

# Arduino based Antenna Positioning System



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South Bay Amateur Radio Association

# Video Introduction

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Umesh Ghodke, K6VUG, SBARA

# Presentation Overview

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1. Mechanical Assembly
2. RC Servo Basics
3. Arduino Pro Mini Microcontroller
4. Programming The Arduino
5. Position Control Program
6. Hands On Demonstration

# Close-up View

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Umesh Ghodke, K6VUG, SBARA

# Mechanical Assembly

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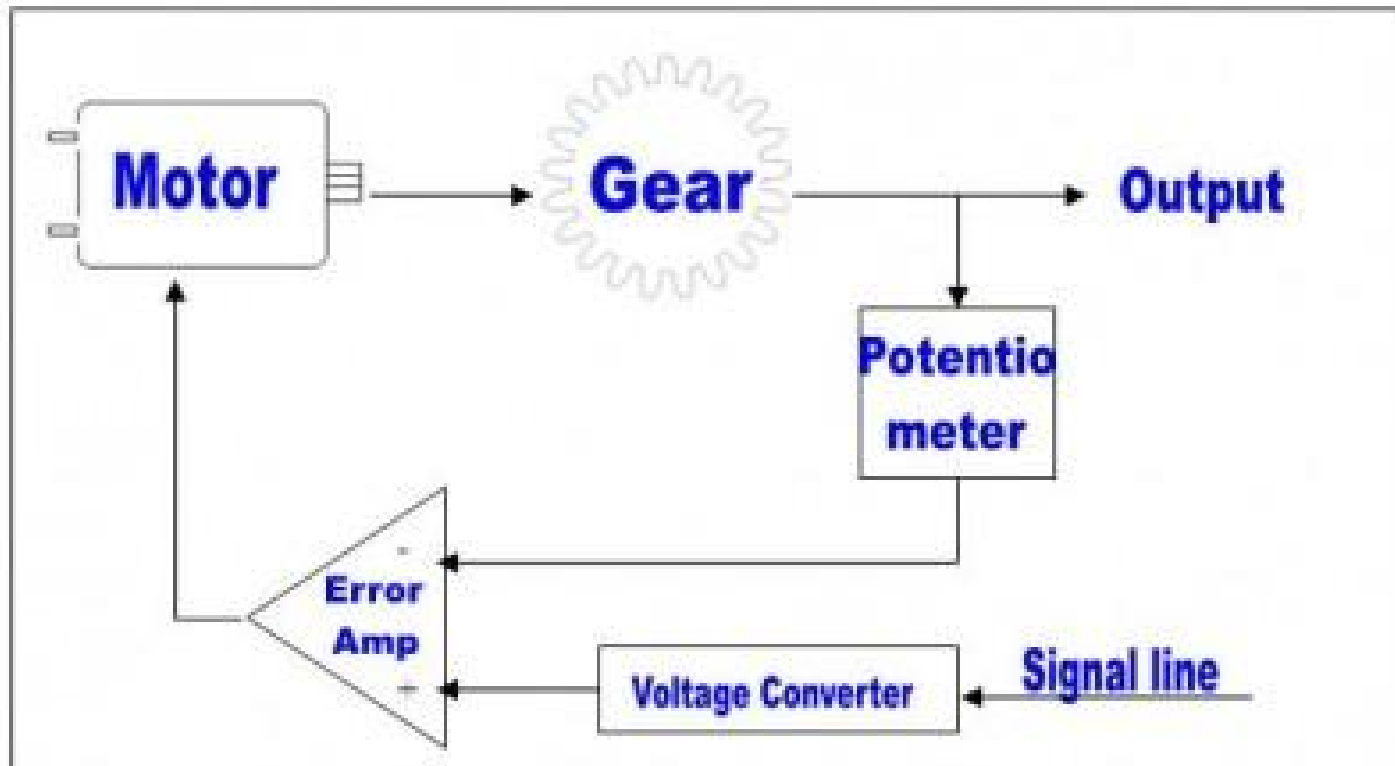
## a) Azimuth Rotator

- Housing for Servo
- Mounts to tripod or mast
- Rotates Elevation Rotor thru 180 degrees

## b) Elevation Rotator

- Housing for Servo
- Mounts on top of Azimuth Rotor
- Provides mounting for antenna etc.
- Rotates antenna thru 180 degrees

# RC Servo Overview



A Closed Loop Positioning System

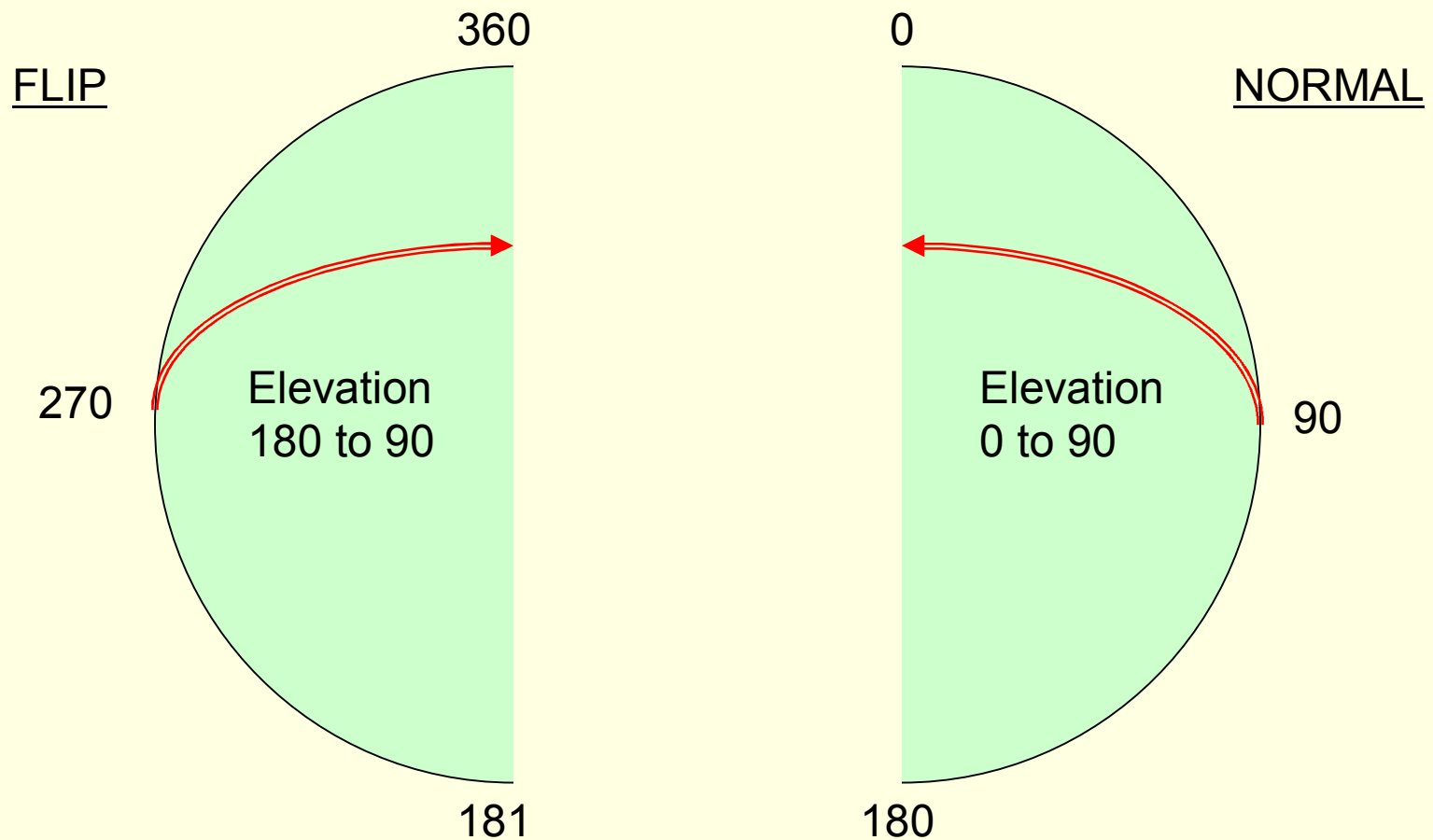
# RC Servo Specifications (typical)

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- Rotation Angle – 180 degrees \*\*\*
- High Speed – 60 deg in 0.25 seconds
- Excellent Torque – 7.1 kg/cm
- Pulse Width – 1 to 2 microseconds
- Pulse Rate – 20 milliseconds
- Simple Power Requirements – 4.5 V, 1.2 A

Precision Angle Control by PWM signal  
Small & Easy-to-use Package

# 360° Azimuth using Flip Mode





# Arduino Microcontroller

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- Popular & Easy to use Microcontroller Boards
- Efficient Interrupt-driven Architecture
- Pulse Width Modulation Feature Built-in \*\*\*
  
- Web Site [www.arduino.cc](http://www.arduino.cc)
- Jump Start Instructions & Samples
- Free IDE Software for Development and Test

# Arduino Specifications (typical)

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- ATmega32x 16 MHz Microcontroller
- 32 KB Flash Memory (program storage)
- 2 KB SRAM (program execution)
- 1 KB EEPROM (data storage)
- 14 Digital I/O Pins (6 PWM outputs) \*\*\*
- 6 Analog Input Pins
- Operating Voltage 5V, 50mA
- USB or Serial Interface
- Includes Boot Loader (0.5 KB)

# Arduino Uno & Pro Mini



Arduino Pro Mini – Embeds easily into a project

# Writing A Software Program

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## 1. Structure – The Solution

- a. Defines the Sequence of steps (Algorithm)
- b. Independent of Programming Language
- c. Provides Clarity to the Solution

## 2. Syntax – The Code

- a. Encodes Solution into Micro-Actions
- b. Completely Language Specific
- c. May provide ways to be Efficient

# Arduino Program Structure

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// Run Once After Reset

```
void setup () {  
    initialization statements;  
}
```

// Run Continuously Until Next Reset

```
void loop () {  
    data processing statements;  
}
```

# Arduino Program Example

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```
#define pin 13; // specify the LED pin
void setup () {
  pinMode (pin, OUTPUT); // set the 'pin' as output
}
void loop () {
  digitalWrite (pin, HIGH); // turn LED pin on
  delay (1000); // pause for one second
  digitalWrite (pin, LOW); // turn LED pin off
  delay (1000); // pause for one second
}
```

# More Sample Statements

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// Using the Serial Port

```
Serial.begin(BAUDRATE); // initialize COM Port  
inByte = Serial.read(); // read a byte
```

// Using the PWM Output

```
Servo AzServo; // initialize AZ pin  
AzServo.attach(pin9, minPW, maxPW);  
AzServo.write(curAzimuth); // turn the servo
```

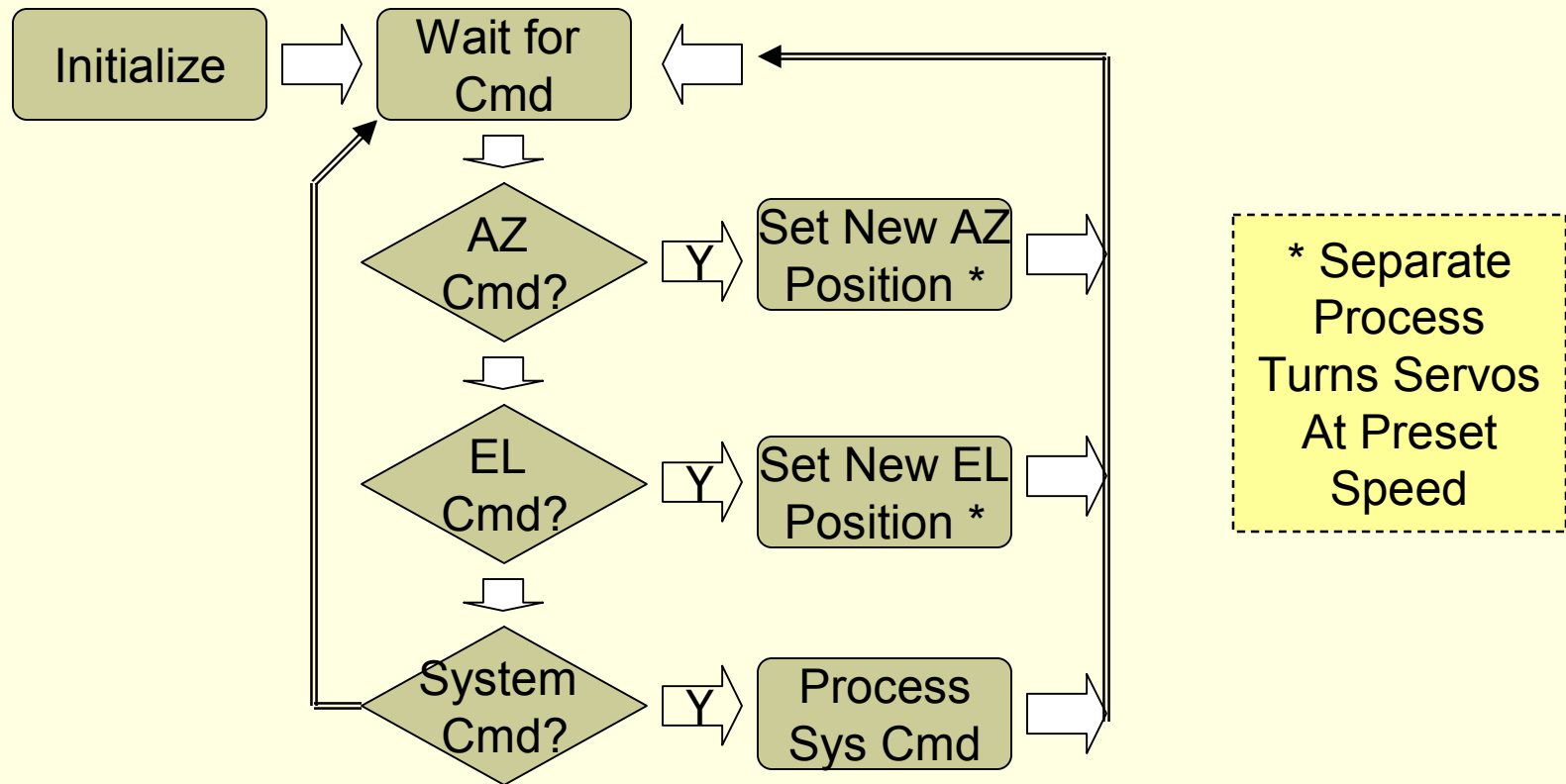
# Position Control Program Specs.

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- Handle EasyComm II commands
- Generate PWM signals to accurately position Azimuth & Elevation Servos
- Provide full sweep using Flip Mode
- Provide a wide range speeds (1 to 50 rpm)



# Control Program Structure



# Commands Implemented

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- VE (display version)
- AZ[nnn.n] (0 – 360 degrees)
- EL[nn.n] (0 – 90 degrees)
  
- HELP (display this page)
- SET (display settings)
- SET AZPW|ELPW [nnn nnnn] (min/max pulse widths)
- SET SPEED [nn] (1 - 50 rpm)
- SET DEFAULTS (load defaults)

( Audience Participation Demo !!! )

# Summary

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- High Utility & Fun DIY Project using Arduino
- Programming Complexity – ‘Intermediate’
- Works with any Software that supports EasyComm II - HRD Satellite, PC-Sat, etc.
- Simple Mechanical Parts
- Easily Portable & Quickly Setup
- Perfect for Light-weight Satellite Antennas !

# Project Cost

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- Arduino Pro Mini ~ \$20
- RS232 Level Converter ~ \$15
- Servos (x2) ~ \$60
- Power Adapter 5V 1.5A DC ~ \$15
- Plastic Sheets 8x10 inch (x2) ~ \$2
- Hardware - Nuts and Bolts ~ \$3
- DB9 Adapters & Phone Cable ~ \$9
- Elbow Grease ~ Priceless !

# References

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- Arduino Web Site [www.arduino.cc](http://www.arduino.cc)
- Arduino Project Ideas  
[www.arduino.cc/playground/Projects/Ideas](http://www.arduino.cc/playground/Projects/Ideas)
- How RC Servos Work [www.pcbheaven.com](http://www.pcbheaven.com)
- RC Store [sheldonshobbies.com](http://sheldonshobbies.com)
- Tap Plastics Store [www.tapplastics.com](http://www.tapplastics.com)

# Thank you !

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Wishing you a fun time  
building Arduino & Amateur Radio projects !

Email Questions or Comments to  
[k6vug@arrl.net](mailto:k6vug@arrl.net)

# The End

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# Arduino Boot Loader

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- Activated by Reset
- Completes basic checks
- Transfers control to the custom uploaded program
  
- Makes it very easy to upload & run new programs



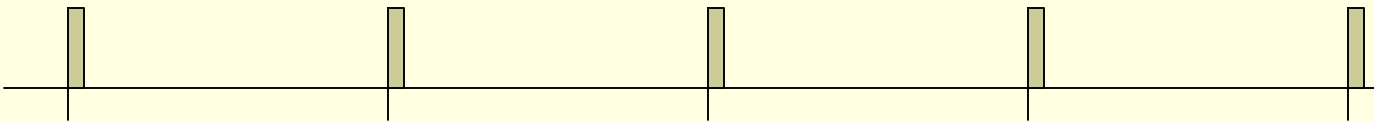
# EasyComm II Protocol

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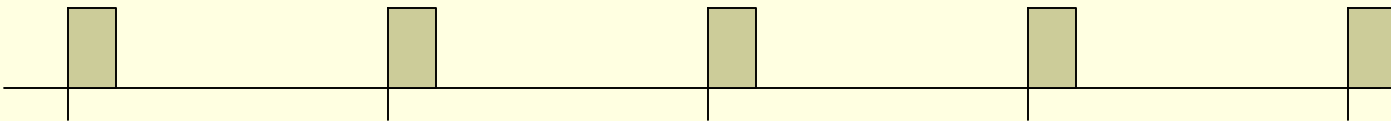
- Specifies Commands to Control Rotator, Radio, etc.
- Simple Text Command Format
  - Example: AZ123.0 EL45.0
- Commands can be spaced out in one line
- New commands override previous commands
  - helps rapid change in movement

# Pulse Width Modulation

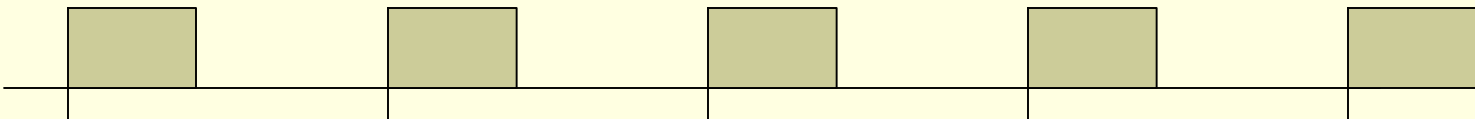
Pulse Width: 1mS



Pulse Width: 3mS



Pulse Width: 8mS



Pulse Rate: 20mS

# PWM Drive in RC Servos

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- Smart way to transmit analog signals over long distances
- Excellent tolerance to electrical noise and attenuation
- Simple algorithm converts a range of analog values to a range of pulse widths
- Simple electronics at the receiving end reconstructs the analog signal