

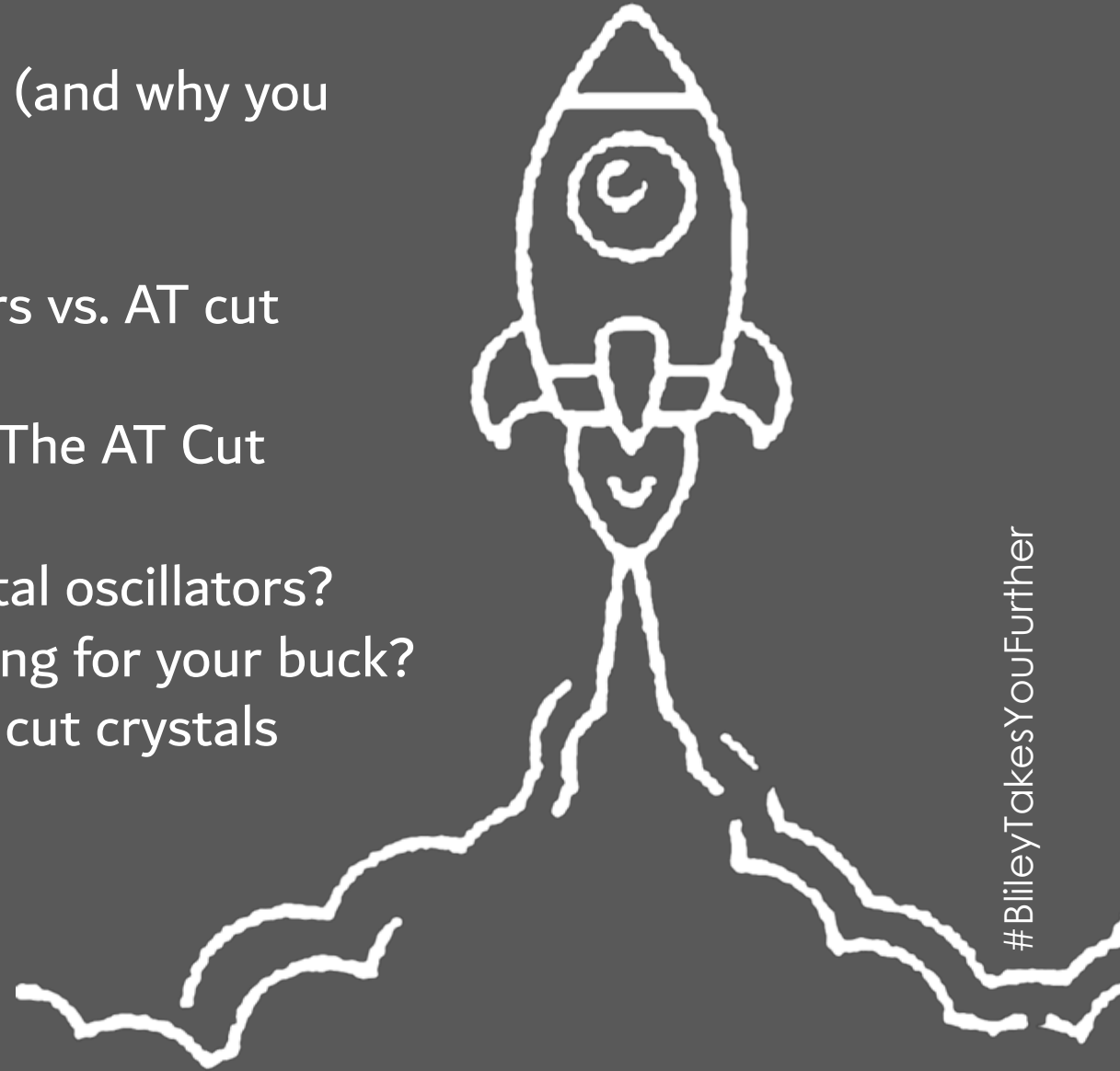
# Are You Paying Too Much for Your Crystal Oscillators?

How SC cut quartz crystals  
can provide a better “bang-for-your-buck”



# What's to Come...

- What the h\*ck are AT & SC cut crystals? (and why you should care)
- AT vs. SC cut crystals
- Performance benefits of SC cut oscillators vs. AT cut oscillators
- 2 hidden problems with AT cut crystals (The AT Cut Conundrum)
- Should you *actually* be using SC cut crystal oscillators?
  - Will SC cut crystals give you more bang for your buck?
- Where to find OCXO Oscillators with SC cut crystals

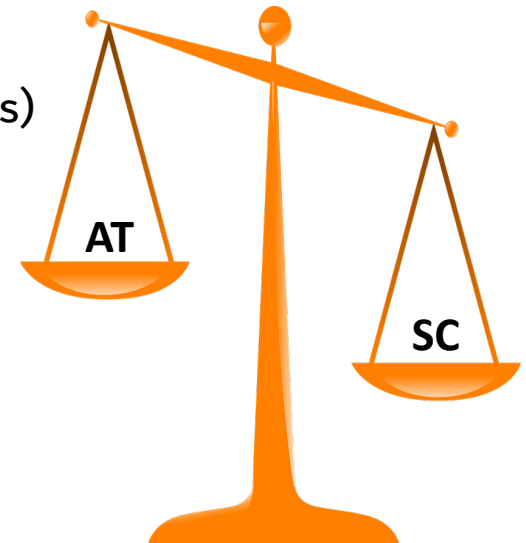


# What the h\*ck are AT & SC cut crystals? (and why you should care)

Inside of every quartz oscillator is something called a crystal blank. The crystal blank is the resonating element of the oscillator that, when subjected to a voltage potential, will begin to vibrate and oscillate at it's "fundamental frequency."

The way this crystal blank is manufactured can have a **significant impact on the oscillator's performance**. One of the most impactful manufacturing steps to crystal (and oscillator) performance is the orientation of the quartz when the crystal blank is cut.

The two most common quartz crystal cuts used in OCXOs (oven controlled oscillators) are AT cuts and SC cuts. And just like any other engineering or design decision, they both come with their own set of advantages and disadvantages that must be traded during the design phase of the frequency control device.



# AT vs. SC Cut Crystals

## AT Cut Crystals

- The AT is a temperature compensated cut, meaning the cut is oriented such that the temperature coefficients of the lattice will have minimal impact on crystal performance.
- Requires less manufacturing effort and is therefore cheaper to produce

## SC Cut Crystals

- The SC (stress compensated) is also temperature compensated.
- Originally developed in 1974, the SC cut is a double rotated cut (similar to a compound miter cut for the woodworkers out there).
- Requires more time and effort to manufacture. This can increase price, but improve overall performance.



**AT Cuts are somewhat cheaper and easier to manufacture, but SC Cuts can enhance overall oscillator performance.**



# Performance Benefits of SC vs. AT

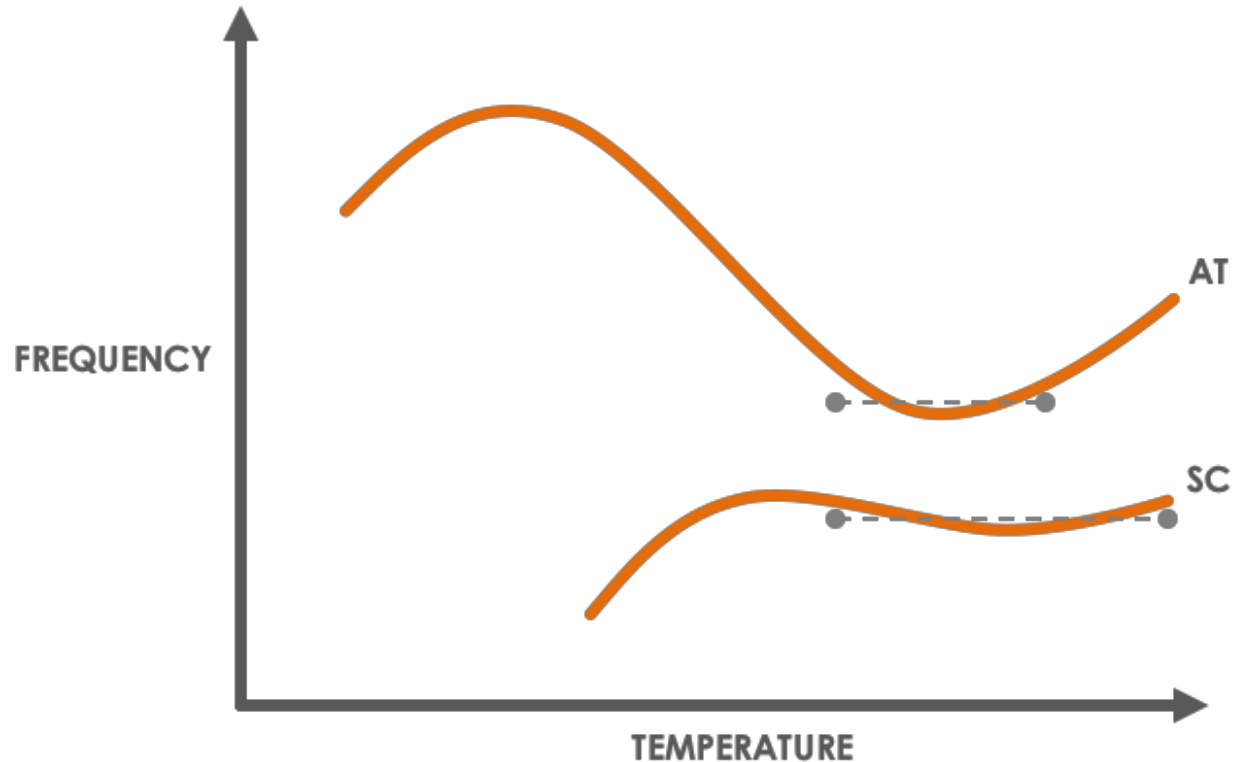
Performance	AT Cut	SC cut
Freq. vs. Temp	★★★★☆	★★★★★
Crystal Aging	★★★★☆	★★★★★
G-sensitivity	★★★☆☆	★★★★☆
Availability	★★★★★	★★★★☆
Cost	\$\$\$	\$\$\$



Overall, SC cut crystals provide better performance but with an increase in cost. However, be sure not to fall for the common mistakes outlined later in this eBook.



# Frequency vs. Temperature Stability



SC cut crystals are better at maintaining the oscillator's specified center frequency with deviations in temperature.



# Additional Performance Advantages of SC Cut Crystals



## Warm-up Time

Warm-up time is also improved just by using an SC cut crystal over an AT. This is simply due to the angle at which the quartz is cut. Quartz works in mysterious ways.



## Phase Noise

SC cuts have a higher Q (function of bandwidth and resonant frequency) – This improves close-end phase noise of an OCXO oscillator.



# The AT Cut Conundrum – 2 Hidden Problems with AT Cut Crystals

It's common for design engineers to try and save costs by using less-expensive AT cut crystals in their OCXO designs and using more Electronic Frequency Control (EFC) pull to try and compensate for the lower performance quality. However, ***this is a myth in many cases and doesn't work out in the long-run.*** Here's why...

If you spec more EFC than you need to cover frequency deviation, costs will significantly increase for the supplier because their overall yield will go down. So in reality, there's really no cost savings to be found when going with an AT cut crystal and compensating with more EFC pull.





# The AT Cut Conundrum (Continued)

Also, using EFC to maintain crystal stability over many months and years is actually very inefficient when compared to using the "natural" stability of a SC cut crystal.

With a 100MHz SC cut crystal, it'd be realistic to see aging of around 0.1 ppm over a year, where as an AT cut would see significantly higher aging of around 1 ppm/yr. Expecting EFC to cover for aging in AT cut crystals is, many times, not the best option.

For those two reasons, **we recommend just sticking with an SC cut crystal in your designs instead of trying to save costs with an AT cut crystal and high EFC pull.**



# Should You *Really* Be Using SC Cut OCXO Oscillators?



SC cut crystals aren't for everyone. However as we've discussed, SC cut crystals provide a handful of performance benefits over AT cut crystals.

If you have any doubts in your mind as to which type of cut will work best in your applications, we recommend calling a trusted oscillator manufacturer to discuss your required specifications.

Overall, SC cut oscillators will often provide a better bang for your buck over AT cut oscillators. This is especially true if you can find a well trusted oscillator supplier/manufacturer that offers competitive pricing on their SC cut oscillators. **This will save you on both costs and longer-term performance issues.**



# Where Do I Find High-Performance SC Cut Oscillators?



[Bliley Technologies](#) has been a trusted crystal oscillator manufacturer for over 90 years. We especially love SC cut oscillators. We use precision SC cut quartz crystals in all of our oscillators.

We're believers that even though SC cuts take some more time and man-power to perfect, they provide the precision long-term performance that is necessary for quality, high-end applications.

Better yet, [Bliley's new online store for SC cut OCXO oscillators](#) offers industry-low pricing without sacrificing any performance. This allows you to purchase higher-performance SC cut oscillators for around the same price as many AT cut oscillators on the market.



