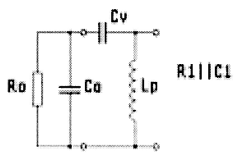
QuartzCom
the communications company

Terminating impedance

Monolithic crystal filters need - as all passive filter networks - for their correct function special terminating impedances, which are specified in the specifications as R1, C1, R2 and C2. These values have to be realized by the customer in the device. The terminating impedances are the impedances presented to the filter by the source or by the load, and they described the resistive portion and the parallel capacitive portion including stray capacitance.
If these values are not conform with the specification, the ripple in pass band or/and the center frequency will be out of the tolerance and the group delay distortion increases. The customer should pay attention to this point at the design of the device! The terminating impedances of monolithic crystal filter can be influenced by the filter design. The value depends on the electrode areas, thus the region is limited. Therefore we produce filter with internal transformer networks and can realize for example terminating impedances of 50 Ohm, but the package is greater and the filter is more expensive. If there is a problem at the adaption, the following transformer networks can be used:

1. Network for smaller device impedance



Ro < R1
$\omega = 2\pi$ fo   fo....nominal center frequency

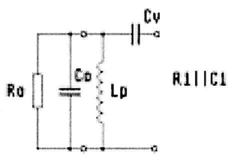
1.1 Conversion of the parallel network Ro||Co into a serial:

$$Ros = \frac{Ro}{1+(\omega CoRo)^2} \qquad Cos = Co\left(1+\frac{1}{(\omega CoRo)^2}\right)$$

1.2 Computing the values of Cv and Lp:

$$Lp = \frac{1}{\frac{\omega\sqrt{Ros(R1-Ros)}}{RosR1} - \omega^2 C1} \qquad Cv = \frac{1}{\omega\sqrt{Ros(R1-Ros)} - \frac{1}{Cos}}$$

2. Network for larger device impedance



Ro < R1
$\omega = 2\pi$ fo   fo....nominal center frequency

2.1 Conversion of the parallel network Ro||Co into a serial:

$$G1s = \frac{1+(\omega C1R1)^2}{R1} \qquad C1s = C1\left(1+\frac{1}{(\omega C1R1)^2}\right) \qquad Go = \frac{1}{Ro}$$

2.2 Computing the values of Cv and Lp:

$$Lp = \frac{1}{\omega\sqrt{Go(G1s-Go)} + \omega^2 Co} \qquad Cv = \frac{1}{\frac{\omega\sqrt{Go(G1s-Go)}}{GoG1s} + \frac{1}{C1s}}$$

Note: The Q-factor of the coils is not taken into consideration!
You can do it by computing the coil-parallel resistance and the resulting R1 or Ro

Group delay distortion
The attenuation of a filter is a function of the frequency variable f depending on pole number and resonance frequencies of the filter system. The group delay is also a function of f and depends on the same parameters. Both are influenced by the filter design, but not independent of one another. Thus, filter with optimum attenuation have a relative high group delay distortion and filter with flat group delay a bad attenuation.
Our phase linear filter are designed in such a way, that group delay only in pass band is flat and the attenuation is Gaussian, but without pass band both, attenuation and group delay, increase. In our design we can find a customer-optimum compromise.

QuartzCom AG
sales@quartzcom.com
QuartzCom Asia
sales-asia@quartzcom.com
QuartzCom USA, Inc.
sales-usa@quartzcom.com
www.quartzcom.com