# Definition Of VCO Terms

# VOLTAGE CONTROLLED OSCILLATOR (VCO):

This is an oscillator designed so the output frequency can be changed by applying a voltage to its control port or tuning port.

# FREQUENCY TUNING CHARACTERISTIC:

Frequency versus tuning voltage performance for a given VCO. This is usually graphed as frequency vs. voltage.

# FREQUENCY VS. TEMPERATURE:

Variation of frequency with temperature at a fixed tuning voltage.

# MONOTONIC TUNING:

This refers to the fact that for a given frequency voltage characteristic, the frequency is single valued at a given voltage, and vise versa. Refer to Q&A's (pg. 25-28) for further details.

# TUNING SENSITIVITY:

This is the slope of the tuning characteristic and is expressed as frequency change per unit voltage change (MHz/V, etc.).

#### TUNING LINEARITY:

The deviation of the frequency versus tuning voltage characteristic from a best-fit straight line.

#### TUNING NON-LINEARITY:

The extent to which the tuning voltage characteristic falls outside the best fit straight line.

# TUNING OR MODULATION, AND DELTA MODULATION SENSITIVITY:

The slope of the tuning voltage characteristic at a given tuning voltage is the tuning or modulation sensitivity. The difference in modulation sensitivity at two operating tuning voltages is the delta modulation sensitivity. (For additional information, see the Q&A section).

# TUNING SPEED (OR RESPONSE TIME):

This is the time required for the output frequency to settle to within 90 percent of its final value after applying a step change in frequency. The settling time or tuning speed is related to the tuning or modulation bandwidth.

# VCO INPUT CAPACITANCE:

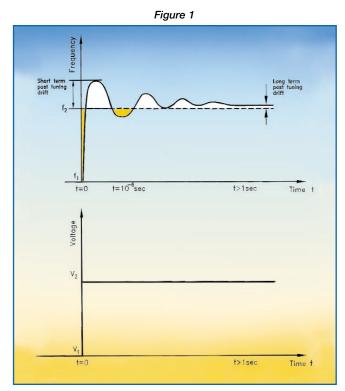
The total equivalent capacitance seen at the tuning port of the VCO. This parameter is a function of the amplitude and frequency of the test signal at the tuning port.

#### MODULATION OR TUNING BANDWIDTH:

The modulating frequency at which the frequency deviation decreases to .707 of its dc value. This is usually a function of the modulating source impedance, which is typically 50 ohms.

# POST TUNING DRIFT:

The application of a step voltage causes the VCO to change its frequency from an initial  $f_1$  value to a final  $f_2$  value. The frequency  $f_2$  will settle to a stabilized value after some time. Post tuning drift is the frequency error compared to a final stabilized value at a specified time after the application of a step voltage. Expressed as frequency error in Hz, kHz, etc. as illustrated in Figure 1.



Post tuning drift illustration

# FREQUENCY DRIFT WITH TEMPERATURE:

This is the frequency drift of the VCO with temperature at a fixed tuning voltage, and may be expressed as a relative percentage change per unit temperature, or as a frequency change per unit temperature.

#### FREQUENCY PUSHING:

The changing of output frequency corresponding to a given change in the supply voltage at a fixed tuning voltage (expressed in MHz per volt).

#### FREQUENCY PULLING:

Frequency variation caused by changes due to the output load. Usually specified at a load return loss of 12dB and all possible phases.

# OUTPUT POWER:

The fundamental sinusoidal frequency output of the oscillator measured into a 50 ohm load.

#### **OUTPUT POWER VARIATION:**

The maximum to minimum power variation (expressed in dB) observed over the specified frequency range in a 50 ohm system at a given temperature.

#### **OUTPUT POWER FLATNESS:**

Variation of the output power from the average output power, expressed in dB.



P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-460 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

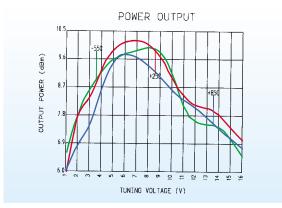
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com



# OUTPUT POWER CHANGE WITH TEMPERATURE:

The change in the output power over the temperature range (example using Mini-Circuits Models POS-765 or JTOS-765 is shown in Figure 2).

# Figure 2



#### HARMONIC CONTENT OR SUPPRESSION:

Harmonics levels are measured relative to the fundamental signal and expressed in dB referenced to the carrier (dBc).

# SPURIOUS RESPONSES OR NON-HARMONIC SPURIOUS CONTENT:

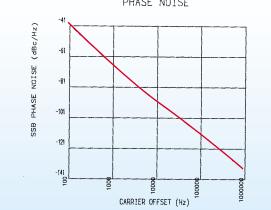
Spurious frequencies are unwanted and non-harmonically related signals present at the oscillator output. Spurious response is usually expressed in terms of dBc.

# SSB PHASE NOISE:

Single side band phase noise in 1Hz bandwidth is measured relative to the carrier power at a given offset from the carrier frequency and is expressed as dBc/Hz, as illustrated in Figure 3 (Mini-Circuits models POS-1025 or JTOS-1025). For more information see Application Note 2.

# FLICKER NOISE:

One of the sources of noise associated with solid state devices, the amplitude of which varies inversely with frequency. It is also referred to as 1/f noise.



# **RESIDUAL FM:**

This is another form of specifying the frequency stability of a signal source. It is the total rms frequency deviation  $\Delta f_{rms}$  within a given bandwidth:  $f_a$  to  $f_b$ . The bandwidth is usually specified between 50Hz to 3kHz. Expressed mathematically, we have

$$\Delta f_{\text{rms}} = \sqrt{2 \int_{f_a}^{f_b} S_c(f) f^2 \delta f}$$

as referred to in Application Note 2.

# Q OR QUALITY FACTOR:

A figure of merit often used in describing the sharpness of a tuned circuit response. A high Q circuit has a sharper response, and vice versa.

#### VARACTOR DIODE:

A diode operated in a reverse biased condition providing a junction capacitance that is a function of the applied reverse bias voltage.

#### PHASE LOCKED LOOP (PLL):

A feedback circuit in which the VCO frequency and phase is locked to the frequency and phase of a stable reference signal.

#### FREQUENCY SYNTHESIZER:

A system that generates any one of equally spaced frequencies within a given band, referenced to a stable frequency.

#### PHASE DETECTOR:

A circuit which compares two coherent RF signals and generates a DC output voltage that is a function of the difference between the phase of two signals.

#### PHASE DETECTOR GAIN:

This is a constant for a given device, and measured in volts per radian.

# BODE PLOT OR BODE DIAGRAM:

A method of describing the transfer characteristic of a circuit or system where the logarithm of the gain function and phase shift is plotted to a logarithmic base of frequency.

#### UNITY GAIN:

The gain at which the magnitude of the open loop gain is equal to 1 (or 0dB).

# UNITY GAIN FREQUENCY:

The frequency at which the magnitude of the open loop gain crosses the 0dB point.

#### LOOP FILTER:

The loop filter is generally a low pass filter which filters the output of the phase detector and determines the noise characteristics of the VCO. If the phase detector generates a current output, then the loop filter will integrate the output signal from the phase detector into a DC voltage to drive the VCO to a specific frequency. The loop filter may take different forms, such as lag/lead network, etc.

see us on the web At: www.minicircuits.com



*Figure 3* PHASE NOISE