INDIAN INSTITUTE OF SCIENCE, BENGALURU

DEPARTMENT OF ELECTRONIC SYSTEMS ENGINEERING

DESIGN FOR ANALOG CIRCUITS LABORATORY REPORT

ASSIGNMENT 12

GYRATOR BASED CIRCUITS

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1.1 Single Op-Amp Gyrator

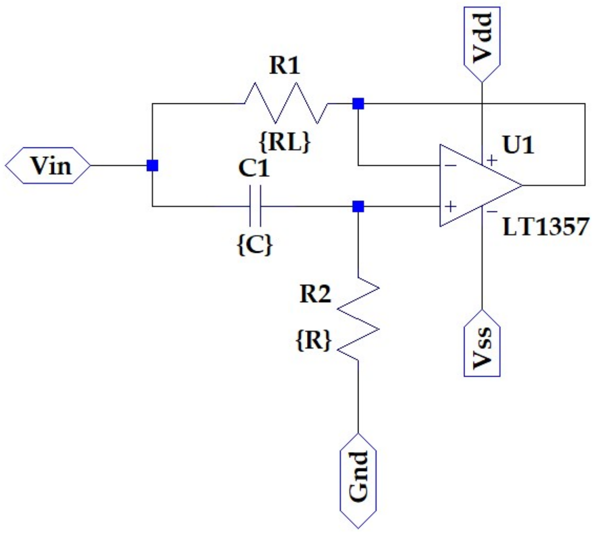

Figure 1: LTSpice Schematic of single op-amp gyrator

The input impedance of the gyrator shown in figure 1 is given by

$$Z_{in} = R_L + j\omega RCR_L$$

assuming ideal opamp and $R_L << R$. For obtaining a $22H$ inductor with a series resistance of 100Ω, $R_l = 100\Omega, C = 0.22\mu F, R = 1M\Omega$ is chosen.

1.2 Frequency Response - Single Op-Amp Gyrator

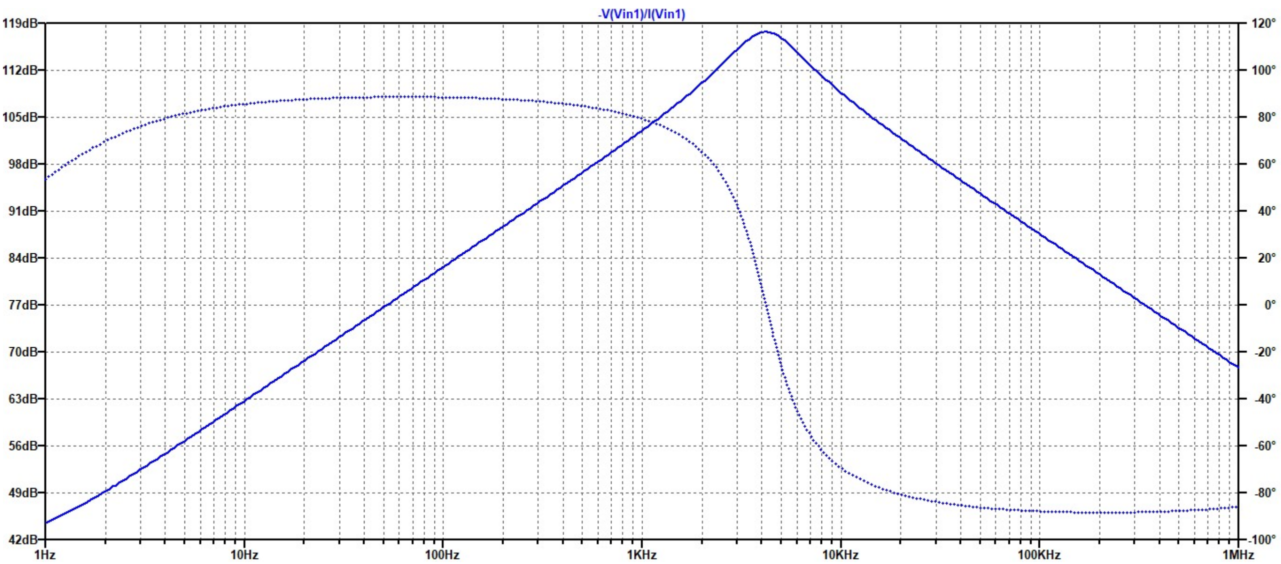

Figure 2: Frequency response of single op-amp gyrator

The figure 2 above shows the frequency response of the $22H$ inductor with a series resistance of 100Ω designed using the single opamp gyrator.

1.3 Double Op-Amp Gyrator

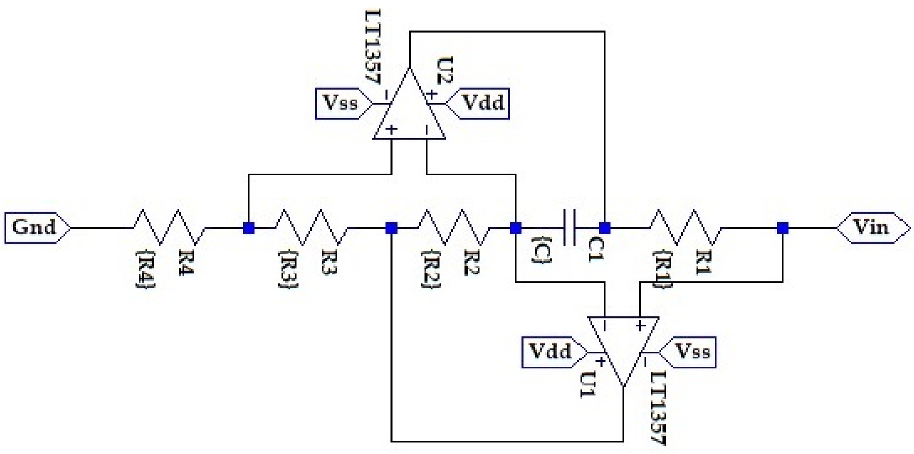

Figure 3: LTSpice Schematic of double op-amp gyrator

The input impedance of the gyrator shown in figure 3 is given by

$$Z_{in} = \frac{j\omega C R_1 R_2 R_4}{R_3}$$

assuming ideal op-amp. For obtaining a $2.5332mH$ inductor, $R_1 = R_2 = R_3 = R_4 = 1k\Omega, C = 2.5332nF$ is chosen; whereas for obtaining an $83mH$ inductor C is changed to $83nF$.

1.4 Frequency Response - Double Op-Amp Gyrator

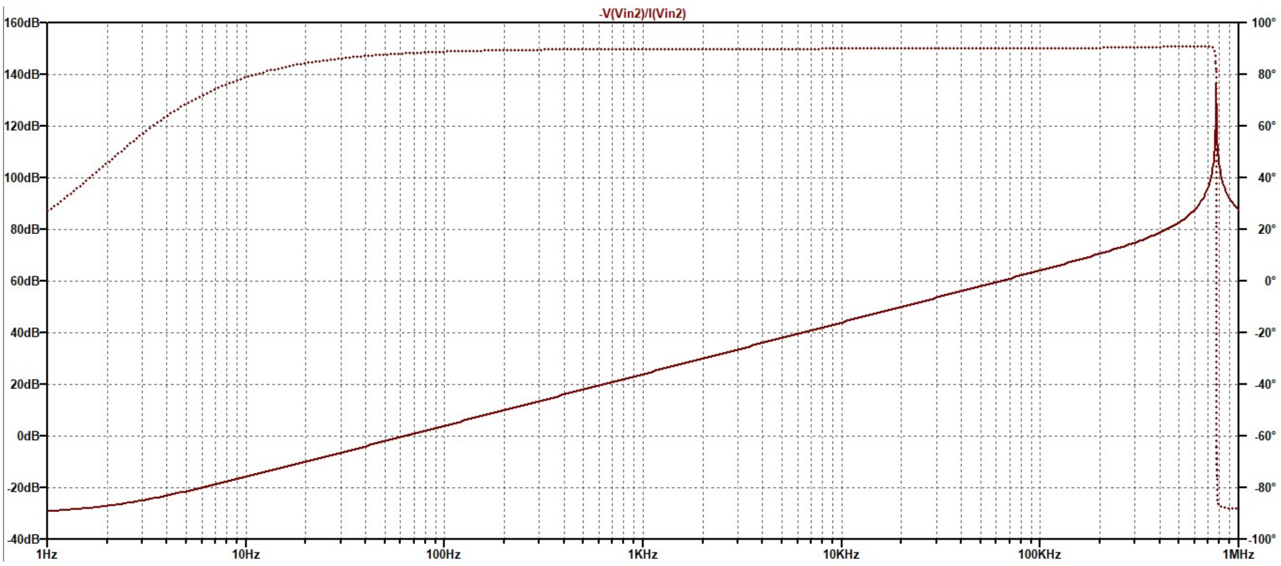

Figure 4: Frequency response of double op-amp gyrator

The figure 4 above shows the frequency response of the $2.5332mH$ inductor designed using the doublele opamp gyrator.

2 Parallel Resonant Circuits

2.1 Aim

To design and perform frequency response simulation of parallel resonant circuits designed using inductor and gyrator and compare the results.

2.2 Schematic

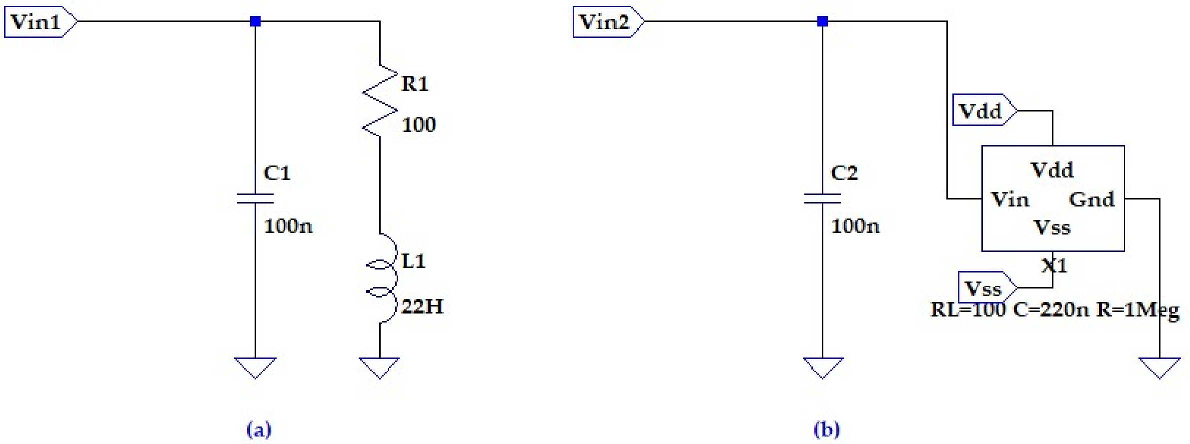

Figure 5: LTSpice Schematic of parallel resonant circuits (a) with inductor, (b) with gyrator

2.3 Frequency Response

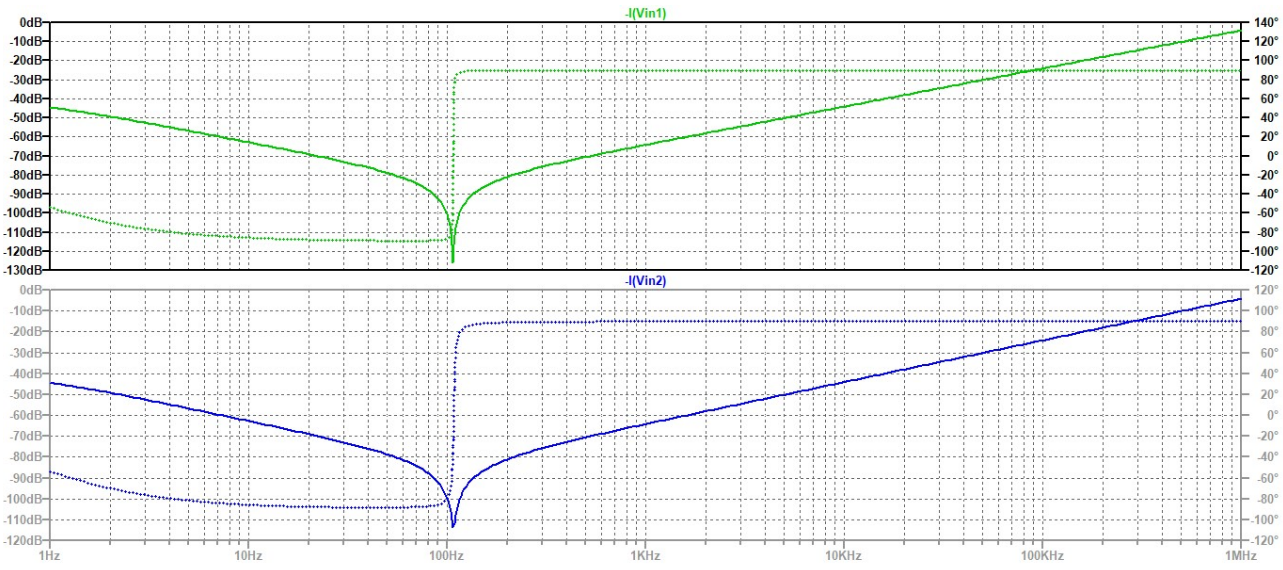

Figure 6: Frequency response of parallel resonant circuits

The figure 6 above shows the frequency response of the parallel resonant circuits (current drawn from the voltage source). The resonant peak is obtained at $107.52Hz$ for both the circuits.

3 Band Pass Filter Circuits

3.1 Aim

To design and perform frequency response simulation of band pass filter circuits designed using inductor and gyrator and compare the results.

3.2 Schematic

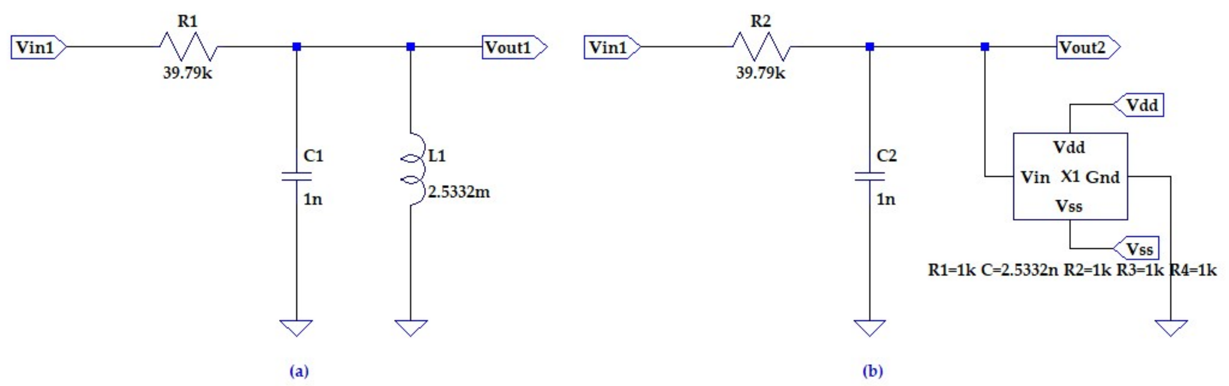

Figure 7: LTSpice Schematic of band pass filter circuits (a) with inductor, (b) with gyrator

3.3 Frequency Response

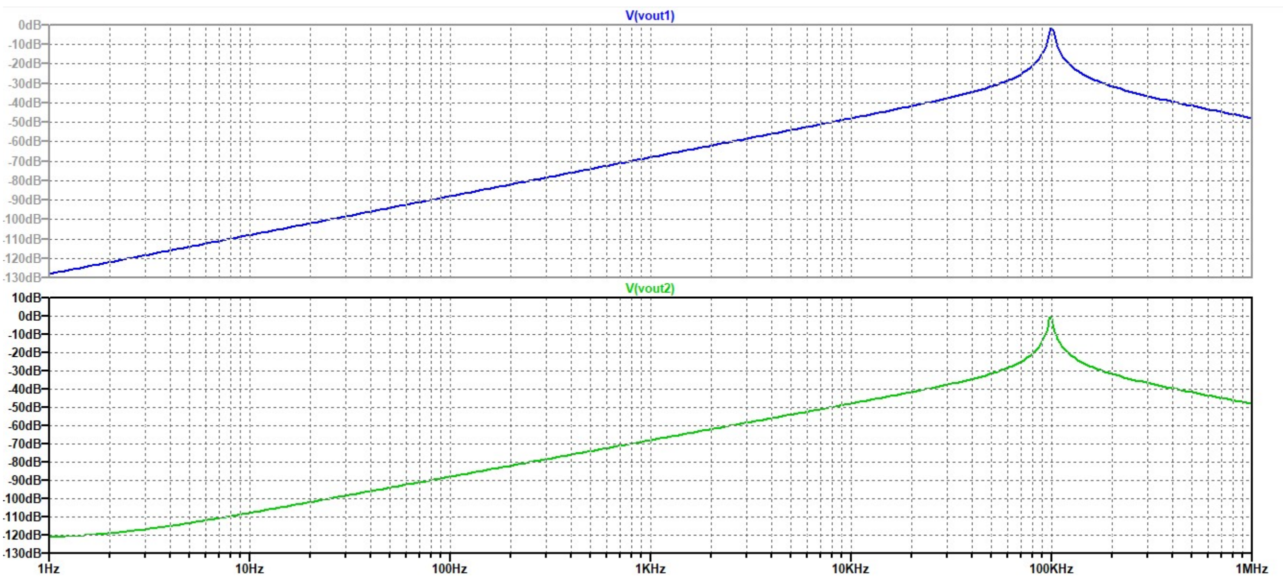

Figure 8: Frequency response of band pass filter circuits

The figure 8 above shows the frequency response of the parallel resonant circuits (current drawn from the voltage source). The resonant peak is obtained at $101.11kHz$ for the inductor based circuit and $98.9kHz$ for the gyrator based circuit.

4 VLF Receiver

4.1 Aim

To design and perform frequency response simulation of VLF Receiver circuits designed using inductor and gyrator and compare the results.

4.2 Schematic

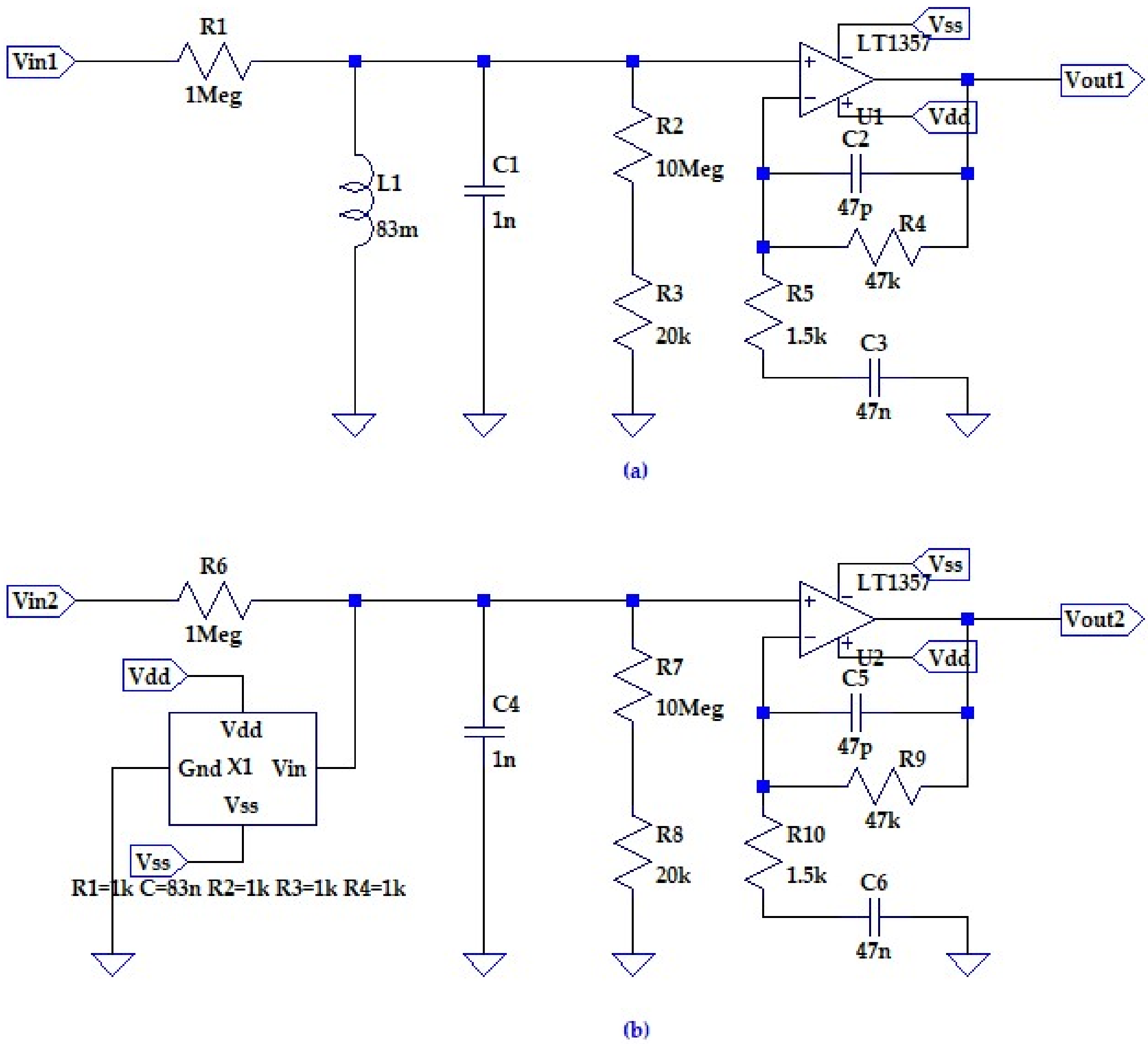

Figure 9: LTSpice schematic of VLF receiver (a) with inductor, (b) with gyrator

4.3 Frequency Response

The figure 10 shows the frequency response of the VLF receiver circuits. The resonant peak is obtained at $17.41kHz$ for the inductor based circuit and $17.29kHz$ for the gyrator based circuit.

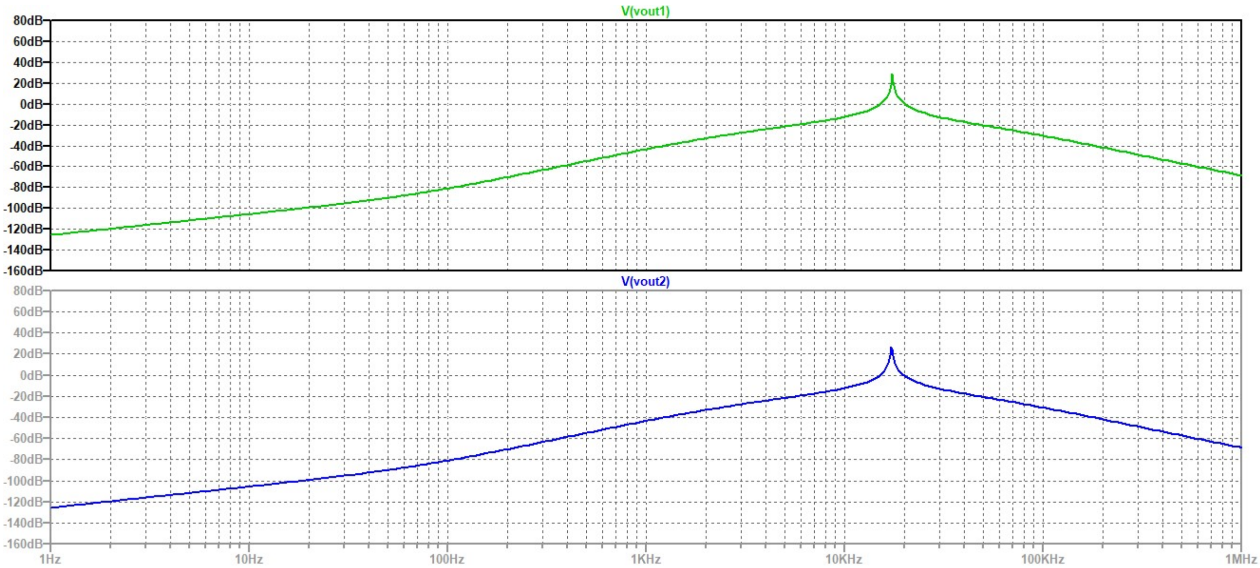

Figure 10: Frequency response of the VLF receiver circuits

4.4 Conclusions

(1). The gyrator circuits can be used to emulate inductors of high value as shown in the filter and receiver circuits, as inductors of high value can be very bulky and costly.

(2). The gyrator finds application only in low frequency applications, where the frequency of interest is well below the op-amp bandwidth.

(3). The two opamp gyrator can also be used to design Frequency Dependent Negative Resistors (FDNR), which can be used to design filter circuits without using inductors.