

MIDI Holiday Lights

Version 1.0

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Parts For This Project

Quantity	Part	Vendor	Part Number
1	1N4148 Diode	Radio Shack	276-1122
8	Red LED	Radio Shack	276-0041
8	1N4004 Rectifier Diode	Radio Shack	276-1103
4	PC Board Terminals	Radio Shack	276-1388
1	100 Ohm 1/4W Resistor	Radio Shack	276-1311
1	220 Ohm 1/4W Resistor	Radio Shack	271-1313
4	560 Ohm, 1/2W Resistor	Radio Shack	271-1116
4	100K Ohm 1/4W Resistor	Radio Shack	271-1347
5	10K Ohm 1/4W Resistor	Radio Shack	271-1335
16	12VDC PC Mount Relay	Radio Shack	275-241
1	SPDT Center Off Toggle Switch	Radio Shack	275-0325
1	SPST Toggle Switch	Radio Shack	275-0324
16	2N2222 NPN BJT Transistor	Radio Shack	276-2009
1	Arduino Uno Rev 3	Radio Shack	276-128
1	Arduino Maker Shield	Radio Shack	276-138
1	Enercell DC Power Adapter	Radio Shack	273-318
1	Enercell K Size Adaptaplug	Radio Shack	273-342
1	MIDI Connector	Spark Fun Electronics	PRT-09536
1	0.1" Pin Headers	Spark Fun Electronics	PRT-00116
2	2 Pin, 6" Jumper Wire	Spark Fun Electronics	PRT-10367
1	3 Pin, 6" Jumper Wire	Spark Fun Electronics	PRT-10368
1	4 Pin, 6" Jumper Wire	Spark Fun Electronics	PRT-10369
1	2 Pin, 12" Jumper Wire	Spark Fun Electronics	PRT-10372
1	3 Pin, 12" Jumper Wire	Spark Fun Electronics	PRT-10373
1	DC Power Connector	DigiKey	CP-202A
1	SPDT Slide Switch	DigiKey	450-1598
1	6N138 Optocoupler	DigiKey	6N138QT
2	74HC595 Shift Register	DigiKey	296-1600-5
1	9.52mm Terminal Blocks	DigiKey	ED2677
1	15A Slow Blow Fuse	DigiKey	F2649
1	15A PC Board Fuse Holder	DigiKey	F1498

Assembly Instructions

Introduction:

This project is a MIDI synthesizer of sorts, in that it receives and interprets MIDI messages, but those messages are translated to light rather than sound. 16 notes centered around middle C are mapped to 16 banks of lights – when a note is played, the corresponding relay turns on.

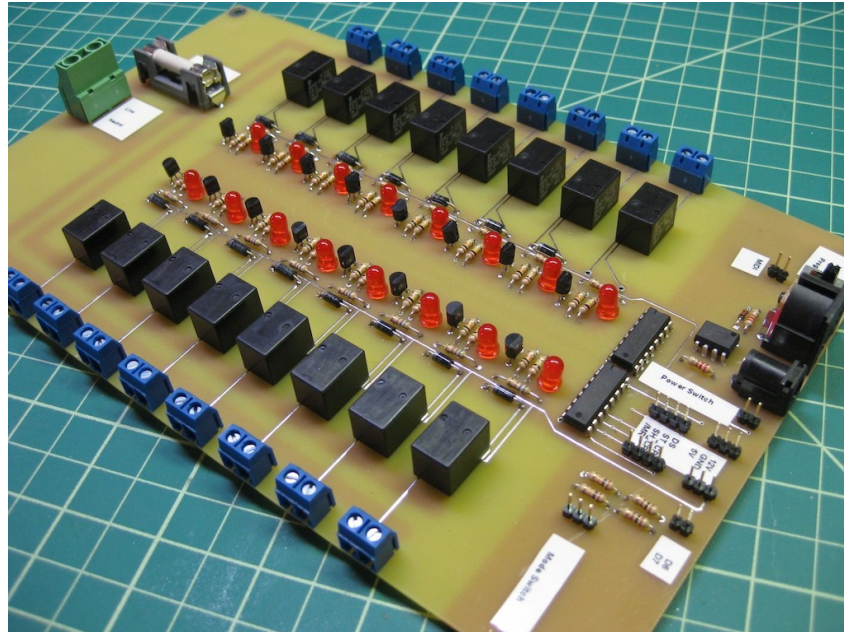
It can run in a standalone mode in which it loops over a previously recorded sequence, or it can play live from a connected instrument. It can even be connected to a sequencer, “playing” the lights in sync with the performance as one instrument in an arrangement.

WARNING: It is strongly recommended that you use this project to control low voltage lighting only, unless you are highly experienced in working with circuits and circuit boards that use 120VAC mains power. Use of mains power involves significant risk. It can potentially hurt or kill you, start fires, etc...

All of the supporting files for this project can be downloaded from:

<https://github.com/vinmarshall/Radio-Shack-MIDI-Lights/zipball/master>

Step 1: Build the Circuit Board



Before building the circuit board, take a minute to study the schematic for this project, which is in the `./schematic` directory of the download. Understanding the schematic will make the circuit much easier to test and debug. Each file corresponds to one section of the circuit. The connections between them are shown with busses, like the +12V, Gnd, and DS busses.

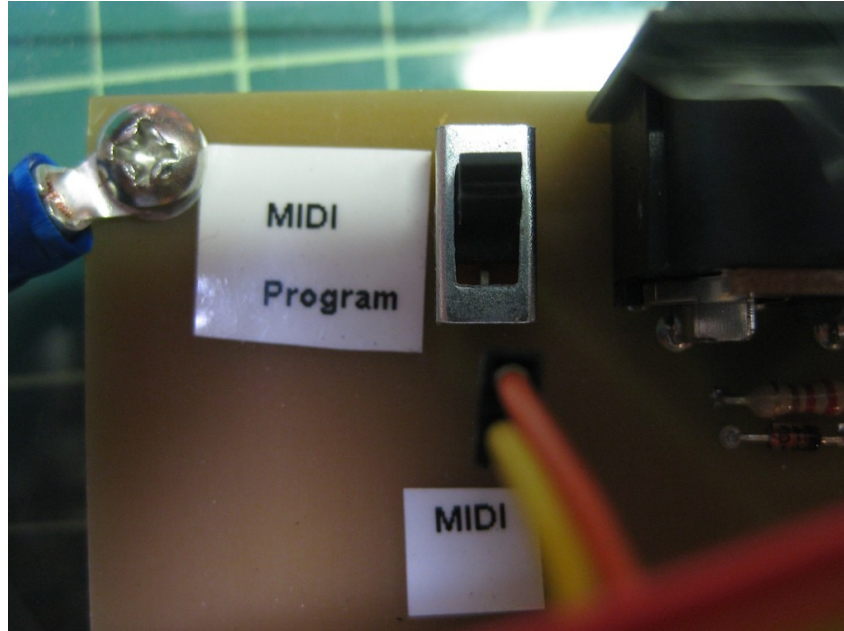
The parts needed to build this circuit are listed in the `./parts` directory of the download. The `ordering_BOM` file lists the parts to order and the `circuit_board_BOM` file shows where to place those components on the circuit board.

There are several options for sourcing the printed circuit board itself:

- Order it from ExpressPCB.com using their free software (windows only) and the `./PCB/rs_midi_lights.pcb` file. There is a minimum order of 2.
- Order it from me (vlm@2552.com).
- Etch the board yourself – either use the PDFs of the top, bottom, and silkscreen layers from the `./PCB` directory or design your own board.
- Do point to point wiring using something like Radio Shack p/n 276-147 – you'll probably need 2.

If you chose to make your own PCB or do point to point wiring, pay careful attention to the size and separation of the traces to carry the lighting power. The circuit and PCB have only been designed and tested as specified in the `rs_midi_lights.sch` and `rs_midi_lights.pcb` files.

Step 2: Program the Arduino



If you don't already have it, download the Arduino software from <http://www.arduino.cc/>.

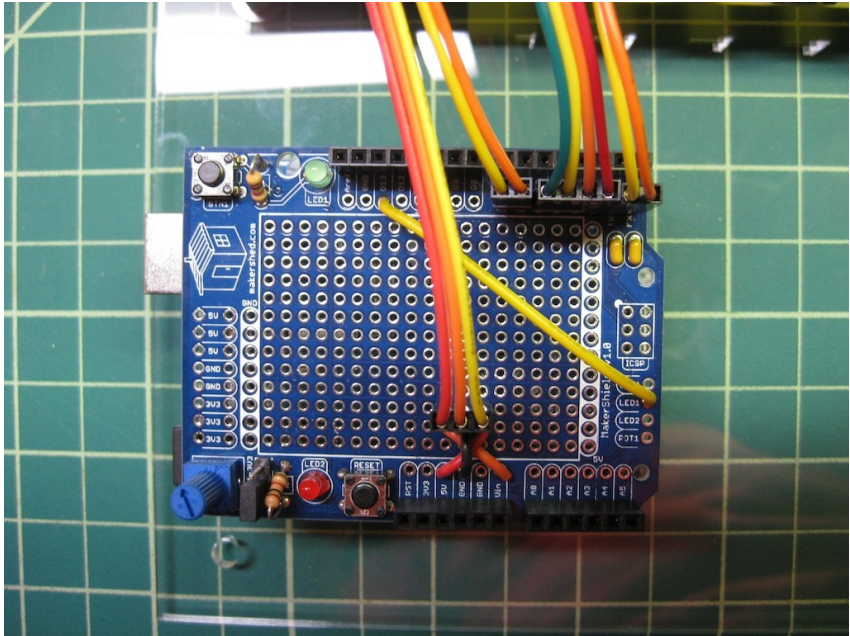
Open the Arduino software and connect the Arduino to your computer via USB. Under the "Tools" drop down menu, select your board type (Arduino UNO for this project) and serial port (/dev/tty.usbmodem***).

Load the MIDI Light Controller software from the ./midi_lights_code directory of the project download and program your Arduino.

If you have any problems with connecting and programming the Arduino, consult the help available in the Arduino forums at <http://arduino.cc/forum/>.

If you want to program the Arduino again after you've connected it to the MIDI lights circuit (1) make sure the lighting power is disconnected and (2) set the MIDI / PROG switch located next to the MIDI connector to Program. Switch it back to MIDI after programming is complete.

Step 3: Connect the Circuit Board



The circuit board is connected to the Arduino by a series of jumpers. A “maker shield” is placed on top of the Arduino to make the connections for these jumpers. The jumpers plug into 0.1” headers.

Wire Arduino pin D13 to the maker shield pin “LED 1”.

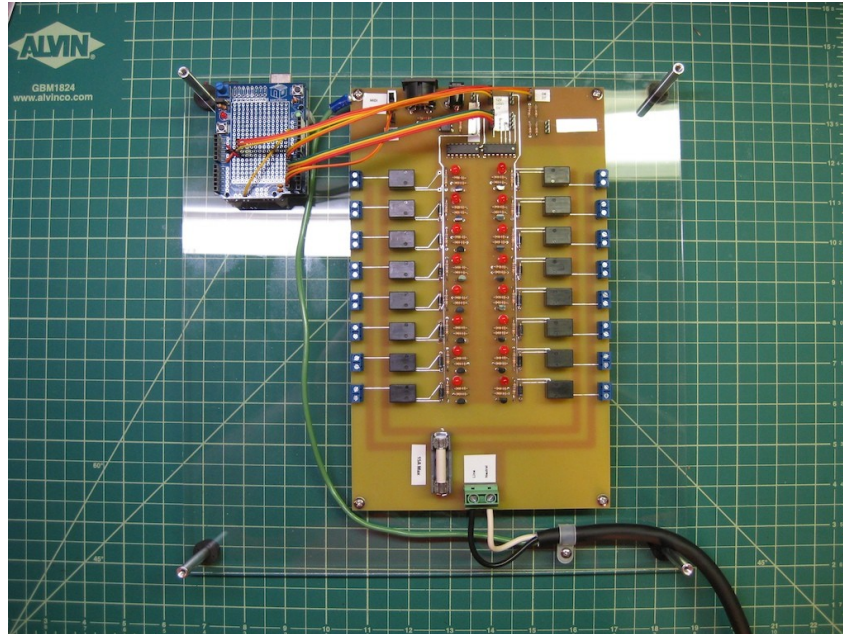
Wire three pins for a Power connection as follows:

Arduino	PCB	Jumper
Vin	12V	3 wire 6” jumper
GND	GND	
5V	5V	

Solder pins to Arduino D1-D8 for connection as follows:

Arduino	PCB	Jumper
D0 (RX)	MIDI IN	2 wire 6” jumper
D1 (TX)	Not Connected	
D2	/MR	4 wire 6” jumper
D3	SH_CP	
D4	ST_CP	
D5	DS	
D6	D6	2 wire 6” jumper
D7	D7	

Step 4: More Wiring



Switches and a lighting power supply also need to be connected to the circuit board.

The switches are easy:

- Cut one end off of a 2 wire, 12" jumper and solder it to the SPST toggle. Connect the other end to the power switch headers on the PCB.
- Cut one end off of a 3 wire, 12" jumper and solder it to the SPDT toggle. Connect the other end to the mode switch headers on the PCB.

The lighting power supply is a bit more complicated. The circuit is set up to provide power to each pair of terminals when the corresponding relay is activated. The lighting power is connected to the set of terminals at the bottom of the board, in the center.

DO NOT connect to any kind of power yet. Read the following before deciding what power to connect to this circuit:

I recommend the use of low voltage lighting with this project. Remember that mains power can potentially burn down your house, kill you - that kind of thing.

Only consider using 120VAC with this project if you are comfortable not only in your ability to safely build and operate a project using mains power, but also in your ability to examine the circuit schematic and the circuit board to verify that it is suitable for this use and meets all applicable standards and regulations in your area. The project isn't a finished consumer product and it shouldn't be treated as such.

Make sure you have thought through and checked the circuit, the board, and all of your wiring and connections to it BEFORE you connect power to this project. It is ultimately your responsibility to do this safely.

If you are using low voltage DC, connect the (+) lead to the power terminal at the bottom of the board marked "Line" and the (-) lead to the terminal marked "Neutral". Observe the same convention at each of the output terminals as you connect the lighting. Note that the

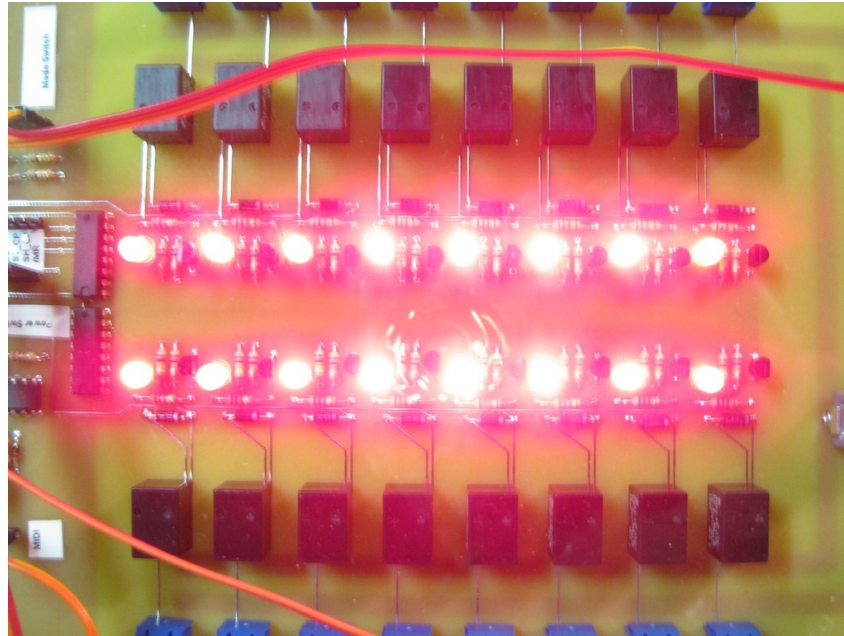
orientation is reversed on the left and right sides of the board.

If you are using 120VAC, connect the black, or hot, leg to the power input terminal at the bottom of the board marked "Line" and the white, or neutral, leg to the terminal marked "Neutral". Observe the same convention at each of the output terminals as you connect the lighting. Note that the orientation is reversed on the left and right sides of the board.

Use a 3AG fuse no larger than 15A in the fuse holder. Size the fuse's rating to your circuit's expected current draw. The relays are rated for 1A maximum at 120VAC or 24VDC.

The Ground from the lighting power source should be attached under the mounting screw at the top left of the circuit board, as pictured above. The chassis ground from your enclosure should also be attached to this point. Grounding the circuit is very important.

Step 5: Testing



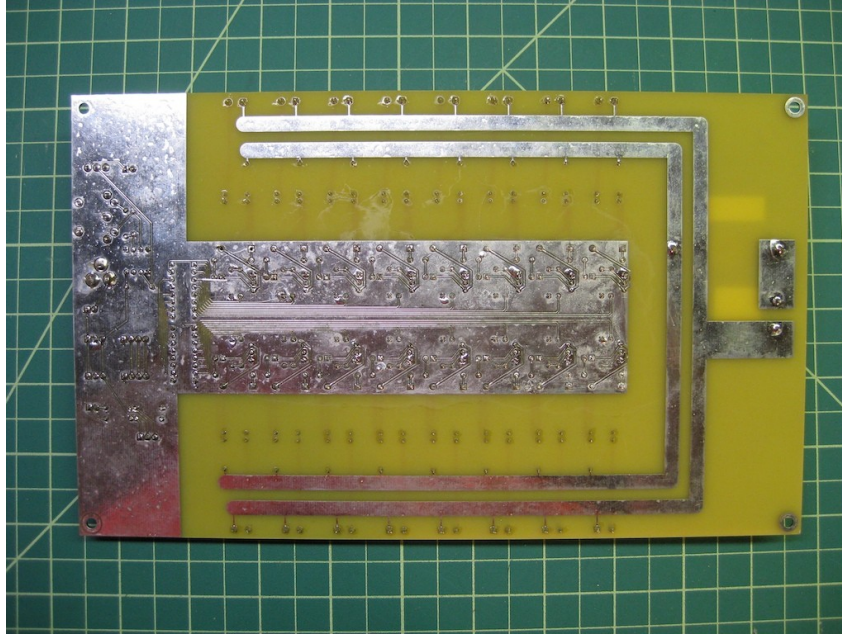
Do this step **BEFORE** making any connections to the relay screw terminals. The lighting power source should **NOT** be connected yet.

Install the barrel tip on the power supply such that the sleeve of the barrel (outside) is negative and the tip (inside) is positive. Connect the 12V power to the barrel jack at the top of the PCB.

Attach a MIDI keyboard and power up the circuit. You should hear all of the relays click 3 times. Put the mode switch in "Live" (center position) and verify that the notes you are playing on the keyboard are being translated into relays turning on and off. You can see which relays are active because the corresponding LEDs will also be lit.

If things are not going smoothly, there are a number of debug modes that can be enabled to assist in troubleshooting. Look at the Arduino code for more detail.

Step 6: Mount the Circuit



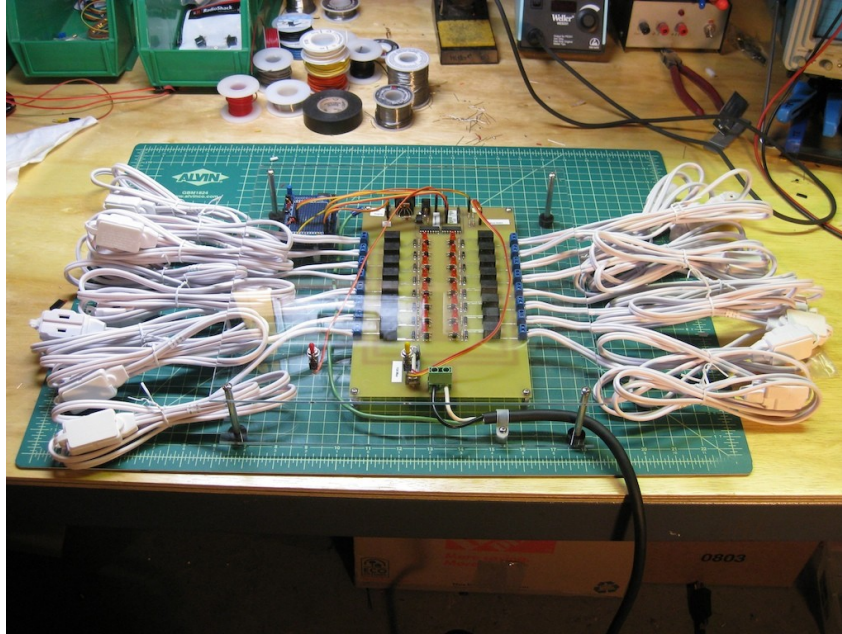
Because of the power traces on the circuit board, it needs to be mounted securely inside a suitable enclosure. A suitable enclosure will isolate and protect the component leads and wiring / traces on the board from any contact with contaminants, foreign objects, body parts, and any conductive part of the enclosure. The board should be isolated by at least 1 inch from anything conductive.

This board and this circuit are NOT designed to be used outside or in any kind of harsh environment.

The acrylic setup in my pictures is NOT an acceptable enclosure – I'm using it only for demonstration purposes. It is not acceptable because it does not protect against intrusion from foreign objects that might come in contact with the power traces.

The chassis ground from the enclosure should be attached to the top left mounting screw of the PCB, along with the ground from the lighting power supply.

Step 7: Power Dongles (Optional)



I used cheap extension cords from Home Depot (SKU# 144983, \$1.47 each) to connect my lighting. This allows you to bring the power to the lighting rather than routing all of the lights back to the MIDI Light Controller.

To prepare these dongles, cut off the plugs, strip about 1/4" of insulation from both leads, and tin them with solder. Keep the solder minimal so that they will still fit into the screw terminals.

These cords are polarized. The wire that connects to the narrow plug slot is the Line (hot) conductor. Make sure that hot wire gets connected to the Line side of the screw terminals. Note that the orientation of the Line / Neutral terminals is reversed on the right and left sides of the board. Refer to the silkscreen layer for markings.

Check the Github repository for the most recent version of this document:

<https://github.com/vinmarshall/Radio-Shack-MIDI-Lights>

DISCLAIMER: This project is not a consumer product; it is just one hobbyist sharing his plans. It is provided "AS IS" without warranty of any kind, either expressed or implied, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. You are building and operating this at your own risk.

If you are going to use this project to switch mains power, you must be aware of and in compliance with UL 60950-1, UL 62368, IPC-2221A, and any and all other relevant or applicable standards. Please do not attempt to use this to switch mains power if you do not possess sufficient experience to do so safely.