2016

Mini Satellite-Antenna Rotator

By

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Mini satellite antenna rotator

- FTM-100DR review
- Battery experiments

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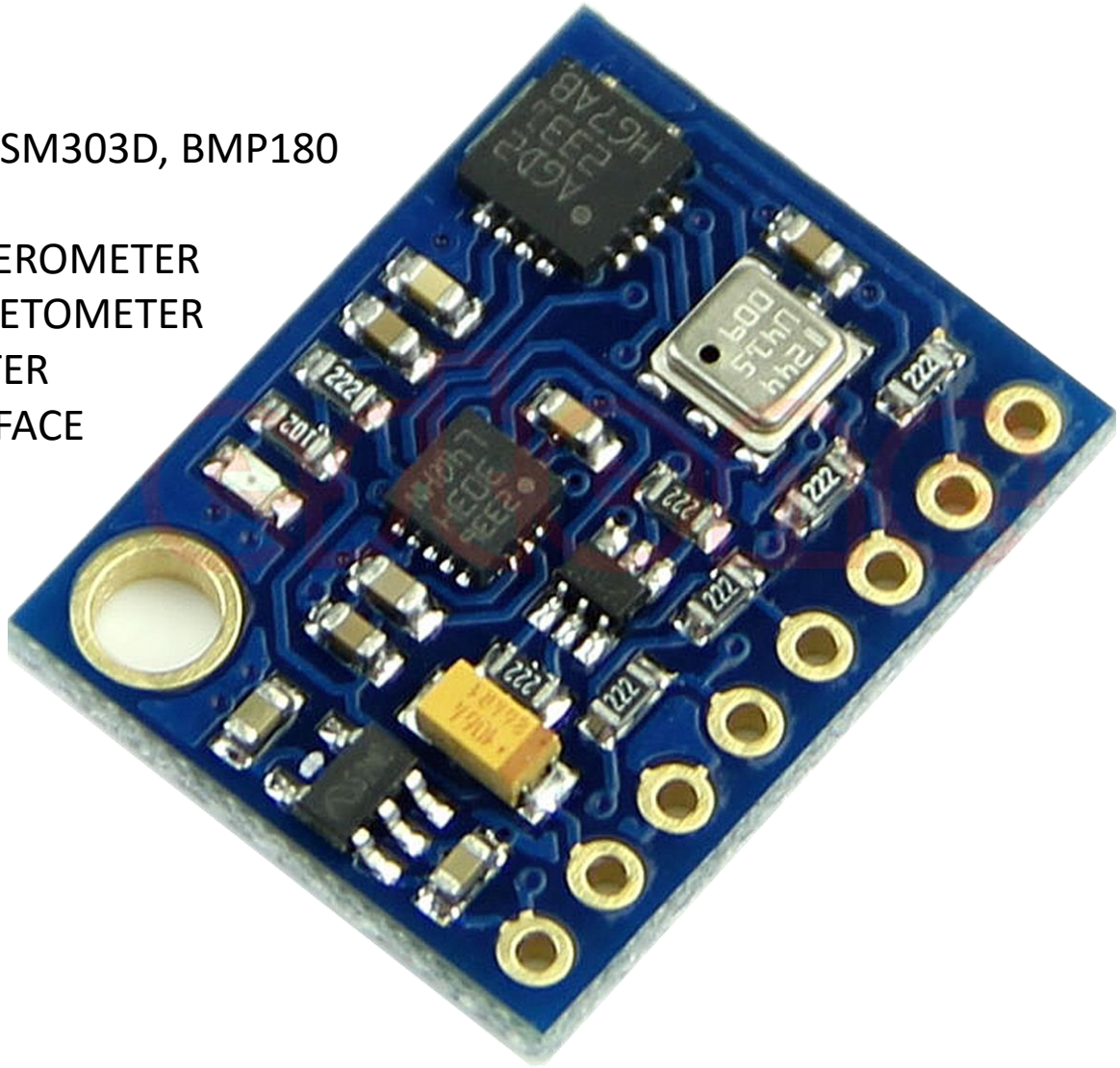
10 DEGREE OF FREEDOM SENSOR

L3GD20, LSM303D, BMP180
3D GYRO
3D ACCELEROMETER
3D MAGNETOMETER
BAROMETER
I2C INTERFACE



VECTOR DIAGRAM

ANTENNA AXES

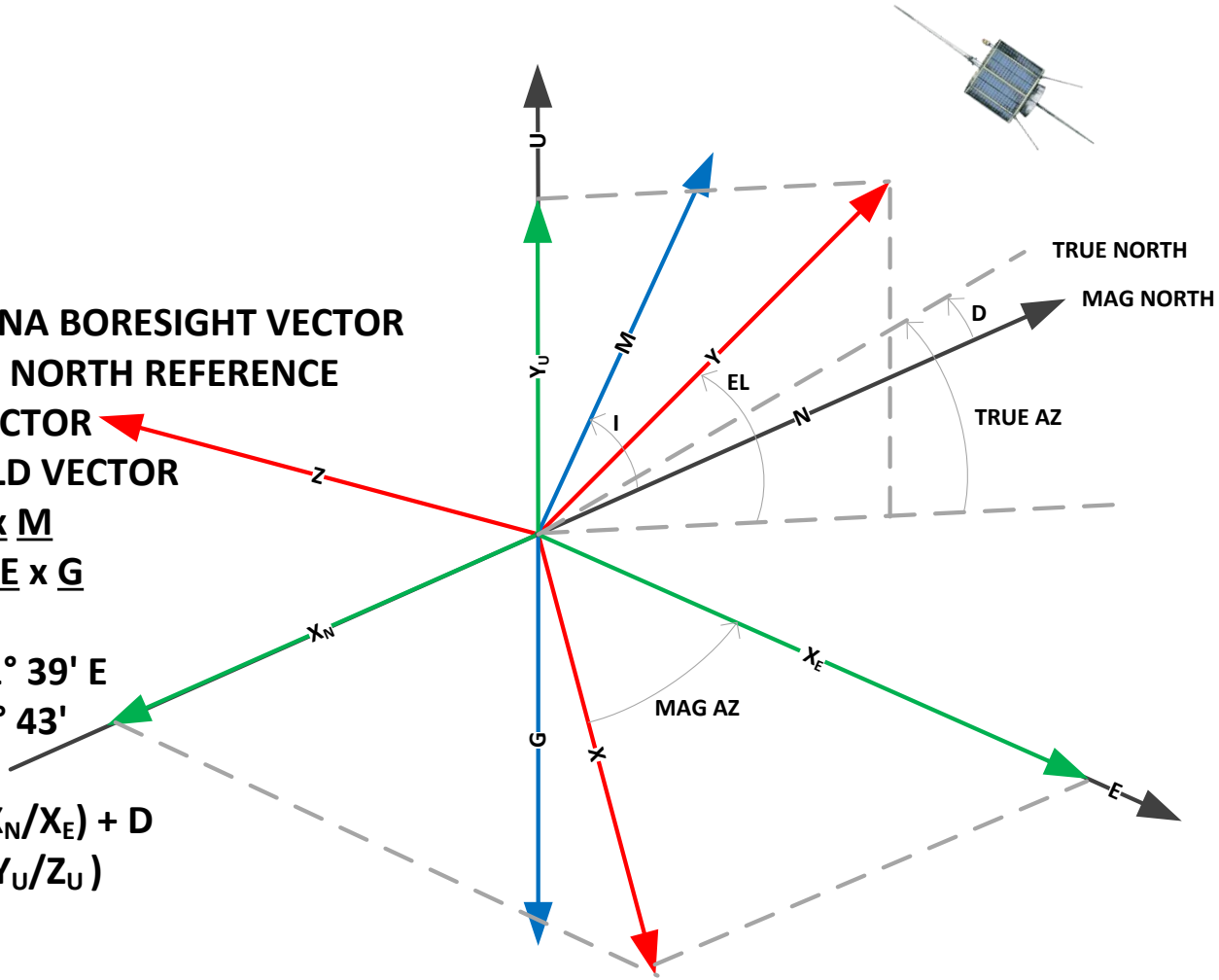
GROUND AXES

SENSOR VECTORS

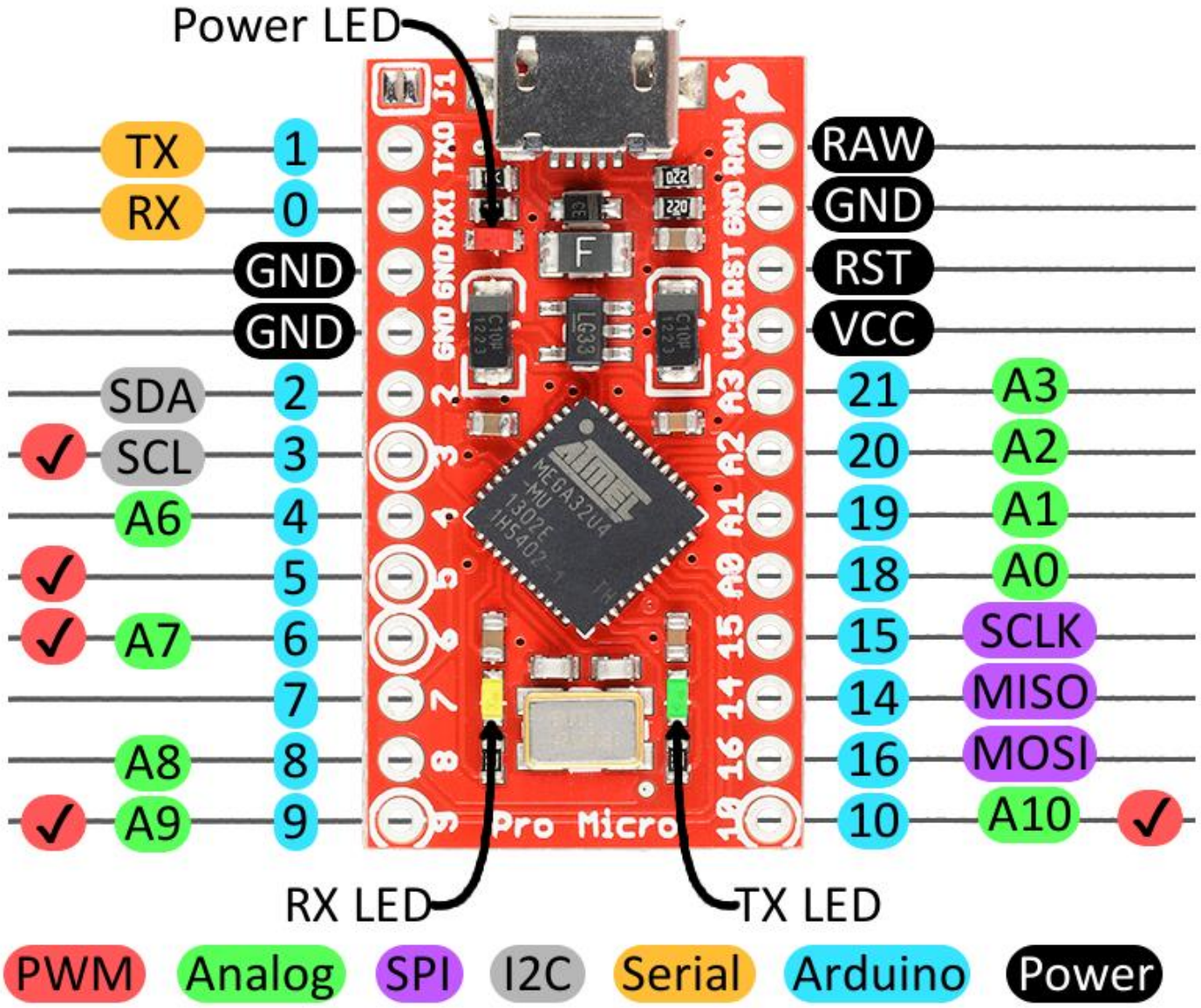
PROJECTION VECTORS

CONSTRUCTION LINES

XYZ = ANTENNA AXES, Y = ANTENNA BORESIGHT VECTOR
ENU = GROUND AXES, MAGNETIC NORTH REFERENCE
M = EARTH'S MAGNETIC FIELD VECTOR
G = EARTH'S GRAVITATIONAL FIELD VECTOR
E = MAGNETIC EAST VECTOR = G x M
N = MAGNETIC NORTH VECTOR = E x G
U = MAGNETIC UP VECTOR = -G
D = MAGNETIC DECLINATION ≈ 11° 39' E
I = MAGNETIC INCLINATION ≈ -68° 43'
Y_U = Y.U, X_N = X.N, X_E = X.E
AZ = TRUE AZIMUTH = ARCTAN($-X_N/X_E$) + D
EL = TRUE ELEVATION = ARCTAN(Y_U/Z_U)

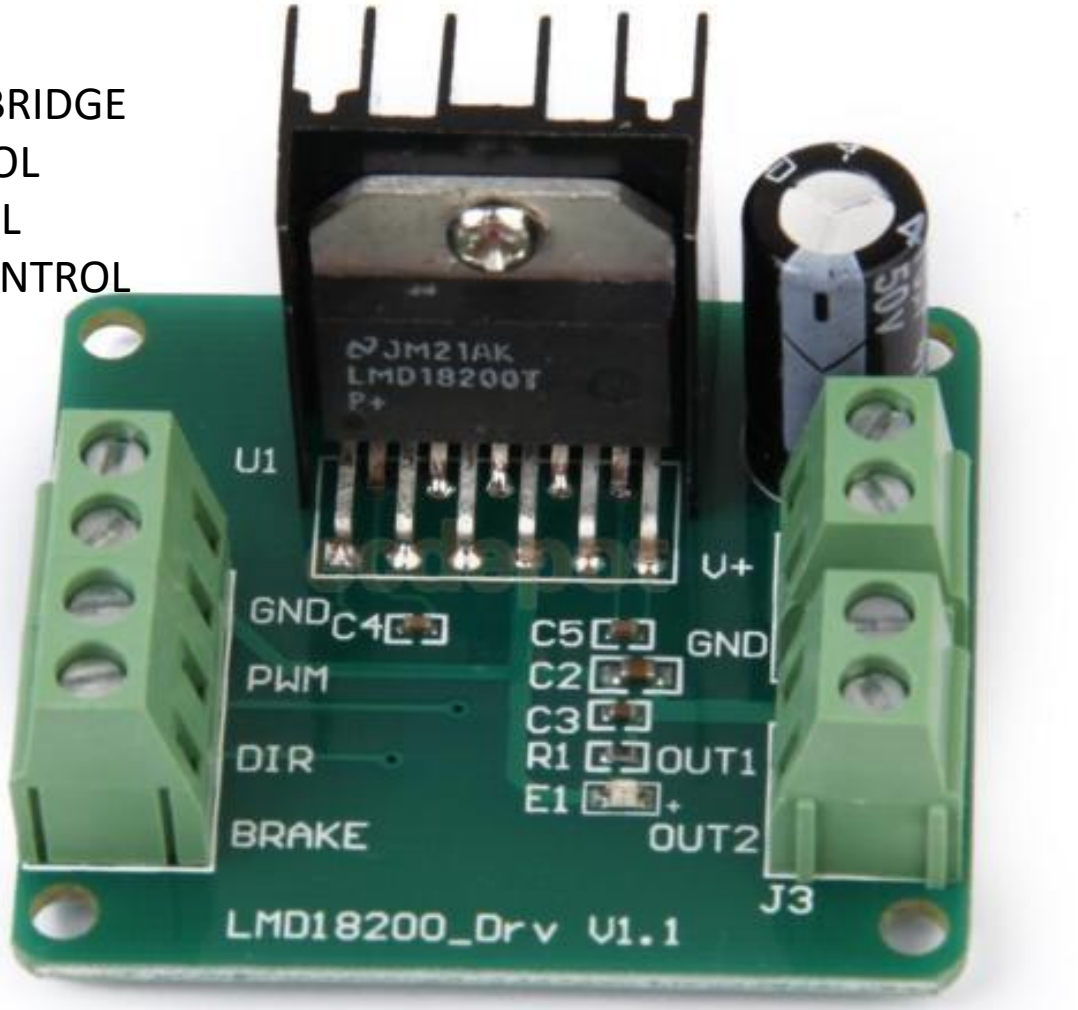


ARDUINO-COMPATIBLE MICROCONTROLLER

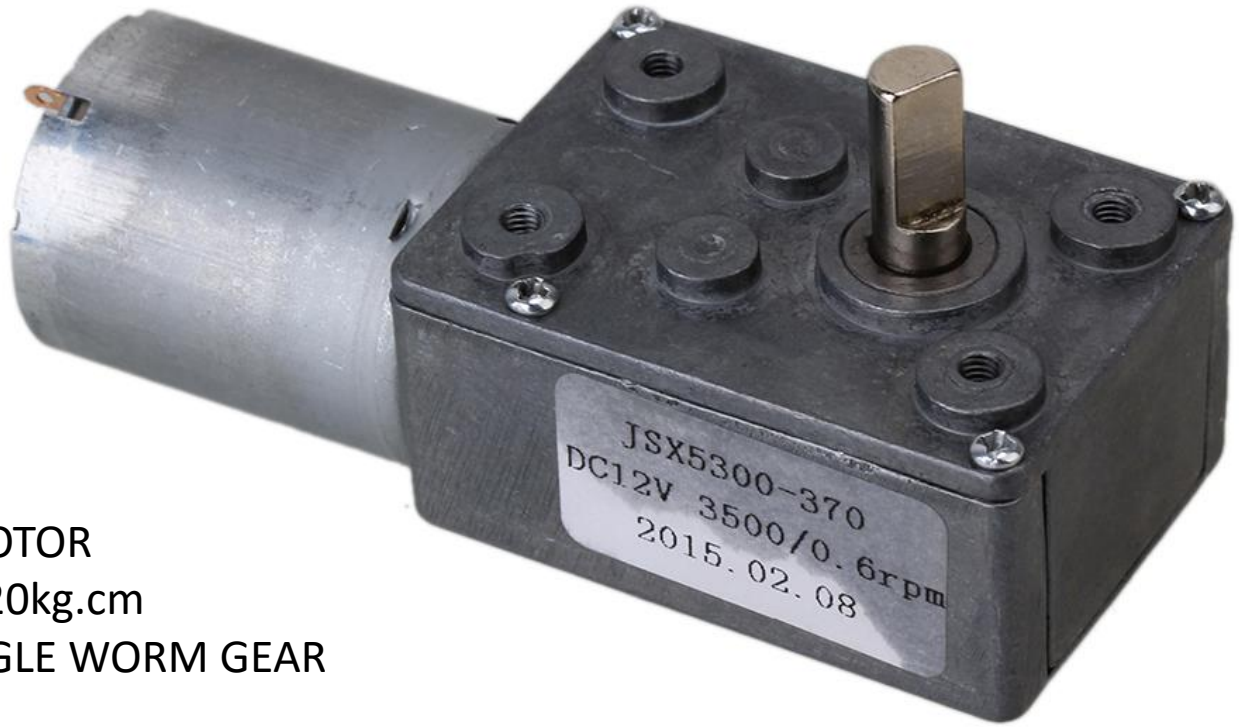


MOTOR DRIVER

LDM18200
12-55V/3A H-BRIDGE
SPEED CONTROL
BRAKE CONROL
DIRECTION CONTROL
5V INTERFACE

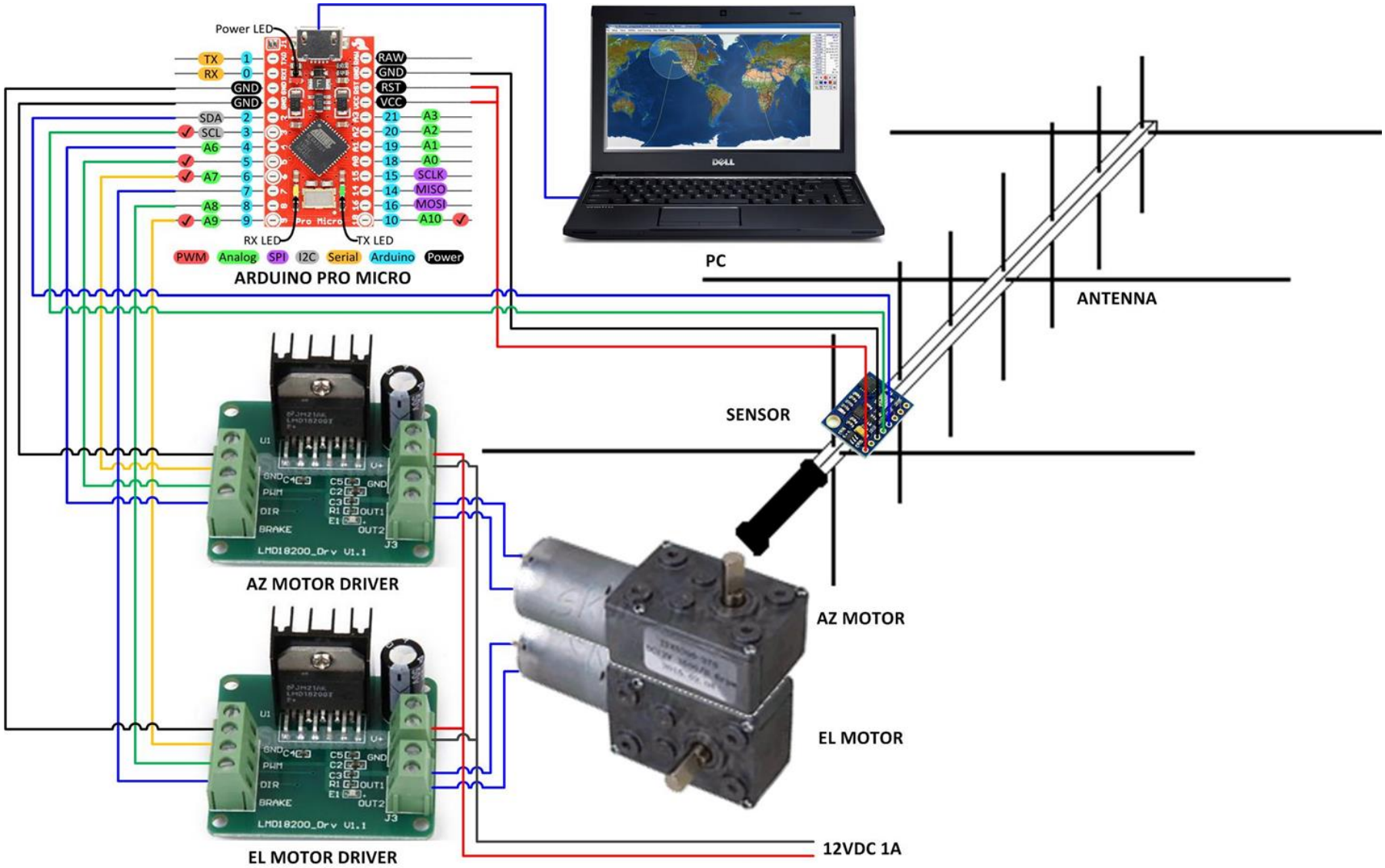


HI TORQUE DC MOTOR



12V DC MOTOR
0.6RPM / 20kg.cm
RIGHT-ANGLE WORM GEAR

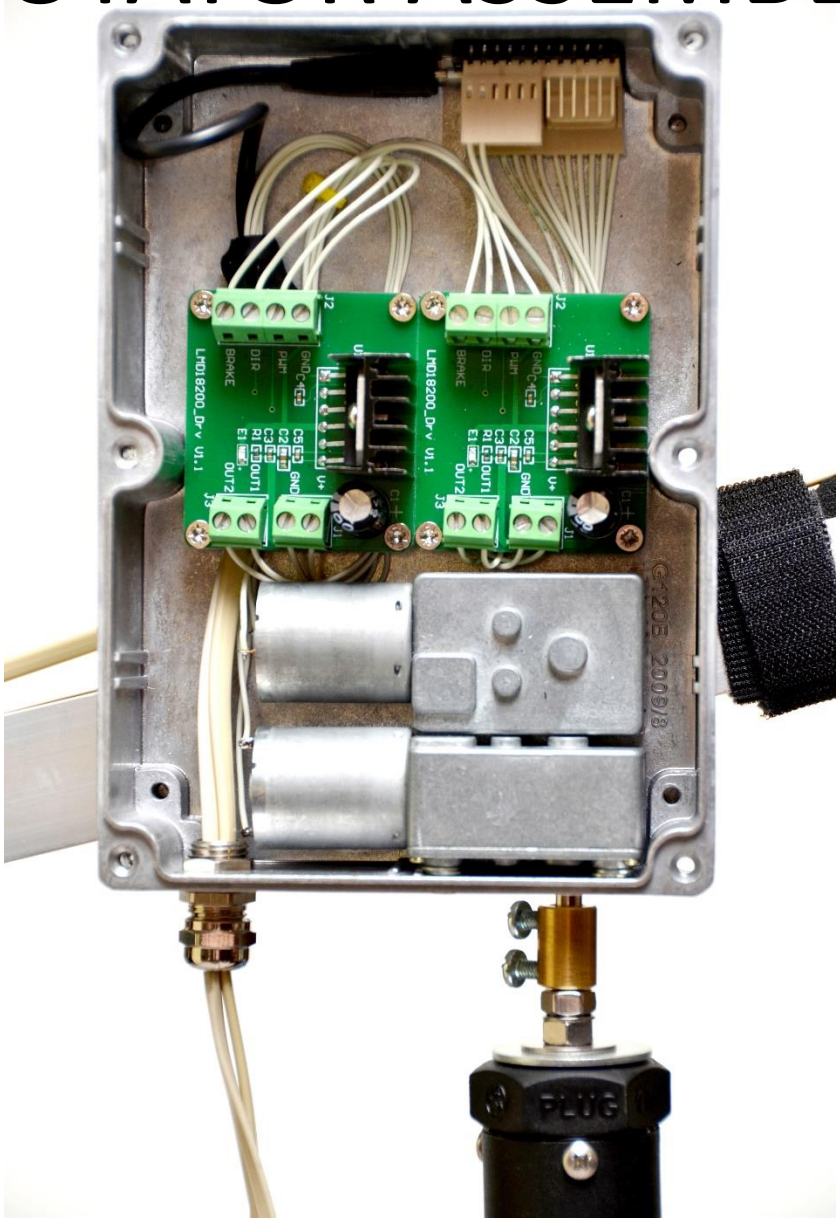
PICTORIAL SCHEMATIC



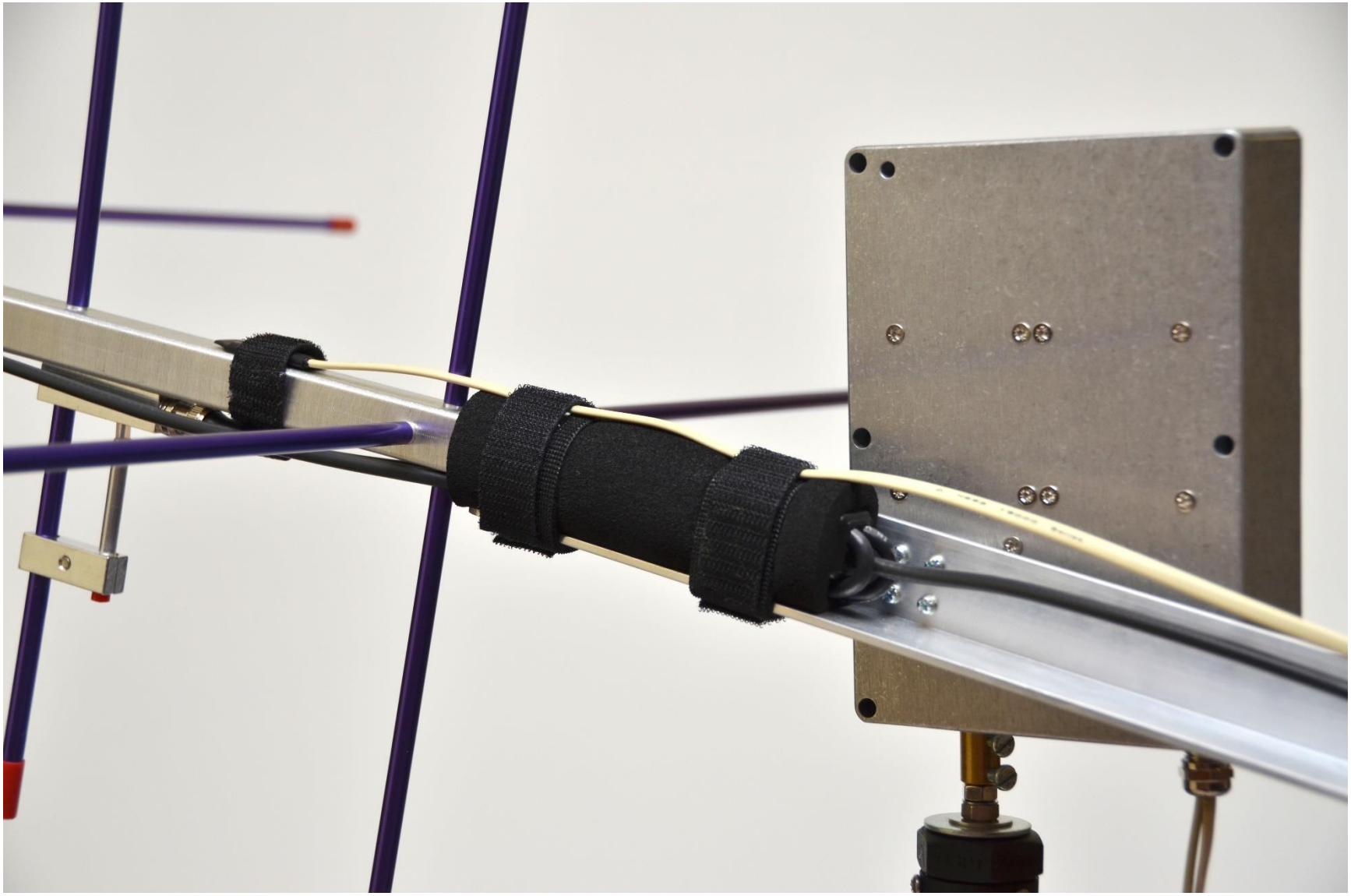
PARTS LIST

Part	Description	Vendor	Qty	Total
Diecast box	HB5046 Sealed Diecast Aluminum Enclosure - 171 x 121 x 55	Jaycar	1	$35.00
DC Motor	DC 12V 0.6RPM Low Speed High Torque Turbo Reducer Motor Right Angle Gear	eBay	2	$17.00
DC Driver	LMD18200T DC Motor Driver Module Board PWM Adjustable Speed for Arduino Robot	eBay	2	$15.00
Sensor	10DOF L3GD20 LSM303D BMP180 Gyro Accelerometer Compass Altimeter For Arduino	eBay	1	$11.00
Controller	1x Brand New Pro Micro ATmega32U4 5V 16MHz Replace ATmega328 Arduino Pro Mini	eBay	1	$7.00
Housing	HM3406 6 Pin 0.1 Header with Crimp Pins - 2.54 pitch	Jaycar	4	$3.00
Header	HM3416 6 Pin 0.1 Straight Locking Header - 2.54 pitch - Single	Jaycar	4	$2.40
Hub	YG2784 Aluminium Hub with Set Screws	Jaycar	1	$8.95
Coupler	YG2600 Solid Shaft Couplers (Female) - Type I	Jaycar	1	$9.95
Other	Lead Counterweight, 5mm O-Rings, 3mm Stand-Offs, Screws, Nuts			
Total				$109.30

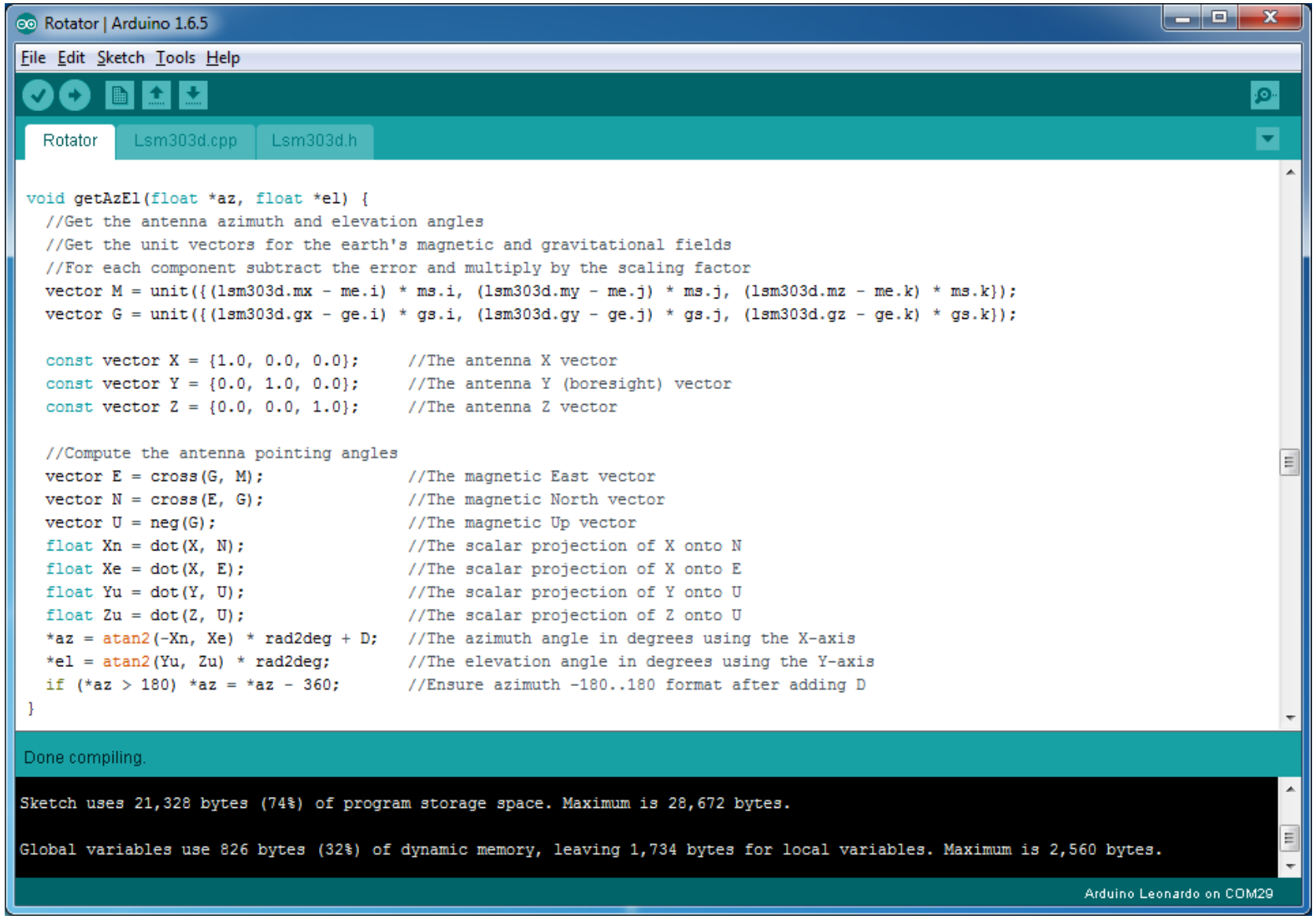
ROTATOR ASSEMBLY



LIFT-ARM AND SENSOR



ARDUINO SOFTWARE

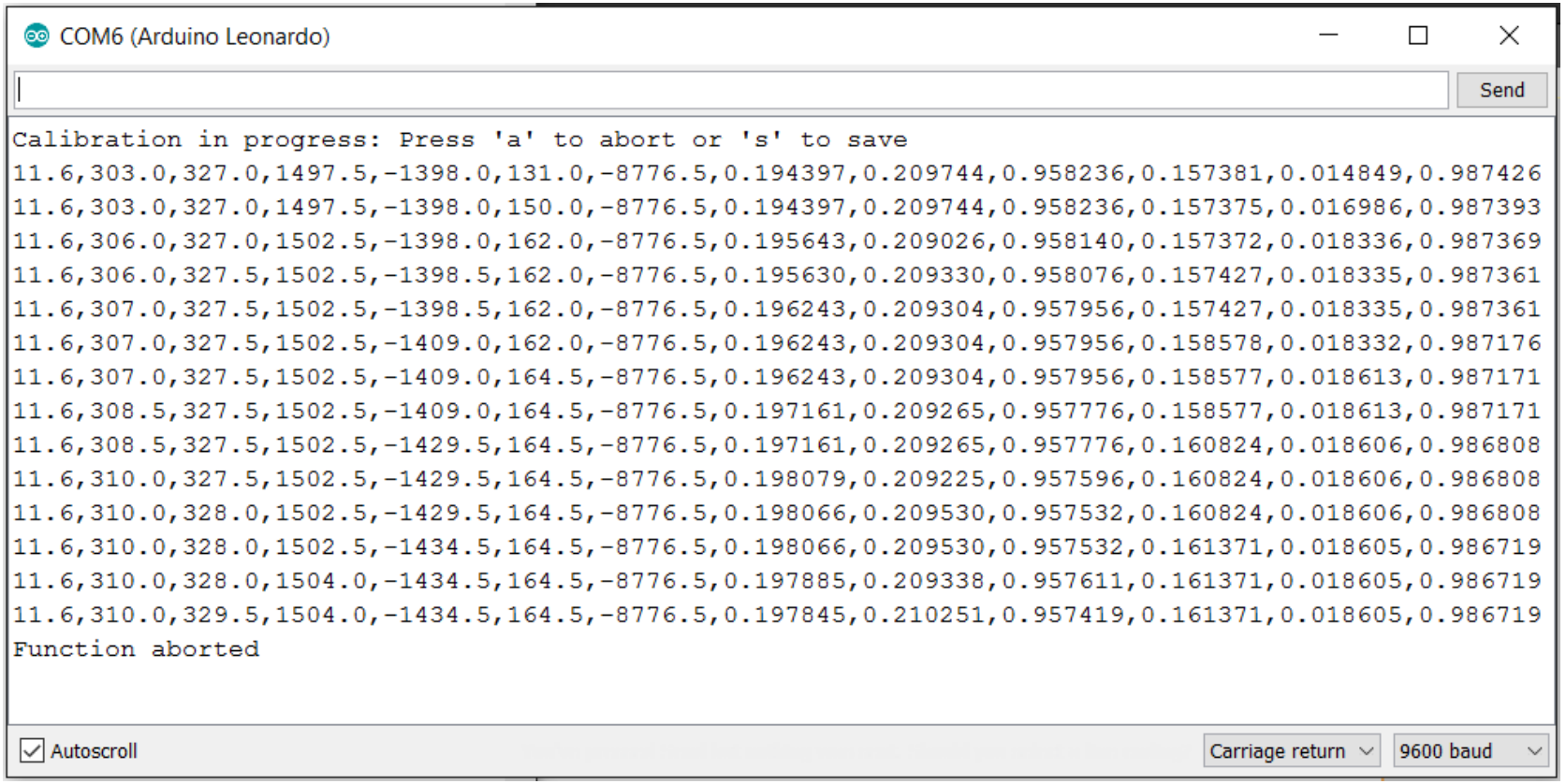


SERIAL CONTROL

- Enter two integers AZ and EL in degrees separated by a space to manually control the rotator. e.g. 270 45<Enter> Note: AZ here works in either 0~180~360 or -180~0~180 degree format.
- r - Reset. Prints the calibration data. Resets the rotator to the home position and resets the windup value.
- b - Debug mode. Prints the raw sensor data: Mx, My, Mz, Gx, Gy and Gz.
- c - Calibrate mode. Displays the calibration data only when it changes.
- d - Demo mode. Tracks linearly through the following AZ/EL points in a cycle: 0/0, 90/90, 0/180, 90/90 0/0, -90/90, -180/0, -90/90, 0/0
- m - Monitor mode. Prints current AZ and EL, set points for AZ and EL, the AZ windup angle, the AZ windup state, the AZ and EL error.
- a - Abort Calibrate, Monitor or Demo mode
- e - Enter Magnetic Declination. e.g. e11.7<Enter>. It is positive for East or negative for West.
- s - Save Magnetic Declination and Calibration Data.

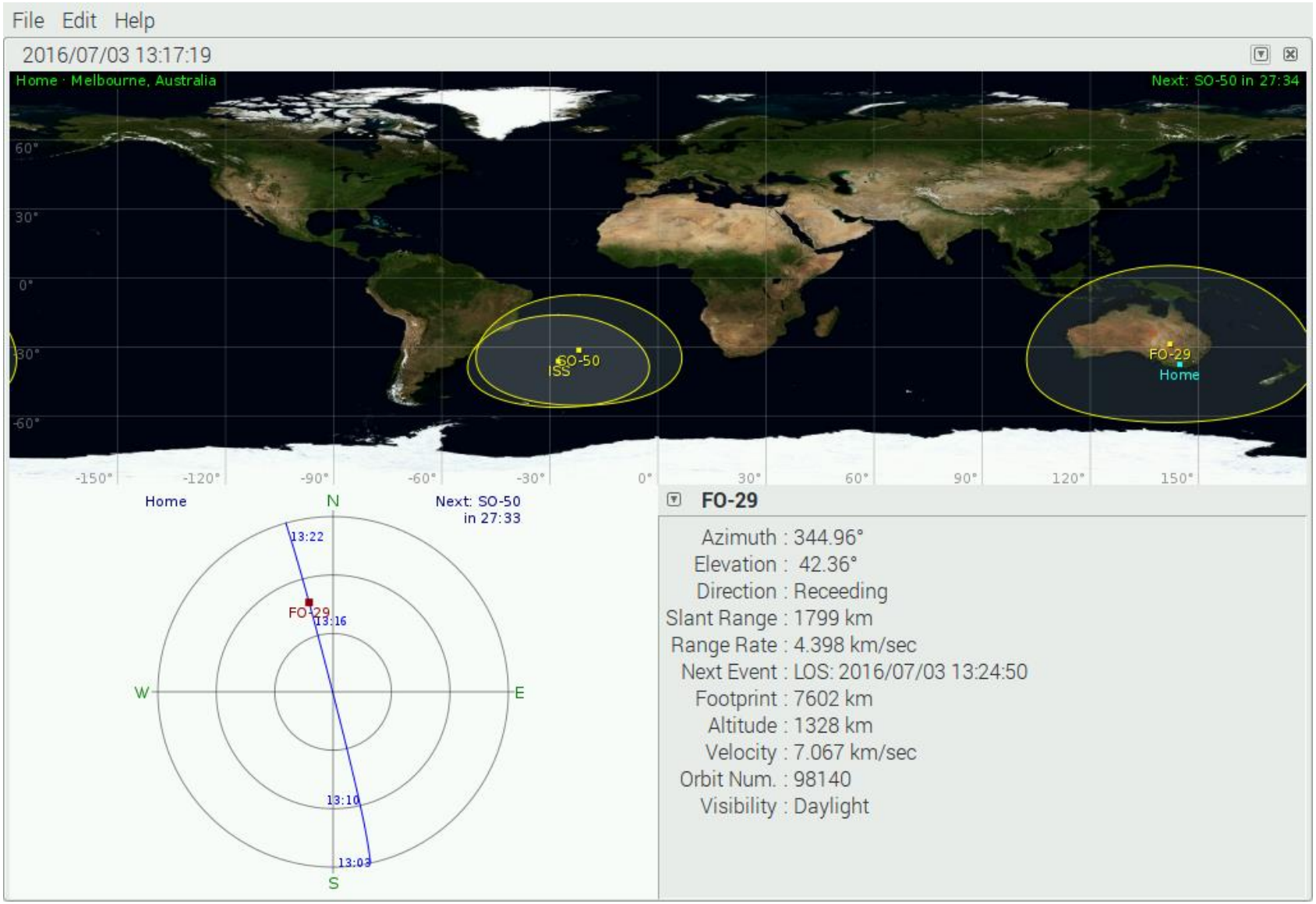
SENSOR CALIBRATION

- Send “e11.6” to set YOUR local magnetic declination. Send “c” to start calibration.
- Think of the sensor as a cube with six faces. GENTLY (without bumping or changing hands):
- Point each face in line with the Earth’s magnetic field
- Point each face in line with the Earth’s gravitational field
- Move about each point until the display below stops changing
- Send “s” to save the calibration data

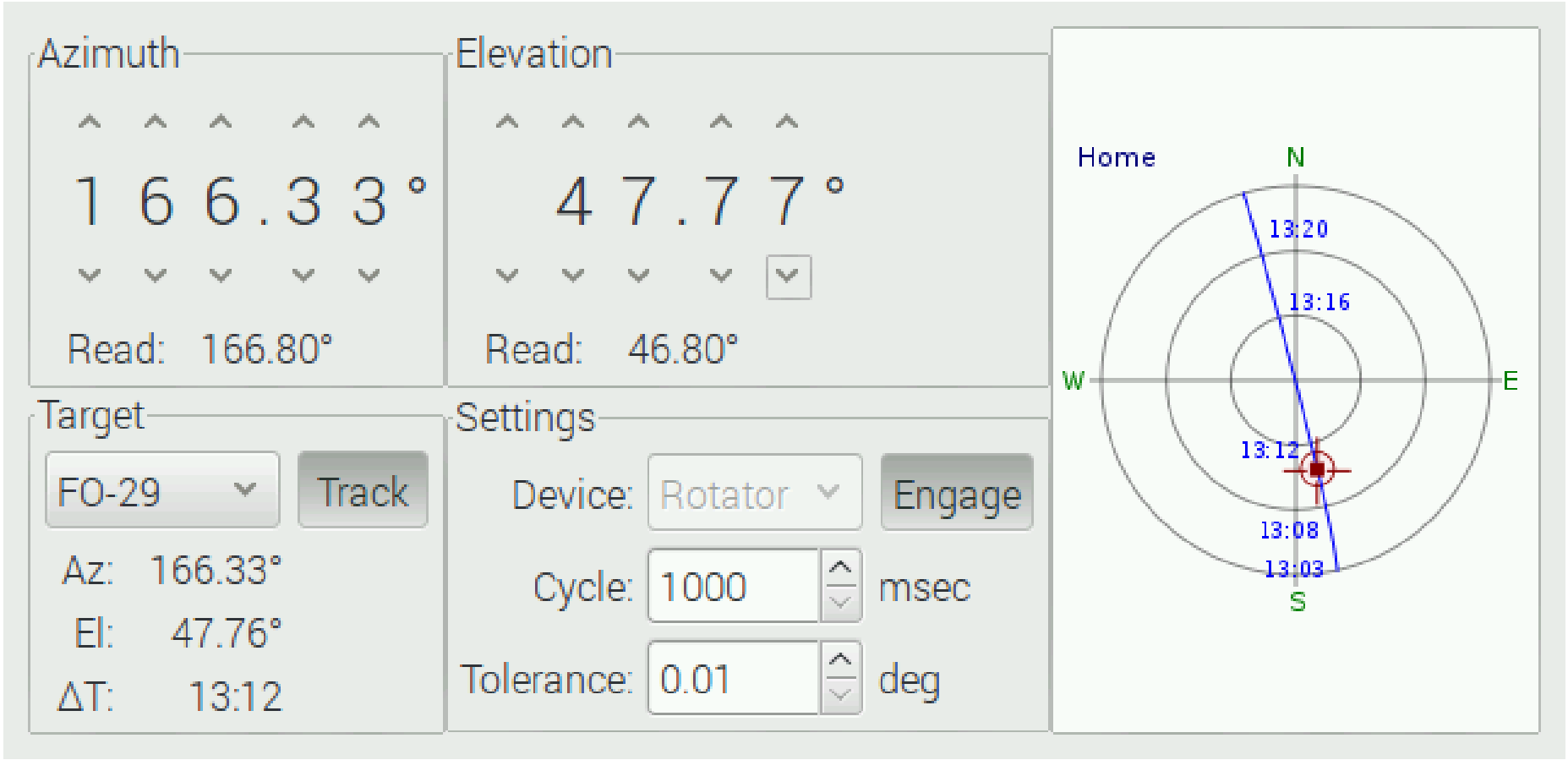


PORTABLE SATELITE TERMINAL

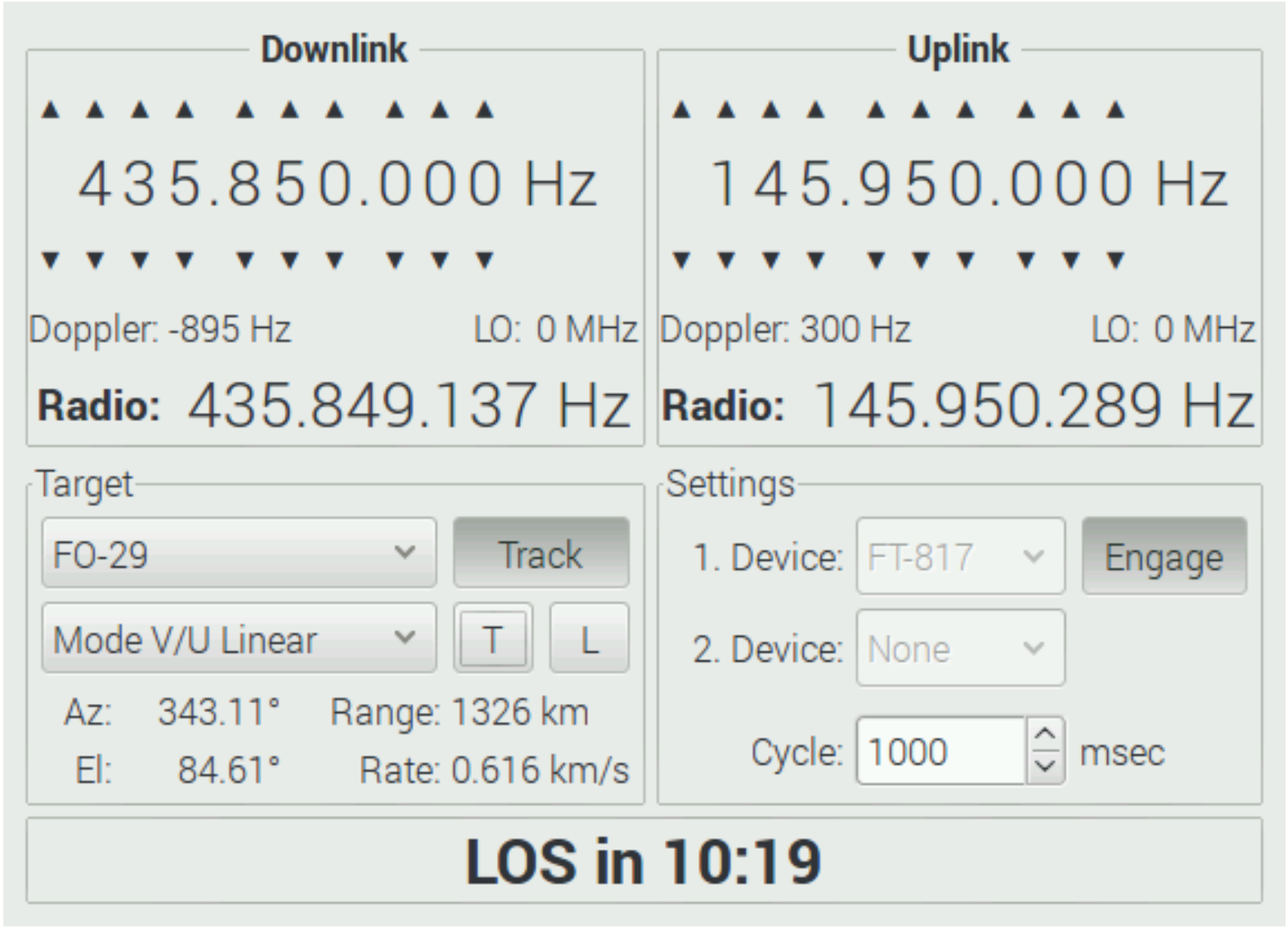
GPREDICT SOFTWARE



ROTATOR CONTROL



RIG CONTROL


Downlink
435.850.000 Hz
Doppler: -895 Hz
LO: 0 MHz
Radio: 435.849.137 Hz
Uplink
145.950.000 Hz
Doppler: 300 Hz
LO: 0 MHz
Radio: 145.950.289 Hz
Target
FO-29
Track
Mode V/U Linear
T
L
Az: 343.11°
Range: 1326 km
El: 84.61°
Rate: 0.616 km/s
Settings
1. Device: FT-817
Engage
2. Device: None
Cycle: 1000
msec
LOS in 10:19

HAMLIB SOFTWARE

```
File  Edit  Tabs  Help
ft817: ft817_init called
rig:rig_open called
ft817: ft817_open called
Opened rig model 120, 'FT-817'
Backend version: 0.5.1, Status: Beta
Connection opened from 127.0.0.1:52925
ft817: cache invalid
ft817: requested freq = 435858342.000000 Hz
ft817: cache invalid
ft817: cache timed out (123 ms)
ft817: requested freq = 145947206.000000 Hz
ft817: cache timed out (433 ms)
ft817: cache invalid
ft817: requested freq = 435858343.000000 Hz
ft817: cache invalid
ft817: cache timed out (996 ms)
ft817: cache timed out (871 ms)
ft817: requested freq = 435858345.000000 Hz
ft817: cache invalid
ft817: cache timed out (998 ms)
ft817: cache timed out (873 ms)
ft817: requested freq = 435858346.000000 Hz
ft817: cache invalid
ft817: cache timed out (998 ms)
ft817: cache timed out (872 ms)
ft817: requested freq = 435858348.000000 Hz
ft817: cache invalid
ft817: cache timed out (998 ms)
ft817: cache timed out (871 ms)
ft817: cache timed out (997 ms)
ft817: cache timed out (996 ms)
ft817: requested freq = 435858351.000000 Hz
ft817: cache invalid
ft817: cache timed out (999 ms)
ft817: cache timed out (861 ms)
```

```
File  Edit  Tabs  Help
rotctld, Hamlib 3.0.1
Report bugs to <hamlib-developer@lists.sourceforge.net>

rot:rot_init called
initrots3_easycomm called
rot_register (201)
rot_register (202)
rot_register (204)
rot_set_conf: timeout='500'
rot:rot_open called
Opened rot model 202, 'EasycommII'
Backend version: 0.4, Status: Beta
Connection opened from 127.0.0.1:53069
rotctl(d): p '' '' '' ''
easycomm_rot_get_position called
easycomm_transaction called: AZ EL

write_block(): TX 7 bytes
0000    41 5a 20 45 4c 20 0a                                AZ EL .
read_string(): RX 15 characters
0000    41 5a 31 36 37 2e 32 20 45 4c 2d 30 2e 39 0a        AZ167.2 EL-0.9.
easycomm_transaction read_string: AZ167.2 EL-0.9

easycomm_rot_get_position got response: AZ167.2 EL-0.9

rotctl(d): P '167.68' '0.00' '' ''
easycomm_rot_set_position called: 167.679993 0.000000
easycomm_transaction called: AZ167.7 EL0.0 UP000 XXX DN000 XXX

write_block(): TX 34 bytes
0000    41 5a 31 36 37 2e 37 20 45 4c 30 2e 30 20 55 50     AZ167.7 EL0.0 UP
0010    30 30 30 20 58 58 58 20 44 4e 30 30 30 20 58 58     000 XXX DN000 XX
0020    58 0a                                               X.
Connection closed from 127.0.0.1:53069
```

SCALING UP

“It should be noted that this particular rotator is very light duty as it uses small and inexpensive motors. It would certainly not take the rigours of prolonged external use nor support a larger antenna”. However, it can be scaled up using:

1. Larger geared motors up to 3A / 55V.
2. Flanged pillow bearings, sprocket and chain
3. 50A/60A/100A DC motor drivers. May use 2 PWM inputs or separate FWD/REW pins, so a small software modification is required.
4. CAT-V USB cable extenders up to 50m

WORKING FO-29 AT BRISBANE RANGES NP

SARC KIDS WORKING SO-50

SOURCES/LINKS

- http://www.sarcnet.org/projects/project_rotator.html
- http://gpredict.oz9aec.net/
- https://sourceforge.net/projects/hamlib/
- http://www.ngdc.noaa.gov/geomag-web/
- http://www.arrowantennas.com/arrowii/146-437.html
- http://www.arrowantennas.com/main/10w.html