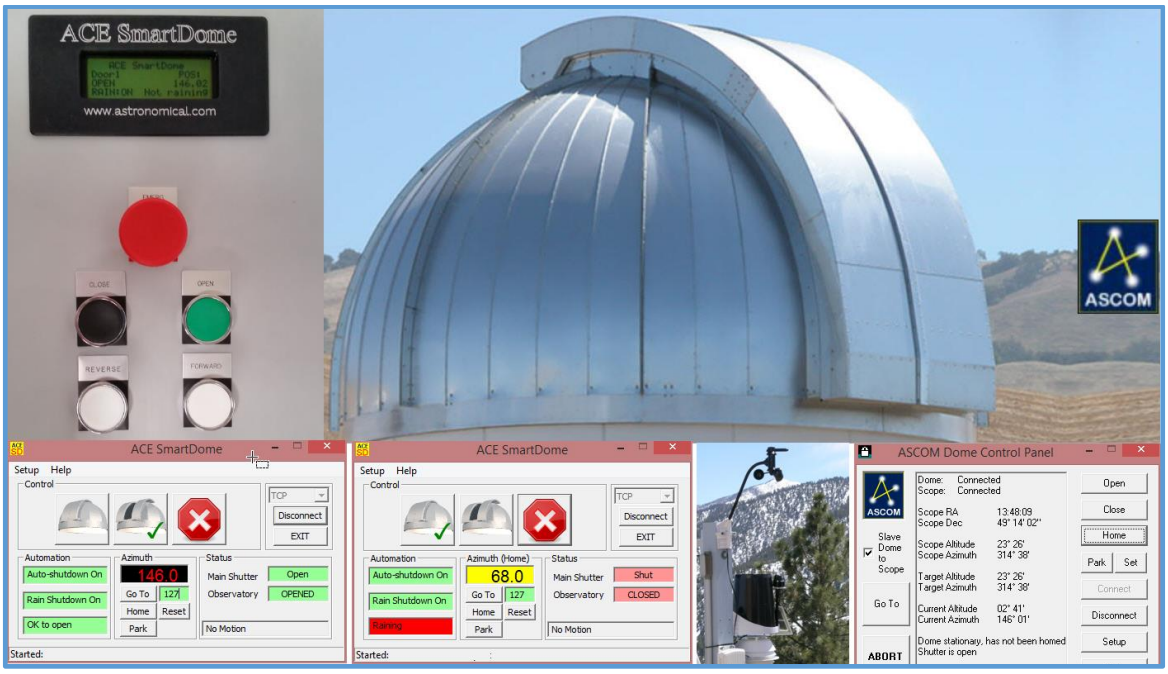
ACE SmartDome™

User Reference Manual

Computer control for

ObservaDome Laboratories enclosures



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1.0 INTRODUCTION

1.1 PURPOSE

The ACE SmartDome is a fault-tolerant controller that allows an ObservaDome Laboratories, Inc, product to be controlled locally, remotely, and robotically.

It works with any ASCOM compliant software such as DC3 Dream's ACP or TheSkyX.

For professional clients wishing to integrate a dome controller directly into their software there is a comprehensive command library. Communication with the ACE SmartDome is through TCP/IP. An option to use a serial communications port is available.

This document describes how to operate the ACE SmartDome™ and how to install the SmartDome™ software.

1.2 SAFETY

☠ WARNING ☠

- The ACE SmartDome™ has automation features that may close the dome without warning.
- In order to prevent unexpected dome motion if you are working on the dome press the ESTOP buttons on the boxes.
- If working on the upper part of the dome consider isolating the conductor bar power if appropriate to the task at hand.
- Read this manual and understand how the system works before doing any work on the dome.

1.3 DEFINITIONS

SmartDome™
The term "SmartDome" refers to the equipment which is used to control an astronomical observatory so as to open and close the dome and align the dome with the telescope. The name is also applied to the high-level software that is used for testing the system.

1.4 ACRONYMS

ABBREVIATIONS & ACRONYMS	
ACE	**A**stronomical **C**onsultants & **E**quipment, Inc. (www.astronomical.com)
ASCOM	See http://ascom-standards.org/
VFD	Variable Frequency Drive

1.5 System Hardware Description

The system can be divided into those components that are static and those that move with the dome.

The static components are:

- Main box with push buttons and a LCD screen
- Azimuth control box
- Azimuth motors
- Encoder
- Home sensor
- Conductor bar power switch
- External cloud or other sensor(s) mounted outside the dome building

Figure 1-1 SmartDome Static Components

The rotating components are:

- Top box with push buttons
- Conductor bars
- Rain snow sensor mounted on the outside of the dome
- Limit switches
- Home sensor trigger arm

FIGURE 1-2 SMART DOME ROTATING COMPONENTS

1.5.1 Main Control Box

This is located on the fixed wall of the observatory, usually vertically below one of the azimuth motors. It contains a Linux-based computer board with an SD card and a proprietary interface board that connects all the hardware to the computer.

There are five push buttons on the front panel. The EMERGENCY STOP button locks into place when it is pressed. To release, twist the button and it pops back out. There is an extra contact on the emergency stop button to allow an independent signal to be sent to the telescope controller. The OPEN/CLOSE buttons are for the main shutter door. There is a small delay (2 seconds) when reversing direction to prevent damage to the system.

Unlike some systems there is no “Remote / Local” switch to go between computer and manual control which could be left in the wrong position requiring a trip back to the observatory. The system can handle both the computer and manual operation simultaneously.

1.5.1.1 LCD Screen

The LCD screen is useful during engineering setup. It gives status of the dome such as azimuth position, the status of the doors, weather, and system status.

1.5.2 Azimuth Control Box

This is located on the fixed wall of the observatory, usually just above the main control box. It contains a programmable variable frequency drive (VFD). This permits slow acceleration and rapid deceleration of the azimuth motor(s).

1.5.3 Azimuth Motors

The system has been equipped with 3-phase azimuth motors that are controlled by the variable frequency drive.

The speed of the dome is determined by two factors:

- The speed of the motor, as programmed by the VFD
- The gear ratio of the box that the motor is attached to.

The ObservaDome is capable of high speed azimuth slewing, up to 15 degrees per second.

1.5.4 Azimuth Encoding

The encoder is attached to the output shaft of the gearbox. It is electrically isolated from the dome. The encoder produces 500 counts per revolution of the gearbox output shaft.

Azimuth is defined as north being zero and increasing to 90° at east.

1.5.5 Home Sensor

The incremental optical shaft encoder is automatically reset each time it passes the home position. The home position is usually placed somewhere near south (for northern hemisphere observatories) as this is likely to be a position that is frequently passed.

The home position is not the park position at the end of the night. The Park position can be anywhere the observer chooses. However, we suggest parking at the home position so that if power is lost the azimuth position will be correctly restored. An option is also available for an absolute encoder.

1.5.6 Conductor bars

The power to the upper part of the dome is sent through a set of circular power bars.

1.5.7 Top Box

The top box controls the shutter door. It is also possible to control additional equipment such as a windscreen, lighting, etc. Please contact ACE for a custom solution if you require these features.

There are three push buttons on the top box. Emergency Stop will lock out the doors and also lock out azimuth rotation. When this button is pressed “Emergency Stop” will appear on the LCD screen. The other buttons are for OPEN / CLOSE of the main shutter.

The top box contains a proprietary ACE circuit board with a microprocessor. The top box communicates with the main box via a set of radios. In the event of a failure of the main box or the radios the top box can be operated completely independently.

As a safety feature to protect the observatory in robotic installations if the top box and bottom box loose communication the top box will close the dome after a timeout period.

1.5.8 Cloud Sensor or other External Sensor

Signals from an optional cloud sensor or any other sensor can be sent to the main box. Contact ACE for your specific requirements. The software allows for automatic closure.

Connecting pins IN1 and IN6 together on the lower box main board will indicate a closure due to an external sensor.

1.5.9 ACE Rain-Snow Sensor

The ACE rain-snow sensor is attached to the rotating part of the dome and will automatically close the dome when precipitation is present. This is a redundant feature since the (optional) cloud sensor should have already closed the dome.

2.0 ACE SMARTDOME™ SOFTWARE

2.1 OVERVIEW

The ACE SmartDome™ software is a C++ application that can run under Microsoft® windows. The following description applies to ACE SmartDome™ Graphical User Interface v206 and later.

This software allows control of the ACE SmartDome™ using any ASCOM application (such as ACP) or by using The Sky X

Communication is via TCP/IP port and / or a serial communications (COM) port.

2.2 SOFTWARE INSTALLATION

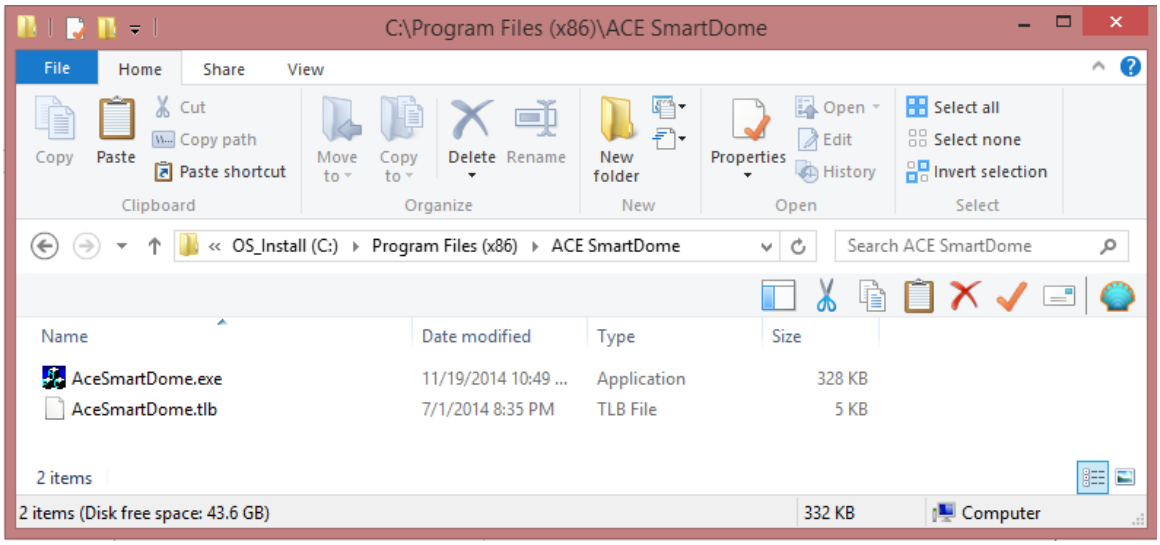


FIGURE 2-1 ACE SMARTDOME DIRECTORY

The ACE SmartDome™ application normally resides in the **ACE SmartDome** sub-directory of the **Program Files (x86)** directory and has just two files.

Executing the application will automatically install the required ASCOM drivers.

2.2.1 TCP/IP Setup

The SmartDome™ must be assigned a static IP address so that the software knows where to find the device each time the computer / network router is restarted. It is shipped with a static address of 192.168.0.142. You will probably need to change the static address to suit your network. Note that the SmartDome does not use DHCP.

Your I.T. department may want to know the MAC address of the SmartDome, to allow it on the network. To discover the mac address enter the command:

```
arp – a 192.168.0.142
```

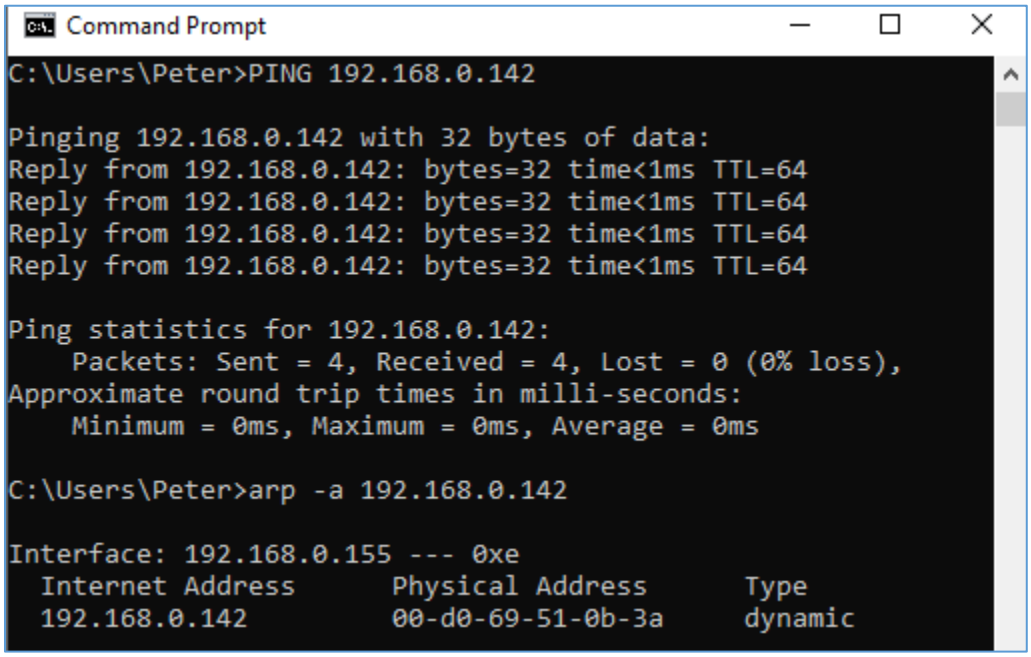


FIGURE 2-2 USING THE COMMAND PROMPT TO DISCOVER THE MAC ADDRESS

To change the static IP address, turn the power off the main box and remove the SD card. To do this press down on the card and it will pop back up.

Insert the SD card into your laptop / desktop. The contents will look similar to Figure 2-3.

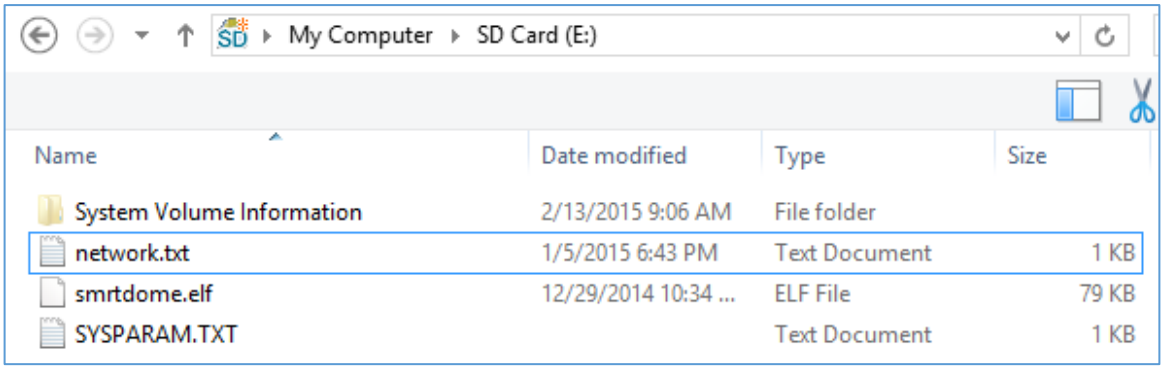


FIGURE 2-3 TYPICAL SD CARD

We need to edit the contents of the network.txt file but notepad and other editors will corrupt the contents of the file. Please use the freely available notepad++ application (download at http://notepad-plus-plus.org/). Once you have installed notepad++ right mouse-click on the network.txt file and select "Edit with notepad++".

A typical example is shown in Figure 2-4.

If you are not sure what to do then try the same netmask and gateway as your computer. Select an address that is the same as your computer except for the last quartet. To see if that IP is already being used open a command line prompt and type the following command:

```
ping 192.168.0.142
```

where you have of course entered the address you want to use.

If the address is already in use you will get a reply. If there is no reply then the address is probably available. Alternatively, contact your I.T. manager.

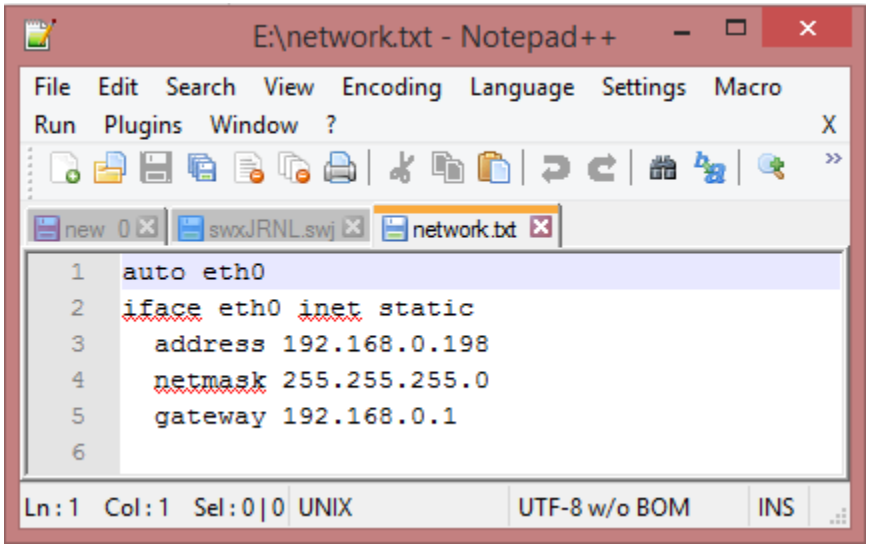


FIGURE 2-4 NETWORK.TXT FILE

Note the bottom of the window pane in Notepad++ displays “UNIX”. If instead it reads “DOS” then the file is corrupted probably by editing using Notepad or similar. To correct the problem from the EDIT menu select EOL Conversion and then UNIX.

Save your file and then re-insert the SD card back into the main box and power it back on.

Simply plug the SmartDome into any router. You should now be able to ping the SmartDome™ and get a response back. From the ACE SmartDome™ application select IP Address from the setup menu and enter the information. The select TCP from the dropdown box and press the Connect button. The three gray boxes in the main display should turn into colorful icons.

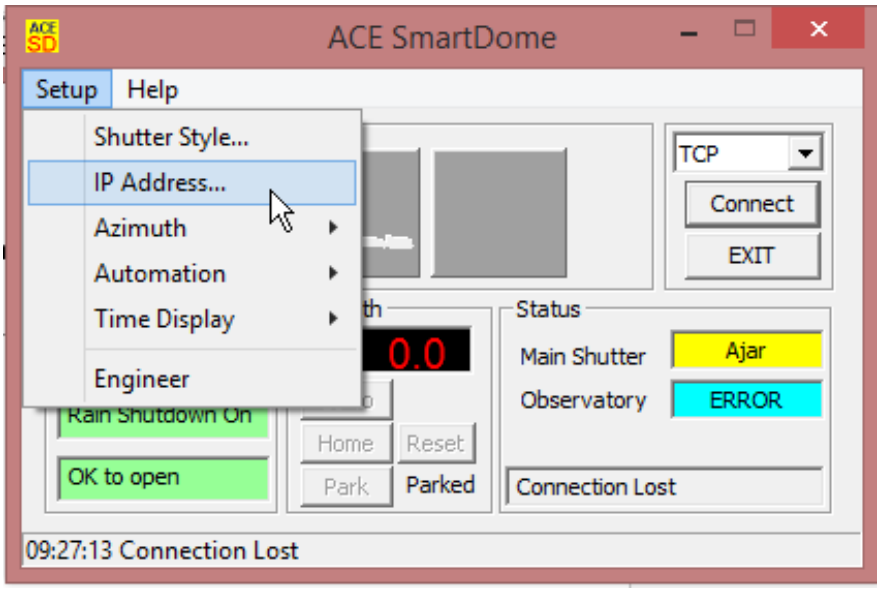


FIGURE 2-5 SETUP IP ADDRESS

2.2.2 Serial Communications Port

We recommend using the TCP/IP for communications. Alternatively, a serial port can be used which requires an available Com port on the control computer. Use either a PCI / PCIe based serial port or a USB-Serial adapter.

Inside the main box there is a ribbon cable with a 9-pin D-Sub male connector. Connect the ribbon cable connector to your computer using a custom cable. Each end of your cable will need a female 9-pin D-Sub connector. Three conductors are required. Connect Pin 5 to Pin 5. Pin 2 to Pin 3. And Pin 3 to Pin 2. This is called a cross-over cable since you have swapped pins 2 & 3.

The other end of the ribbon cable has a 10-pin serial header connector and is plugged into COM2 of the ARM microprocessor by default. Should this port ever fail it can be moved to one of the other free ports but will require editing the contents of the SD card using notepad++. To learn how to remove the SD card and use notepad++ see the previous section on the TCP/IP setup. You will want to edit the file SYSPARAM.TXT. Change the Console serial device from COM2 to the new port you will be using.

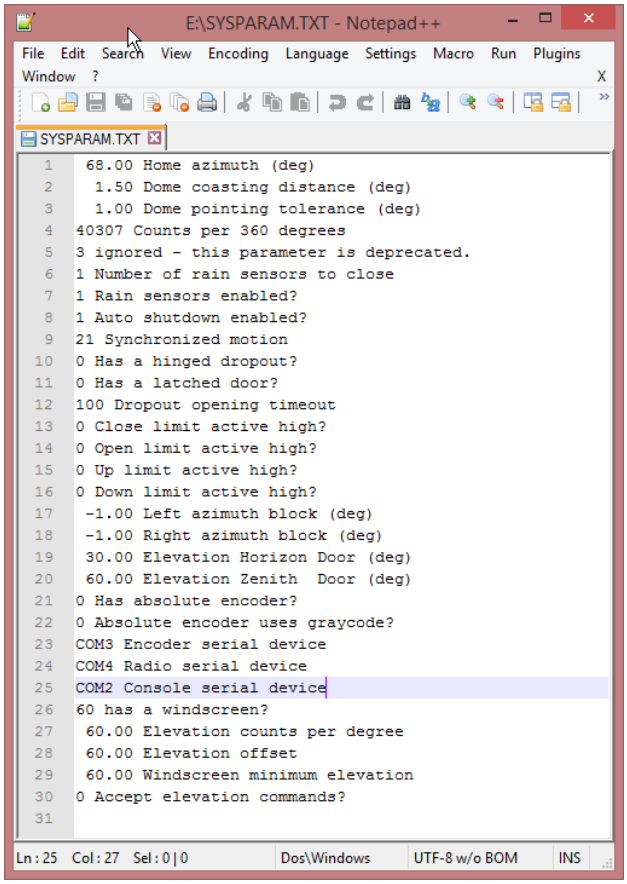


FIGURE 2-6 SYSPARAM.TXT FILE

When using USB to serial port devices make sure the **same** USB port is used each time. If not, Windows might assign a new comport number to the device and it will eventually lead to numerous unused ports! To get rid of the unused ports and start again do the following:

a) Bring up a command prompt and type in the text as shown:

```
C:\>
C:\>cd \WINDOWS\System32

C:\WINDOWS\system32>set devmgr_show_nonpresent_devices = 1

C:\WINDOWS\system32>start devmgmt.msc

C:\WINDOWS\system32>
```

b) From the View menu select Show Hidden Devices
c) From the Ports (COM & LPT) select the ports no longer in use and press delete
d) Reassign the high-numbered port to a lower value or simply unplug the device for a few seconds and when it is re-found it should have a low comport number.

Connect the ACE SmartDome™ to an available computer serial port. The port settings are:

Baud Rate	19200
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

If using the ACE SmartDome™ application simply select the desired comport from the dropdown box and then press **Connect**. The three gray boxes should turn into colorful icons.

2.3 ACE SMARTDOME DIALOG

Once connected to the TCP/IP port (or the COM port) the screen icons will appear and the status of the doors and automation system will be displayed. Assuming that the dome is closed the screen will be similar to that shown in Figure 2-7.

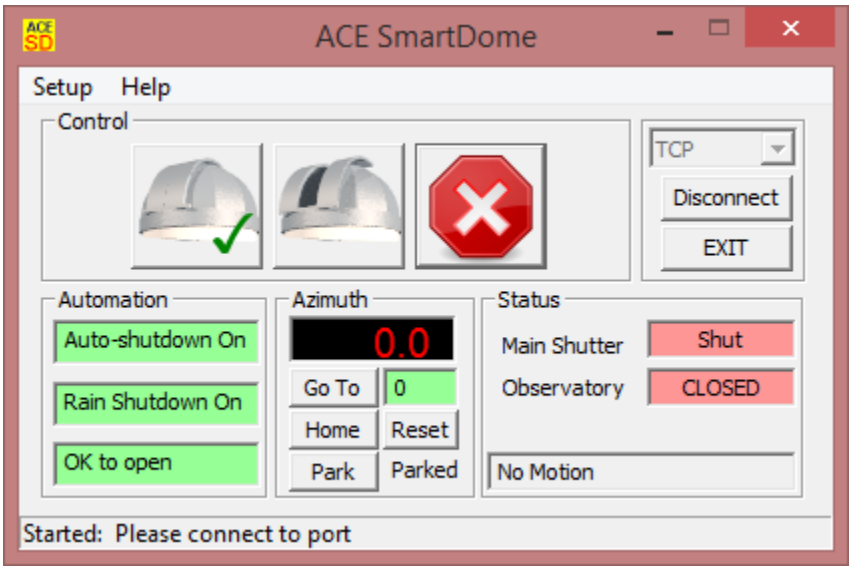


FIGURE 2-7 STARTUP FOR OBSERVADOME WITH THE DOME CLOSED

The dialog uses a "traffic light" scheme where red is closed (or no-observe), green is open (or OK), and yellow is changing.

2.3.1 The Control frame icons:

	Close Observatory Click on this icon to close Green check mark appears when closed
	Open Observatory Click on this icon to open Green check mark appears when opened
	STOP! Stops the dome

2.3.2 The Status frame:

For the *Main Shutter* there are six options:

Shut
Ajar which means neither opened nor closed.
Open
Fault
Opening
Closing

The *Observatory* is a state reported to ASCOM and is explained in more detail in each section. If the shutter door is in an ajar state and not currently moving (that is, left partially open) then the observatory will be in a **Fault** state for ASCOM.

2.4 DOME AZIMUTH

The azimuth is defined as North = 0.0° and East = 90.0° and is bounded by

0.0 <= Azimuth < 360.0 degrees

The azimuth position is reset each time the dome passes the home sensor.

The encoder position is lost during a power failure. Therefore either send the dome home at the start of the observing session (you can check a box is ASCOM to do this) or leave it parked at home just in case there is a power failure. An absolute encoder is also available which retains positional information during a power failure.

A typical view of the **Azimuth** frame is shown in Figure 2-8

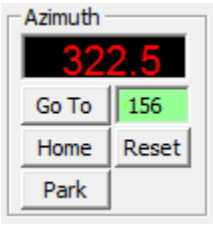
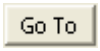


FIGURE 2-8 DOME AZIMUTH FRAME

The current azimuth is reported in a pseudo LED display. Four control buttons are available, which are described below.

2.4.1 Azimuth GoTo



To move to specified azimuth enter the destination in the green entry field and then press **GoTo**. The system always takes the shortest path. The request to move dome is written to the system log and another entry is written once it reaches the destination. A typical move is shown in Figure 2-9.

The current azimuth is reported in degrees. The motion "*Moving Left*" is reported in the status box at the bottom right of the dialog.

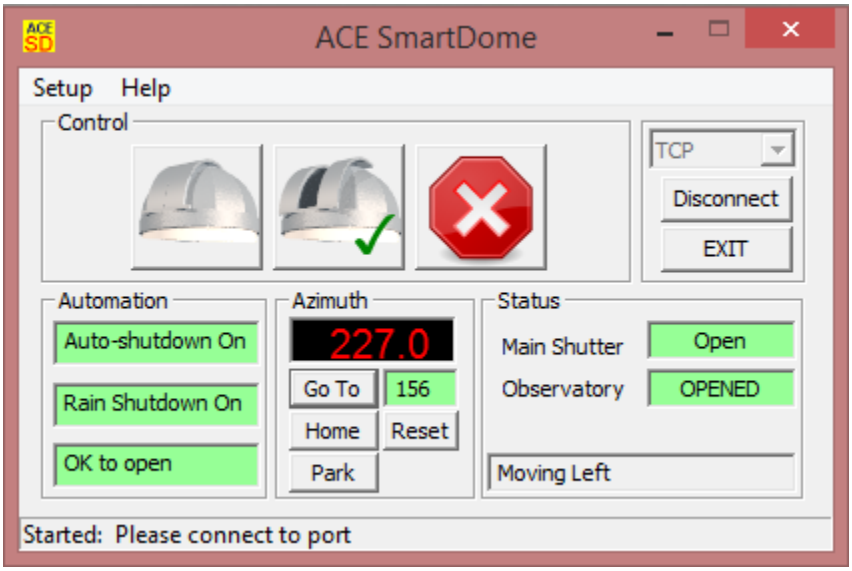


FIGURE 2-9 AZIMUTH GOTO

2.4.2 Home

To move to the home position simply press the **Home** button. The system will move at high speed using the shortest path to home. It will then stop, reverse, and move onto the home sensor. When home the Azimuth display changes to black letters on a yellow background and the frame title changes from Azimuth to **Azimuth (Home)**.

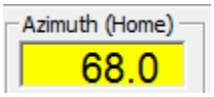


FIGURE 2-10 DOME AT HOME AZIMUTH

2.4.3 Park

Park is another pre-defined azimuth position. Unlike the Home position there is no sensor. Pressing the Park button will move the dome in the shortest path and a message "Parking" will appear next to the button. When the dome is within ±2 degrees of the parked position the message changes to Parked.

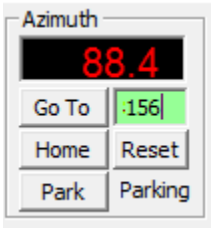


FIGURE 2-11 DOME AZIMUTH PARKING

The ASCOM controller can command the dome to the Parked position. The park position is written to the registry.

2.4.4 Azimuth Reset

This allows the azimuth to be reset to a specified value, like 180 degrees. Its main (if not only) purpose is for use in system setup. If the encoder is lost for some reason the easiest way to correct the problem is to go Home. Note that an **absolute encoder** option is installed the **Reset** button will not be displayed.

2.5 SETUP AZIMUTH

There are two options in the **Setup Azimuth** menu, called **Home** and **Park**:

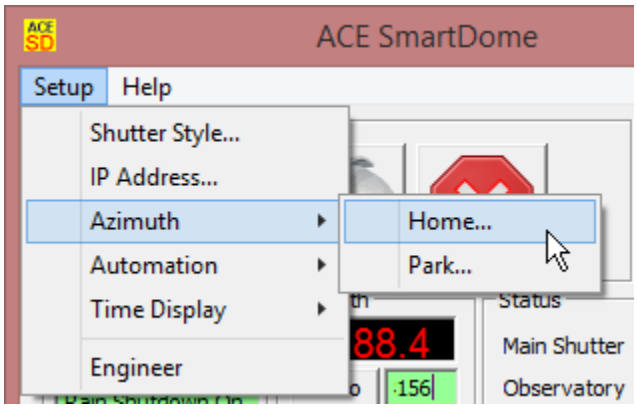


FIGURE 2-12 SETUP AZIMUTH MENU

2.5.1 Setup Azimuth Home

This menu option opens a dialog that allows the home azimuth to be specified. The current value is entered as the default. Changing the value will enable the OK button.

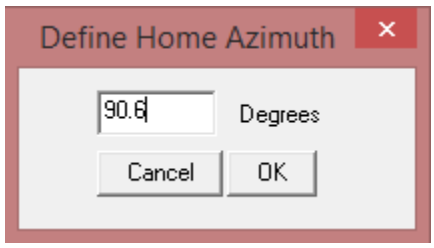


FIGURE 2-13 DEFINE HOME AZIMUTH SETUP DIALOG

The easiest way to determine the home azimuth value is to place the dome at due north (use the polar axis of the telescope to help you here). Then in the main dialog window enter azimuth 0.0 in the edit field and press Reset. This will make the azimuth read zero. Now rotate the dome until it is almost at the home sensor. Read the value and enter this plus a fractional amount into the Define Home Azimuth dialog.

2.5.2 Setup Azimuth Park

This menu option opens a dialog that allows the park azimuth to be specified.

The value is stored in the registry. Note that it is possible to define the park position using ASCOM. Doing so will also update the registry.

2.6 AUTOMATION

Two automation features are possible in ACE SmartDome™ to protect the observatory.

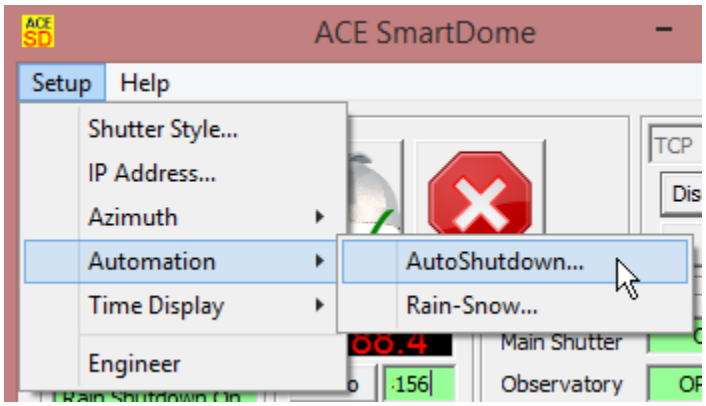


FIGURE 2-14 SETUP AUTOMATION MENU

They are the Auto Shutdown function and, if suitable equipment is installed, the Rain-Snow function.

☠ WARNING ☠

These features will close the dome if a shutdown condition is encountered. Never perform maintenance on the dome without pressing the ESTOP buttons even if the auto-shutdown feature is not enabled.

2.6.1 Auto Shutdown

This feature monitors the communications between the control computer and the ACE SmartDome™ main box. When it is determined that the system is not receiving any communications and the dome is open the SmartDome™ will automatically close the dome if this feature is enabled.

To enable the feature check the Auto Shutdown box and enter the time to shut down. We suggest 600 seconds which gives enough time to reboot your telescope control computer without the dome closing.

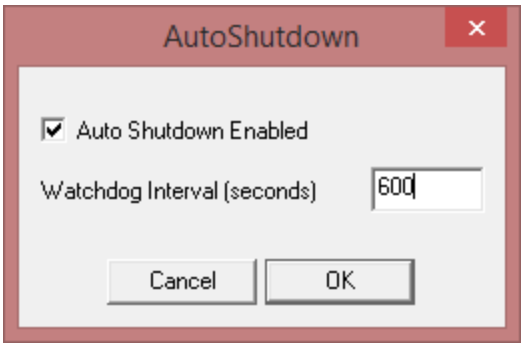


FIGURE 2-15 SMARTDOME AUTOMATION

The Auto-Shutdown window in the main dialog has a green background when it is "ON" (enabled) and a red background when disabled.

The first line on the main box LCD display reads "Auto shutdown OFF" when the feature is disabled or "ACE SmartDome" when enabled.

Note for system engineering: The ? and + commands show [ON] when enabled and [OFF] when disabled.

```
?
Posn 280.37
[ON]
RR 03 004
D1 AJAR
D2 SHUT
>
```

FIGURE 2-16 OUTPUT FOR THE ? COMMAND WITH AUTO SHUTDOWN ENABLED

2.6.2 Rain-Snow

Called Rain-Snow for convenience this feature monitors the Rain-Snow sensor attached to the rotating part of the dome and also any auxiliary sensor (such as a cloud sensor or a power relay) connected to the main box on input IN6. When any one of these sensor is activated it reports "Raining".

To enable the shutdown due to these sensors check **Shutdown when raining** as shown in Figure 2-17

FIGURE 2-17 RAIN-SNOW AUTOMATION

2.7 TIME DISPLAY

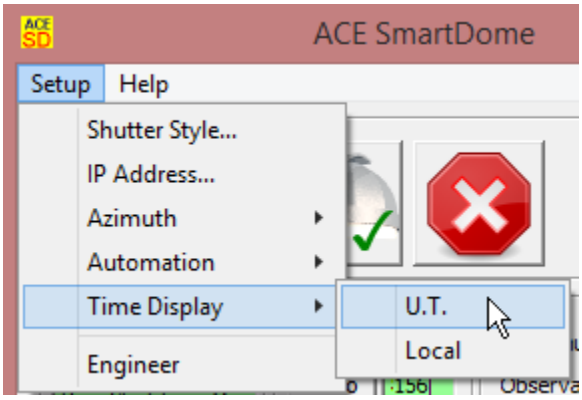


FIGURE 2-18 SETUP TIME DISPLAY MENU

Chose to have the local time or the U.T time displayed and used for log file entries. For locations in the Americas selecting U.T will create only one log file per observing session.

2.8 SMARTDOME LOG FILE

A log file is generated with the name YYMMDD.log where the year, month and day are determined by the time display used in the ACE SmartDome™.

The file is in the directory from which the program was started.
(Typically C:\Program Files (x86)\ACE SmartDome)

To view use Notepad, WordPad or any other text viewer.

2.9 SMARTDOME WEATHER STATION INTERFACE

If the ACE SmartDome was purchased with a weather station then the **Weather Station** will appear in the main menu.

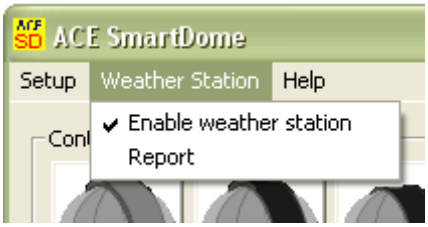


FIGURE 2-19 WEATHER STATION MENU

Current support is for a Davis Instruments station. The weather station itself must be running. A file is created in the ACE SmartDome installation directory called weather.htm.

2.9.1 Enable Weather Station

If the menu item is checked the dome will be closed when a close condition occurs and will stop the user from opening the dome again until the condition clears.

2.9.2 Report

The system checks the status of this file every 30 seconds and it is displayed in the modeless Report dialog.

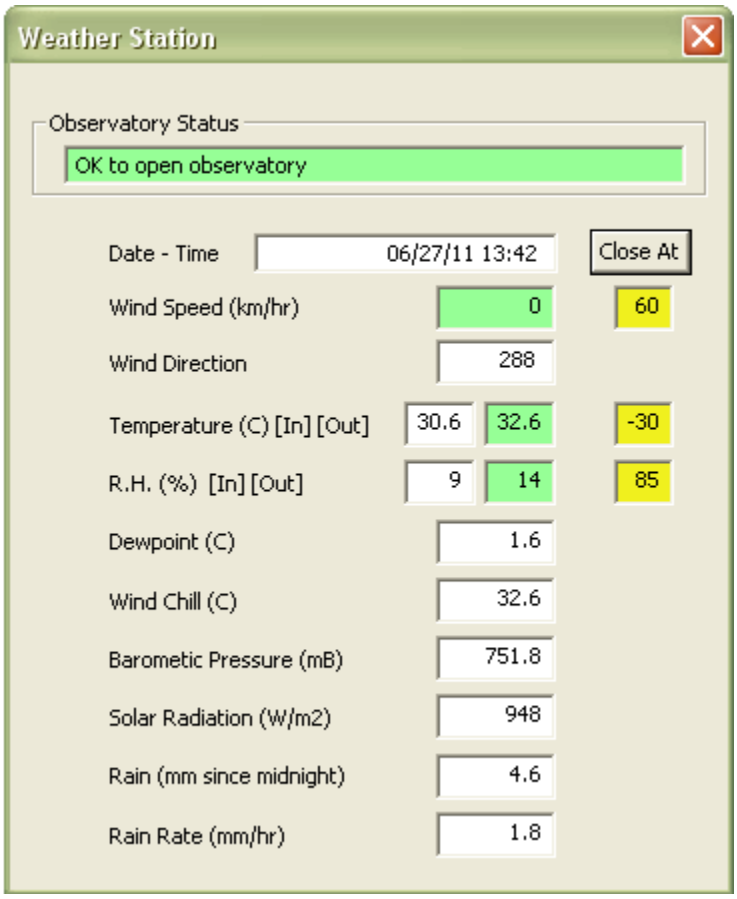


FIGURE 2-20 WEATHER STATION DIALOG

The close conditions are displayed in the rightmost column. To change the close conditions click on the **Close At** button (Figure 2-21). Please note that the weather station must be set up with the same (metric) units.

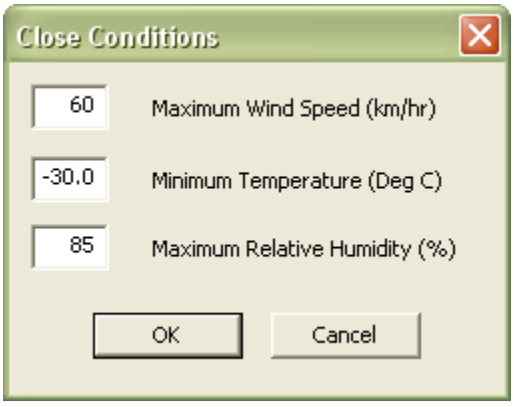


FIGURE 2-21 WEATHER STATION CLOSE CONDITIONS

3.0 SYSTEM ENGINEER SETUP

3.1 OVERVIEW

Before the ACE SmartDome™ can be used it has to be setup by a System Engineer. This is done by an ACE technician as part of the installation procedure and is documented here for future reference.

Note that some of the features available in the ACE SmartDome™ are not relevant to a single door classical ObservaDome enclosure. These features for two doors and for windscreens and should be left at the factory settings.

One of the main purposes of this section is to assist clients who wish to write their own interface to the ACE SmartDome™.

You can talk to the SmartDome using Putty (http://www.putty.org) (on telnet port 2902) or by using the SmartDome Dialog, Setup->Engineer utility.

Note that all commands are CASE SENSITIVE and should be in CAPITALS.

3.2 ACE SMARTDOME™ APPLICATION SYSTEM SETUP.

The **Setup Engineer** menu is password protected for safety. Low level commands can be sent to the controller which can alter the characteristic way in which the dome behaves.

The password is not given is this general user manual. If you have forgotten the password please send email to support@astronomical.com. Once the password is entered the main dialog will expand as shown in Figure 3-1. The System Engineer window is designed for easy data input with some special buttons at the bottom of the window.

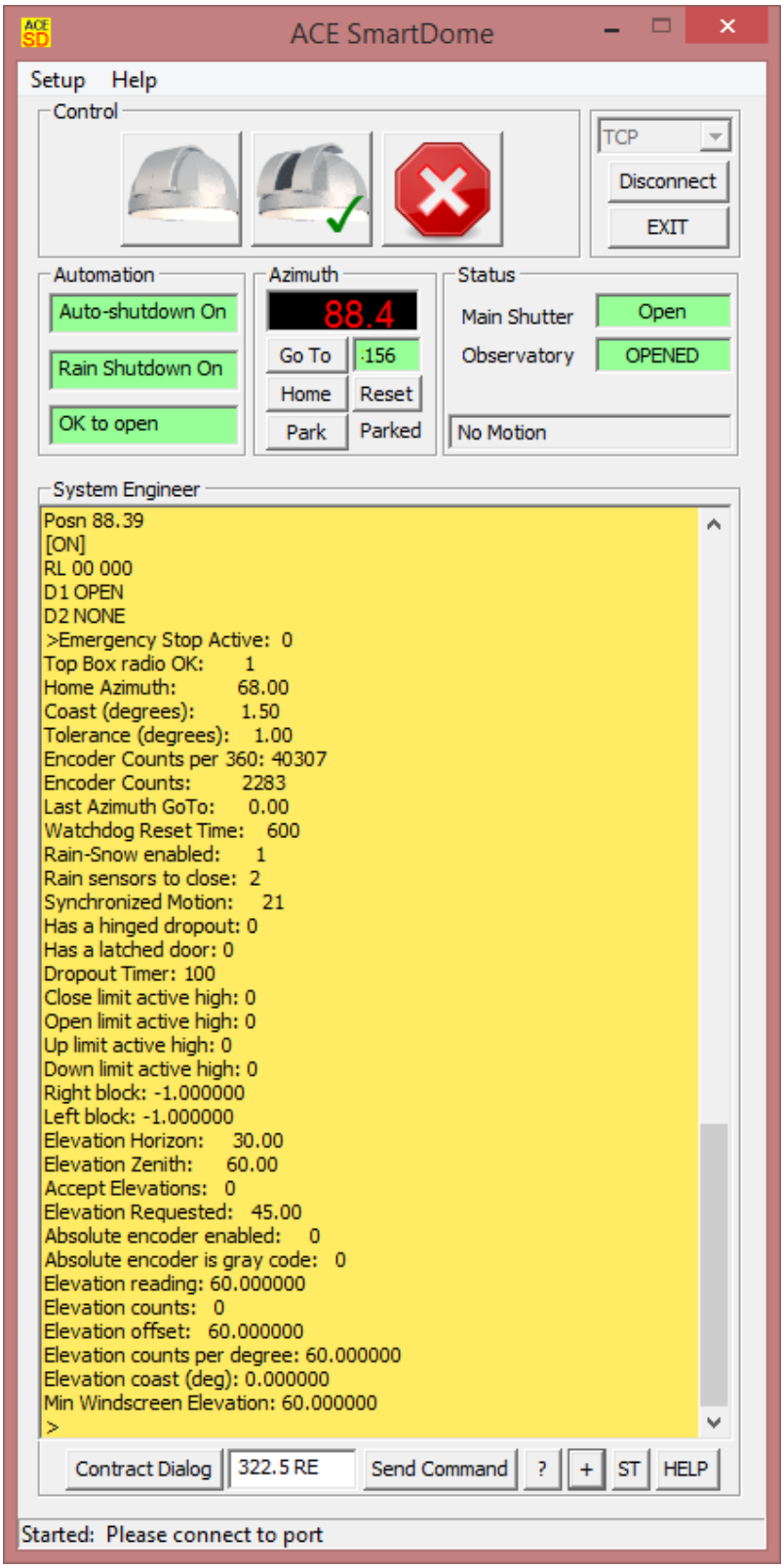
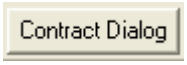


FIGURE 3-1 SYSTEM ENGINEER WINDOW



This button will return the dialog to the normal user state

This button sends the text typed in the white edit box.
The box will convert lower case letters to upper case.
Pressing <CR> in the edit box will not send the text, on purpose.

This button gives a short status report

This button gives a long status report

This button issues a **STOP** command and terminates all pending motion.

This button prints out a list of all the available commands and the version of the software

3.2.1 ACE SmartDome™ Commands

The **HELP** command gives a list of all the commands which are presented in **Error! R eference source not found.**.

The ACE SmartDome™ GUI will automatically convert lower case letters to upper case. If using putty please note that all commands are CASE SENSITIVE and should be in CAPITALS.

TABLE 3-1 COMMAND REFERENCE TABLE

```
HELP
Commands for ACE SmartDome(TM)
Revision 209 Compiled Fri Oct 22 20:05:14 MST 2010
================================================
THESE COMMANDS ARE DESIGNED FOR SYSTEM SETUP
OR FOR USE IN WRITING YOUR OWN INTERFACE.
INCORRECT USE WILL MAKE THE SYSTEM MALFUNCTION.
USE THE ENGINEERING DIALOG AT YOUR OWN RISK.
================================================
  ?    A short status report
  +    A full status report
  ST   STOP all motion now
  SR   Stop rotation
d MV   Rotate to azimuth d degrees (0<=d<360)
d LF   Rotate left  by d degrees (0<=d<360)
d RT   Rotate right by d degrees (0<=d<360)
d HZ   Define home position (0<=d<360)
d RE   Reset encoder to d degrees (0<=d<360)
d CS   Coast  (0<=d<6)
  HM   Rotate to home position
n AE   Accept Elevations (0=NO, 1 = YES)
d ME   Move Elevation (0<=d<90)
d EH   Elevation Horizon Shutter (degrees)
d EZ   Elevation Zenith  Shutter (degrees)
  OP   Open the main shutter
  CL   Close the main shutter
  DN   Put dropout shutter down (open)
  UP   Put dropout shutter up (close)
n SM   Synchronized Motion (21/22)
  SC   Synchronized Close
  SO   Synchronized Open
t DT   Dropout opening time (+10) seconds
t WT   Watchdog interval t seconds
  LR   Learn number of encoder counts per 360
  LM   Manually enter encoder counts per 360
  AO or ON  Enable  AutoShutdown
  AF or  OF  Disable AutoShutdown
  RN   Enable  Rain-Snow shutdown
  RF   Disable Rain-Snow shutdown
n RS   Rain-Snow sensors to shutdown (1<=n<=4)
  SL   Close, swap latch position, and re-open
  HELP   Prints out this menu
  Support information at www.astronomical.com
```

3.3 MOTION CONTROL STATUS

Issuing a ? command will return the current status of the dome.

Output for the ? command	Line	Comments
Posn 134.14 [ON] RAIN RR 03 020 D1 OPEN D2 OPEN >	1	Posn or Home plus DDD degrees
	2	Auto-Shutdown [ON] or [OFF] & Rain
	3	See code table below
	4	Door 1 (OPEN AJAR SHUT ????)
	5	Door 2 Optional windscreen
	6	> prompt

The main shutter, door D1 reports OPEN AJAR SHUT or ????

AJAR means neither opened nor closed. ???? means the radio has not reported a state.

Line 3 has the following Code options:

The two-digit codes should be considered deprecated. They are kept for backward compatibility with classical Version 1.0 ACE SmartDomes still used in the field. For all new applications use the third field of line 3.

Classical	Third Field	Comments
RR		last rotation was to the right
RL		last rotation was to the left
00	000	no motion
01	001	moving right
02	002	moving left
03	004	closing main door
04	008	opening main door
05	016	lowering windscreen (or second door)
06	032	raising windscreen (or second door)
-	064	dome seeking home
99 ESTOP		Emergency Stop switch activated

3.4 ENGINEERING STATUS

Issuing a + command will return the full engineering status of the dome. This is the same as the ? command followed by lots of other information.

```
+
Posn 149.47
[ON]
RR 00 000
D1 OPEN
D2 SHUT
>Emergency Stop Active:  0
Top Box radio  OK:      1
Home Azimuth:          90.00
Coast (degrees):       0.15
High Speed (degrees):  4.00
Tolerance (degrees):    1.00
Encoder Counts per 360: 40257
Encoder Counts:        1652
Last Azimuth GoTo:      -1.00
Watchdog Reset Time:    600
Rain-Snow enabled:      1
Rain sensors to close:  1
Synchronized Motion:    21
Has a hinged dropout: 0
Has a latched door: 0
Dropout Timer: 100
Close limit active high: 1
Open limit active high: 1
Up limit active high: 1
Down limit active high: 1
Right block: -1.000000
Left block: -1.000000
Elevation Horizon:     30.00
Elevation Zenith:      60.00
Accept Elevations:   1
Elevation Requested:   45.00
>
```

The following notes describe some of these parameters. For additional help contact ACE.

3.4.1 Top Box Radio OK

The Top Box radio OK will either read 1 or 0, with 1 being good and 0 being lost. The LCD display will read TOP BOX RADIO LOST if the value is 0. Check the radios. When they are communicating the red/green LED's flash at about 5 HZ. When they are not communicating only one of the LED's will be permanently lit. Make sure that the antennae on both boxes are pointing vertically.

3.4.2 Coast

The coast parameter is the amount of overshoot when the dome is moving at low speed. Set Coast to 0 (command 0 CS) and move the dome to the right by about 10 degrees using the command 123 MV where 123 represents the desired azimuth. Then note where the dome actually stops. The difference is the amount to now set the coast to. Typical values for small domes are around 0.1 to 2.0 degrees.

If the commanded move is less than the coast distance then the coast will not be invoked.

Remember that if you alter the variable frequency drive parameters then this will affect the coast. So tune the VFD first and then set the coast. (See Chapter 7.0 for details).

3.4.3 High Speed

The high speed parameter determines the minimum angular distance before high speed is invoked. Use the command dd HS where dd is the number of degrees. The default value for HS is 6.00 degrees. When the move is greater than 6.0 degrees the VFD accelerates towards the high speed and when the dome gets within HS degrees of the target distance the speed slows down to the low speed or tracking rate. When the dome gets within the coast distance the motor is turned off.

3.4.4 Tolerance.

When the dome is tracking it will slowly nudge along. The tolerance is essentially the minimum move. Tolerance is typically set (using the command dd.d TOL) to 0.5 to 1.0 degree which on a 5-meter diameter dome is 22 to 44 mm respectively. In other words, an insignificant amount.

3.4.5 Encoder Counts per 360.

The number of encoder counts for the dome to go around once. To calibrate a system, position the dome on the home sensor. Then issue the command LR. The dome will move

right and complete one revolution and stop just beyond the home sensor. The number of counts will then be stored.

The current number of counts is reported on the next line. The zero-point of these counts is the home azimuth and not azimuth 0.

3.4.6 Last Azimuth GoTo

The last commanded azimuth position, in degrees, or -1 if never commanded.

3.4.7 Watchdog Reset Time

The number of seconds of inactivity before an auto-shutdown is initiated, assuming that auto-shutdown is ON. Set with the command **tt WR** where **tt** is the time in seconds.

3.4.8 Synchronized Motion.

Used at observatories with two doors. For a classical ObservaDome enclosure this parameter should be set to 21 (command 21 SM).

3.4.9 Has Hinged Dropout / Has Latched Door.

These are set by ACE and cannot be changed by the user. For an ObservaDome the correct value is 0.

3.4.10 Dropout Timer.

Not used in ObservaDome installations

3.4.11 Close Open Up Down Limits.

These values cannot be changed by the user.

3.4.12 Right Block / Left Block.

If there is an obstruction stopping the dome rotating 360 degrees these parameters can be set to solve that problem. Contact ACE for more details. In all other systems the values will be set at -1.

3.4.13 Elevations

The value in degrees for the elevation of the windscreen, if enabled.

4.0 ACE SMARTDOME ASCOM DRIVER

4.1 OVERVIEW

The ACE SmartDome™ is a fully compliant ASCOM device. Therefore any ASCOM compliant software can control the ACE SmartDome™. One of the most popular control packages is ACP by DC3 Dreams. The popular planetarium package TheSkyX also uses ASCOM.

The ACE SmartDome has been tested using ASCOM Platform 6 with Service Pack 1.
It is downloadable from: http://www.ascom-standards.org

Click on the Download button as shown.

FIGURE 4-1 ASCOM PLATFORM 6 DOWNLOAD

Save the file to your computer and install. Upon completion of the installation two icons will appear on the background desktop.

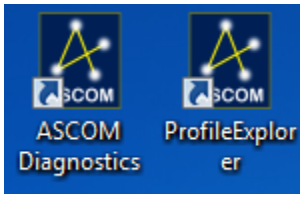


FIGURE 4-2 ASCOM ICONS

Double-click on the ASCOM Diagnostics icon and click on the **Run Diagnostics** button. This will take several minutes to complete.

Now start the ACE SmartDome dialog and connect to the TCP/IP or COM port. Then exit the dialog. This will automatically register the ACE SmartDome.dome ASCOM driver.

From the Start menu select the ASCOM Dome Control as shown in Figure 4-4.

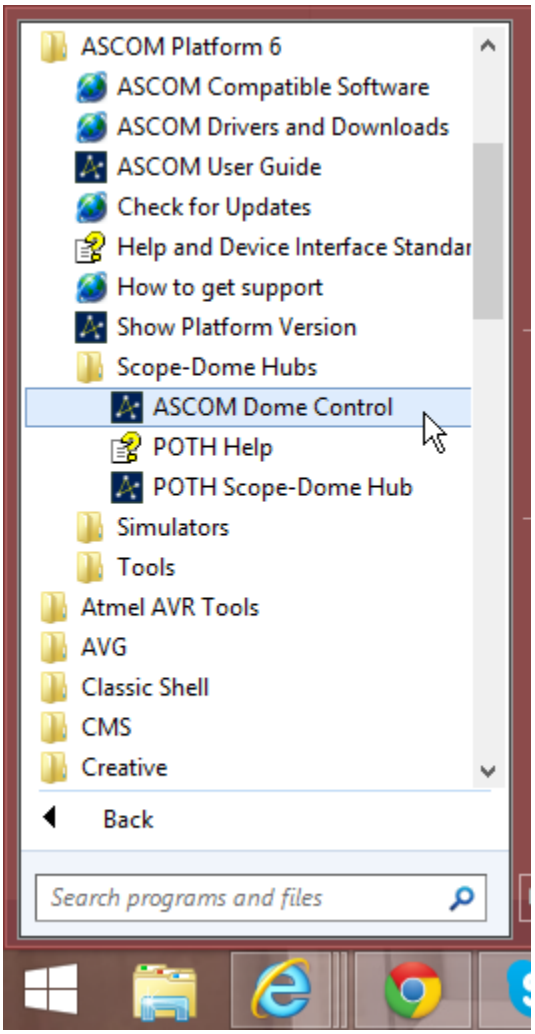


FIGURE 4-3 ASCOM PLATFORM 6 MENU

FIGURE 4-4 ASCOM DOME CONTROL

Use the Setup button to display the setup dialog as shown in Figure 4-5.

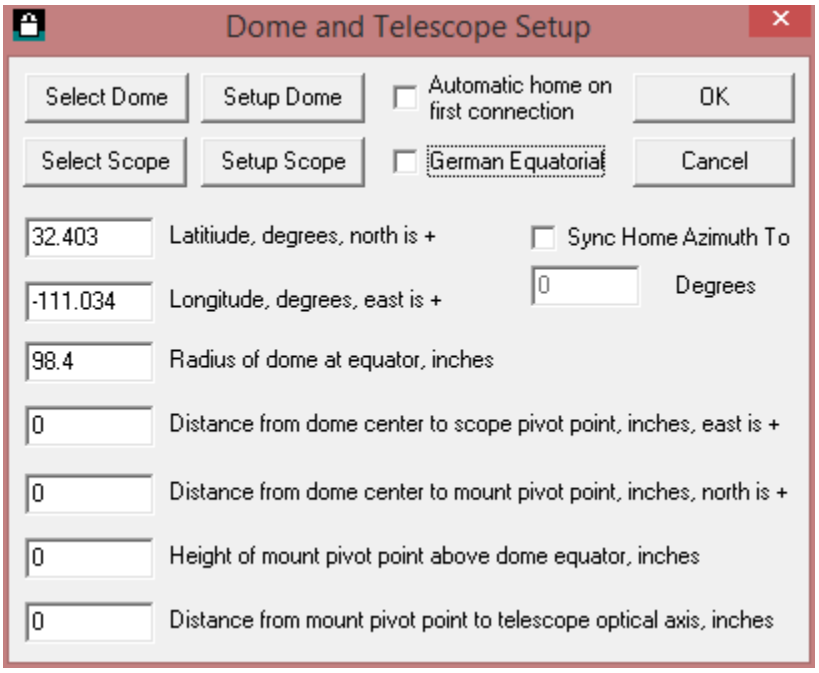


FIGURE 4-5 ASCOM DOME AND TELESCOPE SETUP

Be sure to set the **Latitude, Longitude and radius** of dome or the dome pointing will be wrong! If your mount is a German Equatorial be sure to check the box.

Press the **Select Dome** button to display the ASCOM Dome Chooser and select **POTH Hub** from the drop-down box. (Do not select ACE SmartDome!!!)

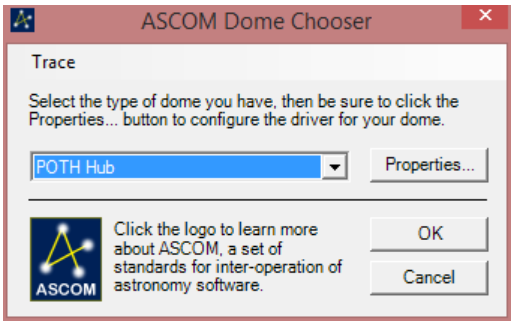


FIGURE 4-6 ASCOM DOME CHOOSER

If this is the first time running the **POTH Hub** you must select the **Properties** button.

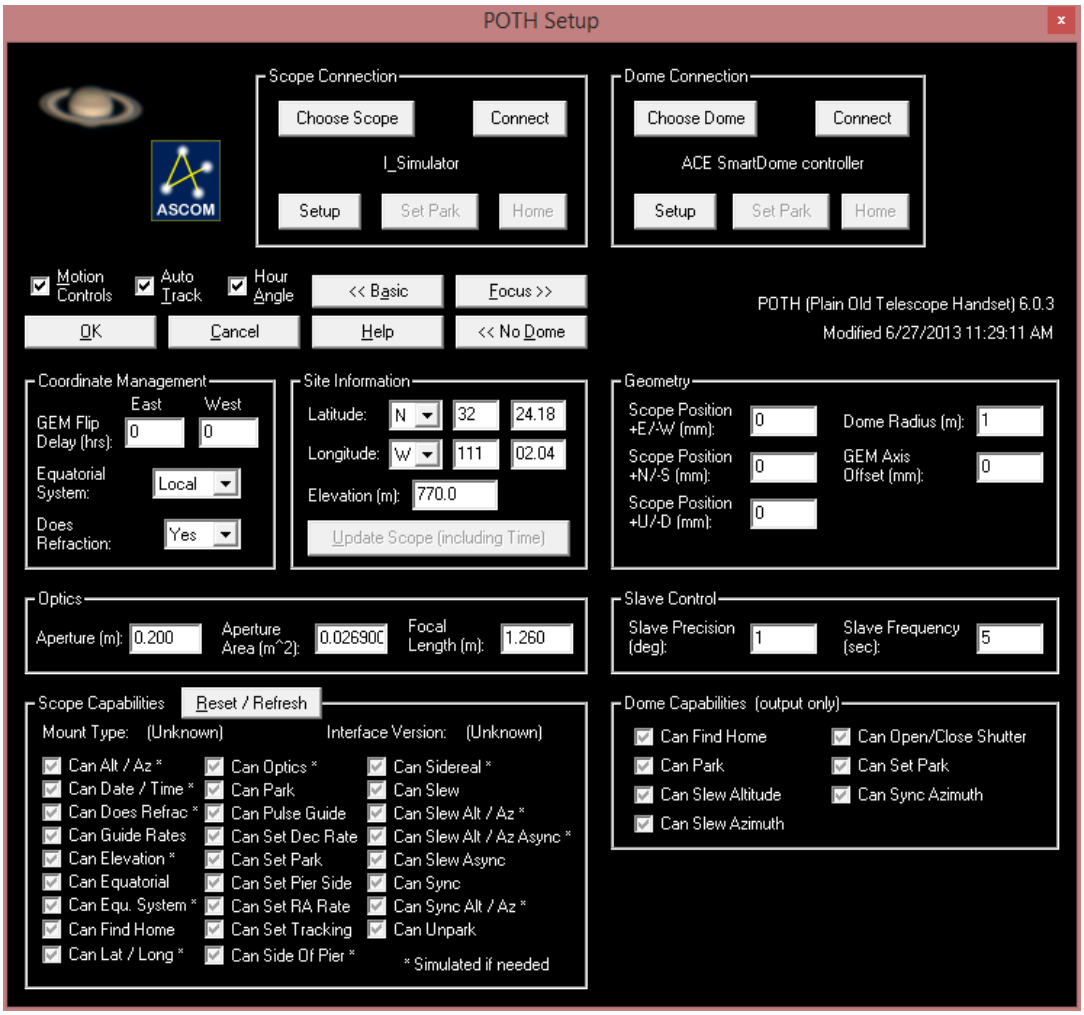


FIGURE 4-7 ASCOM POTH SETUP

Enter the correct **Site Information** (Latitude, Longitude and Elevation). Also enter the correct **Geometry** (Note that it wanted the radius of the dome in inches in the Dome & Telescope Setup, earlier, but now it wants the radius in meters). The **Slave Control** determines the minimum dome move and the update frequency.

In the **Dome Connection** select **Choose Dome** and ACE SmartDome from the list box.

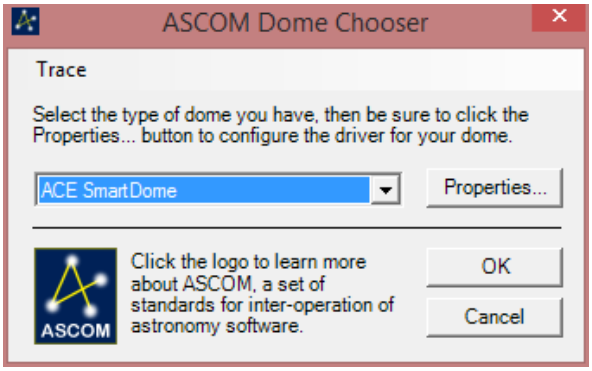


FIGURE 4-8 ASCOM DOME CHOOSER

Finally, in the **Scope Connection**, **Choose Scope.** If the telescope is already installed select the actual device (see your telescope manual on how to install the ASCOM driver for that product). Otherwise choose **Simulator**. Click on the **OK** button to exit the POTH Setup. You should now be back at the Dome and Telescope Setup dialog, Figure 4-5.

Finally, click on OK to get out of the setup dialogs and back to the ASCOM Dome Control panel (Figure 4-4). Click on the Connect button. The panel will be populated with positional information and the ACE SmartDome™ dialog will start if it was not already active. Click on **Slave Dome to Scope** to enable automatic dome tracking.

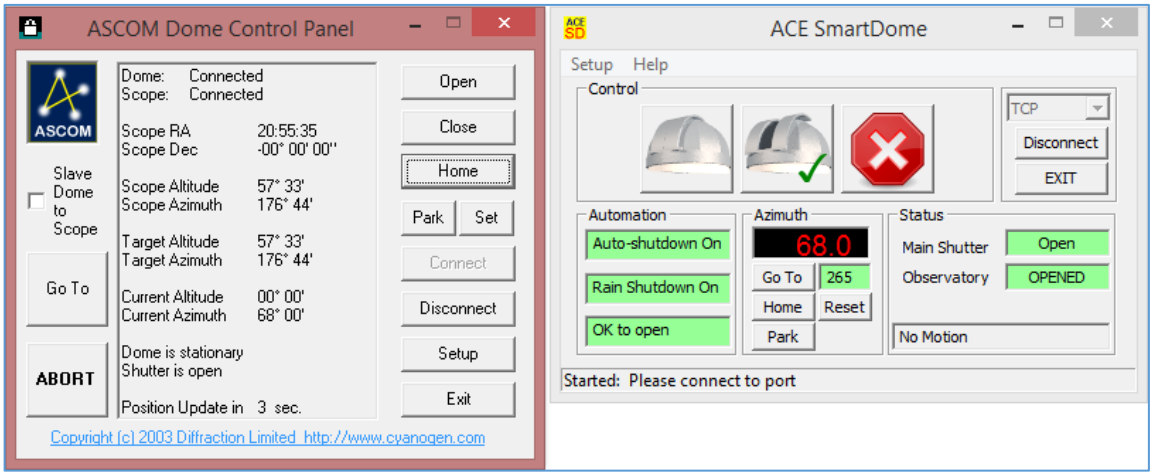


FIGURE 4-9 ASCOM DOME CONTROL PANEL WITH ACE SMARTDOME DIALOG

5.0 USING TheSkyX

5.1 OVERVIEW

This chapter describes how to setup the TheSkyX from Software Bisque to control the ACE SmartDome™. Note that you must have one of the following versions of TheSky installed:

- ☑ TheSky X Pro 10.2.0 or later (this is the best option!).
- ☑ TheSky Version 6.0.0.65 or later
- ☑ TheSky version 5.0.108 (limited support)

TheSkyX uses ASCOM so you must get ASCOM setup and fully working before attempting to use the sky. See Chapter 4 on how to do this. There is one small difference. You must download (from the Software Bisque web site, login required) and install the **ASCOM 2X Mount Adapter**. This will allow the **ASCOM Telescope Driver for TheSky** to be selected in the ASCOM Telescope Chooser.

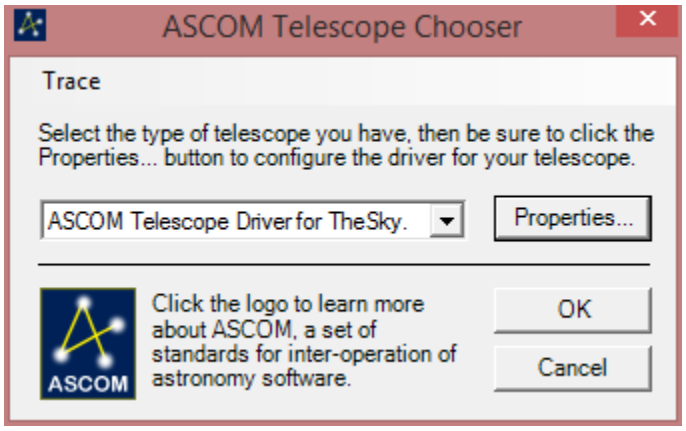


FIGURE 5-1 ASCOM TELESCOPE DRIVER FOR THESKY

There is a *Dome Add On* for TheSkyX from Software Bisque. You don't actually need to purchase this to control the dome. However, the graphic showing the dome slit in the GUI will not be available without it.

5.2 CONFIGURATION

First, you must set the location of the telescope and the correct date and time from the **Input** menu.

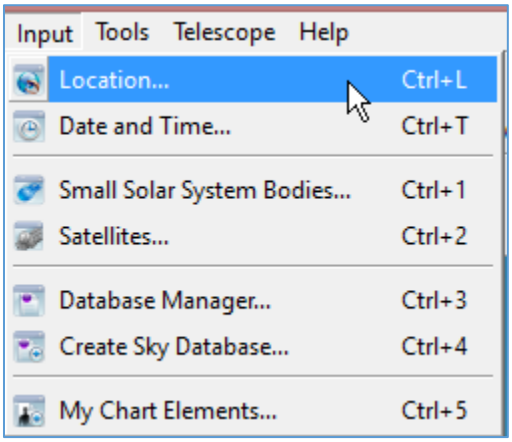


FIGURE 5-2 CONFIGURING THESKYX

Next, from the **Telescope** menu select **Telescope Setup**. This displays the **Imaging System Setup** dialog, as shown in Figure 5-3.

We will be configuring the Mount and the Dome. If you did not purchase the Dome Add On then we will just configure the mount. It is ASCOM that then commands the dome to move when the telescope moves. However, you will not see a graphical representation of the dome slit in the TheSkyX application.

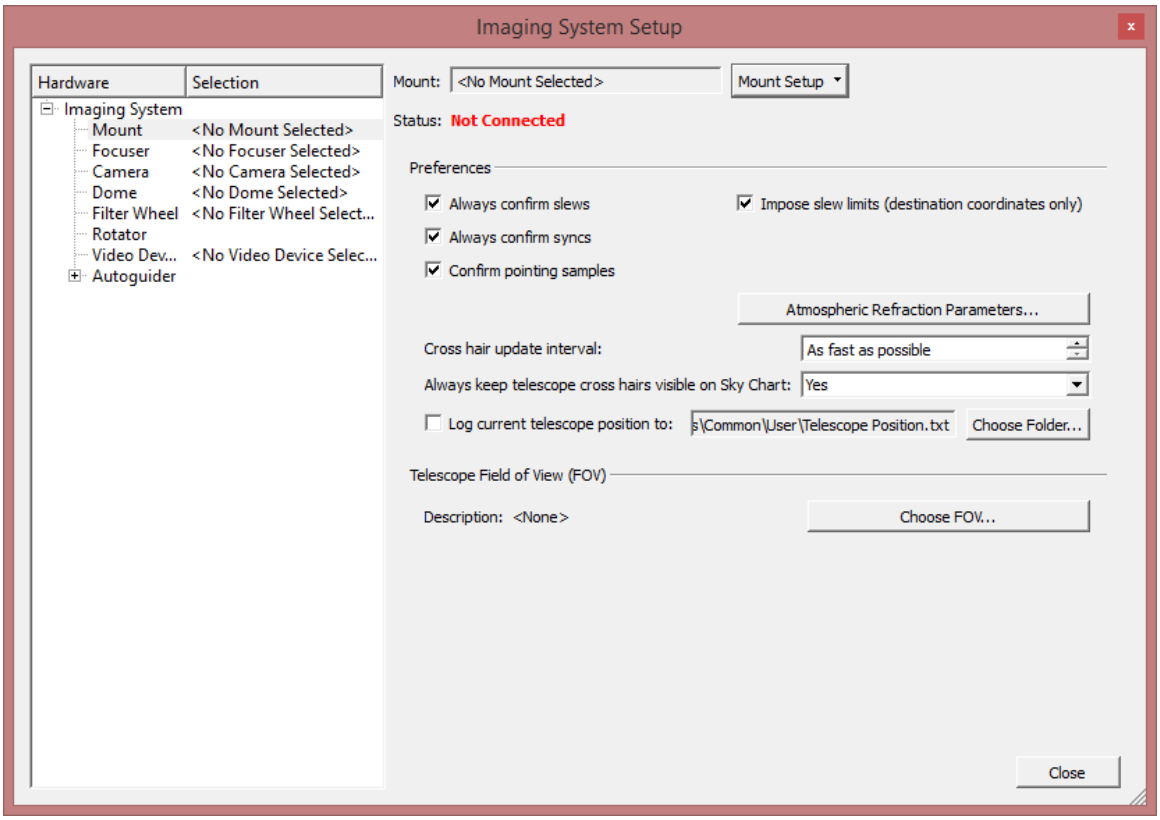


FIGURE 5-3 THESKYX IMAGING SYSTEM SETUP DIALOG

On the left hand side select Mount and then Mount Setup. Choose the telescope mount from the list. If you don't have a telescope installed at the moment then choose the Simulator as shown in Figure 5-4.

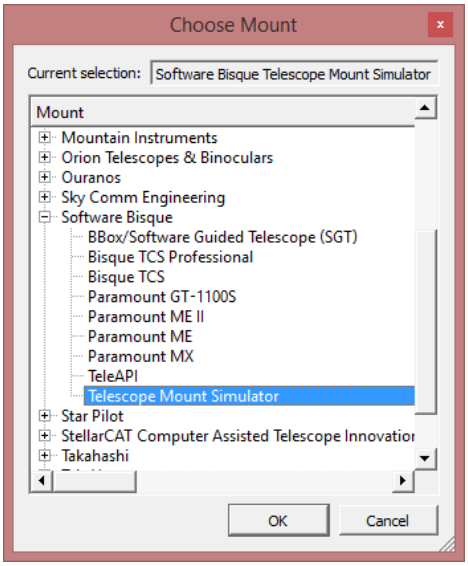


FIGURE 5-4 THESKYX CHOOSE MOUNT DIALOG

If you purchased the Dome Add On then select Dome in the same manner and navigate to the ASCOM Dome as shown in Figure 5-5.

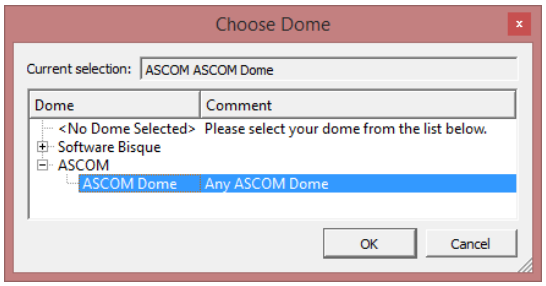


FIGURE 5-5 THESKYX CHOOSE DOME DIALOG

Click on OK to get to the Dome Setup. Note that the default parameters in this dialog box will not work for most systems! Unless you have a German equatorial mount the settings shown in Figure 5-6 should work in most cases.

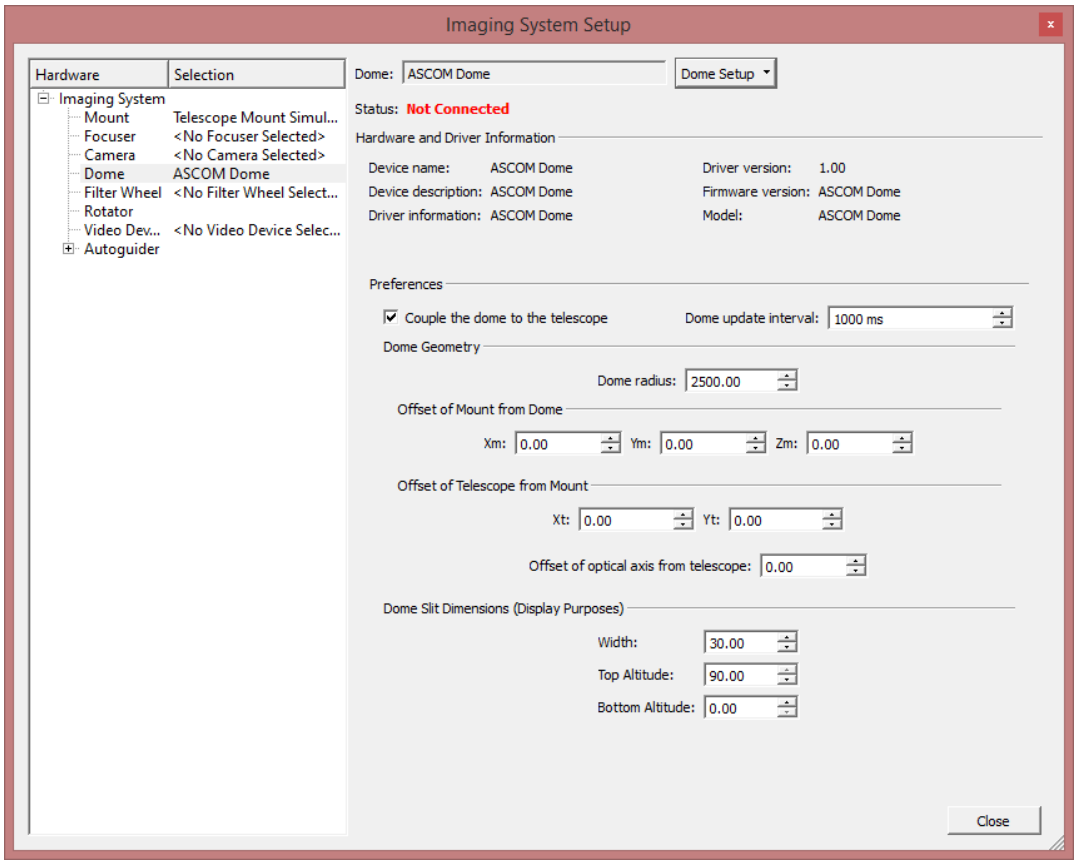


FIGURE 5-6 THESKYX DOME PARAMETERS

Note all the dimensions are in millimeters except the Dome Slit Dimensions which are in degrees. Be sure to check **Couple the dome to the telescope**. Then select **Close**. Then exit TheSky.

Now go to the ASCOM Dome Control Panel. It should look like Figure 5-7 with the Dome being a POTH Hub and the Scope being the ASCOM Telescope driver for TheSky.

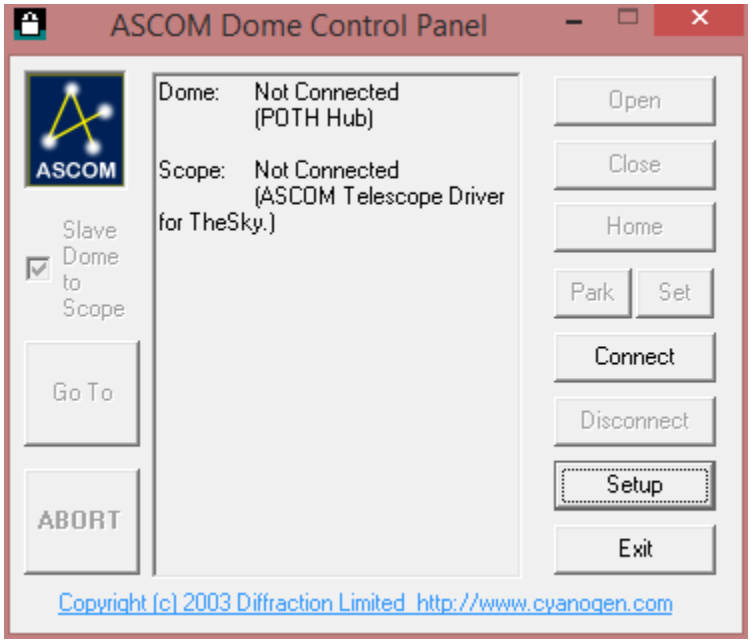


FIGURE 5-7 ASCOM DOME CONTROL PANEL FOR THE SKY

Click on Connect. This will start TheSky and the ACE SmartDome application. When the telescope is slewed the ASCOM Dome Control Panel will keep the telescope and the dome aligned.

6.0 AZIMUTH VARIABLE FREQUENCY DRIVE

6.1 OVERVIEW

The azimuthal positioning of the dome is controlled by a Variable Frequency Drive (VFD). The drive is available in single phase 115 VAC or 240 VAC and also in three phase input. The requirement is written on the front panel of the drive. In all cases the VFD outputs 3-phase power to the 3-phase azimuth motor(s). An encoder feeds back the current azimuth to the ACE SmartDome™.

☠ WARNING ☠

The information given in this Chapter is for reference purposes only and is intended for suitably trained technical staff. Lethal voltages exist on the VFD.
Do not change wiring with power on the VFD.
Wait at least two minutes after powering down for the capacitors to discharge.

6.2 MULTI-SPEED FUNCTION

The drive has a multi-speed function so the dome moves slowly for short angular moves and rapidly for larger moves.

6.2.1 High Speed Moves

The dome will move at high speed (20°/s or more):

- ☑ When the FORWARD / REVERSE push buttons are pressed
- ☑ When seeking the HOME sensor
- ☑ When the commanded position is more than HS degrees away

Change the distance for invoking the High Speed by using the command **dd.d HS** where d.dd is the number of degrees.

When the dome gets within HS degrees of the commanded position the velocity will drop down to the slow speed.

6.2.2 Slow Speed Moves

The dome will move at slow speed:

- ☑ When the commanded distance is less then HS degrees
- ☑ When making a final approach to the HOME sensor

If the commanded azimuth is greater than the COAST distance then power to the motor will be turned off when the dome is less than the COAST distance.

If the commanded move is less than the COAST distance then the COAST feature will not be invoked.

6.3 VFD Low Voltage Control Wiring

The ACE SmartDome™ Main Board has an 8-conductor screw terminal for azimuth drive control, as shown if Figure 6-1, located just by the large relays.

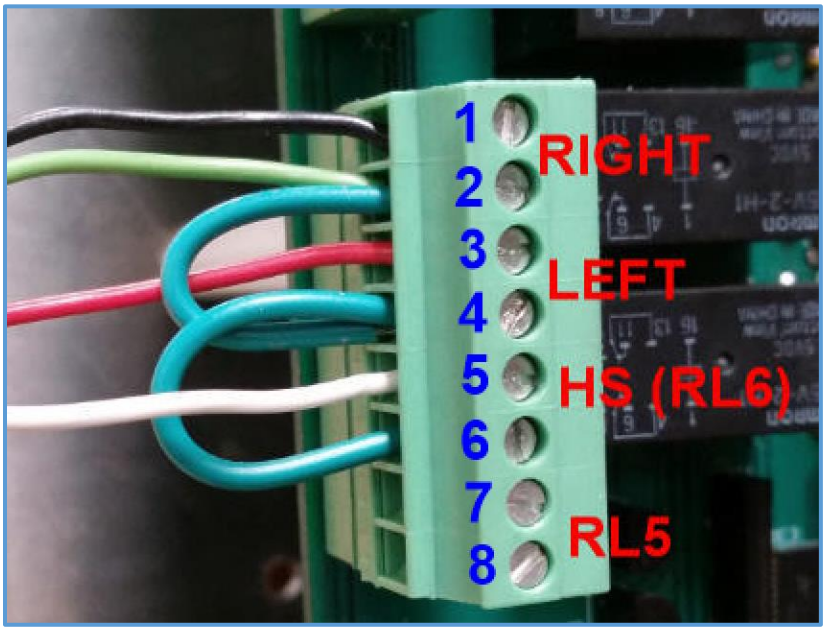


Figure 6-1 Azimuth Screw Terminal Connector

The printed circuit board is marked RT, LFT, RL6 and RL5.

Connect the wiring as shown. A 4-concuctor cable is used to connect the main board to the VFD. A loop wire connects pins 2, 4 and 6.

The connection at the VFD is shown in Figure 6-2. A loop wire connects DI4 to DCM.

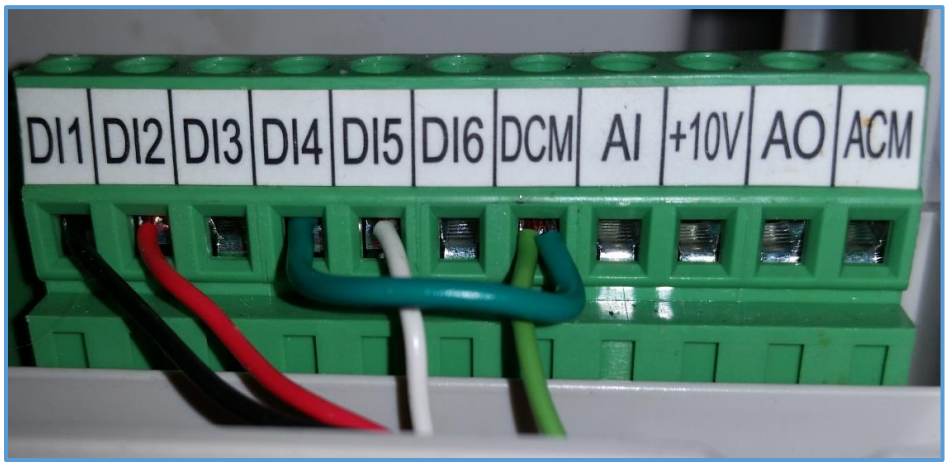


FIGURE 6-2 VFD LOW VOLTAGE CONTROL SCREW TERMINAL

TABLE 6-1 VFD LOW VOLTAGE WIRING

SmartDome	Color	Description	VFD	Note
1	BLACK	Rotate Right	DI1	Red LED
2	GREEN			
3	RED	Rotate Left	DI2	Green LED
4	GREEN LOOP TO 2			
5	WHITE	High Speed	DI5	Yellow LED
6	GREEN LOOP TO 4			
-	GREEN		LOOP DI4 - DCM	

6.4 PROGRAMMING THE VFD

For complete instructions please read the User Manual supplied with the VFD.

The digital keypad is used to program the device. Press the **Program** key. The LED display will display P followed by the chapter number and the parameter number. For example, P3.02 means Chapter 3 Parameter 2. Press the **Enter** key. The display now shows the value for this parameter. To change press the Up/Down keys. Press Enter again to save. The display will briefly show "**End**" or if a mistake was made an error code will be displayed. Refer to the VFD manual for error codes. Press Display to get out of the programming mode. The display defaults to **H 0.0** showing the drive speed in HZ. You can also display other parameters like the current, **A 0.0**. When the motor is in motion non-zero values will be displayed.

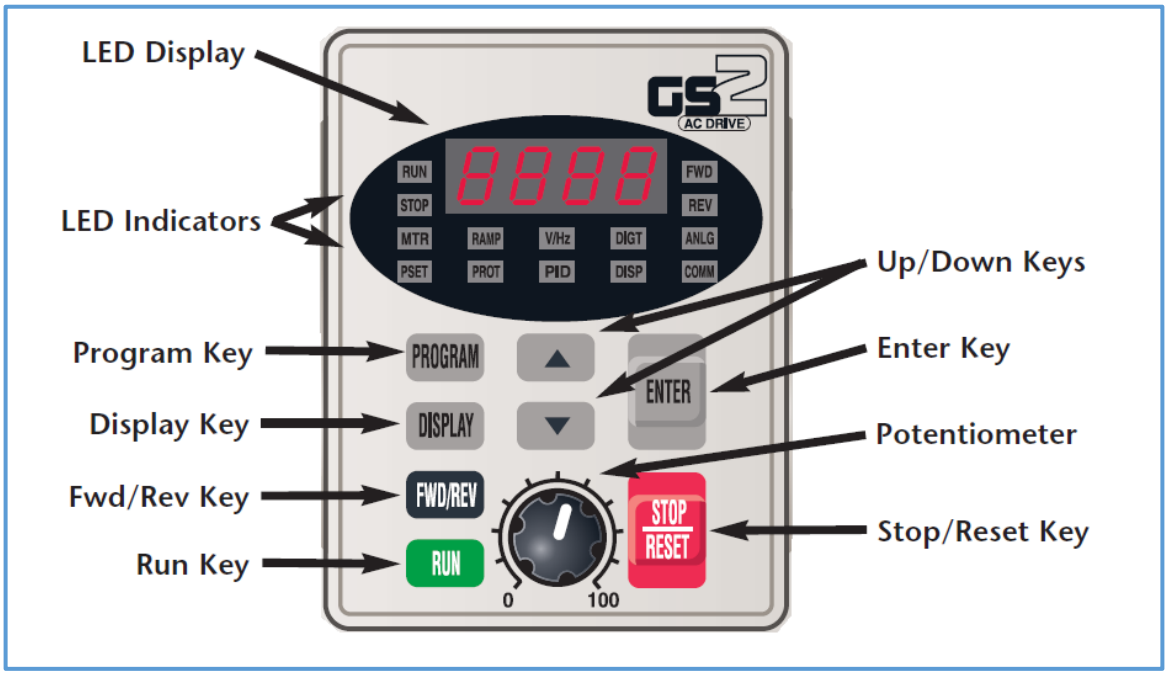


FIGURE 6-3VFD DIGITAL KEYPAD

Note the black potentiometer knob. Always leave this set at 100%.

Table 6-2 lists all of the parameters that must be changed from the factory defaults. Be absolutely certain to change Parameter P1.02 which is the deceleration parameter. Otherwise the dome will take 30 seconds to stop!

Notes:

- ☑ The default for P 0.04 is the same value as P0.03. To make the motor go faster than the rated speed increase P0.04. To move at 1.5x the base speed set this to 1750 *1.5 = 2625.
- ☑ Set the acceleration time to somewhere between 4 and 10 seconds. Very fast acceleration times (under 1 second) can damage the gearing and cause excessive current, especially when setting P 0.04 above the base level. Listen to the behavior of the dome and "tune" to the fastest reasonable value.
- ☑ Set the deceleration (P 1.02) to around 1.0 to 1.5 seconds
- ☑ Try homing the dome from a distance greater than HS. If the dome does not park on the sensor then decrease the deceleration time.
- ☑ P 5.01 and 5.02 are in HZ and cannot exceed the value set in P 0.04. This value is calculated as P 0.04 / P 0.03.

SIMPLIFIED SETTINGS

TABLE 6-2 VFD TYPICAL PARAMETERS

Parameter	Description	ACE value
P 0.00	Motor Nameplate Voltage	230
P 0.01	Motor Nameplate Amps	2.5
P 0.02	Motor Base Frequency	60
P 0.03	Motor Base RPM	1750
P 0.04	Motor Max RPM (See notes)	2625
P 1.00	Stop by ramping, not coasting	00
P 1.01	Acceleration Time (See notes)	4.0
P 1.02	Deceleration Time	1.0
P 3.00	Operation determined by external control, STOP enabled	01
P 3.01	FWD/STOP and REV / STOP buttons	00
P 3.02	Set Jog mode	09
P 3.03	Multi-Function Input terminal DI3	03
P 3.04	Multi-Function Input terminal DI4	04
P 3.05	Multi-Function Input terminal DI5	05
P 5.01	Multi-Speed 1(HZ) (Slow Speed)	12
P 5.03	Multi-Speed 3(HZ) (High Speed)	75

Note: Qualified ACE Control Engineer will tune the drive to optimize performance.

ADVANCED MUTI-SPEED SETTINGS

TABLE 6-3 VFD ADVANCED PARAMETERS
DATA SHOWN FOR 3.5-m Observa-Dome model

Parameter	Description	ACE value
P 0.00	Motor Nameplate Voltage	230
P 0.01	Motor Nameplate Amps	2.5
P 0.02	Motor Base Frequency	60
P 0.03	Motor Base RPM	1750
P 0.04	Motor Max RPM (See notes)	2625
P 1.00	Stop by ramping, not coasting	00
P 1.01	Acceleration Time (See notes)	4.0
P 1.02	Deceleration Time	1.0
P 1.03	Acceleration S-Curve	04
P 1.04	Decelertion S-Curve	00
P 1.05	Acceleration Time 2	5.0
P 1.06	DecelerationTime 2	2.0
P 1.07	Select method for 2nd Acceleration	01
P 1.08	Acceleration #1 to #2 transition	12
P 1.09	Deceleration #2 to #1 transition	12
P 3.00	Operation determined by external control, STOP enabled	01
P 3.01	FWD/STOP and REV / STOP buttons	00
P 3.02	Set Jog mode	00
P 3.03	Multi-Function Input terminal DI3	03
P 3.04	Multi-Function Input terminal DI4	04
P 3.05	Multi-Function Input terminal DI5	05
P 5.01	Multi-Speed 1(HZ) (Slow Speed)	12
P 5.03	Multi-Speed 3(HZ) (High Speed)	75

DATA SHOWN FOR 6.0-m Observa-Dome model

Parameter	Description	ACE value
P 0.00	Motor Nameplate Voltage	230
P 0.01	Motor Nameplate Amps	2.5
P 0.02	Motor Base Frequency	60
P 0.03	Motor Base RPM	1750
P 0.04	Motor Max RPM (See notes)	1750
P 1.00	Stop by ramping, not coasting	00
P 1.01	Acceleration Time (See notes)	10.0
P 1.02	Deceleration Time	0.2
P 1.03	Acceleration S-Curve	01
P 1.04	Decelertion S-Curve	00
P 1.05	Acceleration Time 2	4.0
P 1.06	DecelerationTime 2	1.7
P 1.07	Select method for 2nd Acceleration	01
P 1.08	Acceleration #1 to #2 transition	13.1
P 1.09	Deceleration #2 to #1 transition	13.1
P 3.00	Operation determined by external control, STOP enabled	01
P 3.01	FWD/STOP and REV / STOP buttons	00
P 3.02	Set Jog mode	00
P 3.03	Multi-Function Input terminal DI3	03
P 3.04	Multi-Function Input terminal DI4	04
P 3.05	Multi-Function Input terminal DI5	05
P 5.01	Multi-Speed 1(HZ) (Slow Speed)	40
P 5.03	Multi-Speed 3(HZ) (High Speed)	12

7.0 PROGRAMMING THE SMARTDOME RADIOS

7.1 INTRODUCTION

If two SmartDome systems are installed at the same observatory the radios can cross-talk. To prevent this the radios must be programmed to different ID's.

7.2 PREPARING THE RADIO FOR PROGRAMMING

The bottom box board is used to do the programming.

Turn the power off the top box, to prevent the radios from trying to communicate while programming.

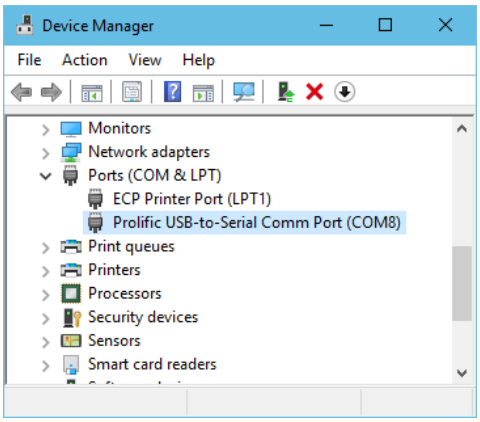
Turn power off the bottom box.

Install the radio you wish to program (no antenna needed) and unplug the ribbon cable marked "RADIO" from the green SmartDome board. Plug the grey-colored ribbon cable that converts a 10-pin header to D-Sub 9 male into the "RADIO" port. Connect the D-Sub cable to a computer serial port. If using a USB serial port adapter, it also has a D-Sub 9 connector, so you will need a Male-Male gender changer. Make your own or get one from ACE. The standard off-the-shelf "gender-bender" make does not work. You need just three wires, straight through: 2-2, 3-3, and 5-5.

Apply power to the lower box but leave the top box off.

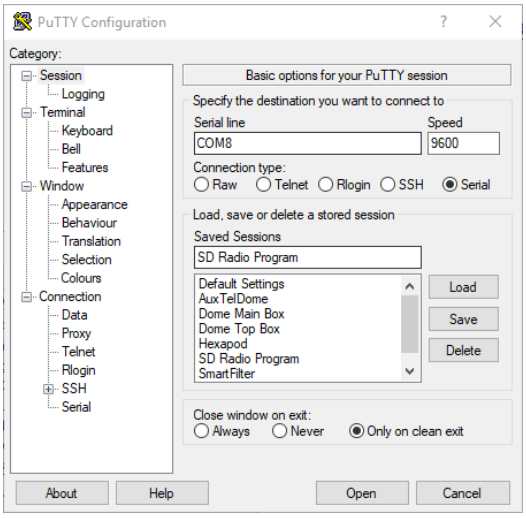
7.3 PROGRAMMING

Use the device manager to determine the serial port being used:

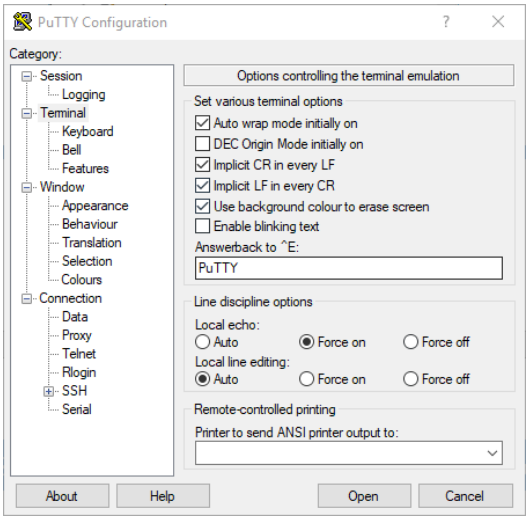


7.3.1 Preparing Putty

Start Putty, a terminal emulator. It is available for free download here.



Select the **Serial** radio button option and edit the COM port number.



Click on **Terminal** and set the values shown above.

Next, click on Session and type SD Radio Program into the **Saved Sessions** edit field. Then click **Save**. The information can be reloaded the next time Putty is run. To start a Putty session click **Open**.

7.3.2 Using Putty

When the session is opened rapidly type +++ to start communicating.

The system will respond with OK.

The system will time out if there is no activity after only a few seconds. To restart simply type +++ again.

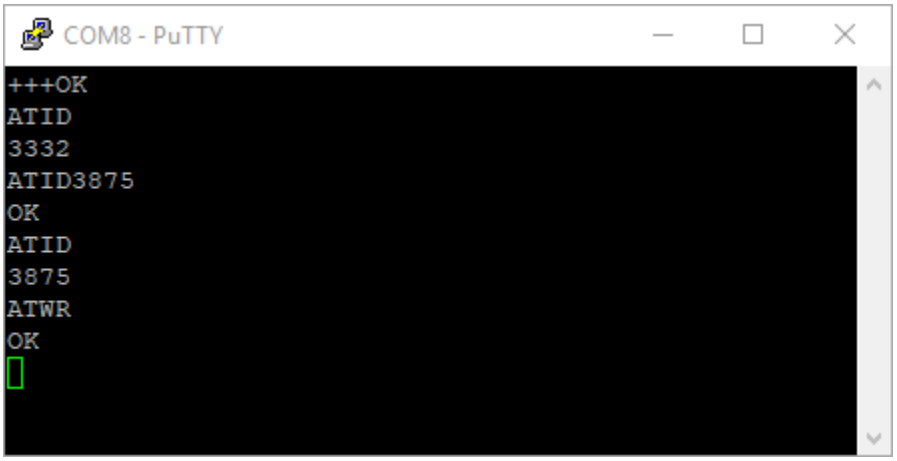
We will be changing the ID parameter, called ATID.

To discover the current ID of the radio enter ATID. The default value is 3333.

To change the value type ATDT #### where ### is the new value.

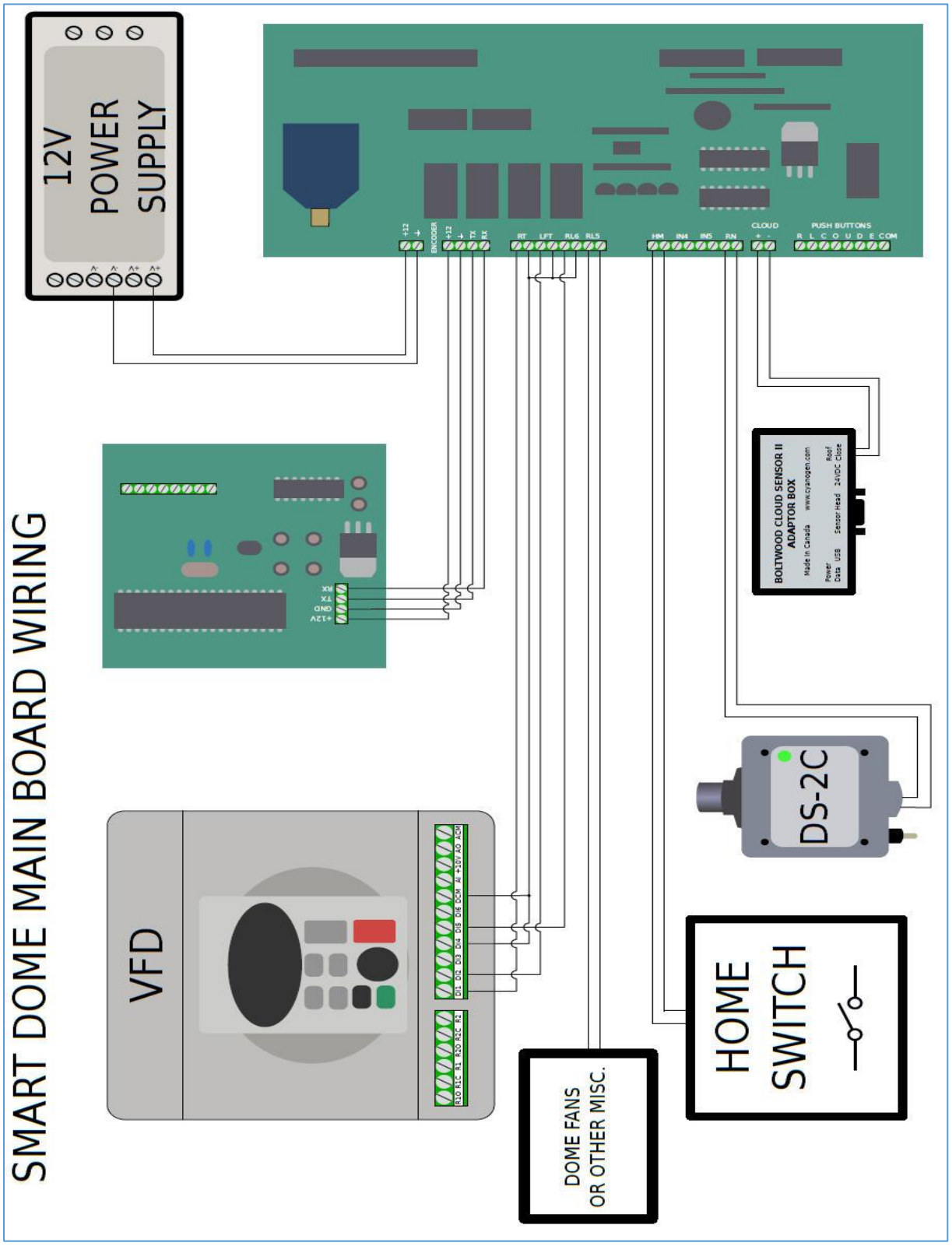
To commit the changes type ATWR. To do a factory reset type ATRE or ATFR followed by ATWR.

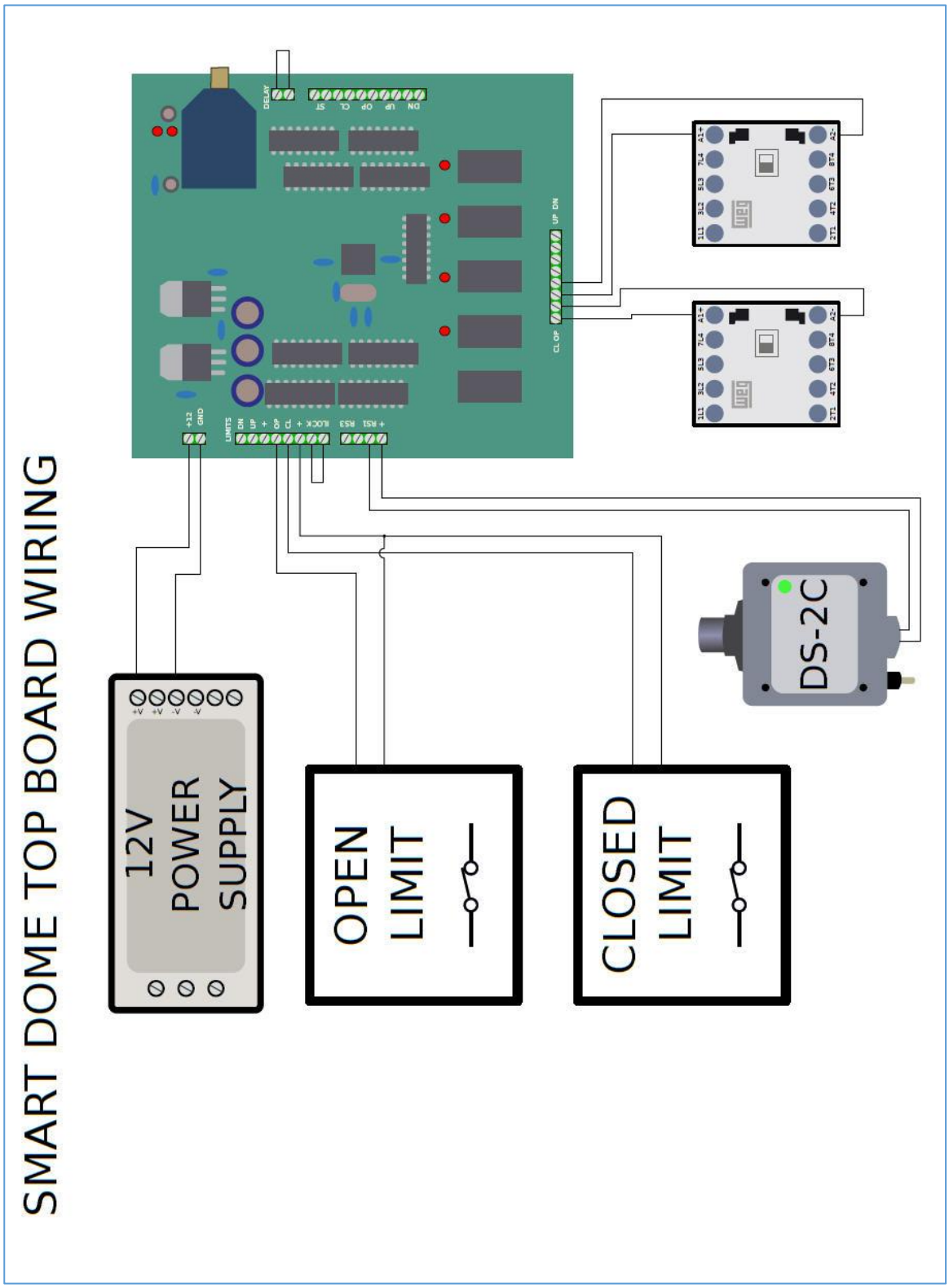
A session is shown below:



Both radios must have the same ID. Make sure the power is turned off when inserting and removing the radios and restore the original multicolored ribbon cable to the RADIO port to test the new configuration.

8.0 ELECTRICAL DIAGRAMS




SMART DOME TOP BOARD WIRING
12V POWER SUPPLY
OPEN LIMIT
CLOSED LIMIT
DS-2C