Application Note VCXO
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Absolute Pull Range vs. Total Pull

Introduction

There is often confusion among engineers when comparing pullability specifications among different manufacturers' datasheets. Some manufacturers use the absolute pull range (APR) method while others use total pullability method to specify the amount of voltage control adjustment. The purpose of this application note is to clarify the differences between the two methods.

Definition

In order to define APR, a basic understanding of a VCXO is required. A VCXO is an oscillator that can vary the output frequency based on an input control voltage. The amount of frequency variation, specified in ppm, is the pullability. Manufacturers often use the terms pull, pullability, frequency modulation and frequency deviation interchangeably. For the purpose of this article, we will refer to pullability as total pullability as it is the raw measurement of the frequency variation. This is the more common method of specifying pullability in a VCXO.

However, some manufacturers often use the APR method instead of the total pullability method. The APR method is defined as the amount of frequency variation after accounting for errors due to variations in temperature, load, supply voltage, and aging.

APR = Total Pullability – (errors due to variations in temperature, load, supply voltage, and aging)

As you can see, the total pullability must be greater than the APR value in order to account for the errors. This is often where the confusion resides. Engineers often compare APR values from one manufacturer against total pullability from another manufacturer as the same spec and assume that one has much more pull than the other. However, this is often not the case.

Example

Let's take an example of a VCXO used in a PLL that needs to track a ±50ppm reference. Below is a typical specification for two VCXO. VCXO A uses the total pullability method while VCXO B uses APR method.

	VCXO A **TOTAL PULL method**	**VCXO B** **APR method**
Nominal frequency	12.800MHz	12.800MHz
Stability vs temperature -40 to 85C	±50ppm	±50ppm
Stability vs load ±10%	±3ppm	±3ppm
Stability vs supply voltage ±10%	±3ppm	±3ppm
Aging (10 years)	±10ppm	±10ppm
Pullability	±100ppm	
APR		±50ppm

**It is important to note that the stability errors above are maximum values and the case represented is the worst case scenario.*

Below is the comparison of both VCXO using equivalent specifications.

	VCXO A	**VCXO B**
MEASURED USING TOTAL PULL	±100ppm	±116ppm
MEASURED USING APR	±34 ppm	±50ppm

At first glance, VCXO A appears to have more pullability, but VCXO B actually has more pullability when all errors are taken into account. If the application requires the PLL to track ±50ppm, the VCXO A may not be suitable.

In effect, the APR value can be considered the "usable pullability". Instead of calculating the errors, the user can simply specify the APR that meets the PLL tracking requirement and be done. This is often the case in Stratum4 applications where a maximum error of ±32ppm is allowed. Rather than calculating the pullability, specifying APR value of ±32ppm will allow the clock to maintain lock under all environmental conditions.

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