

SM010 MATRIXARCHATE: USER'S GUIDE

FIRMWARE VERSION 1.3

Thank you for purchasing an SSSR Labs module! We wish you a long and fruitful experience with this module. On pages of this manual, we will explain how to use the SM010 MATRIXARCHATE.

The MATRIXARCHATE module is a 16x8 input-output sequential matrix signal router capable to establish digitally controlled electrical connections between various signal sources and destinations and store those settings into up to 60 user programs. A set of individually picked programs may also be sequentially recalled by an external clock.

Warning!

Do not connect the unit to a modular system having 15-volt power lines. This unit was not tested for proper operation with 15-volt systems and there is a possibility of overheating and further damaging certain components of the unit.

Do not connect any voltage or current sources that are not intended to be used as musical instrument sound or voltage control outputs to the unit's inputs/outputs! Connecting low-impedance current sources such as power sources of any kind can cause immediate damage to the unit.

Although MATRIXARCHATE can stand voltages above +10V or below -5V, it's not recommended to intensely use such kind of signal sources, and under no circumstances, they may have output impedance lower than 100 Ohms

Not observing the above instructions cancels the warranty!

CONNECTING THE UNIT

The unit is equipped with a 10 to 16-lead Eurorack power cable. The unit has a keyed power connector that prevents the unit from the power connector being plugged in wrong. However when using a 3rd party power cable or non-keyed power busses, please make sure that the -12v line is physically connected to pins 1-2 (below), marked with the **RED STRIPE** label.

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THEORY OF OPERATION

The MATRIXARCHATE router is based on a matrix of 128 digitally addressed analog CMOS cross-point switches. In further reading it will be referred as **Switch Matrix**.

NERD INFO. The switch matrix essentially works very similar to array of passive multiple modules or a switches on a grid of wires. Each switch is bi-directional and bi-polar with "On" resistance of approximately 65 Ohms. The "Off" resistance is comparable to a disconnected mechanical switch. This means that it has no inputs or outputs in its usual meaning.

The switch matrix is updated each time when the state of a certain switch has been toggled by a user, or when a program is recalled. Any switch is constantly accessible in real time right from the front panel, without any so-called menu diving.

The switches are addressed as ROWS labeled by numbers and COLUMNS labeled by letters, exactly as in the good old Battleship game. For ease of understanding we can sometimes describe row jacks as inputs, and column jacks as outputs but the actual direction of the signal can be arbitrary and even both ways at the same time. Why is it made so? Because design of this module is optimized for pitch-accurate CV distribution and fast patching between different CV sources and synthesizer voices, and the I/O configuration allows using larger number of modulation sources with fewer destinations, or vice versa, the using a small set of controls with a complex setup.

MODULE INTERFACE

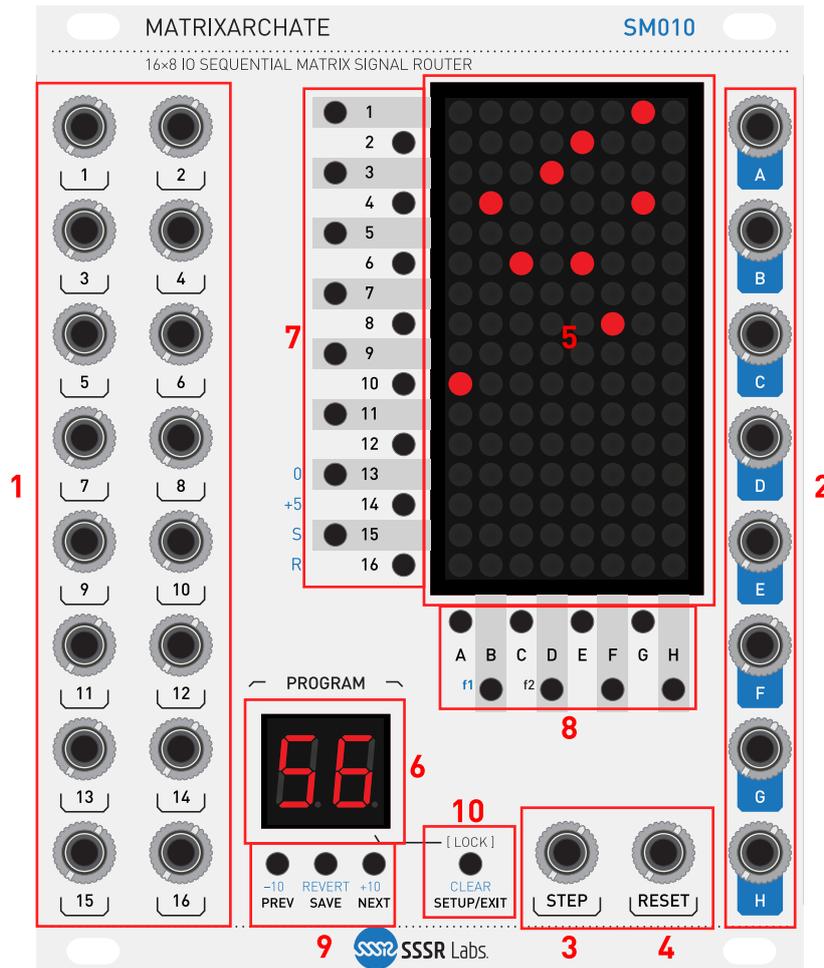
The module has six modes of direct operation: Operative, Saving, Setup, Background Sequencing, Quick Recall and Silent. It also can be remotely controlled using MoNoMe Teletype.

There are three sets of buttons: **Rows**, labeled 1 to 16, **Columns** labeled by letters A to H and **Utility** buttons **PREV**, **SAVE**, **NEXT** and **SETUP**.

The functions of buttons depend on the current mode of operation and its respective context. You can see a number of different labels next to the utility buttons. The **PRIMARY** function, the **SECONDARY** function and the [TERTIARY] function. These functions are accessed by pressing a utility button while holding a **Modifier**, similarly to holding Shift or Alt key on a computer keyboard. Buttons **B** and **D** are labeled as function modifiers for the utility buttons: the secondary function **f1** and the tertiary function **f2**. So, when two buttons are mentioned — the modifier followed by the utility button — the combination is implied: for example **f1-SAVE**. The combination of row and column buttons will be always referenced with the number followed by a letter, therefore **1-F** is a combination of row button **1** and column button **F**, and **f1** is the name of the modifier.

FRONT PANEL CONTROLS

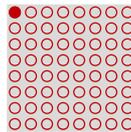
Let's take a look at the front panel. It consists of the following controls:



- Ports 1...16. These 16 ports are associated with **ROWS** of the matrix and usually may be considered inputs. Four of these ports are normalised to other signals, which means that when there is no plugs inserted into corresponding jacks, these rows are connected to certain internal voltage sources and signals. Row 13: 0 V ground, Row 14: +5 V source, Row 15: STEP input, Row 16: RESET input.
- Ports A...H. These 8 ports are associated with **COLUMNS** of the matrix.
- Sequencer **STEP** input. This logical input is used to advance to the next program in a sequence by the input trigger. The threshold voltage is at about 0.7 V.
- Sequencer **RESET** input. This logical input is used to rest to the first program of the sequence by the input trigger. The threshold voltage is also at about 0.7 V.
- 8x16 dots **PATCH** Display. It shows the current state of the switch matrix or other information.
- 2-digit 7-segment **PROGRAM** Display. It shows the number of the currently selected program.
- Row selection buttons 1...16.
- Column selection buttons A...H.
- Program utility buttons: **PREV**, **SAVE**, **NEXT**. These buttons are used for switching between programs and other program-related manipulations.
- SETUP/EXIT** utility button. This button toggles the Setup Mode, cancels some operations and does other useful functions.

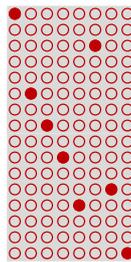
OPERATIONAL MODE

When you turn on your system, Matrixarchate enters the main mode called operational. In this mode the PATCH display shows the active connections. The combination of row and column button toggles the state of the switch at the point of intersection of the respective row and column. This is the only type of combination in which order of button presses is not important. For example, to connect or disconnect input 1 with output A, you press buttons 1 and A at once. The dot located in the cross point between those row and column will indicate the state of the corresponding switch.

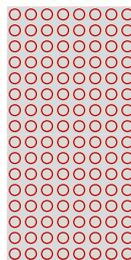


The PROGRAM display shows the number of currently loaded program. You can navigate through programs by pressing the **PREV** and **NEXT** utility buttons. To advance 10 programs up or down press **f1-NEXT** or **f1-PREV**. There is another method of navigation called **Quick Recall Mode**. It will be described later.

The combination **f2-NEXT** instantly generates a random patch. The random patch always has exactly 8 connections: 1 row per column with no collisions.



Below the **SETUP** button you can see the blue label **CLEAR**, which means that pressing **f1-SETUP** clears the switch matrix.



PASSIVE CONNECTIONS CONSIDERATIONS

Here we should understand two things. As soon as a row is connected with the column, they form a NODE, and any additional connection with the same column or row will join this common node. And a node shall not be confused with a mixing stage, logical 'AND' or a dedicated isolated connection. It's just a straight electric node tying all the endpoints together. So, you will get a predictable result only connecting ONE source to one or multiple destinations. When you connect multiple sources together, the signals will not be added. Instead their currents will be added and you will get a mean value of their voltages and only if the source output impedances are close to each other. The Doepfer standard suggests 1 kΩ output impedance but some modules may have significantly lower impedance such as 220 Ohms or even 100 Ohms, so their signal will dominate over others.

Also, you may think: OK, I have two trigger outputs, and a sensitive logical module, so even at the half of the logical one's level it will be triggered, so I can make a logical OR, interconnecting multiple sources in the same node. Most of the time it is so but if some logical module have an open collector going directly to the output jack, it will literally tie this line to ground on the logical zero's state, so everything connected to the line will be grounded as well. However we will further assume that a full standard compliant modules with 1 kΩ output impedance are used.

Example / Nerd Info:

Input 1: $V_{out1}=5\text{ V}$, $R_{out1}=1\text{ k}\Omega$

Input 2: $V_{out2}=8\text{ V}$, $R_{out2}=1\text{ k}\Omega$

Average signal = $(5+8)/2 = 6.5\text{ V}$

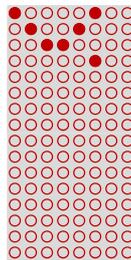
Input 1: $V_{out1}=4\text{ V}$, $R_{out1} = 100\ \Omega$

Input 2: $V_{out2}=8\text{ V}$, $R_{out2} = 1\text{ k}\Omega$

*Average signal = $4 + \frac{(8-4) * 100}{(1000+100)} = 4\frac{4}{11}\text{ V}$*

Please keep these considerations in mind when planning your patch.

Let's assume that in our example we want to also control the cut-off frequency with the pitch CV. Make an additional connection at 1-F:



The correct note tracking is gone and envelope now modulates the pitch. Why is it so? Because we just joined Row 1 with Row 4 via Column F. And also, we joined Column A and Column F via Row 1, so we have a common node joining together pitch CV, envelope's output, V/Oct input of the Kotelnikov module, and also the VCF's input. If we untie envelope from the pitch CV, the pitch tracking will get back to normal operation. Of course, you may experiment with tying many lines together and sometimes get interesting results, but first you need to learn how to make predictable patches.

SAVING MODE

The unit has two memory areas: a non-volatile memory used to store programs and settings, and a temporary operative memory, in which all programs and settings are copied after powering on the module. All editing is performed in operative memory.

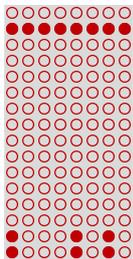
To permanently store the changes you need to save your patch.

Enter the saving mode by pressing the **SAVE** button.

Now, if you press **SAVE** one more time, the active patch will be saved to the current program, overwriting its initial contents. You can also save or copy this patch to another location, pressing the **PREV/NEXT** buttons, or, if you changed your mind, you can exit the saving mode by pressing the **SETUP** button. Hence the full name of this button: **SETUP/EXIT**. The interesting feature of Matrixarchate is that all modified and yet unsaved programs are kept in the operative memory, so even if you switch to another program and later get back to the modified one, all changes still will stay there until module is powered off. You can revert current program to the last saved state by pressing **f1-SAVE** in the operational mode.

SETUP MODE

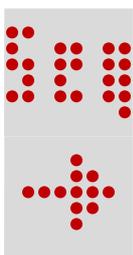
Upon pressing the **SETUP** button in the operational mode, you enter the **SETUP** mode, indicated with two dashes (- -) on the program display. The meaning of the PATCH display is now different. The top part is dedicated for programming the sequencer list. Please refer to the section SEQUENCER for more detailed explanations. The lower part indicates current global settings of the module and sequencer.



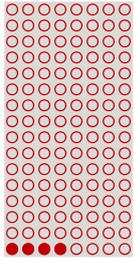
There are 6 options displayed as dots in particular positions:

The sequencer direction, Matrix display mode, Program display mode, Teletype unit number, Program load mode and Optimization for trigger at row 15. All options are set by pressing the certain combination of row and column buttons, and while such combination is held down, you will see icons helping you to understand what's going on.

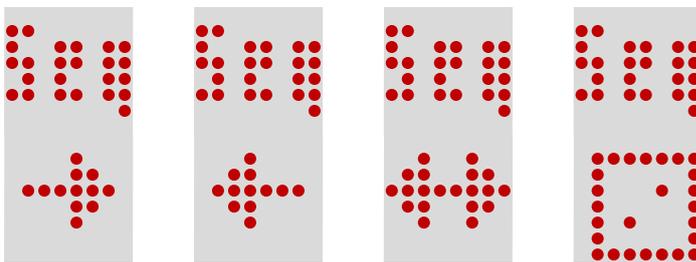
Example:



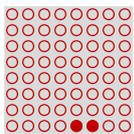
Sequencer direction. (dots 16A..16D)



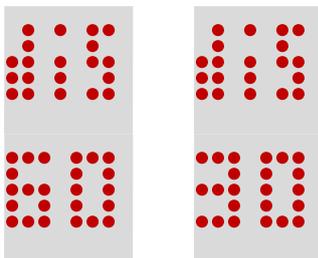
The sequencer of the MATRIXARCHATE has four directions: Forward, Backward, Pendulum, and Random. To switch between these directions, press row button **16** and one of the following column buttons: **A** (Forward), **B** (Backward), **C** (Pendulum), or **D** (Random). Note that when you press and hold these two buttons, the hint will appear on the display.



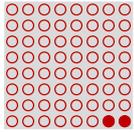
Patch Display Mode (dots 16E, 16F)



Matrixarchate has two options for patch display: **Normal**, and **Graphically assisted**. You can read more detailed explanations on this mode in the section GRAPHICALLY ASSISTED MODE. The Normal mode is chosen by pressing **16-E** combination, and Graphically Assisted mode — by pressing **16-G**. Normal mode is indicated by number **60** in the lower display, and Graphically assisted mode is indicated by number **30**.

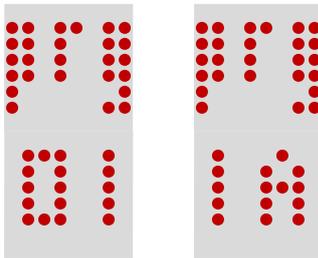


Program display mode (dots 16G, 16H)

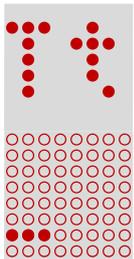


For different kinds of users, MATRIXARCHATE has two available notations of programs: decimal, in which program numbers start with 01 and end with 60 (01...60), and the octal, in which numbers are notated with mix of a number and a letter, starting from 1A and ending with 8D (1A...8D). The letters from A to H are indicated in the right position as A, b, c, d, E, F, G, H.

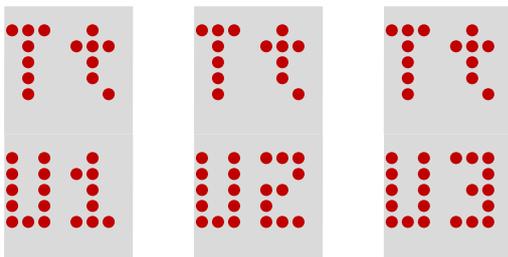
You can switch to the octal mode by pressing 16-H, and return to the decimal mode by pressing 16-G. Those options are indicated by characters 01 and 1A.



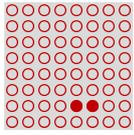
Module unit address for Teletype (dots 15A..15C)



You can choose between three available unit addresses for controlling Matrixarchate with MoNoMe Teletype module.



Program load mode (Dots 15E, 15F)

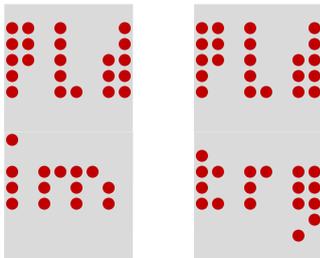


There are two modes: **Immediate** load, indicated as 'im' and **Triggered** load, indicated as 'trg'.

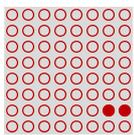
This option defines the moment when the selected program is loaded into the switch matrix.

In Immediate load mode which is default, as soon as a program is selected, it immediately appears on the matrix display and loads into the switch matrix.

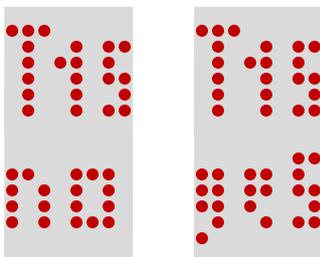
In Triggered load mode, the selected program appears on displays but the switch updates only when a trigger signal appears in the STEP input, or with the press of the **f2-SAVE** combination. The sequencer steps don't advance in this mode.



Forced Trigger Disconnection (Dots 15G, 15H)



When this mode is enabled, all connections with the row 15 are only active while the trigger at the STEP input is in the logical high state. It's implied that row 15 is dedicated for the trigger synchronized with the sequencer STEP triggers. The option is displayed as T15 (Trigger at row 15) and has value 'no' and 'yes'.



As like as patch programs, the setup will be kept in the operative memory until the module is powered off. To permanently save the current setup, press **SAVE** twice.

Exit the setup mode by pressing the **SETUP** button.

DISPLAY LUMINANCE AND THE SILENT MODE

You can change the displays' luminance in Operative mode by pressing combinations from **2-SETUP** to **13-SETUP**. Also, the combination **1-SETUP** turns off both displays and module enters the silent mode. You can exit this mode by pressing any column selection button. The silent mode can be useful when you route audio signal through Matrixarchate because normally displays add a certain amount of digital noise into the signal path.

QUICK RECALL/LOCK MODE

Pressing **f2-SETUP** enables the **Quick Recall** mode and locks the switch matrix, and that's why it's labelled as [LOCK]. This mode is indicated by the right dot on the PROGRAM display, so instead of "**2F**" you will see "**2F.**".

In Quick recall mode, patch editing is inaccessible, but you can quickly access any program just by pressing a combination of row and column buttons. The meaning of combinations depends on the active Program Display mode.

In the **Decimal** mode, you select ones with the row buttons and tens with the column buttons but since we are dealing with numbering starting with 1 instead of 0, the meaning of 10 is a bit unusual. Numbers from 1 to 9 correspond to the ones, starting from 1; letters correspond to tens, starting from zero, and button 10 corresponds to 0 in the ones position but adds 10 to the number.

For example: To load program **01**, press **1-A**. To load program **10**, press **10-A**. To load program **20**, press **10-B**, and to load program **21**, press **1-D**.

In the **Octal** mode, it works in a different and a more natural way: if you want to load program **1A**, you literally press **1-A**, and to load **3E**, you press **3-E**, so the ones are now changed with the column buttons, and eights with the row buttons.

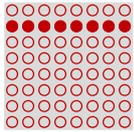
Please refer to the Table 1 for the full list of programs and respective button combinations in both notations, but please believe, it looks complex during reading the manual, but simple in real use.

GRAPHICALLY ASSISTED MODE

While the normal mode is normal: 60 programs are available and the current patch always shown on the patch display as it is, the graphically assisted mode is special: It's made for fun, to trick audience with funny graphics during your performance, or to help you to memorize or illustrate the purpose of your set of programs. Only first 30 programs are available for patches, while the last 30 programs are used for arbitrary graphical hints. For example, we have the program 1 that stores a patch. When this program is recalled, these settings will be loaded into the switch matrix chip, but the patch display will show the contents of program 31 (1+30) instead. However as soon as you press a column button in this mode, the actual active patch will be displayed and available for editing, saving, copying and all usual operations. In Graphically Assisted mode you can't access and edit the hints, so you have to prepare them in advance, in the Normal display mode. Of course, in this mode, you can't include the last 30 programs in the sequence.

SEQUENCER

The module has built-in sequencer based on a list of programs with enabled or disabled entries. Each step it loads adjacent program from the list defined in the setup mode. A program can be either included to the sequencer list once or skipped. The order of programs in the list is strictly sequential, so you shouldn't confuse that with a kind of a song mode: it acts just like a one track trigger sequencer and the difference is that each step is a whole routing patch prepared in advance. The number of steps in the whole sequence is exactly the same as the number of programs enabled in the list.



Let's look at the top half of the patch display in the Setup mode. The sequencer list is indicated by 60 dots in rows going left to the right. The dots in the row 1 indicate programs from 1 to 8, row 2 indicate programs from 9 to 16, and so on up to the last program 60, located at position 8D.

The toggle of a single entry in the list is made the usual way: by pressing a combination of row and column buttons, but you can also instantly toggle a whole row of 8 programs, pressing a combination of the row button **1..8** and one of the utility buttons: **NEXT** button to include or **PREV** button to skip a set of 8 programs. The sequencer list is stored within the setup memory, so don't forget to store it.

SEQUENCER CLOCKING

Now let's talk about how it's clocked.

A trigger at the **STEP** input advances the sequencer one step further. However, if **RESET** input is at logical high state at the time, the sequence will start from the beginning with accordance to the current direction.

The factory default setup has enabled programs from 9 to 16 and default sequencer direction is forward. So, each step it will load next program, and after 16 or if **STEP** was triggered with active **RESET**, it will start over from program 9.

Let's try to change the direction to **BACKWARD** in the middle of the sequence. See what happens: the sequencer immediately changes direction and proceed back. Reset will also return it to the beginning, but in this new context the beginning will be at the end of the list. In pendulum mode it's even more interesting. Direction changes at each boundary of the list, so does the logical beginning. Of course, **RESET** has no meaning in the random mode since each step a new program is randomly chosen from the list in real time.

BACKGROUND SEQUENCING MODE

Usually it's hard to edit the sequenced programs when the sequencer is running, especially on high rate, because the contents of the patch display changes with each step.

Pressing the **f2-PREV** combination toggles the special mode called Background Sequencing mode. It is indicated with the dot in the middle of the PROGRAM display.

In this mode, sequencer advances in background and loads the next patch directly into the switch matrix, without any interaction with the displays. At the same time, user can manipulate programs independently and hear or observe the changes when modified program is reached by the sequencer. The saving process in this mode has a little difference: When saving is confirmed by pressing the SAVE button second time, the actual writing to the non-volatile memory is performed postponed until the moment directly after sequencer loads next patch of the sequence in the matrix because program writing halts all real time processes for a few milliseconds.

USING THE FORCED TRIGGER DISCONNECTION OPTION

While Matrixarchate works perfectly with routing continuous signals or DC voltages, it demands following some rules when you use its sequencer for routing trigger signals. Unlike normal sequencers, which process the trigger inputs through digital processor, or other kind of logic circuits, with program controlled or instantly calculated output, this module feeds all signals through the analog switches. So, there is unavoidable latency between the leading edge of a trigger at the **STEP** input, and the moment when switches are updated. Here is the timeline: about 70 μs after the trigger is detected, all switches go to the off state and all ports disconnect. Then the new program contents are being loaded to the switch matrix and this process ends at the point of nearly 300 μs . This means that if a trigger signal was used (connected) at the previous step, it will appear for a very short, but non-zero time even if the switch should be off at the new step. Depending on design of the destination modules, this short duration can be enough for triggering the dependent event.

There are two methods for solving this issue. The first method is a short (about 1/2 ms) delay or a slew limiting of the leading edge of the routed trigger signal relatively to the sequencer trigger (for example using an free envelope generator, fast slew limiter, etc).

The second method is using **Row 15** for triggers with enabled **Forced Trigger Disconnection (T15)** mode, which was specially designed to improve triggering experience. In this mode all connections with the row 15 are only active while **STEP** trigger is at the high logical state. The rest of the time row 15 is forcedly completely disconnected.

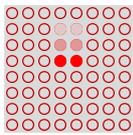
UPDATING FIRMWARE

All firmware updates for Matrixarchate are released in audio format, similar to software stored in data cassettes for 8-bit home computers of '80s. **DO NOT LISTEN THESE SOUNDS LOUDLY!**

To update the firmware please do the following procedure:

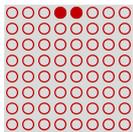
1. Insert a spare cable into row jack **15**. This is needed to unplug **STEP** input from the switch matrix.
2. Connect your audio playback source to the **STEP** input of the module.
3. Cycle the power holding **SETUP** button.

You will see the bright chasing lights animation in two middle columns of the upper half of the PATCH display. This animation indicates the bootloader awaiting data. It works only for dozen of seconds, then module restarts in Operative mode.

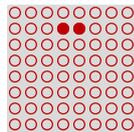


Now, while lights are still chasing, start the audio file with the firmware. Please make sure that the output is not amplified and transmitted through the loud audio system or headphones, because the sound of digital data is harsh and disturbing. Probably you will need to adjust the playback volume to make the code recognizable by the module.

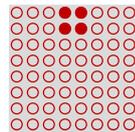
As soon as update is started, you will see increasing binary code in two middle columns of the same upper half of the display, indicating uploaded blocks of code. After successful programming, the module will restart in Operative mode.



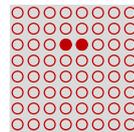
Block 1



Block 2



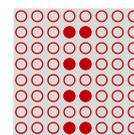
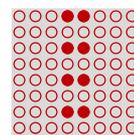
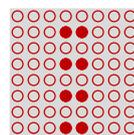
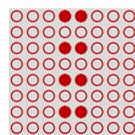
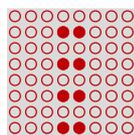
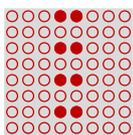
Block 3



Block 4

etc...

In case of **error**, display will show a rapidly changing pattern, and you will need to reset the module and start the update from the beginning.



...

TABLE 1. PROGRAM NUMBERING AND QUICK RECALL

Decimal	Q. Recall	Octal	Q. Recall	Decimal	Q. Recall	Octal	Q. Recall
01	A1	1A	1A	31	D1	40	4G
02	A2	1B	1B	32	D2	4H	4H
03	A3	1C	1C	33	D3	5A	5A
04	A4	1D	1D	34	D4	5B	5B
05	A5	1E	1E	35	D5	5C	5C
06	A6	1F	1F	36	D6	5D	5D
07	A7	1G	1G	37	D7	5E	5E
08	A8	1H	1H	38	D8	5F	5F
09	A9	2A	2A	39	D9	5G	5G
10	A10	2B	2B	40	D10	5H	5H
11	B1	2C	2C	41	E1	6A	6A
12	B2	2D	2D	42	E2	6B	6B
13	B3	2E	2E	43	E3	6C	6C
14	B4	2F	2F	44	E4	6D	6D
15	B5	2G	2G	45	E5	6E	6E
16	B6	2H	2H	46	E6	6F	6F
17	B7	3A	3A	47	E7	6G	6G
18	B8	3B	3B	48	E8	6H	6H
19	B9	3C	3C	49	E9	7A	7A
20	B10	3D	3D	50	E10	7B	7B
21	C1	3E	3E	51	F1	7C	7C
22	C2	3F	3F	52	F2	7D	7D
23	C3	3G	3G	53	F3	7E	7E
24	C4	3H	3H	54	F4	7F	7F
25	C5	4A	4A	55	F5	7G	7G
26	C6	4B	4B	56	F6	7H	7H
27	C7	4C	4C	57	F7	8A	8A
28	C8	4D	4D	58	F8	8B	8B
29	C9	4E	4E	59	F9	8C	8C
30	C10	4F	4F	60	F10	8D	8D

TABLE 2. BUTTON COMBINATIONS AND SINGLE PRESSES

Differences in functions in various modes are marked by colors:
Operational Mode, **Saving Mode**, **Setup Mode**, **Quick Recall Mode**, **Silent Mode**
When the order is important, the first button is shown underlined.

1...8 + A...H: Toggle switch / **Toggle program in the sequence** / **Change setup settings** / **Quick load a program**

A...H: **Disable Silent Mode**

PREV: Load the previous program / **Select the previous program** (cycled)

1...8 + PREV: **Exclude the entire row of programs from the sequence**

f1 + PREV: Jump 10 programs back (cycled)

f2 + PREV: Toggle Background Sequencing mode.

SAVE: Enter Saving Mode / **Save current settings to a selected program location**

f1 + SAVE: Revert to the last saved state of the program

f2 + SAVE: Manual sequencer step or update switch matrix in triggered program load mode

NEXT: Load the next program / **Select the next program** (cycled)

1...8 + NEXT: **Include the entire row of programs in the sequence**

f1 + NEXT: Jump 10 programs forward (cycled)

f2 + NEXT: Generate a random patch.

SETUP/EXIT: Enter Setup Mode / **Exit Setup Mode** / **Exit Saving Mode**

f1 + SETUP/EXIT: Clear current program

f2 + SETUP/EXIT: Enter Quick Recall Mode.

1 + SETUP/EXIT: Enter Silent Mode

2..16 + SETUP/EXIT: Set brightness

TECHNICAL SPECIFICATIONS

- Total matrix switch rows×columns: **16×8**
- Maximum voltage swing at IO: **-5...+10V**
- User programs: **60 (30 in the Graphically assisted mode)**
- Module width: **20hp**
- Module depth (behind the front panel): **36mm**
- Dimensions: **101×129×41mm**
- Weight of the assembled module (inc. power cable and screws): **255g**
- Current draw (+12v): **All lights Off: 22mA. All lights On: 56mA. Normal use: 40mA**
- Current draw (-12v): **2mA**
- Signal/Noise ratio: **63dB with 10Vpp signal**
- Maximum sequence rate: **50 Hz**

RIGHTHOLDERS INFORMATION

The copyright on the firmware and electrical circuit of the SSSR Labs MATRIXARCHATE module and also the SSSR Labs trademark belongs to sole trader Dmitry Shtatnov, Russia, Mytischki.