DACO160EVK Digital Audio-to-Synth System

- Direct audio pitch to DCO square/sawtooth/sine oscillator outputs
- 2-Pole LPF VCF on square/sawtooth with optional envelope modulation
- Low-latency MIDI out
- 1V/octave pitch CV output
- Zero-ripple envelope follower with eight rate settings
- Modulation CV input with +/-2 octave range in semitone resolution
- Gate output with user-configurable threshold
- 23.4375Hz-6kHz frequency tracking range
- Sustain input freezes pitch, envelope, and gate CV outputs

Applications

- Real-time pitch-to-MIDI using virtually any monophonic audio source
- Audio-controlled synthesizers
- Pitch-to-CV converters
- Pitch-dependent audio processing
- Harmonizers
- Guitar and other instrument effects/stompboxes

Description

The DACO160EVK Digital Audio-to-Synth system is an evaluation system for Second Sound's digital audio-controlled oscillator (DACO) technology, an ultra-low-latency, patent-pending frequency-tracking algorithm implemented in a low-power, low-cost ST Microelectronics STM32F303CB micro-controller suitable for audio-controlled music synthesizer applications.

The DACO160EVK exhibits substantially the same features and functionality as the previous ACO160EVK based on the ACO160 audio-controlled oscillator chip. This facilitates comparison of the earlier mixed analog/digital with the current purely digital approach.

The firmware running inside the STM32F303CB micro-controller is a feature-complete digital emulation of the ACO160 audio-controlled oscillator, with several hooks added to improve tracking and increase reliability. The analog CV outputs (pitch and envelope) are so smooth, you won't be able to tell that they come from a digital source. And the frequency tracking range of the DACO160EVK spans a full 8 octaves, rather than the 7.5 octaves of the analog version.

The DACO160EVK additionally includes a balanced preamp with combo XLR + ¼" jack input with 0-50dB gain, adjustable high-pass and low-pass filters for improved frequency detection (if needed) before digitization by the micro-controller, a switch to select square vs. sawtooth waves and a mixer to combine square/saw with sine, an auxiliary mixer to mix another synth voice after this wave mixer, and a knob and CV input to control the harmony of the DACO wave outputs over a +/-2 octave range. In addition, a VCF provides a low-pass filtered version of the square and sawtooth waves, plus optional envelope modulation with 2:1 or 4:1 compression ratios.

The DACO160EVK is meant to assist audio equipment manufacturers with designing products using its unique DACO technology and is not intended to serve as a finished consumer product.

Ordering Information

Part Number	Package	Size
DACO160EVK	PCB	140mm x 120mm

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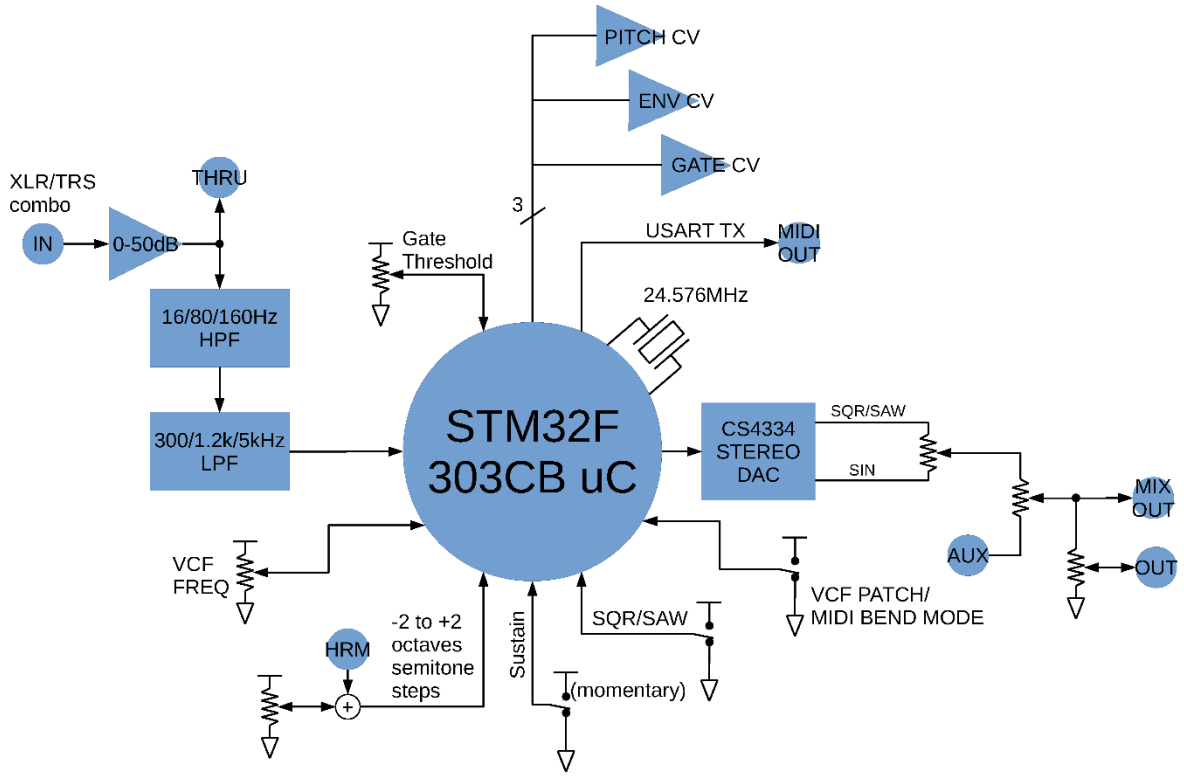
Block Diagram of DACO160EVK Audio-to-Synth Evaluation System



DACO160EVK Inputs and Outputs

Name	Direction	Description
PSU Input	Power	9v PSU input with positive sleeve (compatible with included PSU)
Audio In	Input	Audio input from Neutrik XLR-¼" combo jack
Audio Thru	Input/Output	Unbalanced minijack audio input (LINE IN) and output (LINE OUT) after 0-50dB gain preamp
Harmony	Input	1v/oct minijack harmony input modulates square/saw/sine frequencies, Pitch CV, and MIDI note output over +/-2 octave range on 12-note equal-tempered scale
Aux In	Input	Minijack auxiliary audio input can be mixed in after the wave mixer
Mix Out	Output	Minijack output of the auxiliary audio mixer
Main Out	Output	¼" mono main output (equivalent to the aux mixer out followed by master volume control
Pitch CV	Output	1v/oct pitch CV out (minijack) Pitch CV is tuned so that 23.4375Hz input gives 0v output and 6kHz input gives 8v output.
Env CV	Output	0-6.6v output of zero-ripple envelope follower (minijack) Note: If Env CV output is larger than 5.0v, the preamp may be clipping!
Gate CV	Output	0-5v gate CV out (minijack)
MIDI out	Output	Standard MIDI DIN output

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DACO160EVK Controls

Name	Type	Description
Preamp Gain	Knob	Adjusts preamp gain from 0-50dB.
HPF	Switch	High-pass filter corner frequency set to 16/80/160Hz.
LPF	Switch	Low-pass filter corner frequency set to 300/1.2k/5kHz.
Gate Threshold	Knob	Tunes gate threshold from 0v to 3.3v.
Env Rate Select	8-Pos Rotary Switch	Adjusts the envelope decay rate to accommodate various instruments. Use fast rate (CCW) with fast-decaying sources like bass guitar and slower rate (CW) for sources with complex harmonic profile like violin.
Wave	Switch	Selects square/saw audio output to mix with sine
Sustain	Switch	Can be momentarily held in right position to sustain pitch, envelope, and gate CVs.
Harmony	Knob	Offsets harmony shift to accommodate various CV ranges or for manual control of harmony. Also shifts MIDI note and Pitch CV outputs to accommodate pitch offset of various digital and analog synths.
Wave Mix	Knob	Mixes sine wave (fully CW) with saw/square wave (fully CCW)
Aux Mix	Knob	Mixes DACO output with auxiliary audio input from Aux In
Output Level	Knob	Output master volume
VCF Freq	Knob	Controls cutoff frequency of 2-pole LFP applied to sawtooth and square waves. The Q of this filter is fixed at 2. Tuning tracks the square/sawtooth frequency and ranges from 2 octaves below the fundamental to 8 octaves above.
VCF Patch/ MIDI Bend Mode	Switch	Sets VCF patch and Env compression: Left = No Env compression, static VCF affected only by VCF FREQ knob Middle = 2:1 Env compression, both VCF and VCA modulated by Env Right = 4:1 Env compression, both VCF and VCA modulated by Env Sets MIDI pitch bend mode: Left = Quantize MIDI notes to 12-note equal-tempered scale Middle = Pitch bend over +/-1 quartertone only Right = Pitch bend over full +/-2 semitones.
Reset	Button	Resets micro-controller

Quick Start Guide to your DACO160EVK system

Thank you for choosing to evaluate this DACO160EVK system! Here are some basic instructions to make the most out of your DACO160EVK board:

Basic Setup

1) Apply power via the included 9v power supply unit (PSU). This unit can handle 100-240VAC at its input so will work worldwide, possibly with only an adapter for your local electric socket required.

2) Connect any audio input via the Neutrik combo jack (XLR or ¼" balanced or unbalanced).

3) Play your audio source at a comfortable volume and adjust the preamp gain just before the red LED lights up on the peaks. If the red LED lights up, it could mean the gain is too high, the preamp can clip, and the fundamental frequency detection might not work.

4) Adjust the gate threshold so that the gate LED turns on when no audio is being played. With plucked string instruments like guitar it may take some tuning to get the gate to differentiate exactly when a note is being played from the low-level transients that occur when you mute the strings. Try to set the gate high enough so that the LED remains on when those quiet transient events occur.

5) For almost all cases the HPF and LPF can be left in their default, "open" settings (HPF OFF and LPF at 5kHz). In some extreme cases changing these filtering settings can help, for example if you use a contact mic with a handheld instrument and want to filter out potential low-frequency knocks or percussive effects.

Listening to DACO Analog Outputs

6) Listen to the DACO output via the ¼" main output. To hear the dry + wet sound, connect a 1/8" patch cable between the "LINE OUT" and the "AUX IN" minijacks and adjust the AUX MIX knob to get the desired mix (fully CCW for dry, fully CW for wet). Adjust the master volume ("OUT LVL") knob to get the desired level coming out of the EVK.

7) Select SAW/SQR waves via the 2-way switch to hear the different ACO waveforms and adjust the WAVE MIX knob to achieve the desired mix of saw/square + sine waves. Adjust the VCF FREQ knob to hear its effect on the sawtooth and square waves. Experiment with BEND MODE (VCF PATCH).

8) Adjust the ENV RATE SELECT rotary switch to optimize the frequency tracking for the audio source chosen. For most cases the fastest envelope rate setting (fully CCW) works well. There are some instruments with slower attack/decay and strong harmonics (like bowed strings) which can work better with slow envelope rate settings (CW). Human voice should work well somewhere in the middle. As a rule of thumb, if you hear the DACO locking to higher harmonics of the fundamental, try a SLOWER envelope rate setting (CW); if you hear the DACO locking to lower sub-harmonics of the fundamental, try a FASTER envelope rate setting (CCW).

9) Adjust the "HARM" knob to hear the various pitch shift settings. Here it is especially useful to mix the dry and wet signals together so it's easier to hear what harmony interval is tuned. Note that the harmony knob is continuous, it does not give you "clicks" when moving from one harmony to another.

Controlling External Synths Via CV/MIDI

10) Patch the PITCH, GATE and ENV signals out to an analog synth of your choice and enjoy "playing" that synth with the audio source of your choice! Note that you can now adjust the HARM knob to offset the Pitch CV out in discrete semitone steps over the entire +/-2v range to accommodate the pitch CV input expectations of virtually any analog synth.

11) Connect the MIDI output to the digital synth of your choice via a standard MIDI DIN5 cable and enjoy "playing" that synth with the audio source of your choice. Experiment with the three BEND MODE options to understand how they impact the pitch accuracy and note on/off behavior using MIDI. Note that the HARM knob will pitch shift the MIDI note so adjust HARM to unison if you want MIDI in unison with your audio input.

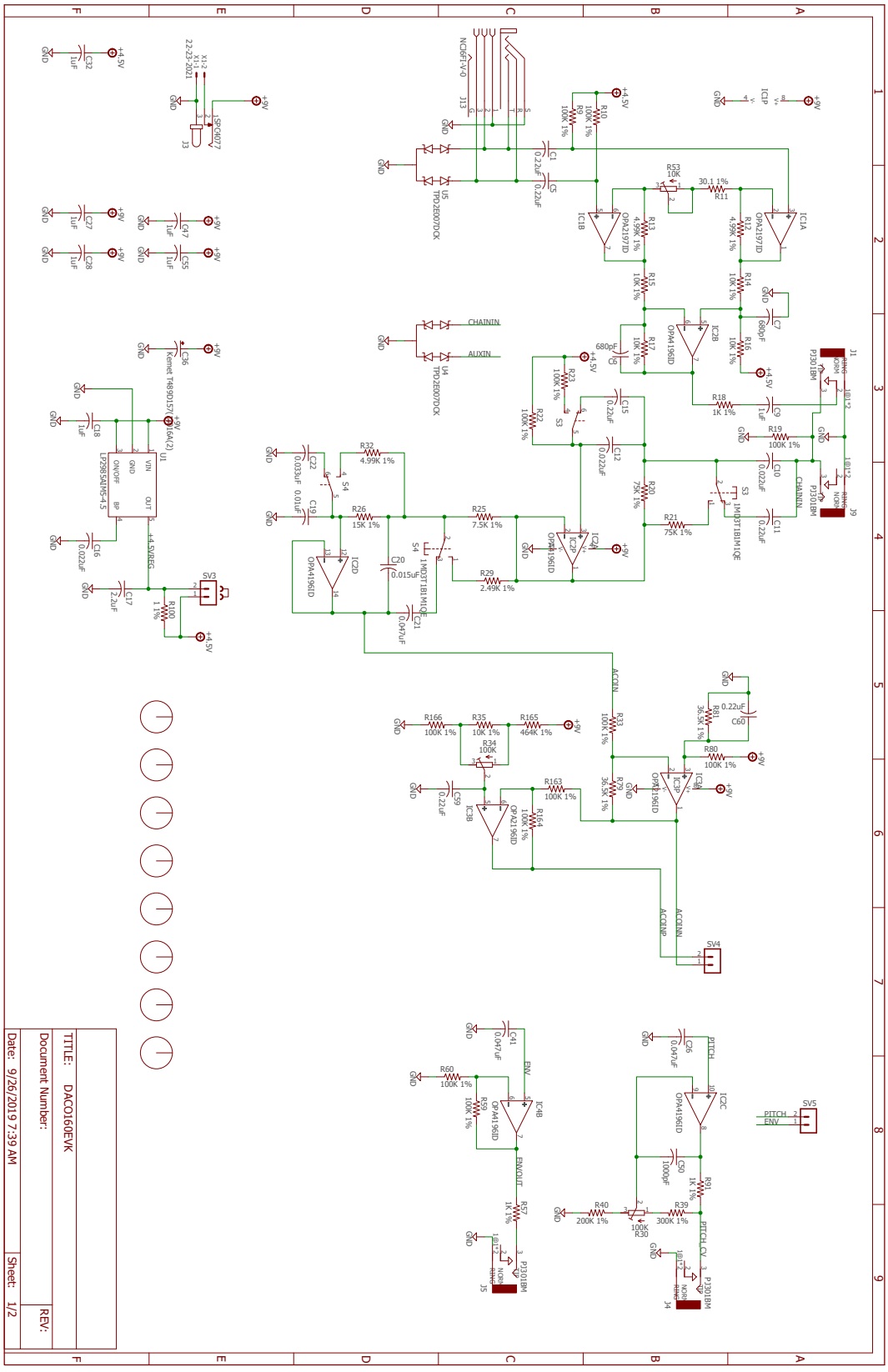
DACO160EVK Calibration

One benefit of the all-digital ACO solution is that there is no longer any calibration required for translating audio input frequency to MIDI notes. This means you can enjoy your DACO160EVK straight out of the box with no worries about tuning accuracy! However, there are a few calibration potentiometers which have been tuned already before shipping but are useful to understand:

1) PITCH CAL (R30): Adjusts the 1v/octave slope of the pitch CV output. This should be tuned before shipping but it can be adjusted by the user if desired.

2) OFFSET (R34): Tunes the DC offset of the audio signal going into the micro-controller ADC input. This signal is DC coupled to avoid undesirable delays in the transient response and this pot should be tuned so that the DC offset which can be measured on pin header SV4 (between INP and INN) is as close as possible to 0v.

3) HARM TUNE (R92): Tunes the harmony CV input so that 1v step on the input gives 1 octave step in the harmony setting.



DACO160EVK Schematic – Page 1

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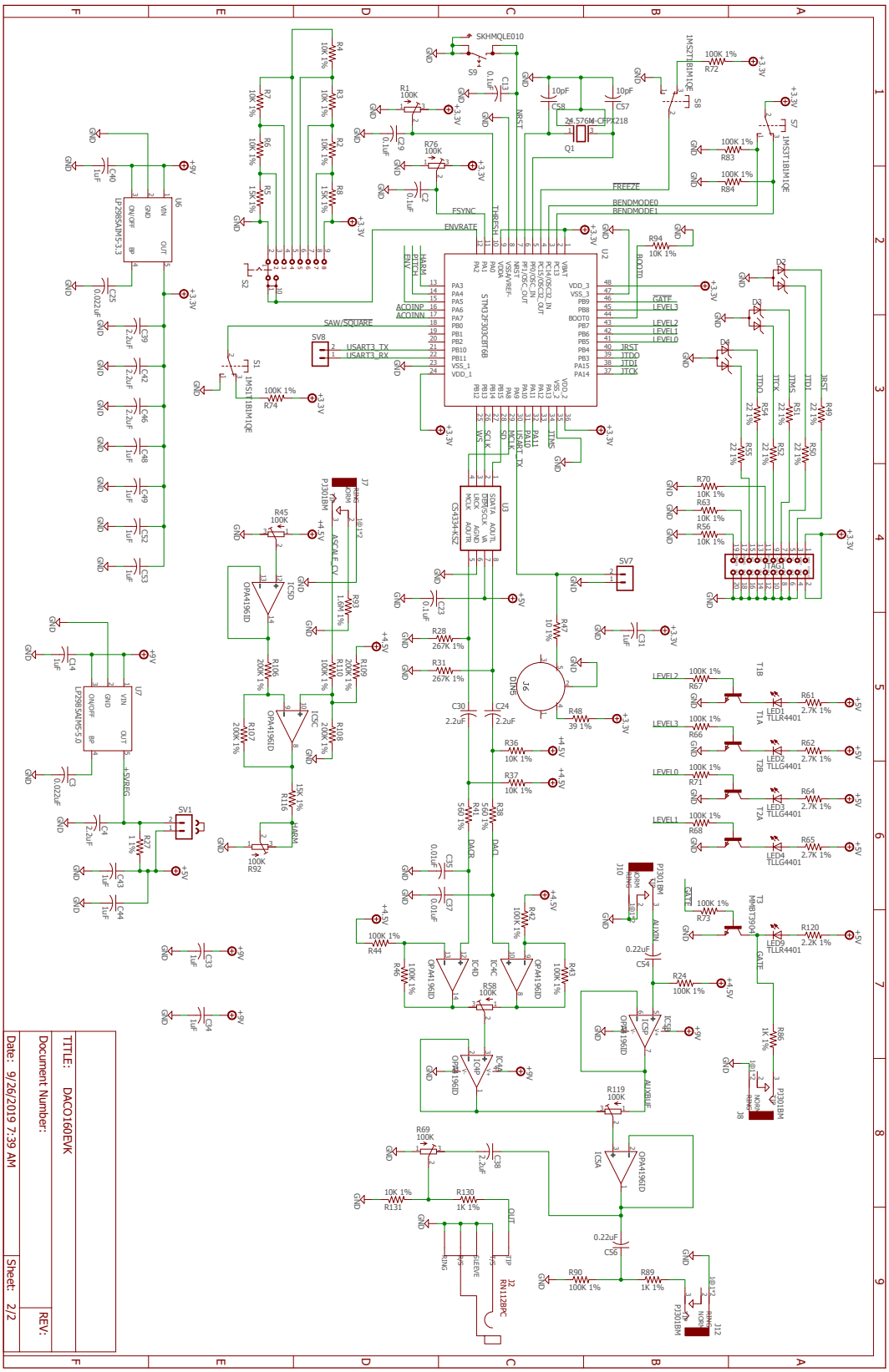

DACO160EVK Schematic – Page 2

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