MIDI BY HIGHLY LIQUID

UMR2

Ultimate User Manual

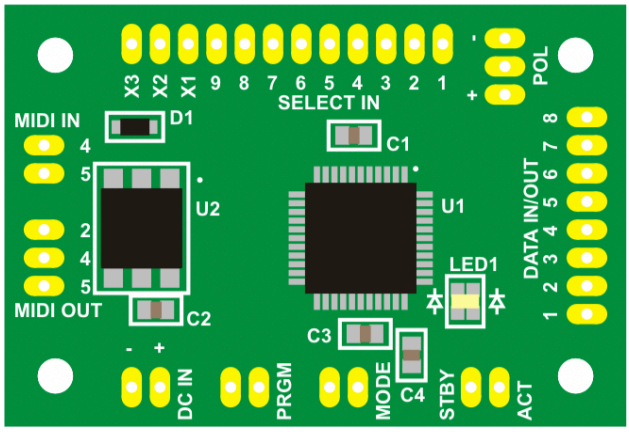
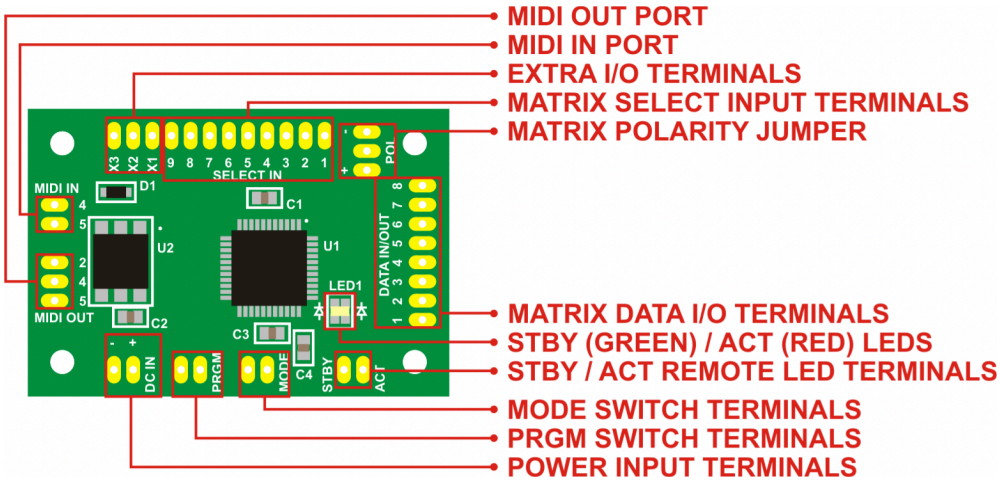


Table of Contents

1.0 Overview

The UMR2 can be used to add MIDI input and output functionality to a wide range of non-velocity- sensitive keyboards.

2.0 Feature Diagram



3.0 Installation

UMR2 installation consists of two parts: *wiring* and *setup*. Both parts must be completed for correct operation.

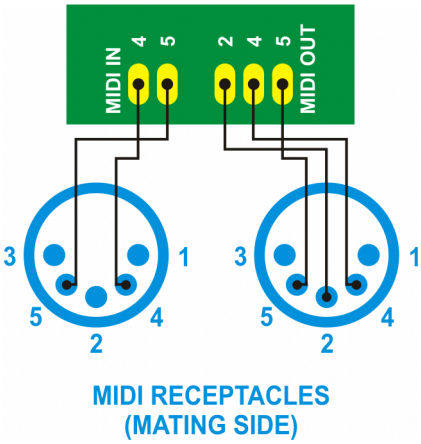
3.1 Recommended Installation Procedure

1. Disconnect power supply and remove any batteries from host keyboard.
2. Complete UMR2 MIDI Wiring, Power Wiring, and PRGM and MODE Switch Wiring.
3. Power host keyboard and test UMR2 “software thru” functionality to verify wiring in step 2.
4. Disconnect power supply and remove any batteries from host keyboard.
5. **Set Matrix Polarity Jumper.**
6. Complete UMR2 Switch Matrix Wiring.
7. Perform UMR2 Setup Procedure.

3.2 Wiring

3.2.1 MIDI Wiring

Wire MIDI connectors as shown. Pins 4 and 5 (MIDI IN) and pins 2, 4 and 5 (MIDI OUT) are used per the official MIDI specification.



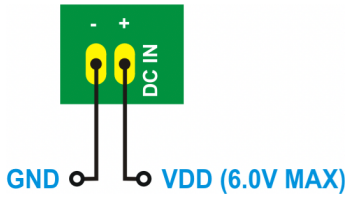
3.2.2 Power Wiring

CAUTION: Reverse power polarity or supply voltages greater than 6VDC can destroy the UMR2.

For correct operation, the UMR2 must be supplied with between 3VDC and 6VDC. Select one of the following power wiring methods. Details for specific keyboards can be found in chapter 7.

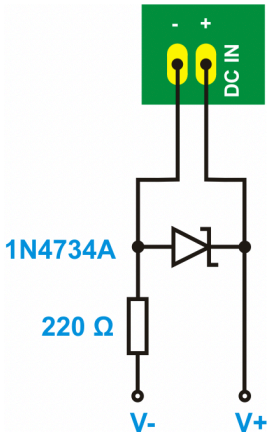
Method A (Direct)

If the host keyboard has suitable power rails, these can be connected directly to the UMR2 as shown below.



Method B (Regulated)

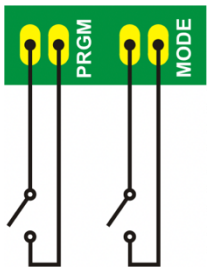
The UMR2 requires additional power regulation circuitry when connecting to certain keyboards. In these cases, the included zener diode and resistor can be used as a voltage regulator.



3.2.3 PRGM and MODE Switch Wiring

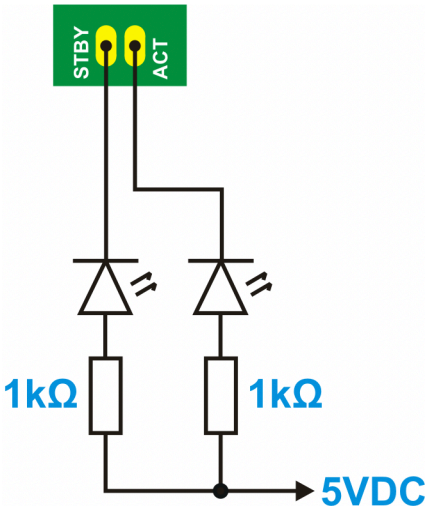
A PRGM switch is used during the UMR2 setup procedure and during firmware updates. Wire any momentary or latching switch (not included) as shown.

A MODE switch is used to select the UMR2 mode of operation. Wire any latching switch (not included) as shown.



3.2.4 Remote LEDs (Optional)

If desired, remote STBY and ACT LEDs can be attached to the UMR2 as shown below. Current limiting resistors (typical value of 1kΩ is shown) must limit LED current to 10mA or less.



3.2.5 Matrix Polarity Jumper

CAUTION: Failure to set or incorrect setting of the Matrix Polarity Jumper can permanently damage the UMR2 and host keyboard.

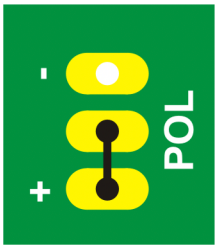
The Matrix Polarity Jumper serves two functions:

- Configures the built-in resistors connected to all UMR2 Matrix Select and Matrix Data terminals as either pull-up or pull-down resistors.
- Controls the logic state (low or high) of signals generated by the UMR2 at the Matrix Data I/O Terminals.

Use a piece of wire to connect only one side of the jumper as shown in the diagrams below.

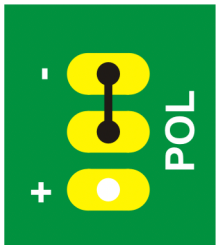
Active High Select / Common Anode Matrix

Use this jumper setting if the host keyboard generates high-state logic pulses at the select lines when reading the switch matrix. The UMR2 built-in resistors act as pull- downs.



Active Low Select / Common Cathode Matrix

Use this jumper setting if the host keyboard generates low-state logic pulses at the select lines when reading the switch matrix. The UMR2 built-in resistors act as pull- ups.



3.2.6 Switch Matrix Wiring

CAUTION: Incorrect wiring of the UMR2 to the host switch matrix can permanently damage the UMR2 and host keyboard.

The UMR2 supports switch matrices with up to 9 select lines and up to 8 data lines. Wire the host switch matrix to the UMR2 as follows:

- Connect each of the host select lines to one of the UMR2 Matrix Select Input Terminals.
- Connect each of the host data lines to one of the UMR2 Matrix Data I/O Terminals.

Connect select lines **only** to UMR2 Matrix Select Input Terminals. Connect data lines **only** to UMR2 Matrix Data I/O Terminals. Within each category, the lines can be connected in any order.

For matrices with fewer than 9 select lines or fewer than 8 data lines, leave the unused UMR2 terminals unconnected.

Wiring details for specific keyboards can be found at chapter 7.

3.3 Setup

After the UMR2 has been wired to the host keyboard, the UMR2 *Setup Procedure* must be completed. The purposes of the setup procedure are the following:

- Set the MIDI channel of the UMR2 for both MIDI input and output.
- Set the MIDI note number corresponding to the lowest (leftmost) note on the host keyboard.
- Allow the UMR2 to "learn" the keyswitch matrix configuration of the host keyboard.

Important notes:

- In addition to the *host keyboard* in which the UMR2 is being installed, the setup procedure requires the use of a second *external MIDI keyboard* that is used to send a single note to the UMR2 in step 5. The MIDI Out port of the external MIDI keyboard should be connected to the MIDI In port of the UMR2. If a MIDI keyboard is not available, this step can be completed using a computer with a MIDI port or other MIDI device.
- Once the setup procedure is completed, the UMR2 will store its settings indefinitely. However, the procedure can be repeated as many times as needed.
- By repeating only steps 1-5 of the setup procedure and disconnecting power, the UMR2 MIDI response (channel and note range) can be changed without altering the learned matrix configuration.

3.3.1 Setup Procedure

1. Power off the UMR2.
2. Press (close) and hold the PRGM switch.
3. Power on the UMR2. The red ACT LED will light.
4. Release (open) the PRGM switch. The green STBY LED will blink continuously.
5. Use an **external MIDI keyboard** to send a single MIDI note to the UMR2. This note specifies the MIDI channel setting for the UMR2. It also specifies the note number that corresponds to the lowest note on the host keyboard. To confirm receipt of the note, the red ACT LED will light for several seconds.
6. Wait for the red ACT LED to clear. The green STBY LED will blink continuously.
7. Briefly press and release each key on the **host keyboard**. Start with the leftmost key and continue in order until the rightmost key is pressed. After each keypress, wait for the red ACT LED to blink before continuing with the next key.
8. Press (close) the PRGM switch. The red ACT LED will light while the UMR2 stores the results of the setup procedure. When both LEDs are clear, power off the UMR2 and open or disconnect the PRGM switch.

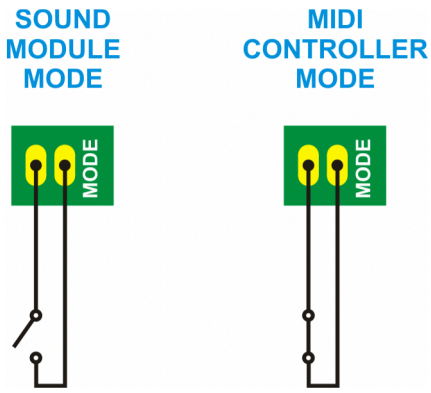
4.0 Operation

4.1 Mode

The UMR2 operates in one of two modes.

- *Sound Module Mode* causes the host keyboard to respond to incoming MIDI notes. All input at the UMR2 MIDI In port is echoed at the MIDI Out port (software thru).
- *MIDI Controller Mode* causes MIDI notes to be sent in response to keystrokes at the host keyboard's manual.

The mode of operation **must be selected at boot-up** using the MODE switch.

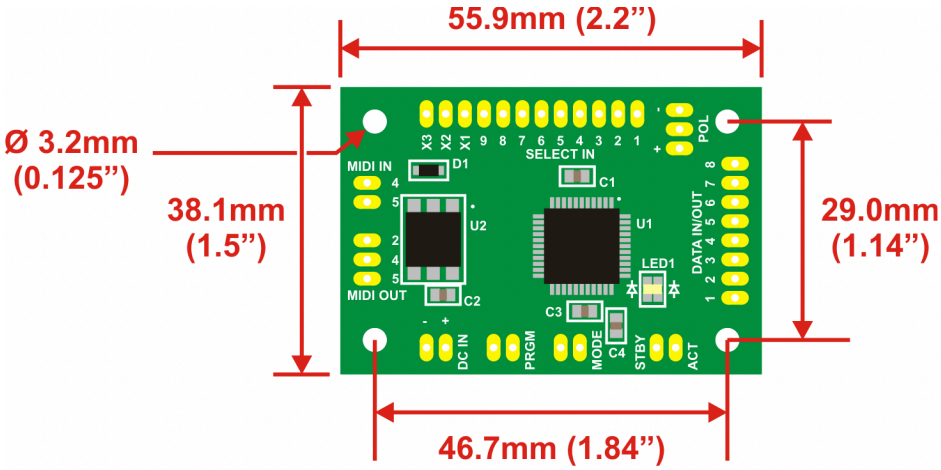


4.2 STBY/ACT LEDs

During normal operation, the UMR2 LEDs have the following functions:

- STBY LED (GREEN): Power indication.
- ACT LED (RED): Blinks briefly to indicate any incoming and outgoing MIDI messages. **Activity does not indicate that incoming MIDI messages match the MIDI channel or note range established during the setup procedure.** The ACT LED performs a self-test of approximately 1 second at boot time.

5.0 Mechanical Diagram



Overall Height: 6.0mm (0.24")

Terminal Pitch: 2.54mm (0.1")

6.0 Keyboard Matrix Explained

6.1 Overview

It is common for an electronic device to have a large number of input buttons (or "keys"). The device's microprocessor (MPU) must monitor these inputs. Since any MPU has a limited number of I/O pins, it is often not practical to dedicate a separate pin to each button or keyswitch. This is especially true in the case of a musical keyboard. If each keyswitch were given a dedicated MPU I/O pin, a keyboard with 32 or 49 keys might not leave any I/O pins for other functions. To make efficient use of MPU I/O, keys are arranged in a matrix. Almost all non-velocity-sensitive musical keyboards use this approach. What follows is a description of the keyboard matrix circuit and its relation to the UMR2 MIDI retrofit. The UMR2 works with many matrix keyboards, but compatibility with all models is not guaranteed.

6.2 Example Key Matrix

The matrix is connected to the MPU by "select" or "common" lines, which are MPU outputs, and "data" lines, which are MPU inputs. To monitor the keyswitch states, the MPU sends a brief pulse to each select output, one-at-a-time. Each pulse "selects" a group of keys. Any closed keyswitches in the group will allow the pulse to pass thru to the data lines, which are "read" by the MPU. All of the keys are read continuously, many times per second. This allows the MPU to respond almost instantly to keyswitch state changes.

There are two categories of key matrix distinguished by the polarity of the select signal. In an “active-high select” keyboard, the state of each data line is low (0V) by default. The select signal is a 5V pulse. In a “active-low select” keyboard, the state of each data line is high (5V) by default. The select signal is a 0V pulse. Figures 1 and 2 below are examples of simple keyboard matrices. Each is a “2/2″ select/data configuration for a 4-key keyboard. In practice, keyboards will have a larger number of select & data lines. Typical 32-key configurations are 4/8, 8/4, or 6/6. 49-key keyboards often use a 9/6 matrix. The maximum number of keys supported by a matrix configuration is governed by the following equation:

$$k=s*d$$

Where k is the maximum number of keys, s is the number of select lines, and d is the number of data lines. Note that each keyswitch is accompanied by a series diode. This diode prevents a potentially damaging short-circuit between select outputs. It also allows the MPU to accurately detect the key states when multiple keyswitches are closed.

Figure 1: “2/2 Active-High Select” Keyboard Matrix and Select Signals

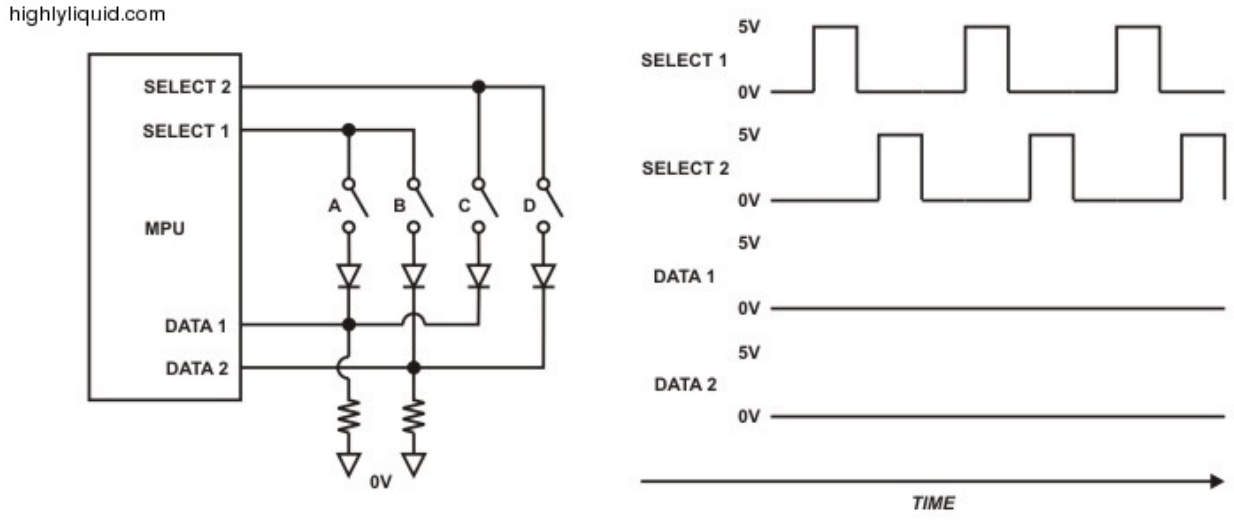
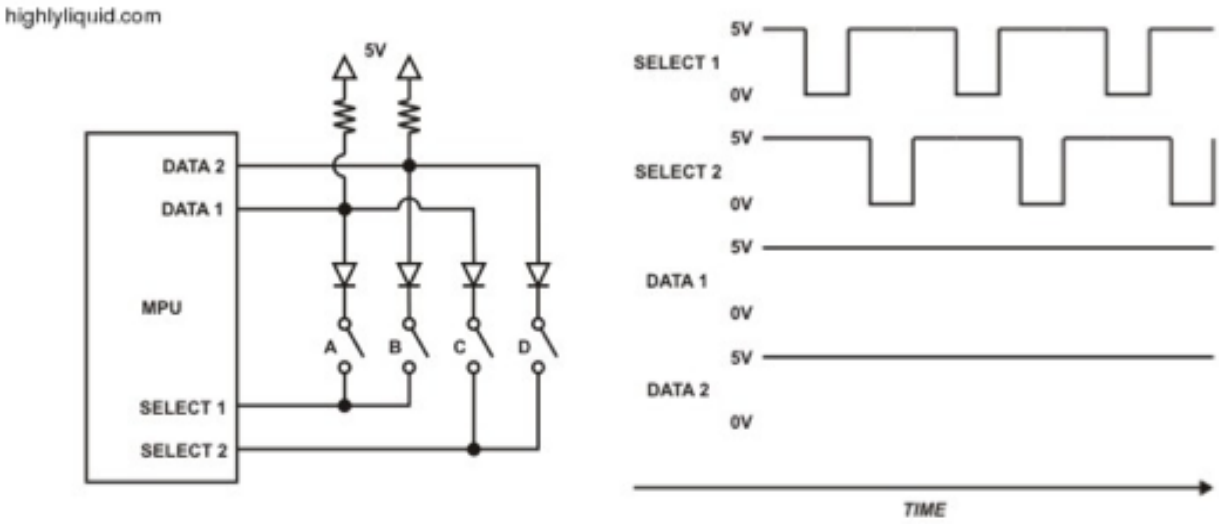


Figure 2: “2/2 Active-Low Select” Keyboard Matrix and Select Signals



6.3 Example Keyswitch States and Data Waveforms

Below are several keyswitch states and the resulting data waveforms for the simple 2/2 matrix. Note that any possible combination of keyswitch states will produce a unique combination of data waveforms.

Figure 3: "2/2 Active- High Select" Keyboard Matrix, Key A Depressed

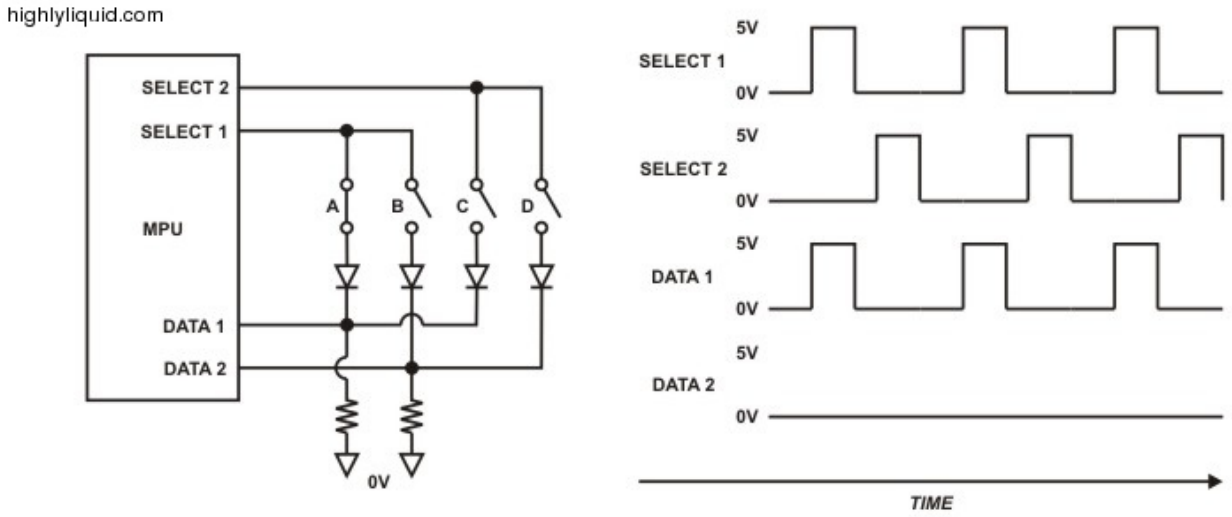


Figure 4: "2/2 Active-High Select" Keyboard Matrix, Key B Depressed

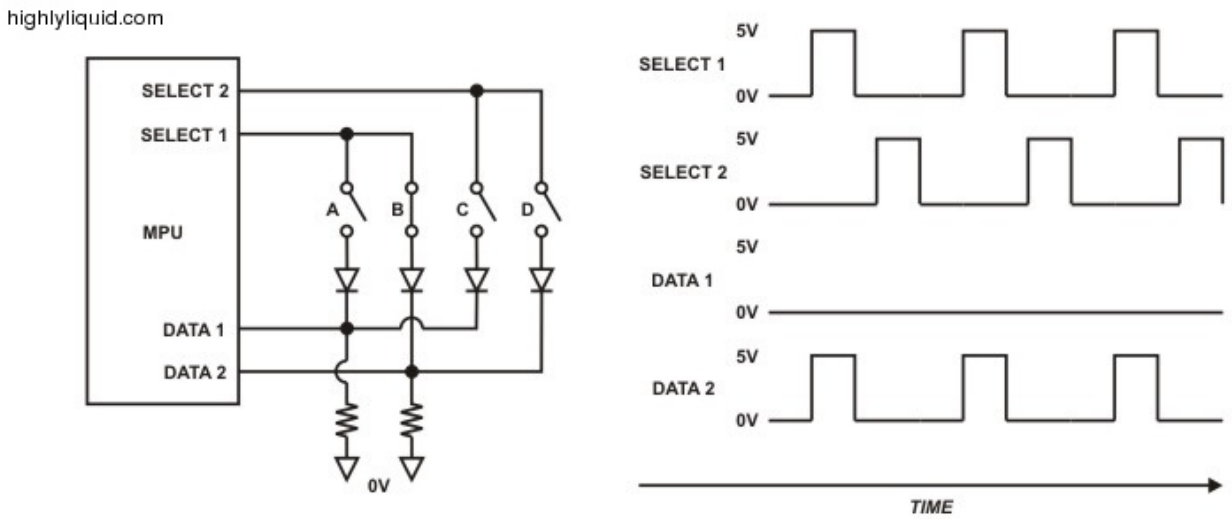


Figure 5: "2/2 Active-High Select" Keyboard Matrix, Keys C & D Depressed

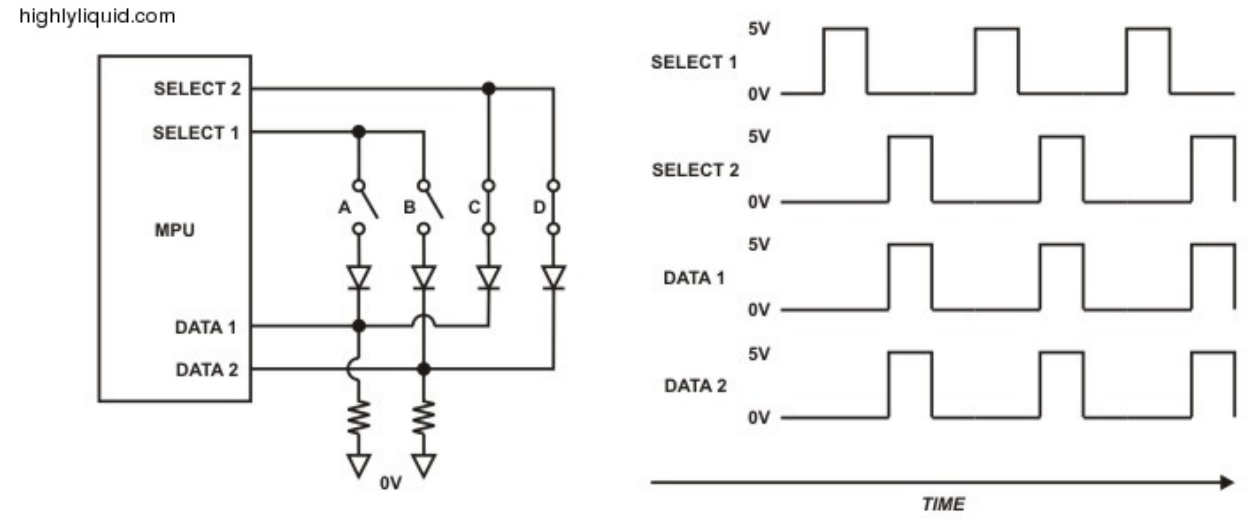
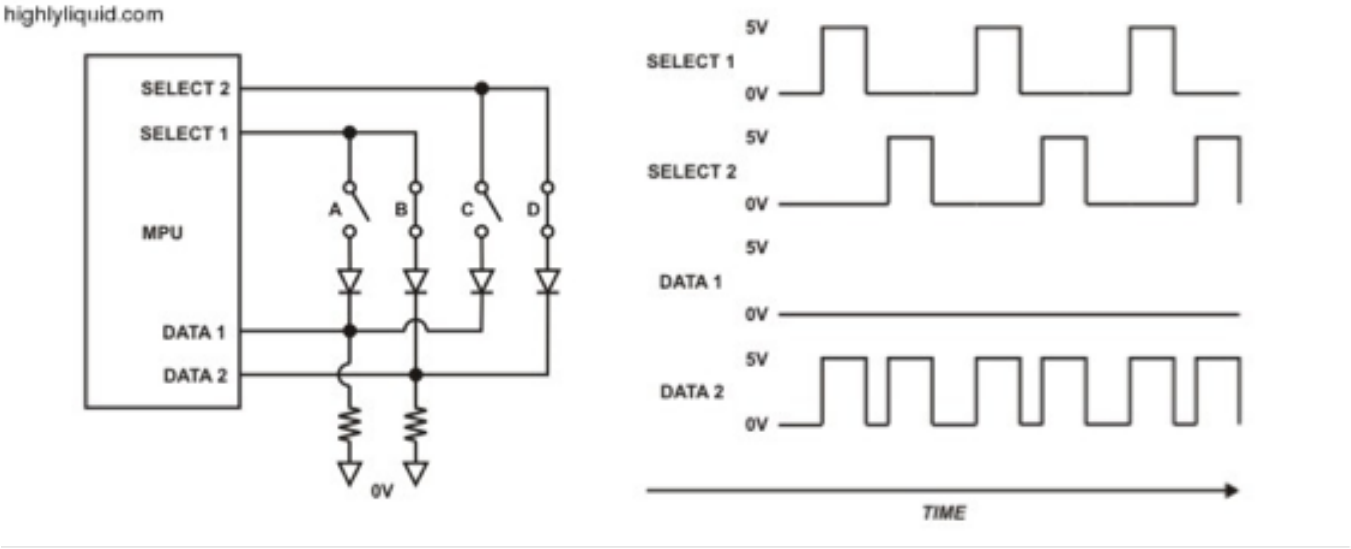


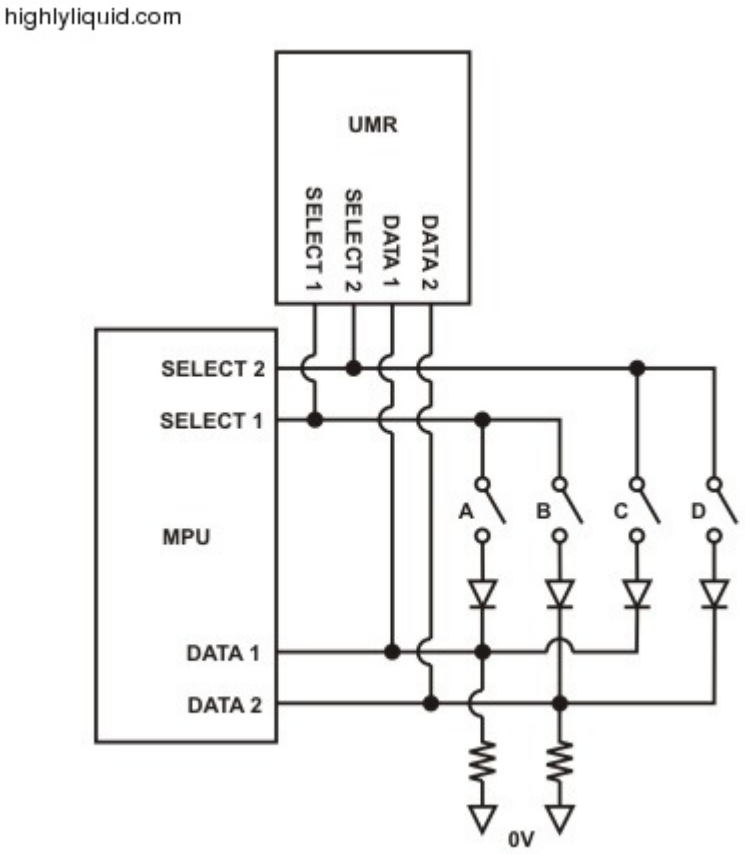
Figure 6: "2/2 Active-High Select" Keyboard Matrix, Keys B & D Depressed



6.3 MIDI Retrofit: "Faking the Data"

To trigger a note, the UMR2 monitors the select signals of the host keyboard's MPU. When a select pulse occurs, the UMR2 injects a corresponding "faked" keypress signal into the data lines. To the host MPU, this signal is indistinguishable from a manual keypress. Installing the UMR2 therefore involves identifying the select and data lines in the host keyboard, determining which select scheme is used ("active-high" or "active-low"), and connecting the UMR2 accordingly. For many keyboard models, the connections have already been tested and documented. For other models, installation may be possible after a bit of inspection as described below. Please check chapter 7.0 for more information.

Figure 7: UMR2 Connections to Host Keyboard Matrix



6.4 Identifying a Keyboard's Matrix Scheme

A keyboard's select and data lines are typically connected from the main PCB to the keyswitch PCB via a ribbon cable. With a help of a continuity tester, the pins of the ribbon cable can be traced to the contacts of the keyswitches. Select lines are typically tied to groups of adjacent keys. Each data line will be connected to one keyswitch in each group. A few keyboard models differ from this convention. When in doubt, it is wise to use an oscilloscope to identify the select and data lines with certainty.

The keyswitch PCB of the Casio MT-210 is used as an example below. The diodes in Figure 9 serve the same function as the diodes in the schematics above. Their polarity provides a clue to the polarity of the select pulse used: review the connection of the diodes in figures 1 and 2, with respect to the data lines. The keyswitch PCB of the Casio MT-210 is shown in figures 10-13 below. 8 select lines are connected to groups of 6 keys each. The 9th select line is connected to a single key. Note the keyswitch diodes on the underside of the PCB. The anodes are connected to the data lines. This indicates an active-low select configuration. If observed with an oscilloscope, the select waveforms will appear similar to those shown in Figure 2. The UMR2 is configured accordingly.

Figure 8: Casio MT-210 Keyboard Matrix Schematic

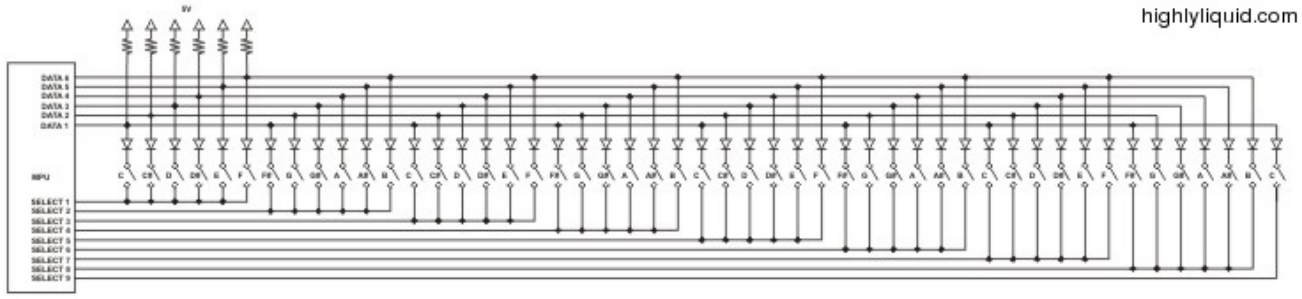


Figure 9: Casio MT-210 Keyswitch PCB—Top

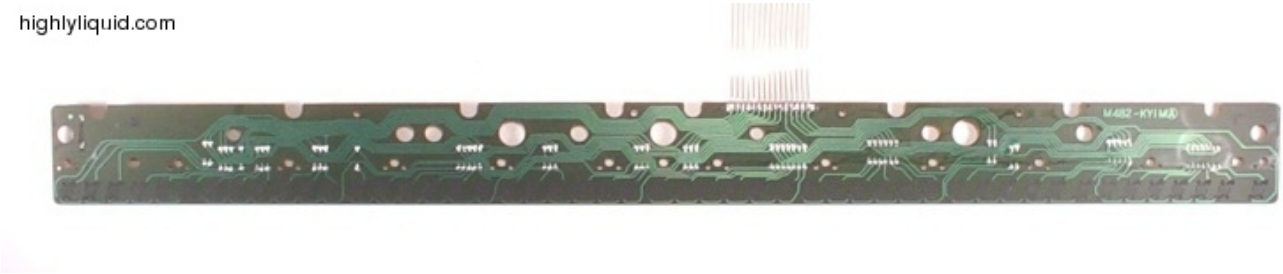


Figure 10: Casio MT-210 Keyswitch PCB—Top, Detail

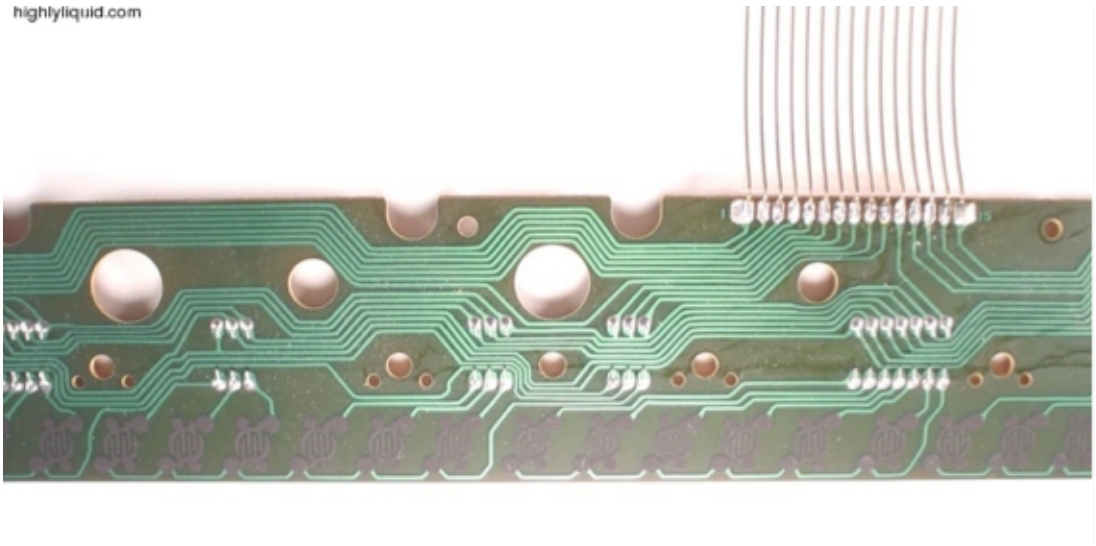


Figure 11: Casio MT-210 Keyswitch PCB—Bottom

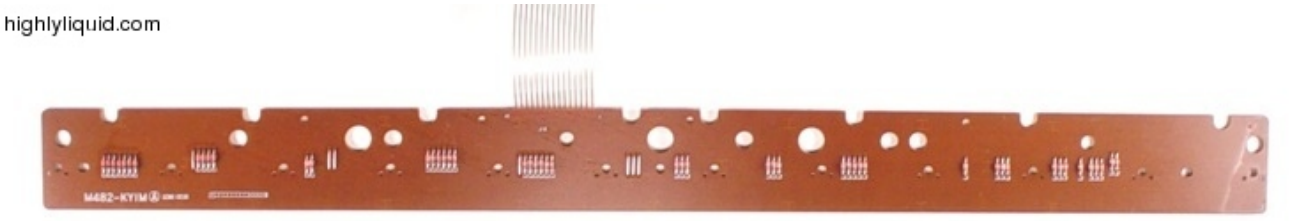
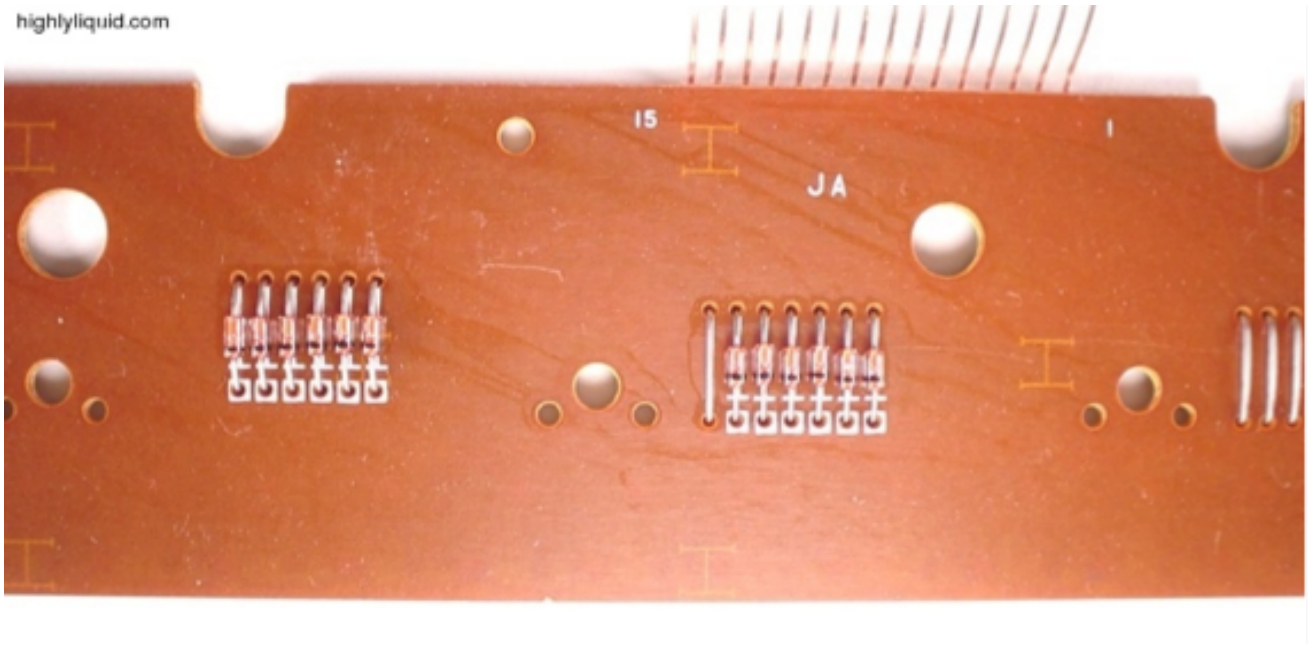


Figure 12: Casio MT-210 Keyswitch PCB—Bottom, Detail



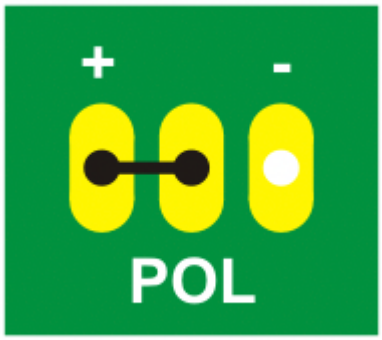
7.0 Examples of Installation

7.1 Casio SK-1

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the SK-1 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active High" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals and MIDI terminals as shown in the diagram. (Note: some users have suggested a series diode in the DC IN "+" connection to allow the UMR2 to reliably power down in sync with the host.)

With the host keyboard powered on, test the MIDI signal path by making the following connections:

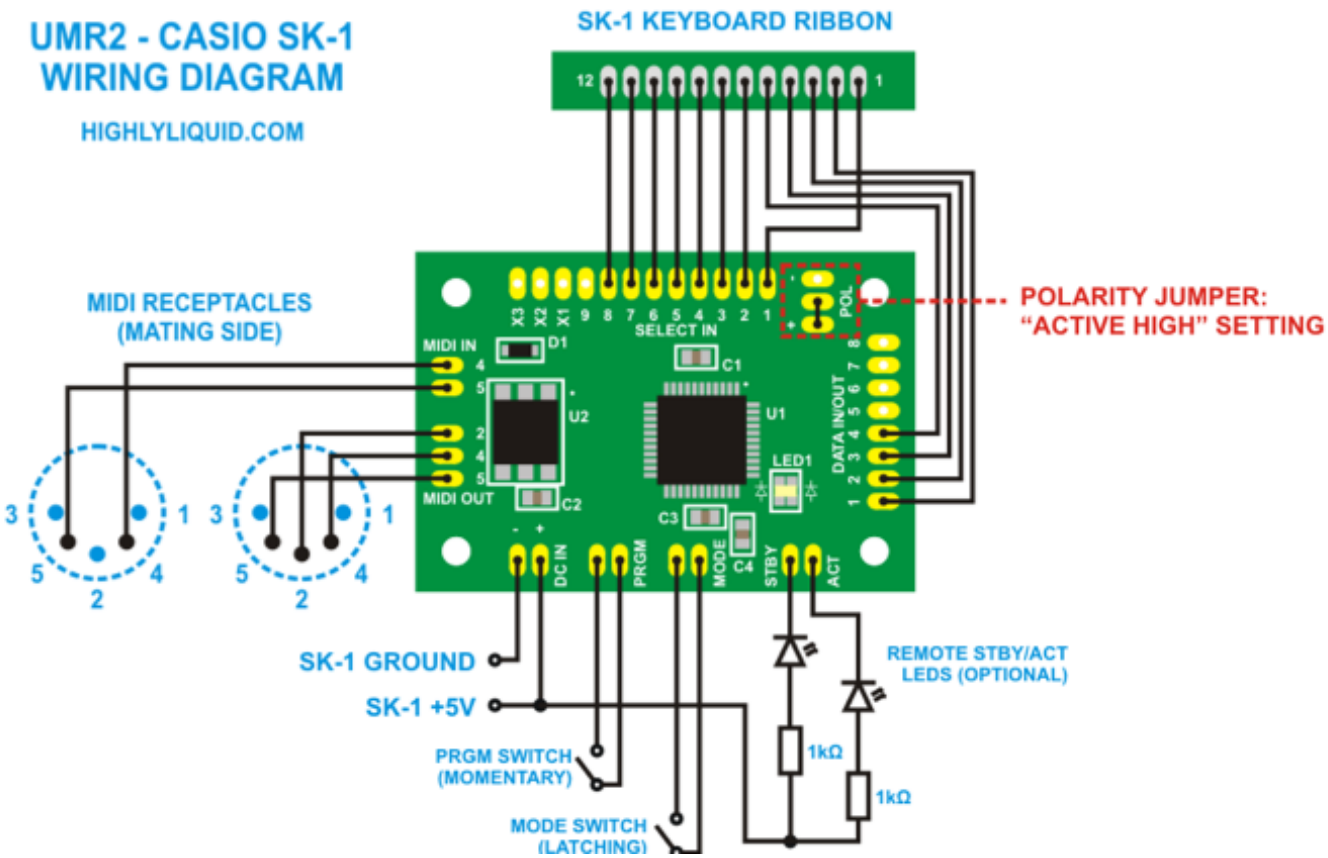
MIDI Controller MIDI Out -> UMR2 MIDI In

UMR2 MIDI Out -> Sound Module MIDI In

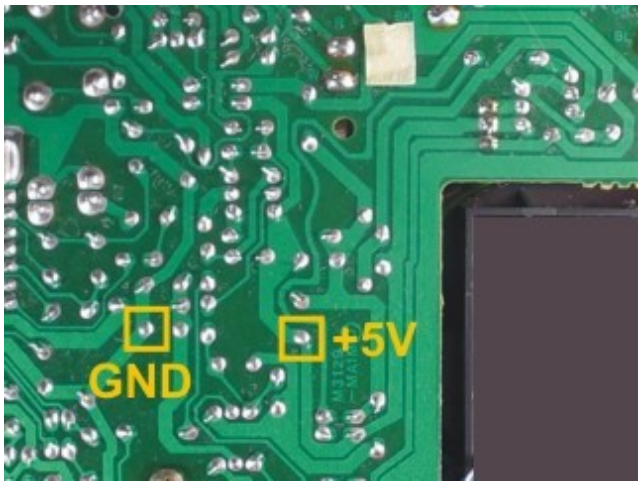
Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

3. Matrix and Switch Wiring

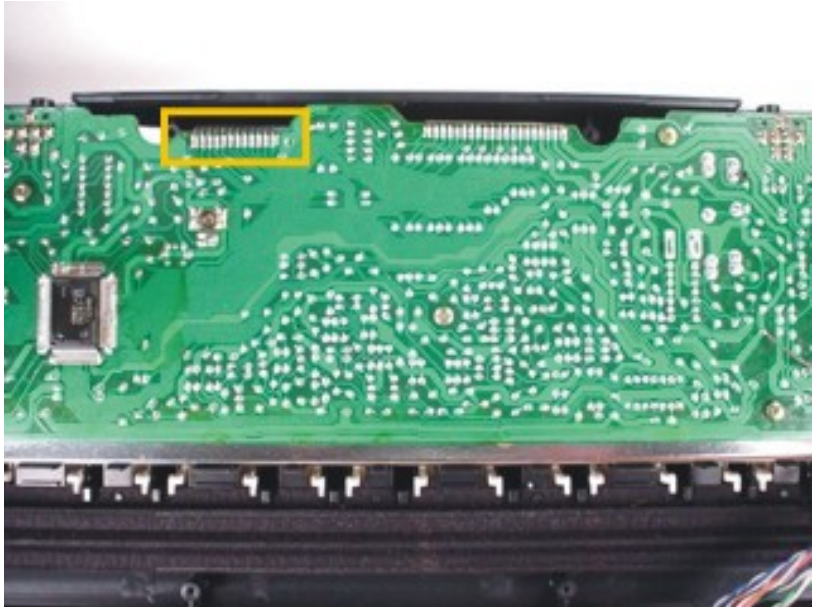
Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.



Host ground and +5V locations:



Host keyboard ribbon location:



4. UMR2 Setup Procedure

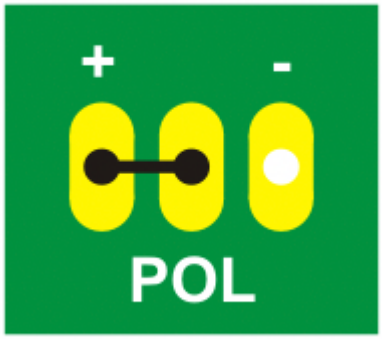
Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.

7.2 Casio SK-5

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the SK-5 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active High" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals and MIDI terminals as shown in the diagram. With the host keyboard powered on, test the MIDI signal path by making the following connections:

MIDI Controller MIDI Out -> UMR2 MIDI In

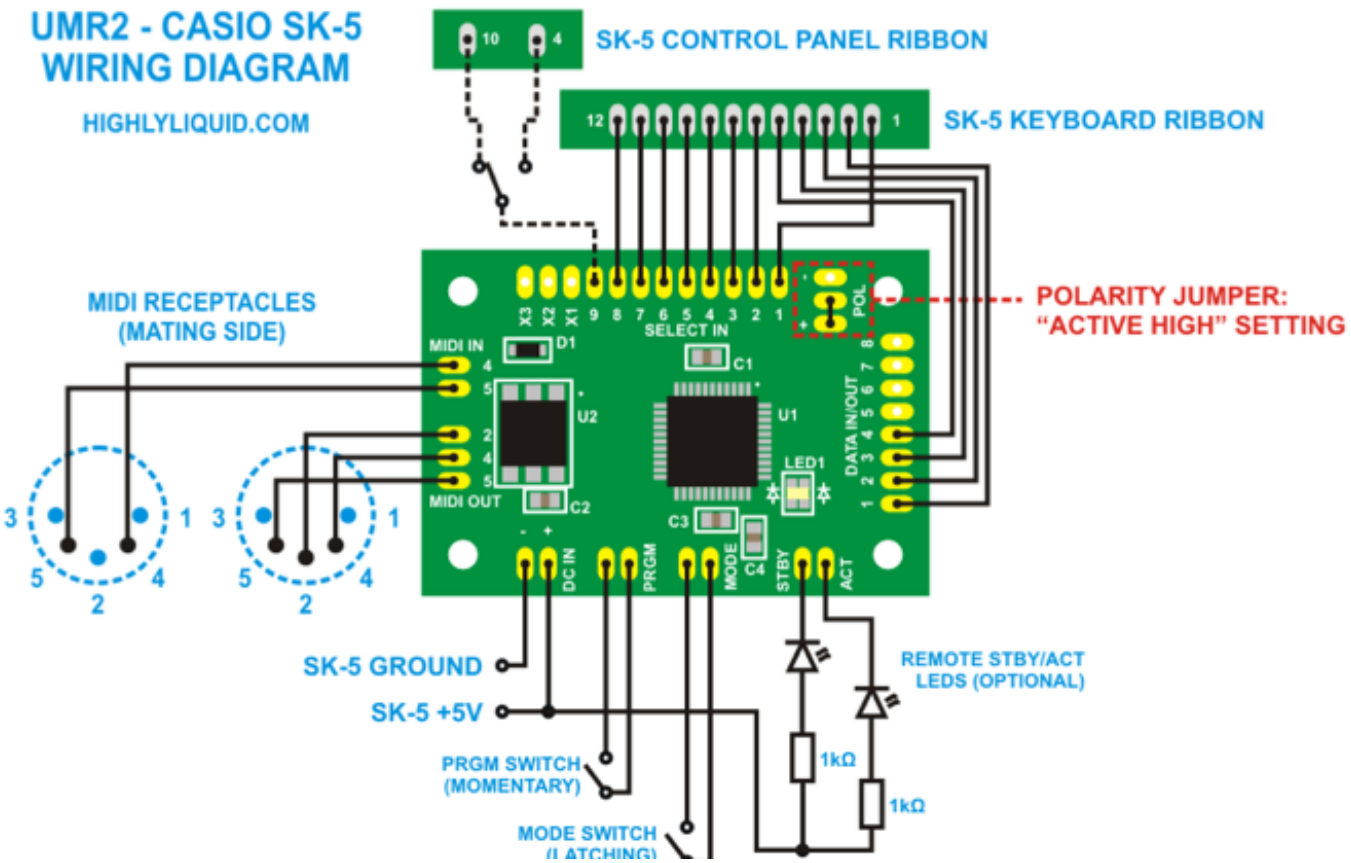
UMR2 MIDI Out -> Sound Module MIDI In

Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

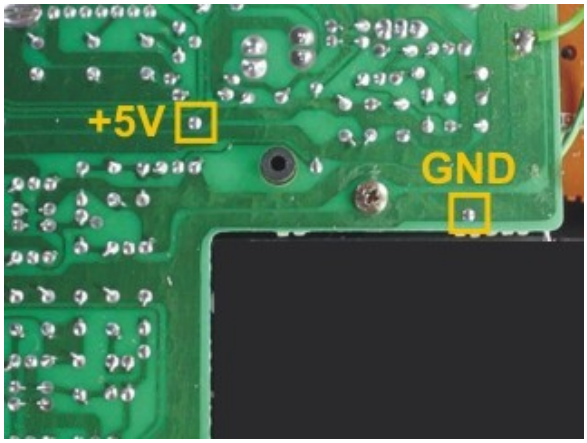
3. Matrix and Switch Wiring

Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.

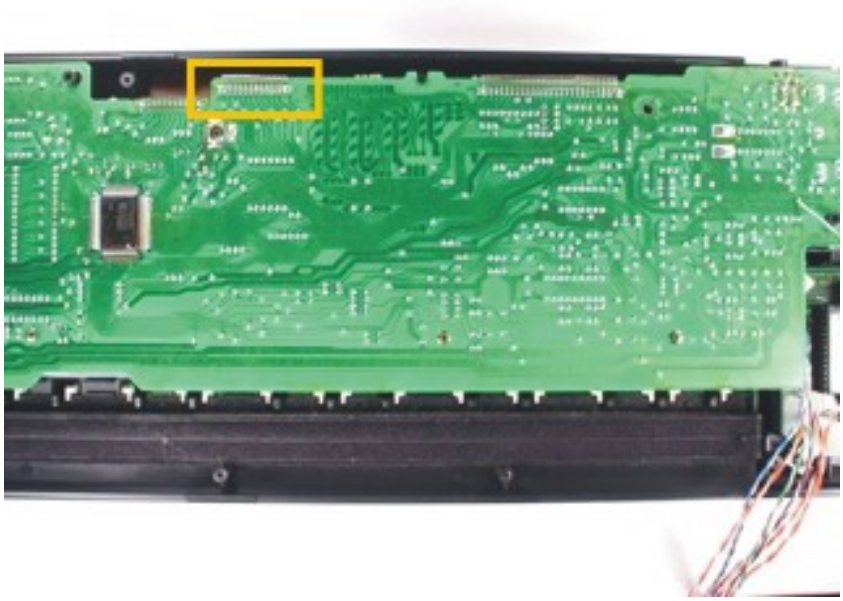
The connection from UMR2 SELECT IN 9 to the SK-5 control panel ribbon is optional. This connection allows MIDI I/O for the sample or percussion pads.



Host ground and +5V locations:
Note: an alternate ground point has been suggested where the green wire is attached in the photo.



Host keyboard ribbon location:



4. UMR2 Setup Procedure

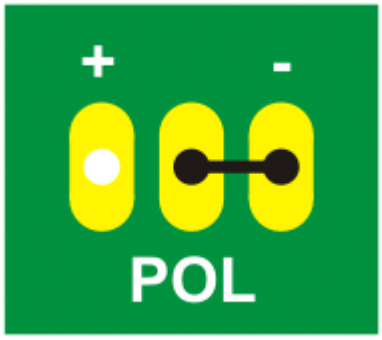
Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.

7.3 Yamaha VSS-30

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the VSS-30 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active Low" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals and MIDI terminals as shown in the diagram. With the host keyboard powered on, test the MIDI signal path by making the following connections:

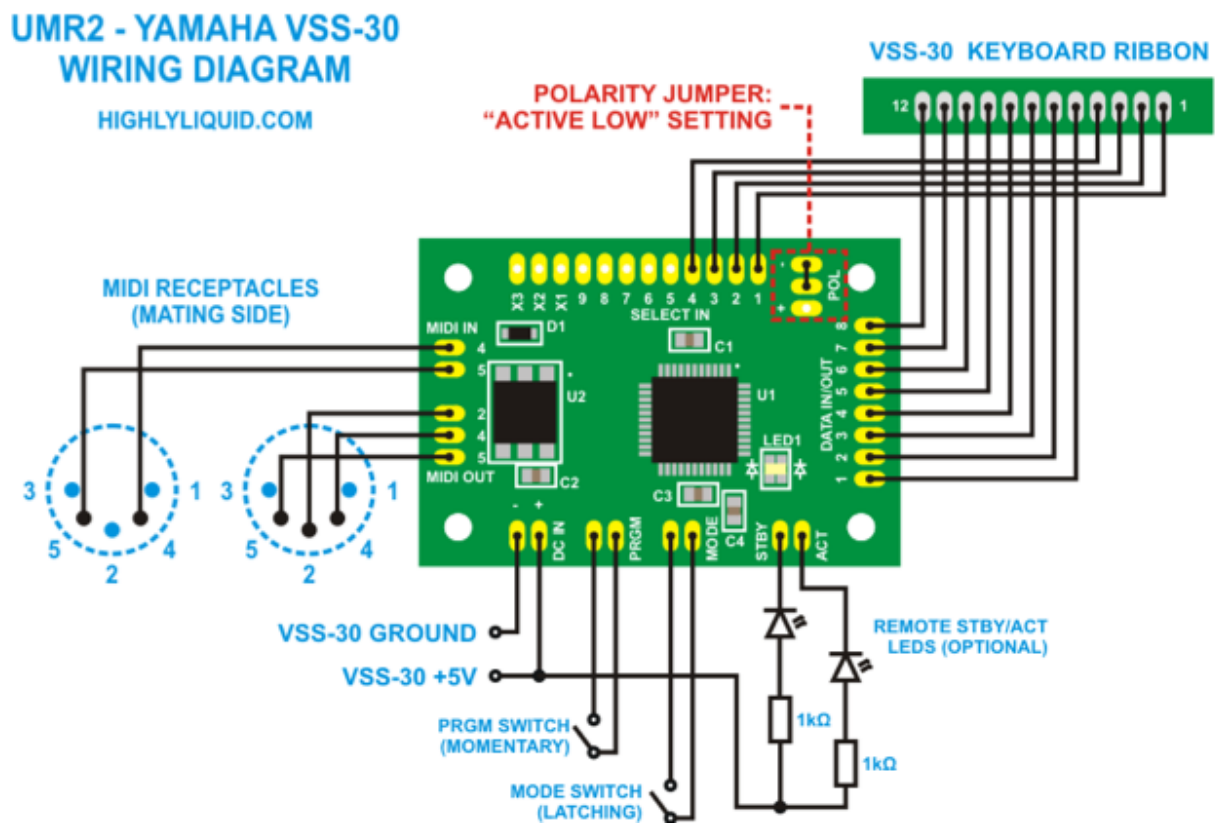
MIDI Controller MIDI Out -> UMR2 MIDI In

UMR2 MIDI Out -> Sound Module MIDI In

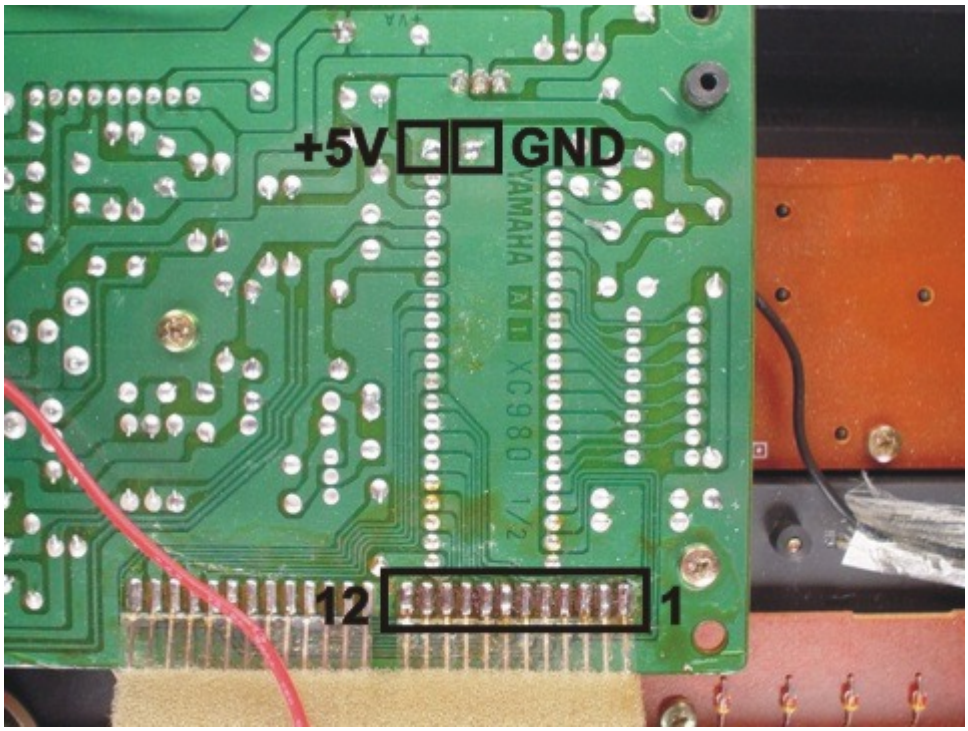
Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

3. Matrix and Switch Wiring

Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.



Host power and ribbon locations:



4. UMR2 Setup Procedure

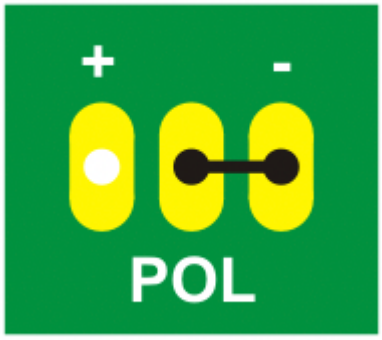
Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.

7.4 Yamaha VSS-100

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the VSS-100 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active Low" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals and MIDI terminals as shown in the diagram. With the host keyboard powered on, test the MIDI signal path by making the following connections:

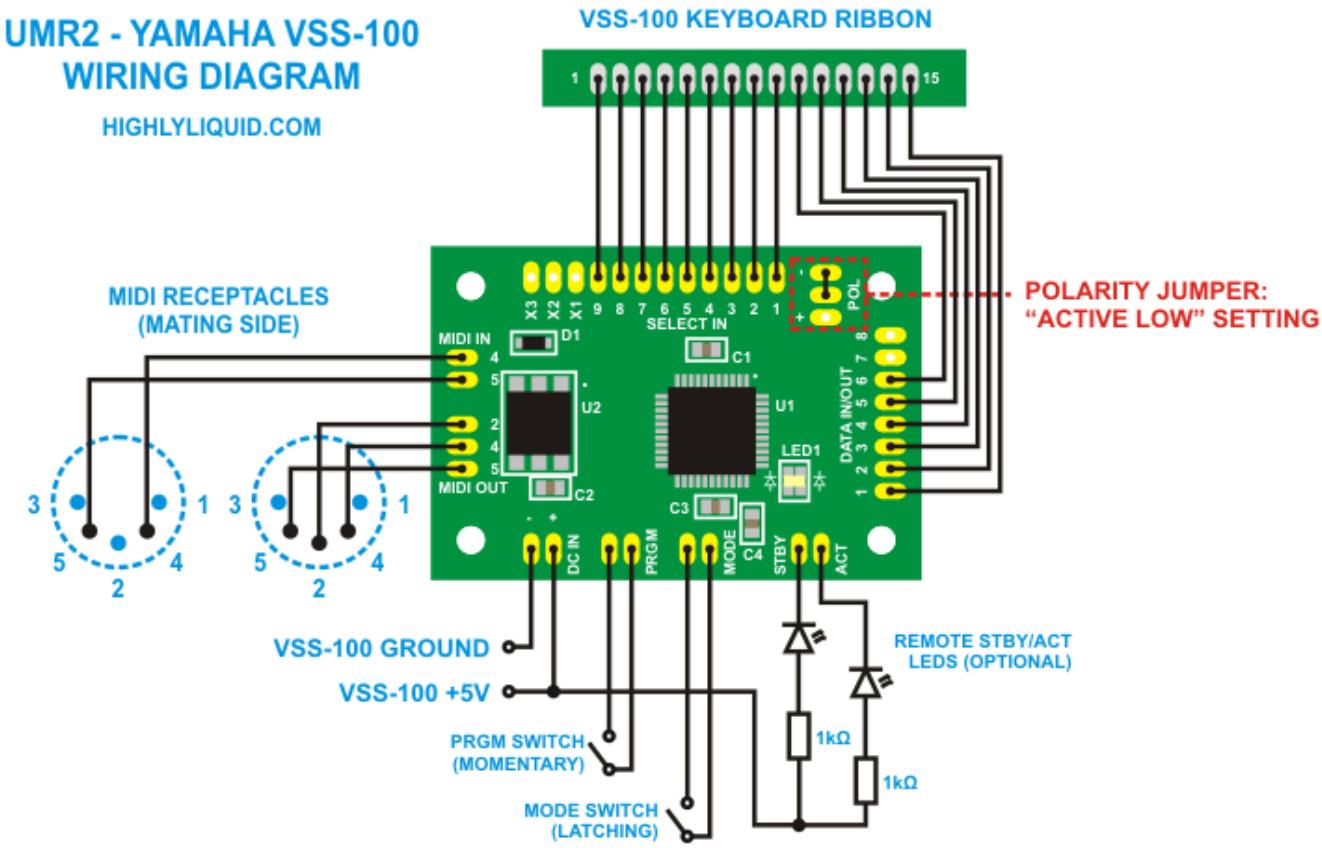
MIDI Controller MIDI Out -> UMR2 MIDI In

UMR2 MIDI Out -> Sound Module MIDI In

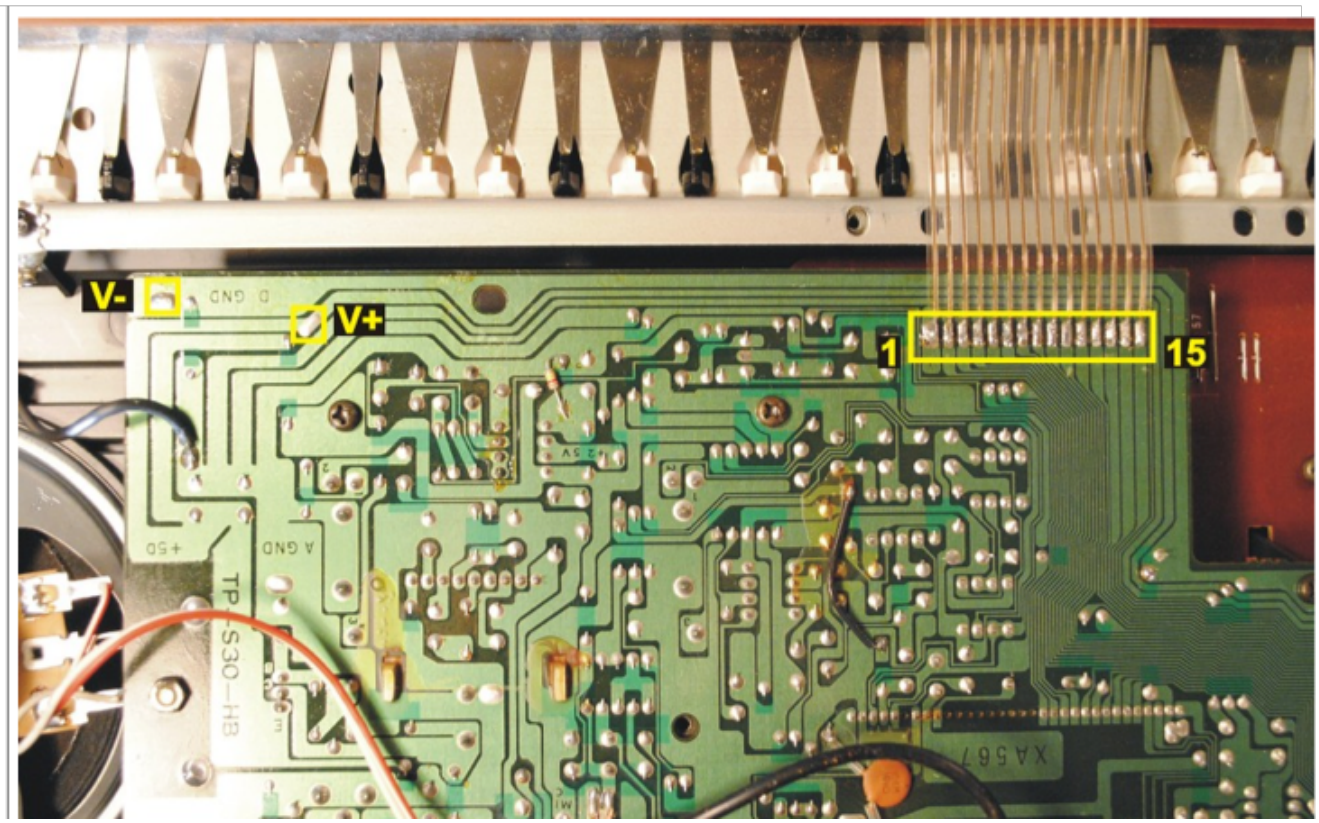
Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

3. Matrix and Switch Wiring

Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.



Host power and ribbon locations:



4. UMR2 Setup Procedure

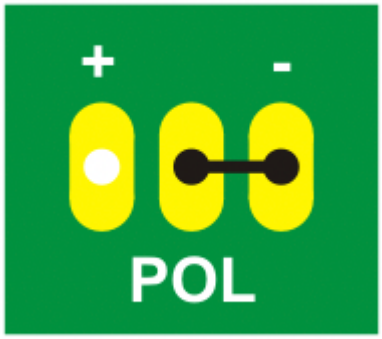
Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.

7.5 Yamaha VSS-200

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the VSS-200 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active Low" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals and MIDI terminals as shown in the diagram. With the host keyboard powered on, test the MIDI signal path by making the following connections:

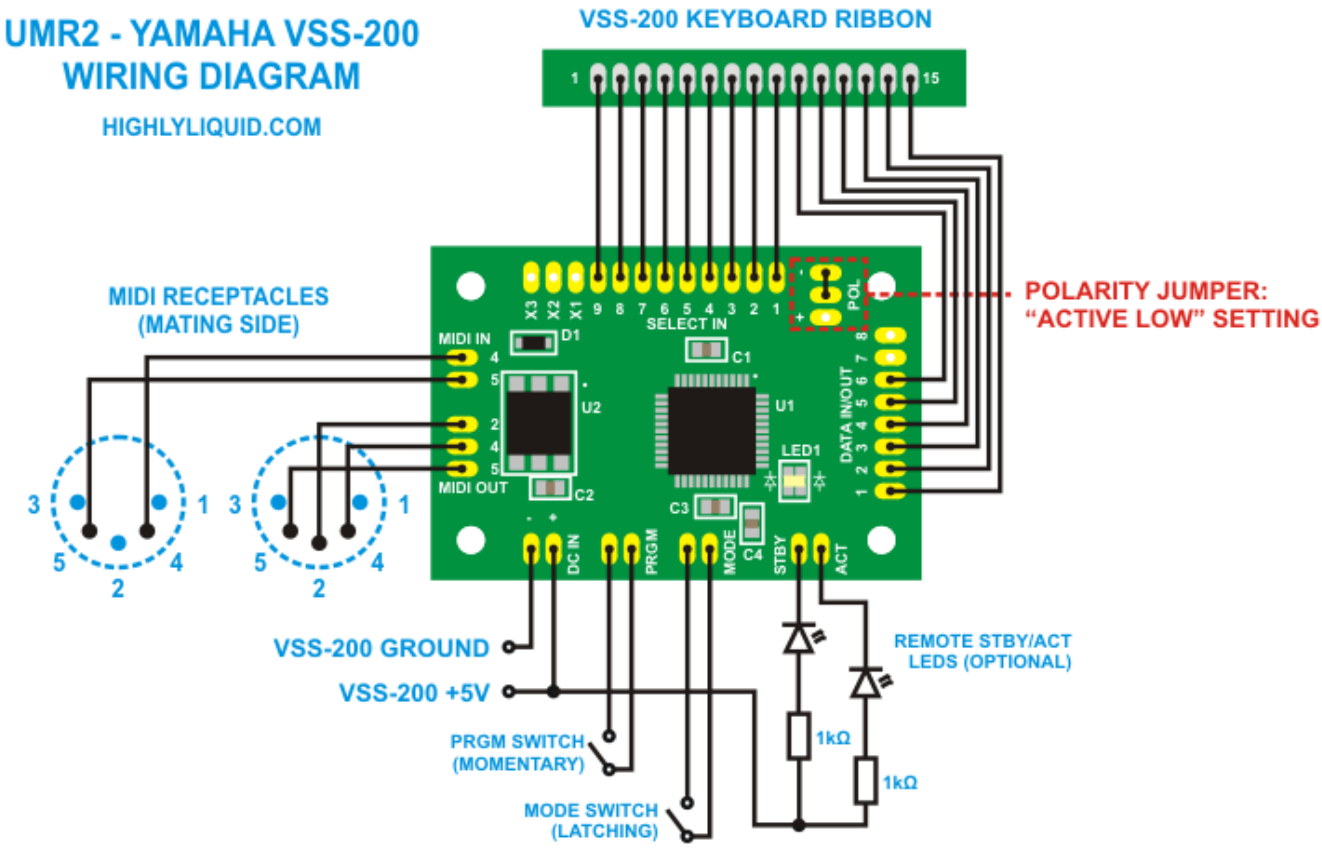
MIDI Controller MIDI Out -> UMR2 MIDI In

UMR2 MIDI Out -> Sound Module MIDI In

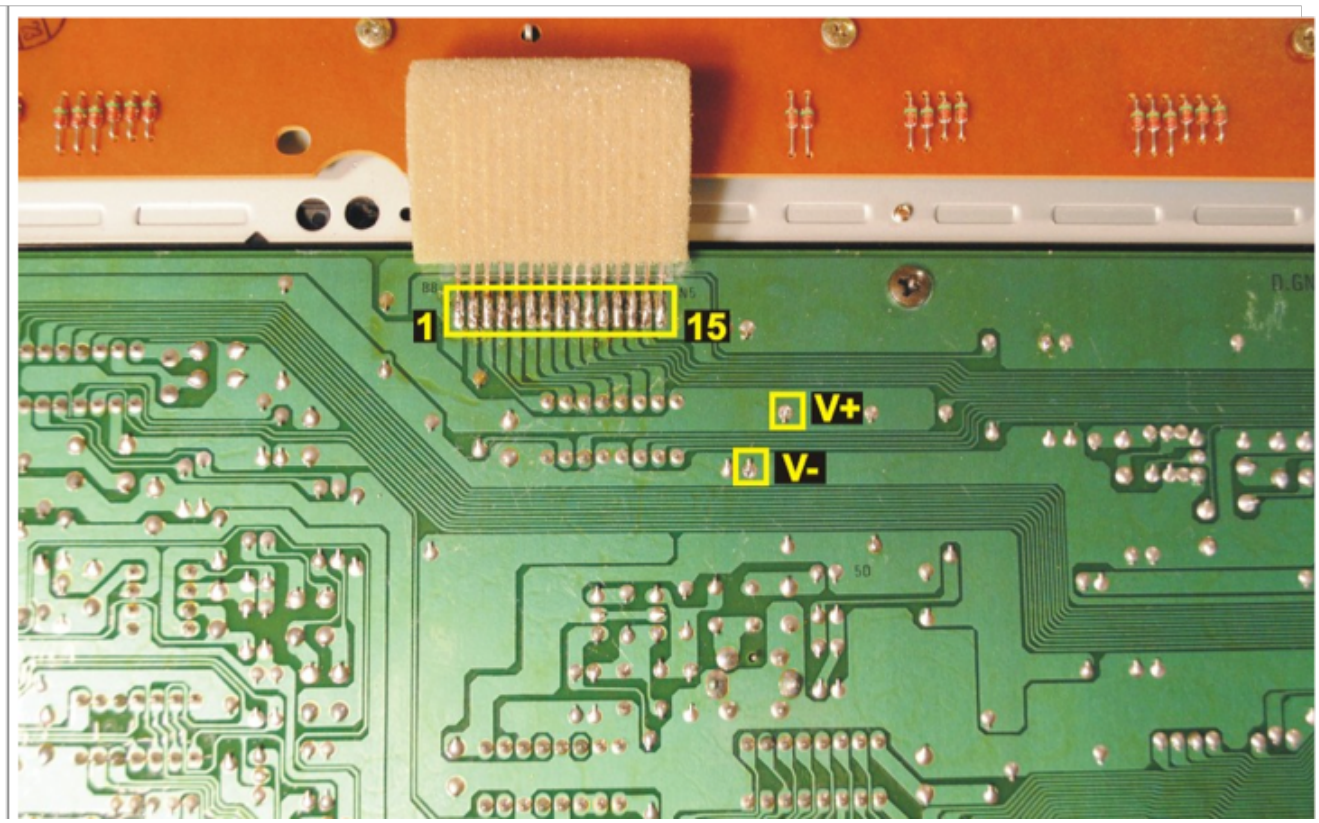
Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

3. Matrix and Switch Wiring

Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.



Host power and ribbon locations:



4. UMR2 Setup Procedure

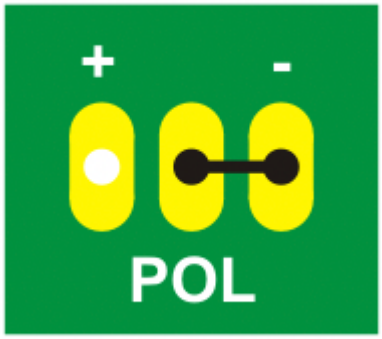
Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.

7.6 Yamaha PSS-470

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the PSS-470 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active Low" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals and MIDI terminals as shown in the diagram. With the host keyboard powered on, test the MIDI signal path by making the following connections:

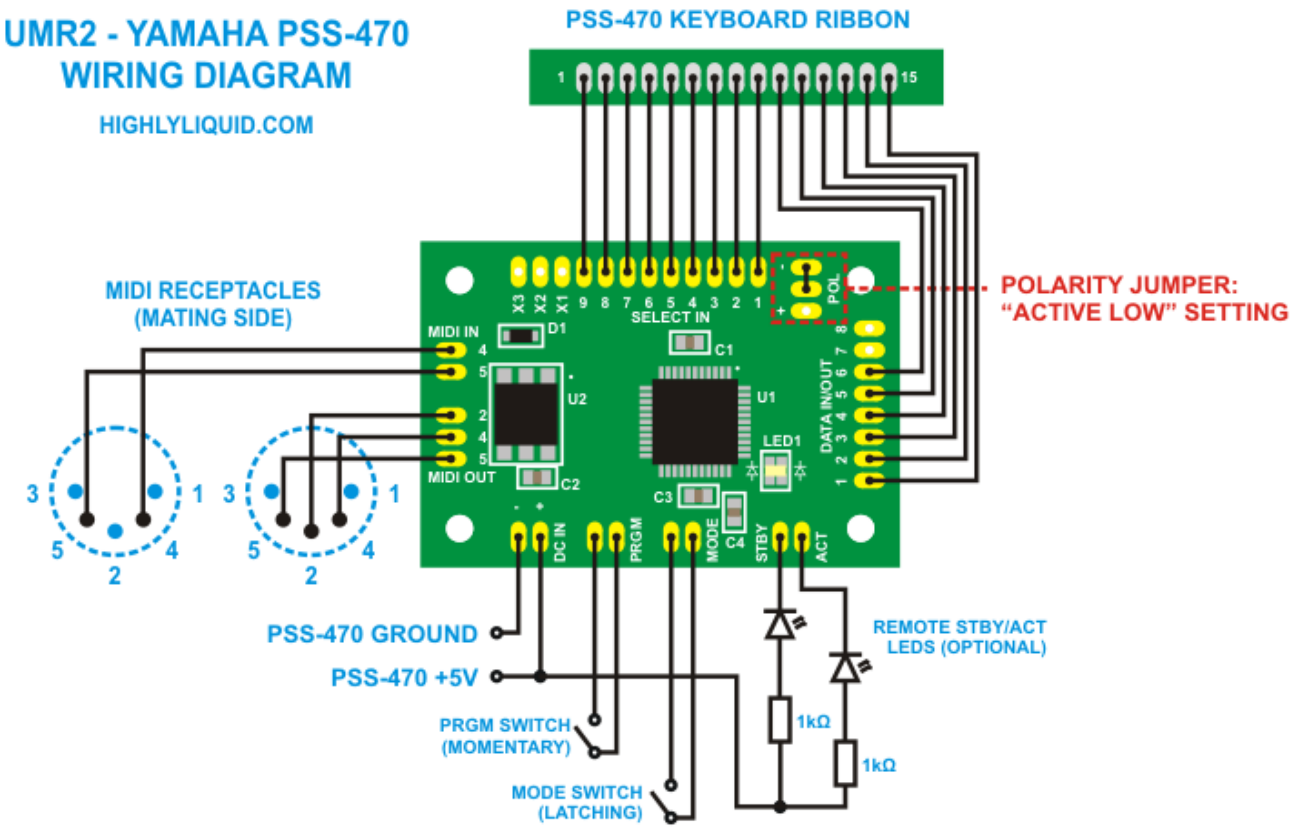
MIDI Controller MIDI Out -> UMR2 MIDI In

UMR2 MIDI Out -> Sound Module MIDI In

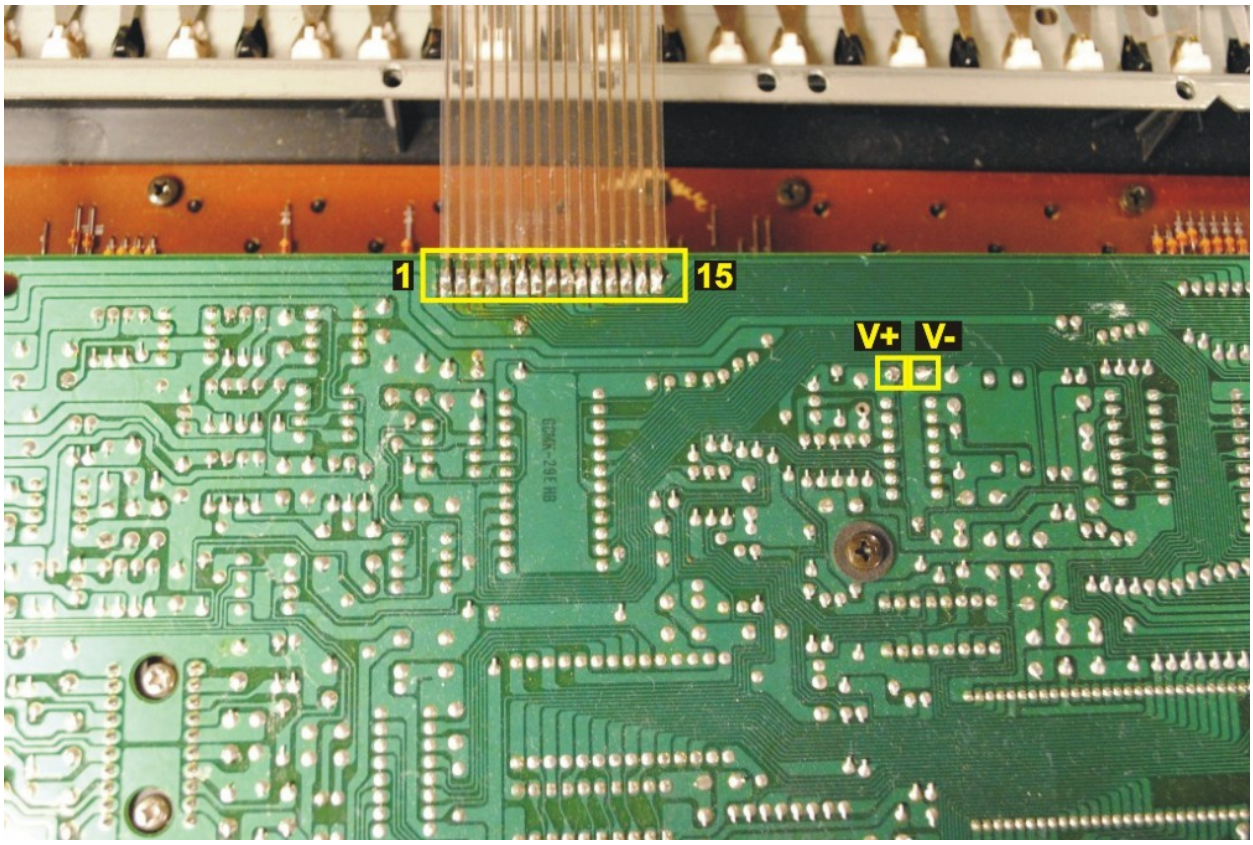
Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

3. Matrix and Switch Wiring

Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.



Host power and ribbon locations:



4. UMR2 Setup Procedure

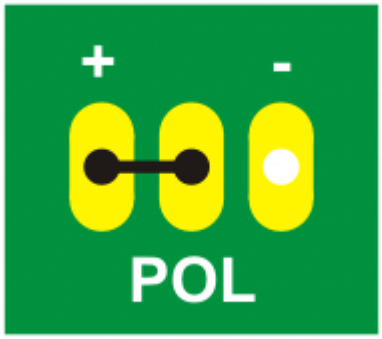
Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.

7.7 Yamaha CS01

0. Read the UMR2 user manual (chapters 3.0-4.0)! Always remove batteries and disconnect any power supply from the CS01 before wiring activity.

1. (VERY IMPORTANT) Connect Matrix Polarity Jumper

Connect the UMR2 Matrix Polarity Jumper for the "Active High" setting. You can do this by soldering a small piece of wire as shown.



2. Power and MIDI: Wiring and Test

Connect the UMR2 "DC IN" terminals as shown in the diagram. The 220-ohm resistor and zener diode 1N4734A are included with the UMR2. They are required to prevent damage to the UMR2.

Connect the MIDI terminals as shown in the diagram.

With the host keyboard powered on, test the MIDI signal path by making the following connections:

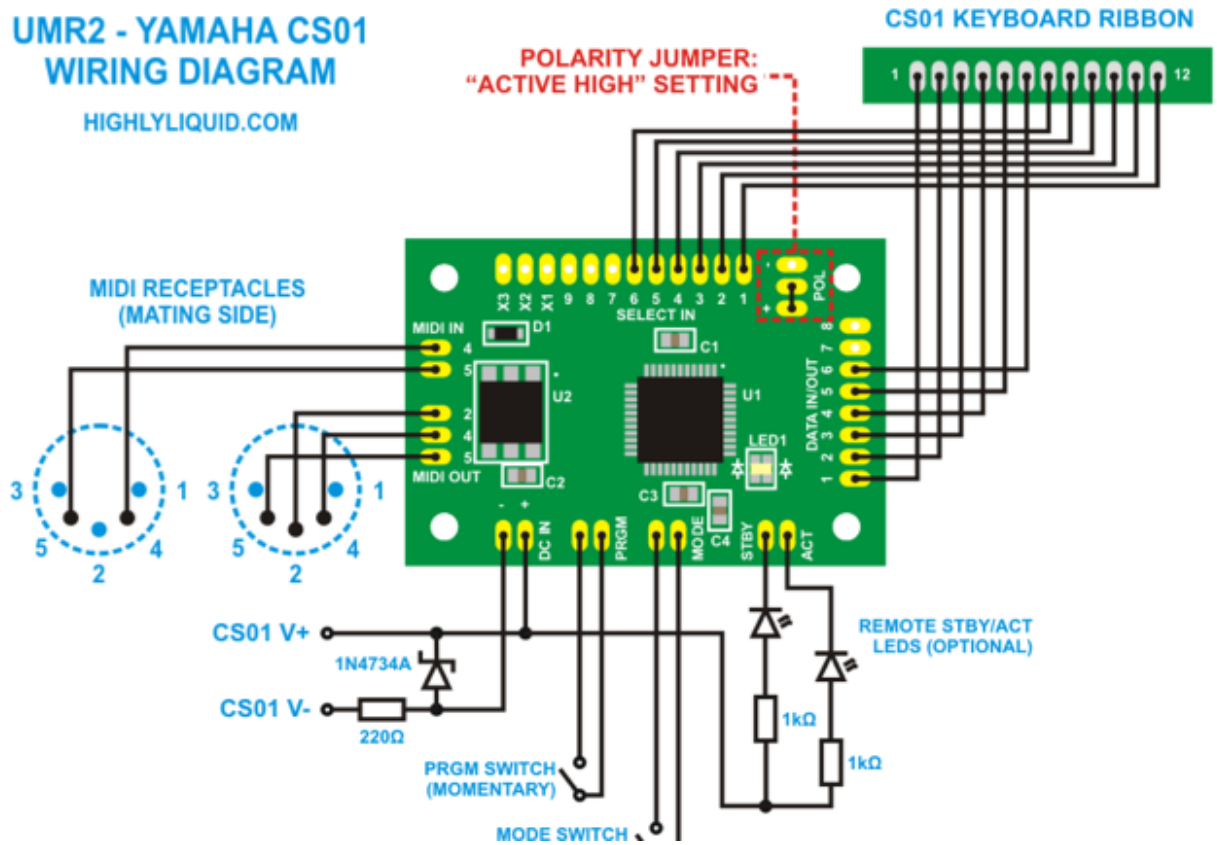
MIDI Controller MIDI Out -> UMR2 MIDI In

UMR2 MIDI Out -> Sound Module MIDI In

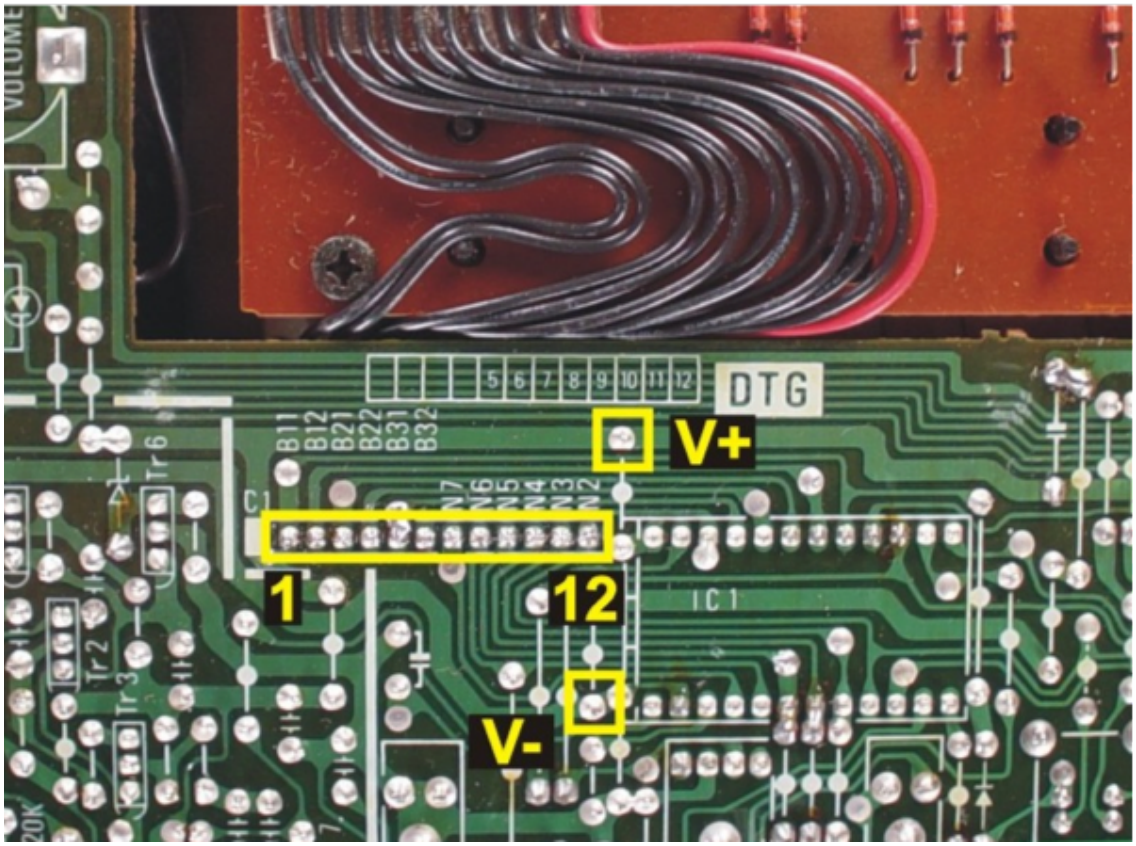
Test the UMR2 "software MIDI thru" by attempting to control the sound module with the MIDI controller. This confirms that the MIDI and power wiring are correct.

3. Matrix and Switch Wiring

Complete the matrix wiring and PRGM and MODE switch wiring as shown in the diagram.



Host V+, V-, and ribbon locations:



4. UMR2 Setup Procedure

Note: move the CS01 "FEET" slider to the 32' setting before performing the setup procedure.

Complete the UMR2 Setup Procedure as described in the UMR2 user manual. This allows the UMR2 to "learn" the keyboard switch matrix configuration of the host, and also sets the MIDI channel and note range.