UM1804
User manual

STM32CubeL1 Nucleo demonstration firmware

Introduction

STMCube™ initiative was originated by STMicroelectronics to ease developers' life by reducing development efforts, time and cost. STM32Cube covers STM32 portfolio.

STM32Cube Version 1.x includes:

- The STM32CubeMX, a graphical software configuration tool that allows to generate C initialization code using graphical wizards.
- A comprehensive embedded software platform, delivered per series (such as STM32CubeL1 for STM32L1 series)
  - The STM32CubeL1 HAL, an STM32 abstraction layer embedded software, ensuring maximized portability across STM32 portfolio
  - A consistent set of middleware components such as RTOS, USB, STMTouch and FatFs
  - All embedded software utilities coming with a full set of examples.

The STM32CubeL1 Nucleo Demonstration platform is built around the STM32Cube HAL, BSP and FatFs middleware component and uses almost the whole STM32 capability to load and display full color bitmaps from a microSD card.

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1 STM32CubeL1 main features

STM32CubeL1 gathers together, in a single package, all the generic embedded software components required to develop an application on STM32L1 microcontrollers. In line with the STM32Cube initiative, this set of components is highly portable, not only within the STM32L1 series but also to other STM32 series.

STM32CubeL1 is fully compatible with STM32CubeMX code generator that allows the user to generate initialization code. The package includes a low level hardware abstraction layer (HAL) that covers the microcontroller hardware, together with an extensive set of examples running on STMicroelectronics boards. The HAL is available in an open-source BSD license for user convenience.

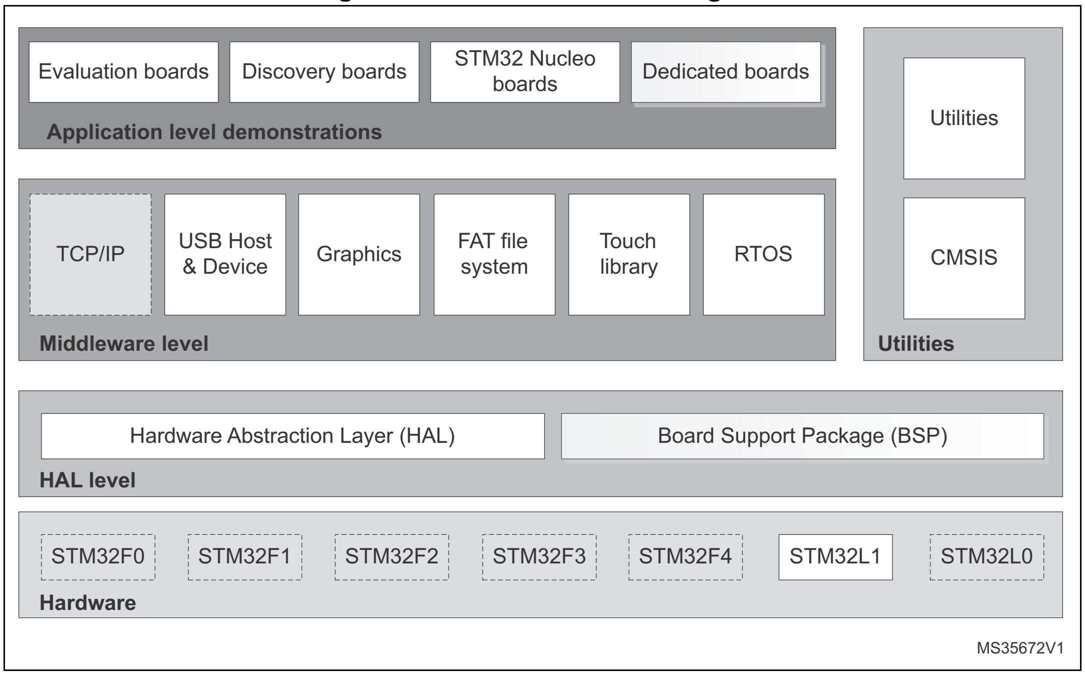
STM32CubeL1 package features a set of middleware components with the corresponding examples. They come with very permissive license terms:

- Full USB Device stack supporting many classes (HID, MSC, CDC, Audio, DFU)
- CMSIS-RTOS implementation with FreeRTOS open source solution
- FAT File system based on open source FatFs solution
- STMTouch touch sensing solution.

A demonstration implementing all these middleware components is also provided in the STM32CubeL1 package.

The block diagram of STM32Cube is shown in *Figure 1*.

Figure 1. STM32Cube block diagram



2 Getting started with the demonstration

2.1 Hardware requirements

The hardware requirements to start the demonstration application are as follows:

- STM32L152 Nucleo board
- Adafruit 1.8" TFT shield with Joystick and microSD (reference ID: 802)
- one 'USB type A to Mini-B' cable to power up the STM32 Nucleo board from the USB ST-LINK (USB connector CN1)
- a Standard Capacity SD card (SDSC) with a capacity up to 4GBytes.

2.1.1 STM32L152 Nucleo board

The STM32 Nucleo board is a low-cost and easy-to-use development kit to quickly evaluate and start some development with ARM® 32-bit Cortex®-M microcontrollers of the STM32 series (STM32F103, STM32F030, STM32F072, STM32L152 and STM32L053). Before installing and using the product, please accept the Evaluation Product License Agreement available at www.st.com/epla.

For more information on the STM32 Nucleo board visit www.st.com/stm32nucleo.

Figure 2. STM32L152 Nucleo board

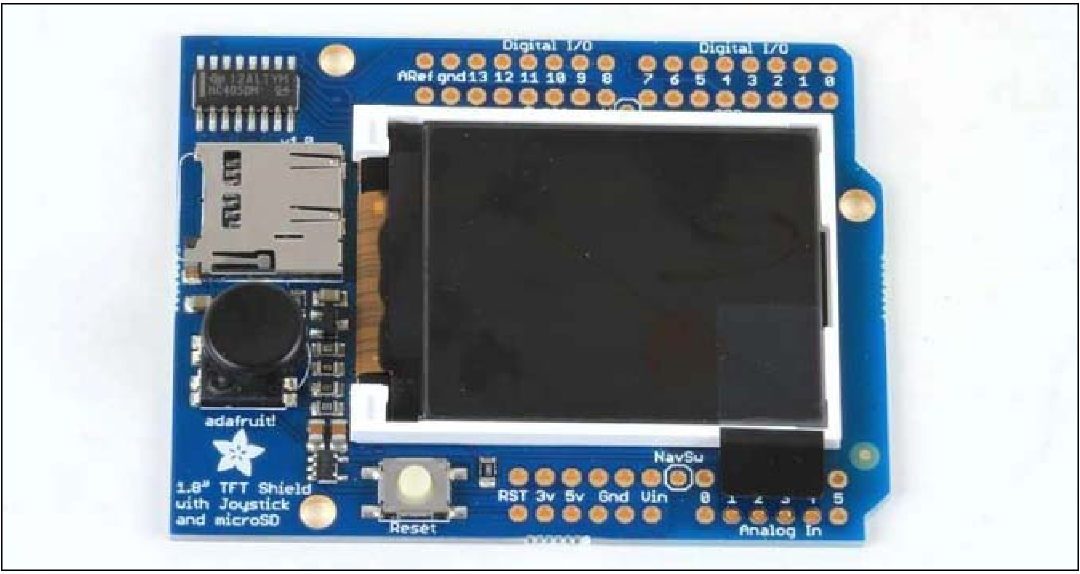
2.1.2 Adafruit TFT shield

The STM32 Nucleo board supports Arduino connectivity.

This Adafruit 1.8" TFT shield may be found on the Adafruit website (reference ID 802) with the following features:

- one 1.8” TFT display with 128x160 color pixels
- one microSD card interface slot
- one 5-way joystick navigation switch (left, right, up, down, select).

Figure 3. Adafruit 1.8” TFT shield



Note: This shield is just an example of Arduino shield usage; you can get more details on Adafruit website.

2.2 Hardware configuration

In addition to gathering the hardware please follow the recommendations below, to start using the Adafruit 1.8” TFT shield with the STM32 Nucleo board.

2.2.1 STM32 Nucleo board configuration

Check jumpers’ positions on the STM32 Nucleo board as follows:

- JP1 OFF
- JP5 (PWR) on U5V side ON
- JP6 (I_{DD}) ON.

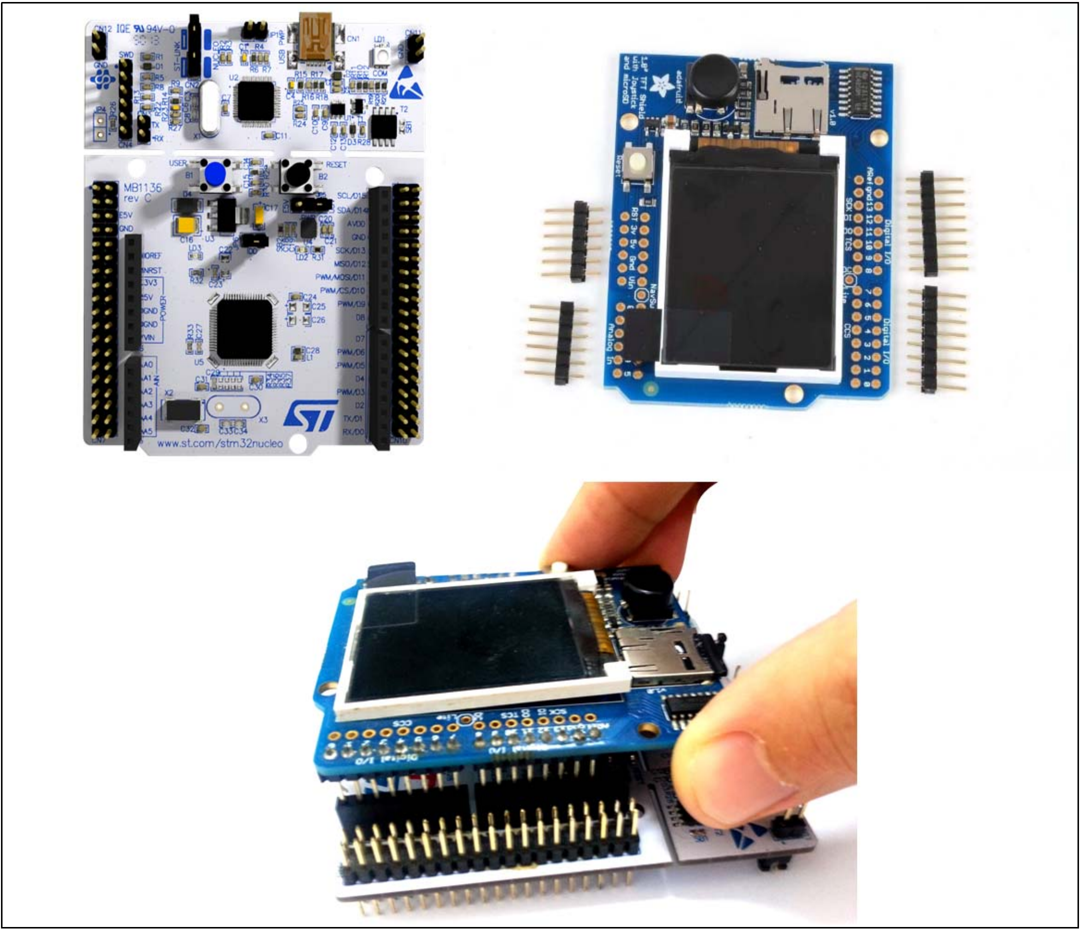
2.2.2 Assembling the Adafruit shield

The Adafruit TFT shield comes with all surface mount parts pre-soldered. User can install the headers following the next steps:

- Cut the breakaway header strip into sections to fit the holes on the edge of the shield: two sections of 6 pins and two other sections of 8 pins are needed.
- To align the header strips for soldering, insert them (long pins down) into the headers of the STM32 Nucleo board using the connectors CN5, CN6, CN8 and CN9.
- Place the shield over the header strips so that the short pins stick up through the holes.
- Solder on each pin of the header onto the shield PCB to ensure good electrical contact.

The sequence is shown in *Figure 4*.

Figure 4. Assembling the Adafruit 1.8" TFT shield

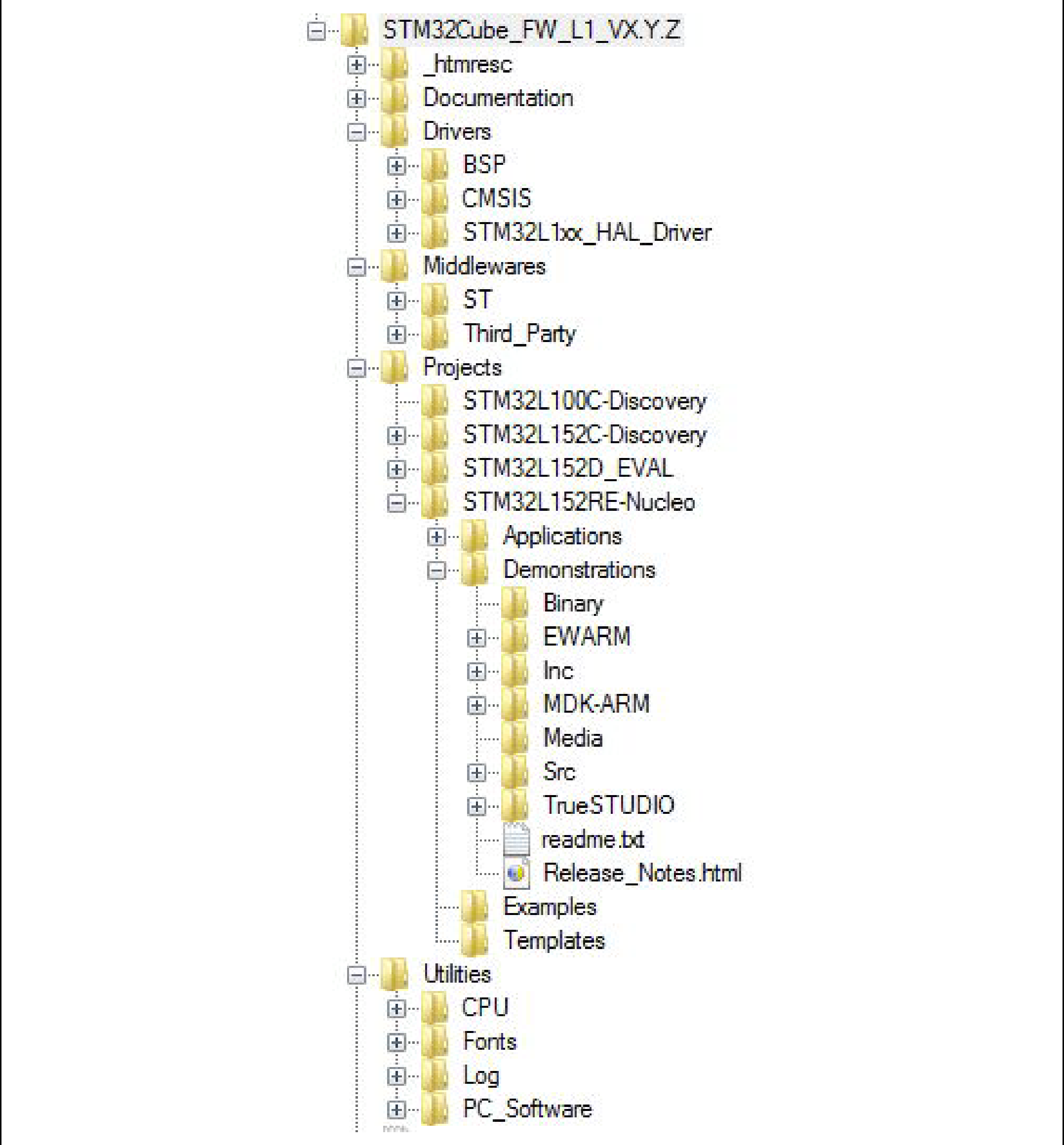


3 Demonstration firmware package

3.1 Demonstration repository

The Nucleo demonstration is provided within the STM32CubeL1 firmware package, as shown in *Figure 5*.

Figure 5. Folder structure



The demonstration sources are located in the projects folder of the STM32Cube package for the STM32L152 Nucleo board. The sources are divided into five groups described as follows:

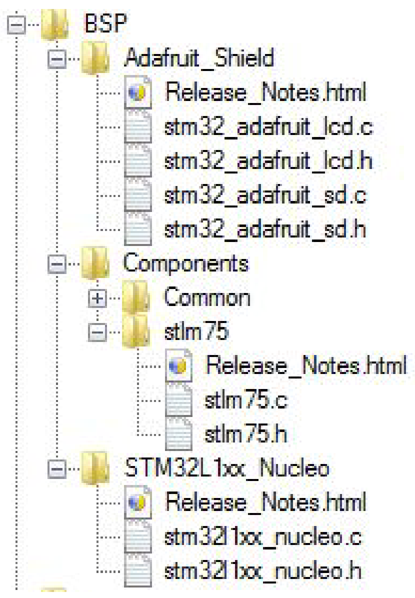
1. Binary: demonstration binary file in Hex format
2. Media: contains the media files (*.bmp) required to run the demonstration

3. Inc: contains the demonstration header files
4. Src: contains the demonstration source files
5. Project settings: a folder per toolchain containing the project settings and the linker files.

3.2 Nucleo board BSP

For each board, a set of Button, LED and Joystick drivers is available within the *stm32l1xx_nucleo.c/.h* files, implementing the board capabilities and the bus link mechanism.

Figure 6. Nucleo BSP architecture



```
BSP
  Adafruit_Shield
    Release_Notes.html
    stm32_adafruit_lcd.c
    stm32_adafruit_lcd.h
    stm32_adafruit_sd.c
    stm32_adafruit_sd.h
  Components
    Common
    stlm75
      Release_Notes.html
      stlm75.c
      stlm75.h
  STM32L1xx_Nucleo
    Release_Notes.html
    stm32l1xx_nucleo.c
    stm32l1xx_nucleo.h
```

3.2.1 Joystick

The 5-way joystick on the shield is based on a resistor trick to permit all the switches to share one analog pin. Each movement of the joystick control connects a different resistor and results in a different voltage reading.

The ADC peripheral is configured within the *stm32l1xx_nucleo.c/.h* driver in order to get analog voltage values through the analog I/O pin 3.

The *BSP_JOY_GetState()* function reads the analog pin and compares the result with 5 different ranges to determine which (if any) direction the stick has been moved (left, right, up, down, select).

3.2.2 LCD

The LCD available on the Adafruit 1.8" TFT shield uses 4-wire SPI to communicate with the STM32L1 chip (Digital I/O pins 13, 11, 10 and 8) and has its own pixel-addressable frame buffer to display text, shapes, lines, pixels, etc.

The SPI peripheral is configured within the *stm32l1xx_nucleo.c/.h* driver which contains also the SPI bus link mechanism and IO operations.

The LCD is controlled by a dedicated BSP LCD driver *stm32_adafruit_lcd.c/.h* which uses the st7735 component that exports in a generic way the LCD IO operations needed for its process.

3.2.3 MicroSD

The microSD slot available on the Adafruit 1.8" TFT shield uses 4-wire SPI to communicate with the STM32L1 chip (Digital I/O pins 13, 12, 11 and 4).

The SPI peripheral is configured within the *stm32l1xx_nucleo.c/.h* driver which contains also the SPI bus link mechanism and IO operations.

The microSD is controlled by a dedicated BSP SD driver *stm32_adafruit_sd.c/.h* which exports in a generic way the SD IO operations needed for its process.

4 Demo functional description

In this demonstration application, we will show how to use the STM32CubeL1 firmware package with either the NUCLEO-L152RE board and the Adafruit 1.8” TFT shield to display a 128x160 pixel full color bitmap from a microSD card using the FatFs file system.

To start with this demonstration application user has to copy the provided 128x160 pixel bitmap pictures available within the FW package under “\Media” folder to the root directory of a FAT formatted microSD card and insert the microSD card into the Adafruit shield microSD holder.

Note that the microSD card can have a storage capacity up to 4GBytes (SDSC) and that the bitmap images must have the properties detailed in *Table 1*.

Table 1. Bitmap image properties

	Dimensions	128 x 160
	Width	128 pixels
	Height	160 pixels
	Bit depth	16
	Item type	BMP file
	Name	Must not exceed 11 characters (including .bmp extension).

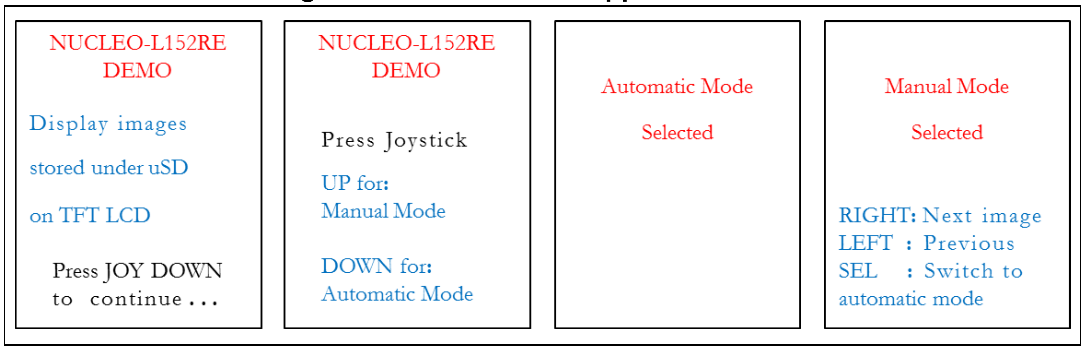
Once started, the application checks the availability of Adafruit 1.8" TFT shield on top of STM32 Nucleo board. This is done by reading the state of IO PB.00 pin (mapped to Joystick available on the shield). If the state of PB.00 is high then the shield is available.

If the Adafruit 1.8" TFT shield is not available, the LED2 is toggling with a frequency equal to ~1Hz. A second press on the User button lets LED2 toggling with a second frequency equal to ~5Hz. The third press, changes LED2 toggling frequency to ~10Hz. The described process is done in an infinite loop.

If the Adafruit 1.8" TFT shield is available, LED2 is turned ON, because it's sharing the same pin with the SPI CLK signal used to communicate with the LCD and microSD available on the shield.

A menu is displayed on Adafruit 1.8" TFT describing the demonstration application, as shown in *Figure 7*.

Figure 7. Demonstration application menu



NUCLEO-L152RE
DEMO

Display images
stored under uSD
on TFT LCD

Press JOY DOWN
to continue . . .

NUCLEO-L152RE
DEMO

Press Joystick
UP for:
Manual Mode
DOWN for:
Automatic Mode

Automatic Mode
Selected

Manual Mode
Selected

RIGHT: Next image
LEFT : Previous
SEL : Switch to
automatic mode

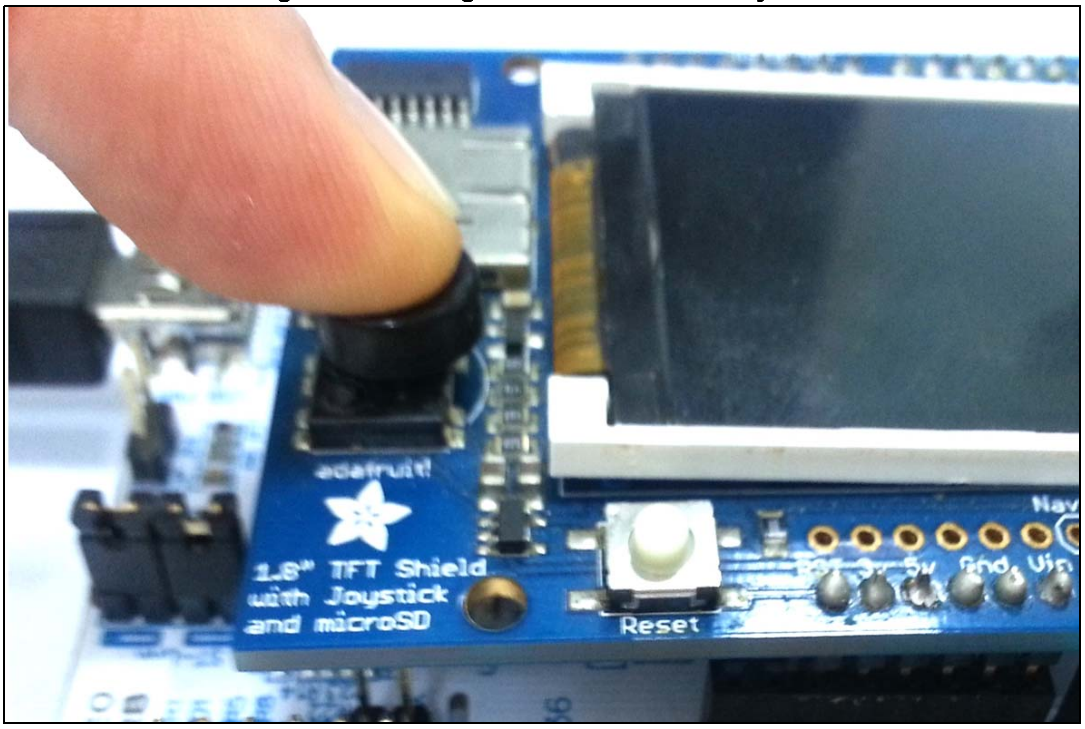
User has to follow the instructions below:

- Press the Joystick DOWN to continue menu display (see *Figure 8*)
- Choose one of the available display modes (manual and automatic) using the Joystick button:
  - **Automatic mode**: by pressing Joystick DOWN

    The bitmap images available on the microSD card are displayed sequentially in a forever loop.
  - **Manual mode**: by pressing Joystick UP

    The bitmap images available on the microSD card are displayed by pressing Joystick RIGHT to display next images, or Joystick LEFT to display previous one. Pressing long (~1s) the Joystick SEL, switches the display mode from manual to automatic.

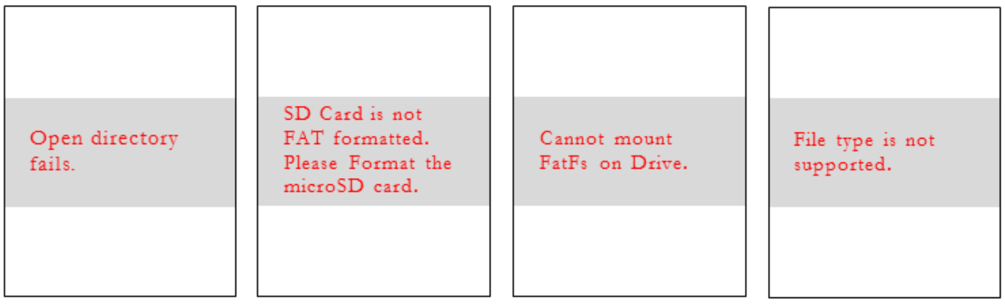
Figure 8. Reading the Adafruit shield Joystick



It is worth noting that the application manages some errors (refer to *Figure 9*) that can occur during the access to microSD card to load the bitmap images:

- If the microSD card is not FAT formatted, a message will be displayed on TFT. In this case, format the microSD card and put into its root directory the bmp files available within the FW package under \Media folder.
- If the content of the microSD card is other than a bitmap file, a message will be displayed on TFT mentioning that it is not supported. User has to ensure that the files available under the microSD card root directory are respecting the above described bitmap properties.

Figure 9. Demonstration application error messages



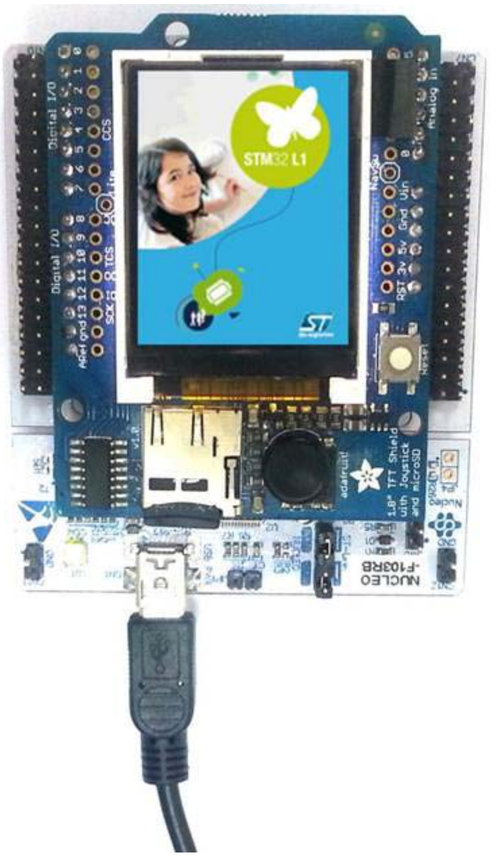
Open directory fails.

SD Card is not FAT formatted. Please Format the microSD card.

Cannot mount FatFs on Drive.

File type is not supported.

Figure 10. Demonstration running



4.1 Programming firmware application

To program the STM32 Nucleo board with the demonstration application please proceed as follows:

1. Install the preferred Integrated Development Environment (IDE)
2. Install the ST-LINK/V2.1 driver available on ST website.

There are two ways of programming the STM32 Nucleo board:

- Method1:

Upload the **STM32CubeL1_Demo_Nucleo.hex** from the firmware package available under Projects\STM32L152RE-Nucleo\Demonstrations\Binary using your preferred in-system programming tool.

- Method2:

  Choose one of two supported tool chains (IAR™ / Keil®) and follow the steps below:
  - Open the application folder: Projects\STM32L152RE-Nucleo\Demonstrations\
  - Chose the desired IDE project (EWARM for IAR, MDK-ARM for Keil)
  - Double click on the project file (for example Project.eww for EWARM)
  - Rebuild all files: Go to **Project** and select **Rebuild all**
  - Load the project image: Go to **Project** and select **Debug**
  - Run the program: Go to **Debug** and select **Go**.

The demonstration software as well as other software examples that allow you to discover the STM32 microcontroller features are available on ST website at www.st.com/stm32nucleo.

5 FAQs

How can I use this application to display my own images?

Use any image editing tool and crop your image to no larger than 160 pixels high and 128 pixels wide. Save it as a 16-bit color BMP format file.

Can I display more bitmap files?

Yes. You can display more pictures, by copying them under the microSD root directory. Just modify the define value of MAX_BMP_FILES constant to the desired number of files. In this case, you must fine tune the _FS_LOCK value, defining the number of files that can be opened simultaneously, under “ffconf.h” the FatFs configuration file.

What about putting the bitmap files not under the root directory of the microSD?

Once put under another folder different from the root directory, the bitmap files cannot the accessed by the demonstration application. The “File type not supported” error message is displayed on the LCD.

To make it work you have to add the new directory path within f_open() and f_opendir() FatFs APIs calls’ under the fatfs_storage.c file.

6 Revision history

Table 2. Document revision history

Date	Revision	Changes
02-Sep-2014	1	Initial release.