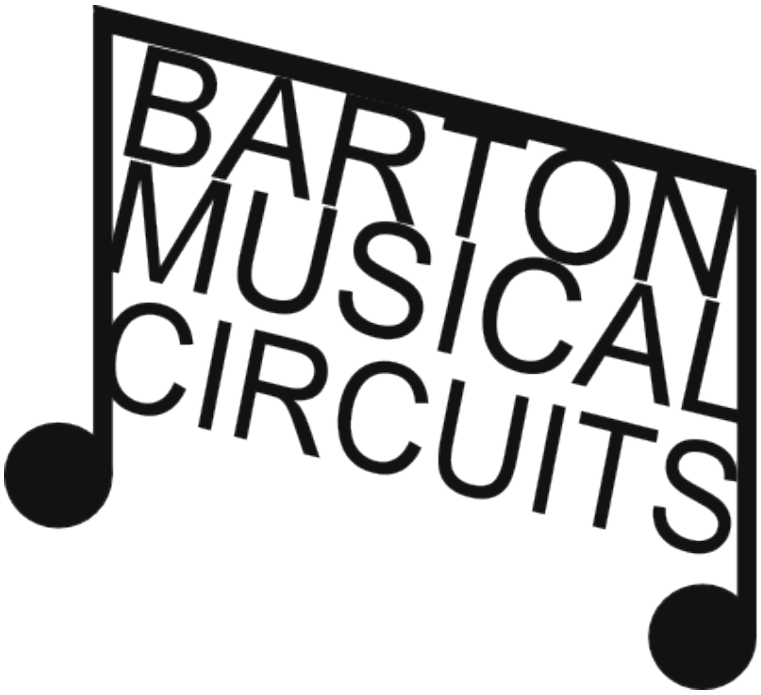


BMC045. Programmable Router.

Last updated 6-25-16

I. Features

A.How it works

This is a micro-controller based synth module that is used in to route signals. Pushbuttons are used to select which output (rows designated by letters A through D) an input (columns designated by numbers 1 through 4) is routed to. LEDs indicate the chosen routing pattern. The routes can be saved and loaded with the micro-controller. A knob selects which of sixteen banks a routing pattern will be saved to or loaded from. There are LED indicators showing which of the sixteen banks is selected.

B.Switching Logic

The router has three different modes of switching rules.

1.Single Input-Many Output (SIMO) – This is the default rule set. A single input can be routed to many different outputs. This helps protect modules from having their output circuits connected and causing possible damage.

2.Single Input- Single Output (SISO) – This rule set sets it so that one input will only go to a single output. It also sets it so that each output is always routed to an input, so selecting a route for one channel will affect the route of another.

3.Many Input- Many Output (MIMO)– Multiple inputs can be routed to the same output and multiple outputs can be routed to the same input. Most modules are not designed to have their outputs sent to the outputs of other modules, and this can cause problems. You have been warned.

Selecting which rule set to use is simple. With the unit powered on, move the knob until the LEDs are in the correct position for the ruleset (see below). Then power the unit off, wait 30 seconds, then hold down the "Save" push button while powering the unit back on. It should now be in the correct rule set. Changing rule sets will erase your saved patterns, as the patterns of one rule set will be invalid with another rule set.

SIMO – to select, make it so neither the white or blue LED is on.

SISO – to select, make it so the blue LED is on, but the white is off.

MIMO – to select, make it so the white LED is on, but the blue is off.

C.Inputs/Outputs/Controls

INPUTS

1-4.Inputs for Routing – These are the inputs that are routed to outputs. These can be any signal produced by your modular synthesizer.

5.Load Trigger – A trigger or gate signal input here will cause the module to load the pattern saved to the selected memory bank.

6.Select CV – A control voltage input here will select which memory bank to be saved/loaded to. The micro-controller only responds to voltages between 0 and +5V, so keep that in mind when selecting CV sources. This input is attenuated by the select knob. It is normalized to +5V.

OUTPUTS

1-4. Outputs from routing – These are the outputs that are routed from the inputs.

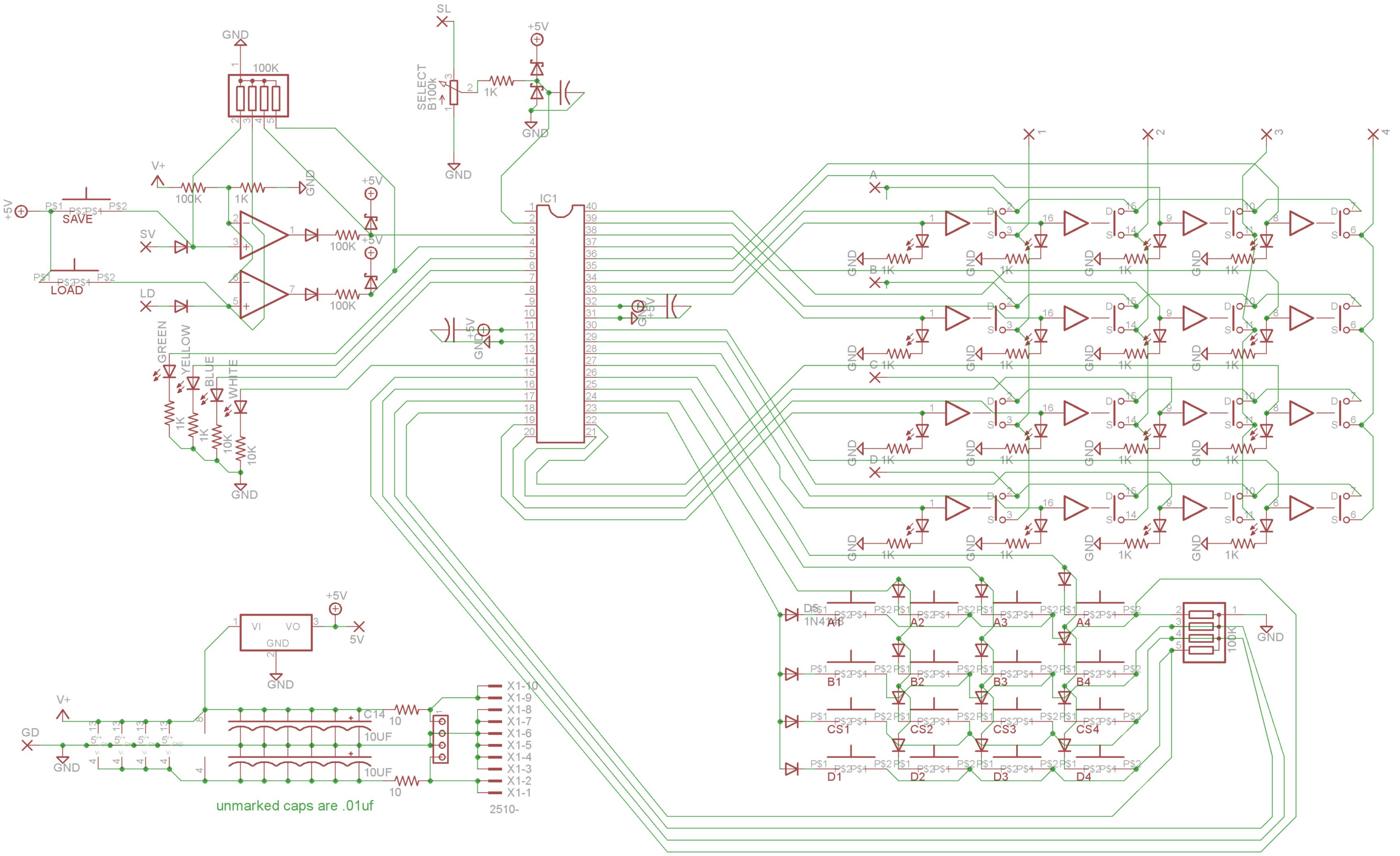
CONTROLS

1-16. Routing pushbutton – These sixteen pushbuttons select which input is routed to which output.

17.Save Button – This saves the current pattern to the selected memory bank. It is also used in selecting rule sets for switching.

18.Load Button – This loads the currently selected memory bank.

19.Select Knob – This selects which memory bank is loaded from or saved to.



SL
SELECT
B100k
GND
+5V
100K
V+
1K
SAVE
LOAD
SV
LD
GREEN
YELLOW
BLUE
WHITE
10K
IC1
A
B
C
D
1
2
3
4
D5
1N4148
A1
A2
A3
A4
B1
B2
B3
B4
CS1
CS2
CS3
CS4
D1
D2
D3
D4
VI
VO
5V
GD
C14
10UF
10
X1-1
X1-2
X1-3
X1-4
X1-5
X1-6
X1-7
X1-8
X1-9
X1-10
2510-
unmarked caps are .01uf

II. Schematic.

On the previous page is the schematic for this project. I've rotated the picture to fit on the page, in my description of the circuit, I'll refer to this image as though it was rotated 90 degrees counter clockwise. Not pictured are the connectors between the two PCBs. Looking at the PCBs it should be easy to tell which parts are on which PCB. T

In the upper left part of the schematic we see the Save/Load buttons and inputs. These circuits are identical. The input wire pad goes through a switching diode to keep signal from the button from feeding to the module driving the input. The buttons are normally off, but connect to +5V. The button and input are then sent to a comparator set with a threshold of 1/100 of the positive voltage. The input of the comparator references ground through a 100k resistor which is part of a resistor array. The output of the comparator's voltage is limited to 0 to +5V by the network of diodes and resistors.

Above the micro-controller is the Select knob and input. The input is attenuated by the potentiometer, and the voltage on the wiper goes through a 1k resistor and a pair of schottkys to limit the voltage to between 0 and +5V. The .01uf capacitor filters high frequency noise out of this signal.

Below the Save/Load switches are the select indication LEDs. Each of these has a current limiting resistor. The blue and white use 10K and the green and yellow use 1k. If using high-effeciency LEDs, you can increase these values to lower the brightness of the LEDs.

Below these LEDs are the power connections. There are two PCB footprints for power connectors which are parallel to each other. The positive and negative voltage rails are filtered by a 10ohm/10uf low-pass filter, and there are additional .01uf capacitors at the power connections for the ICs. The +5V supply is created by a 78L05 voltage regulator. There are wirepads for +5V and Ground to be used for offboard wiring.

To the right of microcontroller is the router control circuitry. Every router input is connected to four analog switches which are controlled by the micro-controller, this requires sixteen switches. The four router outputs are then connected to the other side of these switches. This makes it so the signal being routed is only in contact with the switch, making this as similar to a directly wired connection using electronic means as possible. The control pin of each switch is connected to a pin on the micro-controller and a red indication LED with a 1k current limiting resistor.

Below the router control circuitry are the push buttons for pattern selection. These are laid out in a 4x4 grid, with 4 input pins of the micro-controller monitoring voltages on four pins at a time, and another four output pins of the micro-controller selecting which four pins voltages should be monitored. This is done by only outputting voltage on one output pin at a time. Switching diodes are used to keep accidental positives from pressing multiple buttons at once, and a 100k resistor array provides ground reference.

III.Construction

A.Parts List

Semiconductors

Value	Qty	Notes
TL072	1	8 pin DIP packaging
DG202	4	16 pin DIP packaging
16f914	1	40 pin DIP packaging
1n4148	19	Or other small switching diode. Through hole
1N60P	4	Or other schottky diode
Red LED	16	3mm
Green LED	1	3mm
Yellow LED	1	3mm
Blue LED	1	3mm
White LED	1	3mm
78L05	1	TO-92 Packaging

Resistors

Value	Qty	Notes
10 ohm	2	7.5mm lead spacing, 1/4W Metal film
1K ohm	20	" "
10K ohm	2	" "
100K ohm	3	" "
100Kohm bussed array	2	5-pin array, or use 4 resistors.
B100K Potentiometer	1	9mm Right angle PCB mount, linear taper. Value not critical. Like this.

Capacitors

Value	Qty	Notes
.01uf	13	cheap ceramic 2.54mm
10uf	2	Electrolytic

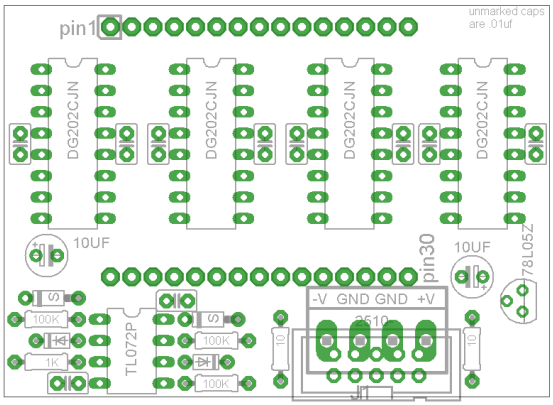
Other

Value	Qty	Notes
Power Connecter	1	Either Eurorack or MOTM
8pin DIP socket	1	
16pin DIP Socket	4	

40pin DIP socket	1	
Jacks	10	One jack needs to be switching type.
Push Button	18	Momentary normally off type.
Male single row header	2	15 pins each. 2.54mm spacing. A single 40-pin header can be broken into two 15 pin headers
Female single row header	2	15 pins each. 2.54mm spacing. A single 40-pin header can be broken into two 15 pin headers

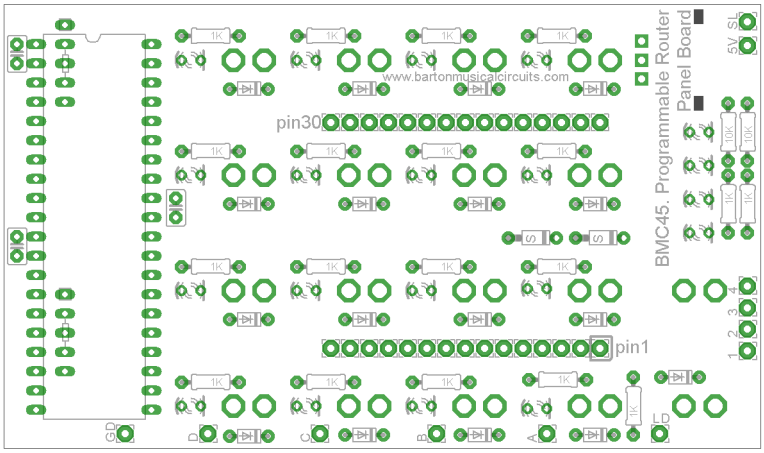
B.The Boards

This project is split into two PCBs. One board is mounted to the panel ("Panel Board") and the other has the power connection and some ICs ("Chip Board"). The two boards are connected by pin headers. The first and last pin headers are marked with numbers. Make sure that the "pin1" and "pin30" are matching when connecting boards.



The chip board (to the right) has all components but the connecters mounted on one side. I recommend installing components in the following order:

1.Resistors/diodes
2.ceramic capacitors
3.IC sockets
4.78L05
5.Power connecter
6.Electolytic capacitors
7.Pin headers (on the opposite side of the PCB)

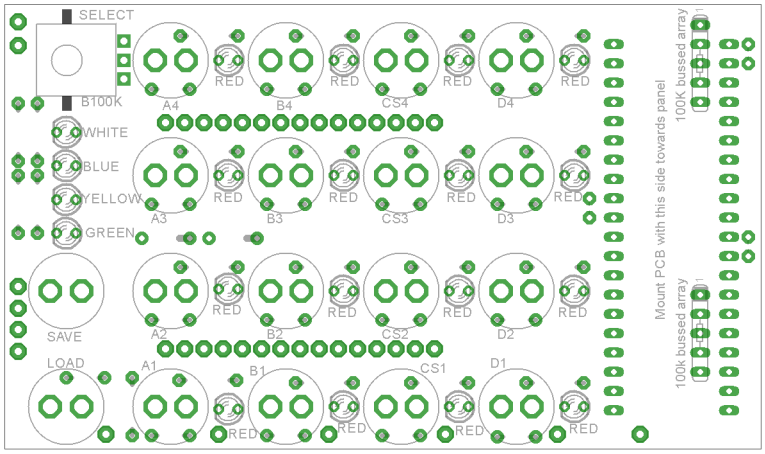


The Panel Board has multiple components on each side. I recommend installing components in the following order:

1.Resistor Arrays.
2.Resistors and diodes.
3.Ceramic capacitors.
4.IC socket.

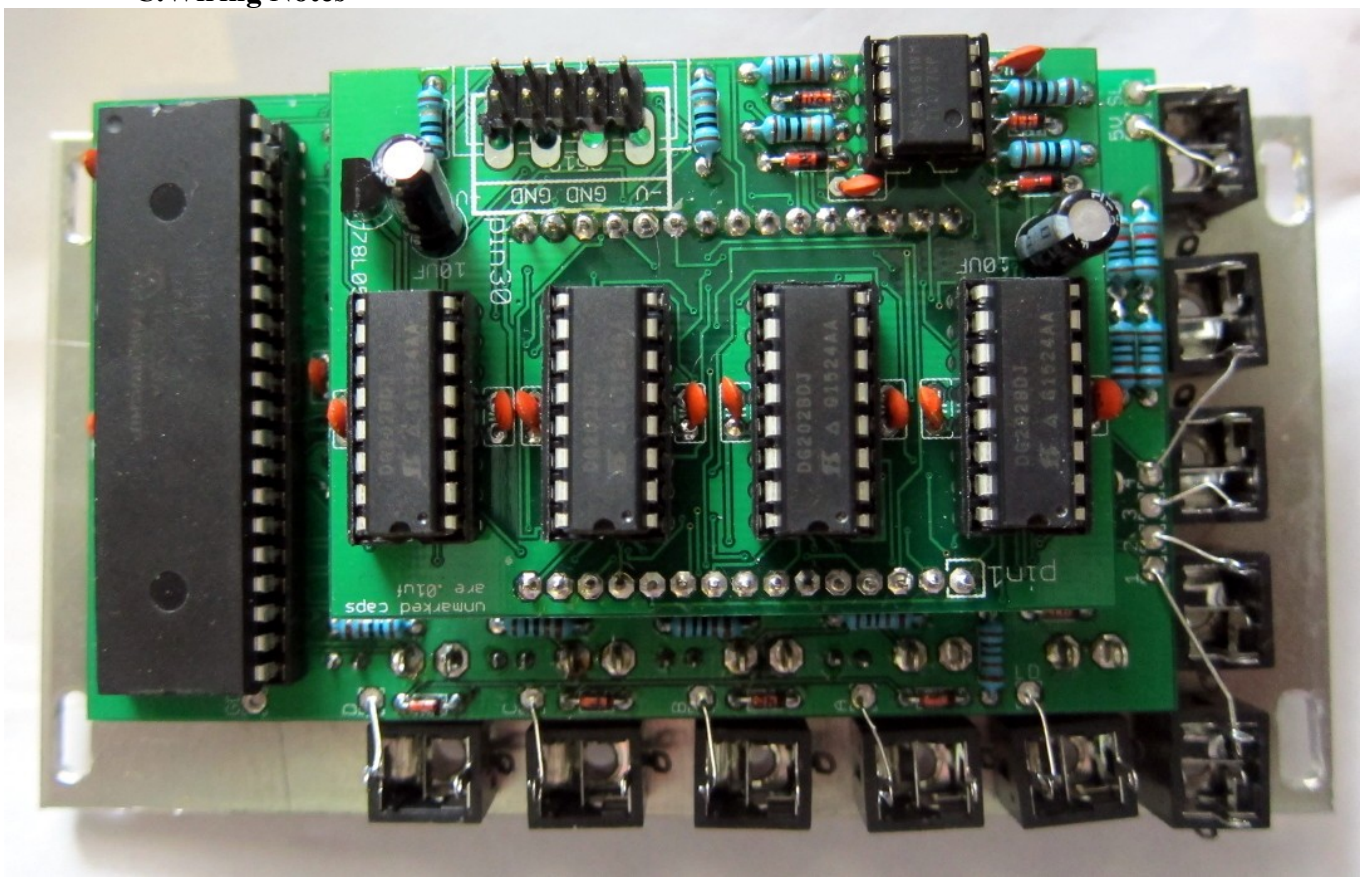
For the following components, I recommend only soldering one pad per component before mounting to the panel, then resoldering this pad and soldering the rest of the pads after mounting. This should reduce mechanical stress on the parts and the PCB.

5.LEDs
6.Pushbuttons
7.Potentiometer.

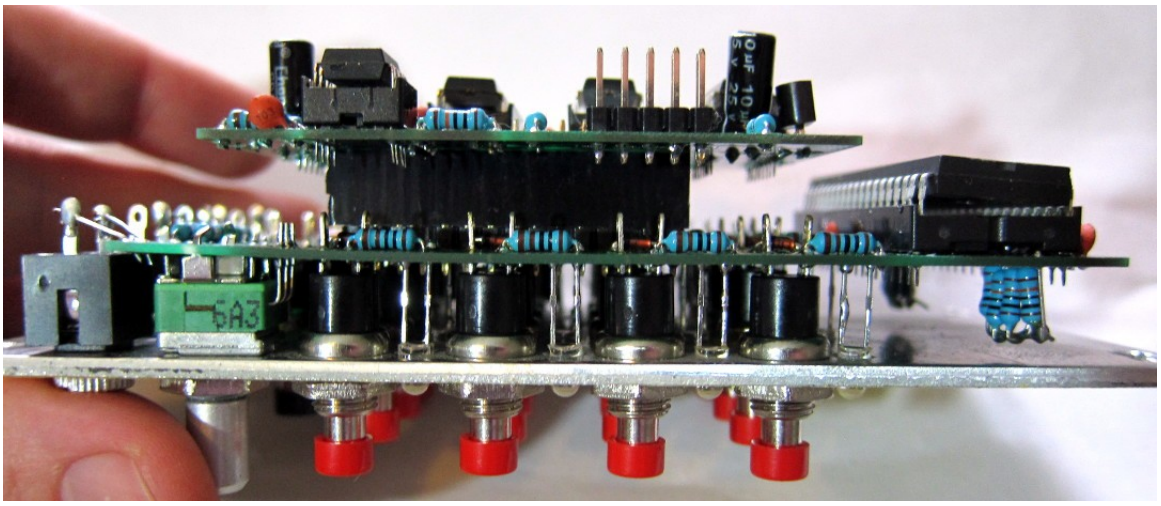


Carefully check your soldering before mounting the panel board to the panel!

C.Wiring Notes



Above is a wired module with the chip board attached. The jacks are close enough to use resistor leads instead of wire in order to connect to the wirepads. The Ground jack is not wired in this photo, wire it to the sleeve connector of any jack.



Above is a sideview of the module.