

## How to use the STEVAL-LLL013V1 evaluation board for STP16CPC26

### Introduction

The STEVAL-LLL013V1 is a 7x25 LED matrix board controlled by two STP16CPC26 LED drivers.

It can display banners in which each pixel can have a different level of brightness (32 levels).

The screen refresh rate is higher than 100 Hz. The banners can be scrolled horizontally in both directions for lights effects. The banners are loaded by the use of the STSW-LLL013GUI PC software app.

The STP16CPC26 is a monolithic, low voltage, 16-bit constant current LED sink driver with a serial input/output interface.

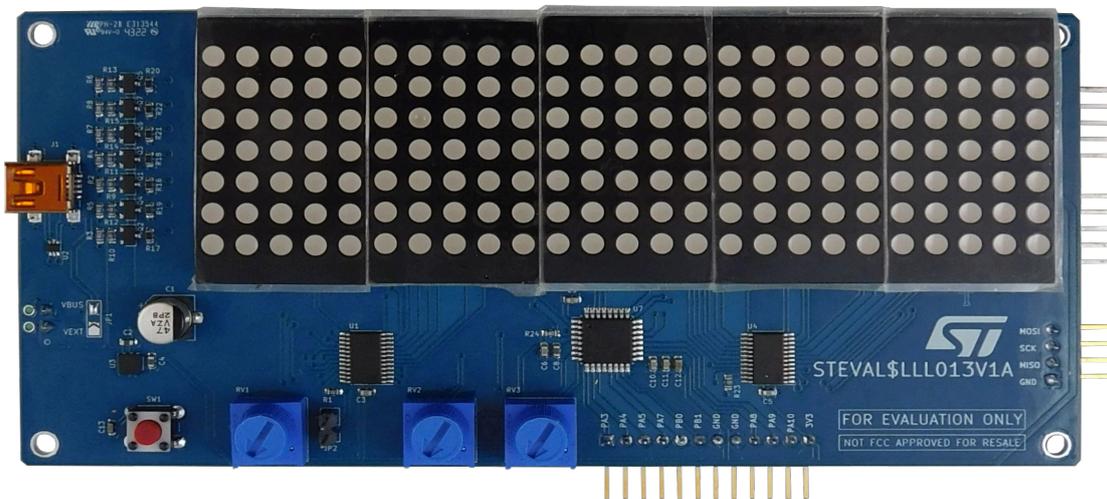
Two STP16CPC26 drive a 7x25 LED matrix. The two LED drivers are connected in a daisy chain and controlled by the STM32F042K6T6 MCU, using an SPI IP interface.

The MCU works as a frame generator for the banners, and as a bridge with the PC software app, by implementing a USB VCP device class.

Additional potentiometers on the board allow you to change the brightness of the whole display and the speed of the banner scrolling effects.

To exploit all the potential features of the board, many hardware resources are available, such as pin connectors that deliver additional MCU features, a JTAG interface, and a serial input/output to cascade other LED drivers.

**Figure 1. STEVAL-LLL013V1 evaluation board**



# 1 Overview

The **STEVAL-LLL013V1** is an evaluation board that shows the features of the **STP16CPC26** when used to drive an LED matrix. In this STEVAL, the LED matrix has been arranged in order to show a banner, with some scrolling animations. Two **STP16CPC26** are connected in a daisy chain, in order to drive a 7x25 LED matrix. Each **STP16CPC26** can drive up to 16 LED channels, arranged in this manner:

- 7 channels of one **STP16CPC26**, marked as U1, are connected to the ROW BUFFER section, which drives the LED matrix rows, while the rest of the 16 channels controls part of the LED matrix columns.
- All the 16 channels of the 2<sup>nd</sup> **STP16CPC26**, marked as U4, are connected to the remaining LED matrix columns.

The U1 and U4 drivers are connected with the STM32F042 MCU, marked as U7, by an SPI bus: the SPI bitrate is 6 Mbit/s. The MCU is responsible of the following task:

- It communicates with the STSW-LLL013GUI PC SW by a virtual COM port
- It generates the timings and the SPI packets for the **STP16CPC26** led drivers
- It generates the scrolling animations for the message and the mask applied

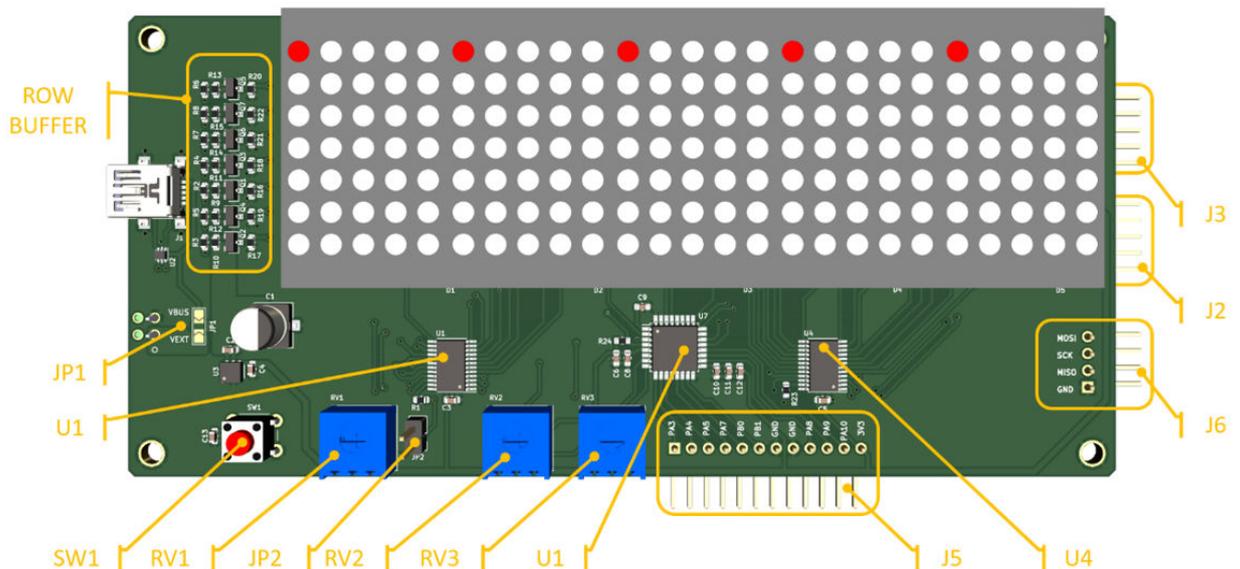
The brightness of the LED matrix can be changed by acting on the RV1 potentiometer, or by closing the JP2 jumper. In the last case RV1 is shorted, getting the max brightness.

The image showed that on the LED matrix is a combination of an image buffer, on which is applied an image mask. The image buffer is composed of a virtual area of 7x146 pixels. This area can be scrolled or bounced horizontally. The scrolling speed can be varied by acting on the RV2 potentiometer. The image mask is an area of 7x25 pixels: the image mask acts as a filter, whose pixel values are multiplied with the pixel of the image buffer, in order to get the final pixel brightness value. Also the image mask can be scrolled or bounced horizontally, and the speed can be changed by acting on the RV3 potentiometer.

In order to promote more demo solutions on the same HW, the STEVAL has been equipped with additional resources: a switch (SW1) and 2 user connectors, J3 and J5. All these resources are directly connected to the MCU spare resources, and are available to the user for further FW developments. A new FW can be uploaded on the board by using the connector J2 (SWD interface).

Using the **STSW-LLL013GUI** PC SW, the user creates its own banner to be shown on the STEVAL board, applying mask and scrolling effects. Each pixel is independent and can assume a 5bits level brightness.

**Figure 2. STEVAL-LLL013V1 top view**



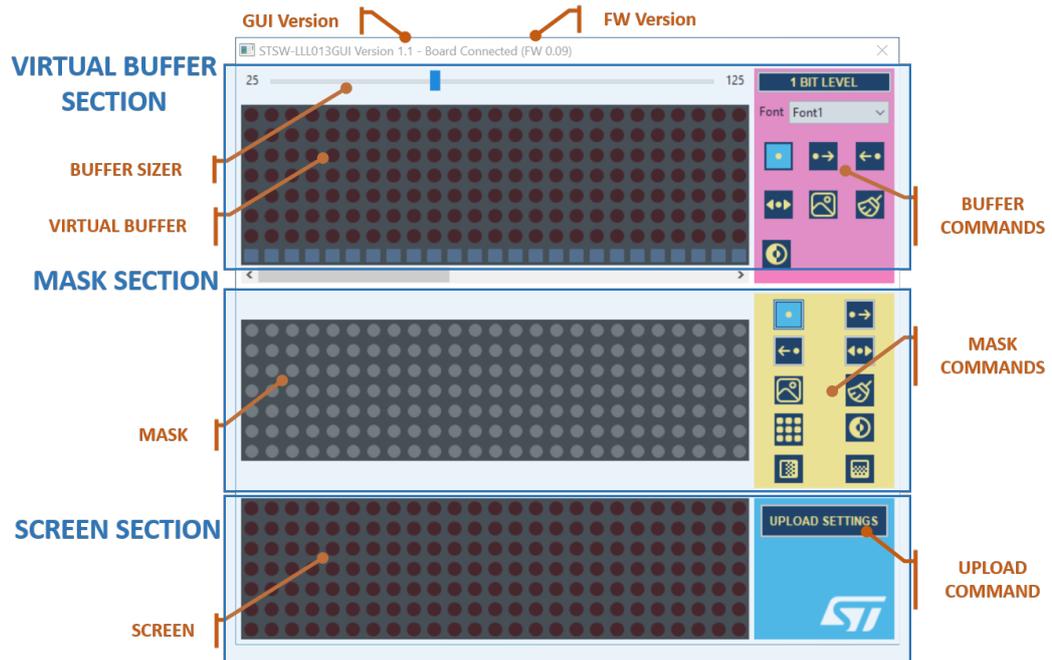
## 1.1 Firmware

The **STEVAL-LLL013V1** is equipped with an on-board demo firmware, the **STSW-LLL013FW**, which performs the features detailed in [Section 1 Overview](#).

## 2 Getting started with the board

To use the [STEVAL-LLL013V1](#) with the [STSW-LLL013FW](#), the [STSW-LLL013GUI](#) PC software GUI is provided. Connect the board to a Windows 10 PC and launch the [STSW-LLL013GUI](#). If the board is connected for the first time, the Windows OS takes some seconds for the USB virtual COM registering process. Once launched, the GUI appears as shown in the figure below:

**Figure 3. STSW-LLL013GUI sections**



The GUI appears divided in three sections:

- virtual buffer section
- mask section
- screen section

The virtual buffer section is where the banner is built. The virtual buffer has an area that can be resized by using the slider above it. The following features are available:

- scrolling and bouncing
- insert stickers
- insert text
- invert buffer

The mask section is where the mask is configured. The values of the mask are multiplied with the values of the virtual buffer to get the final result to be displayed. The following features are available:

- scrolling and bouncing
- insert mask presets
- fill mask
- invert mask
- apply gradients

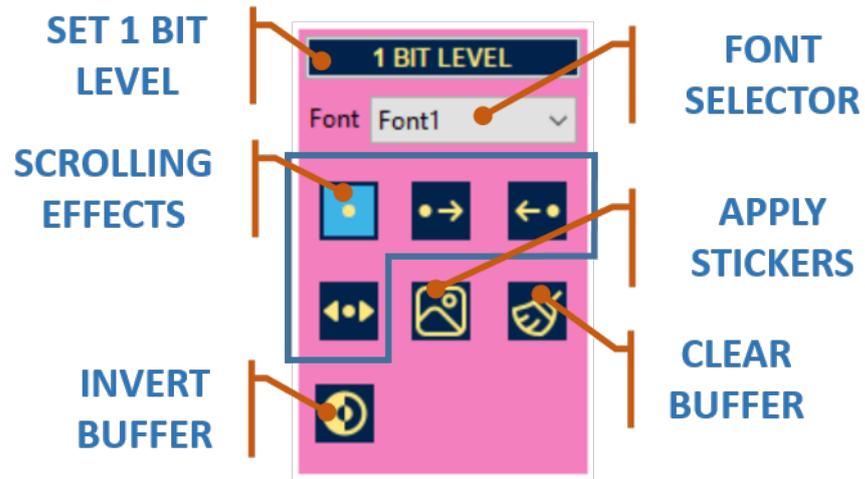
The screen section shows the result of the mask applied to the virtual buffer.

The figure below shows all the features implemented on the virtual buffer. Once the virtual buffer is set, press the **[UPLOAD SETTINGS]** button to send the configuration to the [STEVAL-LLL013V1](#) evaluation board.

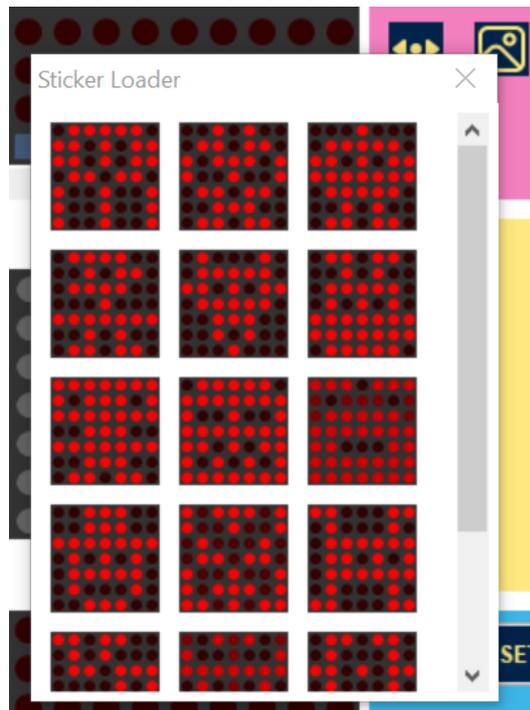
The GUI title shows info about the SW version and the FW version of the board attached: if no board is present, the message “No board connected” is shown.

*Note:* The FW version 0.09 comes with no predefined banner. This means that nothing is displayed when the board is powered up. Use the GUI to build your own banner. New FW versions are periodically updated on the STEVAL-LLL013V1 product page on ST website. Look for the latest version, to get the latest implemented features, such as predefined banners and the possibility to store all the GUI settings into the board. The FW can be downloaded from the ST website and programmed using the STLINK tool.

The figure below shows all the features implemented on the virtual buffer.

**Figure 4. Virtual buffer features**


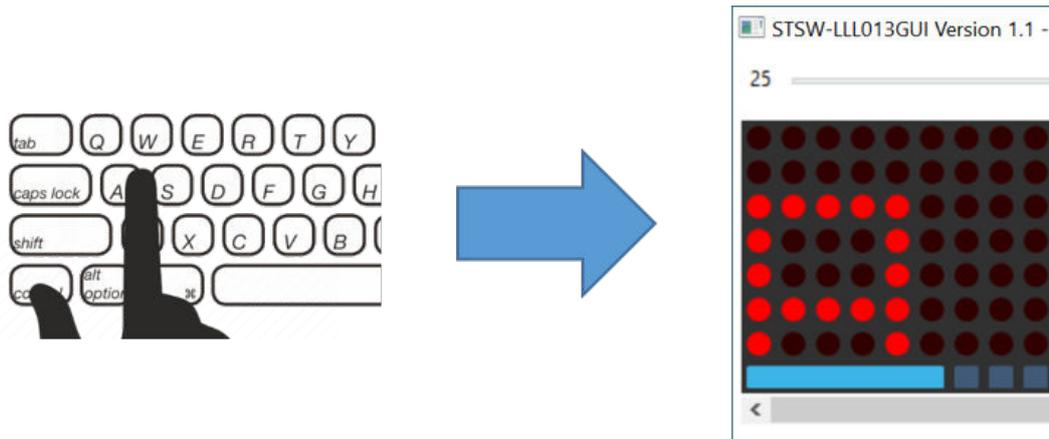
Pressing one of the SCROLLING EFFECTS buttons, a horizontal scrolling or bounce can be applied. The APPLY STICKERS button shows a few selection of stickers to be attached: the sticker can be deleted by pressing the BACKSPACE button.

**Figure 5. Sticker Loader**


The 1BIT LEVEL feature, once enabled, reduces the pixel brightness levels from the range 0-31 to 0-1 levels. This feature can be used with the gradient features of the MASK, allowing the mask to better manage the shades of brightness of the LED matrix: with this feature enabled, each buffer pixel can be enabled or disabled just pressing the mouse left button on it.

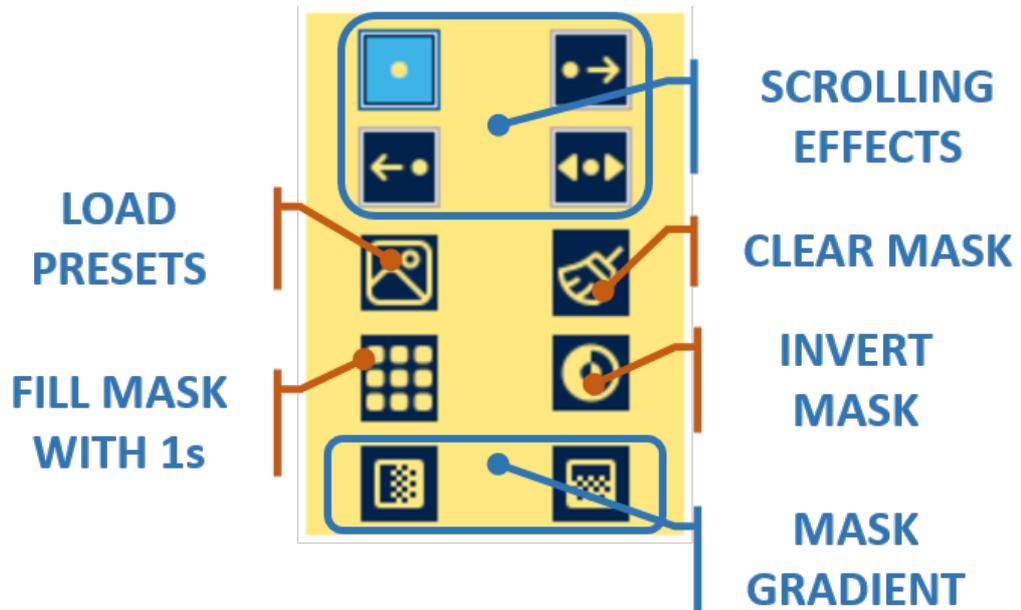
A text message can be composed by typing on the keyboard. The message can be deleted by pressing the BACKSPACE key. A few selections of fonts is available.

**Figure 6. Type on the keyboard to write a text banner**



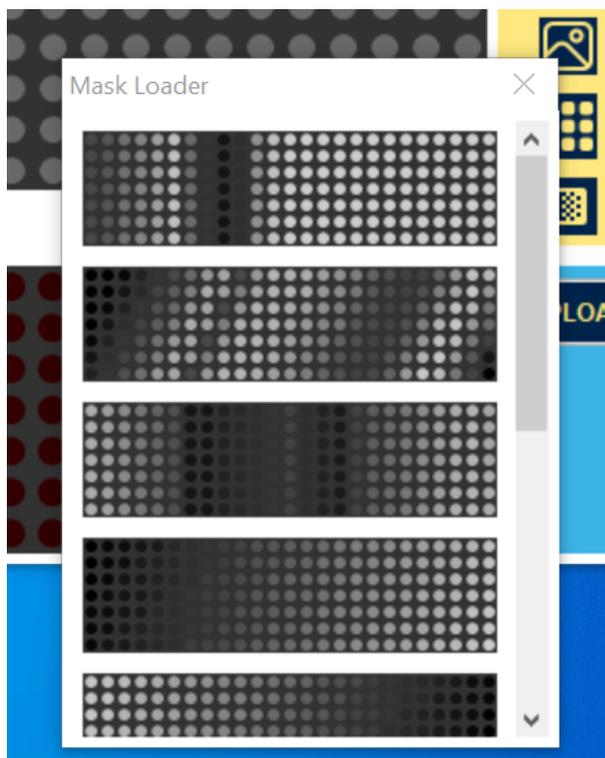
The figure below shows all the features to set the mask: once the mask is set, press the **[UPLOAD SETTINGS]** button to send the configuration to the [STEWAL-LLL013V1](#) board.

**Figure 7. Mask settings**



Pressing one of the SCROLLING EFFECTS buttons, a horizontal scrolling or bounce can be applied. A few selections of mask effects is shown by pressing the LOAD PRESETS button.

Figure 8. Mask Loader Window

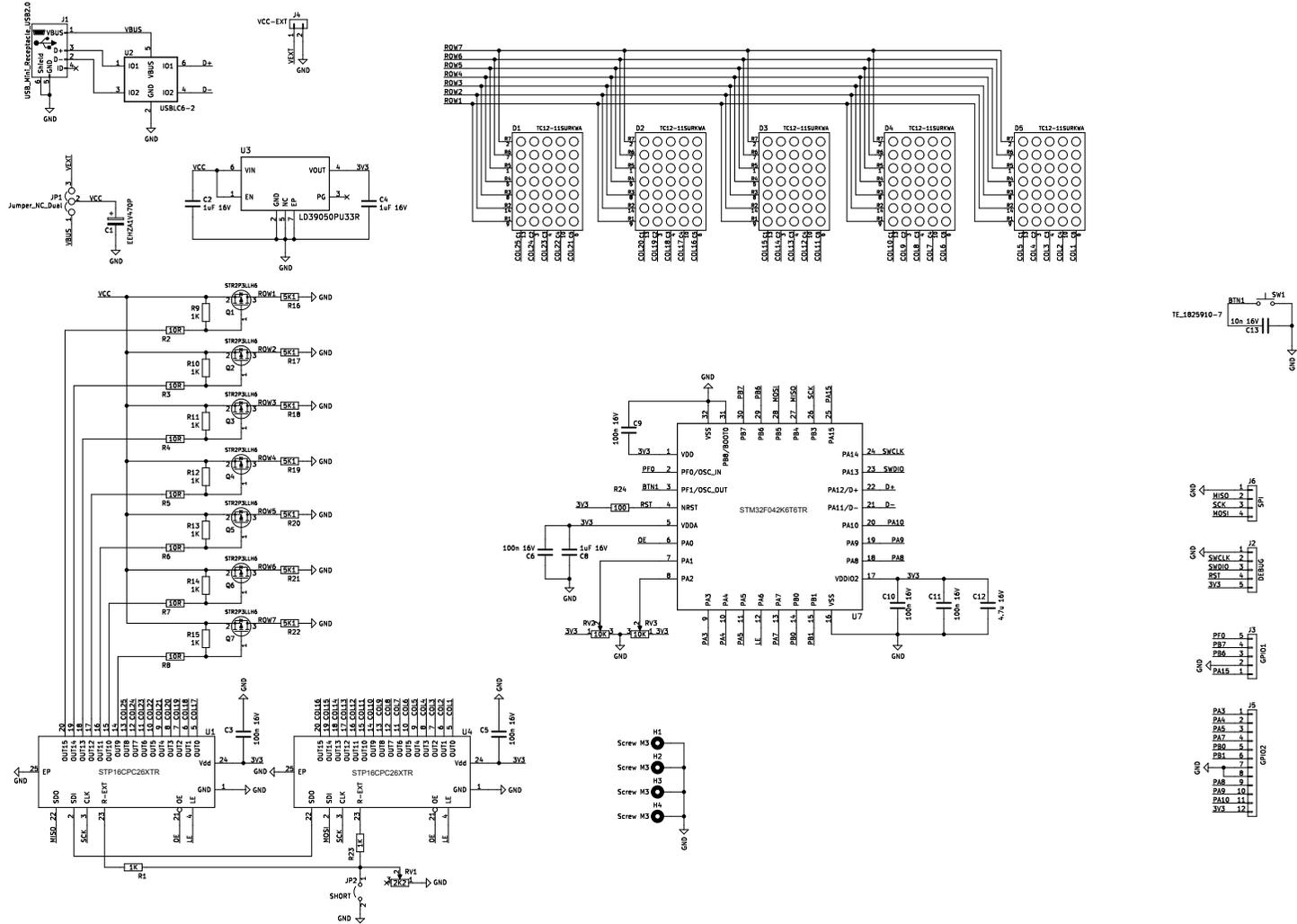


## 2.1 System setup requirements

- A STEVAL-LLL013V1 with the STSW-LLL013FW installed
- A PC/laptop with Windows 10
- STSW-LLL013GUI PC software
- A USB cable with a USB mini-type B connector

# 3 Schematic diagram

Figure 9. STEVAL-LLL013V1 schematic diagram



## 4 Bill of materials

**Table 1. STEVAL-LLL013V1 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	C1	47u 35V CP_Elec_6.3x5.8 35V		PANASONIC	EEHZA1V470P
2	3	C2, C4, C8	1uF 16V C_0603_1608Metric 16V	Unpolarized capacitor	WALSIN	0402S105K160CT
3	6	C3, C5, C6, C9, C10, C11	100n 16V C_0603_1608Metric 16V	Unpolarized capacitor	WALSIN	MT18B104K160CT
4	1	C12	4.7u 16V C_0603_1608Metric 16V	Unpolarized capacitor	MURATA	GRM188C81C475KE11D
5	1	C13	10n 16V C_0603_1608Metric 16V	Unpolarized capacitor	MURATA	GRM033R71C103KE14D
6	5	D1, D2, D3, D4, D5	7x5 LED Matrix TC12-11SURKWA	30.6mm (1.2 INCH) 5x7 DOT MATRIX DISPLAY	KINGBRIGHT	TC12-11SURKWA
7	4	H1, H2, H3, H4	Holes M3 MountingHole_3.2mm_M3	Mounting Hole with connection		
8	1	J1	USB_Mini_Receptacle_USB2.0 USB_Mini-B_Lumberg_2486_01_Horizontal	USB Mini Type B connector	WURTH	65100516121
9	1	J2	DEBUG PinHeader_1x05_P2.54mm_Horizontal	Generic connector, single row, 01x05	AMPHENOL	68016-405HLF
10	1	J3	GPIO1 PinHeader_1x05_P2.54mm_Horizontal	Generic connector, single row, 01x05	AMPHENOL	68016-405HLF
11	1	J4	VCC-EXT Phoenix-1725656	Generic connector, single row, 01x02	PHOENIX	1715022
12	1	J5	GPIO2 PinHeader_1x12_P2.54mm_Horizontal	Generic connector, single row, 01x12	AMPHENOL	68016-112HLF
13	1	J6	SPI PinHeader_1x04_P2.54mm_Horizontal	Generic connector, single row, 01x04	AMPHENOL	68016-104HLF

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
14	1	JP1	Jumper_NC_Dual SolderJumper-3 _P2.0mm_Open _TrianglePad1.0 x1.5mm_NumberLabels	Jumper	Any	Any
15	1	JP2	SHORT PinHeader_1x0 2_P2.54mm_Vertical	Jumper, 2-pole, open	AMPHENOL	68001-102HLF
16	7	Q1, Q2, Q3, Q4, Q5, Q6, Q7	STR2P3LLH6 SOT-23	P-Channel 30 V, 0.048 Ohm typ., 2 A STRipFET H6 Power MOSFET in a SOT-23 package	ST	STR2P3LLH6
17	9	R1, R9, R10, R11, R12, R13, R14, R15, R23	1K R_0603_1608M etric 100mW	Resistor	YAGEO	RC0603FR-1310RL
18	7	R2, R3, R4, R5, R6, R7, R8	10R R_0603_1608M etric 100mW	Resistor	VISHAY	RCS06035K10FKEA
19	7	R16, R17, R18, R19, R20, R21, R22	5K1 R_0603_1608M etric 100mW	Resistor	PANASONIC	ERJ-U03J102V
20	1	R24	100 R_0603_1608M etric 100mW	Resistor	YAGEO	RC0603FR-07100RL
21	1	RV1	2K Potentiometer_ Bourns_3386F_ Vertical 100mW	Potentiometer	BOURNS	3386F-1-202TLF
22	2	RV2, RV3	10K Potentiometer_ Bourns_3386F_ Vertical 100mW	Potentiometer	BOURNS	3386F-1-103TLF
23	1	SW1	TE_1825910-7 TE_1825910-7	Push button switch, generic, two pins	TE	1825910-7
24	2	U1, U4	STP16CPC26X TR HTSSOP24	Low voltage 16- bit constant current LED sink driver	ST	STP16CPC26XTR
25	1	U2	USBLC6-2P6 SOT-666	ESD Protection for USB 2.0 High Speed	ST	USBLC6-2P6
26	1	U3	LD39050PU33R DFN6 3x3	500 mA low quiescent current and low noise voltage regulator	ST	LD39050PU33R

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
27	1	U7	STM32F042K6 T6TR, LQFP 32 7x7x1.4 mm	Mainstream Arm Cortex-M0 USB line MCU with 32 Kbytes of Flash memory, 48 MHz CPU, USB, CAN and CEC functions	ST	STM32F042K6T6TR

## 5 Board versions

**Table 2. STEVAL-LLL013V1 versions**

PCB version	Schematic diagrams	Bill of materials
STEVAL\$LLL013V1A <sup>(1)</sup>	STEVAL\$LLL013V1A schematic diagrams	STEVAL\$LLL013V1A bill of materials

1. This code identifies the STEVAL-LLL013V1 evaluation board first version. It is printed on the board PCB.

## 6 Regulatory compliance information

### Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

- (1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and
- (2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

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For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

### Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

### Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

## Revision history

**Table 3. Document revision history**

Date	Revision	Changes
02-Feb-2023	1	Initial release.

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