Specifying Quartz Crystals

Quartz crystals are the most technically simple product we offer, the package contains only a piece of quartz wafer, all the supporting circuitry needed to create the oscillation must be provided by the customer's circuit. The quartz wafer inside is cut and shaped to give a resonant frequency within the specified limits. Our quartz crystal part numbers all contain the code XTAL.
The electrical parameters are given on the specification to facilitate the correct circuit design. Our Application Support team can provide assistance if required; please contact one of our sales offices.
The limits given in the following specifications are indicative of the standard crystal design, in the event that a specification is needed which is outside the standard crystal designs offered please contact our Sales team.
A typical quartz crystal specification reads like this:
10.0MHz 12SMX-B
50/50/–20 to 70C/20/ FUND TE
The data in the example above is translated in the following order

- Frequency
- Model & Variant
- Frequency Tolerance @ 25°C
- Frequency Stability (over operating temperature range)
- Operating Temperature Range
- Load Capacitance
- Overtone
- Additional Text Code

Frequency

Frequency is normally specified in kilohertz (kHz) up to 999.999kHz and in megahertz (MHz) from 1.0MHz. All our computer-generated transaction documents follow this standard convention automatically.
The frequency should be described to seven significant figures. If seven significant figures are not used, we assume that any figure that might follow those given may be taken as zero. Thus a frequency given as 16.6MHz will be taken as 16.60, not 16.6666.
Some specifiers extend the use of kHz to all crystals operating in fundamental mode, reserving MHz for overtones, this method is not used by us. To minimise the possibility of misunderstanding it is best to use the standard method and specify fundamental or overtone mode separately.
Please contact one of our Sales office for details of developed frequencies.

Model

Before manufacture of the crystal can start, the model must be defined. Each model covers a frequency range which is defined in the relevant specification.
The model information should also cover any mechanical variants required such as a top wire or cropped leads.
For leaded versions, the following variants for example are available for most crystals, either singly or in some cases, in combination:

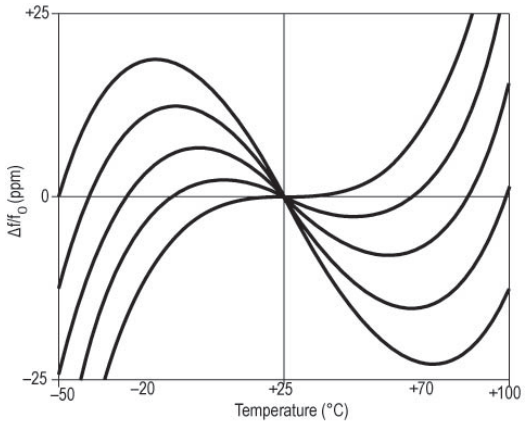
- 3 lead base
- Top wire
- Insulating sleeve
- Fitted insulator
- Cropped leads
- Formed leads
- Frequency Tolerance

The cost of manufacture depends partly on the accuracy required at reference temperature (which in the case of the AT-cut crystal, is usually 25°C).
Where high initial accuracy is important the additional manufacturing cost should be weighed against the cost of including a frequency trimming facility within the oscillator circuit design.

Typical Frequency vs Temperature Curves for various angles of AT-cut quartz crystals

Frequency Stability

Frequency stability is normally specified as a frequency variation over a defined operating temperature range with respect to the frequency at reference temperature.



The temperature ranges are defined for each crystal in the relevant data sheet. However the majority of crystals will continue to operate quite satisfactorily outside the temperature range for which they are specified, but with a possible degradation in the value of frequency stability. Under normal conditions this will not damage the crystal.
A crystal designed for operation over a restricted operating temperature range, (such as from 0 to 50°C) generally has a better frequency stability over that range than one designed for operation over a wide operating temperature range. Therefore it is important not to over specify the temperature range, as doing so will result in inferior performance for the same or greater cost; or greater cost for the same or inferior performance.
Generalised frequency vs temperature curves for the AT-cut crystal types are illustrated below. These indicate that, without compensation, a crystal specified for operation over a wide frequency range will probably have an inferior performance over a narrower range than one whose design was optimised for the narrower range. The angle of cut of the quartz blank from its quartz stone determines which curve will be followed; the chosen angle being subject to its own tolerance. Thus, since manufacturing cost is tolerance-dependent it is wise not to specify a wider operating

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temperature range than is actually needed unless some sacrifice of stability, or an increase in cost, can be accepted.

Standard Frequency Tolerances and Stabilities

±5ppm
±10ppm
±15ppm
±20ppm
±30ppm
±50ppm
±100ppm

Operating Temperature Ranges

The standard operating temperature ranges for a crystal are:

0 to 50°C
–10 to 60°C
–20 to 70°C
–30 to 80°C
–40 to 85°C
–55 to 105°C
–55 to 125°C

Load Condition

The characters 'SR' are used to denote calibration of the crystal at series resonance. If it is to be calibrated at load resonance the characters represent the circuit load capacitance in pF.

Overtone Order

Quartz crystals resonate in specific "modes" depending upon the frequency in question and oscillator circuit configuration in which it is used. The main mode of operation is called "fundamental". i.e. a 10MHz crystal vibrates at a frequency of 10MHz
However for high frequency use, quartz crystals can be made to operate at odd multiples of its fundamental frequency.
These multiples are termed "overtones" and are denoted by their multiple as: 3rd , 5th, 7th, 9th. e.g. a 10MHz crystal can be made to operate at its 3rd overtone which is approximately 3 times its fundamental frequency.
If an overtone mode crystal is chosen then the circuit design must include the relevant components required to suppress the fundamental mode of operation to ensure oscillation at the intended frequency.
Where there is a cross-over band in the modes available, the mode required must be specified when ordering. For general use and simplicity of circuit design we recommend that fundamental mode be chosen where possible.

Additional Text Code

If the product is non-standard, the letter 'T' will appear at the end of the product specification. This refers to additional text on the data sheet to identify the non-standard elements of the specification.

Packaging Codes

These are given directly after the part number for example LFXTAL012345Bulk and LFXTAL012345Reel are the same part packaged either loose in bulk pack or on tape and reel. Tray packaging is available as an option for some products outlined in the individual data sheets.
Unless individual data sheets state Bulk packaging, surface mount versions will be Tape & Reel packed. Please note: only complete reels are sold. Sample quantities are avialable on request

Bulk = Bulk packed
Reel = Tape and reel packed
Tray = Tray packed (option for some products)

Outline Drawings

All dimensions are shown in mm and are nominal unless otherwise stated.

Marking

Due to the small size of modern SMT devices many components are now not marked with any customer readable information beyond the pad 1 denominator. In these cases the marking will be production specific data.

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