COSMOneer **Proto**

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Contents

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Licensing

This work is licensed under the *[Creative Commons Attribution-ShareAlike 4.0 Unported License](#)* and the *[Open Source Hardware (OSHW) Definition 1.0](#)*.

Source Code, Files & 3D Models

The Cosmoneer Proto Rev 01 project is located here:

https://github.com/cosmospioneering/Cosmoneer-Proto

How can I contribute?

Depending on your skills, you may consider the following:

- PCB design work was performed using open source [KiCad EDA Software Suite](#).

- 3D modeling was performed using [Rhino 3D](#)

- 3D printing was performed using 3D System's 3rd Generation Cube 3D (no longer sold)

- Arduino Programming was initially performed using Arduino IDE v1.5.2, now using 1.6.10.

  Please visit www.arduino.cc for more information and downloads.

Disclaimer

This kit is provided "AS IS" and "with all faults". Cosmos Pioneering disclaims all other warranties, expressed or implied, regarding products, including but not limited to, any implied warranties of merchantability or fitness for a particular purpose. Please see our product warranty at the end of this product manual for information regarding a defective product.

 Proto

About Your Kit

Introduction

The Proto is a desktop satellite simulator, designed to expose you to many of the challenges spacecraft face while stationed in orbit or floating in space.

Your project kit is licensed through open hardware and open software licensing because we believe in the sharing of knowledge!

You kit was hand built in the USA. We hope you enjoy it! If you have any questions or problems, please visit our website or send us an email.

Thanks!

Cosmoneer Proto Kit Contents

Your kit contains the following:

- Product manual (this document)
- Cosmoneer specification
- (1) Cosmoneer Proto
- (1) Zero-G simulator stand
- (1) 12V Wall wart power supply
- (1) USB cable & FTDI programmer
- (1) Storage shell
- (1) Serial IrDa communications board
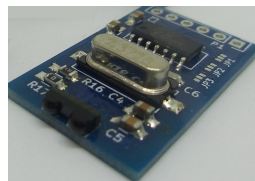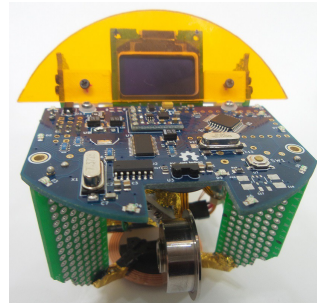
Applies to Note

This document applies to the Rev 02 Proto only.

Tools Needed

In order to get the most from your kit, you will need:

- A computer with the Arduino IDE installed (version 1.5.2 or higher)

- The appropriate Proto sketch (revision specific via download)

- A level surface

- 120V AC power outlet
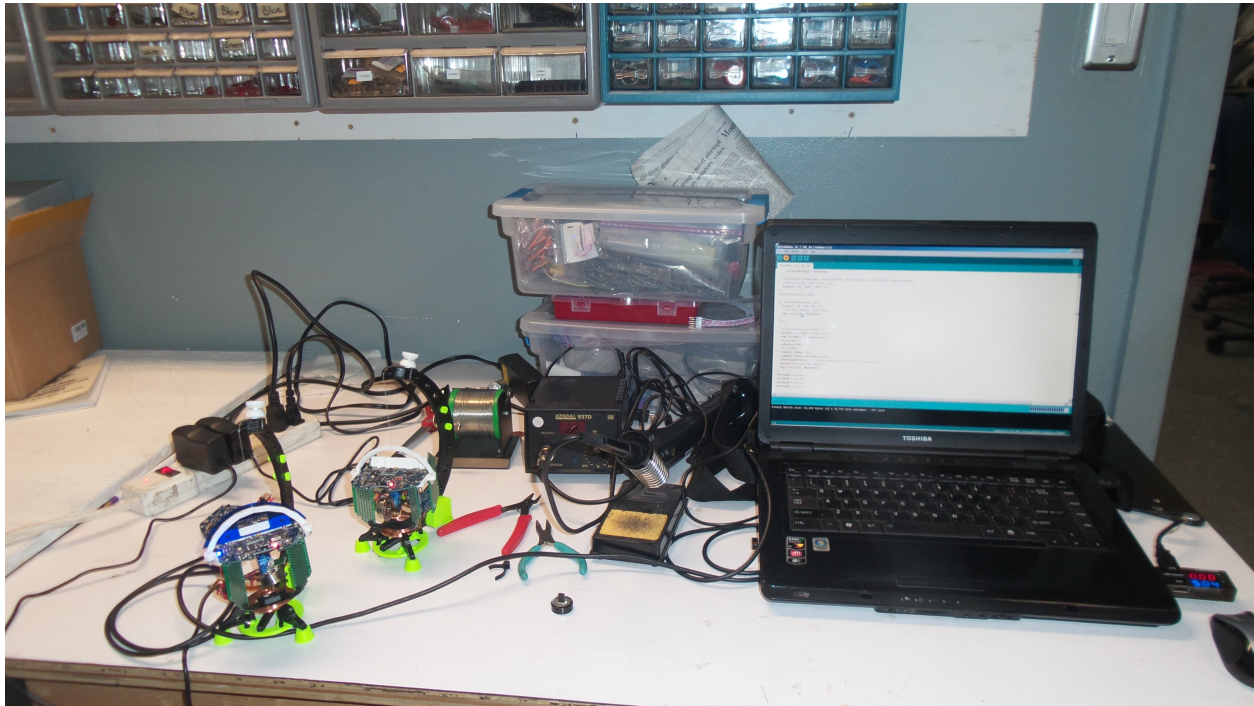
Ideas and suggestions

For other code options, visit the user community at:

http://www.cosmospioneering/community

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Using Your Kit

Getting Started

Setting Everything Up

Once you have everything unpacked and laid out, follow the assembly instructions (http://www.instructables.com/howto/cosmoneer/), and then follow these setup steps:

1. Wind the string in a counter-clockwise direction onto the spool, leaving 3"-4" of string between the spool and the Cosmoneer Proto. Insert the spool's peg into the top of the stand.

2. Maneuver the string onto the guide channel at the front edge of the stand so the string and hook dangle over the center of the coil.

3. Firmly grasp the Cosmoneer and hang it from the hook.

4. Place 2-4 USA pennies (or equivalent) in each counterweight holder on the rear of the unit until the coil of the Cosmoneer appears level and is closely ceneter over the stand's Tx coil.

5. Slowly twist the spool so the Cosmoneer Proto rests approximately 1-2 mm from the TX power coil on the Zero-G stand.

6. Connect the power supply to the ZeroG stand.

7. Once the SuperBurst Battery Replacer Board has fully charged, a green LED will illuminate. Your Cosmoneer should begin to boot up and will initiate it's start-up sequence.

8. The Proto will test its compass calibration and execute a calibration routine for your physical location if it is unable to successfully compelte a rotation. Once completed, it will begin its preprogrammed command sequence.

Uploading Code

When you are ready to write your own code for the Cosmoneer Proto, plug your programming cable into the Proto's programming port, which is the white connector just above the servo under the main pcb.

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Simulating a Satellite in Space

Summary

Generally speaking, "space" begins at 100km, otherwise known as the Kármán line, and Low Earth Orbit (LEO) is considered to lie between 160km and 2,000km. Orbiting spacecraft reside in Low Earth Orbit (or LEO) in order to avoid drag-inducing atmosphere that slows them down until they fall back to Earth. To simulate this same environment., we use low cost materials, wireless power and 3D printed parts. LEO on a shoe-string budget!

Cube satellites, the inspiration for the Cosmoneer Proto, rarely have an independent guidance system to control its attitude. Some tumble, others use Earth's magnetic field, even fewer use fixed spinning wheels and rarely do they use gimbaled control moment gyros. Using simple hobby electronics, we recreated the more advance control moment gyro system. A high speed flywheel (or gyro) is coupled with a servo (gimbal) to provide rotational torque in the Yaw Axis, similar to turning your head left and right.

In order to operate in space, nearly all spacecraft rely on solar energy, a form of wireless power. Using a matched pair of wire coils, we transmit power from the Zero-G stand to the Cosmoneer Proto, providing a very close resemblance to solar power. Satellites are power limited in that they can only harness so much power via its fixed solar array. The Proto is similarly limited in how much power it can consume via the wireless link.

Architecture

All spacecraft designs tend to incorporate at the very least these basic systems: Command & Control, Power, Attitude Control and Communications. Using low cost components, the Cosmoneer Proto incorporates all of these systems at a very simple level.

Building on the Arduino architecture, serial infrared communications and the I2C bus, the Proto is able to further simulate the simple electronic systems built into early spacecraft. In fact, most cell phones have more computing power than many spacecraft in orbit.

Veering away from the cubesat standard, the Proto is housed in a spherical volume instead of a cube shape. While this increases complexity, it makes possible the ability to simulate a full three degrees of freedom (3DOF) in future versions.

Since the system is completely wireless and any communications require a line of sight link, audio and visual feedback are used to provide system status messages. Similar to "tones" used by some interplanetary spacecraft to denote the progression of descent stages during periods of near radio silence, our tones provide quick informational feedback as to what is happening right then.

Satellites tend to use light sensors to locate the sun and the earth to insure they are pointing in the right direction. Interplanetary spacecraft use asteroids and some stars to determine their location in space. The Cosmoneer Proto depends on the Earth's magnetic field to calculate its heading.

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Proto Subsystems

Command & Control

Microcontroller

Used to sensing and controlling every aspect of the Cosmoneer Proto.

Communications

System Status LED

Used for simple user feedback from the MCU itself.

Perimeter LEDs

Controlled by 8 of the 16 individual PWM channels, 8 LEDs provide "at a glance" visual feedback.

Piezo Speaker

A single piezo element provides audio feedback.

Serial IrDA

An infrared transceiver and a serial IrDA protocol chip provide a solid communications protocol that can be initiated between Cosmoneer Protos, or a Proto and a ground-based station.

Attitude Control

Three Axis Compass/Magnetometer

Using the Yaw axis, directional heading values can be obtained.

Control Moment Gyro

A Servo, Gyro motor and brushless motor speed controller used to provide inertial guidance.

Power

Wireless Power Transmitter and Receiver

Used to simulate solar energy, Wireless power not only provides energy to function, but also provides a method to stay energized while remaining near friction-less.

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Product Features & Specifications

Overall

All detailed Mfg spec sheets can be found here.

Cosmoneer Proto Motherboard

Micro Controller – Atmega328p-au, 5V, 16Mhz

Compass – Honeywell HMC5883L, 3.3V

Serial IrDA – MCP2120-SL & TFBS4711, 5V

16ch PWM Controller – PCA9685, 5V

Control Moment Gyro Assembly

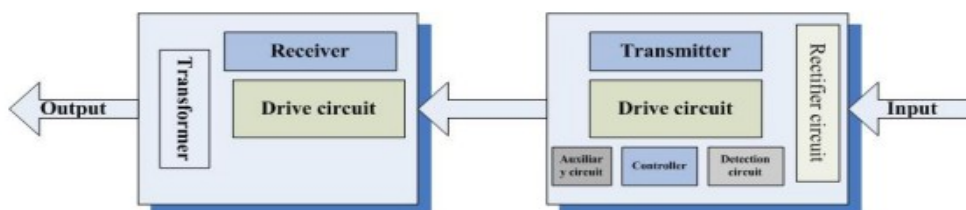5g Micro Servo – 0.6kg torque (8 oz/in), 0.1 sec/60deg(4.8v), 4.2-6v input

Brushless Motor – 5.5v 3 phase

Motor Controller – MX-3A ESC

Storage Sphere

Acrylic Sphere – 100mm OD, 97mm ID

Wireless Power Module

Specifications

Input Voltag	12.0 V
Input Voltage(limits)	13.5 V
Output Voltage	5V
Output Current(maximum)	600mA
Transmitter Coil Inductance	30uH
Coil Diameter	:38mm
Coil Height	2mm

Distance	Voltage	Current
1mm	5V	600mA
2mm	5V	450mA
3mm	5V	360mA
4mm	5V	310mA
5mm	5V	240mA
6mm	5V	210mA
7mm	5V	162mA
8mm	5V	150mA
9mm	5V	132mA
10mm	5V	120mA
11mm	5V	110mA
12mm	5V	70mA
13mm	5V	54mA
14mm	5V	41mA
15mm	5V	28mA
16mm	5V	19mA
17mm	5V	17mA
18mm	5V	10mA

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Schematic
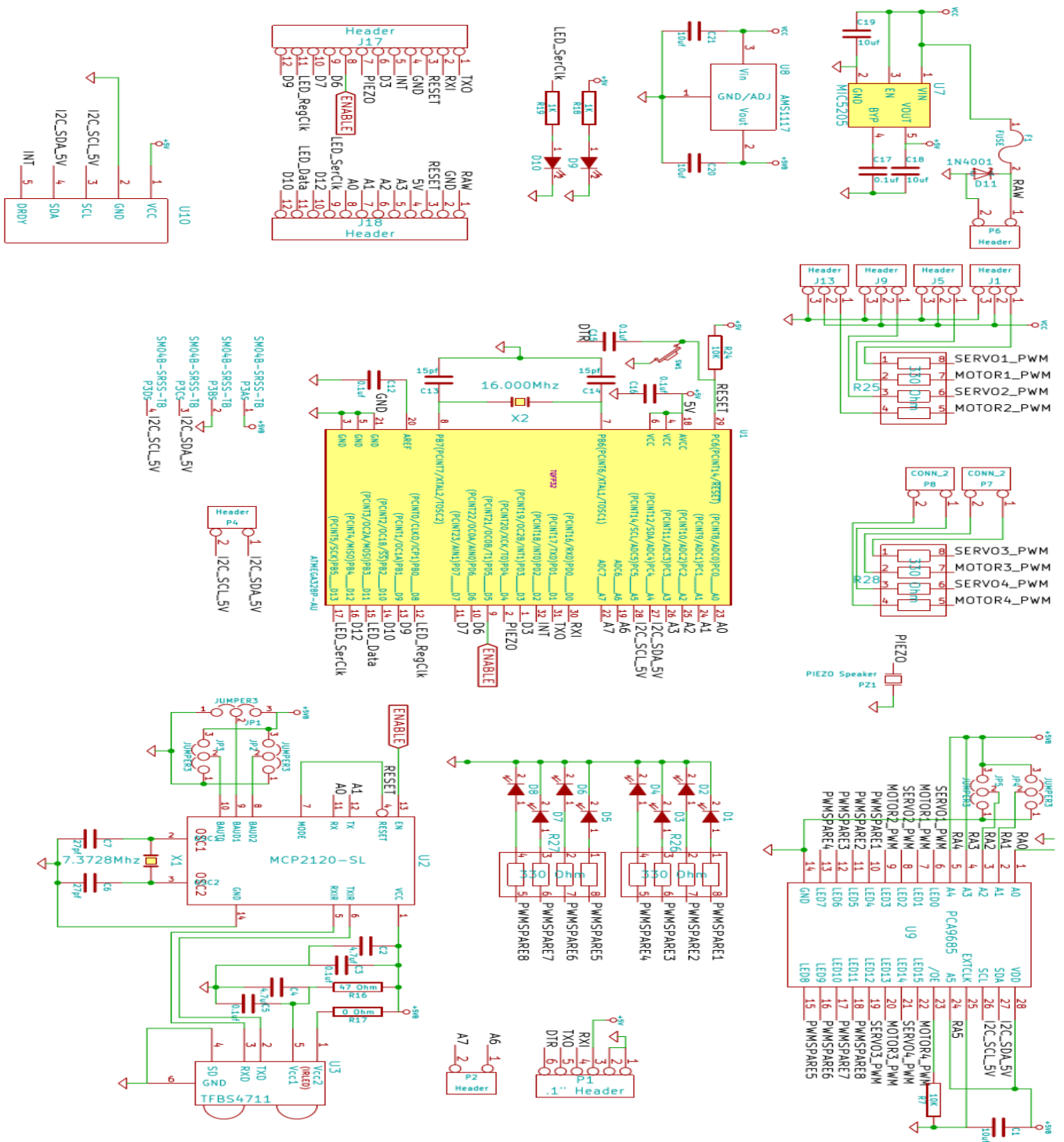
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PCB Pin Map & Jumper Settings

Pin labels (top connector): GND, GND, +5V, RX1, TX0, DTR

Left side: +5v RAW, GND, PWM3, PWM2, PWM1, PWM0, PWM13, PWM12, PWM15, PWM14

Center-left: SDA, SCL, +5V, GND, SCL, SDA, INT

Right side: TX-D0, RX-D1, RST, GND, INT-D2, D3, PIEZO-D4, ENABLE-D5, D6, D7, D8, D9, A6, A7

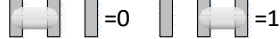Bottom-right: D10, D11, D12, D13, A0, A1, A2, A3, +5V, RST, GND, RAW

PIEZO, GND
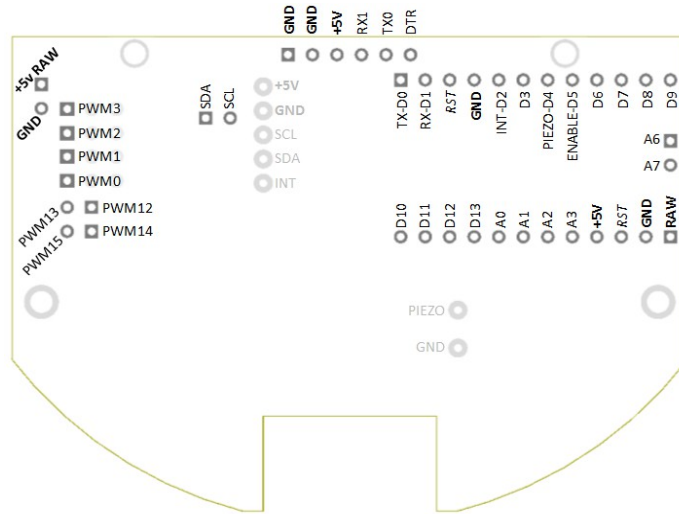
User Configurable Jumper Settings

- Users may adjust jumper profiles to configure specific Cosmoneer settings.

WARNING! Please insure the center jumper does not bridge the two outer jumpers, else a power to ground short will result!

PCA9685 I2C Address Jumper Settings

- Jumpers adhere to the following rule:

=0   =1

RA0-RA5 00(1111) Address 0x7C	JP4(RA0) (Default) JP5(RA1)
RA0-RA5 01(1111) Address 0x7D	JP4 JP5
RA0-RA5 10(1111) Address 0x7E	JP4 JP5
RA0-RA5 11(1111) Address 0x7F	JP4 JP5

MCP2120 Baud Rate Jumper Settings

- Jumpers adhere to the following rules:

JP1 (B1)   =1   =0
JP2(B2) & JP3(B0) =0   =1

B0-B2 000 Baud 9600 (Default)	JP1 JP3 JP2
B0-B2 100 Baud 19200	JP1 JP3 JP2
B0-B2 010 Baud 38400	JP1 JP3 JP2
B0-B2 110 Baud 57600	JP1 JP3 JP2
B0-B2 001 Baud 115200	JP1 JP3 JP2

NOTE: These baud rates coincide with the use of an external 7.2728Mhz crystal (clock source).

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Guarantee, Warranty & Returns Policy

Satisfaction Guarantee

If for any reason you're not 100% satisfied with your Cosmoneer Proto kit in the first 30 days, just return the entire kit and we'll refund the entire product price. No questions asked.

Product Warranty

This Warranty covers any defects in material or workmanship of your Cosmoneer Proto under normal use during the Warranty Period. During the Warranty Period, Cosmos Pioneering will repair or replace, at no charge, products or parts of a product that proves defective because of improper material or workmanship, under normal use and maintenance.

The Warranty Period for this kit is 90 days from the date of purchase. A replacement kit or part assumes the remaining warranty of the original part, or 90 days from the date of replacement or repair, whichever is longer.

This Warranty does not cover any problem that is caused by conditions, malfunctions or damage not resulting from defects in material or workmanship

To obtain warranty service, contact us to determine the problem and the appropriate solution for you.

Returns Policy

In order to return your Cosmoneer Proto, all kit contents must be returned, along with the original packing slip. Unless your kit is approved for return and an RMA number has been issued, the customer will be responsible for return shipping costs.

Returns Process

Please call or email us to obtain an RMA number and return shipping address for defective products. Pack your unit as best as possible to avoid additional damage.

Contact

Cosmos Pioneering

Phone: 1-240-200-4189

Email: cosmoneer@cosmospioneering.com

3D Printable Replacement Parts

https://www.thingiverse.com/thing:2159548

https://www.thingiverse.com/thing:2154587