Getting started with X-CUBE-LED12A1 LED driver software expansion for STM32Cube

Introduction

The X-CUBE-LED12A1 expansion software package for STM32Cube runs on the STM32 and includes drivers that recognize the LED1202 LED Driver IC.

The expansion is built on STM32Cube software technology to ease portability across different STM32 microcontrollers.

The software comes with a sample implementation of the drivers running on the X-NUCLEO-LED12A1 expansion board when connected to a NUCLEO-L073RZ, NUCLEO-L476RG or NUCLEO-F401RE development board.

The X-CUBE-LED12A1 lets you easily create your own application using the driver implemented.

───── **RELATED LINKS** ─────

Visit the STM32Cube ecosystem web page on www.st.com for further information

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For further information contact your local STMicroelectronics sales office.

www.st.com

1   Acronyms and abbreviations

Table 1. List of acronyms

Acronym	Description
LED	Light emitting diode
MCU	Microcontroller unit
PC	Personal computer
I²C	Inter integrated circuit

2 X-CUBE-LED12A1 software expansion for STM32Cube

2.1 Overview

The X-CUBE-LED12A1 software package expands the functionality provided by STM32Cube.

The software package key features are:

- Driver software expansion for X-NUCLEO-LED12A1 expansion board based on LED1202
- Normal and GUI modes
- In normal mode, each LED starts from the minimum intensity to reach the maximum intensity
- In GUI mode, LED intensity can be controlled via GUI
- Sample implementation available for X-NUCLEO-LED12A1 when connected to a NUCLEO-L073RZ, NUCLEO-L476RG or NUCLEO-F401RE development board
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms

This software enables LED driver for the LED1202 devices, running on STM32.

The package also includes a sample application that the developer can use to start experimenting with the code. The sample application is designed to control the LED intensity via PC. For this purpose, the package also includes a utility for Windows PC, which allows you to choose among various options available in the GUI.

2.2 Architecture

This software is a fully compliant expansion for STM32Cube that enables development of applications using the 12-channel low quiescent current LED driver.

The software is based on the STM32CubeHAL, the hardware abstraction layer for the STM32 microcontroller. The package extends STM32Cube by providing a board support package (BSP) for the X-NUCLEO-LED12A1 expansion board and some middleware components for serial communication with a PC.

The software layers used by the application software to access and use the expansion boards are:

- **STM32Cube HAL layer**: consists of simple, generic and multi-instance APIs (application programming interfaces) which interact with the upper layer applications, libraries and stacks. These generic and extension APIs are based on a common framework so that overlying layers like middleware can function without requiring specific microcontroller unit (MCU) hardware information. This structure improves library code reusability and guarantees easy portability across other devices.
- **Board support package (BSP) layer**: provides software support for the STM32 Nucleo board peripherals, excluding the MCU. These specific APIs provide a programming interface for certain board specific peripherals like LEDs, user buttons, etc., and can also be used to identify the specific board version.

Figure 1. X-CUBE-LED12A1 expansion software architecture
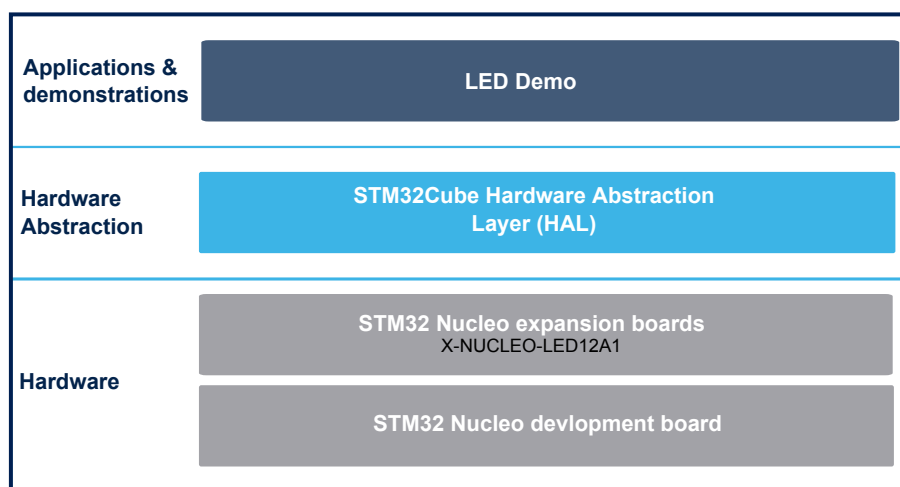
2.3 Folder structure

Figure 2. X-CUBE-LED12A1 package folder structure
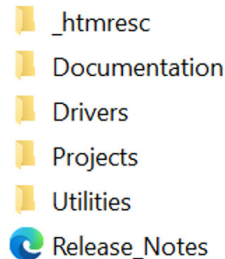
The following folders are included in the software package:

- **Documentation** contains compiled HTML files for each supported STM32 Nucleo board, generated from the source code, detailing the software components and APIs.
- **Drivers** contains the HAL drivers, the board specific drivers for each supported board or hardware platform, including the on-board components, and the CMSIS layer, which is a vendor-independent hardware abstraction layer for the Cortex-M processor series.
- **Projects** contains a sample application used to control LED intensity using the LED driver, provided for the NUCLEO-L073RZ, NUCLEO-L476RG and NUCLEO-F401RE platforms stacked with the X-NUCLEO-LED12A1 plus the panel board with three development environments (IAR Embedded Workbench for ARM, RealView Microcontroller Development Kit, and STM32CubeIDE).
- **Utilities** contains a folder called "PC_software" that provides a Windows PC utility to control LED intensity.

2.4 APIs

Detailed technical information about the available APIs can be found in a compiled HTML file located inside the "Documentation" folder of the software package, which fully describes all the functions and parameters.

2.5 State machine

The X-CUBE-LED12A1 firmware has two modes: normal mode and GUI mode.

You can choose the mode by using `#define GUI_MODE` in the "main.c" file.

The code runs in GUI mode, if it is defined. It runs in normal mode if commented.

In GUI mode, the LED intensity can be controlled via GUI.

In normal mode, it runs the demo written in the firmware. In this case, each LED intensity varies from the minimum intensity to maximum intensity one by one. Using the driver written for LED1202, you can write other applications.

Figure 3. X-CUBE-LED12A1 state machine
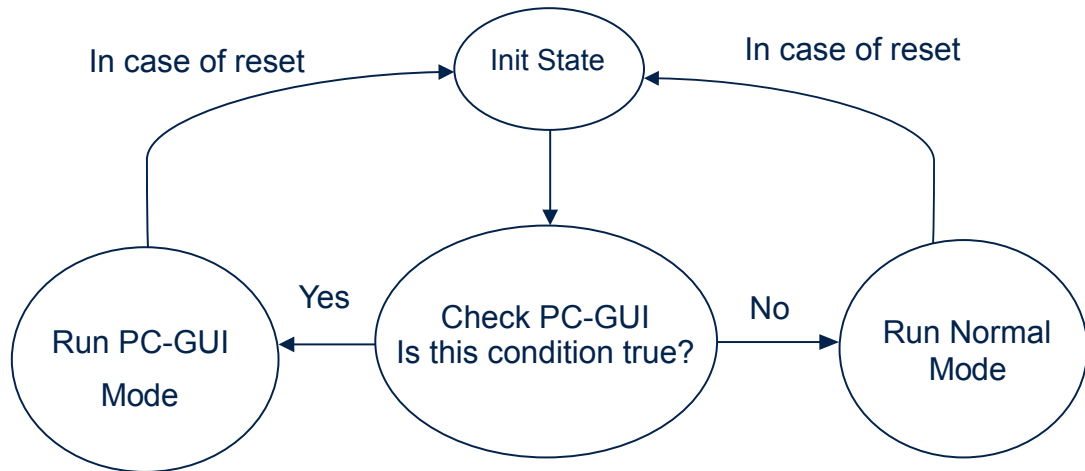
2.5.1 Details

INIT State initializes MCU and peripherals

Check for PC-GUI condition checks whether the GUI condition is defined

GUI Mode: if this condition is true, the LED intensity can be controlled via GUI

Normal Mode: each LED intensity varies from minimum intensity to maximum intensity one by one.

2.6 LED demo in normal mode

An example application, using the X-NUCLEO-LED12A1 expansion board with a NUCLEO-L073RZ, NUCLEO-L476RG or NUCLEO-F401RE development board, is provided in the "Projects" directory. Ready to be built projects are available for multiple IDEs.

To run the demo in normal mode, follow the procedure below.

Step 1. Mount the panel board on the X-NUCLEO-LED12A1.

Step 2. Mount the stacked boards over the development board.

Step 3. Comment the preprocessor "GUI_MODE" in the "main.c" file.

Step 4. Connect the development board to your PC via USB cable.

Step 5. Program the board using the related firmware.
The LED demo automatically runs according to the application. The intensity of the LEDs varies one by one.
– When jumper J1 on the panel board is in 2-3 position, the demo runs on white LEDs.
– When jumper J1 on the panel board is in 1-2 position, the demo runs on RGB LEDs.

2.7 LED demo in GUI mode

The X-CUBE-LED12A1 expansion for STM32Cube contains a utility for Windows PC called "STSW-LED1202GUI". This utility is available in the ROOT_DIR\Utilities\PC_software folder.

Step 1. Uncomment the preprocessor "GUI_MODE" in "main.c" file.

Step 2. Connect the development board to your PC via a USB cable.

Step 3. Program the board using the related firmware.
The LED demo runs and the intensity of the LEDs varies as per GUI settings.
– When jumper J1 on the panel board is in 2-3 position, the demo runs on white LEDs.
– When jumper J1 on the panel board is in 1-2 position, the demo runs on RGB LEDs.

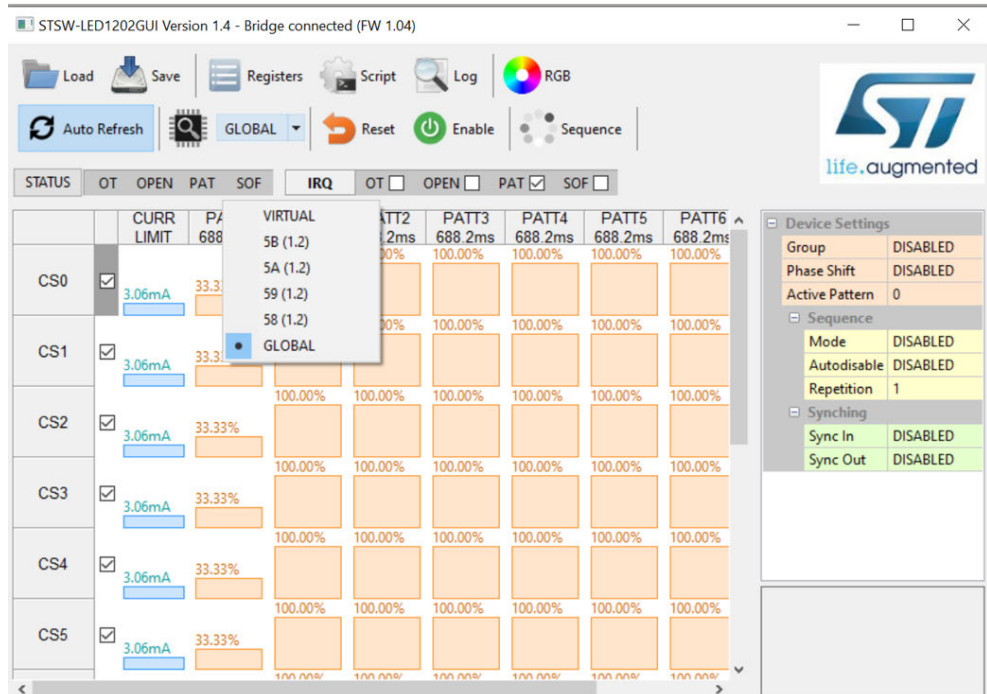**Step 4.** Open the GUI by double-clicking on the software.

Step 5. Connect the programmed board to the PC.

Step 6. Click on the search button.
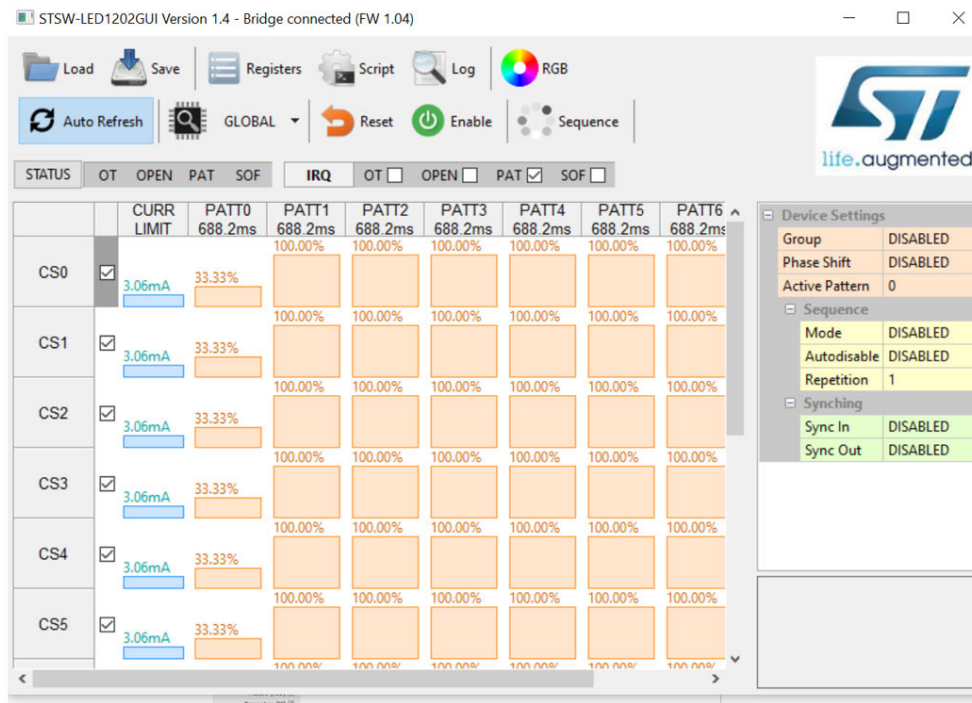
Figure 4. GUI homepage on Windows
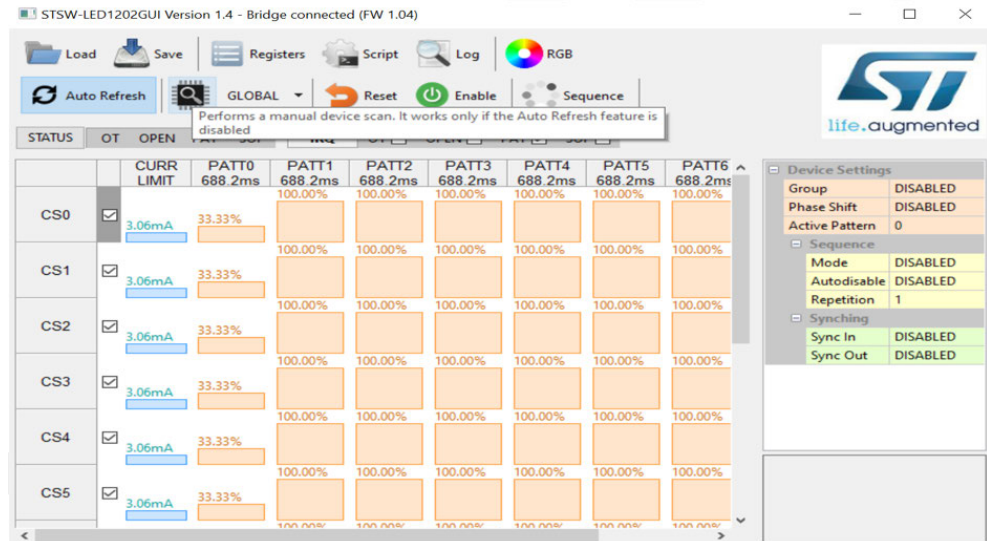
Step 7. Select the address corresponding to the device to control.

Figure 5. Selecting the address on the GUI

Step 8. Vary the current corresponding to the channel.

Figure 6. Varying the current on the GUI

3 System setup guide

3.1 Hardware description

3.1.1 STM32 Nucleo

STM32 Nucleo development boards provide an affordable and flexible way for users to test solutions and build prototypes with any STM32 microcontroller line.

The Arduino connectivity support and ST morpho connectors make it easy to expand the functionality of the STM32 Nucleo open development platform with a wide range of specialized expansion boards to choose from.

The STM32 Nucleo board does not require separate probes as it integrates the ST-LINK/V2-1 debugger/ programmer.

The STM32 Nucleo board comes with the comprehensive STM32 software HAL library together with various packaged software examples for different IDEs (IAR EWARM, Keil MDK-ARM, STM32CubeIDE, mbed and GCC/ LLVM).

All STM32 Nucleo users have free access to the mbed online resources (compiler, C/C++ SDK and developer community) at www.mbed.org to easily build complete applications.

Figure 7. STM32 Nucleo board

3.1.2 X-NUCLEO-LED12A1 expansion board

The X-NUCLEO-LED12A1 LED driver expansion board for STM32 Nucleo features four LED1202 devices that can drive up to 48 LEDs.

The LED1202 is a 12-channel low quiescent current LED driver, which guarantees 5 V output driving capability. Each channel is able to provide up to 20 mA with a headroom voltage of 350 mV (typ.) only.

The output current can be adjusted separately for each channel through an 8-bit analog and 12-bit digital dimming control.

The X-NUCLEO-LED12A1 expansion board comes with an additional LED panel board that houses two LEDs matrices: a 6x8 white LED matrix and a 4x4 RGB matrix.

LED matrices can be supplied via an external power supply connected to J13 connector and by selecting the right path through J15 jumper to reach the maximum luminosity available.

Figure 8. X-NUCLEO-LED12A1 expansion board
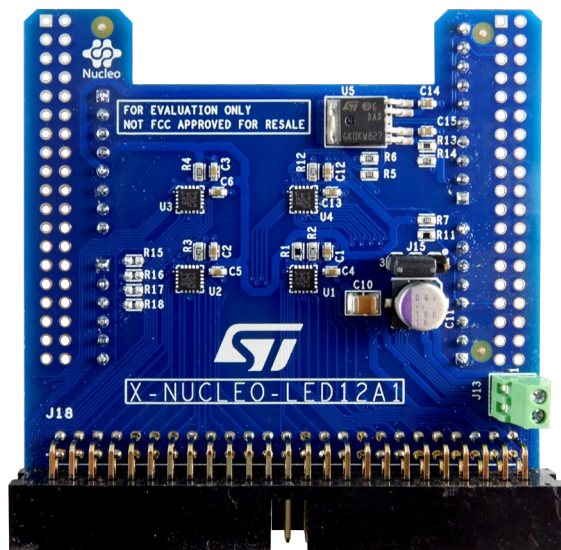
Figure 9. LED panel board
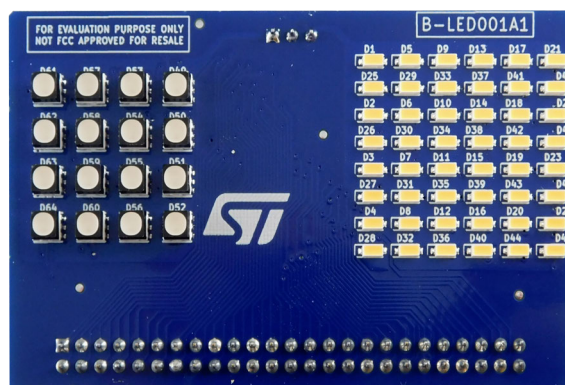
3.2 Hardware setup

The necessary hardware components are:

- One STM32 Nucleo development platform (suggested order code: either NUCLEO-F401RE or NUCLEO-L073RZ or NUCLEO-L476RG)
- One LED1202 expansion board (order code: X-NUCLEO-LED12A1)
- One USB type A to Mini-B USB cable to connect the STM32 Nucleo to the PC

3.3 Software setup

The following software components are necessary to create applications for the STM32 Nucleo equipped with the X-NUCLEO-LED12A1 expansion board:

- X-CUBE-LED12A1: an expansion for STM32Cube dedicated to application development, which requires the use of LED1202. The X-CUBE-LED12A1 firmware and related documentation is available on www.st.com.
- Development tool-chain and Compiler: the STM32Cube expansion software supports the three following environments:
  - IAR Embedded Workbench for ARM$^®$ (EWARM) toolchain + ST-LINK
  - RealView Microcontroller Development Kit (MDK-ARM-STR) toolchain + ST-LINK
  - STM32CubeIDE + ST-LINK

3.3.1 PC utility setup

You can launch the STSW-LED1202GUI utility by simply double-clicking on the STSW-LED1202GUI.exe file, located in the "Utilities\PC_software" folder.

The utility has the following minimum requirements:

- PC with Intel or AMD processor running one of following Microsoft operating system:
  - Windows XP SP3
  - Windows Vista
  - Windows 7 or 10
- At least 128 MBs of RAM
- Two USB ports
- 40 MB of hard disk space

3.4 Setup of STM32 Nucleo and LED expansion board

The STM32 Nucleo development board integrates the ST-LINK/V2-1 debugger/programmer.

You can download the ST-LINK/V2-1 USB driver by looking for STSW-LINK009 software on www.st.com.

The X-NUCLEO-LED12A1 expansion board can be easily connected to the STM32 Nucleo through the Arduino UNO R3 extension connectors. It can interface with the external STM32 microcontroller on the STM32 Nucleo using inter integrated circuit (I²C).

Revision history

Table 2. Document revision history

Date	Revision	Changes
04-Oct-2021	1	Initial release.

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IMPORTANT NOTICE – PLEASE READ CAREFULLY