Consideration on Unloaded Q-factor of Guided Wave Type Resonators

Futoshi Kuroki[(1)] and Yoshihiko Kamo*[(1)]
(1) National Institute of Technology, Kure College, Kure, 7378506, Japan,
kuroki@kure-nct.ac.jp

Generally, Q-factors of transmission lines are expressed by the wave-number of k in media, the transmission loss of α, and the phase constant of β as given by $Q = \frac{k}{2\alpha}\frac{d\beta}{dk}$. This expression is usually applied to discuss the unloaded Q factor of the guided wave type of resonator, however it is to pay attention to treating the expression. Having this fact in mind, a few notes of caution were discussed in this paper. At first, the Q-factor of the coaxial cable as shown in Fig.1 and the unloaded Q-factor of the half-wavelength coaxial line resonator with both ends short-circuited were calculated and the results are shown in Fig. 2 as dotted and solid curves, respectively. The diameters of the outer and inner conductors were 1.31 mm and 0.4 mm and the dielectric filling was assumed as PTFE with a relative permittivity of 2.04 and a loss tangent of 1.5×10^{-4}. The material of the outer and inner conductors and the short-circuited planes was set to be the copper with a conductivity of 5.8×10^{7} S/m. From these results, the Q-factor of the coaxial cable was agreed with the unloaded Q-factor as the operational frequency was less than MHz frequencies, while that differed with the unloaded Q-factor at high frequency regions. Assuming the short-circuited planes to be the perfect conductor, the Q-factor was theoretically identical with the unloaded Q-factor. Next, this consideration was applied into the tri-plate line resonator with both ends terminated by reactance planes. In this structure, the Q-factor was agreed with the unloaded Q-factor even higher frequency region. From these results, it is verified that the unloaded Q-factor can be evaluated by the Q-factor of the transmission line when the dissipation loss of the both ends of the resonator can be negligible. This condition can be realized by using the resonator with both ends terminated by reactance planes or open-circuited. In other words, it should be to pay attention to discuss the unloaded Q-factor of resonators with lossy termination using the Q-factor of the transmission line.

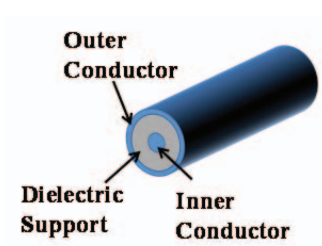

Fig. 1. Structure of coaxial line resonator.

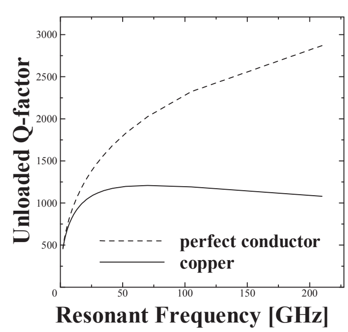

Fig. 2. Calculated Q-factor of coaxial line and unloaded Q-factor of coaxial line resonator with short-circuited both truncated ends.