UM1847
User manual

Getting started with STM32CubeF1 firmware package for STM32F1 series

Introduction

STMCube™ is an STMicroelectronics original initiative to make developers' lives easier by reducing development efforts, time and cost. STM32Cube covers the whole STM32 portfolio.

STM32Cube Version 1.x includes:

- STM32CubeMX, a graphical software configuration tool that allows the generation of C initialization code using graphical wizards.
- A comprehensive embedded software platform, delivered per series (such as STM32CubeF1 for STM32F1 series)
  - The STM32Cube HAL, STM32 abstraction layer embedded software ensuring maximized portability across the STM32 portfolio
  - Low Layer APIs (LL) offering a fast light-weight expert-oriented layer which is closer to the hardware than the HAL. LL APIs are available only for a set of peripherals.
  - A consistent set of middleware components such as RTOS, USB, STMTouch, FatFS and Graphics
  - All embedded software utilities delivered with a full set of examples.

This user manual describes how to get started with the STM32CubeF1 firmware package.

Section 1 describes the main features of STM32CubeF1 firmware, part of the STMCube™ initiative. *Section 2* and *Section 3* provide an overview of the STM32CubeF1 architecture and firmware package structure.

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1 STM32CubeF1 main features

STM32CubeF1 gathers, in a single package, all the generic embedded software components required to develop an application on STM32F1 microcontrollers. In line with the STMCube™ initiative, this set of components is highly portable, not only within STM32F1 series but also to other STM32 series.

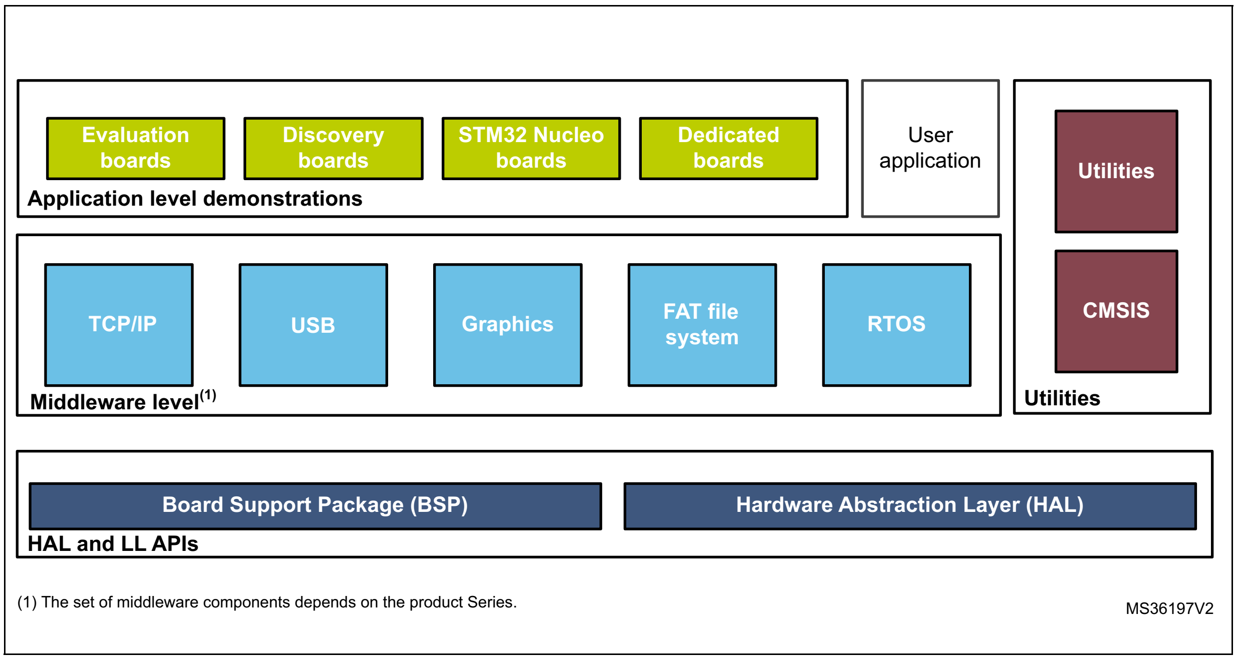
STM32CubeF1 is fully compatible with STM32CubeMX code generator that allows to generate initialization code. The package includes Low Layer (LL) and Hardware Abstraction Layer (HAL) APIs that covers the microcontroller hardware, together with an extensive set of examples running on STMicroelectronics boards. The HAL and LL APIs are available in open-source BSD license for user convenience.

STM32CubeF1 package also contains a set of middleware components with the corresponding examples. They come in free user-friendly license terms:

- Full USB Host and Device stack supporting many classes.
  - Host Classes: HID, MSC, CDC, Audio, MTP
  - Device Classes: HID, MSC, CDC, Audio, DFU.
- STemWin, a professional graphical stack solution available in binary format and based on STMicroelectronics partner solution SEGGER emWin
- CMSIS-RTOS implementation with FreeRTOS open source solution
- FAT File system based on open source FatFS solution
- TCP/IP stack based on open source LwIP solution.

Several applications and demonstrations implementing all these middleware components are also provided in the STM32CubeF1 package.

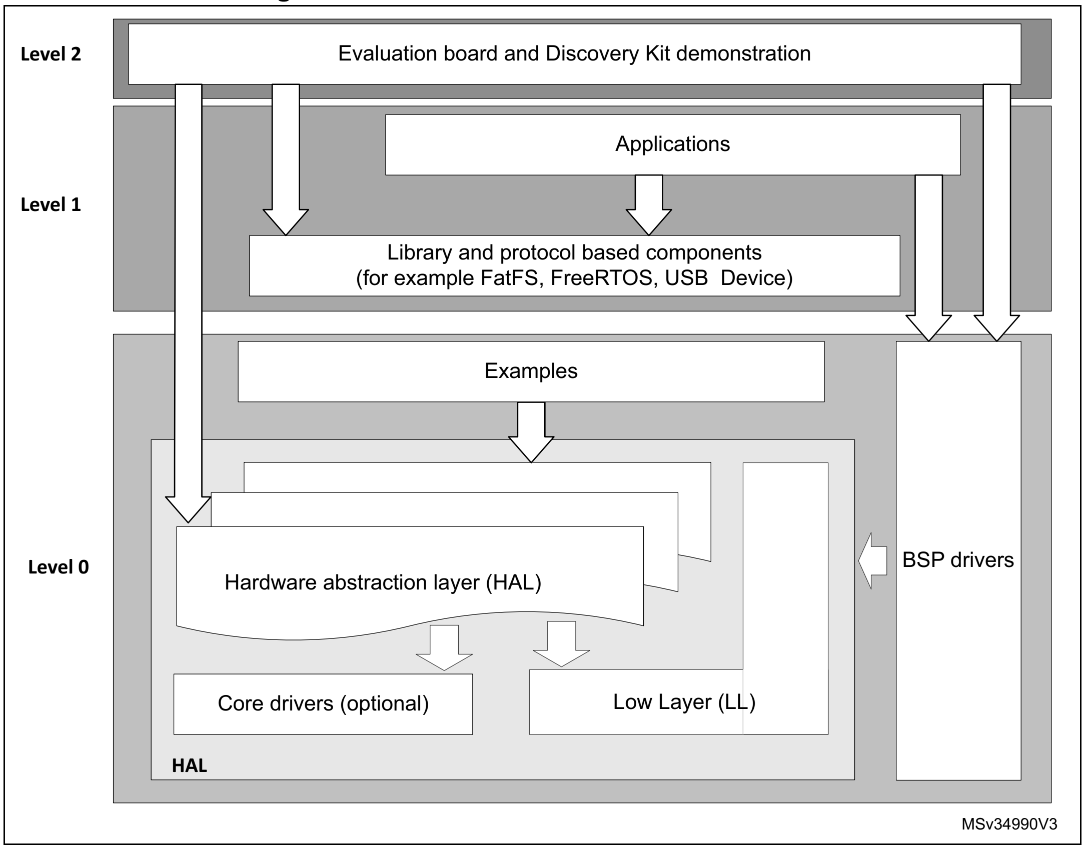
Figure 1. STM32CubeF1 firmware components



2 STM32CubeF1 architecture overview

The STM32Cube firmware solution is built around three independent levels that can easily interact with each other's as described in *Figure 2*:

Figure 2. STM32CubeF1 firmware architecture


Level 2
Evaluation board and Discovery Kit demonstration
Level 1
Applications
Library and protocol based components (for example FatFS, FreeRTOS, USB Device)
Level 0
Examples
Hardware abstraction layer (HAL)
BSP drivers
Core drivers (optional)
Low Layer (LL)
HAL
MSv34990V3

2.1 Level 0

This level is divided into three sub-layers:

- Board Support Package (BSP)
- Hardware Abstraction Layer (HAL)
- Basic peripheral usage examples.

2.1.1 Board Support Package (BSP)

This layer offers a set of APIs relative to the hardware components in the hardware boards (LCD drivers, MicroSD, …). It is composed of two parts:

- Component

  This is the driver relative to the external device on the board and not to the STM32. The component driver provide specific APIs to the BSP driver external components and could be portable on any other board.
- BSP driver

  It allows linking the component driver to a specific board and provides a set of user-friendly APIs. The API naming rule is BSP_FUNCT_Action().

  Example: BSP_LED_Init(), BSP_LED_On()

The BSP is based on a modular architecture allowing an easy porting on any hardware by just implementing the low-level routines.

2.1.2 Hardware Abstraction Layer (HAL) and Low Layer (LL)

The STM32CubeF1 HAL and LL are complementary and cover a wide range of applications requirements:

- The HAL drivers offer high-level function-oriented highly-portable APIs. They hide the MCU and peripheral complexity to end users.

  The HAL drivers provide generic multi-instance feature-oriented APIs which simplify user application implementation by providing ready to use process. As example, for the communication peripherals (I2S, UART…), it provides APIs allowing initializing and configuring the peripheral, managing data transfer based on polling, interrupt or DMA process, and handling communication errors that may raise during communication. The HAL driver APIs are split in two categories:
  - Generic APIs which provides common and generic functions to all the STM32 series
  - Extension APIs which provides specific and customized functions for a specific family or a specific part number.
- The Low Layer APIs provide low-level APIs at register level, with better optimization but less portability. They require a deep knowledge of MCU and peripheral specifications.

  The LL drivers are designed to offer a fast light-weight expert-oriented layer which is closer to the hardware than the HAL. Contrary to the HAL, LL APIs are not provided for peripherals where optimized access is not a key feature, or for those requiring heavy software configuration and/or complex upper-level stack (such as FSMC, USB, or SDMMC).

The LL drivers feature:

- A set of functions to initialize peripheral main features according to the parameters specified in data structures
- A set of functions used to fill initialization data structures with the reset values corresponding to each field
- Function for peripheral de-initialization (peripheral registers restored to their default values)
- A set of inline functions for direct and atomic register access
- Full independence from HAL and capability to be used in standalone mode (without HAL drivers)
- Full coverage of the supported peripheral features.

2.1.3 Basic peripheral usage examples

This layer includes the examples build over the STM32 peripheral and using either the HAL or/and the Low Layer drivers APIs as well as the BSP resources.

2.2 Level 1

This level is divided into two sub-layers:

- Middleware components
- Examples based on the middleware components.

2.2.1 Middleware components

The middleware is a set of libraries covering USB Host and Device Libraries, STemWin, FreeRTOS, FatFS and LwIP. Horizontal interactions between the components of this layer is done directly by calling the feature APIs while the vertical interaction with the low-level drivers is done through specific callbacks and static macros implemented in the library system call interface. For example, the FatFs implements the disk I/O driver to access microSD drive or the USB Mass Storage Class.

The main features of each middleware component are as follows:

- **USB Host and Device Libraries**
  - Several USB classes supported (Mass-Storage, HID, CDC, DFU).
  - Support of multi-packet transfer features that allows sending big amounts of data without splitting them into maximum packet size transfers.
  - Use of configuration files to change the core and the library configuration without changing the library code (Read Only).
  - 32-bit aligned data structures to handle DMA-based transfer in high-speed modes.
  - Support of multi USB OTG core instances from user level through configuration file. This allows to perform operations with more than one USB host/device peripheral.
  - RTOS and Standalone operation.
  - Link with low-level driver through an abstraction layer using the configuration file to avoid any dependency between the Library and the low-level drivers.
- **STemWin Graphical stack**
  - Professional grade solution for GUI development based on SEGGER's emWin solution.
  - Optimized display drivers.
  - Software tools for code generation and bitmap editing (STemWin Builder…).
- **FreeRTOS**
  - Open source standard.
  - CMSIS compatibility layer.
  - Tickless operation during low-power mode.
  - Integration with all STM32Cube middleware modules.
- **FAT File system**
  - FATFS FAT open source library.
  - Long file name support.
  - Dynamic multi-drive support.
  - RTOS and standalone operation.
  - Examples with microSD.
- **LwIP TCP/IP stack**
  - Open source standard.
  - RTOS and standalone operation.

2.2.2 Examples based on the middleware components

Each middleware component comes with one or more examples (called also Applications) showing how to use it. Integration examples that use several middleware components are provided as well.

2.3 Level 2

This level is composed of a single layer which consist in a global real-time and graphical demonstration based on the middleware service layer, the low-level abstraction layer and the basic peripheral usage applications for board based features.

3 STM32CubeF1 firmware package overview

3.1 Supported STM32F1 devices and hardware

STM32Cube offers highly portable Hardware Abstraction Layer (HAL) built around a generic architecture. It allows the build-upon layers, such as the middleware layer, to implement their functions without knowing, in-depth, the MCU used. This improves the library code re-usability and guarantees an easy portability on other devices.

In addition, thanks to its layered architecture, the STM32CubeF1 offers full support of all STM32F1 series. The user has only to define the right macro in stm32f1xx.h.

Table 1 gives the macro to be defined depending on the STM32F1 device used. This macro must also be defined in the compiler preprocessor.

Table 1. Macros for STM32F1 series

Macro defined in stm32f1xx.h	STM32F1 devices
STM32F100xB	STM32F100C4, STM32F100R4, STM32F100C6, STM32F100R6, STM32F100C8, STM32F100R8, STM32F100V8, STM32F100CB, STM32F100RB, STM32F100VB
STM32F100xE	STM32F100RC, STM32F100VC, STM32F100ZC,STM32F100RD, STM32F100VD, STM32F100ZD, STM32F100RE, STM32F100VE, STM32F100ZE
STM32F101x6	STM32F101C4, STM32F101R4, STM32F101T4, STM32F101C6, STM32F101R6, STM32F101T6
STM32F101xB	STM32F101C8, STM32F101R8, STM32F101T8, STM32F101V8, STM32F101CB,STM32F101RB, STM32F101TB, STM32F101VB
STM32F101xE	STM32F101RC, STM32F101VC, STM32F101ZC, STM32F101RD,STM32F101VD, STM32F101ZD, STM32F101RE, STM32F101VE, STM32F101ZE
STM32F101xG	STM32F101RF, STM32F101VF, STM32F101ZF, STM32F101RG, STM32F101VG, STM32F101ZG
STM32F102x6	STM32F102C4, STM32F102R4, STM32F102C6, STM32F102R6
STM32F102xB	STM32F102C8, STM32F102R8, STM32F102CB, STM32F102RB
STM32F103x6	STM32F103C4, STM32F103R4, STM32F103T4, STM32F103C6, STM32F103R6, STM32F103T6
STM32F103xB	STM32F103C8, STM32F103R8, STM32F103T8, STM32F103V8, STM32F103CB, STM32F103RB, STM32F103TB, STM32F103VB
STM32F103xE	STM32F103RC, STM32F103VC, STM32F103ZC, STM32F103RD, STM32F103VD, STM32F103ZD, STM32F103RESTM32F103VE, STM32F103ZE
STM32F103xG	STM32F103RF, STM32F103VF, STM32F103ZF, STM32F103RG, STM32F103VG, STM32F103ZG
STM32F105xC	STM32F105R8, STM32F105V8, STM32F105RB, STM32F105VB, STM32F105RC, STM32F105VC
STM32F107xC	STM32F107RB, STM32F107VB, STM32F107RC, STM32F107VC

STM32CubeF1 features a rich set of examples and applications at all levels making it easy to understand and use any HAL driver and/or middleware components. These examples are running on STMicroelectronics boards as listed in *Table 2*.

Table 2. Boards for STM32F1 series

Board	STM32F1 devices supported
STM3210E-EVAL	STM32F103xG
STM3210C-EVAL	STM32F107xC
STM32VLDISCOVERY	STM32F100xB
NUCLEO-F103RB	STM32F103xB

As for all other STM32 Nucleo boards, the NUCLEO-F103RB feature a reduced set of hardware components (one user key button and one user LED). To enrich the middleware support offer for the STM32CubeF1 firmware package, an LCD display Adafruit Arduino™ shield is used. This shield embeds a microSD connector and a joystick in addition to the LCD.

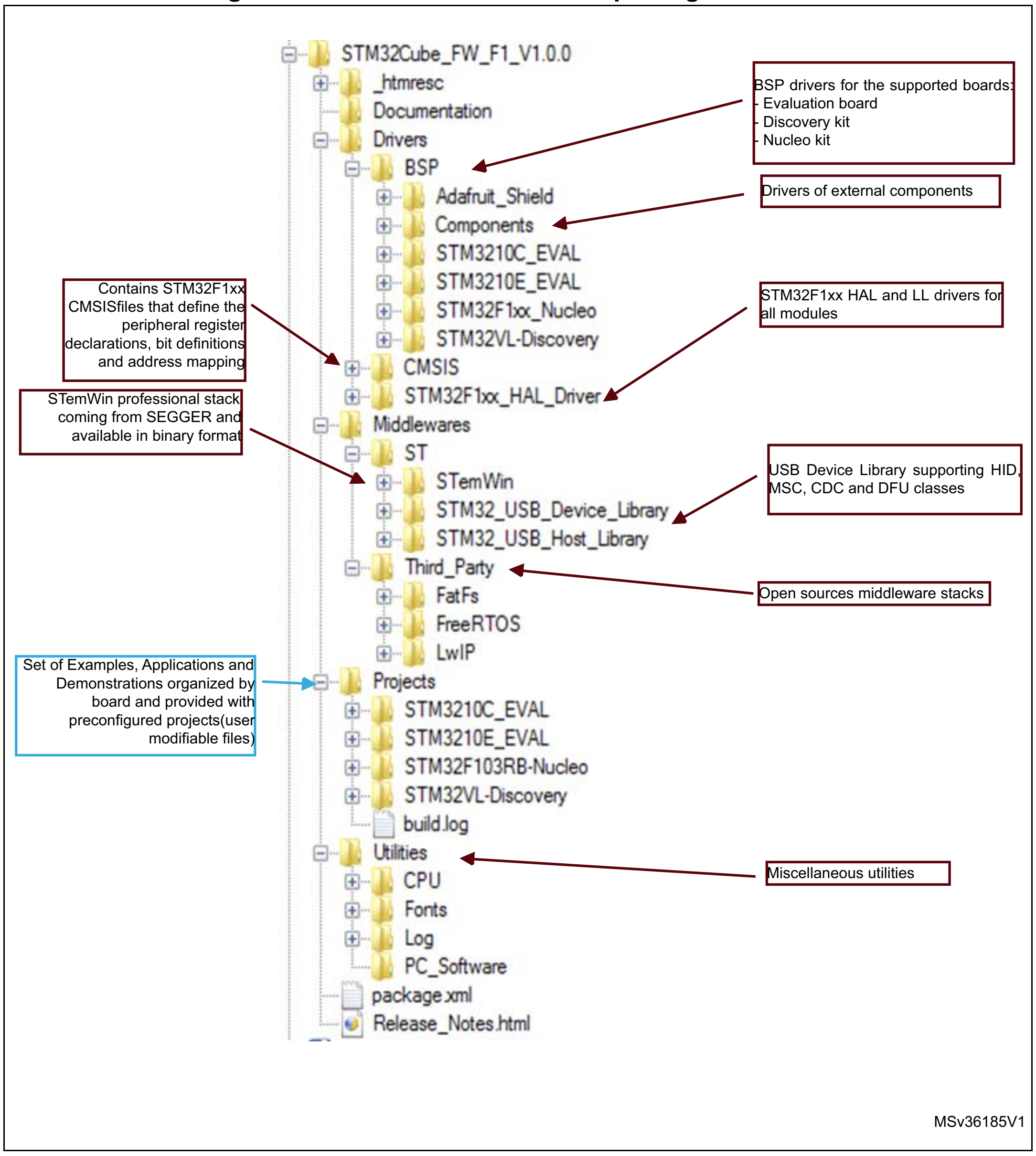
In the BSP component, the dedicated drivers for the Arduino shield are available. Their use is illustrated through either the provided BSP example or in the demonstration firmware, without forgetting the FatFS middleware application.

The STM32CubeF1 firmware is able to run on any compatible hardware. The user simply updates the BSP drivers to port the provided examples on his own board, if this later has the same hardware features (LED, LCD display, buttons...).

3.2 Firmware package overview

The STM32CubeF1 firmware solution is provided in one single zip package having the structure shown in *Figure 3*.

Figure 3. STM32CubeF1 firmware package structure

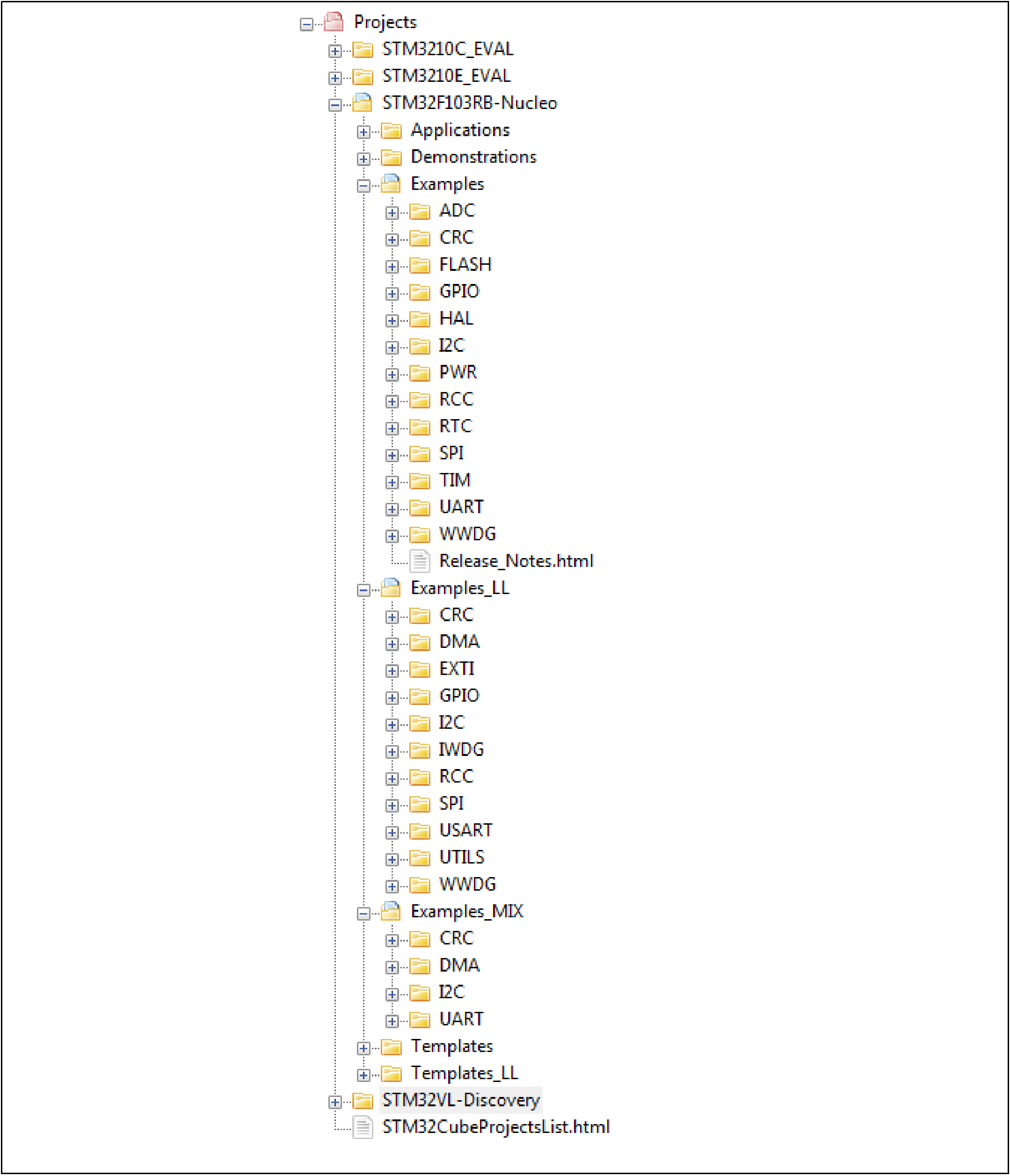

STM32Cube_FW_F1_V1.0.0
_htmresc
Documentation
Drivers
BSP
Adafruit_Shield
Components
STM3210C_EVAL
STM3210E_EVAL
STM32F1xx_Nucleo
STM32VL-Discovery
CMSIS
STM32F1xx_HAL_Driver
Middlewares
ST
STemWin
STM32_USB_Device_Library
STM32_USB_Host_Library
Third_Party
FatFs
FreeRTOS
LwIP
Projects
STM3210C_EVAL
STM3210E_EVAL
STM32F103RB-Nucleo
STM32VL-Discovery
build.log
Utilities
CPU
Fonts
Log
PC_Software
package.xml
Release_Notes.html
BSP drivers for the supported boards:
- Evaluation board
- Discovery kit
- Nucleo kit
Drivers of external components
STM32F1xx HAL and LL drivers for all modules
Contains STM32F1xx CMSISfiles that define the peripheral register declarations, bit definitions and address mapping
STemWin professional stack coming from SEGGER and available in binary format
USB Device Library supporting HID, MSC, CDC and DFU classes
Open sources middleware stacks
Set of Examples, Applications and Demonstrations organized by board and provided with preconfigured projects(user modifiable files)
Miscellaneous utilities
MSv36185V1

1. The library files in brown must not be modified by the user, while the files in blue can be modified.

For each board, a set of examples are provided with pre-configured projects for EWARM, MDK-ARM, TrueSTUDIO and SW4STM32 toolchains.

Figure 4 shows the projects structure for the NUCLEO-F103RB board.

Figure 4. STM32CubeF1 examples overview



```
Projects
    STM3210C_EVAL
    STM3210E_EVAL
    STM32F103RB-Nucleo
        Applications
        Demonstrations
        Examples
            ADC
            CRC
            FLASH
            GPIO
            HAL
            I2C
            PWR
            RCC
            RTC
            SPI
            TIM
            UART
            WWDG
            Release_Notes.html
        Examples_LL
            CRC
            DMA
            EXTI
            GPIO
            I2C
            IWDG
            RCC
            SPI
            USART
            UTILS
            WWDG
        Examples_MIX
            CRC
            DMA
            I2C
            UART
        Templates
        Templates_LL
    STM32VL-Discovery
    STM32CubeProjectsList.html
```

The examples are classified depending on the STM32Cube level they apply to, and are named as explained below:

- Examples in level 0 are called *Examples, Examples_LL and Examples_MIX.* They use respectively HAL drivers, LL drivers and a mix of HAL and LL drivers. without any middleware component.
- Examples in level 1 are called *Applications.* They provides typical use cases of each middleware component.

The *Template* project available in the Template directory allows to quickly build a firmware application on a given board.

All examples have the same structure:

- *\Inc* folder that contains all header files.
- *\Src* folder for the sources code.
- *\EWARM*, *\MDK-ARM*, *\TrueSTUDIO and \SW4STM32* folders contain the pre-configured project for each toolchain.
- *readme.txt* describing the example behavior and needed environment to make it working

Table 3 gives the number of projects available for each board.

Table 3. Number of examples available for each board

Board	Examples	Examples _LL	Examples _MIX	Applications	Demonstration
STM3210E-EVAL	35	4	N/A	8	N/A
STM3210C-EVAL	20	N/A	N/A	19	N/A
STM32VLDISCOVERY	19	N/A	N/A	N/A	N/A
NUCLEO-F103RB	29	61	11	3	1

4 Getting started with STM32CubeF1

4.1 Running your first example

This section explains how simple is to run a first example within STM32CubeF1. It uses as illustration the generation of a simple LED toggle running on STM32F103RB Nucleo board:

1. Download the STM32CubeF1 firmware package. Unzip it into a directory of your choice. Make sure not to modify the package structure shown in *Figure 3*. Note that it is also recommended to copy the package at a location close to your root volume (e.g. C\Eval or G:\Tests) because some IDEs encounter problems when the path length is too long.
2. Browse to \Projects\STM32F103RB-Nucleo\Examples.
3. Open \GPIO, then \GPIO_IOToggle folder.
4. Open the project with your preferred toolchain. A quick overview on how to open, build and run an example with the supported toolchains is given below.
5. Rebuild all files and load your image into target memory.
6. Run the example: the LED2 toggles in an infinite loop (for more details, refer to the example readme file).

To open, build and run an example with the supported toolchains:, follow the steps below:

- EWARM
  a) Under the example folder, open \EWARM sub-folder.
  b) Launch the Project.eww workspace[a].
  c) Rebuild all files: **Project->Rebuild all**.
  d) Load project image: **Project->Debug**.
  e) Run program: **Debug->Go**(F5).
- MDK-ARM
  a) Under the example folder, open \MDK-ARM sub-folder.
  b) Launch the Project.uvproj workspace[a].
  c) Rebuild all files: **Project->Rebuild all target files**.
  d) Load project image: **Debug->Start/Stop Debug Session**.
  e) Run program: **Debug->Run** (F5).
- TrueSTUDO
  a) Open the TrueSTUDIO toolchain.
  b) Click **File->Switch Workspace->Other** and browse to TrueSTUDIO workspace directory.
  c) Click **File->Import**, select **General->'Existing Projects into Workspace'** and then click "**Next**".
  d) Browse to the TrueSTUDIO workspace directory and select the project.
  e) Rebuild all project files: select the project in the "**Project explorer**" window then click **Project->build project** menu.
  f) Run program: **Run->Debug** (F11).
- SW4STM32
  a) Open the SW4STM32 toolchain.
  b) Click **File->Switch Workspace->Other** and browse to the SW4STM32 workspace directory.
  c) Click **File->Import**, select **General->'Existing Projects into Workspace'** and then click "**Next**".
  d) Browse to the SW4STM32 workspace directory and select the project.
  e) Rebuild all project files: select the project in the "**Project explorer**" window then click **Project->build project** menu.
  f) Run program: **Run->Debug** (F11).

a. The workspace name may changes from one example to another.

4.2 Developing your own application

4.2.1 HAL application

This section describes the steps required to create your own application using STM32CubeF1:

1. **Create your project**

   To create a new project, you can either start from the *Template* project provided for each board under \Projects\<STM32xxx_yyy>\Templates or from any available project under \Projects\<STM32xxy_yyy>\Examples or \Projects\<STM32xx_yyy>\Applications (where <STM32xxx_yyy> refers to the board name, e.g. STM3210E_EVAL).

   The *Template* project is providing empty main loop function, however it's a good starting point to get familiar with project settings for STM32CubeF1. The template has the following characteristics:

   – It contains the source code of HAL, CMSIS and BSP drivers which are the minimal components required to develop a code on a given board.
   – It contains the include paths for all the firmware components.
   – It defines the STM32F1 device supported, thus allowing to configure the CMSIS and HAL drivers accordingly.
   – It provides read-to-use user files pre-configured as shown below:
     HAL initialized with default time base with ARM Core SysTick.
     SysTick ISR implemented for HAL_Delay() purpose.
     System clock configured with the minimum frequency of the device (HSI) for an optimum power consumption.

Note: When copying an existing project to another location, make sure to update the include paths.

2. **Add the necessary middleware to your project (optional)**

   The available middleware stacks are: USB Host and Device library, LwIP, STemWin, FreeRTOS and FatFS. To know which source files you need to add in the project files list, refer to the documentation provided for each middleware. You can also look at the Applications available under \Projects\STM32xxx_yyy\Applications\<MW_Stack> (where <MW_Stack> refers to the middleware stack, e.g. USB_Device) to know which sources files and which include paths have to be added.

3. **Configure the firmware components**

   The HAL and middleware components offer a set of build time configuration options using macros # define declared in a header file. A template configuration file is provided within each component, it has to be copied to the project folder (usually the configuration file is named xxx_conf_template.h, the word '_template' needs to be removed when copying it to the project folder). The configuration file provides enough information to know the impact of each configuration option. More detailed information is available in the documentation provided for each component.

4. **Start the HAL Library**

   After jumping to the main program, the application code must call *HAL_Init()* API to initialize the HAL Library, which do the following tasks:

   a) Configuration of the Flash prefetch and SysTick interrupt priority (through macros defined in stm32f1xx_hal_conf.h).

   b) Configuration of the SysTick to generate an interrupt each 1 ms at the SysTick TICK_INT_PRIO interrupt priority defined in stm32f1xx_hal_conf.h, which is clocked by the HSI (at this stage, the clock is not yet configured and thus the system is running from the internal HSI at 8 MHz).

   c) Setting of NVIC Group Priority to 4.

   d) Call of HAL_MspInit() callback function defined in stm32f1xx_hal_msp.c user file to perform global low-level hardware initializations.

5. **Configure the system clock**

   The system clock configuration is done by calling the two APIs described below:

   a) HAL_RCC_OscConfig(): this API configures the internal and/or external oscillators, as well as the PLL source and factors. The user can choose to configure one oscillator or all oscillators. The PLL configuration can be skipped if there is no need to run the system at high frequency.

   b) HAL_RCC_ClockConfig(): this API configures the system clock source, the Flash memory latency and AHB and APB prescalers.

6. **Initialize the peripheral**

   a) First write the peripheral HAL_PPP_MspInit function. Proceed as follows:

   – Enable the peripheral clock.

   – Configure the peripheral GPIOs.

   – Configure DMA channel and enable DMA interrupt (if needed).

   – Enable peripheral interrupt (if needed).

   b) Edit the stm32xxx_it.c to call the required interrupt handlers (peripheral and DMA), if needed.

   c) Write process complete callback functions if you plan to use peripheral interrupt or DMA.

   d) In your main.c file, initialize the peripheral handle structure then call the function HAL_PPP_Init() to initialize your peripheral.

7. **Develop your application**

   At this stage, your system is ready and you can start developing your application code.

   – The HAL provides intuitive and ready-to-use APIs to configure the peripheral. It supports polling, interrupts and DMA programming model, to accommodate any application requirements. For more details on how to use each peripheral, refer to the rich examples set provided in the STM32CubeF1 package.

   – If your application has some real-time constraints, you can found a large set of examples showing how to use FreeRTOS and integrate it with all middleware stacks provided within STM32CubeF1. This can be a good starting point to develop your application.

Caution: In the default HAL implementation, SysTick timer is used as timebase: it generates interrupts at regular time intervals. If HAL_Delay() is called from peripheral ISR process, make sure that the SysTick interrupt has higher priority (numerically lower) than the peripheral interrupt. Otherwise, the caller ISR process will be blocked. Functions affecting timebase configurations are declared as __weak to make override possible in case of other implementations in user file (using a general purpose timer for example or other time source). For more details, refer to HAL_TimeBase example.

4.2.2 LL application

This section describes the steps needed to create your own LL application using STM32CubeF1.

1. **Create your project**

   To create a new project, you can either start from the *Templates_LL* project provided for each board under \Projects\<STM32xxx_yyy>\Templates_LL or from any available project under \Projects\<STM32xxy_yyy>\Examples_LL (<STM32xxx_yyy> refers to the board name, such as NUCLEO-F103RB).

   The *Template* project provides an empty main loop function, however it is a good starting point to get familiar with project settings for STM32CubeF1.

   The template main characteristics are the following:

   – It contains the source code of LL and CMSIS drivers, that are the minimal components to develop a code on a given board.

   – It contains the include paths for all the required firmware components.

   – It selects the supported STM32F1 device and allows configuring the CMSIS and LL drivers accordingly.

   – It provides ready-to-use user files, that are pre-configured as follows:

     main.h: LED & USER_BUTTON definition abstraction layer

     main.c: System clock configuration for maximum frequency.

2. **Port an existing project to another board**

   To port an existing project to another target board, start from the *Templates_LL* project provided for each board and available under \Projects\<STM32xxx_yyy>\Templates_LL:

   a) Select an LL example

      To find the board on which LL examples are deployed, refer to the list of LL examples in STM32CubeProjectsList.html, to *Table 3: Number of examples available for each board*, or to application note "*STM32Cube firmware examples for STM32F1 Series*" (AN4724).

   b) Port the LL example

   – Copy/paste the *Templates_LL* folder to keep the initial source or directly update the existing *Templates_LL* project.

   – Then LL example porting consists mainly in replacing *Templates_LL* files by the *Examples_LL* targeted project.

   – Keep all board specific parts. For reasons of clarity, board specific parts have been flagged with specific tags:

```
/* =========== BOARD SPECIFIC CONFIGURATION CODE BEGIN =========== */
/* ============ BOARD SPECIFIC CONFIGURATION CODE END ============= */
```

   Thus the main porting steps are the following:

   – Replace stm32f1xx_it.h file

   – Replace stm32f1xx_it.c file

- Replace main.h file and update it: keep the LED and user button definition of the LL template under "BOARD SPECIFIC CONFIGURATION" tags.
- Replace main.c file, and update it:

  Keep the clock configuration of the SystemClock_Config() LL template: function under "BOARD SPECIFIC CONFIGURATION" tags.

  Depending on LED definition, replace all LEDx occurrences with another LEDy available in main.h.

  Thanks to these adaptations, the example should be functional on the targeted board.

4.3 Using STM32CubeMX to generate initialization C code

An alternative to steps 1 to 6 described in *Section 4.2* consists in using the STM32CubeMX tool to generate code to initialize the system, peripherals and middleware (steps 1 to 6 above) through a step-by-step process:

1. Select the STMicroelectronics STM32 microcontroller that matches the required set of peripherals.
2. Configure each required embedded software thanks to a pinout-conflict solver, a clock-tree setting helper, a power consumption calculator, and the utility performing MCU peripheral configuration (e.g. GPIO or USART) and middleware stacks (e.g. USB).
3. Generate the initialization C code based on the configuration selected. This code is ready-to-use within several development environments. The user code is kept at the next code generation.

For more information, please refer to STM32CubeMX user manual (UM1718).

4.4 Getting STM32CubeF1 release updates

The STM32CubeF1 firmware package comes with an updater utility, STM32CubeUpdater, also available as a menu within STM32CubeMX code generation tool.

The updater solution detects new firmware releases and patches available from www.st.com and proposes to download them to the user’s computer.

4.4.1 Installing and running the STM32CubeUpdater program

Follow the sequence below to install and run the STM32CubeUpdater:

1. To launch the installation, double-click the SetupSTM32CubeUpdater.exe file.
2. Accept the license terms and follow the different installation steps.
3. Upon successful installation, STM32CubeUpdater becomes available as an STMicroelectronics program under *Program Files* and is automatically launched. The STM32CubeUpdater icon appears in the system tray. Right-click the updater icon and select **Updater Settings** to configure the Updater connection and whether to perform manual or automatic checks. For more details on Updater configuration, refer to section 3 of STM32CubeMX user manual - UM1718).

5 FAQ

5.1 What is the license scheme for the STM32CubeF1 firmware?

The HAL is distributed under a non-restrictive BSD (Berkeley Software Distribution) license.

The middleware stacks made by STMicroelectronics (USB Host and Device Libraries, STemWin) come with a licensing model allowing easy reuse, provided it runs on an STMicroelectronics device.

The middleware based on well-known open-source solutions (FreeRTOS and FatFs) have user-friendly license terms. For more details, refer to the license agreement of each middleware.

5.2 What boards are supported by the STM32CubeF1 firmware package?

The STM32CubeF1 firmware package provides BSP drivers and ready-to-use examples for the following STM32F1 boards: STM3210E-EVAL, STM3210C-EVAL, STM32VLDISCOVERY and NUCLEO-F103RB.

5.3 Is there any link with Standard Peripheral Libraries?

The STM32Cube HAL layer is the replacement of the Standard Peripheral Library.

The HAL APIs offer a higher abstraction level compared to the standard peripheral APIs. The HAL focuses on peripheral common features rather than hardware. Its higher abstraction level allows defining a set of user-friendly APIs that can be easily ported from one product to another.

Customers currently using Standard Peripheral Libraries have access to migration guides. Although existing Standard Peripheral Libraries are supported, they are not recommended for new designs.

5.4 Does the HAL drivers take benefit from interrupts or DMA? How can this be controlled?

Yes, they do. The HAL layer supports three API programming models: polling, interrupt and DMA (with or without interrupt generation).

5.5 Are any examples provided with the ready-to-use toolset projects?

Yes. STM32CubeF1 provides a rich set of examples and applications (around 90). They come with the pre-configured projects for IAR, Keil and GCC toolchains.

5.6 How are the product/peripheral specific features managed?

The HAL drivers offer extended APIs, i.e. specific functions as add-ons to the common API to support features available on some products/lines only.

5.7 How can STM32CubeMX generate code based on embedded software?

STM32CubeMX has a built-in knowledge of STM32 microcontrollers, including their peripherals and software, that allows to provide a graphical representation to the user and generate *.h/*.c files based on user configuration.

5.8 How can I get regular updates on the latest STM32CubeF1 firmware releases?

The STM32CubeF1 firmware package comes with an updater utility, STM32CubeUpdater, that can be configured for automatic or on-demand checks for new firmware package updates (new releases or/and patches).

STM32CubeUpdater is integrated as well within the STM32CubeMX tool. When using this tool for STM32F1 configuration and initialization C code generation, the user can benefit from STM32CubeMX self-updates as well as STM32CubeF1 firmware package updates.

For more details, refer to *Section 4.4*.

5.9 Is there any link with standard peripheral libraries (SPL)?

The STM32CubeF1 HAL and LL drivers are the replacement of the standard peripheral library:

- The HAL drivers offer a higher abstraction level compared to the standard peripheral APIs. They focus on peripheral common features rather than hardware. Their higher abstraction level allows defining a set of user-friendly APIs that can be easily ported from one product to another.
- The LL drivers offer low-level APIs at registers level. They are organized in a simpler and clearer way than direct register accesses. LL drivers also include peripheral initialization APIs, which are more optimized compared to what is offered by the SPL, while being functionally similar. Compared to HAL drivers, these LL initialization APIs allows an easier migration from the SPL to the STM32Cube LL drivers, since each SPL API has its equivalent LL API(s).

5.10 When should I use HAL versus LL drivers?

HAL drivers offer high-level and function-oriented APIs, with a high level of portability. Product/IPs complexity is hidden for end users.

LL drivers offer low-level APIs at registers level, with a better optimization but less portability. They require a deep knowledge of product/IPs specifications.

5.11 How can I include LL drivers in my environment? Is there any LL configuration file as for HAL?

There is no configuration file. Source code shall directly include the necessary stm32f1xx_ll_ppp.h file(s).

5.12 Can I use HAL and LL drivers together? If yes, what are the constraints?

It is possible to use both HAL and LL drivers. One can handle the IP initialization phase with HAL and then manage the I/O operations with LL drivers.

The major difference between HAL and LL is that HAL drivers require to create and use handles for operation management while LL drivers operates directly on peripheral registers. Mixing HAL and LL is illustrated in Examples_MIX example.

5.13 Is there any LL APIs which are not available with HAL

Yes, there are.

A few Cortex® APIs have been added in stm3f1xx_ll_cortex.h e.g. for accessing SCB or SysTick registers.

5.14 Why are SysTick interrupts not enabled on LL drivers?

When using LL drivers in standalone mode, you do not need to enable SysTick interrupts because they are not used in LL APIs, while HAL functions requires SysTick interrupts to manage timeouts.

5.15 How are LL initialization APIs enabled?

The definition of LL initialization APIs and associated resources (structure, literals and prototypes) is conditioned by the USE_FULL_LL_DRIVER compilation switch.

To be able to use LL APIs, add this switch in the toolchain compiler preprocessor.

6 Revision history

Table 4. Document revision history

Date	Revision	Changes
16-Dec-2014	1	Initial release.
11-Jun-2015	2	Added SW4STM32 toolchain in *Section 3.2: Firmware package overview* and in *Section 4.1: Running your first example*.
24-Mar-2017	3	Added support for LL drivers. Added *Section 4.2.1: HAL application* and *Section 4.2.2: LL application*. Updated *Figure 1: STM32CubeF1 firmware components*, *Figure 2: STM32CubeF1 firmware architecture*, *Figure 3: STM32CubeF1 firmware package structure*, *Figure 4: STM32CubeF1 examples overview* and *Table 3: Number of examples available for each board*. Updated *Section 5: FAQ*.