

Tubbutec μ Tune user manual

<http://tubbutec.de>

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1 Introduction

Tubbutec μ Tune is a powerful quantizer, midi to CV interface, CV to midi interface, midi router and general multitool with a lot of features. The two channels of the main module can be expanded to up to 8 channels using μ Tune expanders. μ Tune has many features dealing with microtonal music or generally precise pitch: you can load, edit and save scales and tunings, and it includes a tuner, VCO calibration and even real-time automatic tuning.

μ Tune is not limited to one function at a time. You can route midi midi between DIN and USB, create midi and merge it with existing notes, quantize using a microtonal scale and measure a VCO's frequency all at the same time.

1.1 Introduction to microtonality

Microtonality and alternative tuning systems is a vast and complex topic that can not be covered in this manual.

As a first introduction we recommend the video “Lecture on microtonality with the Tubbutec μ Tune”, a presentation by Phineas De Thornley Head and Matt Ward.

It can be found in our Youtube channel or via the link:

https://www.youtube.com/watch?v=uf_zMCUrqBA

A more in depth introduction can be found here:

<https://www.britannica.com/art/tuning-and-temperament>

We also warmly recommend to check out Sevish, whose albums are a great example of approachable microtonal music and whose scale packs can be found on the μ Tune SD card.

<https://sevish.com>

Sevish is also the creator of “Scale Workshop”, a browser based scale creator completely compatible with μ Tune:

<https://sevish.com/scaleworkshop/>

Speaking of scale creation: The mother of all tools is of course “Scala” by Manuel Op de Coul.:

<http://www.huygens-fokker.org/scala/>

Its .scl format can directly be read and modified by μ Tune. Manuel also generously provided the interval name list used in μ Tune's own scale editor.

1.2 About this manual

This user manual first describes all features and settings that can be found in the μ Tune menu. It then shows typical use cases with examples in the HOW-TO section. This includes examples for quantizing, midi handling, microtonal work and auto-tuning.

This manual describes the features of μ Tune firmware version 2.00. Manual version 2.00

1.3 μ Tune user interface

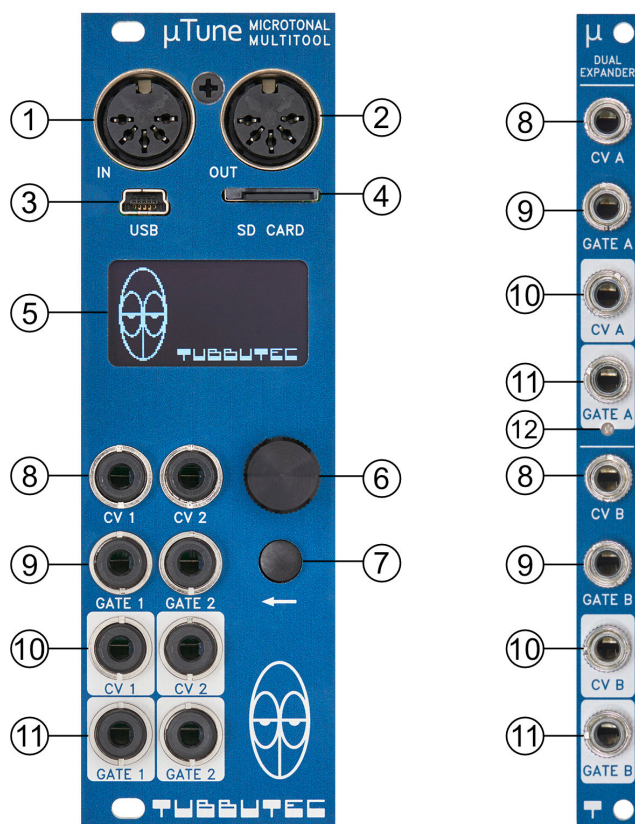


Figure 1: μ Tune interface overview, the main module is 8HP wide, the expander is 2HP

1. DIN-midi input
2. DIN-midi output
3. Mini-USB provides USB midi. μ Tune acts as a USB device.
4. Slot for a micro SD card. The card is inserted with its 'tooth' pointing to the left
5. OLED display
6. Knob and ENTER button for menu navigation.
7. Back button. Will always bring you back to the previous menu page.
8. CV-in channels 1 and 2 and expander channels
9. GATE-in channels 1 and 2 and expander channels
10. CV-out channels 1 and 2 and expander channels
11. GATE-out channels 1 and 2 and expander channels
12. Expander status LED. Shows expander power (green) and GATE-out states (red and blue)

1.4 Connecting expanders

Up to three expanders can be connected to the μ Tune main module. Each expander adds two complete μ Tune-channels with CV-in, GATE-in, CV-out and GATE-out. The expanders are connected to the main module using ribbon cables and are fully powered by the main unit.

WARNING! DO NOT CONNECT THE EXPANDERS WHILE THE MAIN MODULE IS POWERED.

This might damage the main module or the expander.

The expanders are connected as shown in Image 2. The connector on top of the expanders is connected to the main module or bottom connector of the previous expander.

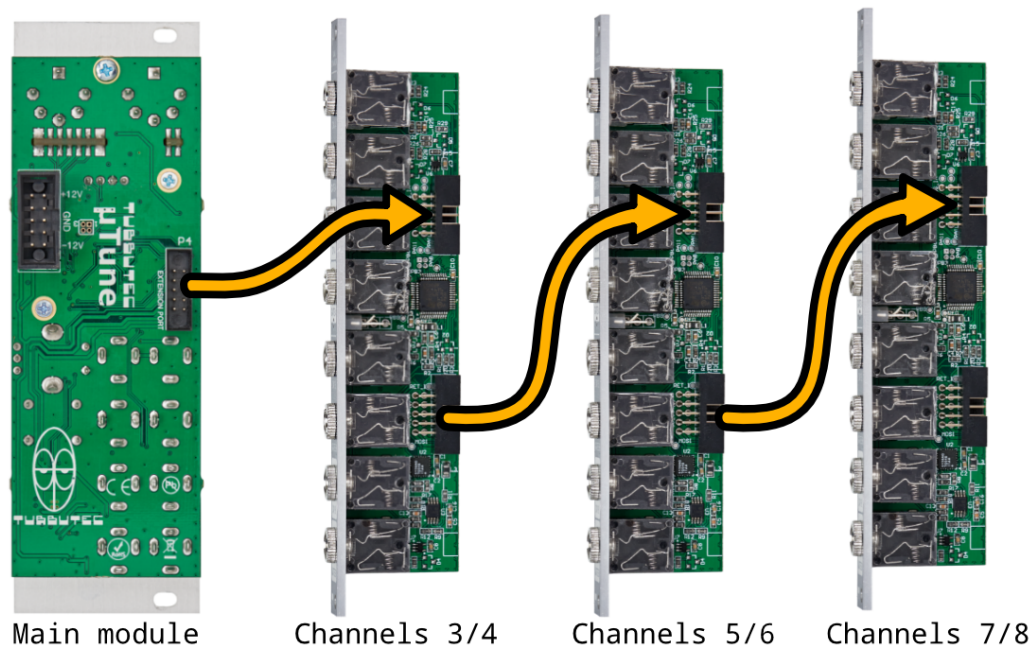


Figure 2: Connecting several expanders.

On startup μ Tune will automatically detect the number of connected expanders and shows the correct number of channels in the main menu.

1.5 Block diagram

Below is a block diagram which shows the most important parts of μ Tune's signal flow. Only one channel is shown.

Simplified μ Tune block diagram

Only one of two channels displayed. Many parameters and connections omitted for clarity.

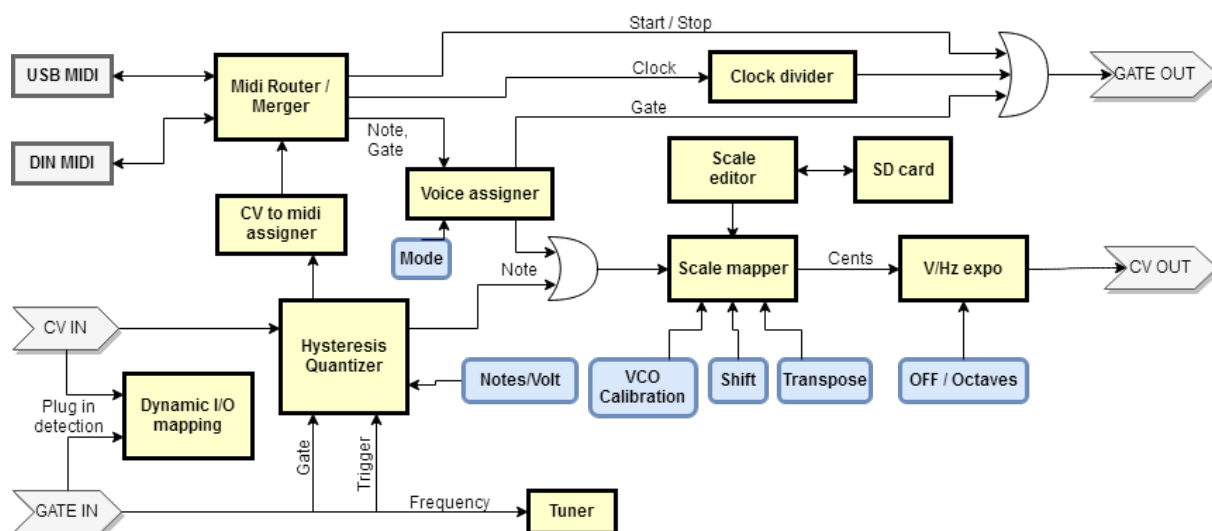


Figure 3: Simplified μ Tune functional flow chart

The input voltage at CV-in is converted to a note number in the quantizer. It uses hysteresis at its input in order to filter noisy signals. The quantizer can work in free-running mode, or be triggered or gated by the signal at the GATE input. GATE-in can also provide other functions such as measuring frequency for the tuner, or trigger a random transpose.

A second possible source of note numbers is midi. Midi note events coming from either USB-midi or DIN-midi are routed in the midi router and passed to the voice assigner. Here note and gate signals are created depending on the voice assign mode and output configuration. Dual mono, or several different duo phonic voice assign modes are available.

The note numbers are then passed to the scale mapper. Here, they are converted to a pitch value via the currently loaded scale. Parameters such as Transpose or Scale Shift are included as well as the VCO correction factors. An optional exponential converter can also be activated, converting between v/Hz and v/oct standards. At the end of this signal chain sits a 16 bit DAC, which turns the value into a high precision voltage between 0V and 10V.

The GATE-out can output Midi Start/Stop signals, Midi clock with adjustable divider or midi gate from the voice assigner.

The configuration of input and output functions is dynamic and reacts to whether CV-in and GATE-in are plugged in. Functions can be defined freely for each possible combination of these. This way μ Tune can change its function based on what you intend to do, without having to change a lot of settings first.

2 Menu

2.1 Main menu



Figure 4: Main menu with 2 channels (no expander)

The main menu shows an overview of μ Tune's status and also contains four sub-menus. Simply enter these menus by navigating to them with the navigation knob and press enter.

On the left side you can see the status of channels 1 and 2. The right pointing arrow shows the GATE-in status. It becomes thicker if the gate is active. Next to it, the 'input note' is displayed. This is the note recognized by the quantizer. The left pointing arrow shows the status of the output gate. Next to it the 'output note' is shown. This is the note that is mapped via the scale mapper and put out to CV-out as a voltage. There are different ways input and output notes can be displayed. (see notations).

If a CV-out is configured to output velocity, aftertouch or midi controller data, the output note is replaced with a bargraph showing the current value.

Below the channel numbers μ Tune displays the status of its plug-in detection. 'g' means a cable is plugged into the gate input. 'c' means something is plugged into the CV-input. And 'b' means something is plugged into both inputs. The plug-in detection is used to switch μ Tune's functionality depending on the used inputs. See chapter 'Channel configuration'.

On the bottom of the main menu, you can see the name of the currently loaded scale.

You can access settings and tools via four sub-menus:

- INFO shows the status of each channel in more details and also displays the detected frequency. It can also be accessed by pressing the BACK button from the main menu
- TOOLS contains various tools, such as VCO calibration, auto-tuning or clock generator.
- TUN (tune) contains functions dealing with tuning and scales
- CONF contains all other settings and configurations of μ Tune

If you have expanders installed the main menu will look different because the status of the additional channels is shown. In the examples below we used different notation settings for the channels: Channel 1 and 2 have notation setting 'decimal'. Channels 3,4,6, and 8 are set to 'semitone' and channels 5 and 6 are set to 'relative 1'. More info about the possible notation display can be found in the chapter about notation settings.

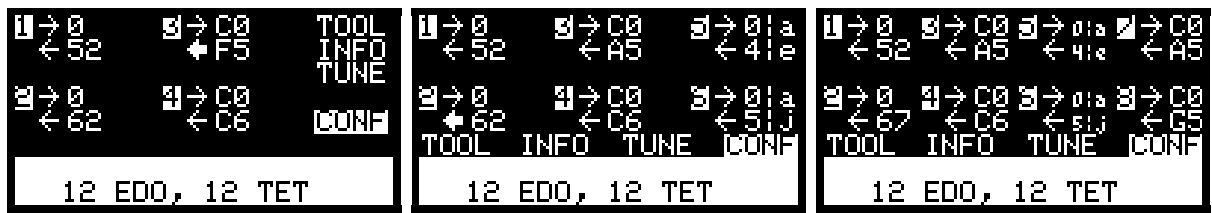


Figure 5: Main menu with 4, 6 and 8 channels (using 1,2 and 3 expanders)

2.2 INFO

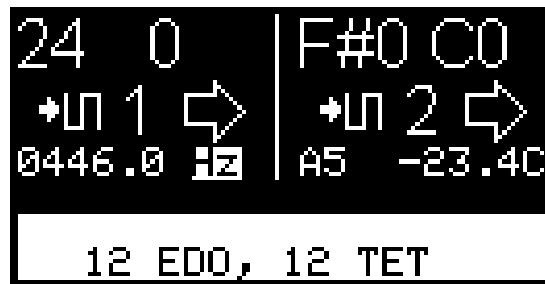


Figure 6: Status and Tuner

The INFO screen shows the status of channels 1 and 2 in more detail. If you have more than two channels by means of expanders, you can scroll to display those as well. Just as in the main menu, you can see input note (upper left corner), output note (upper right corner), input and output gate states (arrows) and the current scale on the bottom.

If a CV-out is configured to output velocity, aftertouch or midi controller data, the output note is replaced with a bargraph showing the current value.

Additionally the frequency detected at the GATE-in input is shown. You can set the display mode of this frequency to the following modes:

- Hz: shows the frequency in Hertz. In the example this mode is used for channel 1.
- Absolute pitch: Shows the frequency like a normal tuner (e.g. guitar tuner) would do. You can see the closest detected note (e.g. C#) and the error in cents. If you however load a different tuning it will use its notes as base for the calculation. So it's a fully microtonal tuner. In the example this display mode is used for channel 2.
- Relative pitch: pretty much like absolute pitch, but shows the difference from the expected pitch based on the current output note. This is very useful when tuning your setup or when preparing a VCO for auto-tuning.
- BPM: Shows the detected frequency as 'beats per minute'. Useful for measuring clock signals

2.3 CONF

In the config menu you can set configuration for inputs and outputs, midi and more. All settings are saved whenever you return to the main menu.

2.3.1 Channel configuration

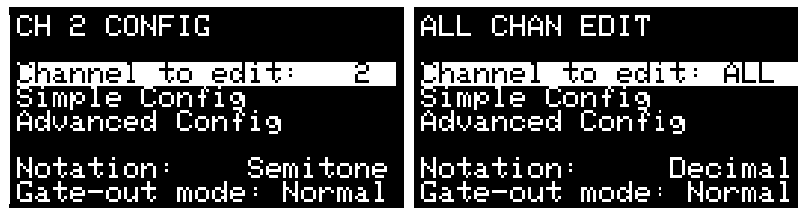


Figure 7: Channel configs for channel 2 and for all channels at once

Each channel can be configured individually in the channel config menu. You can select the channel to edit with the 'Channel to edit' selector. Here, you can also select 'ALL' to configure all channels at once.

µTune can detect whether an input is used and change the configuration accordingly. For each of the four possible modes (cv and gate not plugged in, cv only plugged in, gate only plugged in and both plugged in) you can configure the function of each input and output. This can be done in a simple way which is sufficient in most cases, or you can specify the behavior in full detail.

Plug in detection can be used to automatically change your setup based on the plugged in connections. For example: if no CV-input is connected the channel works as a midi to CV/gate interface, but if you plug it in it quantizes and outputs an automatically generated trigger pulse. The possibilities are almost endless here.

Simple channel config Here you can set configuration for all inputs and outputs. μ Tune will copy these settings to the parameters in the Advanced Config, overriding them if applicable. The following input and output configurations are possible.



Figure 8: Simple config menu

- CV-IN:
 - "None": CV-in is not used
 - "Pitch Map": CV-in is used as input for the quantizer
 - "Transpose": CV-in is used to transpose an other channel. You can set the target channel as well.
 - "Shift": CV-in is used to shift the scale of an other channel. You can set the target channel as well.
 - "GlideSpeed": CV-in is used to set the glide speed of a specific channel.
- GATE-IN:
 - "None": GATE-in is not used.
 - "Gate": The quantizer runs in gated mode and will only quantize if the gate is on.
 - "Trigger": The quantizer runs in triggered mode and will quantize once every time the gate is turned on. Use the 'Trigger delay' parameter to set a delay between detected gate and the actual quantizing. This can be used to compensate for sequencers with a slowly rising CV output.
 - "Glide SW": Can be used to turn glide of a specific channel on and off.
 - "Rand Trig": Each time the gate is turned on, the output will be transposed randomly.
 - "Frequency": Use the gate input for frequency detection only.
- CV-OUT:
 - "Pitch": CV-OUT is used for pitch output from the quantizer or midi.
 - "Velocity": CV-out is used to output midi velocity. You can define which channel should be the source of the velocity.
 - "OffVelo": CV-out is used to output midi off-velocity. You can define which channel should be the source of the off-velocity.

- "Aftertch": CV-out is used to output midi aftertouch. You can define which channel should be the source of the aftertouch.
 - "ChanPres": CV-out is used to output midi channel pressure. You can define which channel should be the source of the channel pressure.
 - "Controllr": CV-out is used for midi controller control. The midi controller number used can be found in the midi controller sheet.
- GATE-OUT:
 - "None": GATE-out is disabled.
 - "Midi Gate": GATE-out is used to output the midi gate
 - "Midi Clk": GATE-out is used to output midi clock. You can also set the divider used here.
 - "Midi S/S": GATE-out is used to output midi start and stop signals.
 - "Clock": GATE-out is used to output clock from the internal clock generator. You can also set the divider used here.
 - "Start/Stp": GATE-out is used to output the start/stop signal from the internal clock generator.
 - "Gate Pass": The input gate is passed directly to the output. This can also be used to invert a gate (by setting the gate polarity to inverted), or convert a normal gate into a switch-trigger gate (by setting the gate polarity to switch trigger). See gate polarity parameter below.
 - "Auto trig": Each new note detected by the quantizer generates a pulse at the gate output. The pulse length can be set here as well.

Advanced channel config Advanced channel config contains all the parameters of simple channel config, but they are adjustable for each of the four possible configurations individually:

- Both unplugged: GATE-in and CV-in are both unplugged
- CV-IN plugged in: Only CV-in is plugged in, GATE-in is unplugged
- GATE-IN plugged in: Only GATE-in is plugged in, CV-in is unplugged
- Both plugged in: Both GATE-in and CV-in are plugged in

Other channel parameters Further channel parameters are adjustable

- Notation: Set the displayed notation of the current note for this channel. (see notations chapter).
- “Gate-out mode”:
 - Normal: normal gate operation: Gate off is 0V, Gate on is 5V/12V
 - Inverted: inverted gate operation: Gate on is 0V, Gate off is 5V/12V
 - Switch trigger: Gate off is an open connection, Gate on is shorted to GND
 - Switch trigger inverted: Gate on is an open connection, Gate off is shorted to GND
- CV-in NOTES/V: The number of notes per Volt the quantizer detects at the input. Usually this number is 12 because of the 1V/octave standard, but for scales with a length different than 12 it may make sense to change this. If you have a quartertone scale for example you can set this to 24 and still maintain 1V/Octave. You can also set this parameter to AUTO and the number of notes in your scale will be used. A higher number of notes will however result in a reduced noise rejection. Depending on the voltage source this might lead to incorrectly detected notes.
- V/Hz: Set the number of octaves for V/Hz mode, or turn it off (default). (See v/Hz chapter for more information.)
- V/Hz Offset: Offset parameter for V/Hz mode, see V/Hz chapter.
- Glide time: Set the glide time for this channel.

2.3.2 Midi configuration

The Midi configuration settings contain parameters for midi input (Midi-to-CV), midi output (CV-to-MIDI), as well as configuration pages for the midi router.

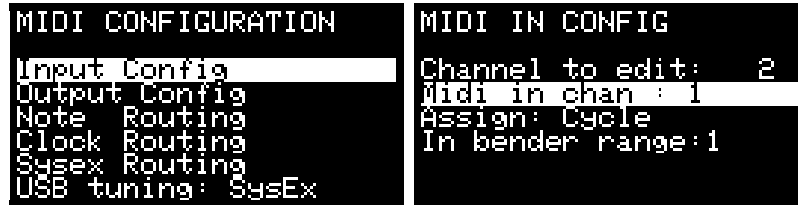


Figure 9: Midi config and Midi input config menu

Input Config The midi input config contains settings for μ Tune's midi input. Each μ Tune-channel (One set of CV-in, GATE-in,...) can have an individual midi input channel assigned to. μ Tune-channels with the same midi channel are grouped into polyphonic midi instruments automatically. This allows you to define multiple polyphonic or monophonic 'synths'.

For monophonic midi channels you can define their behaviour:

- Mono mode: 'Retrigger' will retrigger the gate on each new note, 'Legato' allows legato playing and will not retrigger the note as long as notes are held.
- Glide mode: OFF: no glide, ON: Glide is always on, AUTO: glide is only on, when playing legato. Note that the glide time needs to be set to non-zero for this to have any effect (see channel settings)

Further more two global parameters can be defined here:

- Assign: Is the voice assigner mode for the polyphonic groups:
 - "Mono/Unison": Treats the whole group as a monophonic synthesizer with automatic note priority. All channels in the group will output the same CV and gate.
 - "Cycle": The assigner will cycle through the available voices. Playing the same note multiple times will result in another voice playing it every time. If all voices are used, voice stealing will 'steal' the least recently used voice. This scheme is also used by the Korg Polysix synthesizer.
 - "Cycle Unique": The assigner will cycle through the available voices, unless the specific note has been assigned to one of the voices before. Playing the same note multiple times will result in the same voice playing it. Playing different notes will result in cycling through the available voices. If all voices are used, voice stealing will 'steal' the least recently used voice. This scheme is used by the Roland Juno synthesizers.

- "Stacking": The stacking mode is very useful if your voices have different sounds. If only one note is on, it will always be played by the first voice in the group. If a second note is received, the assigner will use the second voice and so on. It will stack the voices on top of each other. For example: the first voice in your setup has a lower filter setting than the rest. If you now play chords by playing the lowest note first, it will always be assigned to the 'bass voice'.
- "Random" assigns the new notes to the voices randomly.
- In bender range: Range of the pitch bend input in semitones. 1 means the full range of the midi pitch bend message is assigned to ± 1 semitone, 12 means ± 12 semitone. 0 means pitch bend input is turned off. This is needed because the midi standard does not define the bender range and it can be chosen freely by both the midi sender and receiver.
- Mask in chan: Midi channel used for scale mask control. This allows you to toggle scale masks with midi notes. Do not set this to the same channel as the input channel unless that is what you want. Normally you would use a spare midi channel for scale mask control.

Output Config For each μ Tune-channel you can set:

- "Midi out chan": The midi output channel
- "Transpose": An offset added to the midi note when sending.
- "Mode": The midi output mode of this channel
 - "Off": No midi is sent
 - "Note": The channel outputs midi notes
 - "Controller": The channel outputs midi CC for the event detected at the gate and CV inputs. The midi CC numbers used can be found in the midi out sheet at the end of this manual.

Midi Routing A flexible midi router and merger lets you route midi note and real-time messages independently.

- Note routing sets the routing paths for all non-midi real time messages such as: Note messages, controller messages, pitch bend, aftertouch, etc. These messages can be duplicated and merged.
- Clock routing sets the routing paths for midi clock, midi start, midi stop and continue. These messages can be duplicated, but not merged due to their nature.
- Sysex routing defines routing for midi sysex messages. These can also not be merged, but can be duplicated.

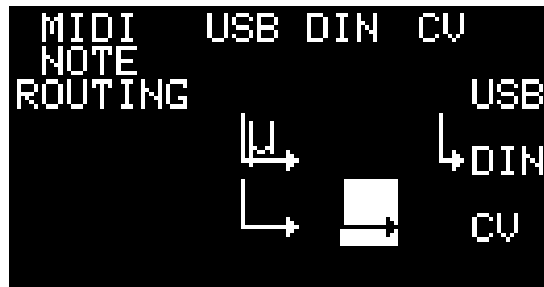


Figure 10: Midi Routing, 'CV' has been changed to ' μ T' in later versions

In the routing menu you can see three midi sources on the top: USB (USB midi input), DIN (DIN midi input) and μ T (midi from μ Tune e.g. CV2Midi). On the right are three midi targets: USB (USB midi out), DIN (DIN midi out) and CV (μ Tune's voice assigner).

You can use the navigation knob and the enter button to turn routing paths on and off. For example in the picture MIDI from CV-in is routed to DIN-out. Re-tuned MIDI notes from USB-in are also routed to DIN-out. USB-in and DIN-in are both routed to CV-out. Nothing is routed to USB-out.

Since merging is not possible with clock and sysex signals, for clock and sysex routing only one source per target is possible.

For targets DIN and USB you can also send microtonal midi. To activate this, press the ENTER button again to display the μ alongside the arrow. This means that this particular path is now re-tuned using the current scale. There are several modes microtonal midi can be sent:

- "Sysex tuning" sends microtonal midi using the 'midi realtime tuning' sysex messages defined in the midi standard. This allows polyphonic tuning but is a mode not all synthesiers understand
- "Pitch bend tuning" uses midi pitch bend to tune the notes as needed. This has the disadvantage that it only works properly monophonically, or if each channel uses a different midi channel. Because the pitch bend resolution is not defined in the midi standard you can define its range between ± 1 and ± 12 seminotes.

These settings can be made for targets USB and DIN independently using the "USB tuning" and "DIN tuning" settings in the midi menu.

2.3.3 MISC menu

The misc menu contains the following sub-pages:

- About: info about the module and its contributors
- "Channels": You can use this to temporarily override the number of channels. This for example allows you to only use channels 1 and 2 even though you have an expander connected.

- Display sleep: μ Tune will turn off the display after a certain time of menu inactivity. Here you can set the timeout as well as turn the feature off.
- Expert settings contain settings not typically needed by the user.

2.3.4 Firmware reset

Select this to set all parameters to their default values.

2.4 TUN

The TUN menu contains all functionality needed to work with alternative scales and tuning.

2.4.1 Load a scale



Figure 11: File browser

To load a scale or tuning, select 'Load scale'. This will open the file browser showing the contents of the SD card. Directories are marked with a 'folder' symbol, scale files with a 'scale file' symbol. In the upper right corner you can see the number of entries in the current directory.

By using the navigation knob you can scroll through the directory contents. When a scale file is selected, the bottom of the screen will show the name of the scale. You can load a scale by pressing ENTER. μ Tune reads and writes the Scala .scl format directly.

When selecting a directory, you can enter it by pressing ENTER. The ... entry brings you up one directory.

Due to limitations of the μ Tune hardware and the FAT file system, the items are not sorted alphabetically, but roughly in the order of their creation. Additionally directory access becomes slower, the further down you scroll in a directory. We therefore recommend to organize scales in a tree structure with not more than about 50 scale files per directory.

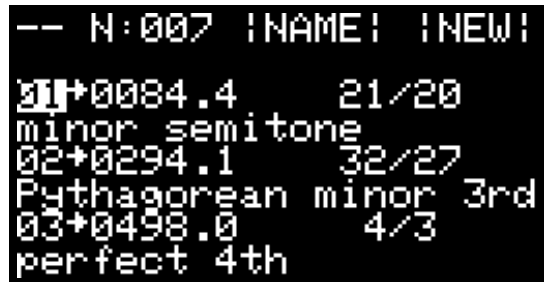
After loading a scale, press the BACK button to get back to the main menu.

2.4.2 Save a scale

Press Save scale to save your current scale. You can now chose if you want to save the scale using a new file name (Save as), save the scale using the current file name (Save) or if would like to first chose the directory to save the scale (Choose directory). If you decide to enter a new file name, you will be presented with the file name dialog. Use the navigation knob to select the next character of the file name. Press enter to use this character. If you want to delete the last character press DEL, for upper case letters press SHIFT. When you are finished entering the file name, press OK. To cancel press the BACK button.

2.4.3 Scale editor

The built in editor lets you create and edit scales without the need of an additional computer.



```
-- N:007 !NAME! !NEW!  
01+0084.4    21/20  
minor semitone  
02+0294.1    32/27  
Pythagorean minor 3rd  
03+0498.0    4/3  
perfect 4th
```

Figure 12: Scale editor

2.4.4 Navigation in scale editor

If your cursor is above a note number on the left and blinking, you can use the navigation knob to scroll up or down. Press enter and the cursor will stop blinking, indicating that you have selected a line to edit. You can now use the navigation knob to select parameters. Press enter on a parameter to edit it and press it again to resume selecting other parameters.

2.4.5 Edit scales

In the first line you can set the number of notes in the scale, change its name (NAME) and create a new equal tempered scale (NEW). In order to create an equal tempered scale, set the number of notes to the desired value, set the repeating interval (see below) and press NEW. A new equal tempered scale will be created and the scale name adjusted accordingly. For example setting the note number to 12 and the repeating interval to 2/1 will create a 12TET scale, setting the note number to 13 and the repeating interval to 3/1 will create the equal tempered Bohlen-Pierce scale.

The other lines starting with 01, 02, etc show the notes of the scale. Each note is displayed in two lines. From left to right the first line shows the note number (03), an active indicator (little arrow), the note pitch in cents and note pitch as fraction. The second line contains the name of the interval if it is a known one.¹

You can edit each of these parameters:

- The active indicator arrow can be highlighted and toggled to deactivate a note in scale, creating a voltage quantizer within your tuning system or temperament. For example, by deactivating C#, E, F#, A and B in any standard 12Tone temperament, you have a Natural Minor quantizer in effect. (also see tuning vs. scale definition at the end of this manual)
- The pitch in cents can be edited by selecting a digit and using the navigation knob to adjust the value. Usually this is a positive number, but some exotic scales contain negative pitches, so negative cents are possible.

- You can also set the pitch as a fraction. In this representation $1/1$ is unison, or 0 Cents, $2/1$ is an octave, $3/2$ is a perfect fifth. Changing the fractional value will adjust the cents accordingly. If it is a known interval, its name will be displayed in the second line. Fractions with a numerator larger than the denominator will create positive cent values, fractions with a numerator smaller than the denominator will create negative cents
- You can also move the cursor to the second line and chose your pitch from a list of intervals. The fractional and cent values will be adjusted accordingly. If no known interval is selected the second line shows nothing, but scrolling starts from the interval closest to the current pitch. So for example if you have a pitch value of 300 cents, you can move the cursor to the second line and starts scrolling. Scrolling will show you “Persian wosta” (302.8 cent), “Wide augmented 2nd” (296.1 cent) , and so on.

¹ μ Tune is programmed to recognize all tuning ratios that have known named intervals: even the very rare ones. This is thanks to a list generously provided by Manuel Op de Coul, creator of Scala).

2.4.6 Scale mapping

In the keyboard mapping menu you can specify how an incoming note number (be it from a midi keyboard or quantized CV-in input) is mapped to the scale.

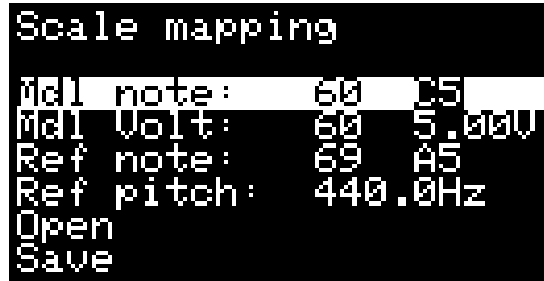


Figure 13: Scale mapping

- Mdl note: The middle note specifies the center of the scale. When playing this note the pitch will be constant no matter which scale you load or how many notes the scale has. μ Tune displays this note in two different notations (number and semitones)
- Mdl volt: The voltage corresponding to the Middle note. This voltage will be at the output if you play the middle note, no matter which scale is loaded. μ Tune displays the voltage in 1/12V steps.
- Ref note: The reference note for which the Reference Frequency is given.
- Ref pitch: Reference pitch, frequency of the Reference Note. This is used for pitch detection (See INFO) and auto-tuning.
- 'Open' and 'Save' access the file browser and let you open and save scale mappings using the SD card.

More about scale mapping can be found in chapter "Scale mapping" in the HOW-TO section.

2.4.7 Send via SysEx

This will send the current scale via sysex to a connected synthesizer. μ Tune uses midi 'bulk tuning dump' to send a complete scale at once.

2.5 TOOLS

2.5.1 MPE Setup

MPE setup allows you to quickly setup your μ Tune channels for midi MPE. MPE uses a separate midi channel for each voice and each midi channel also transmits aftertouch, pitch bend and controller values specific for this channel.

The MPE Setup tool will configure μ Tune for a given number of MPE voices.

- **Voices:** The number of MPE voices to use
- **Midi CH Start:** number of the first used midi channel.
- **CV-OUT:** Function assigned to additional CV-outs
- **GATE-out:** Function assigned to additional GATE-outs
- **SETUP MPE:** Press this to setup all channels according to the settings above

Example:

You have a μ Tune with 3 expanders, so 8 channels total. You would like to set this up as 4 voice MPE with additional CV-outs outputting aftertouch.

Additionally, the spare gate outputs should output a midi clock.

Set: Voices=4, Midi CH Start=1, CV-OUT=Aftertouch, Gate-out=Midi Clock and press SETUP MPE

Channels 1-4 now output pitch data and Gate, channels 5-8 output aftertouch CV and midi clock. Channel 1 will react to midi channel 1, channel 2 to midi channel 2 and so on.

2.5.2 Midi monitor

The midi monitor can help with debugging midi issues. For each midi message that passes through μ Tune you can see:

- The source (D = DIN-midi, U= USB-midi, μ = μ Tune)
- The target(s) (D = DIN-midi, U= USB-midi, μ = μ Tune)
- Nature of the message

2.5.3 VCO calibration

VCO calibration allows you to adjust μ Tune's output voltage in order to linearize the characteristics of a VCO. You can save the calibration data for a particular VCO and load it into any μ Tune channel at a later time.

Please see HOW-TO chapter for a description how to use the VCO calibration.

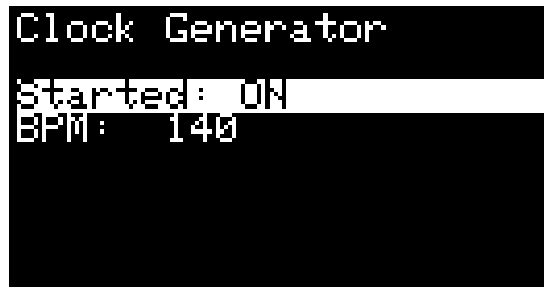


Figure 14: Clock generator

2.5.4 Clock generator

The Clock generator can be used to generate a master clock that can be send out using the GATE-out outputs. For each GATE-out you can define a different clock divider in the channel settings. The start/stop signal can also be sent using GATE-out.

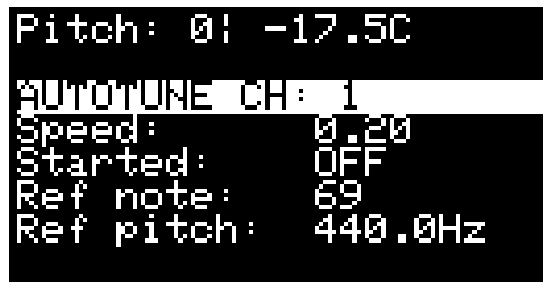
- “Started”: Turns the clock generator on or off.
- BPM: Tempo of the clock in beats per minute

2.5.5 Auto tuning

Auto tuning allows you to take control of your VCO's pitch by constantly measuring its frequency and correcting it accordingly. More info and how to setup this correctly can be found in the auto tuning chapter in the HOW-TO section.

Only two parameters are unique to this menu page, the others are mirrors of those parameters in other menu pages:

- "AUTOTUNE CH": The channel these settings are made for.
- "Speed": The speed of automatic re-tuning
- "Started": If autotuning is turned on or off



```
Pitch: 0! -17.50
AUTOTUNE CH: 1
Speed:      0.20
Started:    OFF
Ref note:   69
Ref pitch:  440.0Hz
```

Figure 15: Autotuning

3 How to's

3.1 Quantizing

Setting up the quantizer is very simple and when settings are reset to default it will work out of the box. In this example however we show you how to configure all parameters from scratch.

We would like to quantize on channel 1. Furthermore we would like to use gated quantizing if we plug something into GATE-in, otherwise the quantizer should run continuously. Additionally we want to create a trigger pulse on GATE-out every time the quantizer detects a new note. We use this pulse to trigger an envelope generator.

We navigate to CONF-> Channel config and select CH1. We then go to Simple Config and use the following settings:

- CV-in: Pitch map
- GATE-in: Gate
- CV-out: Pitch
- GATE-out: Auto-trig. Here, you can also set the trigger length, the default is 2ms.

Simple config will automatically configure the parameters to do what we want. Namely: if nothing is plugged into GATE-in, the quantizer will run continuously, but if we plug something into GATE-in, the quantizer will run in gated mode.

3.2 Midi to CV

In our example we have a μ Tune with two expanders, so 6 channels total. We would like to use these six channels to:

- Have one 4 voice polyphonic synthesizer with CV and GATE outputs.
- One monophonic synthesizer with CV and GATE outputs.
- Use the remaining sixth channel to
 - Output velocity of the monophonic synth
 - Output a 16th midi synced clock

In order to set this up the following steps need to be done:

- Go to chan config -> Simple config and set CV-out of channels 1-5 to 'Pitch' and GATE-out to 'Midi Gate'. You can speed this up using the ALL channel
- Go to channels 6 chan config -> Simple config and select: CV-out: Velocity, from CH5
- Also in channel 6 simple config set GATE-out to 'Midi clock'.

- In the channel 6 config set the 'Clock divider' to '16th'
- Go into the midi input config menu and chose the midi channels as follows:

μTune channel	Midi input channel
1	1
2	1
3	1
4	1
5	2
6	3

This groups channels 1-4 into a polyphonic group and sets up channel 5 as a monophonic group.

- Adjust the 'Assign' parameter to your favorite voice assign scheme.
- Go into the midi note routing menu and make sure μTune (CV) receives midi from USB or DIN (whichever you are using)
- In the midi clock routing make sure μTune (CV) is receiving clock from your clock source (USB or DIN)

Notes received on midi channel 1 will now be sent to the polyphonic group, notes on midi channel 2 will be processed monophonically. Midi clock will appear on the gate output as soon as you start sending a midi clock (You might have to press stop then start).

Hint: you can invert the clock by setting 'Gate-out mode' in the channel config to 'Inverted'

We now have used all the outputs, but the inputs remain unused and you can use them for other purposes. Here are some ideas:

- Use the GATE-inputs to measure VCO frequency and activate auto-tuning
- Use a CV input to transpose one or more channels
- Use channel 5 GATE-in to turn glide/portamento on and off, use channel 5 CV-in to control the glide time via CV
- Use some of the CV and GATE inputs for CV/GATE to midi conversion (see chapter CV to Midi) below.

3.3 CV to Midi

Each μ Tune channel can convert CV/Gate to midi note on and off messages. Alternatively you can send controller values based on the CV-in voltage and the GATE-in state.

In order to setup CV to midi we need to

- Enable midi out of the particular channels
- Set-up the midi router

Example:

We have a μ Tune with one expander, so 4 channels total. We would like to use channels 1,2 and 3 to output midi note events to midi channel 2. We would also like to send a signal from an envelope generator as midi CC on midi channel 3.

μ Tune is connected via USB midi

- Go into Midi output config and select ALL as the channel selector.
- Set midi channel 2 as output channel
- Set Mode to 'Note'
- Select μ Tune-channel 4
- Set midi channel 3 as output channel
- Set Mode to 'Controller'
- Go into Midi note routing and set the path from CV to USB

μ Tune will now send midi notes on each gate on and off event. It will also send a new control change CC message on each voltage change at channel 4 CV-in.

If you are using an alternative scale you might want to activate microtonal midi:

- In note routing set the path with re-tuning (' μ ' symbol beside the arrow)
- Set your desired microtonal midi mode (sysex or pitch bend) in the midi menu 'USB tuning'.
- If you use sysex tuning, make sure sysex can be sent from μ Tune to USB by enabling the patch in sysex routing.

Tip: If your synthesizer does not understand sysex tuning, but does have the ability to accept notes on all midi channels (omni) + has individual pitch bend for each channel: Just configure each μ Tune-channel to send on a different midi channel and use pitch bend tuning. This allows polyphonic microtonal midi.

3.4 Midi to midi tuning

In order to convert incoming midi notes to microtonal midi we need to setup the following μ Tune settings:

- The midi router
- The microtonal midi mode
- The scale

In our example we have midi coming in from both USB and DIN-midi. We would like to convert these midi notes into a microtonal scale and send them back out to the DIN-midi output.

- In 'midi note routing' route midi from USB to DIN and DIN to DIN with re-tuning (the ' μ ' beside the arrow).
- In the midi menu set your desired microtonal midi mode (sysex or pitch bend): DIN midi tuning
- Load or create a scale in the TUNE menu

Note: you can use all other μ Tune functions normally while re-tuning midi in the background.

3.5 Scale mapping

In order to understand scale mapping, let's have a look at the well tempered 12TET tuning used in western music. It has 12 notes per octave and we can label the notes with C C# D, D#... We play keys on the keyboard and each key is mapped to one note in our scale. When using the CV-input, the detected input note will also map to a specific note.

When working with different tunings or scales the semitone notation might become meaningless, so for better understanding we label the notes with numbers from 0 to 11 .. and then continue for the next octaves.

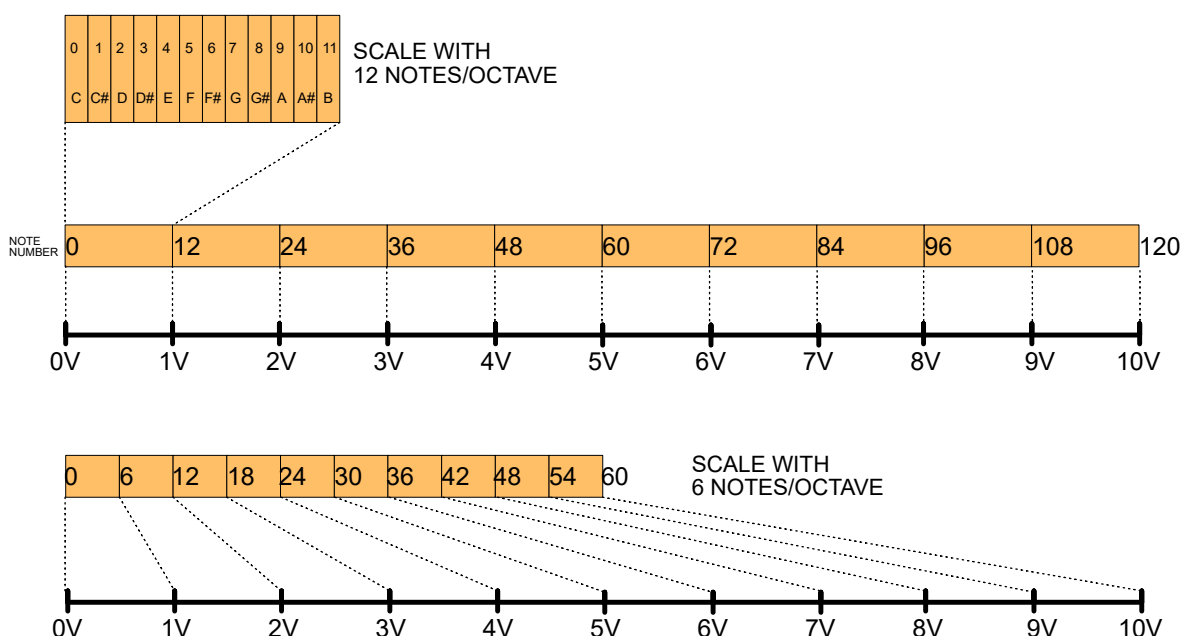


Figure 16: Scale mapping - 12 TET and 6 TET scales

Here we labeled 10 octaves with the numbers 0 to 120. Analogue CV voltage is typically scaled with 1V/octave. This means this whole range of 120 notes maps to the voltages 0 to 10V, with each note being 1/12th volt higher then the previous one.

Now let's have a look at a different scale. This one only has 6 notes per octave. The exact pitch of these notes is not important for our explanation, but let's assume it is also a well tempered scale. If we now label the notes with numbers you will notice that now we only have to count 6 notes until we are one octave up. If we map this tuning to our output voltage, 10 volts is already reached after 60 notes instead of 120. This also means if we put in note number 36 for example, in our first tuning it will be three octaves up, in our second tuning it will be much higher, at 6 octaves. This is because every 6 notes the pitch is one octave higher and $36 \text{ notes} / (6 \text{ notes} / \text{octave}) = 6 \text{ octaves}$. Similarly, if we have a tuning with more than 12 notes, the note number we put in will result in a much lower pitch than with the 12 TET tuning. e.g. Note 36 in 24TET = $36/24 = 1.5\text{v}$ (which would sound like an octave and perfect 5th in ordinary 12TET). There is no way around this, but we can use scale mapping to simplify things for us when working with multiple scales.

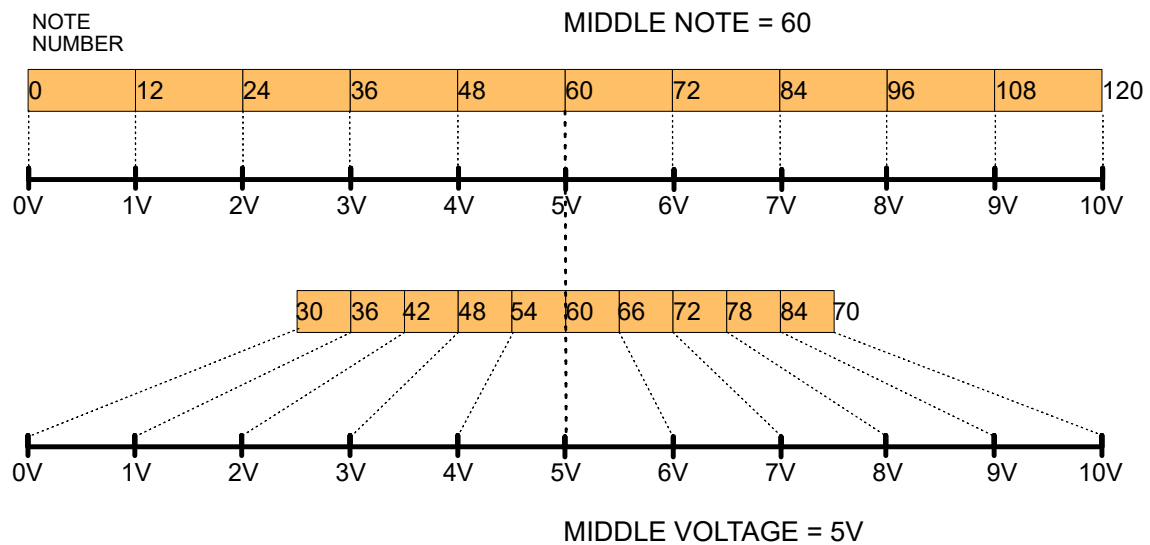
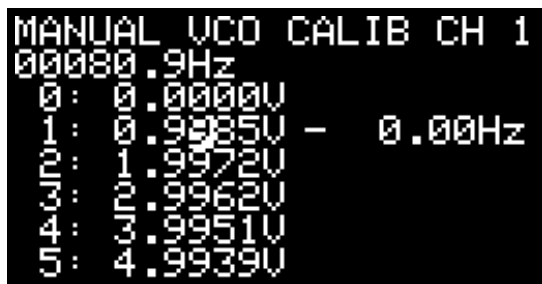


Figure 17: Use middle note and voltage to define a new scale center

Instead of starting at note 0 and building our scale from there¹, we define a new point to start: this is the 'middle note' parameter. Here we set the middle note to 60 – the middle of our keyboard. The scales are now developed around this point. No matter which scale, playing the middle note will always result in the same pitch. We can also define which voltage μ Tune should output at the middle note. This is the 'middle voltage' parameter. Normally you would set it equally to the middle note, but it can be used to transpose the whole setup. This has the effect of adding or subtracting a voltage from the output. It does however limit μ Tune's range because it can still only output 0..10V. Whether you use midi or CV, it is good practice to define a tuning center – the middle note, which you can use as a reference and build your compositions around.

¹Note by Phineas Head: "We count from 0 so each 'octave' is a multiple of the Tone system we are using e.g. 12TET calls C=0, C#=1...B=11 so the next C=12 and each subsequent C is a multiple of 12 (24, 36, 48 etc.). Counting C=1 would actually be more confusing because subsequent Cs would be 13, 25, 37—horrible!"

3.6 VCO calibration



```
MANUAL VCO CALIB CH 1
00080.9Hz
0: 0.0000V
1: 0.9985V - 0.00Hz
2: 1.9972V
3: 2.9962V
4: 3.9951V
5: 4.9939V
```

Figure 18: VCO calibration

μTune contains an 11-point output calibration for VCOs. VCO calibration can be used to improve tracking of a VCO, or to adjust the V/Octave scaling.

The VCO calibration menu lets you select the channel, open and save a calibration file, reset the calibration to default and perform the actual calibration.

To perform a calibration make sure your VCO is plugged into CV-out. (Let's say on channel 2). Select channel 2 and enter 'Manual VCO calibration'.

Now plug the output from your VCO into GATE-in on channel 2. In the upper left corner you will see the detected VCO frequency. Navigate to the 0V entry and press enter. μTune will now output 0V and save its frequency. When the frequency reading is stable, press enter again and navigate to the 1V entry. Press enter and μTune will now output 1V. The pitch of the VCO should now be an octave higher. μTune shows you the difference between the detected and the expected pitch. If the detected pitch is negative you have to increase the voltage, if it is positive you have to decrease it. Try adjusting the voltage until the frequency difference reads 0Hz. Depending on how stable your VCO is this might not be quite possible due to pitch drift, but try to zero in as well as possible.

When finished repeat this for all voltages.

You can now save the calibration. It is completely independent from the channel, so if you later connect the same VCO to channel 1, you can just load the file into it.

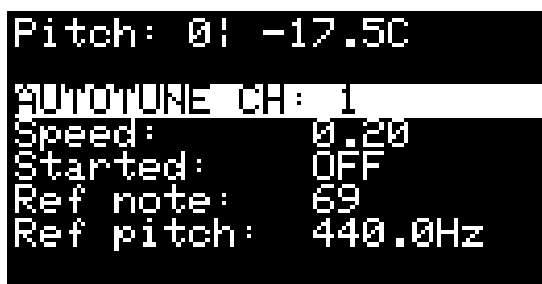
VCO calibration can also be used to change the output V/Oct scaling. The EMS Synthi A for example uses 0.32V/Oct or 0.26V/Oct. Just set 1: to 0.32V, 2 to 0.64V, and so on and you are ready to go!

VCO calibration also works in V/Hz mode, the voltages displayed are meaningless, but it works nevertheless.

3.7 Auto-tuning

While the VCO calibration measures the characteristics of a VCO once and then applies the voltages 'blindly', auto-tuning measures the VCO's frequency and adjusts it continuously - as a so called closed loop approach. In order to use auto-tuning successfully the VCO and μ Tune settings need to be adjusted. Your VCO's CV input needs to be connected to μ Tune's CV-out and one of the VCO's waveform outputs needs to be connected to GATE-in in order to measure the VCO frequency. In our example we use μ Tune channel 1.

If you open the auto-tuning menu you can see the following page:



```
Pitch: 0! -17.5C
AUTOTUNE CH: 1
Speed: 0.20
Started: OFF
Ref note: 69
Ref pitch: 440.0Hz
```

Figure 19: VCO calibration

- At the top you can see the measured pitch of the VCO in relative mode. Here it shows the frequency of the VCO differs from the expected frequency by 0 octaves and -17.5 cents.
- Next you can set the channel for which you want to configure auto-tuning. Since we connected the VCO to channel one, we use CH: 1 here.
- The auto-tune speed parameter defines how quickly the algorithm should correct pitch differences. A setting close to 0 will adjust the pitch very slowly. This can be used to correct temperature drift of a VCO but will keep the VCO's short time pitch characteristics. A setting close to 1 on the other hand means a pitch difference is corrected very quickly. This will lead to a much more stable pitch, but might nullify some analogue characteristics of the VCO.
- Started: Here you can turn auto-tuning ON and OFF for this particular channel.
- Ref note and Ref pitch are global parameters and the same as in the 'Scale mapping' menu

The following steps need to be performed to use auto-tuning:

1. Auto-tune works best if your VCO has been calibrated using the VCO-calibration (see above). Uncalibrated VCOs may cause drift or pitch jumps each time a new note is played.
2. Make sure μ Tune has a constant output note at the channel. A changing output note will cause confusion.

3. Use the tune knob on the VCO (most VCOs have one) to bring the pitch reading close to 0. You don't need to be precise here, but we recommend to bring it in tune between -100 Cent and 0. It is good practice to tune the VCO slightly below 0, so μ Tune can correct the pitch even for note number 0.
4. If you can not tune the VCO to 0 using the pitch knob, you need to adjust the pitch μ Tune expects. You can do this using Ref note and Ref pitch. Currently μ Tune expects 440Hz with note number 69 (A5). If your VCO can not tune low enough, you can change the Ref note to 57 (A4), 45 (A4) or anything you like.
5. If you are finished and the pitch reading is slightly below 0, turn autotune on. μ Tune will adjust the output voltage until the pitch reading is 0. If speed is slow this will take a very long time, in such a case we recommend to start with a fast speed and set a slow speed when tuning has reached a stable point.

3.8 Hz/V

µTune provides an optional Hz/V output mode for VCOs / synthesizers with a linear (as opposed to exponential V/Oct) input. Examples are the Korg MS20, or a linear modulation input of a VCO module. Providing the correct voltages to such a VCO can be tricky and sometimes requires calibration. We tried to make interfacing as easy as possible though.

In Hz/V mode pitch precision is not constant on an exponential scale. This means that within a finite voltage range (0V-10V) precision measured in cents varies with the maximum number of octaves - the more octaves you want, the less precision you get on the low end. The picture below shows the worst case precision in relation to the maximum number of octaves:

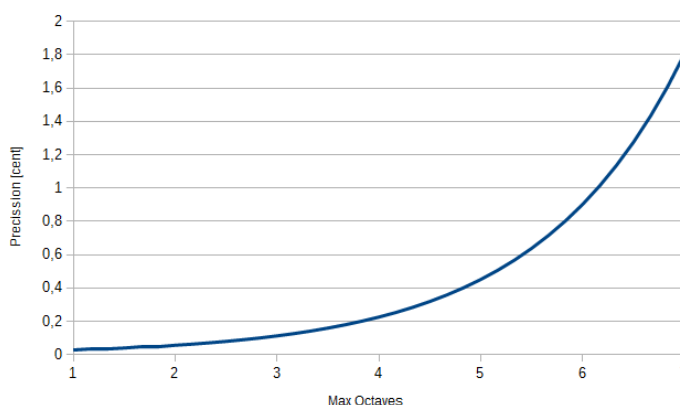


Figure 20: Precision in Hz/V mode

In order to get the most precision, µTune maps the highest note to 10V and then goes down from there. So for example if you have a maximum of 3 octaves, C3 will be mapped to 10V, C2 to half of it: 5V, C1 to 2.5V and C0 to 1.25V. Since µTune's output resolution is fixed to about 0.15mV, but each added octave means half the voltage range, the precision halves with each added octave.

Some VCOs or synthesizers add or subtract a fixed voltage at the linear input. To compensate for this, µTune has a voltage offset parameter. If your VCO's frequency is not 0 at 0V input, there is an internal offset added. It usually is positive, so to compensate you'd have to set a negative voltage offset.

As an example let us take the Doepfer A-110-2 VCO. With 0V at the linear input it is running, but stops if -2V are applied. So if we set the offset to -2V, we can use the linear input and obtain correct tune. However this means that of the numbers above (10V, 5V, 2.5V, 1.25V) 2V are subtracted, effectively limiting the maximum range. You could instead subtract 2V with an adder module and not have this side effect. Usually however this is not necessary, normally the offset is much smaller - if it exists at all.

3.8.1 How to find the correct V/Hz setting for a synths or linear VCO

V/hz mode should be very simple:

- Send 0V and you will get a pitch of 0 - the VCO is stopped
- Send some voltage v , say 1V and you will get a certain pitch which you can pitch up and down with a pitch knob on the synth.
- Send double of that voltage and you will get double the pitch (i.e. an octave higher).

This is true for any synth and VCO with a linear relationship between input voltage and pitch. Unfortunately many synths or VCOs add an internal bias voltage which needs to be compensated by the external control voltage interface. In order to compensate correctly one needs to find the value of the internal bias voltage V_b .

Finding the internal bias voltage One way to find the internal bias is to input a (negative) voltage V_b until the VCO stops. This is our bias. If you have a way to create a negative voltage and measure it (for example with a multimeter) you are done.

Unfortunately μ Tune can not output negative voltages. Luckily there is an other way:

- Connect μ Tune to the VCO.

- Set μ Tune's output to V/Oct (important!).
- Open the VCO calibration menu and click 0V. μ Tune will now output 0V and save the associated pitch.
- Now switch to the 1V entry and adjust the voltage until the pitch display reads 0 cents. You now have the voltage which corresponds to double the pitch. This is also the internal bias voltage V_b .
- Reset the calibration, this is important because we were just using the calibrator as voltage output, not actually performing a calibration.
- You can now enter $-V_b$ in μ Tune V/Hz settings as offset voltage and turn on V/Hz mode.

3.9 Notations

µTune offers a range of different notations to indicate which note is currently played. The following notations are available:

- Decimal: Numbers notes starting from 0 in decimal notation
- Hexadecimal: Numbers notes starting from 0 in hexadecimal notation.
- Semitone: Will display notes as semitones (C0, C#0, D0, D#0 ...). The numbers indicate the octave. Works with scales with 12 notes or less.
- Quartertone: Will display a quartertone notation (C, C|, C#, C||, D, ...) where | and || are the symbols for a quartertone step and a 3-quartertone step. Works well with scales with 24 notes or less.
- Relative 1: Displays notes in the form Repetition | Letters a-z, A-Z, and Greek letters denoting notes in the scale
- Relative 2: Displays notes in the form Repetition | Letters i-z, I-Z, Greek letters denoting notes in the scale. Here the letters a - h (and A - H) are omitted to avoid confusion with traditional notation which uses the letters A - H.

Relative 1 and 2 notations are designed to display scales that are not simple 12-Note scales, so the idea of # or b as harmonically functional units of traditional chords no longer really applies - we can treat them notationally as just a stream of notes.

The first note in the scale will get the letter a, the second letter b and so on. If the lower case letters are exhausted, uppercase letters are used. If those are exhausted, Greek letters are used. Relative 2 notations omits letters a-h and A-H to avoid possible confusion with the semitone notation. For scales that are based on the octave, the repetition number is the same as the octave number.

A 7 note scale in 'Relative 1' notation would thus look like this:

0|a, 0|b, 0|c, 0|d, 0|e, 0|f, 0|g, 1|a, 1|b, 1|c, 1|d, 1|e, 1|f, 1|g

Here is how a scale with 52 notes would be displayed in Relative 1 notation:

..., 1|a, 1|b, 1|c, 1|d, 1|e, 1|f, 1|g, 1|h, 1|i, 1|j, 1|k, 1|l, 1|m, 1|n, 1|o, 1|p, 1|q, 1|r, 1|s, 1|t, 1|u, 1|v, 1|w, 1|x, 1|y, 1|z, 1|A, 1|B, 1|C, 1|D, 1|E, 1|F, 1|G, 1|H, 1|I, 1|J, 1|K, 1|L, 1|M, 1|N, 1|O, 1|P, 1|Q, 1|R, 1|S, 1|T, 1|U, 1|V, 1|W, 1|X, 1|Y, 1|Z, 2|a, 2|b, 2|c, 2|d, 2|e, 2|f, 2|g...

4 Midi controller CC numbers

μTune-Channel	CV CC	GATE CC
1	0	8
2	1	9
3	2	10
4	3	11
5	4	12
6	5	13
7	6	14
8	7	15

Figure 21: Midi output CC numbers (CV and GATE to midi controller)

μTune-Channel	CV CC
1	0
2	1
3	2
4	3
5	4
6	5
7	6
8	7

Figure 22: Midi input CC numbers (Midi controller to CV)

5 Terms used in this manual

CV	Stands for Control Voltage. In analogue synthesisers CV can represent a number of parameters such as pitch, filter cutoff or modulation amount. μ Tune can input and output control voltages between 0V and 10V
GATE	In this manual the term gate is used for a control voltage with only 2 states (on and off). It can be used to control a number of parameters and is typically used for clock signals or gating. μ Tune detects any voltage above 1.5V as on. On the output side, μ Tune can send either 5V or 12V gates.
Channel	A μ Tune channel consisting of CV-in, GATE-in, CV-out, GATE-out
Midi channel	One of 16 midi channels defined by the midi standard.
Tuning and Scale	<p>A tuning defines the pitch of all notes available for a given instrument.</p> <p>A scale is usually a sub-set of these notes (but might include all of them).</p> <p>When working with .scl files, the boundaries between the two are blurred. Some .scl files define tunings, other clearly define scales. μTune uses scale masks to define scales on top of tunings. This is a backward-compatible extension to the .scl format.</p> <p>For each note of a tuning you can define if it is used or deactivated.</p>
TET	TET stands for 'Tone Equal Temperament'. 12TET for example means a tuning that consists of 12 equally spaced intervals. As opposed to EDO tunings however, those intervals need not necessarily add up to an octave.
EDO	Equal divisions of an Octave. 12 EDO for example defines a tuning that divides an octave into 12 equally spaced intervals. This is the tuning used by Western music.

Table 1: Terms used in this manual