HG-30® Tuning and calibration

The HG-30 tuning instructions for customers are described in the main manual. They are sufficient for normal use. However, for service personnel, additional calibration may also be needed, identical to the operations done in factory calibration. This additional calibration is related to the linearity checking and correction of the note determining VC note A/D conversion values.   Instructions are given in the later section "Linearity calibration"

Tuning

HG-30 uses a precision 12 bit A/D converter to convert the VC note signal from the bus to the note value. Therefore it stays well in tune, and normally tuning is not needed. However, if the input VC note value itself is inaccurate, HG-30 has means for compensating for the inaccuracies. The two common errors are:

1. An offset error: each C note should correspond to an exact integer VC voltage value. HG-30 scale starts at C1 = 32.70Hz which corresponds to an input voltage value of 0V. A constant difference from the integer   values along the scale will make an offset error.
2. A scale error: the input should follow accurately the 1V/octave scale. If the scaling is incorrect, there is an increasing difference from the correct note when going the scale up.

Hardware tuning

HG-30 has a front panel opening below the text **tune**. Under it there is a trimmer for fine adjustment for compensating possible input scale error. This is typically sufficient for normal situations. If not, there is a software facility for adjusting both the offset and scaling errors. Errors can also occur in the pitch bend signal (**CV pitch** input), so they can also be compensated in software. This is described in the following.

Software tuning

For software tuning, turn the **mode select** -knob to position 15 (i.e. one full rotation until the +10 led turns on, then to position 5). The output signal amplitude is now controlled only by the **volume** knob, not by any of the sliders. Only sliders 1 and 30 are functional in this mode. When **slider 30** is fully down, you can compensate for VC note errors. When it is fully up, you can compensate for errors in pitch bend and/or adjust the pitch bend range.
Start by moving both **slider 1** and **slider 30** fully down and connecting the output to a precision tuner. Play A1# in the keyboard (not A1, because A1# allows you to observe both positive and

negative offset errors). The offset error can now be zeroed by turning **adjust 1**. Only the internal A/D offset is compensated, so the adjustment range is small. For large offset error compensation, see the pitch bend offset compensation section later.
Next, play a high note, e.g. C5, and use **adjust 2** for possible scale error compensation. If no pitch bend corrections are needed, you can now raise **slider 1** fully up. This move will burn the new calibration values to the nonvolatile memory.

Pitch bend tuning

If pitch bend adjustments are needed, keep **slider 1** down and move **slider 30** fully up. Connect your pitch bend signal source to **CV pitch.** Check that the pitch bend signal is inactive. Use **adjust 1** to compensate for possible pitch bend offset. Activate the pitch bend signal and use **adjust 2** for adjustment of the desired range. Again, when **slider 1** is moved up, the values are stored in the nonvolatile memory.

Warning: The sum of VC note and pitch bend offsets make the total note offsets. Therefore pitch bend offset can also be used for compensating such large offset errors in the VC note signal that are out of its own adjustment range. However, then you have to remember that when you disconnect the **CV pitch** source, the tuning is different. Also, if you have adjusted the pitch bend offset, you have to redo the VC note calibration process described above. Because during this tuning process it would be impossible otherwise to find out which offset is wrong, there are additional means for hearing the difference: With zero or disconnected **CV pitch** bend, the output signal has both the fundamental and second harmonic at equal amplitudes when the pitch bend signal is close to zero. Otherwise only the fundamental frequency can be heard. Therefore, you can find the ideal situation when there is zero voltage at the pitch bend input - and it thus has no effect on the note - by adjusting **adjust 1** when **slider 30** is up until you hear both. If you need to adjust the pitch bend offset so large that only the fundamental is heard, then you have to remember that disconnecting pitch bend will change the tuning.

It is easy to find the adjustment that corresponds to zero pitch bend offset, because when you are getting close to the correct value, there is first strong noise, because the second harmonic is randomly going on and off. When you adjust **adjust 1** further, the noise disappears and you also hear the second harmonic. If you continue adjusting, you again hear noise, and when going still further, the second harmonic disappears. So you just use to stay between the noisy regions, hearing only the fundamental and 2nd harmonic.

Linearity calibration (factory/service only)

Even though the 12 bit A/D used for converting the note determining VC note signal has sufficient resolution, its specs allow an INL of several LSBs from the ideal straight curve. When a 12 bit range has 4096 steps for the 5V scale, we have more than 1 mV corresponding to one step. When one seminote corresponds to a difference of 83mV, then one LSB error corresponds to more than 1 cent error in the tuning meter. Therefore the nominal INL accuracy of the A/D converter is not sufficient for good tuning over the whole scale. For linearity calibration, you need to have a DAC that has a better accuracy than the 12 bit A/D of HG-30. In principle, a near perfect 12 bit D/A converter with less than ½ bit INL would do, but in practise, it is easier to use a DAC with higher number of bits. In factory calibration, a 18bit DAC (Analog Devices AD5760) is used. It has a serial input with three signals, clk, sync, and sdin. In addition, the GND and digital 3.3V and analog +12V and -12V signals are needed. The DAC output terminal has to be connected to the VC note input terminal. These signals are connected to the corresponding terminals of HG-30. For access, the backside metal cover has to be removed.

For calibration, turn the **mode select** -knob to position 16. Keep **slider 1** down. When the calibrator is connected, the HG-30 detects the existence of the calibrator. This can be verified by using **slider 29:** When it is down, C1# is output to the A/D note input for offset adjustment, and when it is up, C5 is output for the scale adjustment. Use the front panel trimmer to adjust correct C5, and use **adjust 1** for the offset adjustment. The C5 adjustment is important, otherwise the linearity correction also includes a possible systematic error. When both the C1# and C5 are in tune, raise **slider 1** up: there should be a slow sweep up from C1 to C6. After the sweep the new calibration values are burnt to the nonvolatile flash memory. For verification of the correct calibration process, all the 60 notes from C1 to C6 are played automatically (about half seconds each). There should be a maximum of +-1.5 cent tuning error for the whole scale. Do not interrupt the process until all notes are played.

NOTE: When doing the linearity calibration, only the trimmer potentiometer can be used for scale adjustment, so only **adjust 1** (offset adjustment) is active, not **adjust 2.**

NOTE 2: For storing any new tuning or calibration values, there has to be any, even minor, change in the offset adjustment from the previously stored one (i.e. turning adjust 1 when slider 30 is down).

NOTE 3: Incorrect grounding may result in a tuning error of several cents. If the calibration is done in an Eurorack, always connect the HG-30 closest to the power supply, and if using a MIDI interface as the voltage reference, connect it to the subsequent slot. If you have multiple buses in the rack with direct connection to the power supply ground, connect the rest of the modules to a different bus. That way the power supply return current through the bus ground does not make excess ground potential difference between the calibrator and the HG-30.