Rotor Control

A Microhams Open Source Project

General Project Requirements

- Simple: A beginners project
  - Computer control of one or more pieces of ham equipment
  - Web base interface
  - Not require a lot of knowledge of electronics or electronic assembly (a little smoke, not a lot)
- Low Cost: < $200
- Open Source
  - Open Source Software
  - Open Source Hardware
- Easy to understand
- Extensible
- Value Add
- Ethernet or wireless interface

- High Wants
  - Web Interface
  - Map Integration
  - Point and Click Bearing
    - Select point on a map
    - Select a contact from a contact list
    - Select a grid cell
  - View coverage area

What is out there?

COMPUTER ROTOR CONTROL INTERFACES

Computer Rotor Control Interfaces

- Yaesu GS 232B - $589.95
  - RS232 Computer Interface
- DX Engineering EA4TX - $229.00
  - USB Interface
- MDS RC1 - $260.00
  - USB Interface
- Easy Rotor Control - ~$230.00
  - RS232/USB, optional Enet
  - Kit
  - prices range between ~$140 - $350 depending on options.

- Developing our own
  - Computer Board
    - Raspberry Pi ~$25.00
    - Beagle Board Black ~$40.00
  - Misc. Cables and part < $40.00
  - Software Open Source and You Develop (free?)

Requires Client Software
Requires a Rotor with interface

Protocols

DCU-1

Command	Remarks
AP1xxx<cr>	Set bearing and rotate
AP1xxx;	Set bearing no rotate
AM1;	Execute rotation
AT1; or AT1<cr>	Current Location
;	Stop rotation
V	Version
K	Enter Calibration
k	Exit Calibration

GS232A

Command	Remarks
Maaa	Set bearing and rotate
Msss aaa bbb …	Time Interval move
T	Execute time move
C	Current Location
A [S}	Stop [All Stop] rotation
R [L]	CW [CCW] rotation
O [F}	Offset [Full} calibration
Xn	Speed (1,2,3,4)

Rotors Available

SELECT A ROTOR

Selecting a rotor

What you need to know to select a rotor?

- Wind Load for the Antenna(s) (AWL).
- Antenna Turn Radius
- Weight of antenna(s) and mast.
- Mount: Tower or Pole
  - For pole mounts you need to de-rate the rotor
    - AWL * mast height <= .45
- Design Criteria
  - Antenna Wind Load (AWL) < rotor wind load
  - What about K factor?
    - K_{factor} = Antenna Turning Radius(m) * [Antenna weight + Mast Weight] <= Rotor K factor. K Factor is specified by Yaesu only

Wind Load Area Yagi Antennas

Band	Number of Elements	Area (m^2)	Area(ft^2)
40m	2	2.2	23.681
20m	3	0.7	7.535
20m	4	1.2	12.917
20m	5	1.7	18.298
40m/20m	4 Tapered	0.8	8.611
15m	4	0.6	6.458
10m	5	0.6	6.458
6m	6	0.37	3.983
2m	10	0.2	2.153
70cm	12	0.06	0.646

Rotor Suppliers

Azimuth

- Alliance
- CDE
- Create
- Daiwa
- Emotator
- Fukner
- Glavannini
- HyGain
- Kenpro
- Orion
- Radio Shack
- Walmar
- Yaesu
- …

Elevation

- Create
- Emotator
- Kenpro
- Yaesu
- …

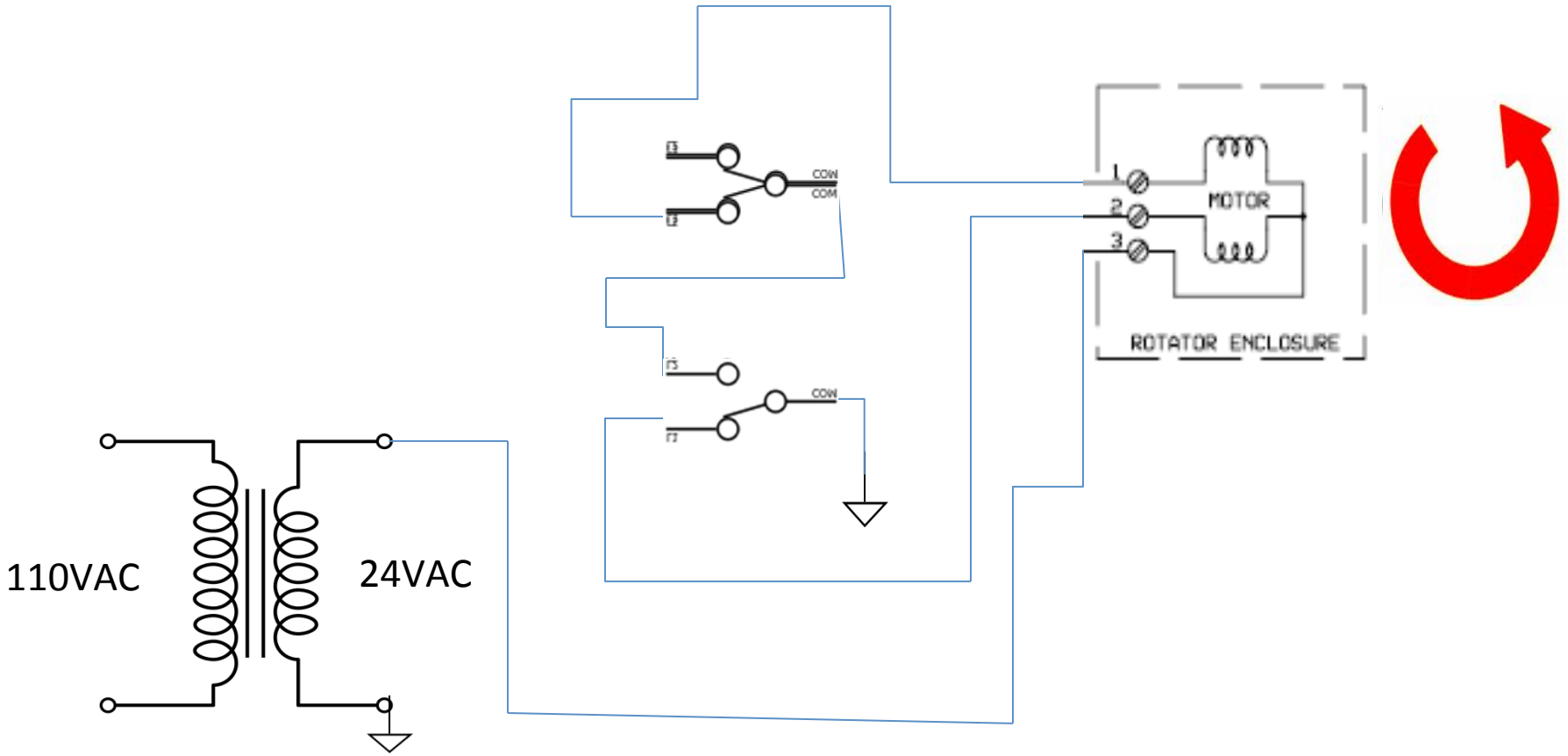
Rotor Pricing

	Radio Shack	G-450A	G-800SA	G-800DXA	G-1000DXA	G-2800DXA
						
Duty:	Light	Light	Medium	Medium	Heavy	Extra Heavy
Wind Load:	10 Sq.Ft.	10 Sq.Ft.	16 Sq.Ft.	16 Sq.Ft.	23 Sq.Ft.	32 Sq.Ft.
Vertical Load	99 Lbs.	242 Lbs.	440 Lbs.	440 Lbs.	440 Lbs.	661 Lbs.
Interface to CC	No	No	No	Yes	Yes	Yes
Price	**$59.95**	**$299.95**	**$419.95**	**$499.95**	**$599.95**	**$1299.95**

Reducing the cost

BUILDING INTEGRATED ROTOR CONTROL

Rotor Basics



Controlling where you point

Some engineering

- Motor is synchronous to 60 Hz.
- ~1 minute to rotate 360° with no load. Exact time depend on Frequency
- 60 'cycles' per second (e.g. 60Hz)
- 10 cycles per degree of movement (1 second = ~6°)
- Calibrate
  - Line up marks on rotor and point it in a know direction.
  - Rotate CW until rotor hit stop (On > 1Min)
  - Rotate CCW until rotor hits stop (On > 1 min)
  - Enter the direction into the controller (note 0/360 is North)

Rotating

- Get the desired heading and normalize it (0 to 360)
- Calculate the difference between the desired heading and the current heading in degrees
- - rotate clockwise, + rotate counter clockwise
- Divide by 6 to get the time in seconds to activate the motors

Assumptions/Concerns

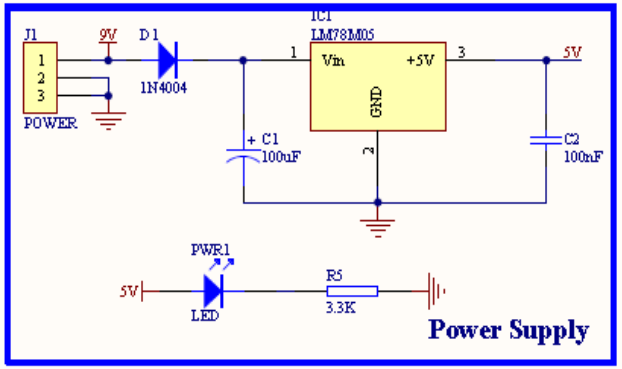
Assumption

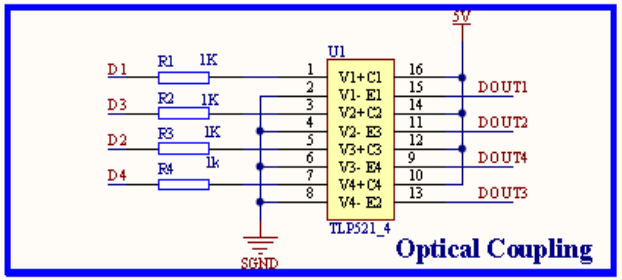
- The rotor stops at 0° and 360°
- Cannot pass through n*360 where n >= 0
- 0° is ‘North’
- Close counts

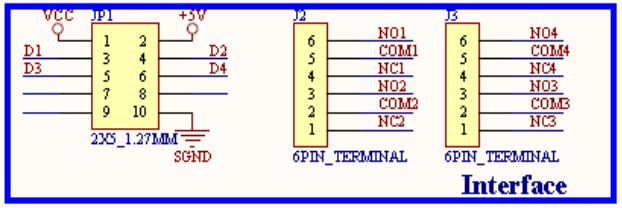
Concerns

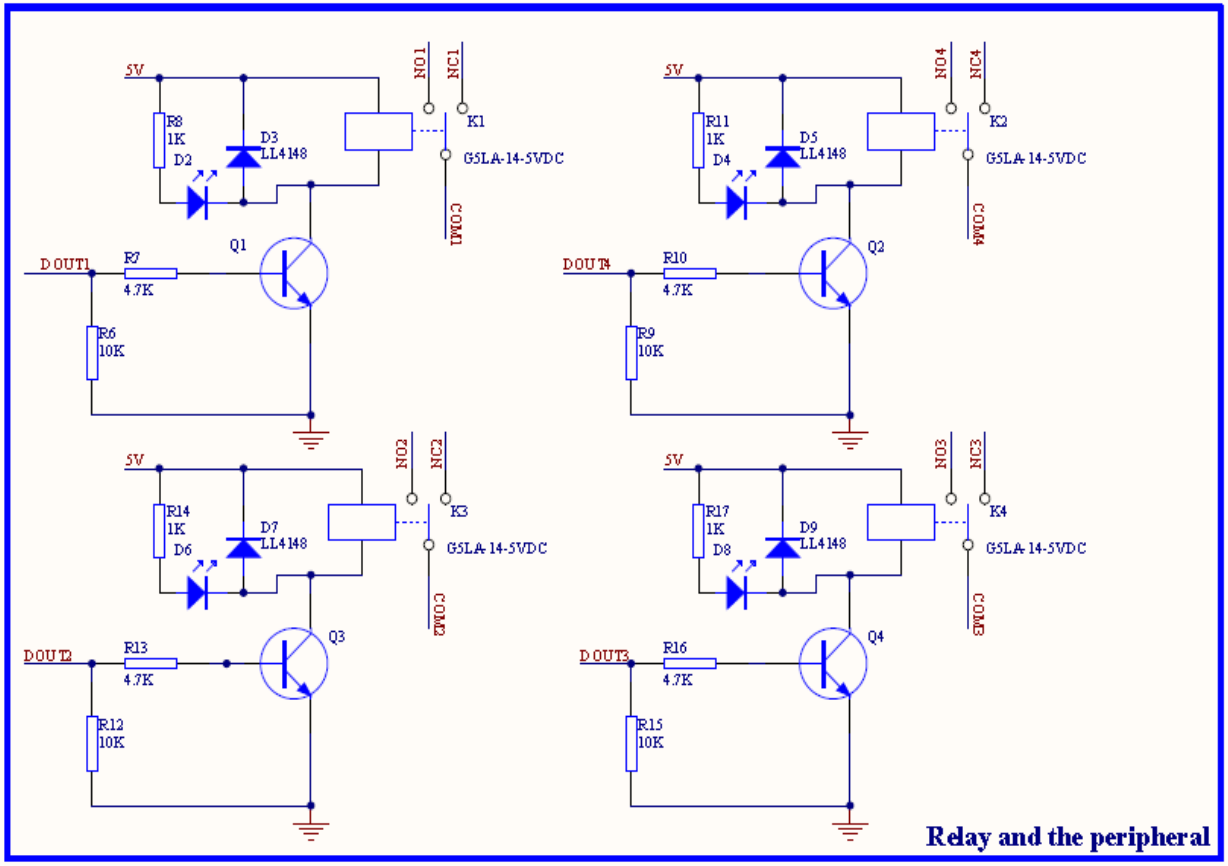
- No stop, and the rotor will wrap your coax (feed line).
- Coax wrapping
- Not point north requires that care be taken in calculating rotation direction and time.
- Cannot track object that pass through zero
- Low Accurcy

Rotor Interface Schematic









Build or Buy

2 Relay Board ~$4 - $9
4 Relay Board ~$5 - $15

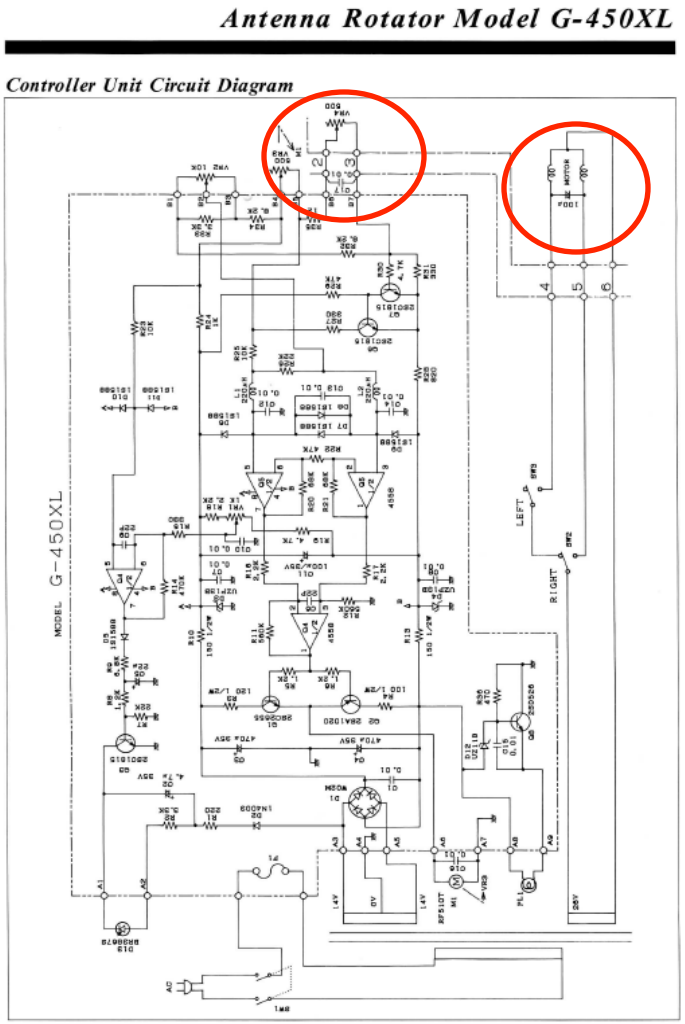
BUY!!

Cost Check

- CPU Board: Beagle Board Black - ~$40.00
- Relay Board: ~$6.00
- Power Supply: ~12.00 + Labor
- Misc. Jumper Cables ~$3.00
- Rotor - ~$60.00
- Total - ~$121.00

Yaesu Rotor

- Uses similar synchronous motor
- Does not have ‘hard stops’
  - Allows you to go through the zero point
- Provides feedback through a potentiometer circuit
  - Use the A/D converter to read feedback voltage



Enhancements

FEEDBACK

Types of Feedback

- Position
  - where is the antenna pointing?
  - Potentiometer
  - Rotary or Shaft Encoder
  - Compass chip
- Velocity
  - How fast is the antenna moving?
  - Differentiator
  - Timer
  - Velocity Chip
- Acceleration
  - How fast is it changing?
  - Accelerometer

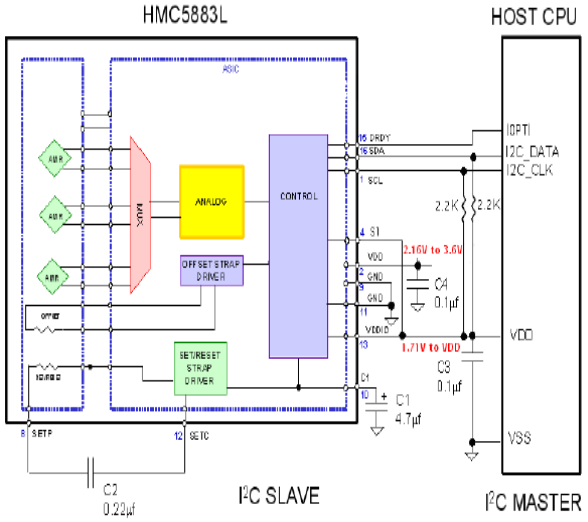
Direction - HMC5883L

Features

- 3-Axis Magnetoresistive Sensor
- Built in self test
- Low Voltage Operation
- I2C Interface
- 1° -2 ° resolution
- Built in degaussing
- Wide Magnetic Field Range to allow use in strong magnetic field environments.
- 160Hz output rate

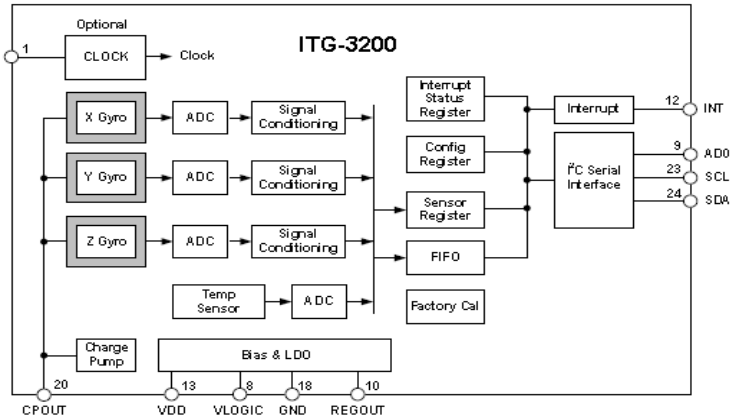
Concerns

- Senses magnetic fields – need to keep it away from steal



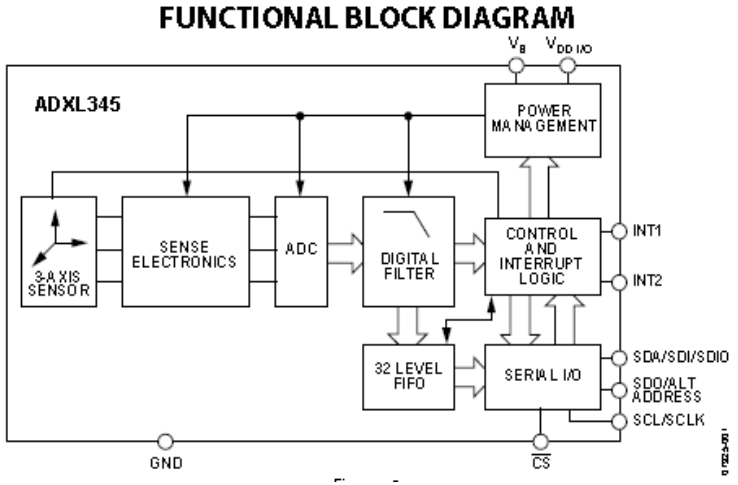
Velocity – ITG3200

- 3 Axis digital gyroscope
- Low Voltage
- I2C interface

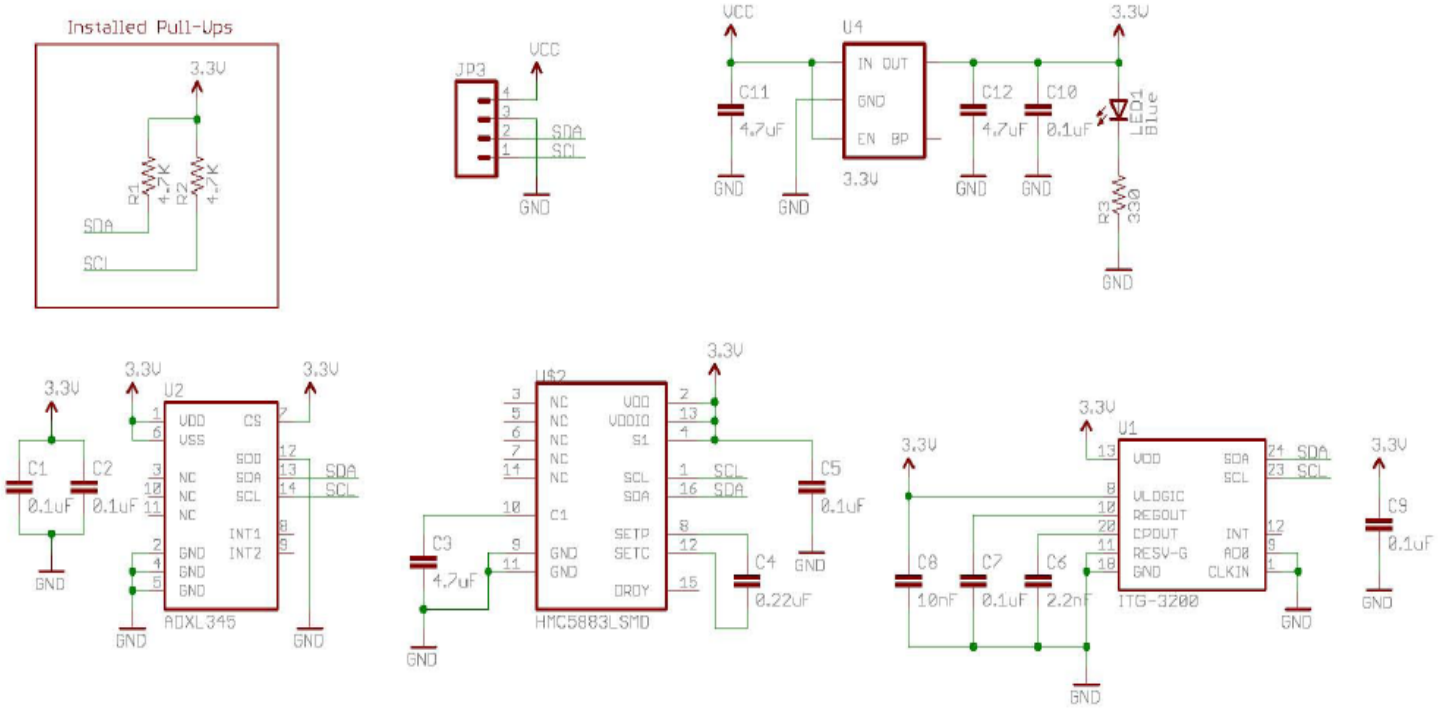


Acceleration – ADXL345

- 3 Axis Digital Accelerometer
- Low Voltage (2-3 V)
- I2C Interface



Feedback Board



Web Interface

Why Web Interface

- Restful Interface
- Browser base interface
  - Any smart device can control it.
- Build mash ups as applications
  - Point and click grid cells
  - Coverage mapping
  - Point and click satellite tracking

Node JS

- Built on Chrome javaScript Runtime
- Event Driven
- Non Blocking I/O
- Built in Web Server

Project Status

Hardware/Software

- Hardware
  - Components are Identified
  - Hardware Interfaces are designed for rotor control and feedback boards
  - Beagleboard Interface board is designed and we are getting PCB costing
  - Kit price available in late April

Software

- Software
  - Select node JS framework
  - Peek and Poke tested the hardware components

WHAT YOUR INTEREST ?

What next?

- Who is interested?
  - We will be posting a project update on our web (Microhams.com)
  - If you are interested you can sign up and order a kit
  - We will schedule a few weekend meeting for kit construction and software workshops
- Want to do a feature?
  - List of add on features
  - You can signup to work on a feature and contribute
- Open Source and Open Hardware
  - You will be free to take our design and improve