grayscale

Polyrhythm Firmware Documentation
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Polyrhythm is an alternate firmware for the Grayscale Algorhythm, a timing sequencer module for the Eurorack format. Polyrhythm effectively provides eight Algorhythm modules in one, with eight simultaneous channels of gate/trigger sequencing, variable pattern and sequence lengths, and probability-based randomization functions.

Each channel can be used independently or operated in series with adjacent channels, providing options for a 1x64 step sequence, 2x32 step sequences, 4x16 step sequences, or 8x8 step sequences. Each segment can repeat up to 8 times, allowing for a maximum of 512 steps (8 repeats x 64 steps) before starting over.

All of the original Algorhythm features remain intact, including pattern length, pattern looping and endpoint programming, randomization, and per-step gate/trigger settings. If you're familiar with the original firmware, you'll easily be able to work with the Polyrhythm firmware. And just like the original, all changes are automatically stored so that you can come back to your patch the next day without losing your work.

See the FIRMWARE UPDATE section at the end of this document for full instructions. Note that you can revert to the original Algorhythm code at any time.

I/O CHANGES

Compared to the original Algorhythm firmware, certain inputs and outputs behave differently with the Polyrhythm firmware installed.

1-8 OUTPUTS

Previously there was only one channel of up to 8 steps, so each step within the sequence had its own output. In the new firmware, each channel has its own output. Outputs can be mirrored when the OR logic feature is active.

MODE INPUT

The "Mode" input, which toggles between sequential and random playback, is now a global input that can potentially control all channels simultaneously. This can be enabled or disabled on a per-channel basis so that when the Mode input receives a pulse, only certain channels will toggle between Seq/Rand modes.

PATTERN OUTPUT

The Pattern output, which was previously the output for just one internal pattern, is now the logical OR of all channels. Use this output for unexpected rhythmic "crosstalk" between channels (especially when some degree of randomization is in effect) or route it through a NOR logic module so that every step *not* triggered on the Algorhythm generates a timing pulse for another sequencer.

LINK IN/OUT

The LINK IN and LINK OUT headers on the back of the module, which could previously be used to connect multiple Algorhythm modules in series, are now non-operational. The features provided in the new firmware make the Link functionality obsolete. Newer modules and DIY kits don't include these headers, but you can always solder them in if you want to use the v1 firmware and link multiple modules together.

GLOBAL MENUS

There are three new top-level menus to control the global parameters that affect all channels. To access these menus, hold the Start/Stop button for about 450ms. Tap any of the white LED switches (excluding Start/Stop) to change to a different menu.

OVERVIEW MENU (Loop/End switch)

Overview always appears when the module is powered on, because it's a good place to see what's happening with each channel before you dive into programming. It's also the default view when you hold Start/Stop to enter the global menu level.

Overview displays what's happening with each of the 8 channels. The 1-8 LEDs flash brightly when an output voltage is high, and glow dimly when an output voltage is low.

You can also mute channels from the Overview by tapping the channel switch. Muted channel LEDs still flash (albeit less brightly) during playback so that you can keep track of what muted channels are doing before unmuting them. Mutes are applied on a per-segment basis, meaning that you can mute any segment within a chain while the other segments continue to play.

MODE RESPONSE MENU (Seq/Rand switch)

Mode Response controls whether or not a channel will respond to a pulse at the Mode input jack, which (if enabled) toggles between linear and random playback. A bright LED indicates that the Mode input will affect that channel. LEDs that are off represent channels that will ignore Mode input pulses.

CHAINING MENU (Gate/Trig switch)

Chaining allows you to combine individual channels into a longer sequence by playing them sequentially instead of simultaneously.

Tap switch 1 for a 1x64 chain, where each of the 8 segments play in series. Tap switch 5 for a 2x32 chain. Tap switches 3 or 7 for a 4x16 chain. Or tap switch 8 for an 8x8 setup, where each channel is independent (chaining is off). Fully bright LEDs indicate the first channel in a chain. Switches 2, 4, and 7 have no function in this menu.

By default, outputs for each chain are combined using a boolean OR function. For example, if channels 1+2 are chained, output jacks 1+2 will send out the same thing (the combined sequence of channels 1+2) no matter which segment is currently playing. This reduces the number of patch cables required if you want to send a chained sequence to a single destination, or if you want to send the same sequence to multiple destinations without using a multiple module or cable splitter. When the OR function is enabled, the LED of the first channel in the chain will be bright, and any subsequent channels in that chain will have a half-bright LED.

If you want to disable the OR function for a chain, double-tap the switch that corresponds to the first step in the chain (this will be switch 1, 5, or 3/7 depending on your chaining setup). This must be done fairly quickly (within 450ms). Now each output will only generate pulses when the corresponding channel is actually playing. When the OR function is disabled, the LED of the first channel in the chain will still be bright, but the LEDs for subsequent channels in that chain will be off. Double-tap again to re-enable the OR function.

Each chain can have its own independent OR setting. The module automatically stores you preferred OR settings for each of the available chaining setups.

Segment chains take the loop length, endpoint, and sequence length parameters of each individual channel into consideration. This means that you can repeat segments up to 8 times before the next segment in the chain starts to play. This also allows you to break out of the 4/4 grid by chaining segments that have different sequence lengths. Combine an 8-step pattern with a 1-step pattern to create a 3/4 time signature, for example (9 total steps in the chained pattern). Or play chains of varying lengths against each other for patterns that go in and out of phase but periodically align (works such as "Violin Phase" by Steve Reich are some of the most well-known example of this technique).

Note that making changes to the chaining setup during playback will reset each chain to the first step of the first segment. A pulse at the Reset input will do the same.

Also note that you might perceive a slight delay when modifying the chaining setup. A timing window of 450ms must close before the firmware can evaluate what type of input occurred: a single tap (for modifying the chaining setup) or a double tap (for modifying the OR behavior).

PATTERN EDITING

The programming paradigm for each of the 8 channels/segments is essentially identical to the Algorhythm v1.x firmware. Refer to the original manual for details.

You can change between channels/segments at any time, from any menu, by holding down one of the 1-8 switches for 450ms.

If you lose track of which pattern you're editing, return to the Overview to see the big picture and then dive back into an individual channel for making further edits.

HOW TO UPDATE THE FIRMWARE

There's little risk of damaging your module while updating the firmware, but please follow the instructions carefully and take precautions against electrostatic discharge whenever the module is outside of your case.

1) You'll need a Microchip PICKit or ICD programming device to update the firmware. The least expensive option is to get a PICKit clone on eBay, Amazon, etc. Make sure that it comes with a ribbon cable for connecting the programmer to the module. The PICKit itself has firmware, this *should* be updated automatically when you connect it to your computer with MPLAB IPE running. Try getting a PICKit 3.5 to have the most up-to-date firmware for the device out of the box.

2) Download the compiled Algorhythm firmware from Github (https://github.com/grayscalemodular/modules/tree/master/Algorhythm). v1.x is the original single-channel firmware. v2.x is the new "Polyrhythm" firmware. Don't right-click to download the code from the main page – click the name of each .hex file, then click the "Raw" button on the subsequent page where the source code is actually displayed. Save that raw data to your computer with a .hex file extension.

3) Download and install the latest version of the free MPLAB X software suite from http://www.microchip.com/mplab/mplab-x-ide (this software runs on Mac, Linux, and Windows). During the installation, only the IPE application is needed, the IDE doesn't need to be installed.

4) Connect the USB cable of the PIC programmer to your computer. The LEDs on the programmer should illuminate (if not, your USB cable might be defective). Don't attach the rainbow programming cable to the PICKit yet as you need to inspect your Algorhythm first to choose the correct orientation.

5) With your modular system powered off, take your Algorhythm out of the case with the power cable still attached. Ensure that no loose patch cables or other items are touching the module PCBs. Now power on your modular system.

6) Look on the lower right corner of the main Algorhythm PCB, just below the LINK IN connector. You'll either see a 5-pin header or 5 vertically-aligned holes on the PCB. The bottom pin (or the hole with the square solder pad) is Pin 1. This pin aligns with Pin 1 on the PICKit, indicated by a small triangle silkscreened onto the front near the programming cable connector: http://grayscale.info/img/pickit.png

7) Now take a close look at your PICKit programming cable. One end will have a male pin header connected directly to the cable. The other end will probably have a female header with a removable 6-pin header inserted into it. Plug the end with the non-removable header into the PICKit. Orientation of the cable itself with respect to Pin 1 on the PICKit doesn't matter. There is no "red stripe down" for this cable, it can be

inserted either way. What's important is that Pin 1 on the PICKit must align with Pin 1 on the Algorhythm.

8) If your Algorhythm has the 5-pin header installed, remove the male header from the programming cable and attach the female connector to the 5-pin header on on the Algorhythm (taking care to align Pin 1 on the PICKit with Pin 1 on the Algorhythm). If your programming cable has six pins, that's no problem, just install the cable with the correct orientation and Pin 6 will not be connected to the Algorhythm. If your Algorhythm doesn't have the 5-pin header (only 5 holes in the PCB), you'll need to pull out one pin from the removable male header with a small pair of pliers. Otherwise, the cable can't be inserted into the PCB.

9) The LEDs on the Algorhythm might blink when the programmer is connected, this is normal. Ensure that all five pins are making good contact with the PCB.

10) Open the MPLAB IPE application. In the dropdown menu for Device, choose "*PIC18F66K22*" (this is the type of microcontroller used in the Algorhythm). The "Tool" dropdown should automatically show your programmer type (i.e. PICKit3). If no device is shown, make sure that your PICKit programmer is connected to the USB port on your computer using a known-good USB cable. When a connection is made, the LEDs on the PICKit (Power, Active, and possibly Status) will illuminate.

11) Now click the "*Connect*" button to sync MPLAB with the Algorhythm. If you try to connect and you see a message that says "*Downloading Firmware*," then the PICKit software is being updated. You may need to click "Connect" a few times before this process is fully completed. Read the MPLAB console output to see what's going on. If you continuously see "*Connection Failed*" and never see a "*Downloading Firmware*" message, your PICKit firmware is not compatible with the version of MPLAB IPE that you installed. You'll need to update the PICKit firmware, which may require access to a Windows PC.

12) If the connection was successful, you'll see a notice that says: "*CAUTION: Check that the device selected is the same one that is physically attached to the debug tool.*" You can click OK and ignore this message, it's just a generic notice.

13) The console in MPLAB should now show "*Target detected*" along with a device ID. If you see a message that says, "*Target device was not found*," check the connection between the programming cable and the Algorhythm to ensure that all five pins are

making contact, with the correct orientation between Pin 1 on the PICKit and Pin 1 on the Algorhythm.

14) In the "*Source*" area of the MPLAB interface, click Browse and select the .hex file that corresponds to the Algorhythm firmware version that you want to install. The console in MPLAB should show: "*Hex file loaded successfully*." If you don't see this message, try downloading the .hex file from Github again, because your previous download may have been corrupted. (See step 1 for instructions on the proper way to download the source code from Github, i.e. don't try to flash the microcontroller with an HTML file).

15) Finally, the moment of truth... click the "*Program*" button to send the new firmware to the module. This only takes a few seconds. If the MPLAB console shows a "*Programming complete*" message, the firmware has been updated. Now disconnect all the cables, turn off your computer, and start patching.

16) To install a different firmware version, to back to step 14 and choose a different .hex file, then reprogram the module. You can freely switch between v1.x and v2.x as needed.