OVERTONE CRYSTAL

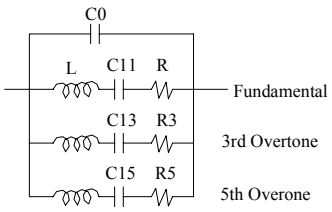

Figure 8

The C_1 value can be changed for a particular resonant frequency by varying the electrode area. The range of variation of the electrode area depends on the diameter of the quartz element.

FORMULAS

Rs = Series Resistance = $\frac{2\pi frL_1}{Q}$

Fr = (Series) Frequency = $\frac{1}{2\pi\sqrt{L_1C_1}}$

C1 = Motional Capacitance = $\frac{2\Delta f}{fs}(C_0 + CL)$

L1 = Motional Inductance = $\frac{1}{4\pi^2 fs^2 C_1}$

C0 = Shunt Capacitance = $\frac{fsC_1}{2\Delta f} - C_1$

Q = Quality Factor = $\frac{2\pi fsL_1}{R_1} = \frac{1}{2\pi fsC_1R_1}$

Δf = Change in Frequency = $\frac{fsC_1}{2(C_0 + CL)}$

(Series to Parallel)

CL = Load Capacitance = $\frac{fsC_1}{2\Delta f} - C_0$

APPLICATION NOTES

Selecting a crystal for a micro controller

1.0 Purpose:

This application note describes the selection of a crystal used with any type of micro controller that accepts a parallel mode, AT or BT cut crystal, fundamental or third-overtone mode.

2.0 Functionality and comparability:

Unless otherwise specified in the micro controller data sheet, this application note can be used as a general guidance in the selection of a crystal which can be used with many leading manufacturers of micro controllers.

3.0 Circuit description:

Most micro controllers include an inverter design with a positive feedback resistor (typical 1 MΩ) with an optional series resistor with value varied from 10Ω to 1kΩ (see figure 9).

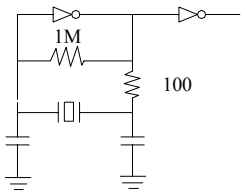

Figure 9

The micro controller has an input port (normally called XIN, XTAL) and an output port (XOUT, XTALO) for crystal connections between those two ports. Most chips are designed with an option either driven by an external clock oscillator fed to the crystal input port, or with an external crystal. Depending on frequency, crystals can be selected as fundamental or an overtone mode. Normally, frequencies above 30 MHz requires the third overtone mode for price advantage and delivery. In parallel mode, where the crystal reactance is inductive, two external capacitors C_1 and C_2 are required for a necessary phase shift in oscillation. C_1 and C_2 are needed whether the crystal is in fundamental mode or overtone mode. Values of C_1 and C_2 are specified by the chip manufacturer and vary from 6pF to 47pF. C_1 and C_2 may not be balanced, i.e., equal in value, but sometimes are offset in a particular ratio (C_1/C_2) for best performance, depending on crystal and amplifier characteristics and board lay-out. Figure 10 shows a typical configuration for a fundamental mode operation.

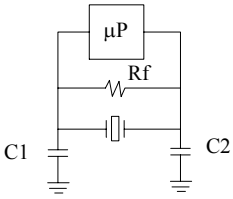

Figure 10

In an overtone mode, an additional inductor L_1 and capacitance Cc is required to select the third-overtone mode while suppressing or rejecting the fundamental mode. Choose L_1 and Cc component values in the third overtone crystal circuit to satisfy the following conditions:

•The L_1Cc components from a series resonant circuit at a frequency below the fundamental frequency, which makes the circuit look inductive at fundamental frequency. This condition does not favor to oscillation at fundamental mode.