A Wideband Superconducting Filter with Harmonic Rejection for L Band Receivers

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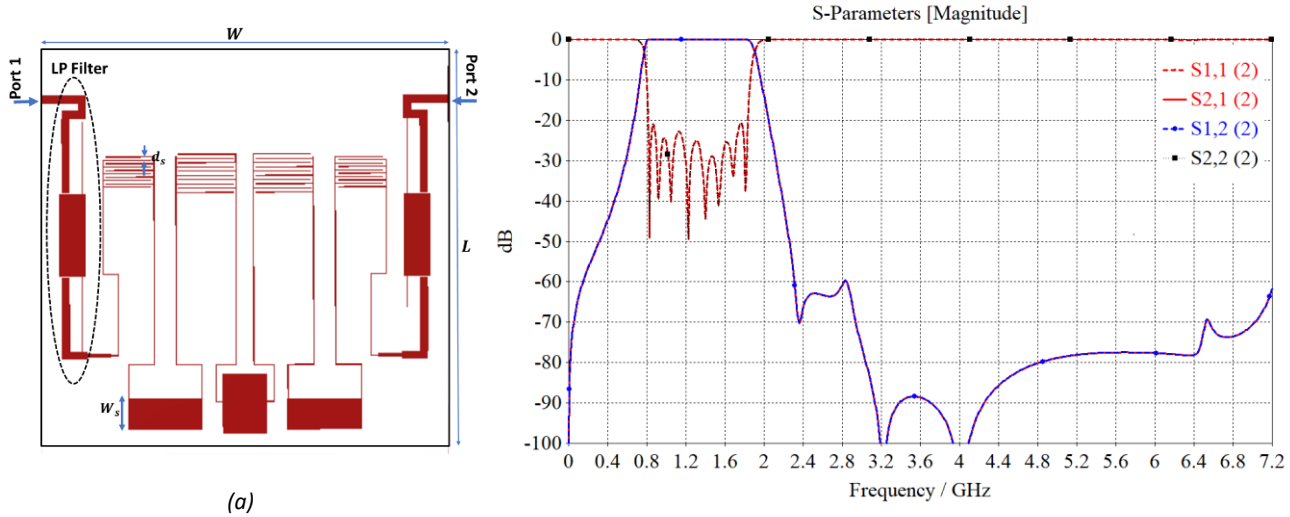
High-temperature superconductive filters, with their attractive performance such as small insertion loss, steep skirt slope, and high out-of-band rejection have found widespread application in radio astronomy, third generation (3G) mobile communications, meteorological, and satellite communications [1]. The Q factor of these filters can reach hundreds of thousands, owing to the HTS material's surface resistance which is 100-1000 times lower than that of conventional metals like copper and gold at microwave frequencies. HTS devices are typically operated between 40-77 K which makes them good candidates for filters used in radioastronomy cryogenic receivers.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is involved in upgrading the receiver of the DSS-43 station in the Canberra Deep Space Communication Complex [2] near Canberra. This wideband receiver will be located in the vicinity of other stations with high-power transmitters at 2.1 and 7.14 GHz. Therefore, wideband low-loss HTS filters are required before the LNAs. These filters require a steep band edge slope, high out-of-band rejection and the lowest insertion loss possible.

Coupled resonators [3] and Multimode resonators (MMRs) [4] have been utilized to enhance the bandwidth of the filters. To avoid the complexity associated with MMR filters and achieve higher out-of-band rejection, new design approaches have been explored in this paper. The filter is constructed as a bandpass filter designed using Quarter-wavelength resonators that integrate interdigital capacitors and capacitive open-ended stubs for internal coupling strength (Fig. 1(a)). The wideband pass design is inspired by the filter proposed in [3]. To mitigate the third harmonic of the bandpass filter without significantly affecting the filter profile or introducing additional loss, a proposed LP filter with a cutoff frequency of 2.5 GHz depicted in Fig. 1(a) is integrated at the input and output of the bandpass filter. This LP filter is constructed using a commonly used stepped impedance microstrip low-pass structure and two folded open stub lines. The final structure is designed on an MgO substrate with a permittivity of 9.68, featuring PEC as the conductive parts, and having the overall dimensions of 25mm × 25mm. In Fig. 2(b), the S parameters of the bandpass filter show an insertion loss better than 0.05 dB and a return loss exceeding 22 dB.



(a) *(b)*

Fig. 1: (a) Microstrip layout, and (b) Simulated S parameters of the proposed BP filter with second harmonics suppression.

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