

Elektor Formant VCO haraldswerk.de x Erica Synths take.

Description:

To keep the characteristic of the original Elektor Formant I kept the heated exponential converter, here build around the AS3046. The PCB is developed to hold the DIL and the SOIC version as well, and more stable SOIC version is included in the kit. The Schmitt Trigger used is the CD4093BE. Due to different switching levels in the original some transistors are added for level shifting. The octave switch is build with the OPA2277 and the voltage reference LM4040AIZ-10.0/NOPB. Fine tune of the pitch is done with R3. If you need a wider range for the tuning you can change it with changing the potentiometer or the resistors values here. The basic pitch is set with R9. Output voltage is set with R55 and the DC offset with R52.

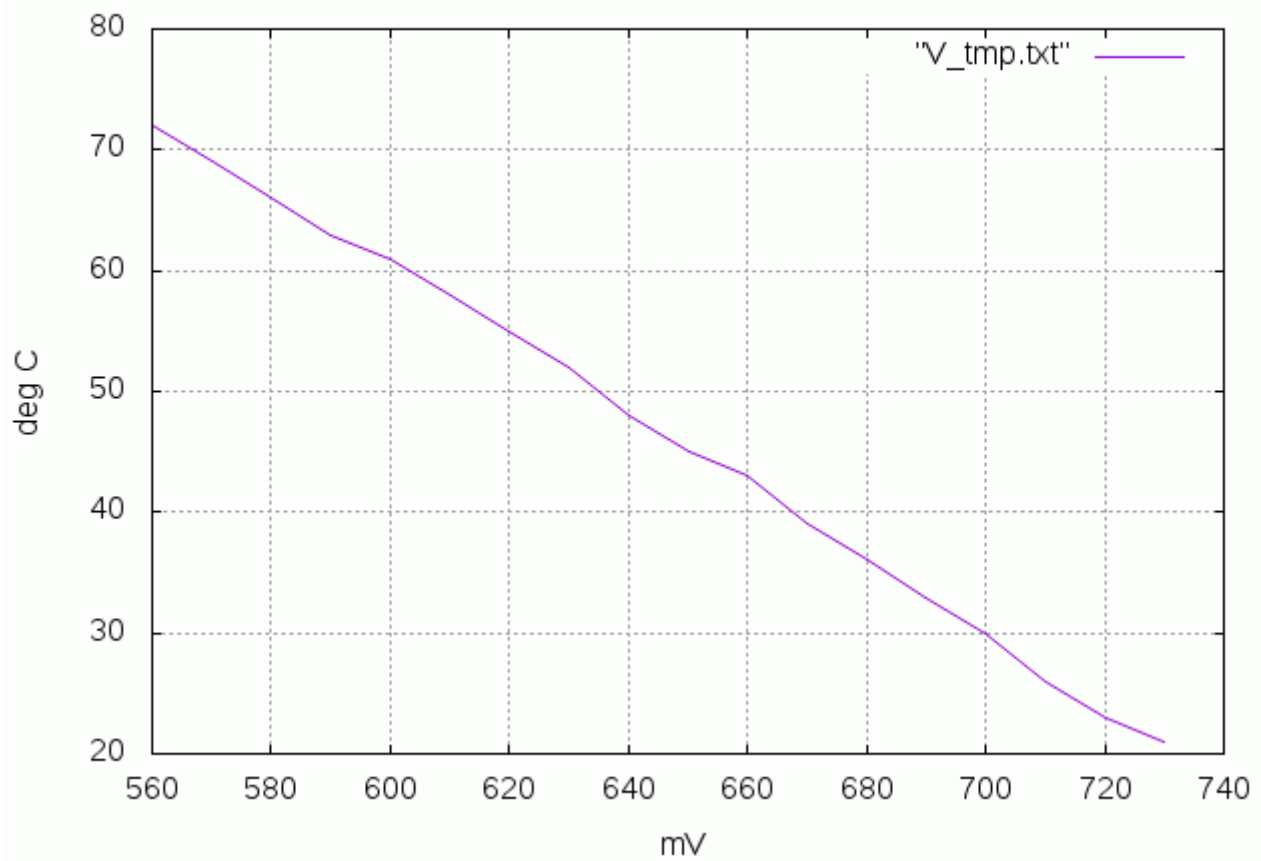
Heater

Description:

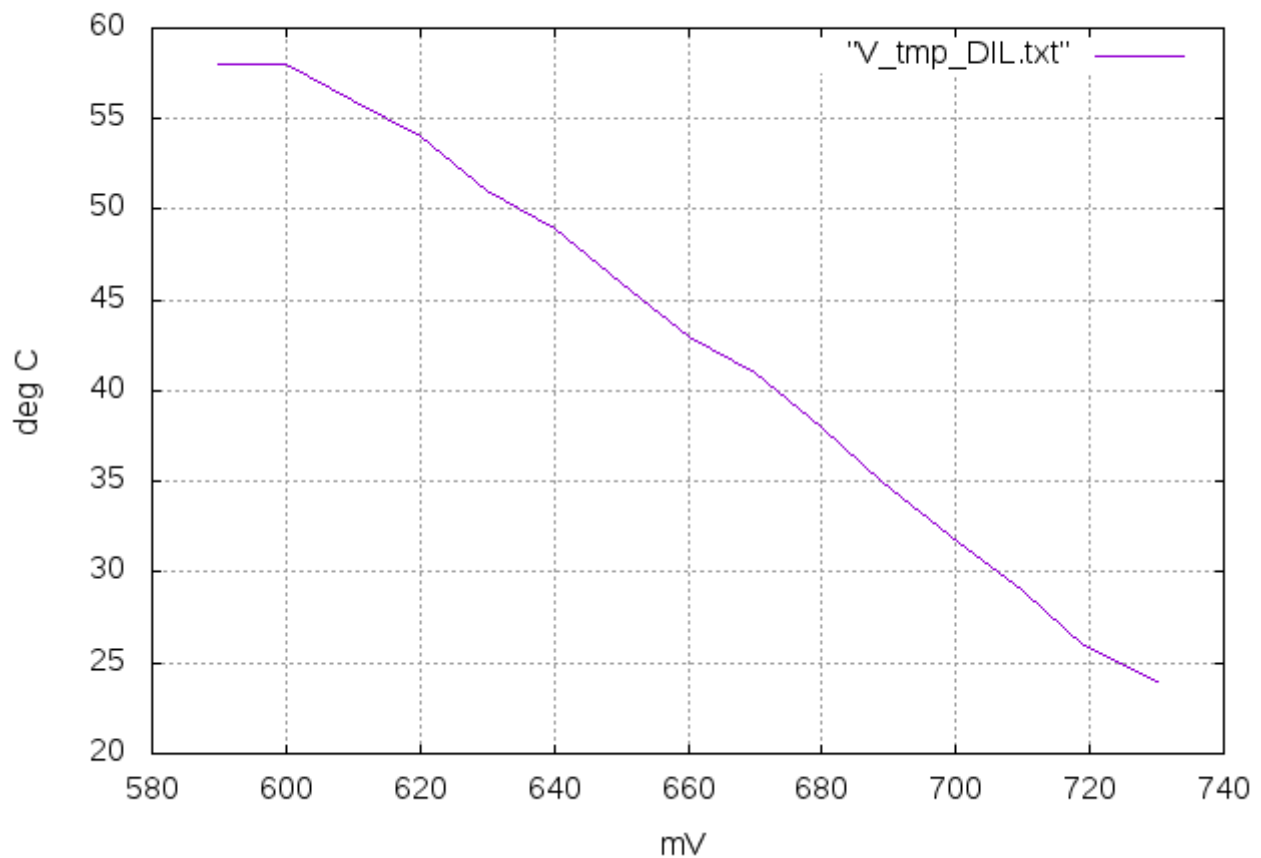
This circuitry is part of my NGF VCO Core 2. It make use of two transistors to heat the AS3046. It works with the SMD and DIL Version as well. The given resistor values keep the current values and the power dissipation below the maximum ratings. DA14B is used to measure the actual temperature. The voltage drop over DA14B is direct proportional to the chip temperature. It is compared to the voltage at pin 2 of the AS3046 which is derived from R46. The temperature is easily adjusted with R46. Between heating off and maximum temperature. The testing bridge is driven with a stabilized 10V voltage source. DA14C and DA14D are used as heaters. R56 and R59 limit the maximum current. The different values are selected with purpose to keep pin 13 of the AS3046 (the substrate) the lowest negative point at the chip.

The below pictures shows the graph temperature in deg. Celsius vs. Voltage in mV at pin2. It is quite linear. You can easily derive the needed voltage for your preferred temperature from the graph. The data for the first graph were taken from a LM3046 SMD mounted on a PCB. The figures for the DIL Version are slightly different. You can see them on the second graph. Temperature was measured with Fluke 63 IR thermometer.

Temperature(deg Celsius) vs. Voltage(mV): LM3046 SMD mounted on PCB



Temperature(deg Celsius) vs. Voltage(mV): LM3046 DIL mounted on PCB



CALIBRATION

Connect an oscilloscope to the saw out of the VCO and turn the power on. You should see a saw wave. If not debug.

Heater temperature setting.

Choose your wanted temperature and read the correspondent voltage from the diagram. Set the **660mV** voltage (temperature) for the heater with R46. The voltage is measured at pin2 of DA3 (TP6). This should always be the first step when calibrating.

Please remember: Every time when you change the temperature settings you have to redo the complete calibration process!

Saw wave symmetry setting.

Now, let's adjust saw wave! There are two adjustments – DC offset and amplitude. Both are critical for proper operation of the waveshaper to extract other waves on the VCO. Set the oscilloscope to **DC coupling mode** (it's critical here), connect the oscilloscope to the output of the module and set the OUT LVL potentiometer all way clockwise (max level). Adjust R52 to center the saw wave around 0V. Now adjust R55 (amplitude) so the level of the saw wave is 10V ptp. If needed readjust R52 so that the saw wave spans from -5V to +5V (10Vptp symmetrical to 0V). Remember – the oscilloscope has to be in DC coupling mode.

Pitch offset calibration.

Let the VCO “warm up” for some 10 minutes. First, let's adjust tuning offset – it defines, what note will sound, when no CV is applied and the octave switch is set to 12:00. To do so, connect a chromatic tuner to the output of the VCO, set the octave switch to 12:00, the TUNE knob to 12:00 and the LEVEL knob to max – all way clockwise. Flip the saw wave switch ON, all other switches OFF. Now, rotate the PITCH OFFSET TRIM **R9** so that a chromatic tuner reads approximately C4.

1V/Octave calibration.

1V/Octave calibration can be done in two ways: 1) with MIDI keyboard and chromatic tuner (you need to have INTERFACE module assembled and calibrated or you can use any other MIDI-CV module), 2) with oscilloscope and voltmeter (Harald's approach).

MIDI keyboard approach. This is, basically, how most DIY VCOs are calibrated.

1. Connect a MIDI keyboard to the INTERFACE module or any other MIDI-CV module in your modular system, make sure no portamento is applied, and connect the CV output of the module to the ECV input of the VCO module. Flip the toggle switch to ECV position.
2. Connect a chromatic tuner to the output of the VCO, set the octave switch to 12:00, the TUNE knob to 12:00 and the LEVEL knob to max – all way clockwise. Flip the saw wave switch ON, all other switches OFF.
3. No play C4 on the MIDI keyboard (you may want to measure voltage on the CV output of the MIDI-CV module; it should read 4V) and see, what note reads on the chromatic tuner. It has to be close to C4 +-few semitones. If it's octave off, most probably, the MIDI-CV module doesn't output 4V, and you need to play different octave on the MIDI keyboard.
4. Now, adjust the TUNE setting on the VCO, so you read C4 on the chromatic tuner.
5. Play C5 on the MIDI keyboard and check the pitch reading on the chromatic tuner. If the **pitch is higher than C5**, rotate the R35 (1V/OCT TRIM) trimpot so that the frequency on

- the tuner **increases**. If the **pitch is lower than C5**, rotate the R35 (1V/OCT TRIM) trimpot so that the frequency on the tuner **decreases**. The more off from the C5 frequency is, the more rotations of the R35 you need. For most of my builds the frequency was higher.
- Now, play C4 again and **adjust TUNE setting** on the VCO so the **tuner reads C4** again. Repeat step 5, and readjust R35 in the same way. With each repetition you will get closer to the octave interval C4 – C5. Occasionally you may need to adjust the R9 (PITCH OFFSET TRIM) to have C4 at 12:00 of the TUNE knob.
 - Once happy, play C6, C7, C3, C2, etc and adjust R35 until you get exact tuning over multiple octaves.
 - For perfect tuning in higher octaves you may need to adjust R48 (HIGH FREQ. TRACK TRIM).
 - Once happy, play C4 and rotate the OCTAVE switch to check, if readings on the chromatic tuner change by the octave. There can be minor, few cent inaccuracies, but overall the VCO tracks well over 8 octaves and is comparably temperature stable.
 - Finally, disconnect the cable from the ECV input, set the OCTAVE switch to 12:00, TUNE to 12:00 and readjust the R9 (PITCH OFFSET TRIM) to read C4 on the output. 1V/Oct calibration complete!

Oscilloscope and voltmeter approach.

- Start with rough adjustment: adjust R35 so that the voltage difference at pin2 of the AS3046 changes about 19,3mV when you change the control voltage 1V (Use the octave switch).
- Fine low:
 - Octave switch in position 2 (~40Hz). Write down exact frequency (f1).
 - Calculate the next higher frequency ($f1 * 2 = f2$).
 - Move octave switching position 3 (~80Hz). Write down exact frequency (f3).
 - Calculate deviation $f3 - f2$. Write down.
 - Divide f3 by 2. Move Octave switch in position 2. Adjust R35 until $f3/2$ is reached.
 - Jump to b. Repeat until the $f3 - f2$ is zero. If the difference is increasing you are turning to the wrong side.

Check the lowest frequency again and set it to 20Hz with R9.
- Fine high: According to Fine low. Start with octave switch in position 8 (~2.6kHz).

Calibration example

	measure/adjust	calculate	measure	calculate
	f1	f1*2	f3	f3-f2
Start/measure	39,66	79,32	76,99	-2,33
adjust	38,50	76,99	75,00	-1,99
adjust	37,50	75,00	73,33	-1,67
adjust	~	~	~	~
adjust	~	~	~	~
adjust	34,92	69,84	68,96	-0,88
adjust	~	~	~	~
adjust	~	~	~	~
adjust	30,04	60,08	60,59	0,51
adjust	~	~	~	~
adjust	32,04	64,08	64,07	-0,01

Waveshaper calibration

Connect the oscilloscope to the output of the VCO module and set the LEVEL potentiometer to max. Make sure all waveform switches are in OFF setting (pulsewave/squarewave switch should be set in middle position).

1. Before you begin, flip the SAW switch ON and double check that the saw is symmetrical to 0V and spans -5V..+5V! Flip the SAW switch to OFF position.
2. Turn the TRIANGLE switch ON. Adjust R95 to zero DC offset for triangle.
3. Adjust R10 for best triangular shape. Flip the TRIANGLE switch to OFF position.
4. Turn the SINE switch ON. Adjust R70, R89 for best sine shape. Flip the SINE switch to OFF position.
5. Turn the SPACED SAW switch ON. Adjust R62 for "best" sound of spaced saw. Depends on your preference. Adjust R102 for desired spaced saw volume. Flip the SPACED SAW switch to OFF position.
6. Turn the SQUARE switch ON. Adjust R85 for square volume. Because squarewave is subjectively louder, I set its amplitude to 5V_{ptp}. Flip the SQUARE switch to OFF position.
7. Turn the PULSE switch ON. Adjust R100 for pulse volume. Because pulsewave is subjectively louder, I set its amplitude to 5V_{ptp}. Rotate the PULSE WIDTH potentiometer and check, if you observe pulse width change. Check, if you observe pulse width change, when CV is applied to PWM IN.
8. Now, turn various waveform switches on and off and observe complex waveforms on output.

Final checks.

Apply a modulation source (CV form LFO) to FM CV input, and check if you observe frequency modulation. Adjust frequency modulation depth via FM DEPTH potentiometer. Check. If there are differences, when FM switch is in LOG FM and LIN FM positions. LIN FM typically has less FM depth.

Once you have the second VCO completed, set it to squarewave waveform and connect its output to the SYNC IN input of another VCO. Observe the synchronization is present.