UM0574
User manual

STEVAL-ILL015V1 - LED dimmer demonstration board based on the STP24DP05 and STM32™

Introduction

This user manual provides instructions for using the STEVAL-ILL015V1 LED dimmer demonstration board based on the STP24DP05 LED driver and the STM32™ microcontroller accelerated by SPI and DMA. This document provides information including hardware setup, description of demonstration firmware functionality, PC interconnection options and evaluation of the STP24DP05 LED driver.

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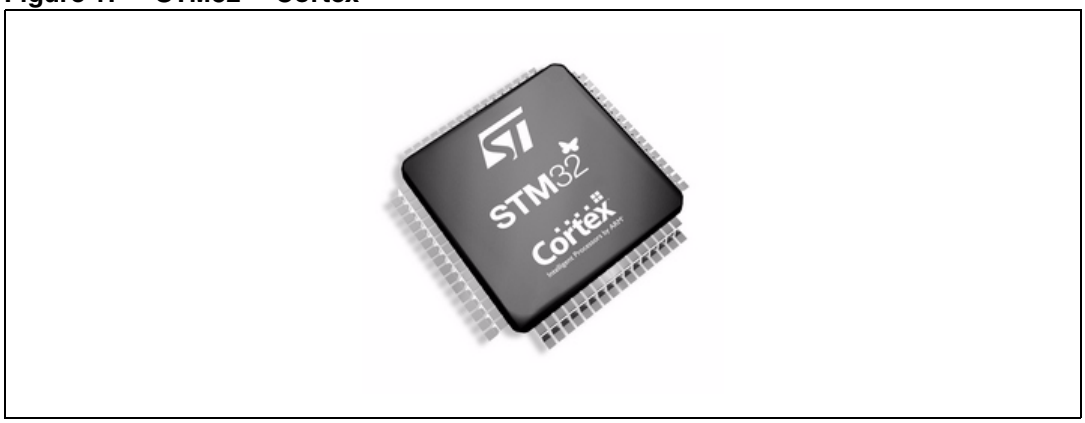
1 STEVAL-ILL015V1 functional overview

STEVAL-ILL015V1 demonstration board features:

- Two STP24DP05 (TQFP48) for connection of 16 RGB LEDs
- 16 RGB high-brightness LEDs
- STM32 microcontroller using internal HS oscillator
- High-efficiency switching DC-DC power supply using the ST1S010
- DC power supply 7.5 - 18 V (undifferentiated polarity, over voltage protection)
- DC input current 0.7 A max., standard supply connector
- LED current regulation
- Controlled by 3 buttons, a knob and a reset/back button
- Available test point for each important signal
- JTAG interface for microcontroller firmware change/update
- Error and over temperature LEDs for each LED driver.
- 3 jumpers allowing disconnection of 3 LEDs from the driver for testing the error detection mode
- 3 jumpers allowing shorting of 3 LEDs from the driver for testing the error detection mode
- Mini USB connector for PC interconnection

Figure 1. STM32™ Cortex™



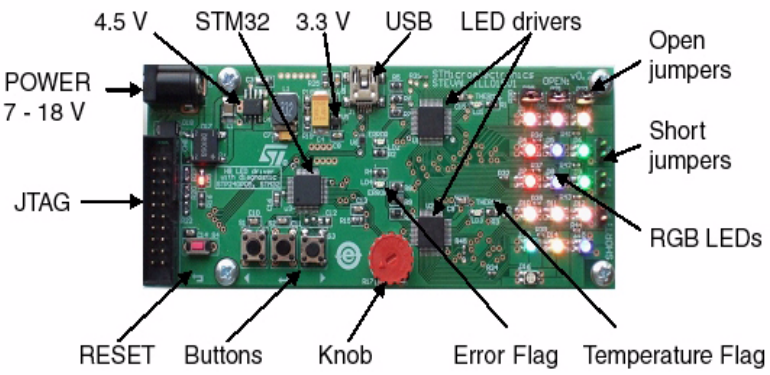
The board is distributed with firmware which enables standalone and non standalone demonstration. Features include:

- LED diagnostic
- Adjustable brightness and color of each individual LED
- Animated text
- GUI (graphical user interface) software for LED diagnostics (see *Figure 6*)

2 Hardware setup

Figure 2 shows the component description and layout of the STEVAL-ILL015V1 demonstration board.

Figure 2. STEVAL-ILL015V1 demonstration board layout



2.1 Power supply

The demonstration board can be supplied by a DC voltage from 7.5 V to 18 V. The power source must deliver a current of 0.7 A. Since the board features a built-in diode bridge, the polarity of the input voltage is not specified.

2.2 Microcontroller JTAG

The STM32 on-board microcontroller can be programmed and debugged using the standard JTAG 20-pin connector included on the board.

2.3 Microcontroller clock, reset and USB clock

The STM32 microcontroller uses its internal RC oscillator to generate an 8 MHz clock (after PLL is converted to 48 MHz). The clock is used to drive the USB also. Since the internal RC oscillator does not guarantee clock stability, which is defined in the USB specification, we do not recommend using the internal oscillator together with USB functionality. The USB is used in this case only for demonstration purposes, but performance is limited due to internal RC oscillator stability issues.

2.4 Error Flag and Temperature Flag signals

Each LED driver has one pin dedicated to an Error Flag (EF) signal and Temperature Flag (TF) signal. Both signals can directly drive an LED. The LEDs are assembled on the board and the driver status can be easily checked.

The EF indicates the condition of the driven LEDs. If any of them is found to be defective, error detection mode is activated and the EF LED turns on.

The TF indicates the thermal condition of the LED driver. If the temperature exceeds the maximal allowed temperature, the driver automatically switches off its outputs. The TF LED shines over the whole period while the driver outputs are switched off due to the over temperature.

2.5 Jumpers for LED failure simulation

Some LED defects can be simulated. The removal of jumper P20, P21 and P22 causes open circuits of the D1-green, D2-green and D3-green LEDs, respectively. The attachment of the jumper to position P1, P2 and P3 causes a short-circuit of the D6-blue, D9-blue and D12-blue LEDs.

These simulated defects can be detected during activation of the error detection mode (see *Chapter 3*, which describes the firmware modes). The defective LED is indicated by switching of the corresponding red LED.

3 Demonstration firmware functionality description

Main features of the firmware:

- Demonstrate brightness control for each LED separately
- Demonstrate color control for each LED separately
- Perform error detection to detect LED failure
- Provide a simple game simulation

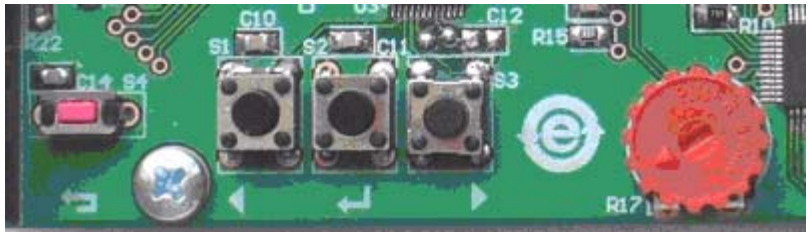
A menu displayed on the RGB LEDs after powering up the board. The menu items are depicted as the letters "A", "B", "C", "D" and "E", as shown in *Figure 3*. After power up, the letter "A" - the first item on the RGB LED array - begins blinking. Pressing the buttons changes the display to the next successive letter, to permit the selection of the desired menu item.

Figure 3. The letter "A" indicates the first menu item

The board can be controlled by four buttons and one knob, as shown in *Figure 4*:

- Back/reset button (S4) - exits from current task and returns to the main menu
- Left button (S1) - changes the menu item in descending order
- Center button (S2) - selects the displayed menu item
- Right button (S3) - changes the menu item in ascending order
- Knob (R17 potentiometer) - changes the color of the menu display from blue to red

Figure 4. Demonstration board controls



The firmware mode menu items:

- Mode "A" - Color Tetris
- Mode "B" - Wave color demonstration
- Mode "C" - Solid color demonstration
- Mode "D" - Error detection (DM)
- Mode "E" - Error detection LE + OE (Feature may not be available for all firmware releases).

3.1 Mode "A" - Color Tetris

Mode "A" is a simple game similar to Tetris. The game begins with a green “brick” moving from the bottom to the top of the LED display. The X-axis position of the brick can be controlled using the left and right buttons. Once the brick reaches the top of an LED area occupied by another settled brick, it settles also and its color changes to blue. Once the brick becomes blue, it cannot be moved. When a full row of blue bricks is completed, the row disappears and the player is awarded points. The game ends when the blue bricks reach the bottom of the LED area. When the game is over, the points obtained are shown. Pressing the center button starts new game. The knob changes the light intensity of the LEDs.

3.2 Mode "B" - Wave color demonstration

Mode "B" demonstrates various color effects. The effect changes automatically after a few cycles of a given effect. The effect can also be changed manually using the center button. The knob changes the speed of the effect.

3.3 Mode "C" - Solid color demonstration

Mode "C" allows the display of a single color on all of the LEDs. Pressing of the right button changes the colors in the following order: red, green, blue, yellow (red + green), cyan (green + blue), magenta (red + blue), white (red + green + blue) and black (all LEDs off). The left button changes the colors in the reverse order. The knob changes the light intensity of the LEDs.

3.4 Mode "D" - Error detection (DM)

Mode "D" performs and displays the detection of faulty LEDs. Every two seconds, an error detection is performed by the LED drivers. If any defective LEDs are detected, they can be identified by red light on the corresponding LED diode position. By opening P20, P21 and P22, an open circuit can be created (LED defective by disconnection) to simulate a defect of the D1-green, D2-green and D3-green LEDs, as shown in *Figure 5*. By closing P1, P2 and P3, a short-circuit is created (LED defective by shorting) to simulate a defect of the D6-blue, D9-blue and D12-blue LEDs. Entering the diagnostic mode is done using the DM signal.

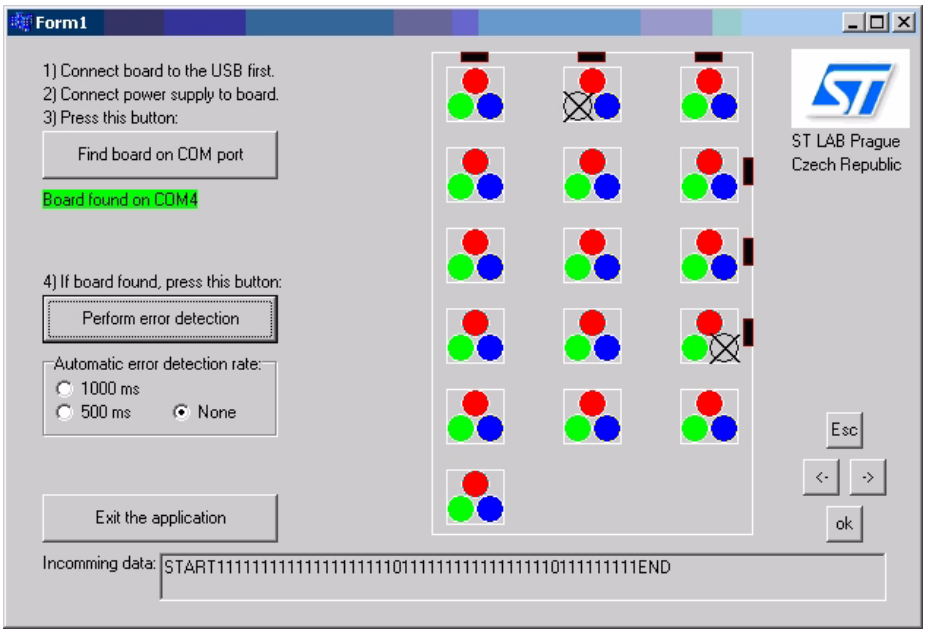
Figure 5. Moving the jumper from P21 to P2 results in detection of two defective LEDs

3.5 Mode "E" - Error detection (LE + OE)

Mode "E" (which may not be available in some firmware releases) demonstrates the same functionality as the mode "D", but entering the diagnostic mode is done using LE + OE signals.

4 PC and software interconnection

Figure 6. Software - MS Windows®



In order for the software to run correctly, the following steps must be performed:

1. Disconnect the power supply from the board
2. Connect the board to the computer using the USB cable
3. Connect the board to the power supply
4. If Windows requests the installation of an appropriate driver, use the driver supplied by ST, VirtualCOMPort

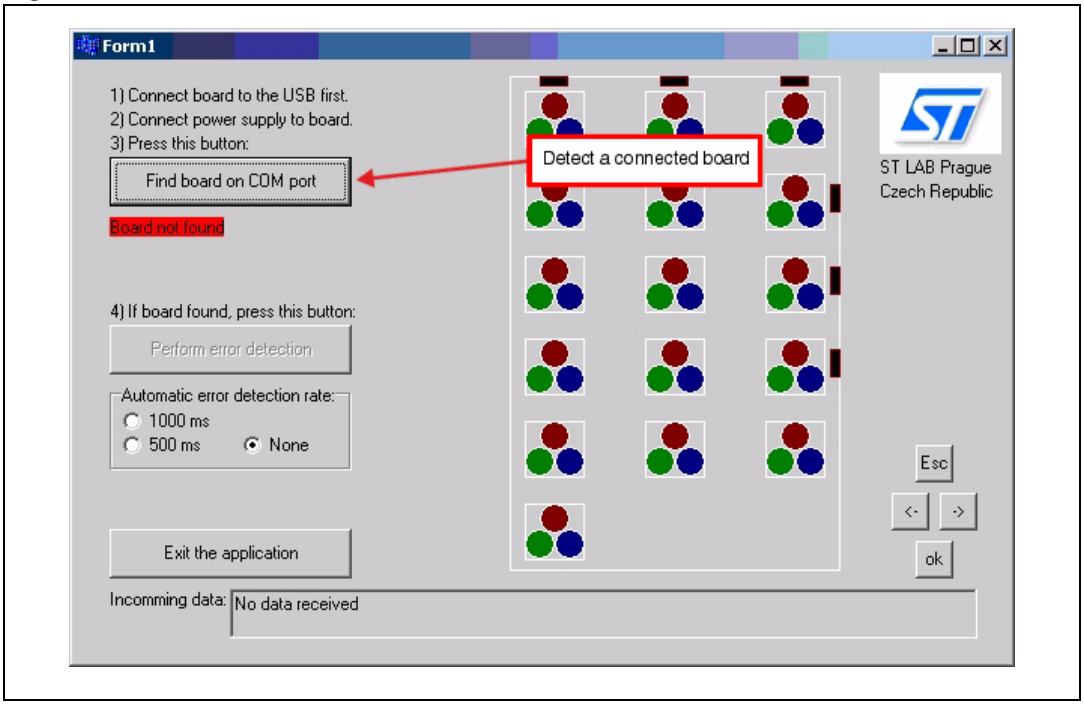
Figure 7. The USB host (PC) detection in progress

Figure 8. The USB host (PC) detected

Figure 9. The USB host (PC) not found

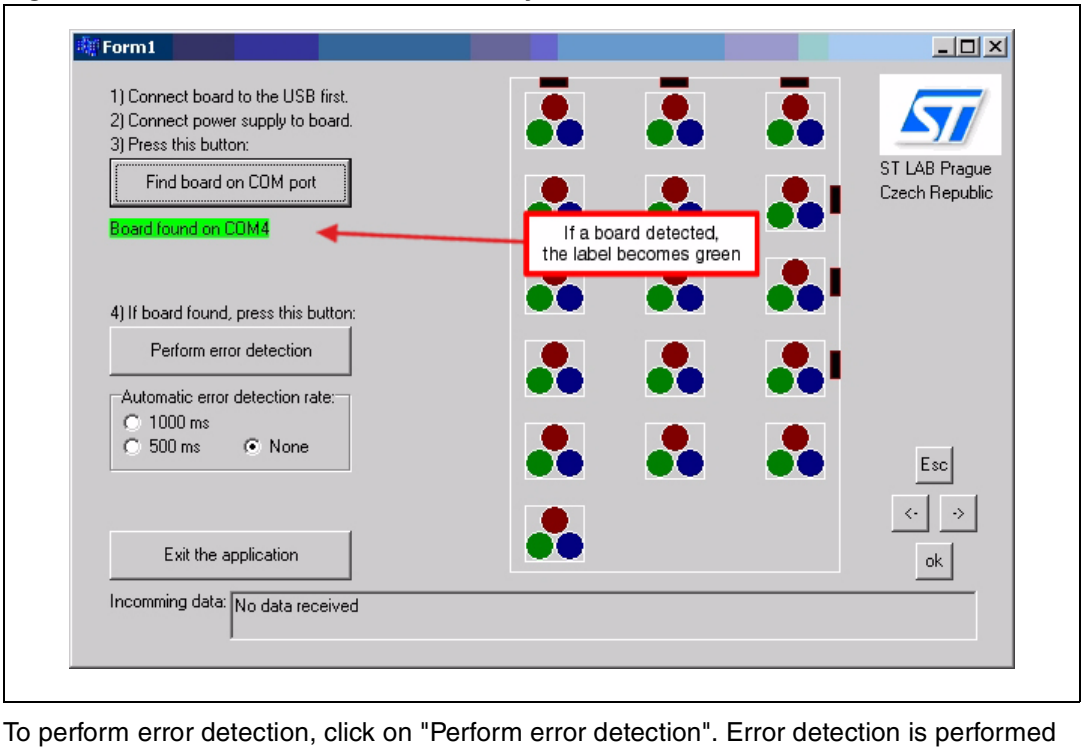
5. Run the SWforDimmer.exe application on the computer
6. If the board is not detected automatically, press the button "Find board on COM port" as shown in *Figure 10*.

Figure 10. Manual board connection



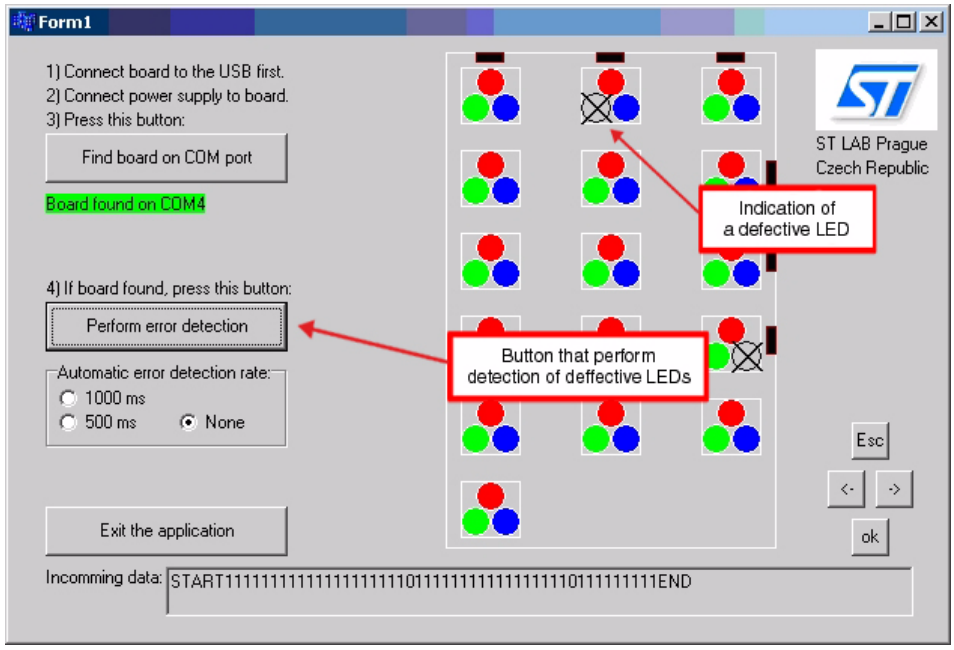
If the board is found and connected successfully, a green label is displayed on the application as shown in *Figure 11*.

Figure 11. Board connected successfully



To perform error detection, click on "Perform error detection". Error detection is performed correctly and does not depend on the mode to which the board is set.

Figure 12. Error detection mode performed



The evaluation of the error detection over USB:

1. If the jumpers P20, P21 and P22 are closed and the jumpers P1, P2 and P3 are open, no defective LED should be reported by the application graphically after pressing the button "Perform error detection". See *Figure 12*.
2. Moving the jumper from P21 to P2 should result in the indication of a simulated defective green LED in the first row and the second column and a simulated defective blue LED in the third row and the third column.
3. Exit the application and disconnect the board before testing another.

5 Schematics

Figure 13. Block diagram - microcontroller, connectors, buttons, USB

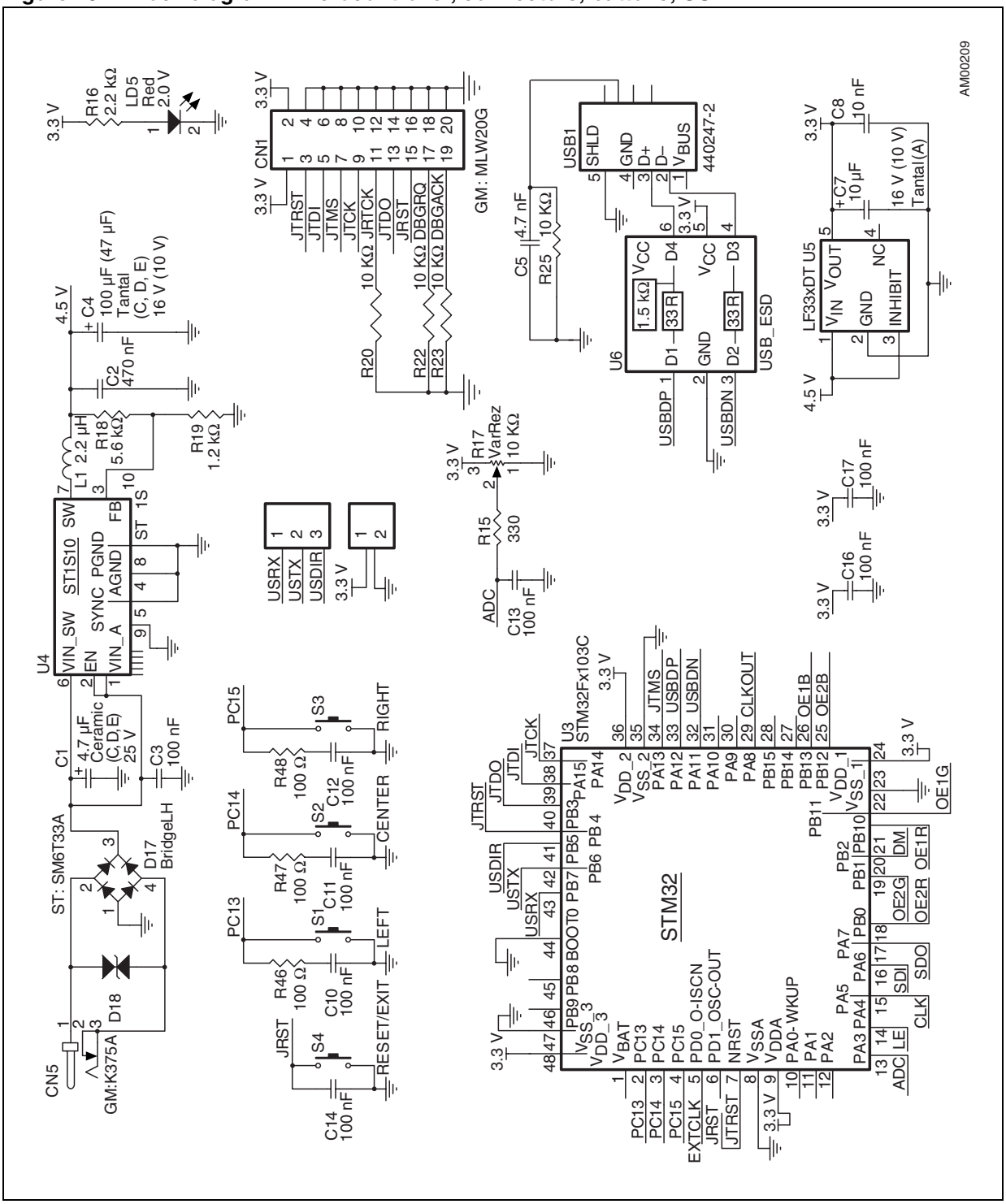
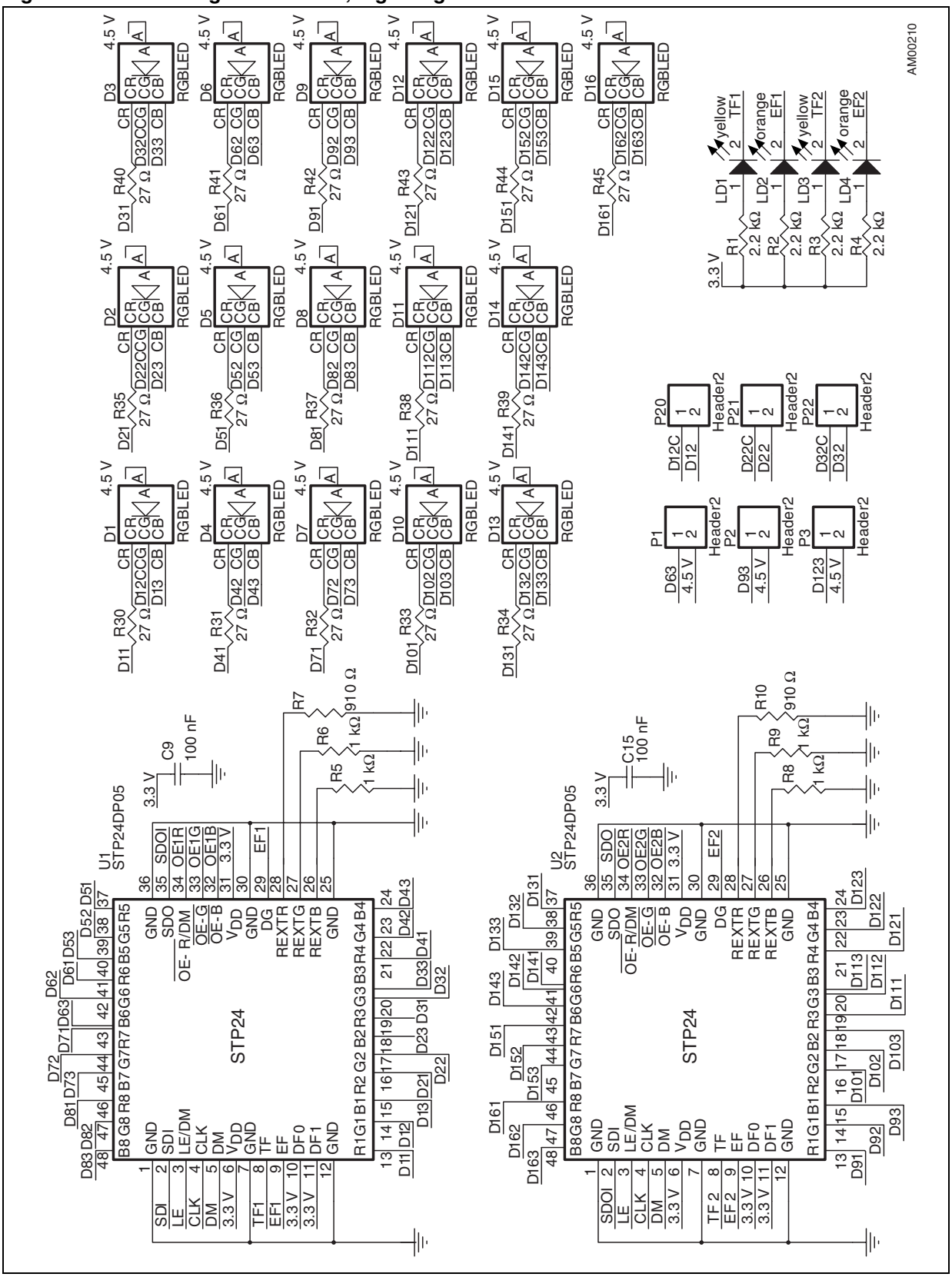


Figure 14. Block diagram - drivers, high-brightness LEDs



6 Bill of materials

Table 1. Bill of materials

Designator	Comment	Description	Footprint
C1	4.7 µF (10 µF)	Ceramic capacitor 25 / 35 V	1812LH
C2	470 nF	Capacitor	0805
C3	100 nF	Capacitor	0805
C4	100 µF (47 µF) size D, 16 V	Tantal capacitor - polarized	7343_LH
C5	4.7 nF	Capacitor	0805
C7	10 µF size A 16 V (10 V)	Tantal capacitor - polarized	3528_ABLH
C8	10 nF	Capacitor	0805
C9 -C17	100 nF	Capacitor	0805
CN1	GM: MLW20G	Header 10X2, JTAG, 10 pin, dual row	HDR2X10keyLH
CN5	GM: K375A	Input power, 4.4 V-36 V	DC10B
D1 - D16	RGBLED	LATB_T686	TOPLED
D17	BridgeLH	Full wave diode bridge	GMBridgeBig
D18	ST:SM6T33A		SMA
DDD1	ST_LOGO		ST LOGO
DDD2	ROH1		ROH1
DDD3	ROH2		ROH2
Hole1 - hole4	Distance hole		
J1	440247-2	USB 2.0, right angle, SMT, B type, receptacle, 5 position, black	440247LH
L1	3.3 µH	Inductor	inductor332
LD1	Yellow	Typical yellow, orange GaAs LED	D0805LH
LD2	Yellow	Typical yellow, orange GaAs LED	D0805LH
LD3	Yellow	Typical yellow, orange GaAs LED	D0805LH
LD4	Yellow	Typical yellow, orange GaAs LED	D0805LH
LD5	Red	Typical red/amber GaAs LED	D0805LH
P1	Header 2	Header, 2-pin	HDR1X2
P2	Header 2	Header, 2-pin	HDR1X2
P3	Header 2	Header, 2-pin	HDR1X2
P4	Signal for serial	Header, 3-pin	HDR1X3
P5	Power for serial	Header, 2-pin	HDR1X2
P20	Header 2	Header, 2-pin	HDR1X2
P21	Header 2	Header, 2-pin	HDR1X2
P22	Header 2	Header, 2-pin	HDR1X2

Table 1. Bill of materials (continued)

Designator	Comment	Description	Footprint
R1 - R4	2.2 kΩ		0805
R5	1 kΩ		0805
R6	1 kΩ		0805
R7	750 Ω		0805
R8	1 kΩ		0805
R9	1 kΩ		0805
R10	750 Ω		0805
R15	330 Ω	Resistor	0805
R16	2.2 kΩ	Resistor	0805
R17	10 kΩ	Potentiometer	VR5
R18	5.6 kΩ	Resistor	0805
R19	1.2 kΩ	Resistor	0805
R20	10 KΩ		0805
R22	10 KΩ		0805
R23	10 KΩ		0805
R25	100 KΩ		0805
R30 - R45	27 Ω		0603LH
R46	100 Ω	Resistor	0805
R47	100 Ω	Resistor	0805
R48	100 Ω	Resistor	0805
S1	LEFT	Switch	Button_double
S2	CENTER	Switch	Button_double
S3	RIGHT	Switch	Button_double
S4	RESET/EXIT	Small switch	Button_DT2112C
U1	STP24DP05	LED driver 24-channel	
U2	STP24DP05	LED driver 24-channel	
U3	STM32F103Cx	Microcontroller Cortex	
U4	ST1S10	ST1S10	DFN8cool4LH
U5	LF33xDT	Linear voltage stabilizer	SOT23-5L
U6	USB_ESD	USB signal over voltage protection	SOT666IP

7 Revision history

Table 2. Document revision history

Date	Revision	Changes
10-Oct-2008	1	Initial release.