ACO160 Audio Controlled Oscillator

- Direct audio to analog square/sawtooth/sine oscillator output
- 1V/octave pitch CV output (with calibrated post-amplifier)
- Rail-to-rail output zero-ripple envelope follower
- Modulation CV input with +/-2 octave range and semitone resolution
- Hard sync input for internal audio oscillators
- Gate output with user-configurable threshold
- "Track" input enables freezing of pitch when input is weak
- Fully balanced audio signal path
- Support for MIDI out with additional uC
- 7mm x 7mm 32-pin LQFP
- 25mA max current consumption from 4.5-5.5v supply
- One-cycle latency
- 25Hz-5.2kHz frequency tracking range

Applications

- Audio-controlled modular and semi-modular synthesizers
- Pitch-to-CV converters
- Harmonizers
- Guitar and other instrument effects/stompboxes

Description

The ACO160 audio-controlled oscillator is an ultra-low latency, low-power frequency-tracking oscillator suitable for audio-controlled music synthesizer applications. It contains a fundamental frequency detector based on dual switched-capacitor peak detectors with frequency-dependent decay time for ultra-wide detection range, ultrasonic analog oscillator and frequency tracking engine that forces the analog oscillator to run at 8192 times the frequency of the incoming audio signal detected at the input. This ultrasonic analog oscillator is then divided back down to audio range using programmable dividers that are controlled by the harmony CV input and which cover a +/-2 octave range with semitone precision over the entire range.

Additionally, the ACO160 features an integrated switched-capacitor envelope follower which exhibits zero ripple, even for the lowest frequency signals the chip can detect (down to 25Hz). An integrated gate generation comparator has the envelope signal wired to its positive input and allows the user to set the voltage on the negative input. This voltage functions as the gate threshold and generates a rail-to-rail gate CV output.

The ACO160 consumes only 25mA max from a 4.5-5.5V power supply, making it ideal for battery-powered applications. Together with other signal conditioning blocks such as a VCA, VCF, PWM, the ACO100 can provide a complete low-power analog audio-controlled synthesizer solution.

For digital synth applications, the internal 16-bit frequency detected by the chip is transmitted via an SPI interface for easy processing by a micro-controller. Together with the envelope and gate outputs, it is easy to convert this information into MIDI commands for controlling digital synths with short enough latency to satisfy even the most demanding real-time applications.
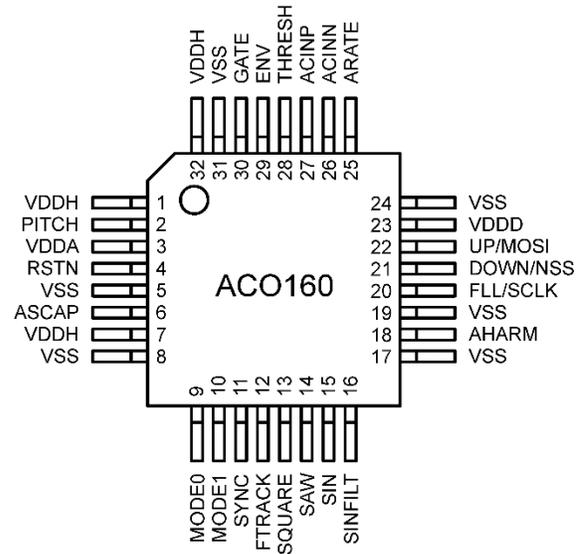
Ordering Information

Part Number	Package	Body Size
ACO160	LQFP-32	7mm x 7mm

999 SW 1st Ave. #1617, Miami, FL 33130

Simplified Block Diagram
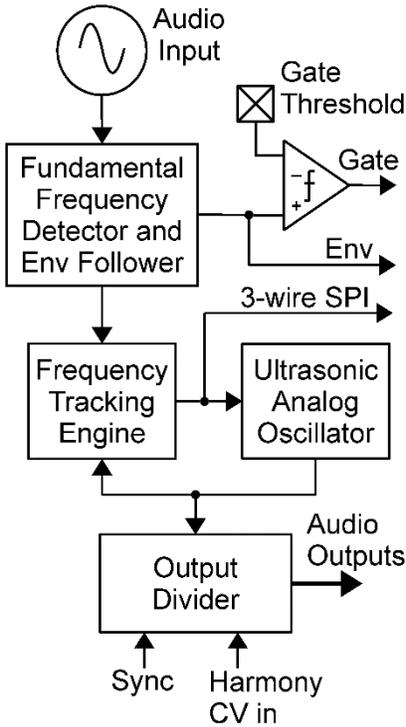
32-pin TQFP pinout

ACO160 Pins

Pin	Name	Direction	Description
1	VDDH	Supply	4.5-5.5v I/O supply
2	PITCH	Out	Pitch CV out at approximately 0.42v/oct
3	VDDA	Supply	3.3v analog supply, bypass with 1.0-2.2uF ceramic capacitor
4	RSTN	Input	0-VDDH Asynchronous active low reset
5	VSS	Supply	Ground
6	ASCAP	Input	Tuning input for DC offset of PITCH output, tunable from VSS to VDDH in 8 discrete steps
7	VDDH	Supply	4.5-5.5v I/O supply
8	VSS	Supply	Ground
9 10	MODE0/ MODE1	Input	0-VDDH, sets ACO160 mode: MODE1/0 = 00: Test mode only MODE1/0 = 01: CK1024, audio on MODE1/0 = 10: MIDI on, audio off MODE1/0 = 11: MIDI, audio both on
11	SYNC	Input	0-VDDH input with hysteresis around VDDH/2 to hard sync analog oscillator outputs, can AC couple to VDDH/2
12	FTRACK	Input	Set to VDDH to enable frequency tracking, set to 0v to freeze current pitch. Can tie to GATE output for intelligent pitch freeze operation.
13	SQUARE	Output	0-VDDA Square wave output
14	SAW	Output	0-VDDA Sawtooth wave output

Pin	Name	Direction	Description
15	SIN	Output	0-VDDA Sine wave output level-shifted up by about 1v.
16	SINFILT	In/Out	0-VDDA Filter node for sine wave, bypass this pin to ground with a 100pF capacitor close to the chip
17	VSS	Supply	Ground
18	AHARM	Input	Harmony CV input: 0v = -2 octaves; VDDA = +2 octaves; in between, tunes to the nearest semitone on the chromatic equal-tempered scale
19	VSS	Supply	Ground
20	FLL/SCLK	Output	0-VDDA: In MIDI mode (MODE1 = 1), SPI clock (SCLK) In synchronous sample clock mode (MODE1/0 = 00), ACO output divided down by the appropriate power of two to give a sample frequency roughly between 100kHz and 200kHz In analog-only synth mode (MODE1/0 = 01), quiet
21	DOWN/NSS	Output	0-VDDA: In MIDI mode (MODE1 = 1), SPI active-low enable (NSS) In synchronous sample clock mode (MODE1/0 = 00), single pulse over one cycle of FLL output when the sample frequency drops by 2x In analog-only synth mode (MODE1/0 = 01), quiet
22	UP/MOSI	Output	0-VDDA: In MIDI mode (MODE1 = 1), SPI master out slave in (MOSI) In synchronous sample clock mode (MODE1/0 = 00), single pulse over one cycle of FLL output when the sample frequency increases by 2x In analog-only synth mode (MODE1/0 = 01), CK1024 clock running 1024x the input signal frequency (for external SC filters)
23	VDDD	Supply	3.3v digital supply, bypass with 1.0-2.2uF ceramic capacitor and connect to VDDA on the PCB
24	VSS	Supply	Ground
25	ARATE	Input	Analog input for envelope follower rate control: 0v-VDDH/8: envelope decays to 32% of its initial value in one cycle VDDH/8-2*VDDH/8: envelope decays to 45% of its value in one cycle 2*VDDH/8-3*VDDH/8: envelope decays to 56% of its value in one cycle 3*VDDH/8-4*VDDH/8: envelope decays to 67% of its value in one cycle 4*VDDH/8-5*VDDH/8: envelope decays to 75% of its value in one cycle 5*VDDH/8-6*VDDH/8: envelope decays to 82% of its value in one cycle 6*VDDH/8-7*VDDH/8: envelope decays to 86% of its value in one cycle 7*VDDH/8-VDDH: envelope decays to 90% of its value in one cycle
26	ACINN	Input	0-VDDH negative polarity audio input
27	ACINP	Input	0-VDDH positive polarity audio input
28	THRESH	Input	0-VDDA analog gate threshold input
29	ENV	Output	0-VDDH analog envelope follower output
30	GATE	Output	Gate output; When ENV output exceeds THRESH voltage, Gate = VDDH; When ENV output is below THRESH voltage, GATE = 0v. Internal hysteresis is included to avoid double toggling when GATE changes state.
31	VSS	Supply	Ground
32	VDDH	Supply	4.5-5.5v I/O supply

Package Information for 32-pin LQFP
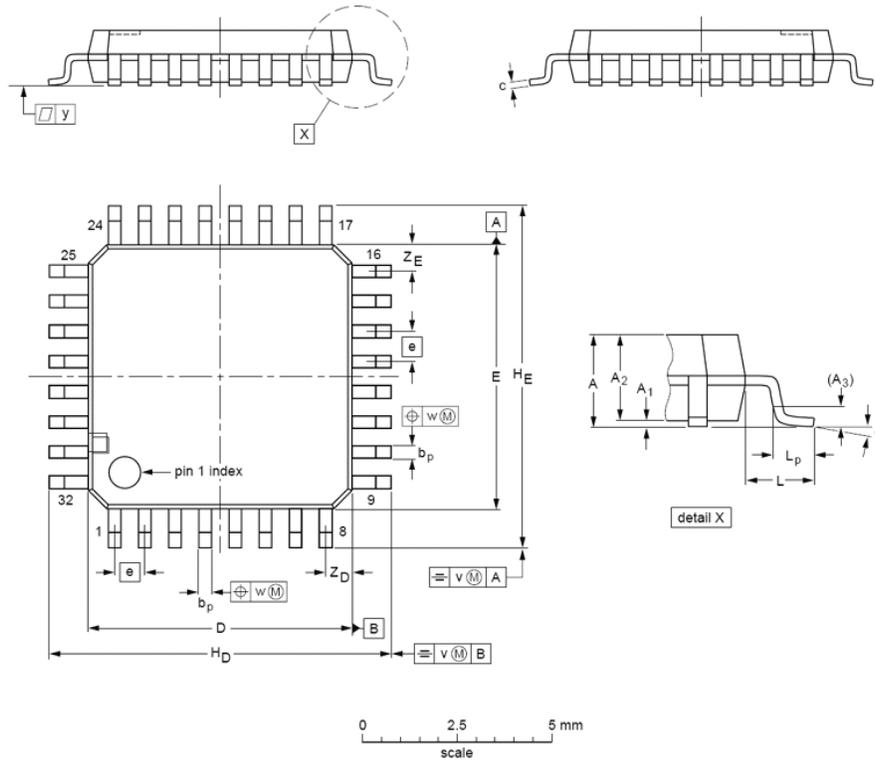
DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A₁	A₂	A₃	b_P	c	D(1)	E(1)	e	H_D	H_E	L	L_P	v	w	y	Z_D (1)	Z_E (1)	θ
mm	1.6	0.20 0.05	1.45 1.35	0.25	0.4 0.3	0.18 0.12	7.1 6.9	7.1 6.9	0.8	9.15 8.85	9.15 8.85	1	0.75 0.45	0.2	0.25	0.1	0.9 0.5	0.9 0.5	7° 0°

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