Intrinsically-Switched Filters and Applications

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Filters are essential components in a wide range of microwave systems, and a single filter's performance can a have a very large impact on the performance of a system. For example, filters are often needed before the LNA in the RF path of a receiver to define the frequency band of operation and to protect the LNA from large out-of-band interferers. However, the insertion loss of the filter will significantly degrade the noise figure (and thus the sensitivity) of the receiver when used in this way, and so it must be kept to a minimum. Also, in order to meet the needs of future frequency-agile systems there is a strong need for high-performance filters possessing at least some degree of reconfigurability. Intrinsically-switched filters have been recently developed to address this need.

Intrinsically-switched filters are multi-function devices that combine the functionality of filters and switches while providing superior performance compared to conventional designs. Intrinsically-switched tunable filters are switched on and off using the tuning elements that tune their center frequencies and/or bandwidths, without requiring an increase in the tuning range of the tuning elements (i.e., the filter is not simply tuned out of the band of interest). Since the insertion loss of a tunable filter is proportional to its tuning range, this means that the switching function is essentially achieved for free, without the insertion loss penalty that comes with the use of a separate discrete switch. The tuning elements can be continuously tunable (e.g. varactors) or discretely tunable (e.g. switched-capacitor banks). Intrinsically-switched bandpass and bandstop filters have been developed, and each uses distinct switching mechanisms. Intrinsically-switched bandpass filters utilize the cancellation of coupling between resonators to realize the high-isolation bandpass off state, while intrinsically-switched bandstop filters utilize the constructive interference between two signal paths to realize the low-insertion-loss bandstop off state.

One of the more exciting applications of intrinsically-switched filters is their use in switched filter banks. Tunable filter bank configurations are used to realize tunable filters with wide tuning ranges while keeping passband insertion loss to minimum. As the number of filters in the bank is increased for a given total tuning range, the tuning range for each individual filter decreases, resulting in a decrease in insertion loss. Since switches are not needed, switched tunable filter banks using intrinsically-switched filters have the potential to be much lower loss compared to conventional switched tunable filter banks.