

The μScale is a 4hp CV quantizer module. 1V/Oct 0-10V range pitch CV signals are fed into the input marked “IN” and 0-10V unipolar or +/-5V bipolar CV is fed into the “SHIFT” input to great interesting and complex melodic CV out of the two outputs “OUT A” and “OUT B”. The buttons and tricolor LEDs allow users to easily program in scales and manipulate how the shift values affect the generated CV voltages in a wide variety of useful combinations. With the μScale it is possible to transform analog voltage sources from sequencers, LFO’s, controllers and CV generators into quantized musical val-

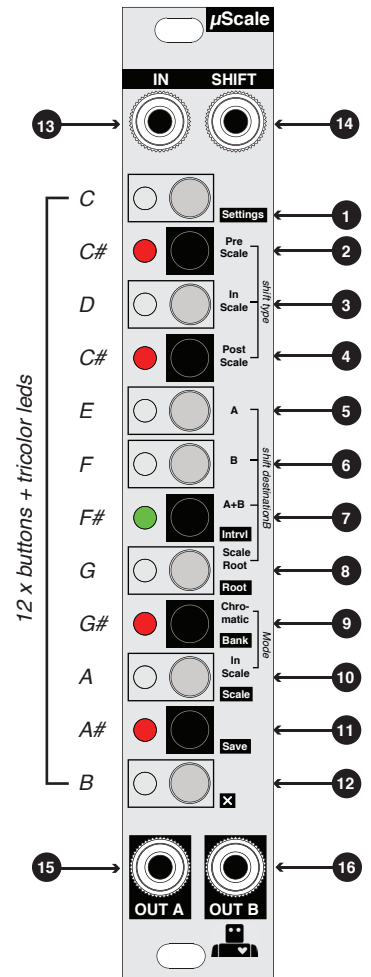
μScale I/O

- 13 **IN:** This input accepts 0-10V. Connect the 1V/Oct (or equivalent) voltage source here from things like a sequencer, keyboard/controller, offset generator etc.
- 14 **SHIFT:** This input accepts either 0-10V or +/-5V signals depending on the jumper setting on the main PCB. Connect modulation sources such as secondary sequencer outputs, LFO, offset generator, keyboard.
- 15 **OUT A:** Pitch CV voltages in the range of 0-10V and tuned to 1V/Oct CV. This outputs is the quantized version of the signal fed to the “IN” jack.
- 16 **OUT B:** Pitch CV voltages in the range of 0-10V and tuned to 1V/Oct. The B outputs voltages are intervals based on the “A” output. The amount of that interval and its harmonic relation to the root note on “A” depends on several configurable settings.

Active Scale

The μScale is real-time programmable which means you can edit the scale while it is in the process of quantizing CV. To do this simply click any of the 12 buttons which represent the keys of a 12tet keyboard where the top most button is C and the bottom most button is B. Adjacent to each button is a tricolor LED. In normal operation (i.e. while not in a submenu display) the notes of the scale are denoted by red LEDs. The currently quantized note (from the “IN” jack) is shown as a green LED. So if you have a variable voltage source such as a sequencer output connected to “IN” and you have more than one note selected to be part of your scale, you should see the green LED lighting up at different positions of the scale to indicate the changing quantized values.

This scale you are editing is volatile and will not be saved unless you save it to a bank and preset. Furthermore if you want to make sure the scale is saved offline you must make sure to store the banks+presets to EEPROM (see below)



Menus (Short Hold)

There are seven menus accessible by pressing and holding the following buttons for approximately 1 second:

- 1 **SETTINGS:** This menu allows you to set three separate settings: Shift Type (Pre Scale, In Scale or Post Scale), Shift Destination (A, B, A+B or ROOT) and B Mode (Chromatic or In Scale). The current menu settings are denoted with three separate and different colored LEDs). To exit the menu make a selection or click the SETTINGS button again.
- 7 **INTRVL:** Set the interval value used by output B. The LED position and color shows the current interval value. A green LED shows a positive value in the range of 1-12 (where position ‘C’ is 1 and ‘B’ is 12). To set a negative value in the range of -1 to -12 simply double click the equivalent positive value. (E.g. for an interval of -3 double click the ‘D’ key). Negative interval values are displayed as a red LED. This interval is calculated in terms of fixed semi tones (chromatic) or scale degrees (in-scale/diatonic) depending on the option set in the SETTINGS menu (*MODE: Chromatic OR In-Scale*)
- 8 **ROOT:** Here you can shift the scale forwards or backwards relative to it’s root note. The green LED indicates the current lowest note of the programmed scale relative to ‘C’. So if I had a C# pentatonic scale programmed (all the black keys) the root note would be the C#. If I then pressed the F key the entire scale would shift 2 semi tones upwards. This means the note A# (last note in the scale) would be shifted off the scale but wrapped around to the bottom as C. Technically the new scale root should be F but since the scale root is always calculated as the lowest note relative to C the new scale root will actually be indicated as C.
- 9 **BANK:** Select one of 12 possible banks. Selected bank is indicated as a red LED. Available non-empty banks are indicated as green LEDs. So if you select a bank from one of the currently available non-empty banks then the LED color will be yellow (red+green = yellow). Unlit LEDs show the empty banks.

Menus (Short Hold) Cont'd

- 10 **SCALE:** Select one of 12 possible scales from the current bank. Selected scale is indicated with a red LED. Blank scales have no LEDs lit while stored scales are indicated with green LEDs. So if you select a scale from one of the currently available non-empty banks then the LED color will be yellow (red+green = yellow).
- 11 **SAVE:** Save scales to one of 12 possible locations in the current bank. Available locations are non-illuminated while used locations are indicated with a green LED.
- 12 **X:** Clear the currently active scale steps by pressing button#12 (B, illuminated as yellow). All other buttons will exit while doing nothing.

Special Functions (Long Hold)

There are three special modes accessible by pressing and holding the following buttons for approximately 2 seconds:

- 9 **LOAD FROM EEPROM (BANK Button):** Use this function to load all banks and settings that are stored in the EEPROM (non-volatile memory). Every time the μ Scale is powered on it automatically performs a load from EEPROM.
- 11 **SCALE SELECT MODE (SCALE Button):** This is a special mode that allows users to select up to 12 different scales from the current BANK via the SHIFT input (using CV). Scale editing becomes disabled (in order to edit the scales you must exit this mode by pressing and holding the SCALE Button again) and the main display will show the currently selected scale pattern in real time. ROOT, SCALE and SAVE menus are all disabled in this mode. You can still choose different banks, edit the interval amount and make changes to SETTINGS (although no SETTINGS will have any current effect except for the *MODE*). Keep in mind that if you have set the SHIFT input jumper setting to bipolar then positive values in the range of 0-5V will select scales 7-12 in the current Bank while -5V to 0V will select scales 1-6.
- 12 **SAVE TO EEPROM (SAVE Button):** Use this function to permanently save all stored scales/banks and settings to EEPROM. If you do not do this, all edits and changes to banks, scales and settings will be lost when you power down the module.

Shifting

The SETTINGS menu allows you to set *Shift Type* and *Shift Destination*.

Shift Type:

The incoming CV values at the "IN" jack are first quantized to a chromatic scale value and then quantized to the current active scale. All shifting is applied after the chromatic quantizing which means it starts with some note value in the 10 octave range. The CV values at the "SHIFT" jack are quantized to a value in the range of +/-12.

Pre-Scale: This type of shifting occurs after the chromatic quantizing but before the scale quantizing. What this means is that the CV value at "IN" is quantized then the "SHIFT" value is added to it, and then it is quantized to the current scale.

For example, if my incoming note was a C2 and my shift value was '3' and the Shift Destination was A (in this case 3 means semitones) then the resulting value is $C2+3\text{semi} = D\#$. This new value is then quantized to the current scale. So if the active scale is CMajor (which contains C,D,E,F,G,A,B) then the final resulting note that will play out of OUTA is E2 (the nearest note in the scale to D#, scale quantizing always rounds up).

The interval value (generated at OUTB) uses the NoteA value as its root but it uses the value before the shifting is added to it.

So in the above example if the interval value was '5' and its mode was 'Chromatic' then the note at OUTB would be $C2+5=F2$ (not $E2+5$).

If the shift destination had been 'B' instead of 'A' then OUTA would have been C2 (no change), but OUTB would be the sum of the chromatically quantized root note at "IN" (in this case C2) plus the shift amount (3) which would then be quantized to the scale (resulting in a value of E2) and then the interval value is added to it (5) so $\text{scaLED}(C2+3)+5=G2\#$.

If the destination had been A+B then the result would have been OUTA = E2 and OUT B = G2# (both got shifted)

In-Scale: This type of shifting is Diatonic and occurs after both the chromatic and scale quantizing. This means that the shift amount represents the amount of degrees within the currently active scale. So a note value of C2 with a shift value of 3, destination of A and an active scale of CMajor would result in a shifted note of OUT A = F2 since this is three scale notes above C2 (remember the CMajor scale C,D,E,F,G,A,B where the distance between C and F is 3 scale degrees).

If the destination had been B then the OUTA would be unchanged (C2) but OUTB would be the diatonically shifted value of C2 (F2) plus the interval value (e.g. 5 semitones) which results in $OUTB = F2+5 = A\#2$.

If the destination had been A+B then then OUTA = F2 and OUTB = A#2.

Shifting - Cont'd

Post-Scale:

Post-Scale shifting is the easiest to understand of all the shifting types. For this type, the shift value is simply added to the scaLED note. So if my scaLED note is C2 and the shift value is 4 and the destination is A (and still using CMajor scale) then the resulting note is $OUTA = C2+4 = E2$. $OUTB$ would be the unshifted note (C2) plus the interval value (e.g. 5) $OUTB = C2+5 = F2$. If the destination was B then $OUTA = C2$ (no change) but $OUTB = C2+interval+shift = C2+4+5 = A2$. If destination was A+B then $OUTA = E2$ and $OUTB = A2$ (i.e. both are shifted by the same amount of semi tones and can be considered to have changed keys by the amount of shifted semitones).

So far we have looked at only using A, B or A+B as shift destinations. The fourth destination "ROOT" is an exception. With this destination the shifting type is irrelevant (and changing those values will have no effect). Instead the shift value is applied to the entire active scale moving it forwards or backwards by the shift amount. When the scale is being shifted it maintains the interval relations between each scale step so that the result is that the root note of the scale is shifted.

It is highly recommended that the user experiment with these different shift type and destinations. You will find that small settings changes can result in dramatic changes in the melodies generated.

Technical Specifications

Inputs:

IN:

0-10V (typically 1V/Oct scaling)

SHIFT:

0-10V if unipolar mode (no jumper on PCB)

-5V to +5V if bipolar mode (jumper connected on PCB)

Outputs:

OUTA:

0-10V (scaLED for 1V/Oct)

OUTB:

0-10V (scaLED for 1V/Oct)

Max Current Draw:

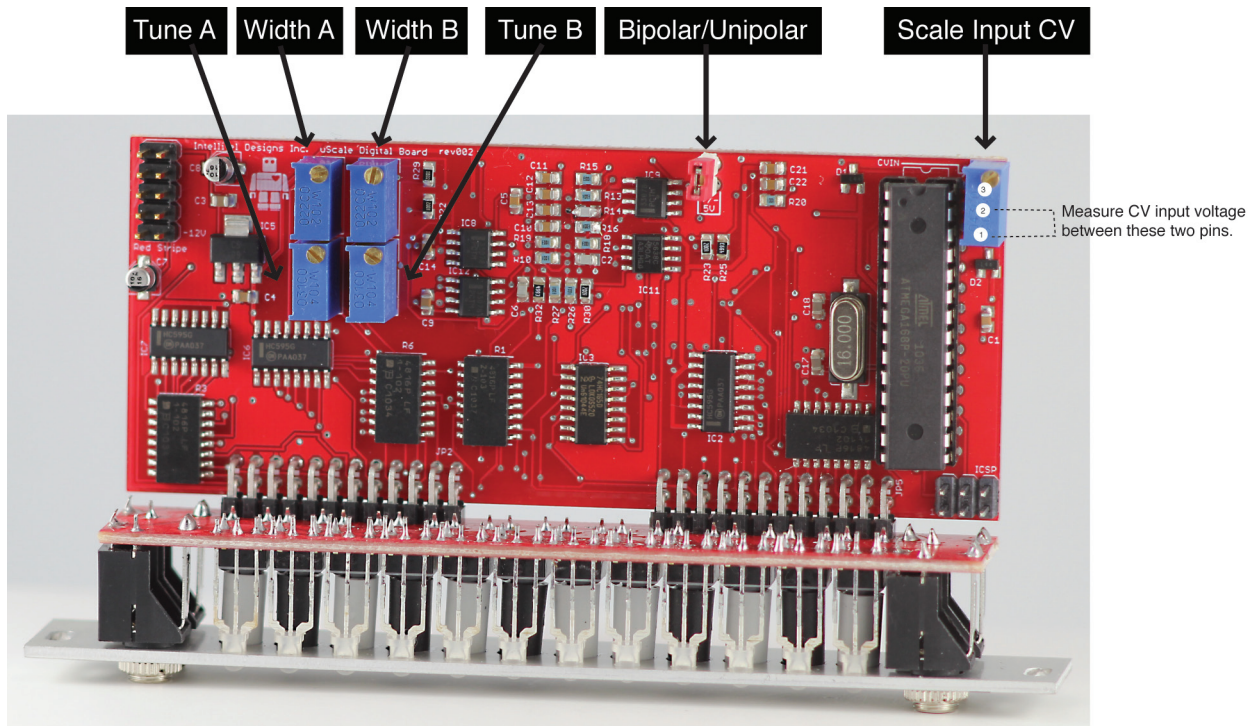
76mA

Module Dimensions:

Width: 4HP

Depth: 60mm

APPENDIX A - CALIBRATION PROCEDURE



In order to accurately calibrate a μ Scale module you will need the following items:

- Digital Multi Meter (DMM) accurate to approximately $\pm 1\text{mV}$ and 4 significant digit display (e.g. capable of displaying a value like '2.003V')
- Variable voltage source preferably with an output range of 0-10V
- Small slotted screw driver for turning the trim pots.

Step 1: Measure the output of your voltage source with your DMM and tune it so that it is exactly 10V. You may also be fine with a lower voltage (e.g. 5V) and use a source like the output of channel 2/3 on a Makenoise Math module or a Doepfer A138C with no inputs patched in.

Step 2: Whatever known fixed voltage you have, patch it into the "IN" jack of μ Scale.

Step 3: On the μ Scale PCB you should see five separate trim pots as labelled in the above photo. Look for the one labelled "Scale Input CV" and connect the ground probe of your DMM to pin 1 and the positive probe to pin 2. Adjust the trim pot until your DMM reads exactly half of the input signal. (E.g. if your fixed voltage source was 10V, then the DMM should read 5V)

Step 4: With the voltage source still connected to the "IN" jack, make sure you have no note selected in the current scale. This will result in the μ Scale outputting the equivalent of 0V on Output A and Output B jacks. Take a patch cable and plug it OUT A. Connect the DMM to the other bare end of the patch cable so that the ground is attached to the shield and the positive lead to the cable tip. Adjust the "TUNE A" trim pot until it reads 0.000V on the DMM.

Step 5: With the same connections as in Step 4, move the patch cable to OUT B and adjust the TUNE B trim pot until it reads 0.000V

Step 6: Move the patch cable back to OUT A and press note C (button #1) on the active scale. This will create a 1 note scale which allows one to easily tune the octave width in 1V/Oct tuning. The DMM should now read somewhere close to the fixed voltage source (it may be an octave below due to the SETTINGS menu settings related to shift and due to the jumper setting). Adjust "Width A" until it is a whole number value (e.g. 10.000V).

Step 7: Move the patch cable to OUT B. Go to the INTRVL menu and choose a value of "1". Since the scale is one note, the interval value (if the SETTINGS menu--> MODE is IN-SCALE) represents the number of octaves above the fixed voltage that OUT B will be (where every octave is 1V). So if your fixed voltage value was 5V, then an interval value of 1 would result in an output voltage of 6V on OUT B (1 octave above 5V).

Again all you are mainly concerned with is tuning via TUNE B so that the output is a whole number value (e.g. 10.000V)

Step 8: You can test the outputs by changing the voltage reference value over the entire range. You should see both outputs jump in 1V increments. You may see variations of $\pm 0.002\text{mV}$ at each stage due to non-linearity in the DAC and output amplifiers.

APPENDIX B - BANK PRESETS

The μ Scale ships with 5 banks pre-filled with scales. The user is free to erase, modify and program their own scales/banks instead. These can serve as a starting point or provide inspiration on how to set up ones own set of banks

BANK 1: MAJOR SCALES

Each of the 12 Major scales is stored at its respective root note. E.g. C Major is on Button#1 (C note), F Major on Button#6 (F note) etc.

BANK 2: NATURAL MINOR SCALES

Each of the 12 Natural Minor scales is stored at its respective root note. E.g. C Minor is on Button#1 (C note), F Minor on Button#6 (F note) etc.

BANK 3: HARMONIC MINOR SCALES

Each of the 12 Harmonic Minor scales is stored at its respective root note. E.g. C Minor is on Button#1 (C note), F Minor on Button#6 (F note) etc.

BANK 4: CHORDS IN Cmajor

The first seven scales are triads based off of each degree of the C Major scale. You can easily shift each one (use the ROOT function) and restore it in a different key. This is just an example of a bank that might be useful for something like SCALE SELECT MODE.

1. Cmaj
2. Dmin
3. Emin
4. Fmaj
5. Gmaj
6. Amin
7. Bdim
8. Cmaj7
9. Dmin7
10. Emin7
11. Fmaj7
12. Gmaj7

BANK 5: CHORDS IN Cminor

1. Cmin
2. Ddim
3. Ebmaj
4. Fmin
5. Gmin
6. Abmaj
7. Bbmaj
8. Cmin7
9. Dm7b5
10. Ebmaj7
11. Fmin7
12. Gmin7

BANK 11: SPECIAL SCALES (mostly in C)

You can use the ROOT function to shift these scales into another key.

1. Chromatic (all notes)
2. C Major Pentatonic
3. C Major Locrian
4. C Hungarian Minor
5. C Gypsy Minor
6. C Arabic Scale
7. C Phygian Dominant
8. C Octatonic
9. C Altered Dominant
10. Wholetone
11. Minor Pentatonic
12. Octave

BANK 12: CV UTILITY

This is a special set of scales that you can use to create a CV bar graph when in SCALE SELECT MODE

Scale 1 has one note while each subsequent scale has an additional note stored right up to Scale 12 which has all 12 notes.

The result is that a CV value of 0 (or -5 depending on the jumper setting on the PCB) will select the lowest scale and the highest CV value will select the highest scale. (See video demo on Intellijel Vimeo page or website)

