High brightness LED array driver with diagnostics for automotive applications based on STAP16DPS05 and STM8A

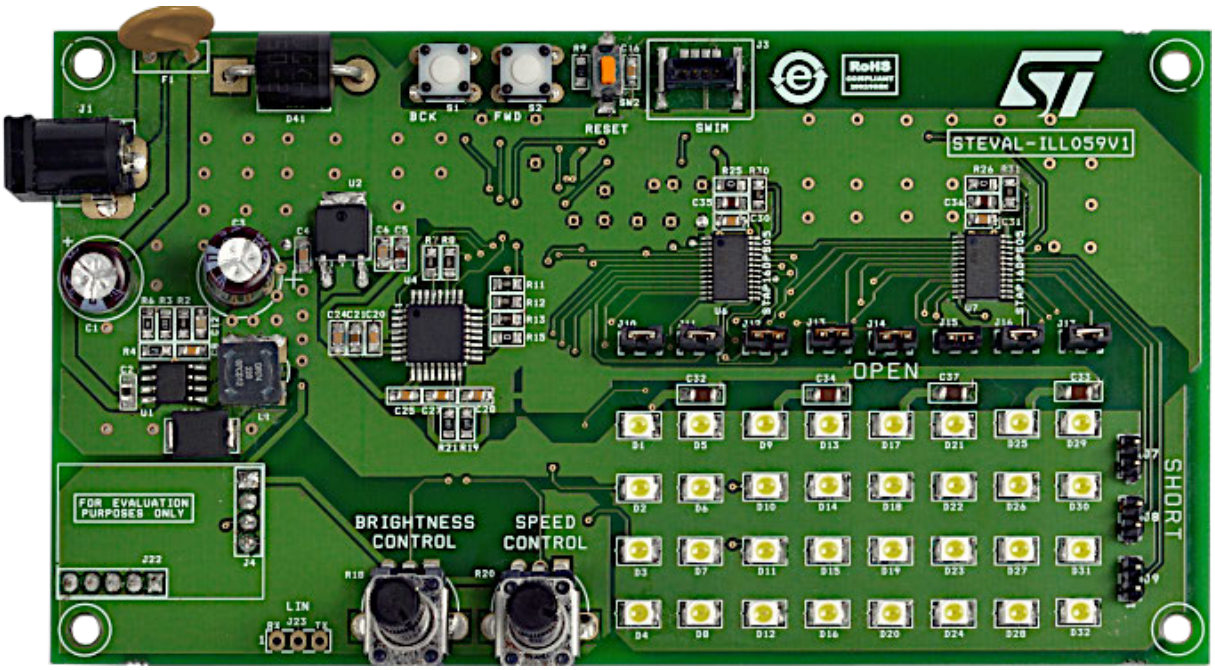
Introduction

The STEVAL-ILL059V1 is a high brightness LED array driver evaluation board with diagnostics based on the STAP16DPS05 low voltage 16-bit constant current LED sink driver for automotive applications.

The LED driver is configured and controlled through an 8-bit automotive grade STM8A microcontroller via SPI interface. The A5974D automotive grade DC-DC converter provides the necessary voltage and power for all the board functions.

The package includes a GUI that helps you evaluate the features of the LED driver and download your own application firmware onto the board through the SWIM interface.

Figure 1. STEVAL-ILL059V1 LED array driver evaluation board

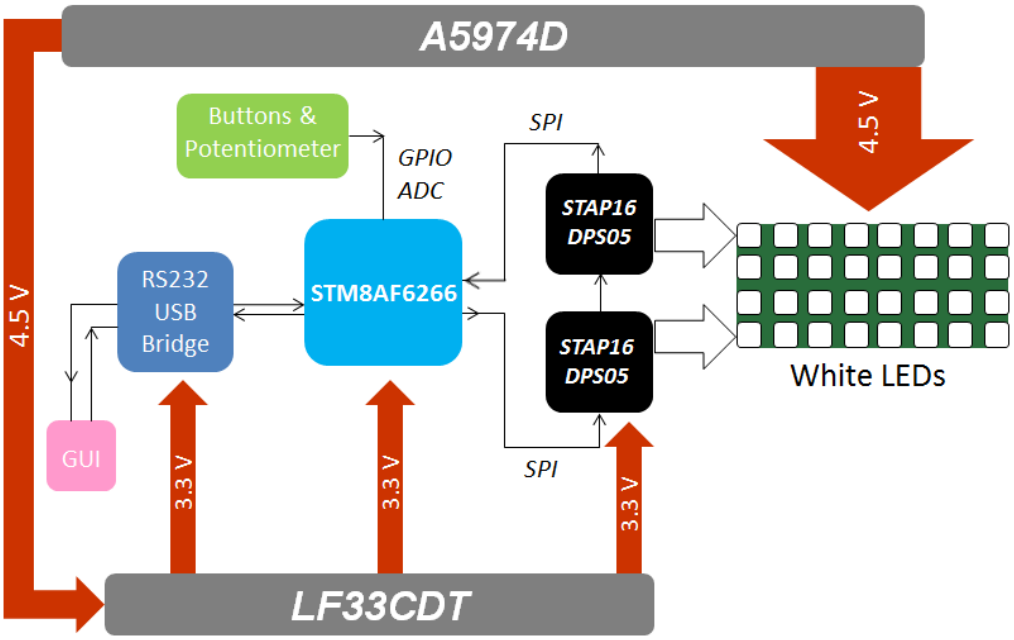


1 Overview

The package consists of the following elements:

- A STEVAL-ILL059V1 evaluation board
- An RS232-USB bridge daughterboard
- Dedicated GUI software
- User documentation

Figure 2. Block diagram of STEVAL-ILL059V1 evaluation board



The STEVAL-ILL059V1 evaluation board includes a DC input power supply, an 8-bit microcontroller and a SWIM connector to program the microcontroller, 32 white LEDs and user interface buttons and potentiometers to control the two STAP16DPS05 LED drivers (each driver controls 8 LEDs

The evaluation board can operate in the following modes:

1. Standalone Mode: the board is controlled via on-board push buttons and potentiometers
2. GUI Mode: is activated when the board is connected to a PC, and lets you control the board through the GUI

The package includes an RS232-USB daughterboard that supports full-duplex communication between USB and UART interfaces, thus allowing communication with the PC GUI via USB. The daughterboard connected is powered by the main board through the UART and SWD connector.

Figure 3. STEVAL-ILL059V1 evaluation board (top)

1. 6–24 V DC power supply with reverse voltage protection and short-circuit protection, standard DC jack input
2. A5974D automotive grade switching regulator for automotive applications
3. LF33: 3.3 Volt linear voltage regulator for automotive applications
4. STM8AF6266 8-bit microcontroller for automotive applications
5. Backwards and forwards button switches
6. Reset switch
7. SWIM connector to program and debug microcontroller firmware
8. Connector for LIN development and evaluation
9. Brightness control potentiometer
10. Speed control potentiometer
11. STAP16DPS05 constant current LED driver
12. 32 white LEDs (PLCC 4)
13. 8 jumpers, to simulate open-circuit error
14. 3 jumpers, to simulate short-circuit error

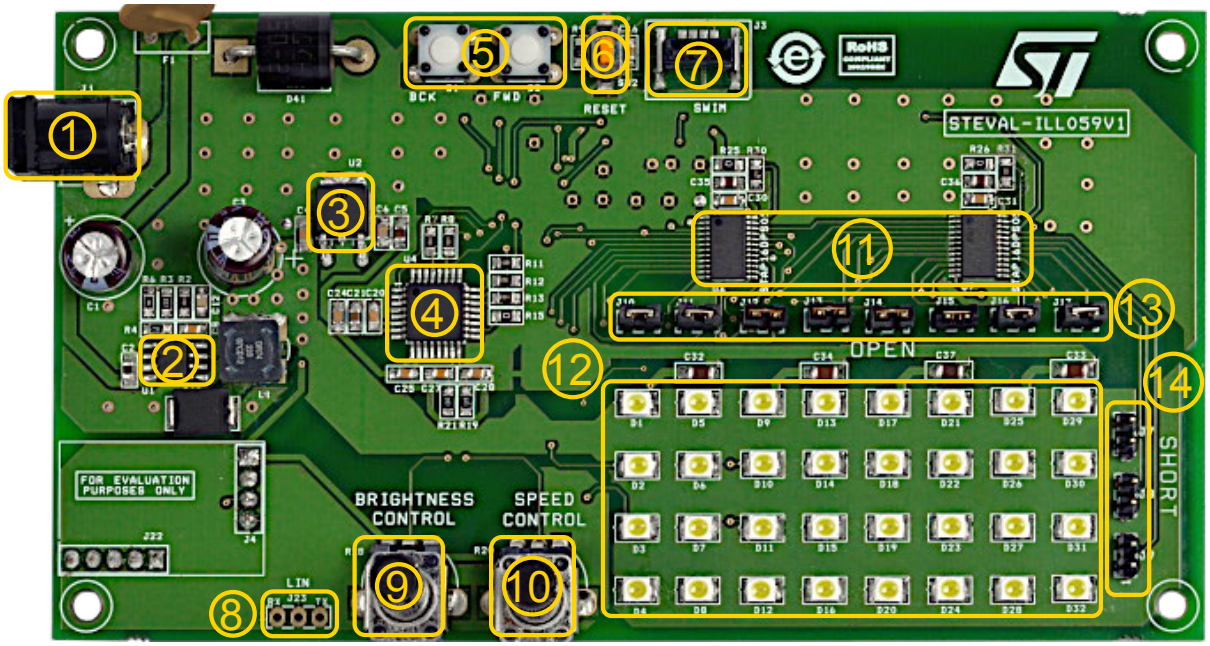


Figure 4. **STEVAL-ILL059V1 evaluation board (bottom)**

15. Slot for USB to UART daughterboard

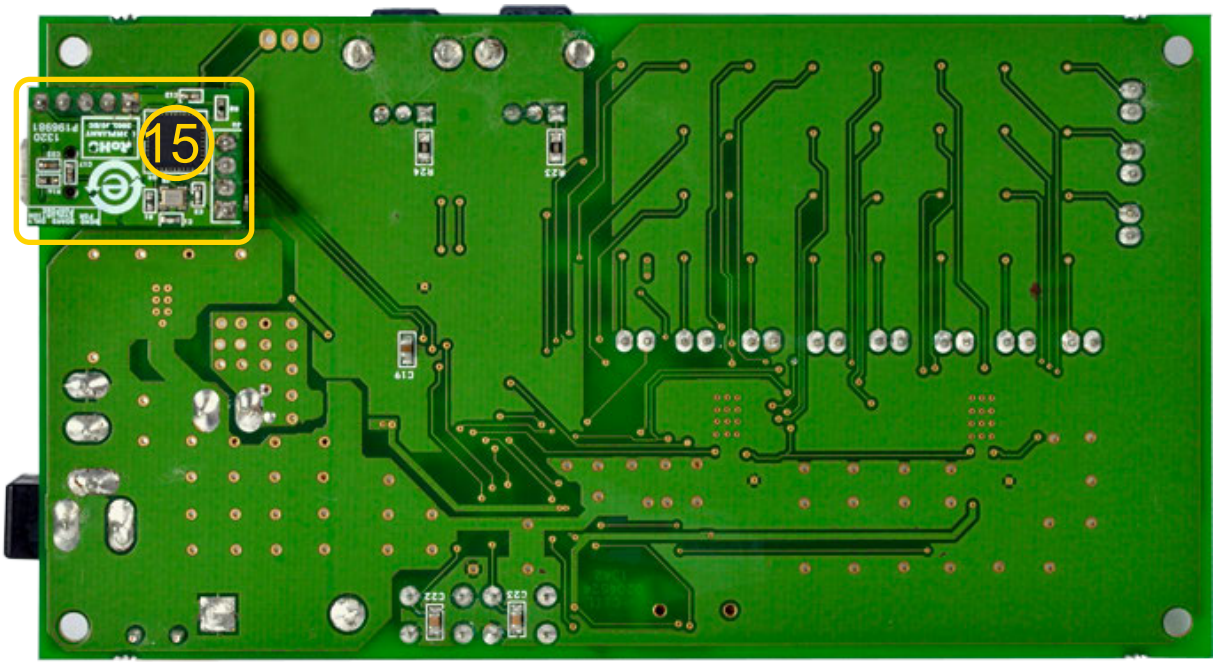


Figure 5. **RS232-USB bridge daughterboard (top)**

1. Mini-B type female USB connector
2. SWD connector (for programming daughter board)
3. Connector for UART communication between main board and daughter board
4. ESDAULC6-3BP6 ESD protection for high speed interfaces

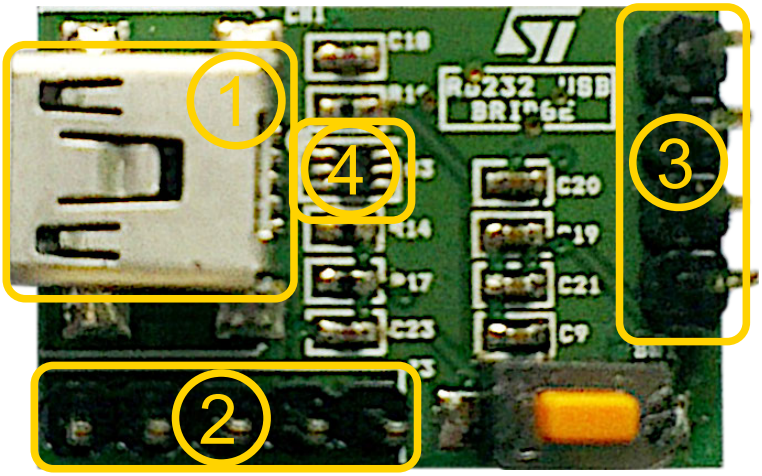
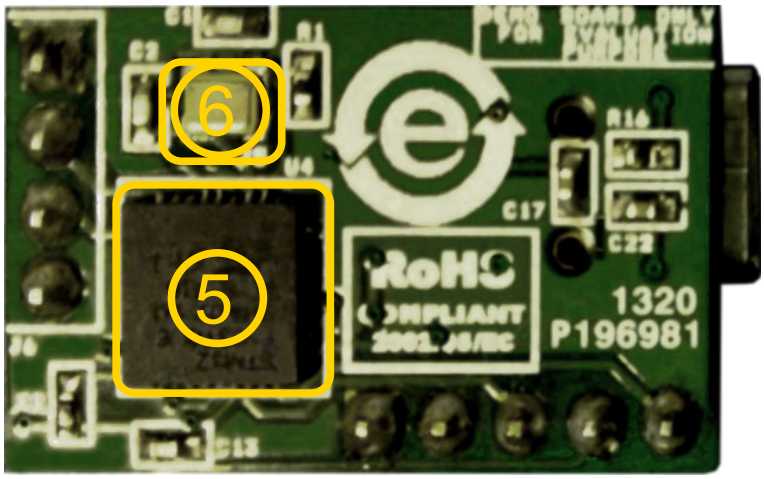


Figure 6. **RS232-USB bridge daughterboard (bottom)**

5. STM32F103C8T7 32-bit microcontroller
6. 16 MHz crystal



1.1 Operating modes

1.1.1 Standalone Mode

In standalone Mode, the STEVAL-ILL059V1 evaluation board is not connected to a PC via the RS232-USB interface board. In this mode, you can perform the following actions:

- run default LED demo patterns
- use two on-board buttons to scroll back and forth between the demo patterns
- use two on-board potentiometers to gradually change the brightness (average maximum LED current) and speed of the patterns
- simulate error conditions and detection using open-circuit and short-circuit jumpers
- use the reset button to reset the microcontroller and return to the first demo pattern

Note: The board immediately starts with brief animation on the LED matrix when DC power is supplied. You can control the board after the animation.

1.1.2 GUI Mode

To control the board using the GUI, use the USB to UART bridge as an interface between the evaluation board and your PC. The bridge supports bi-directional communication.

The GUI allows the following control, programming and monitoring activities:

- Basic actions:
  - all the actions in standalone, but controlled from the GUI
  - switch individual LEDs on and off, and adjust their brightness
  - switch all LEDs on and off at once
  - adjust the brightness of all the LEDs at once
- Use the four preset programs to quickly view how frame programming works on the evaluation board
- Build your own programs to display any pattern of up to 20 frames, with the following settings:
  - transition time between the frames
  - frame count of the number of frames in your program
  - brightness slider to configure the brightness of each frame
- Monitor error detection on the GUI at the following rates:
  - once only
  - every 0.5 seconds
  - every 1 second

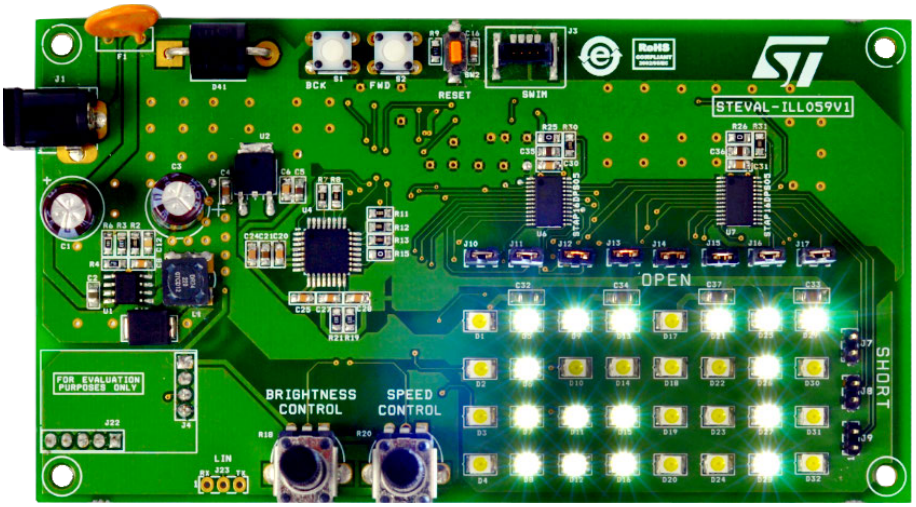
2 Sample firmware demos

2.1 LED demo patterns

Alphanumeric text in flashing mode demo

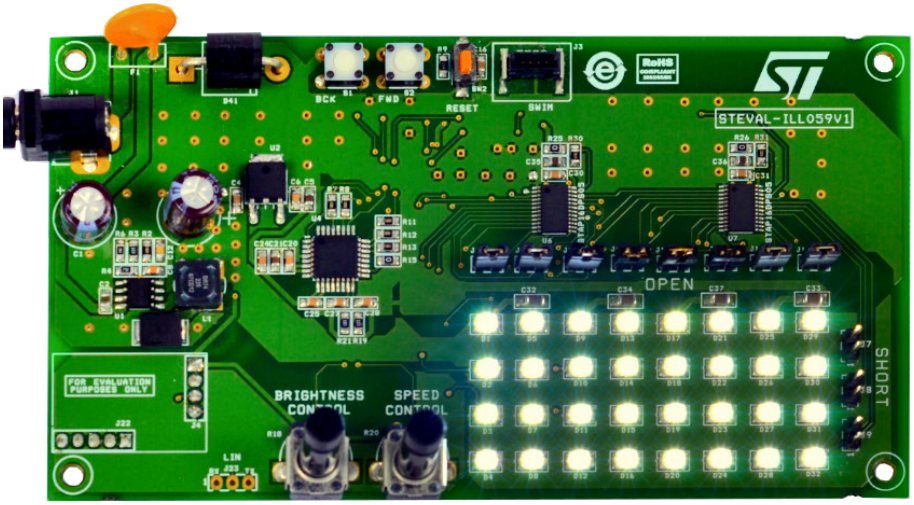
In the alphanumeric text in flashing mode demo, the letters “ST” flash in the LED matrix; the flashing rate is adjustable, but the brightness potentiometer remains inactive in this mode.

Figure 7. Flashing text demo



Curtain pattern

Figure 8. All LEDs on during curtain pattern



Random pattern

Figure 9. **Random pattern 1**

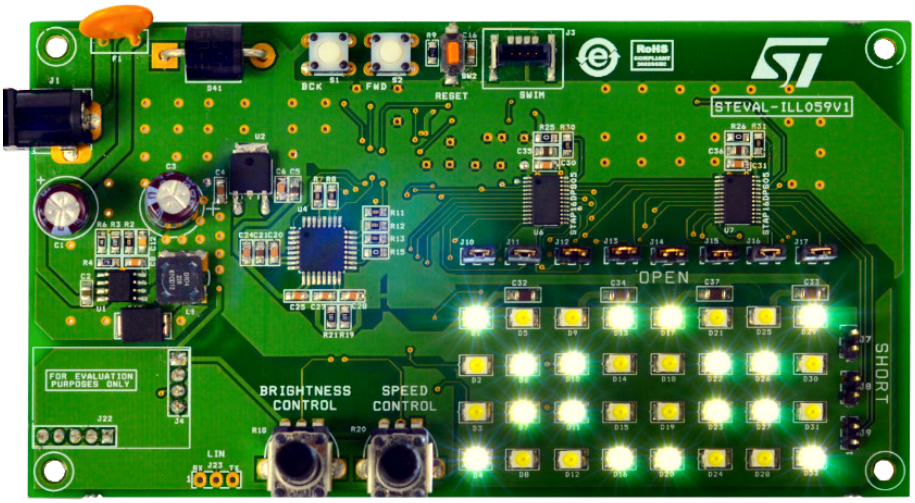


Figure 10. **Random pattern 2**

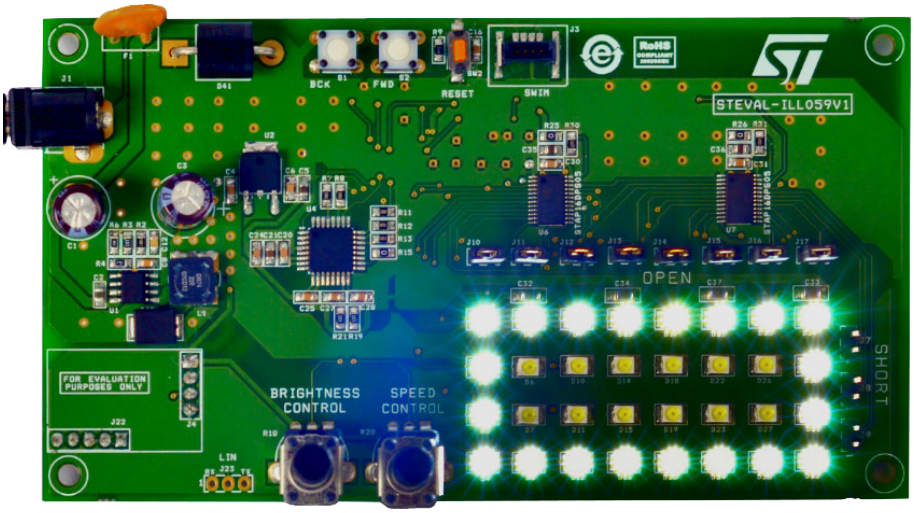


Figure 11. **Random pattern 3**

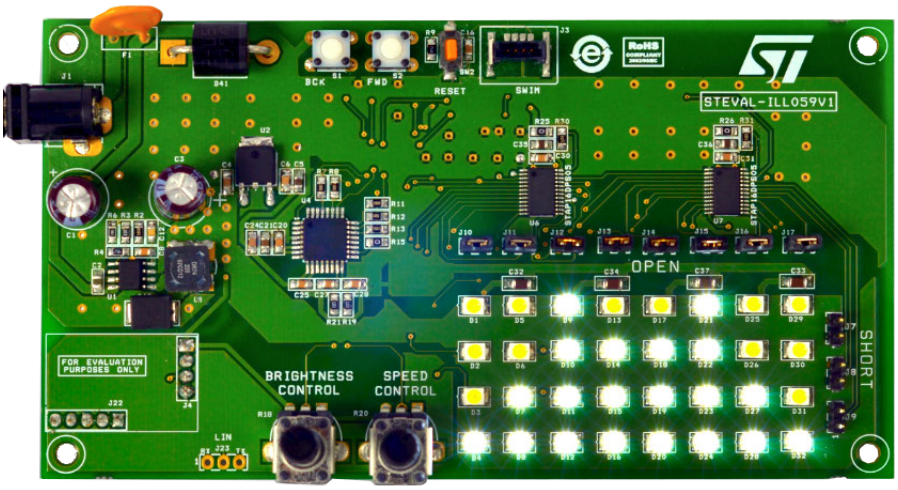
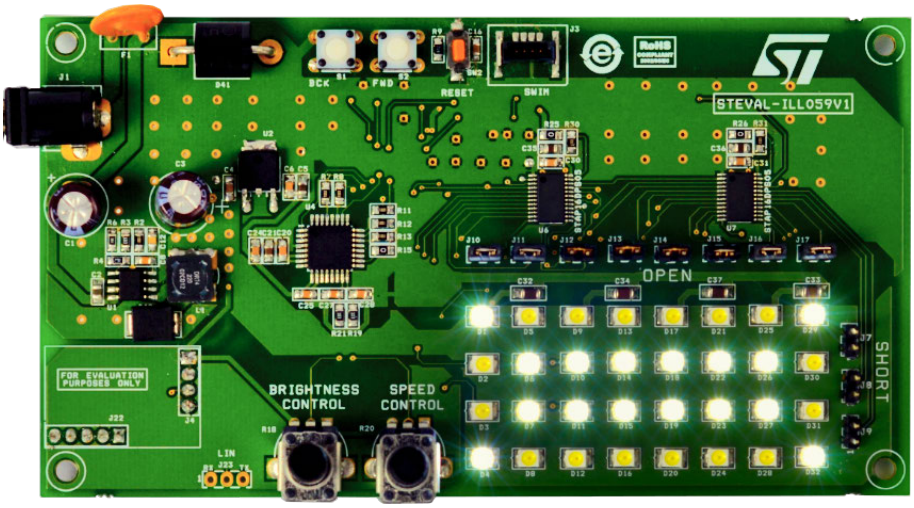


Figure 12. **Random pattern 4**



2.2 Error detection demonstration

In the error detection demo, the drivers perform open-error detection and short-error detection simultaneously. If a defective LED is found, it is signaled by lighting the corresponding LED in the row below for an open circuit fault and on the left for a short-circuit fault.

On the board, open and short-circuit errors are simulated using open and short jumpers, respectively. The following table shows how each jumper provokes a specific fault, and how the fault is signaled on the LED array.

Table 1. **Error detection jumper table**

Jumper	Required action	Fault type	Error in LED	Shown on LED
J7	Place jumper	Short	D30	D26
J8	Place jumper	Short	D31	D27
J9	Place jumper	Short	D32	D28
J10	Remove jumper	Open	D1	D2
J11	Remove jumper	Open	D5	D6
J12	Remove jumper	Open	D9	D10

Jumper	Required action	Fault type	Error in LED	Shown on LED
J13	Remove jumper	Open	D13	D14
J14	Remove jumper	Open	D17	D18
J15	Remove jumper	Open	D21	D22
J16	Remove jumper	Open	D25	D26
J17	Remove jumper	Open	D29	D30

3 How to use the GUI

3.1 GUI setup procedure

Step 1. Run the setup (.exe) file on your Windows computer.

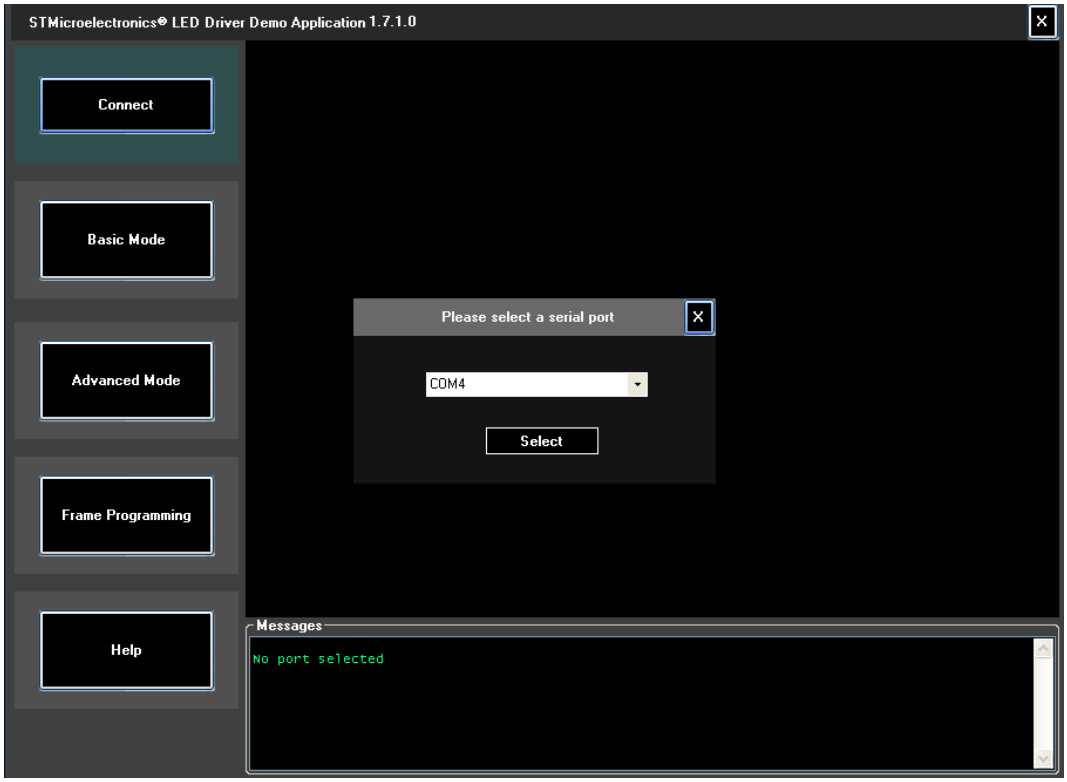
On successful installation, the STAP08DP05 Demo software appears in your list of programs.

Step 2. Install the VCP driver (if it is not already present): …\Program Files\ STMicroelectronics\LED Driver Demo\ST VCP Driver.

Both 32-bit version and 64-bit version are included in the setup.

Step 3. Launch the GUI software.

Figure 13. LED Driver Demo Application main screen



Step 4. Connect the evaluation board to the PC and supply power to the board.

Step 5. Press the [**Connect**] button in the GUI.

– If the GUI identifies the board, the GUI automatically connects with the board

– If the GUI does not identify the board, choose the correct port from the dropdown list and press [**Select**].

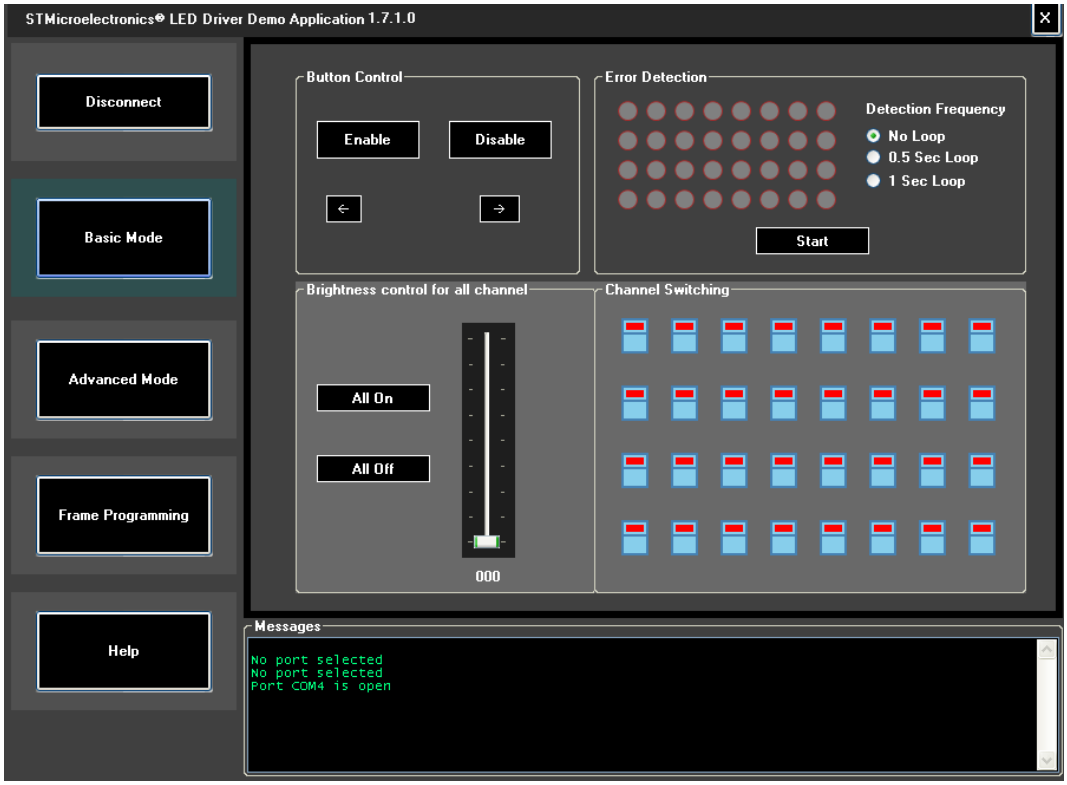
A “Port is open” message is displayed when the GUI is able to interact with the board.

3.2 How to use the Basic Mode functions

Basic Mode includes button control, error detection, brightness control and channel switching sections.

Step 1. In the left panel, select the [**Basic Mode**] button.

Figure 14. **Basic Mode functions**



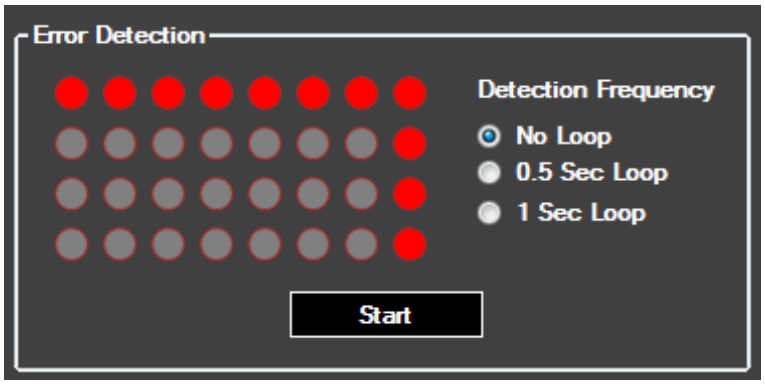
Step 2. In the [**Button Control**] area, use the [←] and [→] arrow buttons to toggle through the preconfigured demos available in the firmware.

You can use the [**Enable**] or [**Disable**] buttons to enable or disable the physical interface controls available on the board.

Step 3. In the [**Error Detection**] section, select an error checking frequency.

- [**No Loop**]: error detection is performed once and the results are displayed
- [**0.5 Sec Loop**]: error detection is performed every 0.5 s
- [**1 Sec Loop**]: error detection is performed every 1 s

Figure 15. **Error Detection options**



Step 4. In the [**Brightness control for channel switching**] and [**Channel Switching**] sections, set individual channels on and off, and control the brightness of the LEDs that are on with the slider.

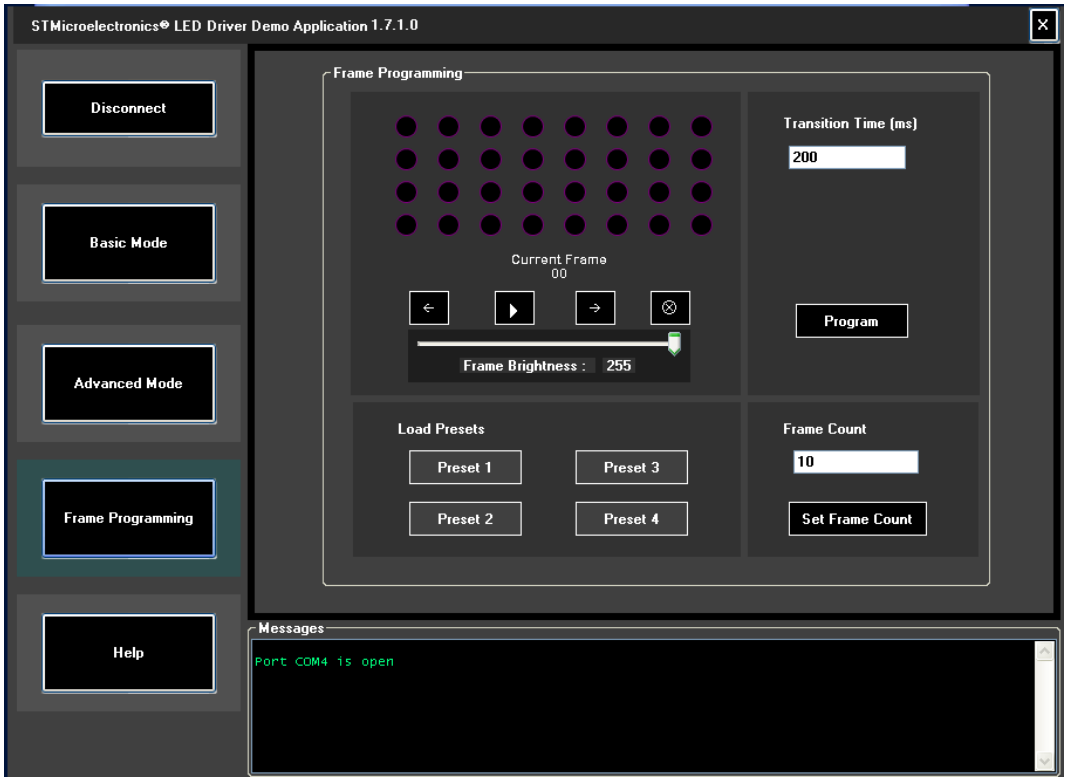
The brightness is divided into 256 incremental levels.

3.3 How to use the Frame Programming functions

Frame programming allows you to define and run your own LED sequence programs on the evaluation board.

Step 1. In the left panel, select the [**Frame Programming**] button.

Figure 16. Frame Programming functions



Step 2. Choose how you want to create your frame:

- In the 8x4 array of circles, toggle the desired LEDs on and off to represent your pattern for a single frame.
- Alternatively, you can load a preconfigured LED sequence from one of those available in the [**Load Presets**] section

Step 3. Use the [**Frame Brightness**] slider to adjust the brightness of the LEDs for the frame.

Step 4. Set the total number of frames you want in your sequence in the [**Frame Count**] box.

There can be maximum of 20 frames (00 to 19).

Step 5. Use the [←] and [→] arrows to move between the frames in your program.

Step 6. Press the [▶] button to run your sequence of frames in the GUI.

Step 7. Set the required time between frames in the [**Transition Time (ms)**] box.

Step 8. Press [**Program**] to download your design onto the evaluation board.

4 Thermal behavior

Below are the thermal images around the TSM8 microcontroller and around the LED drivers and LED array at the maximum current of 20 mA in all channels.

Figure 17. **STEVAL-ILL059V1 thermal image 1**

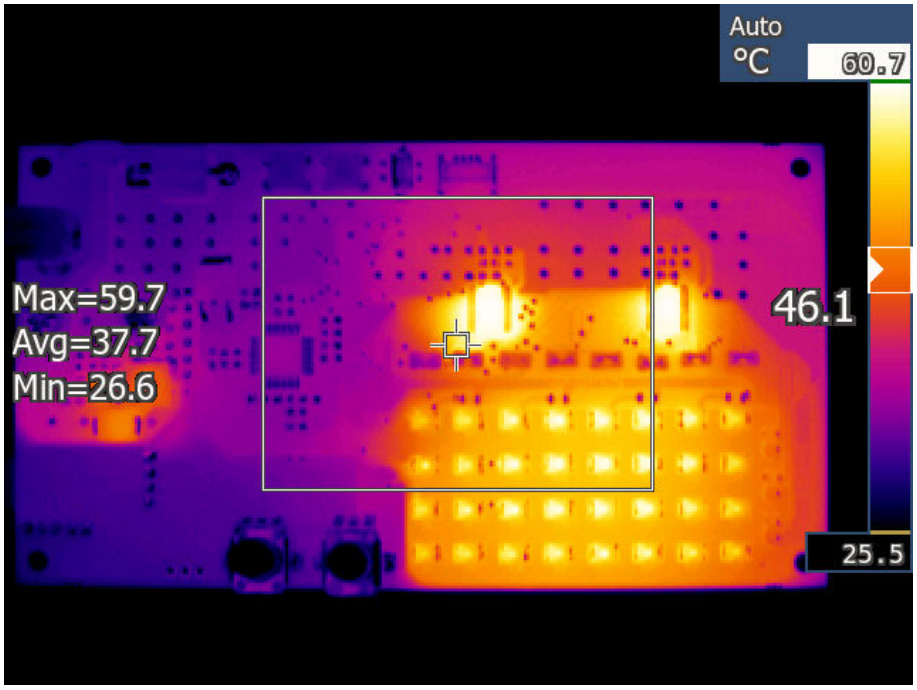
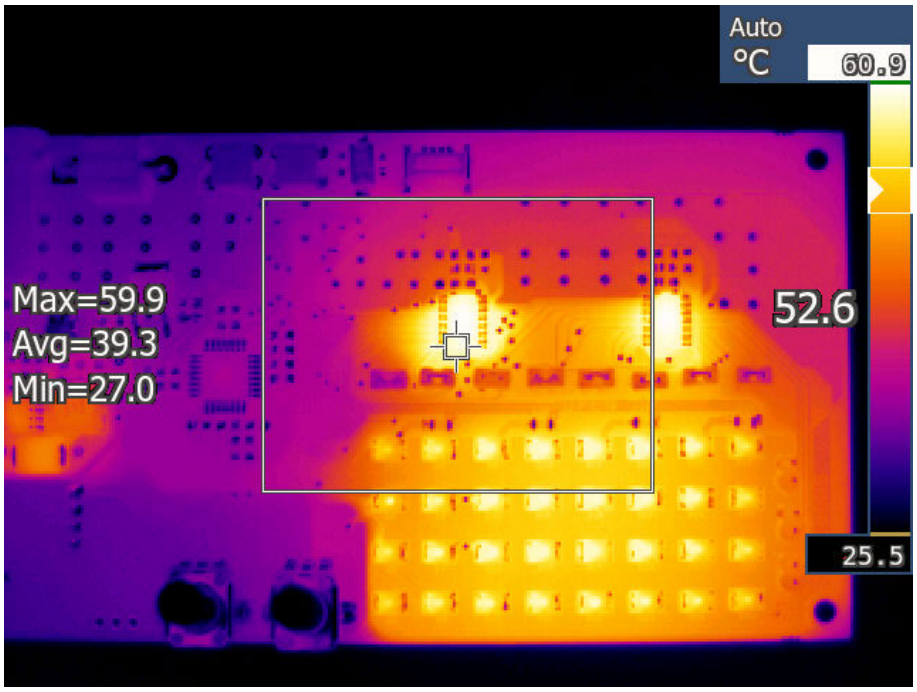


Figure 18. **STEVAL-ILL059V1 thermal image 2**



5 Schematic diagrams

5.1 STEVAL-ILL059V1 schematics

Figure 19. **STEVAL-ILL059V1 schematics - power**

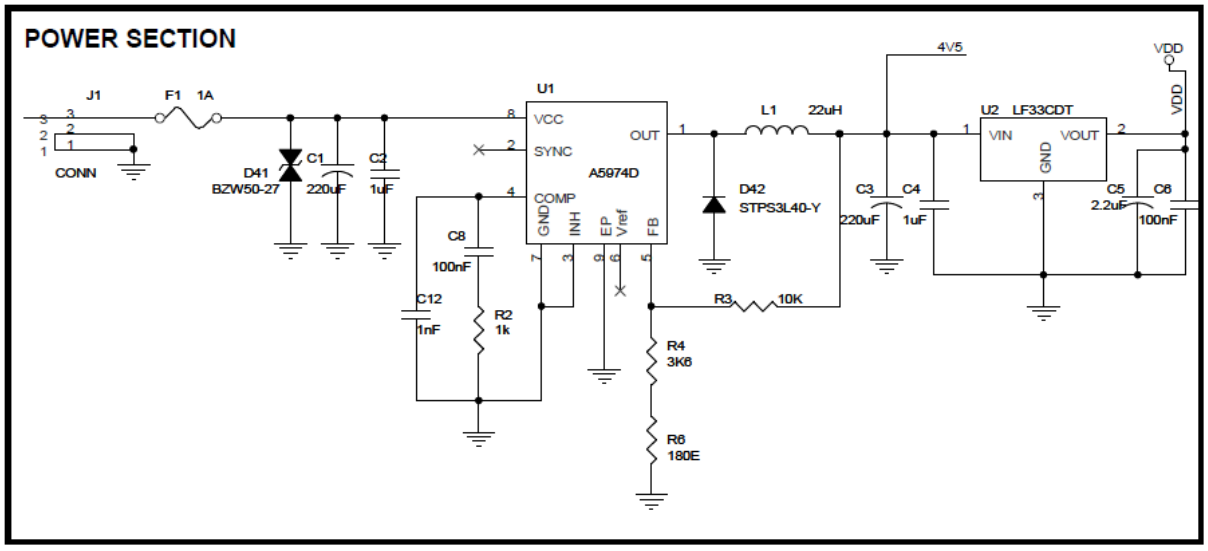


Figure 20. **STEVAL-ILL059V1 schematics - MCU**

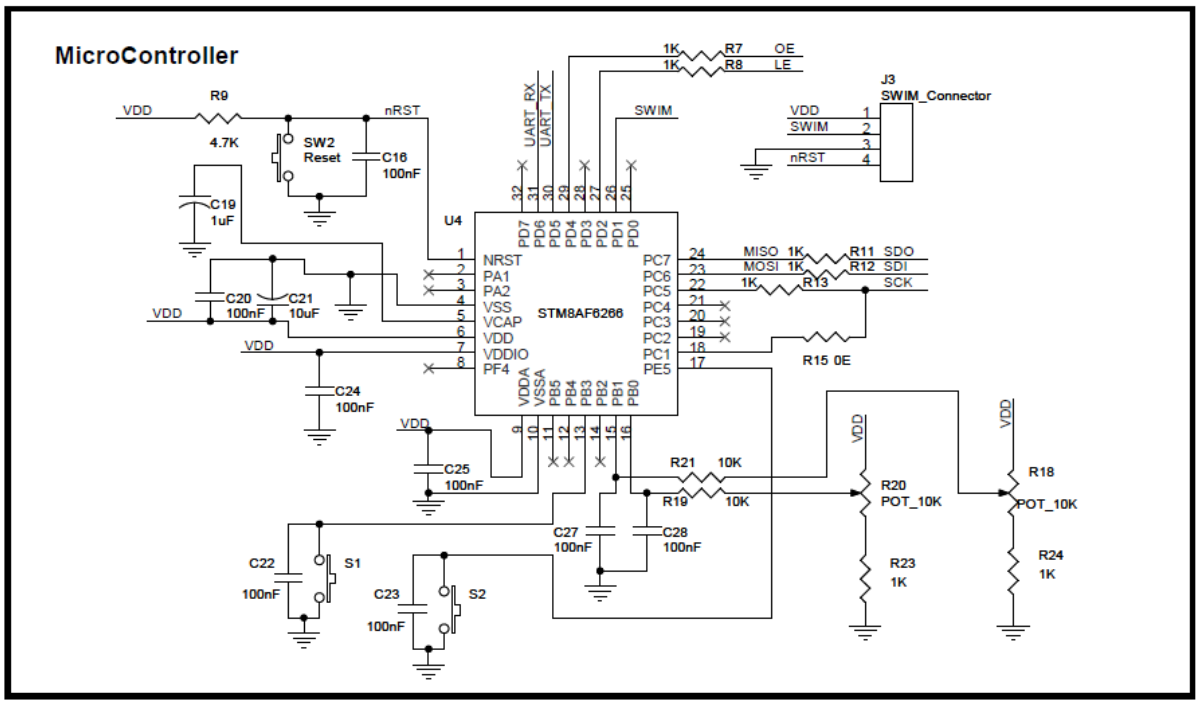
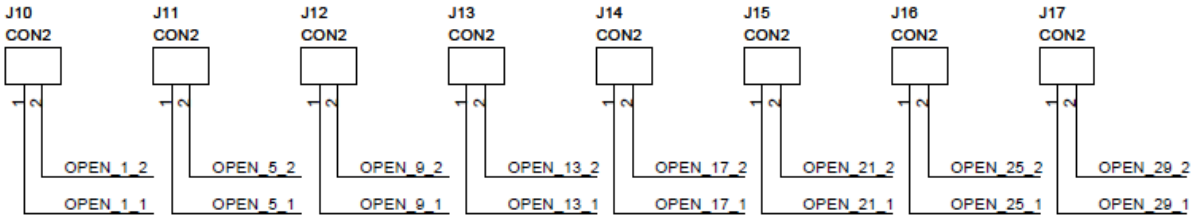


Figure 21. **STEVAL-ILL059V1 schematics – open circuit jumpers**



Break

Figure 22. **STEVAL-ILL059V1 schematics – short circuit jumpers**

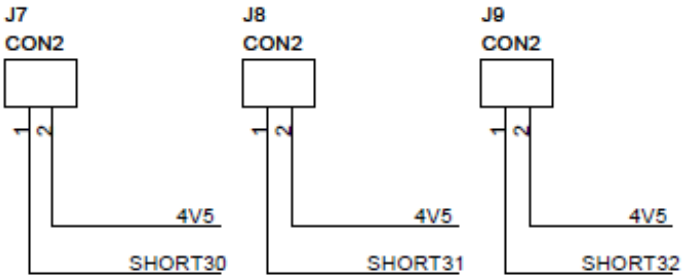
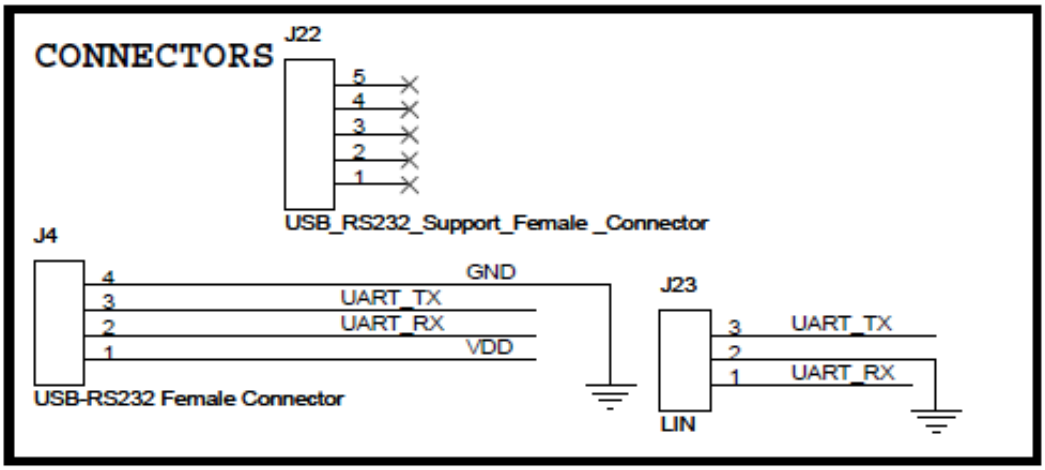
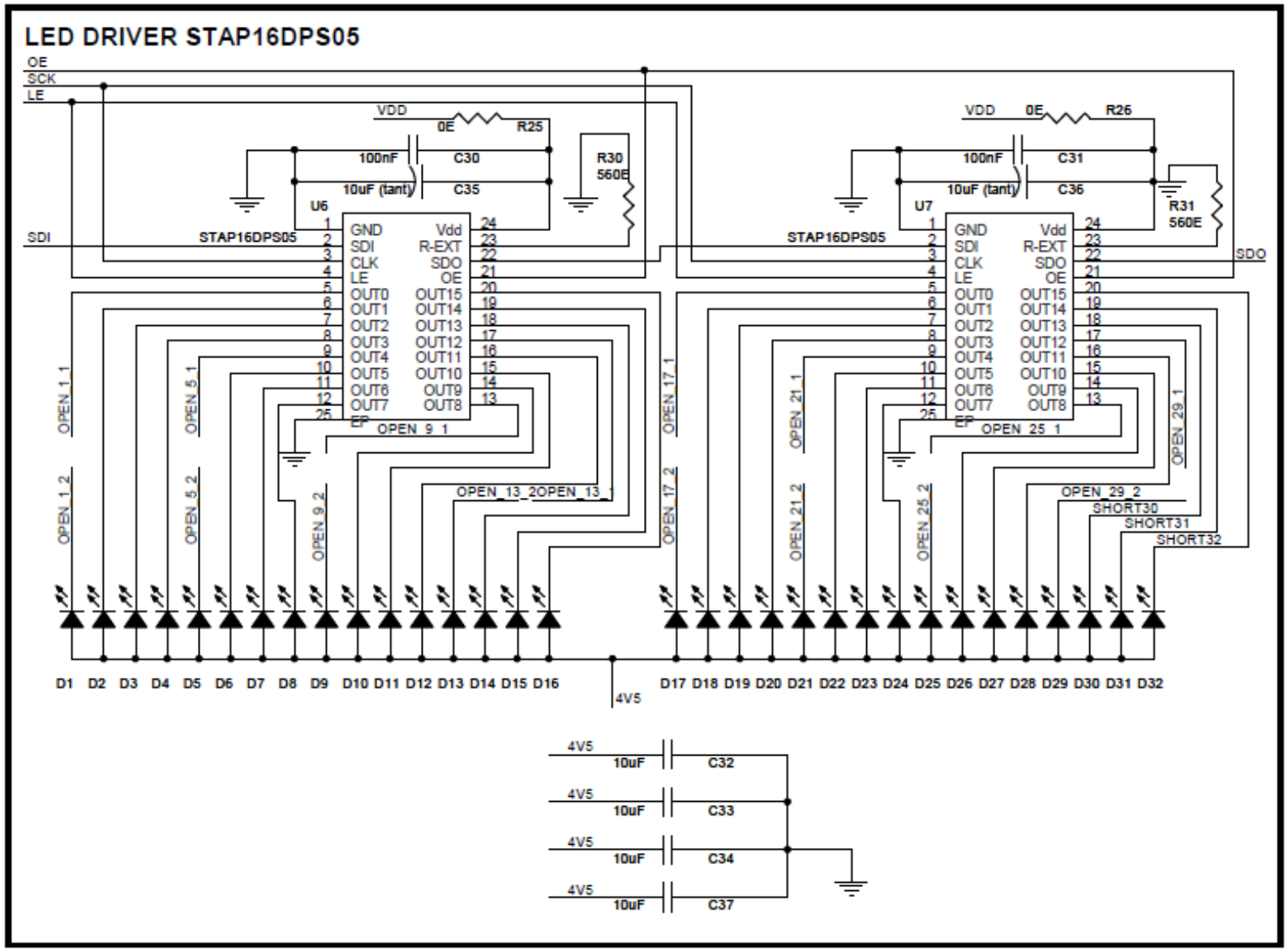


Figure 23. **STEVAL-ILL059V1 schematics - connectors**



5.2 STAP16DPS05 schematics

Figure 24. **STEVAL-ILL059V1 schematics – STAP16DPS05 LED driver section**



5.3 RS232-USB schematics

Figure 25. **RS232-USB schematics – USB section**

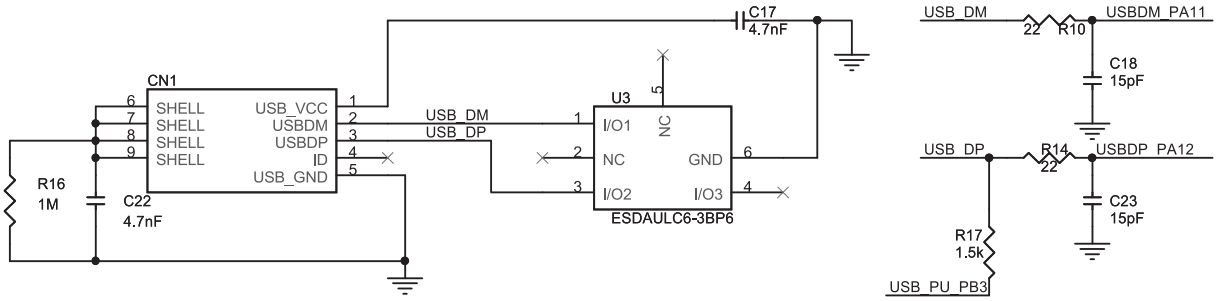


Figure 26. **RS232-USB schematics – STM32 section**

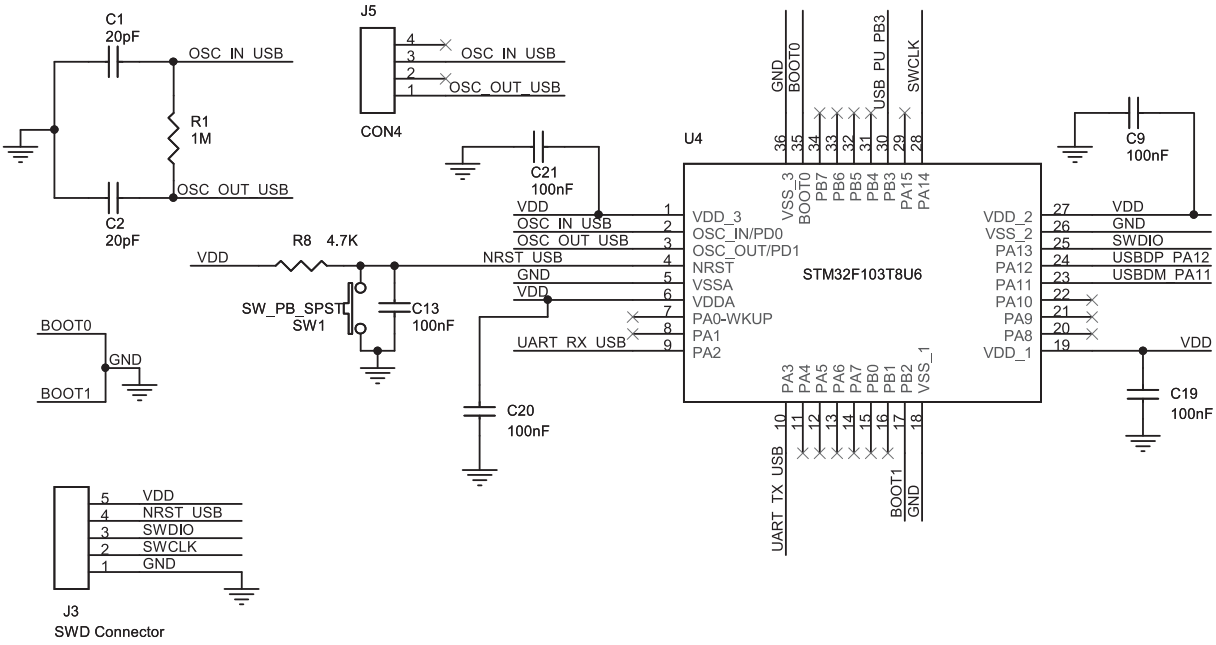
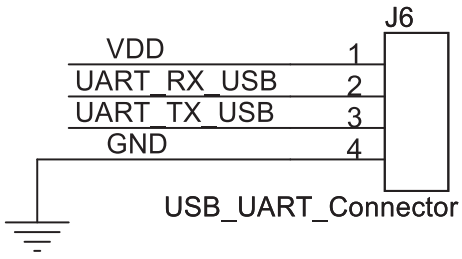


Figure 27. **RS232-USB schematics – USB to UART connector**



Revision history

Table 2. **Document revision history**

Date	Version	Changes
15-Feb-2019	1	Initial release.

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