As no benchmark exists for the comparison of idlers, a microstrip line shunt stub idler with quarter-wavelength at LO frequency (Figure 11) was designed and optimized. The size of the idler is 1.2 mm x 1.7 mm. Table 2 shows a comparison between the two realization approaches. The proposed idler occupies almost one-fifth lesser board area when compared to the microstrip line idler layout. The improved lumped component idler was used to realize the 6X I-Q Mixer. On-wafer measured up-conversion loss (Figure 12) of the 6X mixer was 15.5 dB with 29 dB of side band rejection and 62 dB LO to RF isolation. Size of the chip is 3.2 mm x 2.6 mm. This conversion efficiency and compact size was possible only due to the compact idler design.

Table 2. Comparison of the proposed improved lumped component based idler with microstrip line based idler

Parameter	Microstrip line Idler	Improved lumped component idler
Insertion loss at 3 GHz	0.1 dB	0.4 dB
Return loss at 3 GHz	42 dB	24 dB
Rejection at 100 MHz (IF)	23 dB	19 dB
Rejection at 6 GHz (2X)	27 dB	24 dB
Rejection at 12 GHz (4X)	23 dB	22 dB
Rejection at 18 GHz (6X)	21 dB	23 dB
Size	1.2 mm x 1.7 mm	0.5 mm x 0.75 mm (5 times lesser)

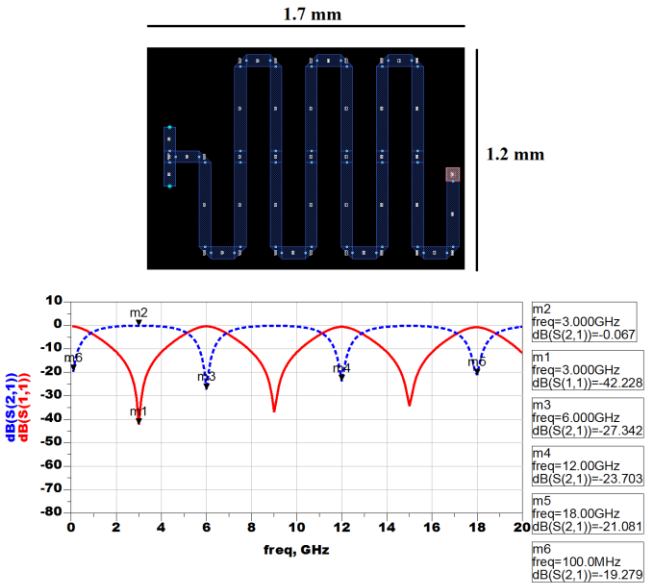

Figure 11. Layout of optimized microstrip line quarter-wave length short stub at 3 GHz and its simulated S-parameter response.

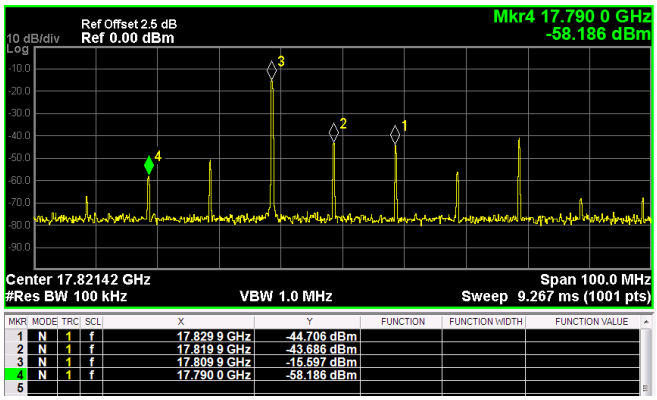

Figure 12. On-wafer measured results of the 18 GHz 6X I-Q Mixer; LO input is 2.97 GHz at +19 dBm, I/Q input is 10 MHz at 0 dBm.

4. Conclusions

In this work, two techniques for realizing low loss and better rejection lumped component idlers have been proposed and demonstrated for 3 GHz LO frequency idler. Using both the techniques together, a multi-frequency idler was designed. The designed idler shows comparable results with microstrip line based idler that tends to be larger in area at lower frequencies. Due to its compact size, the designed idler can be comfortably utilized for realizing complex RF ICs like I-Q mixers in lesser chip area for much higher harmonic mixing and multiplication; ensuring good conversion efficiency at optimal LO power owing to its lower insertion loss.

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