

CUTTING ANGLES AND FREQUENCIES

Because crystal units are widely used for their stable oscillation frequency, superior temperature characteristics are required.

However, as with ordinary materials, a crystal flake cut as a quartz unit is influenced by temperature change, causing its oscillation frequency to change. The level of change in the oscillation frequency (frequency-temperature characteristics) varies depending on the cutting azimuth. As shown by Fig. 3, cutting angles determine the rates of change. Fig. 3 shows typical frequency vs. temperature characteristics for various cutting angles. Fig. 4 shows how to make crystal units which have superlative temperature characteristics, taking the AT-cut crystal wafer (the most popular crystal wafer) for example.

Fig. 4 shows three different temperature characteristics for different cutting angles. You can easily find that curve ② provides the smallest rate of frequency change against temperature change near normal temperatures and therefore, crystal units represented by this curve have excellent characteristics suited for most usual applications.

On the other hand, over a wider temperature range of -55 to $+105^{\circ}\text{C}$, for example, curve ① shows better characteristics.

So it is necessary to determine the most appropriate temperature characteristics taking into consideration applications and required operating temperature ranges.

Fig. 5 shows frequency vs. temperature characteristics in when changing AT-cut angles with the increment of $2'$. Cutting angle allowance is determined by operating temperature range and allowable frequency tolerance.

Fig. 6 shows cutting angle allowances (impracticality) corresponding to frequency vs. temperature characteristics. This figure reveals impractical zone.

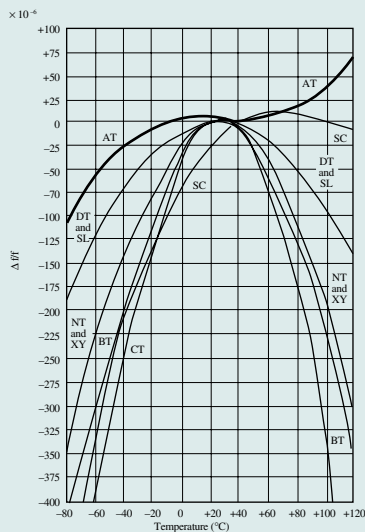


Fig. 3 Theoretical Frequency-temperature Curves of Various Cuts

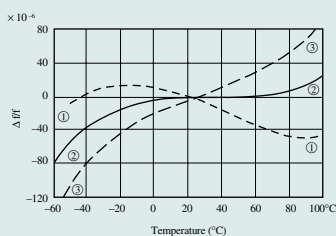


Fig. 4 Characteristics of Frequency-temperature (AT-cut)

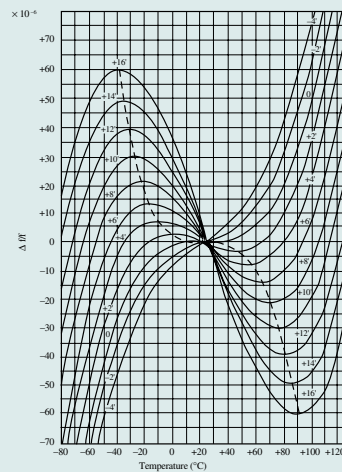


Fig. 5 Frequency-temperature Curves (AT-cut)

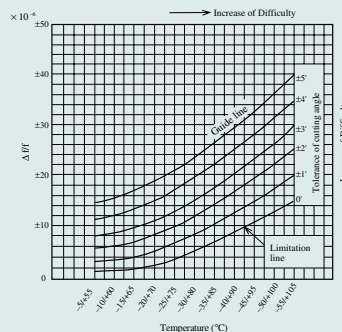


Fig. 6 Frequency Stability Guidance