



SPI LED Controller

LED Strip Studio SPI SD Card Digital LED Strip Controller

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1 Introduction

SPI LED Controller is a SD Card based controller for digital/video LED strips or LED lights.

LED strips or LED lights can use standard IC (controller chips).

Currently are supported following ICs:

- TM1803, TM1809, WS2811, WS2812, WS2813, WS2812B, APA104, SK6812
- WS2801
- APA102
- D705 (not recommended to use anymore)

You can control up to 1024 independent RGB LEDs from one **SPI LED Controller**, every LED using 8bit RGB channels (16,7 million colors). 1024 RGB LEDs are typically about 30m of LED strips or up to 100m of LED pixels (in case the LED pixel distance is 10cm).

You can use LED Strip Studio software to generate content for your SD Card.

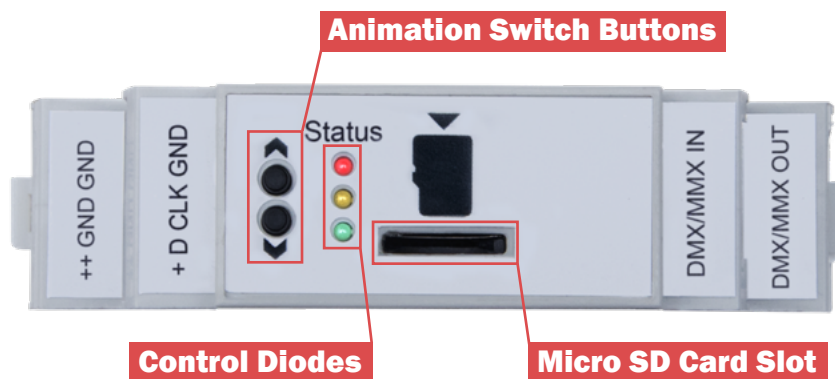
It's quite easy to create nice LED effects with all the options LED Strip Studio software offers.

You can use **SPI LED Controller** in different modes:

- **SD digital player** - standalone SD Card digital animation player, where you can switch between different animations using buttons.
- **DMX-controlled digital player** – you can use DMX signal to switch between the animations stored on the SD Card.
- **DMX pixel controller** – you can control multiple RGB pixels, every one of them using 3 DMX channels.
- **Analog LED strip emulation** – up to 1024 pixels can be controlled using just 3 DMX channels. This is not separate mode, you just can emulate it over DMX Pixel mode.
- **LSS Ethernet distributor** – one additional output for LSS Ethernet.

2 Hardware description

Hardware board contains connectors, buttons and some control diodes.



SPI LED Controller board inputs/outputs

DMX In / MMX In – input for DMX or MMX signal. It's **standard RJ45 connectors** and only some lines are used:

1	D+
2	D-
7	GND
8	GND

SPI LED Controller DMX/MMX in connector

DMX Out / MMX Out – it's generally **thru (out) connector** for DMX or MMX signal. The incoming signal from in connector is copied to this one.

1	D+
2	D-
7	GND
8	GND

SPI LED Controller DMX/MMX out connector

Micro SD card slot – slot for standard micro SD Card. All the animations for digital LED strips or pixels can be saved on **FAT32 formatted** card with size up to 32GB.

Mode/Status indicators – three control diodes displaying status of the device.



Frame sending – in case some picture is being sent to SPI out, this diode flashes.



DMX/MMX signal detected – diode turns on in case DMX or MMX signal is detected. In case MMX signal is connected the diode shines. In case DMX signal is present, the diode flashes.

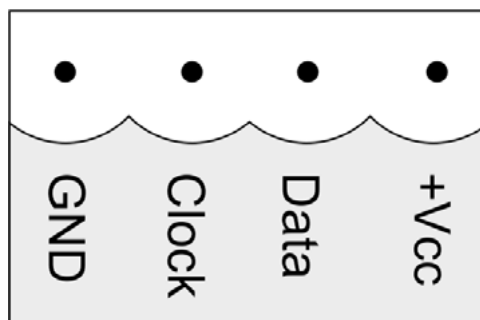


Power on – diode turns on if power is connected.

Animation switch buttons – you can store multiple animations on the SD Card.

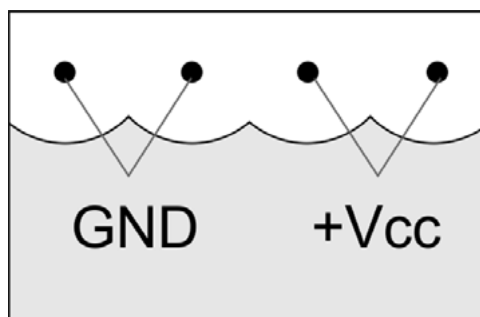
Using these two up/down buttons you can select which animation to play.

SPI Out – digital output for LED strips/LED pixels.



SPI OUT (SH04-5-GY) connector scheme

Power In – power output for power source, 5-24V.



Power In (SH04-5-GY) scheme

3 Connections

This is the typical connection scheme:



You need to connect power source to turn on the board and to power up the LED strips/LED pixels.

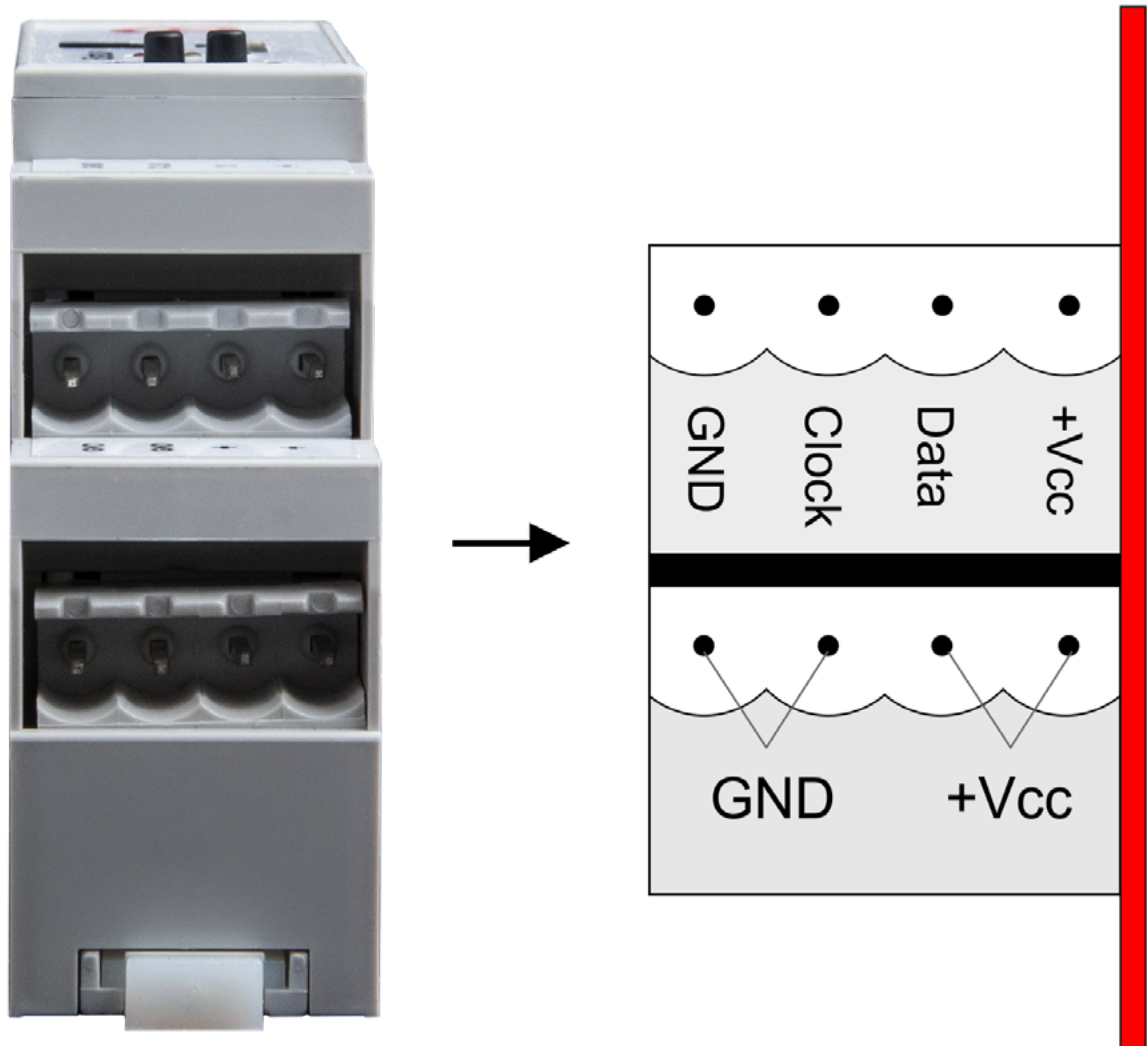
In case you want to control the board over DMX, you can connect DMX console or any other DMX controller to DMX input. And if you use several **SPI LED Controller** boards (or additional DMX controlled devices), you can use DMX out to lead the DMX signal.

SPI output typically uses 3 or 4 pins depending on used LED strip.

GND	To power up the LED strip/pixel
Clock	Some types of LED strips also require Clock pin for synchronization
Data	Control data pin
+Vcc	To power up the LED strip/pixel

3.1 Typical installation examples

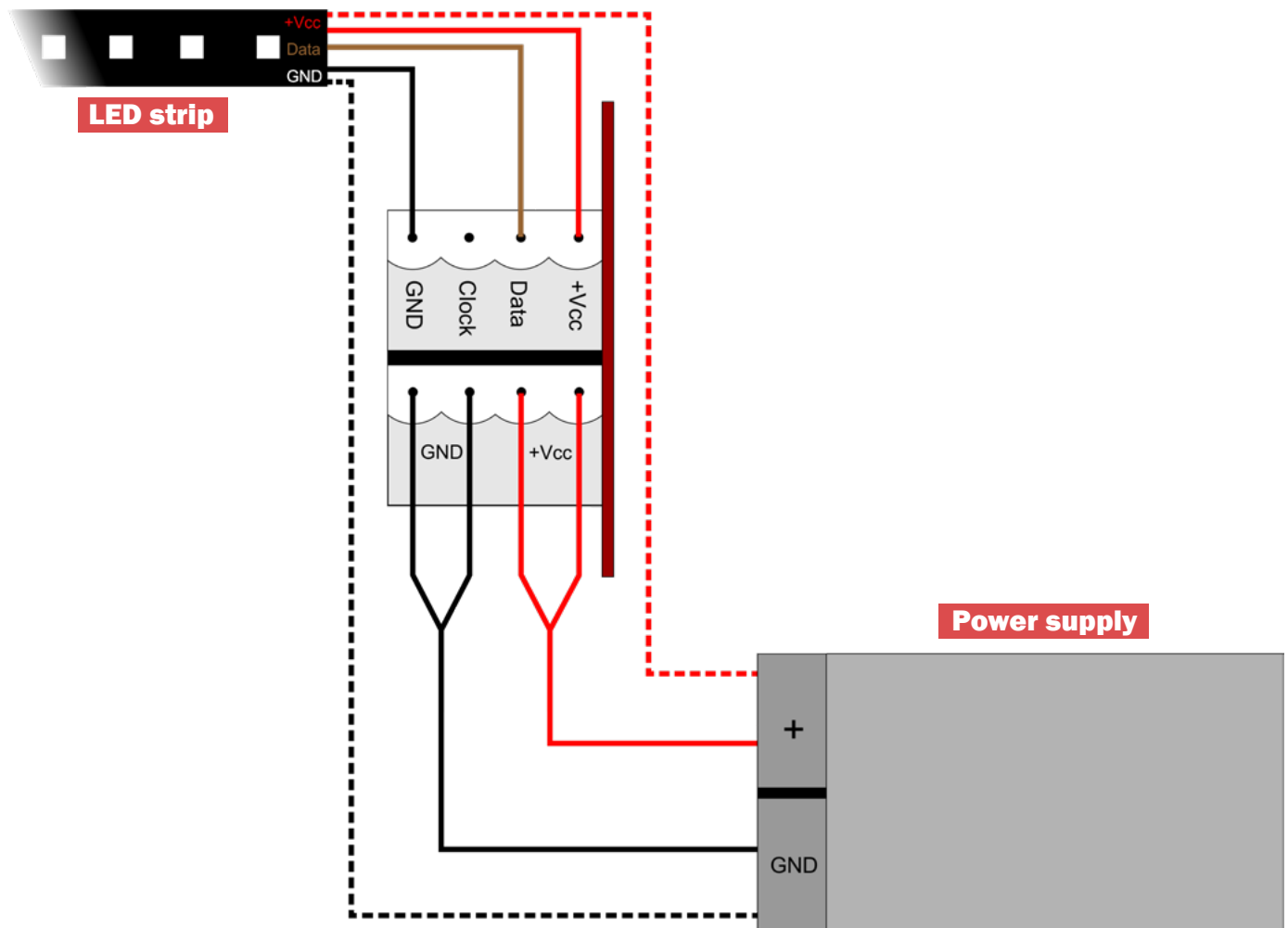
For better explanation, we'll use schematic side picture of the board. Here you can see the **board side with the connector description**.



SPI LED Controller side view and its schematic representation

3.2 Standard connection of Data pin

On following example, you can see connection scheme of one TM1803/TM1809 based LED strip and one power source.



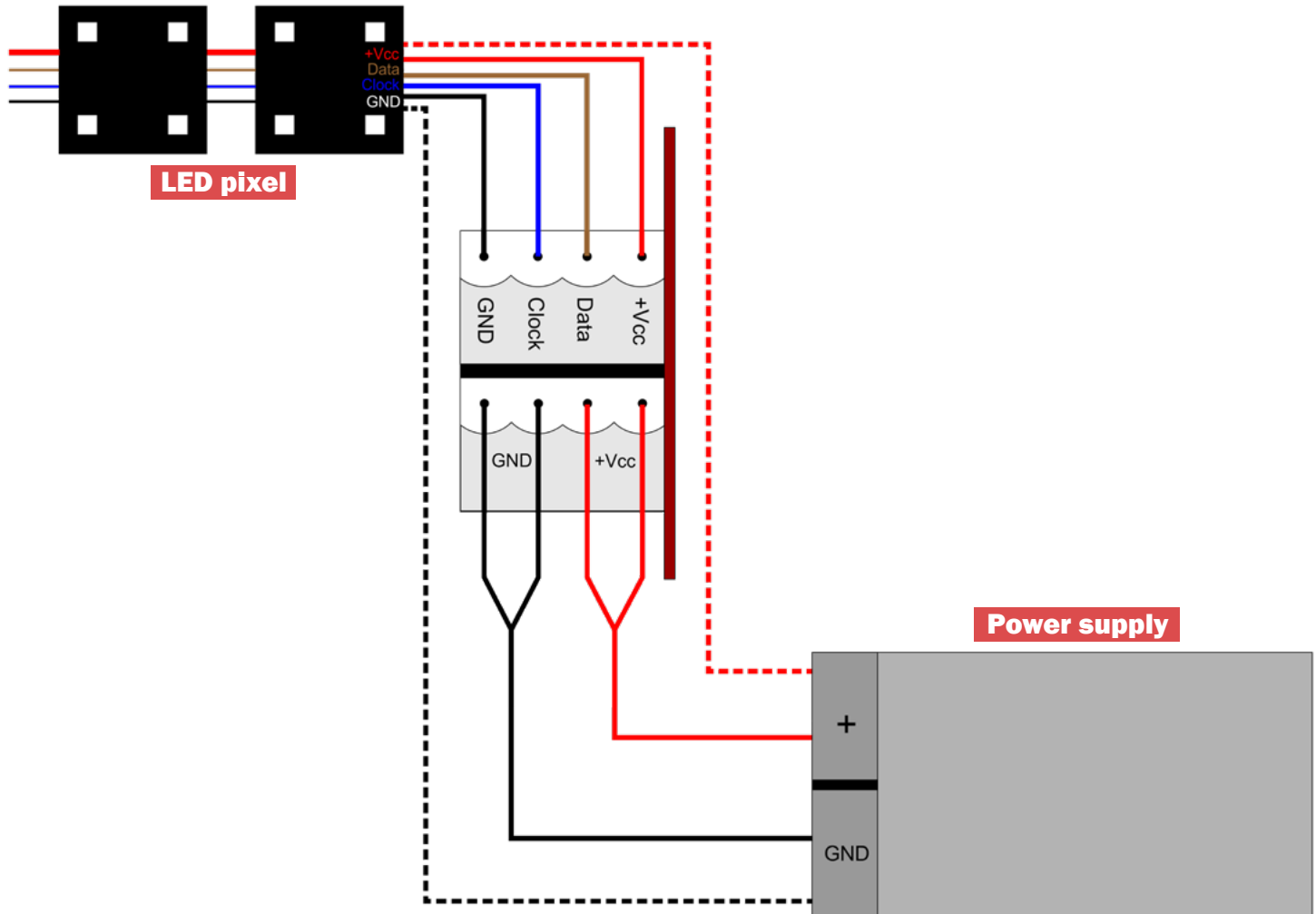
Connecting one LED strip (TM1803/TM1809)

TM1803 or **TM1809** LED strip family requires only **using one data line (no clock required)**.

Recommendation: Sometimes it's better to connect also the power directly to the LED strip (or LED pixel). It's especially important in case you use many LEDs and the LED strip requires lot of power. In this case, you don't need to connect the +Vcc from the LSS SPI to the LED strip. But we strongly recommend to connect GND.

3.3 Connection of Clock Pin

In case you use e.g. LED pixels, some of them require also **Clock pin** for synchronous data transmission. Here you can also see how to boost the power in case you want to use many LED pixels.



Many types of LED pixels require clock to be connected

4 Configurations

You can configure **SPI LED Controller** by **editing text file**.

But it's **easier to use tools we provide in LED Strip Studio software**.

4.1 Configuration file

The board configuration is stored in one simple text file on the SD Card. Name of the file is **settings.txt** and it must be **stored in the root directory of the SD Card**.

Animation files are stored in **LNT file format**.

Both file formats can be generated in LED Strip Studio software.

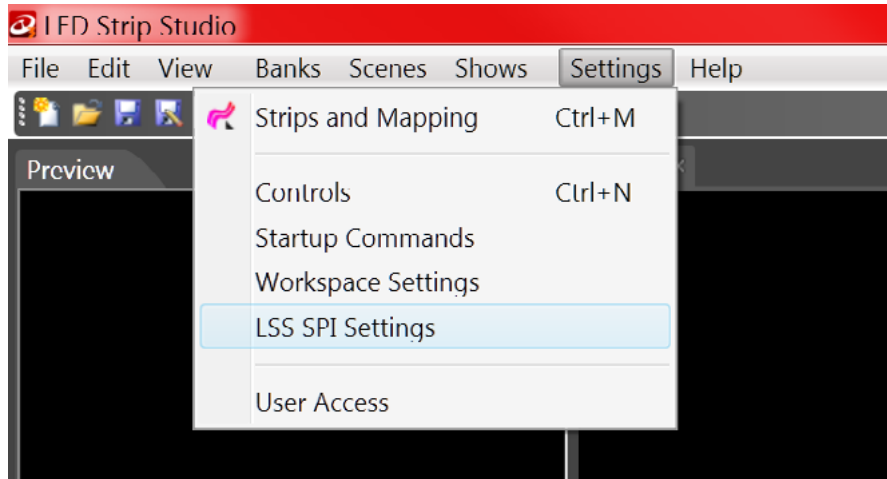
 EFF081.LNT	19.04.2013 17:13	LNT File	224 KB
 EFF082.LNT	19.04.2013 17:13	LNT File	180 KB
 EFF083.LNT	19.04.2013 17:13	LNT File	90 KB
 EFF084.LNT	19.04.2013 17:13	LNT File	180 KB
 EFF085.LNT	19.04.2013 17:13	LNT File	180 KB
 EFF086.LNT	19.04.2013 17:13	LNT File	224 KB
 EFF087.LNT	19.04.2013 17:13	LNT File	180 KB
 EFF088.LNT	19.04.2013 17:13	LNT File	180 KB
 settings.txt	22.12.2017 17:47	Text Document	2 KB

Example of SD Card for SPI LED Controller – animation files in LNT format

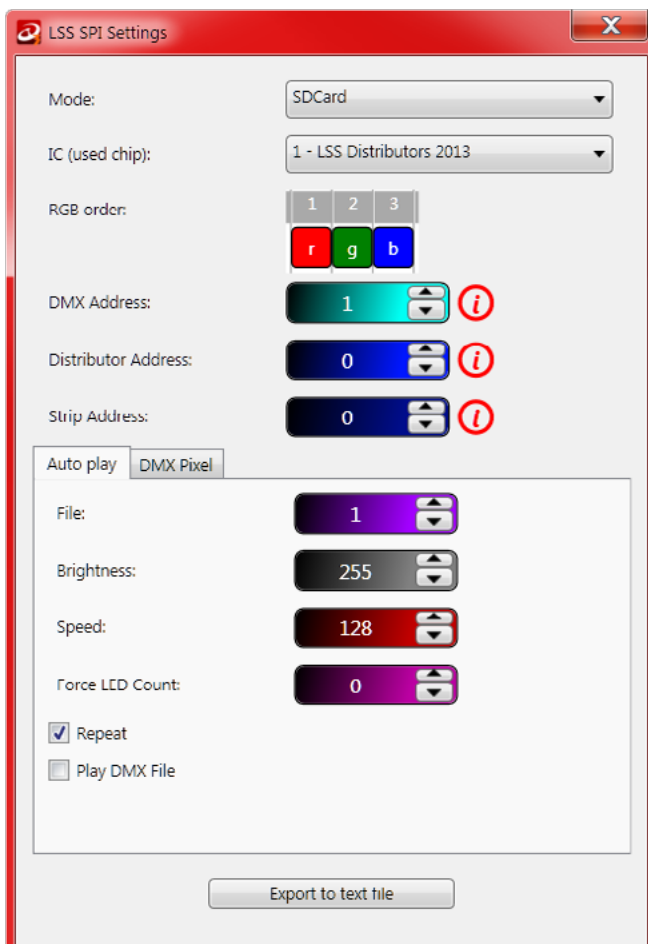
4.2 How to do configuration file

To create settings file, you can use LED Strip Studio software.
Here is example of configuration step by step:

1. Go to menu **Settings** → **LSS SPI Settings**.



2. Following dialog appears.



Mode – allows you to select mode for DMX:

SD Card mode. In this case, SPI LED Controller uses LNT files from the SD Card to be played.
[6 DMX channels are used.](#)

Pixel mode. This mode **converts incoming DMX signal into RGB pixel** format. You can later define how many pixels should be used (in DMX Pixel tab). Each pixel **uses 3 DMX channels for red, green and blue color**. You can also change the order of the RGB color channels.

IC (used chip) - Allows you to select used LED strip type control chip (IC).

RGB order – allows you to define RGB order for the LED strip. Some LED strips might use for example blue, green, red order instead of standard red, green blue. This setting **allows you to change this color order**.

DMX Address – starting DMX address for both, SD Card and Pixel mode.

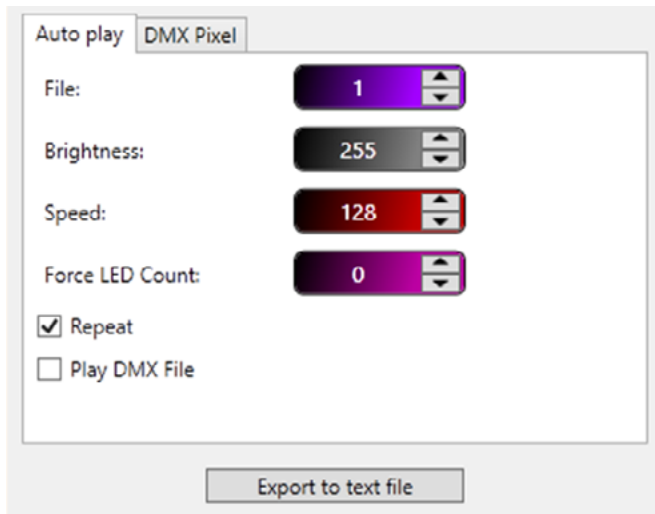
Distributor Address – defines address of distributor, which should be used from SD Card files or MMX input.

Strip Address – LSS Distributor can control up to 4 strips. Here you can define, which of the strips should be used as an output for SPI LED Controller.

SPI LED Controller settings file generator in LED Strip Studio

Autoplay section

Autoplay section is used to **play default file/animation from the SD Card** after the **SPI LED Controller** turns on.



File – this is the initial file, which will be played after the SPI LED Controller is turned on. In case it's 0, LSS SPI won't start any file after start (you can start it only manually using the buttons).

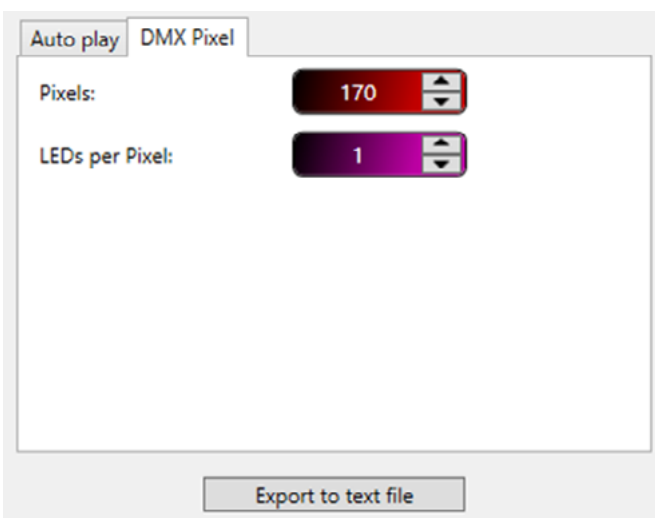
Brightness – you can lower the brightness of the animation. All animations are affected (in case you switch between them using the buttons).

Speed – speed of default animation. **128 is default** animation (as played in LED Strip Studio software). 255 is 4x faster than default animation. If the value is lower than 128, animation is slower ($64 = 1/2$ of speed).

Force LED Count – by default, LSS SPI plays animations on number of LEDs defined in LNT file. But sometimes you can use more or less LEDs on your LED strip or LED pixel and you don't want to export the LNT files once again. This setting will convert all the animations to desired number of LEDs. In case it's 0, number of LEDs is defined by LNT file.

DMX Pixel section

DMX pixel section defines how the **SPI LED Controller** maps DMX channels to LED pixels.



Pixels – defines **how many pixels are used on SPI output**. Value range is from 1 to 170. By 1, SPI LED Controller uses three DMX channels (from DMX Address) and sends it to SPI output as 1 RGB pixel. In case you use 170, SPI converts $170 \times 3 = 510$ DMX channels (almost all the DMX universe).

LEDs per Pixel – three DMX channels are converted to one LED pixel by default. But this setting **allows you to create group of LED pixels controlled by DMX channels**. E.g. in case LEDs per Pixel is 4, four LED pixels behave as one on SPI output (they'll have same color set by these 3 channels). This is quite practical in case your LED strip or LED pixel line uses more than 170 LEDs and you still want to control them over DMX.

Example: Let's say, you set Pixels to 20 and LEDs per Pixel to 3. You'll control total of 60 LED pixels, every 3 following pixels will have the same color set by DMX channels.

Export to text file – export **settings.txt** to selected directory. This file must be saved on the SD Card for SPI LED Controller.

4.3 Standalone (autoplay) mode

If there is NO DMX and MMX signal connected to **SPI LED Controller**, the device **starts automatically playing file defined in settings.txt file**.

The **SPI LED Controller** device locates all LNT files (animations) saved on the SD Card and allows you to **switch between them using up/down buttons**.



You can find more about Standalone SD Card configurations in the section 4.2 Auto play .

It's perfect for standalone applications, where you don't want to use computers. Typical usage is advertisement.

4.4 DMX controlled SPI LED Controller

You can use **SPI LED Controller** in two different modes when controlling over DMX:

- **SD Card**
- **Pixel mode**

DMX mode will start run automatically after DMX signal is detected.

You can find the DMX to RJ45 connection scheme in the [appendix section](#).

4.4.1 SD Card

It's SD player mode, when you are able to choose any file from the SD-Card and play it on your digital LED strips.

You can **use DMX channel to select animation stored on SD Card** and let it play on LED strips/LED pixels. You can see example of right DMX values in this mode:

DMX Order	Property	Example
1	Brightness	255
2	Animation	1
3	Animation speed (default is 128)	128
4	Red	0
5	Green	0
6	Blue	0
7	White	0

SPI LED Controller DMX channels in SD-Card mode

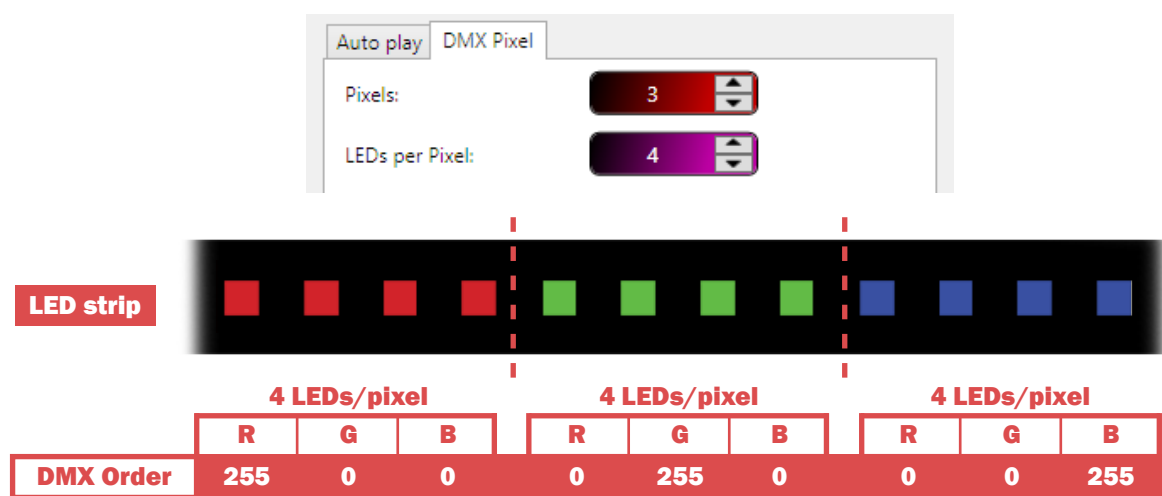
4.4.2 Pixel mode

In this mode you control every LED pixel of your LED strip directly using three DMX channels. You can use more LED pixels than one, thus more DMX channels will be used.

The calculation is easy, you use N pixels, you'll need 3*N DMX channels.

Also, don't forget, you can use LEDs per Pixel setting to create groups of pixels with the same color.

In pixel mode, every **3 DMX channels are used to control red, green and blue color of one (or more) LED pixels**. You can define how many pixels are used (thus how many DMX channels). The only limitation is, **SPI LED Controller** can control up to 1024 LEDs. If you want to use more, you'll have to use several SPI LED Controller devices.



4.5 SPI LED Controller as LSS Distributor (MMX mode)

You can use **SPI LED Controller** as single output LSS Distributor.

SPI LED Controller can receive MMX signal from LSS Ethernet card and send the data to supported digital LED strips. To configure distributor address and what strip output to use, you must create the configuration file.

MMX signal is automatically detected when connected to DMX/MMX input of the SPI LED Controller card.

5 Creating and exporting animations in LED Strip Studio software

To start using **SPI LED Controller** you have to use LED Strip Studio (LSS) software to **create correct strip layout and to prepare your SD Card animations.**

To know more about the LSS software we recommend to watch following tutorials on this [youtube playlist](#).

There is also comprehensive manual for LSS software directly in the menu:

Go to menu **Help** → **View help**.

In this manual, we already assume you know how to define mapping in LSS software and how to create new animations with videos, texts, ...

To export your scene to your SD Card you have to do following steps:

1. Start LSS software.
2. Create correct mapping (for any LSS Ethernet IP address). [link to tutorial](#)
3. Create your scene. [link to tutorial](#)
4. To export scene into LNT file go to menu **Scenes** → **Export scene to SD Card**.
5. Choose LSS Ethernet, where you've created the mapping.



LSS Ethernet is defined by IP address 192.168.1.X, where X is arbitrary. For creating mapping, you can create LSS Ethernet with any IP address.

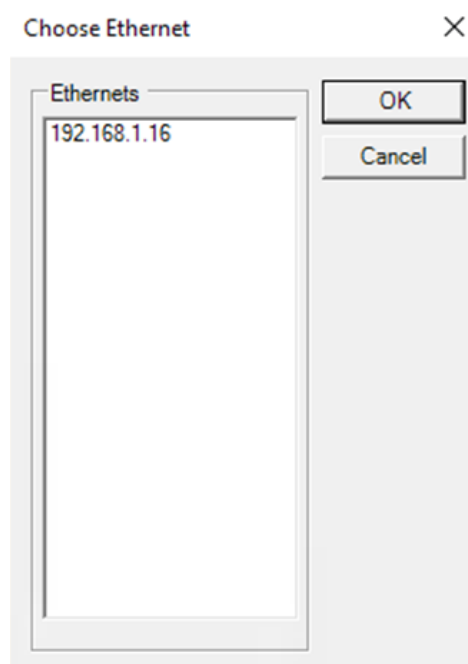
6. Select the folder, where you want to export the file. Typically it's the folder of your SD Card.
7. File index allows you to define on which animation position you'll export the file (from 001 to 255).
8. LSS software exports LNT file with name LSSXXX.LNT, where XXX is from 001 to 255.
9. Save the exported LNT file to your SD Card.

To create **settings.txt** file, which tells the SPI LED Controller what kind of strip and what file it should play you have to create configuration file.

All the files must be saved to your micro SD Card and you have to insert this card to your SPI LED Controller device.

You can also export complete shows from LSS software to your SD card.

Just choose **Shows** → **Export Show** from LSS menu. [link to tutorial](#)



Choose Ethernet with defined mapping to be used for export

6 Technical specification

Required power	5-24V/ 0.3A (DPS only, without the LED strips / LED pixels)
Maximal current	10A
Power connector	standard 4 pin terminal with 5mm contact spacing e.g. SH04-5-GY
SPI OUT connector	standard 4 pin terminal with 5mm contact spacing e.g. SH04-5-GY
DMX/MMX input connectors	RJ-45
DMX/MMX output connectors	RJ-45
Maximal current	Micro SD Card (FAT32, up to 32GB)

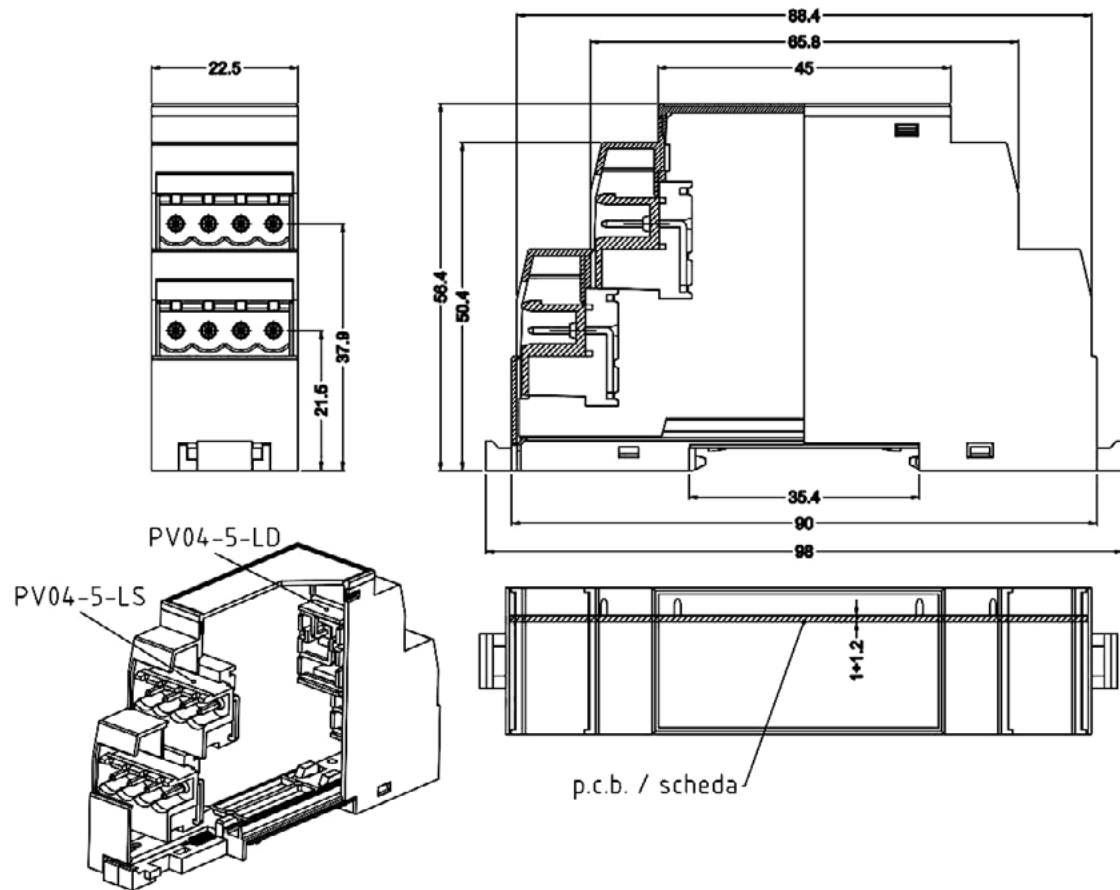
You can buy compatible connectors at Farnell/Newark/element14:

<http://www.newark.com/camdenboss/ctb9202-4/pluggable-terminal-block-4-300/dp/55Y8501>

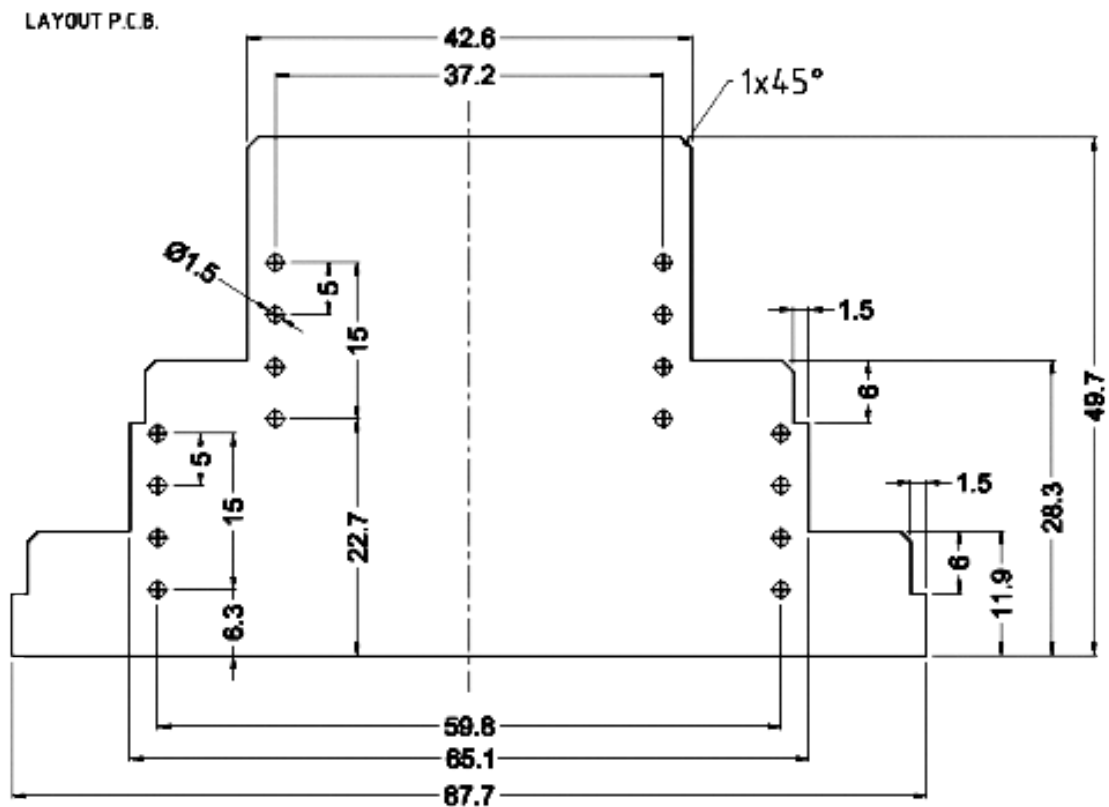


SH04-5-GY or CTB9202/4 are compatible connectors for LSS SPI

7 SPI LED Controller board dimensions



Cover size and design



Board Dimesnions

8 Example of settings.txt

You can create also **settings.txt** manually in e.g. notepad. Here is an example you can copy and paste to your text file. You can also change the settings manually using your text editor.

```
;LSS SPI settings file
;This is configuration file for LSS SPI board.
;Generated on 1/20/2017 4:44:50 PM
;Supported LED strip IC/chips:

;    0 - D705 3x5bit
;    1 - LSS Distributors 2013
;    2 - TM1809 High speed
;    3 - TM1809 Low speed
;    4 - 74HC595 7 color
;    5 - WS2801 3x8bit
;    6 - APA102
;    7 - APA102 double

[Settings]
;DMX mode (SDCard or Pixel)
DMXMode=SDCard

;Used strip: 1 - LSS Distributors 2013
IC=1

;Order of RGB channels for every LED (use RGB letters)
RGBOrder=RGB

;DMX address (1-511)
DMXAdd=1

;Used LSS Distributor address (0 - 31), 0 is the address of LSS Ethernet's integrated distributor
DistrAdd=1

;Used strip on Distributor(0 - 3), 0 is default
StripNum=2

[Autoplay]
;File to play from SD card (1-255), if 0, autoplay is disabled
File=1

;Play the stored digital or DMX file
PlayDMXFile=False

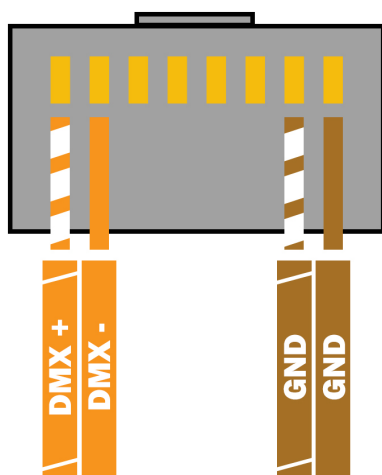
;Brightness 0-255
Brightness=255

;Speed (0-255), 128 is the default speed as in LSS software
Speed=128

;Repeat animation after finished (true or false)
Repeat=True

[DMXPixel]
;Number of used pixels (1 pixel = 3 DMX channels)
Pixels=170
;Number of LEDs per one pixel
LEDsPerPixel=1
```

9 Appendix



Scheme of DMX to RJ-45 connection

10 Dictionary

Digital LED strip (video LED strips) / Digital LED pixel

There are two basic types of LED strips – analog and digital. Analog means, the whole strip is able to use only one color (which you can usually change over DMX). But digital (video) LED strips have the ability to control every LED diode separately. That's why you use many LED strips, you can even create LED screen displaying information. To find out more information about analog and video LED strips we recommend watching following video:

<https://www.youtube.com/watch?v=ZOM20110Vpl>

DMX

Standard light control protocol, full name is DMX512.

For more details please visit <https://en.wikipedia.org/wiki/DMX512>

or see our video <https://www.youtube.com/watch?v=e3KYxUboguY>.

MMX

Communication protocol between LSS Ethernet and LSS Distributor developed for LED Strip Studio products.

LED Strip Studio / LSS software

The main software for creating digital LED strip animations. You can find more information about the software here:

<https://www.ledstripstudio.com>

<https://www.youtube.com/watch?v=di-U3IMrflg>

<https://www.youtube.com/watch?v=S8nPihPgIcM>

LSS Ethernet

LED Strip Studio Ethernet controller. It's the main control board for LED Strip Studio software, which allows you to control your digital LED strips in real time from LED Strip Studio software. It's the best option to create new animations, because you can see the changes in LSS software immediately on your LED strips/LED pixels.

Here is a nice video about LSS Ethernet limits and how you can use more of these devices:

https://www.youtube.com/watch?v=3oUxIDb_2f8

LSS Distributor

Extension board for LSS Ethernet, which enables LSS Ethernet to control additional 4000 LEDs.

SPI

It's the serial protocol used to control digital/video LED strips or LED pixels. There are several types of IC (chips) used to control digital LED strips and you need to match SPI output type.

SPI stands for Serial Peripheral Interface and you can read about it here:

https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

