

# PARALLEL RESONANCE



## Objectives

You will connect several ac *RLC* circuits that illustrate the important characteristics of parallel resonant circuits.

In completing these projects, you will connect circuits, make measurements, perform calculations, draw conclusions, and be able to answer questions about the following items related to parallel resonant circuits:

- Definition of resonance
- Relationships of  $V$ ,  $I$ ,  $R$ ,  $Z$ ,  $\theta$ ,  $Q$ , bandwidth, and frequency in parallel *RLC* circuits
- Finding a circuit's resonant frequency
- Outstanding characteristics of a circuit at parallel resonance

## Project/Topic Correlation Information

PROJECT	TEXT CHAPTER	SECTION	RELATED TEXT TOPIC(S)
<b>58</b> $V$ , $I$ , $R$ , $Z$ , and $\theta$ Relationships when $X_L = X_C$	21	21-6	Parallel Resonance Characteristics
<b>59</b> $Q$ and Impedance in a Parallel Resonant Circuit	21	21-8	Effect of a Coupled Load on the Tuned Circuit
		21-9	$Q$ and the Resonant Rise of Impedance
<b>60</b> Bandwidth Related to $Q$	21	21-10	Selectivity, Bandwidth, and Bandpass



# Parallel Resonance

$V$ ,  $I$ ,  $R$ ,  $Z$ , and  $\theta$  Relationships when  $X_L = X_C$

PROJECT

58

Name: \_\_\_\_\_ Date: \_\_\_\_\_

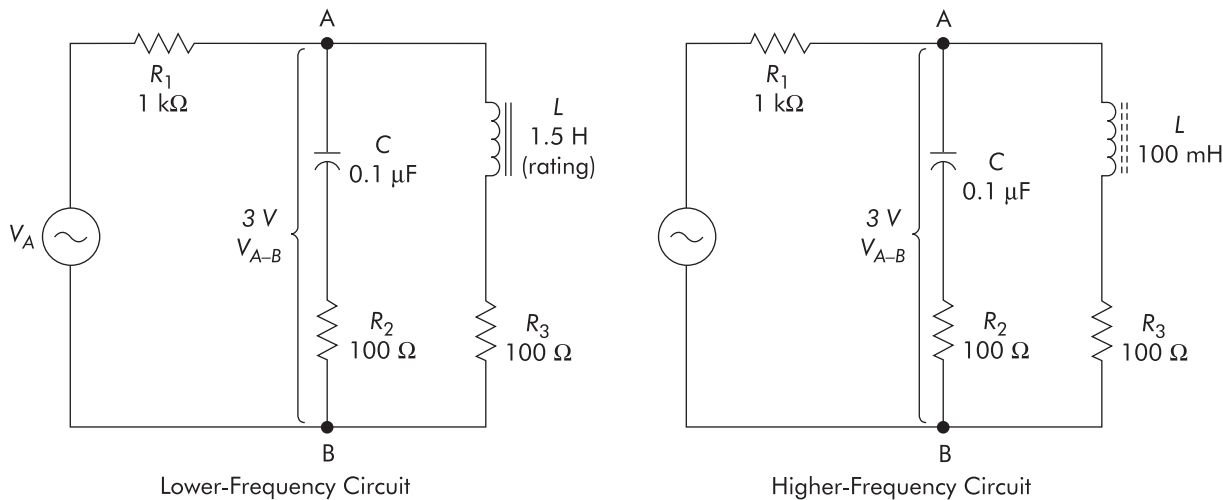


FIGURE 58-1

**PROJECT PURPOSE** To provide experience in performing analysis of a parallel resonant circuit relative to the key electrical parameters. Additionally, to verify that a parallel resonant circuit acts inductively, below the resonant frequency, and capacitively, above the resonant frequency.

**PARTS NEEDED**

- |   |                                     |
|---|-------------------------------------|
| <input type="checkbox"/> DMM                                    | <input type="checkbox"/> Inductors  |
| <input type="checkbox"/> Function generator or audio oscillator | 1.5 H, 95 $\Omega$ (or approximate) |
| <input type="checkbox"/> CIS                                    | <input type="checkbox"/> 100 mH     |
| <input type="checkbox"/> Capacitor 0.1 $\mu$ F                  | <input type="checkbox"/> Resistors  |
|   | 100 $\Omega$ (2) 1 k $\Omega$       |

**SPECIAL NOTE:**

Quickly reviewing, recall that  $X_L$  is directly proportional to frequency, and  $X_C$  is inversely proportional to frequency. For any given circuit containing  $L$  and  $C$ , there is a frequency where  $X_L = X_C$ , often referred to as the *resonant frequency*. Some interesting phenomena occur at resonance, and we will observe some of these for the parallel  $LC$  circuit. The  $R$ s used as current indicators do have an effect on the operation of the circuit; however, not to the extent that we cannot observe some of the resonance phenomena.

## PROCEDURE

1. Connect the initial circuit as shown in Figure 58-1.
2. Adjust  $V_A$  for 3 volts  $V_{A-B}$  between points *A* and *B*. Monitor  $V_1$  with a voltmeter and adjust the frequency for *minimum*  $V_1$ . Check that  $V_{A-B}$  is still 3 volts. Use the measured  $V_1$  and calculate  $I_T$ . Measure  $V_2$  and calculate  $I_C$ . Measure  $V_3$  and calculate  $I_L$ .

### ▲ OBSERVATION

Lower $f$	Higher $f$
$V_{A-B} =$ _____ V.	$V_{A-B} =$ _____ V.
$V_1 =$ _____ V.	$V_1 =$ _____ V.
$I_T =$ _____ mA.	$I_T =$ _____ mA.
$V_2 =$ _____ V.	$V_2 =$ _____ V.
$I_C =$ _____ mA.	$I_C =$ _____ mA.
$V_3 =$ _____ V.	$V_3 =$ _____ V.
$I_L =$ _____ mA.	$I_L =$ _____ mA.
$f \cong$ _____ Hz.	$f \cong$ _____ Hz.

### ▲ CONCLUSION

Are  $I_C$  and  $I_L$  close to being equal at the frequency of minimum  $V_1$ ? \_\_\_\_\_.  
 Would they be precisely equal if we had a pure  $L$  and  $C$  and ideal measurement conditions? \_\_\_\_\_. Does  $I_T$  equal the sum of the branch currents? \_\_\_\_\_.  
 This is because  $I_C$  and  $I_L$  are \_\_\_\_\_. Since  $I_C$  leads  $V_C$  by 90 degrees, and  $I_L$  lags  $V_L$  by about 90 degrees, then  $I_C$  and  $I_L$  must be about \_\_\_\_\_ degrees out of phase with each other. Theoretically, if  $I_C$  and  $I_L$  were exactly equal and 180 degrees out of phase, the resultant  $I_T$  would be \_\_\_\_\_. This means that  $Z$  would be \_\_\_\_\_. In practical circuits, however,  $Z$  is maximum at resonance, and its value depends on the  $Q$  of the circuit.  $Z = Q \times X_L$  (or  $X_C$ ).

3. Calculate the  $Z$  of the parallel resonant circuit using the resultant  $I_T$  of the branches as determined from  $V_1$  and the 3 volts  $V_{A-B}$  ( $Z = V/I$ ).

### ▲ OBSERVATION

Lower $f$	Higher $f$
$Z =$ _____ $\Omega$ . (approximately)	$Z =$ _____ $\Omega$ . (approximately)

### ▲ CONCLUSION

The  $X_C$  of the capacitor at the resonant frequency, according to the  $X_C$  formula, is about: Lower  $f =$  \_\_\_\_\_  $\Omega$ ; Higher  $f =$  \_\_\_\_\_  $\Omega$ . If  $X_L = X_C$ , then  $X_L$  is about: Lower  $f =$  \_\_\_\_\_  $\Omega$ ; Higher  $f =$  \_\_\_\_\_  $\Omega$ . Notice that  $Z$  is greater than either branch's opposition to current. This is in contrast to a purely resistive parallel circuit, where  $Z$  is less than the least  $R$  branch.

4. Keep the same circuit as shown in Figure 58-1.

5. Change the frequency to a new frequency that is well above  $f_r$ . Measure  $V_2$  and  $V_3$ . Calculate  $I_C$  and  $I_L$  and determine whether the circuit is now acting inductively or capacitively.

**▲OBSERVATION**  $I_C$  is now \_\_\_\_\_ than  $I_L$ .

**▲CONCLUSION** Since  $(I_C, I_L)$  \_\_\_\_\_ is now greater than  $(I_C, I_L)$  \_\_\_\_\_, it will cancel it out as far as  $I_T$  is concerned. Therefore, the resultant  $I_T$  is (*leading, lagging*) \_\_\_\_\_. The circuit at this frequency is acting equivalent to a simple  $R$  \_\_\_\_\_ circuit. This means a parallel  $LC$  circuit at a frequency that is above resonance will act (*inductively, capacitively*) \_\_\_\_\_. This is in contrast to a series  $LC$  circuit, which above resonance acts \_\_\_\_\_.

6. Change the input frequency to a new frequency that is well below the resonant frequency of the circuit. Determine  $I_C$  and  $I_L$  and note whether the circuit is now acting inductively or capacitively.

**▲OBSERVATION**  $I_C$  is now \_\_\_\_\_ than  $I_L$ .

**▲CONCLUSION** The circuit is now acting \_\_\_\_\_, since the predominant current is \_\_\_\_\_. Thus, we conclude that a parallel  $LC$  circuit acts \_\_\_\_\_ below resonance. This is in contrast to a series  $LC$  circuit, which acts \_\_\_\_\_ below resonance. Summarizing our observations for a parallel resonant circuit (at resonance), we conclude that  $Z$  is (*minimum, maximum*) \_\_\_\_\_, since the branch currents cancel, causing  $I_T$  to be (*minimum, maximum*) \_\_\_\_\_ at resonance. Since the reactive currents cancel, then the resultant circuit current is (*resistive, capacitive, inductive*) \_\_\_\_\_ and (*in phase, out of phase*) \_\_\_\_\_ with  $V_A$ . This means the circuit phase angle is \_\_\_\_\_ degrees. In order for the branch currents to completely cancel, they must be \_\_\_\_\_ degrees out of phase with each other. At resonance, the parallel  $LC$  circuit acts (*resistively, capacitively, inductively*) \_\_\_\_\_; above resonance acts (*resistively, capacitively, inductively*) \_\_\_\_\_; and below resonance acts (*resistively, capacitively, inductively*) \_\_\_\_\_.



# Parallel Resonance

## $Q$ and Impedance in a Parallel Resonant Circuit

# PROJECT

# 59

Name: \_\_\_\_\_ Date: \_\_\_\_\_

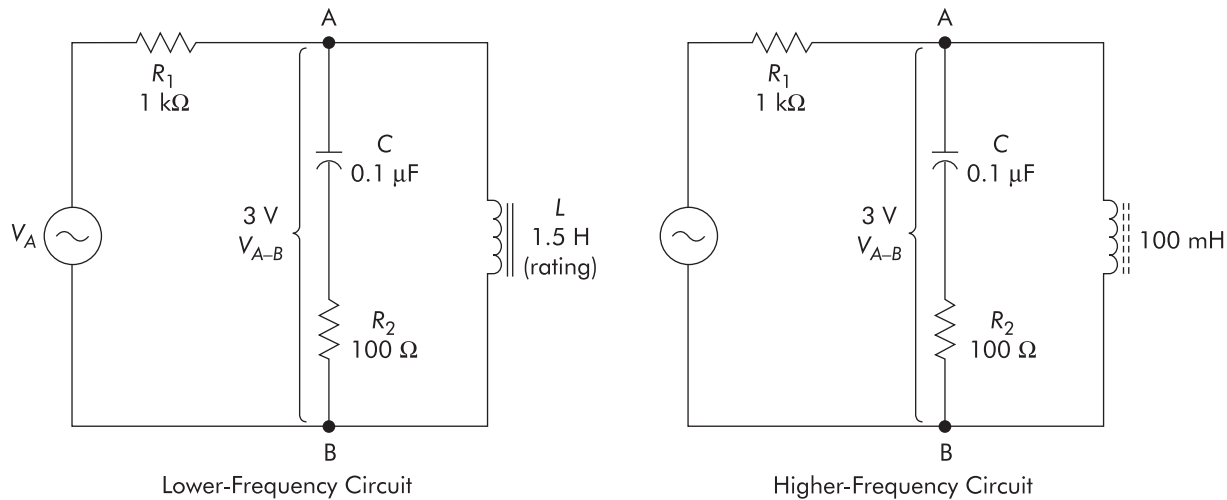


FIGURE 59-1

**PROJECT PURPOSE** To verify that  $Z$  is maximum at resonance due to the approximate 180-degree phase relationship of opposite reactance parallel branch currents. To show that the  $Z$  of the parallel resonant network is related to the circuit  $Q$ .

- PARTS NEEDED**
- |   |                                    |
|---|------------------------------------|
| <input type="checkbox"/> DMM                                    | <input type="checkbox"/> 100 mH    |
| <input type="checkbox"/> Function generator or audio oscillator | <input type="checkbox"/> Resistors |
| <input type="checkbox"/> CIS                                    | 100 $\Omega$                       |
| <input type="checkbox"/> Capacitor                              | 1 k $\Omega$                       |
| 0.1 $\mu$ F   | 10 k $\Omega$                      |
| <input type="checkbox"/> Inductors                              |                                    |
| 1.5 H, 95 $\Omega$ (or approximate)                             |                                    |

### SPECIAL NOTE:

It should be noted that the  $Q$  of a parallel resonant circuit is often considered as the ratio of  $Z/X_L$  (or  $Z/X_C$ ), and that the ratio of branch current to  $I_T$  is approximately this same number. For convenience, we will use the ratio of  $I_C$  to  $I_T$  for determining  $Q$  in this project.

## PROCEDURE

1. Connect the initial circuit as shown in Figure 59-1.
2. Adjust  $V_A$  for 3 volts *between points A and B*. Monitor  $V_1$  and adjust the frequency for minimum  $V_1$  (resonance). Check that  $V_{A-B}$  is still 3 volts. Determine  $I_T$  and  $I_C$  from  $V_1$  and  $V_2$ , respectively.

### ▲ OBSERVATION

	Lower $f$	Higher $f$
$V_{A-B} =$	_____ V.	$V_{A-B} =$ _____ V.
$V_1 =$	_____ V.	$V_1 =$ _____ V.
$I_T =$	_____ mA.	$I_T =$ _____ mA.
$V_2 =$	_____ V.	$V_2 =$ _____ V.
$I_C =$	_____ mA.	$I_C =$ _____ mA.

### ▲ CONCLUSION

$I_C$  is approximately: Lower  $f$  circuit = \_\_\_\_\_; Higher  $f$  circuit = \_\_\_\_\_ . \_\_\_\_\_ times greater than  $I_T$ . This indicates a  $Q$  of about: Lower  $f$  circuit = \_\_\_\_\_; Higher  $f$  circuit = \_\_\_\_\_. The  $X_C$  of the capacitor at the resonant frequency, if calculated by the  $X_C$  formula, is about: Lower  $f$  = circuit \_\_\_\_\_  $\Omega$ ; Higher  $f$  circuit = \_\_\_\_\_  $\Omega$ . If the circuit  $Z$  is calculated from the formula  $Z = Q \times X_C$ , the value of  $Z$  is: Lower  $f$  circuit = \_\_\_\_\_  $\Omega$ ; Higher  $f$  circuit = \_\_\_\_\_  $\Omega$ . If we calculate  $Z$  by Ohm's Law using the measured  $V_A$  and calculated  $I_T$ , the result is  $Z$  equals: Lower  $f$  circuit = \_\_\_\_\_  $\Omega$ ; Higher  $f$  circuit = \_\_\_\_\_  $\Omega$ . Are the two results reasonably comparable considering the measurement errors, and so on? \_\_\_\_\_.

3. If time permits, connect a 10-k $\Omega$  resistor in parallel with points A and B and repeat the procedures of step 2 to determine the new  $Q$  and  $Z$ . Note whether  $Q$  and  $Z$  increased or decreased with the shunt 10-k $\Omega$  present in the circuit.

### ▲ OBSERVATION

	Lower $f$	Higher $f$
$Q =$	_____.	$Q =$ _____.
$Z =$	_____ $\Omega$ .	$Z =$ _____ $\Omega$ .

### ▲ CONCLUSION

We may conclude that the lower the  $R$  in shunt with a parallel  $LC$  circuit, the (*higher*, *lower*) \_\_\_\_\_ the  $Q$  and  $Z$  will be.

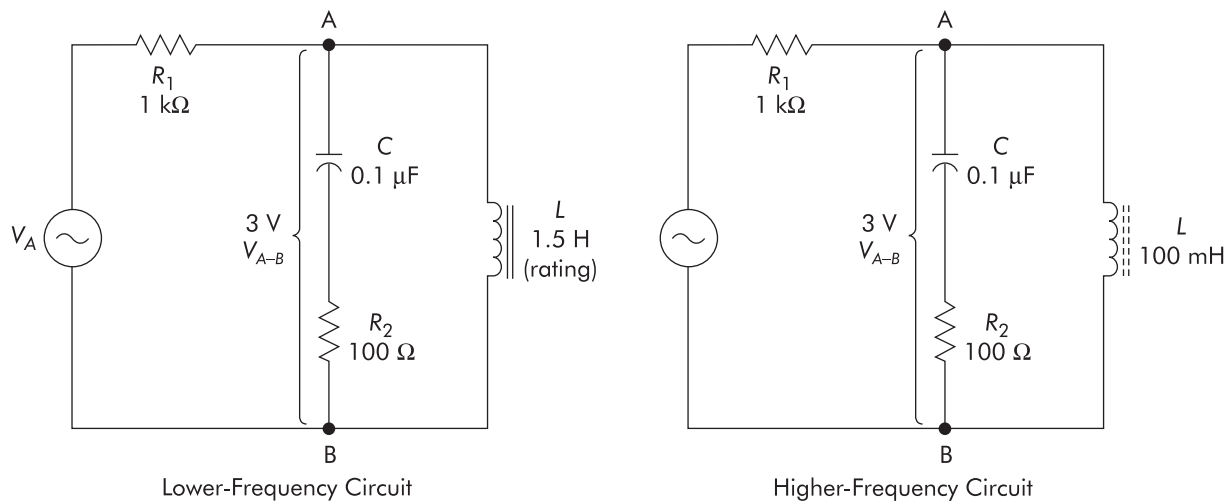
# Parallel Resonance

## Bandwidth Related to $Q$

**PROJECT**

60

Name: \_\_\_\_\_ Date: \_\_\_\_\_



**FIGURE 60-1**

**PROJECT PURPOSE** To provide experience in making measurements and performing analysis of a parallel resonant circuit relative to bandwidth and  $Q$ . To note how  $Q$  and  $Z$  are changed when a shunt resistance is introduced to the circuit.

**PARTS NEEDED**

- |   |                                    |
|---|------------------------------------|
| <input type="checkbox"/> DMM                                    | <input type="checkbox"/> 100 mH    |
| <input type="checkbox"/> Function generator or audio oscillator | <input type="checkbox"/> Resistors |
| <input type="checkbox"/> CIS                                    | 100 Ω                              |
| <input type="checkbox"/> Capacitor                              | 1 kΩ (2)                           |
| 0.1 μF  | 27 kΩ                              |
| <input type="checkbox"/> Inductors                              |                                    |
| 1.5 H, 95 Ω (or approximate)                                    |                                    |

**SPECIAL NOTE:**

Bandwidth for a parallel resonant circuit might be defined as the difference in frequency between two frequencies (one below resonance and one above) at which the circuit impedance is 70.7% of the maximum impedance, which occurs at resonance. When the circuit  $Z$  is 0.707 of maximum, the circuit current will be 1.414 times  $I$  minimum.

## PROCEDURE

1. Connect the initial circuit as shown in Figure 60-1.
2. Adjust  $V_A$  for 3 volts *between points A and B*. Monitor  $V_1$  and adjust the frequency for minimum  $V_1$  (resonance). Check that  $V_{A-B}$  is still 3 volts. Determine  $I_T$  and  $I_C$  from  $V_1$  and  $V_2$ , respectively. Also determine  $Q$  from the formula:  $Q = I_C/I_T$ .

### ▲ OBSERVATION

	Lower $f$	Higher $f$
$V_{A-B} =$	_____ V.	$V_{A-B} =$ _____ V.
$V_1 =$	_____ V.	$V_1 =$ _____ V.
$I_T =$	_____ mA.	$I_T =$ _____ mA.
$V_2 =$	_____ V.	$V_2 =$ _____ V.
$I_C =$	_____ mA.	$I_C =$ _____ mA.
$Q =$	_____.	$Q =$ _____.
	(approximately)	(approximately)

### ▲ CONCLUSION

Since  $I_T$  is the resultant of the two reactive branch currents, we may determine the  $Z$  at resonance of the parallel resonant circuit by dividing the 3.0 volts  $V_{A-B}$  by  $I_T$ .  $Z$  for the parallel resonant circuit thus equals approximately \_\_\_\_\_  $\Omega$  for the lower  $f$  circuit and \_\_\_\_\_  $\Omega$  for the higher  $f$  circuit.

3. Calculate what the current will be at the two frequencies when  $Z = 0.707 \times Z_{max}$  by multiplying the  $I_T$  at resonance by 1.4.

### ▲ OBSERVATION

$I$  at 70.7%  $Z$  points: Lower  $f =$  \_\_\_\_\_ mA; Higher  $f =$  \_\_\_\_\_ mA.

### ▲ CONCLUSION

If the impedance is 70.7% of  $Z$  at resonance, then the current will be 1.4 times  $I_{min}$  because  $1$  divided by  $0.707 =$  \_\_\_\_\_.

4. Keeping  $V_{A-B}$  at 3 volts, find the two frequencies at which  $Z$  is 0.707 of  $Z_{max}$  by monitoring  $I_T$  ( $V_1$ ). One frequency should be above the resonant frequency, one below. Determine the bandwidth from  $f_{hi} - f_{lo}$ .

### ▲ OBSERVATION

Bandwidth equals: Lower  $f =$  \_\_\_\_\_ Hz; Higher  $f =$  \_\_\_\_\_ Hz.

### ▲ CONCLUSION

If bandwidth is determined from the bandwidth  $= f/Q$  formula, using the value of  $Q$  from step 2, the value would be approximately: Lower  $f =$  \_\_\_\_\_ Hz; Higher  $f =$  \_\_\_\_\_ Hz. Does the bandwidth in this step reasonably correlate to the  $f/Q$  formula results, all things considered? \_\_\_\_\_.

5. If time permits, connect a 27-k $\Omega$  resistor in shunt with the parallel  $LC$  circuit (between points A and B) and repeat the procedures of step 4 to determine bandwidth.

### ▲ OBSERVATION

The bandwidth with a shunt 27-k $\Omega$  is (*more, less*): Lower  $f =$  \_\_\_\_\_; Higher  $f =$  \_\_\_\_\_ than without it.

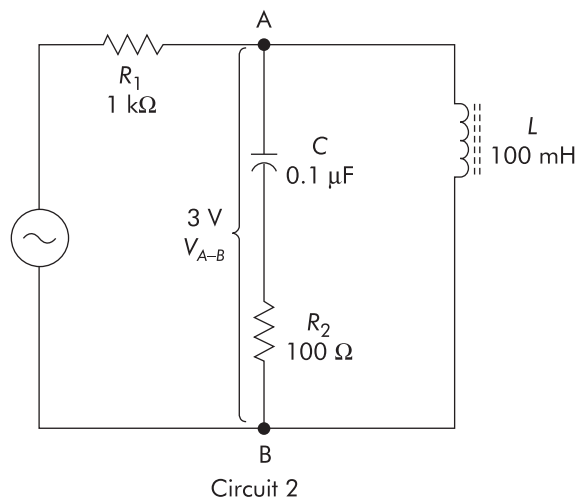
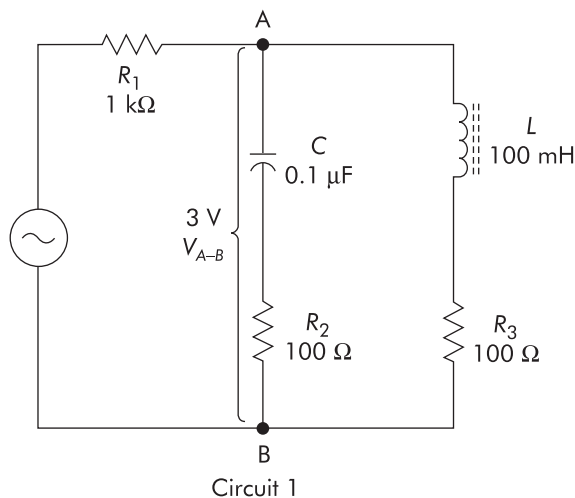
### ▲ CONCLUSION

If the bandwidth is greater, the  $Q$  of the circuit must have (*increased, decreased*) \_\_\_\_\_ according to the Bandwidth  $= f_r/Q$  formula.

# Story Behind the Numbers

## Parallel Resonance

Name: \_\_\_\_\_ Date: \_\_\_\_\_



**NOTE** ➤ Prior to performing this project that will use inductors, be sure to read the **Special Notes to Students and Instructors** at the beginning of Part 9. For this project you will use the higher-frequency circuit option; therefore, pay attention to the cautions regarding DMM measuring limitations (frequency limits). If you are using a DMM, be sure it is rated to properly read voltages at the frequencies required in this project. If a scope is to be used, observe the critical ground connection precautions necessary to prevent shorting out components.

### Procedure

1. Connect Circuit 1 as shown.
2. Adjust  $V_A$  for 3 V *between points A and B*. Monitor  $V_1$  with a DMM and adjust the source frequency for minimum  $V_1$  value. (This will be the circuit resonant frequency.) Check to see that  $V_{A-B}$  is still at 3 V.
3. Measure  $V_{R_1}$  and calculate circuit total current. Record the information on the Data Table, as appropriate.
4. Measure  $V_{R_2}$  and calculate  $I_C$ . Measure  $V_{R_3}$  and calculate  $I_L$ . Record these values on the Data Table, where indicated.
5. Calculate the value of circuit  $Z$ , using the value of voltage across points A–B (3 V) divided by the circuit current ( $I_T$ ). Record the impedance value on the Data Table, as appropriate.
6. Keep Circuit 1 as shown, but change the frequency to 3 kHz (a new frequency above the resonant frequency). Make sure the voltage across points

A and B is still 3 V. Measure the appropriate circuit parameters to enable calculating the values of  $I_C$  and  $I_L$ . Record your calculated values of currents in the appropriate locations on the Data Table.

7. Again using Circuit 1, change the frequency to 1 kHz (a new frequency below the resonant frequency). (Keep  $V_{A-B}$  at 3 V for this frequency.) Measure the appropriate circuit parameters to enable calculating the values of  $I_C$  and  $I_L$ . Again, record your calculated values of branch currents in the appropriate locations on the Data Table.
8. Make a frequency run with Circuit 1 in 200-Hz increments from 1200 Hz to 2200 Hz. Be sure to reset  $V_{A-B}$  to 3 V at each frequency. Measure  $V_{R_1}$  and calculate  $I_T$  at each frequency setting. Calculate the circuit  $Z$  at each frequency. Log the calculated circuit  $Z$  on the Data Table for each frequency of the frequency run.
9. Use the collected data to create a line graph showing circuit  $Z$  versus frequency.

**HINT ►** If you set up the Excel program worksheet to log your impedance and frequency data, the “Chart” creation capabilities will help you create this graph!

10. Connect the circuit as shown in the Circuit 2 schematic diagram.
11. With  $V_{A-B}$  set to 3 V, adjust the source frequency to achieve resonance (minimum  $V_{R_1}$ ). Calculate the circuit current. Use  $V_{A-B}$  and the calculated circuit current to determine  $Z$  at this frequency. Record this value on the Data Table, as indicated.
12. Keeping  $V_{A-B}$  at 3 V for each frequency-setting change, adjust the frequency above resonance until  $I_T$  is 1.4 times its value at resonance. (This indicates that  $Z$  must be 0.707 of its maximum value, which occurred at resonance.) Record this frequency and your calculated value for  $Z$  at this frequency on the Data Table.
13. Keeping  $V_{A-B}$  at 3 V for each frequency-setting change, adjust the frequency below resonance until  $I_T$  is 1.4 times its value at resonance. (Again, this indicates that  $Z$  must be 0.707 of its maximum value, which occurred at resonance.) Record this frequency and your calculated value for  $Z$  at this frequency on the Data Table.
14. **Optional step:** If time permits you may connect a 47-k $\Omega$  resistor in parallel with the circuit (at points A and B) and perform steps 11 through 13 again. Note what happens to  $Q$  and *bandwidth* as you perform these steps with the parallel resistor added to the circuit.
15. After completing the Data Table, answer the Analysis Questions and develop a brief Technical Lab Report to complete the project.

## Data Table

CIRCUIT 1: STEPS 1–9						
Component and Parameter I.D.'s	Measured Values	Calculated Values				
$V_{A-B}$ (V) @ resonance		—				
$V_{R_1}$ (V) @ resonance		—				
Calculated $I_T$ (mA) @ resonance	—					
$V_{R_2}$ (V) @ resonance		—				
Calculated $I_C$ (mA) @ resonance	—					
$V_{R_3}$ (V) @ resonance		—				
Calculated $I_L$ (mA) @ resonance	—					
Calculated $Z$ (k $\Omega$ ) @ resonance	—					
$V_{A-B}$ (V) above resonance		—				
$V_{R_2}$ (V) above resonance		—				
Calculated $I_C$ (mA) above resonance	—					
$V_{R_3}$ (V) above resonance		—				
Calculated $I_L$ (mA) above resonance	—					
$V_{A-B}$ (V) below resonance		—				
$V_{R_2}$ (V) below resonance		—				
Calculated $I_C$ (mA) below resonance	—					
$V_{R_3}$ (V) below resonance		—				
Calculated $I_L$ (mA) below resonance	—					

Data Table (*continued*)

CIRCUIT 1: FREQUENCY RUN						
Component and Parameter I.D.'s	1200 Hz	1400 Hz	1600 Hz	1800 Hz	2000 Hz	2200 Hz
Calculated $Z$ (k $\Omega$ ) at each frequency						
CIRCUIT 2: STEPS 10–13						
Component and Parameter I.D.'s	Measured Values	Calculated Values	Observed Frequency Values			
$V_{A-B}$ (V) @ resonance		—	—			
Frequency @ resonance	—	—				
Calculated $I_T$ (mA) @ resonance	—		—			
Calculated $Z$ (k $\Omega$ ) @ resonance	—		—			
Calculated $1.4 \times I_T$ (mA) = ?	—		—			
Frequency above resonance for $1.4 \times I_T$	—	—				
Calculated $Z$ (k $\Omega$ ) @ this frequency	—		—			
Frequency below resonance for $1.4 \times I_T$	—	—				
Calculated $Z$ (k $\Omega$ ) @ this frequency	—		—			

## Analysis Questions

**NOTE** Answers to these Analysis Questions should be clearly numbered and documented on separate sheets of paper with your name and the date at the top of each page. These answer sheets are to be turned in with the rest of the project documentation, as appropriate.

1. At resonance, what causes the circuit current to be minimum?
2. Are the values of currents through the capacitor branch and the inductor branch approximately equal? Explain what you think might cause any differences.
3. Does total current equal the sum of the branch currents? Why is this true?

4. At a frequency above the resonant frequency, did the circuit act inductively or capacitively? Explain.
5. At a frequency below the resonant frequency, did the circuit act inductively or capacitively? Explain.
6. If all components in the circuit were “ideal,” how would the circuit act, right at the resonant frequency? Explain.
7. Use the data from your table and determine the  $X_C$  of the capacitor at the resonant frequency. Next determine the  $Q$  by using the  $Q = Z/X_C$  formula.
8. What general conditions did your graph of  $Z$  versus frequency indicate regarding the circuit impedance at resonance, above resonance, and below resonance?
9. Using your data and the graph information, determine and record the *bandwidth* and *bandpass* of the circuit on your Analysis Questions answer sheet. Indicate how you determined these values.
10. What would happen to the Circuit  $Q$  and *bandwidth* if a resistor were connected in parallel with the resonant circuit?

## Technical Lab Report

Write a brief technical lab report summarizing the technical facts learned from this project. The report should be organized to provide the following:

1. An introductory paragraph describing the type of circuit being analyzed and the key parameters that will be discussed relating to this circuit.
2. A section describing the most important characteristics of this type of circuit that were shown via the collected data in the tables and graphs.
3. Any special facts or characteristics about this type of circuit that were highlighted in answering the Analysis Questions.
4. A practical example of how the information learned in this project might help you in operating, troubleshooting, error analysis, or adjusting a circuit of this type in your home setting, in your training program setting, or in a job setting in the real world.
5. A summary statement listing the most positive aspects of the project and any parts of the project that were difficult because of equipment problems or unclear instructions. Include areas that might be improved.



# Summary

## Parallel Resonance

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Complete the following review questions, indicating the appropriate response by placing a check in the box next to the correct answer.

- The impedance of a parallel  $LC$  circuit at resonance is
 

<input type="checkbox"/> maximum	<input type="checkbox"/> neither of these
<input type="checkbox"/> minimum	
- The resultant total current of a parallel  $LC$  circuit at resonance is
 

<input type="checkbox"/> maximum	<input type="checkbox"/> neither of these
<input type="checkbox"/> minimum	
- The current “through” either reactive branch of a parallel  $LC$  circuit at resonance is equal to
 

<input type="checkbox"/> $V_A/Z_T$	<input type="checkbox"/> $f_r/Q$
<input type="checkbox"/> $Q \times X_L$	<input type="checkbox"/> none of these
<input type="checkbox"/> $Q \times I_T$	
- The impedance of a parallel  $LC$  circuit at resonance is equal to
 

<input type="checkbox"/> $V_A/I_C$	<input type="checkbox"/> $X_L$
<input type="checkbox"/> $Q \times X_L$	<input type="checkbox"/> $X_L + X_C$
<input type="checkbox"/> $X_C$	<input type="checkbox"/> none of these
- At a frequency higher than the resonant frequency of a parallel  $LC$  circuit, the circuit acts somewhat
 

<input type="checkbox"/> inductive	<input type="checkbox"/> capacitive
------------------------------------	-------------------------------------
- At resonance, the phase angle between  $V_A$  and  $I_T$  for a parallel  $LC$  circuit is
 

<input type="checkbox"/> 0 degrees	<input type="checkbox"/> 180 degrees
<input type="checkbox"/> 45 degrees	<input type="checkbox"/> none of these
<input type="checkbox"/> 90 degrees	
- If the  $Q$  of a parallel resonant circuit is increased, the bandwidth will
 

<input type="checkbox"/> increase	<input type="checkbox"/> remain the same
<input type="checkbox"/> decrease	
- If the  $Q$  of a parallel resonant circuit is decreased, the  $Z$  will
 

<input type="checkbox"/> increase	<input type="checkbox"/> remain the same
<input type="checkbox"/> decrease	
- At a frequency lower than the resonant frequency, a parallel  $LC$  circuit acts somewhat
 

<input type="checkbox"/> inductive	<input type="checkbox"/> capacitive
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10. If the value of shunt resistance in parallel with a parallel  $LC$  circuit is changed, will the resonant frequency change?

- Yes
- No