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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®-M7
Core Size	32-Bit Single-Core
Speed	216MHz
Connectivity	CANbus, EBI/EMI, Ethernet, I²C, IrDA, LINbus, MMC/SD/SDIO, QSPI, SAI, SPDIF, SPI, UART/USART, USB OTG
Peripherals	Brown-out Detect/Reset, DMA, I²S, LCD, POR, PWM, WDT
Number of I/O	140
Program Memory Size	1MB (1M x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	512K x 8
Voltage - Supply (Vcc/Vdd)	1.7V ~ 3.6V
Data Converters	A/D 24x12b; D/A 2x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	176-LQFP
Supplier Device Package	176-LQFP (24x24)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/stm32f769igt6

Contents

The STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx devices offer devices in 10 packages ranging from 100 pins to 216 pins. The set of included peripherals changes with the device chosen.

These features make the STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx microcontrollers suitable for a wide range of applications:

- Motor drive and application control
- Medical equipment
- Industrial applications: PLC, inverters, circuit breakers
- Printers, and scanners
- Alarm systems, video intercom, and HVAC
- Home audio appliances
- Mobile applications, Internet of Things
- Wearable devices: smartwatches.

Figure 2 shows the general block diagram of the device family

- LPR is used in the Stop modes:
  The LP regulator mode is configured by software when entering Stop mode.
  Like the MR mode, the LPR can be configured in two ways during stop mode:
  – LPR operates in normal mode (default mode when LPR is ON)
  – LPR operates in under-drive mode (reduced leakage mode).
- Power-down is used in Standby mode.
  The Power-down mode is activated only when entering in Standby mode. The regulator output is in high impedance and the kernel circuitry is powered down, inducing zero consumption. The contents of the registers and SRAM are lost.

Refer to *Table 3* for a summary of voltage regulator modes versus device operating modes.

Two external ceramic capacitors should be connected on V_{CAP_1} and V_{CAP_2} pin.

All packages have the regulator ON feature.

Table 3. Voltage regulator configuration mode versus device operating mode(1)

Voltage regulator configuration	Run mode	Sleep mode	Stop mode	Standby mode
Normal mode	MR	MR	MR or LPR	-
Over-drive mode(2)	MR	MR	-	-
Under-drive mode	-	-	MR or LPR	-
Power-down mode	-	-	-	Yes

1. '-' means that the corresponding configuration is not available.
2. The over-drive mode is not available when V_{DD} = 1.7 to 2.1 V.

2.19.2 Regulator OFF

This feature is available only on packages featuring the BYPASS_REG pin. The regulator is disabled by holding BYPASS_REG high. The regulator OFF mode allows to supply externally a V_{12} voltage source through V_{CAP_1} and V_{CAP_2} pins.

Since the internal voltage scaling is not managed internally, the external voltage value must be aligned with the targeted maximum frequency.The two 2.2 µF ceramic capacitors should be replaced by two 100 nF decoupling capacitors.

When the regulator is OFF, there is no more internal monitoring on V_{12}. An external power supply supervisor should be used to monitor the V_{12} of the logic power domain. PA0 pin should be used for this purpose, and act as power-on reset on V_{12} power domain.

In the regulator OFF mode, the following features are no more supported:

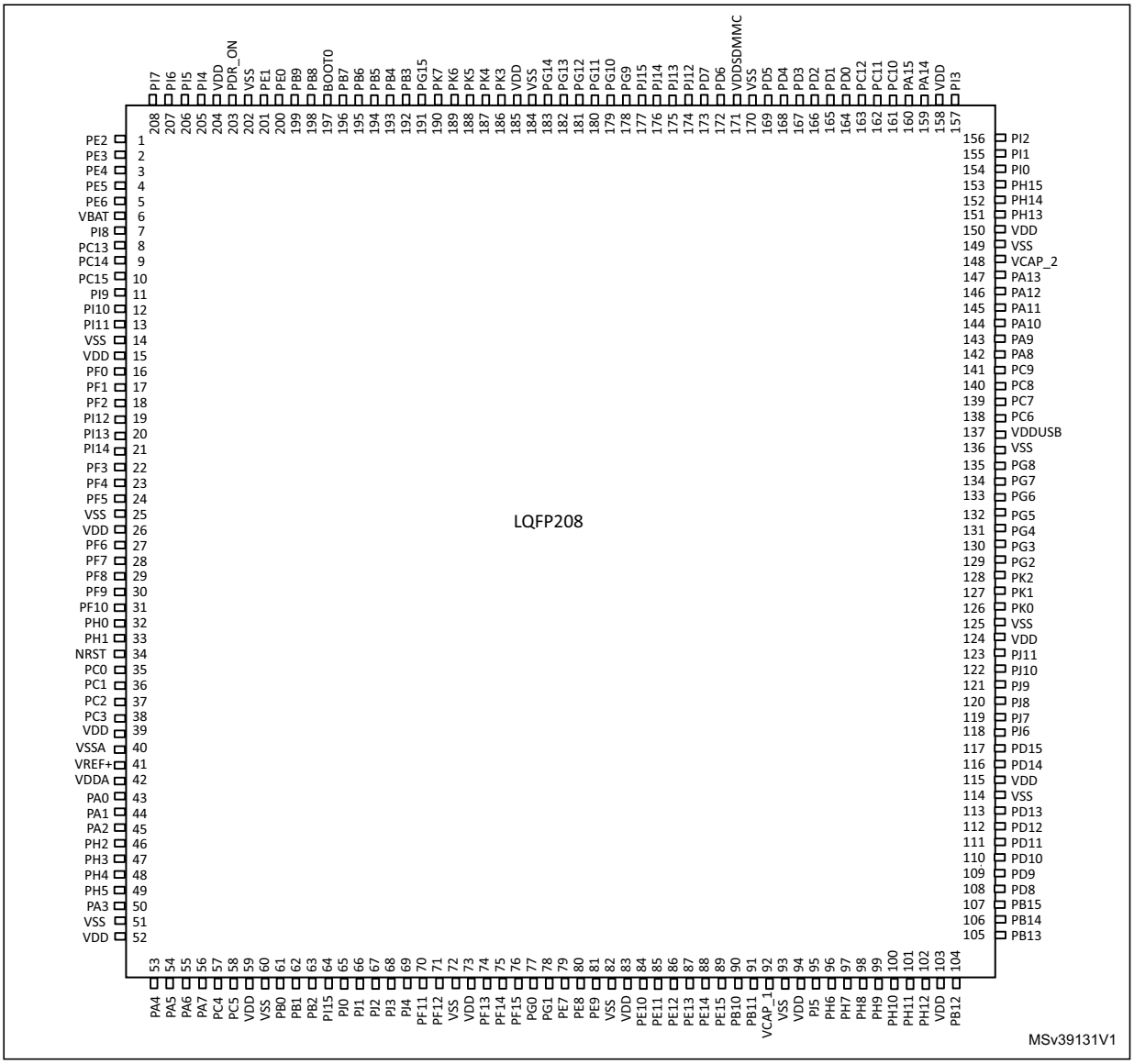
- PA0 cannot be used as a GPIO pin since it allows to reset a part of the V_{12} logic power domain which is not reset by the NRST pin.
- As long as PA0 is kept low, the debug mode cannot be used under power-on reset. As a consequence, PA0 and NRST pins must be managed separately if the debug connection under reset or pre-reset is required.
- The over-drive and under-drive modes are not available.
- The Standby mode is not available.

Table 6. Timer feature comparison

Timer type	Timer	Counter resolution	Counter type	Prescaler factor	DMA request generation	Capture/ compare channels	Complementary output	Max interface clock (MHz)	Max timer clock (MHz)(1)
Advanced -control	TIM1, TIM8	16-bit	Up, Down, Up/down	Any integer between 1 and 65536	Yes	4	Yes	108	216
General purpose	TIM2, TIM5	32-bit	Up, Down, Up/down	Any integer between 1 and 65536	Yes	4	No	54	108/216
	TIM3, TIM4	16-bit	Up, Down, Up/down	Any integer between 1 and 65536	Yes	4	No	54	108/216
	TIM9	16-bit	Up	Any integer between 1 and 65536	No	2	No	108	216
	TIM10, TIM11	16-bit	Up	Any integer between 1 and 65536	No	1	No	108	216
	TIM12	16-bit	Up	Any integer between 1 and 65536	No	2	No	54	108/216
	TIM13, TIM14	16-bit	Up	Any integer between 1 and 65536	No	1	No	54	108/216
Basic	TIM6, TIM7	16-bit	Up	Any integer between 1 and 65536	Yes	0	No	54	108/216

1. The maximum timer clock is either 108 or 216 MHz depending on TIMPRE bit configuration in the RCC_DCKCFGR register.

Figure 16. STM32F76xxx LQFP208 pinout



1. The above figure shows the package top view.

Table 10. STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx pin and ball definitions (continued)

Pin Number										Pin name (function after reset)	Pin type	I/O structure	Notes	Alternate functions	Additional functions
STM32F765xx STM32F767xx						STM32F768Ax STM32F769xx									
LQFP100	LQFP144	UFBGA176	LQFP176	LQFP208	TFBGA216	WLCSP180[1]	LQFP176	LQFP208	TFBGA216						
55	77	P15	96	108	L15	M3	89	108	L15	PD8	I/O	FT	-	DFSDM1_CKIN3, USART3_TX, SPDIF_RX1, FMC_D13, EVENTOUT	-
56	78	P14	97	109	L14	L3	90	109	L14	PD9	I/O	FT	-	DFSDM1_DATIN3, USART3_RX, FMC_D14, EVENTOUT	-
57	79	N15	98	110	K15	M2	91	110	K15	PD10	I/O	FT	-	DFSDM1_CKOUT, USART3_CK, FMC_D15, LCD_B3, EVENTOUT	-
58	80	N14	99	111	N10	K3	92	111	N10	PD11	I/O	FT	-	I2C4_SMBA, USART3_CTS, QUADSPI_BK1_IO0, SAI2_SD_A, FMC_A16/FMC_CLE, EVENTOUT	-
59	81	N13	100	112	M10	J4	93	112	M10	PD12	I/O	FT	-	TIM4_CH1, LPTIM1_IN1, I2C4_SCL, USART3_RTS, QUADSPI_BK1_IO1, SAI2_FS_A, FMC_A17/FMC_ALE, EVENTOUT	-
60	82	M15	101	113	M11	L2	94	113	M11	PD13	I/O	FT	-	TIM4_CH2, LPTIM1_OUT, I2C4_SDA, QUADSPI_BK1_IO3, SAI2_SCK_A, FMC_A18, EVENTOUT	-
-	83	-	102	114	J10	M1	95	114	J10	VSS	S		-	-	-
-	84	J13	103	115	J11	-	96	115	J11	VDD	S		-	-	-
61	85	M14	104	116	L12	L1	97	116	L12	PD14	I/O	FT	-	TIM4_CH3, UART8_CTS, FMC_D0, EVENTOUT	-
62	86	L14	105	117	K13	K2	98	117	K13	PD15	I/O	FT	-	TIM4_CH4, UART8_RTS, FMC_D1, EVENTOUT	-
-	-	-	-	118	K12	-	-	-	-	PJ6	I/O	FT	-	LCD_R7, EVENTOUT	-
-	-	-	-	119	J12	-	-	-	-	PJ7	I/O	FT	-	LCD_G0, EVENTOUT	-

Table 10. STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx pin and ball definitions (continued)

Pin Number										Pin name (function after reset)	Pin type	I/O structure	Notes	Alternate functions	Additional functions
STM32F765xx STM32F767xx						STM32F768Ax STM32F769xx									
LQFP100	LQFP144	UFBGA176	LQFP176	LQFP208	TFBGA216	WLCSP180[1]	LQFP176	LQFP208	TFBGA216						
-	-	F6	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	F7	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	F8	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	F9	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	F10	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	G6	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	G7	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	G8	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	G9	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	G10	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	H6	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	H7	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	H8	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	H9	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	H10	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	J6	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	J7	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	J8	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	J9	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	J10	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	K6	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	K7	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	K8	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	K9	-	-	-	-	-	-	-	VSS	S	-	-	-	-
-	-	K10	-	-	-	-	-	-	-	VSS	S	-	-	-	-

Table 12. STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx alternate function mapping (continued)

Port		AF0	AF1	AF2	AF3	AF4	AF5	AF6	AF7	AF8	AF9	AF10	AF11	AF12	AF13	AF14	AF15
		SYS	I2C4/UART5/TIM1/2	TIM3/4/5	TIM8/9/10/11/LPTIM1/DFSDM1/CEC	I2C1/2/3/4/USART1/CEC	SPI1/I2S1/SPI2/I2S2/SPI3/I2S3/SPI4/5/6	SPI2/I2S2/SPI3/I2S3/SAI1/I2C4/UART4/DFSDM1	SPI2/I2S2/SPI3/I2S3/SPI6/USART1/2/3/UART5/DFSDM1/SPDIF	SPI6/SAI2/USART6/UART4/5/7/8/OTG_FS/SPDIF	CAN1/2/TIM12/13/14/QUADSPI/FMC/LCD	SAI2/QUADSPI/SDMMC2/DFSDM1/OTG2_HS/OTG1_FS/LCD	I2C4/CAN3/SDMMC2/ETH	UART7/FMC/SDMMC1/MDIOS/OTG2_FS	DCMI/LCD/DSI	LCD	SYS
Port C	PC11	-	-	-	DFSDM1_DATAIN5	-	-	SPI3_MISO	USART3_RX	UART4_RX	QUADSPI_BK2_NCS	-	-	SDMMC_D3	DCMI_D4	-	EVENTOUT
	PC12	TRACED3	-	-	-	-	-	SPI3_MOSI/I2S3_SD	USART3_CK	UART5_TX	-	-	-	SDMMC_CK	DCMI_D9	-	EVENTOUT
	PC13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENTOUT
	PC14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENTOUT
	PC15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENTOUT
Port D	PD0	-	-	-	DFSDM1_CKIN6	-	-	DFSDM1_DATAIN7	-	UART4_RX	CAN1_RX	-	-	FMC_D2	-	-	EVENTOUT
	PD1	-	-	-	DFSDM1_DATAIN6	-	-	DFSDM1_CKIN7	-	UART4_TX	CAN1_TX	-	-	FMC_D3	-	-	EVENTOUT
	PD2	TRACED2	-	TIM3_ETR	-	-	-	-	-	UART5_RX	-	-	-	SDMMC_CMD	DCMI_D11	-	EVENTOUT
	PD3	-	-	-	DFSDM1_CKOUT	-	SPI2_SCK/I2S2_CK	DFSDM1_DATAIN0	USART2_CTS	-	-	-	-	FMC_CLK	DCMI_D5	LCD_G7	EVENTOUT
	PD4	-	-	-	-	-	-	DFSDM1_CKIN0	USART2_RTS	-	-	-	-	FMC_NOE	-	-	EVENTOUT
	PD5	-	-	-	-	-	-	-	USART2_TX	-	-	-	-	FMC_NWE	-	-	EVENTOUT
	PD6	-	-	-	DFSDM1_CKIN4	-	SPI3_MOSI/I2S3_SD	SAI1_SD_A	USART2_RX	-	-	DFSDM1_DATAIN1	SDMMC2_CK	FMC_NWAIT	DCMI_D10	LCD_B2	EVENTOUT
	PD7	-	-	-	DFSDM1_DATAIN4	-	SPI1_MOSI/I2S1_SD	DFSDM1_CKIN1	USART2_CK	SPDIF_RX0	-	-	SDMMC2_CMD	FMC_NE1	-	-	EVENTOUT

Table 12. STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx alternate function mapping (continued)

Port		AF0	AF1	AF2	AF3	AF4	AF5	AF6	AF7	AF8	AF9	AF10	AF11	AF12	AF13	AF14	AF15
		SYS	I2C4/UART5/TIM1/2	TIM3/4/5	TIM8/9/10/11/LPTIM1/DFSDM1/CEC	I2C1/2/3/4/USART1/CEC	SPI1/I2S1/SPI2/I2S2/SPI3/I2S3/SPI4/5/6	SPI2/I2S2/SPI3/I2S3/SAI1/I2C4/UART4/DFSDM1	SPI2/I2S2/SPI3/I2S3/SPI6/USART1/2/3/UART5/DFSDM1/SPDIF	SPI6/SAI2/USART6/UART4/5/7/8/OTG_FS/SPDIF	CAN1/2/TIM12/13/14/QUADSPI/FMC/LCD	SAI2/QUADSPI/SDMMC2/DFSDM1/OTG2_HS/OTG1_FS/LCD	I2C4/CAN3/SDMMC2/ETH	UART7/FMC/SDMMC1/MDIOS/OTG2_FS	DCMI/LCD/DSI	LCD	SYS
Port H	PH0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENTOUT
	PH1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EVENTOUT
	PH2	-	-	-	LPTIM1_IN2	-	-	-	-	-	QUADSPI_BK2_IO0	SAI2_SCK_B	ETH_MII_CRS	FMC_SDCKE0	-	LCD_R0	EVENTOUT
	PH3	-	-	-	-	-	-	-	-	-	QUADSPI_BK2_IO1	SAI2_MCK_B	ETH_MII_COL	FMC_SDNE0	-	LCD_R1	EVENTOUT
	PH4	-	-	-	-	I2C2_SCL	-	-	-	-	LCD_G5	OTG_HS_ULPI_NXT	-	-	-	LCD_G4	EVENTOUT
	PH5	-	-	-	-	I2C2_SDA	SPI5_NSS	-	-	-	-	-	-	FMC_SDNWE	-	-	EVENTOUT
	PH6	-	-	-	-	I2C2_SMBA	SPI5_SCK	-	-	-	TIM12_CH1	-	ETH_MII_RXD2	FMC_SDNE1	DCMI_D8	-	EVENTOUT
	PH7	-	-	-	-	I2C3_SCL	SPI5_MISO	-	-	-	-	-	ETH_MII_RXD3	FMC_SDCKE1	DCMI_D9	-	EVENTOUT
	PH8	-	-	-	-	I2C3_SDA	-	-	-	-	-	-	-	FMC_D16	DCMI_HSYNC	LCD_R2	EVENTOUT
	PH9	-	-	-	-	I2C3_SMBA	-	-	-	-	TIM12_CH2	-	-	FMC_D17	DCMI_D0	LCD_R3	EVENTOUT
	PH10	-	-	TIM5_CH1	-	I2C4_SMBA	-	-	-	-	-	-	-	FMC_D18	DCMI_D1	LCD_R4	EVENTOUT
	PH11	-	-	TIM5_CH2	-	I2C4_SCL	-	-	-	-	-	-	-	FMC_D19	DCMI_D2	LCD_R5	EVENTOUT
	PH12	-	-	TIM5_CH3	-	I2C4_SDA	-	-	-	-	-	-	-	FMC_D20	DCMI_D3	LCD_R6	EVENTOUT
	PH13	-	-	-	TIM8_CH1N	-	-	-	-	UART4_TX	CAN1_TX	-	-	FMC_D21	-	LCD_G2	EVENTOUT

Table 13. STM32F765xx, STM32F767xx, STM32F768Ax and STM32F769xx register boundary addresses(1)

Bus	Boundary address	Peripheral
	0xE00F FFFF - 0xFFFF FFFF	Reserved
Cortex-M7	0xE000 0000 - 0xE00F FFFF	Cortex-M7 internal peripherals
AHB3	0xD000 0000 - 0xDFFF FFFF	FMC bank 6
	0xC000 0000 - 0xCFFF FFFF	FMC bank 5
	0xA000 2000 - 0xBFFF FFFF	Reserved
	0xA000 1000 - 0xA000 1FFF	Quad-SPI control register
	0xA000 0000- 0xA000 0FFF	FMC control register
	0x9000 0000 - 0x9FFF FFFF	Quad-SPI
	0x8000 0000 - 0x8FFF FFFF	FMC bank 3
	0x7000 0000 - 0x7FFF FFFF	FMC bank 2
	0x6000 0000 - 0x6FFF FFFF	FMC bank 1
	0x5006 0C00- 0x5FFF FFFF	Reserved
AHB2	0x5006 0800 - 0x5006 0BFF	RNG
	0x5005 2000 - 0x5005 FFFF	Reserved
	0x5005 1000 - 0x5005 1FFF	JPEG codec
	0x5005 0000 - 0x5005 03FF	DCMI
	0x5004 0000- 0x5004 FFFF	Reserved
	0x5000 0000 - 0x5003 FFFF	USB OTG FS

Table 26. Typical and maximum current consumption in Run mode, code with data processing running from Flash memory (Dual bank mode, ART ON except prefetch / L1-cache ON), regulator ON

Symbol	Parameter	Conditions	f_{HCLK} (MHz)	Typ	Max(1)			Unit
					T_A = 25 °C	T_A = 85 °C	T_A = 105 °C	
I_{DD}	Supply current in RUN mode	All peripherals enabled(2)(3)	216	190	219	255	-	mA
			200	177	204	242	268	
			180	157	173	208	228	
			168	139	153	185	204	
			144	107	117	144	161	
			60	48	54	81	98	
			25	23	28	54	71	
		All peripherals disabled(3)	216	92	104	150	-	
			200	86	97	143	170	
			180	76	85	119	140	
			168	67	75	107	126	
			144	52	58	84	101	
			60	23	28	54	71	
			25	11	15	42	59	

1. Guaranteed by characterization results.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
3. When the ADC is ON (ADON bit set in the ADC_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.

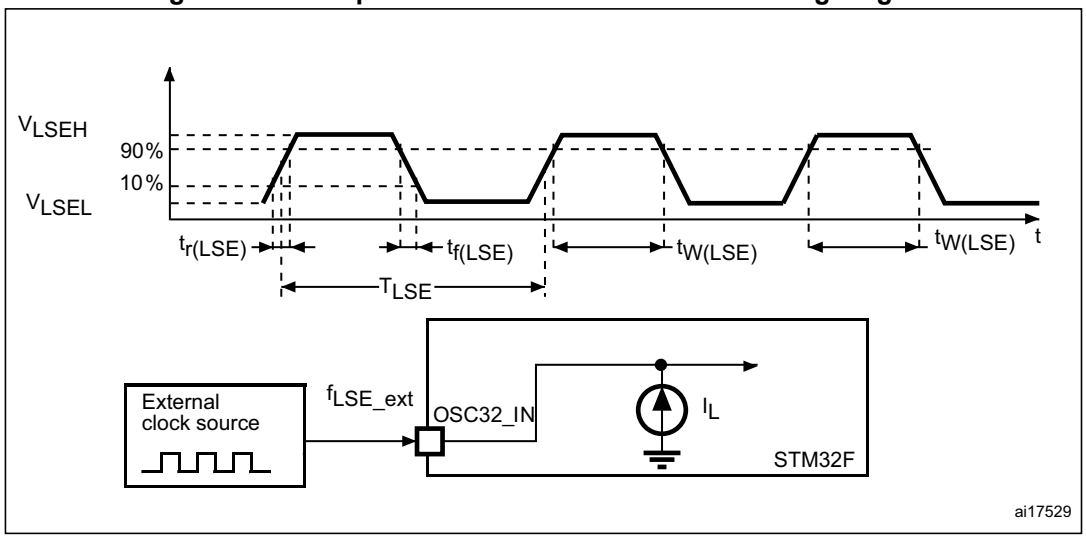
1. Guaranteed by characterization results.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
3. When the ADC is ON (ADON bit set in the ADC_CR2 register), add an additional power consumption of 1.73 mA per ADC for the analog part.

Table 33. Typical and maximum current consumption in Sleep mode, regulator ON

Symbol	Parameter	Conditions	f_{HCLK} (MHz)	Typ	Max(1)			Unit
					T_A = 25 °C	T_A = 85 °C	T_A = 105 °C	
I_{DD}	Supply current in Sleep mode	All peripherals enabled(2)	216	128	144(3)	190(3)	-	mA
			200	119	134	180	214	
			180	105	118(3)	153(3)	178(3)	
			168	93	105	136	156	
			144	72	80	107	124	
			60	33	39	65	82	
			25	17	21	47	65	
		All peripherals disabled	216	18	25(3)	71(3)	-	
			200	17	24	70	112	
			180	14	20(3)	54(3)	75(3)	
			168	13	18	49	69	
			144	10	14	40	58	
			60	6	10	36	53	
			25	4	8	34	51	

1. Guaranteed by characterization results, unless otherwise specified.
2. When analog peripheral blocks such as ADCs, DACs, HSE, LSE, HSI, or LSI are ON, an additional power consumption should be considered.
3. Guaranteed by test in production.

Figure 29. 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 4 to 26 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 43*. 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 43. HSE 4-26 MHz oscillator characteristics(1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{OSC_IN}	Oscillator frequency		4	-	26	MHz
R_F	Feedback resistor		-	200	-	kΩ
I_{DD}	HSE current consumption	V_{DD}=3.3 V, ESR= 30 Ω, C_L=5 pF@25 MHz	-	450	-	µA
		V_{DD}=3.3 V, ESR= 30 Ω, C_L=10 pF@25 MHz	-	530	-	
ACC_{HSE}(2)	HSE accuracy		− 500	-	500	ppm
G_m_crit_max	Maximum critical crystal g_m	Startup	-	-	1	mA/V
$t_{SU(HSE}$(3)	Startup time	V_{DD} is stabilized	-	2	-	ms

1. Guaranteed by design.
2. This parameter depends on the crystal used in the application. The minimum and maximum values must be respected to comply with USB standard specifications.
3. $t_{SU(HSE)}$ is the startup time measured from the moment it is enabled (by software) to a stabilized 8 MHz oscillation is reached. This value is guaranteed by characterization results. It is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.

Table 56. Flash memory programming (single bank configuration nDBANK=1) (continued)

Symbol	Parameter	Conditions	Min(1)	Typ	Max(1)	Unit
V_{prog}	Programming voltage	32-bit program operation	2.7	-	3	V
		16-bit program operation	2.1	-	3.6	V
		8-bit program operation	1.7	-	3.6	V

1. Guaranteed by characterization results.
2. The maximum programming time is measured after 100K erase operations.

Table 57. Flash memory programming (dual bank configuration nDBANK=0)

Symbol	Parameter	Conditions	Min(1)	Typ	Max(1)	Unit
t_{prog}	Word programming time	Program/erase parallelism (PSIZE) = x 8/16/32	-	16	100(2)	µs
$t_{ERASE16KB}$	Sector (16 KB) erase time	Program/erase parallelism (PSIZE) = x 8	-	400	800	ms
		Program/erase parallelism (PSIZE) = x 16	-	250	600	
		Program/erase parallelism (PSIZE) = x 32	-	200	500	
$t_{ERASE64KB}$	Sector (64 KB) erase time	Program/erase parallelism (PSIZE) = x 8	-	1100	2400	ms
		Program/erase parallelism (PSIZE) = x 16	-	800	1400	
		Program/erase parallelism (PSIZE) = x 32	-	500	1100	
$t_{ERASE128KB}$	Sector (128 KB) erase time	Program/erase parallelism (PSIZE) = x 8	-	2.1	4	s
		Program/erase parallelism (PSIZE) = x 16	-	1.5	2.6	
		Program/erase parallelism (PSIZE) = x 32	-	1	2	
t_{ME}	Mass erase time	Program/erase parallelism (PSIZE) = x 8	-	16	32	s
		Program/erase parallelism (PSIZE) = x 16	-	11	22	
		Program/erase parallelism (PSIZE) = x 32	-	8	16	

Table 71. ADC characteristics (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{VREF+}(2)	ADC V_{REF} DC current consumption in conversion mode	-	-	300	500	µA
I_{VDDA}(2)	ADC V_{DDA} DC current consumption in conversion mode	-	-	1.6	1.8	mA

1. V_{DDA} minimum value of 1.7 V is obtained with the use of an external power supply supervisor (refer to *Section 2.18.2: Internal reset OFF*).
2. Guaranteed by characterization results.
3. V_{REF+} is internally connected to V_{DDA} and V_{REF-} is internally connected to V_{SSA}.
4. R_{ADC} maximum value is given for V_{DD}=1.7 V, and minimum value for V_{DD}=3.3 V.
5. For external triggers, a delay of $1/f_{PCLK2}$ must be added to the latency specified in *Table 71*.

Equation 1: R_{AIN} max formula

$$R_{AIN} = \frac{(k - 0.5)}{f_{ADC} \times C_{ADC} \times \ln(2^{N+2})} - R_{ADC}$$

The formula above (*Equation 1*) is used to determine the maximum external impedance allowed for an error below 1/4 of LSB. N = 12 (from 12-bit resolution) and k is the number of sampling periods defined in the ADC_SMPR1 register.

Table 72. ADC static accuracy at f_{ADC} = 18 MHz

Symbol	Parameter	Test conditions	Typ	Max(1)	Unit
ET	Total unadjusted error	f_{ADC} =18 MHz V_{DDA} = 1.7 to 3.6 V V_{REF} = 1.7 to 3.6 V $V_{DDA} - V_{REF}$ < 1.2 V	±3	±4	LSB
EO	Offset error		±2	±3	
EG	Gain error		±1	±3	
ED	Differential linearity error		±1	±2	
EL	Integral linearity error		±2	±3	

1. Guaranteed by characterization results.

Table 73. ADC static accuracy at f_{ADC} = 30 MHz

Symbol	Parameter	Test conditions	Typ	Max(1)	Unit
ET	Total unadjusted error	f_{ADC} = 30 MHz, R_{AIN} < 10 kΩ, V_{DDA} = 2.4 to 3.6 V, V_{REF} = 1.7 to 3.6 V, $V_{DDA} - V_{REF}$ < 1.2 V	±2	±5	LSB
EO	Offset error		±1.5	±2.5	
EG	Gain error		±1.5	±4	
ED	Differential linearity error		±1	±2	
EL	Integral linearity error		±1.5	±3	

1. Guaranteed by characterization results.

Table 100. Asynchronous non-multiplexed SRAM/PSRAM/NOR read timings(1)(2)

Symbol	Parameter	Min	Max	Unit
$t_{w(NE)}$	FMC_NE low time	$2T_{HCLK} - 1$	$2 T_{HCLK} +1$	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. C_L = 30 pF.
2. Guaranteed by characterization results.

Table 101. Asynchronous non-multiplexed SRAM/PSRAM/NOR read - NWAIT timings(1)

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. Guaranteed by characterization results.

Figure 99. UFBGA176+25, 10 x 10 mm x 0.65 mm, ultra fine-pitch ball grid array package recommended footprint

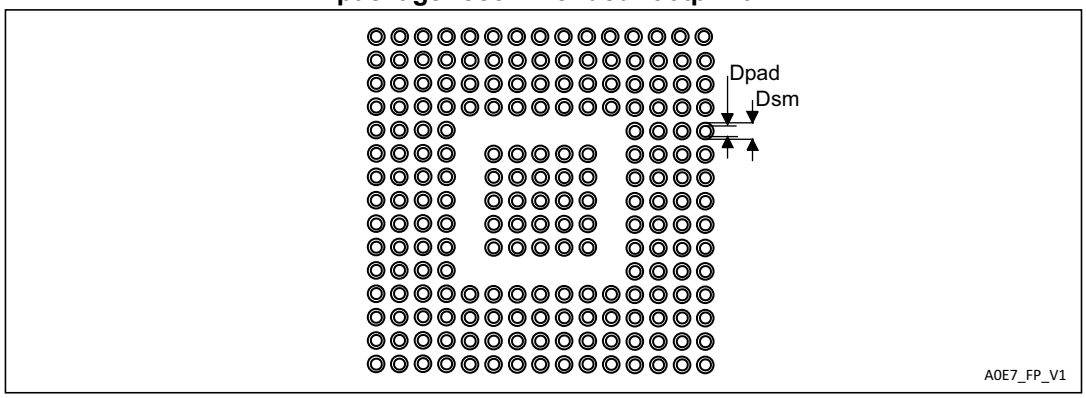
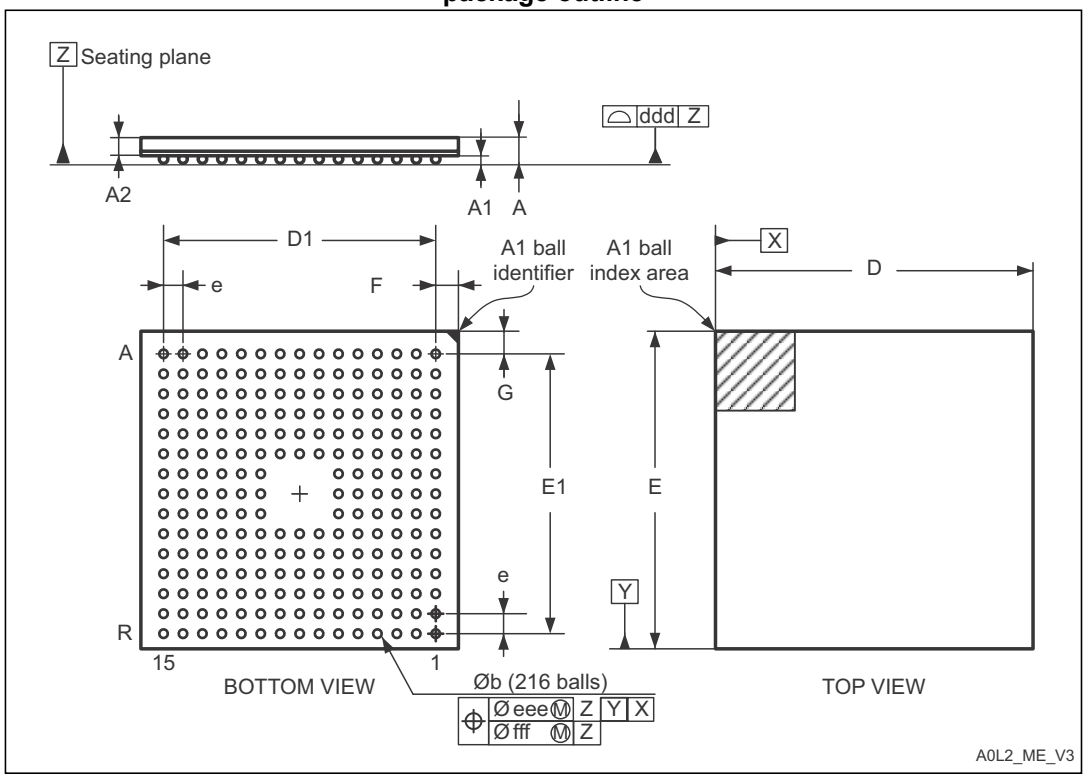


Table 132. UFBGA176+25 recommended PCB design rules (0.65 mm pitch BGA)

Dimension	Recommended values
Pitch	0.65 mm
Dpad	0.300 mm
Dsm	0.400 mm typ. (depends on the soldermask registration tolerance)
Stencil opening	0.300 mm
Stencil thickness	Between 0.100 mm and 0.125 mm
Pad trace width	0.100 mm

6.7 TFBGA216, 13 x 13 x 0.8 mm thin fine-pitch ball grid array package information

Figure 101. TFBGA216, 13 × 13 × 0.8 mm thin fine-pitch ball grid array package outline



1. Drawing is not to scale.

Table 133. TFBGA216, 13 × 13 × 0.8 mm thin fine-pitch ball grid array package mechanical data

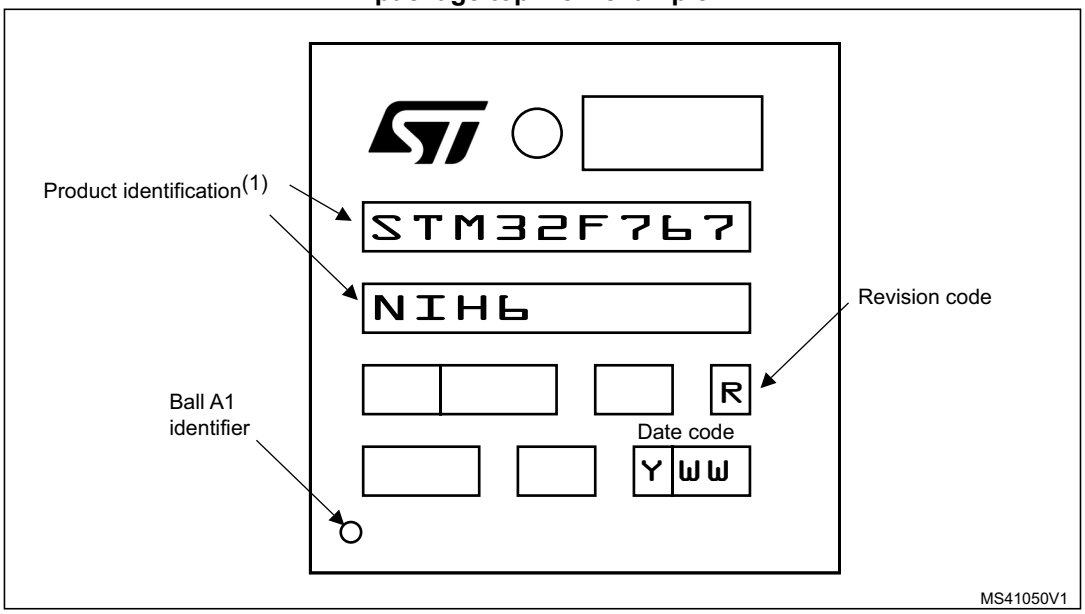
Symbol	millimeters			inches[1]		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.100	-	-	0.0433
A1	0.150	-	-	0.0059	-	-
A2	-	0.760	-	-	0.0299	-
b	0.350	0.400	0.450	0.0138	0.0157	0.0177
D	12.850	13.000	13.150	0.5118	0.5118	0.5177
D1	-	11.200	-	-	0.4409	-
E	12.850	13.000	13.150	0.5118	0.5118	0.5177
E1	-	11.200	-	-	0.4409	-
e	-	0.800	-	-	0.0315	-
F	-	0.900	-	-	0.0354	-

TFBGA216 device marking

The following figure gives an example of topside marking orientation versus ball A1 identifier location.

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

Figure 103. TFBGA216, 13 × 13 × 0.8 mm thin fine-pitch ball grid array 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.