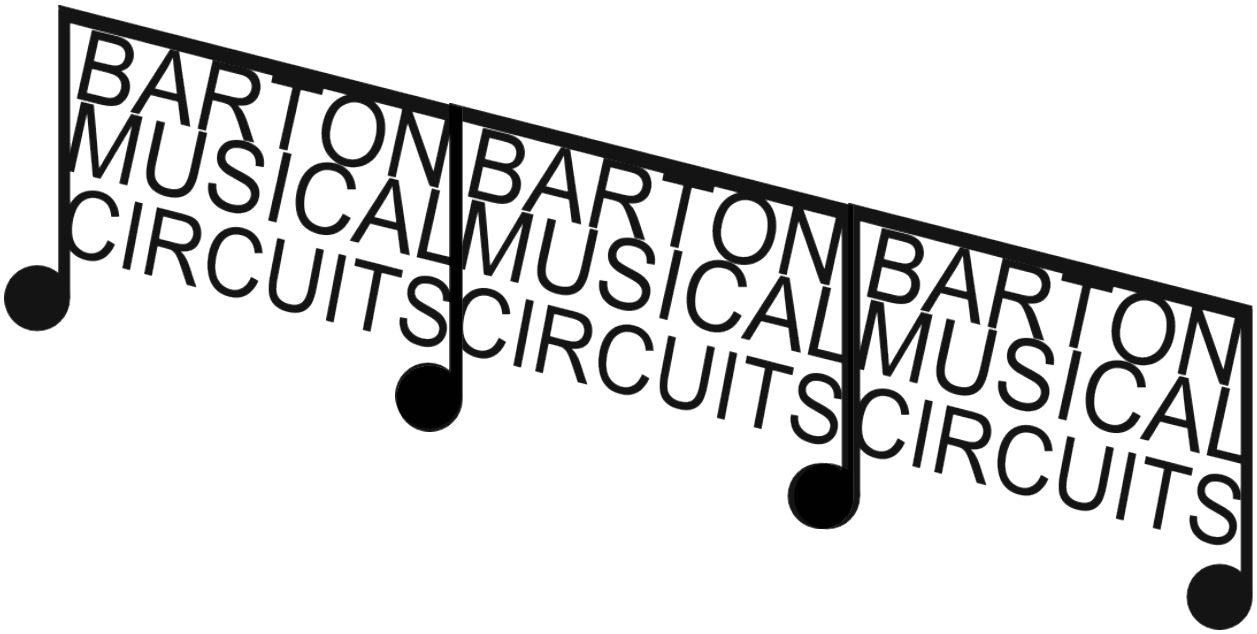


BMC 004. Voltage Controlled Clock/Divider Manual/Build Documentation.

Last edited 5-29-2011

Updates to this file will be posted at www.bartonmusicalcircuits.com
Any questions or suggestions can be e-mailed to Michael@Bartonmusicalcircuits.com

I. Using The Module.

1.CONTROLS.

BMC 004 uses two different types of controls, analog controls controls and digital controls. Analog controls are implemented with via knobs, external control voltages or a combination of the two. They present a finer degree of control than digital controls. Digital controls are implemented via switches or external gate or clock signals. They are either on or off with no middle ground.

A. TEMPO - The TEMPO control is an analog control. When the DIVIDER control is disengaged (see next section) the TEMPO control determines the frequency of the master clock which the dividers derive their frequencies from. When the DIVIDER control is disengaged, the tempo control is unused.

B. DIVIDER- This is a digital control, best implemented as a switch. When set off, the module acts as a master clock, and the RESET control acts as a reset. When set on, the module acts as a divider of an external clock and the RESET control acts as an input for an external clock.

C. RESET - This is a digital control, best implemented as a jack for external signals. When the module is acting as a master clock, a trigger or gate signal inputted to RESET will cause the master clock to reset, turning the internal counter back to zero and turning on all outputs. When the module is acting as a divider for external clocks the RESET is used as the input for the external clocks.

D. DIVISION1 through DIVISION6 - These are analog controls. In standard operation these select the level of frequency division used for each corresponding output. The levels of division available are 1, 2, 3, 4 , 5, 6, 7, 8, 16, 32, 64. In random operation DIVISION1 through DIVISION4 controls are re-purposed and DIVISION5 and DIVISION6 are not used.

E.PWM1 through PWM4 - These are analog controls. Each of these controls the pulse width of the corresponding output.

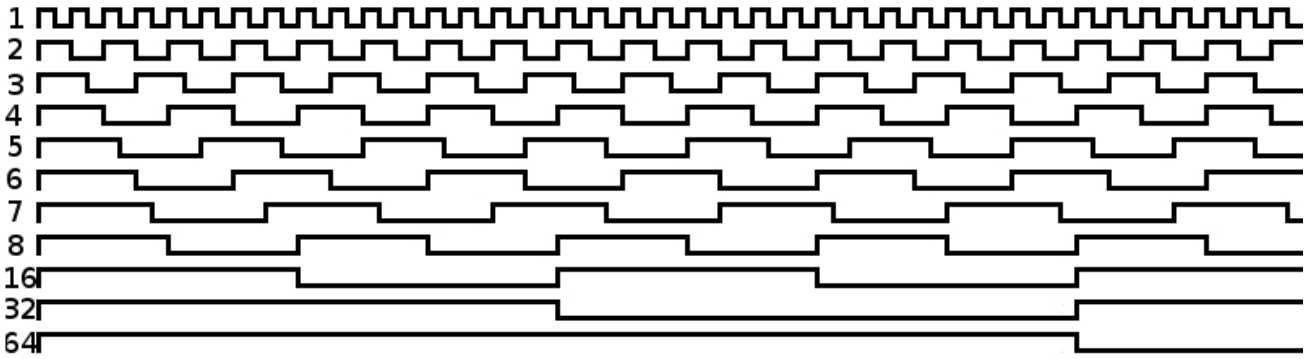
F.RANDOM - This is a digital control. When set off, the module acts in it's normal mode. When set on, the module acts in random mode.

2.STANDARD CLOCK/DIVIDER MODE

In standard mode, the modules outputs pulses whose frequencies are divided by a master frequency. In clock mode, this frequency is controlled by the TEMPO control, and in divider mode this frequency is controlled by the clock inputted to the RESET input. In clock mode a rising edge on the RESET input will reset the clock and dividers, setting all outputs high. Graph 1 illustrates the division of frequencies, showing all outputs having 50% pulse width. Pulse width is varied by the PWM controls for each output (not available if using 6 outputs).

(Note: when changing divisions in any mode, new divisions are not recognized until after the output goes low, so when dealing with very high levels of division, there may be some delay when changing divisions)

GRAPH 1.



3.RANDOM CLOCK/DIVIDER MODE

In random mode, PWM, RESET and TEMPO controls act identically as they did during standard mode, but the division of frequencies is no longer controlled by the DIVISION controls. Instead, frequency division is randomly selected and the DIVISION controls now control how often the division is selected and what levels of division are available. Each output has a re-roll counter which when it reaches zero causes that output to find a new random division. In Random clock mode, a trigger signal on the RESET input will cause new random divisions are reset all re-roll counters.

1.DIVISION1 now controls the re-roll counters lengths. The lengths available are 1, 2, 3, 4, 5, 6, 7, 8, 16, 32, and 64.

2.DIVISION2 now controls the input for the re-roll counters. When the analog voltage inputted is less then 2.5 volts each re-roll counter's input comes from it's corresponding output, thus each output's division will change at times which are not directly related to each other. When the analog voltage inputted to DIVISION2 is greater than 2.5 volts, each re-roll counter's input comes from the master clock frequency. This way division changes will sync up with one another.

3.DIVISION3 when set above 2.5 volts will allow only divisions which are square of two (2,4,8,16,32,64) to be selected.

4.DIVISION4 sets the maximum random division level.

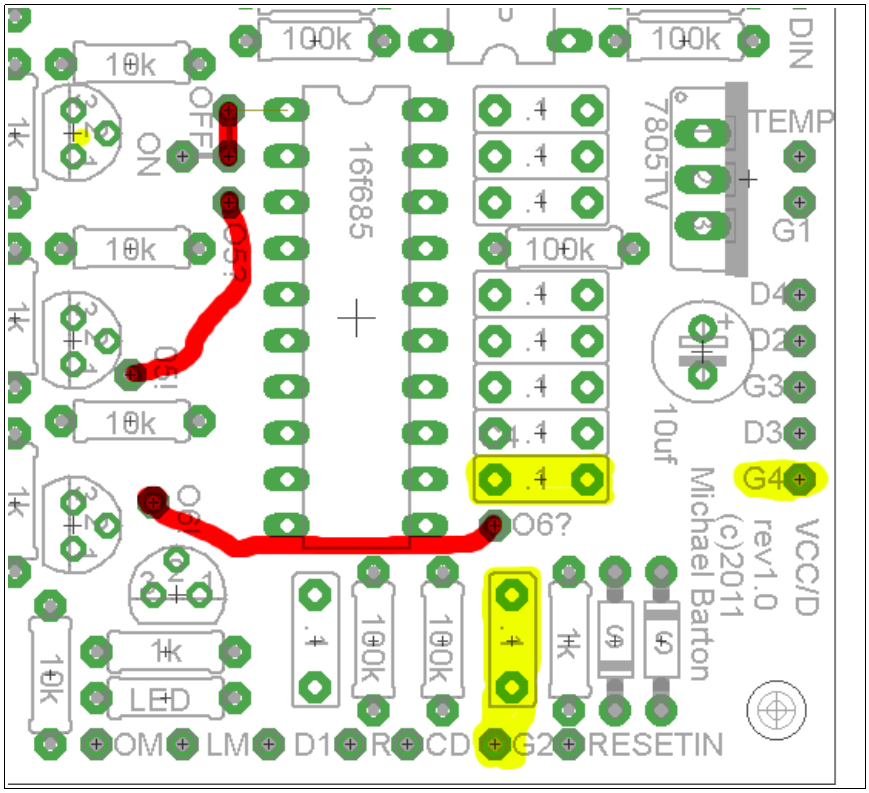
II.BUILDING THE MODULE

1.Decide before you build.

Before you begin to source your parts or stuff the pcb for this build, there are two decisions you need to make. First, whether the module should have the PWM feature or 6 outputs and two how many analog controls need external voltage control.

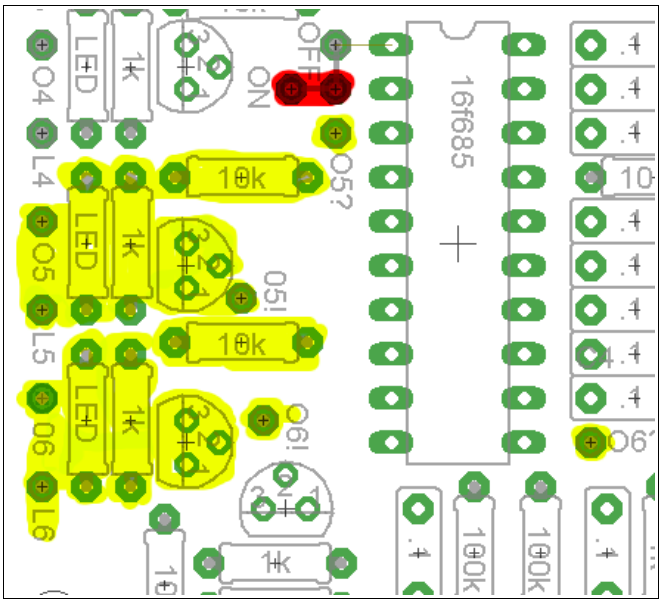
When using 6 outputs the pins on the microcontroller normally used for PWM controls are used instead as two additional outputs and division controls for those outputs. When using 6 outputs on the board you will need to place a jumper from the pad next to pin 2 of the 16f685 to the pad marked "OFF." Additionally, you need to place a jumper from the pad marked "O5?" to "O5!" and another jumper from "O6?" to "O6!" The wiring pads marked "G4" and "G2" should be unused, and the decoupling caps associated with them should not be installed.

The diagram below shows where connections should be made in RED and pads which should be left alone in YELLOW.
DIAGRAM1. Wiring for 6 outputs



When using the PWM control, the transistor buffers used for outputs 5 and 6 do not need to be installed, and a jumper going from the pad near pin 2 of the 16f685 to the pad marked "on" should be placed. The diagram below shows needed jumpers in RED and components which should not be installed in YELLOW.

DIAGRAM2. Wiring for PWM



The next thing that should be decided upon before building the circuit is how many of the analog inputs should have external CV control mixed in with the control knob. The board is set up with four voltage mixer circuits. The inputs of these circuits are marked AIN, BIN, CIN and DIN. The outputs of these circuits are marked A, B, C, and D. If you don't need any external CV mixing both of the TL064s and their associated circuitry can be removed (see diagram 3) and if you only need two channels of CV mixing you can remove one of the TL064s and it's associated circuitry (see diagram 4). An diagram 5 shows how the panel mounted components should be connected with the board.

DIAGRAM3. No CV Mixing. (Yellow = omit part)

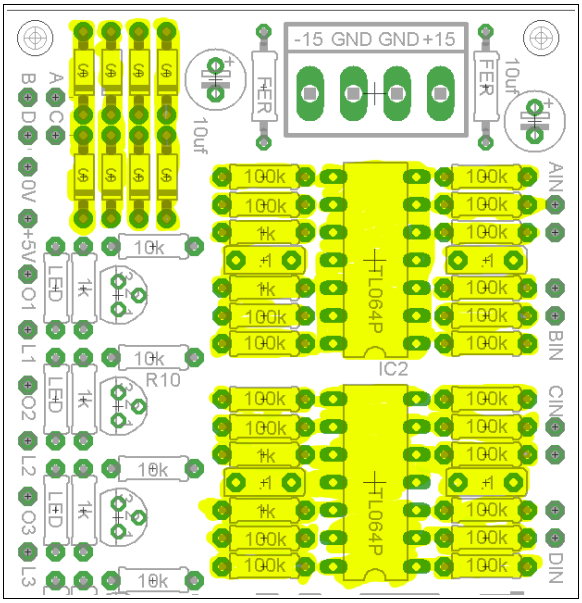


DIAGRAM4. 2 Channel CV Mixing

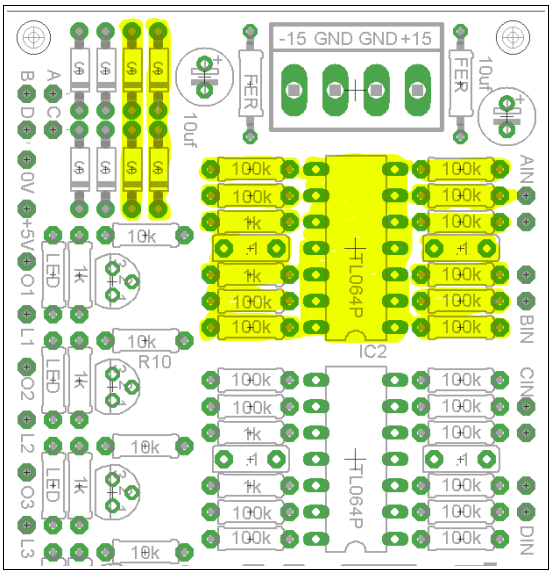
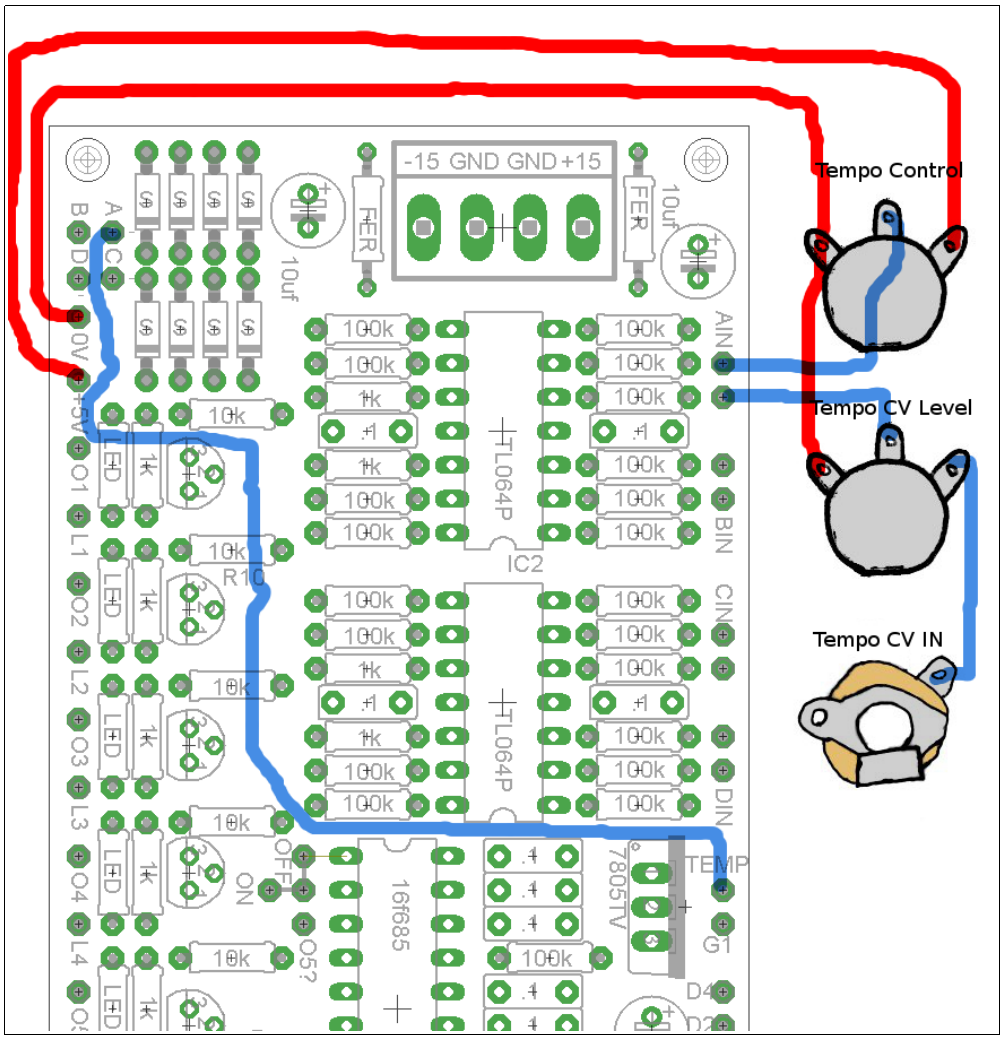
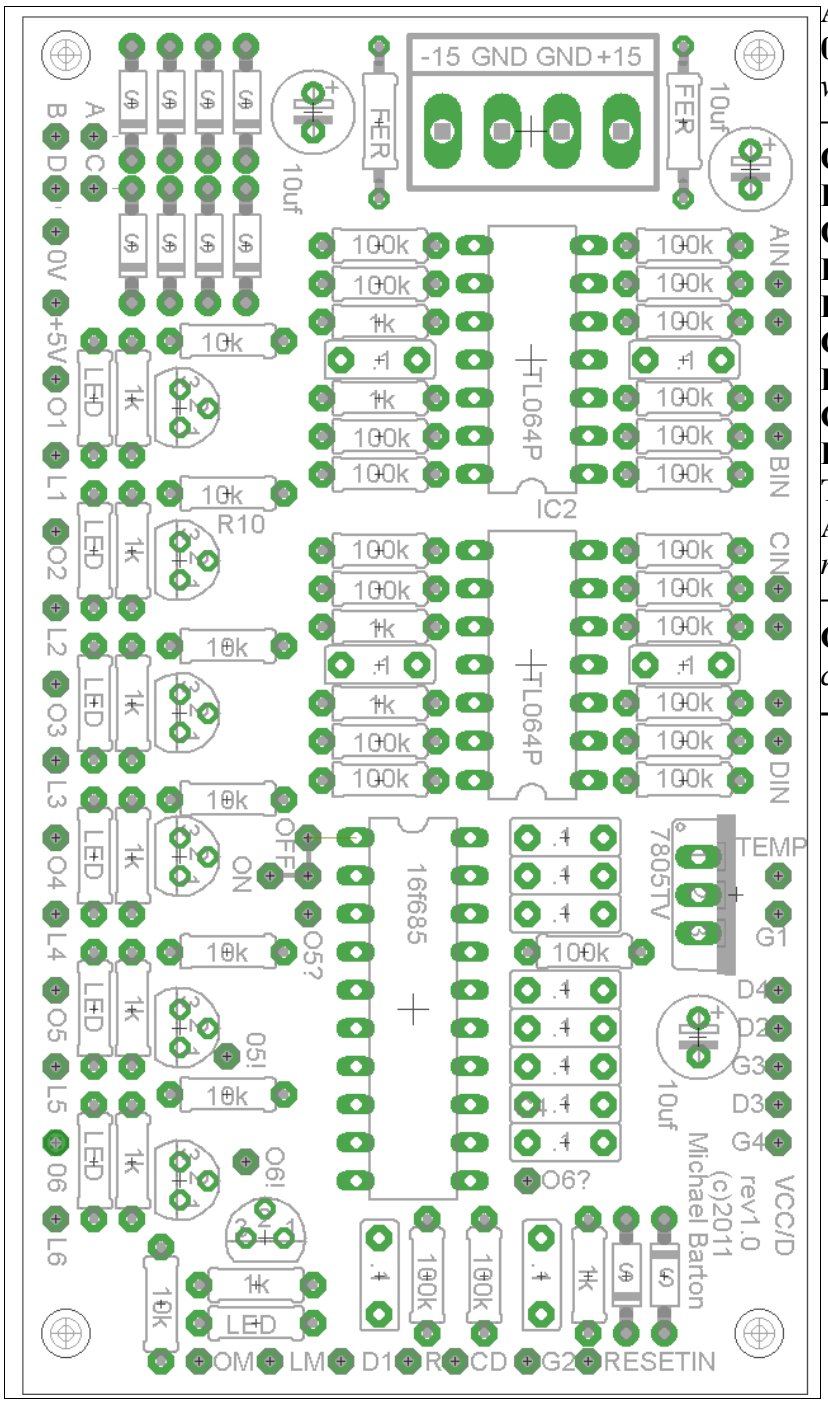


DIAGRAM5. External Tempo Control. Red and Blue indicate connections.



2.BOARD LAYOUT.

The board for this project is 2" wide by 3&5/8" long. Below is it's layout and explanations for the abbreviations on the board used.



A, B, C, D. *Outputs of CV mixers.*
0V. *Ground connection for panel wiring.*
+5V. *+5v connection for panel wiring.*
O1 - O6 *Outputs for divisions 1-6*
L1-L6 *LED outputs for division 1-6*
OM *Master clock output*
LM *Master clock LED Output*
D1-D4 *Inputs for the division controls.*
G1-G4 *Inputs for the PWM controls.*
R *Random control input.*
CD *Clock/Divide select input.*
RESETIN *Reset Input*
TEMP *Tempo control input.*
AIN, BIN, CIN, DIN. *Inputs for CV mixers.*
+15 *Positive power supply connection.*
GND *Ground powers upply connection.*
-15 *Negative power supply connection.*

3.Bill Of Materials.

This bill of materials contains every part possibly needed for building this module, if you are chosing not to use cv mixers or all six outputs, you will not need all of these parts.

Semiconductors.

NAME/Value	*Quantity*	*Note*
Pre programmed 16F685	*1*	
TL064	*2*	*or any quad op amp with same pinout*
2N3904	*6*	
7805 voltage regulator	*1*	
SD101C Schottky diode	*10*	*Not critical, any small signal Schottky diode will work.*

Resistors. 1/4 Watt metal film unless otherwise noted.

Name/Value	*Quantity*	*Note*
1K ohm	*12*	
10Kohm	*7*	
100Kohm	*22*	
FER	*2*	*Use Ferrite bead or 22ohm resistor*
LED	*7*	*Current limiting resistor for LED output, smaller values will have LEDs shine brighter but consume more current, larger values will have dimmer LEDs consuming less current. Adjust for the LEDs you're using, 10K is usually a good median.*

Capacitors.

Name/Value	*Quantity*	*Note*
10uf 16v or higher	*3*	*Radial electrolytic, 2.5mm spacing*
.1uf	*14*	*Ceramic or film. 5mm lead spacing*

Off Panel Wiring. (Remember, these are maximums)

Name/value	*Quantity*	*Note*
SPST switch	*2*	
1/4" Jack	*12*	*or 1/8" or banana jack*
1/4" Switching Jack	*1*	*or 1/8"*
LEDs	*7*	*with mounting hardware if needed*
100K Lin potentiometer	*13*	*with knobs*
Board mounting hardware		

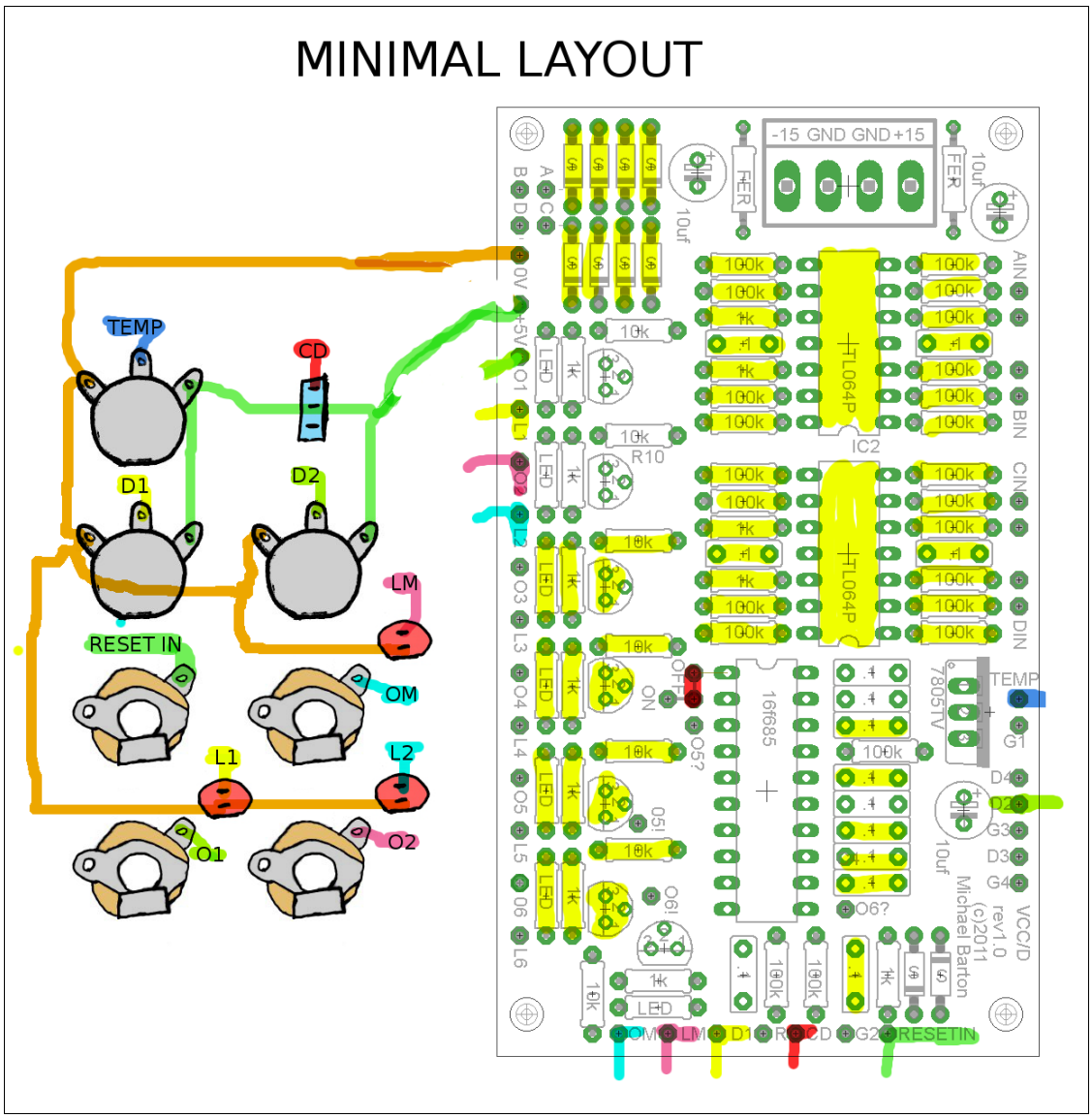
4.Sample Wiring Diagrams.

These sample wiring diagrams are provided to give the user some ideas about ways to wire their module. In all of the diagrams, parts on the board highlighted in yellow should not be installed, and jumper wires on the board are in red or blue. Off panel wiring is color coded, with the wiring pad and the off panel terminal both being colored the same color.

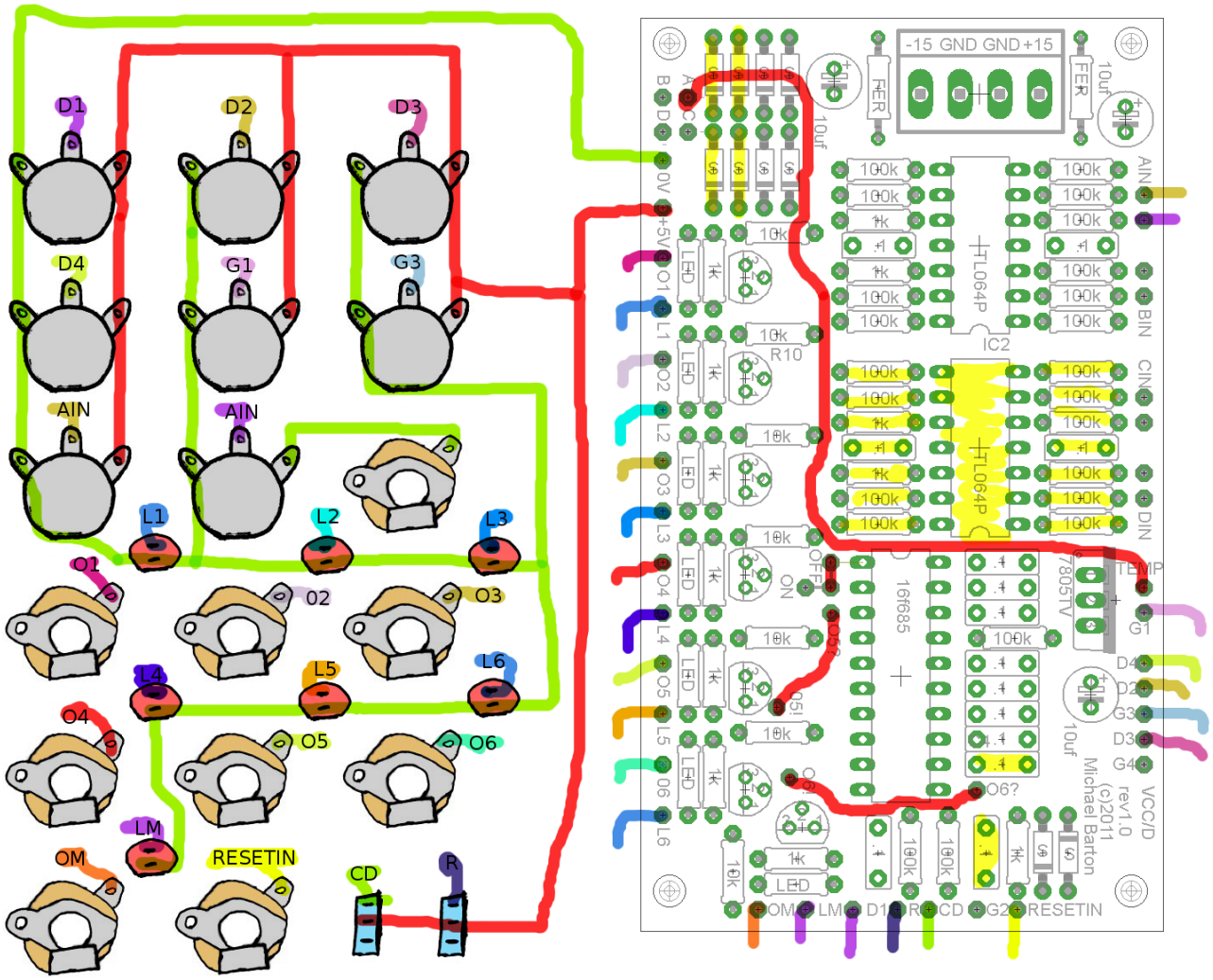
1.Minimal layout. This is a very simple layout, yet creates a very useful module. The PWM is not used, and only 2 outputs are used.

2.Medium layout. 6 Outputs, no PWM. External CV input for the Tempo control.

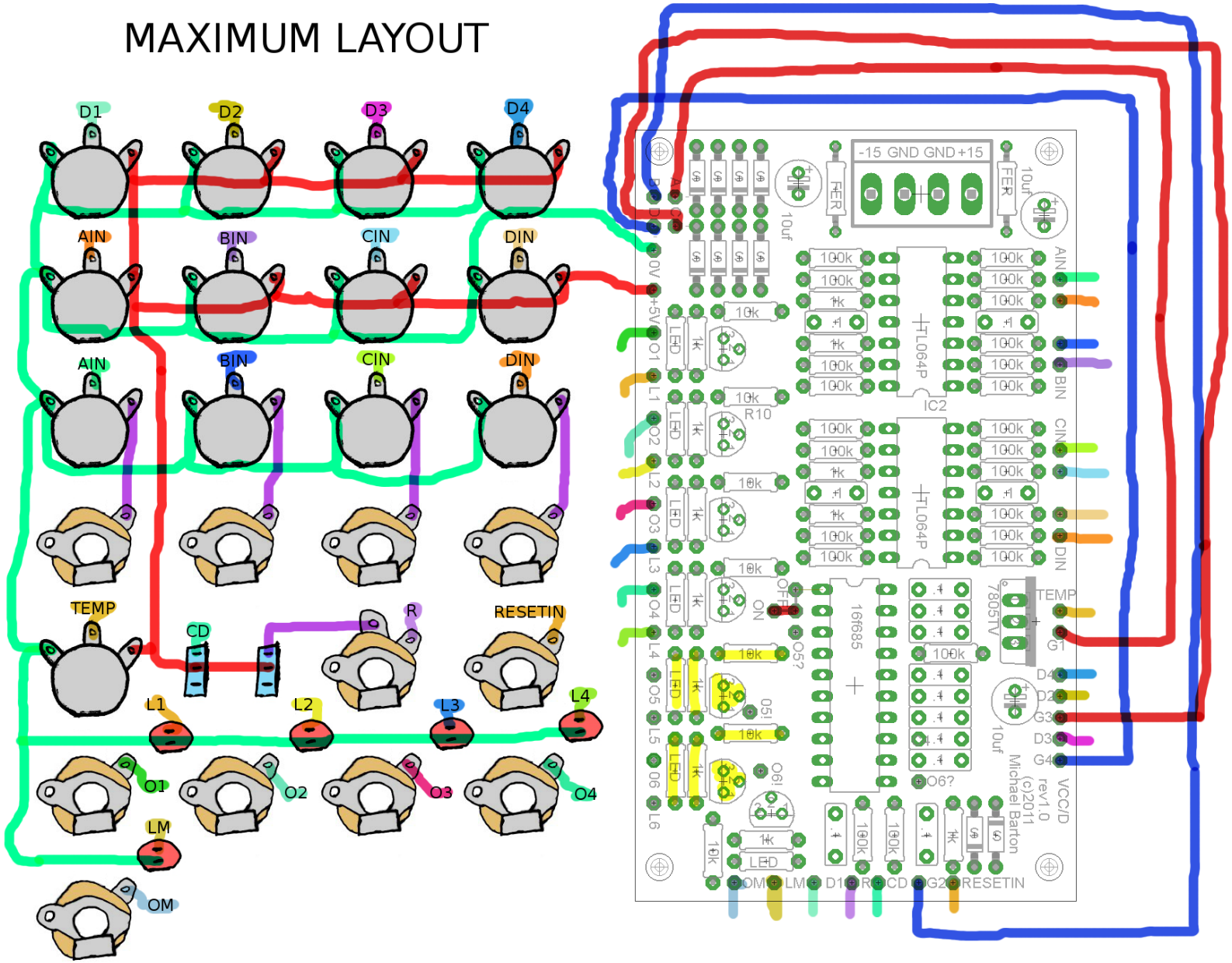
3.Maximum layout. 4 Outputs, with PWM. External CV inputs for all the PWM controls. This also uses a switching jack so that Random can be engaged by a gate control, or a switch.



MEDIUM LAYOUT

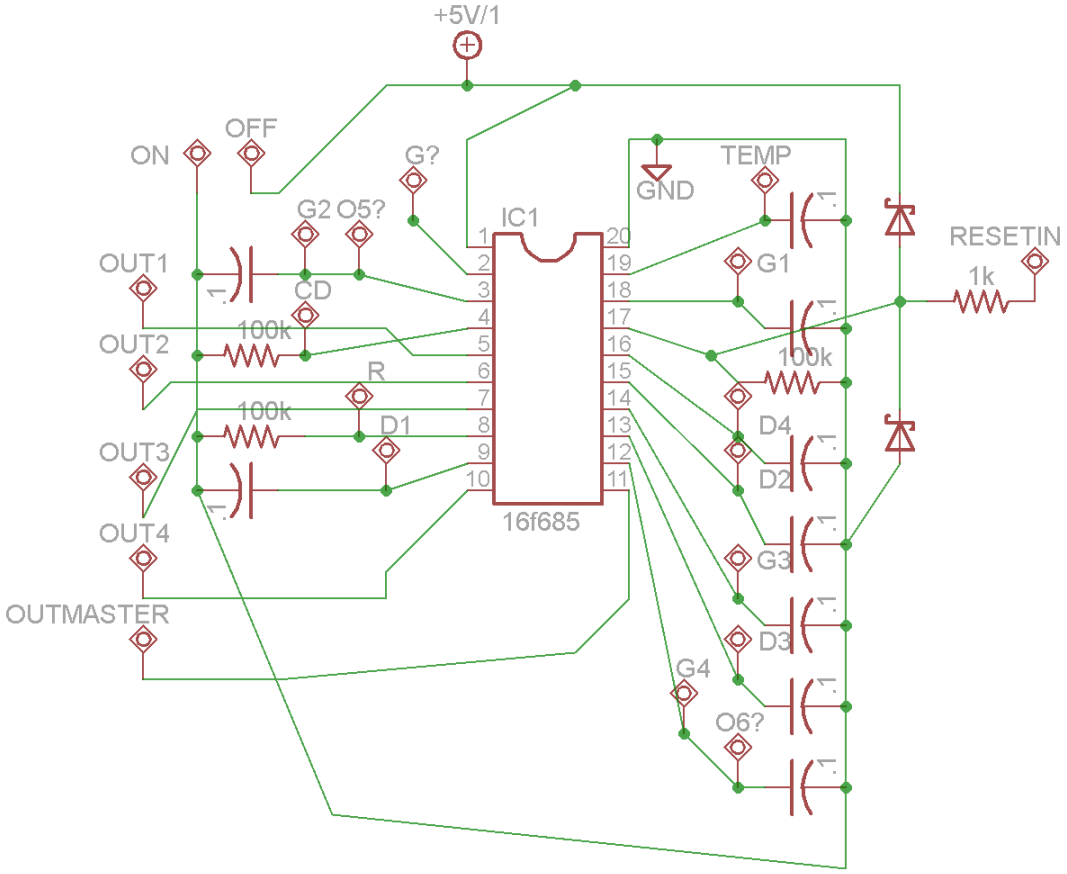


MAXIMUM LAYOUT



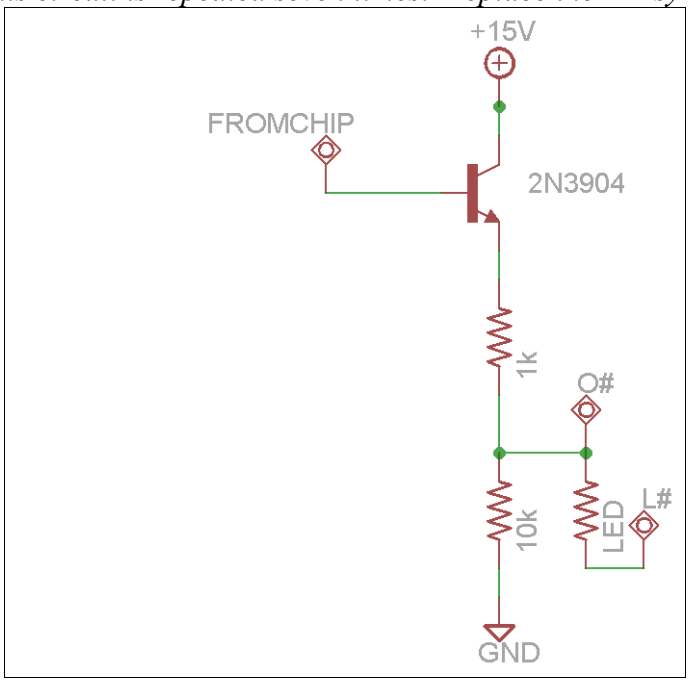
5. Schematic

1.*The microcontroller and immediate circuitry.*

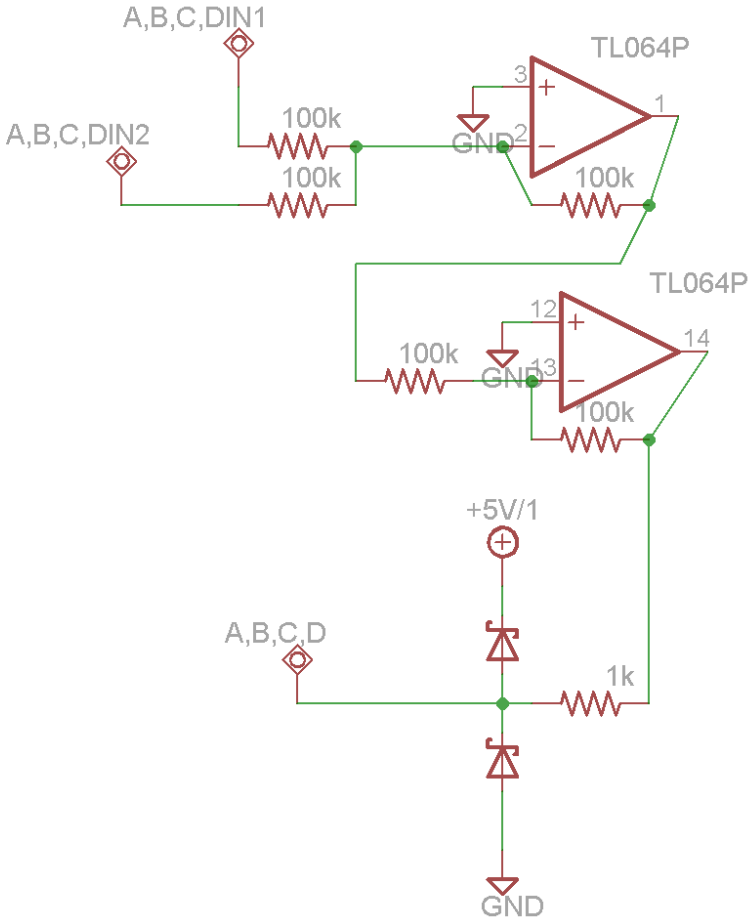


Points marked OUT1, OUT2, OUT3, OUT4 and OUTMASTER attach to the point marked "FROM CHIP" on each output buffer.

2.The Output Buffers. This circuit is repeated seven times. Replace the "#" symbol with the number of the specific output.



3.CV Mixer Schematic. This circuits is repeated 4 times for sections A, B, C, D.



4.Power Supply Schematic. This shows the filters, voltage regulators and decoupling caps for the chips used.