CODEC SOUNDBYTES

AD1819 / AD1819A / AD1819B / AD1881 Crystal Requirements

Last Modified: *10/14/98*
Contributed by: *Fred L.*

Overview

This Edition of Engineer's Notes will cover crystal requirements for clocking Analog Devices' AC97 codecs .

1. Frequency Range.

All Analog Devices' AC97 codecs are designed to work from a crystal with a frequency of 24.576MHz. This crystal rate is required by AC97 1.03. Crystals with a frequency of less than 24.576MHz may be used if the codec is not being used in a AC97 system. If a lower frequency is used the sample rate of the codec is affected and the engineer must keep the following formula in mind.

$$\text{SAMPLE RATE} = \frac{(\text{SRG SETTING})*(\text{XTAL RATE})}{(512)*(48{,}000)}$$

Where :

SRG SETTING = The current sample rate register setting.
XTAL RATE = The crystal frequency in Hz

For more information on using variable samples rates with ADI's AC97 codecs see the engineers note titled HOW TO USE VARIABLE SAMPLE RATES ON ANALOG DEVICES AC97 CODECS.

2. Frequency Tolerance and Stability.

All Analog Devices' AC97 codecs require crystals with Frequency tolerance and stability of less ±100 PPM. This requirement can be met if standard if quartz crystals are used. Therefore, ***ADI recommends QUARTZ crystals only.***

The use of ***other crystals such as ceramic and/or LC resonators are not recommended***. These types of crystals have frequency tolerances of greater than ±5000 PPM. Using resonators with such a wide tolerance my result in audio performance less than AC97 or PC98/98. If such high performance is not a system requirement and low cost is the design goal ceramic crystals may be used.

3. Operating temperature.

All ADI AC97 codecs are design to operate over the temperature range of 0°C to 70°C. Most standard crystal have a temperature range of -10°C to 70°C. However, a crystal with a limited temperature range may be used if the following considerations are made.

High temperature may affect start-up. If the crystal and oscillator system impedance are increased due to high temp the conditions for oscillation, namely Gain > 0 and Phase = n*360° (n=0,1,2…), may not be met and oscillation will not start. Therefore, if the oscillator starts at the highest ambient temperature required by the design there will be no need for a special crystal.

Both high and low temperature may affect the operating frequency of the crystal, but this variation is usually small and therefore not a problem.

4. Series vs. Parallel Crystals.

There is no such thing as a series cut or parallel cut crystal. Series vs. parallel has more to due with the oscillator used in conjunction with the crystal. If the oscillator is inverting then the crystal/oscillator system will oscillate in parallel resonance. If the oscillator is non-inverting the crystal/oscillator system will operate in series resonance.

Most frequency specs for crystals are stated as “series”. This means that the frequency specified for the crystal is the series resonant frequency Fs. All ADI’s AC97 codecs have inverting oscillator circuits, therefore, the codec/crystal system will oscillate in parallel resonance Fp. Fp is usually higher than Fs by about 0.02%. The diagram on page 3 helps to describe the difference between parallel and series resonance.

5. Load Capacitance.

To operate at parallel resonance requires capacitance external to the crystal. The total external capacitance required for parallel resonance is referred to as the load capacitance CL. Please refer to the diagram on page 4 to see the relationship between CL and the external caps used in the oscillator circuit.

6. Equivalent Series Resistance (ESR).

A crystal calibrated for parallel resonance with a load capacitance CL will have an equivalent series given by

$ESR = Rs*(1+Co/CL)^2$

For a description of Rs,Co and CL refer to figures 1 and 2.

7. Drive Level.

The operating drive level is the power dissipated internally in the crystal blank. If the drive level is too low (less than 100 micro-watts), starting of oscillation may not occur. If the drive level is to high (greater than 1mW) frequency shifts, poor long term frequency aging and frequency perturbations over temperature may occur.

All ADI AC97 codecs work well with any crystal that has a drive level of 1 mW maximum.

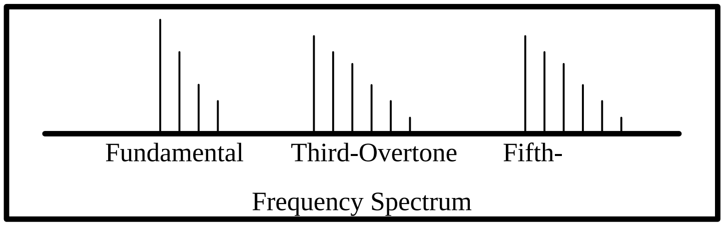
8 Aging.

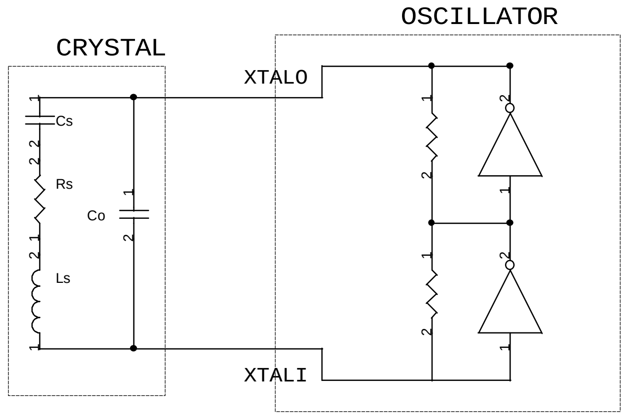
Aging is a general term used to describe the gradual deterioration of the operating characteristics of a crystal unit over time. Many factors contribute to this deterioration, such as internal contamination, excessive drive level, wire fatigue, frictional wear, and surface erosion of the crystal blank. Cleanliness of the manufacturing process and of the quartz blank can greatly reduce aging by contamination. The most rapid aging occurs within the first year. If aging rates of a crystal must be low, the crystal can be pre-aged by temperature-cycling or by high-temperature burn-in for an extended period of time.

9. Spurious Modes.

All quartz crystals have multiple vibrational modes. Spurious modes refer to those that are unwanted and can be a problem if the response is as strong as the main mode. When the oscillator runs on the spur instead of the main mode, the frequency output is changed. Spurious modes should be specified as either a resistance ratio to the main mode or dB suppression. A resistance ratio of 1.5 or 2.0 to 1 is sufficient to avoid mode hopping. A -3dB to -6dB is an approximate equivalent for a specification in terms of dB.

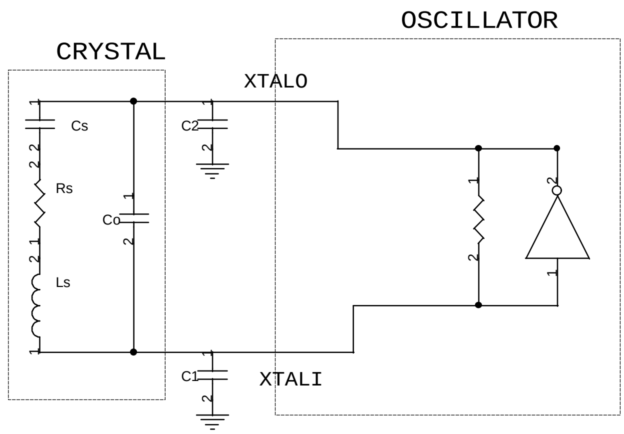
Analog Devices recommends using only Fundamental mode crystals. The use of third-overtone crystal may result a decrease in audio performance due to frequency inaccuracy and drift.





Series Resonant Crystal Oscillator

Fs= 1/ 2*pi*sqrt(Ls*Cs]



Parallel Resonant Crystal Oscillator

Fp = Fs * [1 + Cs/(2*{CL+Cs})]

CL = Load Capacitance (See Section 5)

Title	Figure 1 Series vs. Parallel Resonance	
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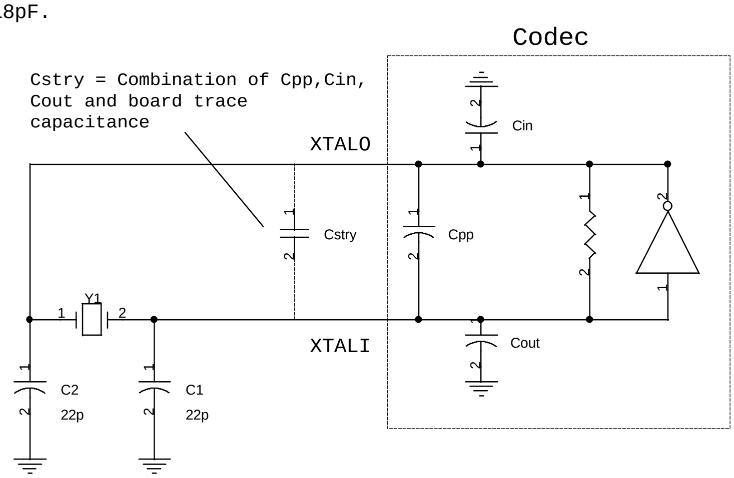
Specifying Load Capacitance for a Crystal

CL=(C1*C2)/(C1+C2) + Cstry

For The AD1819/A/B and the AD1881 Cstry=7.0pF
Therefore, ADI recommends a crystal with CL=18pF.
This leads to C1=C2=22pF



Title	Figure2 : Load Capacitance	
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