

TALON6 Observatories Controller User Manual

Talon6 is a safe control system for observatories automation. It allows manual as well as robotic and automated control of roll off roofs and domes for astronomical observatories. It has been designed to provide maximum safety and versatility to astronomical equipment used locally, remotely or robotically. The system is compatible with the commercial automation programs through the ASCOM platform and allows forcing to park the mount before closing the roof.

This project has been carried out based on the security needs and experiences as users of remote dome and roll-off-roof observatories since 2005, using the system remotely from the PC via internet for astrophotography sessions or locally. Using the provided keypad, we can take control of the observatory for maintenance works, circumventing the security conditions totally or partially, in a permanent or temporary basis.

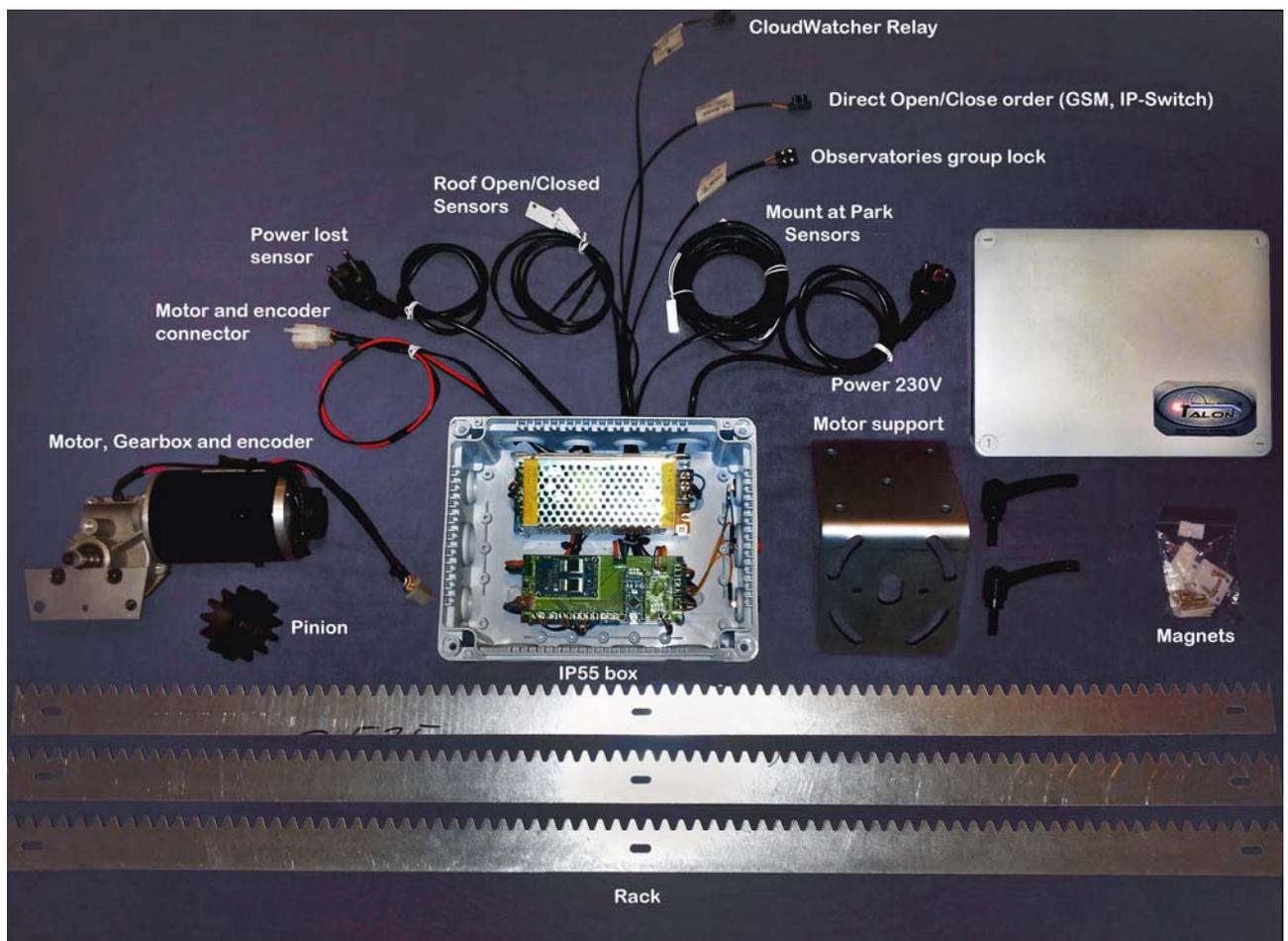


Fig. 1. Talon6 RoR

Description and Mechanical characteristics.

The mechanical system is based on a 12V DC motor with a 75:1 reducing gearbox (18Nm torque) driving a M4 hardened steel spur gear (pinion) that engages an M4 rack, made of 3mm galvanized steel, that is fixed to the roof. The power and speed of the motor is microprocessor controlled using Pulse Width Modulation and PID control.

The position of the roof and its velocity are determined by means of the encoder attached to the main shaft of the motor (before the gearbox), giving a total of 2880 pulses per revolution. This allows for fine control of the position as well as of the amperage, speed and acceleration of the motor. The movements of the roof are soft and silent, accelerating smoothly up to the maximum speed and maintaining this constantly until it decelerates to smoothly stop at the end of its travel. This control also allows protection of the motor and the whole system should the motor stall due to a possible mechanical failure.

Because of the use of the encoder, the system can always accurately show the position of the roof and allows "go-to" commands selecting the percentage we want to open the roof.

The motor is delivered with a simple mounting system which includes a quick release system. This is intended for releasing the motor pinion from the toothed rack. This allows the roof to be manually moved in the case of electric failure, user convenience or for maintenance.

Talon6 RoR Features

As already stated, TALON6 moves the motors silently (microprocessor controlled), accelerating smoothly up to maximum speed and maintaining it until it has to decelerate to smoothly stop at the destination point. It notifies continuously the status of the roof:

- Open (magnetic sensor limit switch)
- Closed (magnetic sensor limit switch)
- Mount at park (magnetic sensors)
- Position of the roof (exact percentage by encoder)
- Last action performed.
- Current status of the sensors and switches shown by light signals in the driver main display.

It monitors continuously the following safety conditions and switches. reporting the status as LEDs in the driver window:

- Communications with the PC lost.
- Internet communications lost.
- Cloud watcher, Cloud Sensor, etc. sensor switch.
- Power fail (before UPS, Uninterruptible Power Supply)

- Countdown to a scheduled shutdown.

Talon6 is able to react safely to any of these eventualities ordering the mount to park and close the roof if needed. When one or more conditions raise a countdown progress bar appears at the bottom of the interface window indicating the closing condition and the time to close.

It also continuously monitors the control inputs reporting the status:

- External keypad with three buttons, OPEN, STOP and CLOSE.
- MGM input to Lock and unlock the driver for observatories group, parking all telescopes before closing the observatories.
- COM input, that allows open and close the roof directly using a GSM or IP relay.

Additional features

- Direct communications with Losmandy Gemini or AP Mount systems (through a dedicated serial port) to order them to park without PC intervention (covers the communication lost problem).
- Includes a specific output to park Paramount mounts without PC intervention.
- Direct connection to the IP-SWITCH for automatic equipment switch-off at the end of the session or after a safety closing.
- Automatic communications port reconnection after PC disconnection.
- Automatic communications port search at the beginning of the connection.
- Maximum aperture control with un-parked mount.
- Possibility of manual Synchronization of the current roof position.

TALON6 will park the mount and will close the roof when any of the above mentioned safety conditions appear, except (in general) when the communications with the PC is lost (due to a hanged or switched off PC). In this case the roof will be closed with the mount un-parked, unless the user configures the system to avoid this closing order. This situation can be avoided for some telescope mounts that allow direct park commands from the Talon6 system.

In addition when the user is at the observatory, TALON6 RoR can be managed manually with a keypad included in the control box, which allow the orders Open, Close and Stop. The system can also be managed remotely by activating an additional input (for example using a relay of our GSM-Switch or IP-Switch or another GSM or IP controlled relays system).

Control program

Running in the PC there is a program that communicates with the Talon6 RoR system with the purpose of giving information to the user and allowing him to manage the system. This is what we name the Talon6 RoR driver. This driver is compatible with the ASCOM platform and can be invoked from any automation program like AutoPilot, CCDCommander, or by image acquisition programs that are dome or roll off roof compatible like MaximDL.

Installing the Driver

Before connecting the Talon6 system to the PC, run the installer.

The software to use the Talon6 RoR system is installed in a very simple way by executing the installation program. The necessary files are automatically copied to the C:/TALON6_ROR directory (this includes the USB drivers for communication) and the ASCOM driver is automatically registered in the ASCOM platform as a dome driver. A shortcut is also created on the desktop.

Operation of the Talon6 RoR

When the Talon6 RoR driver is invoked a window (fig 2) is shown. As it is initially disconnected from the controller, only three of the buttons are active. The orange button that invite us to connect with the controller and two of the blue buttons.

Setup that allows the configuration of the system and Traffic, opens an additional window to show the traffic between the PC and the controller. This is useful for debugging.

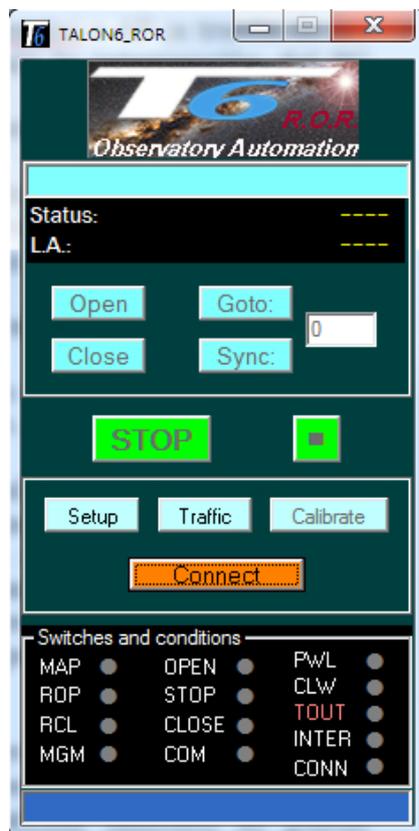


Fig. 2. Talon6 RoR driver disconnected

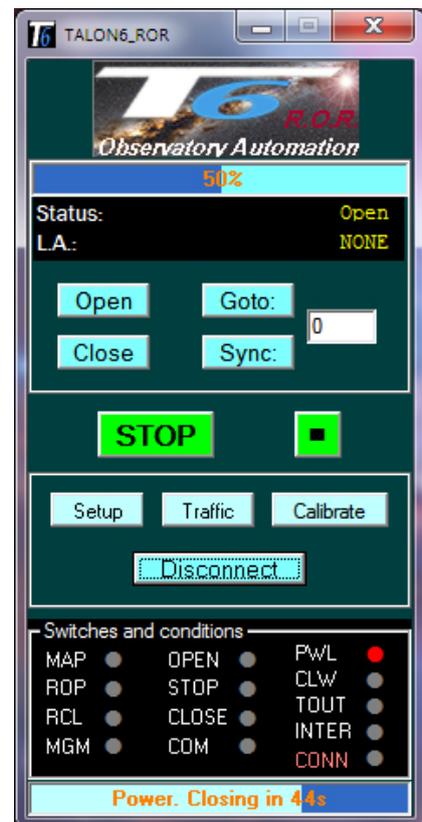


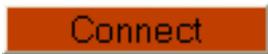
Fig. 3. Talon6 RoR driver connected

In the upper part of the window there is an information area where a progress bar shows the percentage of opening, status of the roof and the last action performed. In the bottom part of the window there is another progress bar where a

countdown appears in case of a closing condition. Above it is an information area where the status of the sensors, switches and conditions is shown simulating green or red LEDs. The names of the closing conditions are colored in red if the condition is disabled in the setup. While the system is not connected the information is not shown and most of the buttons are inactive. Fig 3 shows the same driver window once the connect button has been pushed and connection with the controller has been established. Now all buttons are active.

Buttons

Now we will describe the different buttons present on the control window.

A rectangular button with a dark orange background and the word "Connect" in white text.

It is the button that initiates communications between the PC and the controller and establish the complete safety measures. Although Talon6 RoR can work independently it also opens the door for other automation programs to communicate with it via ASCOM and use its safety features.

A rectangular button with a light blue background and the word "OPEN" in black text.

This button allows us to fully open the roof. The roof starts accelerating smoothly up to the maximum speed and maintains it until it has to decelerate to smoothly look for the "Open" limit switch. The position of the roof is continuously notified to the user. The roof only starts moving if the safety conditions that are enabled at that moment allow it (See: Safety Conditions).

A rectangular button with a light blue background and the word "CLOSE" in black text.

This button is used to fully close the roof. As in the opening, the roof starts accelerating smoothly up to its maximum speed and maintains it until it decelerates smoothly to 'look for' the Closed limit switch. The position of the roof is continuously notified to the user. Before closing occurs, the mount park sensors are checked. Several things can happen:

- If the mount is already parked the roof will be closed immediately.
- If the mount is not parked, the controller notifies to the driver that the mount is to be parked. The Talon6 driver sends the parking order to the driver of the mount. Once the mount is parked the roof will be closed immediately. For this action to work, the mount and the PC must be turned on with communication and the ASCOM driver of the mount installed and running.
- If the mount is not parked and the mount does not park in a time specified by the user (lack of communication between the controller and the PC or between the PC and the mount) the controller will close the roof making a safety absolute closing. This can result in a possible contact of the roof and

the telescope if it protrudes above the roof. **This is a point where the user takes full responsibility for the possible effects over his equipment when programming this safety absolute closing.** For example; They must wait for the effects of the roof-telescope contact against a wet telescope, mount and equipment if it is raining.

Warning.

If the parking timeout established by the user in Setup/Parameters/Del_Park is zero, the roof will never be closed while the mount is not parked. This item is intended for users who do not want their telescope to be pushed by the roof when there is a safety absolute closing and the telescope protrudes above the roof.



Pushing this button stops the roof softly, with a deceleration ramp, provided that it was moving.



Allows to establish manually the position of the roof in terms of opening percentage. Enter the percentage in the text window and push the button.



This button allows us to open the roof up to the desired percentage. Just enter the amount in the text window besides the button and press GOTO. The roof will move ramping up and down reaching the required position. This is provided for example for a possible ventilation with restriction of wind and dust, or for performing maintenance actions at the observatory with natural light.

We can even establish how long the roof will be open by entering the , activating the "Timeout Expired" condition checkbox and typing on his text window the time in seconds we want it open.

This action will be always restricted by the safety conditions if they are activated.



With the roof in stationary state open, partially open or closed this button allow disabling all safety conditions at once. In this way we will be able to freely open and close the roof manually from the driver or from the controller box keyboard, even if there is a safety condition active. If the button is of green color the conditions are enabled or disabled as established in the setup.

To disable all conditions, press the button  (it will change to red color  as a warning that all safety conditions are disabled. **ATTENTION!** Remember to enable them again before working in automated mode.

To enable them again you only need to click the  button. The setup window will open showing the safety conditions:

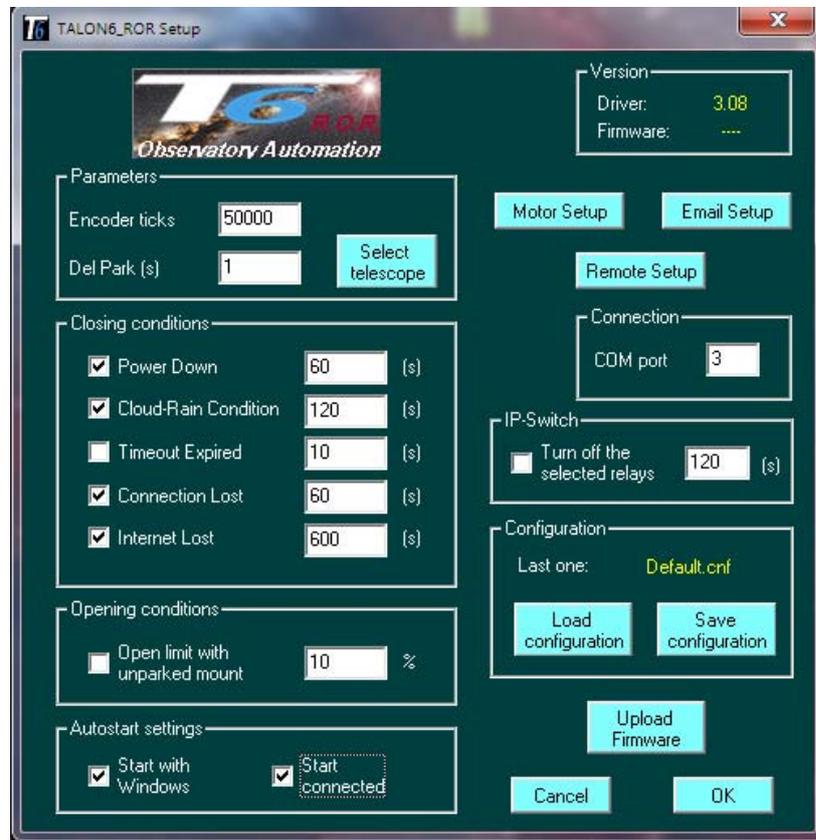


Fig. 4. Setup window

Click on the OK button and the safety conditions will be enabled again in the same state they were before disabling them. The button will change again to green color  .

If this button is pushed when the roof is moving the button will change to red color  and the roof will be stopped suddenly with no deceleration ramp. It is an emergency stop. This action is provided for stopping quickly the motor when a contingency appears that you could see for example through your webcam. This action disables the safety conditions. To enable them again, follow the steps in previous paragraphs. Once activated the button will turn to green again  .

Do not forget to leave the safety conditions enabled if you do care for your equipment.

Traffic

The Traffic button shows different aspects of communications between the Talon6 RoR driver and the controller, ASCOM calls, communication protocols with PC or communications and information of the system as encoder pulses, voltage of the power supply motor power, etc. It is very useful for debugging problems.

Calibrate

Pressing this button with the roof closed allows the calibration of the system, that is, to perform a complete opening looking for the "Open" limit switch, In this way the number of encoder pulses corresponding to 100% open can be stored and used to know with accuracy the position of the roof and manage adequately the acceleration and braking ramps for a soft start and stop of the movement, avoiding sudden impacts in the extreme positions of the roof.

Information sections

Status and Last Action

At the top of the control window there is a section with black background that shows the status of the roof, the last action performed and the timeout countdown, that is, remaining time before the closing programmed in the setup.



The progress bar shows the percentage the roof is open. The status of the roof is shown as: Open, Closed, Opening, Closing, Error.

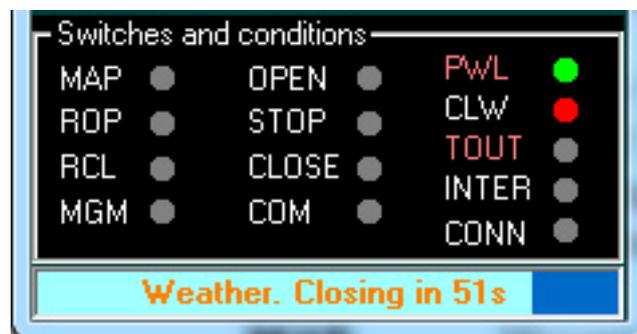
The last action performed by the controller (LA). The different Messages that can be read in Last Action are (The number is the reference in the log file):

Connecting		Connecting the driver with the controller.
Looking for Talon6		Looking for the com port of Talon6.
Talon6 not found		There is no Talon6 available.
Waiting for Talon6		The connection is waiting for the com port.
None	0	No Action.
Open by user	1	Roof opened by the user.
Closed by user	2	Closed Roof (with Park) by the user.
Aux	3	Internal indication.
Go-To by user	4	The user executed a Go-To command.
Calibrate by user	5	Calibration by the user
Closed. Cloud-Rain	6	Roof closed (with Park) due to bad weather.
Closed. Power down	7	Roof closed (with Park) due to power outage.
Closed. Connection Lost	8	Roof closed due to PC connection lost.
Closed. Internet Lost	9	Roof closed (with Park) due to Internet lost.

Closed. Time expired	10	Roof closed (with Park) due to Timeout.
Closed by MGM	11	Roof closed (with Park) by Management
Closed by Automation	12	Roof closed (with Park) by Automation
Stop. Motor Stalled	13	Motor Stop by mechanical/electrical problem.
Stop: Emergency	14	Emergency stop by the user.

Switches and conditions

At the bottom of the control window there is another section with black background that shows in real time the status of all the sensors, switches and conditions of the Talon6 RoR controller. It is very useful to check that all of them are working correctly. There is also a progress bar that shows the closing countdown.



This is the meaning of the information shown:

Conditions:

PWL	Power lost / Power fail
CLW	Cloudwatcher relay closed
TOUT	Closing countdown active
INTER	Internet lost
CONN	Communication lost

Sensors:

MAP	Mount at park position
TOP	Roof totally open
TCL	Roof totally closed

Buttons:

OPEN	Open button pushed
STOP	Stop button pushed
CLOSED	Close button pushed

Direct switches:

MGM	Closed by management input active
COM	Direct command input active

PWL, **CLW** e **INTER** will glow green when the condition is raised. If the safety condition is also enabled in the setup it will glow red. In the figure PWL is green because the power lost condition has raised but the condition is disabled and CLW is red because the condition has raised and it is enabled. You can see also the countdown in the progress bar.

TOUT just will glow red when the condition is enabled in the setup and the countdown is higher than zero.

The rest of them will glow green when they are active.

The name of the conditions PWL, CLW, TOUT, INTER and CONN will be colored red if the condition is disabled. In the fig 4 we can see that the conditions enabled are CLW, INTER and CONN.

Setup

Clicking this button opens the configuration window that allows defining the behavior of the system, the selection of the telescope and defining the safety conditions. In this window, there are 6 sections corresponding to: Version, Parameters, Closing Conditions, Connection, Opening conditions and IP-Switch. There is also a button named Motor setup that opens a new window where the motor parameters can be configured as well as another one named Email setup that also opens a new window where the email settings can be configured to send notifications.

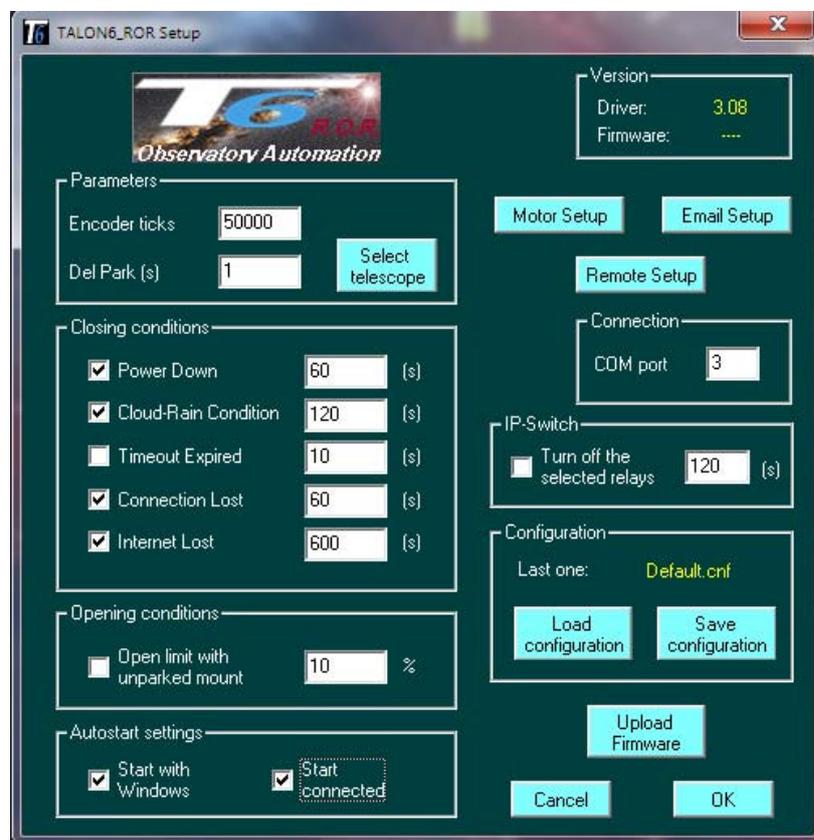


Fig. 4. Setup window

Version section:

Shows the driver version and the controller firmware version.

Parameters section:

Encoder ticks: Defines the number of ticks generated by the encoder during the calibration process Calibrate. Can also be changed manually.

Del Park (s): It is the time in seconds that we give to our mount to park before making a safety absolute closing because the mount has not arrived to the parking point detected by the magnetic sensors.

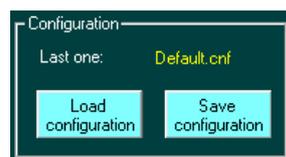
This parking time is determined by taking the mount to an endpoint low and to the west (For the Northern Hemisphere. For the Southern Hemisphere is the other way around) to provoke a Meridian Flip and giving the order to Park. We will then measure the time it takes to reach the established Park position and introduce the data in seconds with a little margin (10 seconds for example), giving time to the mount to reach the parking point before the controller closes the roof. If you put a zero in this box the roof will not close until it detects that the mount is parked.

Personal note

The problem of collisions in case of safety absolute closing is given by the equation: telescope size, column height, mount and height of the observatory (and not always has to happen). This has to be taken into account before deciding how and when the Talon6 RoR controller closes the roof.

Here the user always decides and has to put in the balance what to do when a PC loss or a mount malfunction, etc. arises: To leave the equipment outdoors, exposed to the elements, or to allow the telescope to suffer the push of the roof when the Talon6 RoR orders to close saving the equipment.

Absolute closing. We call absolute closing to the point where the Talon6 controller closes the observatory considering more important to close at all costs avoiding that the equipment remain exposed to uncontrolled atmospheric conditions or security, despite the telescope may suffer some damage when protruding from the roof.



Configuration section:

It allows to save or to load different configurations of the system with a chosen name.

Last one: Indicates with a yellow text the last loaded configuration

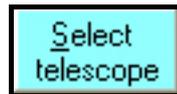
Upload Firmware:



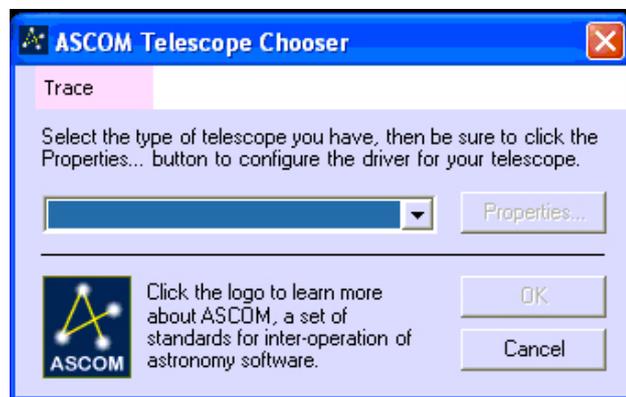
This section allows to upload the firmware updates. When this action is executed following the instructions of the installer a configuration previously stored has to be loaded.

Before proceeding to the firmware upgrade it is recommended to review the setup values and save the configuration.

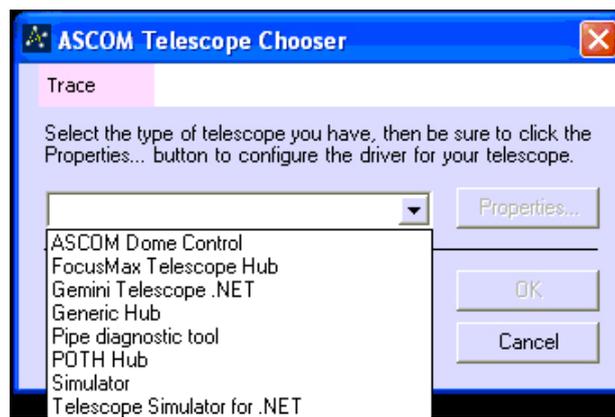
Select Telescope:



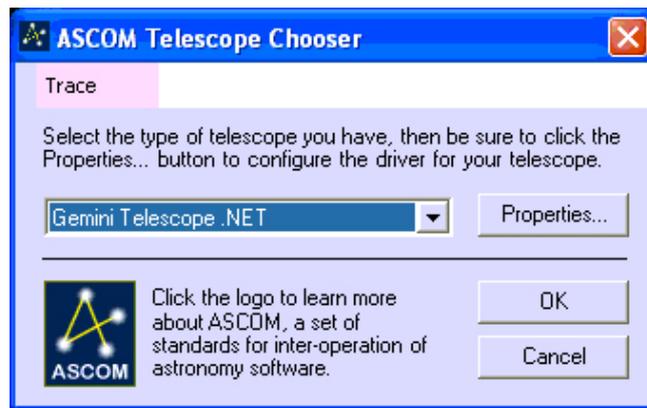
Pushing this button opens the ASCOM telescope chooser window:



Here we will click in the little arrow to see the available mount ASCOM drivers:



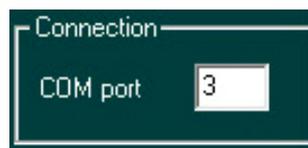
Among them we have to select the driver of our mount that is supposed to be there. In our example, it is a Gemini telescope:



Clicking OK we are telling to the Talon6 driver which one is the driver that has to be invoked to park the mount before closing the roof.

Connection Section

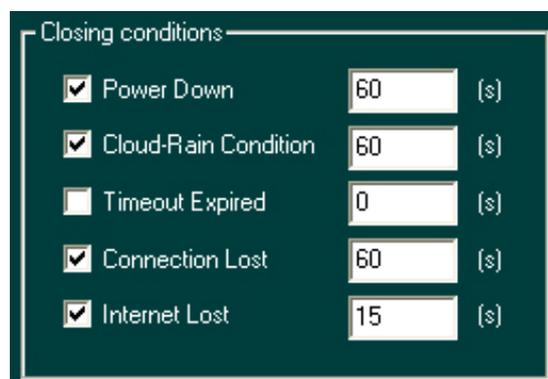
In this section, we tell the driver the com port assigned to the Talon6 controller. This port is assigned by Windows. If a port higher than 16 is assigned we have to relocate it.



If we know the port number we just write it into the window. If we select port 0 the driver will automatically look for a Talon6 among the first 16 ports.

Closing Conditions Section

Here we will find 5 checkboxes with its associated text window for defining the delay in seconds from the instant the condition arises and the starting of the park and close action.



The closing conditions or safety conditions are the following:

Power Down: This condition arises when the power is down. If the power is not restored before the time specified in the text window the controller will order to park the mount and close the roof. This feature works if you have a UPS system

(Uninterruptible Power Supply.) Of course, the sensor has to be connected before the UPS.

Cloud-Rain Condition: This condition is raised by the Cloudwatcher system due to bad weather. If the condition remains active for the time specified in the text window the controller will order to park the mount and close the roof. Waiting for the specified time can prevent a premature closing due to some momentary instability, as a group of loose clouds, etc.

Timeout Expired: This box helps to activate a temporal opening of the roof for a programmed time in seconds. When the countdown reaches the zero value the controller will Order to park the mount and close the roof

If the roof is open when this condition is active, the countdown starts when you exit the setup by pressing OK. If not, it will start when an open command either from the driver or from the keypad of the Talon6 is accepted. The countdown is restarted every time an open command is accepted.

Here again there is no limit for the imagination, programmed ventilation controlled by the rest of the safety conditions, Image acquisition with no automation programs: For example, we can program to close the roof after X hours taking pictures. After that time, the Talon6 controller will order to park the mount and close the roof. During the session, the rest of the safety conditions are protecting the system.

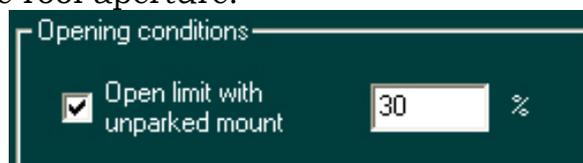
Communication Lost: This condition arises when the communication with the PC is lost. If the communication is not restored before the time specified in the text window, the Talon6 controller will close the roof. If possible, the controller will give a direct park order to the mount. If the mount does not have that feature available a safety absolute closing is performed.

Internet Lost: This condition, managed directly by the driver arises when the internet connection is dead. If this connection is not recovered in the specified time the driver will send a park mount and close roof order to the Talon6 controller.

Losing the Internet connection when working in remote can sometimes jeopardize our equipment for an indefinite period. This safety condition helps to protect the equipment in such kind of situations. The time usually specified for this condition to provoke the reaction of the system is much higher than in the rest of the conditions.

Opening conditions section

Here we find a single checkbox with its associated text window that has the purpose of limiting the roof aperture.

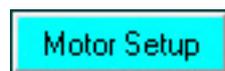


Some observatories allow the telescope to protrude above the roof limit when it is closed. That means that if we open the roof with the telescope un-parked, there is the possibility of contact between the roof and the telescope. This problem can be avoided clicking in this checkbox and writing in the textbox window a percentage of opening that avoid hitting the telescope. In that way, we can be sure that the telescope is not going to be hit in case of giving an opening command or a go-to over the specified percentage.

If the mount is parked there is no restriction to open or go-to commands. If the mount is un-parked and the position of the roof is below the specified limit, any open command or go-to command over the specified percentage will result in the roof open up to the limit (a 30% in the example).

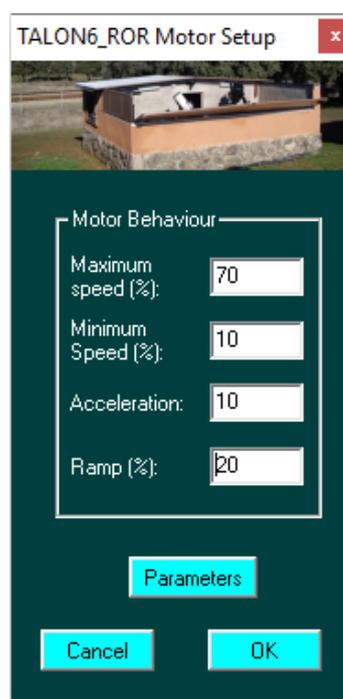
IP-Switch section

Here we find a single checkbox that allows to enable or disable the order to the IP-switch for switching off the selected equipment once the roof has been closed.



Clicking this button opens the motor setup window that allows defining the motor behavior.

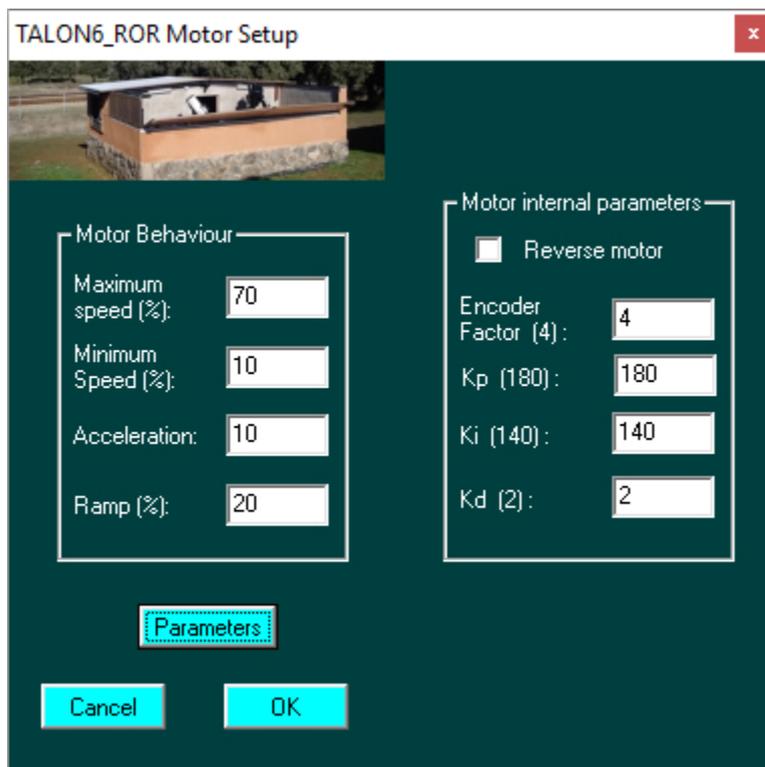
The first two lines are for defining the maximum and minimum speed for the motor in percentage over its absolute maximum speed (0 to 100). The maximum speed has to be higher than the minimum speed.



The third line defines the acceleration (0 to 100) and the fourth one defines how long is going to be the deceleration ramp before stopping (0 to 100).

The the fourth line defines the percentage of the roof travel that is going to run decelerating.

When **Parameters** is clicked the complete motor configuration window is opened:



In the right half of the window, the first line allows inverting the rotation direction of the motor. This would be needed depending on the way the user chooses to install the motor.

The second line defines the encoder factor of the encoder (2 or 4 depending on the version of the motor)

The third, fourth and fifth lines define the behavior of the PID filter that manages the power given to the motor. These parameters should not be changed without proper knowledge because wrong parameters can provoke instabilities in the roof movements.

Email Setup

Clicking this button opens the E-mail configuration window that allows the user to notify via E-mail when the roof is going to be closed due to a condition.

The checkbox of the first line establishes if messages are going to be sent. The rest of the lines define the email server, port, username and password of the email account, as well as the sender email address. The two following lines define the recipients (separated by coma) and other recipients that the user want to send a copy of the email.

The last line allows to define the name of the observatory. Especially useful in case of multiple observatories.

TALON6_ROR E-mail Setup

E-mail setup

Send E-mail on condition

SMTP Server: smtp.gmail.com

SMTP Port: 465

Username: pruebas@gmail.com

Password: *****

From: pruebas@gmail.com

To: pruebas@gmail.com

Cc:

Observatory ID: Name

Test Cancel OK

When all this setup is correctly defined and the checkbox checked the system will send a first email when a condition is raised that forces the closing of the roof. A second message is sent when the roof is finally closed informing of the status of the different sensors.

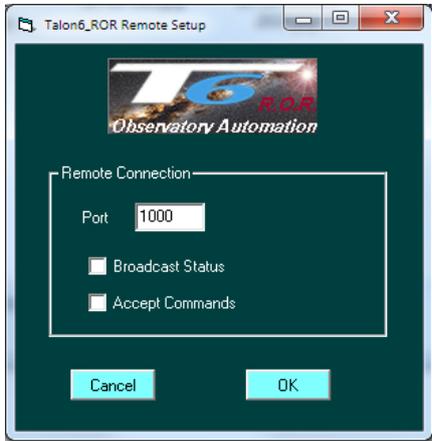
Autostart settings section.

Here we can establish that the driver will be started when windows starts and that automatically connects to the talon6 controller.

Remote Setup

Remote setup:

When Remote setup is clicked a new window opens that configures the system as a server for broadcasting the status of the Talon6 and even to allow remote control via internet.



In this window the socket port can be established. We can also configure the system to allow the broadcast of the status as well as to receive commands from a remote source.

There is another application that can run in a remote PC it is **T6R** that has a similar aspect than the driver interface and where the host and port of the Talon6 driver can be established.

Pushing connect the status can be seen in this remote interface and sine commands can be sent to the system.

This feature is still in development and its future use will be defined.

Talon6 controller keypad

It consists of three buttons:

Open: Orders to open the roof.

Stop: Orders the roof to stop moving.

Close: Orders to close the roof.

If the controller does not open the roof when the Open button is pushed, probably it is because there is a safety condition active from the previous session, for example the Cloudwatcher does not reset its condition relay when the session is closed. It will reset it when its program is run again or when it is powered down and then powered up.

In this case if you want to open anyway press first the Stop Button and the safety conditions will be disabled releasing in that way the open button.

Using the keypad is equivalent in some way to using the Open, Close and Emergency Stop  buttons in the driver. The difference is that pushing the Close button orders to close the roof without previously ordering the mount to park.

Other options



The Talon6 can perform, if necessary, general closures of roofs parking previously the telescope mounts in a set of observatories controlled by our system. Also, by order of the manager of the set of observatories, the roofs can be blocked closed and the running drivers disabled (all the operation buttons will remain inactive), individually or in general.

All this can be done in situ or remotely by simply using the MGM input in the controller prepared for this purpose.

Conclusion

Talon6, once parameterized, becomes a good ally for safety and comfort, working manually, automated and remote, helping our observatory to become a technologically advanced place placing it in the XXI century and providing the automation programs with an intelligent way of communication with our observatory allowing opening and closing it in a much safer way.

For any question please contact:

Antonio Pérez Ambite

aperez@fi.upm.es

Miguel Ángel García Borrella

miguelang555@gmail.com

Updated february-15th-2019

Some images from SPAG Monfrague:



Talon6 installed in the right roof of the observatory



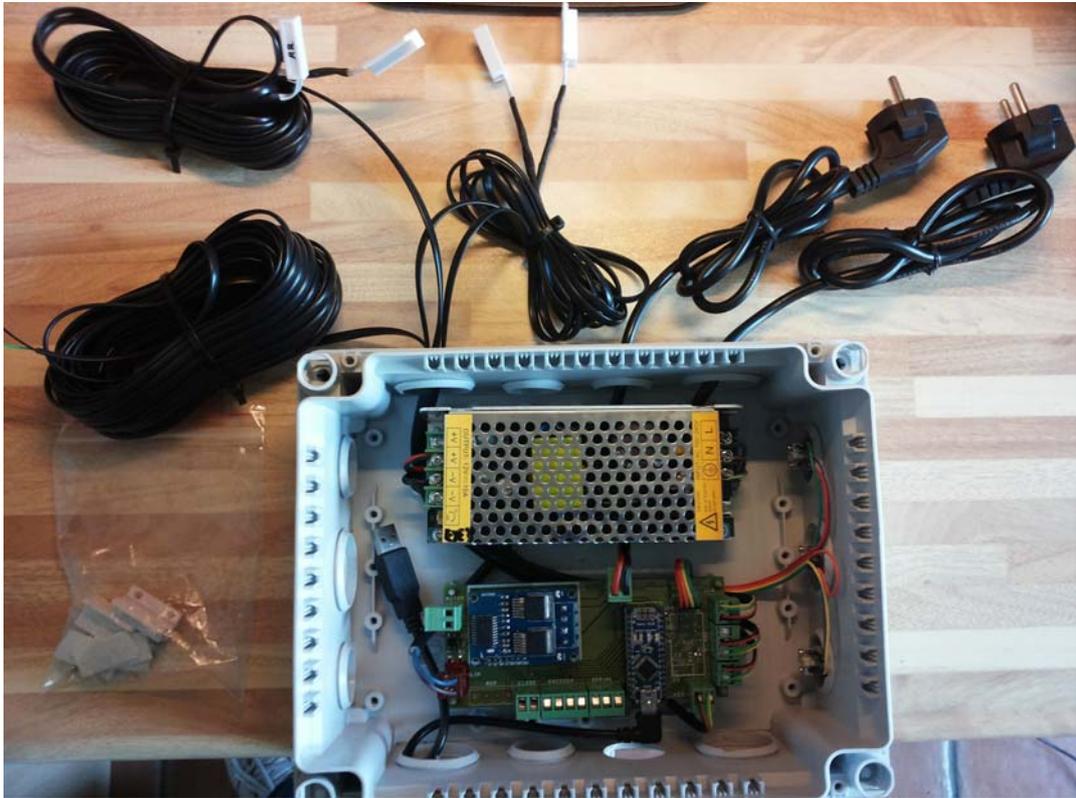
Talon6 installed in the left roof of the observatory



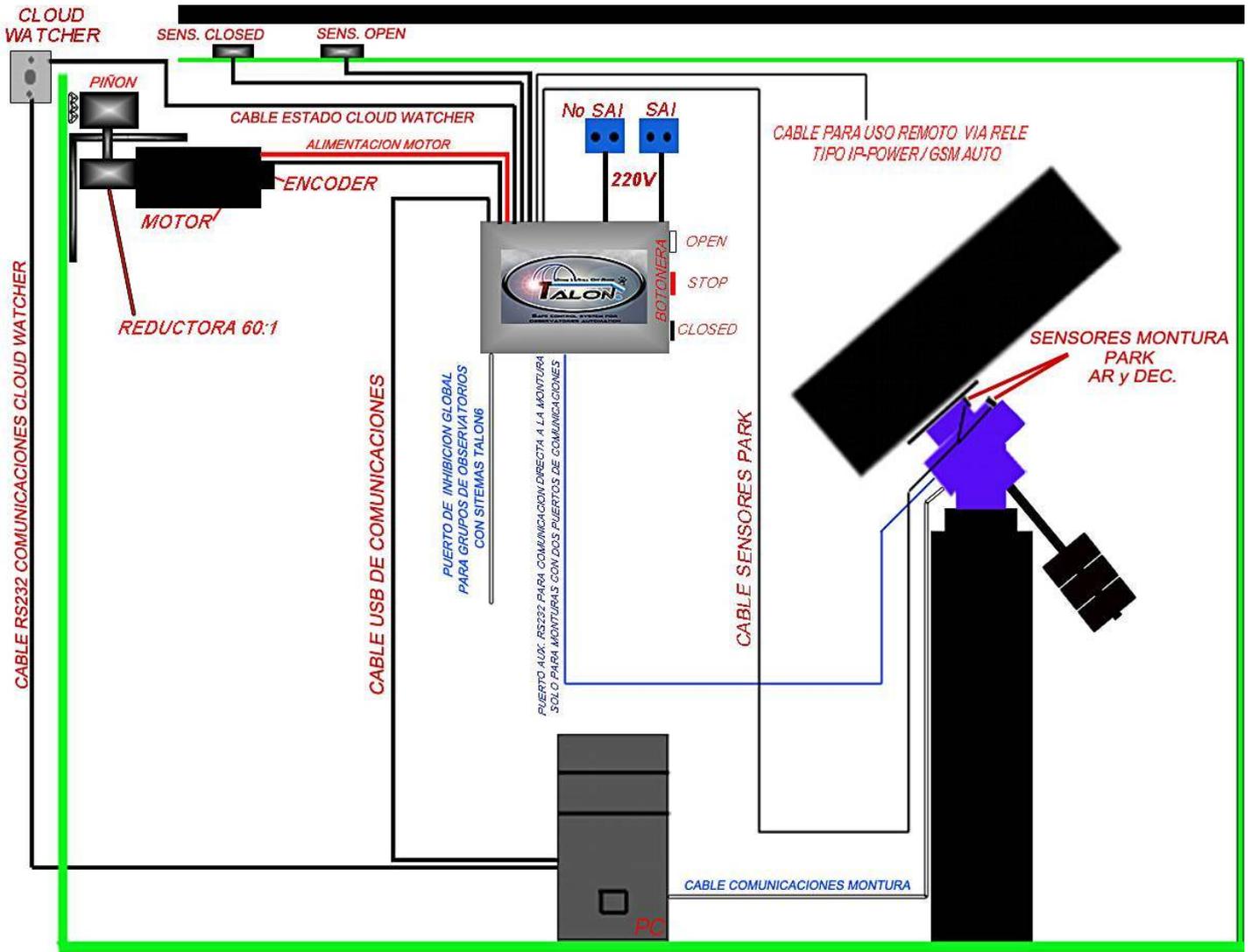
Motor and support with quick release system



Open and Closed sensors



Controller with finished internal wiring



Logic schematic of the Talon6 connections