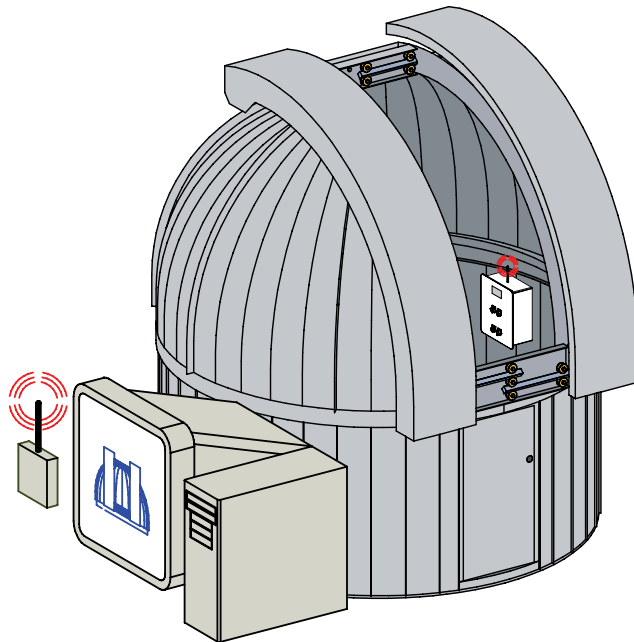




# **Dome Automation**

## **Overview of Control Solutions**



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## Overview

Observe-DOME Laboratories Dome Control System is an industrial strength dome automation package. The system is constructed from the highest quality components and materials and is designed to meet rugged industrial standards for electrical and environmental conditions. It features the ease of use desired by home observers while satisfying the mission critical requirements of heavily used professional observatories.

The Dome Control System may be purchased as an optional feature with a new Observa-DOME or as an upgrade for an existing dome. It is available in several different models based on the size and configuration of the dome to be automated. A wide variety of domes are supported, ranging in size from small domes to the large custom domes found at professional observatories.

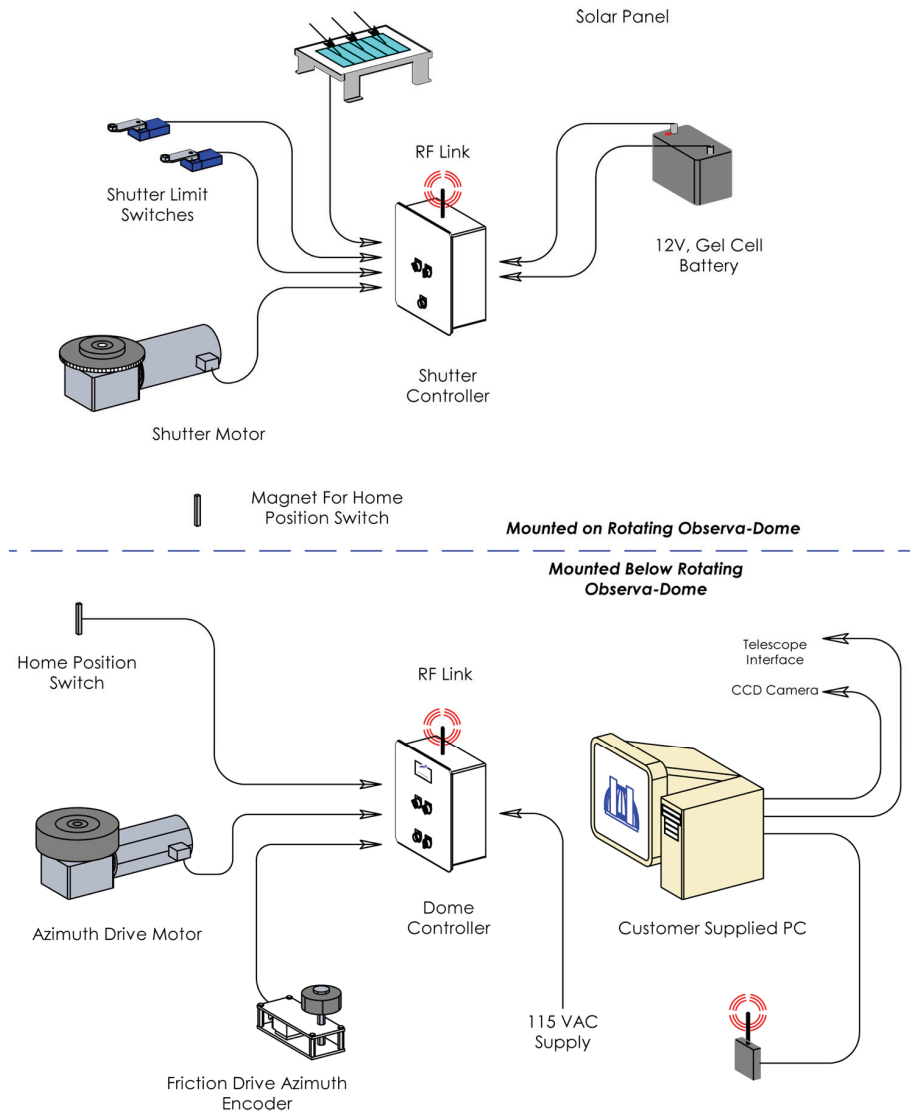


Figure 1: Dome Control System block diagram

The Dome Control System is comprised of independent dome control modules which communicate via a wireless link with software running on a standard PC. Typical installations include a Shutter Control Module, an Azimuth Control Module, and a client RF device with a serial interface to the control computer (Figure 1). The Shutter Module provides control and status information for the dome aperture, while the Azimuth Module controls the dome's rotation, provides position information, and exposes an external connection for automatically closing the dome (i.e. from a weather station). The system enables long range wireless control of the dome and works with network based control software (see below) to enable offsite use for robotic observatories.

### Features

- Fully automated operation of the dome rotation and shutters
- Automated configuration and calibration process
- Powerful 900MHz FHSS RF technology provides reliable long range wireless control of the dome and supports multiple dome environments
- Approved for operation by FCC (USA), IC (Canada) and CE (Europe)
- Failsafe systems close the shutters if the connection with the control computer is lost or the hardware "close" signal is triggered
- Configurable "park" position
- Auto and manual control modes
- User upgradeable firmware for system updates
- Electronics have optically isolated I/O and meet industrial temperature standards
- Modules are housed in NEMA rated industrial enclosures
- Heavy duty, shielded cables with keyed interlocking CPC connectors

### Software Features

- Includes a standalone Dome Control Client *Windows*<sup>1</sup> application
- Works with *TheSky6 Professional*<sup>2</sup> to allow the dome's aperture to be "slaved" to the telescope
- Easily integrates with other automation systems

### Shutter Power Options

- Battery powered with solar charging system: the battery is maintained by a solar panel and charge controller. This enables remote observing as the shutter module does not require any connections below the rotating dome ring
- Battery powered with manual charging system: this requires the user to disconnect the charging cables before rotating the dome
- Powered by dome power bars (AKA "Slip Rings")

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<sup>1</sup> *Windows* is a trademark of *Microsoft*

<sup>2</sup> Integration with *TheSky6 Professional* requires *AutomaDome* software from *Software Bisque*. *TheSky6 Professional* and *AutomaDome* are trademarks of *Software Bisque*

## Control Methodology

The Dome Control System implements a client / server design metaphor where the client is very thin (Figure 2). All of the control algorithms and settings are contained in the embedded electronics of the dome control modules (these are the servers). The control computer, which is connected to the client RF device, sends high level control commands to the dome modules using a reliable serial protocol. Acknowledgement messages are sent back to the control computer for each of the commands received by the control modules.

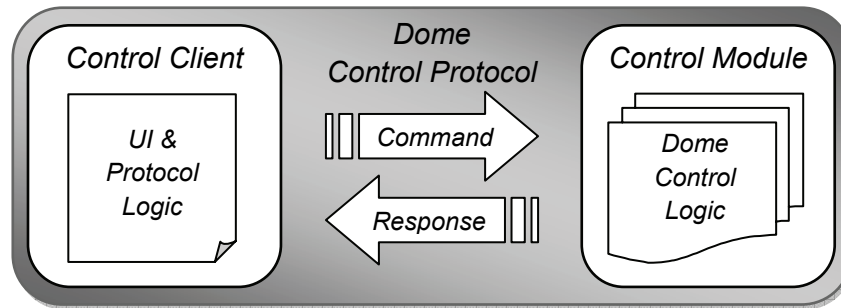


Figure 2: Control architecture

Software is included which implements the *Dome Control Protocol* for controlling the dome from a *Windows* based PC (shown in Figure 3 running on *Windows Vista*). Software components are also provided for controlling the dome from within *TheSky6 Professional*. Additionally, application developers may easily integrate dome control with custom observatory systems by using one of the supplied software libraries or by directly implementing the *Dome Control Protocol*.

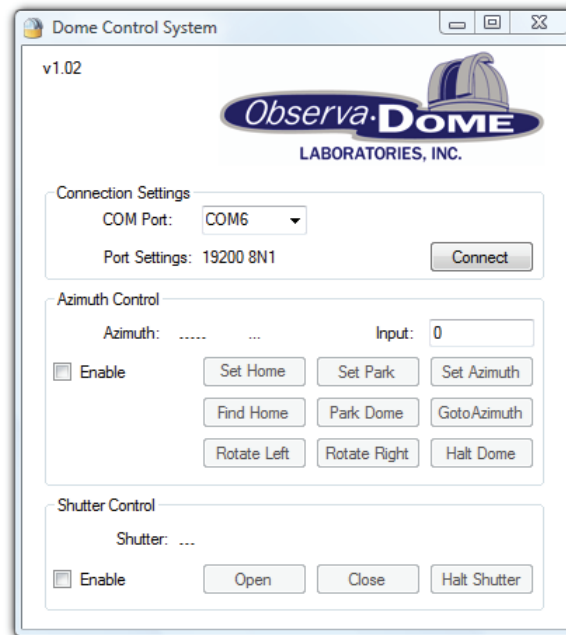


Figure 3: Dome Controller Client application

## Azimuth Control

The dome's position and rotation are managed by the Azimuth Control Module. A high quality optical shaft encoder is mounted to the dome base and makes contact with the inside of the rotating dome ring via a rubber friction wheel. A magnetic "home position" switch is also mounted to the dome base and detects the presence of a reference magnet mounted on the rotating dome ring. The Azimuth Control Module uses the location of the magnet as a reference point to calibrate the dome's position and uses the encoder to keep track of how far the dome rotates in each direction. Once calibrated, the current position of the dome is calculated by using the information from the encoder combined with a user configurable "home position offset", which is the difference in degrees between the "home position" switch and true north. Figure 4 shows a typical dome orientation where the home position switch is mounted 45° from north. The "home position offset" for this orientation would be 315°.

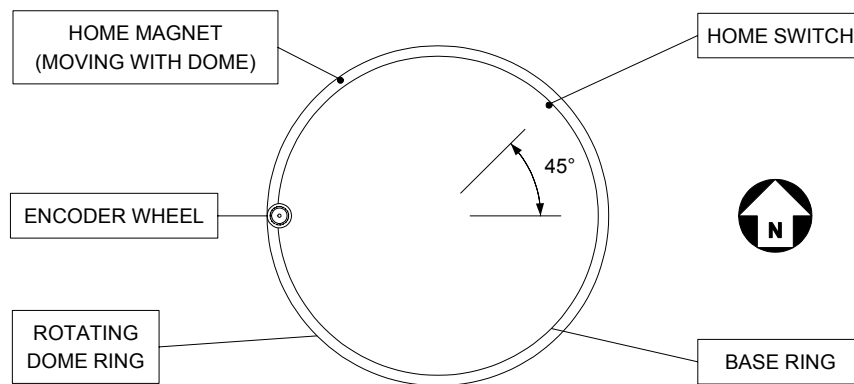


Figure 4: Tracking dome rotation

The Azimuth Control Module provides a mechanism for automatically configuring itself based on the dome's size and rotation speed. This process is started by holding down the "park" button while turning on the module's main power. After initial configuration and calibration, the Azimuth Control Module is able to keep track of the dome's position with a high degree of precision. For example, a 4-meter dome with a 4-inch encoder wheel would result in an internal resolution of 1/27°.

Parking the dome using either the "park" pushbutton on the Azimuth Control Module or through the control computer causes the module to rotate the dome to its user configurable "park position" and to save the resulting encoder state to non-volatile memory. This allows the user to turn off the dome power without losing azimuth calibration. The next time the dome is powered up, the Azimuth Module restores the saved encoder information and the dome is ready to be used. Should the dome need to be recalibrated, it may be performed by issuing the "find home" command from the control computer, causing the Azimuth Module to rotate the dome until it finds the "home position" magnet.

## Shutter Control

The Shutter Control Module manages the operation of the dome's aperture doors and uses two limit switches to determine their state (open, closed, or unknown). The module includes an auto-close function where it will automatically close the dome if it has not heard from the control

computer after 5 minutes. When the auto-close function triggers, the Shutter Module will sound a 4-second alarm before closing the aperture doors. This feature may optionally be disabled through the use of a hardware jumper located on the module's control board.

## Hardware Components

### Azimuth Control Module

- Front Panel:
  - Main power switch
  - Auto/Manual mode switch
  - Forward/Reverse manual rotation switch
  - Park pushbutton
- External Components:
  - Home position sensor
  - Azimuth drive motor
  - Friction drive azimuth encoder
- Cables:
  - Home position sensor cable
  - Azimuth encoder cable
  - Azimuth motor cable
  - External "close dome" cable (2.5V-28V DC input signal, sink or source)
  - Power cable (3 prong, 120 VAC 20A)

### Shutter Control Module

- Front Panel:
  - Auto/Manual mode switch
  - Open/Halt/Close switch
  - Close alarm (sounds when auto-close is triggered)
- External Components:
  - Open and close limit switches
  - Shutter motor
  - 12V sealed gel cell deep cycle battery
  - Battery charging subsystem (depends on power configuration)
- Cables:
  - Open and close limit switch cables
  - Shutter motor cable
  - Power cables (depends on power configuration)

### Client RF device

- Data cable (RS232 DB9 and USB models available)
- 7.5V DC power supply with 6-foot cable