

TEO-5



COMPACT 5-VOICE POLY SYNTH



Oberheim.



Oberheim®

TEO-5

User's Guide

Version 1.0

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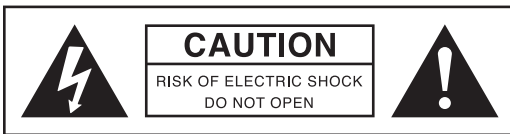
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Special thanks to Robert Rich for the alternative tunings.

TEO-5: A Dream Realized

Thank you for purchasing the Oberheim TEO-5!

Small but powerful, this is the polyphonic synthesizer I have dreamed of making for years – five voices, classic analog warmth, full of great features. The TEO-5 is designed to make the classic Oberheim tone palette widely accessible, encapsulating decades of analog engineering experience in a forward-thinking and innovative musical instrument.

The TEO-5 boasts a five-voice architecture with genuine analog VCOs and VCFs, capturing the distinctive warmth and depth that defined countless hit records. But the TEO-5 isn't just a tribute to the past. Additions like through-zero FM, which adds a contemporary twist to its oscillator X-Mod feature, allow for the exploration of entirely new sonic textures. And the legendary Oberheim SEM filter offers the versatility of morphing between low-pass, notch, and high-pass configurations, along with a switchable band-pass mode for extensive tonal shaping.

Beyond its core synthesis architecture, the TEO-5 features a comprehensive modulation matrix, opening a world of possibilities for sculpting and transforming sounds. Digital effects processors provide classic chorus, delay, reverb, and more, alongside faithful recreations of the revered Oberheim Ring Mod and Phase Shifter effects. A 64-step polyphonic sequencer and multimode arpeggiator further fuel creative exploration, while a premium Fatar keybed ensures a responsive and inspiring playing experience.

We hope the TEO-5 unlocks your creativity in ways you never expected.

A handwritten signature in black ink, appearing to read "Don Oberheim". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

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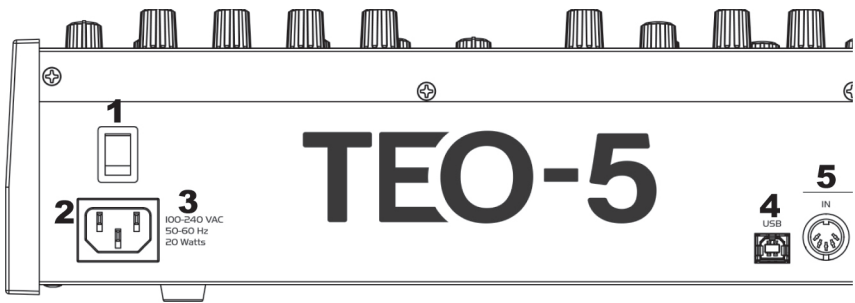
Chapter 1: Getting Started

The TEO-5 is a compact and powerful 5-voice Oberheim poly synth. It combines the warmth and punch of two analog, voltage-controlled oscillators and a 2-pole SEM state variable analog filter with an array of digital effects and extensive modulation capabilities. The result is a classic, warm, organic-sounding subtractive synth with a modern voice.

This chapter of your user’s guide provides an overview of essential tasks such as how to make basic audio connections and how to edit and save sounds. Later chapters explain each of the parameters of the TEO-5, as well as how to program sounds and how to use the GLOBAL menu to manage its overall behavior.

We’ve designed the TEO-5 to be as easy to use as possible. Its essential controls are within easy reach on its front panel, so don’t hesitate to dive in and start turning knobs and pressing buttons. Then, when you’re ready, dig into this user’s guide to explore the deeper parts of the synth.





Rear Panel Connections

The rear panel of the TEO-5 has connectors for power, USB, MIDI, audio, and pedals.

1. Power On/Off—This rocker switch controls power on and off to the TEO-5.

2. AC Power Connector—Accepts a standard, grounded IEC C13-type power cord.

3. Power Requirements—The TEO-5 operates over a range of 100 to 240 volts, 50 or 60 Hz, and consumes 20W.

4. USB—For bidirectional MIDI communication with a computer. The TEO-5 is a Class Compliant USB device and does not require additional drivers when used with Mac OS or Windows. We do not recommend connecting the USB port of your TEO-5 to a powered USB hub.

5. MIDI In, Out, Thru—Standard 5-pin MIDI DIN connectors for communicating with MIDI-equipped devices.

6. Footswitch—Accepts a momentary, normally open, or normally closed footswitch to control sustain or to latch the Arpeggiator on when keys are held. The footswitch can also be used to start/stop the TEO-5's sequencer.

7. Pedal—Accepts a standard expression pedal that has a variable resistor on a TRS (tip-ring-sleeve) ¼ inch phone plug. Once connected, you can use the modulation matrix to route the pedal to control a variety of



things such as volume or filter cutoff frequency to add expressiveness to live performance.

8. Audio Outputs—Unbalanced, TS ¼ inch audio outputs. The TEO-5 sounds great in stereo, but can be switched to mono if needed. See “Global Settings” on page 10.

9. Headphones — ¼ inch stereo headphone jack. Headphone volume is controlled by the **MASTER VOLUME** knob on the front panel.

Setting Up the TEO-5

Here’s how to get your TEO-5 up and running:

1. Plug the power cable into the power connector on the back of the TEO-5.
2. If you have an expression pedal, connect it to the **PEDAL** jack on the back of the TEO-5. You can use it to control volume, filter cutoff, and other aspects of a sound. If you have a sustain pedal, connect it to the **FTSWITCH** jack on the back of the TEO-5.
3. Turn on the TEO-5.
4. Connect the **LEFT** and **RIGHT AUDIO OUT** connectors on the back of the TEO-5 to your amp/mixer/powered speakers using unbalanced, ¼ inch audio cables.
5. Turn up the volume on your amp/mixer/powered speakers.
6. Turn up the Master Volume on the TEO-5.

Tune the Oscillators and Filters

The first time you use the TEO-5, run its built-in oscillator and filter calibration procedure. Repeat the calibration procedure if needed over the next few days. The TEO-5 learns the range of temperatures and will keep itself in tune over this range.

To calibrate the oscillators and filters:

1. Press the GLOBAL settings button.
2. With the SELECT knob, choose the CAL VOICES command.
3. Press the WRITE button.
4. The TEO-5 performs its auto-calibration procedure.
5. When finished, the front panel controls return to normal and you can play the TEO-5.

Listen to the Factory Sounds

The TEO-5 contains 512 programs. These are divided into two sets of 256 programs — a Factory set and a User set.

- When the FACTORY button is lit, the 256 permanent Factory programs are active. These cannot be overwritten.
- When the FACTORY button is not lit, the 256 User programs are active. you can freely edit and resave these. As shipped from the factory, the Factory and User presets are identical.

Most factory programs have a sequence associated with them. A quick and easy way to audition programs is to press the Sequencer's PLAY button to hear its associated sequence.



The Factory, Bank, Program Select, and Manual buttons

To choose a program:

1. Hold down the BANK button then press a PROGRAM SELECTOR (1-8) button to specify the “hundreds” bank of the program.
2. Release the BANK button and press a PROGRAM SELECTOR button (1-16) to select one of the 16 presets in the chosen bank.

To choose program 512, for example:

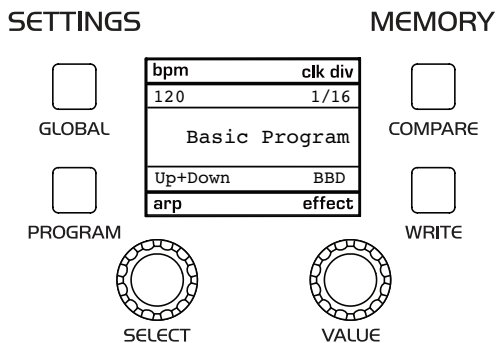
1. Hold BANK and press 5. Release the BANK button.
2. Press PROGRAM SELECTOR button 12.

Using the Main Display

The most frequently used controls on the TEO-5 are on its front panel. But there are additional Global and Program-specific settings accessible from its main display.

For example, pressing the PROGRAM settings button gives you access to several program-related parameters such as pitch bend wheel range, unison detuning, envelope delay time, and more. You can select and edit these additional parameters using SELECT and VALUE knobs located below the display.

The SELECT knob is for scrolling through the list of available parameters and commands. The VALUE knob is for setting values.



The main display

Editing Programs

All of the sound-shaping controls of the TEO-5 appear on its front panel. To edit an existing program, just turn a knob and listen to its effect. Keep turning knobs and pressing buttons and if you like what you've created, save the program (see "Saving a Program" on page 6).

Creating a Program from Scratch

The TEO-5 makes it easy to create a new sound from scratch by providing a "basic program" that you can quickly recall at any time. This provides a simple starting point that you can quickly build on. It consists of a single oscillator (sawtooth), basic filter settings, basic envelope settings, and simple mod and pitch wheel setups.

To recall the Basic Program:

1. Press the GLOBAL settings button.
2. With the SELECT knob, choose the BASIC PROGRAM command.
3. Press the WRITE button.
4. The TEO-5 resets its parameters to the Basic Program.

Alternatively, hold down the TRANSPOSE DOWN button then press the LOW SPLIT -2 button.

Saving a Program

To save a program, you must save it to the User bank. If you edit a Factory program, saving the patch will store it in the User bank.

To save a User program to the same preset location:

1. Press the WRITE button. The LED begins blinking.
2. Press the WRITE button a second time. The LED stops blinking and the program is saved to its current location.

To save a program to a different location:

1. Press the **WRITE** button. Its LED begins blinking.
2. Hold down the **BANK** button then press a **PROGRAM SELECTOR** button to specify the “hundreds” bank of the program.
3. Release the **BANK** button and press a **PROGRAM SELECTOR** button (1-16)
4. Press the **WRITE** button again. The LED stops blinking and the program is saved.

Canceling Save

To cancel the Save process:

- If the **WRITE** button LED is flashing, press the **PROGRAM** settings button. The LED stops flashing and saving is canceled. You can return to editing if you want.

Live Panel Mode

The TEO-5 also features a “live panel” mode in which its sound switches to the current settings of its knobs and switches. In other words, the current preset is ignored and what you see on the front panel is what you hear. This is a great mode for learning, experimentation, and instant gratification.

To enter live panel mode:

- Press the **MANUAL** button to toggle it on. Changing Banks or Programs with Manual on won't affect the sound.

To return to preset mode:

- Press the **MANUAL** button again to toggle it off.

Using Low Split

The TEO-5 has a useful feature called **LOW SPLIT** that allows you to make wider use of its 44-note keyboard by dividing the keyboard into two separate key ranges. You can set the split point to your preference. This can also be saved as part of a program.

In essence it enables you to transpose the lower half of the keyboard either 1 or 2 octaves lower than normal.

By default the split point is set to middle C in the Basic Program, but you can set it to a different point according to your preference. This makes it possible to play lower-register bass parts with your left hand while playing chords or lead parts with your right hand. The program is the same for both key ranges.

To use Low Split:

1. Chose an appropriate sound.
2. Press the -1 OCT button to activate the Low Split point feature and transpose the pitch of notes below middle C down by 1 octave.
3. Alternatively, press the -2 OCT button to activate the Low Split point feature and transpose the pitch of notes below middle C down by 2 octaves.

To set a custom Low Split point:

1. Chose an appropriate sound.
2. Press and hold both the **LOW SPLIT -1 OCT** button and **-2 OCT** button. The Low Split parameters appear in the display.
3. Either press the desired key/split point on the TEO-5 keyboard, or use the **VALUE** knob to set the split point to your preference.
4. Release the **-1 OCT** button and **-2 OCT** buttons.

bpm	clk div
120	LOW SPLIT 1/16
Note G1	
Up+Down	BBD
arp	effect

Setting the Low Split point

Exploring the TEO-5 in More Depth

Before you explore the sound creation possibilities of the TEO-5, we'd like to point you toward a few things that will help you tailor it to your needs. The better you know it, the more you'll get out of it.

First, read “Global Settings” on page 10. There are many useful settings and functions found in the Global menu that will affect the overall behavior of your TEO-5, including tuning, MIDI connections, calibration, and more. In particular, read about Pot Modes and determine which works best for you when you're editing sounds.

Also, in “Rear Panel Connections” on page 1 read about the various connectors on the back of your TEO-5 and how you can use its various pedal, audio, MIDI, and USB inputs and outputs.

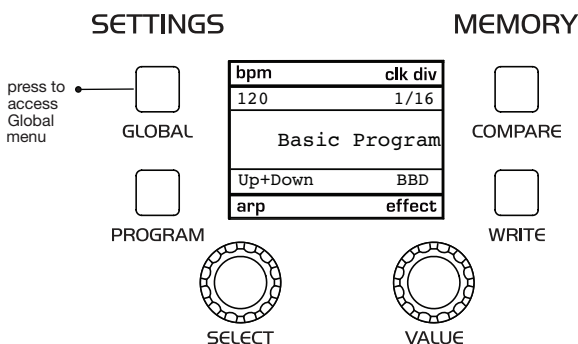
Finally, be on the lookout for tips and notes scattered throughout this manual to gain a better working knowledge of the TEO-5. We wish you many happy hours of sound exploration!

Chapter 2: TEO-5 Controls

This chapter explains all of the front-panel controls of the TEO-5, section by section and the role each plays in synthesizing sounds. If you're just getting started with synthesis, take a look at *Chapter 3, Creating Sounds*, for step-by-step tutorials on how to program some classic sounds such as synth bass, brass, strings, and more.

Global Settings

Global settings are parameters that affect all programs. These include settings such as MIDI Channel, Velocity and Aftertouch curves, and others. Press the GLOBAL button to access them.



Accessing Global settings

To set a Global parameter:

1. Press the GLOBAL button.
2. Use the SELECT knob to scroll through the list of parameters.
3. Use the VALUE knob to set a selected parameter.

Here are descriptions of all of the GLOBAL menu parameters:

1. Master Coarse: -12...+12—Master Transpose control; a setting of 0 is the equivalent of concert pitch. This control steps in semitones one octave up (+12) or down (-12).

2. Master Fine: -50...+50—Master Fine Tune control; 0 centered. Steps in cents as much as a quarter-tone up (+50) or down (-50).

3. Local Control: All Off, Key/Wheels Off, On—When ON (the default), the keyboard and front panel controls directly affect the TEO-5. When OFF, the controls are transmitted via MIDI but do not directly affect the “local” synth (that is, the TEO-5). This is primarily useful for avoiding MIDI data loops that can occur with some external sequencers. When KEY/WHEELS OFF is selected, the front controls are enabled (so that you can edit them) but the keyboard and Pitch/Mod wheels are off.

4. Mono/Stereo: Mono, Stereo—The TEO-5 defaults to stereo operation. When set to Mono, this parameter defeats all pan settings and modulation, effectively making each of the outputs a mono output.

5. Pot Mode: Relative, Passthru, Jump—The rotary controls on the TEO-5’s front panel are a mixture of “endless” rotary encoders and potentiometers or “pots.” The pots are identifiable by their lined knobs and limited amount of travel. There are three pot modes to determine how the synth reacts when the programmable parameters are edited. (Master volume is not programmable, so these modes don’t apply.)

When set to RELATIVE, changes are relative to the stored setting. In Relative mode, the full value range is not available until either the minimum or maximum value and the respective lower or upper limit of the pot’s travel is reached.

For example, the Resonance parameter has a value range of 0 to 254. Let’s say the physical position of the Resonance pot is 12 o’clock. If you switch to a program that has a different Resonance setting and turn the pot all the way up, it may not go to its maximum value. To get to the maximum value, you first have to turn down until the value is at the other extreme and the pot is at the limit of its travel (in this case, 0 and fully counter-clockwise, respectively).

In PASSTHRU mode, turning the pot has no effect until after the edited value equals the preset value (that is, until the edited value “passes through” the stored value).

JUMP mode uses an absolute value based upon the position of the pot when edited: turn a pot and the value jumps immediately from the stored value to the edited value.

6. Foot Function: Sustain, Arp Hold, Arp Hold Momentary, Seq Start/Stop—Sets the function for the Sustain pedal input at the rear of the synthesizer. Selecting `SUSTAIN` chooses normal sustain pedal operation. Selecting `ARP HOLD` and pressing the sustain pedal causes the Arpeggiator to hold the current arpeggio as if you had pressed the hold button on the front panel. Selecting `HOLD MOM` (momentary) causes the Arpeggiator to sustain (even when you release the notes on the keyboard) for as long as you hold down the pedal. Releasing the Sustain pedal stops the Arpeggiator. Selecting `SEQ START/STOP` allows you to start and stop the on-board sequencer using a connected footswitch.

7. Pedal Polarity: Normal, Reversed—There are two types of pedals, normally open and normally closed. Either type can be used with the Sustain switch input. This setting allows you to accommodate both models in case yours behaves in a way that is the opposite of what you expect due to its polarity. Connect your pedal and choose the appropriate setting based on its behavior.

8. Pedal Function: Breath CC2, Foot CC4, Exp CC11, LPF Full, LPF Half—When you use an expression pedal connected to the `PEDAL` jack to control filter cutoff, this sets the range of modulation sent. With `LPF FULL` selected, an expression pedal connected to the `FILTER` jack will control filter cutoff frequency within its full range of 0-1024 (fully closed to fully open). With `LPF HALF` selected, an expression pedal connected to the `FILTER` jack will control filter cutoff frequency within half of its range (fully closed to half open).

9. Aftertouch On: On, Off—Selects whether aftertouch (key pressure) is enabled or disabled. If disabled, the TEO-5 will neither respond to nor transmit aftertouch/key pressure data.

10. Aftertouch Curve: Curve 1... Curve 8—Sets one of eight pressure curves for the keyboard to adjust the aftertouch to your playing style.

11. Velocity Curve: Curve 1... Curve 7—Sets one of the seven velocity curves for the keyboard to adjust the velocity response to your playing style.

12. Scale (Alt Tuning): Equal Temperment, 1...65—Selects one of the TEO-5's 65 built-in tunings. Set to 1. EQUAL TEMPERMENT, the tuning is standard, chromatic tuning. Choosing 2 through 65 selects an alternative, non-chromatic, non-Western scale that can be used to emulate various instruments or in other creative ways. See "Appendix F: Alternative Tunings" on page 78 for a description of each tuning. Additional tunings can be imported as a SysEx message.

Each preset in the TEO-5 can have its own scale setting, separate from the Global selection. To use this feature, scroll to the end of the Program menu for any preset and select any scale other than "Global".

13. Screen Saver: On, Off—The TEO-5 display has a built-in screen saver that puts it to sleep when not in use. This feature is designed to prolong the life of the display and we recommend using it. If, however, you want to disable this feature you can do so by setting it to OFF.

14. MIDI Channel: All, 1...16—Selects which MIDI channel to send and receive data, 1 to 16. Choosing ALL receives on all 16 channels and sends on channel 1.

15. Clock Mode Out: Off, Out, Out No S/S, In, In Thru, In No S/S—Sets the synthesizer's ability to send and receive MIDI clock messages:

When set OFF: MIDI Clock is neither sent nor received

When set to OUT: MIDI Clock is sent, but not received.

When set to OUT NO S/S (no start and stop): Sends MIDI Clock but does not send MIDI Start or Stop commands.

When set to IN: MIDI Clock is received, but not sent.

When set to IN THRU: MIDI Clock is received and passed to MIDI Out.

When set to IN NO S/S (no start and stop): Receives MIDI Clock but does not respond to MIDI Start or Stop command.

***With IN and IN THRU modes, if no MIDI clock is present at the selected input, the Arpeggiator and Sequencer will not function.**

***MIDI clock received over USB is not passed to MIDI DIN out.**

16. Clock Cable In: MIDI, USB—Sets the port (MIDI or USB) by which MIDI clock is received.

17. Clock Cable Out: MIDI, USB, ALL—Sets the port by which MIDI clock is sent.

18. MIDI Param Send: Off, CC, NRPN—Changes to the values of front panel controls are transmitted via MIDI as Non-registered Parameter Number (NRPN) controllers or as Continuous Controllers (CC). Transmission of parameters can also be turned off.

NRPNs are the preferred method of parameter transmission, since they cover the complete range of all parameters, while CCs are limited to a range of 128.

19. MIDI Param Receive: Off, CC, NRPN—Sets the method by which parameter changes are received via MIDI. As with transmission, NRPNs are the preferred method.

20. MIDI Control On: Off, On—When On, the synth will respond to MIDI controllers, including Pitch Wheel, Mod Wheel, Pedal, Breath, Volume, and Expression.

21. MIDI Sysex On: Off, On—Sets whether MIDI System Exclusive data will be received or ignored.

22. MIDI Sysex Cable: MIDI, USB—Sets the port, MIDI or USB, by which System Exclusive data will be transmitted and received.

23. MIDI Out Select: Off, MIDI, USB, All—Sets the port(s) by which MIDI data will be transmitted.

24. MIDI Program Send: Off, On—When On, the synth will transmit MIDI Program Change and other SysEx messages to the MIDI Out.

25. MIDI Program Receive: Off, On—When On, the synth will respond to received MIDI Program Change and other SysEx messages.

26. MIDI Arp Notes: Off, On—When On, the synth's Arpeggiator outputs MIDI note numbers. You can use this feature to drive other MIDI-equipped devices such as synthesizers and drum machines.

27. Arp Beat Sync: Off, Quantize—When set to `QUANTIZE`, Arpeggiator note playback occurs only on the beat (relative to the current clock divide setting) regardless of when you press a key on the keyboard.

28. Basic Program—Press `WRITE` to load a basic, template program into the edit buffer. Press the `WRITE` button again to save it to memory. You can also hold `-2 OCT TRANSPOSE` and hit `-2 OCT LOW SPLIT`.

29. Cal Wheels—Calibrates the Pitch and Mod wheels.

30. Cal Voices—Calibrates the voltage controlled oscillators and filters. With a new TEO-5, you will need to use this feature a few times to establish stable tuning across the full range of the synth's operating temperatures. Since the TEO-5 is factory calibrated, you will usually calibrate to accommodate new environments, while under stage lighting, etc.

31. Reset Globals—Sets the global parameters to the factory default settings.

32. Dump Preset—Transmits the current program in SysEx format via the selected MIDI port. Dumped programs will load back into the same location in memory when imported back into the synth via MIDI.

33. Dump Bank—Transmits the current bank in SysEx format via the selected MIDI port. (See “MIDI SysEx Cable: on page 14.) Dumped banks will load back into the same location in memory when imported back into the synth via MIDI.

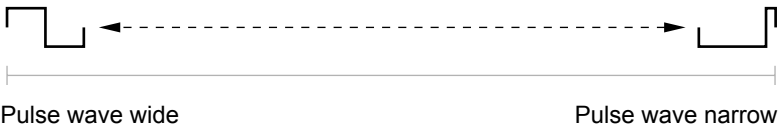
34. Dump All Banks—Transmits all User Banks in SysEx format via the selected MIDI port. (See “MIDI SysEx Cable: on page 14.) Dumped banks will load back into the same location in memory when imported back into the synth via MIDI.

Oscillators

Oscillators generate the raw building blocks of the TEO-5's sound by producing *waveforms*, each of which has its own sound character based on its harmonic content. The TEO-5 has two analog, voltage-controlled oscillators and a sub-oscillator.

Oscillators 1 and 2 generate triangle, sawtooth, and pulse waves. You can select any one or more of these waveshapes by using the *SHAPE* buttons. This allows for a variety of different effective waveshapes and timbres.

The pulse width of the pulse wave shapes can be adjusted using the *PULSE WIDTH* control. Adjusting the *PULSE WIDTH* knob changes the pulse width of Oscillator 1 and 2 simultaneously.

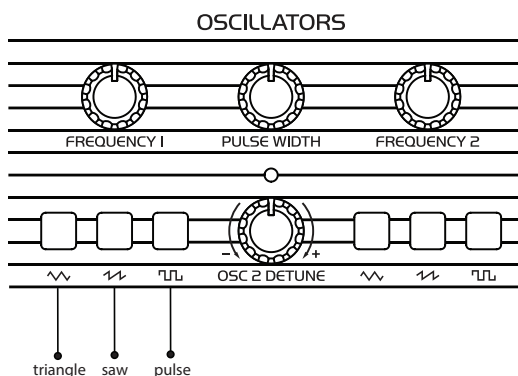


Oscillator pulse width (pulse wave)

Press and hold the *PULSE* waveshape button of either oscillator 1 or 2, then turn the *PULSE WIDTH* or *VALUE* knob to individually adjust each oscillator's pulse width.

Note that the *PULSE WIDTH* control is always in a relative mode. That means that if the two oscillator pulse waves have different settings, adjusting the *PULSE WIDTH* pot will keep their relative offset preserved, even after going full minimum/maximum.

bpm		clk div
120	OSC 1 PW	1/16
30		
Up+Down		BBD
arp		effect



The Oscillators section

To listen to the oscillators:

1. Press the GLOBAL button.
2. Use the SELECT knob to navigate to the BASIC PROGRAM command, then press the WRITE button to set the synth to the Basic Program.
3. In the basic program, only Oscillator 1 is audible - note that the OSC 1 button in the Filter mixer section is lit. (Oscillator 2, the Sub Oscillator, and Noise are turned off in the Filter mixer section by default.)
4. Hold down a note on the keyboard and in the OSCILLATORS section, press the TRIANGLE, SAW, and PULSE buttons to hear the different wave shapes (sawtooth is selected by default in the basic program.) Note that you can activate more than one waveshape at a time. Note also that with the pulse wave selected, it's possible to use the PULSE WIDTH control to make the pulse width so narrow that the sound seems to disappear.
5. Turn on Oscillator 2 in the Filter mixer and experiment with setting each oscillator to a different waveshape. Experiment with the FREQUENCY knobs and notice how slightly detuning the oscillators in relation to each other creates movement and thickness in their combined sound. Try tuning one oscillator to an interval such as a third, a fifth, or a sixth.
6. Experiment with the OSC 2 DETUNE knob and notice the detuning range of osc 2 go from a touch of thickness to rich chorusing almost a quarter tone higher or lower.

7. Rotate the filter's CUTOFF, RESONANCE, and STATE knobs to see how this affects the sound of the oscillators.
8. With Oscillator 1 and 2 selected in the Filter section, press the SYNC button on Oscillator 2. Now rotate Osc 1's FREQUENCY knob while you hold a note. This is the classic *hard sync* sound that you've probably heard before. Instead of rotating the FREQUENCY knob by hand, you can use the modulation matrix to route an envelope to Oscillator 1 to sweep its pitch and create this effect each time you play a note. You'll learn more about the mod matrix in "Modulation" on page 34.

Oscillator Parameters

Frequency: Sets the base frequency of an oscillator over a 5-octave + minor third range. The global MASTER COARSE and MASTER FINE settings affect the pitch of the oscillators, as well. See "Global Settings" on page 10 for more information.

Osc 2 Detune: Fine tune control of Oscillator 2, with a range of +/- 49.2 cents up or down. The 12 o'clock position is detented. The LED above the pot will light when any amount of detune is applied.

Shape: These buttons toggle on and off the waveshapes generated by the oscillator. Oscillators 1 and 2 produce triangle, sawtooth, and pulse analog waveshapes. All waveshapes can be simultaneously selected.

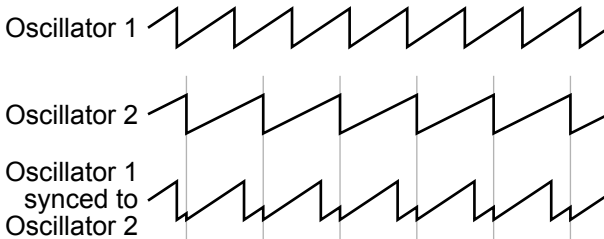
In the modulation matrix you can use a modulator such as an LFO waveshape or Envelope 1 to modulate the pulsewidth of Oscillator 1 or 2 or both simultaneously. To learn more about about how to use modulation, see "Modulation" on page 34.

Osc Mod Parameters

X-Mod: Sets the amount of through zero frequency modulation from Oscillator 2's triangle waveshape to Oscillator 1's frequency. X-Mod in the TEO-5, unlike digital FM techniques, uses modulation between analog oscillators, so some pitch instability may be present at certain settings.

Sync 2-1: Off, On—Turns on oscillator hard sync. When this is enabled, Osc 2's wave cycle forces Oscillator 1's waveform to reset to its zero phase on each cycle of Oscillator 2. This causes the synced oscillator to

create harmonically complex waveforms — particularly when the synced oscillator’s pitch is set higher than the master oscillator’s pitch. See “Creating a Hard-Sync Lead” on page 65 to learn how to set up this type of sound.



Oscillator hard sync

Additional Oscillator Parameters (Program Menu)

Additional oscillator parameters are accessible by pressing the front-panel PROGRAM button and scrolling through the list that appears.

Osc 1 Key On: Off, On—When on, oscillator 1 tracks the keyboard or note data received via MIDI. When off, the oscillator plays at its base frequency setting, though its pitch may be affected by modulation from other sources.

Osc 2 Key On: Off, On—When on, oscillator 2 tracks the keyboard or note data received via MIDI. When off, the oscillator plays at its base frequency setting, though its pitch may be affected by modulation from other sources.

Osc 1 Detune: Fine tune control with a range of +/- 49.2 cents up or down.

Osc 2 Detune: Fine tune control with a range of +/- 49.2 cents up or down.

Osc 1 PW: Sets pulse width of the Oscillator 1 pulse wave from %50-%100 duty cycle, with %50 at minimum pot setting. At %100 the pulse width narrows to silence.

Osc 2 PW: Sets pulse width of the Oscillator 2 pulse wave.

Osc 1 Glide: 0...127—Sets oscillator 1 glide (*portamento*) amount. Glide causes the pitch of a note to glide smoothly up or down from the pitch of the previously played note. It can be set independently for each oscillator. Low values are shorter/faster. The GLIDE switch must be on to hear the effect of GLIDE RATE. For a detailed explanation, see “Portamento” on page 50.

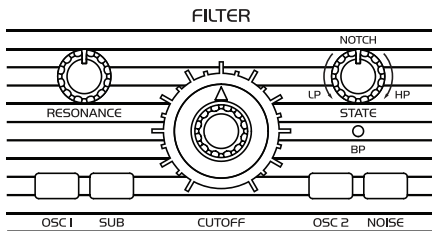
Osc 2 Glide: 0...127—Sets oscillator 2 glide (*portamento*) amount.

Osc 2 Filter Bypass: Off, On. Turning this on causes Oscillator 2 to be directly routed to the VCA, bypassing the filter. This can be used to generate unusual textures, especially when using X-Mod. Sending a low-pitched triangle wave directly to the VCA can also add body to sounds that employ the band or high pass filter.

Filter

The function of the TEO-5’s 12dB/2-pole state variable filter is to subtract frequencies from the sound produced by the oscillators and noise generator, thereby changing the overall harmonic content of the synth’s sound. This change is varied over time using the Filter Envelope and other modulators to produce more dynamic timbres.

The Filter section also includes the mixer section, where you can toggle on and off the TEO-5’s various sound generators. These include oscillators 1 and 2, the sub oscillator, and the noise generator. You must enable at least one of these sources in order to make sound with the TEO-5. Note that the TEO-5’s filter does not self-oscillate.



The Filter section

To hear the effect of the filter:

1. Recall the Basic Program by pressing the GLOBAL button and using the SELECT knob to navigate to the BASIC PROGRAM command, then press WRITE.
2. Hold down a note and rotate the filter's CUTOFF knob. By default, it's set to the low pass state. Notice how it cuts the high frequencies as you rotate counter-clockwise, making the sound of the oscillator less bright. If you turn the CUTOFF knob fully counterclockwise you'll filter out all frequencies and hear nothing.
3. Return the CUTOFF knob to its halfway position, hold down a note again then turn the RESONANCE knob about halfway up.
4. Rotate the filter's CUTOFF knob again and listen to the sound change as a band of frequencies near the cutoff is amplified. This is how to create a classic resonant filter sweep.
5. Now try rotating the STATE knob, and listen to the timbral change as the filter state shifts from low pass to notch to high pass and back.

In the previous example, you controlled the filter cutoff by hand. In most cases, you will use the Filter Envelope to do this. To learn more about the Filter Envelope, see “About the Filter Envelope” on page 25.

Filter Parameters

Cutoff: Sets the filter's cutoff frequency, or the point at which the filter begins removing harmonic content from the audio signal.

Resonance: Emphasizes a narrow band of frequencies around the cutoff frequency.

State: Smoothly mixes between low pass, notch, and high pass filter states. If the band pass state is set active in the Program menu, it replaces notch at the center position of the STATE knob. When band pass is selected, the BP LED on the front panel will light to indicate its selection.

Osc 1: Toggles Oscillator 1's output to the input of the filter.

Sub: Toggles the sub oscillator's output, which is generated from Osc 1.

Osc 2: Toggles Osc 2's output.

Noise: Toggles the white/pink noise generator.

Although the sound source buttons set the source level at maximum volume (127) by default when toggled on, you can still set the individual volume level for each source. Like in the Oscillators section, press and hold the toggle button for the sound source you want to adjust, then use the VALUE knob to adjust the volume. The selected level is shown on the main display.

bpm		clk div
120	OSC 1 LEVEL	1/16
127		
Up+Down		BBD
arp	effect	

Additional Filter Parameters (Program Menu)

Additional Filter parameters are accessible by pressing the front-panel PROGRAM button and scrolling through the list that appears. The parameter explained below does not appear on the front panel.

Filter Key Amt: 0...127—Sets the amount of modulation from the keyboard to the filter's cutoff frequency. Any setting above zero means that the higher the note played on the keyboard, the more the filter opens. This is useful for adding brightness to a sound as higher notes are played, which is typically how acoustic instruments behave. When set to zero, keyboard filter tracking is off, meaning that filter frequency is unaffected by playing higher or lower notes on the keyboard.

Filter Bandpass: Off, On—Enables band pass mode for the state variable filter. When On, Band Pass replaces Notch at the mid-point of the STATE control.

Envelopes

The TEO-5 has two 5-stage DADSR envelope generators (**d**elay, **a**ttack, **d**ecay, **s**ustain, **r**elease), using the voltage curves from the historic Oberheim OB-8 (these are also found as an option on the Oberheim OB-X8). They are useful for creating modulation that varies over time according to the shape of the envelope. Routing an envelope to Filter Cutoff, for example, causes the filter to open or close according to the contour of the envelope. Routing an envelope to Amplifier causes the volume to change according to the contour of the envelope.

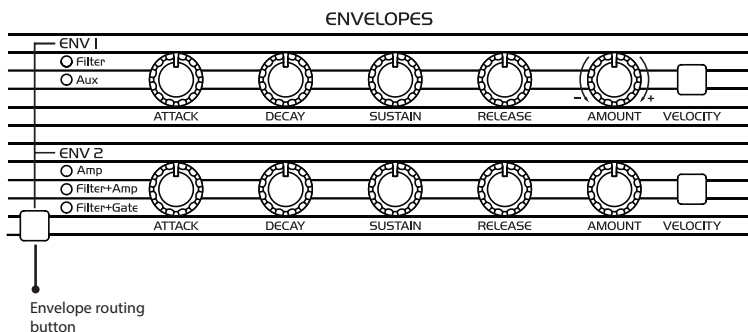
Similarly, using one of the envelopes as an auxiliary envelope and routing it to a different destination in the mod matrix allows you to apply modulation that changes according to the contour of the envelope.

There are many creative ways to use the Envelopes:

- Use the mod matrix to route Envelope 1 or 2 to one of the oscillators' **FREQUENCY** parameter to create the classic “pitch blip” effect used in many synth lead sounds.
- Use the mod matrix to route Envelope 1 or 2 to one or both of the oscillators' **PULSE WIDTH** parameter to make their timbre evolve according to envelope's contour.
- Use the mod matrix to route Envelope 1 or 2 with a fast attack and short decay to **NOISE (level)** to add a percussive attack to a sound. (Noise level should be set to zero in the Mixer.)

Using the Env Routing Button to Assign the Envelopes

The envelope routing button provides a way to assign the envelopes to specific destinations. Pressing the ENV ROUTING button toggles through the various options. Note that the options are fixed - that is, envelopes are not freely assignable, but instead toggle through the fixed routing schemes.



Env 1 Destinations:

- FILTER - Envelope 1 controls Filter Cutoff frequency
- AUX - Envelope 1 functions as an auxiliary envelope that can be used to modulate a destination selected through the Mod Matrix. The Aux setting is available when Env 2 is set to FILTER + AMP OR FILTER + GATE.

Env 2 Destinations:

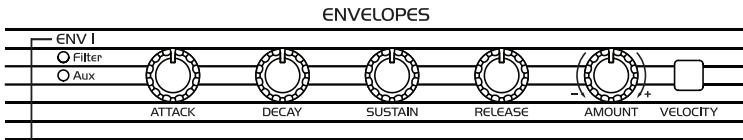
- AMP - Envelope 2 controls the Amplifier (loudness)
- FILTER + AMP - Envelope 2 controls both Filter Cutoff frequency and the Amplifier (loudness). Note that if the Env 2 VELOCITY button is on, it affects only Filter Cutoff and not Amplifier volume.
- FILTER + GATE - Envelope 2 controls Filter Cutoff frequency while Amplifier volume is simply triggered (gated) on/off each time you press a key on the TEO-5 keyboard. Note that if the Env 2 VELOCITY button is on, it affects only Filter Cutoff and not Amplifier volume.

About the Filter Envelope

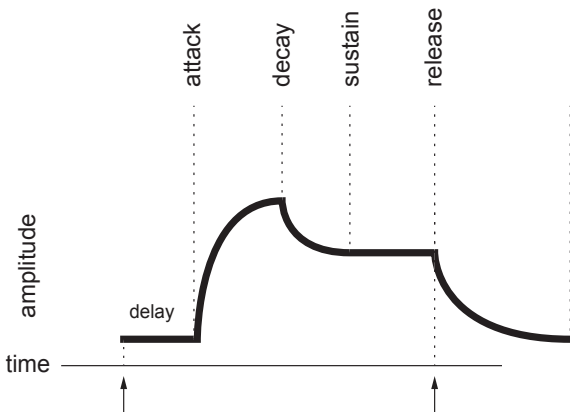
Routing Envelope 1 or 2 to the Filter shapes the harmonic characteristics of a synthesized sound by giving you filtering control with each of the envelope stages (delay, attack, decay, sustain, release).

A filter envelope is one of the most important aspects of a synthesized sound. Without an envelope, the filter would be static and unchanging. It would stay open or closed by a fixed amount that wouldn't change over the duration of a sound. That's not very expressive or interesting to listen to — and it's not how most real-world instruments behave.

In general, sounds produced by an acoustic instrument are brighter at their beginning (the attack stage) and grow mellower as they die out (the decay and release stages). In other words, their harmonic content changes over time. This is exactly what the filter envelope is designed to emulate.



Envelope 1 parameters



A typical 5-stage DADSR envelope

To hear the effect of the Filter Envelope:

1. Recall the Basic Program by holding the **TRANSPOSE DOWN** button then pressing the **LOW SPLIT -2** button.
1. Hold down a note and rotate the filter's **CUTOFF** knob to set it to an 8 o'clock position.
2. Play a note. At this point you may not hear anything because you've closed the filter significantly.
3. In the Envelopes section, turn the **AMOUNT** knob of Env 1 (which is routed to the Filter by default) to a 3 o'clock position.
4. Play a note. Notice how the sound has changed. The Filter Envelope is controlling filter cutoff by the amount you set with the **AMOUNT** knob.
5. Repeatedly strike a note on the keyboard as you turn the Filter Envelope's **DECAY** knob clockwise and counterclockwise. Notice how it changes the sound as the note decays faster or slower after its initial attack stage.
6. Now experiment with the Filter Envelope's **ATTACK** knob. Notice how the attack becomes faster or slower.
7. Now hold down a note and experiment with the Filter Envelope's **SUSTAIN** knob. This controls how wide the filter stays open while you hold down a key on the keyboard.
8. The Filter Envelope's **RELEASE** parameter acts in conjunction with the Amplifier Envelope (Envelope 2 by default), so to hear its effect, first set the Amp Envelope's **RELEASE** value to a 1 o'clock position.
9. Now repeatedly strike a note on the keyboard as you turn the Filter Envelope's **RELEASE** knob clockwise and counterclockwise. Notice how the note fades out faster or slower as you change the **RELEASE** value.
10. Continue experimenting with various Filter Envelope settings while you adjust Envelope 1's **AMOUNT** knob. Notice how greater **AMOUNT** settings amplify the effect of the envelope on the filter.

As noted above, the Filter Envelope and Amplifier Envelope often work in conjunction, with the Filter Envelope controlling how the filter opens and closes and the Amplifier Envelope controlling how the Amplifier controls the overall volume shape of the sounds you create. Note that in **FILTER + AMP** routing mode, Envelope 2 controls the filter and the amp simultaneously. To learn more about the Amplifier Envelope, see “About the Amp Envelope” on page 28.

Envelope Parameters

The following parameters refer to both the Filter and Amp envelopes of the TEO-5.

Attack: Sets the attack time of the envelope. The higher the setting, the slower the attack time and the longer it takes for the filter to open from the level set with the filter CUTOFF knob to the level set by the filter envelope amount, or for the amp volume to rise to the level set by Voice Volume in the Program menu. Percussive sounds typically have sharp (short) attacks.

Decay: Sets the decay time of the envelope. After a sound reaches the filter frequency set at its attack stage, DECAY controls how quickly the filter then transitions to the cutoff frequency set with the SUSTAIN knob. The principle is the same for amp volume. The higher the setting, the longer the decay. Percussive sounds, such as synth bass, typically have shorter decays.

Sustain: Sets the filter cutoff frequency or the amp level for the sustained portion of the sound. The sound will stay at this level for as long as a note is held on the keyboard.

Release: Sets the release time of the envelope. This controls how quickly the filter closes or the volume drops to zero after a note is released.

Velocity Off/On: Off, On—Allows key velocity to influence filter cutoff frequency and amp volume. If ON, the harder you play, the more the filter will open and the brighter the sound will be, or the higher the amp volume will be. If OFF, key velocity will not affect the filter or amp. This control allows for more touch-sensitive sounds.

Amount: Sets the amount of modulation from the filter envelope to the filter's cutoff frequency. Any setting above zero means that each time you strike a key, the envelope controls how its assigned parameter rises and falls. Higher amounts more dramatically affect the cutoff or amp amount. Note that this control is bipolar. Positive settings produce standard behavior. Negative settings invert the envelope.

Additional Envelope Parameters (Program Menu)

Additional Envelope parameters are accessible by pressing the front-panel PROGRAM button and scrolling through the list that appears. The parameters below do not appear on the front panel.

Env 1 Delay: 0...127—Sets a delay between the time the envelope is triggered (note on) and when the attack portion begins.

Env 2 Delay: 0...127—Sets a delay between the time the envelope is triggered (note on) and when the attack portion begins.

Env Repeat: Off, ENV1, ENV2, ENV1 + ENV2—When on, the Delay, Attack, and Decay segments of the selected envelopes repeat indefinitely.

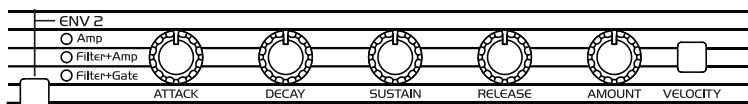
Sustain still affects the level at which the Decay segment ends, but instead of sustaining at a fixed level while a key is held down, Delay, Attack, and Decay loop until the key is released. (The Release segment begins when the key is released, just as it does when Repeat is off.)

About the Amp Envelope

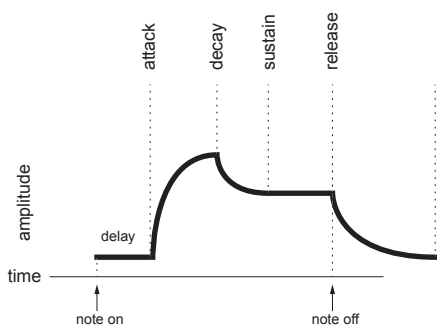
After passing through the filters, a synthesized sound goes into an amplifier, which controls its overall volume. The Amp envelope is used to shape the volume characteristics of a sound over time by giving you control over these stages. Along with the Filter envelope, this is one of the most important aspects of a synthesized sound.

Without a volume envelope, the volume of a sound wouldn't change over the duration of a note. It would begin immediately, remain at its full volume for its duration of the note, then end immediately when the note was released. Again, that's not very interesting sonically and it's not typically how instruments behave in the real world.

To give you a real-world example, the main difference between the sound of the wind and the sound of a snare drum is that they have very different volume envelopes. Otherwise, they are essentially both white noise. Wind has a relatively slow attack, a long sustain, and a long decay and release. A snare drum has a sharp attack, no sustain, and very little decay or release. But again, they are both fundamentally white noise.



Envelope 2 parameters



A typical 5-stage, DADSR envelope

The Amplifier Envelope controls the overall volume shape of the sounds you create.

To hear the effect of the Amplifier Envelope:

1. Recall the Basic Program by pressing the GLOBAL button and using the SELECT knob to navigate to the BASIC PROGRAM command, then press WRITE.
2. Repeatedly strike a note on the keyboard as you turn the Amplifier Envelope's ATTACK knob clockwise. Notice how the attack becomes slower and more gradual the further you turn the knob.
3. Reset the ATTACK parameter to zero (fully counter-clockwise).
4. Next, repeatedly strike a note on the keyboard as you turn the Amplifier Envelope's SUSTAIN to zero. Notice how it changes the sound so that the sound no longer sustains even if you hold down the key. The only sound you hear is the decay portion of the sound.
5. Now, with SUSTAIN still set to zero, repeatedly strike a note on the keyboard as you turn the Amplifier Envelope's DECAY knob clockwise and counterclockwise. Notice how it changes the sound as the note decays faster or slower after its initial attack stage.
6. Set the DECAY parameter to 3 o'clock.

7. Finally, with `DECAY` set to 3 o'clock and `SUSTAIN` still set to zero, repeatedly strike a note on the keyboard as you turn the Amplifier Envelope's `RELEASE` knob clockwise. Notice how the release becomes longer the further you turn the knob.
8. Continue experimenting with various Amp Envelope settings while you also adjust the Filter Envelope to hear how these two controls interact.

Auxiliary Envelope

Envelope 1 can be designated as an Auxiliary envelope using the front-panel `ENVELOPE ROUTING` button. By doing so, you can set its shape as you wish and use the modulation matrix to route it to a specific parameter destination to create modulation that varies over time according to the shape of the envelope. Routing an envelope to an oscillator's frequency, for example, causes the oscillator's pitch to rise and fall according to the contour of the envelope.

Either of the TEO-5's envelopes can be routed to any destination (or multiple destinations) using the modulation matrix. See "Modulation" on page 34 for more details.

There are many ways to make creative use of the Auxiliary Envelopes:

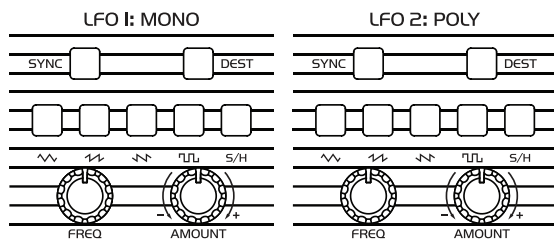
- Route an envelope to one of the oscillators' `OSC 1 FREQUENCY` parameter to create the classic "pitch blip" effect used in many synth lead sounds.
- Route an envelope to the filter's `CUTOFF` parameter (in addition to the standard Filter Envelope) to create a more complex filter envelope shape.
- Route an envelope to one or more of the oscillators' `PULSE WIDTH` parameter to make their timbre evolve according to envelope's contour.
- Route an envelope with a fast attack and short decay to `NOISE LEVEL` to add a percussive attack to a sound. (The `NOISE` button should be set `ON` in the Filter mixer, but with noise level at 0.)

Low Frequency Oscillators

LFOs are special-purpose oscillators that produce a frequency that is typically below the range of human hearing (although these can actually extend into the audio range if set to their maximum frequency). The LFOs are used for periodic modulation such as vibrato (periodic pitch modulation) and tremolo (periodic amplitude modulation). They can also be used as modulation sources for any of the many modulatable parameters in the TEO-5.

The LFOs produce a variety of waveshapes, including triangle, sawtooth, reverse sawtooth, square, and S&H (sample & hold/random). Though most often used for low-frequency modulation, the TEO-5 LFOs can actually function at speeds that extend into the audible range for extreme effects.

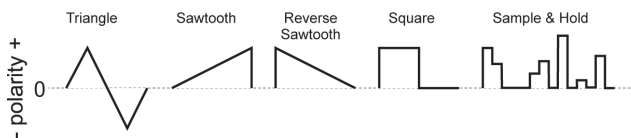
The LFOs can be free-running or synced to the Arpeggiator, Sequencer, or MIDI clock for tempo-synced effects such as filter sweeps, tremolo, and so on.



The Low Frequency Oscillators

The triangle wave is bipolar. That is, its waveshape is positive for half of its cycle and negative for the other half. This makes it possible to generate a vibrato that goes alternately sharp and flat in equal amounts on either side of a center frequency.

The square, sawtooth, reverse sawtooth, and sample & hold waves generate only positive values. In the case of the square wave, this makes it possible to generate trills.



LFO waveshapes

Global LFO Versus Per-Voice LFO

The TEO-5 has two separate LFOs. LFO 1 is “global” and LFO 2 is “per voice.” It’s useful to understand the difference.

Global LFO (LFO 1)

LFO 1 is a Global LFO and is a single modulator that is applied to all voices in a program equally — with no variation from voice to voice. A simple example of this is using LFO 1 to modulate Osc 1 Freq. Doing so will change the pitch of all notes you play in exactly the same way and with the same timing. In other words, if you play a chord, and strike each note within the chord at slightly different times, the notes will shift their pitch synchronously with each other with no variation from note to note/voice to voice. Compare this to the example given below for LFO 2, which is per voice.

Per-Voice LFO (LFO 2)

LFO 2 is a per-voice modulator that is applied to each voice individually, and can vary from voice to voice. A simple example of this is using LFO 2 to modulate Osc 1 Freq. Doing so will change the pitch of all notes that you play, but the modulation will be applied separately to each note. In other words, if you play a chord, and strike each note within the chord at slightly different times, each note will be modulated individually beginning from the time it is struck, making the cycle of the pitch shift different from note to note/voice to voice. It’s a subtle but noticeable difference.

LFO Parameters

Frequency: Sets the frequency of the selected LFO from a slow .022Hz to a fast 500Hz. This is affected by the CLK SYNC (clock sync) parameter as explained below.

Amount: Sets the amount of LFO modulation routed to the selected destination. Setting an amount here applies the selected modulation continuously. You can also use the modulation matrix to route an LFO to additional destinations and use a different modulation amount if you want.

Shape: Triangle, Sawtooth, Reverse Sawtooth, Square, S&H—This button sets the waveshape of the selected LFO.

Clock Sync: When on, the LFO synchronizes with the master clock, which controls the Arpeggiator, Sequencer, and certain effects such as the various delays.

Hold an LFO's SYNC button to display the current clock sync division on the main display.

Destination: Various—Routes the selected LFO to one of the many modulation destinations within the synthesizer. These appear in the display. You can also use the modulation matrix to route an LFO to additional destinations.

There are many ways to make creative use of the LFOs:

- Route an LFO to the OSC 1 and/or OSC 2 DETUNE parameter to create vibrato (TRIANGLE wave) or random pitches (S&H).
- Route an LFO's triangle wave to the filter's CUTOFF parameter and use a medium FREQ and AMOUNT setting to create a wah-wah effect, or use a slow FREQ setting and low AMOUNT setting to create subtle harmonic movement.
- Route an LFO's square wave to the amplifier's AMOUNT parameter and use a medium FREQ and AMOUNT setting to create a tremolo effect.
- Route an LFO to an oscillator's SHAPE parameter to make its timbre evolve.
- Route the LFO's triangle wave to the TIME parameter of the stereo delay and use a slow FREQ and low AMOUNT setting to create a chorus effect.

Any LFO can be routed to any destination (or multiple destinations) using the modulation matrix. See “Appendix B: Modulation Destinations” on page 68 for a list of destinations.

Additional LFO Parameters (Program Menu)

Additional LFO parameters are accessible by pressing the front-panel PROGRAM button and scrolling through the list that appears. The parameters explained below do not appear on the front panel.

LFO 1 Slew: 0-127—Adjusts amount of slew for LFO 1. Adding slew to an LFO smooths out LFO waveshapes by altering the speed at which voltage levels change. Adding slew can change a square wave LFO to a triangle or sine shape, for example.

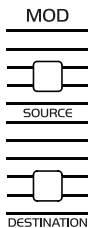
LFO 2 Slew: 0-127—Adjusts amount of slew for LFO 2.

LFO 1 Note Reset: Off, On—When off, the LFO is free running. When on, the LFO is re-started each time a new note is played. However, if the first note is held and more notes are played, the LFO does not reset on the newly played notes. LFO reset is useful if you want to ensure that the LFO waveshape is set to its zero phase each time you strike a key.

LFO 2 Note Reset: Off, On—Sets LFO 2 Note Reset on.

Modulation

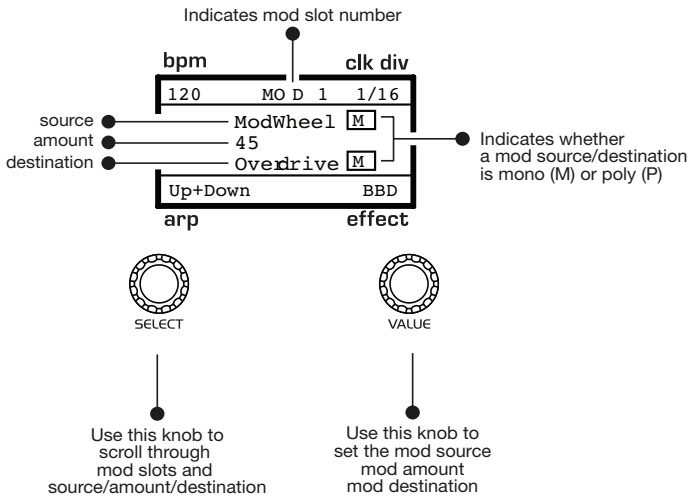
Although the overall sonic character of the TEO-5 is determined by its oscillators and filters, much of its power to make unique sounds comes from creative use of modulation. Modulation is the process of routing one parameter (used as a control voltage) to another parameter in order to change the way the targeted parameter behaves.



The Mod section Source and Destination controls

The idea is simple:

1. Choose a source.
2. Choose a destination.
3. Set an amount. The amount can usually be either positive or negative.



You already understand and apply the concept of modulation whenever you use the filter envelope to control the filter's cutoff frequency. In this case, the modulation *source* is the filter envelope (or more precisely, any of its controls, such as attack, decay, sustain, or release). The modulation *destination* is the filter's CUTOFF frequency. The modulation *amount* is set with the Filter Envelope's AMOUNT knob.

There are 19 different modulation sources and 65 different destinations to choose from. This gives you a large number of sound-shaping options.

There is a useful shortcut for routing modulation to various front panel sources/destinations. Simply hold down the SOURCE button and move the control you want to use as a source (the Mod wheel, for example). Then hold down the DESTINATION button and move the control that you want to use as a destination (filter cutoff, for example). Set the amount with the VALUE knob while referring to the display. Be aware that not all front-panel controls can be used as a modulation source/destination.

Mono and Poly Modulation Sources/Destinations

There are two types of mod sources and destinations: mono and poly. In general, you don't need to think too much about which to use when assigning modulation, but it's useful to understand the difference.

- A mono modulation source, such as LFO 1: Global, is a single modulator that is applied to all voices in a program equally — with no variation from voice to voice. Other mono mod sources include the Pitch Bend wheel or Mod wheel, which can be used to control oscillator frequency (pitch) or other aspects of a sound depending on how you assign it in the Mod Matrix (in the display).
- A poly modulation source, such as Key Velocity, is a modulator that is applied to each voice individually, and can vary in its amount from voice to voice. A simple example of this is using key velocity to control filter cutoff frequency per voice or the volume of individual voices (Amp). Other poly mod sources include LFO 2, Envelope 1, Envelope 2, Note Number, and others. These can all be used to control things such as the pitch of individual oscillators/voices, oscillator wave shape per voice, and many other things.
- A mono source applied to a poly destination will act monophonically, and vice versa.

Modulation Examples

Here are several modulation scenarios that illustrate how to use the modulation matrix. The examples provide step-by-step instructions for clarity. Some of these setups are built into the basic program, which you can recall from the GLOBAL menu.

To use the Mod wheel to add vibrato:

1. In the LFO section, set LFO 1 to TRIANGLE and set FREQUENCY to a medium value. Set DESTINATION to OSC ALL DETUNE. Set AMOUNT to 0. (You will control the amount with the Mod wheel.)
2. In the MODULATION section, press the SOURCE button. Use the SELECT knob to scroll to Mod Slot 1 if it's not already displayed.
3. Use the VALUE knob to scroll through the various mod sources and choose MOD WHEEL (As a shortcut for steps 2 and 3, you can hold down the SRC ASSIGN button and move the Mod wheel.)

4. Use the `VALUE` knob to set the amount to 30.
5. Use the `VALUE` knob to scroll through the various mod destinations and choose `LFO 1 AMT`. (As a shortcut you can hold down the `DEST ASSIGN` button and move the `LFO 1 AMOUNT` knob.)
6. Hold down a note on the keyboard and turn the Mod wheel. You should hear vibrato.

You can also use Pressure as the modulation source instead of the Mod Wheel in the previous example to add vibrato with key pressure/after-touch.

To use the Mod Wheel to control the filter cutoff:

1. In the `MODULATION` section, press the `SOURCE` button. Use the `SELECT` knob to scroll to Mod Slot 1 if it's not already displayed.
2. Use the `VALUE` knob to scroll through the various mod sources and choose `MOD WHEEL`.
3. Use the `VALUE` knob to scroll through the various mod destinations and choose `CUTOFF`.
4. Hold down a note on the keyboard (or press the `HOLD` button and play a note on the keyboard) and move the Mod Wheel up and down.
5. Use the `VALUE` knob to set the amount to your preference. Higher `AMOUNT` settings cause the filter to open wider the farther up you move the Mod Wheel. A negative amount setting will close the filter the farther up you move the Mod Wheel.

Again, you can use Pressure as the modulation source instead of the Mod Wheel in the previous example to open the filter (positive `AMOUNT`) or close the filter (negative `AMOUNT`) with key pressure (aftertouch).

Other modulation ideas:

- To create the classic “attack pitch blip” effect in many synth brass sounds, choose a good two-oscillator synth brass sound. Press the ENVELOPE ROUTE BUTTON to set ENV 1 to AUX and ENV 2 to FILTER + AMP. In the Mod Matrix route ENV 1 to OSC 2 DETUNE. Set ENV 1 to Attack: 0, Decay: 9 o’Clock, Sustain: 0, and Release: 0 with an amount of 30.
- Route an LFO to PAN to create an auto-panning effect. Panning width is controlled by the modulation amount. Panning speed is controlled by the LFO frequency. Add a second mod path to control the LFO speed with the Mod wheel for a controllable rotating speaker spin-up/spin-down effect. Add the rotating speaker effect as Effect 1 and set up a third mod path to control FX1 MIX with the Mod wheel for even better results.
- Route VELOCITY to OVERDRIVE to distort a synth lead sound the harder you play.

Unison

When UNISON is on, the TEO-5 acts like a monophonic synthesizer in that only 1 note can be played at a time. However, that one note can be powered by as many as five voices, depending on how many you choose to use.

To use Unison:

1. Press and hold the UNISON button.
2. With the UNISON button held down, use the VALUE knob to choose the number of voices to stack, then release the Unison switch.

bpm		clk div
120	UNISON	1/16
4 Voices		
Up+Down		BBD
arp		effect

Setting the number of Unison voices

To detune the oscillators in Unison:

1. Press PROGRAM settings button.
2. With the SELECT knob, choose the UNISON DETUNE command
3. Use the VALUE knob to set the amount of detuning. A setting of 0 is minimum detuning. A setting of 7 is maximum detuning.

bpm		clk div
120	PROGRAM	1/16
11. Unison Detune		
3		
Up+Down		BBD
arp		effect

Detuning Unison voices

Using Chord Memory

Unison has a useful feature called chord memory. Instead of assigning voices to a single note, hold down a chord on the keyboard and press the UNISON switch. The TEO-5 memorizes the notes of the chord. Single notes played on the keyboard then trigger all notes of the stored chord, transposing them as you play up or down the keyboard. Try using this feature to create powerful chord stabs.

To use chord memory:

1. Hold down a chord on the keyboard (5 notes maximum).
2. Press the UNISON switch. The chord voicing is memorized. Play a few notes to listen to the result.
3. If you save the program, the unison chord memory is saved with it.

To clear chord memory:

1. Turn off Unison.
2. Hold down a single note.
3. Press the UNISON button

Additional Unison Parameters (Program Menu)

Additional Unison parameters are accessible by pressing the front-panel PROGRAM button and scrolling through the list that appears.

Unison Key Mode: Low, High, Last—Determines which note has priority when more than one note is played simultaneously in Unison mode. Low, selects low-note priority. High selects high-note priority. Last selects last-note priority.

Unison Env Retrigger: Off, On—Determines whether the envelopes are retriggered if a note is held while additional notes are played.

Effects

You can add up to two digital effects per program. The first effect can be one of several classic device emulations, including various delays, chorus, flanging, ring modulation, and others. The second effect is a dedicated reverb with variable decay, pre-delay, size, and tone. Effects are saved with programs.

Effect Types

- Delay - classic stereo digital delay
- BBD - vintage bucket-brigade delay emulation
- Tape Delay 1 - vintage tape delay emulation
- Tape Delay 2 - vintage tape delay emulation with more tape saturation
- Chorus - vintage stereo chorus
- Flanger - vintage through-zero flanger
- Phaser - vintage 6-stage phaser
- HP Filter - high-pass filter
- Distortion - classic op amp distortion
- Ring Mod - modelled on the 1972 Maestro/ Oberheim ring modulator
- Rotating Speaker - vintage rotating speaker emulation
- Lo-Fi - emulates the transformative effects of a badly-calibrated tape machine
- Dedicated Reverb (Effect 2) - plate reverb with variable time, tone, and early reflections.

EFFECT	TIME KNOB	DEPTH/MIX KNOB	FBACK/MISC KNOB
Stereo Delay	Time	Mix	Feedback
BBD	Time	Mix	Feedback
Tape Delay 1	Time	Mix	Feedback
Tape Delay 2	Time	Mix	Feedback
Chorus	Rate	Depth	LPF Cutoff
Flanger	Rate	Depth	Feedback
Phaser	Rate	Depth	Feedback
High-pass Filter	Frequency	Mix	Resonance
Distortion	Gain	Output Level	Tone
Ring Modulation	Pitch/Carrier Freq	Mix	Pitch Track On/Off
Rotating Speaker	Speed	Drive	Mic Distance
Lo-Fi	Frequency	Wow & Flutter Amt	Drive

To add an Effect:

1. Press the EFFECT ON/OFF button to turn it on.
2. Turn the TYPE knob to select an effect. The effect name is shown in the lower right of the main display. Names are abbreviated. For instance “bbd” is the bucket-brigade delay. Refer to the previous list.
3. Turn the DEPTH/MIX knob clockwise to blend in the processed signal.
4. Use the TIME and FEEDBACK/MISC knobs to adjust effect parameters. Refer to the chart to see which parameters each of these knobs control

To add Reverb:

1. Press the REVERB ON/OFF button to turn it on.
2. Turn the MIX knob clockwise to blend in the processed signal.
3. Use the DECAY knob to adjust the length of the reverb tail.
4. Use the PRE-DELAY knob to adjust the pre-delay.
5. Use the TONE knob to shape the frequency content of the reverb. The TONE parameter uses both high-pass and low-pass filtering to sculpt the reverb’s sound.
6. Use the SIZE knob to adjust the size of the virtual hall.

Vintage Knob

Because the TEO-5 has analog VCOs and filters, it is capable of producing many classic, vintage poly synth sounds, even though it was designed and constructed with state-of-the-art technology and components. To add even more vintage character, we designed the VINTAGE knob, which introduces parameter variations from voice to voice. This type of behavior was a big part of why vintage synths sounded so warm, organic, and alive. Turning up the VINTAGE knob adds progressively more filter, pitch, and envelope variation between voices. Try it out!



The Vintage knob

To use the Vintage knob:

- Turn the VINTAGE knob clockwise to add progressively more variation from voice to voice.

Overdrive

The TEO-5 has an Overdrive effect that is separate from the digital effects available in the Effect and Reverb sections. A little Overdrive is great for adding harmonic complexity and an aggressive edge to sounds. The character of the Overdrive is affected by the harmonic content of a program. Sounds with more high-end will sound different than sounds with fewer harmonics.



The Overdrive knob

To add Overdrive:

- Turn the OVERDRIVE knob clockwise to add progressively more of this effect.

Arpeggiator

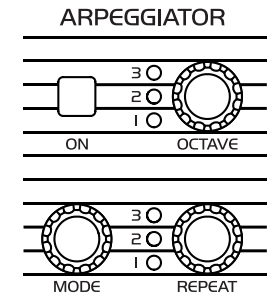
The Arpeggiator allows you to hold a chord and the synthesizer will play a pattern based on the individual notes held. You can adjust the playback mode (up, down, up+down, random, assign), the octave range (1, 2, 3), the number of repeats per note (1, 2, 3), and the tempo. The Arpeggiator usually works best on sounds with a fast attack.

While you hold down a key, pressing any additional notes will add those notes to the arpeggio. You can change chords and notes and the arpeggio will latch and change along with them.

You can also use the HOLD feature with the Arpeggiator. When you enable HOLD, you can release the notes on the keyboard and the arpeggio will continue to play. A new arpeggio will be started each time you change notes.

To allow the Arpeggiator to add new notes to an arpeggio when keys are continuously held, and to continue to play those notes (and any new notes) when HOLD is used, turn ARP RELATCH OFF in the Program menu. To do this, press the PROGRAM button and use the SELECT knob to scroll to the ARP RELATCH parameter. Use the VALUE knob to set it to OFF.

Set the tempo of the Arpeggiator with the TAP TEMPO or BPM and DIVIDE controls. To use TAP TEMPO, tap this button 4 times to set the tempo. You can also sync the Arpeggiator to external MIDI clock.



The Arpeggiator

To use the Arpeggiator:

1. Press the ARPEGGIATOR ON/OFF button to turn it on.
2. Hold down one or more notes on the keyboard. The Arpeggiator plays them according to the settings you've chosen.
3. To latch arpeggiation on (so that you don't have to continuously hold down notes) press the HOLD button.
4. On the front panel, adjust settings such as MODE, OCTAVE RANGE, REPEATS, and BPM.
5. To synchronize a delay effect to the Arpeggiator, enable Effect 1, choose a delay, then turn on SYNC in the delay's parameter page in the display. Adjust the delay's TIME parameter as desired.

Arpeggiator “Momentary Sustain” Mode

The TEO-5 allows you to use the sustain pedal to turn the Arpeggiator's Hold function on and off and perform other Arpeggiator-related functions. To access this feature, use the FOOT FUNCTION setting in the GLOBAL menu.

There are three modes to choose from:

- SUSTAIN - With the Arp running in this mode, pressing and holding the Sustain pedal sustains the notes, as the Sustain pedal normally would.
- ARP HOLD - With the Arpeggiator running in this mode, pressing the Sustain pedal once causes the Arpeggiator to hold the sequence (even when you release the notes on the keyboard). Pressing it again stops the Arpeggiator.
- ARP HOLD MOM - With the Arpeggiator running in this mode, pressing and holding the Sustain pedal causes the Arpeggiator to sustain (even when you release the notes on the keyboard) for as long as you hold down the pedal. Releasing the Sustain pedal stops the Arpeggiator.

To select the Arpeggiator's sustain pedal mode:

1. Press the GLOBAL button then use the SELECT knob to scroll to FOOT FUNCTION.
2. Use the VALUE knob to select SUSTAIN, ARP HOLD, or ARP HOLD MOM, depending on your preference. Press the GLOBAL button again to exit the Global menu.

MIDI Note Output from the Arpeggiator

The Arpeggiator outputs MIDI note messages. Any notes that you hold on the keyboard will be arpeggiated according to the current settings of the Arpeggiator and output over MIDI as MIDI notes. You can use this feature to drive other MIDI-equipped devices such as synthesizers and drum machines. To access this feature, use the MIDI ARP NOTES setting in the GLOBAL menu.

To enable MIDI Note output from the Arpeggiator:

1. Press the GLOBAL button, then use the SELECT knob to locate the MIDI ARP NOTES parameter.
2. Use the VALUE knob to select ON.

To control an external MIDI device:

1. Connect the MIDI or USB output of the TEO-5 to the MIDI or USB input of the external device, depending on which type of connection the external device requires.
2. On the TEO-5, press the GLOBAL button, then use the SELECT knob to locate the MIDI CABLE OUT parameter.
3. Use the VALUE knob to select MIDI, USB, or ALL, depending on how your TEO-5 and external device are connected.
4. Press the GLOBAL button again to exit the Global menu.
5. On the external device, set the the MIDI Channel and MIDI Receive port to match the TEO-5.
6. Hold down a chord on the TEO-5 or start Sequencer playback. The external device should be triggered by the arpeggiated or sequenced notes.

Arpeggiator Parameters

Arpeggiator On/Off: This button turns the Arpeggiator on and off.

Arp Mode: Sets the order in which notes play when the Arpeggiator is on. The setting appears in the lower left of the display. See the table below.

Arp Mode	Behavior
Up	Plays from lowest to highest note
Down	Plays from highest to lowest note
Up + Down	Plays from lowest to highest and back to lowest
Random	Plays notes in random order
Assign	Plays notes in the order the keys were pressed

Octave: 1, 2, 3—Set to 1, only the held notes are arpeggiated. Set to 2, the held notes and the notes one octave above them arpeggiate. Set to 3, the held notes and the notes one and two octaves above them arpeggiate.

Repeat: 1, 2, 3 —Set to off, each note in the arpeggio plays once. Set to 1, each note in the arpeggio plays twice. Set to 2, each note in the arpeggio plays three times. Set to 3, each note in the arpeggio plays four times.

Arp Relatch (in the Program Menu): Off, On—Works in conjunction with HOLD. When HOLD and the Arpeggiator are on, and ARP RELATCH is off, played notes are held on and arpeggiated, with additional played notes added to the held notes and the arpeggio. When ARP RELATCH is on, played notes are held on and arpeggiated, but additional played notes will restart the arpeggio with the new notes. If you release all keys and play new notes, the arpeggio restarts using the new notes.

Clock Parameters

BPM: 30...250—Sets the tempo for the Arpeggiator in BPM (beats per minute). The TAP TEMPO LED flashes at the BPM rate. When SYNC is enabled on the low-frequency oscillator, or enabled in the Effects section, the BPM rate affects the LFO frequency and/or delay effect. When syncing to an external MIDI clock source, the BPM setting has no effect.

Clock Divide—Selects a basic note value relative to the BPM. See table:

Name	Tempo	Timing Division
1/2	BPM/2	Half note
1/4	BPM	Quarter note
1/8	BPM x 2	Eighth note
1/8 T	BPM x 3	Eighth note triplets
1/16	BPM x 4	Sixteenth note
1/16 T	BPM x 6	Sixteenth note triplets
1/32	BPM x 8	Thirty-second note
64th	BPM x 16	Sixty-fourth note

Tap Tempo—Pressing the TAP TEMPO button 4 times sets the tempo. The LED flashes at the BPM rate you set.

Step Sequencer

The step sequencer allows you to record a series of notes and chords of up to 64 steps in length. You can record up to a 5-note chord on each step. It records note and velocity data, but not timing. You can add ties and rests while recording notes. Once you have recorded a sequence, you can play it back and adjust its playback speed with the BPM control. You can also play along with a sequence (if there are voices available), and transpose its playback.

Adding a rest will place one or more gaps in between notes (you can add multiple consecutive rests, if you like), extending the space between notes. Adding ties will extend the previously entered note or tie, effectively lengthening a note.

To program a note sequence:

1. Press the RECORD button.
2. Play the notes of your sequence on the keyboard. The display indicates the current step as you play.
3. To add a rest as you play, press the PROGRAM settings button for that step, then continue playing. To add multiple rests, press the PROGRAM settings button multiple times.
4. To add a “tie” that extends the length of a note or existing tie, play a

note, then press the **WRITE** button repeatedly to extend the note for the number of steps you want for that note.

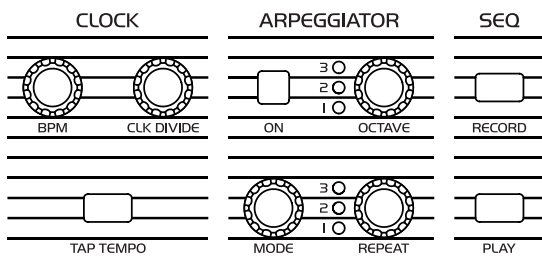
5. When you're done, press **PLAY** to listen to your sequence. Use the **BPM**, **VALUE**, or **TAP TEMPO** controls to adjust sequencer playback speed
6. To save the sequence, save the program and they are saved together.

When recording a chord as a step, as long as you continue to hold at least one note down, you can keep adding notes to the chord/step, and even use the **TRANPOSE** buttons to extend the keyboard range while doing it.

If you want to play live along with the sequencer, be sure to leave voices available. In other words, don't play 5-note chords for every step in the sequence!

To transpose a sequence:

1. Press **PLAY**. The sequence begins playback.
2. Press and hold **RECORD** and press a key on the keyboard. "Middle C" is the reference point. Playing a note above middle C transposes the sequence higher by that interval. Playing a note below middle C transposes the sequence lower by that interval.
3. When **UNISON** is active, the sequence can be transposed by simply pressing a key.



The Clock, Arpeggiator, and Sequencer controls

Master Volume/Program Volume

The master output level of the TEO-5 is controlled by the front-panel VOLUME knob. In addition, the volume of an individual program can be set with the PROG VOLUME parameter in the PROGRAM menu. This is useful for ensuring that your sounds have roughly the same volume program to program.

bpm		clk div
120	PROGRAM	1/16
15. ProgVolume 127		
Up+Down		BBD
arp		effect

Setting Program Volume in the PROGRAM menu

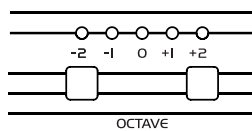
To set the volume of an individual program:

1. Choose a program.
2. Press the PROGRAM button to the lower left of the display.
3. Use the SELECT knob to locate the PROG VOLUME parameter.
4. Use the VALUE knob to set the volume level.
5. Press the WRITE button twice to save the program.

Note that MIDI volume can also influence the overall volume of the TEO-5 if you are controlling it from an external MIDI source using CC7.

Transpose

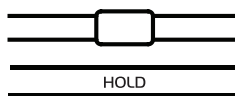
The UP and DOWN buttons in the TRANSPOSE section transpose the keyboard up or down in octaves. The LED indicates the current keyboard transposition state. Transposing the keyboard also changes the MIDI note numbers of the keys so that MIDI notes sent are also transposed. Transpose settings are global and are not saved with individual programs. Note that press one of the Transpose button won't affect any keys currently held down. It only affects keys/notes played after you have transposed the keyboard. Transpose can be saved per patch.



The Transpose controls

Hold

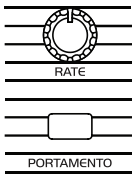
When HOLD is on, any notes played will continue to play until HOLD is turned off. When used in conjunction with the Arpeggiator, notes are latched on.



The Hold button

Portamento

Portamento, also known as glide, causes the pitch of a note to slide up or down from the pitch of the previously played note. Portamento is turned on and off using the PORTAMENTO switch, but the RATE must also be set. If the PORTAMENTO button is on, but RATE is set to 0, portamento/glide has no effect. Portamento can be set individually for each oscillator.



The PORTAMENTO button and RATE control

To use Portamento:

1. Press the PORTAMENTO button to turn Portamento on.
2. Play a series of notes up and down the keyboard while you turn the Portamento RATE knob to adjust the amount of glide.

Portamento Modes

There are four modes that determine how portamento/glide behaves. You can set your preferred mode using the PROGRAM menu.

Fixed Rate: The time to transition between notes varies with the interval between the notes; the greater the interval, the longer the transition time. The glide rate is fixed. This is the default portamento mode.

Fixed Rate A: The same as Fixed Rate, but portamento is only applied when playing legato. That is, portamento only occurs when a note is held until the next note is played. This effectively allows glide to be turned on and off from the keyboard. This mode is only available when Unison is on.

Fixed Time: Portamento is set to a fixed time, regardless of the interval between notes.

Fixed Time A: The same as Fixed Time, but portamento only occurs when playing legato with UNISON active.

To select a Portamento Mode:

1. Press the PROGRAM button.
2. Use the SELECT knob to locate the PORTAMENTO MODE parameter.
3. Use the VALUE knob to choose a portamento mode.

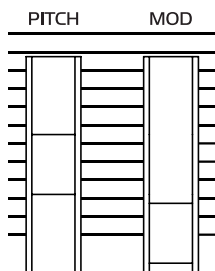
4. Play a series of notes up and down the keyboard to hear the effect.
5. Once you've chosen the desired mode, press the WRITE button twice to save the program.

To set the Portamento Amount separately for each oscillator:

1. Press the PROGRAM button.
2. Use the SELECT knob to locate the OSC 1 GLIDE parameter.
3. Use the VALUE knob to set the amount as you play a series of notes up and down the keyboard to hear the effect.
4. Once you've chosen the desired amount of portamento for oscillator 1, use the SELECT knob to locate the OSC 2 GLIDE parameter.
5. Use the VALUE knob to set the desired amount of portamento for oscillator 2 as you play a series of notes up and down the keyboard to hear the effect.
6. When you're finished, press the WRITE button twice to save the program.

Pitch and Mod Wheels

The TEO-5 has a spring-loaded Pitch wheel and a Mod wheel. You can use these controls to enhance live performance by bending notes and adding modulation in real time as you play.



The Pitch and Modulation wheels

Pitch Wheel

You can set a range in semitones for the Pitch wheel, depending on your playing preference. The upward range is 12 semitones (1 octave). The downward range is 24 semitones (2 octaves). Many musicians use a range of 2 semitones (a whole step) since this is the bend range of many acoustic instruments. For guitar whammy bar effects, you may wish to set a wider range.

To set the pitch bend range:

1. Press the PROGRAM button.
2. Use the SELECT knob to locate the PITCH BEND UP parameter.
3. Use the VALUE knob to choose a bend interval.
4. Hold a note and move the Pitch wheel up to hear the effect.
5. Once you've set the bend up interval as desired, use the SELECT knob to locate the PITCH BEND DOWN parameter.
6. Use the VALUE knob to choose a bend interval.
7. Hold a note and move the Pitch wheel down to hear the effect.
8. Once you've chosen the desired mode, press the WRITE button twice to save the program.

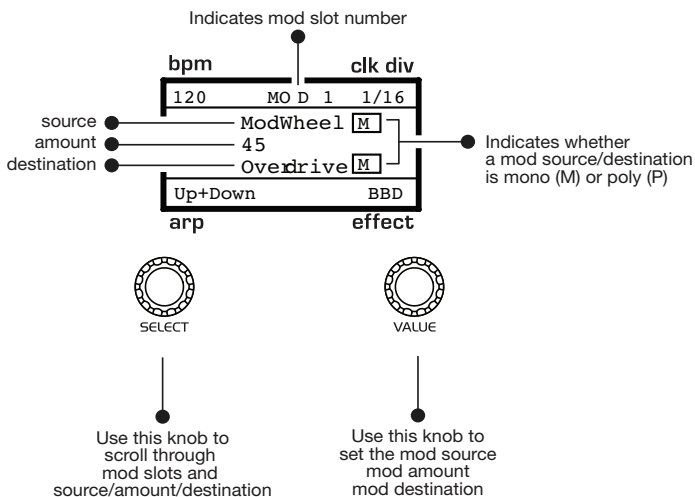
Modulation Wheel

The Mod wheel controls the amount of modulation for any program that uses it as a modulation source. This allows you to “perform” modulation in real time by moving the wheel. This is a great way to add expressiveness to a sound or performance by using it to control vibrato, filter effects, and potentially a lot more.

As a shortcut, you can hold down the ASSIGN button and move the Mod wheel to quickly assign this modulation path.

To choose a modulation destination for the Mod wheel:

1. In the MODULATION section, press the ASSIGN button. Use the select knob to scroll to Mod Slot 1 if it's not already displayed.
2. Use the VALUE knob to scroll through the various mod sources and choose MOD WHEEL.
3. Use the VALUE knob to scroll through the various mod destinations and choose a parameter (such as OVERDRIVE).
4. Hold down a note on the keyboard (or press the HOLD button and play a note on the keyboard) and turn the Mod wheel.
5. Use the VALUE knob to set the modulation amount to your preference. Higher AMOUNT settings add greater modulation the further you push the Mod wheel. A negative AMOUNT setting will apply modulation in the negative direction.



Using the Mod Matrix to assign the Mod Wheel

Adding Aftertouch

Aftertouch is a performance feature that allows you to add modulation to a sound by applying additional pressure to a key after the key is already down. The greater the pressure applied, the more modulation is applied. The TEO-5 provides *monophonic* (or “channel”) aftertouch, which means that applying pressure to any key within a chord will apply modulation to *all* notes currently held.

The Mod Matrix lets you choose the amount of modulation applied using aftertouch and also which parameters are modulated (oscillator frequency, filter frequency, and so on). You can set either a positive or negative amount.

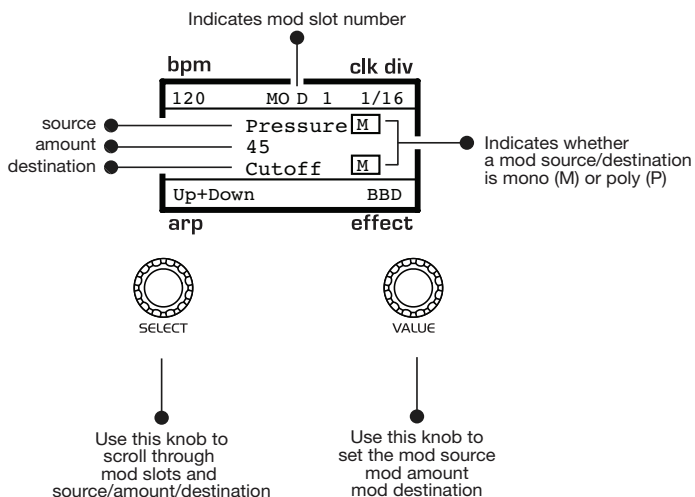
For example, if you select the filter cutoff as modulation destination (CUTOFF), set a *positive* amount of pressure, then push a key down harder, the filter cutoff frequency will increase, making the filter open wider and the sound become brighter.

Conversely, if you select the filter frequency as destination, set a *negative* amount of pressure, then push a key down harder, the filter cutoff frequency will be lowered, making the filter close more and the sound become more muted.

To choose aftertouch (pressure) as a source for modulation:

1. Press the MOD button. The Mod Matrix appears in the display.
2. Use the SELECT knob to scroll through the various mod sources and choose PRESSURE. (As a shortcut, hold down the SRC ASSIGN button and press a key repeatedly to toggle through the available key-related mod sources.)
3. Use the VALUE knob to scroll through the various mod destinations and choose a parameter (such as CUTOFF).
4. Hold down a note on the keyboard. Then, press harder.
5. Hold a note and move the Pitch wheel to hear the effect.
6. Use the VALUE knob to set the amount to your preference. Higher AMOUNT settings add greater modulation the harder you press a key. A negative amount setting will apply modulation in the negative direction.

The TEO-5 provides eight different aftertouch/pressure response settings. The default setting provides a linear response. To choose a different response curve, use the **AFTERTOUCH CURVE** parameter in the **GLOBAL** menu.



Using the Mod Matrix to assign the pressure (aftertouch)

Chapter 3: Creating Sounds

The TEO-5 can produce a huge variety of sounds. While the factory programs give you some idea of its scope, if you only make use of its presets, you're not really using the TEO-5 to its full potential. The real excitement is in creating sounds that are uniquely your own.

This chapter provides some brief tutorials. While there isn't enough space here to cover how to use every TEO-5 function, the examples will help you get familiar with some basic concepts.

Synthesis 101: Synth Bass

Many great synth bass sounds consist of a single oscillator, a bit of filter resonance, the right envelope, and not much else. So start with the Basic Program and go from there.

Short Version

To create a classic synth bass:

1. Press the GLOBAL button.
2. Use the SELECT knob to navigate to the BASIC PROGRAM command, then press the WRITE button to set the synth to the Basic Program. Alternatively, hold -2 TRANSPOSE and hit -2 OCT KEY SPLIT.
3. In the basic program, only Oscillator 1 is audible. (The selector buttons for Oscillator 2, the Sub Oscillator, and Noise are off in the Filter mixer by default).
4. Repeatedly play a note on the keyboard as you do the following and listen to how the sound evolves:
5. Set OCTAVE TRANSPOSE to -2.
6. Set filter CUTOFF to zero.
7. In the ENVELOPES section, set Envelope 1's AMOUNT somewhere between the center detent and fully clockwise.
8. Set filter RESONANCE to a 10 o'clock position.
9. Play a low note on the keyboard. Instant synth bass!
10. Experiment with ENV 1 (the Filter Envelope) AMOUNT and DECAY settings

to fine tune your synth bass sound.

Long Version with Explanations

Here's a more detailed version that provides insight into the process. You'll start with the Basic Program, then learn how to choose an appropriate oscillator waveshape, how to use the filter, how to use the envelopes, and how to use Unison to fatten things up.

Start with the Basic Program.

In the Basic Program, only Oscillator 1 is audible. Its waveshape is set to sawtooth and its level is 127 in the Filter mixer.

Each of the oscillator's waveforms have their own unique sound:

The sawtooth waveform is a good starting point for sounds because it has plenty of harmonics. This gives you a lot to work with in terms of a raw sound that you can filter and modulate. To simplify, The sawtooth generates both even and odd-numbered harmonics

The square wave is a good starting point, too, but sounds different than the sawtooth, because of its different harmonic content. The square wave generates only odd-numbered harmonics.

The triangle wave has less harmonic content than the saw and square. It's useful used alone for its more pure tone, or in combination with another oscillator to reinforce the fundamental pitch of a sound and add weight.

To listen to the various oscillator waveshapes:

1. In the **OSCILLATORS** section, the **SAW** waveform is selected by default. Play and hold a note, then press the **TRIANGLE** button. You'll note that the **SAW** button is still lit, meaning both waveshapes are now audible.
2. Press the **SAW** waveshape button to deactivate the saw wave. You will hear only the triangle wave.
3. Now press the **SQUARE** waveshape button to enable the square wave, and press the **TRIANGLE** waveshape button once more to disable it. Now you'll hear only the square wave.
4. Press the **SQUARE** button and then the **SAW** button to return to listening only to **OSCILLATOR 1** sawtooth wave.

Next, you'll use the filter to shape the raw sound of the saw wave.

To adjust the filter:

1. Press and hold down a key and turn the filter's CUTOFF knob. Notice how it cuts the high frequencies as you rotate counter-clockwise, making the sound of the oscillator less bright. If you turn the CUTOFF knob fully counterclockwise you'll filter out all frequencies and hear almost no sound.
2. Return the CUTOFF knob to its 12 o'clock position.
3. Repeatedly strike a note and turn the RESONANCE knob about three quarters of the way up. Notice how the sound changes as a band of frequencies near the cutoff is amplified.
4. Rotate the filter's CUTOFF knob again and you'll hear a classic resonant filter sweep. You're going to use this to create your synth bass.
5. Set the filter CUTOFF to zero.
6. In the ENVELOPES section, set Envelope 1's AMOUNT close to fully clockwise. This will cause the Envelope 1 (the Filter Envelope) to more strongly modulate (open) the filter according to the shape of the envelope (its attack, decay, sustain, and release settings).
7. Set filter RESONANCE to a 2 o'clock position. This gives the synth bass its funky "zap."
8. Play some low notes and listen to the sound. Classic synth bass.

To tweak the sound:

1. Experiment with the Filter Envelope's AMOUNT knob. Notice how positive AMOUNT settings amplify the effect of the envelope on the filter. Since this control is bipolar, you can also turn it counterclockwise for a negative envelope shape, producing rather different effects.
2. Repeatedly strike a note on the keyboard as you turn the Filter Envelope's DECAY knob clockwise and counterclockwise. Notice how it changes the sound as the note decays faster or slower.
3. Experiment with the Filter Envelope's CUTOFF and STATE knobs. Notice how the sound is highpassed (bass is filtered out) as the state knob is turned clockwise (through NOTCH toward the HIGHPASS state).

4. The Filter Envelope's `RELEASE` parameter acts in conjunction with the Amplifier Envelope. In other words, you can't hear a long release on the filter envelope if the amplifier envelope is short! So to hear the filter envelope's `RELEASE` parameter in action, set the both the Filter Envelope and Amp Envelope's `RELEASE` values to an 11 o'clock position.
5. Now repeatedly strike a note on the keyboard as you turn the Filter Envelope's `RELEASE` knob clockwise and counterclockwise. Notice how the note fades out faster or slower as you change the `RELEASE` value.
6. Add thickness by pressing the `UNISON` button. This will set the TEO-5 to monophonic mode. Hold `UNISON` and use the `VALUE` knob to fatten the sound by assigning two or more voices to a single key press.
7. Add movement to the thickened bass sound by adjusting the `OSC 2 DETUNE` knob, or by adjusting the amount of Unison Detune in the Program menu.

Now you know how to create a simple synth bass program using the most essential synthesizer components of the TEO-5: the oscillators, the filters, and the envelopes. Using just these three things you can create an enormous variety of sounds. Keep experimenting with them and if you like what you've created, save the programs in one of the user banks. (See "Saving a Program" on page 6.)

Creating Synth Brass

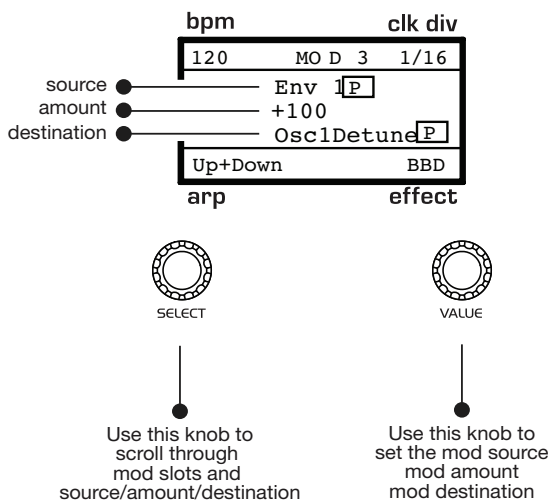
Here's another easy-to-construct sound: synth brass, with a classic “pitch blip” effect on the attack. In this example you'll learn how to use an auxiliary envelope to modulate the pitch of Oscillator 2 to simulate an aggressively blown horn effect.

To create synth brass:

1. Recall the basic preset.
2. In the Filter's mixer section, press the OSC 2 button to enable the oscillator.
3. In the OSCILLATORS section, adjust the DETUNE knob on Oscillator 2 to slightly detune it and thicken the sound.
4. In the FILTER section, set CUTOFF to a 9 o'clock position.
5. Set RESONANCE to a 10 o'clock position.
6. Set ENVELOPE 1'S AMOUNT to a 3 o'clock position.
7. Set ENVELOPE 1'S, ATTACK to 10 o'clock, DECAY to 10 o'clock, SUSTAIN to 11 o'clock, and RELEASE to 10 o'clock.
8. Enable touch sensitivity by pressing and enabling the VELOCITY button.
9. Play some chords and listen to the sound. Classic synth brass.
10. Use the VINTAGE knob to make the brass sound even more organic by adding parameter variations from voice to voice.

To add a “pitch blip” to the brass sound:

1. In the MOD section, hold the SRC ASSIGN button.
2. While holding the SRC ASSIGN button, set env 1 as the mod source of a new mod slot by moving any one of the ENV 1 knobs.
3. When you release the SRC ASSIGN button, the VALUE field will be selected. Use the VALUE knob to set it to +5, or a little more.
4. Now hold the DESTINATION button while turning the OSC 2 DETUNE KNOB.
5. Play some notes in the upper range of the keyboard. Even more classic synth brass!
6. Experiment with different envelope AMOUNT and DECAY settings.



Turning Synth Brass into a String Pad

It's a simple matter to turn the previous synth brass sound into a string pad by simply adjusting its envelope and filter settings.

To turn the synth brass into a string pad:

1. Remove the pitch blip effect by setting the ENV 1 to OSC 2 DETUNE mod amount to 0.
2. In the OSCILLATORS section, set OSC 2 DETUNE to about 1 o'clock.
3. In the FILTER section, set the CUTOFF to 12 o'clock.
4. In the filter section, set STATE to between 11 and 12 o'clock.
5. In the ENV 1 (Filter) section, set the AMOUNT to 2 o'clock
6. Set ENV 1 (Filter) ATTACK to 2 o'clock, DECAY to 2 o'clock, SUSTAIN to 2 o'clock, and RELEASE to 12 o'clock.
7. Set ENV 2 (Amp) ATTACK to 11 o'clock, DECAY to 2 o'clock, SUSTAIN to 5 o'clock, and RELEASE to 2 o'clock.
8. Play some chords. You've now got a good basic string pad.

Making the String Pad More Lush

Now lets make the string pad more lush by using the LFOs to modulate the oscillator waveshapes and recreate the classic “pulse-width mod” strings found on many vintage synths.

To use waveshape mod to make the string pad more lush:

1. On Oscillator 1, press the SQUARE WAVESHAPE button.
2. On Oscillator 2, do the same.
3. In the Mixer section, press and then hold the SUB button, and use the value knob to set the level to 70.
4. On LFO 1: GLOBAL hold the DEST button and press OSC 1 PW (Oscillator 1 pulse width) button.
5. Set the AMOUNT parameter to +20.
6. On LFO 1: GLOBAL, set FREQUENCY to 10 o'clock.
7. Next, On LFO 2: PER VOICE press the DEST ASSIGN button and using the controls in the display, set the destination to OSC 2 PW (Oscillator 2 pulsewidth).
8. Set the AMOUNT parameter to -40.
9. On LFO 1: GLOBAL, set FREQUENCY to 9 o'clock.
10. Play some chords and listen to the sound.

You are now modulating the waveshape of each oscillator differently. This gives the sound more animation. Try experimenting with different LFO FREQUENCY, SHAPE, and AMOUNT settings.

Adding Effects to the String Pad

You can enhance the string pad adding an effect such as chorus, flanging, or phasing for a retro feel.

To add effects to the string pad:

1. In the EFFECT section, press the ON button.
2. Turn the TYPE knob and choose PHASER.
3. Set TIME to 8 o'clock.
4. Set DEPTH/MIX to 12 o'clock.

5. Set FEEDBACK/MISC to 12 o'clock.
6. Play some chords. Retro string machine! For even more dramatic phasing, set DEPTH/MIX and FEEDBACK/MISC to 3 o'clock.
7. Experiment with changing the effect to the flanger or chorus and adjust their settings to your preference.

Adding Reverb to the String Pad

Adding reverb can also enhance the string sound in a very lush way.

To add Reverb to the string pad:

1. In the REVERB section, press the ON button.
2. Turn the MIX knob to 10 o'clock.
3. Set SIZE to 2 o'clock.
4. Set PREDELAY to 11 o'clock.
5. Set DECAY to 3 o'clock.
6. Set TONE to 11 o'clock.
7. Play some chords. Experiment with the SIZE, DECAY, PREDELAY, and TONE settings to fine tune the reverb sound to your preference.

Creating a Hard-Sync Lead

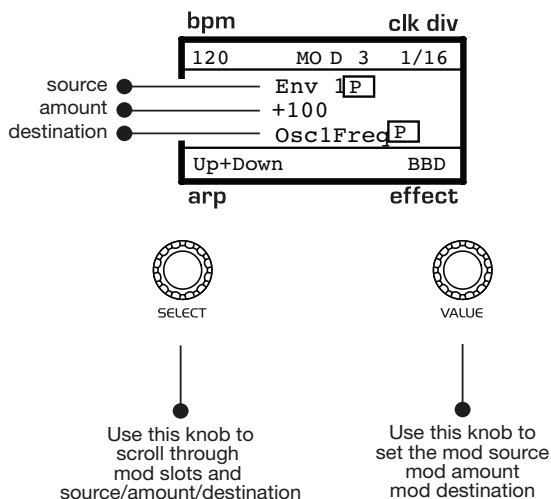
Here's another classic sound: a hard-sync lead. A famous example of this is "Let's Go" by the Cars (originally performed on a Prophet-5). In this example you'll learn how to hard-sync the oscillators, pitch-modulate one of them with an auxiliary envelope, then add effects.

To create a hard-sync lead:

1. Recall the basic preset (remember: hold OCTAVE -2 and press LOW SPLIT -2).
2. In the Filter mixer, press the OSC 2 button.
3. Enable the SYNC button.
4. Set Oscillator 1's FREQUENCY to c+2. This will allow for a wide range of pitch modulation in step 9.
5. Set the keyboard OCTAVE button to -1. This will set Osc 2's octave down

from Osc 1 to help create a more aggressive hard-sync effect.

6. In the ENVELOPE section, set the envelopes to ENV 1: AUX and ENV 2 FILTER + AMP. This will allow you to use Envelope 1 as an auxiliary envelope that will modulate the pitch of oscillator 1.
7. Hold the SRC ASSIGN button and turn any ENV 1 knob to choose ENV 1 as the source.
8. Set the AMOUNT to 100 using the VALUE knob.
9. Hold SRC ASSIGN and turn the OSC 1 FREQUENCY knob to set the destination.
10. This routes Envelope 1 to modulate Oscillator 1 pitch according to its ADSR (attack, decay, sustain, release) settings.
11. Set Envelope 1 (Aux) to ATTACK: 9 o'clock, DECAY to 1 o'clock, SUSTAIN to 10 o'clock, and RELEASE to 12 o'clock. This will set the amount and "shape" of the modulation.
12. Play some notes. Classic hard-sync lead!
13. Experiment with Envelope 1's Attack, Decay, Sustain, and Release settings to better understand how these affect the shape of pitch modulation routed to Oscillator 1. You can also try increasing the mod amount to get even more extreme sync effects.



Adding Effects to the Lead

You can enhance the sync lead by adding some delay and reverb.

To add a delay effect:

1. In the EFFECTS section, press the EFFECT 1 button.
2. Use the TYPE knob to select DELAY.
3. Set TIME to 12 o'clock.
4. Set DEPTH/MIX to 10 o'clock.
5. Set FEEDBACK/MISC to 10 o'clock.
6. Play some notes. Perfect hard-sync lead!

A Final Word

The examples given here are fairly basic, but they give you some idea of the power of synthesis. Imagine what you can create by using these as starting points, then modulating the filters, oscillators, and even effects with LFOs, Envelopes, and other modulation sources.

It's often useful to start with a simple sound and make it progressively more complex, while saving edited versions as you go so that you can retrace your steps and branch off at different points in the sound design process if you want.

Appendix A: Modulation Sources

Off
Osc 2
Noise
LFO 1
LFO 2
Env 1
Env 2
Voice Spread
Pitch Bend
Mod Wheel
Pressure
Breath
Foot Pedal
Expression Pedal
Velocity
Note Number
Filter Out
Random
DC
Audio Out

Appendix B: Modulation Destinations

No Dest
Osc 1 Frequency
Osc 2 Frequency
Osc All Frequency
Osc 1 Detune
Osc 2 Detune
Osc All Detune
Osc 1 Pulse Width
Osc 2 Pulse Width
Osc All Pulse Width
Osc 1 Level
Osc 2 Level
Sub Level
Noise
X-Mod Level
Cutoff
Resonance
Filter State
FX Mix
FX Time
FX Misc
Reverb Mix
Reverb Size
Reverb PreDelay
Reverb Decay
Reverb Tone
LFO 1 Freq
LFO 2 Freq
LFO All Freq
LFO 1 Amt
LFO 2 Amt
LFO All Amt
Env 1 Amt

Env 2 Amt
Env 1 Delay
Env 2 Delay
Env 1 Attack
Env 2 Attack
Env 1 Decay
Env 2 Decay
Env 1 Sustain
Env 2 Sustain
Env 1 Release
Env 2 Release
Voice Volume
Panning
Overdrive
Vintage Amount
Unison Detune
Mod 1 Amount
Mod 2 Amount
Mod 3 Amount
Mod 4 Amount
Mod 5 Amount
Mod 6 Amount
Mod 7 Amount
Mod 8 Amount
Mod 9 Amount
Mod 10 Amount
Mod 11 Amount
Mod 12 Amount
Mod 13 Amount
Mod 14 Amount
Mod 15 Amount
Mod 16 Amount

Appendix C: Troubleshooting and Support

Troubleshooting

If you're experiencing problems or unexpected behavior from your TEO-5, here are a few typical scenarios and their solutions:

If the TEO-5 isn't producing sound:

1. Recall the Basic Program. (Hold -2 OCTAVE and press -2 LOW SPLIT).
2. If the problem is still there, check the following:
 - Volume - make sure it's set to an appropriate value
 - Rear-panel output jacks - make your audio cables are connected to LEFT/RIGHT OUTPUT.
 - In the GLOBAL menu, make sure that LOCAL CONTROL is set to ON.

If the sequencer or arpeggiator has stopped running:

- Check the MIDI CLOCK MODE setting in GLOBAL to ensure the TEO-5 is set to OUT OF OFF. Or if set to IN OF IN THRU OR IN NO S/S, make sure the TEO-5 is receiving MIDI clock.

If some of the programs sound different than usual:

- In the Global menu, check SCALE/ALT TUNING and make sure it's set to EQUAL TEMPERAMENT. Also, check the Mod wheel position. The Mod wheel can do more than just add vibrato. Also, check the CLOCK MODE setting in the GLOBAL menu to ensure the TEO-5 is set to OUT OF OFF. Or if set to IN OF IN THRU OR IN NO S/S, make sure the TEO-5 is receiving MIDI clock.

If there is a ground hum in the audio output:

- USB can cause ground loops, so try to resolve any grounding issues between the computer (if connected) and the TEO-5. Or use MIDI, which is opto-isolated.

If the TEO-5 is behaving erratically:

- This is almost always caused by a MIDI feedback loop. Make sure that any MIDI Thru functionality is turned off on the MIDI interface/hardware or in the MIDI software application. Disconnect all TEO-5 MIDI connections (MIDI and USB cables) and see if the problem persists. You can also monitor the MIDI traffic with *MIDI Monitor* (Mac OS) or *MIDI-OX* (Windows) to see if the TEO-5 is being overrun with duplicate messages.

If the TEO-5 doesn't seem to respond to its controls:

- Make sure LOCAL CONTROL IS ON in the GLOBAL menu.

If MIDI System Exclusive data is not transmitted/received:

- Make sure that the MIDI SYSEX CABLE setting in the GLOBAL menu is set to USB or MIDI depending on which you are using to transmit or receive MIDI messages.

If the TEO-5 plays out of tune:

- Check the MASTER COARSE and MASTER FINE parameter in the GLOBAL menu to make sure they are both set to 0.
- You may need to recalibrate the oscillators. See “Calibrating the VCOs and Filters” on page 73.

If the pitch or Mod wheel doesn't go to full range:

- Recalibrate the Pitch and Mod wheels. See “Calibrating the Pitch and Mod Wheels” on page 73.

If the filter sounds strange or out of tune:

- You may need to recalibrate the oscillators and filters. See “Calibrating the VCOs and Filters” on page 73.

Resetting the Global Parameters

If you're trying to track down a problem, it's sometimes a good idea to reset the Global parameters to their defaults. This is a quick way to make sure that the TEO-5 returns to its factory settings. To note, resetting global parameters does not affect any user or factory presets.

To reset all Global parameters to their default settings:

1. Press the GLOBAL button.
2. Use the SELECT knob to select RESET GLOBALS, then press WRITE. Globals are reset. You can now play the TEO-5 again.

Contacting Technical Support

If you are still having a problem with the TEO-5, contact Technical Support at support@oberheim.com. Please include the purchase date of your TEO-5, its serial number, and the operating system version. Press the GLOBAL button to see the OS version at the bottom of the main display.

If you haven't already reset the Global parameters and run the calibration routines (see Troubleshooting), you should do it before contacting Technical Support. This is probably the first thing you will be asked to do.

Warranty Repair

Oberheim warrants that the TEO-5 will be free from defects in materials and/or workmanship for 1 year from the date of purchase. Please register your product online at www.oberheim.com to establish the date of purchase. (This is not a requirement for warranty service, but will provide a helpful reference.)

Please contact support@oberheim.com to determine the best course of action for getting your TEO-5 repaired. For your own protection, as well as ours, please do not return any product to Oberheim without a return authorization (RA) number. To issue an RA number, Technical Support needs:

- Your name
- Your return shipping address
- Your email address
- A phone number where you can be reached
- Your TEO-5's serial number
- The date of purchase and where purchased (and whether purchased new or used)

If you need to return your instrument for repair, you are responsible for getting it to Oberheim. We highly recommend insuring it and packing in the original packaging and packing materials. Damage resulting from shipping a product with insufficient packaging is not covered by warranty.

Appendix D: Calibrating the TEO-5

The TEO-5 is calibrated at the factory, and controls such as the Pitch and Mod wheels, VCOs and VCFs usually won't require re-calibration. But if you experience unexpected behavior with these controls, you can use the calibration function to tune them occasionally. You may also need to add more calibrations to cover the operating temperature range of the instrument to accommodate your studio environment, or high ambient heat under stage lights, for example. You may find that you need to run a few calibrations to stabilize the TEO-5's tuning.

Calibrating the VCOs and Filters

To calibrate the VCOs and filters:

1. Press the GLOBAL button.
2. Use the SELECT knob to select CAL VOICES, then press WRITE.
3. The synthesizer performs its auto-calibration procedure.
4. When finished, the front panel controls will return to normal.

Calibrating the Pitch and Mod Wheels

To calibrate the Pitch and Mod wheels:

1. Press the GLOBAL button.
2. Use the SELECT knob to select CAL WHEELS, then follow the instructions in the display.
3. When finished, press the GLOBAL button again to exit the GLOBAL menu.

Resetting the Global Parameters

If you're trying to track down a problem, it's sometimes a good idea to reset the Global parameters to their defaults. This is a quick way to make sure that the TEO-5 returns to its factory settings.

To reset all Global parameters to their default settings:

1. Press the GLOBAL button.
2. Use the SELECT knob to select RESET GLOBALS, then press WRITE. Globals are reset. You can now play the TEO-5 again.

Appendix E: Exporting and Importing Programs and Banks

You can use the `DUMP PRESET`, `DUMP BANK`, and `DUMP ALL BANKS` commands in the `GLOBAL` menu to transmit the current program, bank, or all banks in SysEx format via the selected MIDI port. This allows you to save your programs so that you can share or archive them. You will need a computer and software application such as SysEx Librarian for Macintosh, or MIDIOX for Windows. Dumped programs will load back into the same bank and program location in memory when received by the TEO-5 via MIDI.

To export a program or bank as a SysEx file over USB:

1. Connect your synthesizer to a computer using a USB cable.
2. Open your MIDI librarian software (SysEx Librarian, etc.) and configure it to receive SysEx messages.
3. Press the `GLOBAL` button on the TEO-5.
4. Use the `SELECT` knob to select `MIDI SYSEX CABLE`, then use the value knob to choose `USB`.
5. Use the `SELECT` knob to select `DUMP PRESET`, `DUMP BANK`, or `DUMP ALL BANKS`, depending on which of these you would like to do.
6. Press `WRITE`. The program or bank is exported.

Programs can also be dumped directly from one TEO-5 to another using the MIDI DIN jack, if the `MIDI SYSEX CABLE` parameter is set to `MIDI` in the `GLOBAL` menu.

To send a program or bank to another TEO-5 as a SysEx file over MIDI:

1. Connect two TEO-5 synthesizers together using MIDI cables and the `MIDI IN` and `MIDI OUT` jacks on their rear panels.
2. On both synthesizers, Press the `GLOBAL` button and use the `SELECT` knob to select `MIDI SYSEX CABLE`, then use the `VALUE` knob to choose `MIDI`.
3. On the TEO-5 that you want to send the programs to, press the `GLOBAL` button again to exit the `GLOBAL` menu.
4. On the TEO-5 that you want to send the programs from, in the `GLOBAL` menu select `DUMP PRESET`, `DUMP BANK`, or `DUMP ALL BANKS`, depending on

which of these you would like to do.

5. Press WRITE. The program or bank is exported to the other TEO-5.

Importing Programs and Banks

You can use a MIDI librarian application such as SysEx Librarian for Macintosh, or MIDI-OX for Windows to transmit exported program or banks back into your TEO-5. You will need a computer and an appropriate software application.

To import a program or bank as a SysEx file over MIDI:

1. Connect your synthesizer to a computer using a USB cable (or MIDI cable, if you are using a dedicated MIDI interface).
2. Press the GLOBAL button on the TEO-5.
3. Use the SELECT knob to select MIDI SYSEX CABLE, then use the value knob to choose USB or MIDI, depending on which port you are using to connect to your computer.
4. Open your MIDI librarian software and configure it to send SysEx messages to your TEO-5.
5. In the MIDI librarian, open the programs and/or banks you want to send.
6. Transmit the programs. The TEO-5 should load them. They will replace any existing programs in those same memory locations on the synth.

Again, note that programs will load back into the same bank and program locations from which they were originally exported.

Appendix F: Alternative Tunings

By default, the TEO-5 is set to standard, chromatic western tuning. Additionally, it supports up to 64 additional alternative tunings, which you can access using the `ALT TUNINGS` parameter in the `GLOBAL` menu. Any of the alternative tunings loaded to the TEO-5 can be saved as part of a program.

These 64 alternative tunings range from Equal temperament to Indonesian Gamelan tunings. If you want, you can replace these with other tunings that you can find on the Internet. These must be in SysEx format. You can download them into the TEO-5 using SysEx Librarian for Mac or MIDI-OX for Windows.

Here are descriptions of the default TEO-5 alternative tunings:

1. 12-Tone Equal Temperament (non-erasable)

The default Western tuning, based on the twelfth root of two.

2. Harmonic Series

MIDI notes 36-95 reflect harmonics 2 through 60 based on the fundamental of A = 27.5 Hz. The low C on a standard 5 octave keyboard acts as the root note (55Hz), and the harmonics play upwards from there. The remaining keys above and below the 5 octave range are filled with the same intervals as Carlos' Harmonic 12 Tone that follows.

3. Carlos Harmonic Twelve Tone

Wendy Carlos' twelve note scale based on octave-repeating harmonics. A = 1/1 (440 Hz). 1/1 17/16 9/8 19/16 5/4 21/16 11/8 3/2 13/8 27/16 7/4 15/8

4. Meantone Temperament

An early tempered tuning, with better thirds than 12ET. Sounds best in the key of C. Use this to add an authentic touch to performances of early Baroque music. C=1/1 (260 Hz)

5. 1/4 Tone Equal Temperament

24 notes per octave, equally spaced $24\sqrt[24]{2}$ intervals. Mexican composer Julian Carillo used this for custom-built pianos in the early 20th century.

6. 19 Tone Equal Temperament

19 notes per octave ($19\sqrt[19]{2}$) offering better thirds than 12 ET, a better overall compromise if you can figure out the keyboard patterns.

7. 31 Tone Equal Temperament

Many people consider $31\sqrt[31]{2}$ to offer the best compromise towards just intonation in an equal temperament, but it can get very tricky to keep track of the intervals.

8. Pythagorean C

One of the earliest tuning systems known from history, the Pythagorean scale is constructed from an upward series of pure fifths ($3/2$) transposed down into a single octave. The tuning works well for monophonic melodies against fifth drones, but has a very narrow palate of good chords to choose from. C=1/1 (261.625 Hz) 1/1 256/243 9/8 32/27 81/64 4/3 729/512 3/2 128/81 27/16 16/9 243/128

9. Just Intonation in A with 7-Limit Tritone at D#

A rather vanilla 5-limit small interval JI, except for a single $7/5$ tritone at D#, which offers some nice possibilities for rotating around bluesy sevenths. A=1/1 (440 Hz) 1/1 16/15 9/8 6/5 5/4 7/5 3/2 8/5 5/3 9/5 15/8

10. 3-5 Lattice in A

A pure 3 and 5-limit tuning which resolves to very symmetrical derived relationships between notes. A=1/1 (440 Hz) 1/1 16/15 10/9 6/5 5/4 4/3 64/45 3/2 8/5 5/3 16/9 15/8

11. 3-7 Lattice in A

A pure 3 and 7-limit tuning which resolves to very symmetrical derived relationships between notes. Some of the intervals are very close together, offering several choices for the same nominal chords. A=1/1 (440 Hz) 1/1 9/8 8/7 7/6 9/7 21/16 4/3 3/2 32/21 12/7 7/4 63/32

12. Other Music 7-Limit Black Keys in C

Created by the group Other Music for their homemade gamelan, this offers a wide range of interesting chords and modes. C=1/1 (261.625 Hz)
1/1 15/14 9/8 7/6 5/4 4/3 7/5 3/2 14/9 5/3 7/4 15/8

13. Dan Schmidt Pelog/Slendro

Created for the Berkeley Gamelan group, this tuning fits an Indonesian-style heptatonic Pelog on the white keys and pentatonic Slendro on the black keys, with B and Bb acting as 1/1 for their respective modes. Note that some of the notes will have the same frequency. By tuning the 1/1 to 60 Hz, Dan found a creative way to incorporate the inevitable line hum into his scale. Bb, B = 1/1 (60 Hz) 1/1 1/1 9/8 7/6 5/4 4/3 11/8 3/2 3/2 7/4 7/4 15/8

14. Yamaha Just Major C

When Yamaha decided to put preset microtunings into their FM synth product line, they selected this and the following tuning as representative just intonations. As such, they became the de-facto introduction to JI for many people. Just Major gives preferential treatment to major thirds on the sharps, and a good fourth relative to the second. C= 1/1 (261.625) 1/1 16/15 9/8 6/5 5/4 4/3 45/32 3/2 8/5 5/3 16/9 15/8

15. Yamaha Just Minor C

Similar to Yamaha's preset Just Major, the Just Minor gives preferential treatment to minor thirds on the sharps, and has a good fifth relative to the second. C= 1/1 (261.625) 1/1 25/24 10/9 6/5 5/4 4/3 45/32 3/2 8/5 5/3 16/9 15/8

16. Harry Partch 11-Limit 43 Note Just Intonation

One of the pioneers of modern microtonal composition, Partch built a unique orchestra with this tuning during the first half of the 20th century, to perform his own compositions. The large number of intervals in this very dense scale offers a full vocabulary of expressive chords and complex key changes. The narrow spacing also allows fixed-pitched instruments like marimbas and organs to perform glissando-like passages. G = 1/1 (392 Hz, MIDI note 67)

1/1 81/80 33/32 21/20 16/15 12/11 11/10 10/9 9/8 8/7 7/6 32/27 6/5 11/9
5/4 14/11 9/7 21/16 4/3 27/20 11/8 7/5 10/7 16/11 40/27 3/2 32/21 14/9
11/7 8/5 18/11 5/3 27/16 12/7 7/4 16/9 9/5 20/11 11/6 15/8 40/21 64/33
160/81

17. Arabic 12-Tone

A 12-tone approximation of an Arabic scale, which appears in some electronic keyboards designed for use with Arabic music. Not a JI scale, nor equal tempered. These are the intervals in Cents relative to C:

60 = Cents 0

61 = Cents +151

62 = Cents +204

63 = Cents +294

64 = Cents +355

65 = Cents +498

66 = Cents +649

67 = Cents +702

68 = Cents +853

69 = Cents +906

70 = Cents +996

71 = Cents +1057

72 = Cents +1200

18. 12 Out of 19-tET Scale from Mandelbaum's Dissertation

An interesting non-just 12 tone scale that has some unusual relationships.

note 0=0

note 1=63

note 2=189

note 3=253

note 4=379

note 5=505

note 6=568

note 7=695

note 8=758

note 9=884

note 10=947

note 11=1074

note 12=1200

19. 12 Out of 31-tET, Meantone Eb-G#

note 0=0

note 1=77

note 2=194

note 3=310

note 4=387

note 5=503

note 6=581

note 7=697

note 8=774

note 9=890

note 10=1006

note 11=1084

note 12=1200

20. Terry Riley's Harp of New Albion scale, Inverse Malcolm's Monochord

Original 1/1 on C#, here it is set to C.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +609.776284	Ratio: 64/45 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

21. Lute tuning of Giovanni Maria Artusi (1603). 1/4-comma w. Acc. 1/2-way Naturals

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +96.578	Ratio: 8607/8140
62 = Cents +193.157	Ratio: 2889/2584
63 = Cents +289.735	Ratio: 11687/9886
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +503.422	Ratio: 5267/3938
66 = Cents +600.	Ratio: 11482/8119
67 = Cents +696.578	Ratio: 7876/5267
68 = Cents +793.157	Ratio: 14771/9342
69 = Cents +889.735	Ratio: 11718/7009
70 = Cents +986.314	Ratio: 17561/9934
71 = Cents +1082.892	Ratio: 18204/9739
72 = Cents +1200.	Ratio: 2/1 (JUST)

22. J.S. Bach “well temperament”, Acc. to Jacob Breetvelt’s Tuner

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +92.18	Ratio: 10472/9929
62 = Cents +200.	Ratio: 5252/4679
63 = Cents +296.09	Ratio: 11781/9929
64 = Cents +390.225	Ratio: 9638/7693
65 = Cents +500.	Ratio: 6793/5089
66 = Cents +590.225	Ratio: 45/32 (just)
67 = Cents +700.	Ratio: 10178/6793
68 = Cents +794.135	Ratio: 15708/9929
69 = Cents +895.1125	Ratio: 14857/8859
70 = Cents +998.045	Ratio: 12503/7025
71 = Cents +1090.225	Ratio: 18484/9847
72 = Cents +1200.	Ratio: 2/1 (JUST)

23. Bulgarian Bagpipe tuning, Empirically Measured.

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +66.	Ratio: 5427/5224
2 = Cents +202.	Ratio: 1925/1713
3 = Cents +316.	Ratio: 11586/9653
4 = Cents +399.	Ratio: 4965/3943
5 = Cents +509.	Ratio: 7451/5553
6 = Cents +640.	Ratio: 13435/9283
7 = Cents +706.	Ratio: 857/570
8 = Cents +803.	Ratio: 2681/1686
9 = Cents +910.	Ratio: 12130/7171
10 = Cents +1011.	Ratio: 1205/672
11 = Cents +1092.	Ratio: 12599/6705
12 = Cents +1200.	Ratio: 2/1 (JUST)

24. Wendy Carlos' Alpha Scale with Perfect Fifth Divided in Nine. 19 Tone cycle

Octaves are stretched, and the tuning is quite microtonal.

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +78.	Ratio: 7241/6922
2 = Cents +156.	Ratio: 8994/8219
3 = Cents +234.	Ratio: 10686/9335
4 = Cents +312.	Ratio: 11873/9915
5 = Cents +390.	Ratio: 11636/9289
6 = Cents +468.	Ratio: 13024/9939
7 = Cents +546.	Ratio: 12433/9070
8 = Cents +624.	Ratio: 11605/8093
9 = Cents +702.	Ratio: 14999/9999
10 = Cents +780.	Ratio: 3471/2212
11 = Cents +858.	Ratio: 15361/9358
12 = Cents +936.	Ratio: 11467/6678
13 = Cents +1014.	Ratio: 17889/9959
14 = Cents +1092.	Ratio: 12599/6705
15 = Cents +1170.	Ratio: 18593/9459
16 = Cents +1248.	Ratio: 14957/7274
17 = Cents +1326.	Ratio: 8049/3742
18 = Cents +1404.	Ratio: 9617/4274
19 = Cents +1482.	Ratio: 1111/472

25. Wendy Carlos' Beta Scale with Perfect Fifth Divided by Eleven. 23-Tone Cycle

Octaves are stretched, and the tuning is quite microtonal (First repeat shown.)

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +63.8	Ratio: 6191/5967
2 = Cents +127.6	Ratio: 9725/9034
3 = Cents +191.4	Ratio: 7739/6929
4 = Cents +255.2	Ratio: 8821/7612
5 = Cents +319.	Ratio: 7636/6351
6 = Cents +382.8	Ratio: 11690/9371
7 = Cents +446.6	Ratio: 9007/6959
8 = Cents +510.4	Ratio: 1500/1117
9 = Cents +574.2	Ratio: 13547/9723
10 = Cents +638.	Ratio: 12529/8667
11 = Cents +701.8	Ratio: 5584/3723
12 = Cents +765.6	Ratio: 9281/5964
13 = Cents +829.4	Ratio: 15760/9761
14 = Cents +893.2	Ratio: 1047/625
15 = Cents +957.	Ratio: 9629/5540
16 = Cents +1020.8	Ratio: 16551/9178
17 = Cents +1084.6	Ratio: 16263/8692
18 = Cents +1148.4	Ratio: 13585/6998
19 = Cents +1212.2	Ratio: 17231/8555
20 = Cents +1276.	Ratio: 12503/5983
21 = Cents +1339.8	Ratio: 10583/4881
22 = Cents +1403.6	Ratio: 12564/5585
23 = Cents +1467.4	Ratio: 8727/3739

26. Wendy Carlos' Gamma Scale with Third Divided by Eleven or Fifth by Twenty. 36 Tone

Octaves are stretched, and the tuning is quite microtonal.

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +35.099	Ratio: 1146/1123
2 = Cents +70.198	Ratio: 7449/7153
3 = Cents +105.297	Ratio: 4118/3875
4 = Cents +140.396	Ratio: 475/438
5 = Cents +175.495	Ratio: 5363/4846
6 = Cents +210.594	Ratio: 3990/3533
7 = Cents +245.693	Ratio: 11307/9811
8 = Cents +280.792	Ratio: 4495/3822
9 = Cents +315.891	Ratio: 9707/8088
10 = Cents +350.99	Ratio: 1989/1624
11 = Cents +386.089	Ratio: 1926/1541
12 = Cents +421.188	Ratio: 7321/5740
13 = Cents +456.287	Ratio: 2089/1605
14 = Cents +491.386	Ratio: 8563/6447
15 = Cents +526.485	Ratio: 6117/4513
16 = Cents +561.584	Ratio: 148/107
17 = Cents +596.683	Ratio: 2895/2051
18 = Cents +631.782	Ratio: 7627/5295
19 = Cents +666.881	Ratio: 13901/9457
20 = Cents +701.98	Ratio: 3/2 (just)
21 = Cents +737.079	Ratio: 5477/3578
22 = Cents +772.178	Ratio: 6981/4469
23 = Cents +807.277	Ratio: 14613/9167
24 = Cents +842.376	Ratio: 10660/6553
25 = Cents +877.475	Ratio: 1255/756
26 = Cents +912.574	Ratio: 3959/2337
27 = Cents +947.673	Ratio: 16513/9552
28 = Cents +982.772	Ratio: 15424/8743
29 = Cents +1017.871	Ratio: 7563/4201
30 = Cents +1052.97	Ratio: 7367/4010
31 = Cents +1088.069	Ratio: 11918/6357
32 = Cents +1123.168	Ratio: 13310/6957
33 = Cents +1158.267	Ratio: 17050/8733
34 = Cents +1193.366	Ratio: 14586/7321
35 = Cents +1228.465	Ratio: 13368/6575
36 = Cents +1263.564	Ratio: 1276/615

27. Carlos Super Just

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +104.95541	Ratio: 17/16 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +551.317942	Ratio: 11/8 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +840.527662	Ratio: 13/8 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

28. Jon Catler 24-tone JI from "Over and Under the 13 Limit"

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +53.272943	Ratio: 33/32 (JUST)
62 = Cents +111.731285	Ratio: 16/15 (JUST)
63 = Cents +203.910002	Ratio: 9/8 (JUST)
64 = Cents +231.174094	Ratio: 8/7 (JUST)
65 = Cents +266.870906	Ratio: 7/6 (JUST)
66 = Cents +315.641287	Ratio: 6/5 (JUST)
67 = Cents +342.905379	Ratio: 128/105
68 = Cents +359.472338	Ratio: 16/13 (JUST)
69 = Cents +386.313714	Ratio: 5/4 (JUST)
70 = Cents +470.780907	Ratio: 21/16 (JUST)
71 = Cents +498.044999	Ratio: 4/3 (JUST)
72 = Cents +551.317942	Ratio: 11/8 (JUST)
73 = Cents +590.223716	Ratio: 45/32 (JUST)
74 = Cents +648.682058	Ratio: 16/11 (JUST)
75 = Cents +701.955001	Ratio: 3/2 (JUST)
76 = Cents +813.686286	Ratio: 8/5 (JUST)
77 = Cents +840.527662	Ratio: 13/8 (JUST)
78 = Cents +884.358713	Ratio: 5/3 (JUST)
79 = Cents +905.865003	Ratio: 27/16 (JUST)
80 = Cents +968.825906	Ratio: 7/4 (JUST)
81 = Cents +996.089998	Ratio: 16/9 (JUST)
82 = Cents +1061.427339	Ratio: 24/13 (JUST)
83 = Cents +1088.268715	Ratio: 15/8 (JUST)
84 = Cents +1200.	Ratio: 2/1 (JUST)

29. John Chalmers JI-1, Based loosely on Wronski's and similar JI scales, May 2, 1997.

(Chalmer's book "Divisions of the Tetrachord" is a late 20th century masterwork, exploring the mathematical underpinnings of just tunings.)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +104.95541	Ratio: 17/16 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +297.513016	Ratio: 19/16 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +603.000409	Ratio: 17/12 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +795.558015	Ratio: 19/12 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +999.468017	Ratio: 57/32 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

30. John Chalmers JI-3, 15 16 17 18 19 20 21 on 1/1, 15-20 on 3/2, May 2, 1997.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +216.686695	Ratio: 17/15 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +409.244301	Ratio: 19/15 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +582.512193	Ratio: 7/5 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +918.641696	Ratio: 17/10 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1111.199302	Ratio: 19/10 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

31. John Chalmers JI-4, 15 16 17 18 19 20 on 1/1, same on 4/3, + 16/15 on 16/9

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +216.686695	Ratio: 17/15 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +409.244301	Ratio: 19/15 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +609.776284	Ratio: 64/45 (JUST)
67 = Cents +714.731694	Ratio: 68/45 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +907.289301	Ratio: 76/45 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1107.821284	Ratio: 256/135
72 = Cents +1200.	Ratio: 2/1 (JUST)

32. Chinese scale, 4th century

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +99.2	Ratio: 3735/3527
2 = Cents +199.5	Ratio: 11126/9915
3 = Cents +296.7	Ratio: 9181/7735
4 = Cents +398.	Ratio: 10405/8268
5 = Cents +492.9	Ratio: 448/337
6 = Cents +595.2	Ratio: 11312/8021
7 = Cents +699.	Ratio: 6439/4300
8 = Cents +790.9	Ratio: 7578/4799
9 = Cents +896.1	Ratio: 15436/9199
10 = Cents +984.9	Ratio: 6357/3599
11 = Cents +1091.4	Ratio: 1591/847
12 = Cents +1200.	Ratio: 2/1 (JUST)

33. Chinese Lu scale by Huai Nan Zi, Han era. (P. Amiot 1780, Kurt Reinhard)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +98.954592	Ratio: 18/17 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +394.347297	Ratio: 54/43 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +608.351986	Ratio: 27/19 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +800.909593	Ratio: 27/17 (JUST)
69 = Cents +905.865003	Ratio: 27/16 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1106.396986	Ratio: 36/19 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

34. Colonna 1

Fabio Colonna lived in Naples, and published a treatise in 1618 called “La Sambuca Lincea”, which included a description of the instrument by that name which he built on commission from Scipione Stella, who had had the opportunity in 1594 to examine Vincentino’s “Archicembalo” — a 31-tone-per-octave (not equal-tempered) keyboard instrument.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +182.403712	Ratio: 10/9 (JUST)
63 = Cents +287.359122	Ratio: 85/72 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +568.717426	Ratio: 25/18 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +733.721654	Ratio: 55/36 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +989.314122	Ratio: 85/48 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

35. Colonna 2 - Second 12 Note Subset of the Colonna Scale

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +582.512193	Ratio: 7/5 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1049.362941	Ratio: 11/6 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

36. Ivor Darreg's 19 ratios in 5-limit JI for his Megalyra Family

Darreg was one of the great modern theorists of just intonation.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +111.731285	Ratio: 16/15 (JUST)
63 = Cents +182.403712	Ratio: 10/9 (JUST)
64 = Cents +203.910002	Ratio: 9/8 (JUST)
65 = Cents +274.582429	Ratio: 75/64 (JUST)
66 = Cents +315.641287	Ratio: 6/5 (JUST)
67 = Cents +386.313714	Ratio: 5/4 (JUST)
68 = Cents +498.044999	Ratio: 4/3 (JUST)
69 = Cents +590.223716	Ratio: 45/32 (JUST)
70 = Cents +609.776284	Ratio: 64/45 (JUST)
71 = Cents +701.955001	Ratio: 3/2 (JUST)
72 = Cents +772.627428	Ratio: 25/16 (JUST)
73 = Cents +813.686286	Ratio: 8/5 (JUST)
74 = Cents +884.358713	Ratio: 5/3 (JUST)
75 = Cents +905.865003	Ratio: 27/16 (JUST)
76 = Cents +976.537429	Ratio: 225/128
77 = Cents +1017.596288	Ratio: 9/5 (JUST)
78 = Cents +1088.268715	Ratio: 15/8 (JUST)
79 = Cents +1200.	Ratio: 2/1 (JUST)

37. Dorian Diatonic Tonos

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +231.174094	Ratio: 8/7 (JUST)
63 = Cents +359.472338	Ratio: 16/13 (JUST)
64 = Cents +427.372572	Ratio: 32/25 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +571.725653	Ratio: 32/23 (JUST)
67 = Cents +648.682058	Ratio: 16/11 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +902.486984	Ratio: 32/19 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1095.04459	Ratio: 32/17 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

38. Almost Equal 12-tone Subset of Duodenarium

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +92.178716	Ratio: 135/128
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +296.088718	Ratio: 1215/1024
64 = Cents +405.866283	Ratio: 512/405
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +609.776284	Ratio: 64/45 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +794.133717	Ratio: 405/256
69 = Cents +903.911282	Ratio: 2048/1215
70 = Cents +998.043719	Ratio: 3645/2048
71 = Cents +1107.821284	Ratio: 256/135
72 = Cents +1200.	Ratio: 2/1 (JUST)

39. Ellis's Just Harmonium

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +519.551289	Ratio: 27/20 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

40. Bali/Java Slendro, Siam 7, empirical

0 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +519.551289	Ratio: 27/20 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

41. Tibetan Ceremonial, empirical

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +58.	Ratio: 2762/2671
2 = Cents +232.	Ratio: 6889/6025
3 = Cents +310.	Ratio: 10601/8863
4 = Cents +378.	Ratio: 11945/9602
5 = Cents +522.	Ratio: 849/628
6 = Cents +618.	Ratio: 483/338
7 = Cents +725.	Ratio: 605/398
8 = Cents +773.	Ratio: 13070/8363
9 = Cents +896.	Ratio: 14076/8389
10 = Cents +1019.	Ratio: 12585/6986
11 = Cents +1086.	Ratio: 16205/8654

42. Erlangen, revised

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +92.178716	Ratio: 135/128
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +294.134997	Ratio: 32/27 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +590.223716	Ratio: 45/32 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +794.133717	Ratio: 405/256
69 = Cents +905.865003	Ratio: 27/16 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

43. Euler - Monochord (1739)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +274.582429	Ratio: 75/64 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +590.223716	Ratio: 45/32 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +772.627428	Ratio: 25/16 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +976.537429	Ratio: 225/128
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

44. Fokker's 7-limit 12-tone Just Scale

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +119.442808	Ratio: 15/14 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +266.870906	Ratio: 7/6 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +590.223716	Ratio: 45/32 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +821.397809	Ratio: 45/28 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

45. Bagpipe tuning from Fortuna (“Try Key of G with F Natural”)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +29.849602	Ratio: 117/115
62 = Cents +187.681869	Ratio: 146/131
63 = Cents +256.596489	Ratio: 196/169
64 = Cents +343.090647	Ratio: 89/73 (JUST)
65 = Cents +493.957077	Ratio: 141/106
66 = Cents +548.648344	Ratio: 81/59 (JUST)
67 = Cents +684.728649	Ratio: 150/101
68 = Cents +729.878736	Ratio: 125/82 (JUST)
69 = Cents +871.94838	Ratio: 139/84 (JUST)
70 = Cents +985.798925	Ratio: 205/116
71 = Cents +1049.362941	Ratio: 11/6 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

46. Gamelan Udan Mas (approx) s6,p6,p7,s1,p1,s2,p2,p3,s3,p4,s5,p5

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents 0.	Ratio: 1/1 (JUST)
62 = Cents +182.403712	Ratio: 10/9 (JUST)
63 = Cents +266.870906	Ratio: 7/6 (JUST)
64 = Cents +427.372572	Ratio: 32/25 (JUST)
65 = Cents +510.367002	Ratio: 47/35 (JUST)
66 = Cents +571.725653	Ratio: 32/23 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +745.786052	Ratio: 20/13 (JUST)
69 = Cents +996.089998	Ratio: 16/9 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1126.319346	Ratio: 23/12 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)
73 = Cents +1200.	Ratio: 2/1 (JUST)

47. Kraig Grady's 7-limit "Centaur" Scale, 1987.

See Xenharmonikon 16.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +84.467193	Ratio: 21/20 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +266.870906	Ratio: 7/6 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +582.512193	Ratio: 7/5 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +764.915905	Ratio: 14/9 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

48. Harmonics 1 to 12 and Subharmonics Mixed

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +203.910002	Ratio: 9/8 (JUST)
62 = Cents +231.174094	Ratio: 8/7 (JUST)
63 = Cents +386.313714	Ratio: 5/4 (JUST)
64 = Cents +498.044999	Ratio: 4/3 (JUST)
65 = Cents +551.317942	Ratio: 11/8 (JUST)
66 = Cents +648.682058	Ratio: 16/11 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +968.825906	Ratio: 7/4 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1200.	Ratio: 2/1 (JUST)

49. Michael Harrison, *Piano Tuning for "Revelation" (2001)*

Original 1/1=F, here it is set to C.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents -27.264092	Ratio: 63/64 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +176.64591	Ratio: 567/512
64 = Cents +407.820003	Ratio: 81/64 (JUST)
65 = Cents +470.780907	Ratio: 21/16 (JUST)
66 = Cents +611.730005	Ratio: 729/512
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +674.690909	Ratio: 189/128
69 = Cents +905.865003	Ratio: 27/16 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1109.775004	Ratio: 243/128
72 = Cents +1200.	Ratio: 2/1 (JUST)

**50. Helmholtz's two-keyboard Harmonium Tuning Untempered,
24 notes per octave**

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +92.178716	Ratio: 135/128
62 = Cents +111.731285	Ratio: 16/15 (JUST)
63 = Cents +182.403712	Ratio: 10/9 (JUST)
64 = Cents +203.910002	Ratio: 9/8 (JUST)
65 = Cents +274.582429	Ratio: 75/64 (JUST)
66 = Cents +294.134997	Ratio: 32/27 (JUST)
67 = Cents +386.313714	Ratio: 5/4 (JUST)
68 = Cents +405.866283	Ratio: 512/405
69 = Cents +478.49243	Ratio: 675/512
70 = Cents +498.044999	Ratio: 4/3 (JUST)
71 = Cents +590.223716	Ratio: 45/32 (JUST)
72 = Cents +609.776284	Ratio: 64/45 (JUST)
73 = Cents +680.448711	Ratio: 40/27 (JUST)
74 = Cents +701.955001	Ratio: 3/2 (JUST)
75 = Cents +772.627428	Ratio: 25/16 (JUST)
76 = Cents +792.179997	Ratio: 128/81 (JUST)
77 = Cents +884.358713	Ratio: 5/3 (JUST)
78 = Cents +905.865003	Ratio: 27/16 (JUST)
79 = Cents +976.537429	Ratio: 225/128
80 = Cents +996.089998	Ratio: 16/9 (JUST)
81 = Cents +1088.268715	Ratio: 15/8 (JUST)
82 = Cents +1107.821284	Ratio: 256/135
83 = Cents +1178.49371	Ratio: 160/81 (JUST)
84 = Cents +1200.	Ratio: 2/1 (JUST)

51. North Indian Gamut, Modern Hindustani 12 Selected from 22 or More Shrutis

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +590.223716	Ratio: 45/32 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +905.865003	Ratio: 27/16 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

52. Carnatic Gamut. Kuppuswami: Carnatic Music and the Tamils, p. v

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +98.954592	Ratio: 18/17 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +394.347297	Ratio: 54/43 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +596.999591	Ratio: 24/17 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +800.909593	Ratio: 27/17 (JUST)
69 = Cents +905.865003	Ratio: 27/16 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1096.302298	Ratio: 81/43 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

53. Observed South Indian Tuning of a vina, Ellis

Octaves are stretched.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +97.	Ratio: 8644/8173
62 = Cents +195.	Ratio: 10974/9805
63 = Cents +312.	Ratio: 11873/9915
64 = Cents +397.	Ratio: 3372/2681
65 = Cents +515.	Ratio: 9782/7265
66 = Cents +596.	Ratio: 12731/9023
67 = Cents +692.	Ratio: 13439/9011
68 = Cents +782.	Ratio: 6031/3839
69 = Cents +883.	Ratio: 6793/4079
70 = Cents +997.	Ratio: 4863/2734
71 = Cents +1092.	Ratio: 12599/6705
72 = Cents +1207.	Ratio: 15117/7528

54. 7-limit 12-tone Scale

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +266.870906	Ratio: 7/6 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +582.512193	Ratio: 7/5 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +933.129094	Ratio: 12/7 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

55. Alternate 7-limit 12-tone Scale

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +182.403712	Ratio: 10/9 (JUST)
63 = Cents +266.870906	Ratio: 7/6 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +470.780907	Ratio: 21/16 (JUST)
66 = Cents +582.512193	Ratio: 7/5 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +933.129094	Ratio: 12/7 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

56. Kurzweil "Just with Natural b7th", is Sauveur Just with 7/4

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +590.223716	Ratio: 45/32 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +968.825906	Ratio: 7/4 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

57. 3 and 7 prime rational interpretation of 17-tET

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +62.960904	Ratio: 28/27 (JUST)
62 = Cents +140.949098	Ratio: 243/224
63 = Cents +203.910002	Ratio: 9/8 (JUST)
64 = Cents +294.134997	Ratio: 32/27 (JUST)
65 = Cents +357.095901	Ratio: 896/729
66 = Cents +435.084095	Ratio: 9/7 (JUST)
67 = Cents +498.044999	Ratio: 4/3 (JUST)
68 = Cents +561.005903	Ratio: 112/81 (JUST)
69 = Cents +638.994097	Ratio: 81/56 (JUST)
70 = Cents +701.955001	Ratio: 3/2 (JUST)
71 = Cents +764.915905	Ratio: 14/9 (JUST)
72 = Cents +842.904099	Ratio: 729/448
73 = Cents +905.865003	Ratio: 27/16 (JUST)
74 = Cents +996.089998	Ratio: 16/9 (JUST)
75 = Cents +1059.050902	Ratio: 448/243
76 = Cents +1137.039096	Ratio: 27/14 (JUST)
77 = Cents +1200.	Ratio: 2/1 (JUST)

58. 11-limit 'prime row' from Ben Johnston's "6th Quartet".

Not octave repeating, with some very narrow intervals. These are the first 30 pitches:

0 = Cents 0.	Ratio: 1/1 (JUST)
1 = Cents +70.672427	Ratio: 25/24 (JUST)
2 = Cents +182.403712	Ratio: 10/9 (JUST)
3 = Cents +274.582429	Ratio: 75/64 (JUST)
4 = Cents +386.313714	Ratio: 5/4 (JUST)
5 = Cents +505.756522	Ratio: 75/56 (JUST)
6 = Cents +568.717426	Ratio: 25/18 (JUST)
7 = Cents +733.721654	Ratio: 55/36 (JUST)
8 = Cents +772.627428	Ratio: 25/16 (JUST)
9 = Cents +884.358713	Ratio: 5/3 (JUST)
10 = Cents +923.264486	Ratio: 75/44 (JUST)
11 = Cents +1088.268715	Ratio: 15/8 (JUST)
12 = Cents +1151.229619	Ratio: 35/18 (JUST)
13 = Cents +1221.902045	Ratio: 875/432
14 = Cents +1333.633331	Ratio: 175/81 (JUST)
15 = Cents +1425.812047	Ratio: 875/384
16 = Cents +1537.543332	Ratio: 175/72 (JUST)
17 = Cents +1656.986141	Ratio: 125/48 (JUST)
18 = Cents +1719.947045	Ratio: 875/324
19 = Cents +1884.951273	Ratio: 1925/648
20 = Cents +1923.857046	Ratio: 875/288
21 = Cents +2035.588332	Ratio: 175/54 (JUST)
22 = Cents +2074.494105	Ratio: 875/264
23 = Cents +2239.498333	Ratio: 175/48 (JUST)
24 = Cents +2302.459237	Ratio: 1225/324
25 = Cents +2373.131664	Ratio: 30625/7776
26 = Cents +2484.862949	Ratio: 6125/1458
27 = Cents +2577.041666	Ratio: 30625/6912
28 = Cents +2688.772951	Ratio: 6125/1296
29 = Cents +2808.215759	Ratio: 4375/864
30 = Cents +2871.176663	Ratio: 30625/5832

59. 1/9-Harrison's comma mean-tone scale

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +74.23293	Ratio: 8315/7966
62 = Cents +192.63798	Ratio: 6334/5667
63 = Cents +266.870906	Ratio: 7/6 (JUST)
64 = Cents +385.27596	Ratio: 6671/5340
65 = Cents +503.68101	Ratio: 13025/9737
66 = Cents +577.91394	Ratio: 2632/1885
67 = Cents +696.31899	Ratio: 14567/9743
68 = Cents +770.55192	Ratio: 9743/6243
69 = Cents +888.95697	Ratio: 1885/1128
70 = Cents +963.1899	Ratio: 13187/7560
71 = Cents +1081.59495	Ratio: 1780/953
72 = Cents +1200.	Ratio: 2/1 (JUST)

60. Rousseau's Monochord, Dictionnaire de musique (1768)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +70.672427	Ratio: 25/24 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +568.717426	Ratio: 25/18 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

61. Persian santur tuning. 1/1=E in Original

Here it is set to C. Note that scale is 8 notes per octave, so it will not map normally to a 12 note keyboard.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +129.99971	Ratio: 10727/9951
62 = Cents +345.	Ratio: 4710/3859
63 = Cents +490.00034	Ratio: 5797/4368
64 = Cents +630.00051	Ratio: 8153/5666
65 = Cents +849.99952	Ratio: 13952/8539
66 = Cents +1034.99975	Ratio: 20/11 (just)
67 = Cents +1137.00011	Ratio: 15866/8227
68 = Cents +1200.	Ratio: 2/1 (JUST)
69 = Cents +1329.99971	Ratio: 21454/9951
70 = Cents +1545.	Ratio: 18281/7489
71 = Cents +1690.00034	Ratio: 5797/2184
72 = Cents +1830.00051	Ratio: 28347/9850
73 = Cents +2049.99952	Ratio: 32211/9857
74 = Cents +2234.99975	Ratio: 36331/9991
75 = Cents +2337.00011	Ratio: 38073/9871
76 = Cents +2400.	Ratio: 4/1 (JUST)

62. Vallotti & Young (Vallotti Version)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +94.135	Ratio: 10487/9932
62 = Cents +196.09	Ratio: 10851/9689
63 = Cents +298.045	Ratio: 4679/3939
64 = Cents +392.18	Ratio: 3843/3064
65 = Cents +501.955	Ratio: 5467/4091
66 = Cents +592.18	Ratio: 13863/9847
67 = Cents +698.045	Ratio: 8182/5467
68 = Cents +796.09	Ratio: 13019/8220
69 = Cents +894.135	Ratio: 2427/1448
70 = Cents +1000.	Ratio: 17189/9647
71 = Cents +1090.225	Ratio: 18484/9847
72 = Cents +1200.	Ratio: 2/1 (JUST)

**63. LaMonte Young, Tuning of For Guitar '58. 1/1 March '92,
inv.of Mersenne lute 1**

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +182.403712	Ratio: 10/9 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +590.223716	Ratio: 45/32 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +1017.596288	Ratio: 9/5 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

64. LaMonte Young's Well-Tuned Piano

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +176.64591	Ratio: 567/512
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +239.606814	Ratio: 147/128
64 = Cents +470.780907	Ratio: 21/16 (JUST)
65 = Cents +443.516816	Ratio: 1323/1024
66 = Cents +674.690909	Ratio: 189/128
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +737.651813	Ratio: 49/32 (JUST)
69 = Cents +968.825906	Ratio: 7/4 (JUST)
70 = Cents +941.561815	Ratio: 441/256
71 = Cents +1172.735908	Ratio: 63/32 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

65. Thomas Young - well temperament (1807). Also Luigi Malerbi nr.2 (1794)

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +90.224996	Ratio: 256/243
62 = Cents +196.09	Ratio: 10851/9689
63 = Cents +294.134997	Ratio: 32/27 (JUST)
64 = Cents +392.18	Ratio: 3843/3064
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +588.269995	Ratio: 1024/729
67 = Cents +698.045	Ratio: 8182/5467
68 = Cents +792.179997	Ratio: 128/81 (JUST)
69 = Cents +894.135	Ratio: 2427/1448
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1090.225	Ratio: 18484/9847
72 = Cents +1200.	Ratio: 2/1 (JUST)

Original 1/1 on C#, here it is set to C.

60 = Cents 0.	Ratio: 1/1 (JUST)
61 = Cents +111.731285	Ratio: 16/15 (JUST)
62 = Cents +203.910002	Ratio: 9/8 (JUST)
63 = Cents +315.641287	Ratio: 6/5 (JUST)
64 = Cents +386.313714	Ratio: 5/4 (JUST)
65 = Cents +498.044999	Ratio: 4/3 (JUST)
66 = Cents +609.776284	Ratio: 64/45 (JUST)
67 = Cents +701.955001	Ratio: 3/2 (JUST)
68 = Cents +813.686286	Ratio: 8/5 (JUST)
69 = Cents +884.358713	Ratio: 5/3 (JUST)
70 = Cents +996.089998	Ratio: 16/9 (JUST)
71 = Cents +1088.268715	Ratio: 15/8 (JUST)
72 = Cents +1200.	Ratio: 2/1 (JUST)

Appendix G: Categorized Program List

Bank		Program	Category	
1	0	1	It's An Oberheim	pad
1	0	2	Hero Brass	brass
1	0	3	OB-X Pad	pad
1	0	4	PressurePluck	arp
1	0	5	Tommy	bass
1	0	6	Saka Keys	poly
1	0	7	Glitterati	poly
1	0	8	2001 Choir	voice
1	0	9	Belladonna	bell
1	1	0	Stargazer	pad
1	1	1	TeoEspressivo	lead
1	1	2	Reed Between	keys
1	1	3	Shimmer String	string
1	1	4	Snap Bass	bass
1	1	5	Smokey Organ	organ
1	1	6	Sync Growl	lead
2	0	1	Rock Cliche	poly
2	0	2	Waterfall Cavern	arp
2	0	3	Zizzle Touch	poly
2	0	4	Fragile Stability	poly
2	0	5	Zuma's Brass	brass
2	0	6	Burnished	pad
2	0	7	Organic	organ
2	0	8	Perforator Lead	lead
2	0	9	Eagerly	pluck
2	1	0	Proud Nerd	keys
2	1	1	Landing Pad	pad
2	1	2	TEO Pluck	pluck
2	1	3	GOAT MW	lead
2	1	4	Dark Side	pad
2	1	5	Balorean	arp
2	1	6	Abduction	sfx

3	0	1	Bowin'	string
3	0	2	Glacial	pad
3	0	3	Eastern Bells	bell
3	0	4	Baumann's Seq	arp
3	0	5	Pulse Ping	pluck
3	0	6	LeadReed	lead
3	0	7	Bounce Back	poly
3	0	8	BuzzFlow	poly
3	0	9	Super Collider	poly
3	1	0	Plektrum	pluck
3	1	1	Rosewood Perc	Tuned Perc
3	1	2	Solid Square	bass
3	1	3	Dirty Keys	keys
3	1	4	Bandpass Arp	arp
3	1	5	Life Clock	sfx
3	1	6	Mouth Pad	voice
4	0	1	Tomita Bells	bell
4	0	2	Harmonic Dream	poly
4	0	3	ElectroBody Bass	bass
4	0	4	Clavinator	keys
4	0	5	OB-X Glide Pad	pad
4	0	6	Bouncy Min9	lead
4	0	7	Malletizer	arp
4	0	8	PadGPT	pad
4	0	9	Coronet	brass
4	1	0	Teo Keys	keys
4	1	1	Unisynx Five	lead
4	1	2	Ethereal HPSCHD	keys
4	1	3	Seagulls Arp	arp
4	1	4	Strummer	string
4	1	5	SynthpopString	string
4	1	6	Alien Modular Foo	sfx

Bank		Program		Category
5	0	1	Latenight 4am	poly
5	0	2	Black & Blue	poly
5	0	4	BronzeGongs	bell
5	0	3	Haus Bazz	bass
5	0	5	Calm The CPU	arp
5	0	6	Expo2k Chord	lead
5	0	7	Nuwave Shift MW	poly
5	0	8	Quintuple Mono	bass
5	0	9	Noisy Afterall	poly
5	1	0	Weeping Wah	lead
5	1	1	Industry Beat	sfx
5	1	2	Flutey Keypad	poly
5	1	3	Bite Force	bass
5	1	4	Plogku	pluck
5	1	5	Star Crystals	sfx
5	1	6	Cinematique	pad
6	0	1	FlyLike a TEO	lead
6	0	2	Space Hiccups	poly
6	0	3	Acid Basser	bass
6	0	4	Babypluck	pluck
6	0	5	High Wire	poly
6	0	6	M12 Brazz	brass
6	0	7	Bluey Arp	arp
6	0	8	Paleocene Pad	pad
6	0	9	Wet & Wild Bass	bass
6	1	0	Pins & Needles	poly
6	1	1	AluminumGroup	poly
6	1	2	FM Perks	perc
6	1	3	Jumbler	pad
6	1	4	Sans Seraphim	voice
6	1	5	Nickel Clavicord	keys
6	1	6	Jets5	sfx

7	0	1	Frantasia	pluck
7	0	2	Infinite Power	bass
7	0	3	Space Pollen	arp
7	0	4	Solar Memories	pad
7	0	5	Anno D2	poly
7	0	6	Stimdrink Lead	lead
7	0	7	Digital Age	poly
7	0	8	StateShifter	pad
7	0	9	Pearl Pipes	organ
7	1	0	Carillon	bell
7	1	1	Solo String	string
7	1	2	Santur	poly
7	1	3	Send Signals Up	sfx
7	1	4	Magic Arp	arp
7	1	5	Rising Pulse (MW)	poly
7	1	6	Triangles	Tuned Perc
8	0	1	Lil Lips	brass
8	0	2	Vibey Thing	Tuned Perc
8	0	3	FlootyToot	poly
8	0	4	Trampled Bass	bass
8	0	5	Wanderer	pad
8	0	6	Processional	organ
8	0	7	Dusty Flangarp	arp
8	0	8	Cat Piss Oxide	poly
8	0	9	Chatty Bells	bell
8	1	0	Lead Alive	lead
8	1	1	Afterglow	arp
8	1	2	Trancendance	poly
8	1	3	Modular?	arp
8	1	4	HarpsiTines	keys
8	1	5	Lead LEAD	lead
8	1	6	Cushion Pad	pad

Bank		Program		Category
9	0	1	OB-8 SoftSweep	poly
9	0	2	Life's Been Gd	sfx
9	0	3	Introvert	poly
9	0	4	Intervalics	poly
9	0	5	Phat Boi	bass
9	0	6	OB-Xa Brass PWM	brass
9	0	7	Zippy Syncy	arp
9	0	8	Dreamtime Breath	pad
9	0	9	Gamelan	bell
9	1	0	Textures	poly
9	1	1	S&H Bass	bass
9	1	2	Razorlight	poly
9	1	3	Put Everything in it	poly
9	1	4	Overruled Lead	lead
9	1	5	Riser Reaper	sfx
9	1	6	Up Stroke Down	arp
A	0	1	Major Talk	lead
A	0	2	GX Dreams	poly
A	0	3	Buzzy Blob Bass	bass
A	0	4	TEOcaster	string
A	0	5	Harp Runner	arp
A	0	6	Lush Squares	pad
A	0	7	Tank The Co. (PW)	poly
A	0	8	Pipeline Pluck	pluck
A	0	9	Throaty 303	bass
A	1	0	Hollowspit	poly
A	1	1	Sunset Rays	pad
A	1	2	Kaytra Vibe	poly
A	1	3	Pads 90 Eighteen	pad
A	1	4	NemoClavier	keys
A	1	5	Harpies	keys
A	1	6	Millennium Mambo	poly

B	0	1	Springboard	poly
B	0	2	GradualExpansion	pad
B	0	3	Super Notch	lead
B	0	4	Tin Tines	keys
B	0	5	OB-X S & H	poly
B	0	6	Ring Laboratory	arp
B	0	7	Bizarreau	lead
B	0	8	Buster Organ	organ
B	0	9	Magical Bells	bell
B	1	0	Sweep Mocean	poly
B	1	1	PluckyWaaWhls	pluck
B	1	2	Zeetar	string
B	1	3	Just Too Rude	poly
B	1	4	Exoerance	poly
B	1	5	Fields Pad	pad
B	1	6	OnlyStonesRemain	poly
C	0	1	The Grind	bass
C	0	2	Warm Pad	pad
C	0	3	Obee Time	poly
C	0	4	Paddy Gates	pad
C	0	5	Super Harmonik	poly
C	0	6	Tine Tune Time	arp
C	0	7	MixedNsemble	brass
C	0	8	Plucked Repeater	pluck
C	0	9	Gzyoww	poly
C	1	0	Hard Band Bass	bass
C	1	1	Familiar Sync	lead
C	1	2	Velimba	Tuned Perc
C	1	3	StudentArtFilm	poly
C	1	4	Steppy Arpy	arp
C	1	5	Death Ray	sfx
C	1	6	Fabric Soft	poly

Bank		Program		Category
D	0	1	Vaguely Prog?	poly
D	0	2	Tour de Bass	bass
D	0	4	Sparklage	arp
D	0	3	Shamisen-Like	pluck
D	0	5	Pulsaar	pad
D	0	6	Tine To Shine	keys
D	0	7	Synth Gtr Lead	lead
D	0	8	Buzzard Brass	brass
D	0	9	Orchestron	string
D	1	0	Noisy Bass	bass
D	1	1	Res-y Pad	pad
D	1	2	Ghosts of Ireland	poly
D	1	3	Picky Lead	lead
D	1	4	Silence Structures	pad
D	1	5	Odd Overtone	Tuned Perc
D	1	6	Electromechanik	keys
E	0	1	Aggro 808	perc
E	0	2	Snares	perc
E	0	3	Toms	perc
E	0	4	SnapS+Claps	perc
E	0	5	BrightCymbals	perc
E	0	6	SEM Swirl	pad
E	0	7	Fizzy Lead	lead
E	0	8	Kitchen Sync	lead
E	0	9	Xylophone	Tuned Perc
E	1	0	Bass Front	bass
E	1	1	Machinery	arp
E	1	2	Vintage Wows	poly
E	1	3	Digibubblz	poly
E	1	4	Fairy Magic	arp
E	1	5	Lofi Pad	pad
E	1	6	Comp Splitoon	keys

F	0	1	Teo~Pad	pad
F	0	2	XTeoC	poly
F	0	3	Sterile Piano	keys
F	0	4	Sub0Bass	bass
F	0	5	HAL 8086	sfx
F	0	6	Undercurrent Pad	pad
F	0	7	Octaves Arp	arp
F	0	8	Rhythmix	poly
F	0	9	Pip Squeak	pluck
F	1	0	Steel Jers	bell
F	1	1	Velo Octaves	poly
F	1	2	A Fifth of TEO	pad
F	1	3	Klavinot	keys
F	1	4	Jacob'sLadder	poly
F	1	5	Bossy Bass	bass
F	1	6	Sad Tangerine	poly
G	0	1	Triangle Lead	lead
G	0	2	Party Starter	arp
G	0	3	Morse Pad	pad
G	0	4	Secret Treasure	poly
G	0	5	x4RP-PR4x	arp
G	0	6	Prime Organ	organ
G	0	7	Bass Kalimba	Tuned Perc
G	0	8	Double Vision	poly
G	0	9	Mettle Pd	pad
G	1	0	Foreshore	pluck
G	1	1	2049	pad
G	1	2	Pot Lids	arp
G	1	3	Astral Dominator	bass
G	1	4	Harpsorgan	organ
G	1	5	Handperc	perc
G	1	6	Spiral flow	poly

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