

Advanced LED Controller (LED Chaser)

Introduction.

Advanced LED controller (also known as LED Chaser) is microcontroller based circuit designed to produce various visual LED light effects by controlling the timing and intensity of the LED lights. The unique method of controlling light effects, simplified LED connection, expendability and compact design make this product perfect fit for a hobby projects, model building, automotive, custom display signs and various other applications.

What differentiates this circuit from other LED chasers on the market is ability for the end user to create their own light effects. The brightness and timing of each LED can be precisely controlled with 4096 gradation levels which is very important for lighting effects with smooth brightness transitions. Single board has 16 individual channels each capable of driving number of LEDs. The number of channels can be extended to 32, 48 etc by connecting additional passive boards. There are six analog/digital inputs on board which internal firmware could take advantage of to trigger or perform various functions. The default firmware is using inputs to allow user to change between various effect files and change effect display rate. One of the great features of this circuit is upgradable firmware which gives the end user ability to keep the firmware up to date or load different firmware designed to provide unique features and controls. One of the examples of such updates is firmware to control inexpensive strings of popular color LEDs strings (WS2812B) found from various suppliers.

Technical details.

Number of LED channels: 16

Brightness levels per channel: 4096

Maximum current per channel: 100ma

Number of LED per channel: 1 to 20 (depends on configuration)

Power supply: 7V to 15V (upto 2amp)

Expendable number of LED channels: Yes (requires additional board)

Number of visual effects: Unlimited (user controlled)

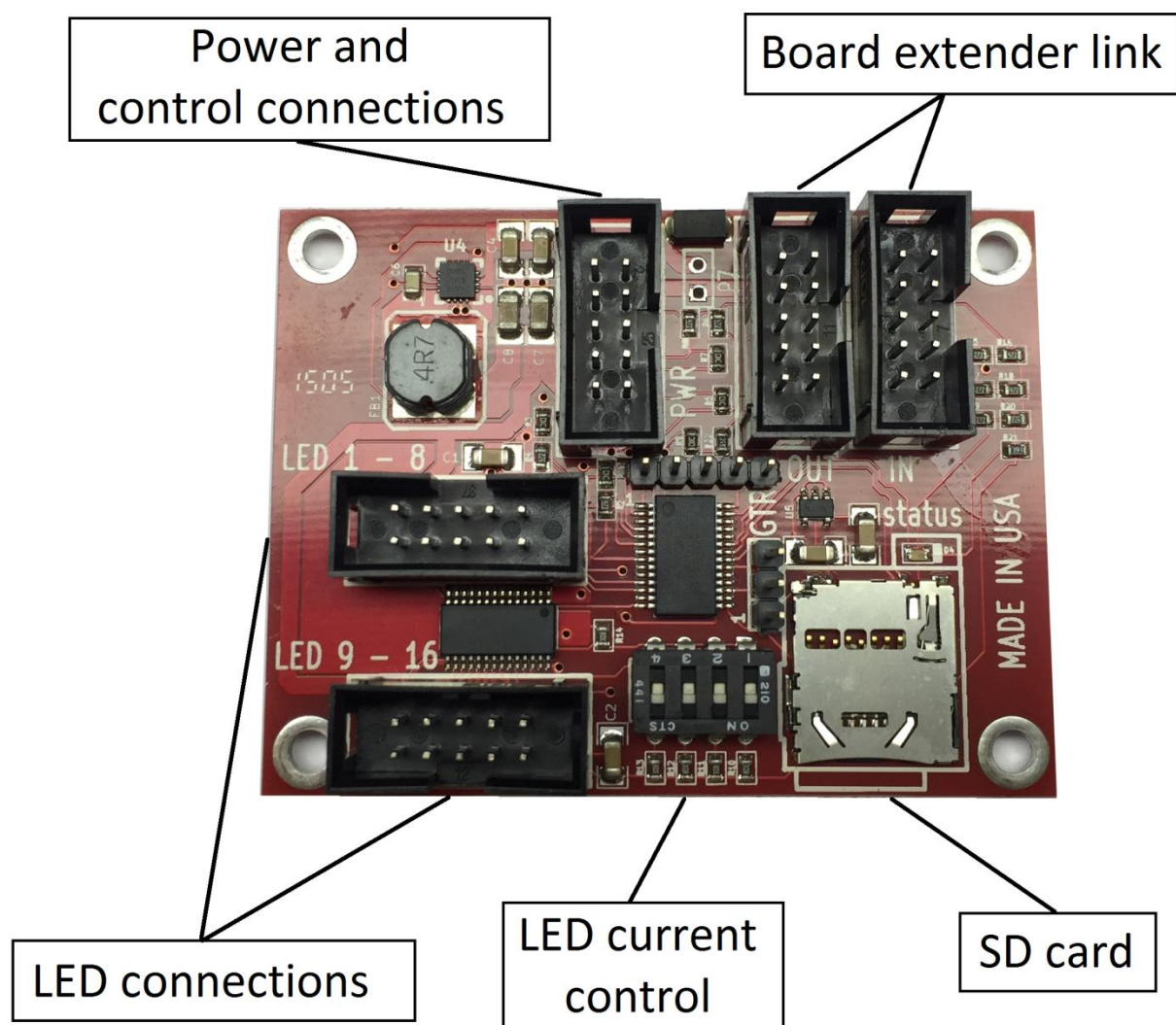
Upgradable firmware: Yes

Board size: 66mm x 50mm (2.6" x 2)

Get started.

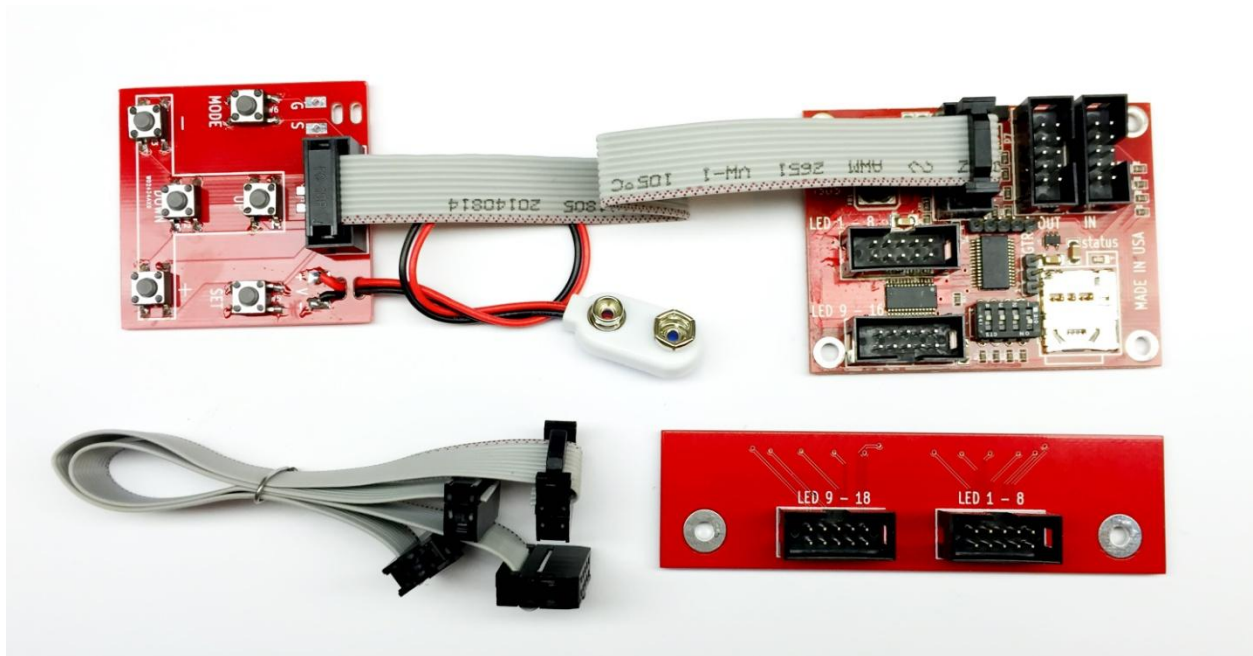
Content:

- Main Board.
- Control Pad.
- Sample LED 16 led board.
- Connection cables.
- SD Card with default effect files.



Initial startup.

Advanced LED controller comes with controller pad, 16 channel LED board and ready to be used right out of the box. Connect controller pad to the controller board power connector as shown on the picture below and connect LED board by connecting LED 1-8 and LED 9-16 sockets respectively between LED controller and LED board.



Verify LED Control dip switches are all set to OFF before connecting power for the first time.

To reset the configuration to default light effect file and default speed hold the SET button on the controller pad, connect 9v battery and then release the button.

UP and DOWN buttons will switch between available light effect files.

PLUS and MINUS buttons will increase and decrease effect display rate.

Effect file is CSV (comma separated value) file. It contains the header (first line) describing the columns:

- **LED Type** - LED for standard lights and RGB for multicolor LED
- **Boards/RGB Quantity** - provides number of LED boards or quantity of RGB leds
- **Delay 1/100 sec** - the time each frame is displayed in 1/100 of the seconds.
- **LED1 through LED16** - intensity for each light from 0 to 4095 levels.

The remaining rows provide data for effect frames.

Light effect file is like a video tape, it contains individual frames which periodically displayed. Contrarily to the video tape LED effect frames are not displayed with the set frequency of 24 or 60 frames per second. The timing of the frames is controlled by the value in the DELAY column. For example if we want to create effect for a single LED moving from left to right we would create the following file.

| | A | B | C | D | E | F | G | H | I | J |
|----|----------|------------|-----------------|------|------|------|------|------|------|------|
| 1 | LED Type | Boards/RGB | Delay 1/100 sec | LED1 | LED2 | LED3 | LED4 | LED5 | LED6 | LED7 |
| 2 | LED | 1 | 5 | 4095 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | LED | 1 | 5 | 0 | 4095 | 0 | 0 | 0 | 0 | 0 |
| 4 | LED | 1 | 5 | 0 | 0 | 4095 | 0 | 0 | 0 | 0 |
| 5 | LED | 1 | 5 | 0 | 0 | 0 | 4095 | 0 | 0 | 0 |
| 6 | LED | 1 | 5 | 0 | 0 | 0 | 0 | 4095 | 0 | 0 |
| 7 | LED | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 4095 | 0 |
| 8 | LED | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | LED | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | LED | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

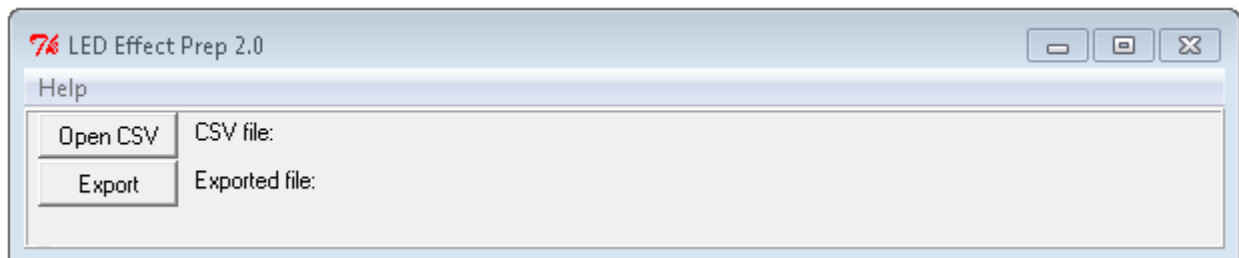
In the first frame we light up the first LED to 100% brightness and display it for 50ms (or 1/20 of the second), then moving to the second LED and also displaying frame for 50ms. And so on. If we want to slow down the effect we can change the timing to 100ms (or 0.1 second).

Open other examples of provided effect files to see how various effects are constructed.

Watch the YouTube where we are demonstrating creation of LED effect files.

Once the effect CSV file is created it needs to be converted to the file understood by the LED Chaser.

Conversion program is provided on the micro SD card in the directory: */LedEffect Conversion*. Run the program *LedEffectPrep.exe*



Click on Open CSV and select source effect file. Click on export and specify destination directory and file name. Filename should be in the following format LED00???.bin (where ??? is a sequence number). For example: LED00000.bin , LED00001.bin , LED00002.bin etc.

LED Chaser expects to find consecutively named files on micro SD card so start with LED00000.bin and increment sequence for the next file.

Transfer file to the micro SD card, plug it into the LED Chaser and power it up to display created effect. If you need to reset the LED Chaser to initial file and display rate hold the SET button before powering up.

Power and LED connections.

Power connector is used for external power supplied to pins 7,8 and 9,10. Pins 1-6 are used for control pad. Control pad is optional.

Sockets LED 1-8 and LED 9-16 are used for LEDs connection.

| Power Connector | |
|-----------------|-------------|
| Conn | Description |
| 1 | UP |
| 2 | - |
| 3 | DOWN |
| 4 | + |
| 5 | SET |
| 6 | MODE |
| 7 | Ground |
| 8 | Ground |
| 9 | Power |
| 10 | Power |

| LED 1-8 | |
|---------|-------------|
| Conn | Description |
| 1 | LED1 |
| 2 | LED2 |
| 3 | LED3 |
| 4 | LED4 |
| 5 | LED5 |
| 6 | LED6 |
| 7 | LED7 |
| 8 | LED8 |
| 9 | +5V |
| 10 | Ground |

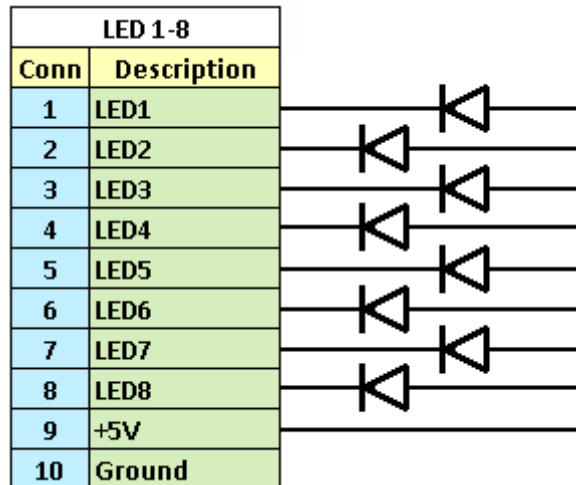
| LED 9-16 | |
|----------|-------------|
| Conn | Description |
| 1 | LED9 |
| 2 | LED10 |
| 3 | LED11 |
| 4 | LED12 |
| 5 | LED13 |
| 6 | LED14 |
| 7 | LED15 |
| 8 | LED16 |
| 9 | +5V |
| 10 | Ground |

Connecting LEDs.

Warning!!! Improper LED connection could cause the control chip to overheat and cause damage to the board. Read the next chapter to understand how to properly design and connect LEDs to the board.

LED control board outputs are Pulse Width Modulated (PWM) which allows for 4095 grey scale gradation levels. The outputs are also constant current controlled with 20ma minimum settings. Additional 20ma can be added by moving one of the dip switches to ON position (more on this later). By default all the dip switches should be in OFF position.

Connecting LEDs are fairly simple. Below is sample connection for a single LED per channel. Anode of the LED connects to internal +5v supply and Cathode connect directly to LED control board channel. Same for LED 9-16 channels.

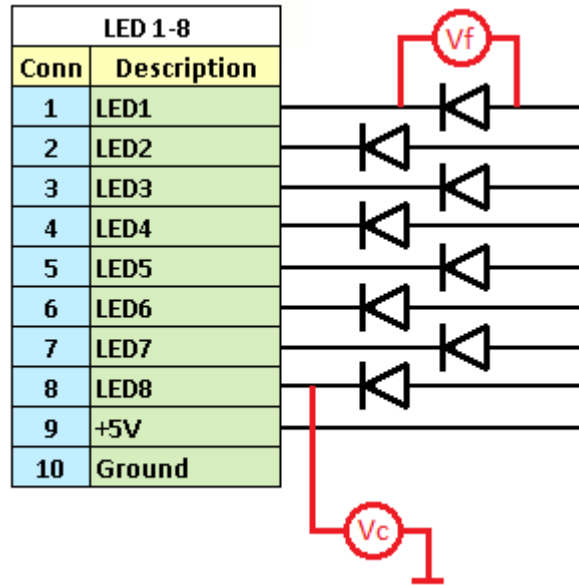


Connecting more than one LED per channel is also pretty simple but takes a little consideration. LED has what it called Forward Voltage or Voltage Drop. Forward voltage defines how many volts need to be applied to the LED for it to light up. The voltage values are between 1.2v and 4v and depend on LED color and manufacturing process. The forward voltage can be found on LED data sheet.

If we measure the voltage V_f across the fully light up LED it would measure to the value specified by the manufacture (see drawing below). Measuring the voltage V_c on the LED channel will be $V_c = 5v - V_f$. The supply voltage (5v in this case) minus the voltage drop on the LED. So if the LED forward voltage $V_f=2.2v$ then $V_c = 5v - 2.2v = 2.8v$.

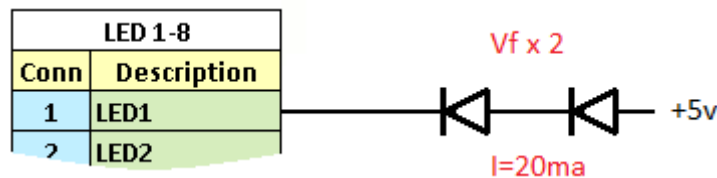
It is very important to keep the V_c (Voltage on the LED channel) low to about 0.6V value. LED control chip can only dissipate 1Watt so when connecting multiple LED always check the V_c voltage and make sure it

is in 0.6v range with fully lit up LED. With a single LED per channel this consideration can be ignored. Total heat dissipation requirement with one LED per channel is less than one watt.

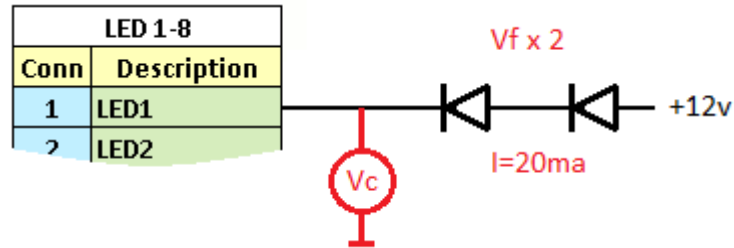


In this section we are going to discuss how to connect multiple LEDs and what can be done to keep V_c to the minimum.

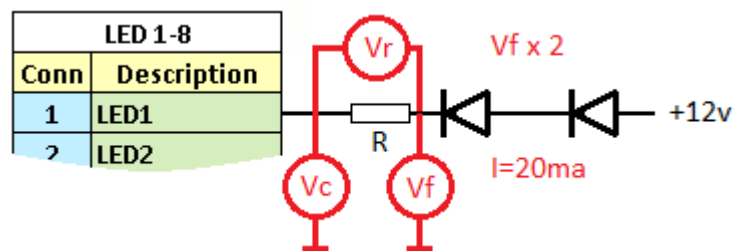
The first choice is to connect two or more LED in-line. In that case LED Forward Voltage multiples by number of LEDs but the current is still 20ma as with a single LED.



If the V_f for a selected LED is 2.2v then total Voltage Drop is 4.4v. That makes $V_c = 5v - 4.4v = 0.6v$ which within our target. If the selected LEDs have $V_f=3v$ then Voltage Drop will be $3v*2=6v$ which is higher than supplied 5v voltage and LED will never be fully lit. In that case LEDs should be connected to a higher voltage source.



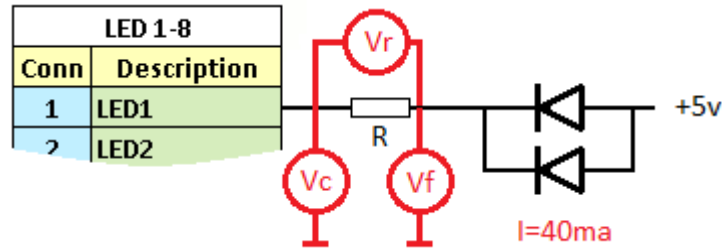
With $V_f = 3\text{v}$ the $V_c = 12\text{v} - 3\text{v} \times 2 = 6\text{v}$. The voltage is too far from target 0.6v so it needs to be lowered. To lower the V_c voltage resistor has to be added.



V_f is equal $12\text{v} - 3\text{v} \times 2 = 6\text{v}$. The V_c target is 0.6v so the voltage drop on the resistor we need to achieve $V_r = 6\text{v} - 0.6\text{v} = 5.4\text{v}$. Knowing the current going through the resistor is the same as through the LEDs $I = 20\text{ma}$ and the voltage drop we need to achieve we can employ Ohms Law ($I = U/R$) to find the resistance R . $R = U/I = 5.4\text{v}/0.020\text{a} = 270$ Ohms.

By adding 270 Ohm resistance to the circuit we can lower the voltage V_c and prevent the circuit from overheating.

The other choice is to connect LEDs in parallel. In that case V_f will stay the same 3v but the current will double $I = 40\text{ma}$.



Let's calculate resistor needed for this scenario. $V_f = 5v - 3v = 2v$. V_c target is $0.6v$ so $V_r = 2v - 0.6v = 1.4v$. $R = U/I = 1.4/0.04 = 35 \text{ Ohms}$.

Use above techniques to calculate necessary resistor for more than two LEDs connected in-line or in parallel. The in-line connection is preferred over parallel as it lowers the current going through the control circuit.

In addition watch the YouTube video where we explain how to connect number of LEDs to the board.

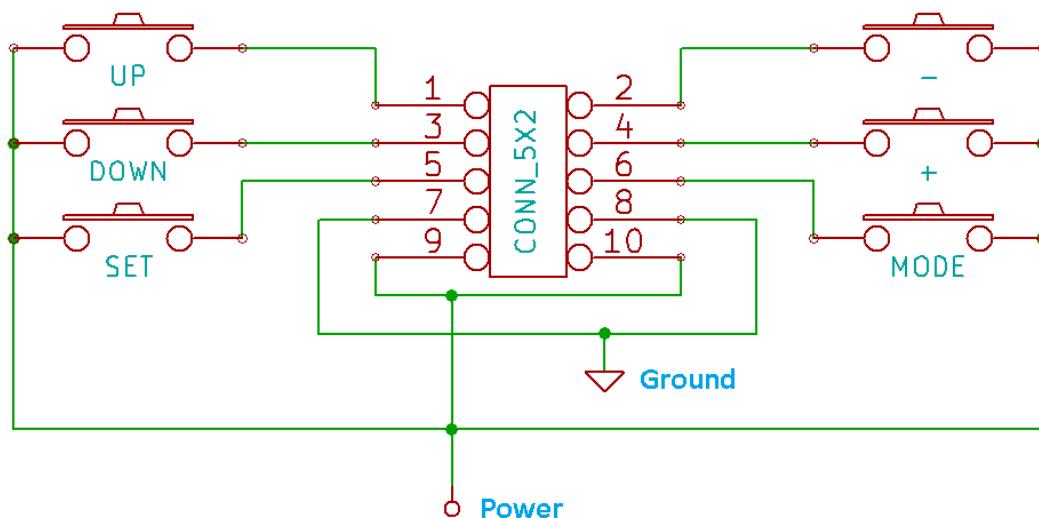
Controlling LED current.

When number of LEDs connected in parallel the current would need to be increased from the default 20ma . With all LED controller dip switches in OFF position the current is limited to 20ma . Each dip switch moved to ON position adds 20ma . There are total of four dip switches on the board, so moving all four to ON will add additional 80ma to the default 20ma .

Extending number of LED channels.

Number of LED channels can be extended to 32, 48, 64 and etc by adding additional boards. Additional boards will have to be loaded with passive firmware and connected to the main board, connecting main board OUT connector to the passive IN.

Schematic of the control pad.



Upgrading LED controller firmware.

In the event the LED controller firmware needs to be upgraded or changed follow the following procedure:

- Download necessary firmware file.
- Place the firmware file on the micro SD card with the file name *reflash.bin*
- Insert micro SD card into the LED controller board.
- Power the board. In a couple seconds board Status LED should light up, which would indicate successful load of the firmware.