L152xE Ordering information scheme

Example: STM32 L 151 R E T 6 D TR

Device family

STM32 = ARM-based 32-bit microcontroller

Product type

L = Low-power

Device subfamily

151: Devices without LCD

152: Devices with LCD

Pin count

R = 64 pins

V = 100/104 pins

Z = 144 pins

Q = 132 pins

Flash memory size

E= 512 Kbytes of Flash memory

Package

H = BGA

T = LQFP

Y = WLCSP104

Temperature range

6 = Industrial temperature range, –40 to 85 °C

7 = Industrial temperature range, –40 to 105 °C

Options

No character = V_{DD} range: 1.8 to 3.6 V and BOR enabled

D = V_{DD} range: 1.65 to 3.6 V and BOR disabled

Packing

TR = tape and reel

No character = tray or tube

For a list of available options (speed, package, etc.) or for further information on any aspect of this device, please contact the nearest ST sales office.