

QUAD LFO AND PHASE EXPANDER



Modulation Source

Manual Revision 1.0



SPECIFICATIONS

Quad LFO

Size	8HP
Depth	32mm
Power Consumption	+12V 51mA -12V 51mA
Frequency Range	5+ minutes to 23Hz
Input Range	0–10V
Input Impedance	40k Ω
Output Swing	-5V–+5V peak
Output Impedance	1k Ω
Output Drive	2k Ω (min), 20k Ω + (ideal)

LFO Phase Expander

Size	6HP
Depth	22mm
Power Consumption	+12V 21mA -12V 21mA
Output Swing	-5V–+5V peak
Output Impedance	1k Ω
Output Drive	2k Ω (min), 20k Ω + (ideal)

INSTALLATION

Before installing the module, make sure the power is off. Attach the power cable to the module and to the bus. Double check the alignment of the red stripe (or the brown wire for a multicolor cable) with the markings on the module and the bus. The red stripe should correspond with -12V, as is standard in Eurorack. Check the documentation of your bus and power solution if you are unsure. Screw the module to the rails of the case using the provided screws. (M2.5 and M3 size screws are provided.)

New Systems Instruments modules all have keyed headers and properly wired cables. But please remember to double check the other side of the cable for proper installation with the bus. Additionally, if using a different power cable, note that not every company wires modular power cables such that the red stripe will align properly with a keyed header. While our modules are reverse polarity protected as much as is practical, it is still possible that you could damage the module, your power supply, or another module by installing the power cable improperly.

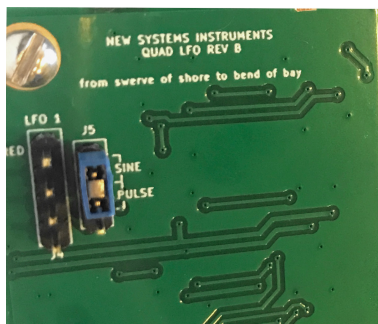
Lastly, please fully screw down the module before powering on your case. The electronics are potentially sensitive to shorts, and if the module is not properly attached to a case, there is a risk of contact with conductive or flammable matter.

INSTALLING THE EXPANDER

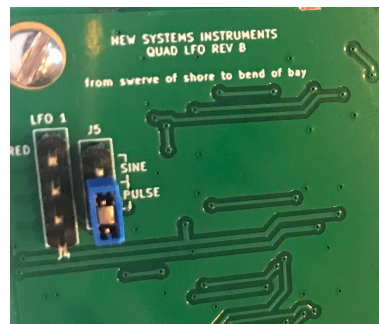


Each LFO Phase Expander comes with a 4 pin connector suitable for connecting it with the Quad LFO. This should be plugged such that the red wire is aligned with the "RED" text on each PCB. The Quad LFO has four connectors, one for each LFO. You can plug an expander into any one or more of them. Note that both the Quad LFO and the Expander must be connected to power.

SELECTING PULSE OR SINE OUTPUT WAVEFORMS



Sine wave output



Pulse wave output

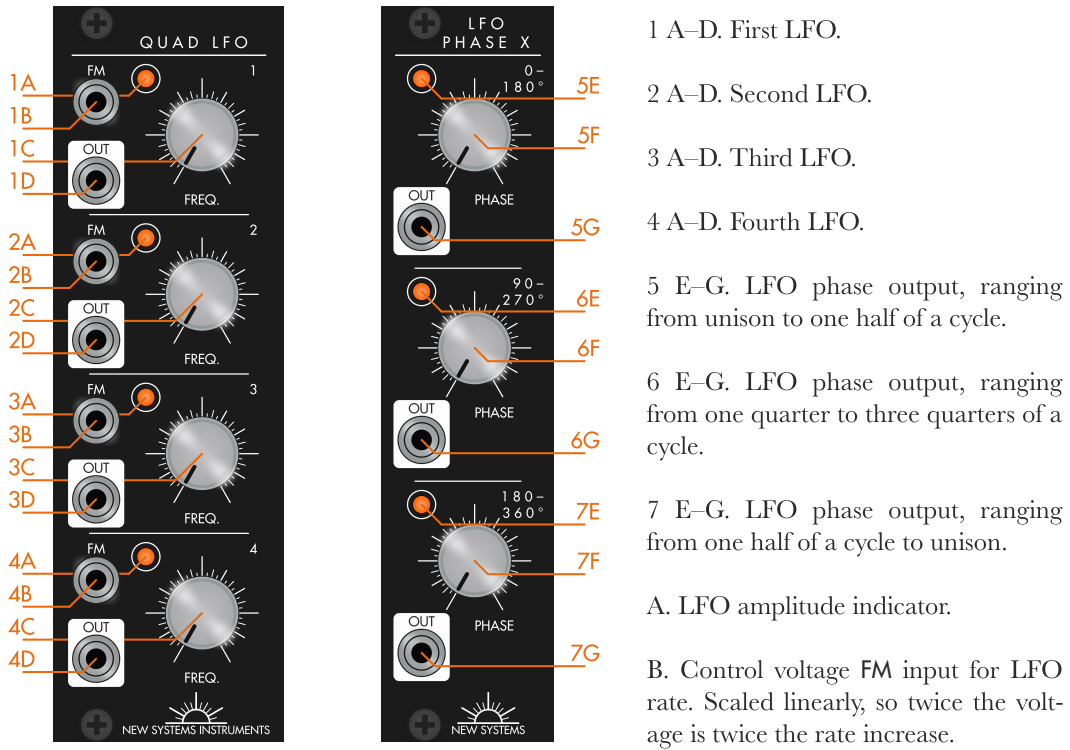
On the reverse of the Quad LFO module there's a jumper to set each output to either sine or pulse (square) waveforms. To switch, gently take hold of the blue jumper and pull it off the header. Then place it in the new position and press it until it is flush with the black plastic of the pin header.

OVERVIEW

The Quad LFO gives you four independent modulation sources, selectable between sine and pulse waves with a jumper on the back. The rate of each LFO is controlled by the combination of a knob and a voltage input.

Each LFO Phase Expander gives you three more sine wave outputs at the same rate as the associated LFO, but with a different phase. That is, each expander gives you three more modulation sources which peak at a different time from the associated LFO.

INTERFACE



1 A–D. First LFO.

2 A–D. Second LFO.

3 A–D. Third LFO.

4 A–D. Fourth LFO.

5 E–G. LFO phase output, ranging from unison to one half of a cycle.

6 E–G. LFO phase output, ranging from one quarter to three quarters of a cycle.

7 E–G. LFO phase output, ranging from one half of a cycle to unison.

A. LFO amplitude indicator.

B. Control voltage FM input for LFO rate. Scaled linearly, so twice the voltage is twice the rate increase.

C. FREQ knob for LFO rate. Ranges from ~0 to 23Hz, with the center ~1Hz.

D. LFO output.

E. Amplitude indicator for this phase output.

F. PHASE control knob.

G. LFO phase output.

QUICK START

Modulation source: The simplest use of an LFO is often the best: apply continually changing modulation to some parameter, such as a pitch input (for vibrato), a filter cutoff, or (with an offset) to a VCA control.

Clock/trigger: To use one of the LFOs as a periodic trigger, a voltage controlled clock, or some other digital signal, use the appropriate jumper to set a pulse wave output.

Rhythmic LFO: With the expander attached, plug all four phase related outputs into an analog logic ANY (maximum), such as Babel. Adjust the phase of each LFO, so that the LFO varies with a particular rhythm.

Clock synced LFOs: When you select a pulse wave output, this does not affect the output of the LFO Phase Expander. This means that a pulse wave output with an attached expander will give you three phases of LFOs synced to a clock signal. Pair this with a clock divider or multiplier to get all kinds of rhythmic options.

Quadrature LFO: When all three knobs of the phase expander are centered, the four related LFO signals will be in quadrature with each other. Quadrature has many uses, such as rotating a signal between four speakers.

MODEL AND PARAMETERS

The Quad LFO provides four sinusoidal outputs with a linear rate control, according to the following equation:

$$y = \sin(\omega t)$$

Or alternately, a pulse wave output according to the following piecewise equation:

$$y = \begin{cases} 5 & \sin(\omega t) \geq 0 \\ -5 & \sin(\omega t) < 0 \end{cases}$$

ω is proportional to FM and FREQ via the following relation:

$$\omega \propto FM + FREQ$$

Where the FREQ knob ranges from zero to 5 volts, $FM + FREQ$ at zero is approximately zero, and $FM + FREQ$ at 5 volts is approximately 23 Hz.

The phase expander produces three more sine wave outputs according to the following equations:

$$y_1 = \sin(\omega t - \phi_1)$$

$$y_2 = \sin(\omega t - \phi_2)$$

$$y_3 = \sin(\omega t - \phi_3)$$

Where $\phi_1 = PHASE_1$ ranges from 0° to 180° , $\phi_2 = PHASE_2$ ranges from 90° to 270° , and $\phi_3 = PHASE_3$ ranges from 180° to 360° .