Introduction

In many circumstances, it is desirable to operate a resonator circuit at high impedance to obtain better loaded Q characteristics. This impedance transformation may be accomplished by tapping either the inductor or capacitor in the resonant circuit. This short report compares the modeled performance of the tapped-capacitor system to a known tapped-inductor system in a 7-MHz bandpass filter[1]

Figure 1 illustrates the equivalent circuit of a tapped-capacitor resonator. Equations 1 and 2 can be used to determine the characteristics of a resonator for a given capacitor tap point.

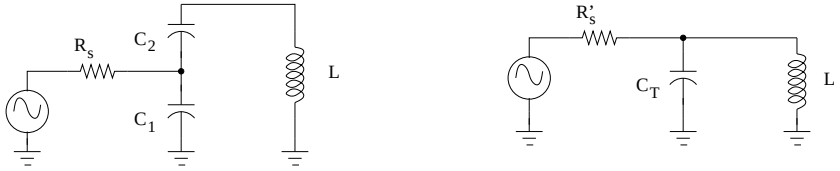

Figure 1: Basic equivalent circuit models for tapped-capacitor resonator

$$R_s' = R_s \left(1 + \frac{C_1}{C_2}\right)^2 \tag{1}$$

$$C_T = \frac{C_1 C_2}{C_1 + C_2} \tag{2}$$

Design

In the Wetherhold designs, the filter input and output resonators (1 and 4) are the ones that benefit most from being operated at high impedance. We can accomplish the capacitance tap by modifying the circuit to look like Figure 2. Notice that the impedance transformation occurs *only* for the input and output resonators.

For the 7-MHz filter, we know that we want $R_s' = 25R_s$ because a quintifilar ($\gamma = 5$) winding is specified for the tapped inductor. If we let $C_1 = C_T$, simultaneous solution of Equations 1 and 2 yields the values of C_{1a} and C_{1b} in Equations 3 and 4. The same equations work for Resonator 4, as well. Table lists the component changes made to the original W3NQN design for the tapped-capacitor resonators.

$$C_{1a} = \frac{\gamma}{\gamma - 1} C_1 \tag{3}$$

$$C_{1b} = (\gamma - 1) C_{1a} = \gamma C_1 \tag{4}$$

[1] E. Wetherhold, W3NQN. "Receiver Band-Pass Filters Having Maximum Attenuation in Adjacent Bands," *QEX*, Jul/Aug 1999, pp 27–33.

4-194 EE/CSci Building – 200 Union St SE – Minneapolis, MN 55455
Cell: 330.231.3671 — Office: 612.624.5865
E-mail: ethan@ece.umn.edu

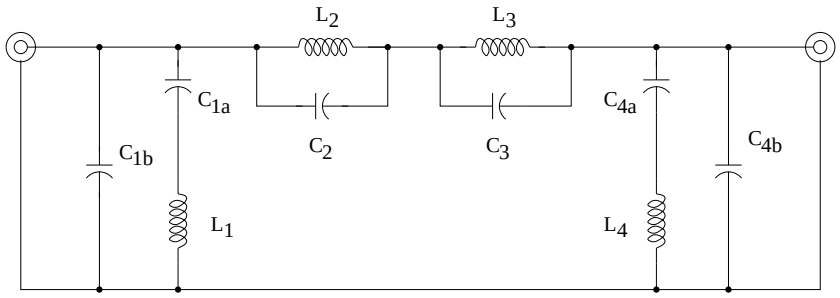

Figure 2: W3NQN bandpass filter with tapped-capacitor resonators

Table 1: Component value comparison for 7-MHz Filter

Component	W3NQN Value	Tapped-Capacitor Value
C_1	100 pF	X
C_{1a}	X	125 pF
C_{1b}	X	500 pF
C_4	100 pF	X
C_{4a}	X	125 pF
C_{4b}	X	500 pF

Modeling

Both the tapped-inductor and tapped-capacitor circuits are simulated using Ansoft Serenade SV 8.5 (Harmonica solver). Figure 3 shows the IL and RL of the original tapped-inductor design, while Figure 4 shows the IL and RL for the new tapped-capacitor design. Notice the significant degredation of stop-band attenuation, particularly below the passband.

4-194 EE/CSci Building – 200 Union St SE – Minneapolis, MN 55455
Cell: 330.231.3671 — Office: 612.624.5865
E-mail: ethan@ece.umn.edu

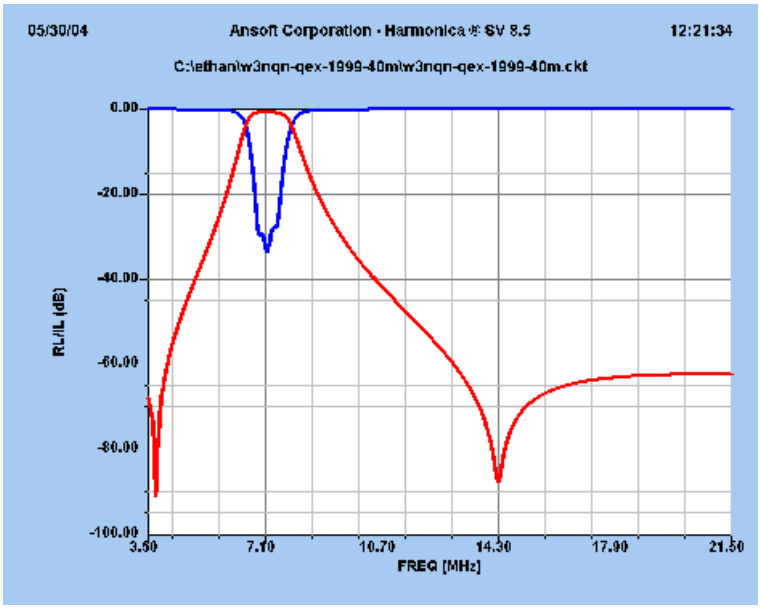

Figure 3: W3NQN bandpass filter with tapped-inductor resonators

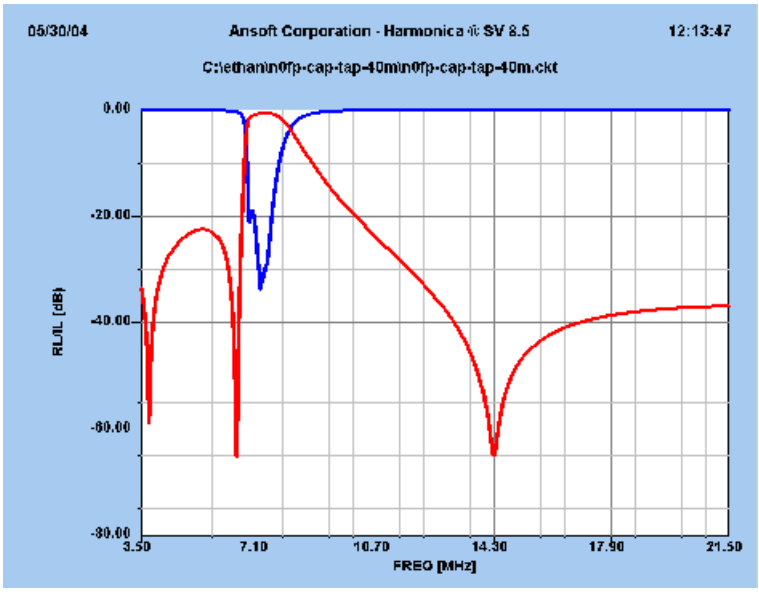

Figure 4: W3NQN bandpass filter with tapped-capacitor resonators

4-194 EE/CSci Building – 200 Union St SE – Minneapolis, MN 55455
Cell: 330.231.3671 — Office: 612.624.5865
E-mail: ethan@ece.umn.edu