Cornerstone Electronics Technology and Robotics I Week 21
Function Generator and Oscilloscope Lesson 2

- Administration:
  - Prayer
  - Turn in quiz
- Function Generator:
  - A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes.
  - Our function generator generates sine, triangle & square waveforms from 0.5Hz to 4MHz.
  - The basic controls on a function generator vary the amplitude and frequency of the output waveform.
  - Basic Operation: Perform Oscilloscope/Function Generator Lab 1 – Basic Operation of a Function Generator.
  - Perform Oscilloscope/Function Generator Lab 2 – Offset Function on the Function Generator.
- Electricity and Electronics, **Section 10.5**, Oscilloscope Continued:
  - Perform Oscilloscope/Function Generator Lab 3 – Displaying a DC Voltage and Dual Display.
  - Perform Oscilloscope/Function Generator Lab 4 – Other Dual Displays.

Electronics Technology and Robotics I Week 21
Oscilloscope/Function Generator Lab 1 – Basic Operation of a Function Generator

- **Purpose:** The purpose of this lab is having the student learn the basic controls of a function generator.
- **Apparatus and Materials:**
  - 1 – Oscilloscope
  - 1 – Function Generator
  - 1 – BNC Male to BNC Male Cable
- **Procedure:**
  - Select the type of waveform by rotating the **Function Switch** (FG2). See the Figure 21 – 1 for the function generator control locations.
  - Select the frequency range by rotating the **Frequency Range Selector Switch** (FG).
  - Connect the function generator **Main Output** (FG6) to the **CH1 Input Jack** (O10) on the oscilloscope. See the Figures 21 – 2 and 21 - 3 for the oscilloscope control locations.
  - Set the oscilloscope **Vertical Mode Control** (O13) to CH 1.
  - Adjust the oscilloscope **CH 1 Variable Attenuator** (O11) to the full clockwise position.
  - Set the oscilloscope **CH 1 Volts/Div Control** (O12) to 5.
  - Set the oscilloscope **CH 1 Input Coupling Switch** (O9) to AC.
  - Turn on both the oscilloscope **Power Switch** (O1) and the function generator **Power Switch** (FG4).
  - Select different types of waveforms by rotating the function generator **Function Switch** (FG2).
  - Adjust the amplitude of the waveform by rotating the function generator **Amplitude Control** (FG3)
  - Adjust the frequency by changing the function generator **Frequency Control** (FG5) and **Frequency Range Selector Switch** (FG1).
  - Set the period of your waveform to 1 ms. Have the instructor verify. Calculate the frequency and compare it to the function generator display.

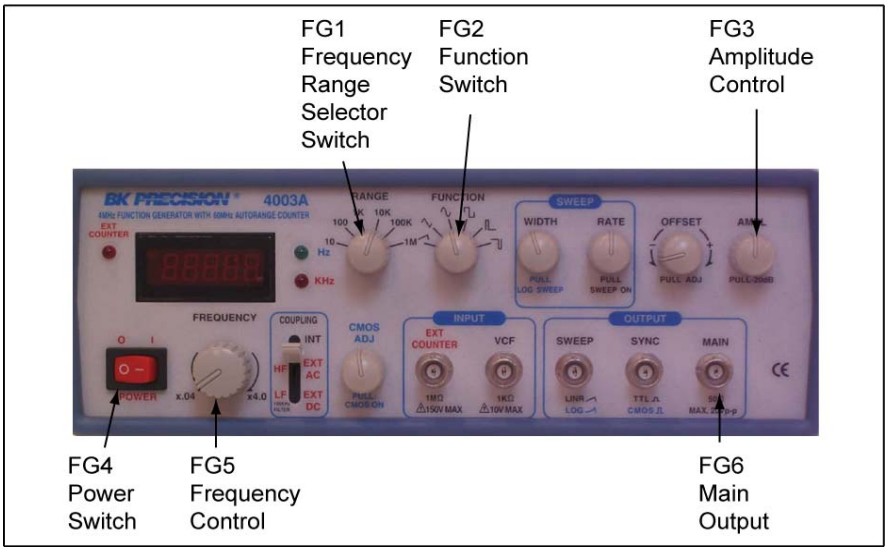

Figure 21 – 1 BK Precision 4003A Function Generator Controls for Lab 1

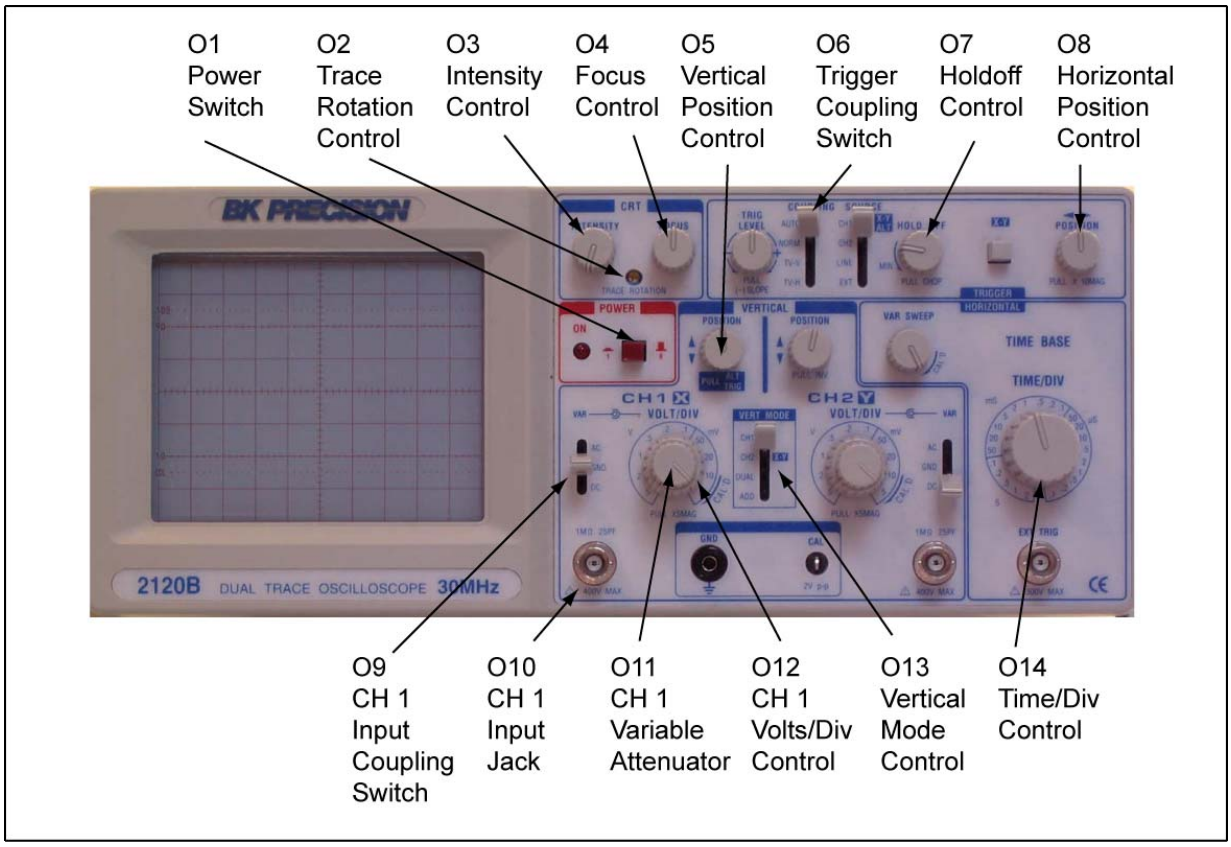

Figure 21 – 2 BK Precision 2120B Oscilloscope Controls for Lab 1

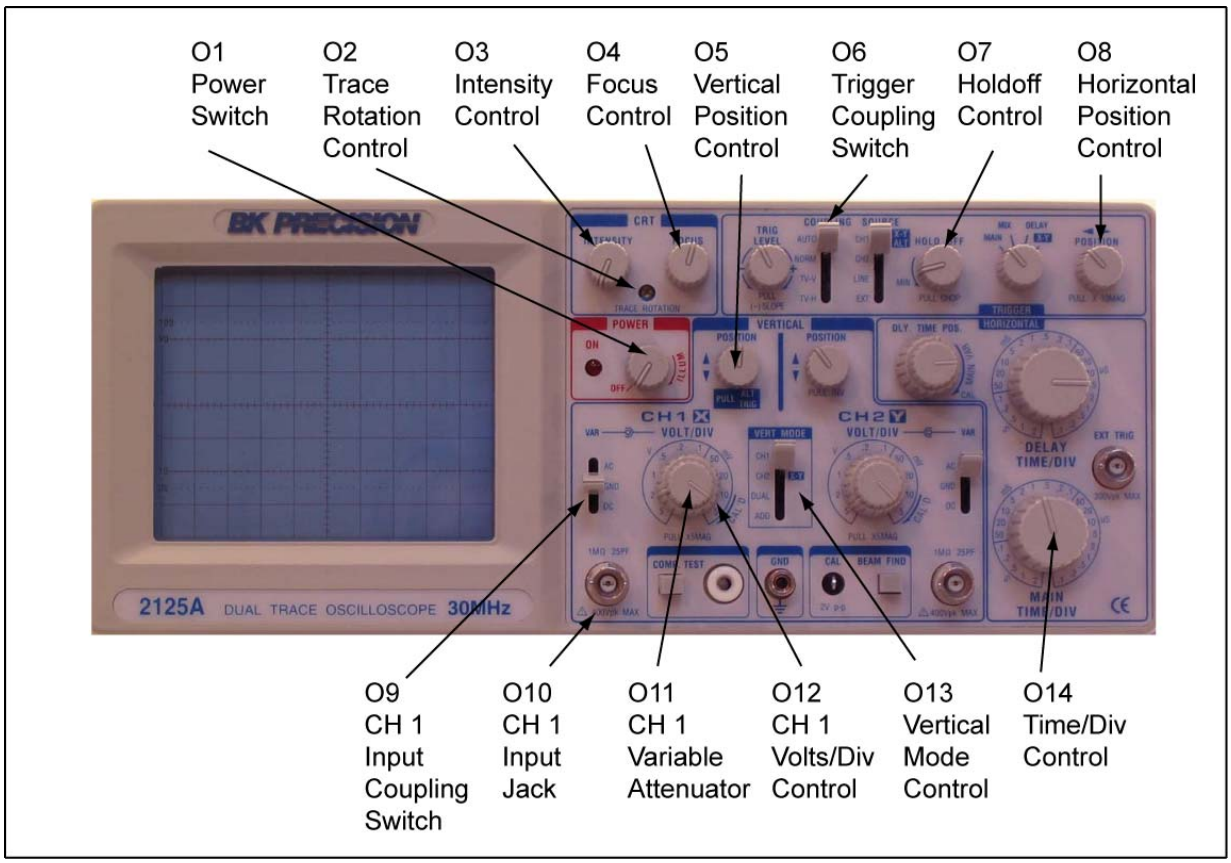

Figure 21 – 3 BK Precision 2125A Oscilloscope Controls for Lab 1

Electronics Technology and Robotics I Week 21
Oscilloscope Lab 2 – Offset Function on the Function Generator

- **Purpose:** The purpose of this lab is to display a dc voltage and a dual voltage trace on an oscilloscope.

- **Apparatus and Materials:**

    - 1 – Oscilloscope
    - 1 – Function Generator
    - 1 – BNC Male to BNC Male Cable

- **Procedure:**
    - Set the oscilloscope **Vertical Mode Control** (O13) to CH 1.
    - Set the oscilloscope **CH 1 Volts/Div Control** (O12) to 5.
    - Set the oscilloscope **CH 1 Input Coupling Switch** (O9) to AC.
    - With the function generator, create a sinusoidal waveform with a peak-to-peak voltage of 10 volts. Ask the instructor to verify your settings.
    - Reset the oscilloscope **CH 1 Input Coupling Switch** (O9) to DC.
    - Pull the **Offset Control** on the function generator.
    - Adjust the **Offset Control** to the – and + sides and observe the waveform on the oscilloscope. You are adding a dc component to the ac signal.
    - Now adjust the **Offset Control** until the + peak ac signal is 15 volts. Ask the instructor to verify your settings.
    - Reset the oscilloscope back to **CH 1 Input Coupling Switch** (O9) to AC. Notice that the dc component is eliminated.

Electronics Technology and Robotics I Week 21
Oscilloscope Lab 3 – Displaying a DC Voltage and Dual Display

- **Purpose:** The purpose of this lab is to display a dc voltage and a dual voltage trace on an oscilloscope.

- **Apparatus and Materials:**

    - 1 – Oscilloscope
    - 1 – Function Generator
    - 1 – BNC Male to BNC Male Cable
    - 1 – 9 V Battery

- **Procedure:**
    - Leave the function generator **Main Output** connected to the **CH1 Input Jack** on the oscilloscope.
    - Set the **Vertical Mode Control** to Dual.
    - Connect a scope probe to the **CH 2 Input Jack**. The Channel 2 controls are identical to the Channel 1 controls except they are to the right of the **Vertical Mode Control**.
    - Adjust the **CH 2 Variable Attenuator** to the full clockwise position.
    - Set the **CH 2 Volts/Div Control** to 5.
    - Set the **CH 2 Input Coupling Switch** to DC.
    - Connect the probe's ground clip to the (–) terminal of the battery.
    - Set the probe slide switch to x1.
    - Connect the probe tip to the (+) terminal of the battery.
    - Turn on both the oscilloscope **Power Switch** and the function generator **Power Switch**.
    - Adjust the **CH 1 Vertical Position Control** and the **CH 2 Vertical Position Control** such that the ac signal is above the dc signal.

Electronics Technology and Robotics I Week 21
Oscilloscope Lab 4 – Other Dual Displays

- **Purpose:** The purpose of this lab is to display circuit inputs and outputs as a dual voltage trace on an oscilloscope.

- **Apparatus and Materials:**

  - 1 – Oscilloscope
  - 1 – Function Generator
  - 1 – BNC Male to BNC Male Cable
  - 1 – 555 Timer
  - 1 – 74LS04 Hex Inverter
  - 1 – 74LS107 Flip-flop
  - 1 – 74LS47 BCD-to-Seven-Segment Decoder
  - 1 – Jameco 97172 Common Anode 7-Segment Display
  - 1 – 150 Ohm Resistor
  - 2 – 1K Resistors
  - 1 – 10K Resistor
  - 1 – 10K Potentiometer
  - 0.1 Microfarad Capacitor
  - 0.01 Microfarad Capacitor

- **Procedure:**
  - **Inverter Circuit:**
    - Wire the 74LS04 inverter circuit below.

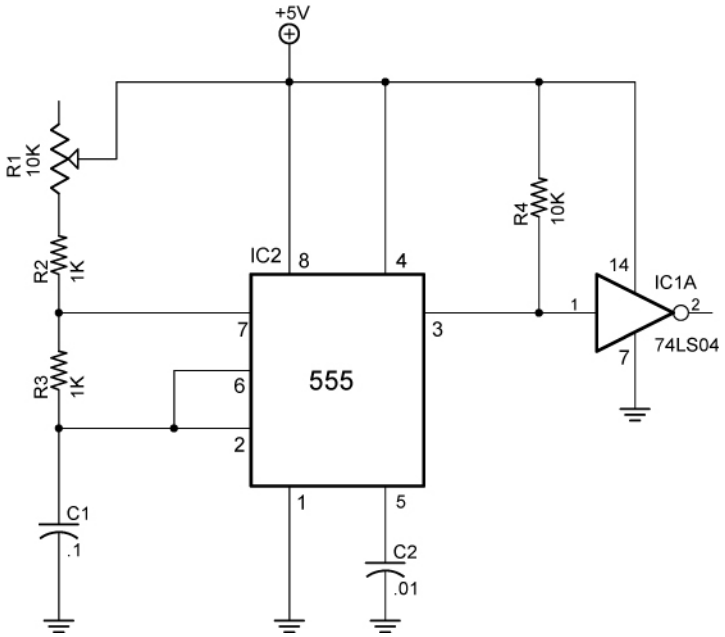

Figure 21-4 74LS04 Inverter Circuit

    - Connect the 74LS04 Pin 1 to the **CH 1 Input Jack** on the oscilloscope and the 74LS04 Pin 2 to the **CH 2 Input Jack**.

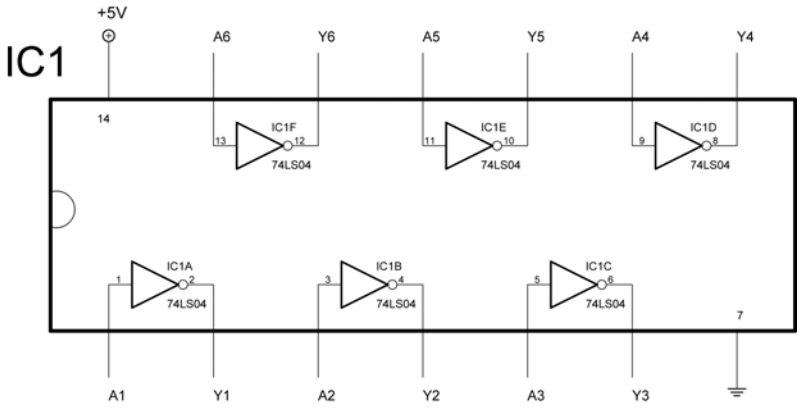

Figure 21 – 5 74LS04 Hex Inverter

$Y = \overline{A}$	
Input A	**Output Y**
L	H
H	L

H = High Logic Level (+5 V)
L = Low Logic Level (0 V)

Figure 21 – 6 Inverter Truth

- Observe that the input level (Channel 1) is inverted at the output (Channel 2).

- **Binary Count Circuit:**
  - Wire the following dual J-K flip-flop circuit.
  - Use a function generator set at a 1 KHz square wave as the clock input.
  - Connect Q1 to **CH 1 Input Jack** and Q2 to **CH 2 Input Jack** on the oscilloscope.
  - Adjust function generator **Offset Control** to display the Q1 and Q2 output waveforms as shown in Figure 29 – 9 below.

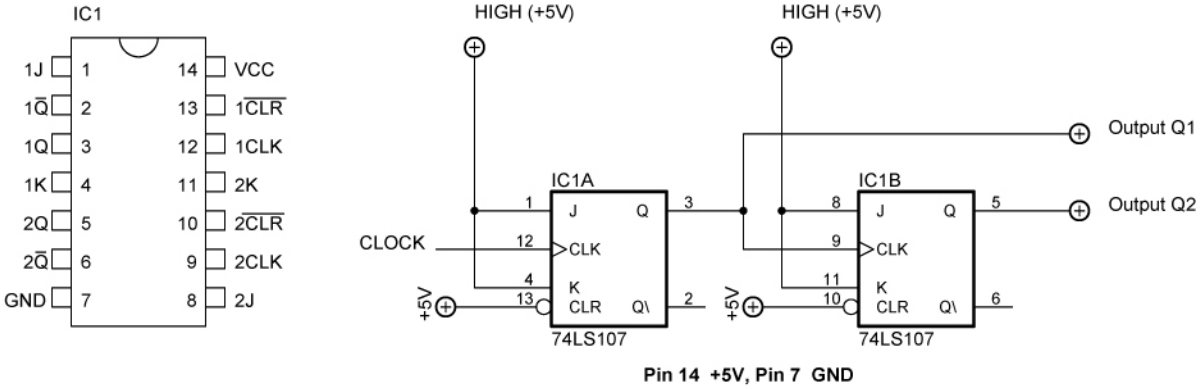

Figure 21 – 7 74LS107 Flip-Flop Pin Layout and Binary Counting Circuit

Decimal	Binary
0	00
1	01
2	10
3	11

Figure 21 – 8 Counting to 0 – 3 in Binary

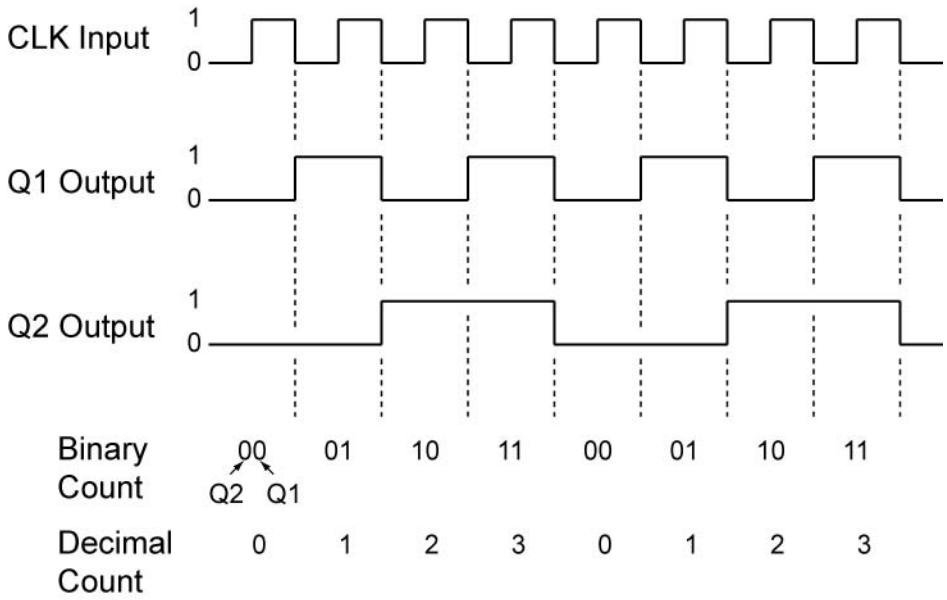

Figure 21 – 9 Q1 and Q2 Outputs

- Wire the circuit in Figure 21 – 10.
- Before connecting the binary counting circuit outputs Q1 and Q2 to the circuit, apply the HIGHs (+5V) and LOWs (ground) to pins 7,1,2 and 6 of the 74LS47N as listed in the table below.
- The 74LS47N is a BCD-to-seven-segment decoder which decodes the Q1 and Q2 signals to illuminate the numbers 0 – 3 on a seven-segment display. The table lists the input BCD code and the 7-segment display decimal output.

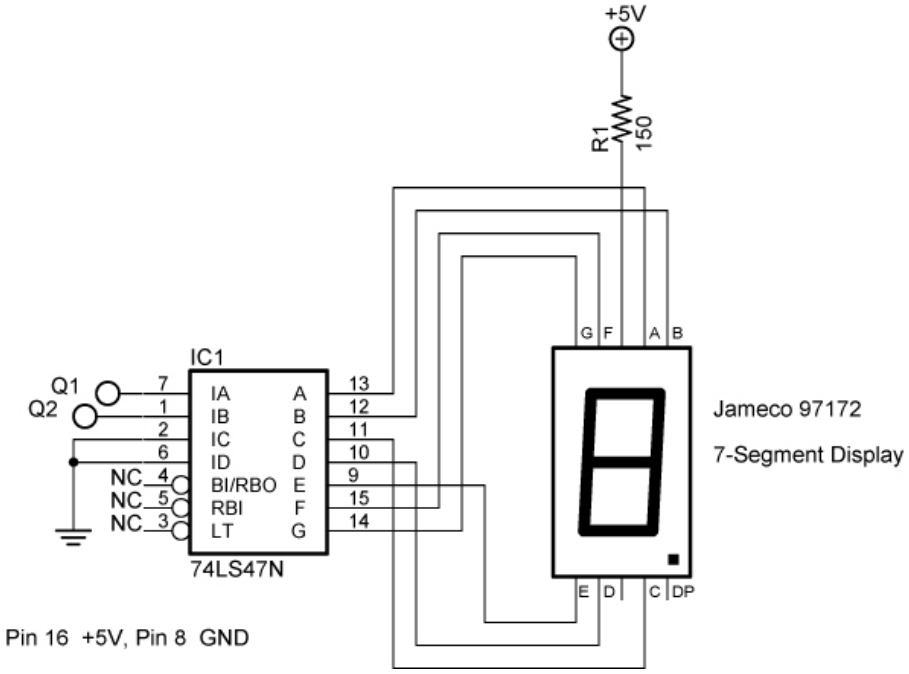

Figure 21 – 10 74LS47 BCD-to-Seven-Segment Decoder Circuit

BCD Code	74LS47 Pin Inputs (BCD Code)				7-Segment
	Pin 6	Pin 2	Pin 1 (Q2)	Pin 7 (Q1)	Display
	ID	IC	IB	IA	Decimal Output
0000	0	0	0	0	0
0001	0	0	0	1	1
0010	0	0	1	0	2
0011	0	0	1	1	3
0100	0	1	0	0	4
0101	0	1	0	1	5
0110	0	1	1	0	6
0111	0	1	1	1	7
1000	1	0	0	0	8
1001	1	0	0	1	9

- Now connect Q1and Q2 outputs from the counting circuit above to the decoder circuit.
- Adjust the function generator frequency (the clock) to about 1.5 Hz.