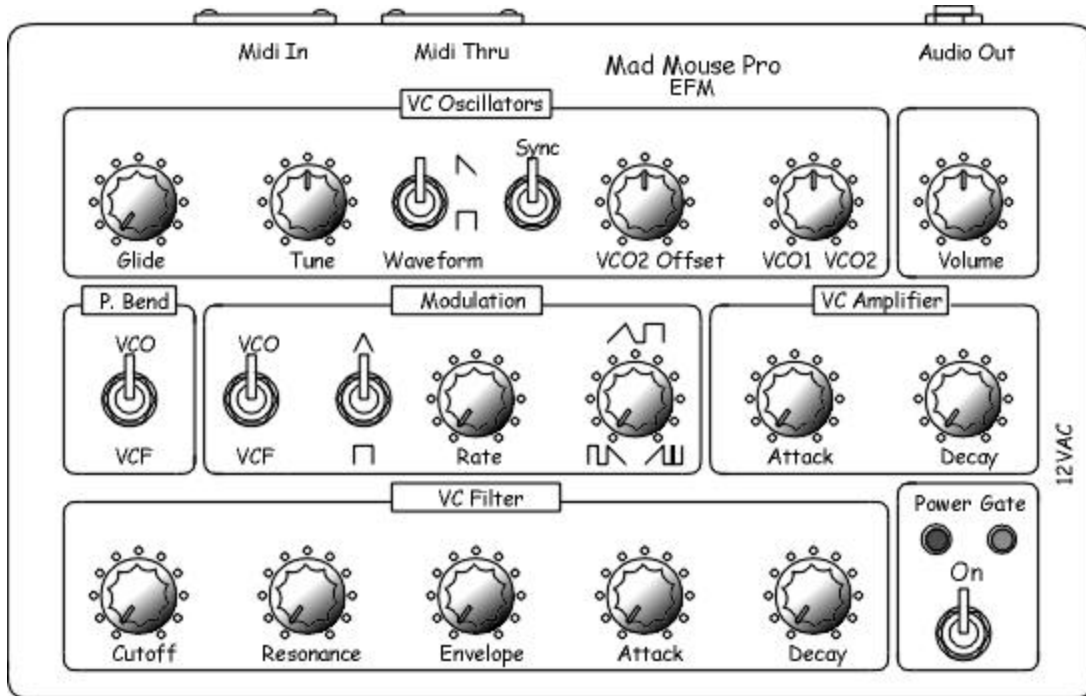


EFM Mad Mouse Pro - Midi Synthesizer

V1.0 (C) 2001 EFM Synthesizers



Assembly and Setup Manual

The Mad Mouse-Pro is a midi controlled analog synthesizer. It is designed to be built as a small stomp-box sized analog so that it can be positioned on top of your master midi controller for easy access to it's controls. The Mad Mouse story started in late 1998 when I decided to design a small inexpensive analog synthesizer that could be built for under \$50 dollars. I wasn't entirely successful in a lot of ways. First of all it requires a separate midi to control voltage converter that cost more that the synthesizer did and I went over budget by about \$20 dollars. Still....it was a working analog synthesizer for under \$200 dollars and that included about \$100 bucks for the separate midi converter.

The MM-pro contains an on-board midi to cv converter, a +/-12 +5V power supply, two Odyssey type oscillators, one MS20 2-pole resonate VCF , two LM13600 VCAs and one MS10 type LFO.

The MM-pro's midi converter responds to midi pitch, pitch bend, mod, key-gate and glide-gate. The midi messages are converted to control voltages. These voltages are used to control the analog sections of the synthesizer.

Mad Mouse Pro - Parts List

Board Location	Product Name	Source	Qty Used	Unit Price	Total Price
Capacitors					
C3, C4, C5, C6, C27	Capacitor - Ceramic 0.1 uF	Mouser 140-50q9-104z	5	\$0.18	\$0.90
C9	Capacitor - Ceramic 10 pF	Mouser 140-50N5-100J	1	\$0.06	\$0.06

C7, C8	Capacitor - Ceramic 22 pF	Mouser 140-50N5-220J	2	\$0.06	\$0.12
C28, C29	Capacitor - Ceramic .001 uF	Mouser 140-50p2-102k	2	\$0.09	\$0.18
C10, C17	Capacitor - Ceramic .01 uF	Mouser 140-50p5-103k	2	\$0.14	\$0.28
C22, C23, C25, C26	Capacitor - Electrolytic 10 uF	Mouser 140-XRL25V10	4	\$0.05	\$0.20
C24	Capacitor - Electrolytic 100 uF	Mouser 140-XRL25V100	1	\$0.07	\$0.07
C1, C2	Capacitor - Electrolytic 470 uF	Mouser 140-XRL50V470	2	\$0.37	\$0.74
C16	Capacitor - Monolithic 1 uF	Mouser 539-CK06105K	1	\$3.71	\$3.71
C11 ,C12, C13, C14, C15	Capacitor - Monolithic 0.1 uF	Mouser 539-CK05103K	5	\$0.43	\$2.15
C20, C21	Capacitor - Polyester .0022 uF	Mouser 140-PF2A222J	2	\$0.12	\$0.24
C18, C19	Capacitor - Polyester .01 uF	Mouser 140-PF2A103J	2	\$0.14	\$0.28
Connectors					
J4	Connector - 1/4" Panel Jack * 1/4" Jack	Mouser 502-11	1	\$2.00	\$2.00
J1	Connector - 2.5mm AC jack	Mouser 161-0725	1	\$0.74	\$0.74
J3, J2	Connector - DIN 5-Pin PCB	Mouser 161-0503	2	\$1.69	\$3.38
Diodes					
LED2	Diode - LED 5.0mm * LED104 Green	Mouser 604-L53GD	1	\$0.19	\$0.19
LED1	Diode - LED 5.0mm * LED105 Red	Mouser 604-L53HD	1	\$0.16	\$0.16
D1, D2	Diode - Rectifier 1N4001	Mouser 583-1N4001	2	\$0.03	\$0.06
D3- D20	Diode - Signal * 1N4148	Mouser 78-1N4148	17	\$0.50	\$8.50

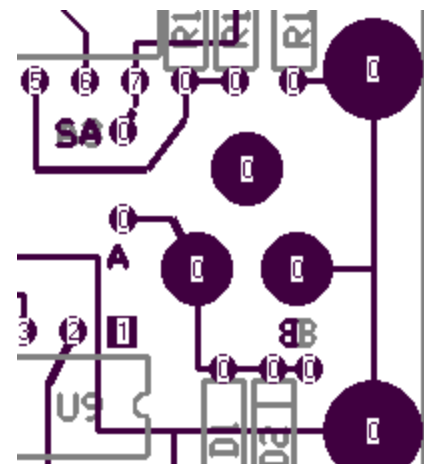
<u>ICs</u>					
U6	Dual 8-Bit DAC - 20 pin DIP TLC7528CN	Digi-key	1	\$5.89	\$5.89
U4	IC 6N138 - Opto Isolator - 8 Pin Dip	Mouser	1	\$1.30	\$1.30
U3	IC 7805T Voltage Regulator +5	Mouser 511-L7805CV	1	\$0.40	\$0.40
U1	IC 7812T Voltage Regulator +12	Mouser 511-L7812CV	1	\$0.40	\$0.40
U2	IC 7912T Voltage Regulator -12	Mouser 511-L7912CV	1	\$0.40	\$0.40
U9	IC CMOS CD4051 8 chn Mux/Dmux	Mouser 511-4051	1	\$0.52	\$0.52
U13, U14	IC LM13600 - OTA - Dual	Mouser 511-NJM13600D	2	\$0.80	\$1.60
U8	IC LM336Z-5.0 Voltage Reference	Radioshack.com 900-4524	1	\$1.25	\$1.25
U15	IC LM556 - Timer - Dual	Mouser 511-NE556	1	\$0.64	\$0.64
U5	IC Pic Microcontroller - 18 Pin DIP 16F84-10/P-ND	EFM	1	\$15.25	\$15.25
U12	IC TLO71 Opamp - Jfet	Mouser 511-TLO71CN	1	\$0.40	\$0.40
U7, U11	IC TLO72CP Opamp - Dual Jfet	Mouser 511-TLO72ACP	2	\$0.74	\$1.48
U10, U16	IC TLO74 - Opamp - Quad Jfet	Mouser 511-TLO74CN	2	\$0.79	\$1.58
<u>Potentiometers</u>					
P14	Pot 16mm Panel Mount Linear 100K	Mouser 13-1000-100K	1	\$1.15	\$1.15
P1, P9, P10, P11, P12, P13	Pot 16mm Panel Mount Linear 1M	Mouser 31JN601	6	\$1.15	\$6.90
P2, P3, P4, P5, P6, P7, P8	Pot 16mm Panel Mount Linear 50K	Mouser 31JN401	7	\$1.15	\$8.05
<u>Resistors</u>					
R115	Resistor 100	Mouser 271-100	1	\$0.09	\$0.09

R29, R35, R40, R41, R44, R46, R48, R58, R63, R66, R67, R70, R72, R82, R89, R90	Resistor 100K	Mouser 271-100K	17	\$0.09	\$1.53
R4, R5, R7, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R30, R33, R36, R38, R52, R55, R76, R79, R87, R88, R93, R94, R95, R98, R99, R101, R103, R104, R105, R106, R111, R113, R118, R122, R126, R128	Resistor 10K	Mouser 271-10K	39	\$0.09	\$3.51
R43	Resistor 150K	Mouser 271-150K	1	\$0.09	\$0.09
R3, R45, R47, R50, R69, R71, R74, R116, R117, R120	Resistor 1K	Mouser 271-1.0K	10	\$0.09	\$0.90
R45, R69	Resistor 1K Tempco	EFM	2		\$5.00
R39	Resistor 1M	Mouser 271-1.0M	1	\$0.09	\$0.09
R2, R9, R10, R91, R92, R96, R97, R108, R109, R123, R124	Resistor 220	Mouser 271-220	9	\$0.09	\$0.99
R64, 65	Resistor 220K	Mouser 271-220K	2	\$0.09	\$0.99
R42, R53, R54, R68, R77, R78, R64, R65	Resistor 22K	Mouser 271-22K	8	\$0.09	\$0.72
R1, R27, R28, R32, R34, R102, R112, R114, R121, R127	Resistor 2.2K	Mouser 271-2.2K	9	\$0.09	\$0.81
R110, R119, R125	Resistor 33K	Mouser 271-33K	4	\$0.09	\$0.36
R6, R8	Resistor 3.3K	Mouser 271-3.3K	2	\$0.09	\$0.18
R59, R60, R83, R84	Resistor 470K	Mouser 271-470K	4	\$0.09	\$0.36
R26, R56, R57, R61, R62, R80, R81, R85, R86, R107	Resistor 47K	Mouser 271-47K	9	\$0.09	\$0.81
R11, R12, R13, R14, R15, R31, R37, R49, R51, R73, R75, R100	Resistor 4.7K	Mouser 271-4.7K	12	\$0.09	\$1.08
R129, R130, R131,	Resistor 62K	Mouser 271-62K	4	\$0.09	\$0.36

R132					
Switches					
S1	Switch - Mini Toggle on/off SPST	Mouser 10TC220	1	\$1.70	\$1.70
S3, S4	Switch - Mini Toggle on/on DPDT	Mouser 10TC260	2	\$2.58	\$5.16
S5, S6	Switch - Mini Toggle on/on SPDT	Mouser 10TC230	2	\$1.88	\$3.76
S2	Switch 4X Dip 4X DIP RA	Mouser 571-4358023	1	\$1.79	\$1.79
Transistors					
Q15, Q19, Q24, Q28, Q29	Transistor - 2N3819 N Fet (J112)	Mouser 610-2N3819	5	\$0.55	\$2.70
Q1, Q13, Q18, Q21, Q22, Q27, Q31, Q32, Q33, Q34	Transistor - 2N3906 GP NPN	Mouser 625-2N3906	10	\$0.10	\$1.00
Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q14, Q16, Q17, Q20, Q23, Q25, Q26, Q30	Transistor - 2N3904 GP PNP	Mouser 625-2N3904	18	\$0.10	\$1.80
Q12	Transistor - 2N5460 P Fet	Mouser 610-2N5460	1	\$0.36	\$0.36
Trimmers					
T1, T2, T3, T4, T5, T6, T7	Trimmer - Multiturn Cermet 50K	Mouser 72-T93YA-50K	7	\$1.20	\$8.40

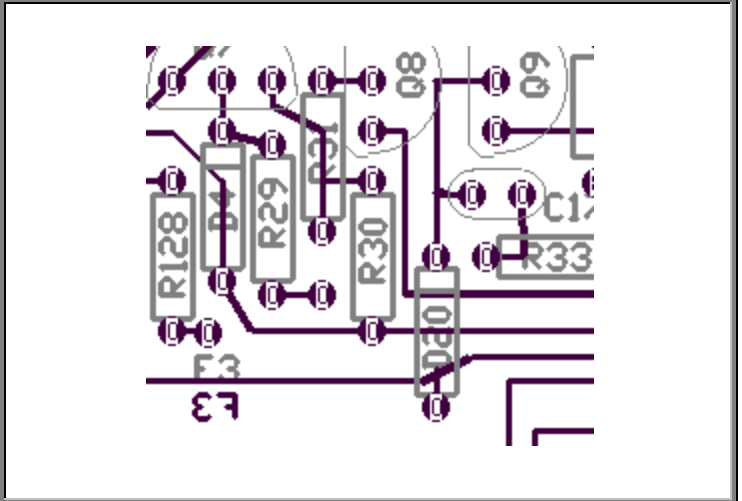
Initial Assembly

If you want to install a power jack extra holes will need to be drilled in the large power-pads. Drill a hole on each side of the current hole in the direction of the jack terminals and use a sharp pointed x-acto knife to cut out the space between the holes.



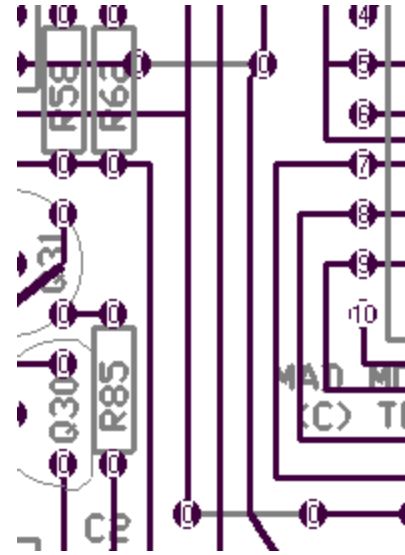
	Color	Value	Multiplier	Tolerance %	
	Black	0	1	+/- 20	
	Brown	1	10	+/- 1	
	Red	2	100	+/- 2	
	Orange	3	1,000	+/- 3	
	Yellow	4	10,000	+/- 4	
	Green	5	100,000	-	
	Blue	6	1,000,000	-	
	Violet	7	10,000,000	-	
	Gray	8	100,000,000	-	
	White	9		-	
	Gold	-	0.1	+/- 5	
Install all of the resistors except R45 and R69.	Silver	-	0.01	+/- 10	
	No Color	-		+/- 20	

Install all of the diodes. We'll get to the LEDs later. NOTE: that the pad for the anode (the side without the stripe) of D4 does not go to ground as it should. Do not use this pad, instead connect it to the lead coming off the anode of D20 it does go to ground as it should.







Install IC sockets in all spaces marked for ICs. NOTE: DO NOT INSTALL THE ICs YET.

Install all Jumpers (15) except the one that's next to R62 and the jumper next to PAD-C2 and R85. These two jumpers will be installed after the midi converter is working. They supply power to the analog sections on the board. As long as these are dis-connected the VCOs, filter, amps and egs will not work.



Install all of the capacitors.

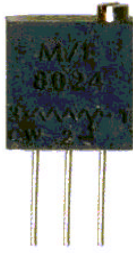
Mono Cap	Ceramic Cap	Electrolytic Cap	Polyester Cap
			

I have been using strips of 0.1 break-away pcb pin headers for all pads on recent projects. This gives a convent place to solder to or connect your test probe. The Mouser # for a 36 contact long tail pin strip header is.517-834-03-36 \$0.83ea. I urge you to use these instead of wiring directly to the board. The tail is long enough so there is still room to solder even if the pin is placed through the under side of the board.

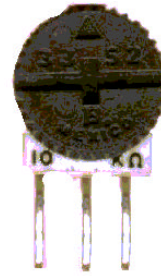


Install the trimmers and DIP switch S2.

You can use less expensive trimmers for T4,7



T1,2,3,5,6



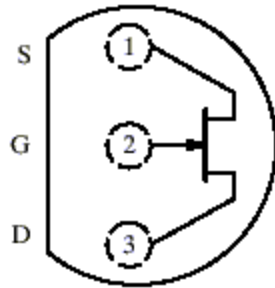
T4 & T7

Install all transistors except Q29, and the Q13/Q14, Q16/Q17, Q22/Q23, Q25/Q26 pairs. NOTE: the pin-out on the pcboard for the N-Fets is for 2N3819s. NOTE: If you substitute J112s the leads will have to be twisted to the proper pad.

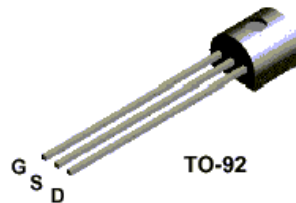
2N3819

J112

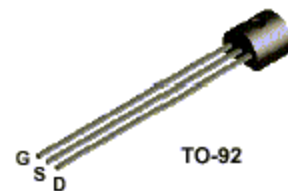
2N5460



Top View



TO-92


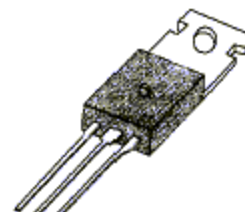



TO-92

Install the 10MHz Crystal in the space marked for X1.



Install the voltage regulators U1, U2, U3 and U8 (+5V DAC reference).




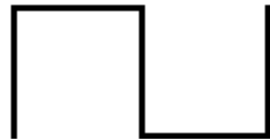


LM7805 / LM7812	LM7912	LM336 5.0
<p>TO-220</p>  <p>1. Input 2. GND 3. Output</p>	<p>TO-220</p>  <p>1: GND 2: Input 3: Output</p>	<p>TO-92</p>  <p>1. Adj 2.+ 3. -</p>



Power Supply Test

Hook up a 12VAC@500mA wall transformer to large PAD-A and the large ground PAD
Before you plug it in be ready to up-plug it in case of smoke or heat.
Get your meter and set it to AC Volts.
Plug the transformer in. Nothing should smoke or be hot to the touch.
Measure the AC voltage on PAD-A and ground. It should be between 12 and 14VAC
Set your meter to DC Volts.
Attach the negative lead to ground and measure the voltage on pin-4 of the socket for U11. It should be about -12VDC .
Measure the voltage on pin-8 of the socket for U11. It should be about +12VDC .
Measure the voltage on pin-7 of the socket for U4. It should be about +5VDC .
Unplug the transformer.

Midi Interface Test and Setup

Install U4, U5, U6, U7, U9, U10, U11 NOTE: U5,U6 and U9 are static sensitive make sure you take the proper precautions and handle these with care.
Connect a 5-pin DIN Jack (midi-in) to Pads E and F.
Connect a midi keyboard set to midi channel 1 to the midi-in jack.
Make sure all switches on S2 are off.
Plug the transformer in.


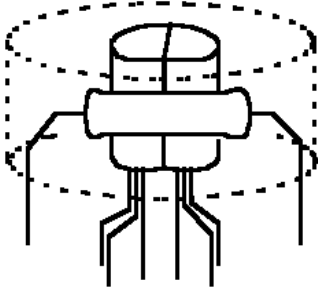
<p>If you have a scope. Measure Pins 15 and 16 of U5. You should see the PIC clock running at about 10MHz.. Pin-3 of U9 is multiplexed data (looks like a changing staircase) when a midi key is played.</p>		
PIC U5 Pins 15 & 16 10MHz	4051 U9 Pin 3 (C3 midi-kbd)	4051 U9 Pin 6
		
4051 U9 Pin 8	4051 U9 Pin 9	4051 U9 Pin 10
		

<p>With a digital probe or scope you should see a low going pulse on pin-6 of U4 when a midi key is played. If not power down and reverse the wires going to the midi jack then try again. Your keyboard may or may not generate midi clock</p>	
6N138 U4 Pin 5 Midi Clock	6N138 U4 Pin 5 Midi Data
	


Set your meter to DC Volts.
Measure the voltage on pin-7 of U7. Adjust T1 until it's -10.56VDC.
Measure the voltage on the GATE and CV outputs when you play the keyboard.
PAD-I is Pitch-CV 1V/Oct .
PAD-L is Pitch-Bend and should be 0-5VDC as the PB lever is applied.
PAD-M is a 0-5VDC gate.
PAD-P is 0-5VDC as the MOD lever is applied.
PIN-8 of U10 is 0-5VDC glide-gate when two keys are played.
Unplug the transformer.

	Remove the PIC (U5), DAC (U6) and MUX (U9) place them in protective foam
	Disconnect the midi-jack

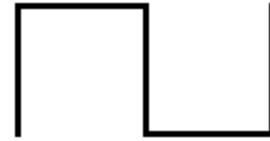
VCO Assembly and Setup

<p>The Q16/Q17 and Q25/Q26 pairs need to be thermally connected. NOTE: Q16/Q17 and Q25/Q26 are dual NPNs and may be replaced with 2SC1583s or other dual NPNs. Place a dab of heat-sink compound on the face of one transistor. Place the other flat to flat and secure together with heat-shrink tubing. Solder to the board bending the leads so there is no pressure on the pair to separate.</p>	<p>The Q13/Q14 pair are PNP/NPN and should be thermally connected with 1K tempco resistor R48. Place a dab of heat-sink compound on the face of one transistor. Place the other transistor flat to flat and secure together with heat-shrink tubing. Solder to the board bending the leads so there is no pressure on the pair to separate. Once soldered cut the heat-shrink off. Solder R48 into place so that the body of the resistor is in contact with the transistor pair. Then using a larger size of heat-shrink secure both transistors and resistor</p>
	

	Install the jumper next to R62 and the jumper next to PAD-C2 and R85. These two jumpers supply power to the analog sections on the board. As long as these are dis-connected the VCOs, filter, amps and eggs will not work.
	Run a jumper from PAD-I (keyboard pitch-out) to PAD-T (vco pitch-in)
	Replace the PIC (U5), DAC (U6) and MUX (U9)
	Connect a 5-pin DIN Jack (midi-in) to Pads E and F.

	Connect a midi keyboard set to midi channel 1 to the midi-in jack. Make sure all switches on S2 are off.
	Connect your scope or monitor to VCO1 PAD-B2
	Plug the transformer in.
<p>You should see/hear a sawtooth wave. The pitch should change when you play the midi keyboard.</p>	

	Adjust trimmer T3 until the pitch is one octave apart when playing the C3-C4 octave on the keyboard
	Connect your scope or monitor to VCO1 PAD-X
	Adjust trimmer T4 until you see/hear a 50% square wave. It will sound smoothest.
	Connect your scope or monitor to VCO2 PAD-V



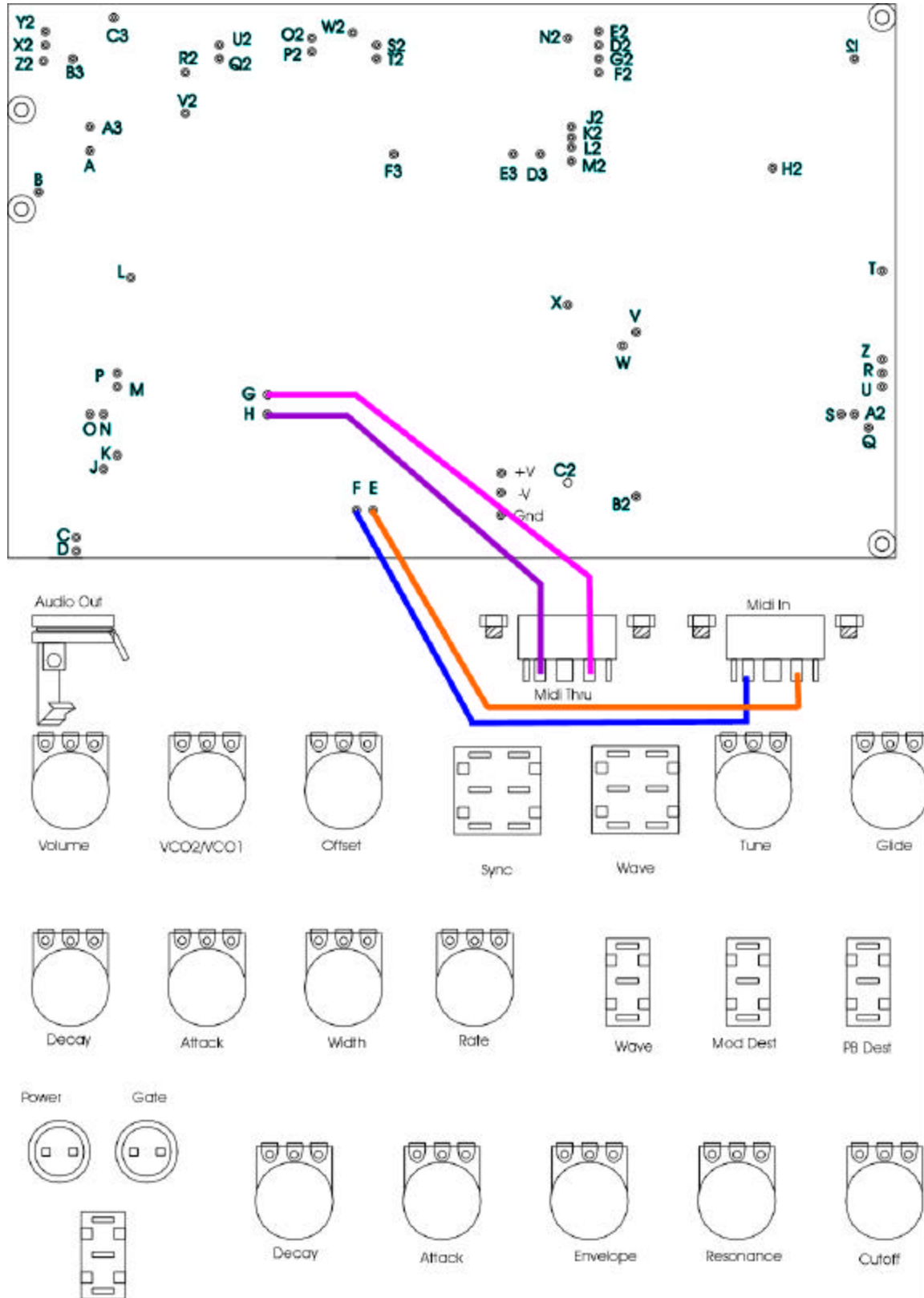
	Adjust trimmer T6 until the pitch is one octave apart when playing the C3-C4 octave on the keyboard
	Connect your scope or monitor to VCO2 PAD-C2

	Adjust trimmer T7 until you see/hear a 25% square wave. Just a little past the smooth sound. This will keep the oscillators from locking to the same beat frequency and canceling each other out.
	Unplug the transformer.
	Remove the PIC (U5), DAC (U6) and MUX (U9) place them back in protective foam.
	Disconnect the midi-jack

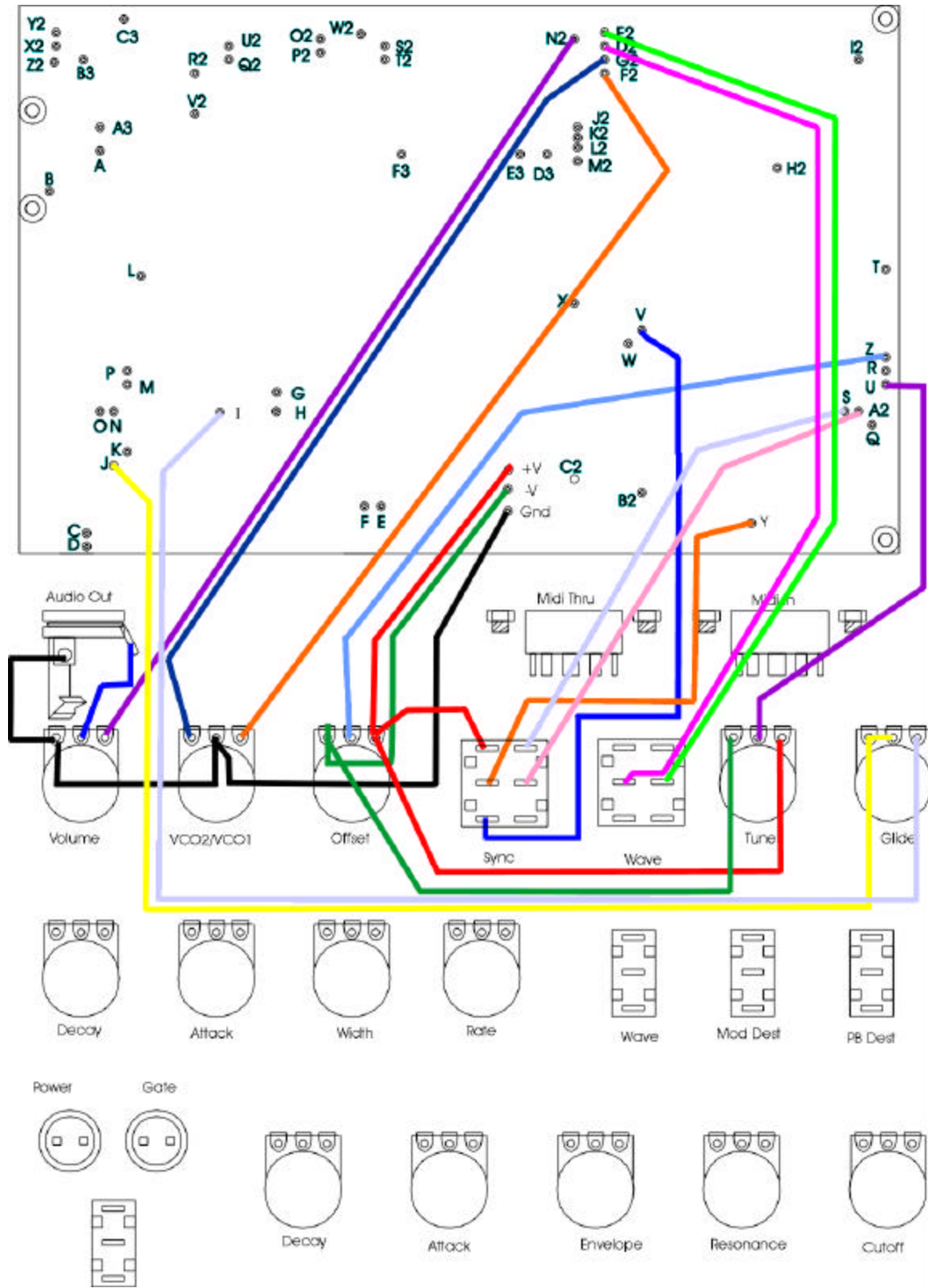


<u>Wiring and Assembly Options</u>	
	Once the initial setup is complete you are ready to finish the wiring before fine tuning the circuit.
	The wiring instructions are for the normalized stomp box style synthesizer. The Modular option is self-descriptive and presented at the end of this manual.

Midi Wiring

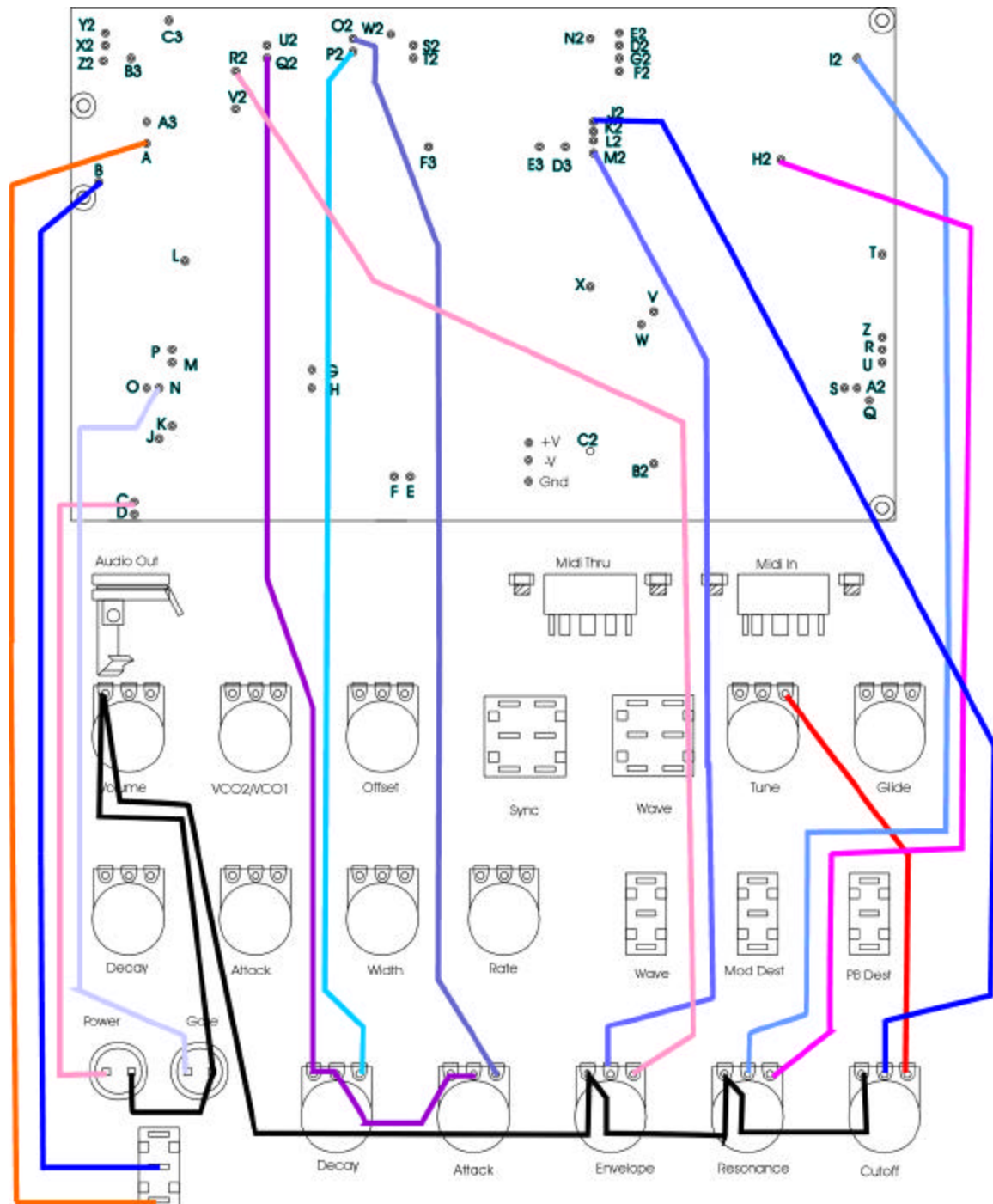


Row 1 Wiring



Row 3 Wiring

NOTE: I reversed the common wire for the Attack/Decay Pot when I drew this. This will cause the pots to function in reverse. Connect the common to the center and right terminal, connect the wire from the board to the left terminal.



Final Assembly and Setup

Now is a good time to install and line up the spacers you intend to use to suspend the board over the controls. The best way I've come up with is to attach the spacers to the board. Put a drop of model paint or ink on the end and then position it in place. The paint will mark the inside of the case so you can drill the holes in the right place.

There are two test traces on the board break the trace between the large PAD-A and the two small pads connected to PAD-B. This allows the power switch to turn the unit off.

Break the trace between PAD-A2 and PAD-S. This allows the Sync switch to disconnect VCO2 from pitch-bend CV for Sync sweeps.

Secure the board in the case .

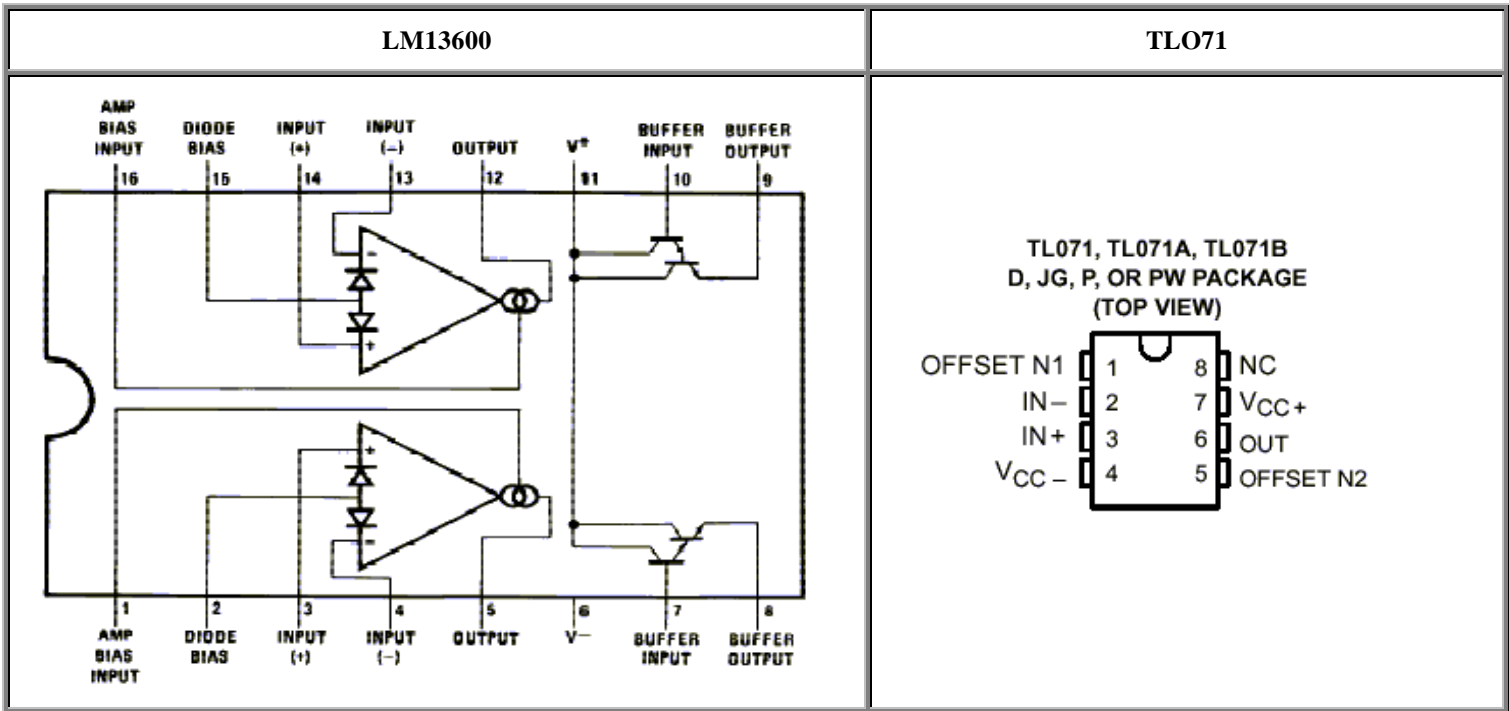
Set the controls to the basic patch

Glide	0%
Tune	50%
Waveform	Saw
Sync	Off
VCO2 offset	50%
VCO mix	50%
Volume	25%
P. Bend Destination	VCO
Mod Destination	VCO
Mod Wave	Tri
Mod Rate	80%
Mod Wave Shape	50%
VCA - Attack	0%
VCA- Decay	100%
VCF - Cutoff	100%
VCF- Resonance	0%
VCF- Envelope	0%
VCF-Attack	0%
VCF-Decay	100%

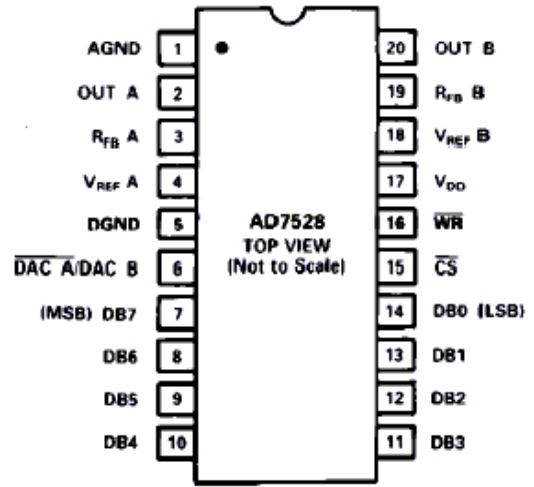
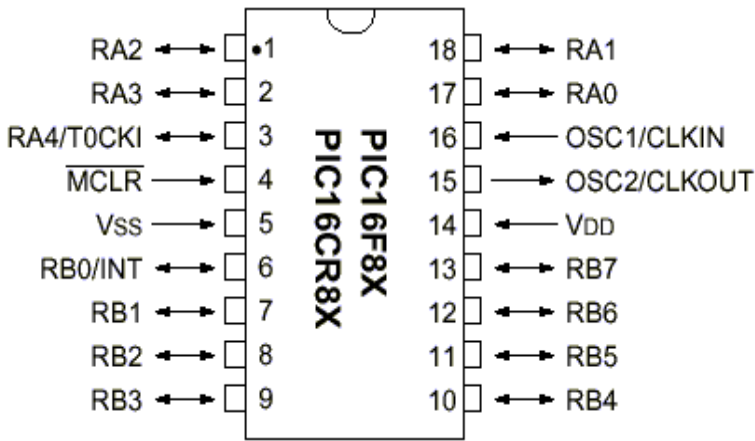
Install all of the ICs. U1 the +12V regulator needs to be in thermal contact with the case or a small heat sink can be used.

Connect the output to a monitor amp and connect the power transformer. Turn the unit on.

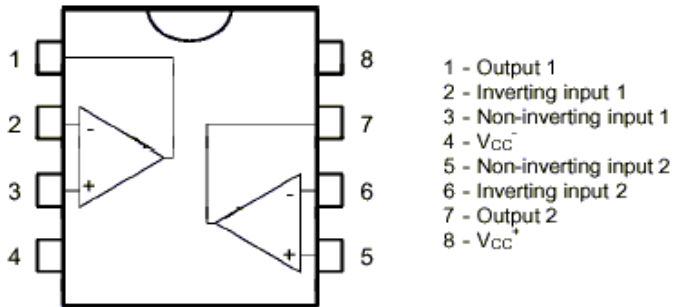
	Nothing should smoke or be hot to the touch. There should be no sound coming from the monitor amp.
	Check for +5 and +/-12VDC.
	Press a key on your keyboard. You should hear VCO1 and 2 mixed through the VCF and VCA.
	Tune VCO2 to VCO1 by adjusting T5 to match the initial frequency of VCO2 to VCO1.
	Fine tune T3 and T6 VCO1 and 2 scale trimmers so that the vcOs track together. Get as close as you can. You will have to play with the trimmers for the VCOs to get them correct.
	Adjust T2 so that when the pitch bend lever is applied the pitch of VCO1 and 2 change by one note up and one note down. Play C2 and push the lever all the way up. Adjust T2 so that a D2 comes out. Push the lever all the way down and pressing C2 should play a B1.
	Your Mad Mouse Pro is complete. You will want to fine tune things in a few days to tighten everything up but it should be ready to go.
	Test all of the controls to make sure all the functions work. Enjoy your Mad Mouse-Pro



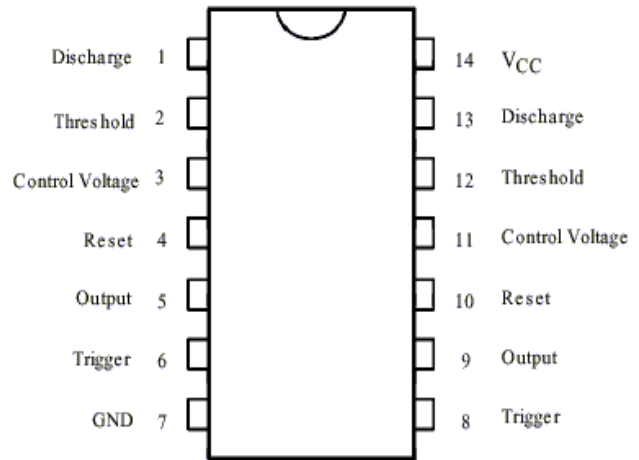
PIC16F84	AD7528
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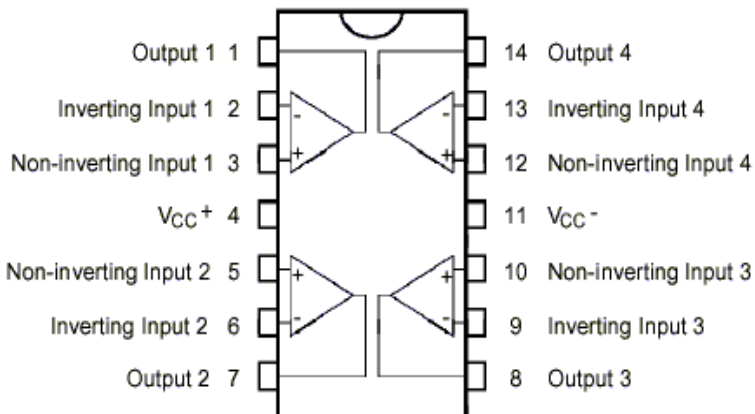
TLO72



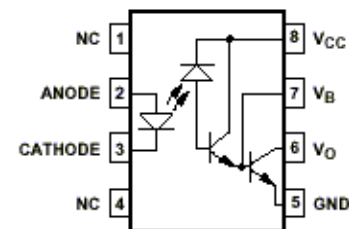
LM556



TLO74



6N138



TRUTH TABLE

LED	V _O
ON	LOW
OFF	HIGH

