The motional impedance as a unique characteristic of the anti-reciprocal system

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Abstract

We investigate a classical notion named ‘Motional impedance (Z_{mot})’ introduced by Kennelly in 1912 which was explored by many other researchers early in the 20th century. The Z_{mot} refers to components of the input impedance that depends directly on changing output load conditions. Its unique characteristics can be explained by the anti-reciprocal nature of an electro-mechanical system along with a gyrator having the negative real parts (resistance). The shunt eddy current loss on the electrical side of the system is one possible source of this negative real parts of Z_{mot}. Note that the gyrator represents the anti-reciprocity. Unlike in general impedances, Z_{mot} is just a type of transfer function, not a minimum-phase nor a positive-Real (PR) function. By taking a Balance Armature Receiver (BAR) as a specific example of the electro-mechanical systems, this study puts BAR’s physics on both the empirical and theoretical basis.

Conclusions

The Z_{mot} reflects a purely mechanical behavior, a resonance, when it is looked at electrical side, thus it has a circular shape. And we have shown that the nature of anti-reciprocity makes a loop in the impedance of the electro-mechanical system by applying the mobility analogy with a gyrator which represents an anti-reciprocal characteristic.