**Design Routine for Contoured AT-Cut Resonators**

John H. Sherman, Jr.
2002 Woodcrest Drive
Lynchburg, VA 24503
(804) 384-2403

Errata

Two errors in this paper, which is found between pages 131 and 138 of the proceedings of the Fifth Quartz Crystal Conference, are corrected.

Equation 1 should read:

\[ f_{100} = \sqrt{\frac{106}{4\rho}} \left( 1 + 0.53 \frac{E}{\sqrt{R}} \right) \]  

(1)

This is to be compared with Equation 8.

Equation (15) and accompanying text is corrected and rewritten as follows:

\[ R' = \text{Req} \left( 1 - \exp \left( n \frac{\text{Re}}{t} \right)^2 \right) \left( \frac{t}{R} \right)^{\frac{3}{4}} \]  

(15a)

**Requantulation of Design Equations:**

**Plano Convex Equations**

Central Thickness:

\[ ft = 1.661 \times 10^6 (n + 0.49) \left( \frac{t}{R} \right)^{\frac{3}{4}} \]

Minimum Diameter:

\[ D \geq 4.5 \left( \frac{R}{n^2 t} \right)^{\frac{3}{4}} \]

Maximum Diameter:

\[ D \leq 2(2R - t)^{\frac{3}{4}} \]

Edge Thickness:

\[ Te = t - R \left( 1 - \left[ 1 - \left( \frac{t}{2R} \right)^2 \right] \right) \]

Static Capacitance:

\[ C_0 = 0.2526 \times 10^{-12} \frac{\text{arcmin} (D/2R)}{\text{Rain 88A}} \left[ \cos \theta - (1 - t/R) \right] \]

Motional Capacitance:

\[ \text{Req} = 1.53 t \left( \frac{R}{n^2 t} \right)^{\frac{3}{4}} \]

\[ R' = \text{Req} \left( 1 - \exp \left( n \frac{\text{Re}}{t} \right)^2 \left( \frac{t}{R} \right)^{\frac{3}{4}} \right) \left( \frac{t}{R} \right)^{\frac{3}{4}} \]

\[ C_1 = 3.96 \times 10^{-22} R^2 t / n^2 \]

Inharmonic Frequencies:

\[ f_{n02} = f_{n00} \left( 1 + \frac{0.88 E}{n \sqrt{R}} \right) \]

\[ f_{n20} = f_{n00} \left( 1 + \frac{1.11 E}{n \sqrt{R}} \right) \]

Orientation Adjustment:

\[ \Delta \theta = 220t/R + 8.5 \left[ 1 - \exp \left( -11t/R \right) \right] \]

**Double Convex Equations**

Central Thickness:

\[ ft = 1.661 \times 10^6 (n + 0.49) \left( \frac{2t}{R} \right)^{\frac{3}{4}} \]

Minimum Diameter:

\[ D \geq 4.5 t \left( \frac{R}{2n^2 t} \right)^{\frac{3}{4}} \]

Maximum Diameter:

\[ D \leq 4R - t \left( \frac{3}{4} \right) \]

Edge Thickness:

\[ Te = t - 2R \left( 1 - \left[ 1 - \left( \frac{t}{2R} \right)^2 \right] \right) \]

Static Capacitance:

\[ C_0 = 0.1263 \times 10^{-12} \frac{\text{arcmin} (D/2R)}{\text{Rain 88A}} \left[ \cos \theta - (1 - t/2R) \right] \]

Motional Capacitance:

\[ \text{Req} = 1.53 t \left( \frac{R}{2n^2 t} \right)^{\frac{3}{4}} \]

\[ R' = \text{Req} \left( 1 - \exp \left( n \frac{\text{Re}}{t} \right)^2 \left( 2t/R \right)^{\frac{3}{4}} \right) \left( 2t/R \right)^{\frac{3}{4}} \]

\[ C_1 = 3.96 \times 10^{-22} R^2 t / n^2 \]

Inharmonic Frequencies:

\[ f_{n02} = f_{n00} \left( 1 + \frac{1.24 E}{n \sqrt{R}} \right) \]

\[ f_{n20} = f_{n00} \left( 1 + \frac{1.56 E}{n \sqrt{R}} \right) \]

Orientation Adjustment:

\[ \Delta \theta = 440t/R + 17 \left[ 1 - \exp \left( -11t/R \right) \right] \]