Adding a **SYNCHRONOUS MANUAL LOAD** function to your KLEE Sequencer

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Skill Level : Prior Building Experience Required

The Objective:

Here is a modification that you can make to your Klee sequencer that will be useful for beat based music. It has to do with the operation of the Klee "MANUAL LOAD" function. In the original design, a 16 stage pattern will be loaded, in accordance to the program switch settings, immediately when the MANUAL LOAD button is activated, regardless of the state of the master CLOCK input, or any other signal for that matter. We will call this the asynchronous mode of operation in reference to the CLOCK input. However, sometimes it would be desirable to activate the MANUL LOAD function and have the Klee LOAD a new 16 stage pattern only when a new clock arrives, the rising edge, thus allowing the new pattern to be loaded on a beat or CLOCK tick. This allows a smooth, on the beat, transition when patterns load. This shall be called "synchronous" mode of operation. Some may not care if they are not creating any beat based music so this function may not be useful at all when performing some types of music. That is why this modification will allow you to switch between asynchronous (original function) and synchronous operation. It also includes an additional panel LED that illuminates when there is a "PENDING" load in the synchronous mode of operation while waiting for the next CLOCK event. A PENDING condition exists when the operator presses the manual load before the next clock arrives. This lets the operator know when a load is about to occur on the next rising clock edge. Not so much a value added function but does have a higher coolness factor.

The Implementation:

The reasoning of doing this small project was to demonstrate the use of an MCU to replace standard logic. To implement the function I used what I think is the perfect chip for low speed logic replacement. The chip I chose was the small 8 pin Microchip 12F510 MCU shown in figure 1 below. The chip comes in either an 8 pin DIP package or a small outline package (SOP) for surface mount applications. It's becoming more and more popular to replace standard logic building blocks such as TTL and CMOS MSI (Medium Scale Integration) and SSI (Small Scale Integration) logic using either programmable logic or low cost 8 bit microcontrollers. Besides, making changes in code is a whole lot easier then rewiring connections between chips on my breadboard or worse yet, on my PC board. Everything I need is built right on the chip including the on chip oscillator so not even an external crystal is required to run the thing. The digital outputs have plenty of drive (about 25 mA each) and the chip can run at 2 MIPS (Million Instructions per Second) when the internal 8 MHz oscillator is selected. This is more than enough speed to sample the 22 uS CLOCK from the Klee digital board. Another advantage is the chip only costs about a buck at Mouser in single quantities. Many suppliers stock this chip and Microchip is one of the few microcontroller companies that don't obsolete their chips. Even the oldest of the product line, the 12 bit instruction word based 16C54, and other pin for pin compatible variants are still around to purchase. I usually stock lots of these 8 pin, and some 14 pin variants, MCU chips just for these types of "quickie" projects. In quantities of 10 or more, the 12F510 costs only $ 0.87 USD and lower. Not bad for a complete 8 bit microcontroller unit with a built in oscillator, WDT, 8 Bit A/D with multiplexor, Flash EEPROM, SRAM, 8 BIT TIMER, etc. The program residing in the chip began life as 35 lines of "PIC BASIC Pro" source level code (Micro Engineering Labs) which ended up using, after compiling, about 145 memory locations out of the available 1024 in the chip. The chip probably replaced a couple flip flops and a couple logic gates. Sure I could have used standard CD4000 logic that could directly interfaced to the Klee's logic 15V or 12V levels but I wanted to use this little guy. Besides, for a few pennies, I put two silicon transistors and half a dozen resistors to work to do the required level shifting.

Figure 1 Microchip PIC 12F510 MCU

Klee Digital Board Preparation:

There is one modification that needs to be done to the Klee Digital board. This can be accomplished very easily if your IC's were installed into sockets. If not, then removal will be more work but not impossible. Remember, too much heat will destroy the IC's and possibly damage the circuit board by lifting pads so be careful when desoldering. These IC's do not have any large ground planes so not much heat should be necessary to remove the solder.

Follow steps 1 through 4 below for board preparation. These steps allow the breakout of the MANUAL LOAD and the CLOCK signals. There are three signals that you will need. They are the 22 uS positive pulse version of the CLOCK INPUT at U2-12, MANUAL LOAD output at U2-6, and the LOAD INPUT that's routed back into U3-2. The clock input signal does not need to be broken out but just needs to be simply tapped into by lap soldering a wire to U2-12. Note the highlights on the assembly drawing in figure for reference.

1) Isolate U2-6 and U3-2 on the Klee Digital board by removing the ICs U2 and U3 notating their part numbers. First bend U2 pin 6 so that it sticks straight out so that it is parallel with the top of the IC package. Now cut the skinny portion of the pin that normally inserts into the socket.

2) Reinsert U2 into its respective socket noting the correct part number. U2 pin 6 should now be isolated from the rest of the circuit.

3) Perform the same operation on U3 pin 2 then reinsert U3 into its respective socket.

4) Now U2-6 and U3-2 should have enough surface area to solder a wire on each as pictured below.

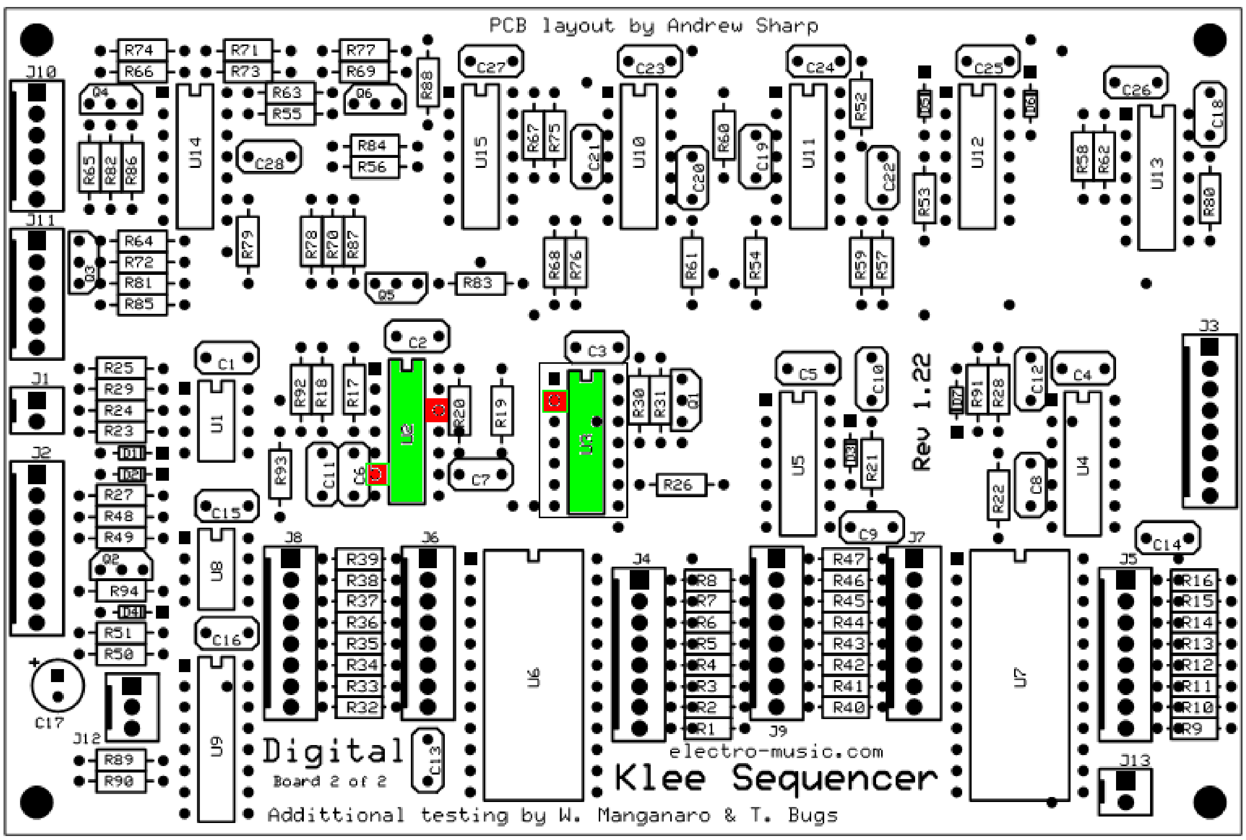


Figure 2 Klee Digital Circuit Board

Here is my Klee digital board in Figure 3 after adding wires to the breakout added above.

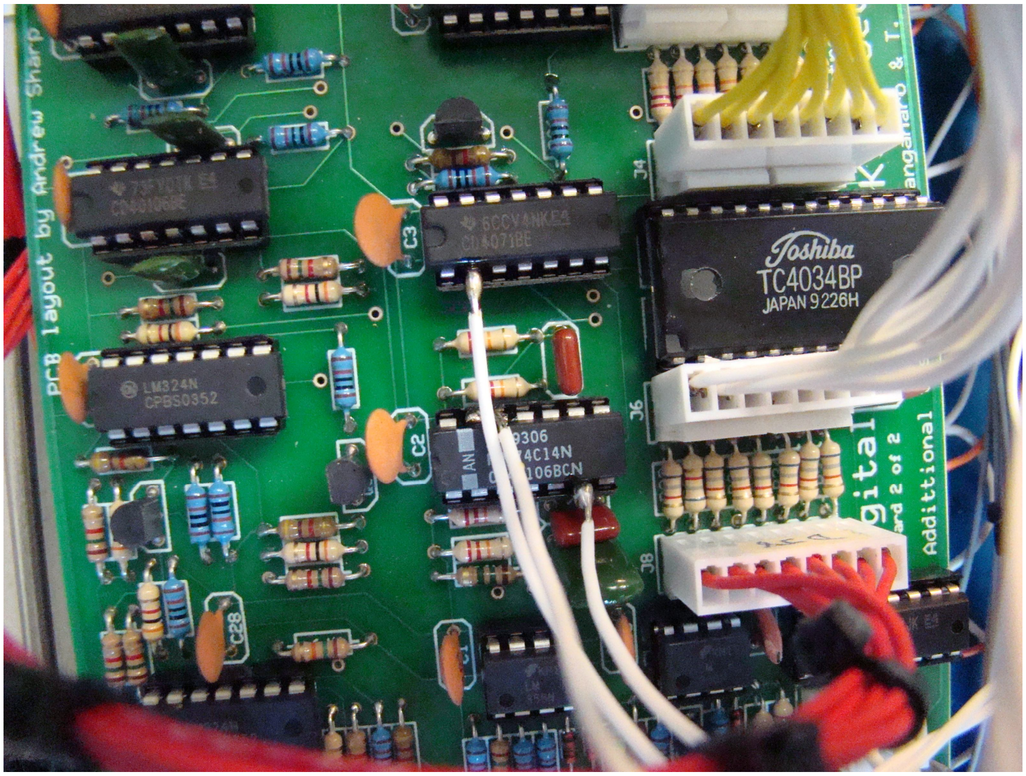


Figure 3 Klee Digital Circuit Board With Wires Added

BUINLDING THE SYNCHRONOUS LOAD BOARD:

Using the “SYNCHRONOUS MANUAL LOAD SCHEMATIC” in appendix “A” as your guide and the parts list shown below, you should be able to construct the board using a small 3” x 4” prototype board. You can use any technique you like such as wire wrap, strip board, point to point wiring, or rolling your own PC board. If you plan to mount this board on standoffs, first select the size you want and then drill 4 holes on each corner of the board if needed. Some boards may come predrilled in which case you would just select 4 standoffs that will fit these holes. It is best to first use the board as a template to facilitate mounting standoffs to your enclosure before placing any components onto it. Place the board on the surface you intend to mount it on and mark where each hole center goes for these standoffs.

NOTE: This board utilizes power from the Klee’s positive power supply. It is best to mount this sync board close enough such that the connector on J1 of the Klee digital board, power connector, can be removed and placed on J1 power connector of sync board.

After this marking the standoff hole centers, you may start to mount your components and connectors.

NOTE: Firmware 1.0 (syncload.hex) is available upon request, just mail me at : thex@optonline.net so that you may program your own 12F510 chip.

Be sure to set the programmers configuration memory to the following settings:

In Microchip MPLAB IDE, set the following

Oscillator – Internal, 1 ms DST

WDT – OFF

CODE Protect – OFF

Internal Oscillator Speed – 4 MHz

After programming the chip, insert it into the U1 socket (NOTE PIN 1 LOCATION) on your SYNCHRONOUS LOAD BOARD.

This completes the assembly of your board. Check all connections, component orientations, and make sure no short exists from +V to ground. You are ready to mount it to the surface you marked earlier using standoffs you provide. Be sure to use lock and flat washers to prevent it from vibrating loose. Here is a photo of my board after completion below in Figure 4. I did add a couple other things to mine such as a small proto area and more connectors for other stuff but it gives you the idea.

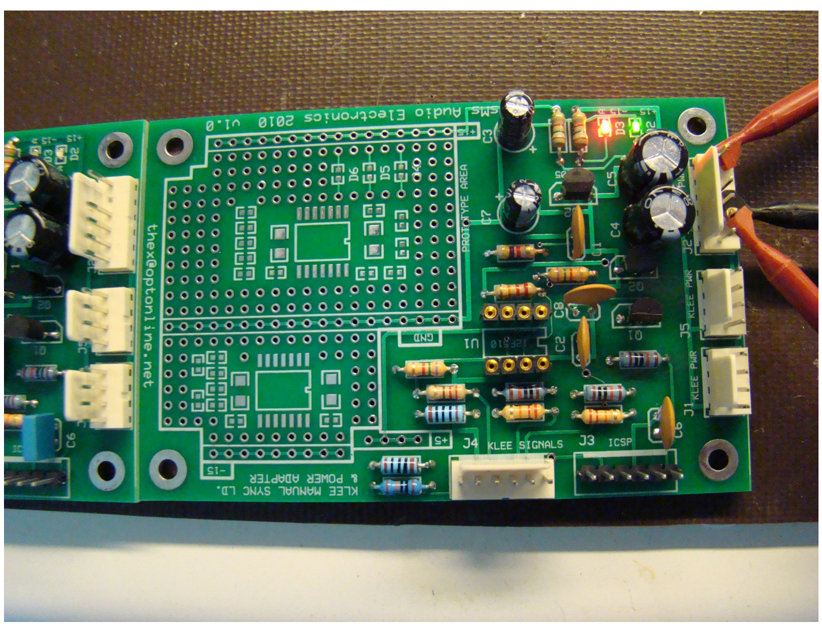


Figure 4 Completed Sync Circuit Board Assembly

Figure 5 shows the board with the MCU installed.

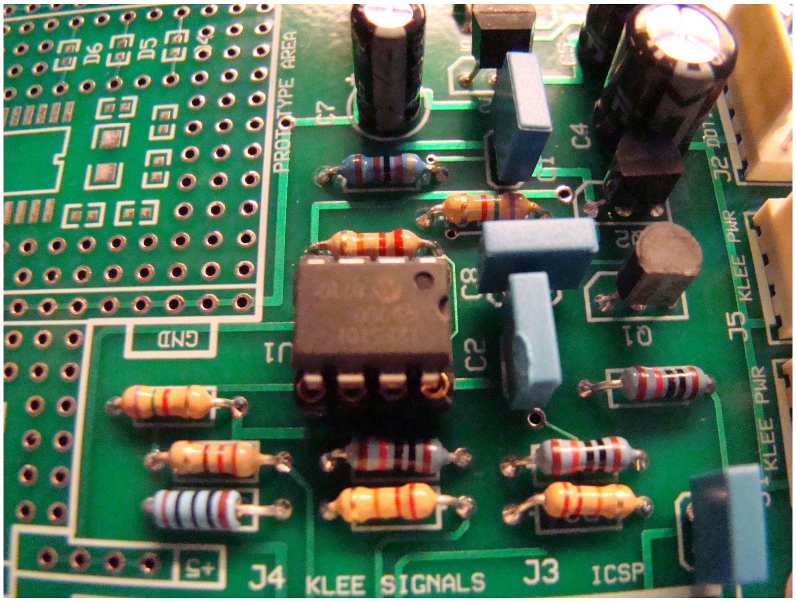


Figure 5 Sync Board with MCU U1 Installed

PART LIST

CAPACITORS

C1, C2, C6, C8 100 nF, 50 V or greater ceramic disk

C3, C7 22 uF, Electrolytic 25V or greater

C4, C5 47 uF. Electrolytic 25V or greater

SEMICONDUCTORS

U1 12F510 BLANK 8 BIT MICROCONTROLLER 8 PIN 0.3" DIP

NOTE: Firmware 1.0 (syncload.hex) is available for download if you want to program your own chip.

U2 LM78L05 LINEAR VOLTAGE REGULATOR, 100 Ma, TO-92 CASE

Q1 2N3904 NPN Si Switching TRANSISTOR PLASTIC TO-92 CASE

Q2 2N3906 PNP Si Switching TRANSISTOR PLASTIC TO-92 CASE

DS1 LED T 1 ¾ FOR PANEL & LENS [OPTIONAL]

RESISTORS (ALL ¼ W, 5% TOLERENCE, CARBON FILM)

R1, R3, R11 22K

R2, R4, R6 10K

R5 220

R7 100

R8, R9 7.5K

R10 4.7K

CONNECTORS

J1, J3 2 PIN HEADER 0.1" Spaced Molex "KK" Straight or Equivalent

J2 6 PIN HEADER 0.1" Spaced Molex "KK" Straight or Equivalent

SWITCHES

SW1 DPDT ON-ON SWITCH, PANEL MOUNTED (1/4" PANEL HOLE)

MISCILLANIOUS

SOCKET (8 pin, Low Profile, DIP)

SOLDER

WIRE 24 AWG, stranded, insulated (As required)

(4) 1" STANDOFFS & associated mounting hardware (lock washers, flats, screws, etc …)

PERFORATED BREADBOARD with copper pad per hole (Approximately 3" x 4")

(2) 2 PIN CONNECTOR HOUSINGS (0.1" Molex "KK")

(1) 6 PIN CONNECTOR HOUSING (0.1" Molex "KK")

(12) CRIMP TERMINALS [2 SPARE]

<u>POWER</u>

The power for the sync board is taken from the V+ Klee power supply connection that goes to J1 of the digital PC board. To achieve this, some simple routing is necessary. This will require that you make a 2 wire cable that is long enough to reach between Klee digital board J1 and Sync board J3. The internal logic for the sync board does not require an external 5V power supply because it derives voltage using a 78L05 linear regulator. The incoming V+ used by the Klee can be either 12V or 15V. This Klee V+ voltage is used by the sync board and passed back out the J3 connector to route back to the Klee digital PC board.

To provide this power remove the power connector J1 on the Klee digital board and install onto J1 of the sync load board. Now run a cable from the sync boards J3 connector to the digital boards J1 connector. This is the 2 wire cable mentioned earlier. You will need two 2 pin housings and 4 crimp terminals.

Power connections should now be complete.

PANEL COMPONENT MOUNTING

First, make sure your switch is good by doing a resistance check in each switch position. The worst thing is to mount and wire a BAD switch only to have to redo your work. Also, make sure your LED is good. Never apply too much heat to the switch terminals as they are usually held in epoxy potting and come loose very easily. Set you iron to 650 F, use a small soldering iron tip and use a small bit of flux to improve solder wetting.

Mount your switch and LED on your front panel. Typically the hold size for toggle switches is ¼" but make sure by measuring yours. Same is true for the LED.

After mounting the switch and LED, the LED should be labeled "PENDING LOAD", and the switch UP position should be labeled "SYNC" and the DOWN position should be labeled "ASYNC" with a switch label MANUAL LOAD. Figure 6 shows my cheesy panel.

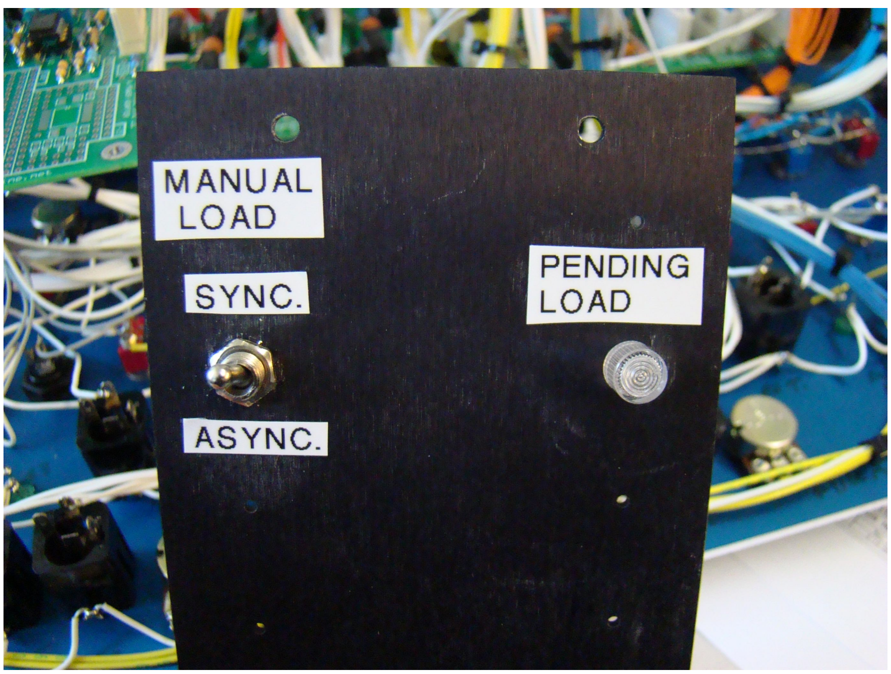


Figure 6 Cheesy Panel

KLEE SIGNALS, SWITCH, AND LED WIRING

Using a 6 position connector housing, cut and strip 5 wires about ¼" on one end, crimp (recommended) and solder terminals to the end of each wire. Clean your terminals before inserting into the housings using alcohol. Make sure you cut more wire length than you will need to reach all the wire destinations. Insert wires in pin locations 1 through 5 and make sure they "snap" into place and don't pull out. Pin 6 is unused.

Using the wiring diagram in Figure 1 of the schematic (Sheet 2) in Appendix A, wire SW1 and DS1 in accordance to the diagram. The anode connection for DS1 is typically the longer lead. The switch pictorial is shown as if it were looking at SW1 from the back of the panel, or, the wiring side.

Wire J2-3 to U2-12, CLOCK. Use Figure 2 as reference to locate U2.

This completes the modification to your Klee. Figure 7 shows the switch and LED wiring. Figure 8 shows the entire modification before mounting into my enclosure.

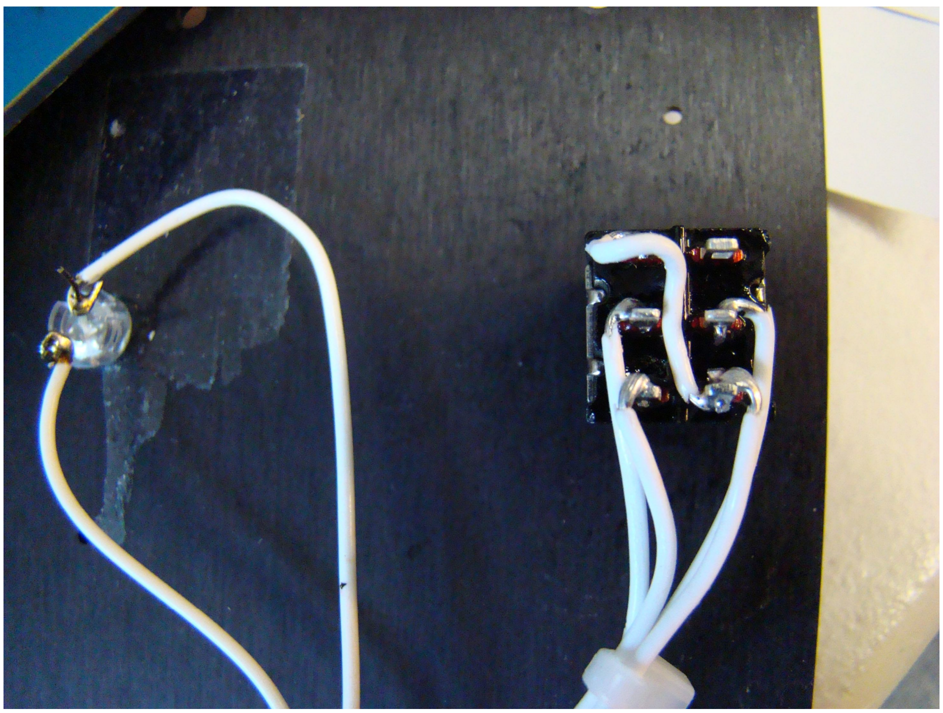


Figure 7 Switch and LED Wiring

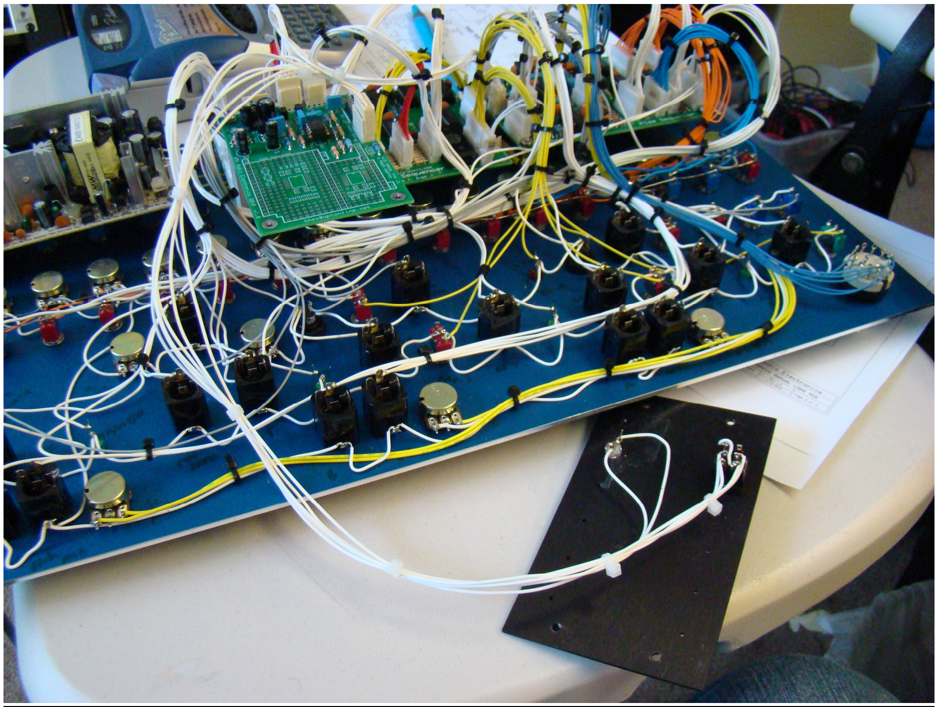


Figure 8 Completed Modification Before Mounting Into Enclosure

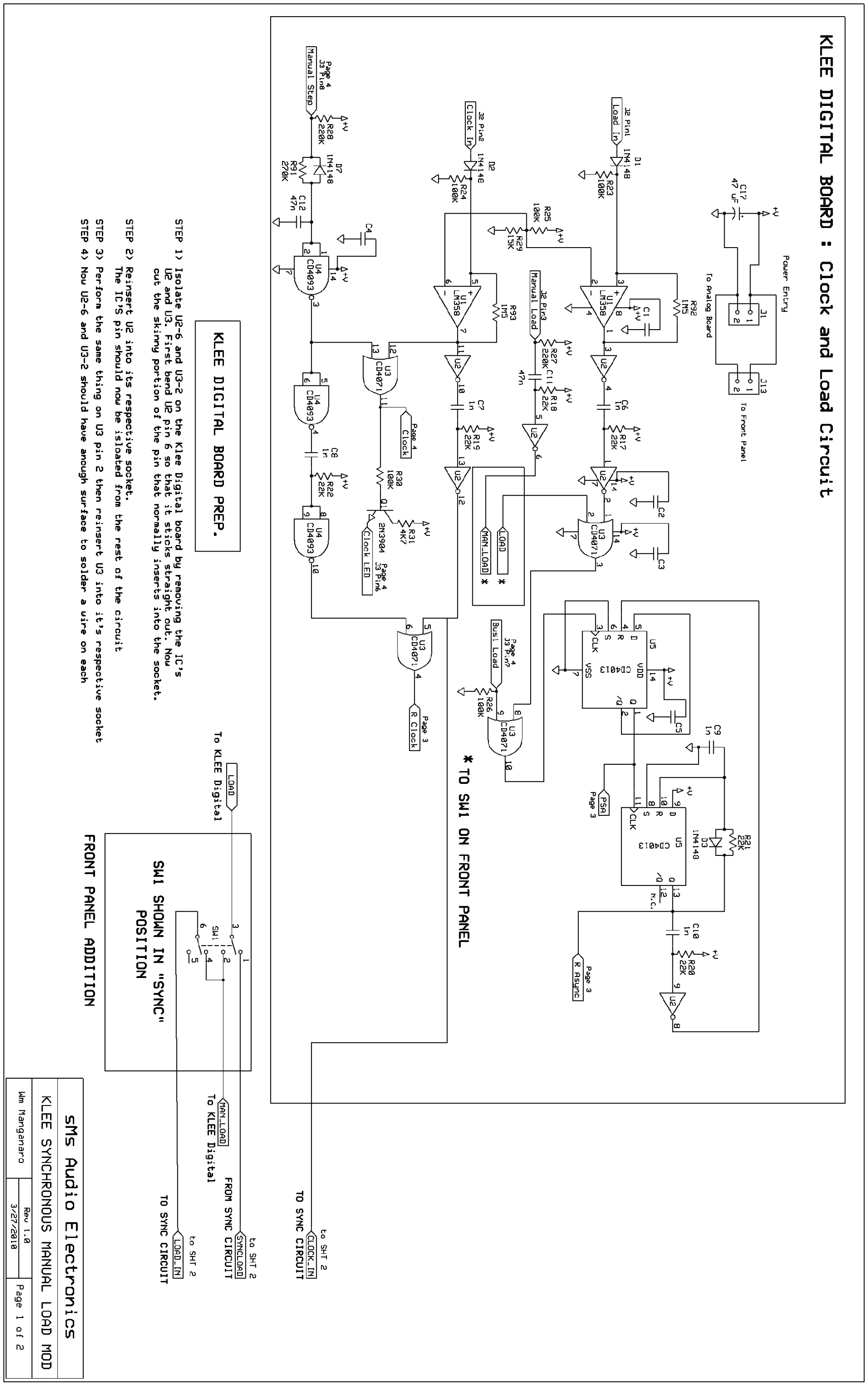
OPERATION AND CHECKOUT

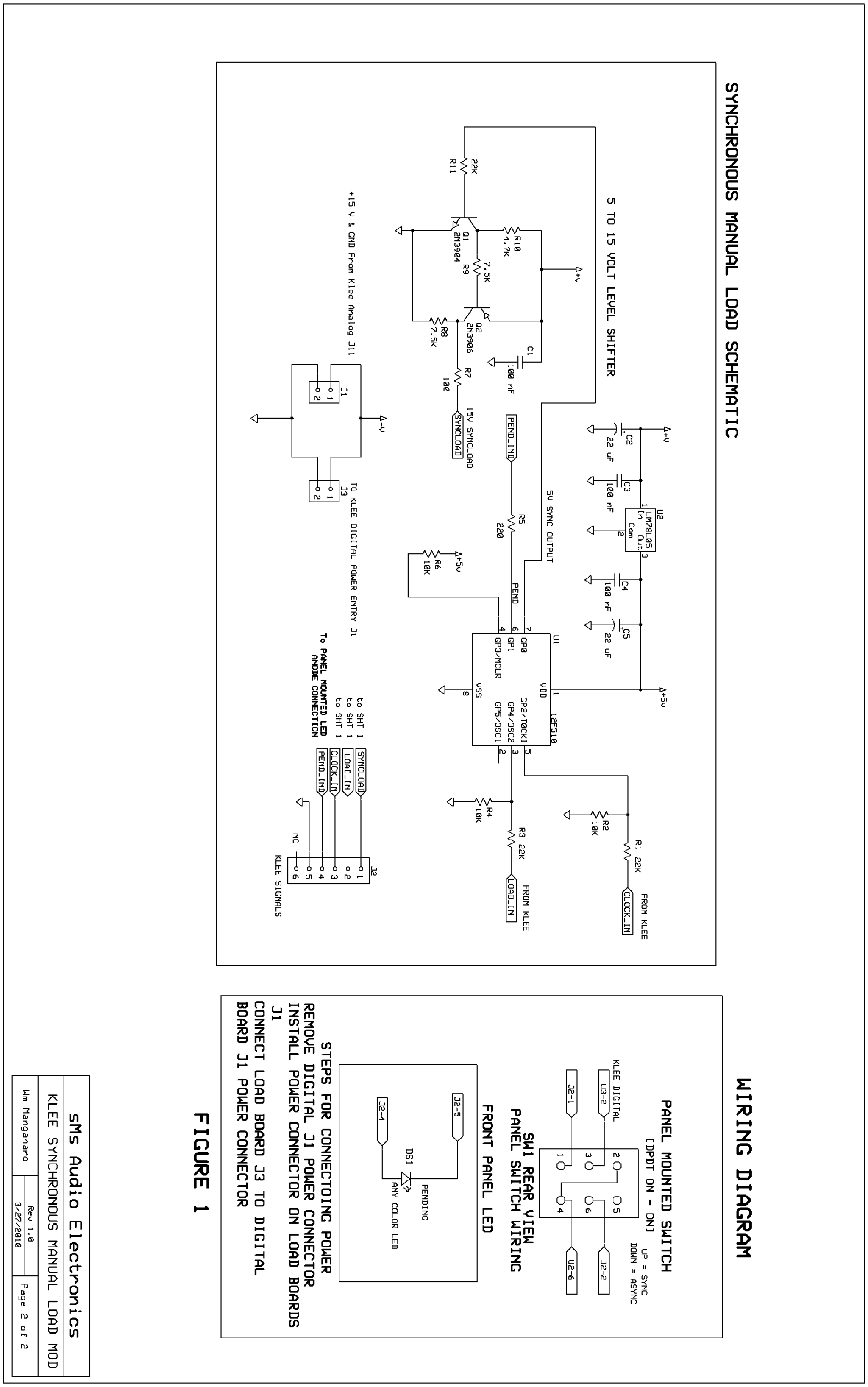
Power up the unit and observe the following. The PENDING LED should not be illuminated at this time. If it is, turn the unit off and on one more time just to be sure it's consistent. If it turns on again, then power the unit OFF and check your PCB once more and make sure U1 is installed correctly. If everything looks good so far, then proceed.

Place the switch in the "ASYNC" position. Input a slow running clock into the CLOCK input of the KLEE and set up any pattern you wish to load. Make sure clock enable is ON. While the Klee is running, press the MANUL LOAD button. The pattern you set will load immediately into the shift registers and the PENDING LED shall NOT illuminate. This is how the original Klee works.

Now switch to the "SYNC" position and press MANUAL LOAD button. The "PENDING" LED should illuminate and wait until a new clock comes along. At this time, when a clock arrives, the pattern will load and the LED should extinguish since no new LOAD is pending. The pattern now loads on a rising clock edge, or, "on the beat" instead of loading immediately. Sometimes if you press MANUL LOAD very close to a rising clock edge, the PENDING LED may only be on for a very short time so try to do this test using a slow clock (0.5 Hz or below), and press MANUAL LOAD just after the pattern has shifted.

APPENDIX "A" MODIFICATION SCHEMATIC




SYNCHRONOUS MANUAL LOAD SCHEMATIC
5 TO 15 VOLT LEVEL SHIFTER
+15 V & GND From Klee Analog J11
TO KLEE DIGITAL POWER ENTRY J1
To PANEL MOUNTED LED ANODE CONNECTION
15V SYNCLOAD
5V SYNC OUTPUT
FROM KLEE
KLEE SIGNALS
WIRING DIAGRAM
PANEL MOUNTED SWITCH
[DPDT ON - ON]
UP = SYNC
DOWN = ASYNC
KLEE DIGITAL
SW1 REAR VIEW
PANEL SWITCH WIRING
FRONT PANEL LED
PENDING
ANY COLOR LED
STEPS FOR CONNECTOING POWER
REMOVE DIGITAL J1 POWER CONNECTOR
INSTALL POWER CONNECTOR ON LOAD BOARDS J1
CONNECT LOAD BOARD J3 TO DIGITAL BOARD J1 POWER CONNECTOR
FIGURE 1
sMs Audio Electronics
KLEE SYNCHRONOUS MANUAL LOAD MOD
Wm Manganaro
Rev 1.0
3/27/2010
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