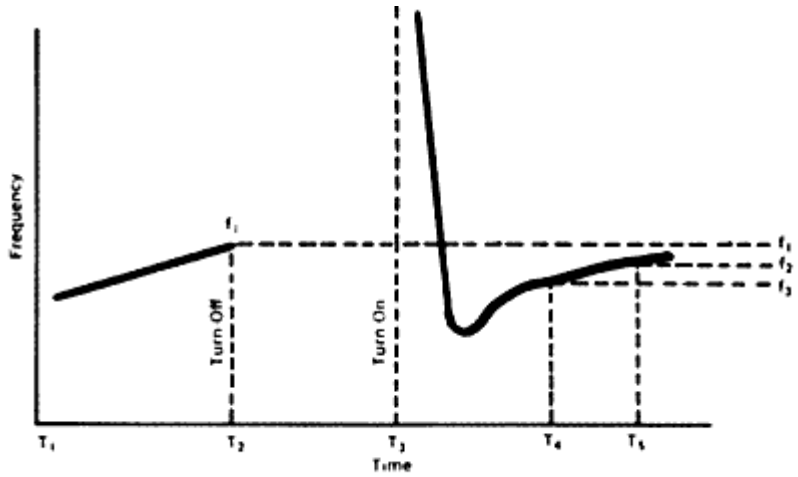
Restabilisation And Retrace

When a crystal oscillator is turned off for a period of time and then turned on again (as occurs when the unit is shipped), the crystal requires a restabilisation period. The characteristic is similar to the initial factory aging characteristic, but high stability is achieved significantly more quickly because the crystal has been factory pre-aged.

In most applications, oven-controlled crystal oscillators are continuously energized. This being the case, aging is the critical characteristic with turn-off/turn-on characteristic being of little or no significance. However, certain applications require that oven controlled crystal oscillators be frequently deenergized and re-energized (a practice which should be avoided whenever possible). When applications require frequent turn-off, an additional series of characteristics should be considered.



- Figure 6 -

In Figure 1, assume that an oscillator is energized until time T2 when it is turned off for a period of time and then turned on again at time T3. Three characteristics may then be of significance:

1. How close does the oscillator return to the output frequency at turn-off, a specified time after turnon. This is called the retrace characteristic. Retrace error at T4 = fl - f3.
2. How much will the frequency change over moderate periods of time (hours) after the oven has stabilised. This is called the restabilisation, or warmup, characteristic. Restabilisation rate from T4 to T5 = (f3 - f2) / (T5 - T4)
3. How long does it take the oscillator to achieve its specified aging rate following a specified off period (This is called "reaging").

Retrace limits the accuracies achievable with OCXOs in applications where the OCXO is on-off cycled. Typical values of hysteresis in TCXOs range from 1 to 0.1 ppm when the temperature-cycling ranges are 0 to 60°C and -55 to +85”C.
Typical OCXO retrace specifications, after a 24-hour off period at about 25°C range from 2 x l0-8 to 1 x 10-9. Low-temperature storage during the off period, and extending the off period usually make the retrace worse .

The causes of hysteresis and retrace are not well understood; the experimental evidence to date is inconclusive. The mechanisms that can cause these effects include strain changes, changes in the quartz, oscillator circuitry changes, contamination redistribution in the crystal enclosure, and apparent hysteresis or retrace due to thermal gradients.

There is significant variation in these characteristics from crystal to crystal and they should only be specified when absolutely required and then only to the degree needed, as "tight" specifications in this area can have a major impact upon oscillator cost due to low yield. These characteristics are of little consequence in oscillators which are energized continuously.

Measurement of retrace characteristic acc. MIL-PRF-55310:

The retrace is measured in accordance with the procedure illustrated on figure 1. The oscillator is energized and all operating parameters adjusted to specified values at specified temperature (for example 25°C). When stabilised, the fequency (f1) will be recorded.

The oscillator will be turned off for a specified time periode (t3-t2). At the end of this period (typ. 24 hours), power will be again applied and the frequency will be recorded as a function of time.

The retrace error is the frequency difference between the frequency at time of turn off (f1 at t2) and the frequency at the specified time after turn on.