✓ Also, try using both horizontal and vertical cursors at the same time to measure both the voltage and time differences between the peaks of the P and T waves.
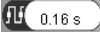
SUMMARY

This chapter surveyed a variety of circuit, microcontroller programming, and measurement techniques for time varying signals. Human speed time varying signal measurements were applied to:

- Binary pushbutton and LED signals viewed with the logic analyzer
- Varying potentiometer wiper voltage displayed with the Oscilloscope
- BASIC Stamp D/A and PropScope function generator signals viewed with the Oscilloscope.

The PropScope's function generator was also used to generate signals with certain amplitudes, offsets, and frequencies.

The oscilloscope's horizontal time and vertical voltage display knobs were used to adjust the time/division and volts/division settings. The Oscilloscope's divisions were used to measure voltage, time and frequency, and the measurements were compared to values obtained from the Measure tab and from cursor placement.

Questions

1. Is it possible for the distance between two horizontal division lines to mean two different things?
2. What happens in the Oscilloscope screen if the voltage varies over a range of a few seconds but the Horizontal scale is set to a small value like 50 μs?
3. How do you adjust the portion of the plot the PropScope displays?
4. How many logic analyzer channel inputs does the DAC card have?
5. What does the line inside this symbol 🐥 indicate?
6. Is this a frequency or a period measurement? 📊 0.16 s Why?
7. If you need to measure three binary signals, what tool would be most appropriate?
8. What can the PropScope's Oscilloscope view measure that the Logic Analyzer cannot?

Exercises

1. A signal repeats itself every 0.3 seconds. Calculate the frequency.

2. A signal is repeating at a frequency of 4 Hz. Calculate the period?
3. Set the amount of time displayed by the Oscilloscope screen to 1 second.
4. Assume the Horizontal knob is set to 20 ms but the waveform is hard to examine because it won't stay still in the display. Describe two ways to make the waveform sit [🗏] for examination.
5. A waveform's is displayed and is stable on the screen. Explain what to do if you need to examine a portion of the plot that is to the right of what's visible in the oscilloscope screen.
6. Use the time divisions to approximate the period and frequency of the signal in Figure 3-11.

3

Projects

1. Use the PropScope to tune Alternate High Low Signals.bs2 so that it flashes the LEDs at as close to 20 Hz as possible.
2. Use the PropScope's function Generator to transmit the signal shown in Figure 3-17, but make it 10 times as fast. Hint: Slide the switch to custom and click Generator panel's Edit button.

Comment [AL48]: Change to match the Your Turn section in that activity.

Solutions

Q1. Yes, the distance between two horizontal division lines might be a certain number of volts per division on the channel 1 scale, and a different number in the channel 2 scale.

Q2. The voltage trace will appear to be a flat line that rises and falls in the display.

Q3. …by adjusting the position of the plot area bar.

Q4. Four.

Q5. The Trigger tab's Edge has been set to rising, meaning the trigger occurs as the voltage rises from below to above the trigger voltage level.

Q6. It's a period measurement because it's units are seconds (s).

Q7. The PropScope Logic Analyzer displaying signals probed by the DAC card.

Q8. The Oscilloscope can measure voltage levels. The Logic Analyzer only displays signals as high or low.

E1. $f = 1 \div T = 1 \div 0.3 \text{ s} = 3.33… \text{ Hz}$

E2. $T = 1 \div f = 1 \div 4 = 0.25 \text{ s}$

E3. The Oscilloscope displays ten voltage divisions at a time, so the horizontal dial needs to be set to 100 ms since it's in terms of ms/division. $1 \text{ s} \div 10 \text{ div} = 0.1 \text{ s/div} = 100 \text{ ms/div}$.

E4. Either toggle the Run button to off, or configure the oscilloscope's trigger tab settings.

E5. Slide the plot area bar slightly to the right.

E6. It looks like the signal starts at 40 ms and repeats starting at just over 140 ms. Since we are "approximating", let's call the period T ≈ 100 ms. $f = 1 \div T = 1 \div (T \approx 100 \text{ ms}) = 1 \div 0.1 \text{ s} = 10 \text{ Hz}$.

E1. A first cut to getting as close to 20 Hz as possible would be to calculate the HIGH and LOW times and ignore processing time. The period of the signal is $T = 1 \div f = 1 \div 20 \text{ Hz} = 50 \text{ ms}$. So, we need PAUSE 25 for the HIGH and LOW signal times. Next, test the modified Alternate Blinking LEDs. bs2 with the PropScope.

```
' Alternate Blinking LEDs (first cut).bs2
' Turn LEDs connected to P14 and P15 on and off.

' {$STAMP BS2}
' {$PBASIC 2.5}

PAUSE 1000
DEBUG "Program Running!"

DO

  HIGH 14
  LOW 15
  PAUSE 25
  LOW 14
  HIGH 15
  PAUSE 25

LOOP
```

Below is a display of the test on the first cut. The Trigger has been set to Continuous, and the trigger time marker was adjusted so that the first rising edge lines up with the second vertical division line at 20 ms. Note that the second rising edge is not right on the 70 ms division, for a period of 50 ms. So there is room for improvement. Note also that the cursor's Δ measurement is telling us our work is done, but it's not true.

Comment [AL49]: Whoa! Test this in v1.0.6, and in the next revision.
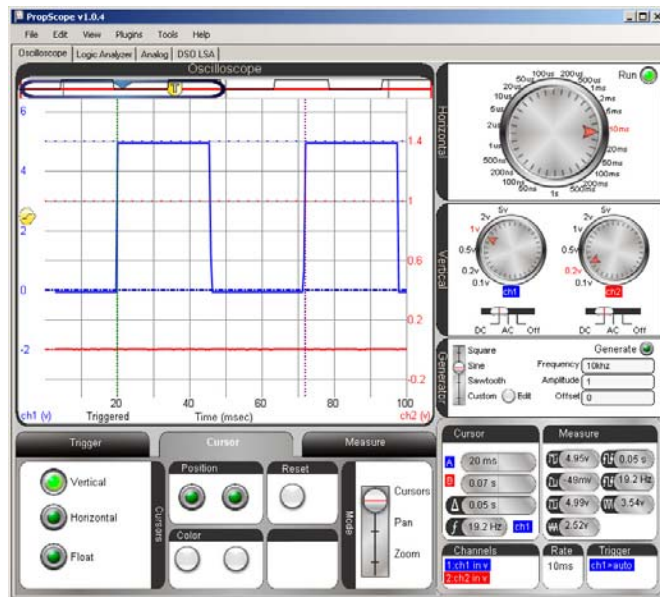
3

Let's try shaving 1 ms off both PAUSE commands by changing them both to PAUSE 24. Look how nicely the rising edges line up with the 20 ms and 70 ms divisions now (below).
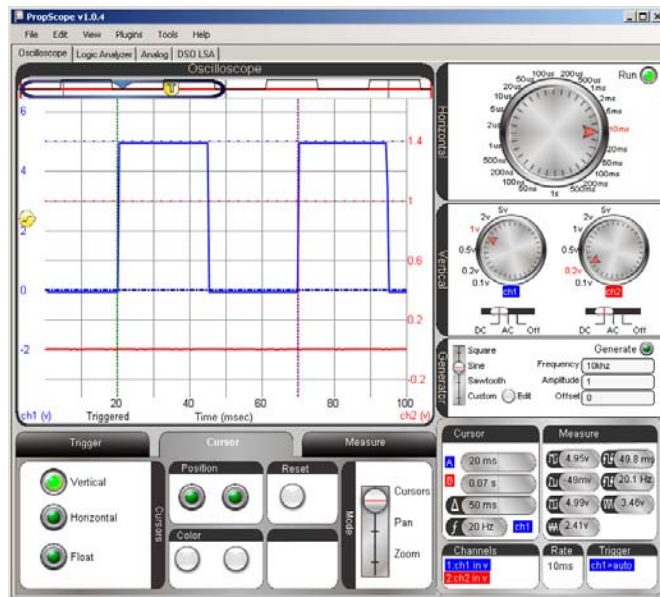
So the correct solution is:

```
' Alternate Blinking LEDs (final adjustment).bs2
' Turn LEDs connected to P14 and P15 on and off.

' {$STAMP BS2}
' {$PBASIC 2.5}

DEBUG "Program Running!"

DO

  HIGH 14
  LOW 15
  PAUSE 24
  LOW 14
  HIGH 15
  PAUSE 24

LOOP
```
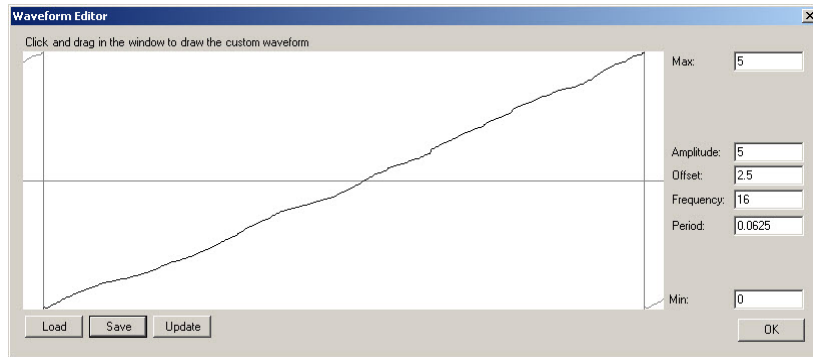
E2. Following the hint, we get to this screen. An earlier exercise guided us through determining that the frequency of the triangle wave is 1.6 Hz, so a signal that's 10 times as fast would be 16 Hz. Max and min voltages are 5 and 0.

3

Waveform Editor ⊠

Click and drag in the window to draw the custom waveform

Max: 5

Amplitude: 5
Offset: 2.5
Frequency: 16
Period: 0.0625

Min: 0

Load   Save   Update   OK

Make sure to connect one of the probes to the DAC CARD's function generator output, and the other to PropScope CH1. ~~You can optionally just clip the probes to each other, or plug both probes into a common row on a breadboard~~. Make sure to click the WaveForm Editor's Update button, and you may also need to click the Generator panel's Generate button. In the Oscilloscope view, go to the trigger tab and set the Mode to Continuous. The rest of the settings are shown. Make sure to verify the frequency with cursors (or time divisions, whichever you prefer).
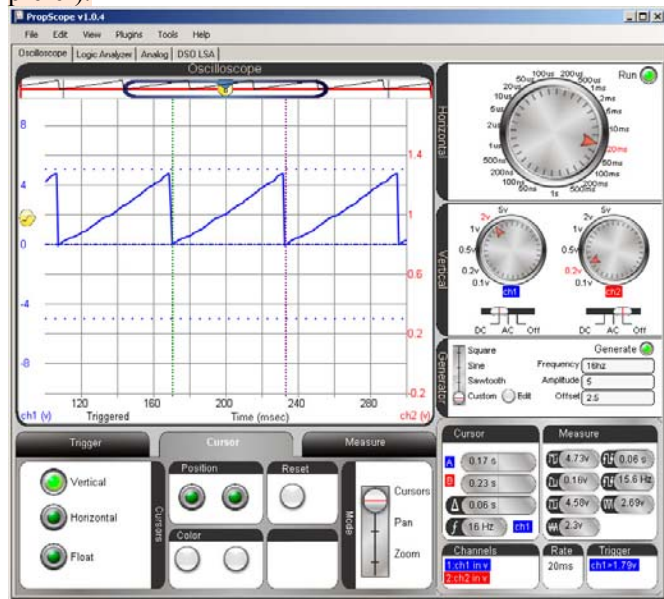
Comment [AL50]: Update this to triangle wave. Sawtooth should use built-in feature.