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

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M4
Core Size	32-Bit Single-Core
Speed	80MHz
Connectivity	CANbus, I²C, IrDA, LINbus, MMC/SD, QSPI, SAI, SPI, SWPMI, UART/USART, USB OTG
Peripherals	Brown-out Detect/Reset, DMA, LCD, PWM, WDT
Number of I/O	52
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	320K x 8
Voltage - Supply (Vcc/Vdd)	1.71V ~ 3.6V
Data Converters	A/D 16x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	64-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32l496ret6

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Table 2. STM32L496xx family device features and peripheral counts (continued)

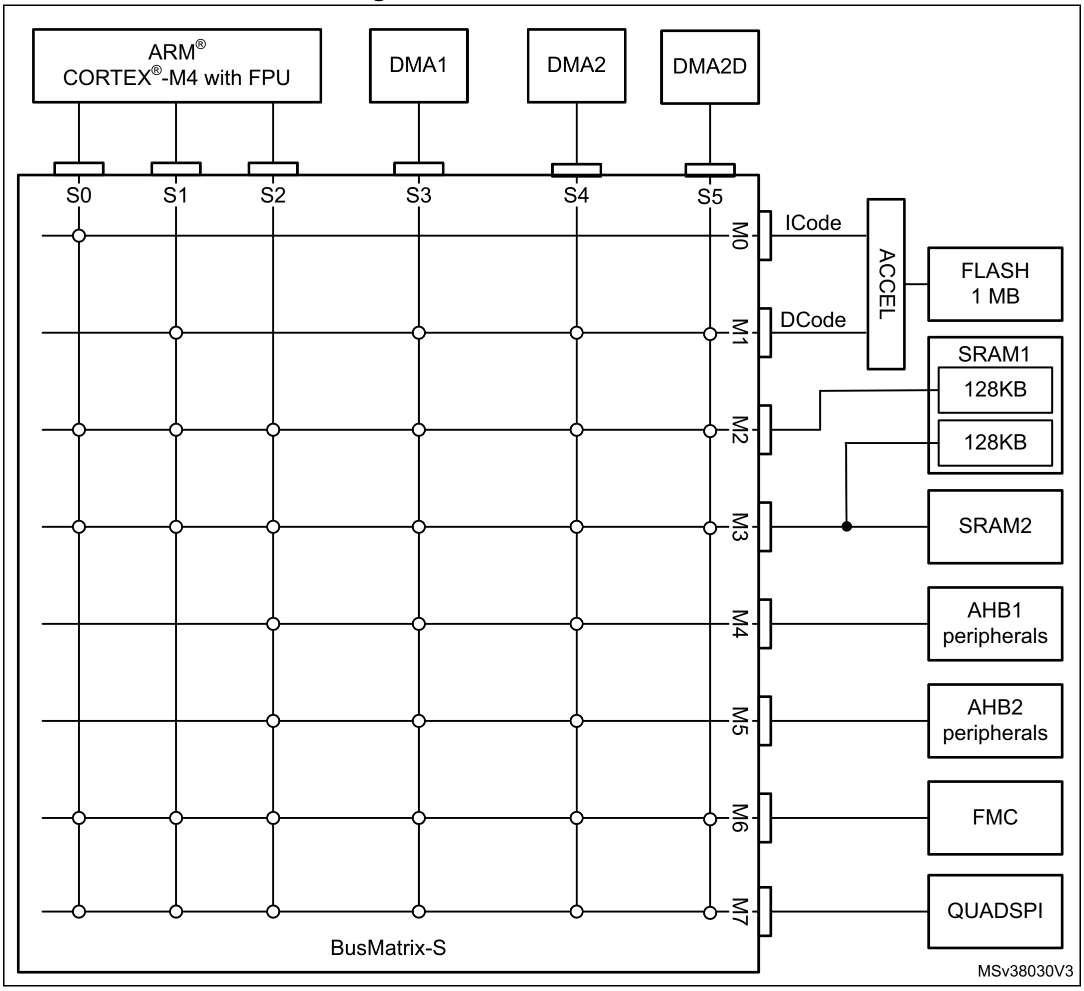
Peripheral	STM32L496Ax	STM32L496Zx	STM32L496Qx	STM32L496Vx	STM32L496Rx
LCD COM x SEG	Yes 8x40 or 4x44				
Random generator	Yes				
GPIOs(3) Wakeup pins Nb of I/Os down to 1.08 V	136 5 14	115 5 14	110 5 14	83 5 0	52 4 0
Capacitive sensing Number of channels	24	24	24	21	21
12-bit ADCs Number of channels	3 24	3 24	3 19	3 16	3 16
12-bit DAC channels	2				
Internal voltage reference buffer	Yes				
Analog comparator	2				
Operational amplifiers	2				
Max. CPU frequency	80 MHz				
Operating voltage (VDD)	1.71 to 3.6 V				
Operating voltage (VDD12)	1.05 to 1.32 V				
Operating temperature	Ambient operating temperature: -40 to 85 °C / -40 to 105 °C / -40 to 125 °C Junction temperature: -40 to 105 °C / -40 to 125 °C / -40 to 130 °C				
Packages	UFBGA169	LQFP144	UFBGA132	LQFP100 WLCSP100	LQFP64

1. For the LQFP100 and WLCSP100 packages, only FMC Bank1 is available. Bank1 can only support a multiplexed NOR/PSRAM memory using the NE1 Chip Select.
2. Only up to 13 data bits.
3. In case external SMPS package type is used, 2 GPIO's are replaced by VDD12 pins to connect the SMPS power supplies hence reducing the number of available GPIO's by 2.

3.6 Multi-AHB bus matrix

The 32-bit multi-AHB bus matrix interconnects all the masters (CPU, DMAs and the DMA2D) and the slaves (Flash memory, RAM, FMC, QUADSPI, AHB and APB peripherals) and ensures a seamless and efficient operation even when several high speed peripherals work simultaneously.

Figure 2. Multi-AHB bus matrix



3.7 Firewall

The device embeds a Firewall which protects code sensitive and secure data from any access performed by a code executed outside of the protected areas.

Each illegal access generates a reset which kills immediately the detected intrusion.

Table 4. STM32L496xx modes overview

Mode	Regulator[1]	CPU	Flash	SRAM	Clocks	DMA & Peripherals[2]	Wakeup source	Consumption[3]	Wakeup time
Run	MR range 1	Yes	ON[4]	ON	Any	All	N/A	108 µA/MHz	N/A
	SMPS range 2 High							40 µA/MHz[5]	
	MR range2					All except OTG_FS, RNG		93 µA/MHz	
	SMPS range 2 Low							39 µA/MHz[6]	
LPRun	LPR	Yes	ON[4]	ON	Any except PLL	All except OTG_FS, RNG	N/A	129 µA/MHz	to Range 1: 4 µs to Range 2: 64 µs
Sleep	MR range 1	No	ON[4]	ON[7]	Any	All	Any interrupt or event	32 µA/MHz	6 cycles
	SMPS range 2 High							11.5 µA/MHz[5]	
	MR range2					All except OTG_FS, RNG		30 µA/MHz	
	SMPS range 2 Low							13 µA/MHz[6]	
LPSleep	LPR	No	ON[4]	ON[7]	Any except PLL	All except OTG_FS, RNG	Any interrupt or event	51 µA/MHz	6 cycles
Stop 0	MR Range 1[8]	No	OFF	ON	LSE LSI	BOR, PVD, PVM RTC,LCD, IWDG COMPx (x=1,2) DACx (x=1,2) OPAMPx (x=1,2) USARTx (x=1...5)[9] LPUART1[9] I2Cx (x=1...4)[10] LPTIMx (x=1,2) *** All other peripherals are frozen.	Reset pin, all I/Os BOR, PVD, PVM RTC, LCD, IWDG COMPx (x=1..2) USARTx (x=1...5)[9] LPUART1[9] I2Cx (x=1...34)[10] LPTIMx (x=1,2) OTG_FS[11] SWPMI1[12]	TBD	2.7 µs in SRAM 6.2 µs in Flash
	MR Range 2[8]							127 µA	

interrupt is generated if enabled. LSE failure can also be detected and generated an interrupt.

- Clock-out capability:
  - **MCO: microcontroller clock output:** it outputs one of the internal clocks for external use by the application
  - **LSCO: low speed clock output:** it outputs LSI or LSE in all low-power modes (except VBAT).

Several prescalers allow to configure the AHB frequency, the high speed APB (APB2) and the low speed APB (APB1) domains. The maximum frequency of the AHB and the APB domains is 80 MHz.

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

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

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

3.23 Liquid crystal display controller (LCD)

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

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

3.24 Digital filter for Sigma-Delta Modulators (DFSDM)

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

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

Table 15. STM32L496xx pin definitions (continued)

Pin Number									Pin name (function after reset)	Pin type	I/O structure	Notes	Pin functions	
LQFP64	WLCSP100	WLCSP100_SMPS	LQFP100	UFBGA132	LQFP144	LQFP144_SMPS	UFBGA169	UFBGA169_SMPS					Alternate functions	Additional functions
-	A4	A4	-	-	121	121	-	-	VDD	S	-	-	-	-
-	D5	B5	87	B6	122	122	E7	E7	PD6	I/O	FT	-	DCMI_D10, QUADSPI_BK2_IO1, DFSDM1_DATIN1, USART2_RX, QUADSPI_BK2_IO2, FMC_NWAIT, SAI1_SD_A, EVENTOUT	-
-	C5	C6	88	A5	123	123	F7	F7	PD7	I/O	FT	-	DFSDM1_CKIN1, USART2_CK, QUADSPI_BK2_IO3, FMC_NE1, EVENTOUT	-
-	B5	D6	-	D9	124	124	B7	B7	PG9	I/O	FT_s	-	SPI3_SCK, USART1_TX, FMC_NCE/FMC_NE2, SAI2_SCK_A, TIM15_CH1N, EVENTOUT	-
-	A5	A5	-	D8	125	125	D6	D6	PG10	I/O	FT_s	-	LPTIM1_IN1, SPI3_MISO, USART1_RX, FMC_NE3, SAI2_FS_A, TIM15_CH1, EVENTOUT	-
-	D6	E5	-	G3	126	126	E6	E6	PG11	I/O	FT_s	-	LPTIM1_IN2, SPI3_MOSI, USART1_CTS, SAI2_MCLK_A, TIM15_CH2, EVENTOUT	-
-	B6	B6	-	D7	127	127	F6	F6	PG12	I/O	FT_s	-	LPTIM1_ETR, SPI3_NSS, USART1_RTS_DE, FMC_NE4, SAI2_SD_A, EVENTOUT	-
-	-	-	-	C7	128	128	G7	G7	PG13	I/O	FT_fs	-	I2C1_SDA, USART1_CK, FMC_A24, EVENTOUT	-
-	-	-	-	C6	129	129	G6	G6	PG14	I/O	FT_fs	-	I2C1_SCL, FMC_A25, EVENTOUT	-
-	-	-	-	F7	130	130	A7	A7	VSS	S	-	-	-	-
-	A6	A6	-	G7	131	131	B6	B6	VDDIO2	S	-	-	-	-

Table 17. Alternate function AF8 to AF15 (for AF0 to AF7 see Table 16) (continued)

Port		AF8	AF9	AF10	AF11	AF12	AF13	AF14	AF15
		UART4/5/ LPUART1/ CAN2	CAN1/TSC	CAN2/ OTG_FS/DCMI/ QUADSPI	LCD	SDMMC/ COMP1/2/FM C/SWPMI1	SAI1/2	TIM2/15/16/17/ LPTIM2	EVENOUT
Port I	PI0	-	-	DCMI_D13	-	-	-	-	EVENTOUT
	PI1	-	-	DCMI_D8	-	-	-	-	EVENTOUT
	PI2	-	-	DCMI_D9	-	-	-	-	EVENTOUT
	PI3	-	-	DCMI_D10	-	-	-	-	EVENTOUT
	PI4	-	-	DCMI_D5	-	-	-	-	EVENTOUT
	PI5	-	-	DCMI_VSYNC	-	-	-	-	EVENTOUT
	PI6	-	-	DCMI_D6	-	-	-	-	EVENTOUT
	PI7	-	-	DCMI_D7	-	-	-	-	EVENTOUT
	PI8	-	-	DCMI_D12	-	-	-	-	EVENTOUT
	PI9	-	CAN1_RX	-	-	-	-	-	EVENTOUT
	PI10	-	-	-	-	-	-	-	EVENTOUT
	PI11	-	-	-	-	-	-	-	EVENTOUT

Table 26. Current consumption in Run and Low-power run modes, code with data processing running from Flash, ART enable (Cache ON Prefetch OFF)

Symbol	Parameter	Conditions			TYP					MAX[1]					Unit
		-	Voltage scaling	f_{HCLK}	25 °C	55 °C	85 °C	105 °C	125 °C	25 °C	55 °C	85 °C	105 °C	125 °C	
I_{DD_ALL}(Run)	Supply current in Run mode	$f_{HCLK} = f_{HSE}$ up to 48MHz included, bypass mode PLL ON above 48 MHz all peripherals disable	Range 2	26 MHz	2.65	2.69	2.82	3.05	3.51	2.9	3.0	3.3	3.8	4.7	mA
				16 MHz	1.68	1.72	1.85	2.07	2.53	1.9	2.0	2.2	2.7	3.7	
				8 MHz	0.91	0.94	1.07	1.29	1.74	1.0	1.1	1.4	1.8	2.8	
				4 MHz	0.52	0.55	0.68	0.9	1.35	0.6	0.7	0.9	1.4	2.4	
				2 MHz	0.33	0.36	0.48	0.7	1.15	0.4	0.5	0.7	1.2	2.2	
				1 MHz	0.23	0.26	0.38	0.6	1.06	0.3	0.4	0.6	1.1	2.0	
				100 kHz	0.14	0.17	0.3	0.52	0.97	0.2	0.3	0.5	1.0	2.0	
			Range 1	80 MHz	9.44	9.5	9.67	9.93	10.4	10.3	10.4	10.7	11.3	12.4	
				72 MHz	8.52	8.59	8.75	9.01	9.53	9.3	9.4	9.7	10.3	11.4	
				64 MHz	7.61	7.67	7.83	8.09	8.61	8.3	8.4	8.7	9.3	10.4	
				48 MHz	5.72	5.78	5.94	6.2	6.72	6.3	6.4	6.7	7.3	8.4	
				32 MHz	3.87	3.92	4.07	4.33	4.84	4.2	4.4	4.7	5.2	6.3	
				24 MHz	2.94	2.99	3.14	3.39	3.9	3.2	3.4	3.6	4.2	5.3	
				16 MHz	2.01	2.06	2.2	2.45	2.95	2.2	2.3	2.6	3.2	4.2	
I_{DD_ALL} (LPRun)	Supply current in Low-power run mode	$f_{HCLK} = f_{MSI}$ all peripherals disable		2 MHz	274	307	444	678	1150	318	425	656	1167	2197	µA
				1 MHz	158	195	328	564	1040	195	309	558	1047	2084	
				400 kHz	88.2	123	256	490	969	116	232	485	973	2012	
				100 kHz	63	90.6	223	457	934	79	195	447	942	1975	

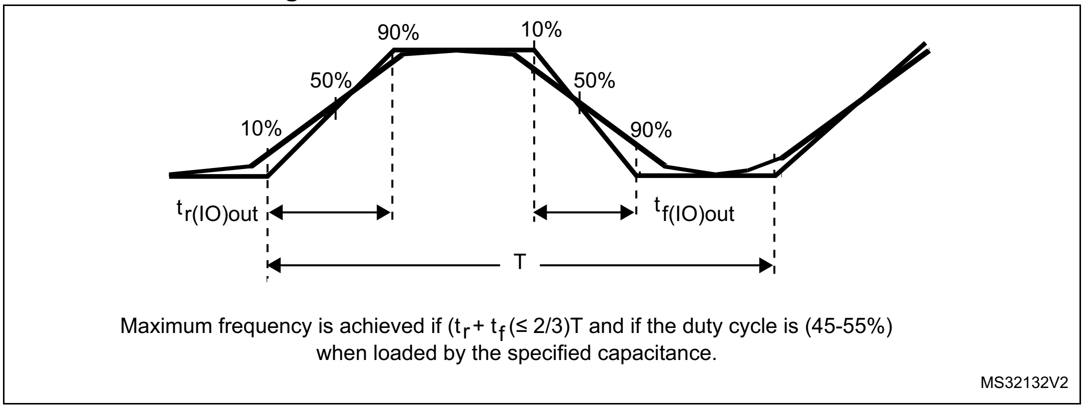
1. Guaranteed by characterization results, unless otherwise specified.

Table 48. Current consumption in Shutdown mode

Symbol	Parameter	Conditions		TYP					MAX(1)					Unit
		-	V_{DD}	25 °C	55 °C	85 °C	105 °C	125 °C	25 °C	55 °C	85 °C	105 °C	125 °C	
I_{DD_ALL} (Shutdown)	Supply current in Shutdown mode (backup registers retained) RTC disabled	-	1.8 V	24	161	983	3020	8970	84.7	556	3314	10498	31391	nA
			2.4 V	31	193	1150	3530	10300	111.5	648	3844	11897	35017	
			3 V	44	242	1400	4260	12500	153.7	780	4447	13473	39297	
			3.6 V	76	338	1790	5220	14700	235.9	1009	5354	15679	44571	
I_{DD_ALL} (Shutdown with RTC)	Supply current in Shutdown mode (backup registers retained) RTC enabled	RTC clocked by LSE bypassed at 32768 Hz	1.8 V	225	363	1190	3230	9180	-	-	-	-	-	nA
			2.4 V	314	478	1440	3820	10700	-	-	-	-	-	
			3 V	421	621	1790	4660	12900	-	-	-	-	-	
			3.6 V	561	831	2280	5730	15300	-	-	-	-	-	
		RTC clocked by LSE quartz (2) in low drive mode	1.8 V	341	472	1253	3059	-	-	-	-	-	-	
			2.4 V	435	586	1502	3591	-	-	-	-	-	-	
			3 V	553	732	1832	4345	-	-	-	-	-	-	
			3.6 V	716	948	2320	5325	-	-	-	-	-	-	
I_{DD_ALL} (wakeup from Shutdown)	Supply current during wakeup from Shutdown mode	Wakeup clock is MSI = 4 MHz. See (3).	3 V	0.6	-	-	-	-	-	-	-	-	-	mA

1. Guaranteed by characterization results, unless otherwise specified.
2. Based on characterization done with a 32.768 kHz crystal (MC306-G-06Q-32.768, manufacturer JFVNY) with two 6.8 pF loading capacitors.
3. Wakeup with code execution from Flash. Average value given for a typical wakeup time as specified in *Table 51: Low-power mode wakeup timings*.

Figure 29. I/O AC characteristics definition(1)



1. Refer to *Table 72: I/O AC characteristics*.

6.3.15 NRST pin characteristics

The NRST pin input driver uses the CMOS technology. It is connected to a permanent pull-up resistor, R_{PU}.

Unless otherwise specified, the parameters given in the table below are derived from tests performed under the ambient temperature and supply voltage conditions summarized in *Table 22: General operating conditions*.

Table 73. NRST pin characteristics(1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{IL(NRST)}$	NRST input low level voltage	-	-	-	0.3_xV_{DDIOx}	V
$V_{IH(NRST)}$	NRST input high level voltage	-	0.7_xV_{DDIOx}	-	-	
$V_{hys(NRST)}$	NRST Schmitt trigger voltage hysteresis	-	-	200	-	mV
R_{PU}	Weak pull-up equivalent resistor(2)	$V_{IN} = V_{SS}$	25	40	55	kΩ
$V_{F(NRST)}$	NRST input filtered pulse	-	-	-	70	ns
$V_{NF(NRST)}$	NRST input not filtered pulse	1.71 V ≤ V_{DD} ≤ 3.6 V	350	-	-	ns

1. Guaranteed by design.
2. The pull-up is designed with a true resistance in series with a switchable PMOS. This PMOS contribution to the series resistance is minimal (~10% order).

Table 76. Maximum ADC RAIN[(1)(2)] (continued)

Resolution	Sampling cycle @80 MHz	Sampling time [ns] @80 MHz	RAIN max (Ω)	
			Fast channels[(3)]	Slow channels[(4)]
6 bits	2.5	31.25	220	N/A
	6.5	81.25	560	330
	12.5	156.25	1200	1000
	24.5	306.25	2700	2200
	47.5	593.75	3900	3300
	92.5	1156.25	8200	6800
	247.5	3093.75	18000	15000
	640.5	8006.75	50000	50000

1. Guaranteed by design.
2. The I/O analog switch voltage booster is enable when V_{DDA} < 2.4 V (BOOSTEN = 1 in the SYSCFG_CFGR1 when V_{DDA} < 2.4V). It is disable when $V_{DDA} \geq$ 2.4 V.
3. Fast channels are: PC0, PC1, PC2, PC3, PA0.
4. Slow channels are: all ADC inputs except the fast channels.

6.3.18 Digital-to-Analog converter characteristics

Table 81. DAC characteristics(1)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DDA}	Analog supply voltage for DAC ON	DAC output buffer OFF, DAC_OUT pin not connected (internal connection only)		1.71	-	3.6	V
		Other modes		1.80	-		
V_{REF+}	Positive reference voltage	DAC output buffer OFF, DAC_OUT pin not connected (internal connection only)		1.71	-	V_{DDA}	
		Other modes		1.80	-		
V_{REF-}	Negative reference voltage	-		V_{SSA}			
R_L	Resistive load	DAC output buffer ON	connected to V_{SSA}	5	-	-	kΩ
			connected to V_{DDA}	25	-	-	
R_O	Output Impedance	DAC output buffer OFF		9.6	11.7	13.8	kΩ
R_{BON}	Output impedance sample and hold mode, output buffer ON	V_{DD} = 2.7 V		-	-	2	kΩ
		V_{DD} = 2.0 V		-	-	3.5	
R_{BOFF}	Output impedance sample and hold mode, output buffer OFF	V_{DD} = 2.7 V		-	-	16.5	kΩ
		V_{DD} = 2.0 V		-	-	18.0	
C_L	Capacitive load	DAC output buffer ON		-	-	50	pF
C_{SH}		Sample and hold mode		-	0.1	1	µF
V_{DAC_OUT}	Voltage on DAC_OUT output	DAC output buffer ON		0.2	-	V_{REF+} – 0.2	V
		DAC output buffer OFF		0	-	V_{REF+}	
$t_{SETTLING}$	Settling time (full scale: for a 12-bit code transition between the lowest and the highest input codes when DAC_OUT reaches final value ±0.5LSB, ±1 LSB, ±2 LSB, ±4 LSB, ±8 LSB)	Normal mode DAC output buffer ON CL ≤ 50 pF, RL ≥ 5 kΩ	±0.5 LSB	-	1.7	3	µs
			±1 LSB	-	1.6	2.9	
			±2 LSB	-	1.55	2.85	
			±4 LSB	-	1.48	2.8	
			±8 LSB	-	1.4	2.75	
		Normal mode DAC output buffer OFF, ±1LSB, CL = 10 pF		-	2	2.5	
t_{WAKEUP}(2)	Wakeup time from off state (setting the ENx bit in the DAC Control register) until final value ±1 LSB	Normal mode DAC output buffer ON CL ≤ 50 pF, RL ≥ 5 kΩ		-	4.2	7.5	µs
		Normal mode DAC output buffer OFF, CL ≤ 10 pF		-	2	5	
PSRR	V_{DDA} supply rejection ratio	Normal mode DAC output buffer ON CL ≤ 50 pF, RL = 5 kΩ, DC		-	-80	-28	dB

Table 84. COMP characteristics[1] (continued)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{DDA}(COMP)	Comparator consumption from V_{DDA}	Ultra-low-power mode	Static	-	400	600	nA
			With 50 kHz ±100 mV overdrive square signal	-	1200	-	
		Medium mode	Static	-	5	7	µA
			With 50 kHz ±100 mV overdrive square signal	-	6	-	
		High-speed mode	Static	-	70	100	
			With 50 kHz ±100 mV overdrive square signal	-	75	-	
I_{bias}	Comparator input bias current	-		-	-	-[4]	nA

1. Guaranteed by design, unless otherwise specified.
2. Refer to *Table 25: Embedded internal voltage reference*.
3. Guaranteed by characterization results.
4. Mostly I/O leakage when used in analog mode. Refer to I_{lkg} parameter in *Table 70: I/O static characteristics*.

6.3.21 Operational amplifiers characteristics

Table 85. OPAMP characteristics[1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DDA}	Analog supply voltage	-	1.8	-	3.6	V
CMIR	Common mode input range	-	0	-	V_{DDA}	V
VI_{OFFSET}	Input offset voltage	25 °C, No Load on output.	-	-	±1.5	mV
		All voltage/Temp.	-	-	±3	
ΔVI_{OFFSET}	Input offset voltage drift	Normal mode	-	±5	-	µV/°C
		Low-power mode	-	±10	-	
TRIMOFFSETP TRIMLPOFFSETP	Offset trim step at low common input voltage (0.1 x V_{DDA})	-	-	0.8	1.1	mV
TRIMOFFSETN TRIMLPOFFSETN	Offset trim step at high common input voltage (0.9 x V_{DDA})	-	-	1	1.35	

Table 91. TIMx[(1)] characteristics

Symbol	Parameter	Conditions	Min	Max	Unit
$t_{res(TIM)}$	Timer resolution time	-	1	-	$t_{TIMxCLK}$
		$f_{TIMxCLK}$ = 80 MHz	12.5	-	ns
f_{EXT}	Timer external clock frequency on CH1 to CH4	-	0	$f_{TIMxCLK}/2$	MHz
		$f_{TIMxCLK}$ = 80 MHz	0	40	MHz
Res_{TIM}	Timer resolution	TIMx (except TIM2 and TIM5)	-	16	bit
		TIM2 and TIM5	-	32	
$t_{COUNTER}$	16-bit counter clock period	-	1	65536	$t_{TIMxCLK}$
		$f_{TIMxCLK}$ = 80 MHz	0.0125	819.2	µs
t_{MAX_COUNT}	Maximum possible count with 32-bit counter	-	-	65536 × 65536	$t_{TIMxCLK}$
		$f_{TIMxCLK}$ = 80 MHz	-	53.68	s

1. TIMx, is used as a general term in which x stands for 1,2,3,4,5,6,7,8,15,16 or 17.

Table 92. IWDG min/max timeout period at 32 kHz (LSI)[(1)]

Prescaler divider	PR[2:0] bits	Min timeout RL[11:0]= 0x000	Max timeout RL[11:0]= 0xFFF	Unit
/4	0	0.125	512	ms
/8	1	0.250	1024	
/16	2	0.500	2048	
/32	3	1.0	4096	
/64	4	2.0	8192	
/128	5	4.0	16384	
/256	6 or 7	8.0	32768	

1. The exact timings still depend on the phasing of the APB interface clock versus the LSI clock so that there is always a full RC period of uncertainty.

Table 93. WWDG min/max timeout value at 80 MHz (PCLK)

Prescaler	WDGTB	Min timeout value	Max timeout value	Unit
1	0	0.0512	3.2768	ms
2	1	0.1024	6.5536	
4	2	0.2048	13.1072	
8	3	0.4096	26.2144	

Figure 37. Quad SPI timing diagram - SDR mode

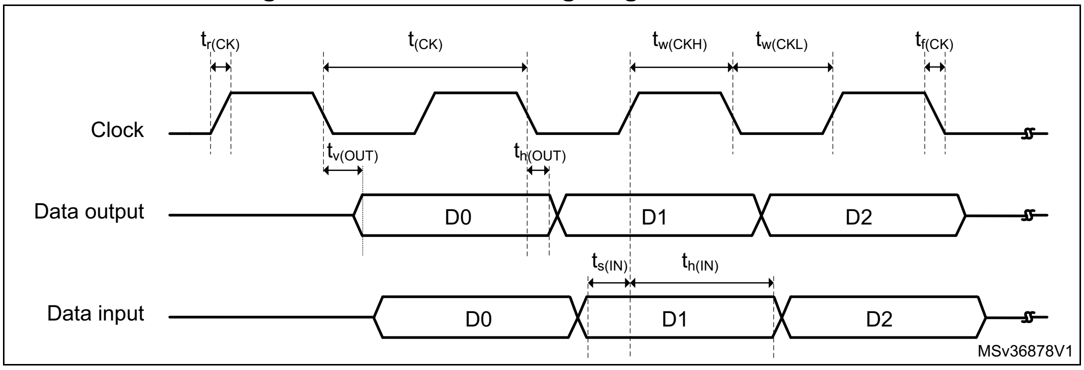


Figure 38. Quad SPI timing diagram - DDR mode

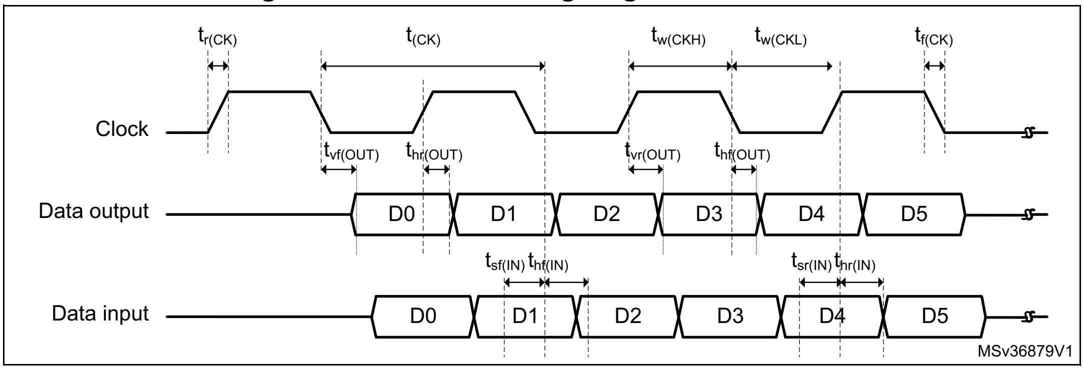


Table 102. Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings[(1)(2)]

Symbol	Parameter	Min	Max	Unit
$t_{w(NE)}$	FMC_NE low time	$2T_{HCLK}$-1	$2T_{HCLK}$+1	ns
$t_{v(NOE\_NE)}$	FMC_NEx low to FMC_NOE low	0	0.5	
$t_{w(NOE)}$	FMC_NOE low time	$2T_{HCLK}$-1	$2T_{HCLK}$+1	
$t_{h(NE\_NOE)}$	FMC_NOE high to FMC_NE high hold time	0	-	
$t_{v(A\_NE)}$	FMC_NEx low to FMC_A valid	-	0.5	
$t_{h(A\_NOE)}$	Address hold time after FMC_NOE high	0	-	
$t_{v(BL\_NE)}$	FMC_NEx low to FMC_BL valid	-	0.5	
$t_{h(BL\_NOE)}$	FMC_BL hold time after FMC_NOE high	0	-	
$t_{su(Data\_NE)}$	Data to FMC_NEx high setup time	T_{HCLK}-1	-	
$t_{su(Data\_NOE)}$	Data to FMC_NOEx high setup time	T_{HCLK}-1	-	
$t_{h(Data\_NOE)}$	Data hold time after FMC_NOE high	0	-	
$t_{h(Data\_NE)}$	Data hold time after FMC_NEx high	0	-	
$t_{v(NADV\_NE)}$	FMC_NEx low to FMC_NADV low	-	0	
$t_{w(NADV)}$	FMC_NADV low time	-	T_{HCLK}+1	

1. CL = 30 pF.
2. Guaranteed by characterization results.

Table 103. Asynchronous non-multiplexed SRAM/PSRAM/NOR read-NWAIT timings[(1)(2)]

Symbol	Parameter	Min	Max	Unit
$t_{w(NE)}$	FMC_NE low time	$7T_{HCLK}$-1	$7T_{HCLK}$+1	ns
$t_{w(NOE)}$	FMC_NWE low time	$5T_{HCLK}$-1	$5T_{HCLK}$+1	
$t_{w(NWAIT)}$	FMC_NWAIT low time	T_{HCLK}-0.5	-	
$t_{su(NWAIT\_NE)}$	FMC_NWAIT valid before FMC_NEx high	$5T_{HCLK}$+1.5	-	
$t_{h(NE\_NWAIT)}$	FMC_NEx hold time after FMC_NWAIT invalid	$4T_{HCLK}$+1	-	

1. CL = 30 pF.
2. Guaranteed by characterization results.

Table 111. Synchronous multiplexed PSRAM write timings[(1)(2)]

Symbol	Parameter	Min	Max	Unit
$t_{w(CLK)}$	FMC_CLK period	$2T_{HCLK}$- 0.5	-	ns
$t_{d(CLKL-NExL)}$	FMC_CLK low to FMC_NEx low (x=0..2)	-	2	
$t_{d(CLKH-NExH)}$	FMC_CLK high to FMC_NEx high (x= 0…2)	T_{HCLK}+ 0.5	-	
$t_{d(CLKL-NADVL)}$	FMC_CLK low to FMC_NADV low	-	1	
$t_{d(CLKL-NADVH)}$	FMC_CLK low to FMC_NADV high	0	-	
$t_{d(CLKL-AV)}$	FMC_CLK low to FMC_Ax valid (x=16…25)	-	4.5	
$t_{d(CLKH-AIV)}$	FMC_CLK high to FMC_Ax invalid (x=16…25)	T_{HCLK}	-	
$t_{d(CLKL-NWEL)}$	FMC_CLK low to FMC_NWE low	-	1.5	
$t_{d(CLKH-NWEH)}$	FMC_CLK high to FMC_NWE high	T_{HCLK}+ 0.5	-	
$t_{d(CLKL-ADV)}$	FMC_CLK low to FMC_AD[15:0] valid	-	3	
$t_{d(CLKL-ADIV)}$	FMC_CLK low to FMC_AD[15:0] invalid	0	-	
$t_{d(CLKL-DATA)}$	FMC_A/D[15:0] valid data after FMC_CLK low	-	3.5	
$t_{d(CLKL-NBLL)}$	FMC_CLK low to FMC_NBL low	-	2	
$t_{d(CLKH-NBLH)}$	FMC_CLK high to FMC_NBL high	T_{HCLK}+ 0.5	-	
$t_{su(NWAIT-CLKH)}$	FMC_NWAIT valid before FMC_CLK high	2	-	
$t_{h(CLKH-NWAIT)}$	FMC_NWAIT valid after FMC_CLK high	3.5	-	

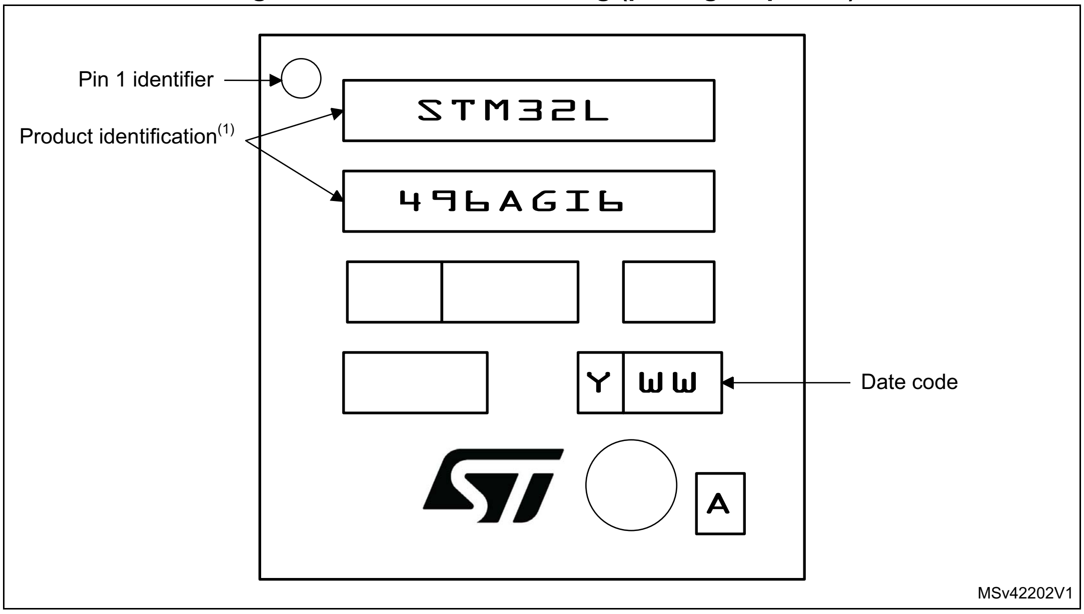
1. CL = 30 pF.
2. Guaranteed by characterization results.

Device marking

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

Other optional marking or inset/upset marks, which identify the parts throughout supply chain operations, are not indicated below.

Figure 60. UFBGA169 marking (package top view)



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.

Table 122. LQFP144 - 144-pin, 20 x 20 mm 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	21.800	22.000	22.200	0.8583	0.8661	0.8740
D1	19.800	20.000	20.200	0.7795	0.7874	0.7953
D3	-	17.500	-	-	0.6890	-
E	21.800	22.000	22.200	0.8583	0.8661	0.8740
E1	19.800	20.000	20.200	0.7795	0.7874	0.7953
E3	-	17.500	-	-	0.6890	-
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°	3.5°	7°	0°	3.5°	7°
ccc	-	-	0.080	-	-	0.0031

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