Crystal Oscillator

■ Terminology

The main terms used for crystal oscillators are explained as follows:

Operating temperature range:
Ambient temperature range within which the specified characteristics of a product can be achieved.

Frequency/temperature characteristics:
This means the upper and lower limits of the variation of output frequency when the ambient temperature is changed under rated conditions excluding the temperature. However, the amount of change in temperature is dependent on the normal temperature (25±2 °C).

Frequency/voltage coefficient:
This means the upper and lower limits of the variation of output frequency when the power supply voltage is changed under rated conditions excluding the power supply voltage. However, the temperature when the power supply voltage is changed is a normal temperature (25±2 °C) and the power supply voltage to be changed is a rated value.

Tristate (Standby function):
Any output circuit used for its output must be high impedance when output is OFF is installed.

Frequency adjustment range:
Frequency variation from nominal frequency shows a minimum value under rated conditions (normal temperature, rated voltage, and rated load).

Frequency control characteristic:
This shows the variable frequency amount when voltage within a specified range is applied to the frequency control input. When voltage is applied, temperature is normal temperature (25±2 °C) and power supply voltage is a rated value.

Overall frequency tolerance:
This shows the frequency stability when the relationship with temperature, power supply, load, etc. is not taken into consideration.

■ Explanation

Crystal oscillators are generally classified into four types according to the difference in the general circuit. With the addition of a new type NDK now provides five types of crystal oscillator.

(1) Simple Packaged Crystal Oscillator (SPXO)

An oscillator with no compensation or control of temperature. Generally, the AT-cut method is used for crystal units, and their frequency-temperature characteristic shows a cubic curve. The frequency-temperature characteristic of a simple packaged crystal oscillator is almost the same as that of a crystal unit, and also shows as a cubic curve.

Simple packaged crystal oscillators are mainly used as the reference oscillator of communication equipment, measuring instruments, controllers, etc. They are also used as the clock oscillator of computers, office automation equipment, information terminal devices, etc.

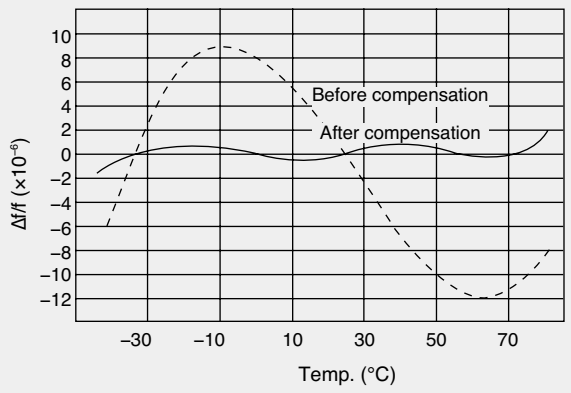

Figure 1 Example of the frequency-temperature characteristic of a temperature-compensated crystal oscillator

(2) Temperature-Compensated Crystal Oscillator (TCXO)

Temperature-compensated crystal oscillators have temperature-compensated circuits incorporated and are designed to have a satisfactory temperature characteristic across a wide temperature range.

There are two types of temperature-compensated crystal oscillators: one is combined with resistors and capacitors with thermistors used as thermo-sensitive devices, and the other is made up of temperature-compensated circuits with the devices in an LSI used as thermo-sensitive devices.

A crystal oscillator of which the temperature-compensated circuits are integrated into an LSI normally has its oscillating circuits as a whole integrated into a single-chip LSI.

Figure 1 shows an example of the temperature characteristics of a temperature-compensated crystal oscillator.

TCXO has a good temperature characteristic and its power consumption is low. In addition, it is compact and light, with a short start time. Therefore, it is used as the reference oscillator of communication devices (mobile phones, GPS, land mobile radio systems, microwave communication and satellite communication systems) and of measuring instruments, such as frequency counters and synthesizers.

A VC-TCXO (Voltage-Controlled TCXO) with an external supply voltage and the function of controlling frequencies (VC, AFC (Automatic Frequency Control) is also treated as a TCXO.

■ Explanation

(3) Voltage-Controlled Crystal Oscillator (VCXO)

A voltage-controlled crystal oscillator has variable-capacitance diodes inserted in series with a crystal unit, and the capacitance of the diodes are changed by the application of an external voltage, which causes the oscillator to develop frequency variations according to the load capacitance characteristic of the crystal unit. NDK's voltage-controlled crystal oscillators have wide-range frequency variation and satisfactory frequency linearity with the combination of the applied voltage of the variable-capacitance diodes and the capacitance characteristic and oscillation frequencies of the crystal unit all being taken into consideration. In addition, the oscillator has a wide-range frequency band of 2 to 780 MHz.

The temperature characteristics of this crystal oscillator are basically the same as that of a simple packaged crystal oscillator (SPXO), and it is the sum of the temperature characteristics of the crystal unit and the oscillating circuit that gives a cubic curve.

This is used mainly for the synchronization (PLL) and demodulation (jitter filter) of a transmitter and a switchboard.

(4) Frequency Controlled Crystal Oscillator (FCXO)

A frequency controlled crystal oscillator module allows output frequencies that are synchronized with external input standard frequencies. Ideal for frequency conversion of transmission devices and frequency synchronization.

(5) Oven-Controlled Crystal Oscillator (OCXO)

An oven-controlled crystal oscillator has a much better temperature characteristic than those of other types of crystal oscillators because the ambient temperature of its crystal unit is kept constant by a thermostatic oven.

The temperature characteristics of this crystal oscillator are determined mainly by which part of the crystal oscillator is housed in the thermostatic oven and the temperature characteristics of the oven because the temperature inside the oven is set to the temperature of the zero temperature coefficient point (inflection point of a cubic curve) of the crystal unit.

In addition, the lower limit of this oscillator's operating temperature range is determined by the maximum value of power consumption, and the upper limit is determined by the set temperature of the thermostatic oven and the thermal contribution rate of the circuit power consumption.

Generally, oven-controlled crystal oscillators in this catalogue are also known as highly stable crystal oscillators.

The crystal unit used for this oven-controlled crystal oscillator has been developed and manufactured using cutting edge technology and in an ideal environment. By using such excellent crystal units, crystal oscillators with superb frequency aging characteristics, short-term stability, frequency reproducibility, and phase noise and temperature characteristics can be manufactured. This oven-controlled crystal oscillator is best suited as the reference oscillator for various types of communication equipment such as mobile base stations, etc., and for various types of electronic measuring instruments, such as frequency counters and spectrum analyzers.