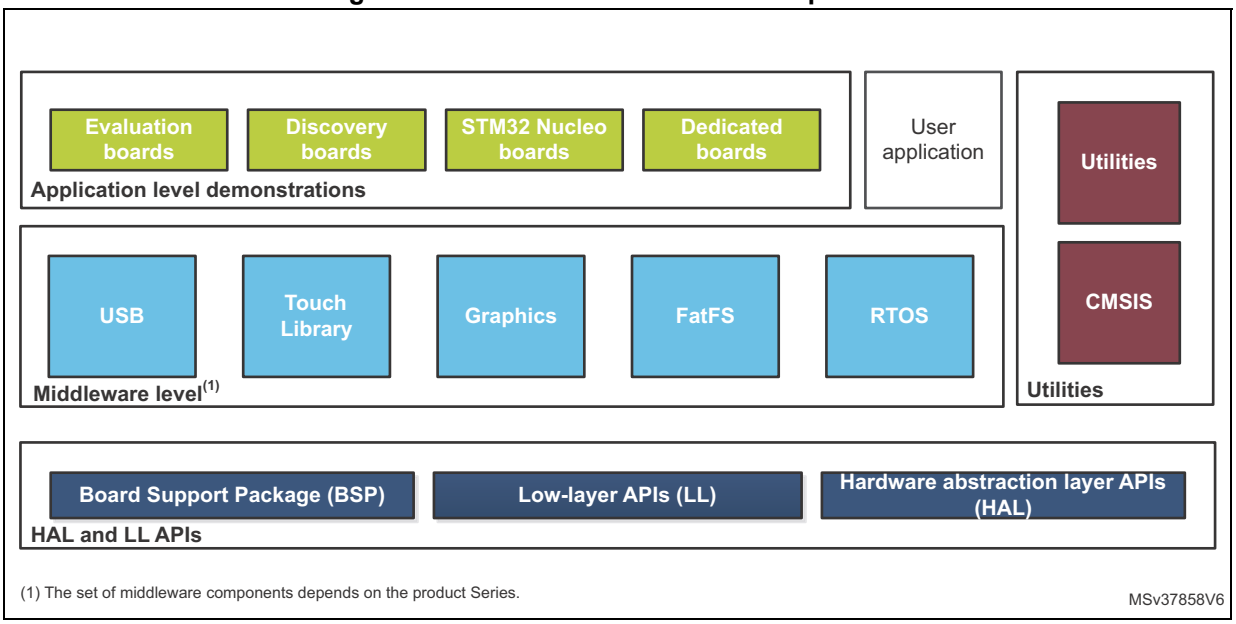
AN4726
Application note

STM32Cube firmware examples for STM32L4 Series and STM32L4+ Series

Introduction

The STM32CubeL4 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. STM32CubeL4 firmware components



Contents

1 Reference documents

The following user manuals are available on www.st.com/stm32cubefw:

- Latest release of STM32CubeL4 firmware package
- *Getting started with the STM32CubeL4 firmware package for STM32L4 Series and STM32L4+ Series* (UM1860)
- *Description of STM32L4xx HAL drivers* (UM1884)
- *STM32Cube USB Host library* (UM1720)
- *STM32Cube USB Device library* (UM1734)
- *Developing applications on STM32Cube with FatFS* (UM1721)
- *Developing Applications on STM32Cube with RTOS (*UM1722)
- *STM32CubeL4 Nucleo demonstration firmware* (UM1916).
- *STM32CubeL4 Demonstration firmware for 32L476GDISCOVERY* discovery kit (UM1919).
- *STM32CubeL4 Demonstration firmware for STM32L476G-EVAL board* (UM1937).
- *STM32CubeL4 Demonstration firmware for 32L496GDISCOVERY discovery kit* (UM2145).

2 STM32CubeL4 examples

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

- **Examples**

  These examples use only the HAL and BSP drivers (the middleware is not used). Their objective is to demonstrate the product/peripherals features and usage. They are organized per peripheral (one folder for each peripheral, e.g. TIMER). Their complexity level ranges from the basic usage of a given peripheral (e.g. PWM generation using timer) to the integration of several peripherals (e.g. 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, e.g. TIM) and run exclusively on Nucleo board.

- **Examples_MIX**

  These examples use only 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:

  – HAL offers high-level function-oriented APIs with high portability level by hiding product/IPs complexity for end users.

  – LL provides low-level APIs at register level with better optimization.

  The examples are organized per peripheral (one folder for each peripheral, e.g. 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 (one folder per middleware, e.g. USB Host) or by product feature that require high-level firmware bricks (e.g. Audio). The integration of applications that use several middleware stacks is also supported.

- **Demonstrations**

  The demonstrations aim at integrating and running the maximum number of peripherals and middleware stacks to showcase the product features and performance.

- **Template projects**

  The templates projects are provided to allow to quickly build a firmware application on a given board either with the HAL API or the LL API.

The examples are located under *STM32Cube_FW_L4_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 an 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 STM32CubeL4 firmware package.

Table 1. STM32CubeL4 firmware examples

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Templates_ LL	-	Starter project	This project provides a reference template based on the STM32Cube LL API that can be used to build any firmware application.	X	X	X	X	X	X	X	X	New	X
	Total number of templates_ll: 10			**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Templates	-	Starter project	This project provides a reference template based on the STM32Cube HAL API that can be used to build any firmware application.	X	X	X	X	X	X	X	X	New	X
	Total number of templates: 10			**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 of the STM32L476G-EVAL board.	-	X	-	-	-	X	-	X	-	-
	ADC	ADC_Analog Watchdog	This example provides a short description of how to use the ADC peripheral to perform conversions with analog watchdog and out-of-window interruptions enabled.	X	X	-	-	-	-	-	-	-	-
		ADC_DMA_ Transfer	This example describes how to configure and use the ADC to convert an external analog input and get the result using a DMA transfer through the HAL API.	X	X	-	X	-	-	X	-	New	-
		ADC_Dual ModeInter leaved	This example provides a short description of how to use two ADC peripherals to perform conversions in Interleaved dual-mode.	X	X	-	-	-	-	-	-	-	-
		ADC_ LowPower	This example provides a short description of how to use the ADC peripheral to perform conversions in ADC low-power Auto-wait mode.	-	-	-	X	-	-	-	-	-	-
		ADC_ OverSampler	This example describes how to configure and use the ADC to convert an external analog input combined with oversampling feature to increase resolution through the HAL API.	X	X	-	X	-	-	X	-	New	-
		ADC_Regular Conversion_ Interrupt	This example describes how to use the ADC in Interrupt mode to convert data through the HAL API.	-	-	-	X	-	-	X	-	New	-
		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	-	New	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	ADC	ADC_Regular_injected_groups	This example provides a short description of how to use the ADC peripheral to perform conversions using the two ADC groups: regular group for ADC conversions on main stream and injected group for ADC conversions limited to specific events (conversions injected within main conversions stream).	X	X	-	-	-	-	-	-	-	-
		ADC_Sequencer	This example provides a short description of how to use the ADC peripheral with sequencer to convert several channels.	X	X	-	-	-	-	-	-	New	-
	CAN	CAN_Networking	This example shows how to configure the CAN peripheral to send and receive CAN frames in Normal mode.	-	X	-	-	-	-	-	-	-	-
	COMP	COMP_Analog Watchdog	This example shows how to make an analog watchdog using the COMP peripherals in Window mode.	X	X	-	-	-	-	-	-	-	-
		COMP_Interrupt	This example shows how to configure the COMP peripheral to compare the external voltage applied on a specific pin with the Internal Voltage Reference.	X	X	-	X	X	-	X	-	-	-
	CRC	CRC_Bytes_Stream_7bit_CRC	This example guides you through the different configuration steps by means of the HAL API. The CRC (cyclic redundancy check) calculation unit computes 7-bit long CRC codes derived from buffers of 8-bit data (bytes).	X	-	-	-	X	-	X	-	New	-
		CRC_Data_Reversing_16bit_CRC	This example guides you through the different configuration steps by means of the HAL API. The CRC (cyclic redundancy check) calculation unit computes a 16-bit long CRC code derived from a buffer of 8-bit data (bytes).	X	-	-	-	X	-	X	-	New	-
		CRC_Example	This example guides you through the different configuration steps by means of the HAL API. The CRC (cyclic redundancy check) calculation unit computes the CRC code of a given buffer of 32-bit data words, using a fixed generator polynomial (0x4C11DB7).	X	X	-	X	X	-	X	X	New	-
		CRC_UserDefined Polynomial	This example guides you through the different configuration steps by means of the HAL API. The CRC (cyclic redundancy check) calculation unit computes the 8-bit long CRC code of a given buffer of 32-bit data words, based on a user-defined generating polynomial.	X	X	-	X	X	-	X	X	New	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	CRYP	CRYP_ AESModes	This example provides a short description of how to use the CRYP peripheral to encrypt and decrypt data using AES in chaining modes (ECB, CBC, CTR).	X	X	-	X	-	-	-	-	-	-
		CRYP_ AESModes_ Suspension	This example provides a short description of how to use the CRYP AES peripheral to suspend then resume the AES ECB, CBC and CTR processing of a message in order to carry out the encryption or decryption of a higher priority message.	X	X	-	X	-	-	-	-	-	-
		CRYP_DMA	This example provides a short description of how to use the CRYP peripheral to encrypt and decrypt data using AES 128 Algorithm with ECB chaining mode in DMA mode.	X	X	-	X	-	-	-	-	-	-
		CRYP_GCM_ GMAC_CMAC_ Modes	This example describes how to encrypt, decrypt data and compute authentication tag with GCM, GMAC and CMAC AES algorithms.	X	X	-	X	-	-	-	-	-	-
		CRYP_GCM_ GMAC_CMAC_ Suspension	This example provides a short description of how to use the CRYP AES peripheral to suspend then resume the AES GCM, GMAC and CMAC processing of a message in order to carry out the encryption, decryption or authentication tag computation of a higher priority message.	X	X	-	X	-	-	-	-	-	-
	Cortex	CORTEXM_ 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	X	-	X	X	-	X	-	-	-
		CORTEXM_ ModePrivilege	This example shows how to modify Thread mode privilege access and stack. Thread mode is entered on reset or when returning from an exception.	X	X	-	X	X	-	X	-	-	-
		CORTEXM_ ProcessStack	This example shows how to modify Thread mode stack. Thread mode is entered on Reset, and can be entered as a result of an exception return.	X	-	-	X	-	-	-	-	-	-
		CORTEXM_ SysTick	This example shows how to use the default SysTick configuration with a 1 ms timebase to toggle LEDs.	X	X	-	X	X	-	X	-	-	-
	DAC	DAC_Signals Generation	This example provides a description of how to use the DAC peripheral to generate several signals using DMA controller.	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	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	DCMI	DCMI_Capture Mode	This example provides a short description of how to use the DCMI interfaced with a camera module, continuously capture RGB565 images, crop them from size 320x240 to 240x240, then display the video stream on LCD.	-	-	-	-	-	-	-	-	-	X
		DCMI_Preview	This example provides a short description of how to use the DCMI interfaced with a camera module, continuously capture RGB565 images, crop them from size 320x240 to 240x240, then display the video stream on LCD with the possibility to freeze/unfreeze the video stream.	-	-	-	-	-	-	-	-	-	X
		DCMI_Snap shotMode	This example provides a short description of how to use the DCMI to interface with a camera module, capture a single RGB565 image and crop it from size 320x240 to 240x240, and once the full camera frame is captured, display it on a 240x240 LCD in RGB565 format.	-	-	-	-	-	-	-	-	-	X
	DFSDM	DFSDM_Audio Record	This example shows how to use the DFSDM HAL API to perform stereo audio recording.	-	X	-	-	-	-	-	X	-	X
		DFSDM_ Thermometer	This example shows how to use the DFSDM HAL API to perform temperature measurements.	-	X	-	-	-	-	-	-	-	-
	DMA	DMA_FLASH ToRAM	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 HAL API.	-	X	-	X	-	-	X	-	-	X

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	DMA2D	DMA2D_MemToMemWithBlending	This example provides a description of how to configure DMA2D peripheral in Memory-to-Memory with blending transfer mode.	-	-	-	-	-	-	-	-	-	X
		DMA2D_MemToMemWithLCD	This example provides a description of how to configure DMA2D peripheral in Memory-to-Memory transfer mode and display the result on LCD.	-	-	-	-	-	-	-	-	-	X
		DMA2D_MemToMemWithPFC	This example provides a description of how to configure DMA2D peripheral for transfer in Memory-to-Memory with Pixel format conversion (PFC) mode.	-	-	-	-	-	-	-	-	-	X
		DMA2D_MemoryToMemory	This example provides a description of how to configure the DMA2D peripheral in Memory-to-Memory transfer mode.	-	-	-	-	-	-	-	-	-	X
		DMA2D_RegToMemWithLCD	This example provides a description of how to configure DMA2D peripheral in Register-to-Memory transfer mode and display the result on LCD.	-	-	-	-	-	-	-	-	-	X
	FIREWALL	FIREWALL_VolatileData_Executable	This example shows how to use the Firewall peripheral to protect a volatile data segment and define it as executable.	X	-	-	-	X	-	-	-	-	-
		FIREWALL_VolatileData_Shared	This example shows how to use the Firewall peripheral to protect a code segment as well as volatile and non-volatile data segments.	X	-	-	-	X	-	-	-	-	-
	FLASH	FLASH_DualBoot	This example guides you through the different configuration steps to program the internal Flash bank 1 and bank 2, and to swap between both of them by mean of the FLASH HAL API.	X	X	-	-	X	-	-	X	-	X
		FLASH_EraseProgram	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
		FLASH_FastProgram	This example describes how to configure and use the FLASH HAL API to erase and fast program the internal Flash memory.	X	X	-	X	X	-	-	X	-	X
		FLASH_WriteProtection	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	-	X

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	FMC	FMC_NOR	This example describes how to configure the FMC controller to access the NOR Flash memory.	-	X	-	-	-	-	-	-	-	-
		FMC_SRAM	This example describes how to configure the FMC controller to access the SRAM.	-	X	-	-	-	-	-	-	-	-
	GPIO	GPIO_EXTI	This example shows how to configure external interrupt lines.	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
	HAL	HAL_TimeBase _TIM	This example describes how to customize the HAL timebase using a general-purpose timer instead of the SysTick as main timebase source.	X	X	-	X	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	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	-	-	-	-	-	-	-	New	-
		HASH_HMAC_SHA224SHA1_DMA_Suspension	This example describes how to suspend the HMAC digest computation when data are fed to the HASH IP by DMA.	-	-	-	-	-	-	-	-	New	-
		HASH_HMAC_SHA224 SHA256_MultiBuffer_DMA	This example describes how to handle text messages longer than the maximum DMA transfer length. In this case, the input data have to be split into several buffers with sizes within the DMA limit, and the buffers must be consecutively fed to the HASH peripheral.	X	-	-	-	-	-	-	-	New	-
		HASH_HMAC_SHA256MD5_IT_Suspension	This example describes how to suspend the HMAC digest computation when data are fed either under interruption.	X	-	-	-	-	-	-	-	New	-
		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	-	-	-	-	-	-	-	New	-
		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	-	-	-	-	-	-	-	New	-
		HASH_SHA1SHA224_IT_Suspension	This example describes how to suspend the HASH peripheral when data are fed in Interrupt mode.	X	-	-	-	-	-	-	-	New	-
		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	-	-	-	-	-	-	-	New	-
		HASH_SHA256MD5_DMA_Suspension	This example describes how to suspend the HASH peripheral when data are fed to the HASH IP by DMA.	-	-	-	-	-	-	-	-	New	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	I2C	I2C_EEPROM	This example describes how to ensure I2C data buffer transmission/reception with DMA. Data are exchanged with an I2C EEPROM memory.	-	X	-	-	-	-	-	-	-	-
		I2C_ IOExpander	This example describes how to perform I2C data communication with the I/O expander device mounted on the evaluation board.	-	X	-	-	-	-	-	-	-	-
		I2C_Two Boards_ AdvComIT	This example describes how to perform I2C data buffer transmission/reception between two boards, using an interrupt.	X	X	-	X	X	-	X	-	New	-
		I2C_Two Boards_ ComDMA	This example describes how to perform I2C data buffer transmission/reception between two boards, via DMA.	X	X	-	X	X	-	X	-	New	-
		I2C_Two Boards_ComIT	This example describes how to perform I2C data buffer transmission/reception between two boards using an interrupt.	X	X	-	X	X	-	X	-	New	-
		I2C_Two Boards_ ComPolling	This example describes how to perform I2C data buffer transmission/reception between two boards in Polling mode.	X	X	-	X	X	-	-	-	New	-
		I2C_Two Boards_Restart AdvComIT	This example describes how to perform a multiple I2C data buffer transmission/reception between two boards in Interrupt mode and with a restart condition.	X	X	-	X	X	-	X	-	New	-
		I2C_Two Boards_Restart ComIT	This example describes how to perform a single I2C data buffer transmission/reception between two boards in Interrupt mode and with a restart condition.	X	X	-	X	X	-	X	-	New	-
		I2C_WakeUp FromStop	This example describes how to perform I2C data buffer transmission/reception between two boards using an interrupt when the device is in Stop mode.	X	X	-	-	X	-	X	-	-	-
		I2C_WakeUp FromStop2	This example describes how to perform I2C data buffer transmission/reception between two boards using an interrupt when the device is in Stop 2 mode.	X	X	-	X	X	-	-	-	-	-
	IWDG	IWDG_Reset	This example describes how to ensure IWDG reload counter and simulate a software fault that generates an MCU IWDG reset when a programmed time period has elapsed.	X	X	-	X	X	-	-	-	-	-
		IWDG_Window Mode	This example describes how to periodically update the IWDG reload counter and simulate a software fault that generates an MCU IWDG reset when a programmed time period has elapsed.	X	X	-	X	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	LCD	LCD_Blink_ Frequency	This example describes how to use the embedded LCD glass controller and how to configure the LCD blink mode and blinking frequency.	-	X	-	-	-	-	-	-	-	-
		LCD_ SegmentsDrive	This example describes how to use the embedded LCD controller to drive the Pacific Display LCD glass mounted on the board.	-	X	-	-	-	-	-	-	-	-
	LPTIM	LPTIM_PWM ExternalClock	This example describes how to configure and use LPTIM to generate a PWM at the lowest power consumption, using an external counter clock, through the HAL LPTIM API.	X	X	-	X	X	-	-	-	-	-
		LPTIM_PWM_ LSE	This example describes how to configure and use LPTIM to generate a PWM in low-power mode using the LSE as a counter clock, through the HAL LPTIM API.	-	X	-	X	-	-	-	-	-	-
		LPTIM_Pulse Counter	This example describes how to configure and use LPTIM to count pulses through the LPTIM HAL API.	X	X	-	X	X	-	X	-	-	-
		LPTIM_ Timeout	This example describes how to implement a low-power timeout to wake up the system using the LPTIM peripheral through the HAL LPTIM API.	X	X	-	X	-	-	X	-	-	-
	LPUART	LPUART_Two Boards_ComIT	This example describes a LPUART transmission (transmit/receive) in interrupt mode between two boards.	X	-	-	-	-	-	-	-	-	-
		LPUART_ WakeUpFrom Stop	This example shows how to configure a LPUART to wake up the MCU from Stop mode when a given stimulus is received.	X	-	-	-	-	-	-	-	-	-
	OPAMP	OPAMP_PGA	This example shows how to use the built-in PGA mode (OPAMP programmable gain).	X	X	-	-	X	-	X	-	-	-
		OPAMP_ STANDALONE	This example shows how to configure OPAMP peripheral in Standalone mode. In this mode, the gain can be set externally (external gain setting mode).	X	X	-	-	-	-	X	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	PWR	PWR_LPRUN	This example shows how to enter and exit the Low-power Run mode.	X	-	-	X	X	-	X	-	New	-
		PWR_LPRUN_SRAM1	This example shows how to enter and exit Low Power run mode.	X	-	-	X	X	-	X	-	New	-
		PWR_LPSLEEP	This example shows how to enter Low-power sleep mode and wake up from this mode using an interrupt.	X	-	-	X	X	-	X	-	New	-
		PWR_Modes Selection	This example shows how to enter the power mode selected by the user application from an HyperTerminal console running on a remote Host computer. The objective is to provide a mean to measure the power consumption using an ampere meter on the IDD connector.	X	-	-	X	X	-	X	-	New	-
		PWR_RUN_SMPS	This example shows how to use the SMPS in Run mode and assess the power consumption gain obtained when the SMPS feature is used.	X	-	X	X	-	-	-	-	-	-
		PWR_SHUTDOWN	This example shows how to enter Shutdown mode and wake up from this mode using an external reset or the WKUP pin.	X	-	-	X	X	-	X	-	New	-
		PWR_SLEEP	This example shows how to enter Sleep mode and wake up from this mode by using an interrupt.	X	-	-	X	X	-	X	-	New	-
		PWR_STANDBY	This example shows how to enter Standby mode and wake up from this mode using an external reset or the WKUP pin.	X	-	-	X	X	-	X	-	New	-
		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 In the associated software. The system clock is set to 120 MHz and the SysTick is programmed to generate an interrupt each 1 ms.	X	-	-	X	X	-	X	-	New	-
		PWR_STANDBY_SMPS	This example shows how to enter SMPS Standby mode and wake up from this mode using an interrupt.	X	-	X	X	-	-	-	-	-	-
		PWR_STOP0_SMPS	This example shows how to enter SMPS Stop 0 mode and wake up from this mode using an interrupt.	X	-	X	X	-	-	-	-	-	-
		PWR_STOP1	This example shows how to enter Stop 1 mode and wake up from this mode using an interrupt.	X	-	-	X	X	-	X	-	New	-
		PWR_STOP1_RTC	This example shows how to enter Stop 1 mode and wake up from this mode using an interrupt from RTC wakeup timer.	X	-	-	X	X	-	X	-	New	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	PWR	PWR_STOP2	This example shows how to enter Stop 2 mode and wake up from this mode using an external reset or a wakeup interrupt. The system clock is set to 120 MHz, an EXTI line is connected to the user button through PC13 and configured to generate an interrupt on falling edge when the button is pressed.	X	-	-	X	X	-	X	-	New	-
		PWR_STOP2_RTC	This example shows how to enter Stop 2 mode and wake up from this mode using an external reset or the RTC wakeup timer.	X	-	-	X	X	-	X	-	New	-
	QSPI	QSPI_Execute InPlace	This example describes how to execute a part of the code from the QuadSPI Flash memory. To do this, a section is created where the function is stored.	-	X	-	-	-	-	-	X	-	X
		QSPI_Memory Mapped	This example describes how to erase part of the QuadSPI Flash memory, write data in DMA mode and access to QuadSPI Flash memory in memory-mapped mode to check the data in a forever loop.	-	X	-	-	-	-	-	X	-	X
		QSPI_PreInit Config	This example describes how to execute a part of the code from the QuadSPI Flash memory configured in memory-mapped mode before the call to main() function so that QuadSPI Flash memory is available after the reset.	-	X	-	-	-	-	-	X	-	X
		QSPI_Read Write_DMA	This example describes how to erase part of the QuadSPI Flash memory, write data in DMA mode, read data in DMA mode and compare the result in a forever loop.	-	X	-	-	-	-	-	X	-	X
		QSPI_Read Write_IT	This example describes how to erase part of the QuadSPI Flash memory, write data in Interrupt mode, read data in Interrupt mode and compare the result in a forever loop.	-	X	-	-	-	-	-	X	-	X
	RCC	RCC_CRS_ Synchronization _IT	This example describes how to use the RCC HAL API to configure the clock recovery service (CRS) in Interrupt mode.	X	-	-	X	-	-	X	-	-	-
		RCC_CRS_ Synchronization _Polling	This example describes how to use the RCC HAL API to configure the clock recovery service (CRS) in Polling mode.	X	-	-	X	-	-	X	-	-	-
		RCC_ ClockConfig	This example describes how to use the RCC HAL API to configure the system clock (SYSCLK) and modify the clock settings in Run mode.	X	X	-	X	X	-	-	X	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	RNG	RNG_MultiRNG	This example guides you through the HAL API different configuration steps to ensure 32-bit long random numbers generation by RNG peripheral.	X	X	-	X	-	-	X	-	New	-
		RNG_MultiRNG_IT	This example guides you through the HAL API different configuration steps to ensure 32-bit long random numbers generation by RNG peripheral interruptions.	X	X	-	X	-	-	X	-	New	-
	RTC	RTC_Alarm	This example guides you 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 you through the different configuration steps by mean of HAL API to configure the RTC calendar.	-	X	-	X	-	-	-	-	-	-
		RTC_Internal TimeStamp	This example guides you through the different configuration steps by means of the RTC HAL API to demonstrate the internal timestamp feature.	-	X	-	-	-	-	-	-	-	-
		RTC_LSI	This example demonstrates and explains how to use the LSI clock source auto calibration to get a precise RTC clock.	X	X	-	X	X	-	X	-	-	-
		RTC_ LowPower_ STANDBY	This example shows how to enter Standby mode and wake up from this mode using the RTC alarm event.	-	-	-	X	-	-	-	-	-	-
		RTC_Tamper	This example guides you through the different configuration steps by means of the RTC HAL API to write/read data to/from RTC Backup registers. It also demonstrates the tamper detection feature.	X	X	-	X	X	-	-	-	-	-
		RTC_ TimeStamp	This example guides you through the different configuration steps by means of the RTC HAL API to demonstrate the timestamp feature.	X	X	-	X	X	-	-	-	-	-
	SAI	SAI_AudioPlay	This example shows how to use the SAI HAL API to play an audio file using the DMA circular mode and how to handle the buffer update.	-	X	-	-	-	-	-	X	-	-
	SMART-CARD	SMARTCARD_ T0	This example describes a firmware smartcard Interface based on USART. The main purpose of this firmware example is to provide resources that ease the development of applications using USART in Smartcard mode.	-	X	-	-	-	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	SPI	SPI_FullDuplex_ComDMA	This example shows how to perform SPI data buffer transmission/reception between two boards via DMA.	X	-	-	X	X	-	X	-	New	-
		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	-	New	-
		SPI_FullDuplex_ComPolling	This example shows how to ensure SPI data buffer transmission/reception in Polling mode between two boards.	X	-	-	X	X	-	X	-	New	-
		SPI_HalfDuplex_ComPolling	This example shows how to ensure SPI data buffer half-duplex transmission/reception in Polling mode between two boards.	X	-	-	X	X	-	-	-	-	-
	SWPMI	SWPMI_Session	This example shows how to use the SWPMI interface and open a communication session with a SWP compliant card in no software buffer mode.	-	X	-	-	-	-	-	-	-	-
	TIM	TIM_DMA	This example provides a description of how to use DMA with timer update request to transfer data from memory to TIMER Capture Compare Register 3 (TIMx_CCR3).	X	X	-	X	X	-	X	-	-	-
		TIM_DMABurst	This example shows how to update the TIMER channel1 period and the duty cycle using the TIMER DMA burst feature.	X	X	-	X	X	-	X	-	-	-
		TIM_ExtTriggerSynchro	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	-	-	-
		TIM_OCActive	This example shows how to configure the TIM peripheral in Output Compare Active mode (when the counter matches the capture/compare register, the concerned output pin is set to its active state).	X	X	-	X	X	-	X	-	-	-
		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	-	X	-	-	-
		TIM_OCToggle	This example shows how to configure the TIM peripheral to generate four different signals with four different frequencies.	X	X	-	X	X	-	X	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples	TIM	TIM_OnePulse	This example shows how to use the TIM peripheral to generate a single pulse when a rising edge of an external signal is received on the timer Input pin.	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	-	-	-
		TIM_PWM Output	This example shows how to configure the TIM peripheral in PWM (pulse width modulation) mode.	X	X	-	X	X	-	X	-	-	-
		TIM_TimeBase	This example shows how to configure the TIM peripheral to generate a timebase of one second with the corresponding Interrupt request.	X	X	-	X	X	-	X	-	-	-
	TSC	TSC_Basic Acquisition_ Interrupt	This example describes how to use the HAL TSC to perform continuous acquisitions of one channel in Interrupt mode.	-	X	-	-	-	-	-	-	-	-
	UART	UART_Hyper Terminal_DMA	This example describes an UART transmission (transmit/receive) in DMA mode between a board and an HyperTerminal PC application.	-	X	-	-	-	-	-	-	-	-
		UART_Printf	This example shows how to re-route the C library printf function to the UART.	-	X	-	-	-	-	-	-	-	-
		UART_Two Boards_ ComDMA	This example describes an UART transmission (transmit/receive) in DMA mode between two boards.	X	-	-	X	X	-	X	-	-	-
		UART_Two Boards_ComIT	This example describes an UART transmission (transmit/receive) in Interrupt mode between two boards.	X	-	-	X	X	-	X	-	-	-
		UART_Two Boards_ ComPolling	This example describes an UART transmission (transmit/receive) in Polling mode between two boards.	X	-	-	X	X	-	X	-	-	-
		UART_WakeUp FromStop	This example shows how to configure an UART to wake up the MCU from Stop 1 mode when a given stimulus is received.	X	-	-	X	X	-	X	-	-	-
	WWDG	WWDG_ Example	This example guides you through the different configuration steps by means of the HAL API to perform periodic WWDG counter update and simulate a software fault that generates an MCU WWDG reset when a predefined time period has elapsed.	X	X	-	X	X	-	-	-	-	-
	Total number of examples: 488			**101**	**87**	**3**	**85**	**69**	**1**	**62**	**17**	**41**	**22**

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_LL	ADC	ADC_Analog Watchdog	This example describes how to use a ADC peripheral with 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 STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_ Continuous Conversion_ TriggerSW	This example describes how to use a ADC peripheral to perform continuous ADC conversions of a channel, from a software start. This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_ Continuous Conversion_ TriggerSW_Init	This example describes how to use a ADC peripheral to perform continuous ADC conversions of a channel, from a software start. This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_ Continuous Conversion_ TriggerSW_Low Power	This example describes how to use a ADC peripheral with ADC low-power features. This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_Groups RegularInjected	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 STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_Multi ChannelSingleC onversion	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 STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	ADC	ADC_ MultimodeDual Interleaved	This example describes how to use several ADC peripherals in multimode, mode interleaved. This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_ Oversampling	This example describes how to use a ADC peripheral with ADC oversampling. This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_Single Conversion_ TriggerSW	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel at each software start. This example uses the polling programming model (for interrupt or DMA programming models, refer to other examples). This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_Single Conversion_ TriggerSW_ DMA	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel at each software start;. This example uses the DMA programming model (for polling or interrupt programming models, refer to other examples). This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_Single Conversion_ TriggerSW_IT	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel, at each software start; This example uses the interrupt programming model (for polling or DMA programming models, refer to other examples). This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	ADC	ADC_SingleConversion_TriggerTimer_DMA	This example describes how to use a ADC peripheral to perform a single ADC conversion of a channel at each timer trigger event. Converted data are indefinitely transferred by DMA into a table (circular mode). This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		ADC_Temperature Sensor	This example describes how to use a ADC peripheral to perform a single ADC conversion of the internal temperature sensor and calculate the temperature in Celsius degrees. This example uses the polling programming model (for interrupt or DMA programming models, refer to other examples). This example is based on the STM32L4xx ADC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	COMP	COMP_CompareGpioVsVrefInt_IT	This example describes how to use a comparator peripheral to compare a voltage level applied on a GPIO pin with the internal voltage reference (VREFINT), in interrupt mode. This example is based on the STM32L4xx COMP LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		COMP_CompareGpioVsVrefInt_IT_Init	This example describes how to use a comparator peripheral to compare a voltage level applied on a GPIO pin with the internal voltage reference (VREFINT), in interrupt mode. This example is based on the STM32L4xx COMP LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
		COMP_CompareGpioVsVrefInt_OutputGpio	This example describes how to use a comparator peripheral to compare a voltage level applied on a GPIO pin with the internal voltage reference (VREFINT). The comparator output is connected to a GPIO. This example is based on the STM32L4xx COMP LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	COMP	COMP_ CompareGpioVsVrefInt_ Window_IT	This example describes how to use a pair of comparator peripherals to compare a voltage level applied on a GPIO pin with two thresholds: the internal voltage reference (VREFINT) and a fraction the internal voltage reference (VREFINT/2), in interrupt mode. This example is based on the STM32L4xx COMP LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	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	-	-	-	X	-	-	-	-	-
	CRC	CRC_CalculateAndCheck	This example shows how to configure 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 service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		CRC_ UserDefinedPolynomial	This example shows how to configure and use CRC calculation unit to get a 8-bit long CRC of a given data buffer, based on a user-defined generating polynomial. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	CRS	CRS_ Synchronization_IT	This example describes how to configure Clock Recovery Service in Interrupt mode through the STM32L4xx CRS LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	-	-	-	-	-	-
		CRS_ Synchronization_Polling	This example describes how to configure Clock Recovery Service in Polling mode through the STM32L4xx CRS LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	-	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	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 STM32L4xx DAC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		DAC_GenerateConstantSignal_TriggerSW_LP	This example describes how to use the DAC peripheral to generate a constant voltage signal with DAC low-power sample-and-hold feature. To be effective, a capacitor must be connected to the DAC channel output and the sample-and-hold timings must be tuned depending on the capacitor value. This example is based on the STM32L4xx DAC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		DAC_GenerateWaveform_TriggerHW	This example describes how to use the DAC peripheral to generate a waveform voltage from digital data stream transferred by DMA. This example is based on the STM32L4xx DAC LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		DAC_GenerateWaveform_TriggerHW_Init	This example describes how to use the DAC peripheral to generate a waveform voltage from digital data stream transferred by DMA. This example is based on the STM32L4xx DAC LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
	DMA	DMA_CopyFromFlashToMemory	This example describes how to use a DMA channel to transfer a word data buffer from Flash memory to embedded SRAM. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		DMA_CopyFromFlashToMemory_Init	This example describes how to use a DMA channel to transfer a word data buffer from Flash memory to embedded SRAM. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	DMA2D	DMA2D_ MemoryTo Memory	This example describes how to configure the DMA2D peripheral in Memory-to-Memory transfer mode. The example is based on the STM32L4xx DMA2D LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	-	-	-	-	-	-	-	-	-	X
	EXTI	EXTI_Toggle LedOnIT	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 STM32L4xx LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		EXTI_Toggle LedOnIT_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 STM32L4xx LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
	GPIO	GPIO_Infinite LedToggling	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 STM32L4xx LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		GPIO_Infinite LedToggling_ 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 STM32L4xx LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
	I2C	I2C_OneBoard_ Adv Communication _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	-	-	-	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 service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	I2C	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 service functions for optimization purpose (performance and size).	X	-	-	-	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	-	-	-	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 service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		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 service functions for optimization purpose (performance and size).	X	-	-	-	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 service functions for optimization purpose (performance and size).	X	-	-	-	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	-	-	-	X	-	-	-	-	-
		I2C_TwoBoards_WakeUpFromStop2_IT	This example describes how to receive data byte from an I2C Slave device in Stop2 mode using Interrupt mode to an I2C Master device Interrupt mode. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	IWDG	IWDG_RefreshUntilUserEvent	This example describes how to configure the IWDG to ensure periodic counter update and generate an MCU IWDG reset when a user button is pressed. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	LPTIM	LPTIM_Pulse Counter	This example describes how to use the LPTIM in counter mode to generate a PWM output signal and update PWM duty cycle. This example is based on the STM32L4xx LPTIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		LPTIM_Pulse Counter_Init	This example describes how to use the LPTIM in counter mode to generate a PWM output signal and update PWM duty cycle. This example is based on the STM32L4xx LPTIM LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
	LPUART	LPUART_WakeUpFromStop2	This example shows how to configure GPIO and LPUART peripherals to allow characters received on LPUART RX pin to wake up the MCU from low-power mode. This example is based on the STM32L4xx LPUART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		LPUART_WakeUpFromStop2_Init	This example shows how to configure GPIO and LPUART peripherals to allow characters received on LPUART RX pin to wake up the MCU from low-power mode. This example is based on the STM32L4xx LPUART LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	OPAMP	OPAMP_PGA	This example describes how to use a operational amplifier peripheral in PGA mode (programmable gain amplifier). To test the OPAMP, a voltage waveform is generated by the DAC and feeds the OPAMP input. This example is based on the STM32L4xx OPAMP LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		OPAMP_PGA_Init	This example describes how to use a operational amplifier peripheral in PGA mode (programmable gain amplifier). To test the OPAMP, a voltage waveform is generated by the DAC and feeds the OPAMP input. This example is based on the STM32L4xx OPAMP LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
	PWR	PWR_EnterStandbyMode	This example shows how to enter Standby mode and wake up from this mode using an external reset or a wakeup interrupt.	X	-	-	-	X	-	-	-	-	-
		PWR_EnterStopMode	This example shows how to enter Stop 2 mode.	X	-	-	-	X	-	-	-	-	-
		PWR_LPRunMode_SRAM1	This example shows how to execute code (Low-power run mode) from SRAM1.	X	-	-	-	X	-	-	-	-	-
		PWR_OptimizedRunMode	This example shows how to increase/decrease frequency and VCORE and how to enter/exit Low-power run mode.	X	-	-	-	X	-	-	-	-	-
	RCC	RCC_HWAutoMSICalibration	This example demonstrates and explains how to use the MSI clock source hardware auto-calibration to get an accurate MSI clock using LSE (PLL mode).	X	-	-	-	X	-	-	-	-	-
		RCC_OutputSystemClockOnMCO	This example describes how to configure MCO pin (PA8) to output the system clock.	X	-	-	-	X	-	-	-	-	-
		RCC_UseHSEasSystemClock	This example describes how to use the RCC LL API to start the HSE and use it as system clock.	X	-	-	-	X	-	-	-	-	-
		RCC_UseHSI_PLLasSystemClock	This example shows how to modify the PLL parameters in run time.	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	RNG	RNG_Generate Random Numbers	This example shows how to configure the RNG peripheral to generate 32-bit long random numbers. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		RNG_Generate Random Numbers_IT	This example shows how to configure the RNG peripheral to generate 32-bit long random numbers, using interrupts. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	RTC	RTC_Alarm	This example guides you through the different configuration steps by mean of LL API to ensure Alarm configuration and generation using the RTC peripheral. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		RTC_Alarm_Init	This example guides you through the different configuration steps by mean 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	-	-	-	X	-	-	-	-	-
		RTC_Calendar	This example guides you through the different configuration steps by mean of LL API to configure the RTC calendar. The peripheral initialization done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		RTC_Exit StandbyWith WakeUpTimer	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	-	-	-	X	-	-	-	-	-
		RTC_ Programming TheWakeUp Timer	This example shows how to configure the RTC in order to work with the RTC wakeup timer. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	-	-	-	-	-	-
		RTC_Tamper	This example guides you 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 service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	RTC	RTC_ TimeStamp	This example guides you through the different configuration steps by mean of LL API to ensure Timestamp configuration using the RTC peripheral. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	SPI	SPI_OneBoard_ HalfDuplex_ DMA	This example shows how to configure GPIO and SPI peripherals to transmit bytes from an SPI Master device to an SPI Slave device in DMA mode. The example is based on the STM32L4xx SPI LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		SPI_OneBoard_ HalfDuplex_ DMA_Init	This example shows how to configure GPIO and SPI peripherals to transmit bytes from an SPI Master device to an SPI Slave device in DMA mode. The example is based on the STM32L4xx SPI LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
		SPI_OneBoard_ HalfDuplex_IT	This example shows how to configure GPIO and SPI peripherals to transmit bytes from an SPI Master device to an SPI Slave device in Interrupt mode. The example is based on the STM32L4xx SPI LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		SPI_TwoBoards _FullDuplex_ DMA	This example shows how to ensure SPI data buffer transmission and reception in DMA mode. The example is based on the STM32L4xx SPI LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		SPI_TwoBoards _FullDuplex_IT	This example shows how to ensure SPI Data buffer transmission and reception in Interrupt mode. The example is based on the STM32L4xx SPI LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	SWPMI	SWPMI_ Loopback_ MultiSWBuffer	This example describes how to configure SWPMI to start a communication using DMA multibuffers in Loopback mode. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		SWPMI_ Loopback_ MultiSWBuffer_ Init	This example describes how to configure SWPMI to start a communication using DMA multibuffers in Loopback mode. The peripheral initialization is done using LL initialization function to demonstrate LL initialization usage.	X	-	-	-	X	-	-	-	-	-
		SWPMI_ Loopback_ NoSWBuffer	This example describes how to configure SWPMI to start a communication using No software buffer mode in Loopback mode. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	TIM	TIM_Break AndDeadtime	This example shows how to configure the TIM peripheral to perform the following operations: – generate three center-aligned PWM and complementary PWM signals – insert a defined dead time value – use the break feature – lock the desired parameters This example is based on the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		TIM_DMA	This example provides a description of how to use DMA with TIMER update request to transfer data from memory to TIMER Capture Compare Register 3 (TIMx_CCR3). This example uses the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		TIM_Input Capture	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. This example uses the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	TIM	TIM_OnePulse	This example shows how to configure a timer to generate a positive pulse in Output Compare mode with a length of t_{PULSE} and after a delay of t_{DELAY}. This example is based on the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		TIM_Output Compare	This example shows how to configure the TIM peripheral to generate an output waveform in different output compare modes. This example uses the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		TIM_PWM Output	This example describes how to use a timer peripheral to generate a PWM output signal and update PWM duty cycle. This example using the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		TIM_PWM Output_Init	This example describes how to use a timer peripheral to generate a PWM output signal and update PWM duty cycle. This example is based on the STM32L4xx TIM LL API. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
		TIM_TimeBase	This example shows how to configure the TIM peripheral to generate a timebase. This example uses the STM32L4xx TIM LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	USART	USART_ Communication _Rx_IT	This example shows how to configure GPIO and USART peripheral for receiving characters from HyperTerminal (PC) in Asynchronous mode using Interrupt mode. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		USART_ Communication _Rx_IT_ Continuous	This example shows how to configure GPIO and USART peripheral for continuously receiving characters from HyperTerminal (PC) in Asynchronous mode using Interrupt mode. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	USART	USART_ Communication _Rx_IT_Init	This example shows how to configure GPIO and USART peripheral for receiving characters from an HyperTerminal (PC) in Asynchronous mode using Interrupt mode. The peripheral initialization is done using LL initialization function to demonstrate LL init usage.	X	-	-	-	X	-	-	-	-	-
		USART_ Communication _Tx	This example shows how to configure GPIO and USART peripherals to send characters asynchronously to an HyperTerminal (PC) in Polling mode. If the transfer could not be complete within the allocated time, a timeout allows to exit from the sequence with a timeout error code. This example is based on STM32L4xx USART LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		USART_ Communication _TxRx_DMA	This example shows how to configure GPIO and USART peripheral to send characters asynchronously to/from an HyperTerminal (PC) in DMA mode. This example is based on STM32L4xx USART LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		USART_ Communication _Tx_IT	This example shows how to configure GPIO and USART peripheral to send characters asynchronously to HyperTerminal (PC) in Interrupt mode. This example is based on STM32L4xx USART LL API. The peripheral initialization is done using LL unitary services functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		USART_ HardwareFlowControl	This example shows how to configure GPIO and USART peripheral to receive characters asynchronously from HyperTerminal (PC) in Interrupt mode with Hardware Flow Control feature enabled. This example is based on STM32L4xx USART LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		USART_Sync Communication _FullDuplex_ DMA	This example shows how to configure 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 STM32L4xx USART LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_ LL	USART	USART_SyncCommunication_FullDuplex_IT	This example shows how to configure GPIO, USART, DMA and SPI peripherals to transmit bytes from/to a USART peripheral to/from an SPI peripheral (in slave mode) by using Interrupt mode through the STM32L4xx USART LL API (the SPI uses the DMA to receive/transmit characters sent from/received by the USART). The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
		USART_WakeUpFromStop1	This example shows how to configure GPIO and USART peripherals to receive characters on USART RX pin and wake up the MCU from low-power mode, using STM32L4xx USART LL API. The peripheral initialization is done using LL unitary service functions for optimization purpose (performance and size).	X	-	-	-	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 call the UTILS LL API.	X	-	-	-	X	-	-	-	-	-
		UTILS_ReadDeviceInfo	This example describes how to read UID, Device ID and Revision ID and save them into a global information buffer.	X	-	-	-	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 service functions for optimization purpose (performance and size).	X	-	-	-	X	-	-	-	-	-
	Total number of examples_ll: 186			**94**	**0**	**0**	**0**	**91**	**0**	**0**	**0**	**0**	**1**

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
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 Polling or DMA programming models, refer to the other examples). This example is based on the STM32L4xx ADC HAL and LL API. The LL API is used for performance improvement.	-	-	-	-	X	-	-	-	-	-
	CRC	CRC_Polynomial Update	This example provides a description of how to use the CRC peripheral through the STM32L4xx CRC HAL and LL API. The LL API is used for performance improvement.	X	-	-	-	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 STM32L4xx DMA HAL and LL API. The LL API is used for performance improvement.	X	-	-	-	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
		DMA2D_MemToMemWithRBSwap	This example provides a description of how to configure DMA2D peripheral in Memory-to-Memory transfer mode with pixel format conversion and images blending, 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 two slaves with different address sizes (7-bit or 10-bit). This example uses the STM32L4xx I2C HAL and LL API (LL API used for performance improvement) and an interrupt.	X	-	-	-	X	-	-	-	-	-
	OPAMP	OPAMP_CALIBRATION	This example describes how to use an operational amplifier peripheral with OPAMP calibration and operation. This example is based on the STM32L4xx OPAMP HAL and LL API (LL API used for performance improvement).	-	-	-	-	X	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Examples_MIX	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 STM32L4xx RTC and RCC HAL and LL API (LL API used for performance improvement).	X	-	-	-	X	-	-	-	-	-
		PWR_STOP1	This example shows how to enter Stop 1 mode and wake up from this mode using external reset or a wakeup interrupt (all the RCC function calls use RCC LL API for footprint and performance improvements).	X	-	-	-	X	-	-	-	-	-
	SPI	SPI_FullDuplex_ComPolling	This example shows how to ensure SPI data buffer transmission/reception in Polling mode between two boards.	X	-	-	-	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	-	-	-	X	-	-	-	-	-
	TIM	TIM_6Steps	This example shows how to configure the TIM1 peripheral to generate six-step PWM signal. The STM32L4xx TIM1 peripheral allows programming in advance the configuration for the next TIM1 output behavior (or step) and changing the configuration of all the channels simultaneously. This operation is possible when the COM (commutation) event is used. This example is based on the STM32L4xx TIM HAL and LL API (LL API used for performance improvement).	X	-	-	-	X	-	-	-	-	-
	UART	UART_HyperTerminal_IT	This example describes how to use a 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 STM32L4xx UART HAL and LL API (LL API used for performance improvement).	X	-	-	-	X	-	-	-	-	-
		UART_HyperTerminal_TxPolling_RxIT	This example describes how to use a 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 STM32L4xx UART HAL and LL API (LL API used for performance improvement).	X	-	-	-	X	-	-	-	-	-
	Total number of examples_mix: 24			**10**	**0**	**0**	**0**	**12**	**0**	**0**	**0**	**0**	**2**

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Applications	-	Proximity	This application shows how to use the VL53L0X sensor mounted on the B-L475E-IOT01A board to provide proximity information.	-	-	-	-	-	X	-	-	-	-
	BLE	HeartRate	This application shows how to use BLE component for HeartRate profile application.	-	-	-	-	-	X	-	-	-	-
		P2P_LedButton	This example aims at demonstrating point-to-point communications using the BLE component.	-	-	-	-	-	X	-	-	-	-
	FatFS	FatFs_RAMDisk	This application provides a description on how to use STM32Cube firmware with FatFS middleware component as a generic FAT file system module. The objective is to develop an application that exploits the FatFS features to configure a RAM disk (SRAM) drive.	-	X	-	-	-	-	-	-	-	-
		FatFs_uSD_DMA_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 that exploits the FatFS features with microSD drive in RTOS mode configuration.	-	X	-	-	-	-	-	-	-	X
		FatFs_uSD_Standalone	This application provides a description on how to use STM32Cube firmware with FatFS middleware component as a generic FAT file system module. The objective is to develop an application that exploits the FatFS features to configure a microSD drive.	-	X	-	-	-	-	-	-	-	X

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Applications	FreeRTOS	FreeRTOS_Low Power	This application shows how to enter and exit low-power mode with CMSIS RTOS API.	X	X	-	X	-	-	-	-	New	-
		FreeRTOS_Low Power_LPTIM	This application aims to enter Stop mode when all RTOS tasks are suspended.	-	-	-	-	-	X	-	-	-	-
		FreeRTOS_Mail	This application shows how to use mail queues with CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ Mutexes	This application shows how to use mutexes with CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ Queues	This application shows how to use message queues with CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ Semaphore	This application shows how to use semaphores with CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ Semaphore FromISR	This application shows how to use semaphore from ISR with CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ Signal	This application shows how to perform thread signaling using CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ SignalFromISR	This application shows how to perform thread signaling from an interrupt using CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
		FreeRTOS_ ThreadCreation	This application shows how to implement thread creation using CMSIS RTOS API.	X	X	-	X	X	-	X	X	-	-
		FreeRTOS_ Timers	This application shows how to use timers of CMSIS RTOS API.	X	X	-	X	-	-	-	-	-	-
	IAP	IAP_Binary_ Template	This 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	-	-	-	-	-	-	-	-
		IAP_Main	This directory contains a set of sources files and preconfigured projects that describes how to build an application to be loaded into Flash memory using In-Application programming (IAP) through USART.	-	X	-	-	-	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Applications	NFC	WrAARtoRunBLEapp	This application aims at showing how to write an AAR NDEF message to an M24SR type 4 NFC tag so that the BLE STM32 Profiles application is launched on the smartphone when it comes near the NFC antenna.	-	-	-	-	-	X	-	-	-	-
		WriteTag	This application aims at showing how to write NDEF messages to an M24SR type 4 NFC tag so that the associated application is launched on the smartphone when it comes near the NFC antenna.	-	-	-	-	-	X	-	-	-	-
	STemWin	STemWin_HelloWorld	This application shows how to implement a simple "Hello World" example based on STemWin.	-	X	-	-	-	-	-	-	-	X
		STemWin_SampleDemo	This application shows how to implement a sample demonstration example allowing to show some of the STemWin Library capabilities.	-	X	-	-	-	-	-	-	-	X
	SubGhz	P2P	This application aims at demonstrating point-to-point communication between two B-L475E-IOT01A boards with SubGhz module using Spirit1 driver and STM32Cube firmware.	-	-	-	-	-	X	-	-	-	-
	Touch Sensing	TouchSensing_1touchkey	This firmware is a basic application on how to use the STMTouch driver with one touchkey sensor. The Environment Change System (ECS) and Detection Time Out (DTO) are also used.	-	X	-	-	-	-	-	-	-	-

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Applications	USB_Device	CDC_ Standalone	This example describes how to use USB device application based on the Device Communication Class (CDC) following the PSTN subprotocol on the STM32L4xx devices.	-	X	-	X	-	-	-	-	-	X
		CustomHID_ Standalone	This example describes how to use USB device application based on the Custom HID Class on the STM32L4xx devices.	-	X	-	-	-	-	-	-	-	-
		DFU_ Standalone	This example describes how to use USB device application based on the Device Firmware Upgrade (DFU) on the STM32L4R5ZI devices.	-	X	-	X	-	-	X	X	New	X
		HID_Standalone	This application describes how to use USB device application based on the Human Interface (HID) on the STM32L4R5ZI devices.	-	X	-	X	-	X	X	X	New	X
		HID_Standalone _BCD	This example describes how to use the BCD feature based on the USB HID device application on the STM32L4xx devices.	-	X	-	X	-	-	X	X	-	X
		HID_Standalone _LPM	This example describes how to use USB device application based on the Human Interface (HID) with Link Power Management Protocol (LPM) on the STM32L4xx devices.	-	X	-	X	-	-	X	X	-	X
		MSC_ Standalone	This example describes how to use USB device application based on the Mass Storage Class (MSC) on the STM32L4xx devices.	-	X	-	-	-	-	-	-	-	-
	USB_Host	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 STM32L4xx devices.	-	X	-	-	-	-	-	-	-	-
		HID_Standalone	This application describes how to use USB host application based on the Human Interface Class (HID) on the STM32L4xx devices.	-	X	-	-	-	-	-	-	New	X
		MSC	This example describes how to use USB host application based on the Mass Storage Class (MSC) on the STM32L4xx devices.	-	-	-	-	-	X	-	-	-	-
		MSC_ Standalone	This application describes how to use USB host application based on the Mass Storage Class (MSC) on the STM32L4xx devices.	-	X	-	-	-	-	-	-	New	X

Table 1. STM32CubeL4 firmware examples (continued)

Level	Module Name	Project Name	Description	NUCLEO-L496ZG	STM32L476G-EVAL	NUCLEO-L433RC	NUCLEO-L452RE	NUCLEO-L476RG	B-L475E-IOT01A	NUCLEO-L432KC	32L476G DISCOVERY	NUCLEO-L4R5ZI	32L496G DISCOVERY
Applications	WiFi	WiFi_Client_Server	This application shows how to use the Es-WiFi module to perform a TCP client mode using STM32Cube HAL. It demonstrates how to set up a client program and 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	-	-	-	-
	Total number of applications: 91			**10**	**28**	**0**	**15**	**1**	**11**	**5**	**5**	**5**	**11**
Demons-trations	-	Adafruit_LCD_1_8_SD_Joystick	This demonstration firmware is based on STM32Cube. It helps you to discover STM32 Cortex-M devices that can be plugged on an STM32 Nucleo board.	X	-	-	X	X	-	-	-	New	-
		MB1184	The STM32Cube demonstration platform comes on top of the STM32Cube as a firmware package that offers a full set of software components based on a modular architecture.	-	-	-	-	-	-	-	X	-	X
		Gravitech_4digits	This demonstration firmware is based on STM32Cube. It helps you to discover STM32 Cortex-M devices that can be plugged on an STM32 Nucleo-32 board.	-	-	-	-	-	-	X	-	-	-
		MB1144	The STM32Cube demonstration platform comes on top of the STM32Cube as a firmware package that offers a full set of software components based on a modular architecture. All modules can be reused separately in standalone applications. All these modules are managed by the STM32Cube demonstration kernel that allows to dynamically add new modules and access common resources (storage, graphical components and widgets, memory management, real-time operating system). The STM32Cube demonstration platform is built around the powerful graphical STemWin library and the FreeRTOS real-time operating system. It uses almost all STM32 features and offers a large scope of use cases based on the STM32Cube HAL BSP and several middleware components.	-	X	-	-	-	-	-	-	-	-
	Total number of demonstrations: 8			**1**	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**1**
Total number of projects: 817				**218**	**118**	**5**	**103**	**176**	**14**	**70**	**25**	**49**	**39**

3 Revision history

Table 2. Document revision history

Date	Revision	Changes
06-Jul-2015	1	Initial release.
15-Sep-2015	2	Added UM1916 and UM1919 in *Section 1: Reference documents*. Updated *Figure 1: STM32CubeL4 firmware components*. Updated *Section 2: STM32CubeL4 examples* to add Low Layer drivers.
26-Feb-2016	3	Added UM1937 in *Section 1: Reference documents*. *Table 1: STM32CubeL4 firmware examples*: updated HAL and LL examples.
10-Mar-2016	4	Added NUCLEO-L432KC board together with several examples, applications and Gravitech_4digits demonstration. Added I2C_TwoBoards_RestartAdvComIT and I2C_TwoBoards_RestartComIT examples for STM32L476G-EVAL and NUCLEO-L476RG boards. Added QSPI_PreInitConfig example for STM32L476G-EVAL and 32L496GDISCOVERY boards.
14-Nov-2016	5	Updated description of template projects in *Section 2* introduction. Added NUCLEO-L452RE board with several examples, applications and demonstration with Adafruit shield. Added Templates_LL new projects to allow to quickly build a firmware application on a given board with the LL API.
13-Dec-2016	6	Removed NUCLEO-L452RE board.
28-Feb-2017	7	Updated *Figure 1: STM32CubeL4 firmware components*. Added NUCLEO-L496ZG and 32L496GDISCOVERY boards as well as corresponding examples, applications and demonstrations (such as Adafruit shield on the Nucleo board and graphic demonstration on the Discovery kit)
25-Jun-2017	8	Updated *Figure 1: STM32CubeL4 firmware components*. Modified LL APIs preferred spelling to ‘low-layer APIs. Added B-L475RE-IOT01A and NUCLEO-L452RE boards together with several examples, applications and project templates.

Table 2. Document revision history (continued)

Date	Revision	Changes
25-Jul-2017	9	Added NUCLEO-L433RC-P board together with several examples, applications and project templates.
01-Sep-2017	10	Added NUCLEO-L4R5ZI board together with several examples, applications and demonstration based on Adafruit shield.