

Crystal Oscillator and MEMS Oscillator Glossary of Terms

Rev A

Aging

The systematic change in frequency with time due to internal changes in the quartz crystal or MEMS resonator and/or oscillator. Aging is often expressed as a maximum value in parts per million per year (ppm/year). The following factors effect oscillator aging: adsorption and desorption of contamination on the surfaces of the resonator, stress relief of the mounting and bonding structures, material outgassing, and seal integrity.

APR

The abbreviation for Absolute Pull Range. The minimum guaranteed frequency deviation, specified in parts per million (ppm), from the nominal frequency over all operating parameters. These operating parameters typically include: frequency tolerance, frequency stability over operating temperature range, supply voltage, output load, and aging. Also called Tracking Range, it is the difference between the VCXO's (or VCMO's) total pull range and the total frequency stability.

Ceramic Package

Often called a header or leadless chip carrier (LCC), this is a type of surface mount package fabricated using ceramic as its primary packaging material. Integrated with a metal lid or cover, this package provides a hermetically seam-sealed enclosure for the quartz crystal and oscillator integrated circuit.

Clipped Sine Wave Output

An oscillator output signal characterized by driving the oscillator output circuit into a clipped mode so as to achieve a saw-tooth shaped waveform.

Clock Oscillator

A type of crystal or MEMS oscillator that produces a reference frequency used for timing applications.

CML Output Logic

A type of differential output logic, called Current Mode Logic. This oscillator output topology utilizes a constant current source open-drain differential pair with a voltage swing across an output load of 50 ohms to V_{DD} .

CMOS Output Logic

A type of single ended output logic called Complementary Metal Oxide Semiconductor. The oscillator output topology utilizes a combination of p and n channel transistors forming complementary elements with a voltage swing from ground to V_{DD} (rail to rail) across a capacitive output load.

Complementary Output

The condition where one oscillator output signal is the logical opposite (complement) of the other output signal.

Control Voltage

The DC input voltage applied to the control pad of a Voltage Controlled Crystal Oscillator (VCXO) or Voltage Controlled MEMS Oscillator (VCMO) for the measurement of the absolute pull range (APR) or frequency deviation test conditions. Also called External Trim Voltage or Tuning Voltage.

Control Voltage Range

The minimum and maximum DC voltage applied to the control pad of a Voltage Controlled Crystal Oscillator (VCXO) or Voltage Controlled MEMS Oscillator (VCMO).

Coupling

The AC or DC connection between the oscillator output and the external load circuit connected to it.

Crystal Oscillator

A timing device that consists of a quartz crystal resonator and an oscillator sustaining circuit incorporated into a single package, providing an output waveform at a specified reference frequency. This term is often abbreviated as XO or SPXO (Simple Packaged Crystal Oscillator).

Crystal Unit

A passive timing device that consists of a quartz crystal resonator and its associated package.

Cycle

A time domain measurement defined as one complete repetition of an event, it is used to define the output frequency, measured in Hertz, of a clock oscillator.

Differential Output Voltage

The difference between the logic level values of two complementary output signals of an oscillator.

DIP

Acronym for Dual In-Line Package. An oscillator package with rectangular housing and two parallel rows of electrical connecting pins that are mounted by insertion of pins into holes of a printed circuit board.

Disable Current

The amount of current, measured in milliamps (mA), consumed by the oscillator when it is in disable mode.

Duty Cycle

The measure of output waveform uniformity. This term, also referred to as Symmetry, is a measurement of the time that the output waveform is in a logic high state, expressed as a percentage (%). This parameter is measured at a specified voltage threshold or at a percentage of the output waveform amplitude.

Enable/Disable Function

An oscillator control function that enables or disables the output of the oscillator through the application of an external logic control voltage to the oscillator input control pad.

Enable and Disable Input Voltage (V_{IL} and V_{IH})

The low-level and high-level DC voltage applied to the input control pad of an oscillator that enables or disables the output.

Enable/Disable Time

The time between application of the proper voltage to the oscillator enable/disable input pad and the time when the output becomes enabled or disabled.

Fall Time

The transition time, expressed in picoseconds (pSec), from a logic high to a logic low of an oscillator output signal, measured at specified voltage thresholds or at specified percentages of the output waveform amplitude.

Frequency

Measured in Hertz (Hz), it is a periodic repetition of an event within a unit of time. In an oscillator, it is the repetition rate of the output signal of the oscillator.

Frequency Deviation

The frequency shift, expressed in parts per million (ppm), of a VCXO or VCMO as a function of control voltage. This term is also called Pullability.

Frequency Load Stability

The allowable change in frequency, measured in parts per million (ppm), when the load impedance is changed from the minimum to the maximum specified values.

Frequency Stability

The ability of the oscillator to maintain its design frequency with changing environmental and electrical conditions. Parameters which may affect stability include operating temperature, time (aging), supply voltage, output load, shock and vibration. This parameter is specified with a minimum and maximum frequency deviation, expressed in percent (%) or parts per million (ppm).

Frequency Tolerance

The amount of frequency deviation from the specified nominal frequency at room temperature (25°C). Also called Calibration Accuracy or Calibration Tolerance, this term is expressed as a minimum and maximum percent (%) or parts per million (ppm).

Frequency Tolerance/Stability

An inclusive specification, the amount of deviation from the nominal frequency associated with a set of operating conditions. These conditions may include: Frequency Tolerance, Operating Temperature Range, Supply Voltage, Output Load, Aging, Shock and Vibration. This parameter is specified with a minimum and maximum frequency deviation, expressed in percent (%) or parts per million (ppm).

Frequency Voltage Stability

The allowable change in frequency due to changes in supply voltage. This parameter is specified with a minimum and maximum frequency deviation, expressed in parts per million (ppm).

HCMOS Output Logic

A type of single ended output logic called High-Speed Complementary Metal Oxide Semiconductor. The oscillator output topology utilizes a combination of p and n channel transistors forming complementary elements with a voltage swing from ground to V_{DD} (rail to rail) across a capacitive output load.

HCSL Output Logic

A type of differential output logic, called High Speed Current Steering Logic. The oscillator output topology utilizes a constant current source open-drain differential pair with a voltage swing across an output load of 50 ohms to ground.

Hertz

The basic unit of measurement of frequency. It is a measurement used to denote one complete occurrence of an event in one second. The output frequency of an oscillator is measured in megahertz (MHz) or kilohertz (kHz).

IBIS Model

An acronym for I/O Buffer Information Specification. A format for defining the analog characteristics of the input and output of oscillator devices. IBIS models are data files that provide the behavioral information required to model the device without divulging the proprietary design of the circuit.

Input Current

The amount of current consumed by an oscillator, typically specified in milliamps (mA) or micro amps (μ A).

Input impedance

Measured in ohms, the load of the control voltage input pad of a VCXO or VCMO.

Input Leakage Current

The small amount of current that flows through the input pads of an oscillator when it is not operating (Disabled).

Internal Frequency Trim

The amount of frequency change, typically specified in parts per million (ppm), that an oscillator can be mechanically adjusted. This term is also called Trim Range and is used to compensate for long term oscillator frequency shift due to aging.

Linearity

Also called monotonic linearity, the frequency error expressed in percentage with reference from the best straight line curve fit drawn on the output frequency versus control voltage graph. The linearity curve is the relationship between output frequency versus control voltage for a VCXO or VCMO.

Load Drive Capability

The measure of the driving ability of the output of an oscillator. It is typically specified as the type of resistive or capacitive output load.

LVC MOS Output Logic

A type of single ended output logic called Low Voltage Complementary Metal Oxide Semiconductor. The oscillator output topology utilizes a combination of p and n channel transistors forming complementary elements with a voltage swing from ground to V_{DD} (rail to rail) across a capacitive output load. A low voltage class of CMOS oscillators, operating at supply voltages of 3.3Vdc or less.

LVDS Output Logic

A type of differential output logic, called Low Voltage Differential Signaling. The oscillator output topology utilizes a constant current source differential pair with a voltage swing across an output load of 100 ohms between the complementary outputs of the oscillator.

LVPECL Output Logic

A type of differential output logic, called Low-Voltage Positive Emitter-Coupled Logic. The oscillator output topology utilizes an open collector transistor differential pair with a voltage swing into an output load of 50 ohms to $V_{DD} - 2.0V_{DC}$.

Maximum Supply Voltage

This is the highest rated value of the DC voltage supplied to a power supply pad of the oscillator. If a voltage exceeding this value is applied, degradation of characteristics or physical damage may occur.

MEMS

Acronym for Micro-Electro-Mechanical System, a technology that can be defined as miniaturized mechanical and electro-mechanical elements (i.e., devices and structures) that are made using the techniques of micro fabrication.

MEMS Oscillator

A timing device that consists of a MEMS resonator, temperature sensor, temperature compensation, and an oscillator sustaining circuit incorporated into a single package, providing an output waveform at a specified reference frequency. This term is often abbreviated as MO.

Modulation Bandwidth

The frequency, typically measured as a minimum value in kHz, at the input of the oscillator at which the output frequency deviation decreases to -3dB of its DC value for a VCXO or VCMO.

Nominal Frequency

The specified reference or center frequency of the oscillator, typically expressed in megahertz (MHz) or kilohertz (kHz). The desired frequency for which the oscillator is designed and manufactured.

OCXO

An acronym for Oven Controlled Crystal Oscillator. A type of oscillator in which the crystal is placed in a stable oven which is adjusted to a temperature where the crystal's frequency versus temperature has zero slope.

Operating Temperature Range

The minimum and maximum temperatures that a device can be exposed to during oscillation. Over this temperature range, all of the device specified operating parameters are guaranteed.

Output Control Function

An oscillator control function that enables or disables the output of the oscillator through the application of an external logic control voltage to the oscillator input control pad.

Output Current - High Level (I_{OH})

A test condition to measure V_{OH} . The current, specified in milliamps (mA), flowing into an oscillator output when the input conditions are such that the output is in a logic high state.

Output Current - Low Level (I_{OL})

A test condition to measure V_{OL} . The current, specified in milliamps (mA), flowing into an oscillator output when the input conditions are such that the output is in a logic low state.

Output Disable Current

The amount of current consumed by the oscillator when it is in its disabled mode.

Output Enable

An oscillator control function that enables or disables the output of the oscillator through the application of an external logic control voltage to the oscillator input control pad.

Output Frequency

Typically measured in MHz or kHz, the frequency of the output signal of an oscillator.

Output Leakage Current

The small amount of current that flows through the output pad of an oscillator when it is disabled and placed into a tri-state (high impedance) state.

Output Voltage Logic High and Low Levels

The DC voltage levels (V_{OH} and V_{OL}) on the output of an oscillator. The voltage level representing a zero (logic low) and a one (logic high) of an oscillator output signal.

Package

Holder used to contain the resonator and oscillator circuitry. Oscillator packaging includes materials such as metal, plastic, or ceramic, and are classified as through-hole or surface mount.

Period Jitter (Absolute)

A type of period (time domain) jitter on the output clock of an oscillator. The absolute deviation in cycle time of a clock oscillator signal with respect to the ideal period over a number of selected cycles, specified in picoseconds (pSec) as a maximum value.

Period Jitter (Cycle to Cycle)

A type of period (time domain) jitter on the output clock of an oscillator. The deviation in cycle time of a clock oscillator signal with respect to the ideal period over a number of adjacent cycles, specified in picoseconds (pSec) as a maximum value.

Period Jitter (Deterministic)

A type of period (time domain) jitter on the output clock of an oscillator. A measure of the short term frequency stability of the oscillator, this type of jitter is predictable, reproducible and bounded. The deviation in cycle time of a clock oscillator signal with respect to the ideal period over a number of selected cycles, specified in picoseconds (pSec) as a maximum value.

Period Jitter (Peak to Peak)

A type of period (time domain) jitter on the output clock of an oscillator. The absolute deviation in cycle time of a clock oscillator signal with respect to the ideal period over a number of selected cycles, specified in picoseconds (pSec) as a maximum value.

Period Jitter (Random)

A type of period (time domain) jitter on the output clock of an oscillator. The deviation in cycle time of a clock oscillator signal with respect to the ideal period over a number of selected cycles, specified in picoseconds (pSec) as a maximum value. Also called Gaussian jitter, this jitter is unpredictable, unbounded, and occurs randomly.

Period Jitter (RMS)

A type of period (time domain) jitter on the output clock of an oscillator. The one sigma deviation in cycle time of a clock oscillator signal with respect to the ideal period over a number of selected cycles, specified in picoseconds (pSec) as a maximum root mean square (RMS) value.

Phase Jitter (RMS)

Also called Offset Jitter, a time domain measurement derived from phase noise and specified in picoseconds (pSec) as a maximum root mean square (RMS) value. RMS phase jitter is the integration of the phase noise over a given offset bandwidth.

Phase Noise

A measurement of the output signal of an oscillator made in the frequency domain (-dBc/Hz), specified as the ratio of a noise power at an offset frequency away from the carrier to the carrier power in a 1Hz bandwidth.

Power Down Input Voltage (V_{IH} and V_{IL})

The maximum low-level and minimum high-level voltage applied to the input control pad of an oscillator that will power down the output of the oscillator.

PPM

The abbreviation for Parts Per Million, a method of calculation used to specify a change or deviation of the oscillator output frequency.

Quartz Crystal Oscillator

An electronic component, consisting of a quartz crystal and oscillator circuitry mounted inside a hermetically sealed package, providing an output waveform at a specified frequency. This term is also abbreviated as XO or SPXO (Simple Packaged Crystal Oscillator).

Quartz Crystal Unit

An electronic component, consisting of a resonator plate with electrodes and a hermetically sealed package with suitable mounting structures, used in frequency control applications. Quartz crystals exhibit piezoelectric properties and can be used to stabilize the frequency of an oscillator.

Reflow Profile

The reflow profile specifies the temperatures and time periods to be used when mounting electronic components onto printed circuit boards.

Rise Time

The transition time, expressed in picoseconds (pSec), from a logic low to a logic high of an oscillator output clock signal, measured at specified voltage thresholds or at specified percentages of the output waveform amplitude.

RMS Phase Jitter

Also called Offset Jitter, a time domain measurement derived from phase noise and specified in picoseconds (pSec) as a maximum root mean square (RMS) value. RMS phase jitter is the integration of the phase noise over a given offset bandwidth.

Sinewave

An oscillator output waveform described by a sine curve.

Slope

Also called the transfer function of a VCXO or VCMO, it is the direction of frequency change with respect to the control voltage. Positive slope means the output frequency increases with increasing control voltage. Negative slope means that the output frequency increases with decreasing control voltage.

SMD

An acronym for Surface Mount Device, it is a package with pads that mount to the surface of a printed circuit board.

Spread Spectrum Oscillator

Oscillators where the output frequency is primarily controlled by a MEMS or quartz resonator and an integrated complementary metal-oxide semiconductor (CMOS) circuit. Spread spectrum oscillators have the output frequency intentionally modulated in order to reduce the electromagnetic interference (EMI) on the output signal.

SPXO

An acronym for Simple Packaged Crystal Oscillator. A timing device that consists of a quartz crystal resonator and an uncompensated oscillator sustaining circuit incorporated into a single package, providing an output waveform at a specified reference frequency.

Square Wave

An alternating oscillator output voltage whose wave shape is a non-sinusoidal (square) waveform that alternates regularly and instantaneously between two DC voltage levels (V_{OH} and V_{OL}) on the output of an oscillator. The voltage level representing a zero (logic low) and a one (logic high) of an oscillator output signal.

Standby Current

The amount of current consumed by the oscillator when it is in its standby or power down mode, measured as a maximum value in microamps (μA).

Standby Function

A control function where all active circuitry within the oscillator is shut down when the voltage at the control pad is set to a logic low state. In this condition, the output of the oscillator is placed in a tri-state (high impedance) condition and the oscillator input current on the power supply line is negligible.

Start-up Time

The specified time from oscillator power-up to steady state oscillation.

Storage Temperature Range

The minimum and maximum temperatures that the device can be stored or exposed to when in a non-oscillation state. After exposing or storing the device at any temperature over this range, all of the specifications are guaranteed over the operating temperature range. Exceeding the storage temperature range may result in device failure or internal component damage.

Supply Current

The maximum operating current of the oscillator, measured as a maximum value in microamps (uA) or milliamps (mA), at the rated supply voltage.

Supply Voltage

The DC input voltage necessary for oscillator operation, specified in volts.

TCVCXO

An acronym for Temperature Compensated Voltage Controlled Crystal Oscillator. An oscillator that contains circuitry for both compensating the frequency variation according to the crystal oscillator's temperature and a voltage variable modulation circuit. Frequency modulation in the output signal is achieved by variations in the external control voltage.

TCXO

An acronym for Temperature Compensated Crystal Oscillator. An oscillator that contains circuitry for compensating the frequency variation according to the crystal oscillator's temperature.

Temperature Compensation

A technique used to stabilize the frequency of a temperature compensated crystal oscillator (TCXO) or a MEMS oscillator (MO) over a specified temperature range.

Thermal Resistance

The temperature difference that occurs between the semiconductor element within the oscillator package and the package's surface or ambient atmosphere when the device consumes one watt of power.

Through-hole Package

A package that is mounted by the insertion of pins into holes of a printed circuit board.

Transfer Function

Also called Slope, the direction the frequency changes with respect to the control voltage in a VCXO or VCMO. Positive slope means the output frequency increases with an increase in control voltage. Negative slope means that the output frequency is increasing with decreasing control voltage.

Tri-State Input Voltage (V_{IH} and V_{IL})

The maximum low-level and minimum high-level voltage applied to the input control pad of an oscillator that disables the output of the oscillator.

Tri-State Output

An oscillator control function that enables or disables the output of the oscillator through the application of an external logic control voltage to the oscillator input control pad. This feature allows the output to be placed into a high impedance state.

VCMO

An acronym for Voltage Controlled MEMS Oscillator. A type of oscillator where the output frequency of the oscillator is primarily being controlled by a MEMS resonator and a voltage variable modulation circuit. Frequency modulation in the output signal is achieved by variations in the external control voltage.

VCXO

An acronym for Voltage Controlled Crystal Oscillator. A type of crystal oscillator where the output frequency of the oscillator is primarily being controlled by a quartz crystal and a circuit voltage variable load capacitance. Frequency modulation in the output signal is achieved by variations in the external control voltage.

Warm-up Time

The time taken to reach a specified level of stability after a period of being powered down.

XO

A common acronym for Crystal Oscillator, used to refer to a crystal oscillator of fixed frequency that is not temperature compensated or voltage controlled. It is also called a SPXO (Simple Packaged Crystal Oscillator).