

**MaxDome**

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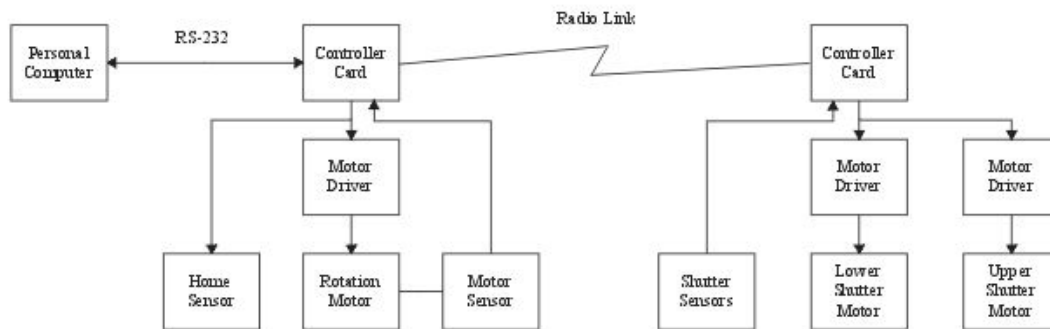
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# Introduction

The MaxDome controller system provides complete automated control of a telescope dome and associated shutter. For lower-cost installations, rotation-only operation is also supported.

The MaxDome controller system is available in two configurations: rotation only, and rotation plus shutter control.



## Rotation

The Controller Card connects directly to a Windows-based Personal Computer via an RS-232 link. The MaxDome driver in the computer handles all communications to the controller board.

The controller card directly controls a motor driver board, which turns on the motor in either the forward or backwards direction.

The Motor Sensor counts rotations of the motor shaft; this is used to detect when the dome has rotated to the correct position. One side of the shaft is colored black, the other is reflective metal. The sensor is optical, and is able to count twice per rotation. This is sufficient to position the dome very accurately.

In order to set the dome to a specific azimuth, a home sensor must be installed.

The home sensor is a simple magnetic switch similar to those used in home burglar alarms. Whenever the home position sensor is detected, the dome position is reset to the user-supplied azimuth value.

## Shutter

A second Controller Card is installed on the dome itself for controlling the shutter motors. Sirius domes have an upper and lower shutter, and therefore two motors.

The motors are sequenced one after the other, to ensure that the shutters do not

mechanically interfere with each other. The motors are turned on for a pre-determined time which is long enough to ensure that the shutter fully opens/closes.

Two magnetic sensors are provided; these should be positioned to switch when the each shutter is fully closed. These switches provide the "shutter closed" indication in the software on the PC. If after the shutters are operated both switches are not engaged, a "shutter error" indication appears.

The link between the two controller cards is via radio. Once every 10 seconds a message is passed between the two cards. Normally this message is simply a "poll" to determine the shutter status. When a command is sent by the PC, the message sends a command to open/close the shutter.

# Safety

## WARNING

Please take care when operating the dome via MaxDome.  
Equipment damage or personal injury may potentially  
result from unexpected motion of the dome.

If an emergency stop is required, you can stop dome movement as follows:

- ASCOM Dome Control Panel – click the **STOP** button to stop the dome
- AutomaDome – click the **Emergency Stop** button.
- Manual Stop – turn off the **power switch**.
- The dome will stop rotating if the manual control is actuated in the opposite direction, but only for as long as the button is held down.

For the safety of both personnel and equipment, please keep in mind the following:

- Make sure that the dome and shutter are not obstructed.
- Make sure that all personnel are clear of the dome during automated operation.
- Do not leave the dome unattended during automated operation
- Power off the dome controller when not in use
- For remote operation, we recommend the use of a webcam or similar device to verify dome operation, especially to verify shutter closure. Although MaxDome includes magnetic switches which confirm dome closure, visual inspection is recommended to ensure that the equipment is protected against the weather.





# Regulatory Notices

## FCC Notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

## Caution

Changes or modifications not expressly approved by Diffraction Limited could void the user's authority to operate the equipment.



# Hardware Installation

## Getting Started

The following tools are required:

- Electric drill
- Small Phillips screwdriver
- Small slotted screwdriver
- Nut driver set

The following materials should be in the kit (rotation and shutter control):

- Screws, washers, and nuts
- Two controller boards
- One motor sensor board
- One motor sensor cable
- Three magnetic sensors with magnets
- One serial (RS-232) cable
- Computer CD-ROM

The following materials should be in the kit (rotation only):

- Screws, washers, and nuts
- One controller board
- One motor sensor board
- One motor sensor cable
- One magnetic sensor with magnet
- One serial (RS-232) cable
- Computer CD-ROM

The following additional materials may be required:

- Extra cable
- Power switches for motor boards

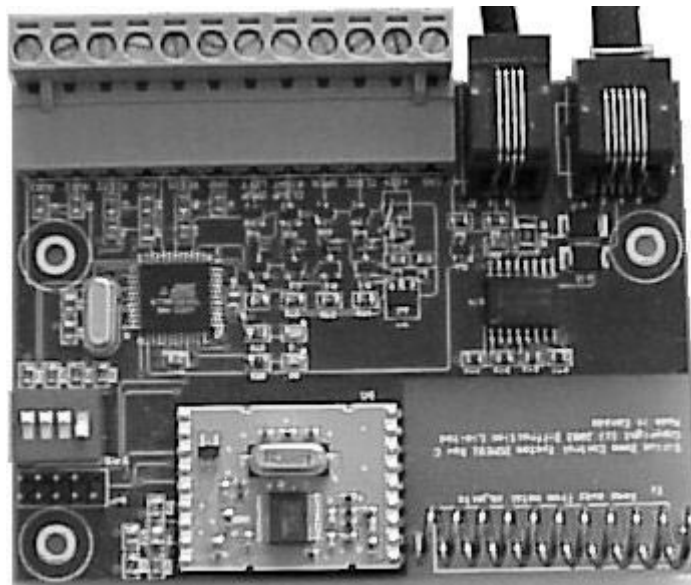
## Rotation Controller Installation

Tools required:

- Electric drill
- Small Phillips screwdriver
- Small slotted screwdriver
- Nut driver set

### Controller Board

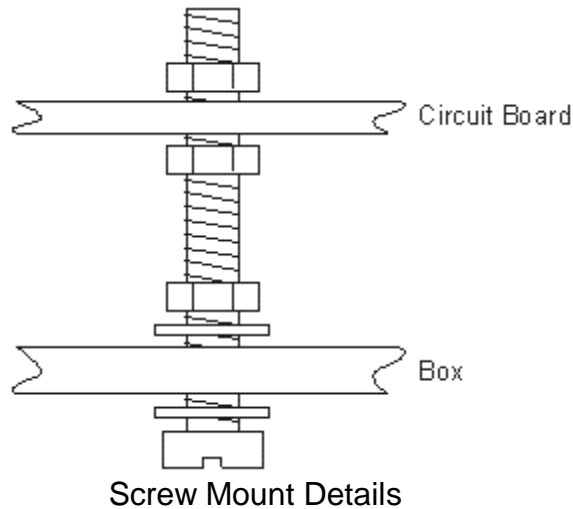
The controller card is shown below. Note that the Rotation Controller and the Shutter Controller boards are identical.



Dome Controller Circuit Card

The circuit card is normally mounted in the corner of the fiberglass box next to the motor assembly. To mount the card, drill four 1/8" mounting holes in the box. The holes are spaced 2" apart vertically and 3-9/16" apart horizontally.

Refer to the picture below for the following steps. Put one washer on each screw and insert the screws into the four holes from the outside of the box. Put another washer on each screw from inside the box, and then attach a nut and tighten firmly to the box.

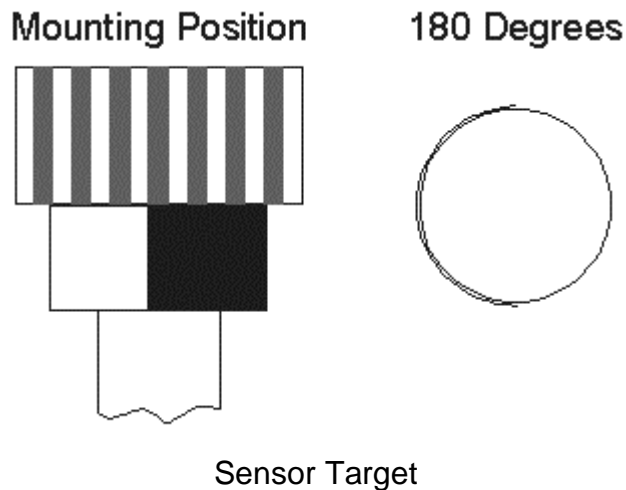


Next place a nut part-way down each screw. Since the fiberglass may be slightly uneven, adjust the nuts so they are in a plane; i.e. when the board is placed on top, each corner must be evenly supported by a nut. Lay the board in place on top of the nuts, and fasten down using additional nuts.

### Optical Motor Sensor

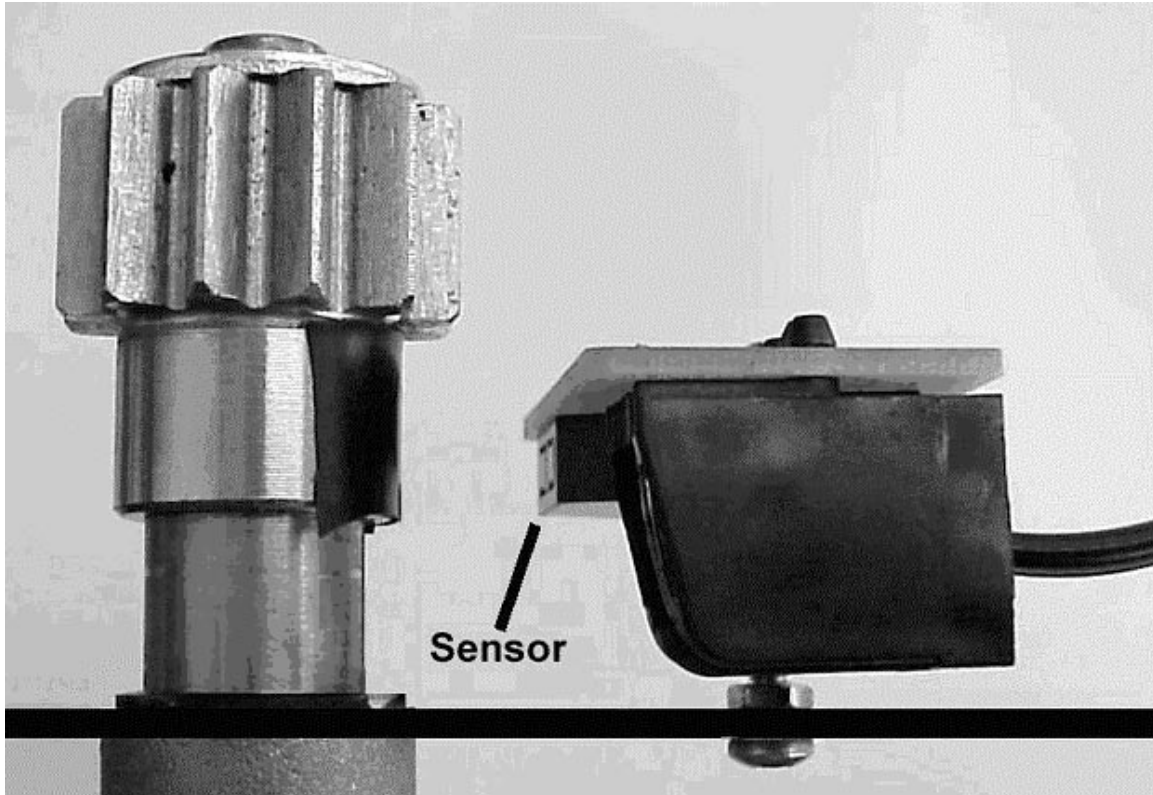
Once the board is installed, the optical sensor must be installed.

The optical sensor works by detecting a dark patch on the rotating shaft just under the gear. To create a target for the sensor, approximately half the shaft must be blackened as shown below – this is important for correct operation of the detector. The simplest way to do this is to use a cut piece of black electrical tape.



The sensor must be positioned viewing this target from the side, as shown below. The sensor must be mounted in a position where it can view the target, yet will not obstruct any of the mechanical components.

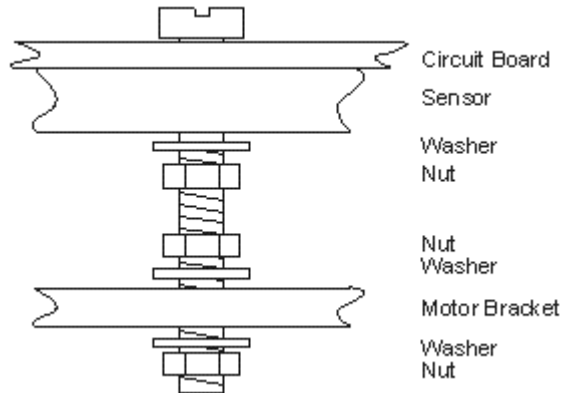
The next picture shows how the sensor board is positioned. You want the head of the sensor to be approximately 3/8" from the shaft. The sensor has to be at the correct distance or it will not reliably detect shaft rotation. Once you have determined the correct spacing, drill two holes in the plate for the mounting screws.



Sensor Position

The sensor board is mounted upside-down; that is, with the connector and sensor underneath the board, facing the motor. This is necessary to position the sensor at the correct height. Fasten it in place with two 4-40 screw, as shown below. Be careful not to scratch the coating on the circuit board, lest the wiring be shorted out.

Once the holes are drilled, mount the sensor using the supplied screws, washers, and nuts as shown below. Please note that there should be a washer under the sensor. Also avoid scratching the coating on the circuit board; it protects the tracks from short circuits.



Sensor Mounting Screw (1 of 2)

Once the sensor is mounted, connect the supplied cable to the phone jack, and route the wires over to the controller board. Be careful to avoid pinch points that might damage the wiring during dome operation.

## Wiring

Referring back to the first picture above, you can see the terminal block (green). Beside that is the dome sensor jack, and the RS-232 serial port connector. The serial port should be connected to the PC COM port using the supplied cable.

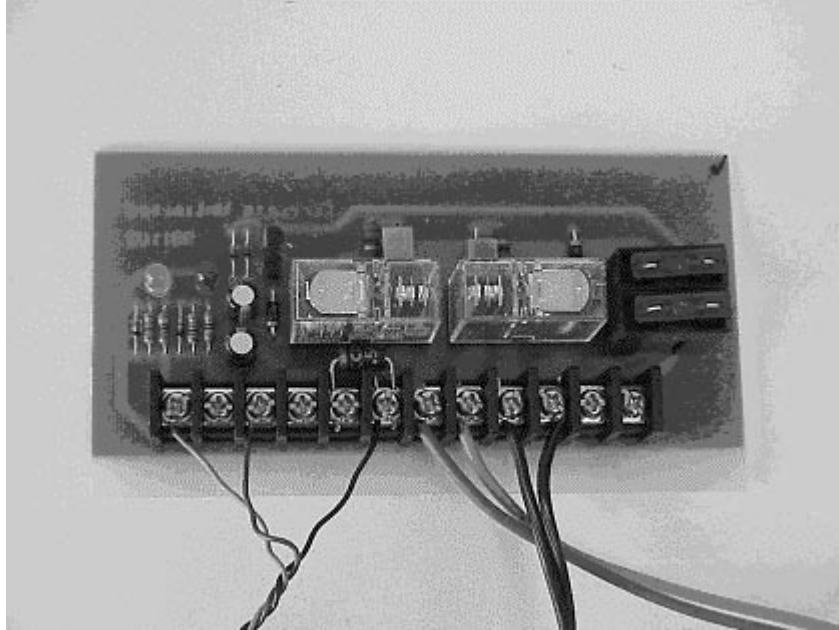
The motor sensor should be plugged into the sensor jack.

The green terminal block includes the following connections, from left to right as shown in the picture above:

AUX1	Optional. Pulling this terminal to ground will cause the dome to close
AUX2	Optional. Pulling this terminal to ground will cause the dome to close
REED2	Not used.
GND	Not used.
REED1	Home position magnetic reed relay
GND	Ground for home position magnetic reed relay
OPUP/LEFT	LEFT motor command
CLSUP/RIGHT	RIGHT motor command
OPEN	Not used.
CLOSE	Not used.
+12V	+12V input. We recommend adding an external power switch.
GND	Ground return for 12V input

Each of these will be described in more detail below.

## Motor Control Wiring



Motor Driver Board

The Left/Right wires go from the Dome Controller board to the Motor Driver board. The wires may be connected in parallel with the manual switch at the Motor Driver board.

A ground wire must also be connected between the boards. This provides a return path for the control lines. This wire can be connected to any of the terminals marked GND.

Note that, if for some reason the dome rotates in the wrong direction, the Left and Right wires can be swapped.

## Magnetic Home Sensor Wiring

The Home Position sensor is a simple magnetic reed switch, commonly used in home burglar alarms. The switch is open when the magnet is not present, and closed when it is present.

The magnet and sensor must be placed adjacent to each other, such that the magnet rotates with the dome, and the sensor remains stationary. The switch will close only when the dome is in a position where the magnet is directly adjacent to the sensor. This allows the Dome Controller to reposition the dome to a known position prior to operation, so that it knows the azimuth of the dome.



The sensor should be wired between the REED1 and GND terminals.

### **Power Supply Wiring**

The controller card requires +12VDC for operation. Please be sure to observe the correct polarity when connecting the power. The board draws 75 mA at 12V. It can operate down to about +9VDC.

The standard 12V DC battery will provide sufficient power for the motor and the controller board. If you use an alternative power source, make sure it can handle the current surge when the motor starts working; if the voltage drops too much it may cause the controller board to reset.

It is recommended that a switch be added to the battery leads to preserve battery life when the unit is not operating. This switch can be mounted onto the side of the fiberglass motor enclosure.

### **DIP Switch**

Switch 4 switches between Channel A and Channel B. Both the Rotation Controller board and the Shutter Controller board must be selected to the same channel.

Switches 1 through 3 are currently not used.

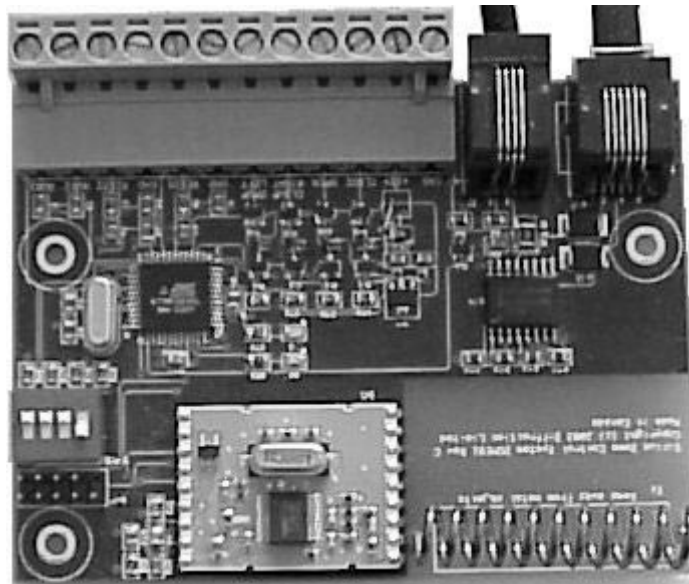
## Shutter Controller Installation

Tools required:

- Electric drill
- Small Phillips screwdriver
- Small slotted screwdriver
- Nut driver set

### Controller Board

The controller card is shown below. Note that the Rotation Controller and the Shutter Controller boards are identical.

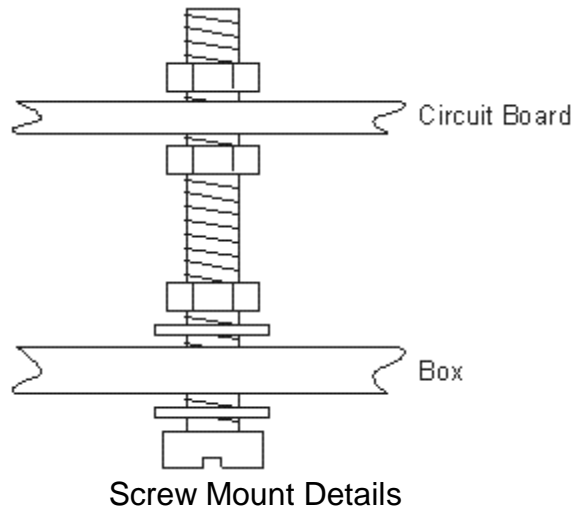


Dome Controller Circuit Card

The circuit card should be mounted in a fiberglass box. Do *not* install it in a metal box since this will block the radio signals.

To mount the card, drill four 1/8" mounting holes in the box. The holes are spaced 2" apart vertically and 3-9/16" apart horizontally.

Refer to the picture below for the following steps. Put one washer on each screw and insert the screws into the four holes from the outside of the box. Put another washer on each screw from inside the box, and then attach a nut and tighten firmly to the box.



Next place a nut part-way down each screw. Since the fiberglass may be slightly uneven, adjust the nuts so they are in a plane; i.e. when the board is placed on top, each corner must be evenly supported by a nut. Lay the board in place on top of the nuts, and fasten down using additional nuts.

## Wiring

Referring back to the first picture above, you can see the terminal block (green). Beside that is the dome sensor jack, and the RS-232 serial port connector. The serial port should be connected to the PC COM port using the supplied cable.

The motor sensor should be plugged into the sensor jack.

The green terminal block includes the following connections, from left to right as shown in the picture above:

AUX1	Optional. Pulling this terminal to ground will cause the dome to close
AUX2	Optional. Pulling this terminal to ground will cause the dome to close
REED2	Shutter closed position magnetic relay
GND	Ground for shutter closed position magnetic relay
REED1	Shutter closed position magnetic relay
GND	Ground for shutter closed position magnetic relay
OPUP/LEFT	Open Upper motor command
CLSUP/RIGHT	Close Upper motor command
OPEN	Open Lower motor command
CLOSE	Close Lower motor command
+12V	+12V input. We recommend adding an external power switch.

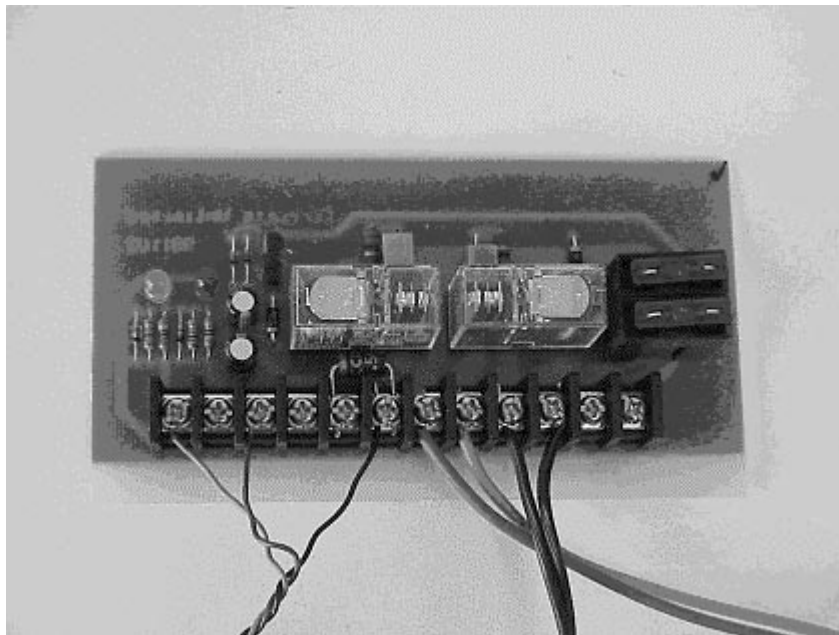
GND	Ground return for 12V input
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Each of these will be described in more detail below.

## Motor Control Wiring

There are two motors; one for the upper shutter and one for the lower. Both are wired identically.

Make sure that the Upper terminals are connected to the Upper motor, and the Lower terminals are connected to the Lower motor. Otherwise the shutters will not sequence properly and will bind.



Motor Driver Board

The Open/Close wires go from the Dome Controller board to the Motor Driver board. The wires may be connected in parallel with the manual switch at the Motor Driver board.

A ground wire must also be connected between the boards. This provides a return path for the control lines. This wire can be connected to any of the terminals marked GND.

Note that, if for some reason the dome rotates in the wrong direction, the Open and Close wires can be swapped.

## Magnetic Closed Sensor Wiring

The Shutter Closed sensors are simple magnetic reed switches, commonly used in home burglar alarms. The switch is open when the magnet is not present, and closed when it is present.

The magnet and sensor must be placed so that they are adjacent when the shutter is closed. This provides a positive confirmation that the shutter is in the closed position. A sensor is provided for both the upper and lower shutters.

One sensor should be connected between the REED 1 and GND terminals. The other sensor should be connected between REED 2 and GND. It does not matter which sensor goes to which REED terminal; both must be closed for the Dome Controller to report back "closed" to the PC.

### **Power Supply Wiring**

The controller card requires +12VDC for operation. Please be sure to observe the correct polarity when connecting the power. The board draws 75 mA at 12V. It can operate down to about +9VDC.

The standard 12V DC battery will provide sufficient power for the motor and the controller board. If you use an alternative power source, make sure it can handle the current surge when the motor starts working; if the voltage drops too much it may cause the controller board to reset.

It is recommended that a switch be added to the battery leads to preserve battery life when the unit is not operating. This switch can be mounted onto the side of the fiberglass motor enclosure.

### **DIP Switch**

Switch 4 switches between Channel A and Channel B. Both the Rotation Controller board and the Shutter Controller board must be selected to the same channel.

Switches 1 through 3 are currently not used.



# Software Installation

## ASCOM Platform

The MaxDome controller requires the ASCOM Dome Control Panel.

To install ASCOM, insert the CD-ROM. The Launcher should automatically appear; if not, then open the CD-ROM and double-click on Launcher.exe.

Click the **Install ASCOM** button and follow the instructions.

## MaxDome Driver

The MaxDome driver is used to communicate with the MaxDome controller board.

To install MaxDome, insert the CD-ROM. The Launcher should automatically appear; if not, then open the CD-ROM and double-click on Launcher.exe.

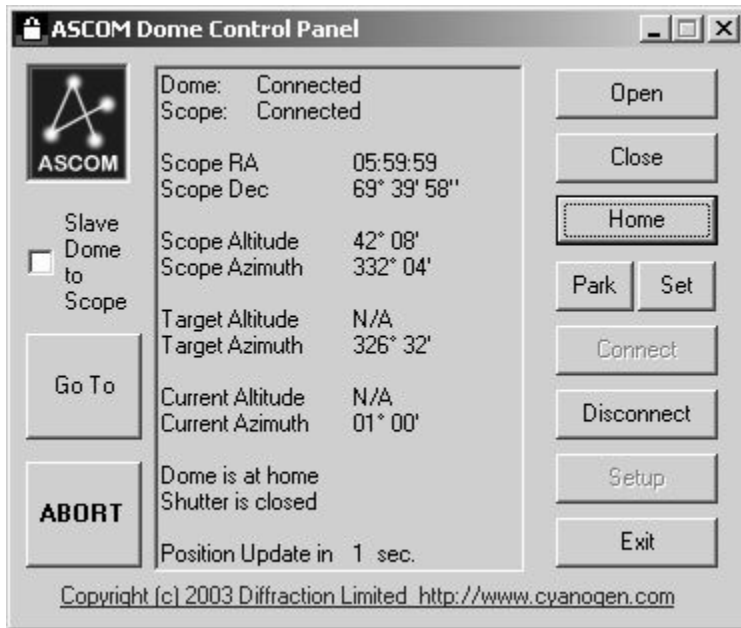
Click the **Install MaxDome** button and follow the instructions.



# Software Operation

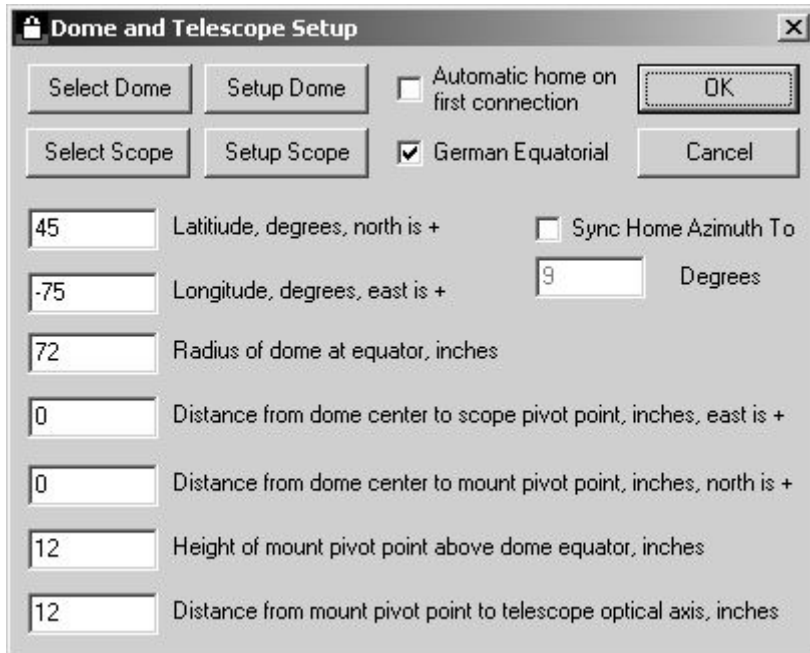
## Dome Setup

Go to the **Start** menu and select **Programs, ASCOM Platform, Dome Controller**.



Click the **Setup** button.

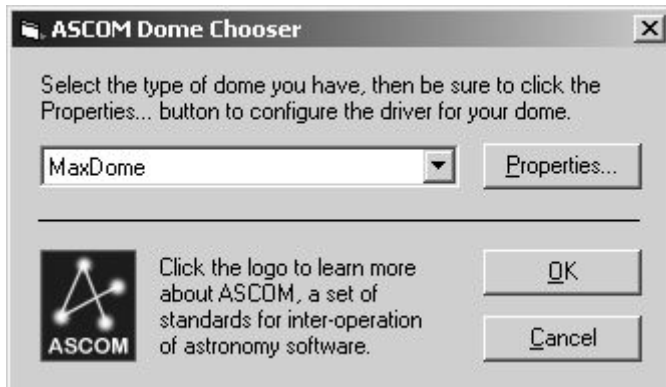
## MaxDome



The "Dome and Telescope Setup" dialog box contains the following elements:

- Buttons: "Select Dome", "Setup Dome", "Select Scope", "Setup Scope", "OK", "Cancel".
- Checkboxes: "Automatic home on first connection" (unchecked), "German Equatorial" (checked), "Sync Home Azimuth To" (unchecked).
- Input fields:
  - Latitude, degrees, north is +: 45
  - Longitude, degrees, east is +: -75
  - Radius of dome at equator, inches: 72
  - Distance from dome center to scope pivot point, inches, east is +: 0
  - Distance from dome center to mount pivot point, inches, north is +: 0
  - Height of mount pivot point above dome equator, inches: 12
  - Distance from mount pivot point to telescope optical axis, inches: 12

Click **Select Dome**.

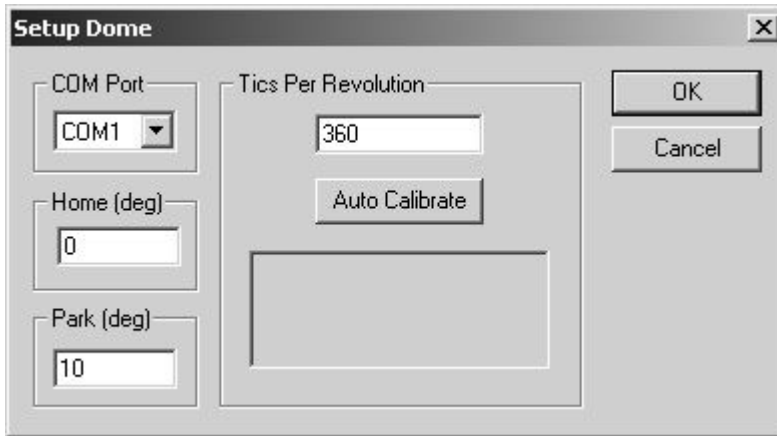


The "ASCOM Dome Chooser" dialog box contains the following elements:

- Text: "Select the type of dome you have, then be sure to click the Properties... button to configure the driver for your dome."
- Dropdown menu: "MaxDome"
- Buttons: "Properties...", "OK", "Cancel".
- ASCOM logo and text: "Click the logo to learn more about ASCOM, a set of standards for inter-operation of astronomy software."

Select **MaxDome** to choose MaxDome controller.

Click **Properties...**



Selects the **COM Port** that the MaxDome controller is plugged into.

The location of the dome Home Position sensor determines the value for **Home (deg)**. Enter the azimuth for the dome when it is at the Home Position sensor. This is necessary for MaxDome to know where it is pointed.

If you wish to park the dome when you are not using it at a different azimuth, enter an azimuth in **Park (deg)**.

Tics Per Revolution must be set accurately in order to have correct dome positioning. Each tic is one half rotation of the motor drive shaft. If the shaft goes through 275 half-turns in a full rotation, enter 275.

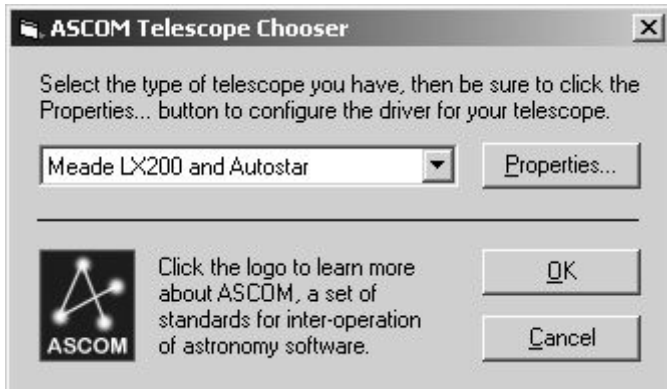
Instead of counting shaft rotations, it is much simpler to click the **Auto Calibrate** button. The dome will start rotating until it finds the home position. It will then move slightly, and search for home again. During this time, it will count the total motor tics. Once it is done it will enter the value for you.

Click **OK** when you are done. The dome is now ready for use.

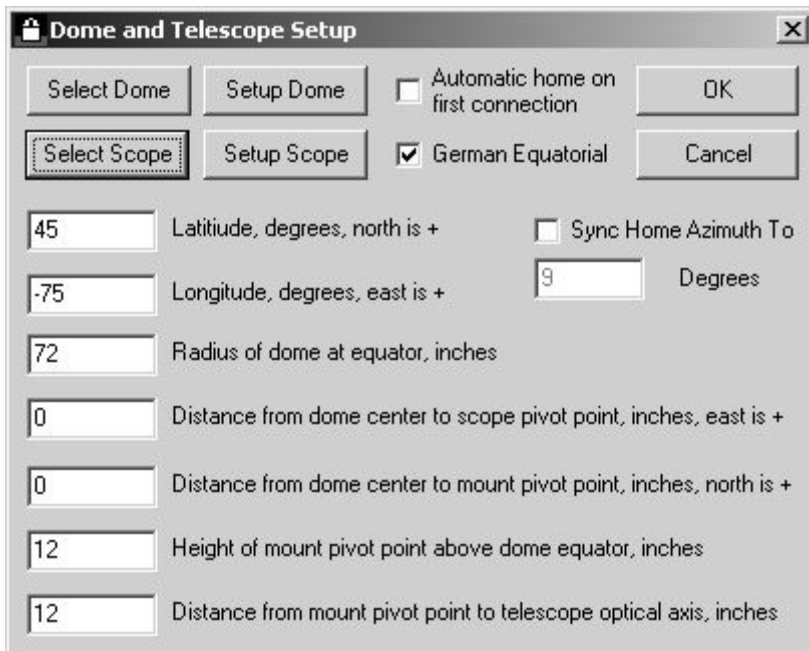
## Slaving Setup

The ASCOM Dome Control Panel can be used to slave the dome to your telescope.

Open the ASCOM Dome Control Panel, as described under Dome Setup. Click the **Setup** button, and click **Select Scope**.



Select the desired telescope, and then click **Properties...** to configure it. When you are done click OK.



Now you must set up some dome parameters. This only need be done once.

- Enter your **Latitude**, in degrees. North is positive. This should be a decimal number, e.g. 45.5.

- Enter your **Longitude** in degrees. Note that the **Western** hemisphere is **Negative**.
- Enter the **Radius** of the dome at its equator, in inches.

We must also enter some parameters for the telescope mount.

- Enter the **east/west** distance from the center of the dome to the telescope pivot point, in inches. The dome center is the geometric center at the equator of the dome (in most cases, the bottom of the dome itself). If the mount is **east** of center, enter a **positive** number; if the dome is **west** of center, enter a **negative** number.
- Enter the **north/south** distance from the center of the dome to the telescope pivot point, in inches. If the mount is **north** of center, enter a **positive** number; if the dome is **south** of center, enter a **negative** number.
- Enter the **height** of the mount pivot point above the dome center, in inches. For a fork mount, this is the point between the two Declination bearings. For a German equatorial mount, this is the point where the RA axis meets the Declination axis.
- Enter the distance from the mount pivot point to the **telescope optical axis** in inches.
- Select **German Equatorial** if your mount is a GE; otherwise turn it off.

We recommend that you turn on **Automatic home on first connection**. This will cause the mount to automatically find its home position when you first connect.

You can override the Home position setting in the MaxDome setup, by turning on **Sync Home Azimuth To** and entering an azimuth in degrees.

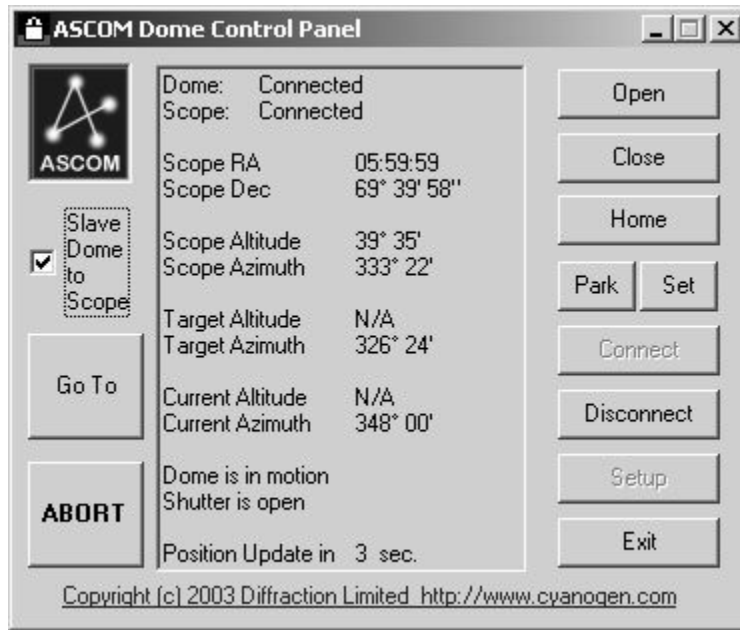
Once this is done, click **OK**.

In your ASCOM-compliant telescope control application (e.g. planetarium or imaging software), switch the **Telescope** setting to **Dome Control Panel**. All commands will now be sent to the telescope through the control panel. The control panel will be able to pick off the RA/Dec commands and use this information to slew the dome. It will also report "slewing" if the dome is still turning after the telescope stops moving.

Please see [Normal Operation](#) for instructions on using dome slaving.

## Normal Operation

Please see [Dome Setup](#) and [Slaving Setup](#) if you have not already set up the dome and telescope.



## Connecting

Make sure that the Dome and Telescope have been properly selected. Note that a Telescope Simulator and Dome Simulator are available if you wish to experiment with the software without the hardware being present.

Click the **Connect** button. The dome and telescope should now be connected. If you get an error message, check the connections.

## Opening the Shutter

Click the **Open** button. The dome should start opening within ten seconds (it has to wait for the next radio message, which is sent every ten seconds). The dome will take about 90 seconds to fully open. The shutters are opened one after the other, and the total motor running time is conservative to ensure that each slit fully opens.

When the open cycle is complete, the status will display **Shutter is open**.

## Find Home

If so configured, the dome will automatically find the home position upon the first connection. Otherwise this must be done manually by clicking the **Home** button. You will not be able to rotate the dome until this is done, because the dome will not know where it is pointing.

## Manual Go To

To send the dome to a specific azimuth, click the **Go To** button. Enter the desired azimuth and click **OK**. (The control panel supports altitude selection as well; this is not required for MaxDome and is therefore disabled.)

## Slaving to Telescope

Turn on **Slave Dome to Scope**. The dome will now turn so that the slit is in front of the telescope aperture. If the dome turns to the wrong position, please see [Troubleshooting](#).

You can connect an ASCOM-compliant control program to the ASCOM Dome Control Panel. In your telescope control application, select Dome Control Panel instead of the telescope. Now whenever the control program sends a command, it will be intercepted by the control panel and used to move the dome.

Applications such as [MaxIm DL/CCD](#) and [Desktop Universe](#) can connect directly. Some applications, such as TheSky and Starry Night may require a plug-in to be installed. The ASCOM Platform installer should have notified you about the installation procedure for these applications during the install process.

For automated applications, the Dome Control Panel will report "slewing" if *either* the telescope or dome is moving as the result of a slew command. That way, you will not get an image of the inside of the shutter if the telescope moves faster than the dome.

For sidereal tracking purposes, the Dome Control Panel checks the telescope position every 10 seconds. If the telescope has moved enough to require dome motion, the dome is automatically moved. If the telescope is slewed from the hand paddle, then the dome will follow the next time a poll occurs. On a long slew the dome may stop and start again, depending on the telescope speed.

## Shutting Down

The shutter can be closed at any time by clicking the **Close** button. The dome should start closing within ten seconds. It will require 90 seconds to fully close.

When the dome is closed, the status display will indicate this. It will display an error message if, after the motors have been operated, it does not get a closed status from both of the magnetic shutter switches.

## MaxDome

We strongly recommend that, regardless of the magnetic switch interlocks, a visual inspection be made to ensure complete dome closure. This will ensure that the dome is secure against weather hazards. For remote applications a webcam can be used for this purpose.

If you wish to park the dome in a particular position, click the **Park** button. You can set this position by moving the dome to a particular position and clicking the **Set** button.

If you do not care about the park position, you may wish to send the dome to the **Home** position. This will be handy the next time you connect, because the dome will already be homed.

Disconnect your control program (planetarium, etc) first. Next click the **Disconnect** button to shut down the links to the telescope and dome.



# Troubleshooting

## Computer Link Not Established

Check that the correct COM port is selected. The baud rate and stop bit settings are controlled automatically by the software, so no adjustments are required.

Check that the COM port is actually working. Some inexpensive USB-to-Serial adapters are unreliable.

Check that the controller board is powered up; the V+ light should be illuminated.

Try swapping the rotation and shutter boards, to see if one is damaged. Note that the terminal strip is a two-piece unit; you can simply unplug the terminal strip from the board.

## Home Position Not Detected

Make sure that the motor ticks are being counted. The home position is declared on the next motor tic after the home position sensor is triggered. If the optical sensor is not working, the home position will not be detected. If the optical sensor is working, the RD2/ROT light should be flashing as the dome is rotating.

Make sure the home position sensor is working by manually moving the dome to the home position. The RD1 light should illuminate.

## Motor Shaft Detector Not Working

When the dome is rotating, the RD2/ROT light should be flashing. It will blink on and off once per motor shaft rotation. If it is not blinking, check that:

- The black strip is in place on the motor shaft
- The sensor is not too close or too far from the shaft
- That bright sunlight is not falling on the sensor
- That the sensor cable is not damaged

## Open/Close Not Working

Make sure the Rotation Controller has power; check that the V+ light is illuminated.

## MaxDome

The Rotation Controller will blink the RF light every 10 seconds, while it is transmitting a message. If a message is received back, it will blink a second time.

The Shutter Controller light will blink if it is receiving poll messages from the rotation controller. Make sure the RF light is blinking.

Make sure the antenna is not close to a large metallic object. Metal will detune the antenna and cause poor reception.

Check for any local sources of electromagnetic interference. Try turning off other devices to see if they are interfering with the link.

Make sure DIP switch #4 is set to the same position on both boards. Both boards must be on the same channel!

## **Dome Rotates the Wrong Way**

Check that all the settings are correct in the ASCOM Dome Control Panel.

If necessary, reverse the Left/Right wires.

## **Shutter Moves Incorrectly**

Make sure the upper/lower shutter motor wires are not reversed.

If a shutter opens when it should be closing, reverse the open/close wires.

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