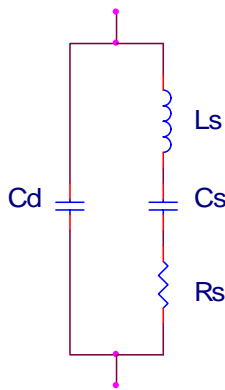


APPLICATION NOTE – AP050913

Equivalent Circuit of Ultrasonic Transducers

The equivalent circuit of piezoelectric ceramic ultrasonic transducer is similar as the well-known crystal, which is composed of a series branch of L_s , C_s and R_s and a parallel branch of C_d .



The values can be simply obtained from calculation of the impedance data.

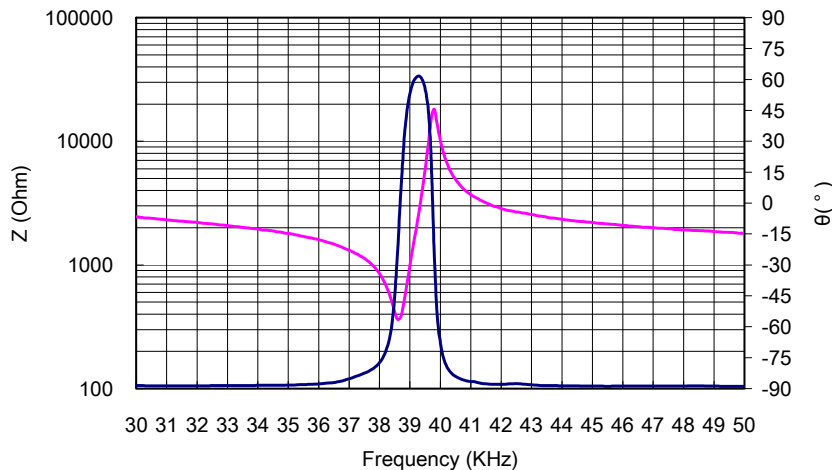
C_d : Clamping Capacity, measured at the frequency far away from resonant frequency, which approximates to static capacity.

L_s : Equivalent Inductor = $1/(4 \pi^2 f_s^2 C_s)$

C_s : Equivalent Capacity = $C_d * [(f_p^2/f_s^2)-1]$

R_s : Real part of the impedance at resonant frequency

A transducer of model 400ER250 has impedance characters shown as below.



$f_s = 38.6 \text{ KHz}$
 $f_p = 39.8 \text{ KHz}$
 $Z_{f_s} = 362 \text{ Ohm}$
 $\theta_s = -22.8^\circ$
 $Z_{f_p} = 18200 \text{ Ohm}$
 $C_d = 2430 \text{ pF}$

Impedance (Z) at resonant frequency of 38.6 KHz is 362 (-22.8°) .

$C_s = 2430 * [(39.8^2/38.6^2)-1] = 153.4 \text{ pF}$

$L_s = 1/[4 * 3.142 * 38600^2 * (153.4/1000000000000)] = 6.99 \text{ mH}$

$R_s = 362 * \cos(-22.8^\circ) = 333.7 \text{ Ohm}$