RGB/RG LED Matrix Backpack

LED Matrix Backpack
RGB/RG LED Matrix Controller
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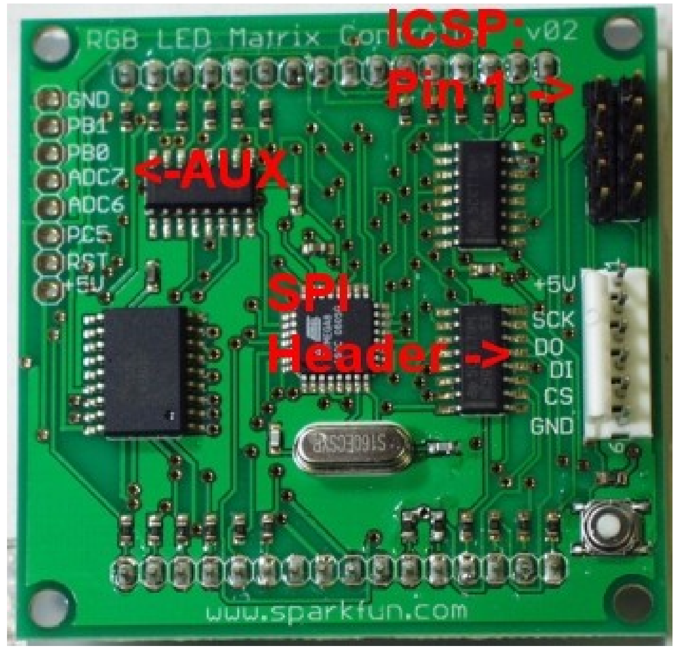
1 Overview

The new LED matrix controller backpacks from Spark Fun offer a versatile way to control dual-color and tri-color common cathode 8x8 LED matrices. The entire controller fits behind the LED matrix so that even larger arrays of matrices may be created. Each backpack is based around an AVR microcontroller and contains all the necessary circuitry to drive the LED matrix.

By default, the microcontroller runs a simple frame buffer program that listens for image data and displays it constantly on the LEDs. Data is sent to the backpack using an SPI interface. The microcontroller may also be reprogrammed to give the LED matrix more individual intelligence.

2 Hardware description

The matrix backpack connects to the RGB/RG matrix using the female .1" headers on the bottom side of the board. There are a number of connections on the top side of the board that can be used depending on the application. The following figure shows the various connections to the LED matrix backpack:



SPI Data Interface:
This header is used in the default frame buffer mode to send data to the matrix. It provides an SPI interface with data in, clock in, data out, and chip select. It also has +5 V and ground connections. In frame buffer (default) mode, this is the only header than needs connection.

ICSP Programming Header:
For custom LED matrix backpack applications, this standard 10 pin header may be used to program the AT Mega 8 microcontroller. It follows the Atmel ICSP SPI standard pin out.

Microcontroller AUX Header:
For custom applications, this header connects to the remaining I/O pins and ADC of the AVR. Switches or sensors may be connected to these lines. The microcontroller reset line, power and ground are also provided.

3 Powering the Backpack

The LED matrix backpack must be powered by a well regulated 5 volt supply. There is no on-board voltage regulation, so voltages that are too low may cause erratic behavior, and voltages that are too high will damage the components.

Because the LED matrix may draw significant currents, and because the power supply will most likely be distant from the backpack, it is highly likely that LED switching will cause undesirable transient behavior on the power and ground rails. This may be symptomatically detected by erratic reset and/or undesired behavior. It is HIGHLY recommended that additional charge storage be located in close proximity to each backpack, and that significant care be taken when distributing power to the devices. The LED matrices use a maximum of 300mA each during operation with the default programming, and typically draw in excess of 100mA.

4 SPI Interface to Default Programming

The RGB/RG matrix backpacks' default program communicates via standard SPI protocol. Data In to the device (MOSI) must be provided via the DI pin. SPI Clock must be provided via the SCK pin. The device will return data via the data out connection (MISO) via the DO pin. All input is ignored as long as the CS pin is logic true (5V) and all data is accumulated as long as the CS pin is logic false (0V).

The device maintains a single 64 byte buffer which represents each position in the matrix. When CS is asserted (low) the device begins reading data from the SPI input and writing it sequentially to the 64 byte buffer. Simultaneously, the device will output the old buffer data, sequentially, on the MISO line. Hence, to program every LED, a set of 64 bytes must be sequentially transferred to the backpack, while maintaining CS asserted. By default, the backpack recognizes only eight colors on the RGB version, and only four colors on the RG version. The following table summarizes the byte-value to color translation.

RG Backpack

Byte Value	*Colors Enable*
0x00	None
0x01	Red
0x02	Green
0x03	Red, Green

RGB Backpack:

Byte Value	*Colors Enabled*
0x00	None
0x01	Red
0x02	Green
0x03	Blue
0x04	Red, Green
0x05	Green, Blue
0x06	Blue, Red
0x07	Red, Green, Blue

SPI Timings:
A delay of 0.5ms is recommended between the assertion of CS and the start of data transfer, as well as after the end of data transfer and the negation of CS. The SPI clock should not exceed 125kHz.

LED Numbering:
The first LED is in the corner immediately underneath the ICSP programming header. Numbering proceeds left to right, top to bottom.

For example:
To have a RGB matrix display “black, red, green, blue” on the first four positions of the first row, and black everywhere else:

1. Assert CS.
2. Delay 0.5 ms
3. Transfer 0x00 via SPI
4. Transfer 0x01 via SPI
5. Transfer 0x02 via SPI
6. Transfer 0x03 via SPI
7. Transfer 0x00 sixty times via SPI
8. Delay 0.5 ms
9. De-assert CS.

5 Programming the LED Matrix Backpack

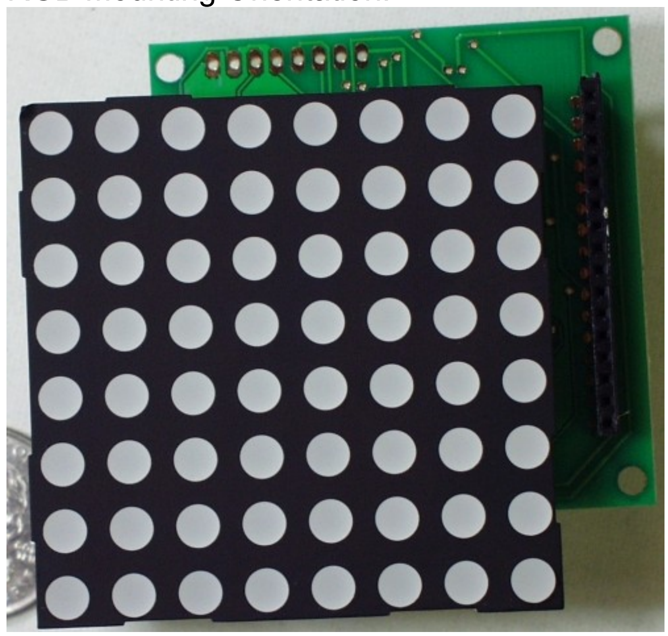
The LED Matrix Backpack provides an ICSP programming interface. Source code is available for the default program mode, as well as a standalone “self control” mode. All programs were compiled, tested, and downloaded to target using the open-source software “WinAVR” freely available from http://winavr.sourceforge.net. Please refer to the self control program for coding examples. Refer to schematics for complete pin configuration.

The AVR sets outputs by way of a 24-bit shift register (16 bits on RG models) and a single 8-bit darlington array. The shift registers provide control to each of the 24(16) LED's which make up a single 8-position row, while the darlington drives the common-cathode of the column. Hence, an image can be created by controlling the columns sequentially and writing all the bits to be displayed on that column to the shift registers.

6 Connection of the LED Matrix

The LED Matrices should be connected to the backpack in the orientations shown in the following diagrams. Pay close attention to the key locations on the outside of the matrix.

RGB Mounting Orientation:



RG Mounting Orientation: