

**MaxDome II**

---



## Table Of Contents

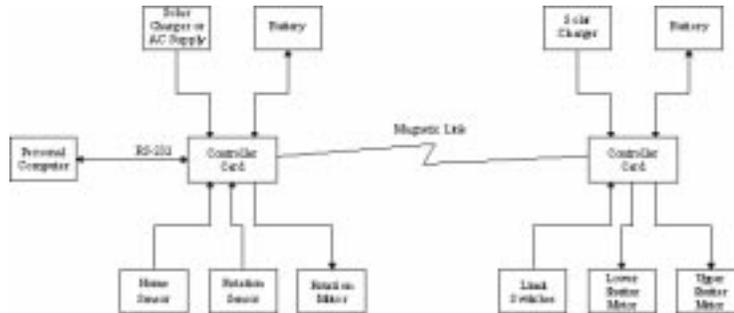
Introduction	1
Rotation	1
Shutter	1
Remote Operation	2
Safety	5
WARNING	5
Regulatory Notices	7
FCC Notice	7
Canadian Regulatory Information (Canada Only)	7
Hardware Installation	8
Getting Started	8
Rotation Controller Installation	10
Controller Board	10
DIP Switch	10
Optical Rotation Sensor	11
Motors	14
Wiring	15
Power Supply Wiring	18
Magnetic Induction "Antenna"	18
Magnetic Home Sensor Wiring	19
Motor Control Wiring	19
Auxiliary Inputs	20
Shutter Controller Installation	22
Controller Board	22
DIP Switch	22
Wiring	23
Power Supply Wiring	26
Magnetic Induction "Antenna"	26
Motor Control Wiring	28
Auxiliary Inputs	28
Software Installation	31
ASCOM Platform	31
MaxDome Driver	32
Software Operation	33

## Table Of Contents

Dome Setup	33
Slaving Setup	37
Normal Operation	41
Connecting	41
Opening the Shutter	41
Find Home	42
Manual Go To	42
Slaving to Telescope	42
Shutting Down	43
Safety Interlocks	43
Troubleshooting	47
Status Lights	47
Computer Link Not Established	47
Rotation Detector Not Working	49
Home Position Not Detected	50
Open/Close Not Working	51
Shutter Does Not Stop	51
Shutter Moves Incorrectly	53
Shutter Status Incorrect	53
Dome Rotates the Wrong Way	53
Index	55

# Introduction

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



## Rotation

The MaxDome II Rotation Controller card directly drives a 12V DC motor through a set of electromechanical relays. The recommended power source is a trickle-charged 12V Gell Cell, which will allow safe automatic closure of the dome in the event of a power loss.

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

The Rotation Sensor counts rotations of the motor shaft. The "tics" from this sensor are used to detect when the dome has rotated to the correct position. One side of the shaft is colored black, the other is white; in this way, the sensor will count tics twice per rotation. This is sufficient to position the dome very accurately. Some installations have used black and white stripes around the perimeter of the dome or other schemes; the main criteria is that tics are cleanly produced and occur no faster than about once a second during rotation.

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 on the next tic.

Manual operation of the dome rotation is supported through an external hand paddle switch (not included). When the dome is operated manually through this switch, the dome keeps track of the current position, eliminating the need to re-home the dome after manual movement.

## Shutter

A second identical card, the Shutter Controller, is installed on the dome itself for controlling the shutter motors. This card is powered by a solar-charged battery, usually a 12V Gel Cell, and a wireless communications link is provided to the rotation card. This means that there are *no* electrical connections to the rotating dome, eliminating a major reliability concern.

One or two shutters may be controlled, depending on the dome configuration. If two shutters are used, they are sequenced so that they can overlap when closed. Usually the "upper" shutter overlaps the "lower" shutter, to provide a better weather seal. If desired, the MaxDome software driver can be configured to open just the upper shutter, for special situations (high winds, light pollution).

Each shutter must have limit switches at each end of the travel. These limit switches connect to the controller card, and go open circuit when the shutter hits the end of travel. The card will automatically deactivate the control relay when the end of travel is detected.

Communications between the two controller cards is provided via a magnetic induction link. Every two seconds messages are passed

back and forth between the cards. When the PC commands a shutter operation via its serial connection to the rotation card, a message is passed to the shutter card to initiate shutter movement. The shutter card reports back the current shutter status at all times.

For observatories where there is some risk of physical collision between the telescope and the shutter mechanism, MaxDome II can be configured to automatically Park the dome prior to operating the shutter. The dome will only be allowed to rotate again under computer control once the shutter is fully closed or fully open.

## **Remote Operation**

Additional features are provided to protect your telescope equipment against failures and power outages, to help reduce the risk of weather damage to the observatory equipment in remote observing situations.

Auxiliary close inputs are available on both cards; a contact closure to ground will initiate shutter closure. This allows for direct connection of cloud and/or rain sensors, such as a Boltwood Cloud Sensor.

If the communications link between the rotation and shutter cards fails for more than ten minutes (perhaps due to a power failure), the shutters will automatically close. Because the Shutter Controller cannot know whether the dome is parked or not when the link is down, this feature can be optionally disabled.

If communications are lost between the Rotation Controller and the PC, the dome will automatically close after ten minutes. This protects the observatory in the event of a power outage or computer failure. If so configured, the dome will automatically park before the shutter is moved, which is important if there is any risk of a collision between the telescope and the shutter actuator.

It is recommended that the rotation controller also be powered by a battery, either AC charged or solar charged. This ensures that the

## MaxDome

dome will be safely closed automatically in the event of a complete power failure, without the need for an external UPS unit.

# 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 or shutter.

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 – we **strongly** recommend the installation of power kill switches for both rotation and shutter control
- The manual rotation and open/close switches can be used to reverse motion; be aware, however, that the system may still be receiving commands from the control computer.

Note that there will be a lag of a few seconds in sending a message from the control computer to the MaxDome II Shutter Controller. Depending on the installation and electrical noise environment, this delay may be larger.

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

## MaxDome

- Power off the dome controller when not in use
- For remote operation, we recommend the use of independent means, such as a webcam, to verify proper dome operation. This is particularly important with respect to shutter operation and weather protection.

**If you are operating the observatory remotely or unattended, please be aware that there is an intrinsic risk of equipment damage due to unexpected adverse weather conditions.** While every effort has been made to minimize the possibility, a failure of control software, electronics, or dome mechanical or electrical hardware could potentially cause the dome shutters to remain open during adverse conditions. We strongly recommend that for remote operation, correct shutter operation be verified by independent means.

For additional safety against rain damage, we recommend that a Boltwood Cloud Sensor or similar weather monitoring device be connected to the AUX inputs. This will automatically trigger shutter closure in the advent of unexpected adverse weather conditions.

# **Regulatory Notices**

## **FCC Notice**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference that may cause undesired operation.

## **Canadian Regulatory Information (Canada Only)**

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Note that Canadian Department of Communications (DOC) regulations provide, that changes or modifications not expressly approved by Diffraction Limited could void your authority to operate this equipment.

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

# Hardware Installation

## Getting Started

The MaxDome controller kits are available in two versions: rotation only, and rotation plus shutter control.

All motors must operate from 12VDC, and reverse by changing the polarity of the supplied current.

The following tools are required:

- Small slotted screwdriver
- Small Phillips screwdriver
- Electric drill and bits
- Wire cutter/stripper

The following materials are included in the kit (rotation and shutter control version):

- Two controller boards
- One motor sensor board
- One motor sensor cable
- One magnetic sensor with magnet
- One serial (RS-232) cable assembly
- Mounting hardware for optical sensor
- Computer CD-ROM
- Induction wire
- Mounting hardware for induction wire

The following materials are included in the kit (rotation only version):

- One controller board
- One motor sensor board

- One motor sensor cable
- One magnetic sensor with magnet
- One serial (RS-232) cable
- Computer CD-ROM

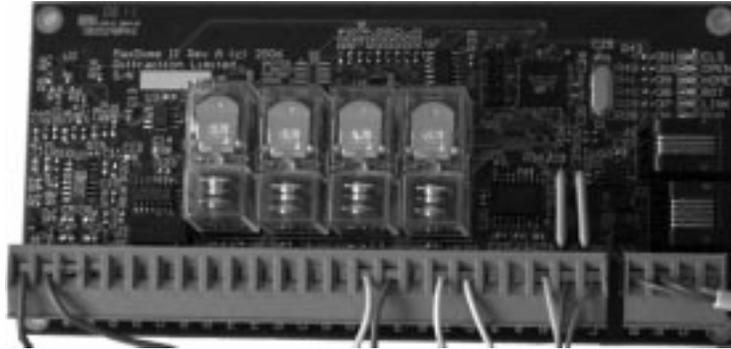
The following additional materials may be required:

- Protective boxes for MaxDome cards (not required for Sirius Observatories)
- Extra wire
- Power cut switches (strongly recommended)
- Additional mounting hardware (depending on installation)

## Rotation Controller Installation

### Controller Board

The controller card is shown below. Note that the Rotation Controller and the Shutter Controller boards are identical; a DIP switch is used to configure each board to rotation mode or shutter mode.



Dome Controller Circuit Card

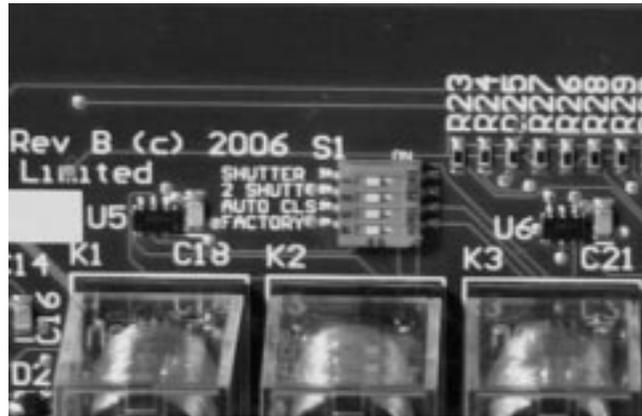
The card should be mounted in a protected enclosure. For Sirius Observatories, it will slide into the slot intended for the original (non-automated) motor relay card. For other types of installations, you can use the four mounting holes, or if mounting on a non-conductive surface you can use stick-on Velcro buttons underneath the board. (Note: Velcro may not stick reliably if applied at low temperatures. Just use a small button of Velcro in each corner; otherwise you may need to apply a lot of force to remove the card, and you will run the risk of damaging it.)

**WARNING:** Use the supplied #4-40 screws, or other #4 or smaller hardware, when attaching the board. Do not force in screws that have threads larger than the hole. ***Using larger screws will damage the board and invalidate your warranty.*** Use appropriate spacers or

standoffs to make sure the board electrical contacts do not touch metal.

## DIP Switch

The DIP switch is located just above the relays. Use the tip of a small precision screwdriver to set the switch positions. As shown in the picture below, **OFF** is to the **LEFT**, and **ON** is to the **RIGHT**.



The DIP switch must be set as follows:

Switch 1 (**SHUTTER**) must be set **OFF** for rotation controller operation.

Switch 2 (**2 SHUTT**) is not used for the rotation controller.

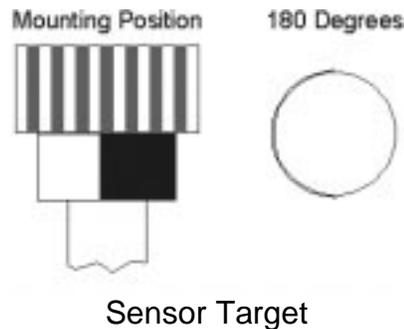
Switch 3 (**AUTO CLS**) is not used for the rotation controller.

Switch 4 (**FACTORY**) must be set **OFF**. It is only used when uploading new firmware and during factory test procedures.

## Optical Rotation Sensor

The optical sensor detects the rotation of the dome by detecting white and black strips. A common way to do this is to paint the motor shaft half black and half white, as shown below. Sirius Observatories drive motors have shafts painted in this fashion.

If you need to do this yourself, the best approach is to use white and black spray paint. Apply the paint in two stages; first paint the whole shaft white and allow to dry. Next apply masking tape to define the black area, and apply black spray paint. For both colors use two coats to ensure good coverage. Note: generally speaking black spray paint absorbs infrared light very well, but many other "black" coatings and materials (including most anodizing treatments) are actually highly reflective in the IR and as a result will not work. You can check the suitability of various materials by pointing the sensor at them and watching the ROT light.

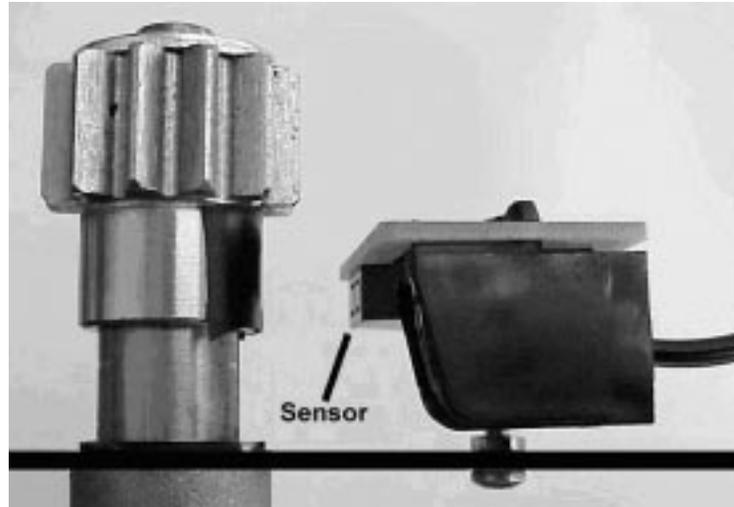


The sensor must be positioned viewing this target from the side, as shown below. The sensor must be mounted in a position where it can view the target, yet will not obstruct any of the mechanical components.

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

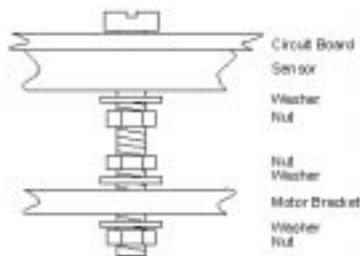
shaft rotation. Once you have determined the correct spacing, drill two holes in the plate for the mounting screws. For Sirius Observatories we strongly recommend that you mount the sensor to the metal plate on the gearbox, rather than the fibreglass case. That way the sensor moves with the motor and keeps a fixed distance from the shaft.

Tip: you can check whether the distance is correct using the ROT light on the Rotation Controller board. Once you connect the power to the shutter board, the light will illuminate whenever the reflective part of the shaft is facing the sensor.



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 1-1/4" 4-40 screws (it is best to use two screws to ensure that the sensor does not rotate). Be very careful not to bridge any contact points on the circuit board. It is best to one screw hole in the center of the sensor, and one screw hole in the corner of the board (the second screw prevents the board from rotating if the cable is tugged).



Sensor Mounting Screw (1 of 2)

Although this is not recommended, some users prefer to mount the sensor module using Velcro, which is quick and allows easy adjustment of the sensor (to avoid any risk of injury due to unexpected motor operation, it is essential to disconnect the MaxDome II power supply before attempting to adjust the sensor). Make sure that all surfaces are clean and apply under "room temperature" conditions to ensure good adhesion. Be careful to tie off the cable so it cannot disturb the sensor position.

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

An alternative method is to paint white and black strips around the diameter of the dome, using masking tape and spray paint. The sensor will have to be mounted so that it maintains a constant distance from the dome; this may require a spring loaded idler wheel. It is recommended that the strips be painted so that there is a transition (from white to black or black to white) once every second as the dome is rotating. This provides a suitable signal for the Rotation Controller to process. Slower is okay, but it is not recommended to go much faster.

There are many other possibilities for sensor mounting; for unusual installations please consult the factory for recommendations.

## Motors

MaxDome is designed to operate 12V DC motors. The maximum continuous current capacity for inductive loads is 5A.

It is possible to connect other types of motors, such as AC motors, using external relays. Please observe all electrical code regulations when installing AC powered motor drives.

The MaxDome II system does not provide motor ramping. We recommend using a modest rotation speed with the system, to avoid the need for ramping and to also ensure safe, reliable operation.

If motor ramping is necessary due to an extremely heavy dome, third party motor control modules can be added.

If necessary, the system will tolerate a couple of seconds of "run-on" past the completion of a slew. If it continues for longer than that, the sensor "tics" will not be recorded and the dome position will be lost. Any minor run-on should be corrected on the next sidereal position update (e.g. the ASCOM Dome Control Panel issues these updates every 10 seconds).

## Wiring

Referring back to the first picture above, you can see the terminal blocks (green), the rotation sensor jack, and the RS-232 serial port jack. The serial port jack should be connected to the PC COM port using the supplied cable. The motor sensor should be plugged into the sensor jack.

There are two green terminal blocks. Note that the terminal blocks can be unplugged from the board by gently pulling them out vertically.

The terminal blocks have the following connections, as shown from left to right in the picture above:

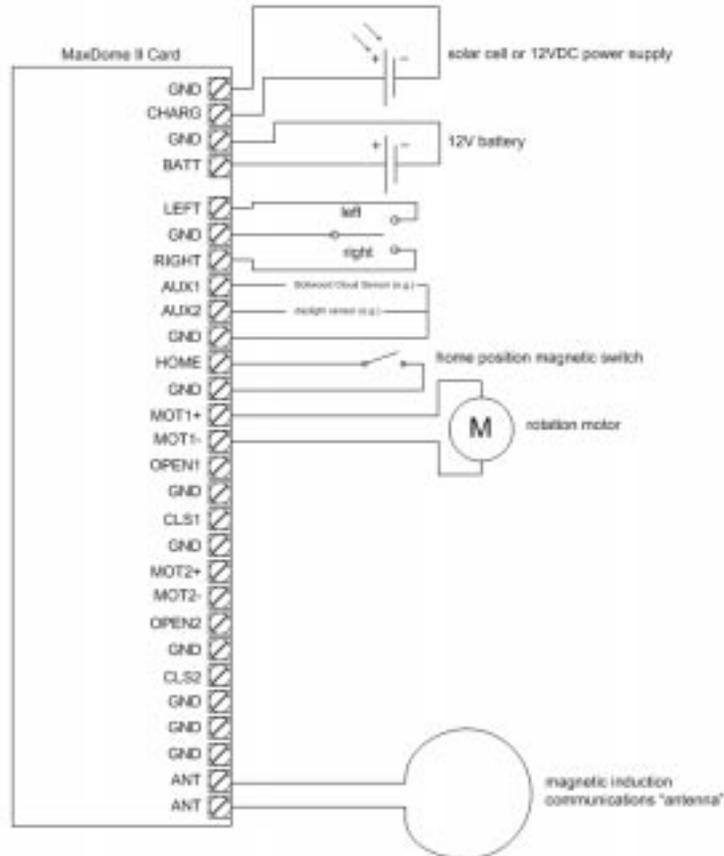
**Large Terminal Block**

ANT	Magnetic induction wire "antenna" (leave open if no shutter controller)
ANT	Magnetic induction wire "antenna" (leave open if no shutter controller)
GND	Spare
GND	Spare
GND	Spare
CLS2	Not used
GND	Spare
OPEN2	Not used
MOT2-	Not used
MOT2+	Not used
GND	Spare
CLS1	Not used
GND	Spare
OPEN1	Not used
MOT1-	Rotation Motor (n.b. reverse wires if motor rotates wrong way)
MOT1+	Rotation Motor
GND	Home position magnetic switch
HOME	Home position magnetic switch
GND	Ground return for Auxiliary inputs
AUX2	Auxiliary close input (e.g. Boltwood Cloud Sensor, etc.)
AUX1	Auxiliary close input
RIGHT	Manual rotation paddle right contact
GND	Manual rotation paddle common
LEFT	Manual rotation paddle left contact

**Small Terminal Block**

BATT	Battery terminal +12VDC
GND	Battery Ground
+12V	+12V power input. We recommend adding an external power switch.
GND	Ground return for 12V input

These connections are shown schematically below. Each connection will also be described in more detail.



## **Power Supply Wiring**

The controller card nominally requires +12VDC for operation, but will operate between 8V and 14V. Both the charger and battery inputs have built-in 10 Amp fuses, which automatically reset once the overload is removed.

When idle, the board draws about 1 mA. When transmitting a magnetic induction message, it briefly draws about 10 mA. When the dome is rotating, the current draw is determined by the motor used.

The battery drain from the controller is minimal, so the battery should be sized to provide sufficient power for the motor during expected operation. A standard 12V, 6 or 12 Amp-hour gell cell battery is usually sufficient. Using a battery supply also ensures that the large inrush currents generated when the motor starts up will not cause the power supply to droop.

If a solar charger is used, it should be sized to fully recharge the battery during a single sunny day (30W is usually sufficient). Please note that high latitudes it may be necessary to use a larger solar cell. If AC power is available, a trickle charger will keep the battery topped up at all times.

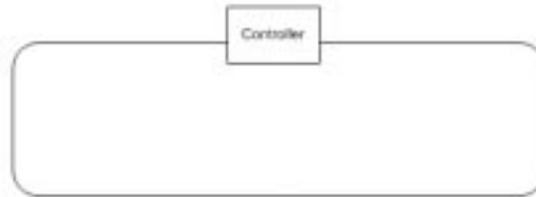
If you do not wish to use a battery, connect the power supply directly to the BATT terminal. Note that the power supply will need enough capacity to handle the large inrush currents when the motor is activated. If the voltage droops too low during startup the microprocessor will reset and the dome will stop.

## **Magnetic Induction "Antenna"**

If the shutter controller is also being installed, then you will need to connect the magnetic induction "antenna". This is simply a loop of wire that runs all the way around the observatory, and connects back to the controller. The wire generates a very low frequency (8 kHz) pulsating

magnetic field, which induces a small voltage in the other controller's wire. The pulsations encode low bit-rate digital data, which is transferred back and forth every two seconds.

Note that only one wire needs to run the full diameter of the dome. Usually the base wire runs the full diameter, to ensure good communications in all dome positions. The upper wire usually only needs to extend about 3-4 feet to provide a reliable link. If this arrangement of the wire is used, return path of the wire *must* be kept at least one foot away from the other side of the loop, as shown in the diagram.



## 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 ("Normally Closed" style).

The sensor should be wired between the **HOME** and **GND** terminals.

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 starting azimuth of the dome. From there it counts the position using the Optical Sensor.

The magnet is usually attached directly to the inside surface of the dome itself, and the sensor attached to the base where it will be close to the magnet at a particular dome position. For Sirius Observatories, the sensor is usually attached to the black wheel track cover, close to the dome itself. Be sure to position the wires so they will not touch any moving parts.

The azimuth of the dome at the Home position is not important, since this can be adjusted for in software. However, it may be useful to position the dome at an easily identifiable position, such as 180 degrees. This will make it easier to determine the correct number to enter. Also it is best to position the sensor in a position where it will be detected often during normal operation; for example, in the Northern Hemisphere, locating the Home position due South will cause it to be detected more often than locating it due North.

## Motor Control Wiring

The MOT1+ and MOT1- wires connect to the rotation motor. The motor receives 12V DC, with the polarity determining the direction of rotation. Note that the +/- designation is arbitrary; if the motor rotates backwards, reverse the wires.

To test it, apply power and start the motor moving using the manual hand paddle. The dome should move right, as seen from inside, when the **Right** input terminal is connected to ground. If the motor rotates in the wrong direction, simply reverse the two motor wires.

As you rotate the dome, make sure the **ROT** light flashes on and off at a steady rate. If it does not, check the optical sensor. If the optical sensor does not operate properly, you will not be able to rotate the dome from the PC. You may need to adjust the spacing of the optical sensor for the best results.

When the dome is near the Home position, the **HOME** light should come on. If not, check the home sensor wiring and the relative position of the magnet and sensor.

## **Auxiliary Inputs**

The shutter may be commanded to close by an external device, by pulling either the AUX 1 or AUX 2 input to ground (GND pin). This is commonly connected to a Boltwood Cloud Sensor or some other type of rain or weather sensor. Before using the AUX inputs, you must install and test the Shutter Controller.

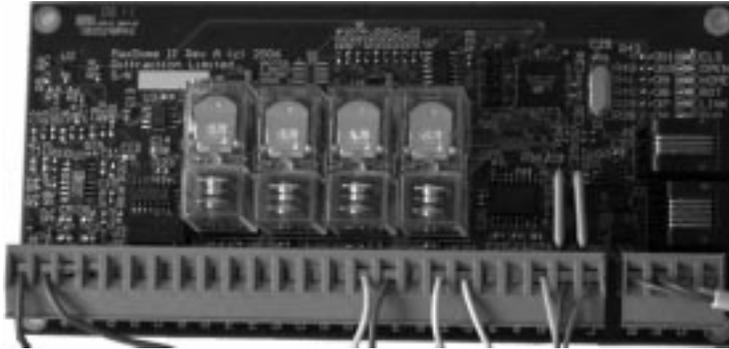
The AUX inputs should be left unconnected if they are not being used.

If the MaxDome system is configured to "Park Dome Before Operating Shutter" (configured in the PC driver setup), then it will also park the dome when an AUX input is detected, prior to closing the shutter. A couple of caveats: if rotation commands are received after the shutter is closed, then the dome will rotate out of Park to the commanded position. Also, because this configuration setting is made at the PC, it will not be remembered if the Rotation Controller loses all power. To restore the setting, you must reconnect connect the link to the PC.

## Shutter Controller Installation

### Controller Board

The controller card is shown below. Note that the Rotation Controller and the Shutter Controller boards are identical; a DIP switch is used to configure each board to rotation mode or shutter mode.



Dome Controller Circuit Card

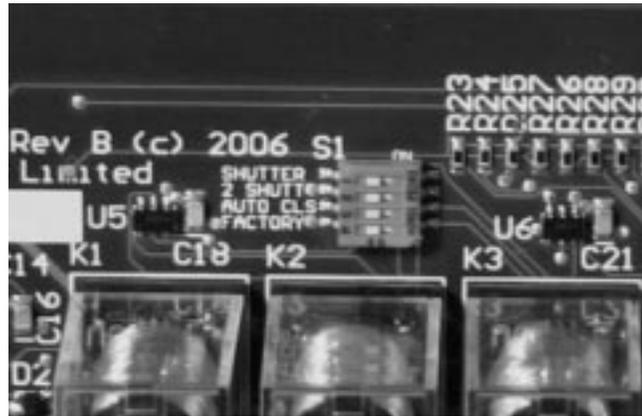
The card should be mounted in a protected enclosure. For Sirius Observatories, it will slide into the slot intended for the original (non-automated) motor relay card. For other types of installations, you can use the four mounting holes, or if mounting on a non-conductive surface you can use stick-on Velcro buttons underneath the board. (Note: Velcro may not stick reliably if applied at low temperatures. Just use a small button of Velcro in each corner; otherwise you may need to apply a lot of force to remove the card, and you will run the risk of damaging it.)

**WARNING:** Use the supplied #4-40 screws, or other #4 or smaller hardware, when attaching the board. Do not force in screws that have threads larger than the hole. ***Using larger screws will damage the board and invalidate your warranty.*** Use appropriate spacers or

standoffs to make sure the board electrical contacts do not touch metal.

## DIP Switch

The DIP switch is located just above the relays. Use the tip of a small precision screwdriver to set the switch positions. As shown in the picture below, **OFF** is to the **LEFT**, and **ON** is to the **RIGHT**.



The DIP switch must be set as follows:

Switch 1 (**SHUTTER**) must be set **ON** for shutter controller operation.

Switch 2 (**2 SHUTT**) must be set **OFF** if you are operating **two shutters**, or **ON** if you are operating **one shutter**.

Switch 3 (**AUTO CLS**) should be turned **OFF** if the shutter can be operated at any dome position. If the switch is **OFF**, then the dome will automatically close ten minutes after loss of communications with the Rotation Controller. If the dome must be parked before operating the shutter, to prevent mechanical interference, then turn this **ON**.\*

Switch 4 (**FACTORY**) must be set **OFF**. It is only used when uploading new firmware and during factory test procedures.

\*The Rotation Controller also has a similar safety feature. It will command the shutter to close if it loses communications with the PC for more than ten minutes. It can be configured to Park the dome prior to operating the shutter, providing an auto-close safety feature without the risk of a mechanical collision with the shutter mechanism. The Rotation Controller is usually powered by a trickle-charged Gell Cell battery, so it will continue running after the PC loses power.

Also please note that the auto-close feature is disabled when the shutter is manually operated, and re-enabled when the shutter is operated under PC control. This interlock prevents the shutter from automatically closing every ten minutes if you are operating the dome manually.

Please note that some adjustments to these switches will be required during initial testing. Be sure to reset them appropriately once the testing is complete.

## Wiring

There are two green terminal blocks. Note that the terminal blocks can be unplugged from the board by gently pulling them out vertically.

The terminal blocks have the following connections, as shown from left to right in the picture above:

### Large Terminal Block

ANT	Magnetic induction wire "antenna"
ANT	Magnetic induction wire "antenna"
GND	Spare
GND	Spare
GND	Return for limit switch
CLS2	Lower shutter closed limit switch (open circuit when

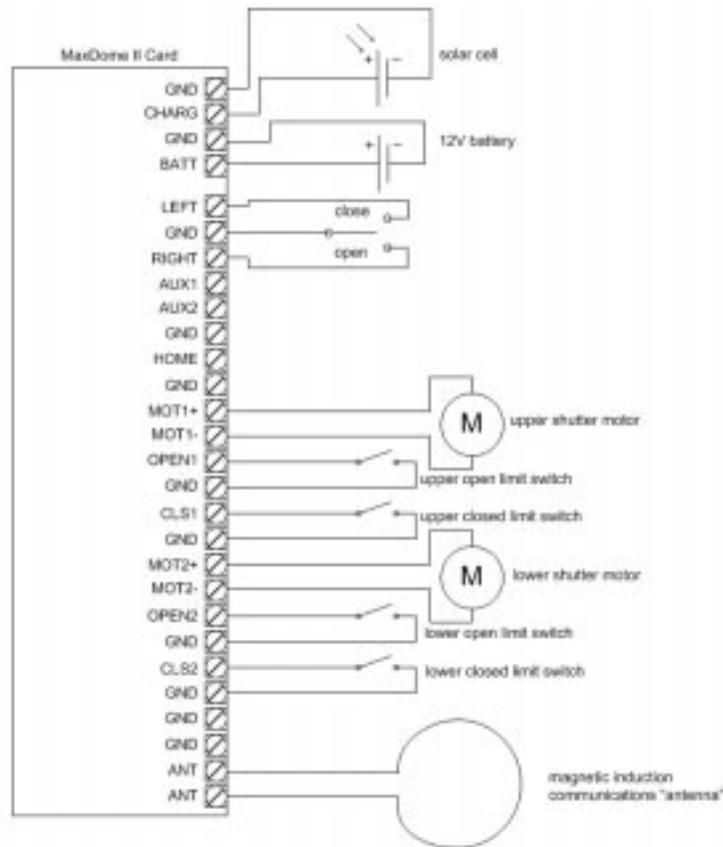
	shutter closed)
GND	Return for limit switch
OPEN2	Lower shutter open limit switch (open circuit when shutter open)
MOT2-	Lower shutter motor (n.b. reverse wires if motor rotates wrong way)
MOT2+	Lower shutter motor
GND	Return for limit switch
CLS1	Upper shutter closed limit switch (open circuit when shutter closed)
GND	Return for limit switch
OPEN1	Upper shutter open limit switch (open circuit when shutter open)
MOT1-	Upper shutter motor (n.b. reverse wires if motor rotates wrong way)
MOT1+	Upper shutter motor
GND	Spare
HOME	Not used
GND	Ground return for Auxiliary inputs
AUX2	Auxiliary close input
AUX1	Auxiliary close input
RIGHT	Manual control switch Open Shutter contact
GND	Manual control switch return
LEFT	Manual control switch Close Shutter contact

### Small Terminal Block

BATT	Battery terminal +12VDC
GND	Battery ground return
+12V	Solar cell +12V DC
GND	Ground return for solar cell

## MaxDome

These connections are shown schematically below. Each connection will also be described in more detail.



## Power Supply Wiring

The controller card nominally requires +12VDC for operation, but will operate between 8V and 14V. Both the charger and battery inputs have built-in 10 Amp fuses, which automatically reset once the overload is removed.

When idle, the board draws about 1 mA. When transmitting a magnetic induction message, it briefly draws about 10 mA. When the shutter is operating, the current draw is determined by the motor used.

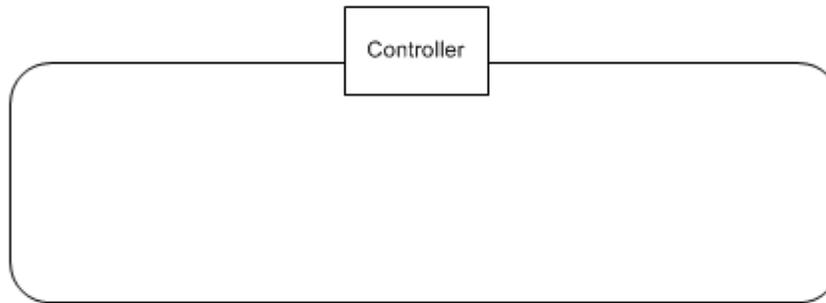
The battery drain by the controller is minimal, so the battery should be sized to provide sufficient power for the motor during expected operation. A standard 12V, 6 or 12 Amp-hour gell cell battery is usually sufficient. Using a battery supply also ensures that the large inrush currents generated when the motor starts up will not cause the power supply to droop.

The solar charger should be sized to fully recharge the battery during a single sunny day (30W is usually sufficient). Please note that high latitudes it may be necessary to use a larger solar cell, to ensure adequate charging during the short winter days. Optimize the angle of the solar cell for the worst-case month (December in the Northern Hemisphere, June in the Southern Hemisphere).

### **Magnetic Induction "Antenna"**

The magnetic induction "antenna" is simply a loop of wire that runs all the way around the dome, and connects back to the controller. The wire generates a very low frequency (8 kHz) pulsating magnetic field, which induces a small voltage in the other controller's wire. The pulsations encode low bit-rate digital data, which is transferred back and forth every two seconds.

Note that only one wire needs to run the full diameter of the dome. Usually the base wire runs the full diameter, to ensure good communications in all dome positions. The upper wire usually only needs to extend about 3-4 feet to provide a reliable link. If this arrangement of the wire is used, return path of the wire **must** be kept at least one foot away from the other side of the loop, as shown in the diagram.



## Motor Control Wiring

There are two identical motors control sets; one for the upper shutter and one for the lower (optional).

**Important:** The upper shutter is Shutter 1, and the lower shutter is Shutter 2. Shutter 1 opens before Shutter 2, and closes after Shutter 2. In many dual shutter designs the upper shutter overlaps the lower shutter to provide a better weather seal, and operating them in the wrong sequence can cause them to bind. Carefully double-check the sequencing when testing the shutters.

Once the shutters are connected, you must test them to ensure that all limit switches and motors are wired correctly. Make sure that the limit switches are open circuit when the shutter is at the limit, and closed circuit when not at the limit. If you are using magnetic "burglar alarm" style switches, this is known as a "Normally Open" switch (i.e. open circuit when magnet present).

The test procedure is as follows:

Power off both the Rotation Controller and the Shutter Controller (if no switch is available, unplug the power terminal block from the board).

Referring to the DIP switch settings above, configure the board as a Shutter Controller, with **one shutter operation** only (**2 SHUTT** switch **ON**), and disable the automatic close feature (**AUTO CLS** switch **ON**). We don't want the shutter to be actuated unexpectedly!

Apply power to the Shutter Controller (do *not* power up the Rotation Controller, to make sure that it does not send any commands).

Now check the upper shutter. Briefly switch the manual control switch to Open (**Right** input terminal connected to ground). The shutter should start to open. If it goes in the wrong direction, reverse the wires to the motor. If the motor does not move, check the limit switches and wiring. The open limit switch must go open circuit only when the upper shutter is fully open. The closed limit switch must go open circuit only when the upper shutter is fully closed. When the shutter is in a middle position, both LEDs should be off.

Now hold down the switch until the shutter fully closes. When you get near the end, be ready to let go of the switch if the limit switch fails to work. If the switch is working properly, the shutter will stop moving when you hit the end. If the limit switch fails to stop the shutter, check that it is actually tripping, that it is wired to the correct terminals (CLS1 and GND), and that the wires are intact. Also bear in mind that it is possible to have *both* the motor direction *and* the manual control switch direction wired backwards, in which case the limit switch will appear to not work because the controller is expecting the other switch to actuate.

Now try to fully open the shutter, and verify that the open limit switch works correctly.

If you have a lower shutter, proceed to test it as follows:

## MaxDome

First, open the upper shutter fully. Then set the DIP switches to enable the lower shutter, and cycle the power to the Shutter Controller on and off (briefly unplug the power terminal block).

Now try to open the shutters. If the upper shutter is not already fully open, it will open first. If the lower shutter starts going in the wrong direction, release the switch and reverse the connections to the motor.

Continue operating the lower shutter until it reaches the fully open position. Again, while approaching the end position, be ready to stop if the limit switch fails to operate. If necessary, correct any problems with the wiring or positioning of the limit switch.

Now start closing the shutter. Once again be ready to stop if the shutter fails to stop at the closed limit switch, and readjust the switch as required. Once the lower shutter is fully closed and the limit switch engaged, the upper shutter will start closing.

Run the shutter through a couple of complete open/close cycles, to ensure that they cycle in the correct order, and that the limit switches are working reliably.

Review the DIP switch settings again, to ensure that they are set for normal dome operation. If you change the settings, cycle the power to the board to reset it.

### **Auxiliary Inputs**

The shutter may be commanded to close by an external device, by pulling either the AUX 1 or AUX 2 input to ground (GND pin).

The AUX inputs should be left unconnected if they are not being used.

**Important Note:** The AUX inputs on the Shutter Controller will **not** park the dome before closing the shutter. If you need the automatic park feature, use the AUX inputs on the Rotation Controller only.

# Software Installation

## ASCOM Platform

The ASCOM Platform provides a set of standardized telescope drivers for many models of telescopes, as well as the ASCOM Dome Control Panel. MaxDome II can be operated from the ASCOM Dome Control Panel, and it can be used to slave the dome to the position of the telescope.

Note that other ASCOM dome control options are available, including the ASCOM "Plain Old Telescope Hub" included with the ASCOM Platform, as well as other third-party applications such as ACP4.

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.

Be sure to check the ASCOM web site at <http://ascom-standards.org> for any updates to the ASCOM Platform or individual drivers.

## MaxDome Driver

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

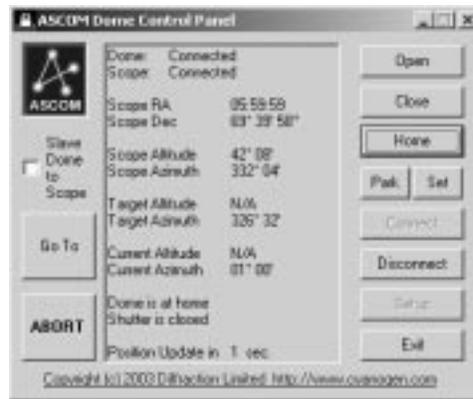
To install MaxDome, insert the CD-ROM. The Launcher should automatically appear; if not, then open the CD-ROM and double-click on Launcher.exe.

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

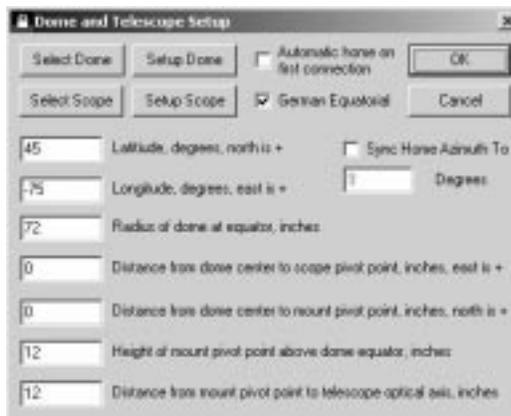
# Software Operation

## Dome Setup

Go to the **Start** menu and select **Programs, ASCOM Platform, Scope-Dome Hubs, ASCOMDome**. The ASCOM Dome Control Panel will appear.



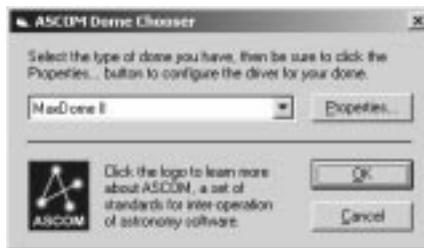
Click the **Setup** button.



## MaxDome

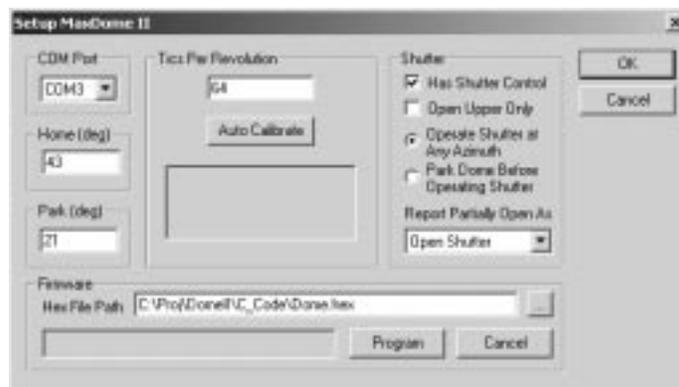
Most of these parameters will be set up in the next step; for now, we just need to initialize the settings for MaxDome II.

Click **Select Dome**.



Select **MaxDome II** to choose the MaxDome II controller.

Click **Properties...** to display the **Setup MaxDome II** dialog box.



Select the **COM Port** that the MaxDome II controller is plugged into.

**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 dome rotation, enter 275. A typical value for a Sirius 2.3m dome is 227 (the actual value may vary slightly depending on installation).

Instead of counting tics manually, it is much simpler to click the **Auto Calibrate** button. The dome will start rotating to the right as seen from inside the dome. Note: if it goes left, the motor is wired backwards; stop and reverse the motor wires before proceeding. The dome will stop when it gets to the Home sensor, move a small distance forward, and then rotate fully around until it hits the Home sensor again. Once this is done, it will enter the measured **Tics Per Revolution**.

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 do not know the azimuth of the home sensor, use this procedure:

1. Click **OK** to go back to the ASCOM Dome Control Panel, and click **OK** to go back to the main controls.
2. Click **Connect**. Click **Home** to send the dome to the home position.
3. Guess at an approximate home position. North is 0 degrees, East is 90 degrees, South is 180 degrees, and West is 270 degrees. Open the **Setup Dome** dialog box and enter your guess.
4. Return to the main control panel. Rotate the dome a little to the left (manually or use the GOTO button), and then click the **Home** button.
5. After the dome stops, click the **GOTO** button and command it to point due North (0 degrees)
6. Check how well the dome lines up with the polar axis of the telescope mount. If it is not accurately aligned, estimate how much to adjust the Home position by and go back to Step 3. Repeat until the alignment is satisfactory.

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

## MaxDome

If your MaxDome II system includes a Shutter Controller card, turn on **Has Shutter Control**. If not, then turn it off. This affects what the MaxDome II driver reports to the controlling software.

If you wish to open only the upper shutter, turn on the **Open Upper Only** check box.

For some domes, there is a risk of an interference between part of the shutter mechanism and the telescope, when the dome and telescope are in particular positions. To avoid a collision, click **Park Dome Before Operating Shutter**. Set the Park position in a safe location where the shutter mechanism cannot touch the telescope. Now whenever the dome is commanded to close, the dome will first park. Note that the shutter will not move during the shutter operation, but it will move if a rotation command is received while it is fully open or fully closed. Also note that this setting is transferred to the MaxDome II Rotation Controller when the link is connected; a complete power failure for the controller could temporarily clear the setting until the link is reconnected.

If there is no risk of a shutter collision at any position, click **Operate Shutter At Any Azimuth**.

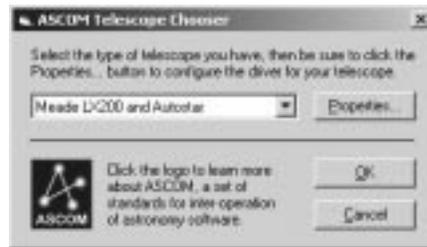
If the shutter is only partially opened, this can be reported as an error, or as "open". In some cases, e.g. manually adjusting the shutter to be partially opened, reporting an error could disable automation software. You can override this by setting **Report Partially Open As** to **Open Shutter**. Normally this should be left set to **Error**.

Click **OK** when you are done. The dome is now ready for use. The next step is to configure the dome slaving. This can be done using ASCOM or AutomaDome.

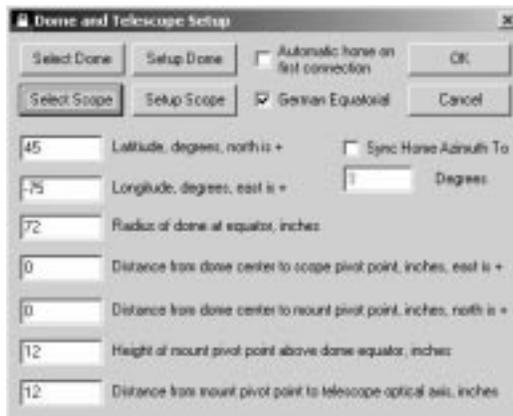
## Slaving Setup

The ASCOM Dome Control Panel can be used to slave the dome to your telescope; alternatively you may wish to use the POTH Scope and Dome Hub, which is also included in the ASCOM Platform. You may also use another application such as ACP4. The general dome setup procedure is the same in each case.

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.



## MaxDome

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 (make sure you enter the radius, which is half the diameter).

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 hemispherical dome itself). If the mount is **east** of center, enter a **positive** number; if the mount 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 mount 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.

You may want to turn on **Automatic home on first connection**. This will cause the dome to automatically find its home position when you first connect, which will ensure that the dome positions will be accurate. If your Rotation Controller has battery or UPS power

available, you probably do not need to do home the dome except after prolonged power outages.

You can optionally override the Home position setting in the MaxDome II Dome Setup dialog box, by turning on **Sync Home Azimuth To** and entering an azimuth in degrees.

Getting the mount/dome parameters correct is critical for proper slaving. It can be very difficult to tell which number is wrong if an error is made. If you find the telescope does not reliably align with the dome when **Slave to Telescope** is checked in the main control panel window, double-check everything, including the following:

1. Make sure you have the latest update to the ASCOM Dome Control Panel.
2. Make sure the dome is not **rotating backwards**. If you click Home it should turn to the right as seen from inside the dome. If it is rotating backwards, reverse the wires to the motor.
3. Make sure the **Tics Per Revolution** in the **Setup Dome** dialog is set correctly.
4. Note that if the pulses from the encoder come too quickly, that could result in loss of tics; the recommended rate is one transition per second. If the optical sensor does not have the correct spacing, or it moves around during dome rotation, it could produce corrupted tics.
5. Use the **GOTO** button to command the dome to slew to 0 degrees, 90 degrees, 180 degrees, and then 270 degrees. Make sure the dome points due North, East, South, and West respectively. If the dome does not move exactly 90 degrees in each step, then your **Tics Per Revolution** is wrong. If the dome moves an appropriate distance but doesn't point the right way, your **Home Azimuth** is wrong. If the positioning is inconsistent check the alignment and spacing of the optical sensor.
6. Make sure you entered the radius of the dome, not the diameter. If you have the radius wrong, the telescope will not

point accurately, especially when it is looking through the slit at an angle.

7. An error in the height of the mount pivot point will have a similar effect as an error in the dome radius. Remember, the pivot point is where the RA and Dec axes intersect.
8. If you have a systematic offset in a particular part of the sky, check the pier centering.
9. If the pointing is inaccurate when your telescope is way over to one side or the other of the GE mount, check the distance from the mount pivot point to the optical axis.

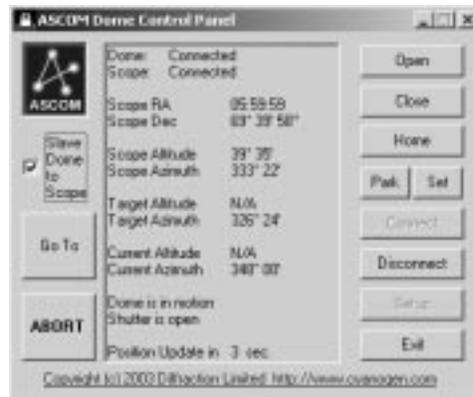
Once the telescope is slaved, the dome will follow the telescope, whether it is slewing or sidereal tracking. The telescope position is read periodically (every 10 seconds for ASCOM Dome Control Panel), so the dome may move in increments if you move the telescope using the hand paddle, or if you are using control software that does not connect through the control panel.

To configure a telescope control program for dome operations, set it to connect to the ASCOM Dome Control Panel, instead of directly to the telescope. Now when a command is sent from the software to the telescope, the Control Panel will intercept the command before it is passed to the telescope. It will simultaneously command the dome to turn to the correction position. It will also report back that the telescope is slewing while either the dome or telescope are still moving. That way, if the dome takes longer to slew than the telescope, you will not get a photo of the inside of the dome!

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.

Note: if the shutter was not fully closed or fully open when the program was started, the display will indicate "Shutter Error" for the shutter status. This simply indicates that the shutter is in an unknown position. It will reset to normal when the shutter position becomes known; for example, if the shutter is closed.

## Opening the Shutter

Click the **Open** button. The dome should start opening within a few seconds. If the dome was set up with **Park Dome Before Operating Shutter**, the dome will first move to the Park position, and then start opening. As a result, the status may not report Opening until the dome is parked. The shutters will open in sequence, one after the other. Once both are fully open, the status will change to Shutter is Open within a few seconds.

## 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 accurately until this is done, because the dome will not know where it is pointing.

Note that if the Dome Control Panel displays "Dome has not been homed", it does not necessarily mean that the dome position is wrong. MaxDome II automatically resets the position if the home sensor is detected. It also remembers the home position as long as power is present on the Rotation Controller, even if the computer is disconnected.

MaxDome II is designed to maintain knowledge of the dome position, even if the dome is rotated manually using the hand paddle. So you do not need to re-home after moving the dome with the paddle.

## 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 Slaving Setup. Some extra suggestions are listed under 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 can connect directly. Some applications, such as TheSky and Starry Night Pro 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 dome 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 repeatedly, depending on the telescope speed. This will not happen for commands linked through the Dome Control Panel.

## Shutting Down

The shutter can be closed at any time by clicking the **Close** button. The dome should start closing within a few seconds. If so configured, it

may Park first before closing. Note however, that this does not permanently park the dome; if slaving is still turned on, the dome will move to synchronize with the telescope again.

We strongly recommend that, regardless of the limit 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. When there is any possibility of damage, it is unwise to rely on a single system, no matter how reliable!

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.

After ensuring that your telescope and dome are parked, you may wish to shut down the software. Disconnect your control program(s) first. Next click the **Disconnect** button in the Dome Control Panel to shut down the links to the telescope and dome. Finally, close the dome control panel.

## Safety Interlocks

### General

It is strongly recommended that you mount easily-accessible master power kill switches in the observatory, for both the Rotation Controller and Shutter Controller. This will allow you to kill the motors if an unsafe condition occurs. When working inside the dome, be aware that the shutter or dome may move at any time, in response to a (possibly remotely triggered) command from the computer. The dome also rotates periodically during sidereal tracking. Keep clear of moving parts at all times.

The MaxDome II boards include 10A automatically resetting fuses. This is to protect against overcurrents that might be caused by short

circuits or possibly stalled motors. If you see the power light slowly cycling on and off, kill the power and correct the problem.

## **Shutter**

The shutters are sequenced in a particular order, assuming that the upper shutter overlaps on top of the bottom shutter. If for some reason the shutters appear not to be sequencing properly, shutter motion will be stopped. Reverse the motion to clear the error.

MaxDome II has a safety feature for detecting loss of communications with the PC. The Rotation Controller will "time-out" if it has not received a message from the PC for ten minutes. This could indicate simply that the user closed the Dome Control Panel without closing the dome, or it might indicate computer failure or power outage. This safety feature is part of the reason we recommend using a trickle charged Gell Cell as the power source for the controller.

In the event of a failure in the communications link between the Rotation Controller and the Shutter Controller, the Shutter Controller can also be configured for a ten minute time-out. Do not turn this feature on if there is a risk that the shutter mechanism could collide with the telescope during the close cycle.

The dome can be set up to automatically park whenever a shutter open or close operation is requested. The dome will lock out rotation commands, rotate to the park position, operate the shutter, and then re-enable rotation commands.

**Warning: all shutter safety features are disabled when the shutter is operated using the manual open/close switch.** The shutter will move immediately, without parking; it is assumed you are present and watching for any mechanical interferences. The time-out closure feature will also be disabled, so that you can open the shutter for more than ten minutes without the PC link being present. Otherwise the dome would keep closing during manual operation.

## **Rotation**

If the rotation sensor does not see any dome rotation after actuating the motor for five seconds, the dome will be automatically stopped. To clear a rotation error, hit the Stop button, then issue a new rotation command. Note that an optical sensor failure will not prevent manual operation; the motor will continue turning under manual control even if the sensor does not see motion. This allows you to operate the dome manually if the rotation sensor fails.

MaxDome II expects the dome to stop rotating fairly quickly when a stop command is issued. Some domes may have significant inertia, and additional encoder ticks may occur after MaxDome II commands the motor to stop. The Rotation Controller will watch for additional ticks for several seconds. If the dome continues rotating for more than two seconds, it may cause problems with the pointing accuracy. If inertia is a problem, then the best solution is to slow down the dome rotation speed.

Note that the dome may not show "At Park" if it coasts too far past the park position. "At Home" will appear when the dome stops after a Home command, even if the dome is slightly out of position. The next command will clear the "At Home" indication. Also note that "At Home" and "At Park" status is only displayed after a command to Home or Park; these indications will not appear if the dome just happens to stop at those positions.

# Troubleshooting

## Status Lights

The MaxDome II controller boards have six indicator lights (Light Emitting Diodes or LEDs). Some LEDs have different functions depending on whether it is operating as the Rotation Controller or the Shutter Controller. The printed name is not always meaningful in both contexts, due to space limitations.

The functions of the LEDs are described in this table:

LED	Rotation Controller	Shutter Controller
CLS	Not Used	Lower Closed Limit Switch
OPEN	Serial Port Activity	Lower Open Limit Switch
HOME	At Home Position	Upper Closed Limit Switch
ROT	Optical Rotation Sensor	Upper Open Limit Switch
LINK	Induction Link Activity	Induction Link Activity
PWR	DC Power On	DC Power On

The **PWR** LED turns on to indicate that power is present on the controller.

The **LINK** LED "warbles" when a message is being transmitted or received over the magnetic induction link between the two controllers. The Rotation Controller always starts the exchange (master), and the Shutter Controller responds (slave). If everything is working normally, two warbles will happen one after the other. This pattern will repeat every two seconds.

If the induction link is dead (e.g. broken induction "antenna" wire), the Rotation Controller **LINK** LED will warble once every two seconds, and the Shutter Controller **LINK** LED will not warble at all. If sometimes it

works and sometimes it doesn't, then either the induction wires are installed incorrectly, or you have some kind of interference problem or other fault. Check the wires and if necessary contact Diffraction Limited for assistance.

The **ROT** LED blinks as the Optical Rotation Sensor sees the alternating white and black bands; it turns on for white and off for black. During dome rotation, this LED should blink steadily, turning on or off once a second or so. If it operates much more quickly than that, you may need to change the sensor installation. If it operates erratically, check the spacing and alignment of the sensor. Also make sure that the sensor is not shifting during dome rotation.

The **HOME** LED turns on when the home sensor magnet is near the sensor. If it does not light up, check the wires, and also verify that the magnet is not mounted too far away from the sensor. Note that the Rotation Controller will not actually recognize Home until the next tic of the Optical Rotation Sensor, so if the Optical Rotation Sensor is not working, the Home position will not be detected even though the LED illuminates.

When operating as a rotation controller, the **OPEN** LED is used as an indicator for serial port traffic. It blinks very briefly whenever a message is exchanged with the PC.

When operating as a Shutter Controller, the **ROT**, **HOME**, **OPEN**, and **CLS** LEDs show the status of the four shutter limit switches. **OPEN** and **CLS** refer to the lower shutter, and **ROT** and **HOME** refer to the upper shutter (**ROT** is **open** and **HOME** is **closed**). When the shutters are fully closed, **CLS** and **HOME** should be on. When the shutters are fully open, **OPEN** and **ROT** should be on. If the shutter is in an intermediate state, both LEDs for that shutter should be off. If both are ever on simultaneously, the switches are either wired incorrectly or are the wrong type (should be open circuit when actuated).

## Computer Link Not Established

Check that the Rotation Controller board is powered up: the **PWR** LED should be illuminated. If it is not illuminated, check the power connections. They must be connected with the correct voltage (12V DC) and polarity. If using a Gel Cell battery, make sure it has charge (note that a trickle charger or solar charger may not have enough power to charge a completely flat battery).

Make sure the **FACTORY** DIP switch is turned **OFF**. (Cycle the power if you change a setting.)

On the Rotation Controller, the **SHUTTER** DIP Switch must be turned **OFF**; otherwise the board will behave like a Shutter Controller and will not respond to computer commands.

Check the **OPEN** LED. It should blink very briefly whenever serial port characters are received. Under normal operation, a very short blink will appear once a second. If the LED does not blink, check the cabling. Also check that the correct **COM** port is selected in the MaxDome driver setup (a list of COM Ports is available in the Windows Device Manager). The baud rate and stop bit settings are controlled automatically by the software, so no adjustments are required.

Check that the computer **COM** port is actually working. Some inexpensive USB-to-Serial adapters are very unreliable, and some have unstable Windows drivers.

If you need to use an extension cable, use a DB9 to DB9 serial port extension cable, available at computer stores. Do not attempt to use a different RJ-11 telephone jack style cable. Many of these cables have only two or four wires, not the required six, and the connectors can also be attached in two different orientations. Use only the supplied RJ-11 to DB9 adaptor; there is no standard for the wiring for these adaptors, and adaptors from other equipment may not work (an Optec

adapter will not work, but Meade and Technical Innovations adapters will).

Try swapping the rotation and shutter boards, to see if one is damaged. Note that the terminal strips are two-piece units. You don't have to unscrew all the connections; you can simply unplug the strip from the board. Don't forget to set the DIP switches.

## Rotation Detector Not Working

Use the manual switch to rotate the dome. The **ROT** LED should be flashing steadily, with an on period of about one second, and an off period of about one second. It will turn on when the bright strip is under the sensor, and off when the dark strip is under the sensor.

If it is not blinking, check that:

- The black and white strip is visible to the sensor
- The sensor is not too close or too far from the shaft. About 3/8" is usually optimum, although the optimum distance will vary slightly from unit to unit. Tip: to find the optimum point, adjust the dome so the white strip is under the sensor. Move the sensor closer until the **ROT** LED goes out, then move it farther away until the LED goes out again. The optimum is half-way between these two points.
- Bright sunlight is not falling on the sensor
- The sensor cable is not damaged (e.g. if not installed properly in a Sirius dome, the cable can get pinched as the motor assembly pivots)

If it still does not work, detach the sensor and try to detect a white piece of paper. You might also try swapping the Rotation and Shutter controllers (adjusting the DIP switches as required), just in case the controller is damaged.

## Home Position Not Detected

Check whether the magnetic home position switch is working by looking at the **HOME** LED on the Rotation Controller board. It should be on when the magnet is near the switch. To check this, manually rotate the dome to the home position. If the LED does not illuminate, check the wiring and the magnet position.

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 **ROT** LED should be flashing as the dome is rotating.

## Open/Close Not Working

Make sure that both the Rotation Controller and the Shutter Controller **PWR** LEDs are illuminated.

Make sure that the **SHUTTER** DIP switch is **OFF** for the Rotation Controller, and **ON** for the Shutter Controller. Make sure the **FACTORY** DIP switch is **OFF** for both controllers. (Cycle the power if you change a setting.)

Try the manual open/close switch on the Shutter Controller. If the manual switch works but the computer commands do not, check the magnetic induction "antenna" on both controllers. The **LINK** LEDs on both the Rotation Controller and Shutter Controller should both be "warbling" twice (with a slight pause in-between) every two seconds. If not, check the induction "antenna" wires. At least one must loop fully around the observatory; otherwise the shutters may not work in certain dome positions. The other loop can be a shorter, but at least three feet long and at least one foot high. If a short loop is used, it must be located with the long side parallel to the other wire, as close to the other wire as possible. Try to avoid placing the loops in direct contact

with ferromagnetic metals like carbon steel, as this might affect the magnetic fields. If you have insufficient signal and are using a short loop on one side, try making the loop longer and wider, or switch to a long loop around the whole dome.

If the manual open/close switch does not work, then check the limit switch LEDs. If the shutters are both closed, the CLS and HOME LEDs should be lit. If they are both open, then the OPEN and ROT LEDs should be lit. If the shutters are at an in-between position, the LEDs should be off. If the LEDs are in the wrong state, then the limit switch problem may be preventing any motor operations.

Open the ASCOM Dome Control Panel. Go to the Dome setup, and set "Report Partially Open As" to "Open Shutter". Connect the link. If the status shows Shutter Error, then the link between the Rotation Controller and Shutter Controller is not working. Check the induction antenna wires, and also check for any local sources of electromagnetic interference. Try turning off other devices to see if they are interfering with the link. (Be sure to restore the setting once this test is complete.)

Interference from other devices is extremely rare. The range of these signals is very limited, and very few devices use these frequencies. A continuously blinking LINK light may indicate interference from another device. Since the communications distance inside the dome is very short, a simple solution to interference may be to reduce the sensitivity of the wire loop. To do this, place a small resistor in series with the wire. The correct value may be determined by trial-and-error: large enough to remove the interference, but small enough to allow communications within the dome.

As of the time of writing, only the FriendlyRobotics® RoboMower is known to potentially cause interference, if the perimeter wire is directly adjacent to the observatory. To prevent interference, either locate the perimeter wire away from the observatory, or turn off the "perimeter switch" during observatory operation.

## Shutter Does Not Stop

If the shutter motor does not stop when the dome is fully closed or fully open, check the wiring and positioning of the limit switches. If these are not functioning properly, the shutter motor will not stop correctly.

## Shutter Moves Incorrectly

Make sure the upper/lower shutter motor wires are not swapped. The upper shutter should open first, and close last. If not, then swap the wires between the two motors.

If a shutter opens when it should be closing, reverse the wires to the shutter.

Repeat the detailed steps for commissioning the shutters in Shutter Controller Installation.

## Shutter Status Incorrect

Check that the shutters can be operated from the ASCOM Dome Control Panel as described above.

Close both shutters. Check that the **CLS** and **HOME** LEDs are lit. If not, then the limit switches are not working. The status will not update properly until both LEDs are on (appropriate limit switches are open). Repeat this test with the shutters fully open (**OPEN** and **ROT** LEDs).

## Dome Rotates the Wrong Way

Command a Home operation from the ASCOM Dome Control Panel. The dome should turn to the right as seen from inside the dome. If it turns left, power down the controller and reverse the wires going to the motor.



# Index

<b>1</b>	
12V	
return .....	10
12V.....	10, 22
12V DC.....	10, 22
12VDC.....	10, 22
<b>9</b>	
9VDC.....	10
<b>A</b>	
Allows	
Dome Controller.....	10
Allows.....	10
Although MaxDome.....	5
antenna .....	10, 22
ASCOM .....	5, 31, 41
ASCOM Dome Control Panel	
Open.....	37
program .....	41
requires.....	31
ASCOM Dome Control Panel.5,	
31, 33, 37, 41, 47	
ASCOM Platform.....	31, 33, 41
ASCOM-compliant	
connect.....	41
ASCOM-compliant.....	37, 41
Auto Calibrate.....	33
Auto Calibrate button.....	33
AutomaDome .....	5
Automatic .....	37
Automatic home on first	
connection .....	37
AUX1 .....	10, 22
AUX2 .....	10, 22
Auxiliary Inputs .....	10, 22
<b>B</b>	
Blink	
RF .....	47
Blink.....	47
<b>C</b>	
CD-ROM	
open .....	31
CD-ROM.....	31, 32
Channel .....	10, 22
Channel B.....	10
Clicking	
Close button.....	41
Home button.....	41
Set button.....	41
Clicking .....	41
CLOSE.....	10
Close button	
clicking .....	41
Close button.....	41
Close Lower.....	22
Close Upper.....	22
CLS.....	47
CLSUP/RIGHT.....	10, 22
COM .....	47
COM Port	
Selects .....	33
COM Port.....	33
Computer CD-ROM .....	8
Computer Link Not Established	
.....	47

## MaxDome

Connect		East/west .....	37
ASCOM-compliant .....	41	Electromagnetic .....	47
Connect .....	22, 41	Emergency Stop button.....	5
Connect button .....	41	Enter	
Controller Board 1, 8, 10, 22, 32		east/west .....	37
Controller Card .....	1, 22	north/south.....	37
<b>D</b>		Radius .....	37
Declination		Enter .....	37
meets .....	37	<b>F</b>	
Declination.....	37	Find Home.....	41
Deg .....	33	<b>G</b>	
Detune .....	47	GE.....	37
DIP.....	22, 47	German .....	37
DIP Switch .....	10, 22	Getting	
Disconnect button .....	41	Started.....	8
Dome .....	41	Getting .....	8
Dome Control Panel .....	37, 41	GND .....	10
Dome Controller		Go To .....	41
allows .....	10	Go To button .....	41
Dome Controller.....	10, 22, 33	<b>H</b>	
Dome Controller board .....	22	Has Shutter Control.....	33
Dome Controller Circuit Card	10, 22	Home .....	1, 22, 33, 37, 41, 47
22		Home Azimuth.....	37
Dome Rotates		Home button	
Wrong Way .....	47	clicking.....	41
Dome Rotates.....	47	Home button.....	41
Dome Rotates the Wrong Way		Home Position.....	1, 10, 33
.....	47	Home Position Not Detected.	47
Dome Setup.....	33, 37	<b>I</b>	
Dome Simulator .....	41	Install ASCOM button.....	31
Down		Install MaxDome button .....	32
Shutting.....	41	Introduction .....	1
Down .....	41	<b>L</b>	
<b>E</b>		Latitude .....	37
East/west		Launcher .....	31, 32
Enter .....	37	Launcher.exe .....	31, 32

- LED .....47
- LEDs .....47
- LEFT ..... 10
- Left/Right
  - reverse.....47
- Left/Right.....10, 47
- LINK .....47
- Longitude .....37
- Lower ..... 1, 22
- M**
- MA.....10
- Magnetic Home Sensor Wiring
  - .....10
- magnetic induction ..... 10, 22
- Magnetic Induction .....10, 22
- Magnetic Induction Antenna.10, 22
- Manual Go To.....41
- Manual Stop .....5
- MaxDome ... 1, 5, 31, 32, 33, 37, 41
- MaxDome Driver ..... 1, 32
- Meets
  - Declination.....37
- Meets .....37
- Motor Control Wiring .....10, 22
- Motor Driver.....1, 10, 22
- Motor Driver Board.....1, 10, 22
- Motor Sensor.....1, 8, 22
- Motor Shaft Detector Not Working.....47
- N**
- Negative .....37
- Normal Operation.....41
- North/south
  - Enter .....37
- North/south ..... 37
- O**
- OK ..... 33, 37, 41
- OPEN ..... 10, 47
- Open button ..... 41
- Open Lower ..... 22
- Open Upper ..... 22
- Open Upper Only..... 33
- Open/Close..... 1, 22, 47
- Open/Close Not Working ..... 47
- Opening
  - ASCOM Dome Control Panel ..... 37
  - CD-ROM ..... 31
  - Shutter..... 41
  - Opening ..... 31, 37, 41
  - Opens/closes ..... 1
  - Operate Shutter At Any Azimuth ..... 33
  - Optical Motor Sensor ..... 10
  - Optical Rotation Sensor..... 10
  - OPUP/LEFT ..... 10, 22
- P**
- Park ..... 33
- Park button ..... 41
- Park Dome Before Operating
  - Shutter..... 33
- PC..... 1, 10, 22
- Power Supply Wiring ..... 10, 22
- Program
  - ASCOM Dome Control Panel ..... 41
  - Program..... 33, 41
  - Properties ..... 33, 37
  - PWR ..... 47

**R**

RA..... 37  
 RA/Dec ..... 37  
 Radius  
     Enter ..... 37  
 Radius ..... 37  
 RD1 ..... 47  
 RD2/ROT..... 47  
 REED..... 22  
 REED1..... 10, 22  
 REED2..... 10, 22  
 Report Partially Open As ..... 33  
 Requires  
     ASCOM Dome Control Panel  
         ..... 31  
 Requires ..... 31  
 Reverse  
     Left/Right..... 47  
 Reverse ..... 47  
 RF  
     blink..... 47  
 RF..... 47  
 RIGHT ..... 10  
 ROT ..... 47  
 rotating backwards..... 37  
 Rotation Controller.... 10, 22, 47  
 Rotation Controller Installation  
     ..... 10  
 Rotation Detector Not Working  
     ..... 47  
 RS-232 ..... 1, 8, 10, 22

**S**

Safety ..... 5  
 Safety Interlocks ..... 41  
 schematic ..... 10, 22  
 Scope

    Slave Dome ..... 41  
 Scope..... 41  
 Screw Mount Details ..... 10, 22  
 Select Dome..... 33  
 Select German Equatorial ..... 37  
 Select MaxDome ..... 33  
 Select Scope..... 37  
 Selects  
     COM Port..... 33  
 Selects ..... 33  
 Sensor Mounting Screw ..... 10  
 Sensor Position ..... 10  
 Sensor Target ..... 10  
 Set button..... 41  
 Setup  
     Slaving..... 37  
 Setup..... 37  
 Setup button..... 33, 37  
 Setup Dome ..... 33  
 Shutter ..... 1, 5, 10, 22, 41  
 Shutter Closed ..... 22  
 Shutter Controller ..... 10, 22, 47  
 Shutter Controller Installation 22  
 Shutter Does Not Stop ..... 47  
 Shutter Moves Incorrectly .... 47  
 Shutter Status Incorrect ..... 47  
 Shutting..... 41  
 Shutting Down..... 41  
 Sirius ..... 1  
 Slave Dome..... 41  
 Slave to Telescope..... 37  
 Slaving  
     Setup ..... 37  
     Telescope..... 41  
 Slaving ..... 37, 41  
 Slaving Setup..... 37

Small Phillips.....	10	Tics Per Revolution.....	33, 37
Starry Night .....	41	Troubleshooting.....	47
Start menu.....	33	<b>U</b>	
Status Lights.....	47	Upper.....	1, 22
STOP button.....	5	Upper Only.....	33
Switch		Upper/lower .....	47
Telescope .....	37	USB-to-Serial.....	47
Switch.....	22, 37	<b>W</b>	
Sync Home Azimuth .....	37	WARNING .....	5
Sync Home Azimuth To.....	37	Webcam.....	5, 41
<b>T</b>		Western .....	37
Telescope		Windows-based Personal	
Slaving.....	41	Computer .....	1
Telescope.....	1, 37, 41	Wiring .....	10, 22
Telescope Simulator.....	41	Wrong Way	
Terminal Block.....	10, 22	Dome Rotates .....	47
TheSky .....	41	Wrong Way.....	47