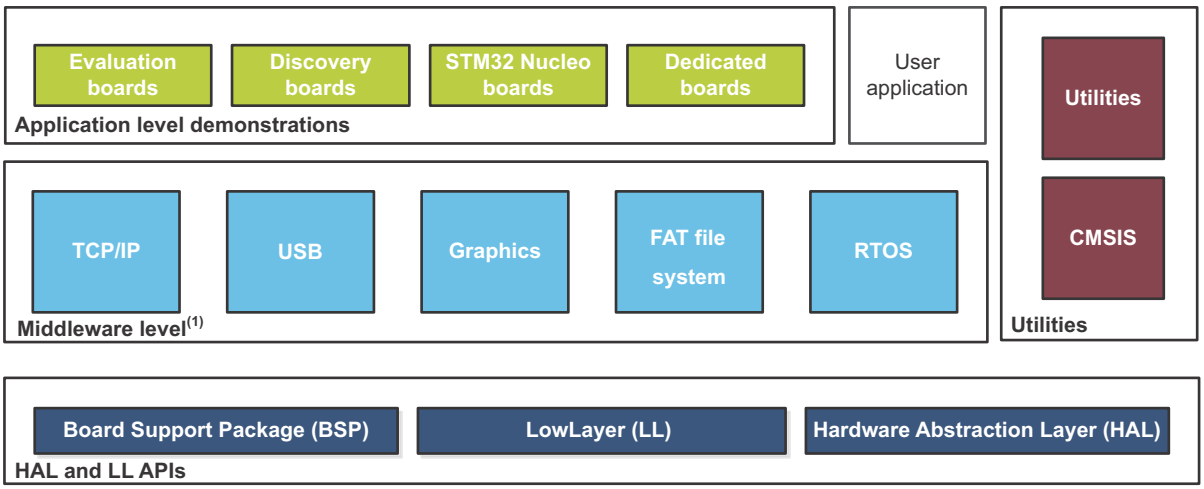
AN4739
Application note

STM32Cube firmware examples for STM32F4 Series

Introduction

The STM32CubeF4 firmware package comes with a rich set of examples running on STMicroelectronics boards. The examples are organized by board and provided with preconfigured projects for the main supported toolchains (see *Figure 1*).

Figure 1. STM32CubeF4 firmware components



(1) The set of middleware components depends on the product Series.

MS33720V4

Reference documents

The reference documents are available on www.st.com/stm32cubefw:

- Latest release of STM32CubeF4 firmware package
- *Getting started with the STM32CubeF4 firmware package for STM32F4 Series (UM1730)*
- *STM32CubeF4 demonstration platform (UM1743)*
- *Description of STM32F4xx HAL drivers (UM1725)*
- *STM32Cube USB Device library (UM1734)*
- *STM32Cube USB Host library (UM1720)*
- *Developing Applications on STM32Cube with FatFS (UM1721)*
- *Developing Applications on STM32Cube with RTOS (UM1722)*
- *Developing Applications on STM32Cube with LwIP TCP/IP stack (UM1713)*
- *STM32Cube Ethernet IAP example (UM1709)*

STM32CubeF4 examples

The examples are classified depending on the STM32Cube level they apply to. They are named as follows:

- **Examples:** the examples use only the HAL and BSP drivers (middleware not used). Their objective is to demonstrate the product/peripherals features and usage. They are organized per peripheral (one folder per peripheral, for example TIM). Their complexity level ranges from the basic usage of a given peripheral (for example PWM generation using timer) to the integration of several peripherals (for example how to use DAC for signal generation with synchronization from TIM6 and DMA). The usage of the board resources is reduced to the strict minimum.
- **Examples_LL**

  These examples use only the LL drivers (HAL drivers and middleware components not used). They offer an optimum implementation of typical use cases of the peripheral features and configuration sequences. The examples are organized per peripheral (one folder for each peripheral, for example TIM) and run exclusively on Nucleo board.
- **Examples_MIX**

  These examples use only the HAL, BSP and LL drivers (middleware components not used). They aim at demonstrating how to use both HAL and LL APIs in the same application to combine the advantages of both APIs:
  - The HAL offers high-level function-oriented APIs with high portability level by hiding product/IPs complexity for end users.
  - The LL provides low-level APIs at register level with better optimization.

  The examples are organized per peripheral (one folder for each peripheral, for example TIM) and run exclusively on Nucleo board.
- **Applications:** the applications demonstrate the product performance and how to use the available middleware stacks. They are organized either by middleware (a folder per middleware, for example USB Host) or by product feature that require high-level firmware bricks (for example Audio). The integration of applications that use several middleware stacks is also supported.
- **Demonstrations:** the demonstrations aim to integrate and run the maximum number of peripherals and middleware stacks to showcase the product features and performance.
- **Template project:** the template project is provided to allow quickly building a firmware application on a given board.

The examples are located under *STM32Cube_FW_F4_VX.Y.Z\Projects*\. They all have the same structure:

- *Inc* folder containing all header files
- *Src* folder containing the sources code
- *EWARM*, \MDK-ARM, *SW4STM32*, and \TrueSTUDIO folders containing the preconfigured project for each toolchain.
- readme.txt file describing the example behavior and the environment required to run the example.

To run the example, proceed as follows:

1. Open the example using your preferred toolchain.
2. Rebuild all files and load the image into target memory.
3. Run the example by following the readme.txt instructions

Note: Refer to "Development toolchains and compilers" and "Supported devices and evaluation boards" sections of the firmware package release notes to know more about the software/hardware environment used for the firmware development and validation. The correct operation of the provided examples is not guaranteed in other environments, for example when using different compiler or board versions.

The examples can be tailored to run on any compatible hardware: simply update the BSP drivers for your board, provided it has the same hardware functions (LED, LCD display, pushbuttons, etc.). The BSP is based on a modular architecture that can be easily ported to any hardware by implementing the low-level routines.

Table 1 contains the list of examples provided within STM32CubeF4 firmware package.

The total numbers of templates, templates_LL, demonstrations, examples, examples_LL, examples_MIX and applications are highlighted in gray in the table.

Table 1. STM32CubeF4 firmware examples

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Templates _LL	-	Starter project	This projects provides a reference template through the LL API that can be used to build any firmware application.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Total number of templates_LL: 19			**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Templates	-	Starter project	This directory provides a reference template project that can be used to build any firmware application for STM32F4xxxx devices using STM32CubeF4 HAL.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Total number of templates: 19			**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Examples	-	BSP	This example provides a description of how to use the different BSP drivers.	X	X	X	X	X	-	-	X	X	-	X	-	X	X	X	X	X	X	X
	ADC	ADC_ DualMode Interleaved	This example provides a short description of how to use two ADC peripherals to perform conversions in interleaved dual-mode.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		ADC_Injected Conversion_ Interrupt	This example describes how to use the ADC in interrupt mode to convert data through the HAL API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		ADC_Regular Conversion_ DMA	This example describes how to use the ADC and DMA to transfer continuously converted data from ADC to memory.	X	X	X	X	X	-	-	X	X	-	X	-	X	X	X	X	X	X	X
		ADC_Regular Conversion_ Interrupt	This example describes how to use the ADC in interrupt mode to convert data through the HAL API.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	X	X
		ADC_Regular Conversion_ Polling	This example describes how to use the ADC in Polling mode to convert data through the HAL API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	X
		ADC_Trigger Mode	This example describes how to use the ADC and TIM2 to convert continuously data from ADC channel. Each time an external trigger is generated by TIM2 a new conversion is started by ADC.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		ADC_Triple Mode Interleaved	This example provides a short description of how to use the ADC peripheral to convert a regular channel in Triple interleaved mode.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	CAN	CAN_LoopBack	This example provides a description of how to set a communication with the CAN in loopback mode.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		CAN_Loopback	This example provides a description of how to set a communication with the CAN in loopback mode.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
		CAN_Networking	This example shows how to configure the CAN peripheral to send and receive CAN frames in normal mode. The sent frames are used to control LEDs by pressing key push button.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
	CEC	CEC_Data Exchange	This example shows how to configure and use the CEC peripheral to receive and transmit messages.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CEC_Listen Mode	This example shows how to configure and use the CEC peripheral to receive and transmit messages between two boards while a third one (the spy device) listens but does not acknowledge the received messages.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CEC_ MultiAddress	This example shows how to configure and use the CEC peripheral to receive and transmit messages in the case where one device supports two distinct logical addresses at the same time.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CRC	CRC_Example	This example guides the user through the different configuration steps by means of HAL API to ensure the use of the CRC (Cyclic Redundancy Check) calculation unit to get a CRC code of a given buffer of data word (32-bit), based on a fixed generator polynomial (0x4C11DB7).	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

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Examples	CRYP	CRYP_ AESModes	This example provides a short description of how to use the CRYPTO peripheral to encrypt and decrypt data using AES in chaining modes (ECB, CBC, CTR) and all key sizes (128, 192, 256) Algorithm.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		CRYP_AES_ CCM	This example provides a short description of how to use the CRYPTO peripheral to encrypt data using AES with Combined Cipher Machine (CCM).	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
		CRYP_AES_ DMA	This example provides a short description of how to use the CRYPTO peripheral to encrypt and decrypt data using AES-128 Algorithm with ECB chaining mode.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		CRYP_AES_ GCM	This example provides a description of how to use the CRYPTO peripheral to encrypt and decrypt data using AES with Galois/Counter Mode (GCM).	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
		CRYP_ DESTDESmodes	This example provides a short description of how to use the CRYPTO peripheral to encrypt and decrypt data using DES and TDES in all modes (ECB, CBC) Algorithm.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		CRYP_TDES_ DMA	This example provides a short description of how to use the CRYPTO peripheral to encrypt data using TDES Algorithm.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	CORTEX	CORTEXM_MPU	This example presents the MPU features on STM32F4xxxx devices and it can be easily ported to any other STM32 device supporting MPU.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	-	X
		CORTEXM_ ModePrivilege	This example shows how to modify the Thread mode privilege access and stack. The Thread mode is entered on reset or when returning from an exception.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	X
		CORTEXM_Proce ssStack	This example shows how to modify the Thread mode stack. The Thread mode is entered on Reset, and can be entered as a result of an exception return.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
		CORTEXM_ SysTick	This example shows how to use the default configuration of SysTick with a time base equal to 1 ms in order to insert a delay between LEDs toggling.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

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Examples	DAC	DAC_Signals Generation	This example provides a short description of how to use the DAC peripheral to generate several signals using DMA controller.	-	-	X	X	-	-	-	-	X	-	X	-	X	-	X	X	-	X	-
		DAC_Simple Conversion	This example provides a short description of how to use the DAC peripheral to do a simple conversion.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	DCMI	DCMI_ CaptureMode	This example provides a short description of how to use the DCMI to interface with camera module and display in continuous mode the picture on LCD.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		DCMI_ SnapshotMode	This example provides a short description of how to use the DCMI to interface with camera module and display in snapshot mode the picture on LCD.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	DFSDM	DFSDM_AudioRecord	This example shows how to use the DFSDM HAL API to perform stereo audio recording.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
		DFSDM_PulseSkipper	This example shows how to use the DFSDM HAL API to perform stereo audio recording.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
	DMA	DMA_FIFOMode	This example provides a description of how to use a DMA channel to transfer a word data buffer from the Flash memory to embedded SRAM memory with FIFO mode enabled through the HAL API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	X	X
		DMA_ FLASHToRAM	This example provides a description of how to use a DMA channel to transfer a word data buffer from the Flash memory to embedded SRAM memory through the HAL API.	X	X	X	X	X	-	-	X	X	-	X	-	X	X	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

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Examples	DMA2D	DMA2D_MemToMem WithBlending	This example provides a description of how to configure DMA2D peripheral in Memory_to_Memory with blending transfer mode.	-	-	X	-	-	-	-	-	X	-	-	-	X	-	-	X	-	-	-
		DMA2D_MemToMem WithLCD	This example provides a description of how to configure DMA2D peripheral in Memory_to_Memory transfer mode and display the result on LCD.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
		DMA2D_MemToMem WithPFC	This example provides a description of how to configure DMA2D peripheral in Memory_to_Memory with pixel format conversion transfer mode.	-	-	X	-	-	-	-	-	X	-	-	-	X	-	-	X	-	-	-
		DMA2D_Memory ToMemory	This example provides a description of how to configure DMA2D peripheral in Memory_to_Memory transfer mode.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
		DMA2D_RegToM emWithLCD	This example provides a description of how to configure DMA2D peripheral in Register_to_Memory transfer mode and display the result on LCD.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
	FLASH	FLASH_ DualBoot	This example guides the user through the different configuration steps by means of HAL API how to program bank1 and bank2 of the Flash memory integrated within STM32F4xxxx devices and swap between both of them.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		FLASH_Erase Program	This example describes how to configure and use the FLASH HAL API to erase and program the internal Flash memory.	X	X	X	X	X	-	-	X	X	-	X	-	X	X	X	X	-	-	X
		FLASH_Write Protection	This example describes how to configure and use the FLASH HAL API to enable and disable the write protection of the internal Flash memory.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	X	-

Table 1. STM32CubeF4 firmware examples (continued)

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Examples	FMC	FMC_NOR	This example describes how to configure the FMC controller to access the SDRAM memory.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
		FMC_PSRAM	This example describes how to configure the FMC controller to access the PSRAM memory.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
		FMC_PSRAM_PreInitConfig	This example describes how to execute a part of the code from the PSRAM external memory.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
		FMC_SDRAM	This example describes how to configure the FMC controller to access the SDRAM memory.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	-	X	-	-	-
		FMC_SDRAM_DataMemory	This example describes how to configure the FMC controller to access the SDRAM memory including heap and stack.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
		FMC_SDRAM_LowPower	This example describes how to configure the FMC controller to access the SDRAM memory in low -power mode (SDRAM Self Refresh mode).	-	-	X	X	-	-	-	-	X	-	-	-	X	-	-	X	-	-	-
		FMC_SRAM	This example describes how to configure the FMC controller to access the SRAM memory.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
		FMC_SRAM_DataMemory	This example guides the user through the different configuration steps by means of HAL API to configure the FMC controller to access the SRAM memory mounted on evaluation board (including heap and stack).	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-
	FSMC	FSMC_SRAM	This example describes how to configure the FSMC controller to access the SRAM memory.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
		FSMC_SRAM_DataMemory	This example describes how to configure the FSMC controller to access the SRAM memory including heap and stack.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

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Examples	GPIO	GPIO_EXTI	This example shows how to configure external interrupt lines.	X	X	X	X	X	-	-	X	X	-	X	-	X	X	X	X	X	X	X
		GPIO_IOToggle	This example describes how to configure and use GPIOs through the HAL API.	-	X	-	X	X	X	X	X	X	X	-	X	-	-	X	X	X	X	X
	HAL	HAL_TimeBase_ RTC_ALARM	This example describes how to customize the HAL time base using the RTC Alarm instead of Systick as main source of time base. The nucleo board user button (connected to EXTI Line13) will be used to suspend or resume tick increment.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		HAL_TimeBase_ RTC_WKUP	This example describes how to customize the HAL time base using the RTC wakeup instead of Systick as main source of time base. The nucleo board user button (connected to EXTI Line13) will be used to suspend orrResume tick increment.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		HAL_TimeBase_T IM	This example describes how to customize the HAL time base using a general purpose timer (TIM6) instead of Systick as main source of time base.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	HASH	HASH_HMAC_ SHA1MD5	This example provides a short description of how to use the HASH peripheral to hash data using HMAC SHA-1 and HMAC MD5 Algorithms.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		HASH_ SHA1MD5	This example provides a short description of how to use the HASH peripheral to hash data using SHA-1 and MD5 Algorithms.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		HASH_ SHA1MD5_DMA	This example provides a short description of how to use the HASH peripheral to hash data using SHA-1 and MD5 Algorithms.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		HASH_SHA224 SHA256_DMA	This example provides a short description of how to use the HASH peripheral to hash data using SHA224 and SHA256 Algorithms.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

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Examples	I2C	FMPI2C_ EEPROM	This example describes how to perform I2C data buffer transmission/reception via DMA. The communication uses an I2C EEPROM memory.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		I2C_ EEPROM	This example describes how to perform I2C data buffer transmission and reception with DMA. The communication is done with an I2C EEPROM memory.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
		I2C_TwoBoards_ AdvComIT	This example describes how to perform I2C data buffer transmission/reception between two boards, using an interrupt.	X	-	X	-	-	X	-	X	-	-	X	X	X	X	-	-	X	-	X
		I2C_TwoBoards_ ComDMA	This example describes how to perform I2C data buffer transmission/reception between two boards, via DMA.	X	-	X	-	-	X	-	X	-	-	X	X	X	X	-	-	X	-	X
		I2C_TwoBoards_ ComIT	This example describes how to perform I2C data buffer transmission/reception between two boards using an interrupt.	X	-	X	-	-	X	-	X	-	-	X	X	X	X	-	-	X	-	X
		I2C_TwoBoards_ ComPolling	This example describes how to perform I2C data buffer transmission/reception between two boards in Polling mode.	X	-	X	-	-	X	-	X	-	-	X	X	X	X	-	-	X	-	X
		I2C_TwoBoards_ RestartAdvComIT	This example describes how to perform I2C data buffer sequential transmission/reception between two boards using an interrupt.	X	-	X	-	-	-	-	-	-	-	X	-	X	X	-	-	X	-	-
		I2C_TwoBoards_ RestartComIT	This example describes how to perform I2C data buffer sequential transmission/reception between two boards using an interrupt.	X	-	X	-	-	-	-	-	-	-	X	-	X	X	-	-	X	-	-
	I2S	I2S_Audio	This example provides basic implementation of audio features.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-
	IWDG	IWDG_Example	This example guides the user through the different configuration steps by means of HAL API to ensure IWDG reload counter and simulate a software fault generating an MCU IWDG reset on expiry of a programmed time period.	-	X	-	X	X	-	-	X	X	-	-	-	X	-	X	X	X	-	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	LCD_DSI	LCD_DSI_CmdMode_DoubleBuffering	This example provides a description of to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_CmdMode_PartialRefresh	This example descrines how to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) and how to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_CmdMode_SingleBuffer	This example provides a description of to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_CmdMode_TearingEffect	This example provides a description of to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_CmdMode_TearingEffect_ExtPin	This example describes how to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_ULPM_Data	This example describes how to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board and manage entry and exit in DSI ULPM mode on data lane only. In this mode, the DSY PHY state machine is entering alow power state on data lane and allows to save some power when the LCD does not need to display.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_ULPM_DataClock	This example provides a description of to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board and manage entry and exit in DSI ULPM mode on data lane and clock lane.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_VideoMode_DoubleBuffering	This example provides a description of to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_VideoMode_SingleBuffer	This example provides a description of to use the embedded LCD DSI controller (using IPs LTDC and DSI Host) to drive the KoD LCD mounted on board.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	LTDC	LTDC_ColorKeying	This example describe how to enable and use the color keying functionality.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		LTDC_Display_1Layer	This example provides a description of how to configure LTDC peripheral to display BMP image on LCD using only one layer.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		LTDC_Display_2Layers	This example describes how to configure the LTDC peripheral to display two Layers at the same time.	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
	PWR	PWR_BOR	This example shows how to configure the programmable BOR thresholds using the FLASH option bytes.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		PWR_Current Consumption	This example shows how to configure the STM32F4xx system to measure different Low-power modes current consumption.	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	X	-	X
		PWR_PVD	This example shows how to configure the programmable voltage detector using an external interrupt line. In this example, EXTI line 16 is configured to generate an interrupt on each rising or falling edge of the PVD output signal (which indicates that the Vdd voltage is below the PVD threshold).	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		PWR_STANDBY	This example shows how to enter the system to STANDBY mode and wake up from this mode using: external RESET, RTC Alarm A or WKUP pin.	-	-	-	X	-	-	-	X	X	-	-	-	X	-	X	X	X	-	X
		PWR_STOP	This example shows how to enter the system in Stop mode and wake up from this mode.	-	-	-	X	-	-	-	X	X	-	-	-	X	-	X	X	X	-	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	QSPI	QSPI_ExecuteInPlace	This example describes how to erase part of the QSPI memory, write data in DMA mode and access to QSPI memory in memory-mapped mode to check the data in a forever loop.	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	X	X	-	-
		QSPI_MemoryMapped	This example describes how to erase part of the QSPI memory, write data in DMA mode and access to QSPI memory in memory-mapped mode to check the data in a forever loop.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
		QSPI_PreInitConfig	This example describes how to execute a part of the code from the QSPI memory. To do this, a section is created where the function is stored.	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	X	X	-	-
		QSPI_ReadWrite_DMA	This example describes how to erase part of the QSPI memory, write data in DMA mode, read data in DMA mode and compare the result in a forever loop.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-
		QSPI_ReadWrite_IT	This example describes how to erase part of the QSPI memory, write data in IT mode, read data in IT mode and compare the result in a forever loop.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-
	RCC	RCC_ClockConfig	This example describes how to use the RCC HAL API to configure the system clock (SYSCLK) and modify the clock settings on run time.	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X
	RNG	RNG_MultiRNG	This example guides the user through the HAL API different configuration steps to ensure 32-bit long random number generation by the RNG peripheral.	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	RTC	RTC_Alarm	This example guides the user through the different configuration steps by means of the RTC HAL API to configure and generate an RTC alarm.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	X
		RTC_Calendar	This example guides the user through the different configuration steps by means of HAL API to ensure Calendar configuration using the RTC peripheral.	-	X	-	X	X	X	-	X	X	X	-	X	-	-	X	X	X	X	X
		RTC_Tamper	This example guides the user through the different configuration steps by means of HAL API to write/read data to/from RTC Backup data registers and demonstrate the Tamper detection feature using the RTC peripheral.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	-	-	X
		RTC_TimeStamp	This example guides the user through the different configuration steps by means of HAL API to ensure Time Stamp configuration using the RTC peripheral.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	X	-
	SAI	SAI_Audio	This example provides basic implementation of audio features.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		SAI_AudioPlay	This example show how to play an audio file using the DMA circular mode and how to handle the buffer update.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
	SMARTCARD	SMARTCARD_T0	This example describes a firmware Smartcard Interface based on the USART peripheral. The main purpose of this firmware example is to provide resources facilitating the development of an application using the USART peripheral in smartcard mode.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	SPI	SPI_FullDuplex_AdvComIT	This example guides the user through the different configuration steps by means of HAL API to ensure SPI Data buffer transmission and reception using Interrupt, in an advance communication mode: Master board is always sending command to slave before any transmission and Slave board is sending acknowledge before going further.	-	-	-	-	-	-	-	X	-	-	X	-	X	-	-	-	X	-	X
		SPI_FullDuplex_AdvComPolling	This example guides the user through the different configuration steps by means of HAL API to ensure SPI Data buffer transmission and reception using Polling, in an advance communication mode: Master board is always sending command to slave before any transmission and Slave board is sending acknowledge before going further.	-	-	-	-	-	-	-	X	-	-	X	-	X	-	-	-	X	-	X
		SPI_FullDuplex_ComDMA	This example shows how to perform SPI data buffer transmission/reception between two boards via DMA.	X	-	X	-	-	-	-	X	-	-	X	-	X	X	-	-	X	-	X
		SPI_FullDuplex_ComIT	This example shows how to ensure SPI data buffer transmission/reception between two boards by using an interrupt.	X	-	X	-	-	-	-	X	-	-	X	-	X	X	-	-	X	-	X
		SPI_FullDuplex_ComPolling	This example shows how to ensure SPI data buffer transmission/reception in Polling mode between two boards.	X	-	X	-	-	-	-	X	-	-	X	-	X	X	-	-	X	-	X
	SRAM	SRAM_ExecuteInPlace	This example describes how to execute a part of the code from the SRAM2 memory. To do this, a section is created where the function is stored.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	TIM	TIM_6Steps	This example shows how to configure the TIM1 peripheral to generate 6 Steps.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_ 7PWMOutput	This example shows how to configure the TIM1 peripheral to generate 7 PWM signals with 4 different duty cycles (50%, 37.5%, 25% and 12.5%).	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_ CascadeSynchro	This example shows how to synchronize TIM peripherals in cascade mode.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_ Complementary Signals	This example shows how to configure the TIM1 peripheral to generate three complementary TIM1 signals, to insert a defined dead time value, to use the break feature and to lock the desired parameters.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_DMA	This example provides a description of how to use DMA with TIM1 Update request to transfer Data from memory to TIM1 Capture Compare Register 3 (CCR3).	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	X	X
		TIM_DMABurst	This example shows how to update the TIM1 channel1 period and the duty cycle using the TIM1 DMA burst feature.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_Encoder	This example shows how to configure the TIM1 peripheral in encoder mode to determinate the rotation direction.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_ExtTrigger Synchro	This example shows how to synchronize TIM peripherals in cascade mode with an external trigger.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_ InputCapture	This example shows how to use the TIM peripheral to measure the frequency of an external signal.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	X	X
		TIM_OCActive	This example shows how to configure the TIM peripheral to generate four different signals with four different delays.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	TIM	TIM_OCInactive	This example shows how to configure the TIM peripheral in Output Compare Inactive mode with the corresponding Interrupt requests for each channel.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_OCToggle	This example shows how to configure the TIM3 peripheral to generate four different signals with four different frequencies.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	-	X
		TIM_OnePulse	This example shows how to use the TIM peripheral to generate a One pulse Mode after a Rising edge of an external signal is received in Timer Input pin.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	-	X
		TIM_PWMInput	This example shows how to use the TIM peripheral to measure the frequency and duty cycle of an external signal.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X
		TIM_PWMOutput	This example shows how to configure the TIM peripheral in PWM (Pulse Width Modulation) mode.	-	X	-	X	X	-	-	X	X	-	-	-	-	-	X	X	X	-	X
		TIM_Parallel Synchro	This example shows how to synchronize TIM2 and Timers (TIM3 and TIM4) in parallel mode.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		TIM_Prescaler Selection	This example shows how to configure the TIM peripheral in PWM (Pulse Width Modulation) mode with clock prescaler selection feature activated using __HAL_RCC_TIMCLKPRESCALER() which allow to double the output frequency.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
		TIM_Prescaler_ Selection	This example shows how to configure the TIM peripheral in PWM (Pulse Width Modulation) mode with clock prescaler selection feature activated using __HAL_RCC_TIMCLKPRESCALER() which allow to double the output frequency.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		TIM_ Synchronization	This example shows how to synchronize TIM1 and Timers (TIM3 and TIM4) in parallel mode.	-	-	-	X	-	-	-		X	-	-	-	-	-	X	X	-	-	-
		TIM_TimeBase	This example shows how to configure the TIM peripheral to generate a time base of one second with the corresponding Interrupt request.	X	-	X	X	-	-	-		X	-	X	-	X	X	X	X	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples	UART	UART_ HyperTerminal_ DMA	This example describes an UART transmission (transmit/receive) in DMA mode between a board and an HyperTerminal PC application.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
		UART_ HyperTerminal_ IT	This example shows how to ensure UART Data buffer transmission and reception with Interrupt. The communication is done with the Hyperterminal PC application.	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
		UART_Hyperterminal_DMA	This example describes an UART transmission (transmit/receive) in DMA mode between a board and an Hyperterminal PC application.	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-
		UART_Hyperterminal_IT	This example describes an UART transmission (transmit/receive) between a board and an Hyperterminal PC application by using an interrupt.	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-
		UART_Printf	This example shows how to reroute the C library printf function to the UART. It outputs a message sent by the UART on the HyperTerminal.	-	X	-	X	X	X	X	X	X	X	-	X	-	-	X	X	X	X	X
		UART_ TwoBoards_Com DMA	This example describes an UART transmission (transmit/receive) in DMA mode between two boards.	X	-	X	-	-	-	-	X	-	-	X	X	X	X	-	-	X	-	X
		UART_ TwoBoards_ComI T	This example describes a UART transmission (transmit/receive) in interrupt mode between two boards.	X	-	X	-	-	-	-	X	-	-	X	X	X	X	-	-	X	-	X
		UART_ TwoBoards_Com Polling	This example describes a UART transmission (transmit/receive) in polling mode between two boards.	X	-	X	-	-	-	-	X	-	-	X	X	X	X	-	-	X	-	X
	WWDG	WWDG_ Example	This example guides the user through the different configuration steps by means of HAL API to ensure WWDG counter update at regular period and simulate a software fault generating an MCU WWDG reset on expiry of a programmed time period.	-	X	-	X	X	-	-	X	X	-	-	-	X	-	X	X	X	-	X
	Total number of examples: 743			**24**	**27**	**30**	**71**	**27**	**13**	**7**	**42**	**87**	**9**	**27**	**16**	**46**	**24**	**72**	**95**	**51**	**27**	**48**

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	ADC	ADC_AnalogWatchdog	This example describes how to use a ADC peripheral with the ADC analog watchdog to monitor a channel and detect when the corresponding conversion data is out of window thresholds. This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_ContinuousConversion_TriggerSW	This example describes how to use a ADC peripheral to perform continuous ADC conversions of a channel, from a SW start. This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_ContinuousConversion_TriggerSW_Init	This example describes how to use a ADC peripheral to perform continuous ADC conversions of a channel, from a SW start. This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_GroupsRegularInjected	This example describes how to use a ADC peripheral with both ADC groups (ADC group regular and ADC group injected) in their intended use case. This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_MultiChannelSingleConversion	This example describes how to use a ADC peripheral to convert several channels, ADC conversions are performed successively in a scan sequence. This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	ADC	ADC_SingleConversion_TriggerSW	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel, at each software start; Example using programming model: polling (for programming models interrupt or DMA transfer, refer to other examples); This example is based on the STM32F4xx ADC LL API; peripheral initialization done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_SingleConversion_TriggerSW_DMA	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel, at each software start. The example is using the programming model: polling (for programming models interrupt or DMA transfer, refer to other examples). This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_SingleConversion_TriggerSW_IT	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel, at each software start. The example is using the programming model: interrupt (for programming models polling or DMA transfer, refer to other examples). This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		ADC_SingleConversion_TriggerTimer_DMA	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel, at each trigger event from timer. The conversion data are transferred by DMA into a table, indefinitely (circular mode). This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	ADC	ADC_TemperatureSensor	This example describes how to use a ADC peripheral to perform a single ADC conversion of the internal temperature sensor and to calculate the temperature in Celsius degrees. The example is using the programming model: polling (for programming models interrupt or DMA transfer, refer to other examples). This example is based on the STM32F4xx ADC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	CORTEX	CORTEX_MPU	This example presents the MPU feature. Its purpose is to configure a memory area as privileged read-only area and attempt to perform read and write operations in different modes.	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CRC	CRC_CalculateAndCheck	This example shows how to configure the CRC calculation unit to get a CRC code of a given data buffer, based on a fixed generator polynomial (default value 0x4C11DB7). The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	DAC	DAC_GenerateConstantSignal_TriggerSW	This example describes how to use the DAC peripheral to generate a constant voltage signal; This example is based on the STM32F4xx DAC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		DAC_GenerateWaveform_TriggerHW	This example describes how to use the DAC peripheral to generate a waveform voltage from digital data stream transfered by DMA. This example is based on the STM32F4xx DAC LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		DAC_GenerateWaveform_TriggerHW_Init	This example describes how to use the DAC peripheral to generate a waveform voltage from digital data stream transfered by DMA. This example is based on the STM32F4xx DAC LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	DMA	DMA_CopyFromFlashToMemory	This example describes how to use a DMA to transfer a word data buffer from the Flash memory to embedded SRAM. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		DMA_CopyFromFlashToMemory_Init	This example describes how to use a DMA to transfer a word data buffer from the Flash memory to embedded SRAM. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	DMA2D	DMA2D_MemoryToMemory	This example describes how to configure the DMA2D peripheral in Memory-to-Memory transfer mode. The example is based on the STM32F4xx DMA2D LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	EXTI	EXTI_ToggleLedOnIT	This example describes how to configure the EXTI and use GPIOs to toggle the user LEDs available on the board when a user button is pressed. It is based on the STM32F4xx LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		EXTI_ToggleLedOnIT_Init	This example describes how to configure the EXTI and use GPIOs to toggle the user LEDs available on the board when a user button is pressed. This example is based on the STM32F4xx LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	GPIO	GPIO_InfiniteLedToggling	This example describes how to configure and use GPIOs to toggle every 250 ms the user LEDs available on the board. This example is based on the STM32F4xx LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		GPIO_InfiniteLedToggling_Init	This example describes how to configure and use GPIOs to toggle every 250 ms the user LEDs available on the board. This example is based on the STM32F4xx LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	I2C	I2C_OneBoard_AdvCommunication_DMAAndIT	This example describes how to exchange data between an I2C Master device in DMA mode and an I2C Slave device in Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		I2C_OneBoard_Communication_DMAAndIT	This example describes how to transmit data bytes from an I2C Master device using DMA mode to an I2C Slave device using Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		I2C_OneBoard_Communication_IT	This example describes how to receive one data byte from an I2C Slave device to an I2C Master device. Both devices operate in interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		I2C_OneBoard_Communication_IT_Init	This example describes how to receive one data byte from an I2C Slave device to an I2C Master device. Both devices operate in Interrupt mode. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		I2C_OneBoard_Communication_PollingAndIT	This example describes how to transmit data bytes from an I2C Master device using Polling mode to an I2C Slave device using Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	I2C	I2C_TwoBoards_MasterRx_SlaveTx_IT	This example describes how to receive one data byte from an I2C Slave device to an I2C Master device. Both devices operate in Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		I2C_TwoBoards_MasterTx_SlaveRx	This example describes how to transmit data bytes from an I2C Master device using Polling mode to an I2C Slave device using Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		I2C_TwoBoards_MasterTx_SlaveRx_DMA	This example describes how to transmit data bytes from an I2C Master device using DMA mode to an I2C Slave device using DMA mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	IWDG	IWDG_RefreshUntilUserEvent	This example describes how to configure the IWDG to ensure period counter update and generate an MCU IWDG reset when a user button is pressed. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	LPTIM	LPTIM_PulseCounter	This example describes how to use the LPTIM in counter mode to generate a PWM output signal and update PWM duty cycle, based on a trigger provided by an external function generator. This example is based on the STM32F4xx LPTIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
		LPTIM_PulseCounter_Init	This example describes how to use the LPTIM in counter mode to generate a PWM output signal and update PWM duty cycle, based on a trigger provided by an external function generator. This example is based on the STM32F4xx LPTIM LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_ LL	PWR	PWR_EnterStandbyMode	This example shows how to enter the system in Standby mode and wake up from this mode using external RESET or wakeup interrupt.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		PWR_EnterStopMode	This example shows how to enter the system in STOP_MAINREGU mode.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	RCC	RCC_OutputSystemClockOnMCO	This example describes how to configure MCO pins (PA8 and PC9) to output the system clock.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RCC_UseHSEasSystemClock	This example describes how to use the RCC LL API how to start the HSE and use it as system clock.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RCC_UseHSI_PLLasSystemClock	This example shows how to modify the PLL parameters in run time.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	RNG	RNG_GenerateRandomNumbers	This example shows how to configure RNG peripheral to allow generation of 32-bit long Random Numbers. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		RNG_GenerateRandomNumbers_IT	This example shows how to configure the RNG peripheral to allow generation of 32-bit long Random Numbers, using interrupts. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	RTC	RTC_Alarm	This example guides the user through the different configuration steps by means of LL API to ensure Alarm configuration and generation using the RTC peripheral. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RTC_Alarm_Init	This example guides the user through the different configuration steps by means of LL API to ensure Alarm configuration and generation using the RTC peripheral. the peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RTC_Calendar	This example guides the user through the different configuration steps by means of HAL API to configure the RTC calendar. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RTC_ExitStandbyWithWakeUpTimer	This example shows how to configure the RTC in order to wake up from Standby mode using RTC wakeup Timer. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RTC_Tamper	This example guides the user through the different configuration steps by mean of LL API to ensure Tamper configuration using the RTC peripheral. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		RTC_TimeStamp	This example guides the user through the different configuration steps by means of LL API to ensure Time Stamp configuration using the RTC peripheral. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	SPI	SPI_OneBoard_HalfDuplex_DMA	This example shows how to configure GPIO and SPI peripherals for transmitting bytes from an SPI Master device to an SPI Slave device by using the DMA mode through the STM32F4xx SPI LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		SPI_OneBoard_HalfDuplex_DMA_Init	This example shows how to configure GPIO and SPI peripherals for transmitting bytes from an SPI Master device to an SPI Slave device by using the DMA mode through the STM32F4xx SPI LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		SPI_OneBoard_HalfDuplex_IT	This example shows how to configure GPIO and SPI peripherals for transmitting bytes from an SPI Master device to an SPI Slave device by using IT mode through the STM32F4xx SPI LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		SPI_TwoBoards_FullDuplex_DMA	This example shows how to ensure the SPI data buffer transmission and reception in DMA mode. The example is based on the STM32F4xx SPI LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		SPI_TwoBoards_FullDuplex_IT	This example shows how to ensure the SPI Data buffer transmission and reception in Interrupt mode. The example is based on the STM32F4xx SPI LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_ LL	TIM	TIM_BreakAndDeadtime	This example shows how to configure the Timer to perform the following: to generate three center-aligned PWM and complementary PWM signals, to insert a defined dead time value, to use the break feature, to lock the desired parameters. This example is based on the STM32F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_DMA	This example provides a description of how to use the DMA with TIMER update request to transfer Data from the memory to the TIMER Capture Compare Register 3 (TIMx_CCR3). The example is using the STM3F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_InputCapture	This example shows how to use the TIM peripheral to measure the frequency of a periodic signal provided either by an external signal generator or by another timer instance. The example is using the STM32F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_OnePulse	This example shows how to configure a timer to generate a positive pulse in output compare mode with a length of tPULSE and after a delay of tDELAY. This example is based on the STM32F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_OutputCompare	This example shows how to configure the TIM peripheral to generate an output waveform in different output compare modes. The example is using the STM32F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_ LL	TIM	TIM_PWMOutput	This example describes how to use a timer peripheral to generate a PWM output signal and update the PWM duty cycle. The example is using the STM32F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_PWMOutput _Init	This example describes how to use a timer peripheral to generate a PWM output signal and update the PWM duty cycle. The example is using the STM32F4xx TIM LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_TimeBase	This example shows how to configure the TIM peripheral to generate a time base. The example is using the STM32F4xx TIM LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	USART	USART_Communi cation_Rx_IT	This example shows how to configure the GPIO and USART peripherals for receiving characters from HyperTerminal (PC) in Asynchronous mode using Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		USART_Communi cation_Rx_IT_Co ntinuous	This example shows how to configure the GPIO and USART peripherals for continuously receiving characters from HyperTerminal (PC) in Asynchronous mode using Interrupt mode. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		USART_Communi cation_Rx_IT_Init	This example shows how to configure the GPIO and USART peripherals for receiving characters from HyperTerminal (PC) in Asynchronous mode using Interrupt mode. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	USART	USART_Communication_Tx	This example shows how to configure the GPIO and USART peripherals to send characters asynchronously to an HyperTerminal (PC) in Polling mode. If the transfer could not be completed within the allocated time, a timeout allows to exit from the sequence with a Timeout error code. This example is based on STM32F4xx USART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		USART_Communication_TxRx_DMA	This example shows how to configure the GPIO and USART peripherals to send characters asynchronously to/from an HyperTerminal (PC) in DMA mode. This example is based on STM32F4xx USART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		USART_Communication_Tx_IT	This example shows how to configure the GPIO and USART peripherals to send characters asynchronously to HyperTerminal (PC) in Interrupt mode. This example is based on STM32F4xx USART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		USART_HardwareFlowControl	This example shows how to configure the GPIO and USART peripherals to receive characters asynchronously from HyperTerminal (PC) in Interrupt mode with Hardware Flow Control feature enabled. This example is based on STM32F4xx USART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_LL	USART	USART_SyncCommunication_FullDuplex_DMA	This example shows how to configure the GPIO, USART, DMA and SPI peripherals for transmitting bytes from/to an USART peripheral to/from an SPI peripheral (in slave mode) by using DMA mode through the STM32F4xx USART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		USART_SyncCommunication_FullDuplex_IT	This example shows how to configure the GPIO, USART, DMA and SPI peripherals for transmitting bytes from/to an USART peripheral to/from an SPI peripheral (in slave mode) by using Interrupt mode through the STM32F4xx USART LL API (SPI is using DMA for receving/transmitting characters sent from/received by USART). The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	UTILS	UTILS_ConfigureSystemClock	This example describes how to use UTILS LL API to configure the system clock using PLL with HSI as source clock. The user application just needs to calculate PLL parameters using STM32CubeMX and to call the UTILS LL API.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		UTILS_ReadDeviceInfo	This example describes how to read UID, Device ID and Revision ID and save them into a global information buffer.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	WWDG	WWDG_RefreshUntilUserEvent	This example describes how to configure the WWDG, periodically update the counter, and generate an MCU WWDG reset when a user button is pressed. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	Total number of examples_LL: 71			**0**	**0**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**62**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_MIX	ADC	ADC_SingleConversion_TriggerSW_IT	This example describes how to use the ADC to perform a single ADC channel conversion, at each software start. This example uses the interrupt programming model (for programming models in Polling or DMA mode, refer to other examples). This example is based on the STM32F4xx ADC HAL and LL API (LL API usage for performance improvement).	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CRC	CRC_CalculateAndCheck	This example provides a description of how to use the CRC peripheral through the STM32F4xx CRC HAL and LL API (LL API used for performance improvement). The fixed generator polynomial used in CRC IP is CRC-32 (Ethernet) polynomial: 0x4C11DB7.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	DMA	DMA_FLASHToRAM	This example provides a description of how to use a DMA to transfer a word data buffer from Flash memory to embedded SRAM through the STM32F4xx DMA HAL and LL API (LL API used for performance improvement).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	DMA2D	DMA2D_MemToMemWithLCD	This example provides a description of how to configure the DMA2D peripheral in Memory_to_Memory transfer mode and display the result on LCD, in resorting to DMA2D LL APIs for performance improvement.	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	I2C	I2C_OneBoard_ComSlave7_10bits_IT	This example describes how to perform I2C data buffer transmission/reception between one master and 2 slaves with different address sizes (7-bit or 10-bit) and different Max speed support (400Khz or 100 KHz). This example uses the STM32F4xx I2C HAL and LL API (LL API usage for performance improvement) and an interrupt.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	PWR	PWR_STANDBY_RTC	This example shows how to enter Standby mode and wake up from this mode using an external RESET or the RTC wakeup Timer through the STM32F4xx RTC and RCC HAL and LL API (LL API usage for performance improvement).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		PWR_STOP	This example shows how to enter the system in STOP with Low-power regulator mode and wake up from this mode using external RESET or wakeup interrupt (all the RCC functions calls use RCC LL API for footprint and performance improvements).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Examples_MIX	SPI	SPI_FullDuplex_ComPolling	This example shows how to ensure SPI data buffer transmission/reception in Polling mode between two boards.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		SPI_HalfDuplex_ComPollingIT	This example shows how to ensure SPI data buffer transmission/reception between two boards by using Polling (LL Driver) an interrupt mode (HAL Driver).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	TIM	TIM_6Steps	This example shows how to configure the TIM1 peripheral to generate 6 Steps PWM signal. The STM32F4xx TIM1 peripheral offers the possibility to program in advance the configuration for the next TIM1 outputs behavior (or step) and to change the configuration of all the channels at the same time. This operation is possible when the COM (commutation) event is used. This example is based on the STM32F4xx TIM HAL and LL API (LL API used for performance improvement).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		TIM_PWMInput	This example shows how to use the TIM peripheral to measure the frequency and duty cycle of an external signal.	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	UART	UART_HyperTerminal_IT	This example describes how to use an UART to transmit data (transmit/receive) between a board and an HyperTerminal PC application in Interrupt mode. This example provides a description of how to use USART peripheral through the STM32F4xx UART HAL and LL API (LL API used for performance improvement).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
		UART_HyperTerminal_TxPolling_RxIT	This example describes how to use an UART to transmit data (transmit/receive) between a board and an HyperTerminal PC application both in Polling and Interrupt modes. This example provides a description of how to use USART peripheral through the STM32F4xx UART HAL and LL API (LL API used for performance improvement).	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	Total number of examples_MIX: 13			**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	Audio	Audio_playback_and_record	This application shows how to use the different functionalities of Audio device and ST MEMS microphones.	X	-	-	X	-	-	-	-	X	-	X	-	X	X	-	X	-	-	-
	Camera	Camera_To_USBDisk	This application provides a short description of how to use the DCMI to interface with camera module and display in continuous mode the picture on LCD and to save a picture in USB device.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	Display	LCD_AnimatedPictureFromSDCard	This application describes how to display an animated picture on LCD saved under micro SD	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_DSI_ImageSlider	This application aims to show the outstanding capability of Display Serial Interface (DSI) peripheral to display images with high resolution (800x480). With a simple movement of finger, the content of GRAM is directly updated and displayed on DSI LCD.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		LCD_Paint	This application describes how to configure LCD touch screen and attribute an action related to configured touch zone and how to save BMP picture in SDCard.	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	-	-	-
		LCD_PicturesFromSDCard	This application describes how to display pictures saved on SD card on LCD DSI.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-
		LTDC_AnimatedPictureFromSDCard	This application describes how to display on LCD an animated picture saved under microSD.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		LTDC_AnimatedPictureFromUSB	This application describes how to display on LCD pictures saved under USB mass storage.	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		LTDC_Paint	This application describes how to configure LCD touch screen and attribute an action related to configured touch zone.	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
		LTDC_PicturesFromSDCard	This application describes how to display on LCD pictures saved under SD card.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	EEPROM	EEPROM_Emulation	This application describes the software solution for substituting standalone EEPROM by emulating the EEPROM mechanism using the on-chip Flash of STM32F4xxxx devices.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X
	FatFs	FatFs_ MultiDrivers	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, in order to develop an application exploiting FatFs offered features with multidrives (RAMDisk, uSD) configuration.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		FatFs_RAMDisk	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, in order to develop an application exploiting FatFs offered features with RAM disk (SDRAM) drive configuration.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	X	-	-	-
		FatFs_RAMDisk_ RTOS	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, in order to develop an application exploiting FatFs offered features with RAM disk (SRAM) drive in RTOS mode configuration.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		FatFs_USBDisk	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module and STM32 USB On-The-Go (OTG) host library, in High Speed (HS) modes (configured in FS), in order to develop an application exploiting FatFs offred features with USB disk drive configuration.	X	X	X	X	X	-	-	X	X	-	X	-	X	X	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	FatFs	FatFs_USBDisk_MultipleAccess_RTOS	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, FreeRTOS as an RTOS module based on using CMSIS-OS wrapping layer common APIs, and also STM32 USB On-The-Go (OTG) host library, in both Full Speed (FS) and High Speed (HS) modes, in order to develop an application exploiting FatFs offered features with USB disk drive in RTOS mode configuration.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-	X	X	-
		FatFs_USBDisk_RTOS	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, FreeRTOS as an RTOS module based on using CMSIS-OS wrapping layer common APIs, and also STM32 USB On-The-Go (OTG) host library, in both Full Speed (FS) and High Speed (HS) modes, in order to develop an application exploiting FatFs offered features with USB disk drive in RTOS mode configuration.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-	X	X	-
		FatFs_uSD	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, in order to develop an application exploiting FatFs offered features with microSD drive configuration.	-	-	-	X	-	-	-	X	X	-	-	-	X	-	X	X	X	X	X
		FatFs_uSD_RTOS	This application provides a description on how to use STM32Cube firmware with FatFs middleware component as a generic FAT file system module, in order to develop an application exploiting FatFs offered features with microSD drive in RTOS mode configuration.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	X	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	FreeRTOS	FreeRTOS_ LowPower	This application shows how to enter and exit low -power mode with CMSIS RTOS API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	X
		FreeRTOS_Mail	This application shows how to use mail queues with CMSIS RTOS API.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X
		FreeRTOS_ Mutexes	This application shows how to use mutexes with CMSIS RTOS API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	X
		FreeRTOS_ Queues	This application shows how to use message queues with CMSIS RTOS API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	X
		FreeRTOS_ Semaphore	This application shows how to use semaphores with CMSIS RTOS API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	X
		FreeRTOS_ SemaphoreFrom ISR	This application shows how to use semaphore from ISR with CMSIS RTOS API.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	-	X
		FreeRTOS_Signal	This application shows how to perform thread signaling using CMSIS RTOS API.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X
		FreeRTOS_Signal FromISR	This application shows how to perform thread signaling from an interrupt using CMSIS RTOS API.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X
		FreeRTOS_ ThreadCreation	This directory contains a set of sources files that implement a thread creation application using CMSIS RTOS API. This application creates two threads with the same priority, which executes in a periodic cycle of 15 seconds	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	X	X	-	X
		FreeRTOS_ Timers	This directory contains a set of source files that implement an application that uses timers of CMSIS RTOS API This application creates a thread that toggles LED2 every 400 ms, and a periodic timer that calls a callback function every 200 ms to toggle the LED1.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	X	X	X

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	IAP	IAP_Main	The directory contains a set of sources files and pre-configured projects that describes how to build an application to be loaded into Flash memory using In-Application Programming (IAP, through USART)	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		IAP_binary_ template	The directory contains a set of sources files that build the application to be loaded into Flash Memory using In-Application Programming (IAP, through USART).	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	LibJPEG	LibJPEG_ Decoding	This application demonstrates how to read jpeg file from USB disk, decode it and display the final BMP image on the LCD.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	X	X	X	-
		LibJPEG_ Encoding	This application demonstrates how to read BMP file from USB disk, encode it, save the jpeg file in USB disk then decode the jpeg file and display the final BMP image on the LCD.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	X	X	X	-
	LwIP	LwIP_HTTP_ Server_Netconn_ RTOS	This application guides STM32Cube HAL API users to run a http server application based on Netconn API of LwIP TCP/IP stack The communication is done with a web browser application in a remote PC.	-	-	-	-	X	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		LwIP_HTTP_ Server_Raw	This application guides STM32Cube HAL API users to run a http server application based on Raw API of LwIP TCP/IP stack The communication is done with a web browser application in a remote PC.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		LwIP_HTTP_ Server_Socket_R TOS	This application guides STM32Cube HAL API users to run a http server application based on Socket API of LwIP TCP/IP stack The communication is done with a web browser application in a remote PC.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		LwIP_IAP	This application guides STM32Cube HAL API users to run In-Application Programming (IAP) over Ethernet.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	LwIP	LwIP_TCP_Echo_Client	This application guides STM32Cube HAL API users to run TCP Echo Client application based on Raw API of LwIP TCP/IP stack To run this application, On the remote PC, open a command prompt window.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		LwIP_TCP_Echo_Server	This application guides STM32Cube HAL API users to run TCP Echo Server application based on Raw API of LwIP TCP/IP stack To run this application, On the remote PC, open a command prompt window.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		LwIP_TFTP_Server	This application guides STM32Cube HAL API users to run a tftp server demonstration for STM32F4xxxx devices.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		LwIP_UDPTCP_Echo_Server_Netconn_RTOS	This application guides STM32Cube HAL API users to run a UDP/TCP Echo Server application based on Netconn API of LwIP TCP/IP stack To run this application, On the remote PC, open a command prompt window.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		LwIP_UDP_Echo_Client	This application guides STM32Cube HAL API users to run a UDP Echo Client application based on Raw API of LwIP TCP/IP stack To run this application, On the remote PC, open a command prompt window.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		LwIP_UDP_Echo_Server	This application guides STM32Cube HAL API users to run UDP Echo Server application based on Raw API of LwIP TCP/IP stack To run this application, On the remote PC, open a command prompt window.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	STemWin	STemWin_HelloWorld	This directory contains a set of source files that implement a simple "Hello World" application based on STemWin for STM32F4xxxx devices.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	X	X	X	-
		STemWin_SampleDemo	This directory contains a set of source files that implement demo based on STemWin for STM32F4xxxx devices.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	X	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	USB_ Device	AUDIO_ Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the AUDIO Class implementation of an audio streaming (Out: Speaker/Headset) capability on the STM32F4xxxx devices.	-	-	-	X	-	-	-	-	X	-	-	-	X	-	X	-	-	-	-
		CDC_Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the Device Communication Class (CDC) following the PSTN subprotocol in the STM32F4xxxx devices using the OTG-USB and UART peripherals.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		CustomHID_ Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the Custom HID Class on the STM32F4xxxx devices.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
		DFU_Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the Device Firmware Upgrade (DFU) on the STM32F4xxxx devices.	-	X	-	X	X	-	-	-	X	-	-	-	X	-	X	X	-	X	X
		DualCore_ Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the STM32F4xx multi core support feature integrating Mass Storage (MSC) and Human Interface (HID) in the same project.	-	-	-	X	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		HID_BCD_Standa lone	The STM32F4xx integrated battery charger detection circuitry supports the USB-IF Battery Charger Detection, BCD (revision 1.2). The hpcd.Init.battery_charging_enable in the usbd_conf.c must be set to 1 to enable the support for BCD.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	USB_ Device	HID_LPM_ Standalone	The STM32F446xx devices support the USB Link Power Management Protocol (LPM-L1) and complies with the USB 2.0 LPM-L1 ECN. The hpcd.Init.lpm_enable in the usbd_conf.c should be set to 1 to enable the support for LPM-L1 protocol in the USB stack.	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
		HID_Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the Human Interface (HID) on the STM32F4xxxx devices.	-	X	-	X	X	-	-	X	X	-	-	-	X	-	X	X	X	X	X
		MSC_Standalone	This application is a part of the USB Device Library package using STM32Cube firmware. It describes how to use USB device application based on the Mass Storage Class (MSC) on the STM32F4xxxx devices.	-	-	-	X	-	-	-	-	X	-	-	-	X	-	X	X	X	X	X
	USB_ Host	AUDIO_ Standalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Audio OUT class on the STM32F4xxxx devices.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	X	-	-
		CDC_Standalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Communication Class (CDC) on the STM32F4xxxx devices.	-	-	-	-	-	-	-	-	X	-	-	-	X	-	X	-	-	-	-
		DualCore_ Standalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the STM32F4xx multi core support feature integrating Mass Storage (MSC) and Human Interface (HID) in the same project.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		DynamicSwitch_S tandalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use dynamically switch, on the same port, between available USB host applications on the STM32F4xxxx devices.	-	-	-	-	-	-	-	-	X	-	-	-	X	-	X	-	-	-	-
		FWupgrade_ Standalone	The firmware upgrade application or In-Application programming (IAP) is a feature that allows a user application to erase and write to on-chip flash memory.	-	-	X	X	-	-	-	-	X	-	-	-	X	-	X	-	-	-	-

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Applica-tions	USB_ Host	HID_RTOS	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Human Interface Class (HID) on the STM32F4xxxx devices.	-	-	-	X	-	-	-	X	X	-	-	-	X	-	X	X	-	-	-
		HID_Standalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Human Interface Class (HID) on the STM32F4xxxx devices.	-	X	-	X	X	-	-	X	X	-	-	-	X	-	X	X	X	X	X
		MSC_RTOS	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Mass Storage Class (MSC) on the STM32F4xxxx devices in RTOS mode configuration.	-	-	-	X	-	-	-	X	X	-	-	-	X	-	X	-	-	-	-
		MSC_Standalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Mass Storage Class (MSC) on the STM32F4xxxx devices.	-	X	-	X	X	-	-	X	X	-	-	-	X	-	X	X	-	X	X
		MTP_Standalone	This application is a part of the USB Host Library package using STM32Cube firmware. It describes how to use USB host application based on the Media Transfer Protocol (MTP) on the STM32F4xxxx devices.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-
	WIFI	WiFi_Client_Server	This application shows how to use the Es-WiFi module to perform a TCP client mode using STM32 Cube HAL. It demonstrates how to set up a client program, connect it to a TCP server.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
		WiFi_HTTP_Server	This application shows how to make HTTP requests using the Es-WiFi module based on STM32Cube HAL.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
	mbedTLS	SSL_Client	This application describes how to run an SSL client application based on mbedTLS crypto library and LwIP TCP/IP stack on STM32F4 Series.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
		SSL_Server	This application guides the STM32Cube HAL API users to run an SSL Server application based on mbedTLS crypto library and LwIP TCP/IP stack.	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-
	Total number of applications: 320			3	6	11	37	7	1	1	8	56	1	3	1	25	3	53	43	24	19	18

Table 1. STM32CubeF4 firmware examples (continued)

Level	Module Name	Project Name	Description	32F411E DISCOVERY	NUCLEO-F446ZE	32F429I DISCOVERY	STM32446E_EVAL	NUCLEO-F429ZI	NUCLEO-F446RE	NUCLEO-F401RE	NUCLEO-F412ZG	STM324x9I_EVAL	NUCLEO-F411RE	32F4 DISCOVERY	NUCLEO-F410xx	32F469I DISCOVERY	32F401C DISCOVERY	STM324xG_EVAL	STM32469I_EVAL	32F412G DISCOVERY	32F413H DISCOVERY	NUCLEO-F413ZH
Demons-trations	-	-	The provided demonstration firmware based on STM32Cube helps the user to discover STM32 Cortex-M devices that can be plugged on a STM32NUCLEO board.	-	X	-	-	X	-	-	X	-	X	-	-	-	-	-	-	-	-	X
			The demonstration firmware is built around the graphical library STemWin and the FreeRTOS real-time operating system and uses almost the whole STM32 capability to offer a large scope of usage based on the STM3Cube HAL, BSP and several middleware components	-	-	-	X		-	-	-	X	-	-	-	X	-	X	X	-	-	-
			The demonstration firmware uses the MEMS motion sensor to blink the four LEDs according to the motion direction and speed. Connecting the board to a PC with a second USB 'type A to micro-B' cable converts it into a standard mouse, and board motion controls the PC cursor.	X	-	X	-	-	-	-	-	-	-	X	-	-	X	-	-	X	X	-
	Total number of demonstration: 16			**1**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Total number of projects: 1201				**30**	**36**	**44**	**111**	**46**	**16**	**10**	**53**	**146**	**86**	**33**	**21**	**74**	**30**	**128**	**141**	**78**	**49**	**69**

Revision history

Table 2. Document revision history

Date	Revision	Changes
27-Jul-2015	1	Initial release.
22-Dec-2015	2	Updated *Table 1: STM32CubeF4 firmware examples* adding Nucleo boards.
18-Jul-2016	3	Updated *Table 1: STM32CubeF4 firmware examples* to support STM32F412xx devices.
24-Mar-2017	4	Updated *Figure 1: STM32CubeF4 firmware components*. Updated *STM32CubeF4 examples* adding examples_LL and examples_MIX. Updated *Table 1: STM32CubeF4 firmware examples* adding the examples, examples_LL, examples_MIX, applications provided with the listed boards.