TC-11

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TC-11

Version 1.0
User Guide

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Getting Started

Introduction

Thank you for purchasing **TC-11**. Your support is greatly appreciated, and it means I can continue developing innovative music apps for iOS and Mac OS X. **TC-11** is the product of countless hours of programming and research into synthesizer controller design.

Your comments, feedback, and news are important to me. If you use **TC-11** in a performance or recording, please let me know through the website [www.bitshapesoftware.com] or email [bitshapesoftware@gmail.com]. Your creative output is one of the reasons making software instruments is rewarding.

TC-11 Overview

TC-11 is a programmable modular synthesizer on the iPad, controlled by multitouch and device motion controllers. All synthesis parameters can be controlled by these two sources, which allows the user to create countless unique patch configurations.

TC-11 does not have on-screen objects to control during performance. Instead, the performer's touches generate the control information. Some controllers are driven by a single touch. For example, the speed of the touch as it moves around the screen is its *Touch Speed*. Other controllers are generated with multiple touches, such as *Distance to Previous Touch*, where the positions of two touches are compared. Finally, the iPad's device motion capabilities can be used as controllers. The accelerometer, gyroscope and compass can be assigned to **Parameters** to turn your iPad into a expressive motion controller.[1]

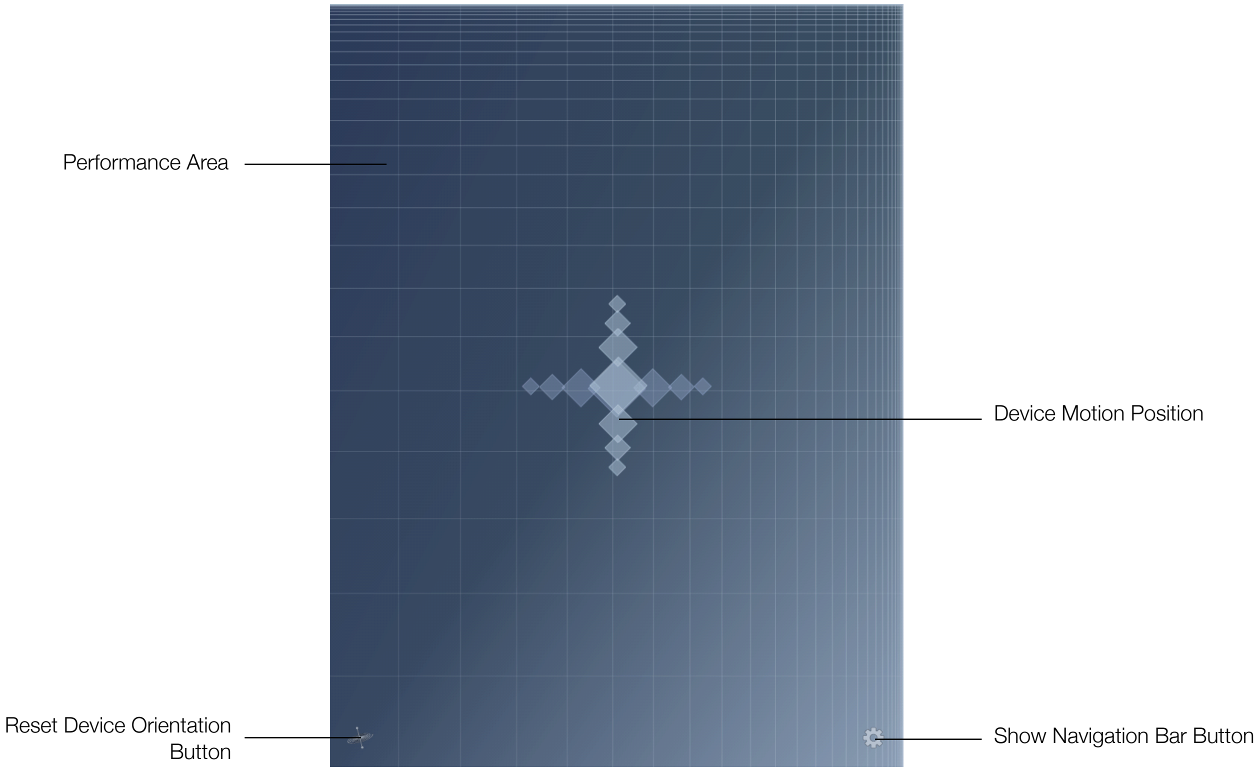
The synthesizer is modular, and uses common **Synth Objects** such as wavetable oscillators, filters, amplifiers, and effects. In addition, there are **AHDSR**, **LFO**, and **Sequencer Modules** that can be used for synth parameter control. Users can activate different **Synth Objects** and **Modules**, then assign multitouch controllers to them to build custom patches.

[1] Gyroscope and compass functionality is not available on the first generation iPad

Interface Overview

In the following pages we will look at the individual sections of the **TC-11** interface. This will help you navigate through the app and familiarize you with the interface. More information about the individual objects and **Modules** can be found in later sections.

1.1 Performance View



Performance View

1.2 Performance Area

The entire screen is used as the performance area. Use multiple simultaneous touches to control your patch's **Parameters**. As you touch the screen, the graphic display will update to show you which types of controllers are active, and what their positions or values are.

1.3 Device Motion Position

When device motion controllers are used (accelerometer, gyroscope, compass), the position of the device will be represented by shifting diamonds on the **Performance View**. Each axis of movement is represented by its own graphic. The accelerometer measures movement along the x-axis, y-axis, and z-axis of the device. The gyroscope measures the devices position as pitch, roll, and yaw. The compass points to the magnetic north heading. Move or rotate the device along its axes to determine the correct motion to use for each controller.

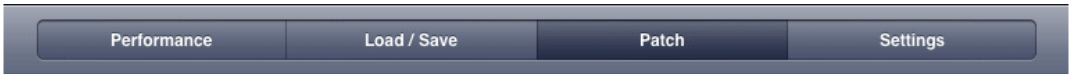
1.4 Reset Device Orientation Button

When the gyroscope is in use, you can reset the 'natural' position of the device by double-tapping this button. The pitch, roll, and yaw positions will all be zeroed. You can reset the orientation any time during performance.

1.5 Show Navigation Bar Button

Double-tap this button to show the **TC-11 Navigation Bar**.

2.1 Navigation Bar



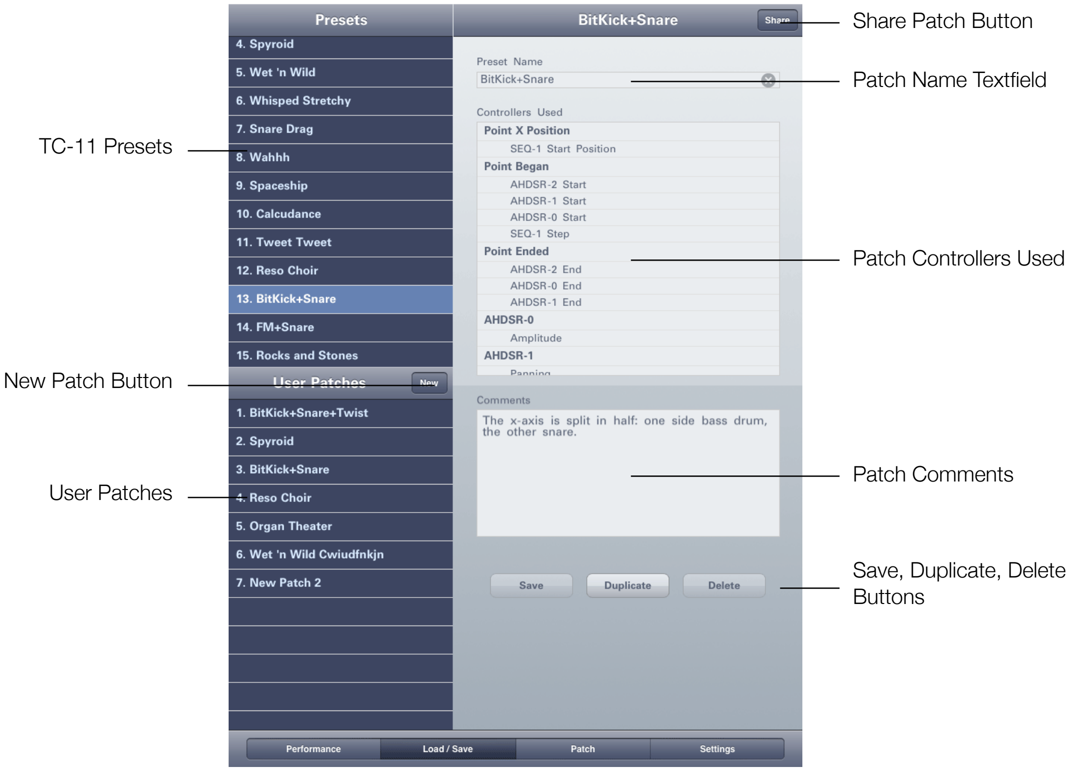
Navigation Bar

Show the **Navigation Bar** by double-tapping the **Show Navigation Bar Button** in the **Performance View**. Here you can switch between views. **TC-11** will fade out the sound when you switch away from the **Performance View**.

2.2 TC-11 Views

The **Performance View** is where you can play the currently loaded patch. The **Load / Save View** is where you can load, save, duplicate, rename and share patches. In the **Patch View**, you can access the **Synth Objects** and **Modules** to edit the currently loaded patch. The **Settings View** allows you to change the display style and colors, and has a quick help reference area.

3.1 Load / Save View



4. Spyroid
5. Wet 'n Wild
6. Whisped Stretchy
7. Snare Drag
8. Wahhh
9. Spaceship
10. Calcudance
11. Tweet Tweet
12. Reso Choir
13. BitKick+Snare
14. FM+Snare
15. Rocks and Stones

1. BitKick+Snare+Twist
2. Spyroid
3. BitKick+Snare
4. Reso Choir
5. Organ Theater
6. Wet 'n Wild Cwiudfnkjn
7. New Patch 2

Preset Name: BitKick+Snare

Controllers Used

Point X Position
SEQ-1 Start Position
Point Began
AHDSR-2 Start
AHDSR-1 Start
AHDSR-0 Start
SEQ-1 Step
Point Ended
AHDSR-2 End
AHDSR-0 End
AHDSR-1 End
AHDSR-0
Amplitude
AHDSR-1
Panning

Comments: The x-axis is split in half: one side bass drum, the other snare.

Load / Save View

The **Load / Save View** is your portal to loading, saving, duplicating, importing and exporting **TC-11** patches. This is the best place to start exploring what **TC-11** has to offer. The included presets demonstrate of variety of control styles and patch constructions.

When working on your own patches, **TC-11** will keep a working copy saved in a temporary location in case you leave the app. However, it is a good idea to save your work permanently by visiting this view.

3.2 TC-11 Presets

Tap a patch name in this list to load one of the included **Preset Patches**. When the patch loads you will see its information displayed in the rightmost column. The included presets cannot be deleted or overwritten, but they can be duplicated into the

User Patches. It is often a good idea to start with a preset patch, edit the parameters, and save your own customized version in the **User Patches**.

3.3 New Patch Button

The **New Patch** button creates a blank patch template in your **User Patches**. Keep in mind that it may be easier to modify a pre-existing patch than start from scratch. Simply **Duplicate** the edited patch to save your new version.

3.4 User Patches

The **User Patches** list your saved custom patches. Tap the name of a patch to load it for performance. Patches that you build will be listed here along with any patches that you import via iTunes or email.

> *Tip: Backing Up Your Patches*
>
> *Your **User Patches** will be listed in iTunes when you connect your iPad. Under the **Apps Tab** for your iPad in iTunes, scroll down to the **File Sharing** section. Here you can add or delete **TC-11** patches (even while the app is running), and copy them to your computer. It is advisable that you back up your patch collection frequently by copying the patch files to your desktop computer.*

It is possible that patches created with newer versions of **TC-11** will not load in earlier versions. If that is the case, a warning will appear when you attempt to load it and the patch will be removed from your **TC-11** documents folder.

3.5 Share Patch Button

Press this button to email the currently loaded patch to a friend. **TC-11** will automatically open a new email window with the patch included as an attachment. When the recipient receives the email on their iPad, they can simply tap the attachment to automatically load the file into **TC-11**.

TC-11 patches have a ‘.tcp’ file extension.

3.6 Patch Name Textfield

Edit the currently loaded patch name. While **Preset Patches** cannot be overwritten, you can change the name then duplicate the patch into your **User Patches** for editing.

3.7 Patch Controllers Used

TC-11 has a large number of control options. When loading a patch, the **Controllers Used** list will show the controllers and **Modules** used by the patch, plus the **Parameters** they target. This list can help you understand how the patch can be played. It can also help pinpoint which synth parameter to change if you want to edit the patch.

3.8 Patch Comments

Saved with each patch is a **Comments** section. The **Comments** can include helpful information about the patch such as the author's name, specific performance instructions, or just general notes about the way the patch was built.

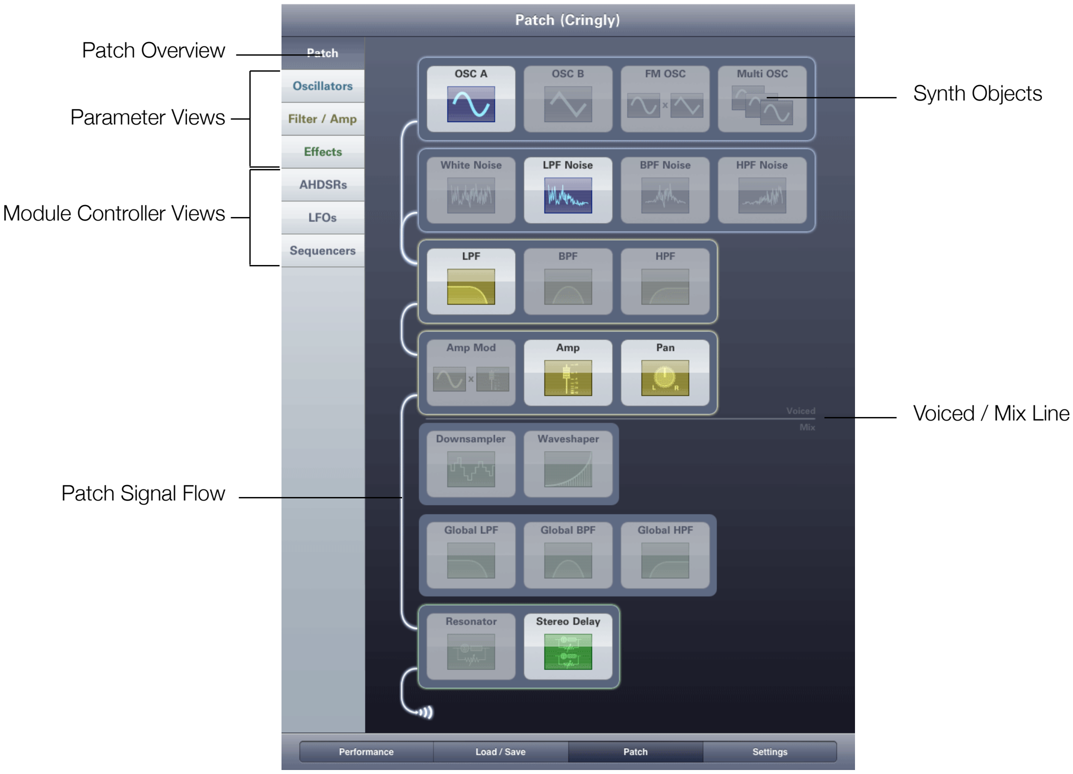
3.9 Save, Duplicate, and Delete Buttons

The **Save** button will overwrite the user patch with the name currently in the **Patch Name Textfield**. Because **Preset Patches** cannot be overwritten, this option is not available when the loaded patch is a preset.

The **Duplicate** button is always available. It makes a copy of the current patch and puts it in the **User Patches**. Use this button to 'save' **Preset Patches** into your **User Patches** for editing. If another user patch has the same name as the current patch, it will incrementally number the newly duplicated patch.

The **Delete** button permanently deletes the currently loaded patch. This action cannot be undone. Because **Preset Patches** cannot be overwritten, this option is not available when the loaded patch is a preset.

4.1 Patch View



Patch View

The **Patch View** contains the guts of the **TC-11**, and always displays the currently loaded patch. It is the editing area. Pictured above is the **Patch Overview**, where you can enable the **Synth Objects** you want for your patch. By selecting a tab in the left column you can edit individual **Parameters**, or build a **Module** controller.

4.2 Patch Overview

Select this button to view the **Patch Overview**. Here you can see the **Synth Objects** listed from top to bottom. Tap an object once to enable or disable it. Groups of objects (objects sharing the same outline) may only allow one or two objects to be enabled simultaneously.

4.3 Parameter Views

Choosing the **Oscillator**, **Filter / Amp**, or **Effects** button will show the currently active **Parameters** for those groups. The content of these areas is determined by which **Synth Objects** are currently enabled. For example, when *Oscillator A* is enabled, the **Oscillator** tab will show the following **Parameters**: *Oscillator A Waveform, Oscillator A Frequency,* and *Oscillator A Level.*

More information about editing your patch in these views can be found in [Programming Parameters, p. 24].

4.4 Module Controller Views

TC-11 has three types of customizable **Module** controllers: envelope generators (**AHDSRs**), low frequency oscillators (**LFOs**), and step sequencers (**Sequencers**). Tap the corresponding button to create, edit or delete these controllers for your patch.

More information about working with **Modules** can be found in [Module Programming, p. 30].

4.5 Patch Signal Flow

The glowing line that connects the **Synth Object** groups shows the audio signal flow of your patch from top to bottom. For example, if the *Waveshaper* object is active, and the *Global LPF* object is active, the signal will pass through the *Waveshaper* before going through the *Global LPF*.

The speaker icon at the bottom is the end of the chain: your iPad's speakers or headphone output.

4.6 Synth Objects

The **Synth Objects** are the guts of your patch. By enabling objects you activate different parts of the synthesizer. Before diving into the deep control options, it is a good idea to understand the basic flow of your patch.

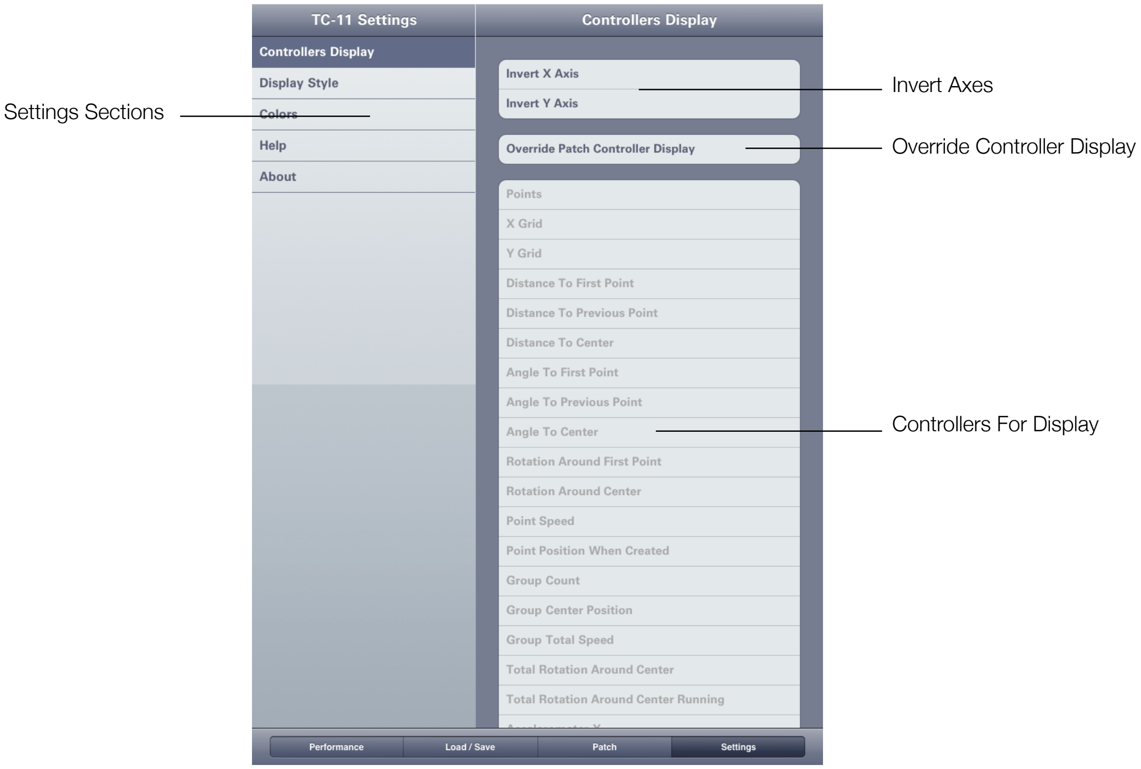
More information about patch construction can be found in [Synth Objects Explained, p. 21].

4.7 Voiced / Mix Line

This line separates the **Synth Objects** that represent individual control of touch voices, and those that affect the combined group audio signal. Above the **Voiced / Mix Line** are voiced objects, and below are mixed objects.

More information about patch construction can be found in [Patch Editing, p. 17].

5.1 Settings View



TC-11 Settings

- Controllers Display
- Display Style
- Colors
- Help
- About

Controllers Display

- Invert X Axis
- Invert Y Axis
- Override Patch Controller Display
- Points
- X Grid
- Y Grid
- Distance To First Point
- Distance To Previous Point
- Distance To Center
- Angle To First Point
- Angle To Previous Point
- Angle To Center
- Rotation Around First Point
- Rotation Around Center
- Point Speed
- Point Position When Created
- Group Count
- Group Center Position
- Group Total Speed
- Total Rotation Around Center
- Total Rotation Around Center Running

Settings View

The **Settings View** is where you can set global options that are not directly related to the current patch or synthesis, such as display settings and color changes. The **Settings View** also has a quick help reference section.

5.2 Settings Sections

The **Controllers Display** section allows you to customize the way the **Performance View** displays controller data. You can invert the screen axes, and choose exactly which controllers you wish to display for aesthetic purposes.

5.3 Invert Axes

One important aspect about **TC-11**'s **Performance View** is that it does not rotate the performance area when the device is rotated. This means that the x and y-axes will stay locked with the physical screen of the device even if you rotate the **Navigation Bar** from vertical to horizontal.

Because each user may have a preferred way of holding their iPad, you can flip the positive / negative orientation of each axis separately. Controllers that directly reference the touch position on the screen will be affected.

It is important to realize that this option is for holding the device in a different way, and should not be used as a way to individually flip a particular controller. Each individual controller can be inverted, including axis-related controllers. If you have a stand or strap that holds your iPad in a particular way, it may be useful to set this permanently.

> *Example:*
>
> *Load preset #7 - GrungeKick+Snare. The lower half of the x-axis is used for the kick drum, and the upper half is used for the snare. Then invert the x-axis in the Settings, and the roles are reversed without having to edit the patch.*

5.4 Override Controller Display

Each patch uses a set of controllers to drive its **Synth Objects**. By default, the only controllers that will draw to screen in the **Performance View** are those used by the currently loaded patch. This is to assist with performance: you can see exactly what touch movements matter, and which do not.

The **Override Patch Controller Display** option is for performers who want an unrelated set of controllers to display in the **Performance View** when they play. This is an aesthetic function only: controllers that have not been programmed into the patch will not affect **Parameters**.

5.5 Controllers For Display

If the **Override Patch Controller Display** option is turned on, you can choose which controllers to display in the **Performance View** from this list. Remember: this is an aesthetic option only. The controllers that are being displayed are not doing anything (except looking good).

Performance

Performance Basics

TC-11 was designed from the ground up as a multitouch driven synthesizer. That is to say, the multitouch data itself is what controls synthesis. Some synthesizers have buttons, sliders, and other on-screen objects that are controlled with a multitouch interface. In these systems, the multitouch capability is meant to enhance the interface accessibility, but it is not the means of control.

TC-11 takes a different approach. The multiple touches on the screen are examined, and relationships between them are used as controller data streams. Take this example: in a traditional synthesizer, there may be a knob that controls the synth volume. The user touches the screen to move the knob, which changes the volume. With TC-11, that job will be given to a touch controller. Perhaps the volume of a synth voice will be controlled by a touch's distance to another touch. The farther the distance between the touches, the louder the volume.

> *Example:*
>
> *Load preset #3 - MStretch. With two touches held down, move the touches closer and farther to one another and listen to the volume and modulation rate change. Then, twist the two touches around one another to change the angle, and hear the result.*

The power of this system is the ability to create complex synth responses using sets of simple touch controllers. When a patch uses multiple touch controllers, the performative capabilities change dramatically depending on the style of performance. In the same way that a violin's sound changes based on many variables (bow position, bow speed, finger pressure, vibrato, etc.), TC-11 patches can draw from many multitouch motions to create complex instruments.

Voice Allocation

Each touch in the Performance View is given its own synthesis voice allocation. In essence, each touch produces its own tone. When the touch begins, it is common for an AHDSR envelope generator to 'open up' the amplitude for that voice, much the same way a key on a keyboard starts a tone. However, it is not always so simple.

Some patches will allow the voices' tones to be heard continuously, while the touches modify the way those tones are filtered. Others will delegate the starting and stopping of voice amplitude envelopes to a **Sequencer**. Regardless of how a voice is heard, the same one-to-one principle of touch-to-voice still applies.

TC-11 has eight [8] voice polyphony. Put another way, **TC-11** can support up to eight [8] simultaneous touches. When a ninth touch is placed, the earliest touch will be dropped in favor of the new touch.

Device Motion

The physical motion of the iPad can be used as a controller. You can turn and twist the device to change filters and effects, or even create vibrato through movement. The screen will display an orientation graphic that will move based on the motion of the device. Follow the graphic carefully to learn how to maneuver the iPad.

For more information about **Device Motion**, see [Device Motion Controllers, p. 18].

Connecting to an Amplifier

TC-11 generates full-frequency audio synthesis. While the iPad speaker is adequate for auditioning patches and casual performance, the full sound and stereo imaging of **TC-11** is best heard through a set of quality speakers. Connect the headphone jack output of the iPad to an auxiliary input of your home stereo (using an 1/8" to stereo RCA cable), or to any professional mixing board and loudspeaker system for best results.

You may wish to disconnect the USB cable from the iPad, as unwanted bus noise can enter your signal output.

Performance Tips

When first performing any patch, try a variety of touch interactions. Some patches are designed to be held down for long durations, others are meant to be 'plucked' with short touches. Here are a few common gestures that can trigger complex responses from patches:

- Hold multiple touches down, and move them around the screen
- Change the number of touches on the screen
- Move touches around the screen quickly, or slowly

- ‘Throw’ the touches by moving them quickly, then releasing
- ‘Pluck’ the screen by tapping and releasing quickly
- ‘Stretch’ a group of touches by moving them farther apart, then closer together
- ‘Twist’ a group of touches like you are turning a knob

Be aware that while some patches may feel as though they are sensitive to touch pressure, the iPad does not respond to touch pressure. Use a light touch when performing **TC-11**. The capacitive touch screen is sensitive to the charge of your finger, not the pressure it exerts on the screen (that is a resistive touch screen).

If you are performing **TC-11** in a live show, you may wish to turn off your iPad’s automatic sleep function (Auto-Lock). You can turn off this function in the iPad’s Settings, under General.

Also, be sure to turn off Multitasking Gestures in the iPad’s Settings, under General. Otherwise, moving groups of touches may close the app, or switch to another open app.

Patch Editing

Controllers Explained

Controllers are the way **TC-11** adjusts **Parameters** in real-time. They are the ‘invisible hands’ that change values like oscillator frequency, filter resonance, delay time, **LFO** rate, or any other value.

The majority of what makes a **TC-11** patch unique is its controller setup. A patch that uses a **Sequencer** to control the frequency of an oscillator will act very differently than one using the touches’ *Distance to First Touch*. When multiple controllers are used to control different areas of the patch, they generate exciting sonic results.

6.1 Voiced vs. Global Controllers

Some controllers generate their values by following a single touch voice [Voice Allocation, p. 14]. These controllers are ‘voiced’ controllers. A simple example of a voiced controller is *Touch X Position*. Each touch has its own position along the x-axis, and the controller reports that position *only* to the voice associated with that touch.

Other controllers may depend on the entire collection of touches to generate their value. These controllers are ‘global’ controllers. A basic global controller is *Group Count*. This controller sends a value based on the number of currently held touches (between 0-8). This number is not unique to a single touch voice, and so the controller will report the same value to *every* voice that follows it.

When assigning controllers to **Parameters**, it is important to know whether the parameter should follow a voiced or global controller. More information about controllers can be found in the following section.

7.1 Controller Types

TC-11 has a variety of controllers to use when building patches, most of which pull data directly from multitouch relationships. There are three types of controllers:

1. Touch-based controllers
2. **Device Motion** controllers
3. **Module** controllers (**LFO**, **AHDSR**, **Sequencer**)

In this section, the different controller types will be explained.

7.2 Touch-based Controllers

Touch-based controllers are created by touching the screen in the **Performance View**. Multitouch data streams are built by comparing these touches to one another.

There are two types of touch controllers. **Single Touch Controllers** are voiced controllers. ‘Single’ refers to the fact that the controller is following a single touch. In many cases more than one touch is needed to generate the data. For example, the *Angle To Previous Touch* checks the position of two touches to find the angle they create on the screen. The latter touch (the one created second) gets sent the *Angle To Previous Touch* controller data.

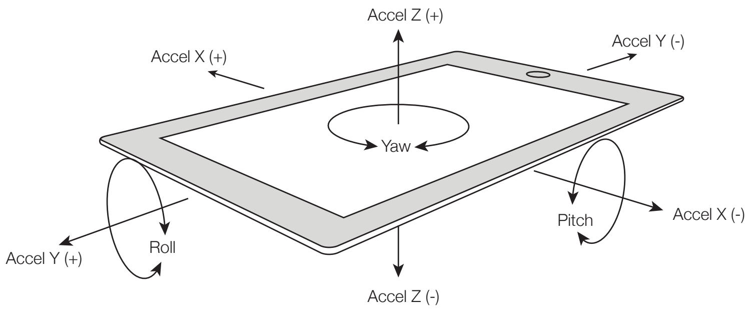
Group Touch Controllers are global controllers. They examine the entire collection of active touches (the group) to generate their data. One example is *Total Distance To Center*, which sums all of the touches’ distances to the center of the screen.

AHDSR and **Sequencers** need triggers to start and stop them. There are **Single Touch Triggers** and **Group Touch Triggers** that can target those parameters. **Single Touch Triggers** are voiced triggers, and **Group Touch Triggers** are global.

7.3 Device Motion Controllers

Device Motion controllers are global controllers that pull data from the physical movement of the iPad. There are three [3] device motion sensors: the accelerometer, the gyroscope, and the compass.[2] The accelerometer measures the rate of change in the device’s motion through three [3] axes. The gyroscope measures the device’s position in space by describing its rotation around three [3] axes. Finally, the compass compares the direction of the device to a fixed heading: magnetic north.

[2] Gyroscope and compass functionality is not available on the first generation iPad



Accelerometer (x, y, z) and gyroscope
(pitch, roll, yaw) motions

TC-11 uses these data sources as continuous controllers. When the iPad's orientation is reset, gyroscope controllers will output their minimum value. As the device is rotated, controller values will increase *in either direction around their axis* until they reach the extremity of that movement.

> *Example:*
>
> *Load preset #4 - Spyroid. This patch uses Gyroscope Roll to change the FM Depth. Reset the orientation (double-tap the Reset Orientation Button), then roll the device back and forth while holding a few touches to hear the change.*

The accelerometer does not require an orientation reset. On the first generation iPad, it always references gravity. On later generations, it filters out gravity and only measures acceleration.

The gyroscope can reset its natural position (orientation). Double-tap the **Reset Orientation Button** to zero the rotation values when you are in a comfortable resting position. The orientation is also reset automatically when you switch to the **Performance View**.

Since the compass reports the same motion as gyroscope yaw, it will not reset to a new fixed heading with the **Reset Orientation Button** is pressed. Use the compass when you want a permanently fixed spatial reference in your patch.

7.4 Module Controllers

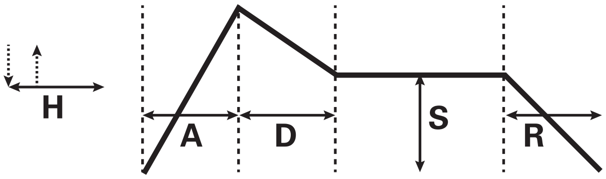
TC-11 has three [3] different **Module** controllers: **AHDSRs**, **LFOs**, and **Sequencers**. In this section their functionality will be explained. For a detailed look at programming **Modules**, see [Module Programming, p. 30].

7.4.1 AHDSR

AHDSRs are envelope generators. **AHDSR** stands for *attack*, *hold*, *decay*, *sustain*, and *release*. This **Module** is controls a **Parameter** by moving its value smoothly along an envelope shape. It is commonly used to control the amplitude of individual voices. However, **AHDSRs** can be used to control any **Parameter**.

Each part of the **AHDSR** envelope shape can be changed in real-time by another controller. Plus, the output of the **AHDSR** can be scaled, allowing for complex shaping of a **Parameter**.

Hold is less common among envelope generators, and warrants explanation. A *Hold* time forces the envelope to continue even if the *Release* trigger has been activated. For example, if the *Hold* value is set to 500ms, and the user releases the envelope after 100ms, the envelope will continue through its path for another 400ms before actually releasing.



AHDSR envelope shape

7.4.2 LFO

LFOs are low frequency oscillators. They are generally used to add a slow periodic change to a **Parameter**. Each **LFO** has an assignable waveform that cycles at controllable rate. In addition, the cycling waveform can be scaled (amplitude adjusted), and shifted (center position change). When a **Parameter** is controlled by an **LFO**, it will be modulated by the incoming slow-cycling waveform.

7.4.3 Sequencer

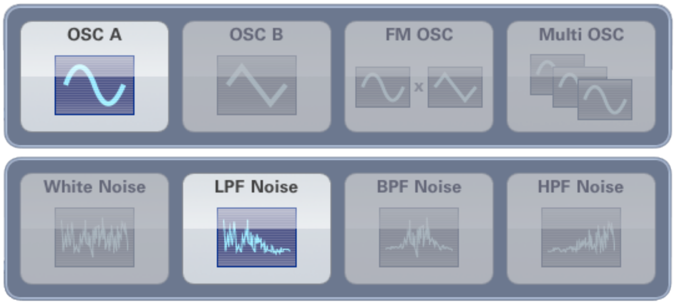
TC-11 has a powerful step **Sequencer**. The **Sequencer** stores up to 128 values which it can step through to generate a customized stream of values. All **Sequencer** parameters are controllable: playback rate, value adjustment, sequence length, and playback triggers. In addition, the **Sequencer** can ‘tune’ its values to note frequencies for certain **Parameters**, and even use a customizable note filter during playback.

The **Sequencer** is the gateway to any traditionally pitched material, and its functionality is often used in creative patch construction. It is a complex tool which you can explore more fully in [Sequencer, p. 34].

Synth Objects Explained

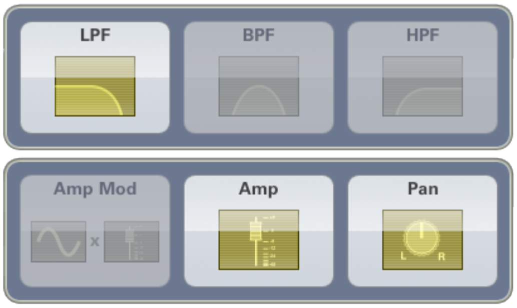
The **TC-11** synthesizer design is based on a set of modular **Synth Objects**. These objects generate or modify the sound in a patch. The number of objects and the connection order are both fixed, but the user decides which objects are active in a patch and which are not.

Switch to the **Patch View**, then to the **Patch Overview** to edit the **Synth Objects**.



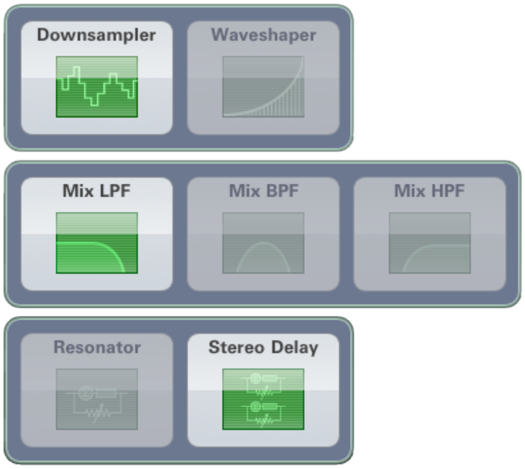
Oscillator objects

The blue **Synth Objects** make up the **Oscillator** group. There are wavetable oscillators: *Oscillator A, Oscillator B, FM Oscillator, Multi Oscillator*. Also available are filtered noise signals: *White Noise, LPF Noise* (low-pass filter), *BPF Noise* (band-pass filter), and *HPF Noise* (high-pass filter).



Filter / Amp objects

The yellow **Synth Objects** make up the **Filter / Amp** group. There are filters: *LPF* (low-pass filter), *BPF* (band-pass filter), and *HPF* (high-pass filter). Also included is an *Amp Mod* (amplitude modulator). The *Amp* and *Pan* objects are always enabled, and control the amplitude and panning of the voice respectively.



Effect objects

The green **Synth Objects** are part of the **Effects** group. These include effects: *Downsampler*, *Waveshaper*, *Resonator*, and *Stereo Delay*. There is also a second group of filters.

Tap a **Synth Object** once to enable that object. If you double-tap the object, you will be taken to the **Parameters** area for that object's group. The **Parameters** corresponding to that object will be highlighted temporarily.

For a detailed description of each **Synth Object**, see [Appendix C: Synth Objects, p. 46].

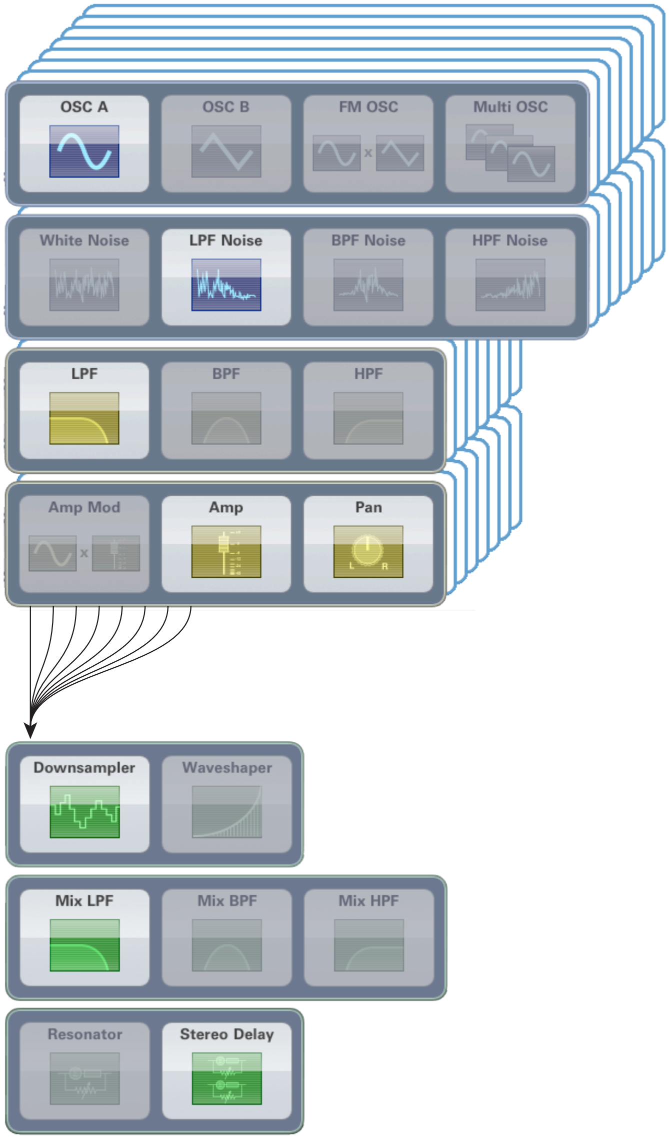
8.1 Voiced vs. Mix Synth Objects

This section will explain the difference between **Voiced Synth Objects** and **Mix Synth Objects**.

8.2 Voiced Synth Objects

The **Synth Objects** above the **Voiced / Mix Line** are the objects that make up the eight [8] polyphonic voices. They are **Voiced Synth Objects**. Each touch voice is built with a copy of these objects, so they can be controlled separately from one another.

Keep this in mind when you are assigning controllers to these objects' **Parameters**. When editing objects in the **Oscillator** and **Filter / Amp** groups, you are setting how individual touches will be controlled. It is likely that you will want to use **Single Touch Controllers**, or **Module** controllers that are 'voiced.' Only choose a **Group Touch Controller** or 'global' **Module** controller if you want each voice to act exactly the same.



Voiced Synth Objects are mixed together before they run through Effects objects

8.3 Mix Synth Objects

The **Synth Objects** below the **Voiced / Mix Line** (essentially the **Effects** group) are **Mix Synth Objects**. All eight [8] touch voices are mixed together before running through these objects. This means that **Effects** will act on the entire signal mix, not individual voices.

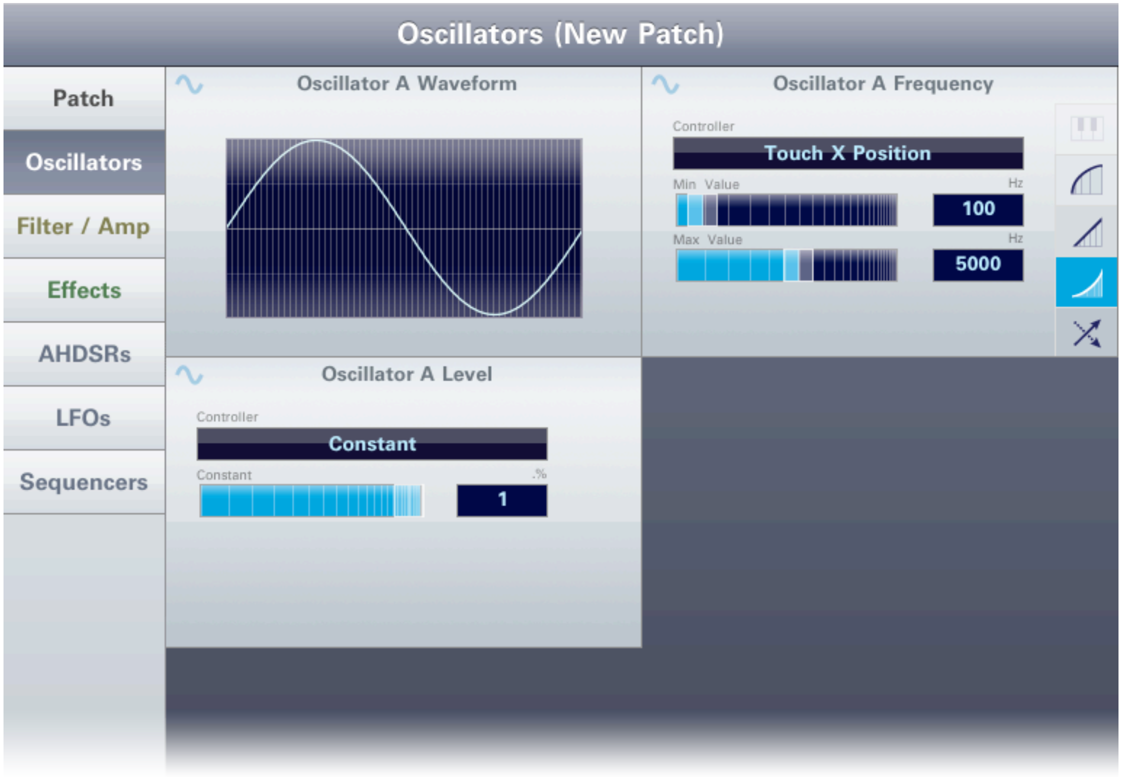
Programming Parameters

TC-11's uniqueness comes from the ability to control any synthesis parameter with any controller. Do you want to open a filter using a touch-based controller like *Group Total Speed*? Maybe you decide that tilting the device with *Gyroscope Roll* is more expressive. Or you could use an **LFO**, or **Sequencer**, or *Distance to Center*, etc., etc..

This section covers programming **Parameters** in detail.

9.1 Parameters Explained

Each **Synth Object** performs a specific synthesis function. The variables that control those functions are its **Parameters**. For example, *Oscillator A* is a wavetable oscillator that produces a tone. It has three [3] **Parameters**: *waveform, frequency,* and *level*. When *Oscillator A* is active in a patch, switching to the **Oscillators** view in the **Patch View** will show the following **Parameter Views**:



Oscillator A Frequency — Controller: Touch X Position; Min Value: 100 Hz; Max Value: 5000 Hz

Oscillator A Level — Controller: Constant; Constant: 1 .%

Oscillator A Parameters: *Oscillator A Waveform, Oscillator A Frequency,* and *Oscillator A Level*

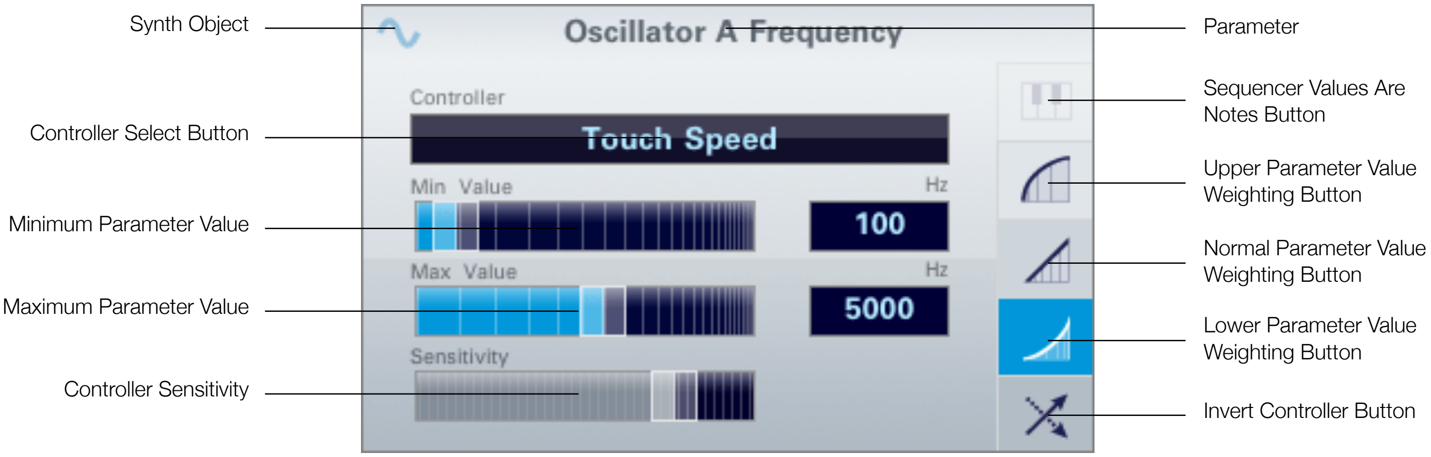
There are three [3] types of Parameters: general, waveform, and set-only.

General Parameters are the most common. They have assignable controllers, variable value ranges, and can adjust the weighting of the incoming controller data. They can follow any controller type (touch-based, Device Motion, or Module).

Waveform Parameters are used when a Synth Object or Module has a selectable waveform. Touching the waveform opens a list of available waveforms. Touch any waveform to load it into the parameter. Waveform Parameters are static, so there are no controller options.

Set-Only Parameters are those that have a fixed value that cannot be changed during performance. One example is the *Patch Gain* parameter in the Filter / Amp group. Set-Only parameters show a simple slider and textfield for static assignment.

10.1 Parameter View



General Parameter View

10.2 Synth Object

This icon shows the Synth Object that contains the Parameter. Synth Objects may have multiple Parameters. Look for this icon to show you which Parameters are part of the same object.

Remember: activating / deactivating Synth Objects is done in the Patch Overview, see [Patch Overview, p. 9].

10.3 Parameter

A **Parameter** is a variable for a **Synth Object** or **Module**. The title at the top of the **Parameter View** indicates which **Parameter** the view is showing. For example, the **Parameter** shown above is *Oscillator A Frequency*. The name includes the **Synth Object** name (*Oscillator A*), along with the variable that is being targeted (*Frequency*).

One way to think of these **Parameter Views** is as **TC-11**'s replacement for a traditional knob or slider. Each view is there to change a single synthesis variable. Get to know what **Parameters** are available, and you will be able to target the specific areas of synthesis that are important for your patch.

10.4 Controller Select Button

The **Controller Select Button** allows you to select which controller will target the **Parameter**. When you press the button, you will be shown a list of controller categories that are appropriate for that **Parameter**. You can navigate the menu to choose a controller. When you tap the controller name, it will be selected as the source for that **Parameter**. You can cancel the selection any time by tapping outside the menu popover.

This is where most of the fun happens in programming **TC-11**. Choosing a novel way of controlling a **Parameter** may open up a new sound or style of performance. Some controllers are driven very directly by the player, like touch-based controllers. Others, like the **LFO Module**, will run by themselves with as much (or as little) user interaction as you decide. When constructing a patch, deciding which areas of your patch you want to control directly is often a good first step.

All controllers have a minimum limit (start) and maximum limit (end). When the user generates values within this range, those values will be mapped to the **Parameter's** minimum to maximum values. The most basic example of this is the *Touch X Position* parameter. The far left of the screen is the controller's minimum limit (0 pixels), and the opposite side of the screen is the maximum limit (768 pixels). The position of the touch within that range would set the **Parameter's** value, mapped to whatever minimum / maximum value range the user has set.

For more information about controllers, see [Controllers Explained, p. 17].

10.5 Minimum / Maximum Parameter Values

Parameters have user-defined minimum and maximum values. This allows you to control the effective range of a parameter. For example, the *Oscillator A Frequency* **Parameter** might be set to cover a range of 50Hz to 350Hz. This would set the oscillator to generate lower frequencies, which may be used for a bass patch.

The sliders allow for course setting of the minimum and maximum values. For fine control, you can type a value directly into the textfields next to the sliders.

Above the textfields is a label which shows the **Parameter's** unit of measurement. Common unit types are:

- Hz - Hertz, cycles per second
- .% - percentage, with a range of 0-1
- # - number, a direct correlate to the **Parameter**
- Q - quality factor, resonance

You cannot set a minimum parameter value higher than a maximum parameter value, and vice versa. If you would like the values to be inverted, press the **Invert Controller Button** to flip the incoming controller values.

10.6 Controller Sensitivity

Some controllers have a user-definable **Controller Sensitivity** setting. For example, you can decide whether *Touch Speed* reacts to slow movements in a drastic way (high sensitivity), or if it should require a violent gesture just to set it going (low sensitivity). Not only does this allow flexibility in performance, but it can dramatically change the sound of the patch.

Controller Sensitivity should be addressed by the user when using time-related controllers. For example, *Creation Time Since Previous Touch* can be used to simulate chording if the sensitivity is high enough.

> *Example:*
>
> *Load preset #26 - Punch in the Face. Each time you create a touch it uses the time since the last touch to change the strength of the synth voice. Press multiple touches simultaneously for the big punch!*

The **Controller Sensitivity** slider will appear automatically for those controllers that support it. Dragging the slider to the right makes the controller more sensitive; to the left makes it less sensitive.

10.7 Sequencer Values Are Notes Button

Some **Parameters**, generally those that deal with audio rate frequencies, can use a **Sequencer** to generate traditional note frequency values. When this button is active, the values from the **Sequencer** are no longer treated like a normal controller, but instead are considered MIDI note values.

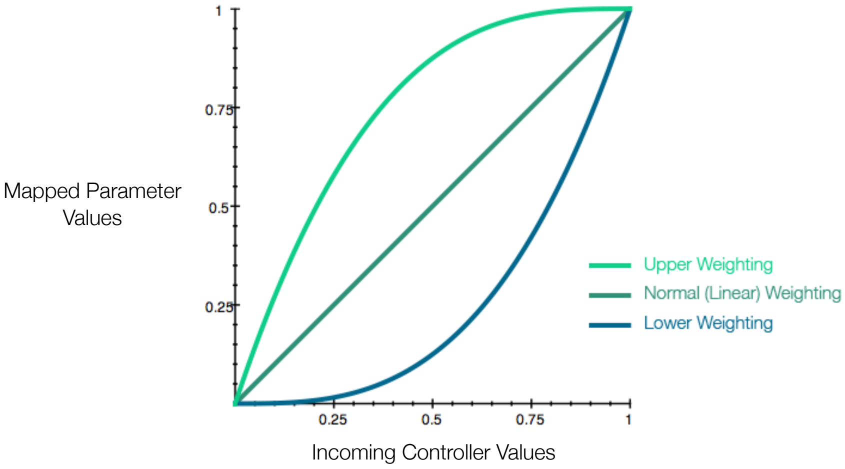
To activate this feature, set the **Parameter** to be controlled by a **Sequencer**. If the **Sequencer Values Are Notes Button** becomes active and selectable, the **Parameter** allows for this type of control. If it does not, the **Parameter** does not support note values.

When the **Sequencer Values Are Notes Button** is activate, there are no controller or range values to set. Incoming **Sequencer** values are treated as MIDI note values (60 = middle C, 61 = C#, etc.). The values will also be filtered according to the **Sequencer's Key Filter**.

For more information about key filtering, see [Keyboard Filter Button, p. 35].

10.8 Parameter Weighting Buttons

Parameter weighting is when controller values are curved to favor a particular range of values when mapped. There are three different weightings: **Normal**, **Upper**, and **Lower Weighting**.



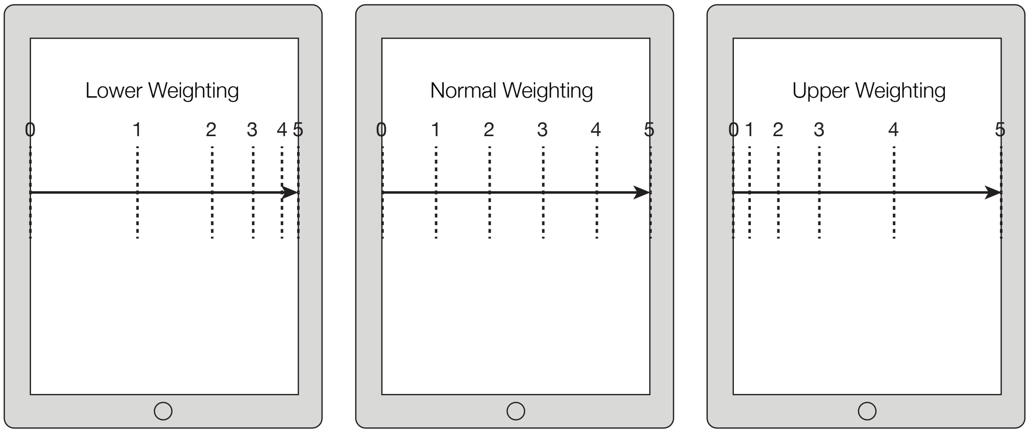
Parameter Weighting Comparison: Upper, Normal, and Lower Weightings

Normal Weighting is a one-to-one (linear) mapping of the controller range to the **Parameter** value range.

Upper Weighting pushes incoming controller values towards the upper range of the **Parameter** values. This means that incoming controller values will quickly push the **Parameter** values up towards their upper range.

Lower Weighting pulls incoming controller values towards the lower range of the **Parameter** values. This means that incoming controller values will keep **Parameter** values closer to the lower range of until they reach the very top.

Weighting is important for all parameters, but one clear example of its importance is when dealing with frequency. Take the following setup: *Oscillator A Frequency* is controlled by the *Touch X Position* controller, and the min. / max. range is 50 Hz - 5000 Hz. If the weighting is set to **Normal Weighting**, the bottom few octaves (50 - 400 Hz) take up only 54 pixels of the screen. With **Upper Weighting**, it's only 28 pixels. But if the weighting is set to **Lower**, the same octaves use 204 pixels to sweep through, which acts much closer to the way we generally perceive frequencies.



Differences in weighting, with the *Touch X Position* mapped to a frequency parameter ranged 0-5 kHz

10.9 Invert Controller Button

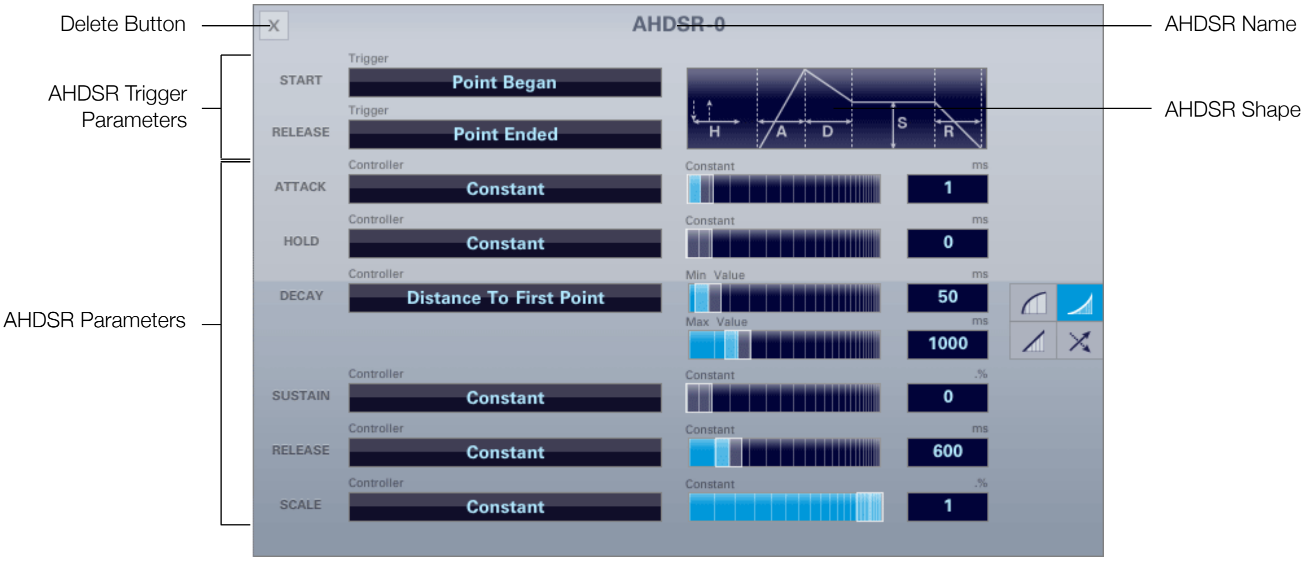
The **Invert Controller Button** will 'flip' incoming controller values to reverse the mapping of the **Parameter** values. For example, if *Touch X Position* controls the frequency of an oscillator, the high frequencies will be towards the upper limit of the x-axis (where the grid lines get closer together in the **Performance View**). If the **Invert Controller Button** is activated, the high frequencies will be towards the lower limit of the x-axis instead.

This is particularly useful for time-based controllers. These controllers start at the lower value limit, and as time passes, move towards the upper limit. If you would like that direction to be reversed, use the **Invert Controller Button**.

Module Programming

The three [3] Module controllers in TC-11 are the AHDSR, LFO, and Sequencer. In this section we will look at their functionality and some tips for using them in your patches.

11.1 AHDSR



Delete Button

AHDSR Name

AHDSR Trigger Parameters

AHDSR Shape

AHDSR Parameters

AHDSR 0

START	Trigger	Point Began		
RELEASE	Trigger	Point Ended		
ATTACK	Controller	Constant	Constant	1 ms
HOLD	Controller	Constant	Constant	0 ms
DECAY	Controller	Distance To First Point	Min Value	50 ms
			Max Value	1000 ms
SUSTAIN	Controller	Constant	Constant	0 .%
RELEASE	Controller	Constant	Constant	600 ms
SCALE	Controller	Constant	Constant	1 .%

AHDSR View

The AHDSR is an envelope generator. When triggered, it ramps a control value along a user-defined envelope shape. Like traditional AHDSRs, the envelope starts at a zero [0] value, then ramps to its full value before returning to zero [0].

AHDSRs are commonly used to apply an amplitude envelope to individual voices. In TC-11 you will almost always see the *Amp* object being controlled by a voiced AHDSR. AHDSRs can target any Parameter to shape its value.

11.2 Delete Button

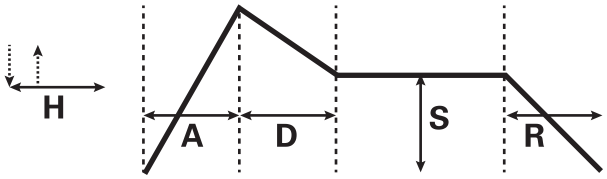
The Delete Button will remove the AHDSR from the synthesis graph. Any Parameters that were controlled by the AHDSR will be reset to *Constant.*

11.3 AHDSR Name

Each **AHDSR** will be assigned a unique name. This name will appear in the controller select popover when programming **Parameters**, and is saved with the patch.

11.4 AHDSR Shape

This image shows the shape of the **AHDSR** envelope.



AHDSR envelope shape

11.5 AHDSR Trigger Parameters

There are two [2] trigger **Parameters** for each **AHDSR**: *Start* and *Release*. The *Start* trigger starts the envelope shape in motion. If the **AHDSR** is in the middle of an envelope, the *Start* trigger will reset the envelope to the beginning (zero [0]). The envelope will generate its values until it reaches the *Sustain Level*, where it will stay until the **AHDSR** receives a *Release* trigger. It then ramps to zero [0] over the *Release* time.

11.6 AHDSR Parameters

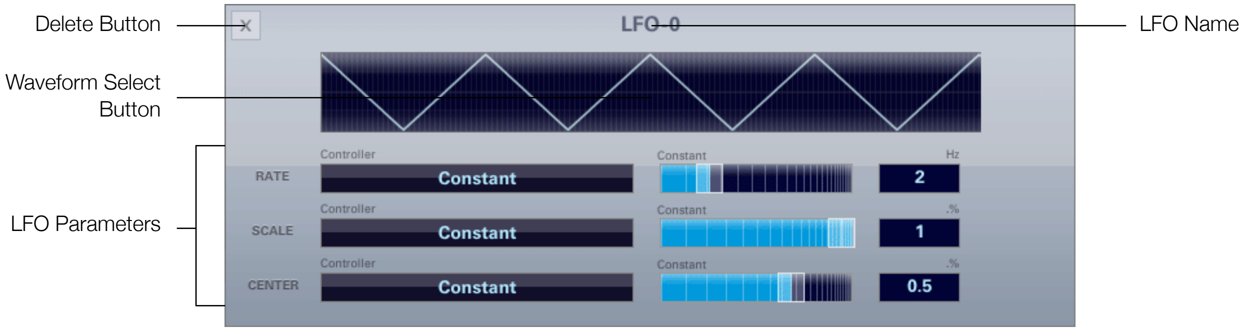
There are six [6] **Parameters** for each **AHDSR**: *Attack, Hold, Decay, Sustain, Release,* and *Scale*. *Attack, Decay,* and *Release* each sets the time (in milliseconds) that its portion of the envelope takes to complete. *Sustain* is the level of the envelope it will output indefinitely when it reaches that portion of the envelope.

Hold is less common among envelope generators, and warrants explanation. A *Hold* time forces the envelope to continue even if the *Release* trigger has been activated. For example, if the *Hold* value is set to 500ms, and the user releases the envelope after 100ms, the envelope will continue through its path for another 400ms before actually releasing.

Scale allows the entire envelope shape to be stretched from full value (a Scale value of 1.0) to flat (a Scale value of 0.0).

While each **Parameter** can be controlled dynamically, note that the envelope will only set the value at the time of triggering. Once the envelope shape is in motion, changing the time of that **Parameter** will have no effect on the envelope until it has reached the next control point.

12.1 LFO



LFO View

The **LFO** is a low frequency oscillator. It has a selectable waveform and basic control over the rate of oscillation and amplitude. **LFOs** are generally used for periodic control of **Parameters**, but can also facilitate quasi-random **Parameter** control.

12.2 Delete Button

The **Delete Button** will remove the **LFO** from the synthesis graph. Any **Parameters** that were controlled by the **LFO** will be reset to *Constant*.

12.3 LFO Name

Each **LFO** will be assigned a unique name. This name will appear in the controller select popover when programming **Parameters**, and is saved with the patch.

12.4 LFO Waveform Select Button

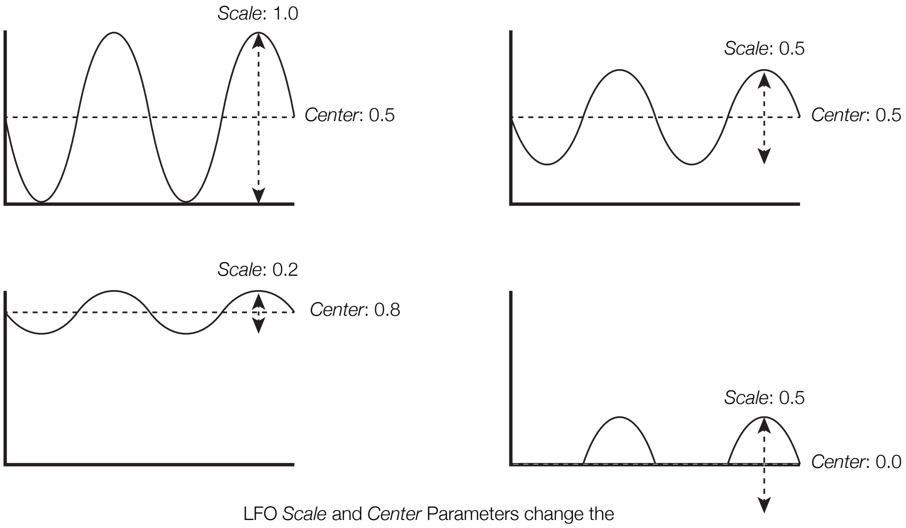
This button shows the selectable waveforms for the **LFO**. Tap the image of a waveform in the waveform select popover to load it into the **LFO**.

12.5 LFO Parameters

There are three [3] parameters that adjust the **LFO**: *Rate, Scale,* and *Center*. *Rate* sets the frequency of the waveform, and has a range of 0 Hz - 50 Hz. *Scale* adjusts the amplitude of the waveform. *Center* adjusts the mid-point of the waveform's amplitude.

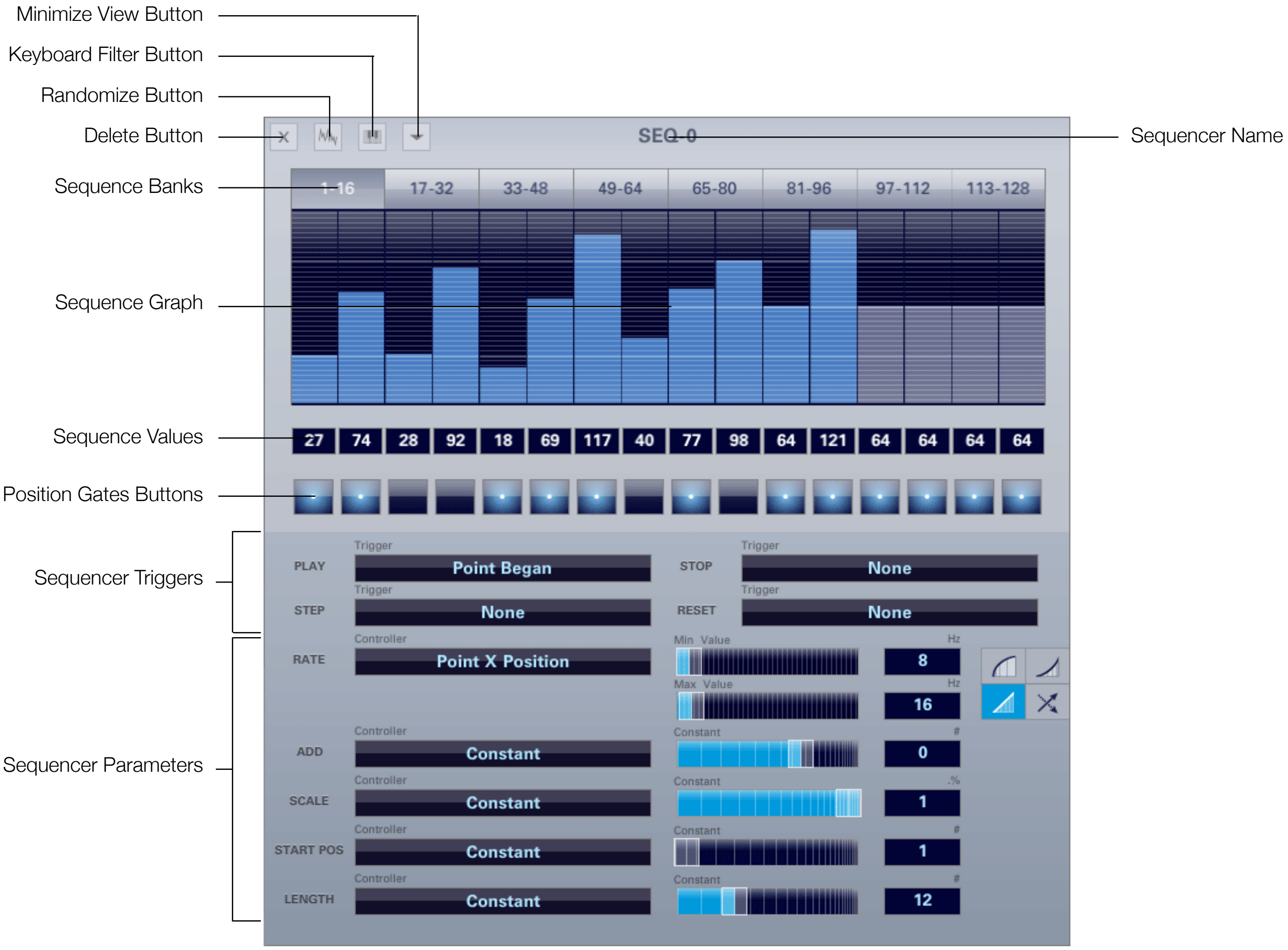
Control values are scaled individually for each **Parameter** they control. If *Scale* is set to 100%, the **LFO** will cycle through the full range of the **Parameter**. When it is set to a lower percentage, it will only cycle through a portion of the **Parameter** range.

Center allows you to offset the **LFO** values within the defined **Parameter** range. When used in conjunction with *Scale*, the **LFO** can be a very flexible controller.



LFO *Scale* and *Center* Parameters change the position and amplitude of the LFO

13.1 Sequencer



Sequencer View

The **Sequencer** is the most powerful **Module** in **TC-11**. It outputs user-set values at a periodic rate, and has controls for all playback functions. It can also be used to send note frequency values, and has the ability to create a note filter so your patch stays in whatever key or mode you choose.

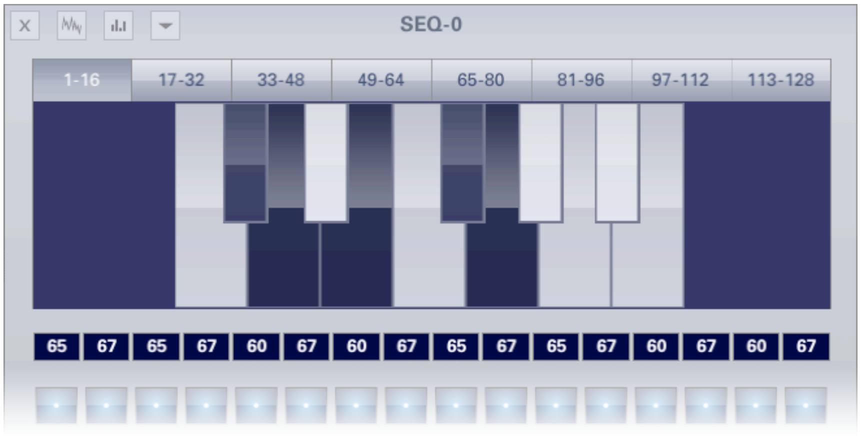
13.2 Minimize View Button

The **Minimize View Button** will hide the **Parameters** to shrink the view size. Press the button again to show the **Parameters**.

13.3 Keyboard Filter Button

When a **Parameter** is set to receive **Sequencer Values Are Notes** [see Sequencer Values Are Notes Button, p. 28], the **Sequencer** values for that **Parameter** are treated as MIDI note numbers. This allows for tuned melodies. To keep the notes within a key when the **Sequence** is shifted or scaled, you can choose to filter out notes you do not want to hear. When a **Sequencer** value gets filtered, it will be rounded to the nearest acceptable note.

The **Keyboard Filter Button** shows the **Keyboard Filter View**. This is where you can choose which notes to allow and which to filter out.



Keyboard Filter View

Light colored notes are allowed through, and dark colored notes are filtered out. Tap any key to toggle its status. The filter settings are saved with your patch.

To return to the normal **Sequence Graph View**, press the **Keyboard Filter Button** again, or tap any of the **Sequence Banks**.

13.4 Randomize Values Button

The **Randomize Values Button** is a quick way to randomize the **Sequence**. When the button is pressed, you are given the option to randomize all **Sequence** values, or only the values within the current playback range.

13.5 Delete Button

The **Delete Button** will remove the **Sequencer** from the synthesis graph. Any **Parameters** that were controlled by the **Sequencer** will be reset to *Constant*. Any triggers that were controlled by the **Sequencer** will be set to *None*.

13.6 Sequence Banks

These buttons will show a sub-range of the full **Sequence**. The **Sequencer** can have a **Sequence** of up to 128 values. They are displayed in groups of 16, accessible through these buttons for editing.

13.7 Sequence Graph

This is the main editing area of the **Sequence**, and shows the values in a standard bar graph. Touch and drag any bar to change its value. You can any value, whether it is currently highlighted for playback or not. Keep in mind that the iPad's screen is multitouch enabled. You can edit multiple bars at the same time.

13.8 Sequence Values

The textfields below the **Sequence Graph** are the **Sequence Values**. Each textfield shows the value of that index of the **Sequence**. You can edit the value directly through these textfields.

Sequencer Values have a minimum value of 0, and a maximum value of 127. This range will be mapped to any **Parameter** that is controlled by the **Sequencer**, unless the **Parameter** is set to **Sequencer Values Are Notes** [see Sequencer Values Are Notes Button, p. 28], in which case they will be treated as MIDI notes.

13.9 Position Gate Buttons

Position Gates are similar to mute buttons: they determine whether or not a **Sequence** index is allowed to be played. When the **Sequencer** steps to its next index, it checks whether or not the **Position Gate** is active. If it is active, the value is output, and a trigger is sent. If the **Position Gate Button** is unchecked, the **Sequencer** sends nothing. It will be heard as a pause, or rest, in the **Sequence**.

Use **Position Gates** to build a specific rhythm for the **Sequence**. For example, the triggers that are sent by the **Sequencer** can be used to start an **AHDSR**. Just by toggling **Position Gate Buttons**, you can create a rhythmic cycle for your **AHDSR**. You do not even have to set any **Sequence Values** in this case.

13.10 Sequencer Triggers

The **Sequencer** has four [4] trigger **Parameters**: *Play, Step, Stop,* and *Reset*. *Play* starts the **Sequence** playing, starting wherever it is currently positioned within the **Sequence**. Sending a second trigger to *Play* while it is playing does nothing. *Step* will instantly move the **Sequencer** to the next **Sequence** value. If *Step* is triggered while the **Sequencer** is currently playing, it will jump to the next value and continue moving forward at the playback rate.

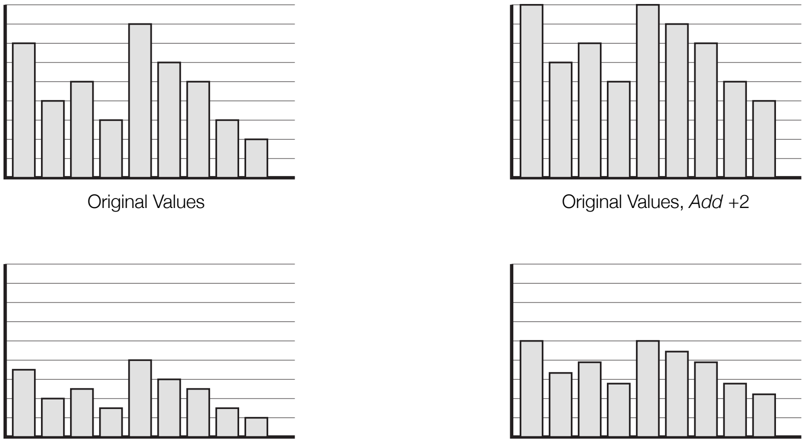
Stop pauses **Sequencer** playback, and holds the current position. *Reset* will jump the playback position to the first value. When this happens, the value is not sent. Triggering *Play* after a *Reset* will start with the first value. If *Reset* is triggered while the **Sequencer** is currently playing, it will jump to the first value and continue moving forward at the playback rate, starting with the first value.

Part of the flexibility of the **Sequencer** is its playback control. Choosing which controllers you want to trigger playback movement is an important part of using the **Sequencer**.

> *Example:*
>
> *Load preset #50 - Martian Drums. The default setting plays the Sequencer when the patch is loaded. Change SEQ-0's PLAY trigger to None, and STOP to Patch Loaded. Then, the Sequencer steps forward only when you create a new touch.*

13.10 Sequencer Parameters

The **Sequencer** has five [5] **Parameters**: *Rate, Add, Scale, Start Position* and *Length*. *Rate* sets the playback rate in Hz. *Add* shifts all values by an equal amount. This value can be positive or negative to shift **Sequence Values** higher or lower. If the minimum or maximum value is reached, the value will be clipped. *Scale* changes values by a proportional amount.



Original Values

Original Values, *Add* +2

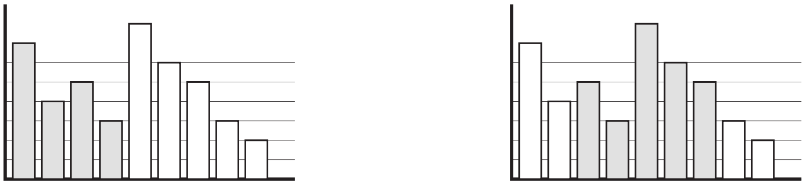
Original Values, *Scale* 0.5

Original Values, *Add* +2, then *Scale* 0.5

LFO *Scale* and *Center* Parameters change the position and amplitude of the LFO

Add will be applied before *Scale*. A common use for *Add* is to shift up a melodic sequence, while *Scale* is more commonly used when a non-frequency based **Parameter** is being controlled by a **Sequencer**.

Start Position sets the first **Sequence** index for playback. When the **Sequencer** reaches its end, it will return to whatever the current Start *Position* is. *Length* is the length of the **Sequence**. When playing back, a **Sequencer** will check to see if it is outside the currently defined **Sequence** range as set by the *Start Position* and *Length*. If it is, it will reset to the *Start Position* index.



Start Position is 1, *Length* is 4

Start Position is 3, *Length* is 5

Start Position and *Length* Parameters

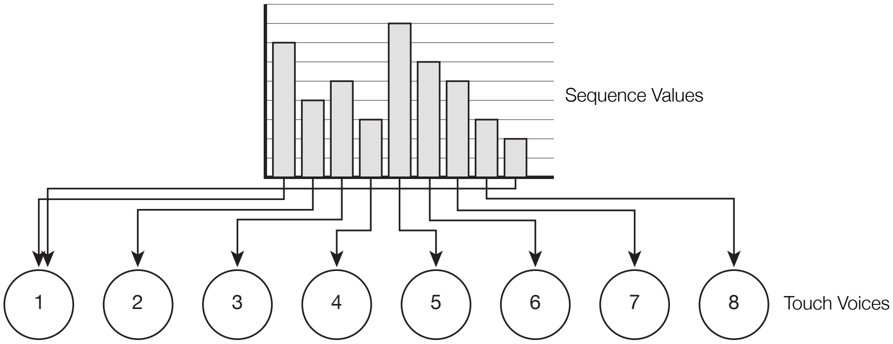
13.11 Sequencer Poly Routed

When controlling a **Parameter** with a **Sequencer**, there are three [3] choices for both normal and trigger controllers:

- SEQ-# Global
- SEQ-# Voiced
- SEQ-# Poly Routed

Global and voiced **Sequencers** act like any other controller: if a **Parameter** is controlled by the **Sequencer** in global mode, it will receive the same output values as all other **Parameters** that follow in global mode. Voiced mode essentially gives each touch voice its own **Sequencer** instance, so that each can have its own *Rate*, *Add*, and other **Parameters**.

Poly Routed mode is a special method of targeting touch voices with **Sequencer Values**. Each time the **Sequencer** steps to a new value, that value will be sent only to the next available touch voice. This way, all of the voices will be controlled by the same **Sequencer** instance (like global mode), but they only receive a single value until the polyphony has cycled around to that voice again.



In Poly Routed Mode, Sequence Values are sent individually to the next available touch voice

It is common to use this mode in conjunction with setting the **Sequencer** *Step* trigger to *Touch Began*. When a touch begins, the **Sequencer** will send off its new value that is specific for that voice. This allows for overlap of **Sequence Values**; you can hold one voice at a specific **Sequence** value while others are free to grab their own. This mode can yield some interesting performance results, since the length of the **Sequence** may not match the number of active touch voices, and voice **Parameters** that change in other parts of the **Patch** will affect individual **Sequence** values!

Appendices

Troubleshooting

If you are experiencing odd behavior from **TC-11**, check the following common solutions for assistance. If your issue is not addressed here, please send a note to [bitshapesoftware@gmail.com] with a description of the problem. If the issue is an app crash, please include the crash log, located at ~/Library/Logs/CrashReporter/MobileDevice/*iPadName/TC-11_iPad.crash.* This will help keep **TC-11** as solid of an app as possible.

14.1 Issues / Solutions

No sound	• Check the iPad device volume. • Check receiver / amp / speaker volume if using the headphone out jack. • Try tilting the iPad during performance. Some patches require device motion to raise the patch volume. • Try using multiple touches to activate the patch. • Load / reload a different patch. • Quit / relaunch **TC-11**. Double-tap the home button, then tap and hold the **TC-11** icon until the minus sign appears, then tap the minus sign. • Restart the iPad.
Buzz or electrical noise during performance	• Disconnect the USB cable from the iPad.
Graphical slowdown	• **TC-11** has been optimized for audio synthesis, which takes priority over graphics. iPad 1 hardware may experience graphical slowdown. • Turn off *Override Controller Display* in the **Settings View**.

Unwanted clicking in audio	• The audio synthesis graph may be overloading the processor. • Simplify your patch by using fewer **Modules**. • Reduce the rate of playback for your **Sequencers**.

Appendix A: Controllers

The term *First Touch* refers to the touch that begins a new group of touches. It will be colored differently than all following touches. The term *Previous Touch* refers to the last touch created before starting a new touch. The x-axis of the iPad is the narrow axis (768 pixels wide). The y-axis of the iPad is the long axis (1024 pixels).

15.1 Single Touch Controllers

Creation Time Since First Touch	The time difference between the new touch beginning and the first touch beginning. Sent once when touch begins. Maximum: 5000 ms.
Creation Time Since Previous Touch	The time difference between the new touch beginning and the previous touch beginning. Sent once when touch begins. Maximum: 5000 ms.
Touch Time Alive	A running value that reports the time a touch has been active. Sent continuously. Maximum: 20000 ms.
Touch Time Stationary	A running value that reports the time a touch has not moved. Sent continuously. Maximum: 20000 ms.
Touch Time Moving	A running value that reports the time a touch has been moving. Sent continuously. Maximum: 20000 ms.
Touch Time Alive When Ended	A value that reports the time a touch has been active. Sent once when touch ends. Maximum: 20000 ms.
Touch X Position	The x-axis position of the touch. Sent continuously.
Touch Y Position	The y-axis position of the touch. Sent continuously.

Touch X Position When Created	The x-axis position of the touch. Sent once when touch begins.
Touch Y Position When Created	The y-axis position of the touch. Sent once when touch begins.
Touch X Position When Ended	The x-axis position of the touch. Sent once when touch ends.
Touch Y Position When Ended	The y-axis position of the touch. Sent once when touch ends.
Touch Speed	The speed of the touch. Sent continuously.
Distance To First Touch	The distance between the new touch position and the first touch position. Sent continuously.
Distance To Previous Touch	The distance between the new touch position and the previous touch position. Sent continuously.
Distance To Center	The distance between the new touch position and the center of the screen. Sent continuously.
Distance Travelled	A running value of the distance a touch has covered since it was created. Sent continuously.
Angle To First Touch	The angle between the new touch position and the first touch. The reference (0°) is fixed. Sent continuously.
Angle To Previous Touch	The angle between the new touch position and the previous touch. The reference (0°) is fixed. Sent continuously.
Angle To Center	The angle between the new touch position and the center of the screen. The reference (0°) is fixed. Sent continuously.
Rotation Around First Touch	The change of angle of the new touch around the first touch. The reference (0°) is always the original new touch position. Sent continuously.
Rotation Around Center	The change of angle of the new touch around the center of the screen. The reference (0°) is always the original new touch position. Sent continuously.

Rotation Speed Around First Touch	The rate of change of angle of the new touch around the first touch. The reference (0°) is always the original new touch position. Sent continuously.
Rotation Speed Around Center	The rate of change of angle of the new touch around the center of the screen. The reference (0°) is always the original new touch position. Sent continuously.

15.2 Group Touch Controllers

Creation Time Since Previous Group	The time difference between the first touch in a group beginning and the first touch of the last group beginning. Sent once when first touch begins. Maximum: 20000 ms.
Group Time Alive	A running value that reports the time a group has been active. Sent continuously. Maximum: 20000 ms.
Group Time Stationary	A running value that reports the time a group has not moved. Sent continuously. Maximum: 20000 ms.
Group Time Moving	A running value that reports the time a group has been moving. Sent continuously. Maximum: 20000 ms.
Group Time Alive When Ended	A value that reports the time a group has been active. Sent once when touch ends. Maximum: 20000 ms.
Group Count	The number of active touches. Sent when any touch begins.
Touches Created Per Second	The number of touches created over the last second. Maximum: 100.
Touches Ended Per Second	The number of touches ended over the last second. Maximum: 100.
Group Center X Position	The average x-axis position of all active touches.
Group Center Y Position	The average y-axis position of all active touches.
Group Total Speed	The sum of all touches' speed.
Group Center Speed	The speed of the group's average position.

Total Distance To First Touch	The sum of all touches’ distance to the first touch.
Total Distance To Previous Touch	The sum of all touches’ distance to their previous touch.
Total Distance To Center	The sum of all touches’ distance to the center of the screen.
Total Angle To First Touch	The sum of all touches’ angle to the first touch.
Total Angle To Previous Touch	The sum of all touches’ angle to their previous touch.
Total Angle Around Center	The sum of all touches’ angle to the center of the screen.
Average Angle To First Touch	The average of all touches’ angle to the first touch.
Average Angle To Previous Touch	The average of all touches’ angle to their previous touch.
Average Angle To Center	The average of all touches’ angle to the center of the screen.
Total Rotation Around Center	The sum of all touches’ rotation around the center of the screen. Sent continuously, resets when group ends.
Total Rotation Around Center Running	The sum of all touches’ rotation around the center of the screen. Sent continuously, does not reset when group ends.
Total Rotation Speed Around Center	The sum of all touches’ rotation speed around the center of the screen.

15.3 Device Motion Controllers

Accelerometer X	The acceleration of the iPad along its x-axis. Minimum value at its resting point, maximum value at either extreme (positive or negative). iPad 2 and higher: filters out gravity.
Accelerometer Y	The acceleration of the iPad along its y-axis. Minimum value at its resting point, maximum value at either extreme (positive or negative). iPad 2 and higher: filters out gravity.
Accelerometer Z	The acceleration of the iPad along its z-axis. Minimum value at its resting point, maximum value at either extreme (positive or negative). iPad 2 and higher: filters out gravity.

Gyroscope Pitch	The device's rotation position around its x-axis. Minimum value at its resting point, maximum value at either extreme (positive or negative). Available iPad 2 and higher.
Gyroscope Roll	The device's rotation position around its y-axis. Minimum value at its resting point, maximum value at either extreme (positive or negative). Available iPad 2 and higher.
Gyroscope Yaw	The device's rotation position around its z-axis. Minimum value at its resting point, maximum value at either extreme (positive or negative). Available iPad 2 and higher.
Compass Heading	The magnetic heading of the device, pointing from the top of the device. The data stream is low-passed to smooth out jarring jumps. Available iPad 2 and higher.

15.4 Miscellaneous Controllers

Constant	A fixed value.

Appendix B: Triggers

The term 'trigger' is used to describe a command to start a synth process. The **AHDSR** and **Sequencer** modules use triggers to control playback. **Sequencers** can also generate triggers.

16.1 Single Touch Triggers

Touch Began	Trigger sent when a touch begins.
Touch Ended	Trigger sent when a touch ends.
Touch Began Or Ended	Trigger sent when a touch begins and when it ends.
Touch Started Moving	Trigger sent when a touch starts moving after being stationary.

Touch Stopped Moving	Trigger sent when a touch stops moving after being in motion.
Touch Started Or Stopped Moving	Trigger sent when a touch starts moving after being stationary, and when it stops moving after being in motion.

16.2 Group Touch Triggers

Group Began	Trigger sent when the first touch of a group begins.
Group Ended	Trigger sent when the last touch of a group ends.
Group Started Moving	Trigger sent when a group starts moving after all touches were stationary.
Group Stopped Moving	Trigger sent when a group stops moving after all touches were in motion.
Touch # Began	Trigger sent when a particular # touch begins in a group. For example, *Touch 3 Begins* sends a trigger when the third touch in a group begins.
Touch # Ended	Trigger sent when a particular # touch ends in a group. It will also send a trigger for touches of lower values. For example, *Touch 3 Ends* sends a trigger when the third touch in a group begins, and also the second and first.

16.3 Sequencer Triggers

SEQ-# Position Gates	Trigger sent when a **Sequencer** steps to its next value. Global trigger.
SEQ-# Position Gates Voiced	Trigger sent when a **Sequencer** steps to its next value. Sent only to voiced controllers.
SEQ-# Position Gates Poly Routed	Trigger sent when a **Sequencer** steps to its next value. Sent only to the next available touch voice.

SEQ-# Reset Trigger	Trigger sent when a **Sequencer** steps to its first value. Global trigger.
SEQ-# Reset Trigger Voiced	Trigger sent when a **Sequencer** steps to its first value. Sent only to voiced controllers.
SEQ-# Reset Trigger Poly Routed	Trigger sent when a **Sequencer** steps to its first value. Sent only to the next available touch voice.

16.4 Miscellaneous Triggers

None	No trigger.
Patch Loaded	Trigger sent once when the user switches to the **Performance View**.

Appendix C: Synth Objects

OSC A	Single wavetable oscillator. Can be paired with *OSC B* to have two simultaneous separate oscillators. Voiced.
OSC B	Single wavetable oscillator. Can be paired with *OSC A* to have two simultaneous separate oscillators. Voiced.
FM OSC	Frequency modulated wavetable oscillator. Voiced.
Multi OSC	Stacked wavetable oscillators. Up to five [5] oscillators, each transposed equally above the previous. Voiced.
White Noise	Random energy, equal energy per frequency band. Voiced.
LPF Noise	Random energy, equal energy per frequency band, filtered through a low-pass filter. Voiced.
BPF Noise	Random energy, equal energy per frequency band, filtered through a band-pass filter. Voiced.
HPF Noise	Random energy, equal energy per frequency band, filtered through a high-pass filter. Voiced.
LPF	Low-pass filter with resonance. Voiced.

BPF	Band-pass filter with resonance. Voiced.
HPF	High-pass filter with resonance. Voiced.
Amp Mod	Amplitude modulation using a selectable wavetable. Voiced.
Amp	Amplitude control. Voiced.
Pan	Panning control. Voiced.
Downsampler	Sample and hold filter with adjustable sample rate. Mix.
Waveshaper	Distortion through mapping incoming signal to a selectable wavetable. Mix.
Mix LPF	Low-pass filter with resonance. Mix.
Mix BPF	Band-pass filter with resonance. Mix.
Mix HPF	High-pass filter with resonance. Mix.
Resonator	Time-shifting variable delay line. Mix.
Stereo Delay	Variable delay lines for left and right channels. Mix.