

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

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Outline

- 1 Introduction
 - Original Goals
 - Motivation
 - Background Material
- 2 Is This Even Possible?
 - Initial Proposal
 - Making it Work
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- To do so with only the Arduino, a computer for display purposes, and passive external components (resistors and capacitors)
- 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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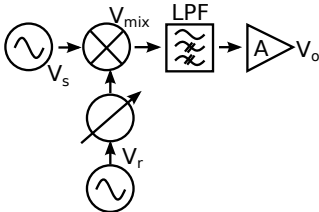
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 - Really no debugging tools, except for serial out

PSD Basics



Mathematics of PSD

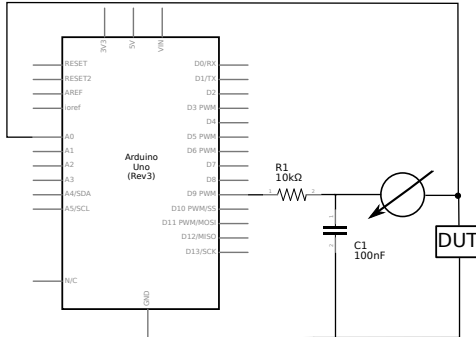
$$V_{mix} = V_s V_r [(\cos(\omega_s - \omega_r) t - (\phi_s - \phi_r))]$$

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

Restrictions

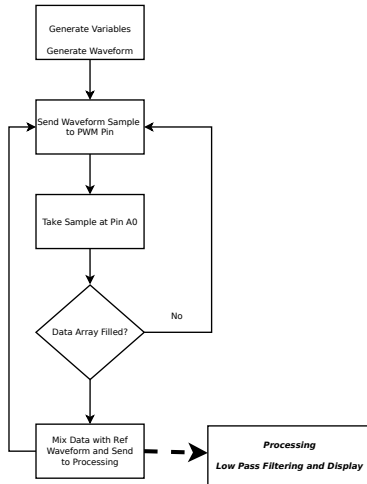
- $\omega_r = \omega_s$
- V_s and V_r have no DC offset

Let's Make a PSD

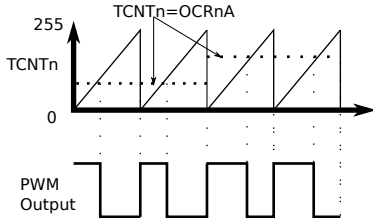


How did it go?

Pseudo Code



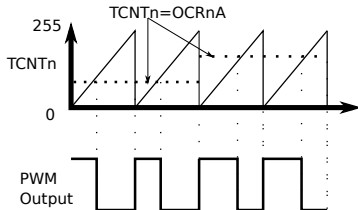
Creating a Reference Signal



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

Creating a Reference Signal



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

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.