ALTURA MKII

User Manual

MIDI THEREMIN

ZEPPELIN DESIGN LABS

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ALTURA MKII

THEREMIN MIDI CONTROLLER

Quick Start Guide and Reference Manual

QUICK START GUIDE

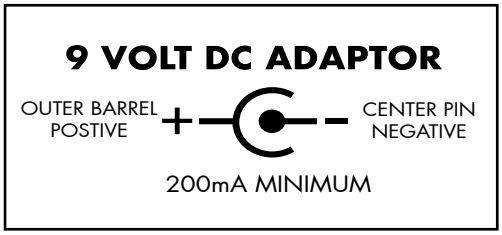
Look for the companion demo videos on our YouTube channel.

The Altura MkII is a MIDI controller and arpeggiator that emulates the classic theremin. The right sensor transmits note data to set the pitch. The left sensor transmits a variety of MIDI controller data to influence the sound in many ways. In X-Y mode, the right sensor mimics the left: both sensors transmit control data of your choosing.

The Altura MkII features 20 preset locations to preserve your setups.

1. **POWER UP** Use a 9V DC power supply or a battery.

   - 9V DC power supply ("wall wart"): Must be rated for 200 mA minimum, with center-negative polarity, such as a typical guitar pedal supply. Look for this graphic on the power supply. (Your controller won't work with a center-positive power supply.) Plugging in the power supply disconnects the battery.



   - 9V battery: Use a high-quality alkaline battery, like Energizer. (Don't waste your money on cheap batteries!) Open your cabinet; insert the battery into its holder; snap the contacts into place; and then push down to snap the battery into the holder. The fit is tight; you may need to use a little screwdriver as a shoe horn to ease the battery into place.

2. **CONNECT A MIDI DEVICE** Plug a standard MIDI cable into the Altura MkII's MIDI OUT jack, and connect it to the MIDI IN of your Macchiato Mini Synth or any other device; or plug into a MIDI patch bay or other port device; or use a MIDI-to-USB cable to plug into your computer.

3. **SET THE KNOBS** to the following default positions, just for this tutorial, until you become familiar with their functions:

DATA FAR	DATA NEAR	FUNCTION	KEY	SCALE	OCTAVE NEAR	OCTAVE FAR
Right	Right	Left	Left	Left	Straiht up	Straight up

4. **TURN ON YOUR SYNTH** If you are using a Macchiato Mini Synth, set it for short attack, long release, and a deep LFO. If you are using a different synth, set its receive channel to 1 or Omni. (By default, the Altura MkII transmits on Channel 1. You will learn how to change this shortly.)

5. **TURN ON YOUR ALTURA MkII** Press the red power button on the back of the Altura. If you built a card stock case, be careful how you squeeze your theremin; you don't want to crush the cabinet. The display will do a little dance, then show "C !", indicating the C Major scale. More on key and scale in a moment.

6. **WAVE YOUR RIGHT HAND** The right sensor selects the pitch to transmit to your synth. As you wave your hand, you should hear notes coming out of your synth! The sensor is sensitive: hold

your hand steady and flat; move it steadily in and out from the Altura MkII until you learn where the beam is pointing. There is much more information in the Reference Manual.

7. **WAVE YOUR LEFT HAND** The left sensor sends Control Change data to your synth to influence the sound in a variety of ways. It is presently in Function 1: Pitch Bend mode. Play a steady note with your right hand, and also wave your left hand. The display will show a cute spinny-graphic that represents Bend Up and Bend Down – try it!

8. **LOAD A PRESET** Touch the Increment and Decrement buttons to cycle through the presets 0-20. Touch the Read / Save button briefly to read the selected preset. The display will show "rd". Check out some of the presets from 0 - 10. Make a few changes. Press and hold the Read / Save button for several seconds until "SAU" is displayed. You have just overwritten a preset!

9. **CHANGE THE FUNCTION** Turn the FUNCTION knob to select functions 1 – 8. The functions are listed in the table below, and on a label on the bottom of your Altura. After the table there's a brief description of each function, with much more to learn in the Reference Manual.

FUNCTION NUMBER	NAME	CONTROLLER NUMBER	DATA FAR	DATA NEAR
1	Pitch Bend	1	Adjust size of neutral zone	Max. pitch bend range (Macchiato only)
2	Modulation	2	Modulation maximum and minimum values	
3	Note-On Velocity	n/a	Velocity maximum and minimum values	
4	Channel Volume	5	Volume maximum and minimum values	
5	Portamento Time	7	Portamento Time maximum and minimum values	
6	X-Y Mode	User Defined	The DATA and OCTAVE knobs set the max and min values transmitted by left and right sensors. KEY and SCALE set the left and right CC#.	
7	Send Channel Select	n/a	DATA FAR sets the MIDI Send channel (default 1)	
8	Arpeggiator	n/a	n/a; see text below	

- Function 1: Pitch Bend

  Wave your hand in front of the left sensor. The display shows a cute spinny-thing to represent Pitch Bend Up and Down. As you move your hand, the display spins and the pitch bends. When you lock into the fully-bent pitch, either up or down, this symbol appears: " 0. " Remove your hand to snap back to the "Neutral", or "No Bend" position, indicated with "_".

Turn the DATA FAR knob to display numbers 0 – 12. With a Macchiato Mini Synth, this sets the number of semitones the pitch will change at maximum bend. On other devices, this knob will have no effect or an unpredictable effect. Set to 0 to disable Pitch Bend.

Turn the DATA NEAR knob to display numbers 0 – 127. This changes the size of the Neutral Zone in the air, separating the Bend Up and Bend Down zones. On startup, the zone was set to 127: you will find a large piece of air where the pitch remains unaffected. Change it to zero and the Neutral Zone diminishes.

- Function 2: Modulation

  Turn DATA FAR to 0 and DATA NEAR to 127. The DATA knobs set the maximum and minimum MIDI value to be transmitted when your left hand is near to or far from the left sensor. Wave your left hand, and as the number rises you should hear note modulation, usually a tremolo effect. As the number falls, the effect fades away. You can reverse the effect by swapping the NEAR and FAR numbers. The controller acts like a mid-air slider: move your hand to the desired value; remove it and the value will "stick". This behavior is the same across Functions 2 – 6 and 8.

  On the Macchiato Mini Synth, Modulation controls the depth of the Low Frequency Oscillator (LFO). Touching the Depth knob on the Macchiato will override the Altura. Using the Altura MkII will override the knob on the Macchiato.

- Function 3: Note-On Velocity

  The Note-On Velocity defaults to 127 upon startup. Use the DATA NEAR and FAR knobs to set maximum and minimum values for Velocity. (Keeping a minimum velocity around 30 will prevent you from accidentally silencing your Altura!) This affects the starting velocity of each new note. Velocity usually impacts the volume of the note, but your synth might use this to influence other effects, such as brightness.

- Function 4: Channel Volume

  The Channel Volume defaults to 127 upon startup. This function affects the overall output volume of your synth, and is useful for volume swells while holding a note.

- Function 5: Portamento

  "Portamento" refers to notes gliding smoothly from one pitch to the next. This effect emulates the classic sound of a theremin. The left sensor sets the Portamento Time: small numbers mean short, fast glides; higher numbers mean long, slow glides. Set the DATA FAR knob to about 10 or 20. Set the DATA NEAR knob to around 80. Play your Altura MkII with a Macchiato Mini Synth and you will hear that spooky theremin sound! Setting Time = 0 will turn Portamento off.

  Some synthesizers will respond to Portamento as readily as the Macchiato; others may only respond with a bit of coaxing; and many synthesizers do not support Portamento at all. Consult your synthesizer's documentation, and the Altura MkII Reference Manual.

- Function 6: X-Y Mode

  In this mode, the right sensor behaves like the left. Each sensor sends MIDI values from 0 – 127 to a different Control Change number. Select left and right CC#'s with the KEY and SCALE knobs. Set the right sensor MIDI max and min with the OCTAVE knobs.

DATA FAR	DATA NEAR	FUNCTION	KEY	SCALE	OCTAVE NEAR	OCTAVE FAR
Left Sensor MIDI Max and Min		Function Select	Left CC# Select	Right CC# Select	Right Sensor MIDI Max and Min	

  Since this mode does not trigger notes, use it with a drone synth or a sequencer. The Altura MkII defaults to CC#'s 85 & 86 on startup, which are undefined. Consult the CC# chart of your synthesizer to select suitable controller numbers. This function is not recommended for use with the Macchiato Mini Synth.

  Here's what the display is telling you:

  0 – 127 When just one sensor is active, this is the MIDI number being transmitted.
  --- Both sensors idle
  ⊢--⊣ Both sensors transmitting.

- Function 7: Send Channel Select

  The Altura MkII defaults to MIDI Send Channel 1. Use DATA FAR knob to change the send channel.

- Function 8: Arpeggiator

  Load Preset 18, which includes an 8-note arpeggio. Wave your right hand and the arpeggio should play in the key and mode displayed. The position of your right hand determines the first note of the arpeggio. Your left hand will multiply the tempo: 1 = Straight time; 2 = Double time; 4, 3 = Quadruple time.

  While in Function 8, the Increment button toggles between "tHr" ("theremin", or "arpeggio play") mode, and "ArP" ("arpeggio setup") mode. In "ArP", the seven knobs now set the notes of the arpeggio. Twirling a knob will display the followng options:

  End rSt HLd -1 -2 -3 -4 -5 -6 -7 1 2 3 4 5 6 7 1.

  End = Ends the arpeggio at this knob
  rSt = Inserts a rest
  HLd = Holds, or extends, the previous note
  -1 = The octave below the root
  -2 through -7 = The second through seventh notes in the scale, in the octave below the root
  1 = The root note; the first note of the arpeggio
  2 through 7 = The second through seventh notes in the scale, in the octave above the root
  1. = The octave above the root

While in "ArP" mode, the Decrement button is now the Tap Time. Press the button a few times. The time between the last two taps is the time it takes to play back the number of notes set by the left hand.

By toggleing back to "tHr" mode, you can change the key and scale in which the arpeggio is playing, and the octave range of the right sensor. Changing to a scale with a different number of notes than the scale in which you set up the arpeggio – such as moving from the diatonic scale to a pentatonic scale – may yield unexpected results.

10. **CHANGE THE KEY AND SCALE** Set FUNCTION to any value from 1 to 4. Now turn the KEY knob slowly to the right while playing notes with your right hand. The display will move through the twelve root notes of the Western scale, with a decimal indicating Sharp:

    C C. d d. E F F. G G. A A. b

    Turn the SCALE knob slowly to the right while playing notes. The display will show 1 – 12. These are the available scales as listed on the label on the bottom of your Altura. The Altura MkII plays a wide variety of scales. See the Reference Manual for more details.

    Playing your scales was never so easy!

11. **TRANSPOSE THE OCTAVE** Turn one of the OCTAVE knobs to cause the Octave display to appear. Twiddle the OCTAVE knobs until you see 5-5. This means near the sensor, you are playing in Octave 5 (out of a range of 1 – 8), and far from the sensor, you are still playing in Octave 5 – a range of one octave. The overscore indicates the octave is ascending as you move from far to near. An underscore indicates a descending scale as you move from far to near.

    a. Turn the OCTAVE FAR knob left until the display shows 5-4. Now your hand covers two octaves ascending: Octave 4 far from the sensor, Octave 5 near the sensor.

    b. Turn the OCTAVE FAR knob right until the display shows 5_6. Now your hand covers two octaves descending: Octave 6 far from the sensor, Octave 5 near the sensor.

    c. Turn the OCTAVE FAR knob left until the display shows 5_5. Now this one-octave range is *descending!* Remember it used to be *ascending?* Whenever you set the Altura MkII to cover one octave, that one octave will ascend if the previous range was ascending, and descend if the previous range was descending.

12. **ARTICULATION** It is possible to adjust the sensitivity of the sensors. This serves to strike a balance between responsiveness and stability. See the Reference Manual for details.

REFERENCE MANUAL

INTRODUCTION

Alexandra Stepanoff playing the theremin on NBC Radio, 1930

The Altura MkII Theremin MIDI Controller by Zeppelin Design Labs was inspired by the early electronic instrument invented by Russian physicist Léon Theremin. Léon's device features a pair of antennae that can sense the capacitance of a person's hands. The right antenna affects a voltage controlled oscillator (VCO) circuit. As the player moves his hand closer to this antenna, the device emits a sine wave tone that rises in pitch. The left antenna affects a voltage controlled amplifier (VCA) circuit. As the player moves his left hand farther away from this antenna, the tone becomes louder. The device is very sensitive and can make wonderful, spooky music – but it is very tricky to play. The performer has to play by ear: there are no frets in mid-air!

The Altura MkII Theremin MIDI Controller makes many improvements on the original device. First, the Altura MkII does not itself make sound; instead, it simply controls synthesizers and computer programs that employ the MIDI protocol (Musical Instrument Digital Interface). Thus any sound that your synthesizer can make the Altura MkII can control. Further, you can determine the key and scale (mode) in which to play. You can even build an eight-step arpeggio and save your work in a bank of presets.

HISTORY

In 1920, as Léon Theremin (1896 - 1993) was developing radio equipment for the Soviet government, he heard strange sounds coming from some of his circuitry. He noticed that the frequency (or pitch) of this sound changed with how close his hand was to the circuit. He developed this device into a musical instrument which he initially called the Thereminvox. In 1927 he left the USSR to tour Europe in promotion of his invention, performing to large audiences and receiving mixed reactions. His tour took him to New York where he stayed for the next 10 years; in which time he opened a laboratory and studio, patented the Theremin, licensed its manufacture to RCA, performed with a theremin ensemble at Carnegie Hall, and invented an electronic cello. In 1930 he conducted the first-ever concert of an electronic orchestra. In 1938 Léon Theremin suddenly disappeared – it was said that he had been kidnapped by Soviet agents; and later he was presumed dead.

Through the late 30's, Theremin's protégé Clara Rockmore rose to prominence as the world's pre-eminent thereminist. She preformed with world-class orchestras in large concert halls. These performances established the theremin as a legitimate performance instrument and started to open the public consciousness to electronic instruments and electronic music in general.

In the late 50's, Rockmore visited Moscow and by chance made contact with her old friend Léon Theremin. After 20 years of mysterious silence, she received word to meet Léon on a subway platform, where they spoke for a few minutes.

It seems Theremin's disappearance may have had more to do with the IRS than the KGB. What is certain is that upon Theremin's return to Russia, he was arrested and sent to the labor camps. He landed in a secret Soviet laboratory where he developed spy gear for the KGB. He was released in 1947 but "volunteered" to continue with the KGB until 1966.

In 1991 Léon, now 95 years old, returned to New York where he gave concerts, received awards, and was reunited with Clara Rockmore. It is not clear that he remembered her. He died in Moscow in 1993, aged 97.

As for his namesake invention, the theremin was just too difficult to play to ever achieve wide-spread popularity. The performer needed to have a very good sense of relative pitch, if not perfect pitch. Also, the instrument takes a lot of skill to play in a controlled manner. So besides Rockmore, there haven't been many other popular thereminists. But the theremin has never completely gone away. In fact, it has consistently been at the center of a sub-culture passionate about electronic instruments and music, where people are not afraid to blur the line between technology and art. One of our personal heroes, Bob Moog, got his start back in the 1960's designing and selling theremin kits, before he revolutionized popular and electronic music with his modular synthesizers. At Zeppelin Design Labs, with our love of electronic instruments and DIY kits, we hope the Altura MkII will continue Léon Theremin's legacy of inspiring both artists and electronics nerds.

HOW IT WORKS

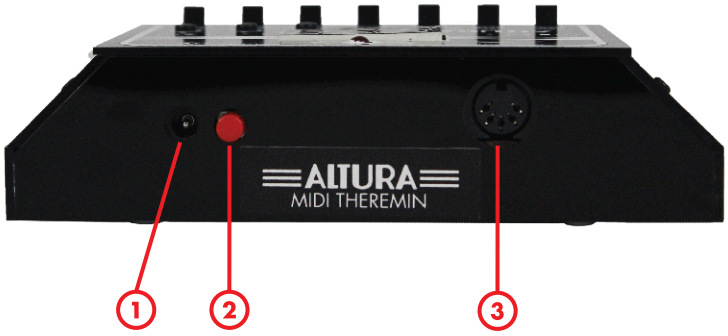
Our MIDI version of Léon's device uses sonar range finders in place of antennae, and rather than producing sound directly, the Altura MkII emits discreet packets of digital data that are interpreted by a separate synthesizer or other sound-making device. The Altura's right-hand sensor transmits Note-On/Off messages to play specific notes, thus controlling pitch. The left sensor transmits Channel Volume data, thus controlling volume. But this is just the start! The left sensor can be set to transmit many MIDI functions, like pitch bend, modulation, note velocity, and portamento time. The Portamento function causes one note to glide smoothly to the next, emulating that spooky Theremin sound; but the device is always gliding to a specific note within a key and scale you designate. As a result, the Altura MkII always plays in tune! In Arpeggio mode, you can program a sequence of up to eight steps that will alsways play in the scale you specify.

The Altura MkII was designed as a companion to the Macchiato Mini Synth by Zeppelin Design Labs. There are a few special features that will only work well when paired with the Macchiato. Otherwise, the Altura MkII conforms with General MIDI specifications and should easily control any device bearing this mark. Many MIDI devices do not conform to the General MIDI specification. These devices will not necessarily respond to the Altura MkII as described herein. In these cases, you may need to fiddle a bit with your synthesizer to get it to behave. Alternatively, you can route your Altura MkII controller through a software application that will enable you to redirect its data as needed.

FEATURE LIST

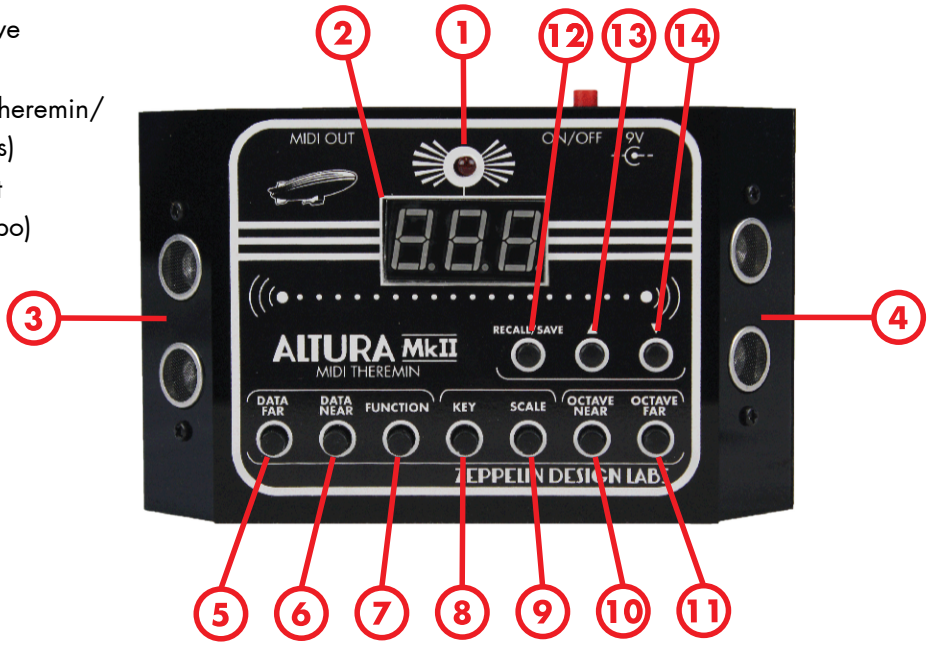
REAR PANEL

1. 9V DC Power Input
2. Power On/Off
3. MIDI Out



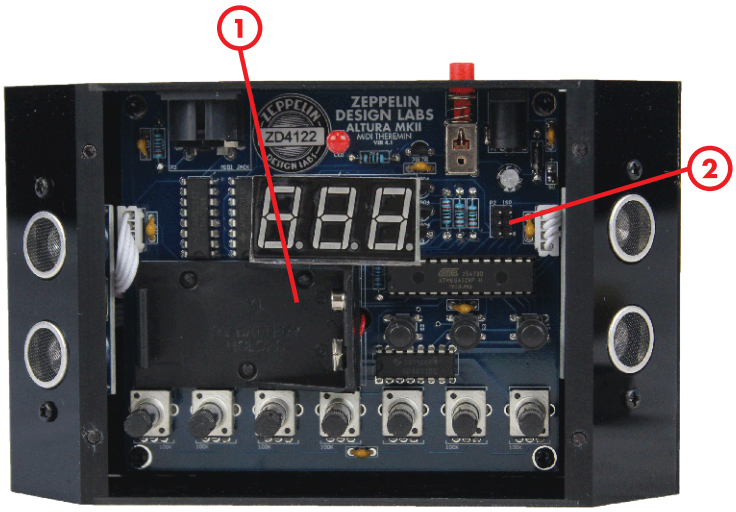
TOP PANEL

1. Power On Indicator
2. 3-Digit Display
3. Left Distance Sensor – MIDI Control Functions
4. Right Sensor – MIDI Pitch
5. DATA FAR Adjust
6. DATA NEAR Adjust
7. FUNCTION Select
8. KEY (Root Note) Select
9. SCALE (Mode) Select
10. OCTAVE NEAR Select
11. OCTAVE FAR Select
12. Preset Recall/Save
13. Preset Increment
    (Fctn 8: Toggle Theremin/
    Arpeggio modes)
14. Preset Decrement
    (Fctn 8: Tap Tempo)



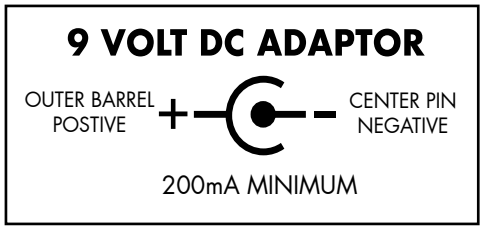
ON THE PCB

1. Battery Holder
2. ISP Header



REAR PANEL FEATURES

1. 9V DC POWER INPUT



You can power your Altura MkII with a plug-in 9V DC power supply ("wall wart"). It must be rated for 200 mA minimum, with center-negative polarity, such as a typical guitar pedal supply. Look for this graphic on the power supply. Your controller won't work with a center-positive power supply. Zeppelin Design Labs offers a suitable power supply as an accessory. Simply plug the cable into the back of your Altura MkII under the "9V" label. This disconnects the battery. It does not matter if you leave the battery inside. The only concern is if years go by and you forget the battery is there, and it leaks all over your Altura MkII.

2. POWER ON/OFF

Push the red button to switch the Altura MkII on. The red LED on top lights up and the display does a little dance, followed by a letter and number, indicating the current key and scale. Push the button again to switch it off.

To display the software version on your unit, turn all seven knobs far left, then power on.

3. MIDI OUT

The Altura MkII transmits data along one pin of a standard MIDI cable. We recommend you connect all your MIDI cables before turning anything on. To use the Altura MkII, simply plug a cable from MIDI OUT to MIDI IN of any MIDI device; or use a MIDI-to-USB converter or other interface device to send the Altura's data directly into your computer. A common problem stems from use of inferior-quality MIDI-to-USB cables. Use a quality, name-brand device from a reputable dealer who will help you if the cable proves defective.

See also "Function 7: Channel Select" on page 19 below.

TOP PANEL FEATURES

This section is very long. The numbered paragraphs are keyed to the illustration on page 10, so the information is not presented in a work flow sequence. Depending on what you are trying to find out, you may want to skip around a bit.

1. POWER ON INDICATOR

This lights up when the power is on. This is a reliable indicator of whether your power supply is working or not. If you run the Altura MkII from a battery, this light will get considerably dimmer rather suddenly when the battery is near the end of its life. The device will also go haywire. Time for a new battery.

2. 3-DIGIT DISPLAY

This display shows a variety of information at different times. It shuts off after 60 seconds of inactivity to spare your battery. To reactivate it, just turn any knob, or wave a hand in front of the left sensor.

Following is a summary of what you might see on the display, and what it means. Each section in the Manual also has its own explanation of what the display is displaying. For instance, Function 8 (Arpeggiator) uses a host of special symbols not summarized here.

IF YOU SEE:	FOR EXAMPLE:	IT MEANS:
A letter and a number	d 3	KEY (letter) and SCALE (number). See those sections below for details. In most cases, the display defaults to this after 3 seconds.
Two separate numbers	4_5 3¯3	OCTAVE NEAR (left number), the octave active NEAR the right sensor; and OCTAVE FAR (right number), the octave active FAR from the sensor. The overscore / underscore indicates whether the scale is ascending or descending. See OCTAVE SELECT below.
A one-, two- or three-digit number	8 67 122	While turning DATA knobs, this is the limiting value of MIDI data the sensors will transmit. See each FUNCTION for details. While waving your hands, the changing number is the MIDI data value that the Altura MkII is transmitting.
A spinning symbol	0. _	Indicates amount of pitch bend, from "_" (no bend) to "0." (maximum bend). See PITCH BEND.
Dashes	– – –	X-Y mode Idle: no data transmitting from either sensor.
This thing:	⊢ – ⊣	X-Y mode Active: both sensors transmitting data.

DISTANCE SENSORS - GENERAL

The distance sensors are ultrasonic ranging devices. One of those eyeballs is a speaker, the other is a microphone. Several times a second, the speaker emits a high-frequency chirp; the microphone listens for an echo. If it fails to hear an echo before a preset timeout, the sensor returns a null value. The Altura

MkII software attempts to distinguish between a timeout because there is truly nothing there, versus a timeout because it simply missed a chirp or two while your hand wiggled around. If the sensor hears an echo before the timeout, it returns the elapsed time in microseconds. The Altura MkII software uses this time to calculate how far away your hand is, and decides what particular data this represents – a note number or a control change value. That data is worked into a standard MIDI message, which is then sent to the MIDI OUT cable.

The sensors monitor a cone-shaped space. They are greaat at spotting things like walls. To spot your hand, you will have to learn exactly where the sensor is looking. This takes practice, as with any fretless instrument.

When most people play with an Altura MkII for the first time, their instinct is to wiggle their fingers and flap their hands. This will produce chaotic results, which may be what you are after. However, for precise melodic control, you must hold your hand flat, steady, and perpendicular to the axis of the sensor. For stage drama, you might want to perform with paddles or dinner plates strapped to your hands. See our YouTube channel for helpful demo videos.

To optimize playability and reliability, we have pre-set the active sensor range to about 3" – 40" (8 – 100 cm). Any object in this range can trigger the Altura: dangling cables, a guitar neck, loose clothes or a swinging pony tail. Keep the play-zone clear!

Since the Altura MkII uses sonar, and measures the speed of sound in air, its performance is somewhat subject to atmospheric conditions. The active range will vary a little if you move between extreme climates. The default range values can be changed if you hack the open-source software. See "Programming The Altura" below. The sensors actually have a maximum range of about 4 meters! You could use the Altura MkII as a door bell, a motion-sensor alarm, or part of an interactive installation, where Alturas are triggered by participants moving about the display space.

3. LEFT DISTANCE SENSOR – MIDI CONTROL FUNCTIONS

The left sensor generally determines a MIDI data value to send to the MIDI OUT. How that data is used is determined by which FUNCTION is currently selected. See "MIDI Function Select" on page 16.

When using Pitch Bend, removing your hand snaps the pitch back to No Bend, just like when you release the Pitch Bend wheel on a conventional controller. When using the other functions, however, removing your hand will fix the controller at the current value, like a slider. You set maximum and minimum values with the DATA NEAR and DATA FAR knobs. See each FUNCTION section below.

4. RIGHT SENSOR - MIDI PITCH

In Functions 1 - 5 and 8, the right sensor transmits Note-On messages, thus controlling pitch. Whenever the Altura MkII detects a new note to send, it first turns off the current note by transmitting a "Note On, Velocity 0"message.

The range over which the sensor is sensitive is pre-set to about 3" – 40" (8 cm - 100 cm). You can alter this by hacking the open-source software. See "Programming the Altura" below. Holding your hand closer than the minimum distance can confuse the sensor and produce unexpected behavior.

Using the OCTAVE NEAR and OCTAVE FAR knobs, you can control how many octaves are active (from one to eight), and whether the scale is ascending or descending. See "10, 11. Octave Near and Octave Far Select" on page 22.

You can set the key and scale in which the Altura MkII will play. See "11. Key (Root Note) Select" on page 20, and "12. Scale (Mode) Select" on page 21.

You can set how sensitive, or responsive, the right sensor is with a feature we call Articulation. See "Articulation Adjust" on page 24.

In Function 6 - X-Y Mode, the right sensor emulates the left sensor and transmits user-defined control change data. See "Function 6: X-Y Mode" on page 18.

5, 6. DATA FAR AND NEAR SELECT

The DATA knobs have slightly different functions depending on the FUNCTION knob setting. These behaviors are summarized in this section, but please see the respective Function sections below for more details.

Function 1 (Pitch Bend): The DATA FAR knob controls the size of what we call the Neutral Zone, where the pitch remains unbent. The DATA NEAR knob sets the maximum semitones of bend when used with a Macchiato Mini Synth.

Functions 2 – 6: The left sensor behaves much like the Data slider found on most MIDI controllers. Use the DATA knobs to set the maximum and minimum values produced by the slider. DATA NEAR sets the limiting value the Altura MkII will transmit when your hand is near the sensor – any value from 0 – 127. DATA FAR sets the limiting value far from the sensor, also any value from 0 – 127. By swapping values, you can make the Altura MkII transmit values that either ascend or descend. Adjusting the DATA knobs does not cause any Controller message to be transmitted. Only waving your hand in front of the sensor will trigger a MIDI message.

Function 7 (Channel Select): The DATA FAR knob sets the MIDI Send channel. The DATA NEAR knob has no function.

Function 8 (Arpeggiator): While in theremin, or Arpeggio Play ("tHr") mode, these two knobs have no function. In Arpeggio Setup ("ArP") mode, all seven knobs are used to define the arpeggio.

When you use the left sensor to send a MIDI control change message, that control value will "stick" even when you change functions. For example, you might wave your hand to set Modulation = 30 and then change to Function 5 to work with Portamento effects. The Modulation effect will remain active at value 30. However, when you return to Function 2 – Modulation, the old values of Modulation Near and Far will be overwritten by the current knob positions. You will continue to hear modulation at value 30 until you use your left hand to change it, but the Near and Far limiting values may have changed! Be aware of this behavior in a live performance situation.

7. MIDI FUNCTION SELECT

The FUNCTION knob determines what type of MIDI data the left sensor will produce. The available functions are:

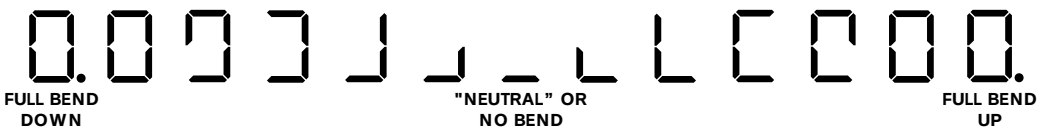
1. Pitch Bend
2. Modulation
3. Note-On Velocity
4. Channel Volume
5. Portamento Time
6. X-Y Mode
7. Channel Select
8. Arpeggiator

A label on the bottom of your Altura MkII reminds you of these functions.

Following is detailed information about each MIDI function. Please also see the sections "Left Distance Sensor – MIDI Control Functions" on page 14 and "8, 9. Data Far And Near Adjust" on page 15 for general notes applicable to all functions.

FUNCTION 1: PITCH BEND

Function 1 emulates the Pitch Bend wheel on a conventional MIDI controller. The Altura MkII sends MIDI values of -8184 to +8184 based on left sensor readings, tagged as Pitch Bend data (Controller #1) on the currently-selected Send channel. The display shows a cute spinny-thing to represent Pitch Bend Down and Pitch Bend Up.



Turn the DATA FAR knob to display numbers 0 – 12. When using a Macchiato Mini Synth by Zeppelin Design Labs, this sets the number of semitones the pitch will change at maximum bend up and down. The Altura sends this information to the Macchiato using the undefined Control Change (CC) #20. If you are using a different synthesizer that happens to make use of CC #20, then turning this knob might have an unexptected effect. If so, avoid touching this knob when in Pitch Bend function.

Turn the DATA NEAR knob to display numbers 0 – 127. This changes the size of the Neutral Zone that separates the Bend Up zone from the Bend Down zone. On startup, the Altura MkII defaults to Function 1: Pitch Bend, and the neutral zone will default based on the physical position of the DATA NEAR knob. At 127, you will find a large piece of air where the pitch remains unaffected. Change it to zero and the neutral zone will essentially disappear.

The Altura MkII lacks the resolution to use the Pitch Bend to produce precise, subtle vibrato effects characteristic of the original theremin. Use the Modulation effect for this instead.

FUNCTION 2: MODULATION

Function 2 emulates the behavior of the Mod Wheel on a conventional MIDI controller. It transmits a value from 0 – 127, as determined by the left sensor, to CC #2 on the currently selected Send channel.

Set DATA FAR to 0, and DATA NEAR to 127. Move your hand near: the number rises, and you should hear note modulation, usually a tremolo or vibrato effect. Move your hand far away: the number falls, and the effect diminishes. You can reverse the effect by swapping the numbers. The controller acts like a mid-air slider: move your hand to the desired value; remove it and the value will "stick". Note that changing the Data knob values will have no effect until you wave your hand in front of the left sensor. Only this will trigger transmission of a MIDI message.

On the Macchiato Mini Synth, Modulation controls the Depth of the Low Frequency Oscillator (LFO). Touching the Depth knob on the Macchiato will override the Altura MkII. Using the Altura MkII will override the knob on the Macchiato.

FUNCTION 3: NOTE-ON VELOCITY

This function emulates the role of key velocity on a conventional keyboard. Whenever the Altura MkII transmits a Note On message, it combines the current Velocity value from the left sensor with the current Pitch value from the right sensor and transmits on the currently selected Send channel. The Note On Velocity defaults to 127 upon startup. Use the DATA NEAR and FAR knobs to set a maximum and minimum value for Velocity. You won't actually hear an effect until you wave your hands in front of both sensors.

Velocity usually affects the note volume, but your synth might use this data for other effects, such as brightness or voice switching. This controller acts like a slider: set Velocity to a particular number; remove your hand and that number will "stick". All notes will now play with that velocity value. You can now switch to another function and the velocity will continue unchanged.

FUNCTION 4: CHANNEL VOLUME

The Channel Volume emulates the Master Volume slider found on many MIDI controllers. Channel Volume defaults to 127 upon startup. Use the DATA NEAR and FAR knobs to set a maximum and minimum value for Volume. (Keeping a minimum volume of at least 30 will prevent you from accidentally silencing your Altura!) This affects the overall output volume of your synth, and is most useful for creating swells as a note sustains. This function lacks the resolution for subtle tremolo effects. It is better to use your Modulation effect for that.

This controller acts like a slider: set Volume to a particular number; remove your hand and that number will "stick". Your synth will continue to play at that volume. You can now switch to another function and the channel volume will continue unchanged.

FUNCTION 5: PORTAMENTO

Portamento means a smooth glide between notes. When you play a slide flute or trombone, you can portamento all the time. This glide effect is what you need to emulate that good ol' theremin sound. We designed the Altura's Portamento function to work well with the Macchiato Mini Synth. Many synthesizers do not implement Portamento at all; some do but only in a limited manner. Consult your synth's documentation to find out if you can use this feature.

When the FUNCTION knob is set to 5, and Portamento Time is other than zero, the Altura MkII sends a "Portamento ON" message (CC #65, value 127) on the currently selected Send channel. If you send a Portamento Time = 0 message, or if you send any Pitch Bend messages, the Altura MkII will send a "Portamento OFF" message (CC #65, value 0, current Send channel).

Waving your left hand transmits a Portamento Time message (CC #7, value 0 – 127, current Send channel). Zero represents an infinitely short glide from note to note, which is the same as no glide at all; that's why Portamento Time = 0 will switch off the effect. Portamento Time = 1 means a very fast glide between notes, almost too fast to perceive. Portamento Time = 127 produces a glide about 1 second long. Intermediate numbers produce glide times along a linear interpolation. It is an absolute time: the glide will last the same number of milliseconds whether the interval is one semitone or six octaves. For pleasant melodic playing, use Time values of about 10 - 25. The Altura MkII sounds most like a theremin at Time values around 30. Set the DATA FAR knob to the slowest effect you want to hear, and DATA NEAR knob to the fastest. See the section "PRESETS" on page 26 for a list of presets that we designed to sound most like a theremin. How they sound on any particular synth will vary widely, so experiment!

FUNCTION 6: X-Y MODE

This function causes the right sensor to emulate the left sensor: it no longer sends Note On messages; instead, it sends control change messages of your choosing, just like the left sensor. You would use this mode not to create melodies, but to shape the sound already being produced by a synthesizer. A typical use would be to assign two different filter sweeps to the left and right sensors, or a filter sweep to one and resonance to the other.

The DATA FAR and NEAR knobs set the limiting MIDI values for the left sensor. The OCTAVE FAR and NEAR knobs do the same for the right sensor. Use the KEY knob to select the Control Change Number (CC#) for the left sensor, 0 – 127, and use the SCALE knob to select the right-sensor CC#. On startup, these default to CC# 85 & 86, which are undefined. See your synthesizer's documentation for a table of available CC's.

DATA FAR	DATA NEAR	FUNCTION	KEY	SCALE	OCTAVE NEAR	OCTAVE FAR
Left Sensor MIDI Max and Min		Function Select	Left CC# Select	Right CC# Select	Right Sensor MIDI Max and Min	

FUNCTION 7: CHANNEL SELECT

DATA FAR sets the Altura Send channel, which defaults to 1 on startup. You can daisy-chain many devices, and only those set to receive on this channel will respond to the Altura MkII.

FUNCTION 8: ARPEGGIATOR / STEP SEQUENCER

This is a major new functionality introduced with the MkII version of the Altura. Follow this typical work flow until you get familiar with this powerul and flexible tool.

- Turn FUNCTION knob to 8. You are in Arpeggio Play mode, and the display shows the current key and scale. Hold your right hand steady, close in front of the right sensor. Do you hear an arpeggio? Probably not.
- To create or edit an arpeggio, touch the Preset Increment button (▲) to toggle into Arpeggio Setup mode. The display shows "ArP" and the seven knobs will now build your arpeggio.
- Twiddle the seven knobs, left to right, to display a variety of positive and negative integers. Now you should hear a crazy arpeggio! Moving your right hand sets the starting note for the arpeggio, which always plays within the current key and scale.
- In "ArP" mode, the Preset Decrement button (▼) is now the Tap Tempo button. Tap it a few times to set the tempo.
- Move your left hand to set a tempo multiplier, 1, 2, 4 or 3. (4 and 3 will sound the same in this context.)
- Touch the Preset Increment button (▲) to toggle back to Arpeggio Play mode. The display shows "tHr". You can now change the key, scale, and octave range, or leave Function 8.
- Touch the Preset Decrement button (▼) to cycle down to a preset number of your choice. Press and hold the Preset Recall / Save button to save your arpeggio.

That's the basic gist of what's going on. Here are a few more specifics:

Arpeggio Note Numbers In "ArP" mode, twirling the knobs gives you access to one full octave of notes above and below the note being played by your right hand. Your right-hand note is *always* Note 1 in the arpeggio scale. The knobs will present you with a range of numbers based on the currently selected scale:

Diatonic	-1 -2 -3 -4 -5 -6 -7 1 2 3 4 5 6 7 1.
Pentatonic	-1 -2 -3 -4 -5 1 2 3 4 5 1.
Whole Tone	-1 -2 -3 -4 -5 -6 1 2 3 4 5 6 1.
Diatonic	-1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -11 -12 1 2 3 4 5 6 7 8 9 10 11 12 1.

For example, Note -5 is the same as Note 5, but an octave apart. Note 1 is the note your hand is playing, -1 is an octave below, and 1. is an octave above.

With the Altura in "tHr" mode, you can change the scale on the fly. Moving between scales with different numbers of notes may yield peculiar results.

But Wait! There's More... In "ArP" mode, at the far left (counterclockwise) position, each knob provides three additional options:

End Ends the arpeggio at this point. Your hand will always trigger the first note in an arpeggio. The first knob, therefore, represents the second note in the pattern. Setting the first knob to End produces a one-note arpeggio. (Try it!) By setting other knobs to End you can create an arpeggio with 2 - 7 notes. No knobs set to End produces an 8-step pattern.

rSt Inserts a rest.

HLd Holds, or extends, the previous note or rest. This is not the same as repeating a note. Repeat a note for a staccato effect. Hold a note to extend the length of one note.

By combining notes, holds and rests, the Altura MkII functions as a genuine step sequencer.

Tap Tempo & Multiplier The left sensor sets the tempo multiplier: 1, 2 or 4. (There is also a 3 available at the far postition, but the 3 does NOT function as a multiplier! During playback, 4 and 3 sound the same. Bear with me and keep reading.) The multipliers always multiply the playback tempo in the ratio 4:2:1.

The multipliers play a role in capturing the tempo too, and this is where the 3 comes in. When you set the tempo by tapping the Tap Tempo button (▼), the multiplier value is the number of notes the Altura will fit into the tap interval. For example, regardless of how many notes there are in your pattern, if the multiplier is set to 2, then when you set the tap time, the Altura will play back two notes per beat. So set the multiplier to the value that is easiest to tap! The 3 is there to help you set the tempo for patterns with three or six notes. We put the 3 at the end of the line because once your tempo is set, the three available multipliers are always in the ratio of 4:2:1. We put those three values together for ease of use.

To set the tempo for patterns with five or seven notes, just break the pattern down in your head into 3+2, or 4+3, and use an appropriate multiplier to set your tempo.

8. KEY (ROOT NOTE) SELECT

The KEY knob sets the root note of the scale you are playing. Turn the KEY knob and the display will show a letter and a number, i.e. d4. The letter will change as you turn. It will display the twelve notes of the Western scale, with a decimal to indicate sharps:

C C. d d. E F F. G G. A A. b

This note will always play at the nearest and farthest points on the right sensor. For instance, if you set KEY to "F.", then the nearest and farthest notes your right hand can find will always be F-Sharps. Which F-Sharps depends on the OCTAVE NEAR and OCTAVE FAR settings.

9. SCALE (MODE) SELECT

The SCALE knob selects from one of a dozen pre-programmed scales, or modes. These scales are listed on a label on the bottom of your Altura MkII for easy reference. We have selected a variety of common and not-so-common scales, including a couple of pentatonic scales popular with guitarists. We have also included the Chromatic scale, which includes all twelve notes in the Western scale.

A "scale" is defined by the intervals between adjacent notes as you make your way up an octave from one root note to the next. The following table describes the interval formulae we used in programming the Altura MkII. You can change this easily to add your own scale by hacking the open-source software. See "PROGRAMMING THE ALTURA MkII" on page 25.

MODE	SEMITONES											
Ionian (Major)	2	2	1	2	2	2	1					
Dorian	2	1	2	2	2	1	2					
Phrygian	1	2	2	2	1	2	2					
Lydian	2	2	2	1	2	2	1					
Mixolydian	2	2	1	2	2	1	2					
Aeolian (Natural Minor)	2	1	2	2	1	2	2					
Locrian	1	2	2	1	2	2	2					
Harmonic Minor	2	1	2	2	1	3	1					
Major Pentatonic	2	2	3	2	3							
Minor Pentatonic	3	2	2	3	2							
Whole Tone	2	2	2	2	2	2						
Chromatic	1	1	1	1	1	1	1	1	1	1	1	1

You cannot program non-Western pitches with the Altura MkII. Each key on the piano has its own standard MIDI number, ranging from 1 – 127. The pitches associated with each is a universal standard. To detune these frequencies to match non-Western music can only be done inside a synthesizer or sometimes with intermediate control software.

10, 11. OCTAVE NEAR AND FAR SELECT

The Altura MkII has a range of eight octaves (1 – 8), covering MIDI note numbers 12 (C0) through 119 (B8). (The original theremin had a range of about 5-1/2 octaves.) You do not have access to the lowest subsonic tones, or the few highest squealing notes. The OCTAVE NEAR knob sets which octave is active when your hand is near the right sensor. The OCTAVE FAR knob sets the octave that is active far from the right sensor. When both OCTAVE knobs are set to the same number, the Altura MkII covers that one octave. The nearest and farthest notes will always be the root note as selected with the KEY knob; in between will be the notes specific to the scale selected by the SCALE knob.

The more octaves you assign to the right sensor, the smaller is the air space for each note. If you are trying to play a specific melody, two octaves is probably your practical limit. If you are jamming along with the band, just set the key and scale and as many octaves as you like, and get grooving. You can adjust octaves on the fly as you play.

If the OCTAVE NEAR value is higher than OCTAVE FAR, such as 6¯4, then naturally the scale will ascend as you move your hand nearer to the sensor, and vice versa. The overscore on the display suggests "ascending". If you set the two octaves to be equal, then the Altura MkII covers a single octave, and its direction will match the previous selection: if it was two octaves ascending, then now it is one octave ascending. If it was two octaves descending, then now it is one octave descending. The display includes an underscore to suggest a descending scale, and an overscore to suggest an ascending scale. Change the Octave Near knob through the following sequence to demonstrate:

- 6¯4 Three octaves ascending (as the hand moves from far to near)
- 4¯4 One octave ascending
- 3_4 Two octave descending
- 4_4 One octave descending

12. PRESET RECALL / SAVE

The ability to save and read presets is a major new functionality introduced with the MkII version of the Altura. Touch this button to display the current preset number. When you release the button, Altura MkII reads the preset and displays "rd" or "rCL". The Altura will now switch to exactly the configuration it was in when this preset was saved, including the Function number.

To overwrite a preset with the Altura's current configuration, press and hold this key. The preset number will display. After 3 seconds, the display will show "Su" or "SAu".

Your Altura MkII comes with all preset locations loaded with sample presets. See "PRESETS" on page 26. Note that how these presets sound depends entirely on the synthesizer into which you plug your Altura MkII. They are merely starting points for your own imagination. Presets 0 - 10 focus on the Altura as a monosynth or theremin instrument. Presets 11 - 20 all load in Function 8, Arpeggio mode.

13. PRESET INCREMENT / ARPEGGIO SETUP TOGGLE

In Functions 1 - 7, touch and release this button (▲) to display the current preset number. Press it repeatedly to increment through preset numbers 0 - 20. To read from or write to the selected preset, use button 5, Preset Recall / Save.

In Function 8 (Arpeggiator), this button toggles the function of the seven pots. When you enter Function 8, by default the device remains in theremin (or Arpeggio Play) mode, and the knobs continue to perform their usual functions. Tap this button (▲) to enter Arpeggio Setup mode. The display shows "ArP" and the knobs can now be used to define an arpeggio of one to eight steps. See "Function 8: Arpeggiator" on page 19. Tap this button aagain to return to theremin, or Arpeggio Play mode. The display shows "tHr" and normal knob function is restored.

14. PRESET DECREMENT / TAP TEMPO

Touch and release this button (▼) to display the current preset number. Press it repeatedly to decrement through preset numbers 20 - 0. To read from or write to the selected preset, use button 5, Preset Recall / Save.

In Function 8, Arpeggiator, when the Preset Increment button (▲) is used to toggle into Arpeggio Setup mode ("ArP"), the Decrement button (▼) becomes the Tap Tempo button. See "Function 8: Arpeggiator" on page 19.

ON THE PCB

Lift the lid off your Altura's acrylic case, or open the top of your card stock case, and take a look inside.

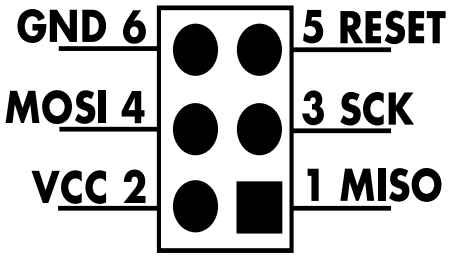
1. BATTERY HOLDER

Use a high-quality 9V DC alkaline battery, like Energizer. Do not waste your money on cheap batteries! You will regret it. Insert the battery into the holder, and push down to snap the battery into place. You may need to use a small screwdriver as a shoe horn to coax the battery into place.

As the battery drains, the ON LED will grow dimmer and the Altura MkII may behave unpredictably. You are not likely to damage anything, but it simply won't work well. Replace the battery!

Plugging in a 9V DC power supply will disconnect the battery. It's okay to leave the battery installed while using an external power supply. The only concern is if you forget the battery is there and years go by. Eventually the battery will leak acid all over your Altura MkII, and this could damage or destroy it.

2. ISP HEADER



On the PCB to the right of the 3-digit display there is a cluster of six pins. This is the In-System Programmer (ISP) header. This is the data port you use to communicate with the microcontroller that runs the Altura MkII. To make use of it, you need a little device called a programmer. This is a little circuit board with cables thaat connects a USB port on your computer to the ISP header. Pin 1 of the header is the bottom right pin; look for a tiny white dot on the PCB. (This is upside-down compared to how ISP headers are typically arranged.) The socket on your programmer will have an indicator on one corner, or a stripe on one wire, to indicate pin 1. Be sure to attach your programmer to the header correctly! When installed correctly, the Altura's LED and display will illuminate.

We used a USB-Tiny clone programmer to develop the Altura MkII. Zeppelin Design Labs offers this programmer as an accessory. If you obtain a programmer from another source such as Sparkfun or Adafruit, be sure it is a USB-Tiny. Some users have had trouble with other types of programmers, such as Arduino boards. How to use the programmer is covered in the section "Programming the Altura".

3. ARTICULATION ADJUST

We developed the Articulation feature to improve the stability and playability of the Altura MkII. Since your hand is a floppy, squashy thing, the Altura can have a hard time figuring out where it is exactly. We use a few data processing tricks to distinguish signal from noise and stabilize the Altura's performance. One of these tricks is to simply increase the minimum allowable time between notes. We call this adjustment "articulation". Low articulation values (below about 25) mean faster response: the

instrument is more responsive, but sometimes it picks up random data or small movements of your hand and it plays unintended notes. High articulation values (above about 50) make the device very stable: the instrument takes plenty of time to decide where your hand is and it seldom gets it wrong. On the down side, the instrument is less responsive and sometimes fails to play a note which you did intend. Your Altura MkII left the Lab with the articulation set to 30, which we think gives a good balance of stability and responsiveness.

To adjust the articulation:

a. Turn off the Altura MkII.
b. Turn all seven control knobs to the far left.
c. Turn on the Altura MkII. The software version will display.
d. Touch the Preset Recall / Save button. The current Articulation value will display.
e. Use the Increment / Decrement (▲,▼) buttons to change the articulation. You can play the Altura MkII as you go, to monitor the effect, but you will probably want to adjust the OCTAVE knobs to something higher than Octave 1!
f. When you like the effect, press and hold the Preset Recall / Save button for three seconds, until "SᴜA" ("Save Articulation") appears.
g. Power the unit off and back on.

PROGRAMMING THE ALTURA MkII

The Altura MkII software was developed in the Arduino integrated development environment (IDE). If you are an Arduino enthusiast, you can download the Altura MkII open-source code from our github repository, edit it to your heart's content, and upload, or "flash", it to your Altura MkII to make your own custom controller. Even if you don't want to do your own programming, the ISP header on your Altura's PCB makes it easy to install software updates. Check out the free and handy Zeppelin Updater App to obtain the latest software for all of our products.

The Altura MkII Theremin MIDI Controller is covered by the Creative Commons Share Alike / Attribution / Non-Commercial license. You are free to modify and redistribute the Altura MkII software as long as you a) redistribute it under the same license as the original, b) give proper attribution to all previous contributors, and c) don't try to sell your work without talking to us about it first.

We host the Altura MkII source code on Github at www.Github.com/zeppelindesignlabs. Please go to the Altura MkII repository page now and read the README.md file for detailed, current instructions on obtaining and modifying the Altura MkII source code.

If you get stuck, please contact us by email at info@zeppelindesignlabs.com, or consult our forum at http://zeppelindesignlabs.com/forums/.

PRESETS

Your Altura MkII contains 21 presets, numbered 0 - 20. They are preprogrammed to demonstrate the variety of the Altura's capabilities. How they sound in your setup depends heavily on the synthesizer you use. Remember that many synthesizers do not implement Portamento effects. With these synthesizers, Function 5 - Portamento will have no effect. Check your synth's documentation for details.

Presets 0 - 9 contain melodic lead setups, with no arpeggio defined. Presets 10 - 20 demonstrate the arpeggio function. While a preset does store all parameters for both Theremin play and Arpeggio play, we nonetheless suggest you designate your presets for one style of play or the other.

THEREMIN PRESETS

	Data						Octave		
Preset	Far	Near	Value	Function	Key	Scale	Near	Far	Notes
0	0	127	35	2	C	1	4	4	Descending
1	4	64	–	1	C.	1	5	5	Ascending
2	127	0	64	2	d	2	4	5	
3	127	40	127	3	d.	3	4	6	
4	40	127	85	4	E	4	4	2	
5	0	127	60	5	F	5	6	2	
6	25	127	100	4	F.	6	4	6	Theremin. Porta Time = 35
7	20	127	64	2	G	7	3	4	Theremin. Porta Time = 25
8	45	85	75	2	G.	8	3	4	
9	30	127	127	3	A	9	4	5	

ARPEGGIO PRESETS

			Octave		Arpeggio Step							
Preset	Key	Scale	Near	Far	2nd	3rd	4th	5th	6th	7th	8th	Notes
10	C	1	4	3	3	5	1	5	3	End		C Maj chord, triplet time
11	C.	1	5	5	4	1	5	1	7	1	1.	
12	D	2	4	5	5	End						Fifth diad. Space Invaders.
13	E	9	4	6	3	5	End					
14	D	4	3	2	3	-5	5	End				
15	F	5	5	2	-7	1	-6	-5	End			
16	D	6	4	4	3	5	1	-5	-3	End		
17	E	3	4	2	-7	1	-6	1	-5	-3	End	
18	A	8	2	4	-6	-7	-5	-4	-2	-3	-1	
19	E	9	4	2	5	Hld	6	5	4	3	Hld	
20	F	7	2	2	1	2	1	3	1	4	3	Peter Gunn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