MIDItriggs

MIDI to/from trigger interface

What is it

MIDItriggs is a simple MIDI to/from trigger interface developed from the sudden desire to add MIDI capabilities to an old Hohner Automatic Rhythm Player. Intended to just trigger the analog sound generators via MIDI in the first place, the project has grown to also provide MIDI output to synchronize MIDI sequencers to the internal sequencer of the machine using a MIDItriggs module. Meanwhile, the other way also works, as the CR-78 adaption makes quite a lot of use from this.
The project is designed as a very versatile module not just for the first unit it is used for, and so the number of usable features may vary with different host machines using this module. More about this can be found later in the technical section.

How to use it

MIDItriggs is designed for simplicity in use and especially in the mechanical work you have to do on your maybe very precious vintage equipment. So no fancy displays or rotary encoders, everything is reduced to just drill some holes for the MIDI connectors and a button.

General description

The module is installed in the host machine and uses a small amount of power from it. The main feature, which usually is used in every installation is the control of the host instrument trigger signals. Depending on the installation and the way the host machine works, it is also possible to read those trigger signals to generate MIDI events from them and if all features are used, the machine clock and start/stop signals are also read to convert them to MIDI signals, while incoming MIDI sync data can be used to control and synchronize the internal sequencer of the host machine.
There is a very simple configuration interface built into the firmware to set things like the MIDI channel, instrument mapping, clock handling and MIDI output features, which is completely controlled by one single button and incoming MIDI note-on events.

MIDI implementation

The MIDI capabilities are very rudimentary, as nothing freaky is needed to control some trigger signals. So is just knows about MIDI note on events coming in, which are mapped to the desired trigger signals, and the MIDI clock/start/stop/continue for some synchronization. The same is supported on the MIDI out, it sends note on/off events to send the trigger signals via MIDI and it sends start/stop/clock messages for synchronization of external equipment.

Trigger synchronization

One MIDI note on event needs at least 0.6 ms to be transmitted, so there is no chance to get rid of latencies when just handling the note on events. So a sort of trigger latch timeout has been implemented which delays firing of the triggers by 2 ms after the reception of the last MIDI note on event. So if in your sequencer, 5 instruments are on the same spot, they still need about 3 ms to be transferred, which leads to sequential triggering of your instruments during this period in a random order. This can sound really evil, so there is a delay, which resets to 2 ms after the first MIDI note on event has been received, and if for those 2 ms no further events are received, the triggers are all switched on at once. The older sync onto the MIDI clock has gone, as it gave too long delays. The consequence is that the new trigger synchronization is now always enabled.

Incoming MIDI start/stop/clock

If you want to synchronize your drum machines internal sequencer, you can easily do it. The hardware driver for your host machine needs to implement the details on how to tell your hardware to start, eventually catch lost clocks to feed them later, and even generate clock signals for a fade-out, while the MIDI clock is already gone. There are sync masters behaving strange (like the Yamaha QY-10, which sends a load of fast clocks after stop) and there are sync slaves needing special handling (like the Roland CR-78). A lot of this is already implemented due to several days of research on how to implement it the best way.
The result is simple and works as desired:
A MIDI start message starts the internal sequencer, but does not yet clock it. The MIDI specs say that after a MIDI start, the first clock is the real start of the playback. It is implemented this way.
A MIDI continue message usually doesn‘t start your pattern at the beginning, but at a specific spot. As this is not possible with the host machines that are currently implemented in MIDItriggs, there is no special handling of this case, continue is handled as start.
MIDI clocks then advance the sequencer, while the machine clock might use a different speed, like the CR-78 using 12 ppqn, while MIDI uses 24 ppqn. So there also is an adaption of this.
After a MIDI stop, no further received clocks are used, as they can be totally wrong. If the machine needs to continue running after a MIDI stop for a while (like the fade-out on the CR-78), the now missing clocks are generated by MIDItriggs. For this, an internal timer is synchronized to the incoming MIDI clocks, providing some sort of PLL to provide the missing clocks. There currently is no rounding, but if there is a jitter of more than 10% in the clock, the timer is not updated and the clock system set to „unlocked“ until 6 clean clocks are received. After start, this lock counter is set to 24 clocks. If a stop is received within those 24 clocks after start or during a jitter period, the sync timer is forced to a locked state, as we need to get clocks from somewhere.

Outgoing MIDI start/stop/clock

If you want to use the sequencer of your host to be the synchronization master of other machines like a sequencer, MIDItriggs can also provide the necessary messages for this if you enable this feature.
As the machine might work with a lower clock rate like 6 ppqn, while MIDI demands 24 ppqn, there is some mechanism to reconstruct the clocks between the machine clocks of the host. This mechanism is using the same timer that is used for MIDI in synchronization, it also uses the locking mechanism to not provide incorrect MIDI clocks due to the sync timer running wild.

This currently is a bit tricky if the host machine is far off the 24 ppqn. For 12 ppqn, both clock signal transitions can be used, while for 6 ppqn, there are 3 of 4 clocks that need to be generated by MIDItriggs.
Besides this, the same messages like MIDI start, stop and clock are transmitted in sync with the machine clock.

Module blocking

It might be necessary to block several states against each other. So on the Hohner Automatic Rhythm Player there is no way to control the internal sequencer. So when the internal sequencer is running, MIDI in is switched off and the configuration menu is aborted, if running. On the CR-78, there appears no sound if the sequencer is not in „running“ state, so the configuration starts the sequencer on it‘s own but doesn‘t provide clocks to it, so no instruments are triggered by the machine.
The in/out locking is done via the state engine, but it‘s perfectly okay to have both running in parallel, due to no sound comes out if the internal sequencer is not in running state.

Configuration menu

The configuration menu uses the single button and MIDI note events as the input devices and gives feedback by triggering instruments. For sure, this is not perfectly intuitive, but as configuration is not the main purpose of MIDItriggs, it should be possible to live with this - on the other side you don‘t need to drill lots of holes into your vintage equipment. As the project is open source, it is no problem to add a more sophisticated configuration system using displays and buttons or encoders if this is desired. In fact, this already exists, but is not (yet) part of the open source version.

To enter the configuration menu, hold the button for at least 1 second. You then hear the kick drum 3 times, a small break, and either the kick or the snare another time. As soon as you hear the first kick drum, you can release the button. This pattern can be simply written as a pattern of 2 measures with quarter notes, running with 120 bpm. Writing the break as „-“, the kick drum as „0“ and the snare drum as „1“, you get the following pattern after entering the configuration:

`000-0---` or `000-1---`

The first 3 triggers are the menu item number in a binary notation. If you are not familiar with binary numbers, it doesn‘t matter, all the patterns for the menu items are described later. The single trigger in the 2nd measure if the value of the parameter currently being edited.

To change the value or trigger an action for the current item, you again push the button for at least 1 second and release it. To switch to the next configuration item, push the button for a short time (less than 1 second).
As the immediate audible feedback can be a bit confusing, you can wait 2 seconds for the pattern to repeat to exactly know where you are.

The following configuration items are available, while the sequence in brackets is the first measure of the trigger pattern, 0 is kick, 1 is snare, and the second measure might give some information described in the description of the configuration item under „value“.

MIDI channel (000)
Value: 0 = omni mode enabled, 1 = MIDI channel configured, omni off
Change: pushing the button for at least 1 second switches to omni mode, sending any note event via MIDI uses the channel of this note event to set the channel of the unit and disable omni mode.

Incoming instrument assignment (001)
Value: 0 on entering the item, last assigned instrument during assignment
Change: sending a note event changes the assignment for this note event by cycling the possible instruments and the empty assignment.
Each time, you send the same note, you will hear the next instrument, if you cycled through all instruments, you will hear nothing, which is there to clear the assignment for this note, and after this, the cycle of instruments re-starts at the first instrument.
If you are happy with the instrument played on the last time you hit this note, you can proceed with the next note, as every note on message changes the assignment and gives immediate feedback.
The value in the feedback sequence (second measure) always is the last assigned instrument if you want to re-check your assignment, but you need to remember the note you sent last to know where this assignment takes place. You can assign the same instrument to multiple notes.

MIDI sync in (010)
Value: 0 if incoming MIDI sync is disabled, 1 if enabled
Change: toggle the value by pushing the button for more than 1 second

MIDI out (011)
Value: 0 if MIDI out is completely disabled, 1 if enabled
Change: toggle the value by pushing the button for more than 1 second

Outgoing instrument assignment (100)
Value: 0 on entering the item, last assigned instrument during assignment
Change: sending a note event changes the outgoing assignment if an instrument is assigned to this note in the incoming assignment.
You can only assign outgoing notes to instruments that already have an incoming note assigned. To assign the outgoing note for an instrument, just hit the incoming note of this instrument you want to be sent for this trigger.
So if you have the kick drum assigned to incoming notes C3 and C4 and the snare drum to D3 and hit C3 here, the kick drum sends a C3 now. If you hit D3, the snare drum now sends D3, the kick drum is unchanged. If you hit C4, the kick drum sends C4 now, the snare drum still sends D3.
So if you want a different assignment for the outgoing instruments, you first need to set the incoming assignments as you want the outgoing assignments to be, then hit all those notes once in the outgoing assignment.

On the other hand, this means that you may need to run the outgoing assignment again after changing the incoming assignment.

MIDI sync out (101)
Value: 0 if MIDI sync out is disabled, 1 if enable
Change: toggle the value by pushing the button for more than 1 second

Exit configuration without saving (110)
Value: 0 as confirmation that the configuration system ended without saving
Activate: push the button for more than 1 second
This doesn‘t save the configuration to non-volatile memory, but keeps it active while the machine is running. If you power down the machine, you will have the previous, stored configuration back on power-up.

Exit configuration with saving (111)
Value: 1 as confirmation that the configuration system ended and the configuration was saved
Activate: push the button for more than 1 second
This stores the current configuration to non-volatile memory, so you keep it between power cycled.

Technical documentation

The following describes the inner workings of MIDItriggs, while all information is valid for the full-featured installation in a Hohner Automatic Rhythm Player and the firmware delivered in the original package. Other installations may vary in the details.

MCU resource usage

Ports
Several port pins are used to input/output the signals from/to the host machine. The use of the port pins depends on installation and is best seen in the platform driver header file.

Timer 0
Running at 1 ms interface, this timer controls all the internal timing like trigger lengths, button time and configuration output sequencer.

Timer 1
This is a 16 bit timer to give the most possible accuracy for the generation of missing clocks for the MIDI clock output feature or machine clocks for the MIDI sync in feature.

Timer 2
This 8 bit timer runs the full range and updates another 16 bit variable, giving a 24 bit CPU clock cycle counter. This counter is used to determine the machine clock speed to calculate the timer value for Timer 1

External interrupts
Installation-dependent, used for handling of machine signals like clock, stop and start to update the timers for the MIDI clock and handle machine trigger scanning.

USART
Configured to 31250 bps to handle MIDI reception and transmission.

Most important module functions

main.c functions
mt_midi.c functions
mt_serial.c functions
mt_config.c functions
mt_config_button.c functions

Host platform driver module functions.

-TBD-

Adding new host platform drivers

Host platform drivers should have separate implementation files, as implemented in the 2 files mt_harp.h and mt_harp.c. Those files can be used as a basis for new host implementations.

-TBD-

Switching to a different micro controller

Hardware specific parts in mt_serial.c and host platform driver, clock out timer stuff in main.c

-TBD-

Schematics, board layouts, installation instructions

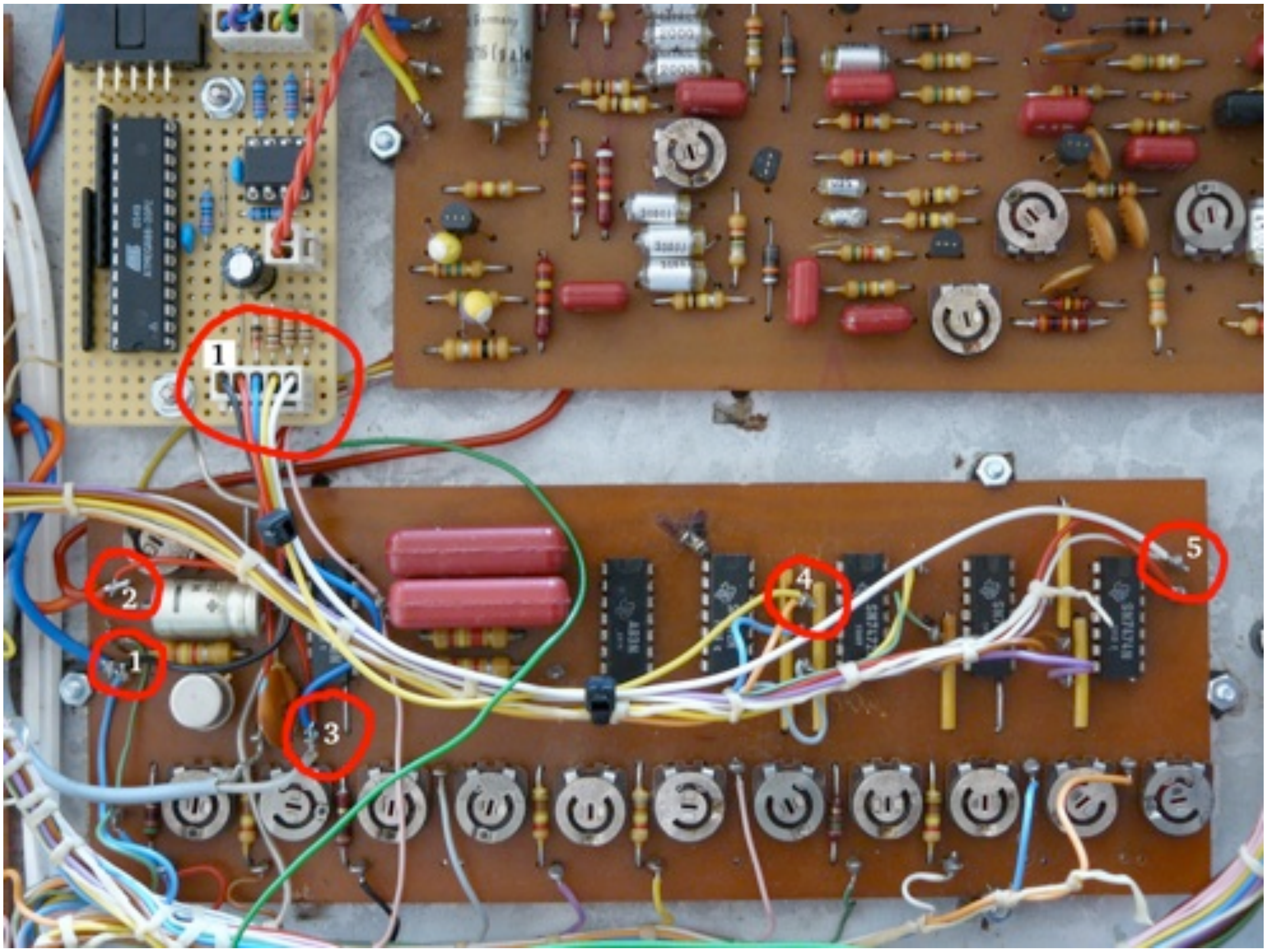
As the MIDItriggs project is very generic, there is no single hardware implementation. This document is growing for the different hardware variants that are implemented and for all the variants, schematics and PCB layout go here. To make your own PCBs, you should use the postscript files included in the hardware subdirectory of the project, as scaling might create some problems otherwise.

Hohner Automatic Rhythm Player veroboard prototype

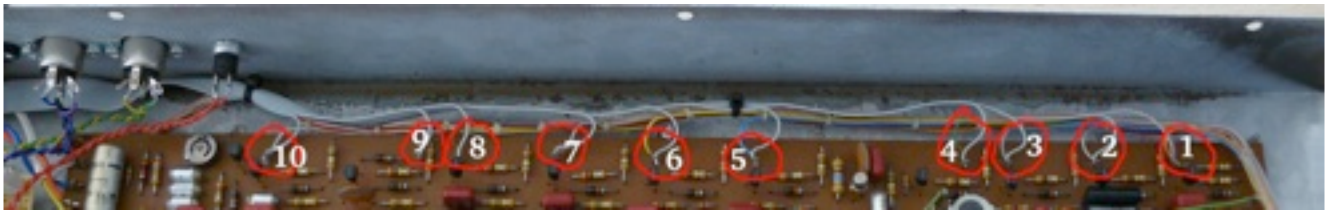
This is the first implementation that existed. It is not recommended to use the layout for a real PCB, though it would be possible. The layout is done for the veroboard version of this implementation, while some of the traces (those that are not on the 100 mil raster) are coated copper wires.

Installation

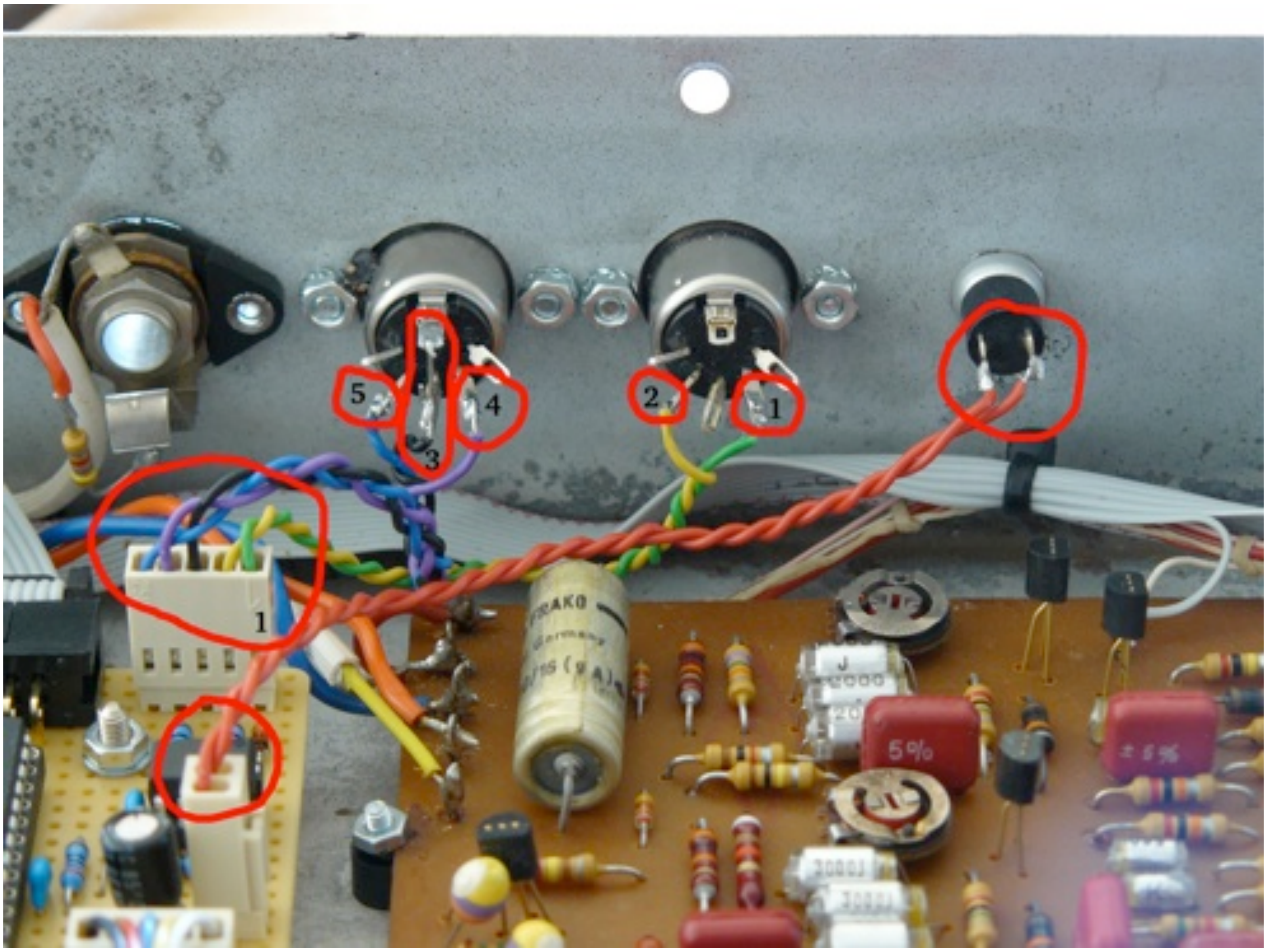
First, solder the cable carrying the power and sync signals in place. See the photo on the next page for pin assignment, the spots of interest are marked with red circles, the pin assignments labeled with white numbers.

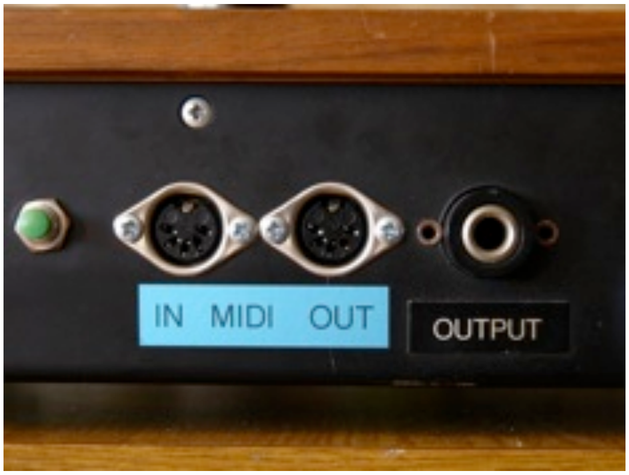


Next, solder the trigger lines for the instruments in place. The flat cable starts with the marked wire on the right side of the voice board and continues in order of wires and instrument signals to the right. In the following photo, the wire assignment is labeled with white numbers

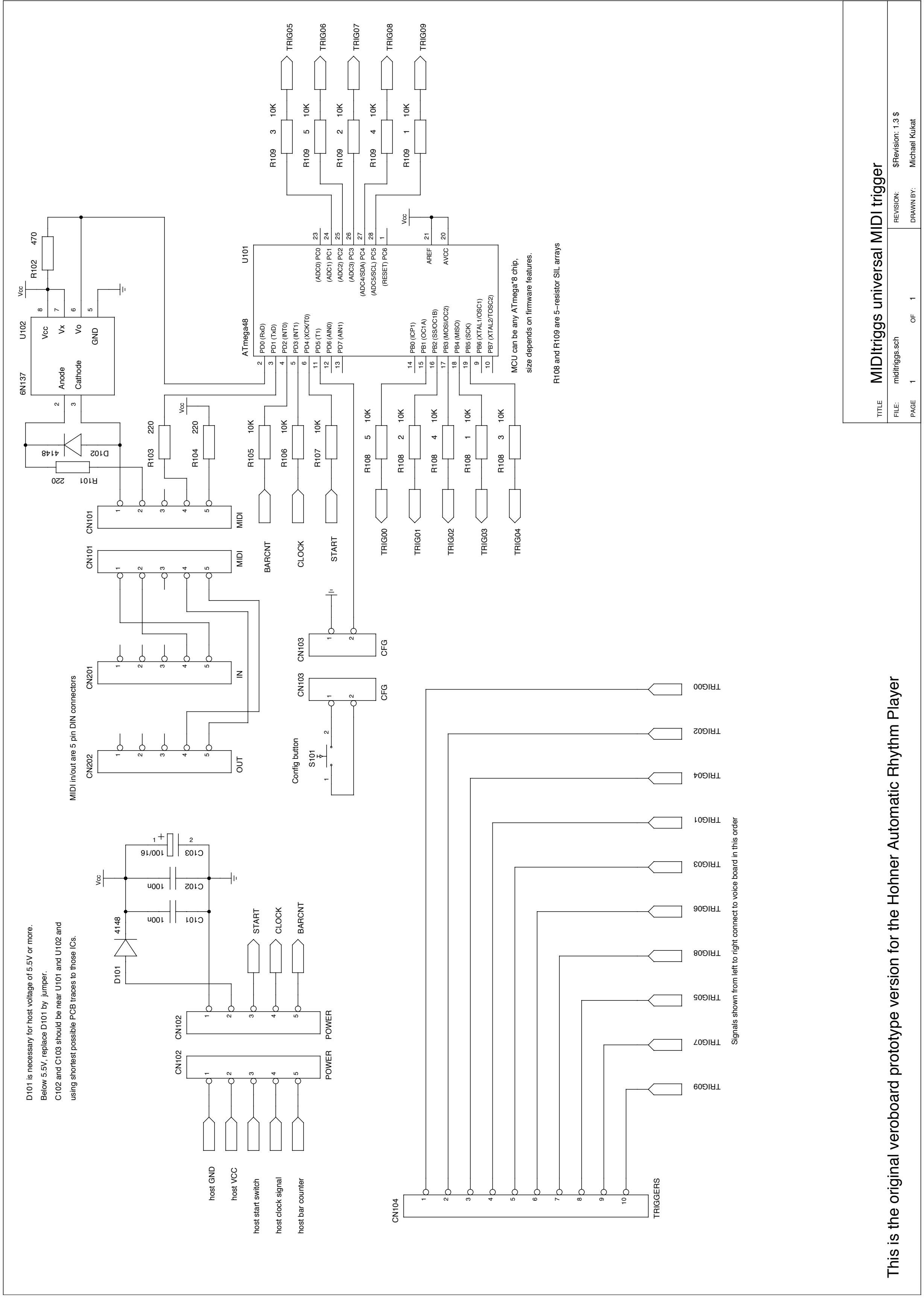


Now it‘s time to connect the configuration button and the MIDI connectors. The following photo illustrates the pin assignment of the board connector to the MIDI connectors. Take care to connect the middle pin of the MIDI OUT connector to the ground connector of the jack. The wiring of the configuration button doesn‘t matter.





The following pages show the schematic diagram and the board layout of this variant.



MCU can be any ATmega*8 chip, size depends on firmware features.

R108 and R109 are 5−resistor SIL arrays

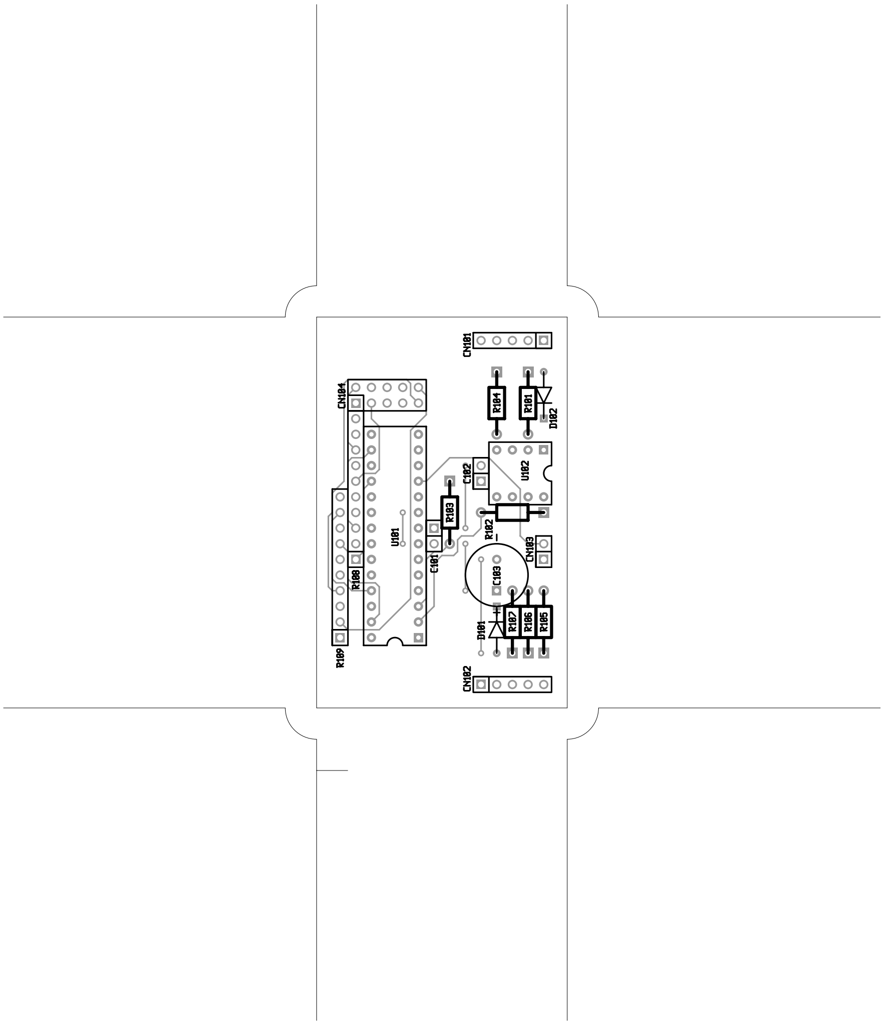
MIDI in/out are 5 pin DIN connectors

D101 is necessary for host voltage of 5.5V or more. Below 5.5V, replace D101 by jumper. C102 and C103 should be near U101 and U102 and using shortest possible PCB traces to those ICs.

Signals shown from left to right connect to voice board in this order

TITLE MIDItriggs universal MIDI trigger
FILE: miditriggs.sch
REVISION: $Revision: 1.3 $
PAGE 1 OF 1
DRAWN BY: Michael Kukat

This is the original veroboard prototype version for the Hohner Automatic Rhythm Player



frontassembly, scale = 1:1.000
/Users/michael/workspace/miditriggs/hardware/miditriggs.pcb

MIDItriggs universal board

After the public interest in this project, i created a real PCB layout for this project, which is the MIDItriggs universal board. In fact, it‘s just a simple micro controller board with the MIDI glue electronics, providing all the spare port pins via protection resistors on 2 header connectors. The purpose of this board is completely defined in the firmware, so you can trigger your drums with it, use it as a trigger to MIDI converter for your DIY e-drum kit, control your lights or power outlets via MIDI or just use it as a MIDI filtering tool. The board is designed in SMT to keep it very small, so you can mount it behind the MIDI connectors in your vintage beatbox or DIY project. The protection resistors are installed in arrays of 4 resistors each, while the Hohner version (called HARP2 in the sources) uses 10 KΩ resistors for the trigger and control signals, the CR-78 version (called CR78 in the sources) uses 1 KΩ resistors. For sure, you can mix the arrays, so if you attach a display/encoder on the 10 pin header connector, you use 1 KΩ resistor arrays or even 0 KΩ.

To upload the boot loader to this board, you can use the SPI signals, which also works with the 10 KΩ resistors in the way. I build a „programming adapter“ connecting the MIDItriggs to my AVRISP programmer. The RESET pin is not available on the header connectors, but there is a larger pad on the board that can be touched with a piece of wire. This is okay if you just want to upload the boot loader onto the board, while it is not very handy if you want to frequently update the firmware. Using the boot loader (the MIDIboot project), you can update the firmware via MIDI, which simplifies development a lot.

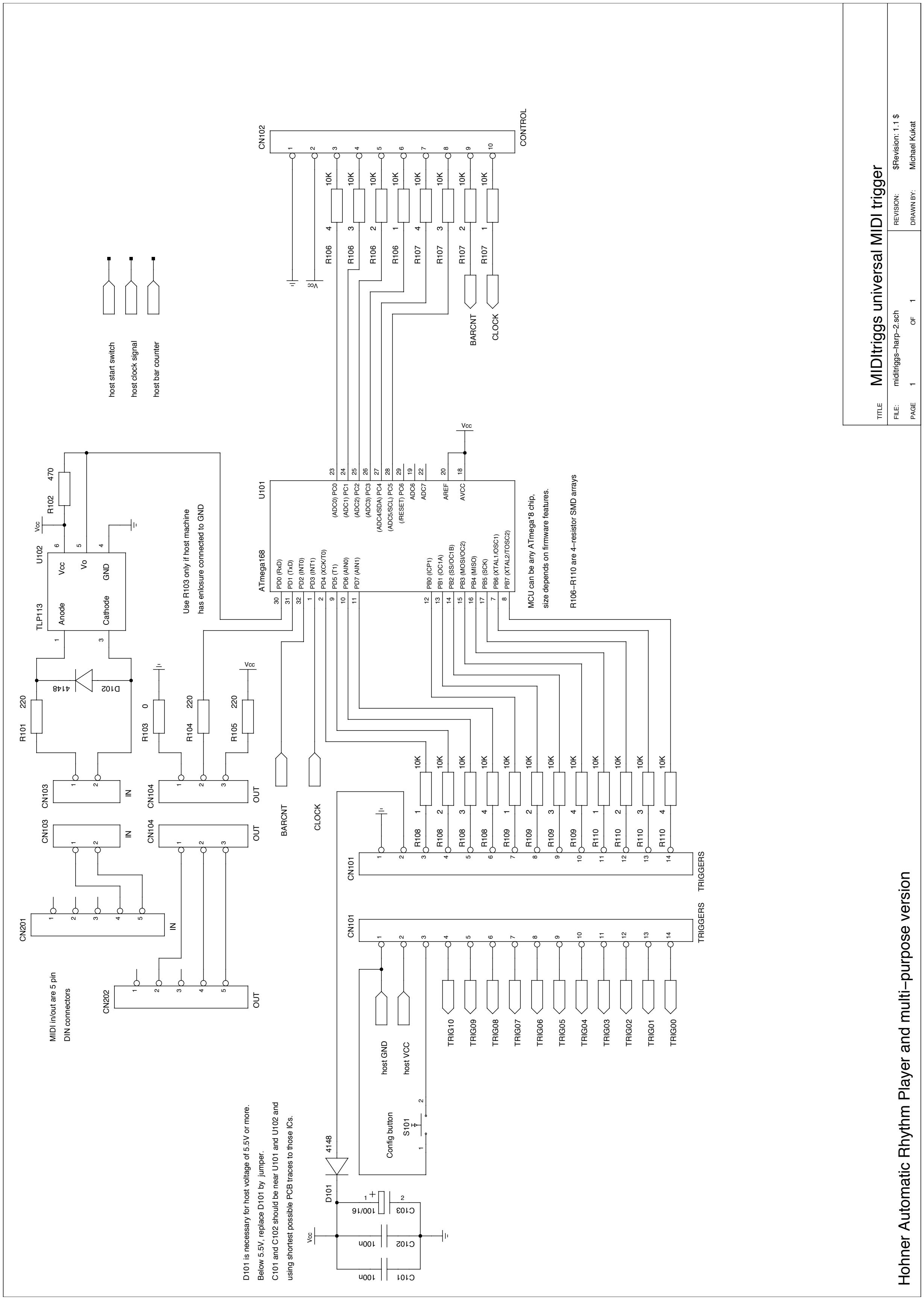
The schematics shown on the following page are for the Hohner Automatic Rhythm Player and are untested in this configuration, because the only host machine using this board version uses an encoder/display configuration (not included in the source package) and so doesn‘t have the single configuration button. Besides this, the trigger signals are mapped differently.

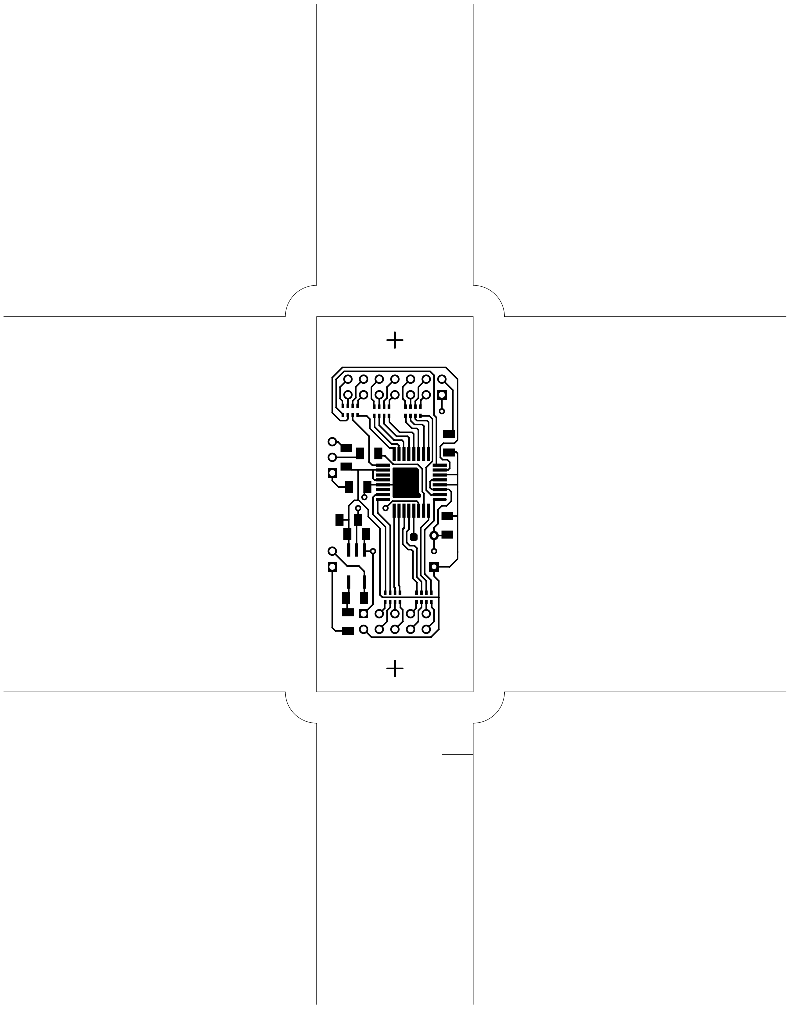
There are some important things about this circuit:

If your enclosure isn‘t connected to the GND of the MIDItriggs, you need to leave away R103 and connect pin 2 of the MIDI out connector to its shield. If you are sure that you don‘t have GND on a different voltage potential than the enclosure ground, install R103 (a 0 Ω resistor) to correctly ground pin 2 of the MIDI out connector.

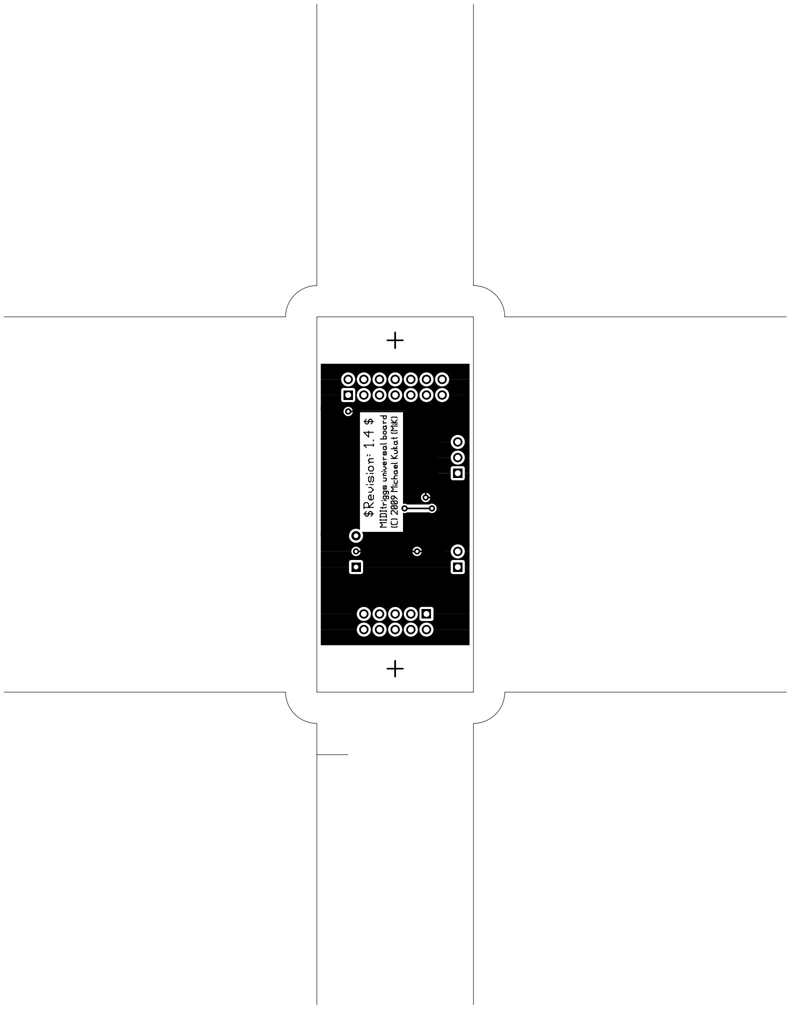
If your power supply is not clean enough and provides more than 5V, install D101 and feed power to the board through CN101. If you have lots more than 5V, you can use a Zener diode as D101. For exact 5V in the host machine, install a 0 Ω resistor in place of D101.

Carefully plan your configuration and the port assignment for simple wiring and efficient use of resources in the host machine. Especially take care of the 10 pin header, as you have 2 interrupt signals and the TWI on the pins there, which you might want to use with those features. The 10 pin header also connects the analog inputs to the MCU, giving even more possibilities.

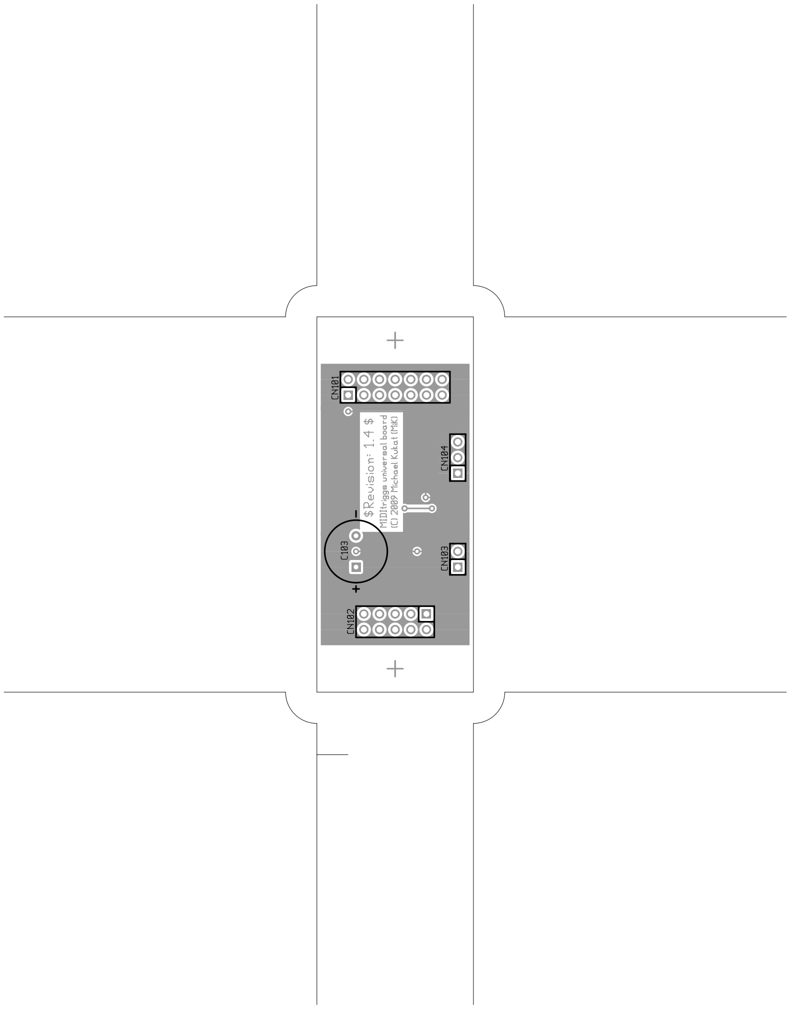

MIDItriggs universal MIDI trigger
TITLE
FILE: miditriggs–harp–2.sch
PAGE 1 OF 1
REVISION: $Revision: 1.1 $
DRAWN BY: Michael Kukat
Hohner Automatic Rhythm Player and multi–purpose version
CN102
CONTROL
R106
R107
10K
BARCNT
CLOCK
host start switch
host clock signal
host bar counter
U101
ATmega168
PD0 (RxD)
PD1 (TxD)
PD2 (INT0)
PD3 (INT1)
PD4 (XCK/T0)
PD5 (T1)
PD6 (AIN0)
PD7 (AIN1)
PB0 (ICP1)
PB1 (OC1A)
PB2 (SS/OC1B)
PB3 (MOSI/OC2)
PB4 (MISO)
PB5 (SCK)
PB6 (XTAL1/OSC1)
PB7 (XTAL2/TOSC2)
(ADC0) PC0
(ADC1) PC1
(ADC2) PC2
(ADC3) PC3
(ADC4/SDA) PC4
(ADC5/SCL) PC5
(/RESET) PC6
ADC6
ADC7
AREF
AVCC
Vcc
MCU can be any ATmega*8 chip,
size depends on firmware features.
R106–R110 are 4–resistor SMD arrays
U102
TLP113
Anode
Cathode
Vcc
Vo
GND
R102
470
R101
220
D102
4148
Use R103 only if host machine
has enlosure connected to GND
R103
0
R104
220
R105
220
CN103
IN
CN104
OUT
CN201
CN202
MIDI in/out are 5 pin
DIN connectors
CN101
TRIGGERS
R108
R109
R110
TRIG10
TRIG09
TRIG08
TRIG07
TRIG06
TRIG05
TRIG04
TRIG03
TRIG02
TRIG01
TRIG00
host GND
host VCC
Config button
S101
D101
4148
C101
100n
C102
100n
C103
100/16
D101 is necessary for host voltage of 5.5V or more.
Below 5.5V, replace D101 by jumper.
C101 and C102 should be near U101 and U102 and
using shortest possible PCB traces to those ICs.



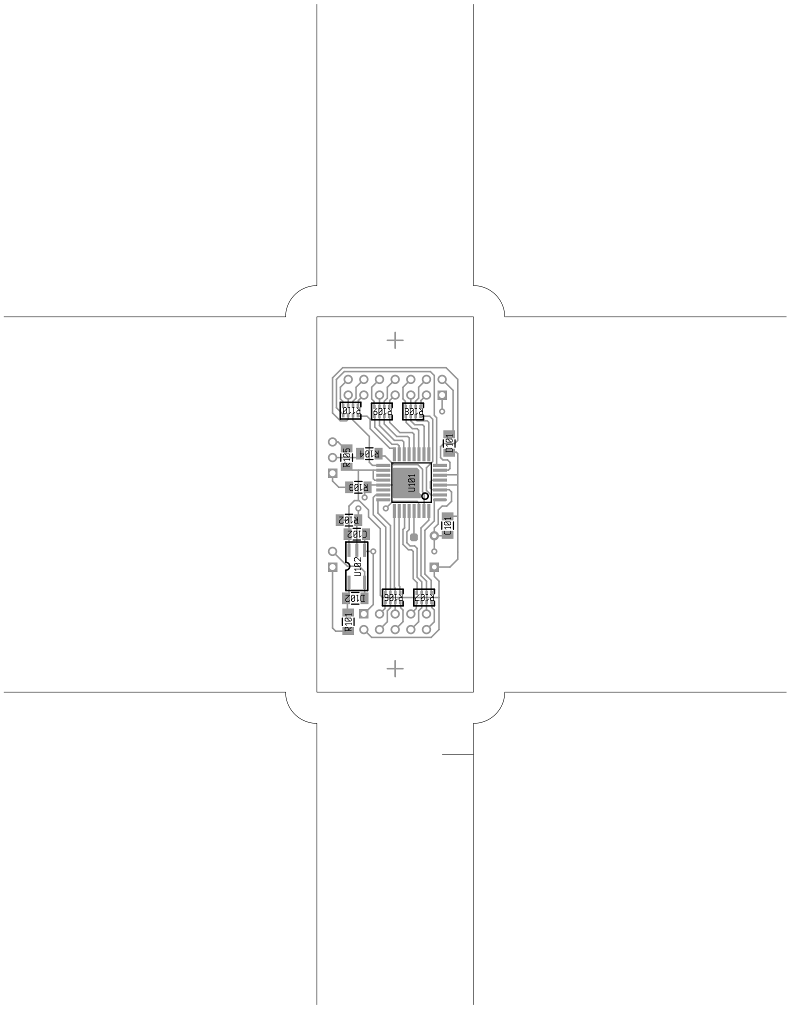
back (mirrored), scale = 1:1.000
miditriggs-harp-2.pcb



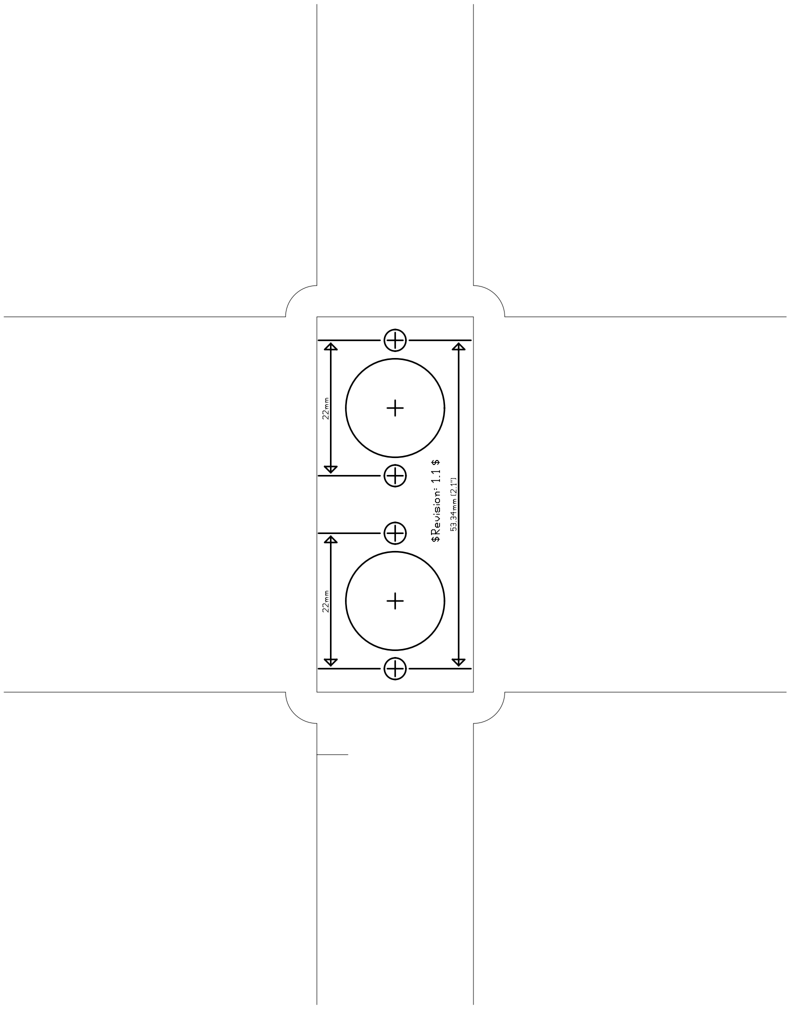
front, scale = 1:1.000
miditriggs-harp-2.pcb



frontassembly, scale = 1:1.000
miditriggs-harp-2.pcb



backassembly (mirrored), scale = 1:1.000
miditriggs-harp-2.pcb



frontsilk, scale = 1:1.000
drillmask.pcb

MIDItriggs universal board in a Roland CR-78

The installation of MIDItriggs into a CR-78 is a bit more complicated as you need some modifications to your CR-78 to enable the bidirectional triggers and MIDI clock control without disrupting the normal standalone operation of the machine. For the CR-78, D101 is a 0 Ω resistor, R103 is a 0 Ω resistor and all the resistor arrays are 1 KΩ. The following pinout for the headers is used:

CN101, Trigger signals and configuration button:
Pins 1 and 2 go to some power lines near the trigger transistors
Pins 3-13 go to the trigger resistors after modifying them. It starts with the Accent trigger on pin 3, BD on pin 4, up to RS on pin 13
Pin 14 is connected to the configuration button, the other end of this button is connected to a GND spot nearby (the connector board is suitable for this)

CN102, control signals and TWI interface:
Pins 1 and 2 carry GND and VCC and are used for TWI peripherals (like the PCF8574 on the memory expansion board)
Pin 3 - Connected between the diodes feeding the start/stop button signal to the flip flop
Pin 4 - Start/stop flip flop output, best grabbed at the correct end of R120
Pin 5 - The machine clock to the machine, connected to the through-hole where the trace has been cut
Pin 6 - Write switch signal, connected to IC120-13
Pins 7 and 8 carry the TWI signals for peripherals
Pin 9 - Start/stop state the CPU sees, connected to IC122-9
Pin 10 - Machine clock from machine clock generator, connected to IC120-2

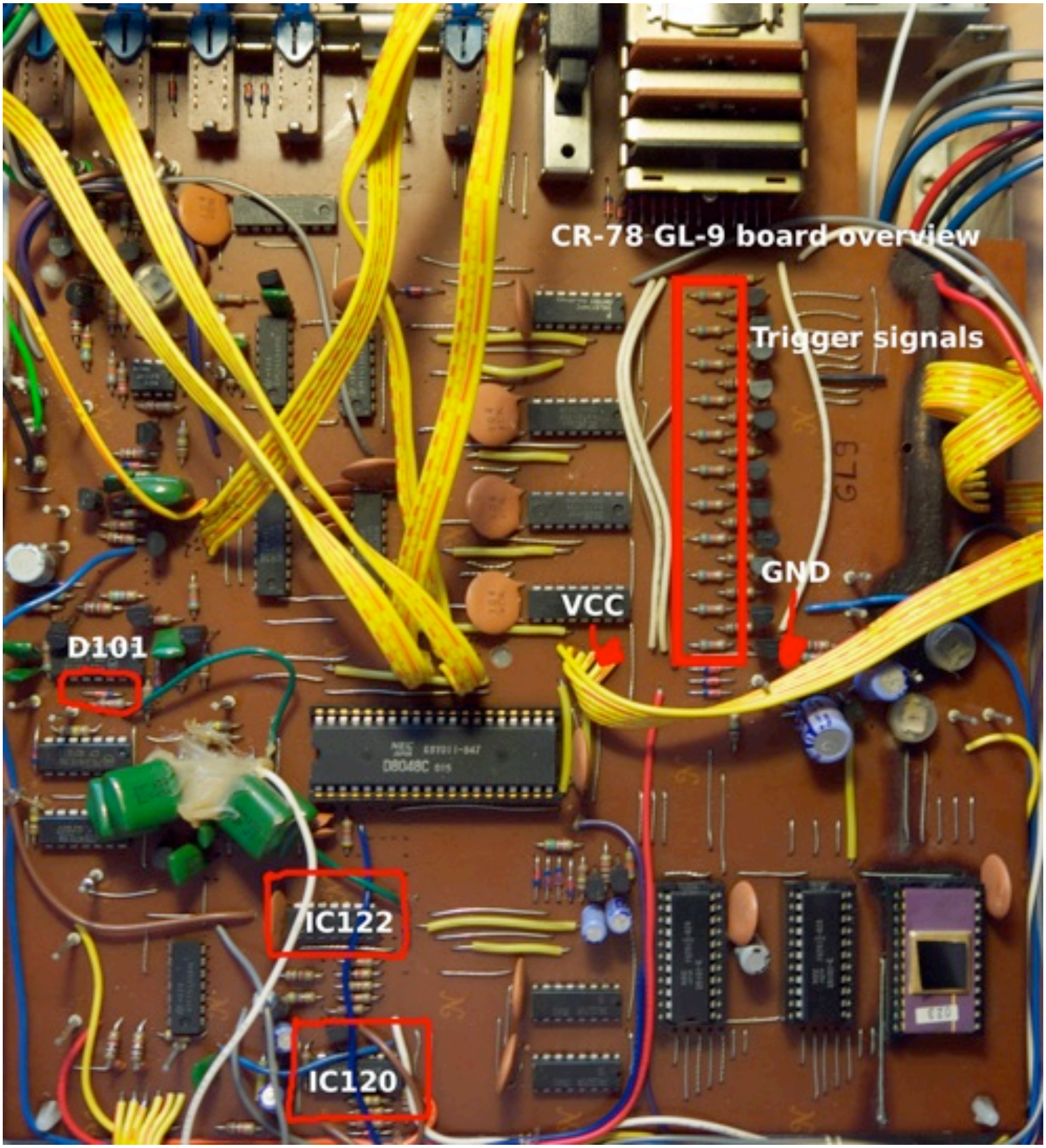
Installation

WARNING! There are 3 different board versions, GL-9, GL-9A and GL-9B. This installation procedure was initially designed for the GL-9B board.
The GL-9 and GL-9A should be nearly identical (single sided board), but the GL-9A has not been seen yet. On the GL-9, some components (like R201, which has to be removed) are on the lower side of the board. The following instructions are valid for the GL-9B board, differences on the GL-9 board are explicitly mentioned.

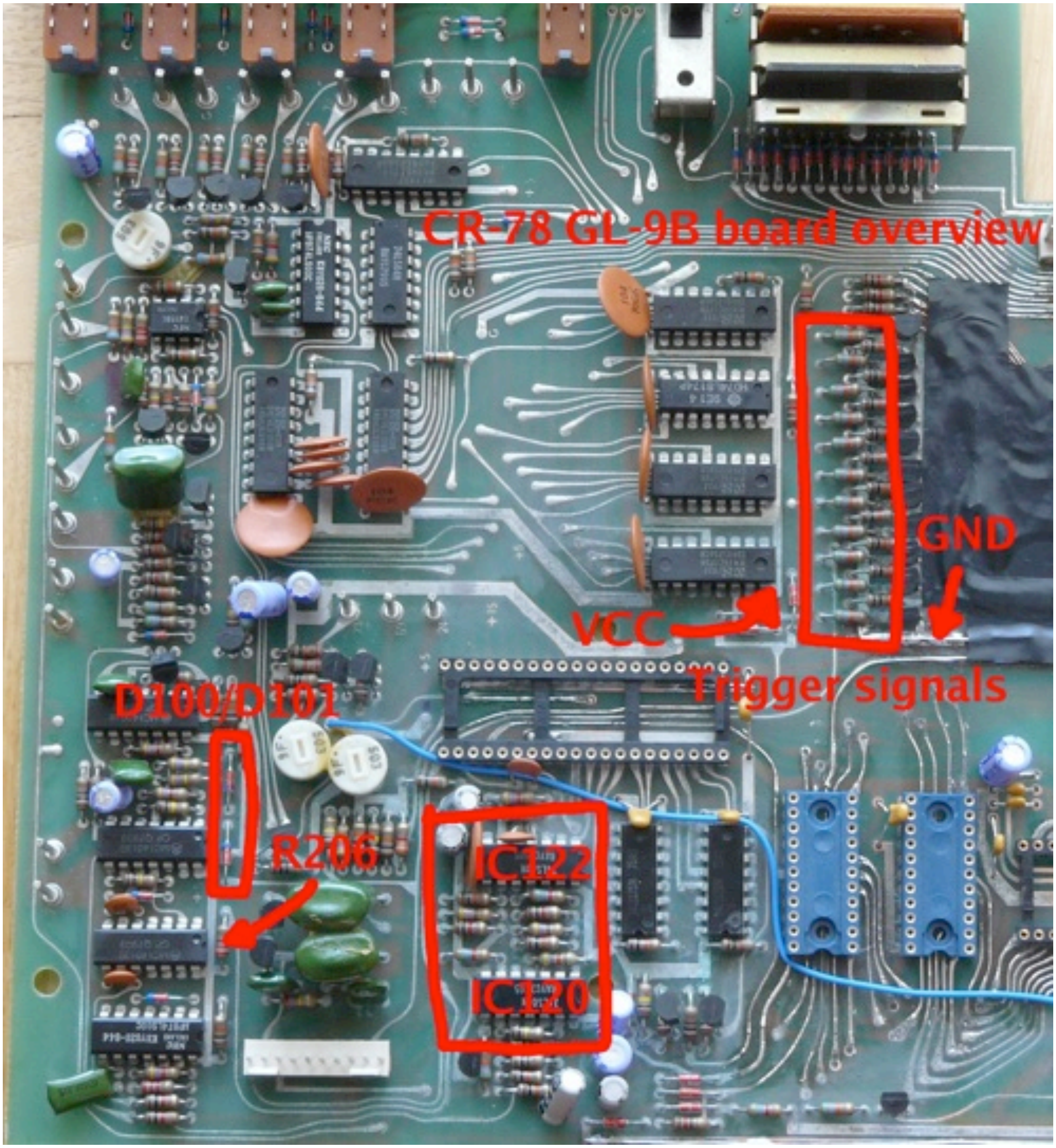
Check the following overview photos against your board to see if you have the right board version.

GL-9B: On the upper side, make sure, D100 and D101 on the left side of the photo are arranged in the same way.
GL-9: D100 is next to IC122, D101 is between IC109 and IC111, make sure you find them. IC120 and IC122 have the same horizontal position on GL-9B, they are a bit shifted on the GL-9 (and maybe GL-9A).
Besides this, the photos give you an overview in what areas you have to work, so you can find those areas for the detail photos coming later.

GL-9 board, upper side

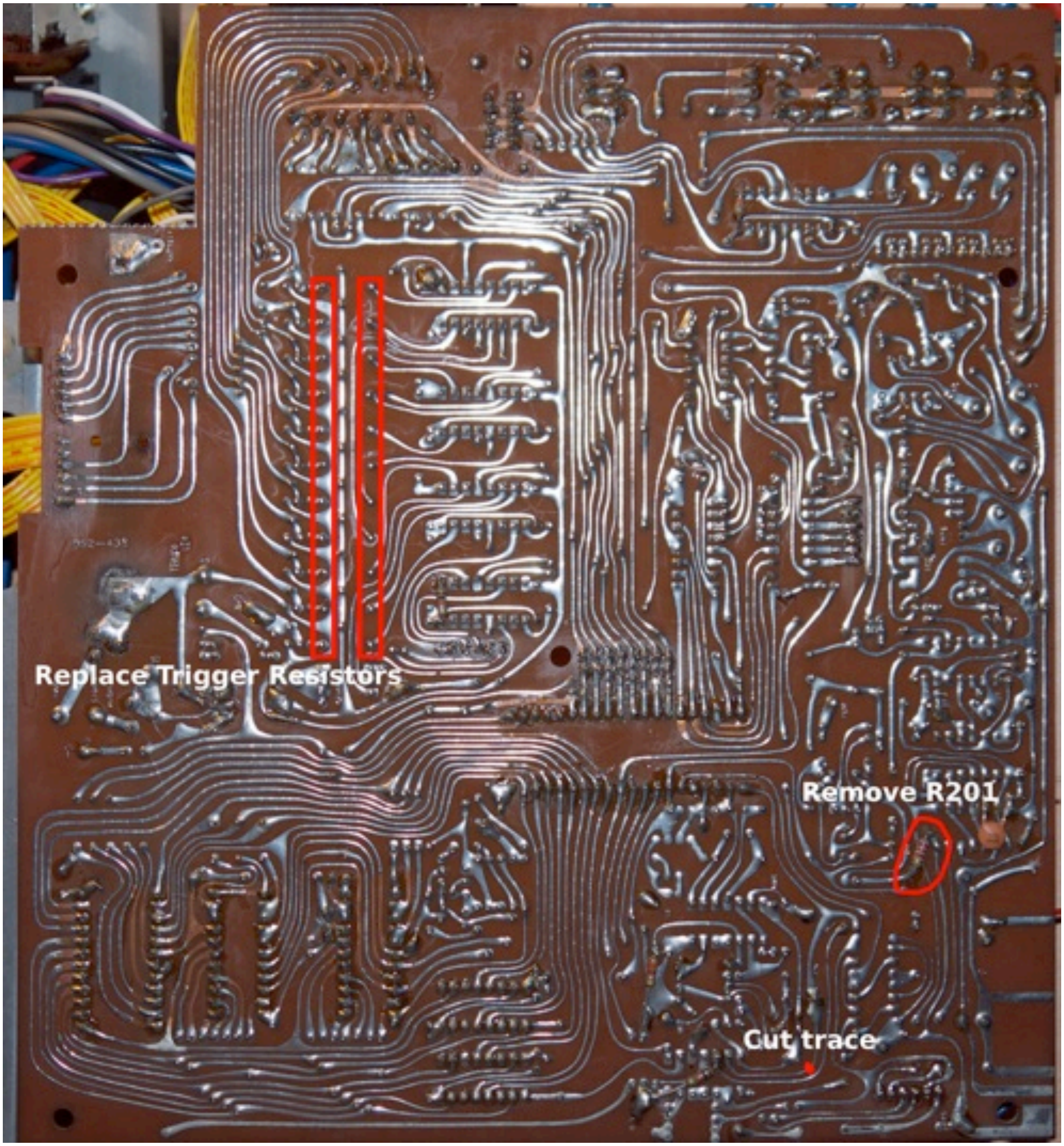


GL-9B board, upper side

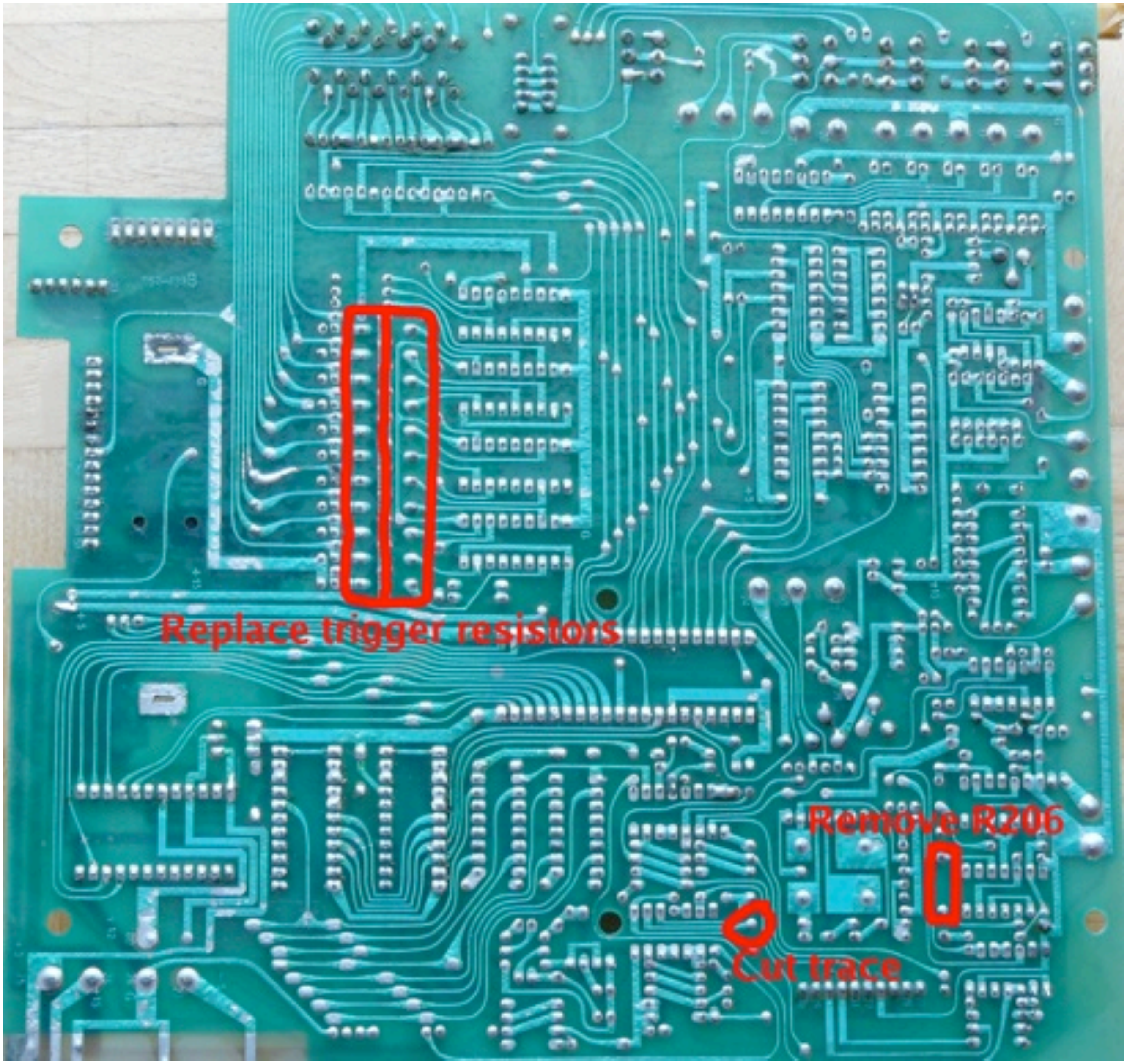


CN101 connects to the spots marked with GND and VCC and all the trigger signals after you replaced the resistors. R206 (on GL-9B board) needs to be removed
2 (GL-9) or 4 (GL-9B) wires of CN102 go to IC120 and IC122, a trace on the other side needs to be cut, 2 wires of CN102 go near D101 and a resistor left of the IC next to it. On GL-9, 2 wires go to jumpers next to the CPU and left of IC122.

GL-9 board, lower side

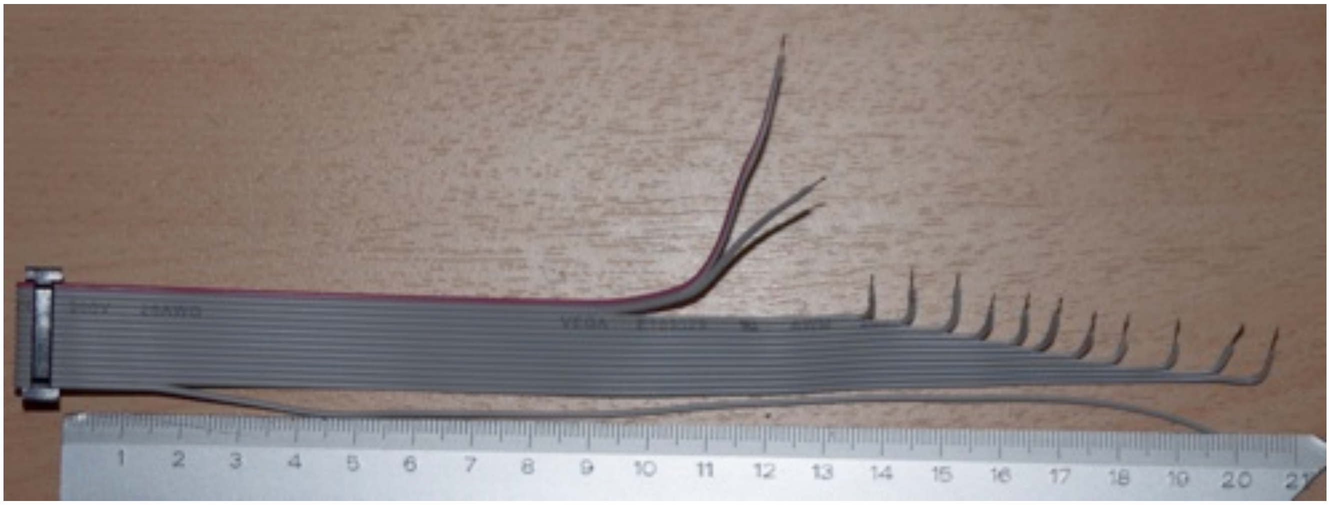


GL-9B board, lower side

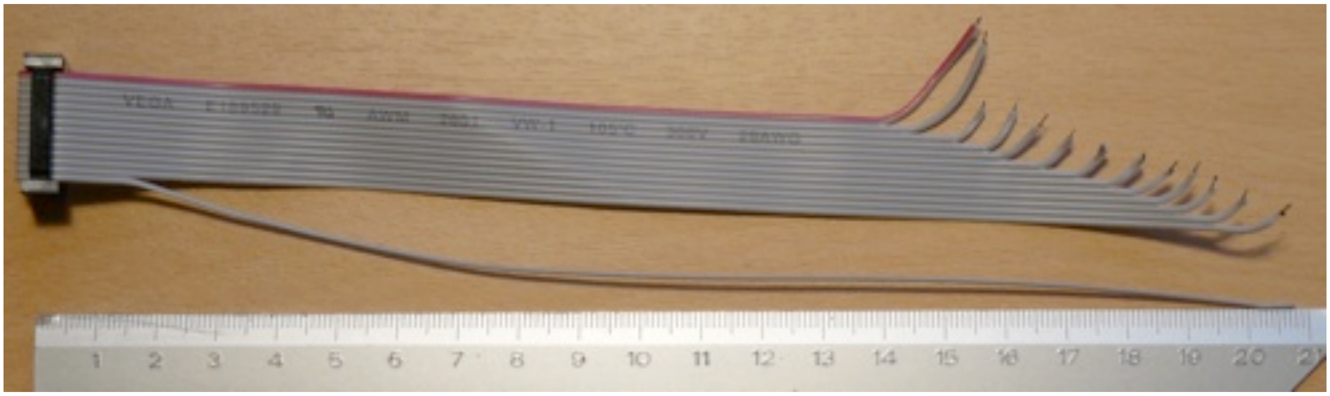


When unsoldering the trigger resistors, only solder at those 22 pins within the red markings. This also shows the places of the trace to cut and the R201 (GL-9) or R206 (GL-9B) to remove. On the GL-9A, R201 should be on the other side of the board, you should be able to locate it with the CR-78 service notes document available on the web.

Now have a look at the cables
Trigger cable for GL-9 (any maybe GL-9A)

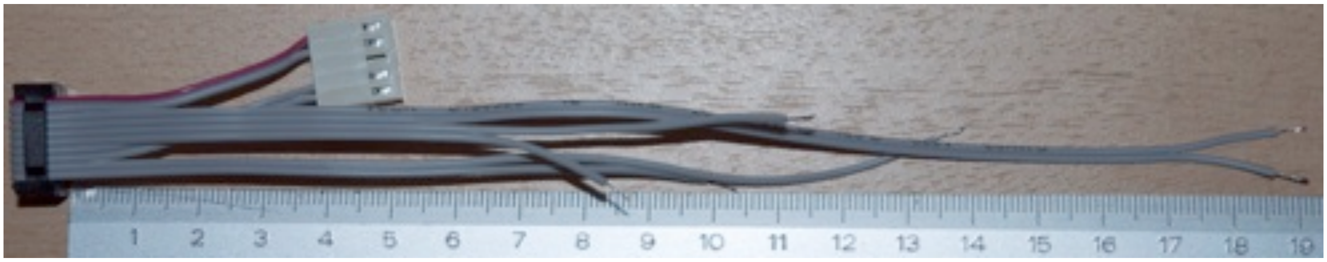


Trigger cable for GL-9B

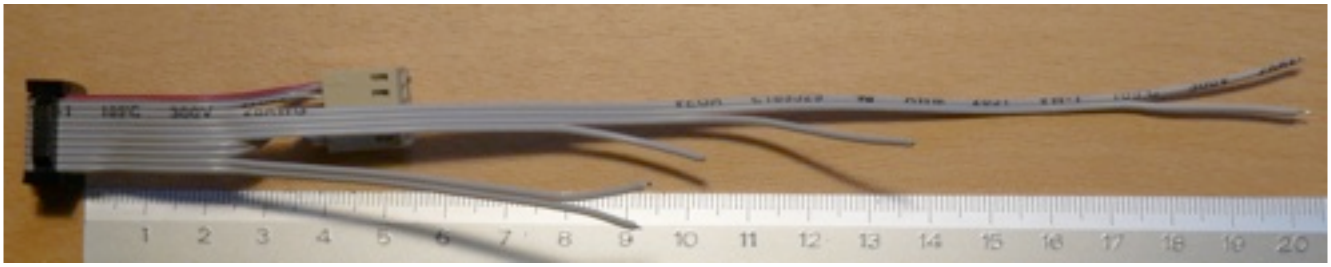


This is the cable for CN101, which is connected to GND with pin 1 (the wire with the red stripe), VCC with pin 2, the 11 trigger signals and the last wire is for the configuration button.

Control cable for GL-9



Control cable for GL-9B



This cable goes to CN102 and carries peripheral connection wires on pins 1, 2, 7 and 8 to the other connector (pins 1, 2, 4 and 5). Pins 3-6 and 9-10 go to the CR-78 board.

With those photos, you should be able to create your own cables with the wires in the tested lengths for this installation. The CN101 cable has a long wire for the configuration button, which usually is cut as needed, while the part of the wire being cut off can be used as the other wire for the configuration button, being connected to GND.

Now it‘s time to take the unit apart and put the MIDItriggs into it. This needs lots of concentration and electronic skills as you might need to remove the wire wrap connections to the board and later being able to restore them. Besides this, it needs good soldering skills. If you make any mistakes here, you can trash MIDItriggs, your CR-78 or both. Or maybe even your life, if you don‘t take care! So please read through the following steps carefully before removing the first screw and then decide if you really want to dive into this adventure.
For the wire wrap connections - if you carefully unwrap them from the end and keep the post with the sharp edges intact, you should be able to wrap the wire back later with having the same good contact as before. If you make mistakes here, you still can apply a bit solder to make sure the cables don‘t fall off, but it definitely is possible to restore the wire wrap connections if you have some experience with this technique, even if the normal wire wrap you might have learned works with different wires and tools. The physics are the same.

First, take the unit apart the following way:
- After removing the wooden enclosure, remove the connector board by unscrewing all the connectors at the rear - take care about the order of all the washers and keep them in a safe place
- Remove the rear panel by unscrewing the 4 screws and pulling it off. Pull the power cable through the hole to be able to put it a bit away from the machine
- Now remove the front panel by pulling all the knobs and unscrewing the 2 screws on the upper side and the 2 screws on the lower side. Take care about washers between the front panel and the main chassis.
- Remove the 2 screws left and right of the cancel switches and remove the nut of the instrument select switch
- Pull all connectors of the logic board and put them a bit away (only possible on the GL-9B, you may need to open the wire wrap connectors on the GL-9)
- Squeeze the board retainers and carefully pull the board upwards until you can get it a bit out of the unit, turn it around carefully without ripping off any cables, you need to work on the lower side later

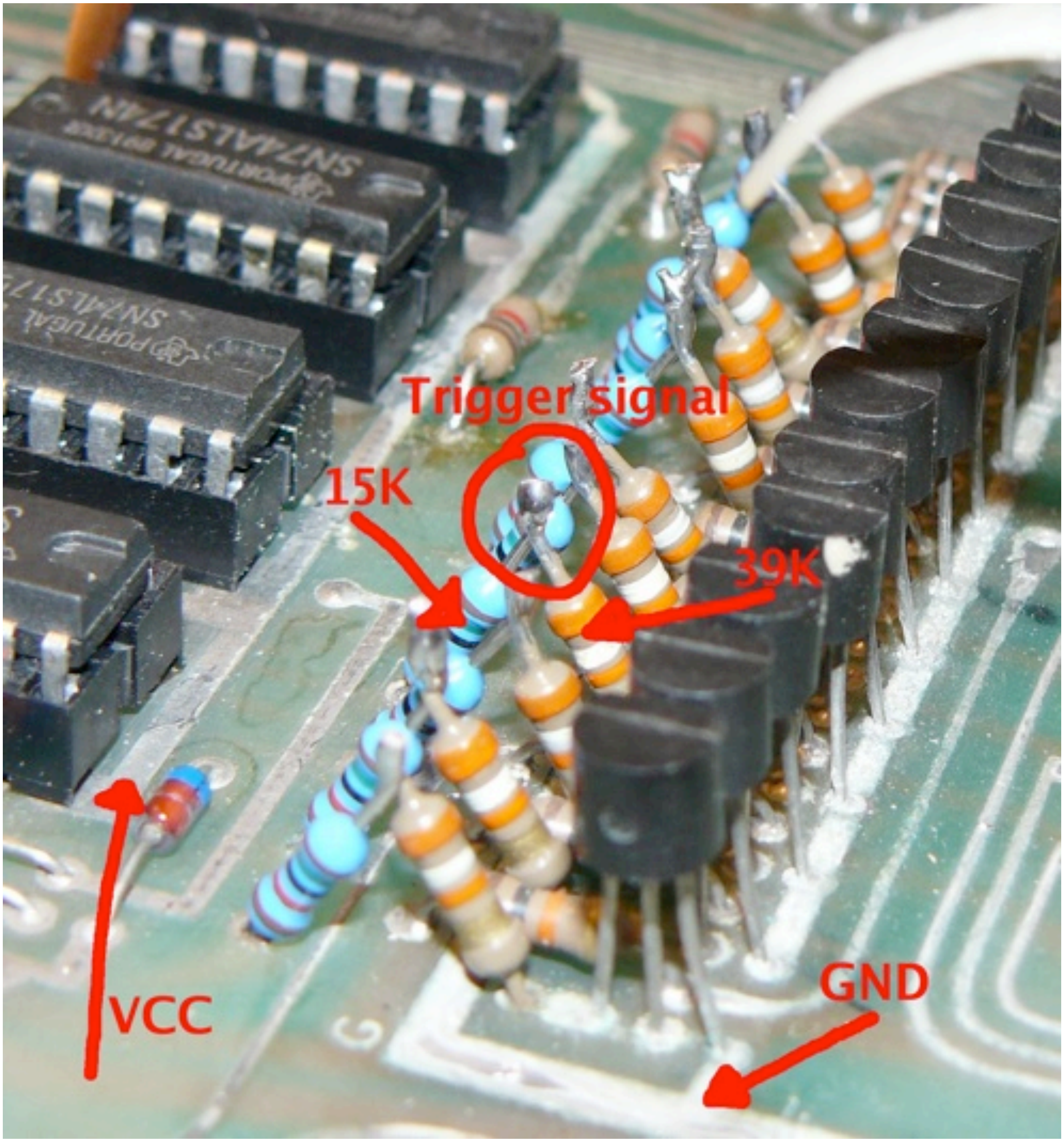
Now, it‘s time to prepare the rear panel for the MIDItriggs board to be mounted

Drill the holes for the MIDI connectors and configuration button:
- Use the drill mask (check the scaling after printing!) to find a suitable spot. Leaving 20 mm between the center of the connector row of the CR-78 and the upper edge of the MIDItriggs board is a good vertical position, center the board around the Start/Stop switch connector and put the configuration button on the same vertical position, aligned to the center of the 8/16/COMBO switch. Make the drill mask stay in position with some adhesive tape.
- Mark all the necessary holes if you don‘t dare to drill through the drill mask (which could be ripped away by the drill) and remove the drill mask afterwards.
- Drill all 7 holes with 3.5 mm
- Drill the 2 MIDI connector holes and the configuration button hole with 7.5 mm
- Drill the 2 MIDI connector holes with 10 mm
- Use a step drill to drill the 2 MIDI connector holes to 16 mm
- Use a deburring tool or some sandpaper to remove sharp edges on all the holes
- Looking at the rear of the unit, insert the MIDI out connector (the one with 3 wires), into the left hole, forming an U with the holes, so the cable goes downwards, put a screw into the right hole of this connector and on the other side, put a lock washer and a nut onto the screw. Tighten the screw a little bit, not too hard currently.
- Do the same with the MIDI in connector, but use the screw on the left hole of the connector
- Use a spacer bolt, add 1 normal washer, put it through the MIDItriggs board, the bolt on the side with the SMD components, add another washer on the other side and a nut, tighten the bold. Do the same with the other spacer bolt.
- Insert a screw in each remaining MIDI connector board, add the lock washer and use the MIDItriggs board (MIDI connectors facing downwards) with the bolts to screw this together. Tighten the screws, holding the bolts so that they don‘t turn.
- Now tighten the remaining screws of the MIDI connectors.
- Connect the MIDI connectors to the MIDItriggs board
- Install the configuration button, having the lock washer inside the unit and the nut outside

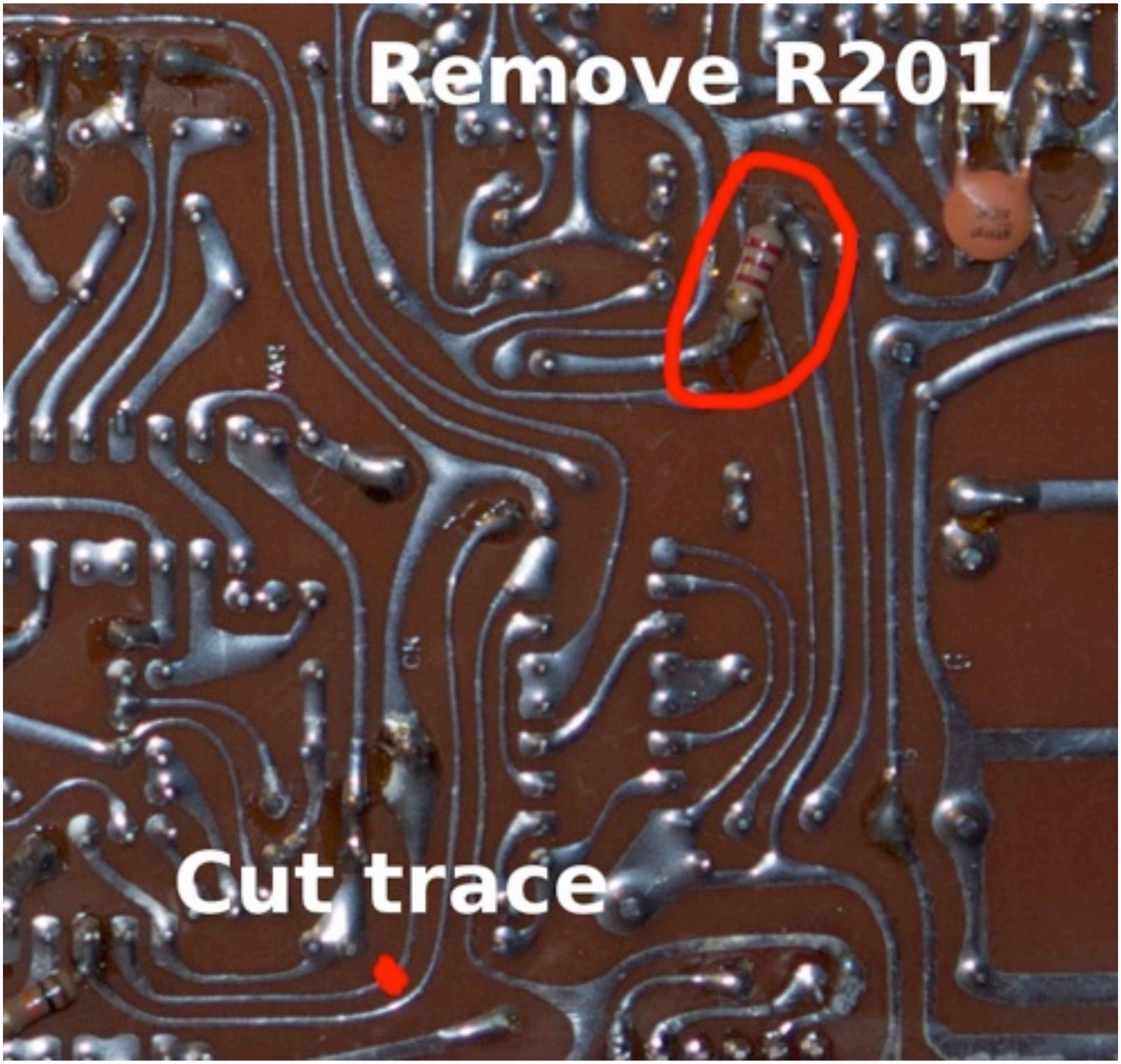
Your rear panel is now nearly completed, it‘s time to work on the board.

Working on the lower side of the board:
- See the board photos above to locate the trigger resistors and unsolder all of them
- Solder one wire of each 39 KΩ resistor to the transistor end of where the original trigger resistors have been (see photo on the next page for details)
- Put something under the board, away from the trigger resistors, to work on the upper side while putting wires through the board.
- Put the 15 KΩ resistors into the holes, twist the other end with the free end of the 39 KΩ resistors and apply a bit of solder to keep them together, cut off the remaining wires.
- Turn around the board and solder the 15 KΩ resistor wires in place, cut off all remaining wires.
- See photos above and detail photos on the next pages to locate the trace to cut. Carefully cut this trace with a sharp knife, make sure there is no connectivity left between the 2 ends
- See photos above to locate R206 (R201 on GL-9 and GL-9A boards, see below) and remove it

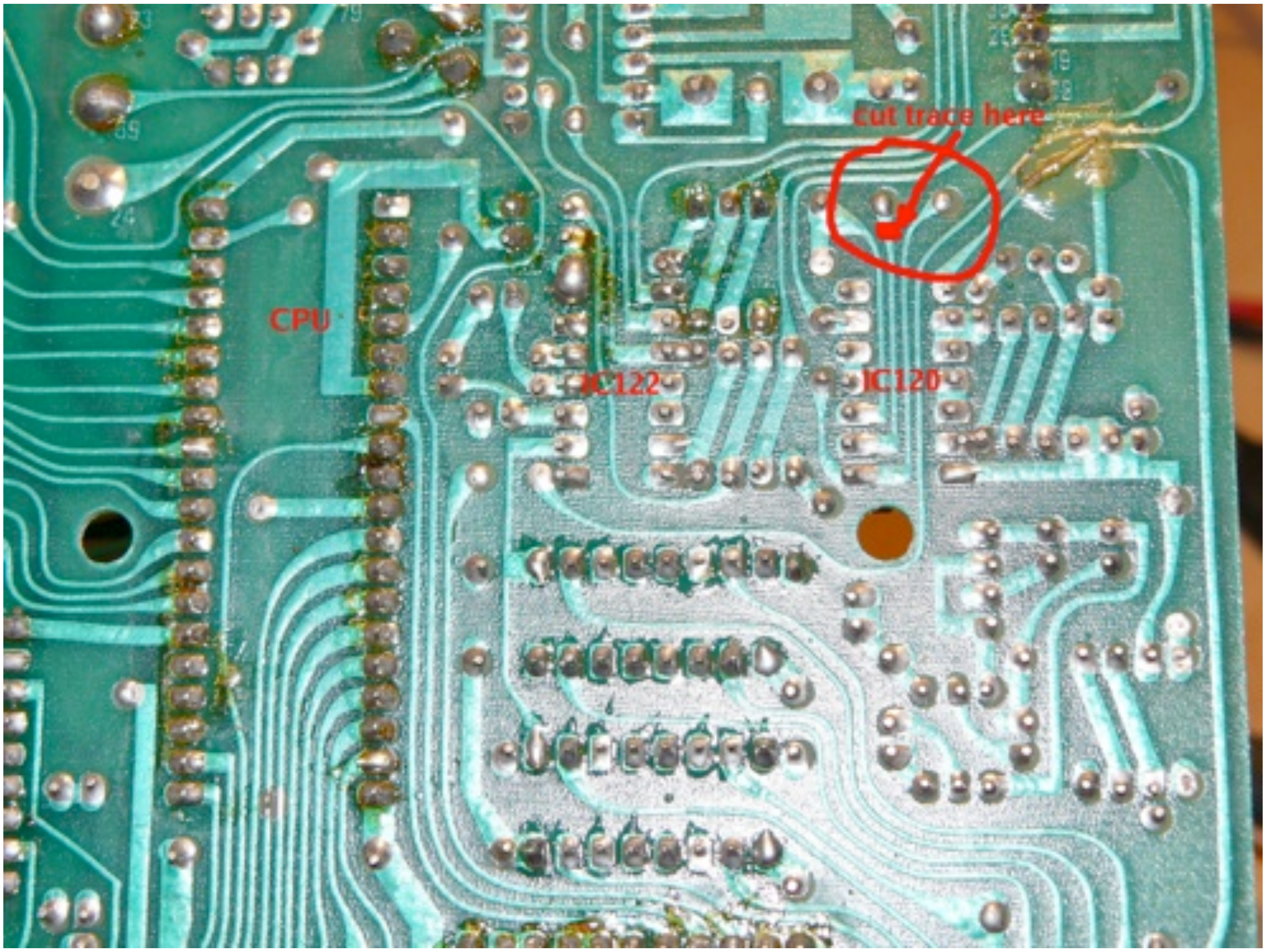
Trigger resistors (shown on GL-9B board)



GL-9 board lower side detail



GL-9B board lower side detail



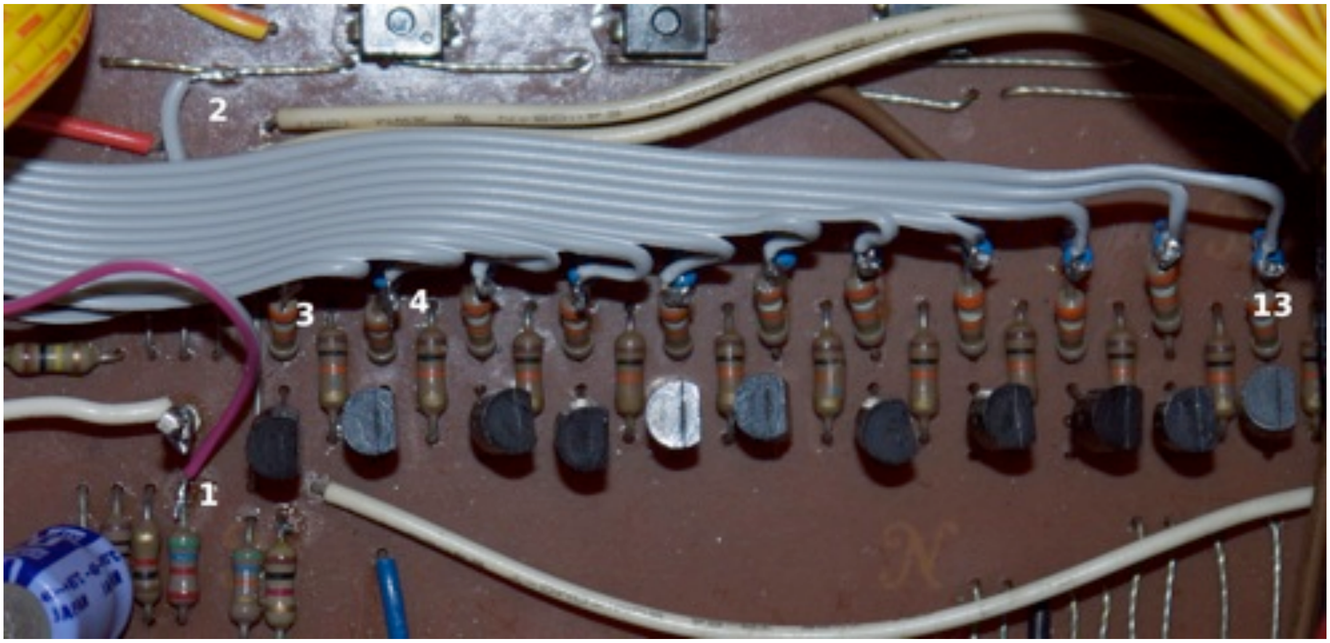
Putting the board and front panel back in place:

- Carefully put the board back into the unit until it safely sits on the retainers, make sure you didn‘t get any cables between board and chassis.
- Put the screws for the cancel switches and the nut for the instrument select switch back in place, take care of the instrument select switch washer.
- Put the front panel back in place, take care about the washers you found while removing it

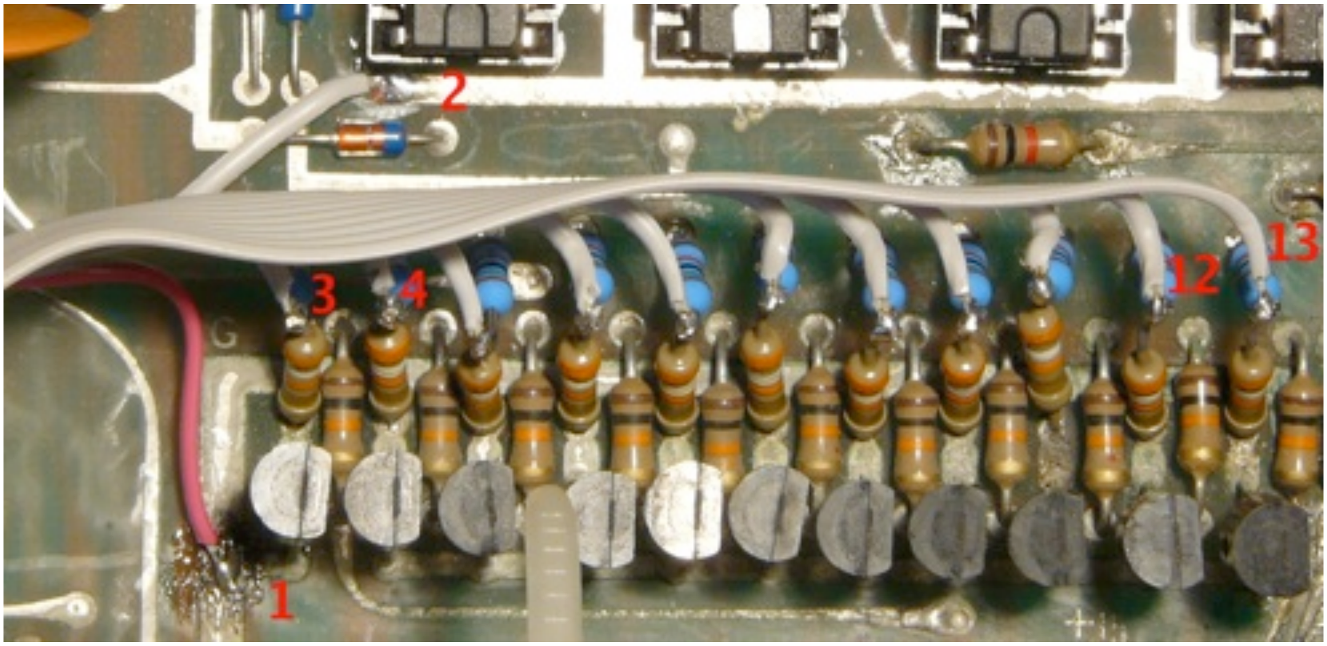
Installing the trigger cable, CN101:

- See the photos below for the details about the trigger cable and solder it into place. Pin 1 (the wire with the red stripe) goes to GND, which is one end of a resistor (GL-9) or a large trace passing the transistors (GL-9B), pin 2 goes to +5V, which is a jumper next to the trigger latch ICs (GL-9) or a large trace passing the left edges of the 4 ICs on the other side of the trigger resistors. Pins 3-13 then go to the spots where you soldered the 39 KΩ and 15 KΩ resistors together, while pin 3 starts with the resistor nearest to the rear of the unit

GL-9 board trigger cable installation



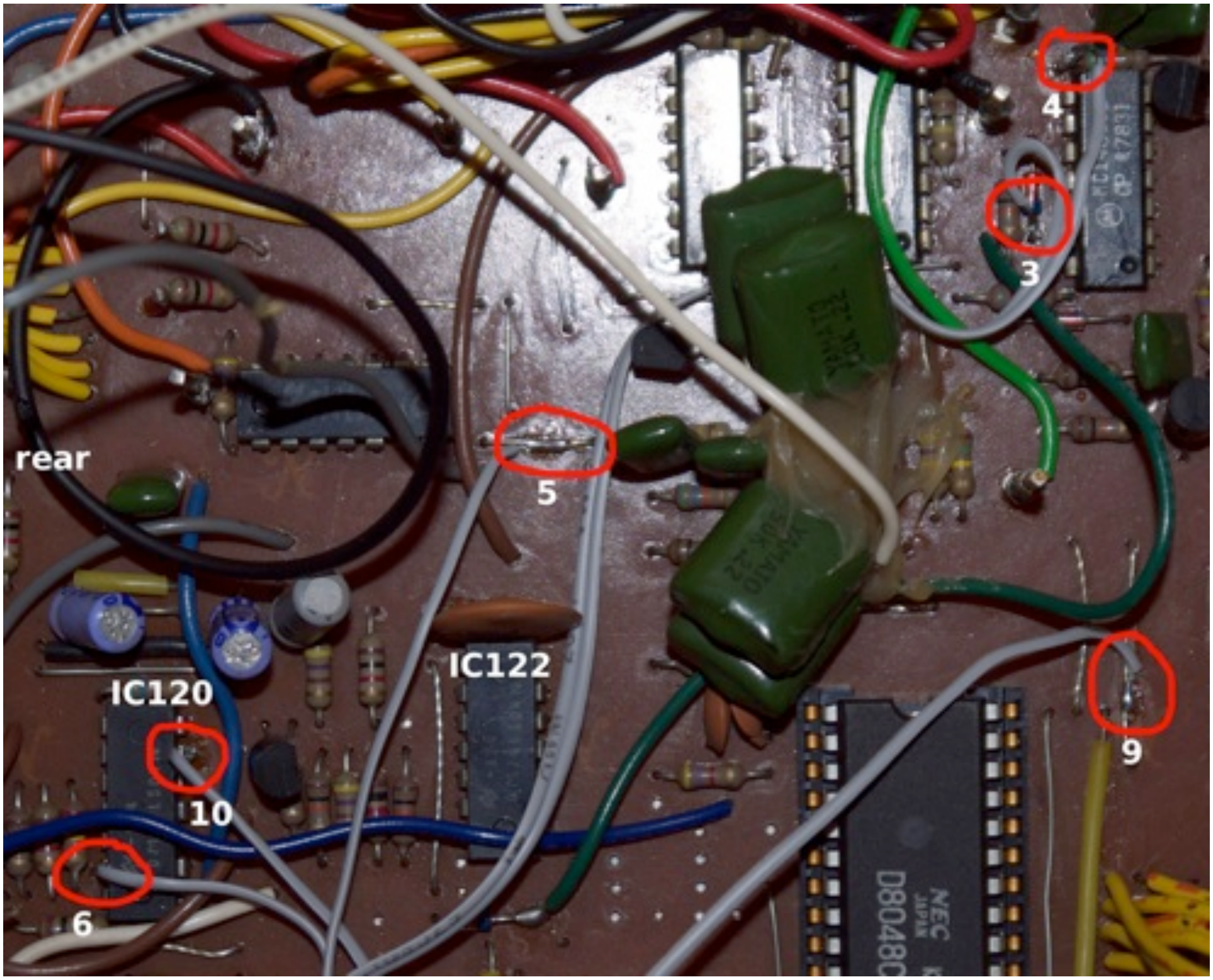
GL-9B board trigger cable installation



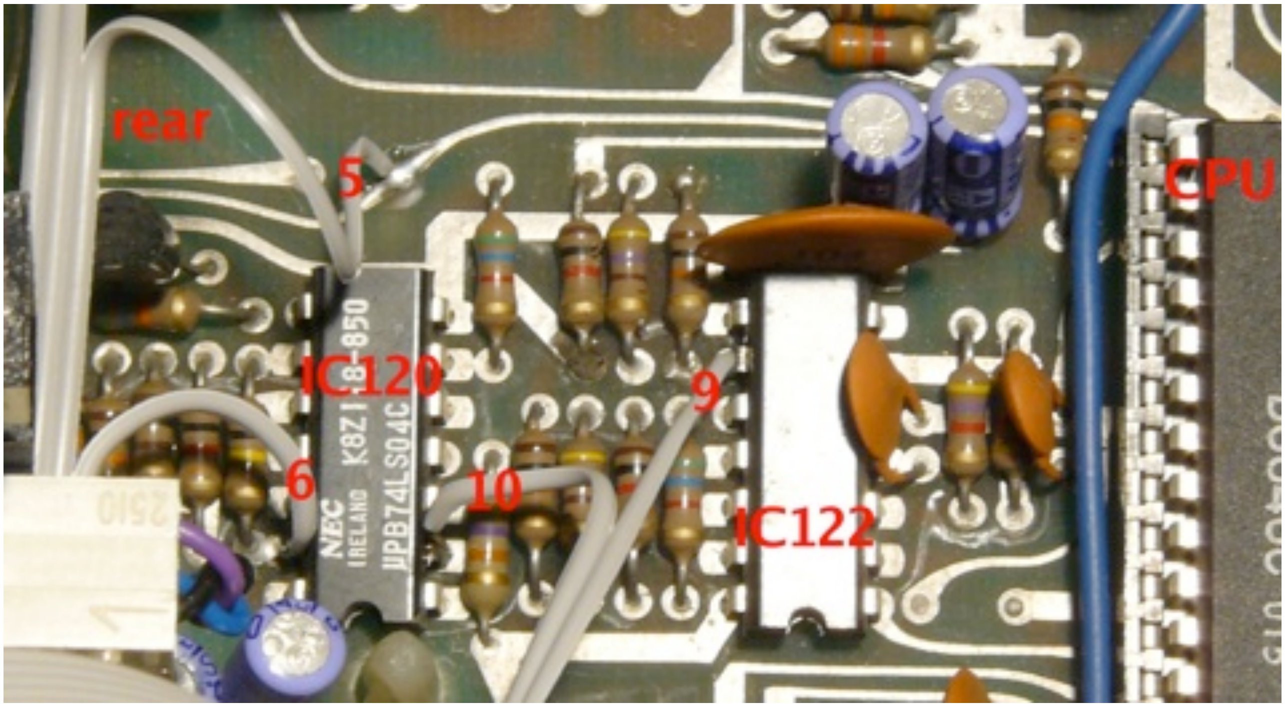
Installing the control cable, CN102:

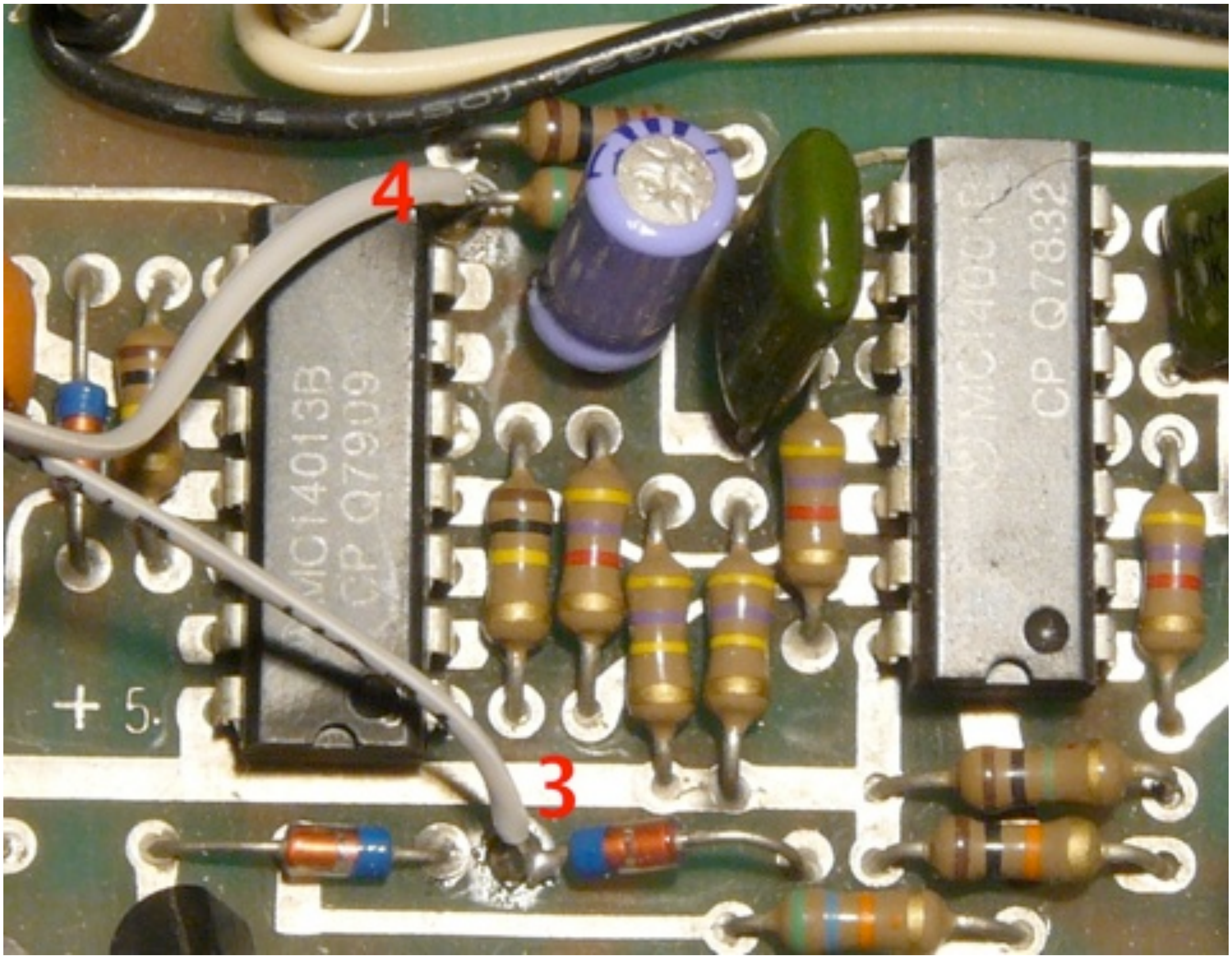
- Carefully check the 10 pin cable and make familiar with the wire numbering. Pin 1 again is the wire with the red stripe. 1, 2, 7 and 8 go to the peripheral connector, 3-6, 9 and 10 are wires of different lengths to go to board specific places.
- Solder wire 6 to IC120, pin 13 (GL-9 and GL-9B)
- Solder wire 10 to IC120, pin 6 (GL-9) or pin 2 (GL-9B)
- Solder wire 9 to the jumper next to the CPU as shown in the photo (GL-9) or IC122, pin 9 (GL-9B)
- Solder wire 5 to the jumper next to the removed R201 (GL-9) or to the trace (GL-9B) as shown in the photo
- Solder wire 3 to the cathode of D101 (GL-9) or one of the 2 diodes where they point to each other (GL-9B)
- Solder wire 4 to R120, the resistor right next to the IC, as shown in the photo below (GL-9 and GL-9B)

Control cable installation on GL-9 board



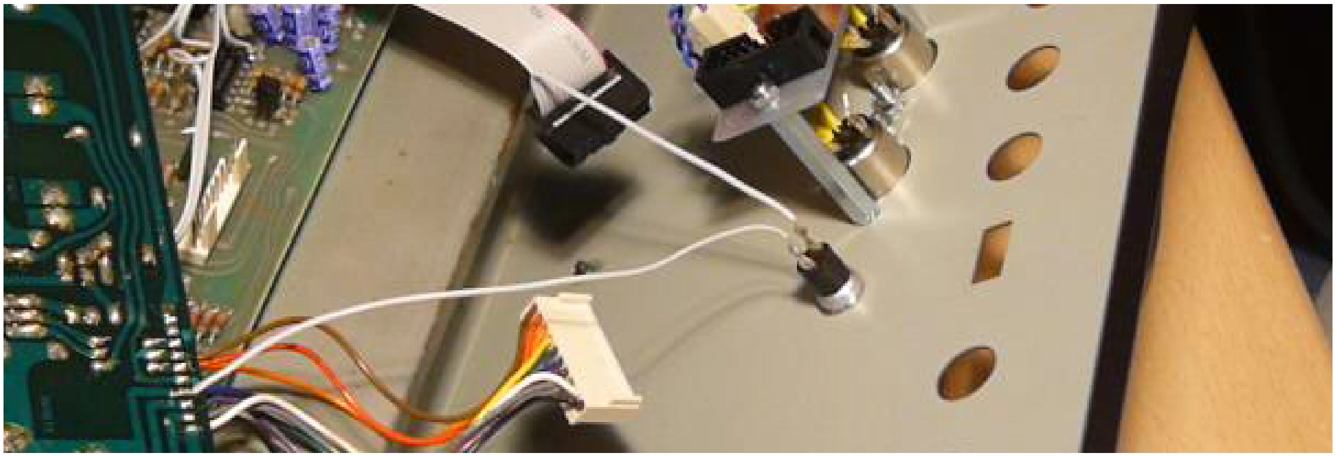
Control cable installation on GL-9B board





Connecting the configuration button:

- Solder the last wire of the 14 pin cable, pin 14, to the configuration button. Depending on where you installed this button, you may cut the wire for a more suitable length.
- Solder the other end of the configuration button to a GND spot, the connector board, pin 4, is suitable for this (see photo, you can locate it by following the large GND traces of the connectors. On GL-9, you can use the GND wire of the EXT CLOCK connector, next to the transistor. If you cut the wire for the configuration button, you can use the part you cut off for this.



Putting the unit back together:

- Re-attach the rear panel, tighten the 4 screws
- Make sure all connectors on the main board are in place
- Connect the CN101 (14 wire) cable to the MIDItriggs board, the red wire shows upwards, the cable shows away from the board
- Connect the CN102 (10 wire) cable to the MIDItriggs board, the red wire shows downwards, the cable shows away from the board.
- Make sure both connectors are perfectly in place and not off by one pin or so.
- Mount the connector board back in place, using all the washers you took care of during disassembly. The thin metal washer on the connector, followed by a plastic washer, with the edge pointing to the rear panel, then comes the rear panel, another plastic washer with the edges pointing to the rear panel again, a thick metal washer and the nut.
- Again make sure all connectors and cables are in place before powering up the unit

First tests:

- Power up the unit, dial Tempo to about 12 o‘clock, select any rhythm, turn off all cancel switches, turn up the volume, turn off the fade-in and fade-out and push start. The unit should behave as usual, react on start/stop like before.
- Connect the unit‘s MIDI out to any MIDI gear able to produce sound when receiving notes in the range C1-A#1 and push start again. The Rhythm should appear on the MIDI out.
- Push the 2 rhythm cancel buttons, connect a MIDI keyboard to the MIDI in and push start. You should be able to play 10 instruments with C1-A1, while A#1 is the accent trigger, which is a bit difficult to hit the right time to hear the accent.
- Push stop on the unit, push and hold the configuration button for longer than 1 second. You should hear a Pattern like this: BD.BD.BD.-.BD.-.-.-
- Power off the unit, put the wooden case back in place, you‘re done with this installation.

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Version 3, 29 June 2007

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