1.0 System Control and Processing

<table>
<thead>
<tr>
<th>Component</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 PC Interface</td>
<td></td>
</tr>
<tr>
<td>1.2 Radio Eyes</td>
<td></td>
</tr>
<tr>
<td>1.3 Telescope Scope Point Program</td>
<td></td>
</tr>
<tr>
<td>1.4 ASCOM Driver</td>
<td></td>
</tr>
</tbody>
</table>

Digital Control

Power [W]

Click Here to Return to Top Level
1.4 Driver Design

TCP ➔ ASCOM Interface

1.4b Sidereal Drive ➔ 1.4c Axial Drive ➔ 1.4d Coordinate Drive ➔ 1.4e Pulse Drive ➔ 1.4f Controller Interface

Controller Interface ➔ ComEvent ➔ uController

Go Up One Level

Click Here to Return to Top Level
1.4b Sidereal Drive

1. Set Tracking Rate
   - Update Base Tracking Speed to Match Speed

2. Set Offset
   - Update Requested Offset to Given Amount

3. Turn Tracking On or Off
   - Turn On?
     - Yes
       - Start Update Thread
     - No
       - End Execution of Update Thread

4. Update Thread

5. Tracking is On?
   - Yes
     - Determine Distances for LA and Rotary
   - No
     - Enough Time has Passed Since Last Update?
       - Yes
         - Communication Interface SlawToPositions(LA, Rotary)
       - No
         - Start Update Thread

Click Here to Return to Top Level
1.4c Axial Drive

Set Axial Rate → Update Respective Axial Rate → Both Speeds 0? → Yes → Kill Update Thread

No

Update Thread → Cooldown been met? → Yes → Determine Distances for LA and Rotary → CommunicationInterfaceSlewtoPositions(LA, Rotary)

Click Here to Return to Top Level

Go Up One Level
1.4d Coordinate Drive

SlewToCoordinateTranslator

Cooldown Passed? → Yes → Determine LA/Rotary Pulses → ControllerInterfaceSlewToPositions(LA, Rotary) → Wait until Arduino Reports Slew has Completed

No → Throw Exception

SlewToCoordinateTranslatorAsync

Cooldown Passed? → Yes → Determine LA/Rotary Pulses → ControllerInterfaceSlewToPositions(LA, Rotary)

No → Throw Exception
1.4e Pulse Drive

PulseGuide(direction, rate)

Determine Update Frequency

Create CoordinateTranslator Objects to meet Update Frequency

Run Thread Loop

Coordinates left?

Yes

Update Coordinate

No

Wait Cooldown Period

Kill Thread

Click Here to Return to Top Level

Go Up One Level
1.4f Controller Interface

Telescope Drive

ControllerInterface method

ControllerInterface method

Execute Update Information

Decode Message

Something Written From Arduino?

Yes

Write Command to Serial Port

Is Global Variable For Command == Nothing?

Yes

Looping Thread

No

No
## 2.2a Shield Characteristics

### General Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor driver:</td>
<td>VNH5019</td>
</tr>
<tr>
<td>Motor channels:</td>
<td>2</td>
</tr>
<tr>
<td>Minimum operating voltage:</td>
<td>5.5 V</td>
</tr>
<tr>
<td>Maximum operating voltage:</td>
<td>24 V²</td>
</tr>
<tr>
<td>Continuous output current per channel:</td>
<td>12 A</td>
</tr>
<tr>
<td>Peak output current per channel:</td>
<td>30 A</td>
</tr>
<tr>
<td>Current sense:</td>
<td>0.14 V/A</td>
</tr>
<tr>
<td>Maximum PWM frequency:</td>
<td>20 kHz</td>
</tr>
<tr>
<td>Reverse voltage protection?:</td>
<td>Y</td>
</tr>
</tbody>
</table>

### H-Bridge Thermal Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>VNH5019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage:</td>
<td>5.5 – 24 V</td>
</tr>
<tr>
<td>MOSFET on-resistance (per leg):</td>
<td>18 mΩ typ.</td>
</tr>
<tr>
<td>Max PWM frequency</td>
<td>20 kHz</td>
</tr>
<tr>
<td>Current sense</td>
<td>0.14 V/A typ.</td>
</tr>
<tr>
<td>Over-voltage shutoff</td>
<td>24 V min. / 27 V typ.</td>
</tr>
<tr>
<td>Logic input high threshold</td>
<td>2.1 V min.</td>
</tr>
<tr>
<td>Time to overheat at 20 A (³)</td>
<td>20 s</td>
</tr>
<tr>
<td>Time to overheat at 15 A (³)</td>
<td>90 s</td>
</tr>
<tr>
<td>Current for infinite run time (³)</td>
<td>12 A</td>
</tr>
</tbody>
</table>
2.1b Arduino Data Flow

ASCOM Driver

Arduino

Setup

Initialize Positional Data

Initialize Pins for Interrupts, Reading, and Writing

Initialize Filter Arrays for Temperature and Current

Loop

Command?

Yes

Decode Command

No

Is System Initialized?

Yes

Run Control System to move to Requested Position

No

Execute Command

Current Filter Value > Threshold?

Yes

Kill Motors Initialized = False

No

Kill Motors Initialized = False

Temperature Filter Value > Threshold?

Yes

Report Error To Driver

No

Report Error To Driver

Click Here to Return to Top Level

Go Up One Level

ASCOM Driver

Arduino

Setup

Initialize Positional Data

Initialize Pins for Interrupts, Reading, and Writing

Initialize Filter Arrays for Temperature and Current

Loop

Command?

Yes

Decode Command

No

Is System Initialized?

Yes

Run Control System to move to Requested Position

No

Execute Command

Current Filter Value > Threshold?

Yes

Kill Motors Initialized = False

No

Kill Motors Initialized = False

Report Error To Driver

Report Error To Driver
DecodeSetup

String is still in process of being determined to allow for modification of control system

Set Defined Values Equal to Parameter Values

Set Initialized == True

DecodeSlewToPositions

DecodeSlewToPositions Parameters: “SlewToPositions|LA|Rotary”

Update Requested Positions to Slew to Positions

Execution is Performed in main Loop

Update Requested Positions to Slew to Positions

Execution is Performed in main Loop

DecodeAbortSlew

DecodeAbortSlew Parameters: “AbortSlew”

Set Request Positions Equal To Current Position

Execution of this Method is Performed in main Loop

DecodeRunLA Pulses

DecodeRunLA Pulses Parameters: “RunLAPulses|Pulses”

requestedPosition = currentPosition + pulses

Is requestedPosition == currentPosition?

Yes → Report Complete

No → Run LA Motor

DecodeRunRotaryPulses

DecodeRunRotaryPulses Parameters: “RunRotaryPulses|Pulses”

requestedPosition = currentPosition + pulses

Is requestedPosition == currentPosition?

Yes → Report Complete

No → Run Rotary Motor
3.0 Azimuth Movement

3.2 AZ Motor

3.1 Slewing Drive

3.3 Encoder

Position [rad/s]

Power [W]

Torque [ft-lbs]

Pulses [V]

Power [W]

Component | Selection
--- | ---
3.1 | SE5A-62-12R
3.2 | H-Fang Motor (12 VDC)
3.3 |
4.0 Altitude Movement

<table>
<thead>
<tr>
<th>Component</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>PA-03-12-400 (12 VDC w/ Hall Effect Sensor)</td>
</tr>
<tr>
<td>4.3</td>
<td></td>
</tr>
</tbody>
</table>
5.0 Satellite Dish

5.1 Satellite Dish
- Torque [ft-lbs]
- RF Data [Digital]
- Clock In [Digital]
- RF Signal
- Power [W]

5.2 Receiver
- Construction Manual
- Noise Analysis
- Software Setup Guide

Click to View
- Stress Analysis: Flange
- Stress Analysis: LA Arm
- Stress Analysis: RA Arm
- Stress Analysis: U-Bracket

Click to View
- Dish Assembly
- Sun Tracking Simulation
- Dish Movement Simulation

Click Here to Return to Top Level
### 6.0 Sensors

#### 6.1 Temperature Sensor

**Voltage [V]**

- Sparkfun TMP36

#### 6.2 Accelerometer

**Voltage [V]**

- Adafruit MMA8451

<table>
<thead>
<tr>
<th>Component</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Sparkfun TMP36</td>
</tr>
<tr>
<td>6.2</td>
<td>Adafruit MMA8451</td>
</tr>
</tbody>
</table>

Click to View

- 6.1 TMP36 Data sheet
- 6.2 MMA8451Q Data sheet
7.0 Power Management

7.1 Back Up Power Supply

APC Back-UPS 550
- 550 VA 390 W
- 6 Minutes of runtime during @ 250 W Load
- PowerPanel software for safe auto shutdown (USB connection).

Power Loss Scenarios

7.2 Power Supply

Power Supply Specifications

<table>
<thead>
<tr>
<th>Power Supply Specifications</th>
<th>Link to Product Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output 1 [V], [A]</td>
<td>SCS120PW12 Data sheet</td>
</tr>
<tr>
<td>Output 2 [V], [A]</td>
<td>SCS120PW12 Drawing</td>
</tr>
<tr>
<td>+/- Tolerance [%]</td>
<td>SCS120PW12 Instruction Manual</td>
</tr>
<tr>
<td>Voltage Input Range [V]</td>
<td></td>
</tr>
<tr>
<td>Voltage Isolation [V]</td>
<td></td>
</tr>
<tr>
<td>Efficiency [%]</td>
<td></td>
</tr>
<tr>
<td>Minimum Load [V]</td>
<td></td>
</tr>
<tr>
<td>Operating TempRange [°C]</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td></td>
</tr>
<tr>
<td>Features</td>
<td></td>
</tr>
<tr>
<td>Mount</td>
<td></td>
</tr>
<tr>
<td>Dimensions [inches]</td>
<td></td>
</tr>
<tr>
<td>Price [$]</td>
<td></td>
</tr>
</tbody>
</table>