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AA5C 23 CM EME Direction Controller

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AA5C 23 CM EME

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My application

AA5C 23 CM EME Direction Controller

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- Objectives
  - Azimuth and Elevation Controller capable of:
    - 0.1 degree azimuth and elevation position readout accuracy
    - CW, CCW, Up, Down control
    - Auto-tracking the moon
- The basic approach is useable for other applications
  - Satellite tracking
  - Azimuth only rotator control

AA5C 23 CM EME Direction Controller - Approach

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- Software - Start with K3NG Rotator Controller open source Arduino Sketch
- Arduino Mega 2560 microcontroller
  - Has four serial ports
  - Supports interrupts
  - EEPROM for storing positions
- Four-relay shield for controlling CW, CCW, Up, Down motors
- Incremental (Differential) Encoders for Position Sensors with RS422 differential interface from tower to shack using twisted pair transmission lines (about 100 feet)
- GPS for timing and own station position
- Nextion Human Machine Interface (HMI) for display and switches

AA5C 23 CM EME Direction Controller – Software/Firmware

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- K3NG Rotator Controller Software (Arduino Sketch)
  - Main routine is about 20K lines of Code
  - The routine has been added to by a number of people and supports a very wide variety of:
    - Features – Azimuth, elevation, autotracking, GPS…
    - Displays – Four line LCD, Nextion HMI…
    - Sensors – Pulse and differential encoders, pots…
    - Controls
    - Indicators
  - The main SW challenge was understanding how to configure it for my hardware and particular application
  - Several “canned” setups are included in the GitHub download

AA5C 23 CM EME Direction Controller - Block Diagram

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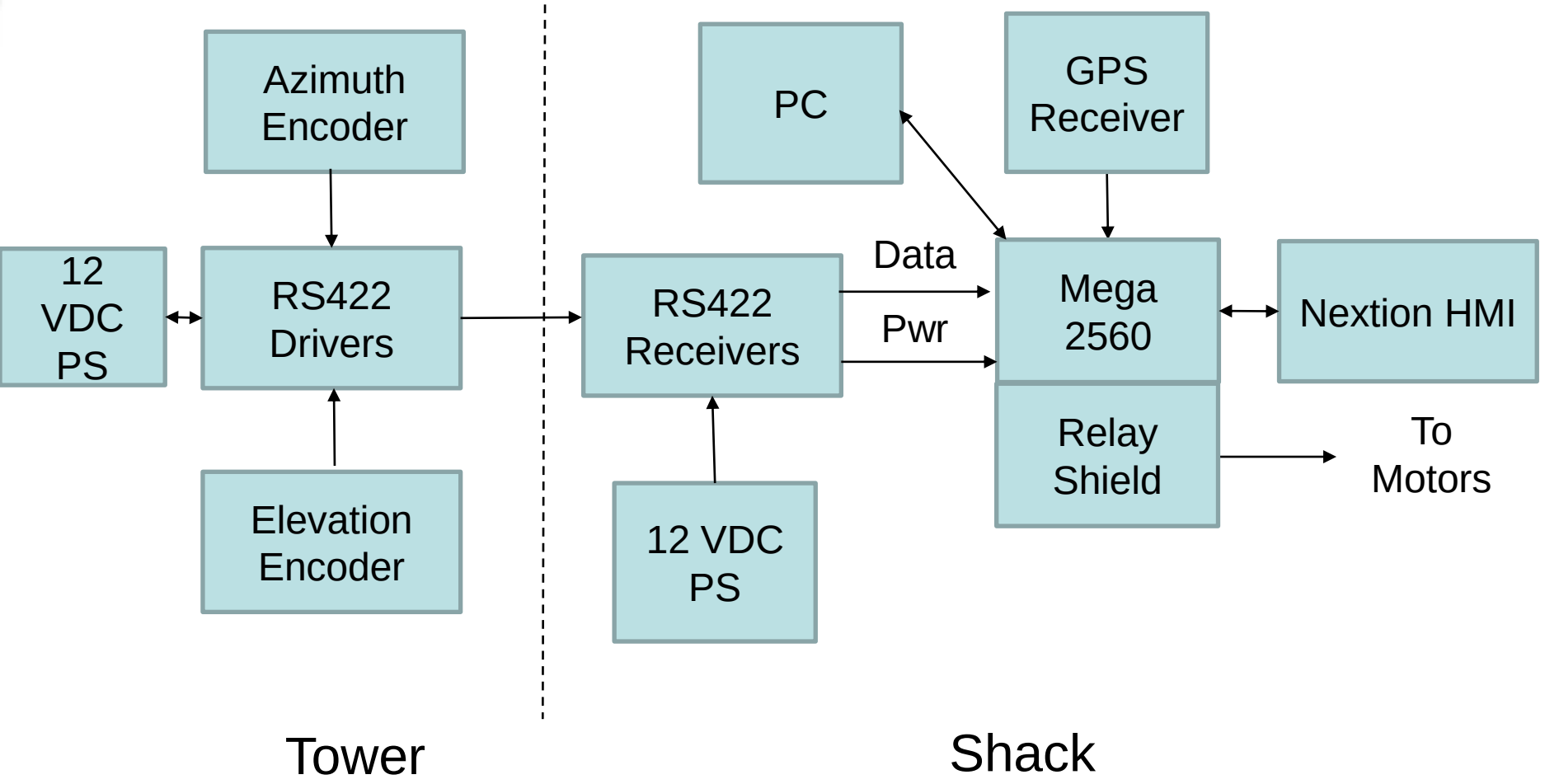

AA5C 23 CM EME Direction Controller - Schematic

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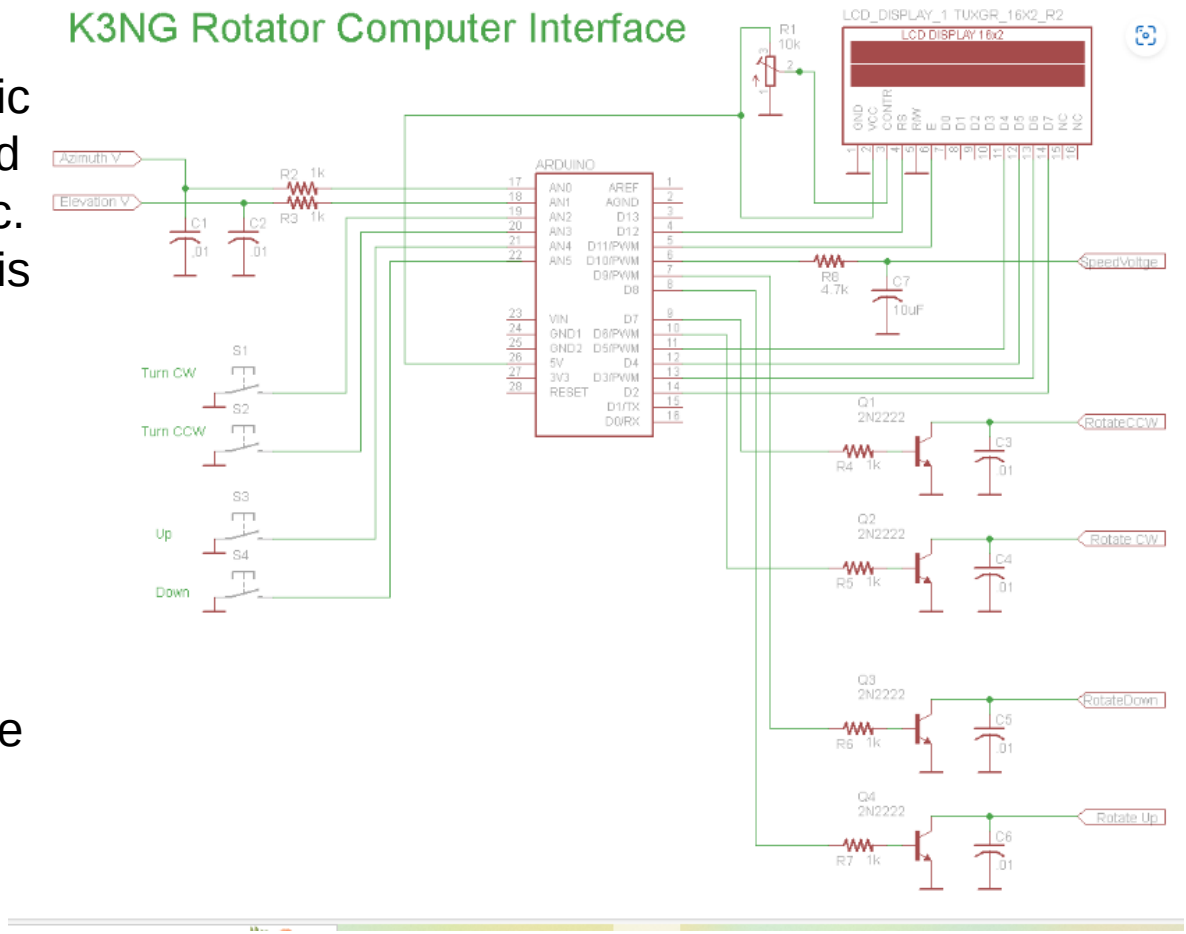
- This is an example schematic
- Your connections will depend on what sensors, displays, etc. you use and what type of I/O is needed and what the Mega 2560 supports.
  - Serial ports
  - Interrupt lines
  - PWM lines
  - Analog

- Arduino pins used need to be defined in the rotator_pins.h file



AA5C 23 CM EME Direction Controller – Back View

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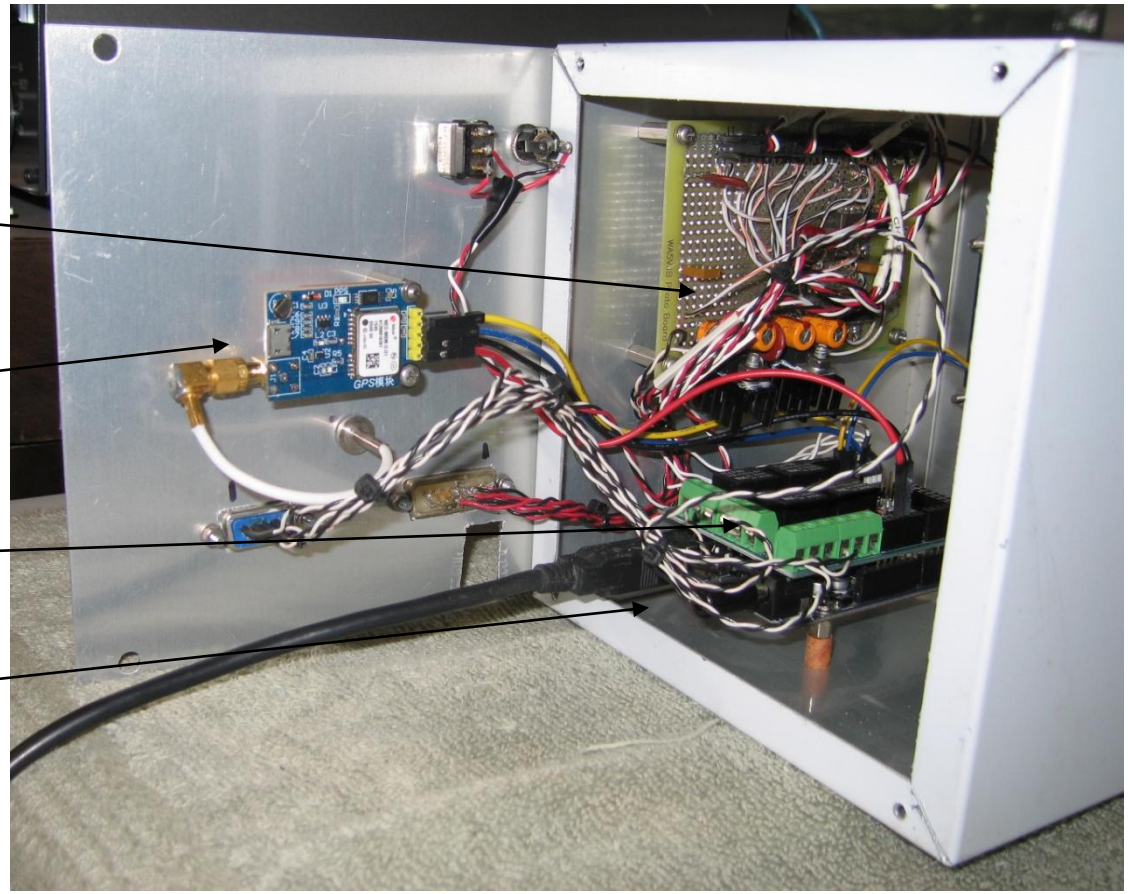
RS422 Receivers And Regulators

NEO-8M GPS Receiver

Four SPDT Relay Shield

Arduino Mega 2560



AA5C 23 CM EME Direction Controller – Back View

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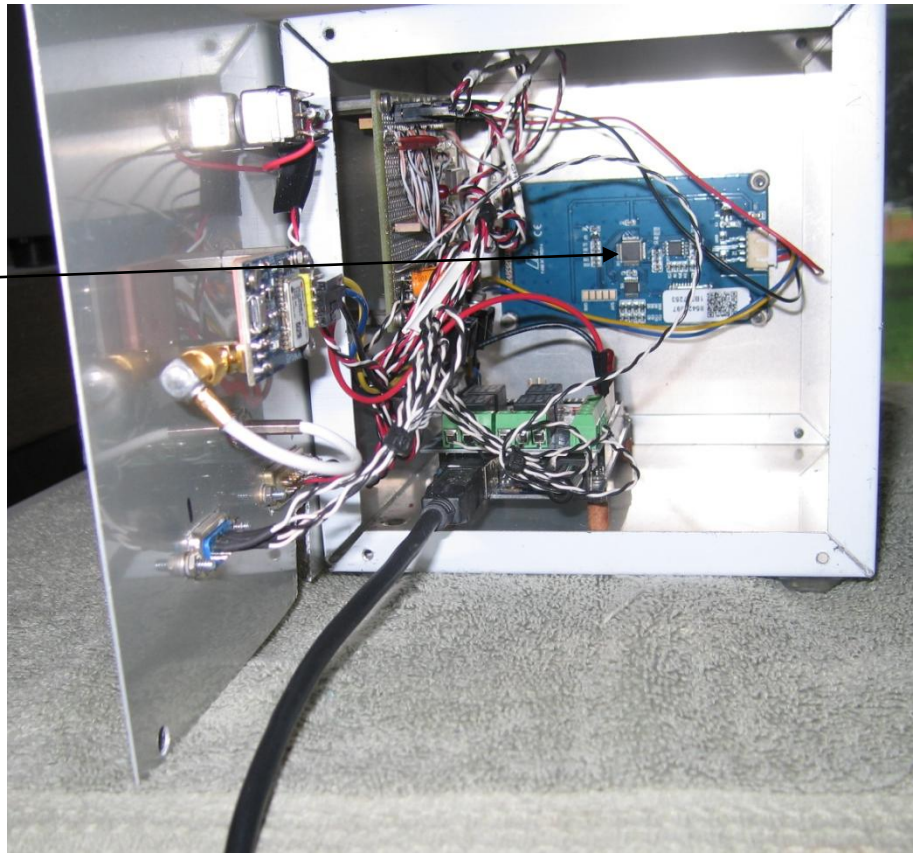
Nextion 3.5 Inch Human Machine Interface (HMI) (back view)



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AA5C 23 CM EME Direction Controller – Back Panel

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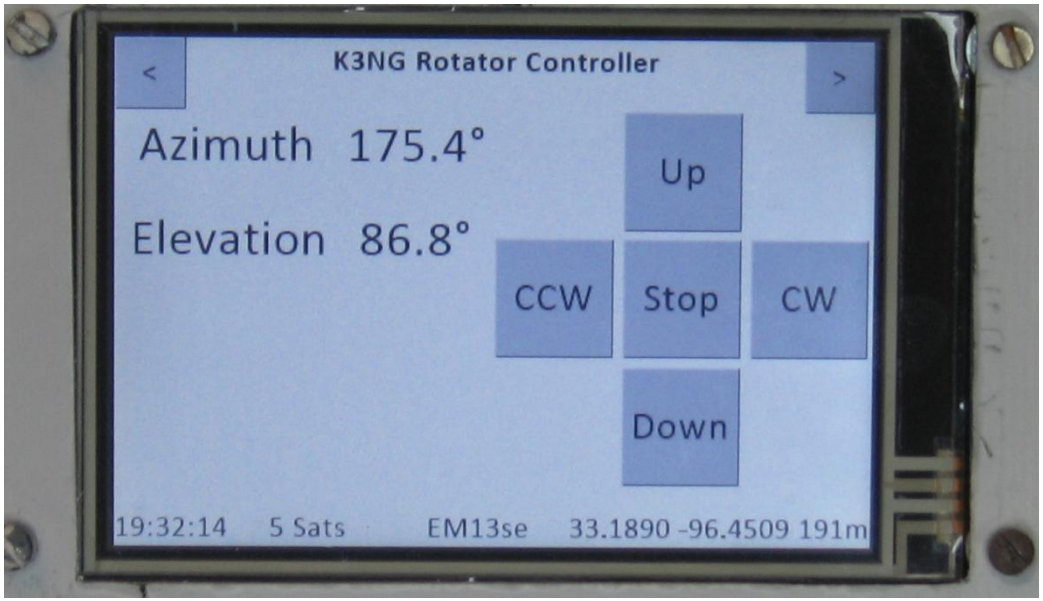
AA5C 23 CM EME Direction Controller – Front Panel

- Nextion X4382T035 HMI
  - Color Display
  - Touch Screen
  - Use Nextion Editor to compile the program and transfer to the unit using a micro SD card
- No separate switches on front panel



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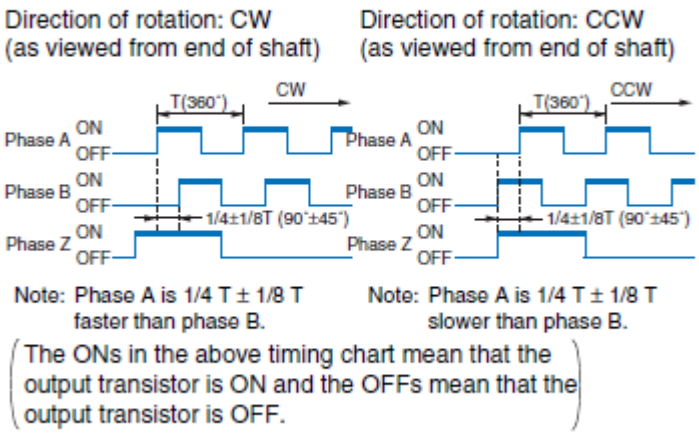
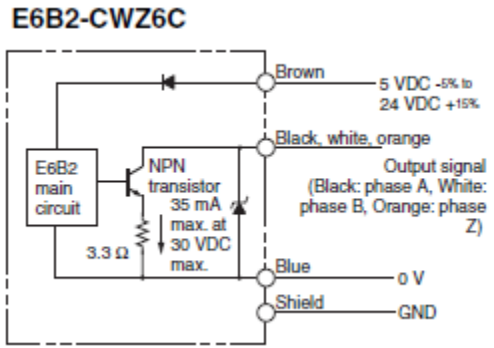
- Omron E6B2-CWZ6C Differential Encoders
  - 1,024 pulses/rev
  - 4,096 edges/rev when used differentially
  - 360º/4,096 = 0.088º/pulse
  - A and B outputs used (Z output not used)

E6B2-CWZ6C NPN Open-collector Output Model
E6B2-CWZ5B PNP Open-collector Output Model





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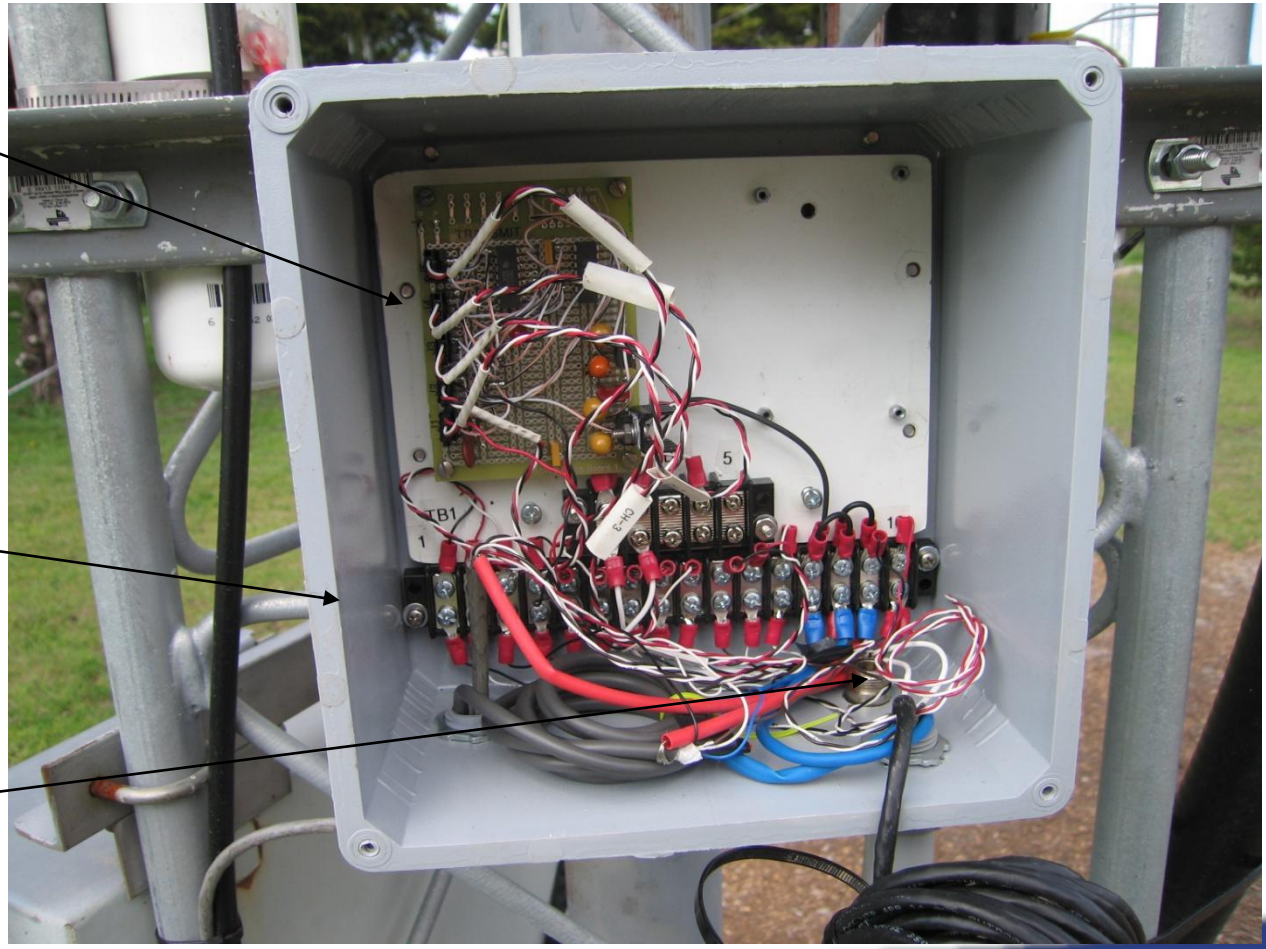
AA5C 23 CM EME Direction Controller – Tower Electronics

RS422 Drivers, Regulators, Cables

Cantex 8”x8”x4” PVC Weatherproof Electrical Box

Two CAT3 Cables to Shack (6 Twisted Pairs, 4 used)



AA5C 23 CM EME Direction Controller – Az Encoder

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Fly Fishing Line

Knob on encoder shaft

Azimuth Encoder
In 2” PVC Pipe

Hose clamp allows for tensioning the fishing line

The ratio of mast diameter to knob diameter time P/R of encoder determine the number of pulses per revolution

AA5C 23 CM EME Direction Controller – El Encoder

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Elevation Encoder In 4”x4”2” PVC Weatherproof Cantex Electrical Box

Lead Weights

AA5C 23 CM EME Direction Controller – K3NG Sketch

- Main routine is about 20K lines long. Very large and can be quite confusing because of all the options
- But…you should only need to modify three files in order to configure the sketch for your application
  - rotator_features.h
    - Enables/disables capabilities like Az only or az/el, GPS, no GPS, display type, etc.
  - rotator_settings.h
    - Sets angle limits, number of pulses/rev for encoders, etc.
  - rotator_pins.h
    - Selects the specific microcontroller pins for external devices connecting to the Arduino Mega 2560

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- The K3NG sketch uses libraries that need to be included at compile time
    - TinyGPS….
- Rather than list them all here, my recommendation is to compile the sketch and the compiler will identify the missing libraries
  - Add…recompile….add…recompile…
  - A few iterations and you can get every one needed

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- Getting K3NG Rotator Controller Sketch
  - https://github.com/k3ng/k3ng_rotator_controller
- Wiki Guide
  - https://k3ng/k3ng
- There is also a GitHub forum for posting issues. (I had no response over two months to an issue I posted, however.)

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- Basics - some of which are NOT explained in the online documentation
  - The Arduino microcontroller (Mega 2560 in my case) needs to be connected to a host computer via the native USB port
    - To get astronomical data for autotracking
    - There is a set of backslash commands for reading and changing settings
      - Used for direction calibration
      - Use a terminal emulator like PuTTY to connect to serial port
    - Position readout and relays still function without computer connection
  - The GPS function works only with $GPxxx messages
    - $GNxxx or $Bxxxx messages confuse it

AA5C 23 CM EME Direction Controller - Summary

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- You can build a robust rotator controller for about $200
  - Arduino, encoders, display, GPS, housings….
  - Differential interface is robust but a lot of wiring to do
- Open source software is available to be leveraged
- Calibration is not straightforward and somewhat emperical
- Tested autotracking but not regularly used at present
  - Need to get az limit switches in place