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What is "Embedded - Microcontrollers"?

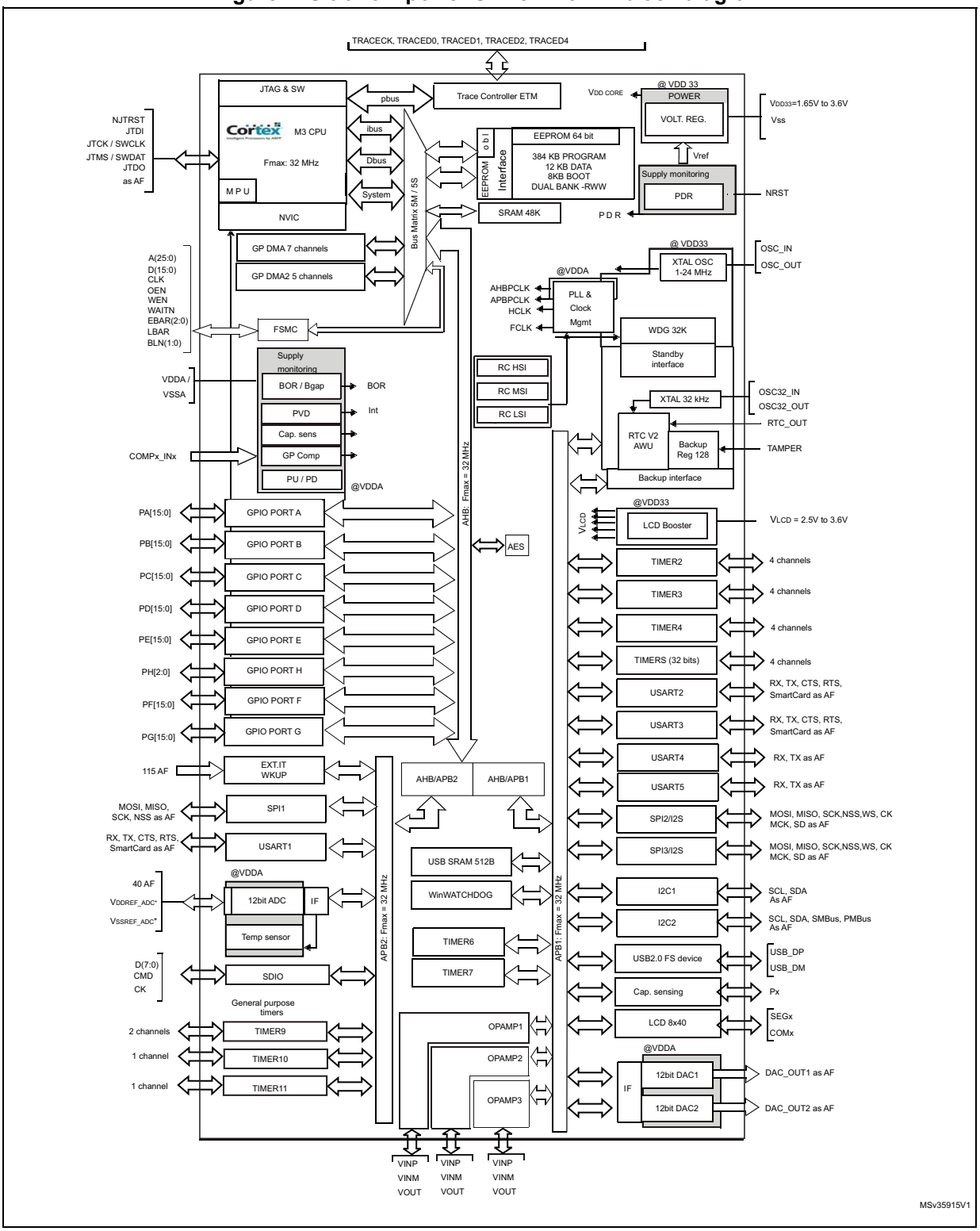
"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" 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, DMA, I²S, LCD, POR, PWM, WDT
Number of I/O	109
Program Memory Size	384KB (384K x 8)
Program Memory Type	FLASH
EEPROM Size	12K x 8
RAM Size	48K x 8
Voltage - Supply (Vcc/Vdd)	1.65V ~ 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	132-UFBGA
Supplier Device Package	132-UFBGA (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32l162qdh6dtr

3 Functional overview

Figure 1. Ultra-low-power STM32L162xD block diagram



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

3.10 LCD (liquid crystal display)

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 V_{LCD} 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
- 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

3.11 ADC (analog-to-digital converter)

A 12-bit analog-to-digital converters is embedded into STM32L162xD devices with up to 40 external channels, performing conversions in single-shot or scan mode. In scan mode, automatic conversion is performed on a selected group of analog inputs with up to 28 external channels in a group.

The ADC can be served by the DMA controller.

An analog watchdog feature allows very precise monitoring of the converted voltage of one, some or all scanned channels. An interrupt is generated when the converted voltage is outside the programmed thresholds.

The events generated by the general-purpose timers (TIMx) can be internally connected to the ADC start triggers, to allow the application to synchronize A/D conversions and timers. An injection mode allows high priority conversions to be done by interrupting a scan mode which runs in as a background task.

The ADC includes a specific low-power mode. The converter is able to operate at maximum speed even if the CPU is operating at a very low frequency and has an auto-shutdown function. The ADC's runtime and analog front-end current consumption are thus minimized whatever the MCU operating mode.

3.11.1 Temperature sensor

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

The temperature sensor is internally connected to the ADC_IN16 input channel 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

Table 7. STM32L162xD pin definitions

Pins					Pin name	Type(1)	I / O Level(2)	Main function(3) (after reset)	Pin functions	
LQFP144	UFBGA132	LQFP100	LQFP64	WLCSP64					Alternate functions	Additional functions
1	B2	1	-	-	PE2	I/O	FT	PE2	TIM3_ETR/LCD_SEG38/ FSMC_A23/TRACECLK	-
2	A1	2	-	-	PE3	I/O	FT	PE3	TIM3_CH1/LCD_SEG39/ FSMC_A19/TRACED0	-
3	B1	3	-	-	PE4	I/O	FT	PE4	TIM3_CH2/FSMC_A20/ TRACED1	-
4	C2	4	-	-	PE5	I/O	FT	PE5	TIM9_CH1/TRACED2 /FSMC_A21	-
5	D2	5	-	-	PE6-WKUP3	I/O	FT	PE6	TIM9_CH2/TRACED3	WKUP3/ RTC_TAMP3
6	E2	6	1	C6	V_{LCD}	S	-	V_{LCD}	-	-
7	C1	7	2	C8	PC13-WKUP2	I/O	FT	PC13	-	WKUP2/ RTC_TAMP1/ RTC_TS/ RTC_OUT
8	D1	8	3	B8	PC14-OSC32_IN(4)	I/O	-	PC14	-	OSC32_IN
9	E1	9	4	B7	PC15-OSC32_OUT	I/O	-	PC15	-	OSC32_OUT
10	D6	-	-	-	PF0	I/O	FT	PF0	FSMC_A0	-
11	D5	-	-	-	PF1	I/O	FT	PF1	FSMC_A1	-
12	D4	-	-	-	PF2	I/O	FT	PF2	FSMC_A2	-
13	E4	-	-	-	PF3	I/O	FT	PF3	FSMC_A3	-
14	F3	-	-	-	PF4	I/O	FT	PF4	FSMC_A4	-
15	F4	-	-	-	PF5	I/O	FT	PF5	FSMC_A5	-
16	F2	10	-	-	V_{SS_5}	S	-	V_{SS_5}	-	-
17	G2	11	-	-	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

Table 7. STM32L162xD pin definitions (continued)

Pins					Pin name	Type[1]	I / O Level[2]	Main function[3] (after reset)	Pin functions	
LQFP144	UFBGA132	LQFP100	LQFP64	WLCSP64					Alternate functions	Additional functions
116	C8	83	54	A3	PD2	I/O	FT	PD2	TIM3_ETR/UART5_RX/ LCD_SEG31/ LCD_SEG43/LCD_COM7 /SDIO_CMD	-
117	B8	84	-	-	PD3	I/O	FT	PD3	SPI2_MISO/ USART2_CTS /FSMC_CLK	-
118	B7	85	-	-	PD4	I/O	FT	PD4	SPI2_MOSI/I2S2_SD/ USART2_RTS /FSMC_NOE	-
119	A6	86	-	-	PD5	I/O	FT	PD5	USART2_TX /FSMC_NWE	-
120	F7	-	-	-	V_{SS_10}	S	-	V_{SS_10}	-	-
121	G7	-	-	-	V_{DD_10}	S	-	V_{DD_10}	-	-
122	B6	87	-	-	PD6	I/O	FT	PD6	USART2_RX /FSMC_NWAIT	-
123	A5	88	-	-	PD7	I/O	FT	PD7	TIM9_CH2/USART2_CK/ FSMC_NE1	-
124	D9	-	-	-	PG9	I/O	FT	PG9	FSMC_NE2	-
125	D8	-	-	-	PG10	I/O	FT	PG10	FSMC_NE3	-
126	-	-	-	-	PG11	I/O	FT	PG11	-	-
127	D7	-	-	-	PG12	I/O	FT	PG12	FSMC_NE4	-
128	C7	-	-	-	PG13	I/O	FT	PG13	FSMC_A24	-
129	C6	-	-	-	PG14	I/O	FT	PG14	FSMC_A25	-
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	A4	PB3	I/O	FT	JTDO	TIM2_CH2/SPI1_SCK/ SPI3_SCK/ I2S3_CK/ LCD_SEG7/JTDO	COMP2_INM
134	A7	90	56	B4	PB4	I/O	FT	NJTRST	TIM3_CH1/SPI1_MISO/ SPI3_MISO/ LCD_SEG8/NJTRST	COMP2_INP

Alternate functions

Table 8. Alternate function input/output

Port name	Digital alternate function number									..			..		
	AFIO0	AFIO1	AFIO2	AFIO3	AFIO4	AFIO5	AFIO6	AFIO7	AFIO8	..	AFIO11	AFIO12	..	AFIO14	AFIO15
	Alternate function														
	SYSTEM	TIM2	TIM3/4/5	TIM9/ 10/11	I2C1/2	SPI1/2	SPI3	USART1/2/3	UART4/5		LCD	FSMC/ SDIO		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
PA11	-	-	-	-	-	SPI1_MISO		USART1_CTS	-		-	-		TIMx_IC4	EVENT OUT

Table 12. General operating conditions (continued)

Symbol	Parameter	Conditions	Min	Max	Unit
T_J	Junction temperature range	6 suffix version	–40	105	°C
		7 suffix version	–40	110	

1. When the ADC is used, refer to *Table 63: ADC characteristics*.
2. It is recommended to power V_{DD} and V_{DDA} from the same source. A maximum difference of 300 mV between V_{DD} and V_{DDA} can be tolerated during power-up and operation.
3. To sustain a voltage higher than VDD+0.3V, the internal pull-up/pull-down resistors must be disabled.
4. If T_A is lower, higher P_D values are allowed as long as T_J does not exceed T_J max (see *Table 79: Thermal characteristics on page 146*).
5. In low-power dissipation state, T_A can be extended to -40°C to 105°C temperature range as long as T_J does not exceed T_J max (see *Table 79: Thermal characteristics on page 146*).

6.3.2 Embedded reset and power control block characteristics

The parameters given in the following table are derived from the tests performed under the conditions summarized in *Table 12*.

Table 13. Embedded reset and power control block characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{VDD}(1)	V_{DD} rise time rate	BOR detector enabled	0	-	∞	µs/V
		BOR detector disabled	0	-	1000	
	V_{DD} fall time rate	BOR detector enabled	20	-	∞	
		BOR detector disabled	0	-	1000	
$T_{RSTTEMPO}$(1)	Reset temporization	V_{DD} rising, BOR enabled	-	2	3.3	ms
		V_{DD} rising, BOR disabled(2)	0.4	0.7	1.6	
$V_{POR/PDR}$	Power on/power down reset threshold	Falling edge	1	1.5	1.65	V
		Rising edge	1.3	1.5	1.65	
V_{BOR0}	Brown-out reset threshold 0	Falling edge	1.67	1.7	1.74	
		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	

6.3.3 Embedded internal reference voltage

The parameters given in *Table 15* are based on characterization results, unless otherwise specified.

Table 14. 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 00F8 - 0x1FF8 00F9

Table 15. 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)	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) (4)	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 iterations.

Table 22. 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	0.82	-	µA
			T_A = -40 °C to 25 °C	1.15	1.9	
			T_A = 55 °C	1.15	2.2	
			T_A= 85 °C	1.65	4	
			T_A = 105 °C	2.75	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	1.05	-	
			T_A = -40 °C to 25 °C	1.35	-	
			T_A = 55 °C	1.55	-	
			T_A= 85 °C	2.1	-	
			T_A = 105 °C	3.3	-	
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	0.305	0.6	
			T_A = 55 °C	0.365	0.9	
			T_A = 85 °C	0.66	2.75	
			T_A = 105 °C	2	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

Low-speed external user clock generated from an external source

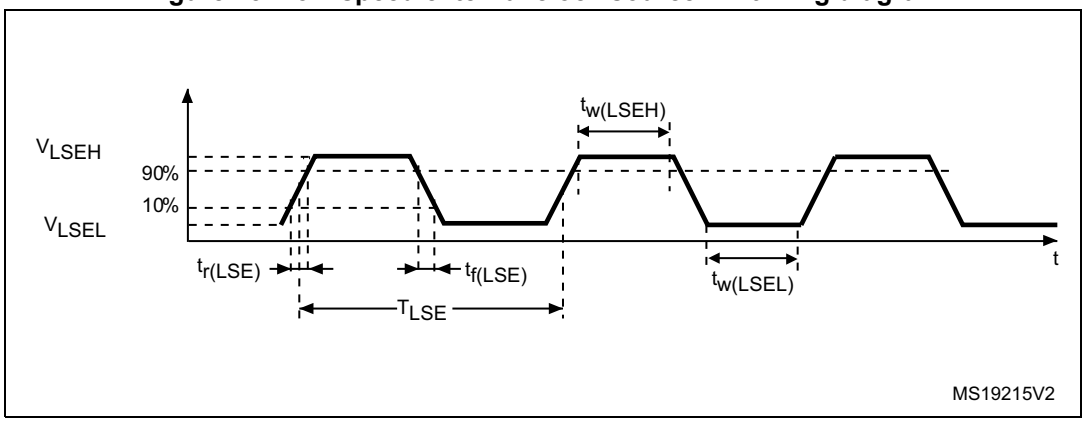
The characteristics given in the following table result from tests performed using a low-speed external clock source, and under the conditions summarized in *Table 12*.

Table 26. 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 27*. 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).

6.3.7 Internal clock source characteristics

The parameters given in *Table 29* are derived from tests performed under the conditions summarized in *Table 12*.

High-speed internal (HSI) RC oscillator

Table 29. HSI oscillator characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{HSI}	Frequency	V_{DD} = 3.0 V	-	16	-	MHz
$TRIM^{(1)(2)}$	HSI user-trimmed resolution	Trimming code is not a multiple of 16	-	±0.4	0.7	%
		Trimming code is a multiple of 16	-	-	±1.5	%
$ACC_{HSI}^{(2)}$	Accuracy of the factory-calibrated HSI oscillator	V_{DDA} = 3.0 V, T_A = 25 °C	-1(3)	-	1(3)	%
		V_{DDA} = 3.0 V, T_A = 0 to 55 °C	-1.5	-	1.5	%
		V_{DDA} = 3.0 V, T_A = -10 to 70 °C	-2	-	2	%
		V_{DDA} = 3.0 V, T_A = -10 to 85 °C	-2.5	-	2	%
		V_{DDA} = 3.0 V, T_A = -10 to 105 °C	-4	-	2	%
		V_{DDA} = 1.65 V to 3.6 V T_A = -40 to 105 °C	-4	-	3	%
$t_{SU(HSI)}^{(2)}$	HSI oscillator startup time	-	-	3.7	6	µs
$I_{DD(HSI)}^{(2)}$	HSI oscillator power consumption	-	-	100	140	µA

1. The trimming step differs depending on the trimming code. It is usually negative on the codes which are multiples of 16 (0x00, 0x10, 0x20, 0x30...0xE0).
2. Guaranteed by characterization results.
3. Guaranteed by test in production.

Low-speed internal (LSI) RC oscillator

Table 30. LSI oscillator characteristics

Symbol	Parameter	Min	Typ	Max	Unit
$f_{LSI}^{(1)}$	LSI frequency	26	38	56	kHz
$D_{LSI}^{(2)}$	LSI oscillator frequency drift 0°C ≤T_A ≤105°C	-10	-	4	%
$t_{su(LSI)}^{(3)}$	LSI oscillator startup time	-	-	200	µs
$I_{DD(LSI)}^{(3)}$	LSI oscillator power consumption	-	400	510	nA

1. Guaranteed by test in production.
2. This is a deviation for an individual part, once the initial frequency has been measured.
3. Guaranteed by design.

6.3.8 PLL characteristics

The parameters given in *Table 32* are derived from tests performed under the conditions summarized in *Table 12*.

Table 32. PLL characteristics

Symbol	Parameter	Value			Unit
		Min	Typ	Max(1)	
f_{PLL_IN}	PLL input clock(2)	2	-	24	MHz
	PLL input clock duty cycle	45	-	55	%
f_{PLL_OUT}	PLL output clock	2	-	32	MHz
t_{LOCK}	PLL lock time PLL input = 16 MHz PLL VCO = 96 MHz	-	115	160	µs
Jitter	Cycle-to-cycle jitter	-	-	±600	ps
I_{DDA}(PLL)	Current consumption on V_{DDA}	-	220	450	µA
I_{DD}(PLL)	Current consumption on V_{DD}	-	120	150	

1. Guaranteed by characterization results.
2. Take care of using the appropriate multiplier factors so as to have PLL input clock values compatible with the range defined by f_{PLL_OUT}.

6.3.9 Memory characteristics

The characteristics are given at T_A = -40 to 105 °C unless otherwise specified.

RAM memory

Table 33. RAM and hardware registers

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VRM	Data retention mode(1)	STOP mode (or RESET)	1.65	-	-	V

1. Minimum supply voltage without losing data stored in RAM (in Stop mode or under Reset) or in hardware registers (only in Stop mode).

Flash memory and data EEPROM

Table 34. Flash memory and data EEPROM characteristics

Symbol	Parameter	Conditions	Min	Typ	Max(1)	Unit
V_{DD}	Operating voltage Read / Write / Erase	-	1.65	-	3.6	V
t_{prog}	Programming/ erasing time for byte / word / double word / half-page	Erasing	-	3.28	3.94	ms
		Programming	-	3.28	3.94	
I_{DD}	Average current during the whole programming / erase operation	T_A = 25 °C, V_{DD} = 3.6 V	-	600	900	µA
	Maximum current (peak) during the whole programming / erase operation		-	1.5	2.5	mA

1. Guaranteed by design.

Table 35. Flash memory and data EEPROM endurance and retention

Symbol	Parameter	Conditions	Value			Unit
			Min(1)	Typ	Max	
N_{CYC}(2)	Cycling (erase / write) Program memory	T_A = -40°C to 105 °C	10	-	-	kcycles
	Cycling (erase / write) EEPROM data memory		300	-	-	
t_{RET}(2)	Data retention (program memory) after 10 kcycles at T_A = 85 °C	T_{RET} = +85 °C	30	-	-	years
	Data retention (EEPROM data memory) after 300 kcycles at T_A = 85 °C		30	-	-	
	Data retention (program memory) after 10 kcycles at T_A = 105 °C	T_{RET} = +105 °C	10	-	-	
	Data retention (EEPROM data memory) after 300 kcycles at T_A = 105 °C		10	-	-	

1. Guaranteed by characterization results.
2. Characterization is done according to JEDEC JESD22-A117.

Table 42. Synchronous non-multiplexed NOR/PSRAM read timings(1) (continued)

Symbol	Parameter	Min	Max	Unit
$t_{su(NWAITV-CLKH)}$	FSMC_NWAIT valid before FSMC_CLK high	6	-	ns
$t_{h(CLKH-NWAITV)}$	FSMC_NWAIT valid after FSMC_CLK high	0	-	ns

1. C_L = 30 pF.

Figure 25. Synchronous non-multiplexed PSRAM write timings

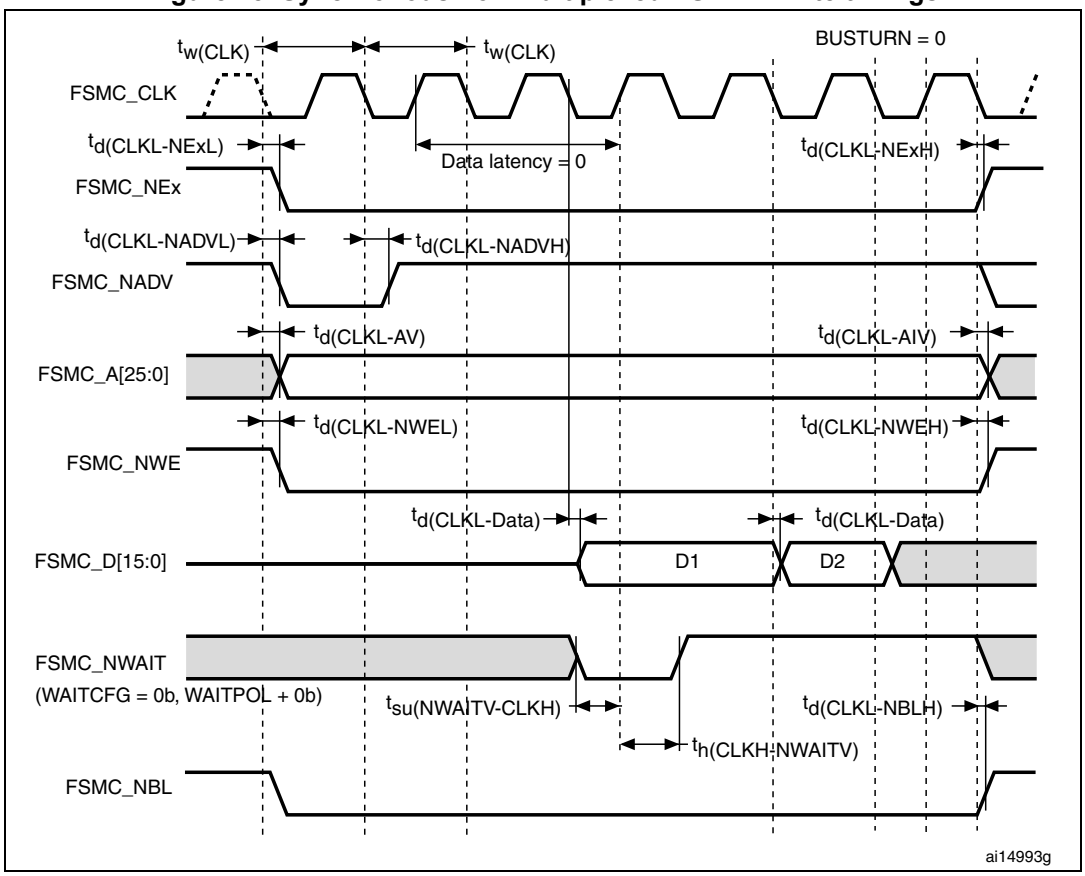


Table 43. Synchronous non-multiplexed PSRAM write timings(1)

Symbol	Parameter	Min	Max	Unit
$t_{w(CLK)}$	FSMC_CLK period	$2*T_{HCLK}$ -3	-	ns
$t_{d(CLKL-NExL)}$	FSMC_CLK low to FSMC_NEx low (x = 0...2)	-	0	ns
$t_{d(CLKL-NExH)}$	FSMC_CLK low to FSMC_NEx high (x = 0...2)	1	-	ns
$t_{d(CLKL-NADVL)}$	FSMC_CLK low to FSMC_NADV low	-	5	ns
$t_{d(CLKL-NADVH)}$	FSMC_CLK low to FSMC_NADV high	7	-	ns
$t_{d(CLKL-AV)}$	FSMC_CLK low to FSMC_Ax valid (x = 16...25)	-	0	ns
$t_{d(CLKL-AIV)}$	FSMC_CLK low to FSMC_Ax invalid (x = 16...25)	T_{HCLK} + 4	-	ns
$t_{d(CLKL-NWEL)}$	FSMC_CLK low to FSMC_NWE low	-	2	ns

6.3.17 Communications interfaces

I^2C interface characteristics

The device I^2C interface meets the requirements of the standard I^2C communication protocol with the following restrictions: SDA and SCL are not “true” open-drain I/O pins. When configured as open-drain, the PMOS connected between the I/O pin and V_{DD} is disabled, but is still present.

The I^2C characteristics are described in *Table 54*. Refer also to *Section 6.3.14: I/O port characteristics* for more details on the input/output ction characteristics (SDA and SCL).

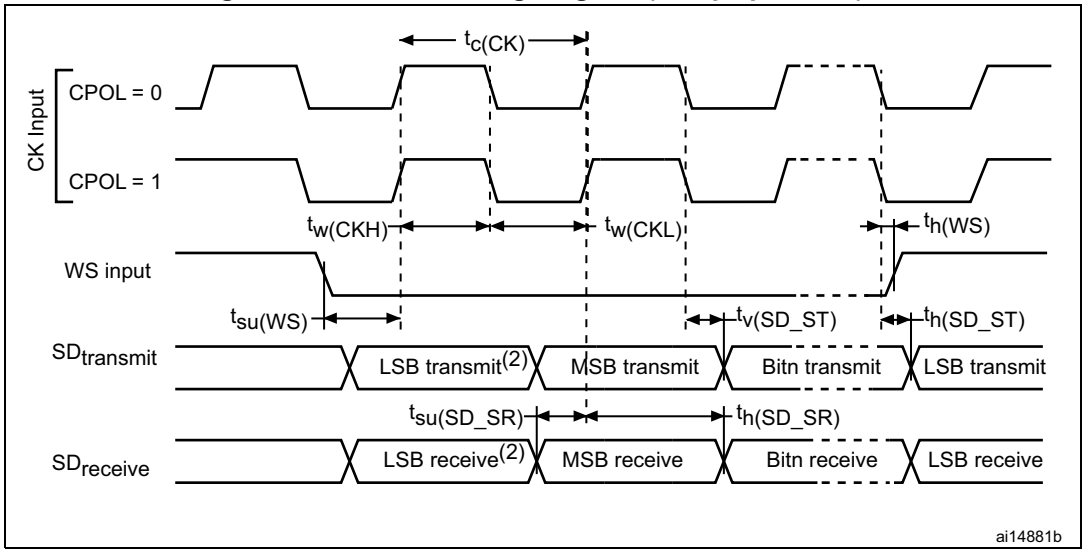
Table 54. I^2C characteristics

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

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

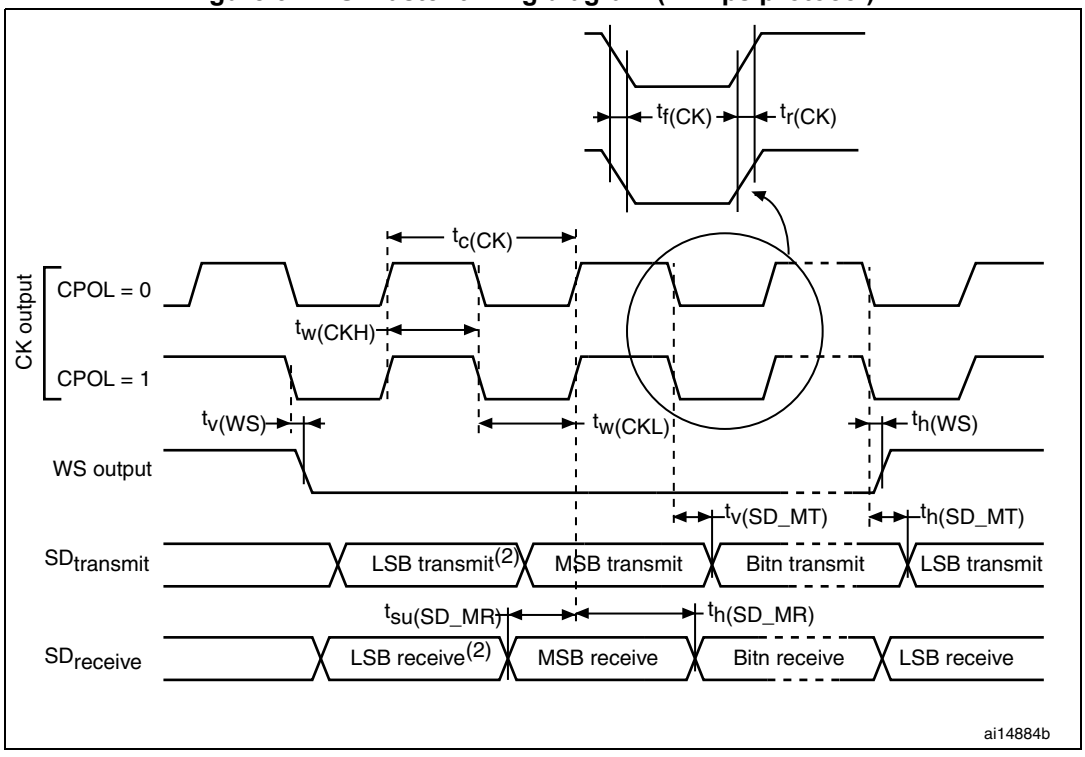
*ODD bit value, digital contribution leads to a min of (I2SDIV/(2*I2SDIV+ODD) and a max of (I2SDIV+ODD)/(2*I2SDIV+ODD). Fs max is supported for each mode/condition.*

Figure 33. I²S slave timing diagram (Philips protocol)(1)



1. Measurement points are done at CMOS levels: $0.3 \times V_{DD}$ and $0.7 \times V_{DD}$.
2. LSB transmit/receive of the previously transmitted byte. No LSB transmit/receive is sent before the first byte.

Figure 34. I²S master timing diagram (Philips protocol)(1)



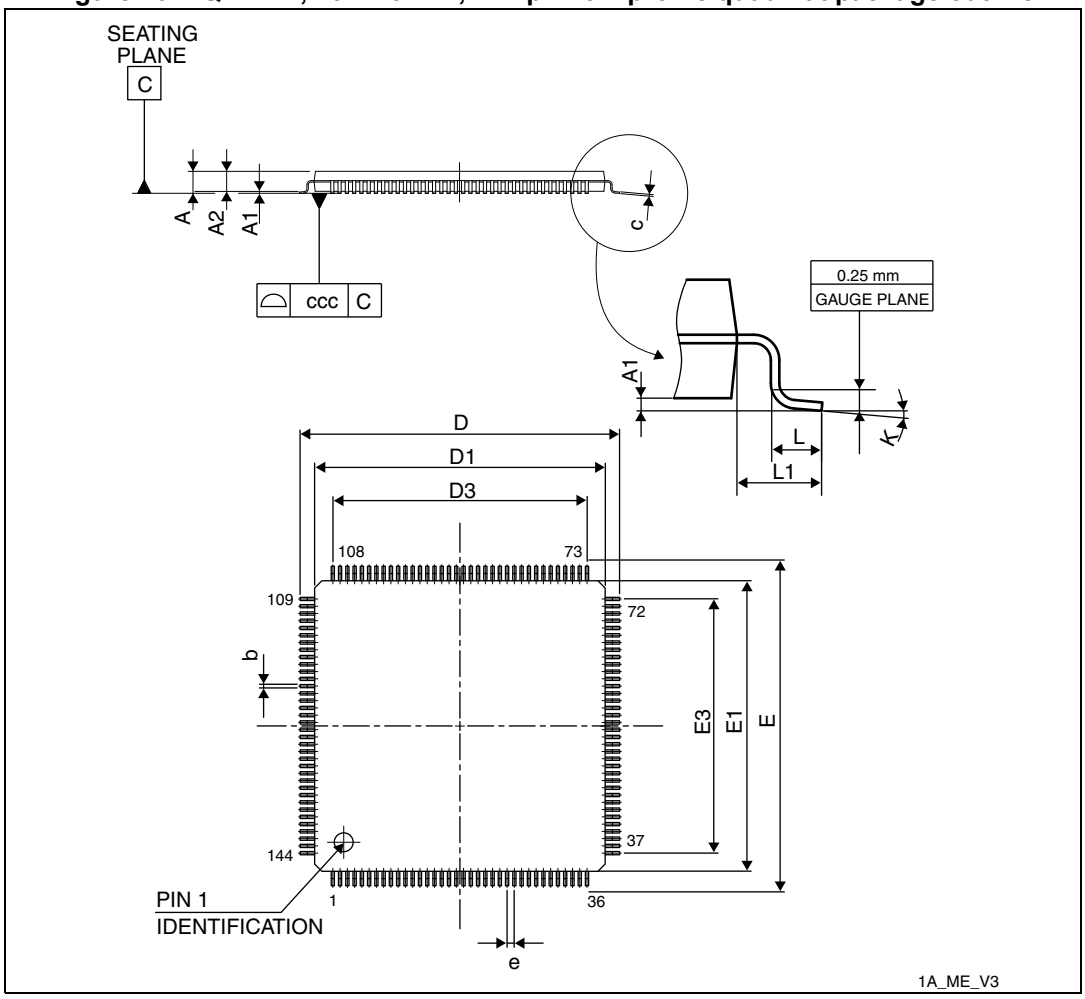
1. Guaranteed by characterization results.
2. LSB transmit/receive of the previously transmitted byte. No LSB transmit/receive is sent before the first byte.

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.

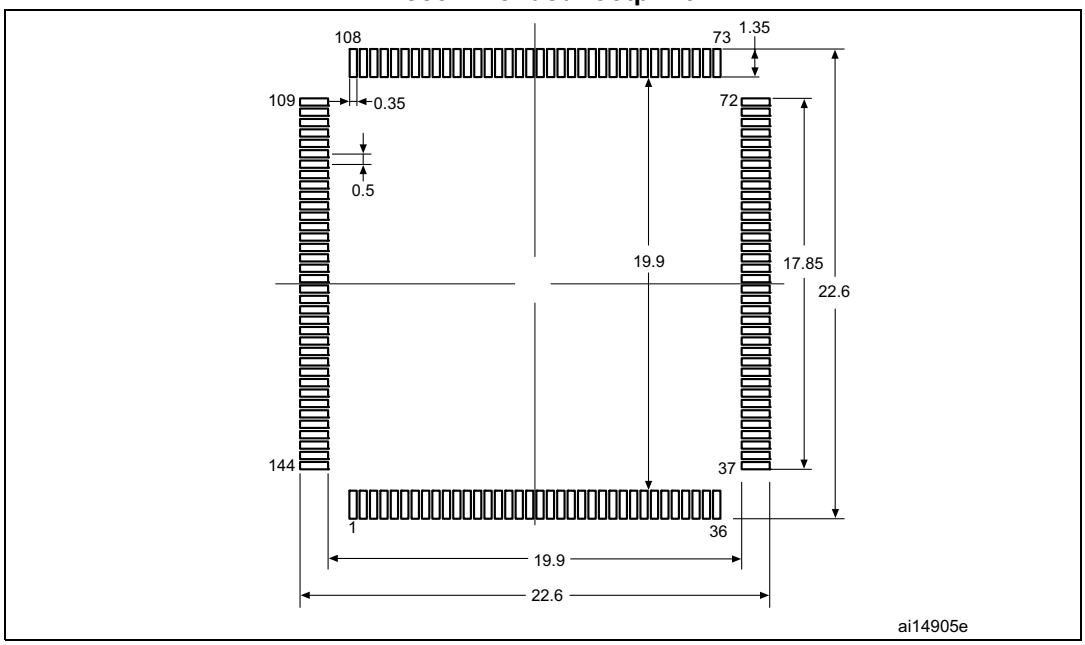
7.1 LQFP144, 20 x 20 mm, 144-pin low-profile quad flat package information

Figure 40. LQFP144, 20 x 20 mm, 144-pin low-profile quad flat package outline



1. Drawing is not to scale.

Figure 41. LQFP144, 20 x 20 mm, 144-pin low-profile quad flat package recommended footprint

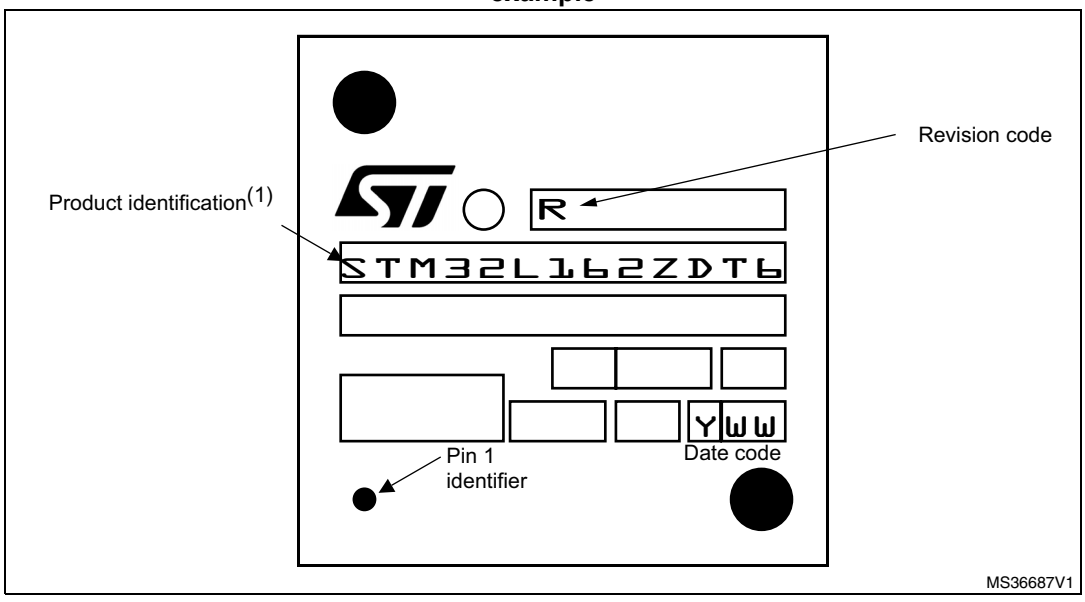


1. Dimensions are in millimeters.

Marking of engineering samples

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

Figure 42. LQFP144, 20 x 20 mm, 144-pin low-profile quad flat package top view example

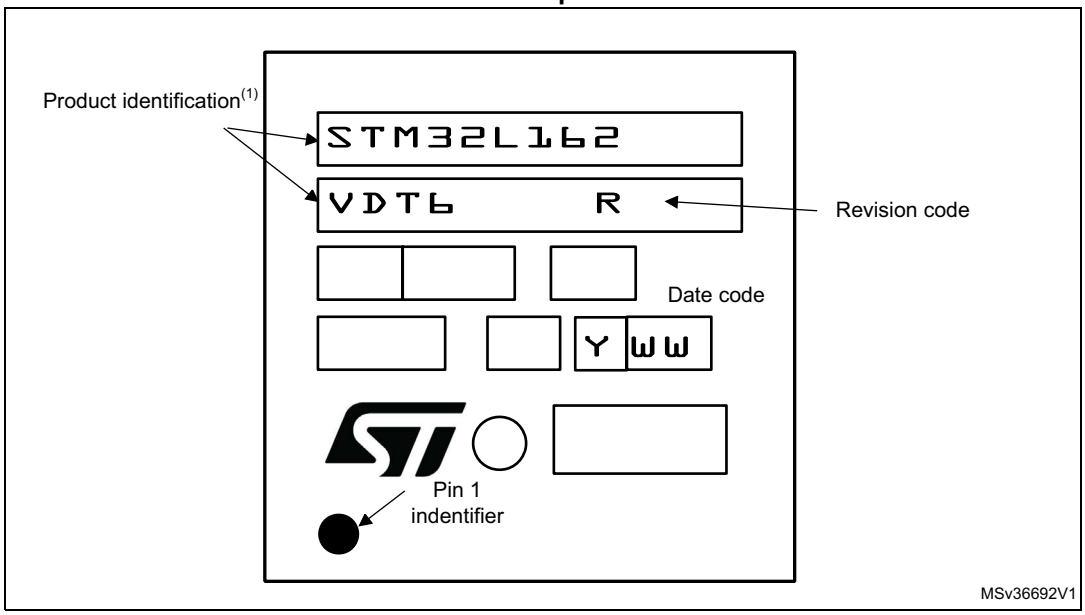


1. Parts marked as “ES”, “E” or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not yet ready to be used in production and any consequences deriving from such usage will not be at ST charge. In no event, ST will be liable for any customer usage of these engineering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

Marking of engineering samples

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

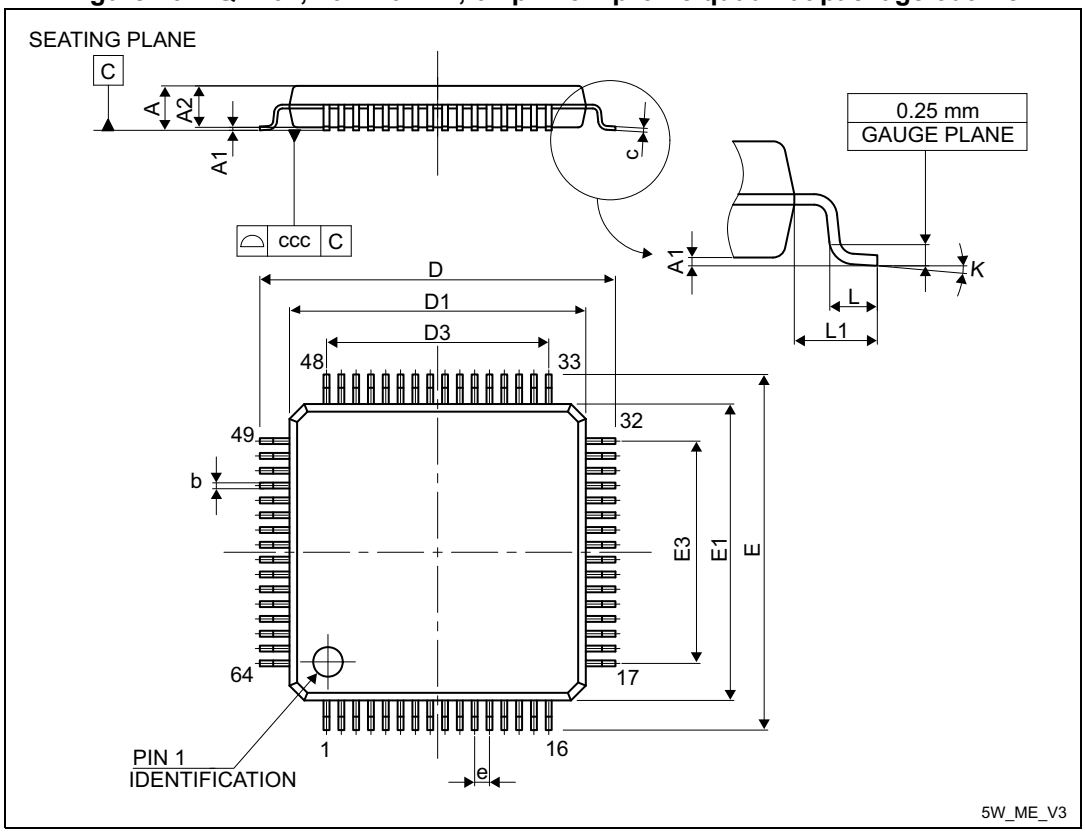
Figure 45. LQFP100, 14 x 14 mm, 100-pin low-profile quad flat package top view example



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

7.3 LQFP64, 10 x 10 mm, 64-pin low-profile quad flat package information

Figure 46. LQFP64, 10 x 10 mm, 64-pin low-profile quad flat package outline



1. Drawing is not to scale.

Table 75. LQFP64, 10 x 10 mm 64-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	-	12.000	-	-	0.4724	-
D1	-	10.000	-	-	0.3937	-
D3	-	7.500	-	-	0.2953	-
E	-	12.000	-	-	0.4724	-
E1	-	10.000	-	-	0.3937	-

9 Revision History

Table 81. Document revision history

Date	Revision	Changes
24-Oct-2011	1	Initial release.
28-Feb-2012	2	Status of the document changed (datasheet instead of preliminary data). Added STM32L162RD part number. Added LQFP64 and WLCSP64 packages. Updated “Low power ” and “Memory” feature on page 1. *Introduction* and *Description*: added ‘high density’. GPIOF replaced with GIOPH. Added SDIO in *Table 5: Ultralow power STM32L162xD device features and peripheral counts on page 13*. *Section 3: Functional overview*: changed ‘128 kHz’ to ‘131 kHz’ in section “Low power run mode”. *Section 3.16: AES*: updated ‘214’ to ‘213’ clock cycles. *Section 3.17.1: General-purpose timers (TIM2, TIM3, TIM4, TIM5, TIM9, TIM10 and TIM11)*: changed ‘six’ to ‘seven’ synchronizable general-purpose timers. Added SDIO in *Table 19: Alternate function input/output on page 86* (FSMC/SDIO instead of FSMC); modified alternate function for PA13 and PA14; removed EVENT OUT for PH2. Modified *Section 3.4: Clock management on page 20*. *Table 15: STM32L162xD pin definitions on page 60*: updated name of reference manual in footnote *4.* Modified *Figure 8: Power supply scheme on page 46*. Modified *Table 2: Functionalities depending on the operating power supply range on page 15*. *Table 18: Current consumption in Run mode, code with data processing running from RAM*: added footnote *3*. *Table 19: Current consumption in Sleep mode*: updated condition for f_{HSE}; added footnote *3*. *Table 23: Typical and maximum current consumptions in Standby mode*: modified max values. *Table 28: Peripheral current consumption*: added AES. *Table 64: USB DC electrical characteristics*: removed two footnotes. Modified *Table 38: Flash memory and data EEPROM characteristics on page 83*. Modified tables in *Section 6.3.4: Supply current characteristics on page 54*.