The trials and tribulations of building a phase-sensitive detector with an Arduino microcontroller

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Outline

Original Goals

- Use Arduino as a tool for teaching about phase-sensitive detection, like.....

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- Can be done, but different lessons are learned

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- Black boxes are useful for application work, but not so much for pedagogical purposes
- Software PSD allows students to peek into the black box.

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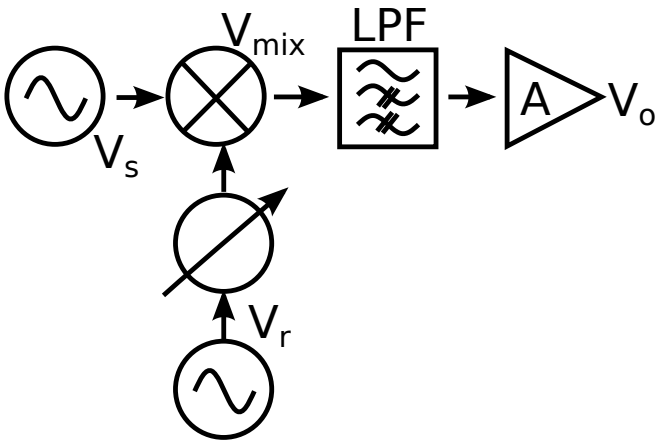
  - Really no debugging tools, except for serial out

PSD Basics



Mathematics of PSD

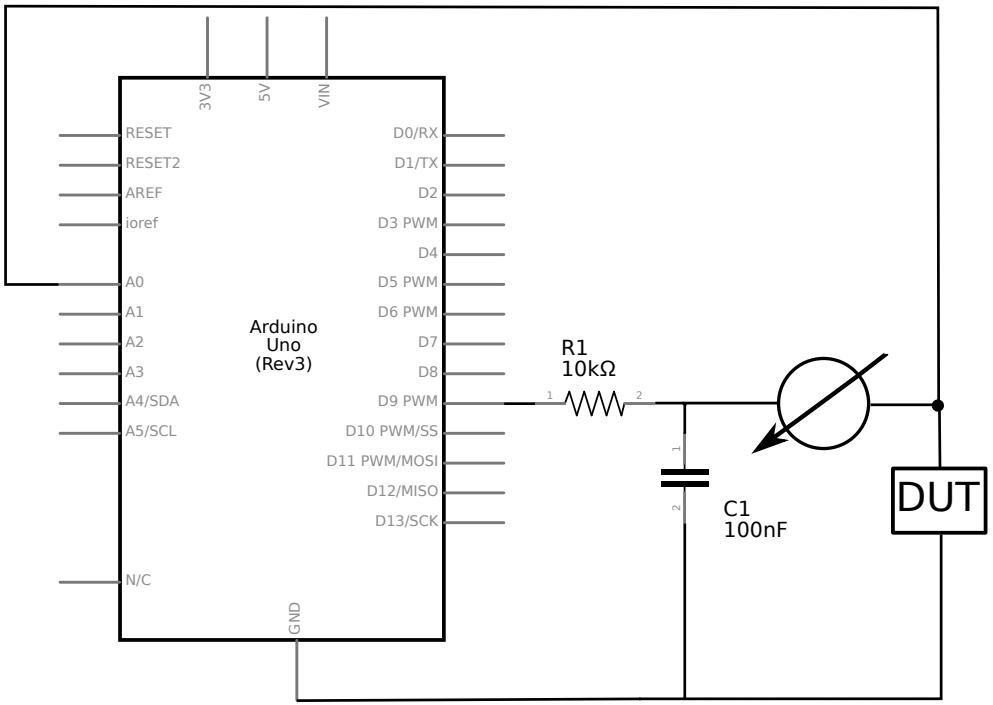
$$V_{mix} = V_s V_r \left[(\cos\left(\omega_s - \omega_r\right) t - \left(\phi_s - \phi_r\right)\right]$$

$$V_o = A\frac{V_s V_r}{2}\left[\cos(\phi_s - \phi_r)\right]$$

Restrictions

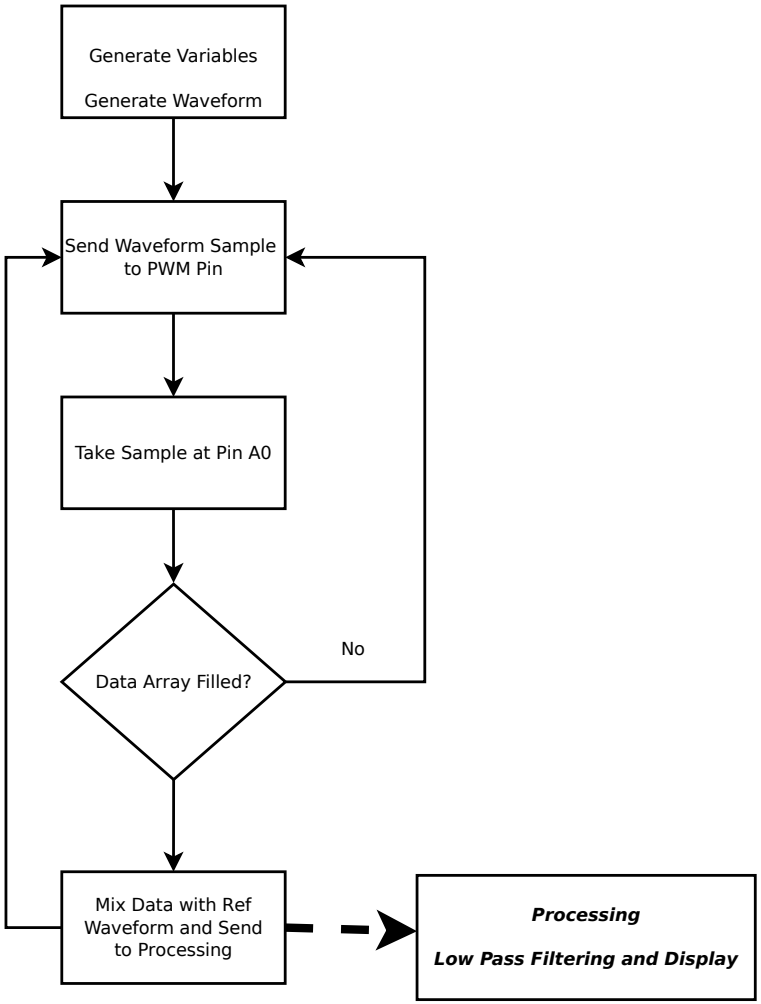
- $\omega_r = \omega_s$
- V_s and V_r have no DC offset

Let's Make a PSD

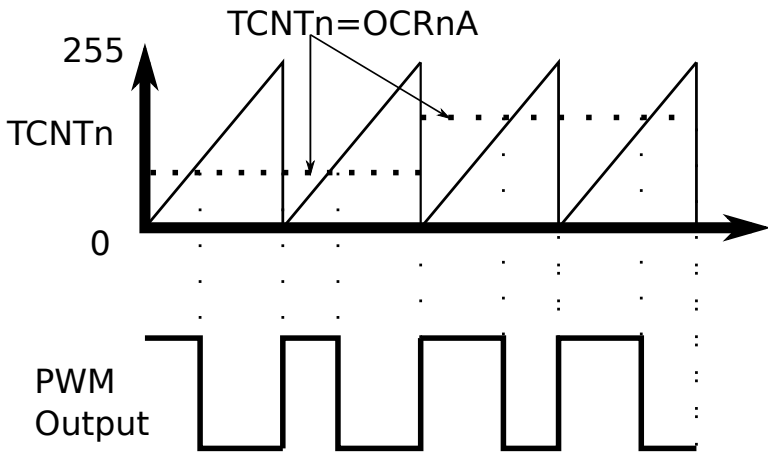


How did it go?

Pseudo Code



Creating a Reference Signal



Timers and Interrupts Part I

- The ratio of PWM on to off determines an average “DC” signal
- When register TCNT1 reaches OCR1A PWM goes low
- When TCNTn overflows PWM goes high again

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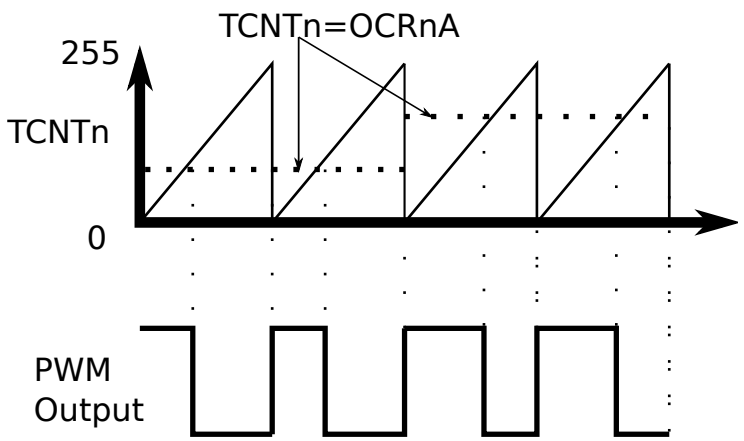

$$f_{ref} = \frac{\text{TCNT2 rate}}{\text{OCR2A value} \times \text{wavetable length}}$$

Timers and Interrupts Part II

- Need fast timer2 and regular timer1, which outputs PWM
- When timer2 reaches OCR2A:
  - Update OCR1A from wavetable
  - read signal at AnalogIn
- When timer1 counts up to OCR1A, PWM goes low
- When timer1 overflows PWM goes high again

Signal Input

Phase Manipulation

Display

For Further Reading I


A. Author.
Handbook of Everything.
Some Press, 1990.


S. Someone.
On this and that.
Journal of This and That, 2(1):50–100, 2000.