

Self-Leveling Stow-Away Pool Table: Operation Manual

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ABSTRACT

The Self-Leveling Stow-Away Pool Table was designed to be a user friendly device that could be easily operated by a novice user through reading the operating instructions. It consists of a network of components which work together to achieve the desired goal. That goal is to allow the pool table to have a traditional look and feel while still being able to stow-away and self-level at the push of a button. Assembly of the product is not required from the user. The stow-away process is quick and easy; it can be done by a single user with help from the operation instructions. Likewise for the self-leveling feature, the user control interface makes the self-leveling process simple and intuitive. If any malfunctions occur with the system, the troubleshooting process consists of determining the source of the malfunction. The three main sources of malfunction commonly are the linear actuators, the pins on the dolly and the inclinometer. To avoid these malfunctions, regular maintenance of the system is highly recommended. This includes lubricating the moving parts, cleaning the entire system, and ensuring all bolts are secured. Replacement of most parts on the table only requires removing a few bolts. Parts such as the bumpers, the slate, and extra nuts or bolts can be easily sourced and quickly replaced. This product was designed for long term reliability, however proper upkeep and maintenance is still required to keep running at top standards.

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1. Introduction

The Self-Leveling Stow-Away Pool Table is the first of its kind. It has the full look, feel and functionality of a traditional, tournament regulation pool table plus the added benefit of stowing away, taking up less than 2 feet by 9 feet of floor space. This may be accomplished by a single user with a few simple steps placing the table in its stow-away position and rolling the table to the side. The table is also equipped with a self-leveling system which allows to the user to move the table to a new location and, with the push of a button, have the table adjust its playing surface to a level position to play pool.

Due to the size and complexity of this system, safely lifting, rotating and moving this pool table with only one person requires extensive mechanical assistance. Although this system was designed with safety as a top priority, dangerous situations can still occur if the system isn't operated properly. The user having no experience operating a system such as this should pay careful attention to the detailed instructions provided. The instructions detail everything that needs to be known about the system so that the user can operate the system in a safe and smart manner. Troubleshooting advice and routine maintenance instructions to maximize the life of the pool table and keep all features fully functioning.

2. Functional Analysis

The Self-Leveling Stow-Away Pool Table consists of many various components in order to provide for quick and easy functionality. These components work together to provide the three primary functionalities of the system: the traditional pool table function, the stow-away function and the self-leveling function.

2.1 Components

2.1.1 Traditional Pool Table Feel

The traditional pool table components serve aesthetic purposes as well as functionality to allow for the game to be played enjoyably. This includes the felt, slate, bumpers, pockets, moldings, and wooden leg housings. The felt is wrapped around the slate and provides the proper surface for playing the game of billiards. Felted rubber bumpers line the edges of the playing surface and are also used in the game to bounce the pool balls off of. In each corner and along the long side of the table are pockets made of nylon mesh which the player shoots the balls into during the game. Figure 1 shows the playing surface of a pool table which consists of the pockets, bumpers, felt and



Figure 1: The playing surface of a traditional pool table.

slate. Lastly, the moldings and wooden housing are equipped for purely aesthetic reasons. As will be explained next, the pool table consists of an unconventional inner steel frame for structural support. The moldings are used along the outside edges of the table to conceal the steel frame and likewise for the wooden housings around the legs.

2.1.2 Stow-Away System

The stow-away function components are what give the pool table structural integrity. This table is designed to be rotated 90 degrees into its stow-away position and then wheeled away to a new location. This requires the support system to be able to withstand the weight and moment of the 250 lb. slate at varying angles of rotation. This is vital to ensuring that this product is safe enough to be operated by a novice user. This table is built on a steel frame which is used to support the weight of the pool table at all times. The frame can be seen in Figure 2. The frame will hold the slate in place even while it is being rotated. This is made possible by clamping the slate between the bottom of the bumper and the top of the frame as illustrated in Figure 4. The four legs of the pool table also have inner steel frames which will house the self-leveling components and support the weight of the table. On each of the long ends of the frame are cylindrical “pin holes” which is where a dolly where connect in order to allow for the pool table to be rotated and wheeled to a new location. The dollies seen in Figure 4 each have three caster wheels which allow them to roll in multiple directions easily over different surfaces. A steel bar extends from the platform of the dollies and contains a pin to place into the pinhole of the table and rotate it 90 degrees into the stow-away position. They also contain a safety bar which stops the pool table from over-rotating and safely hold the table in position while it is being stowed away.

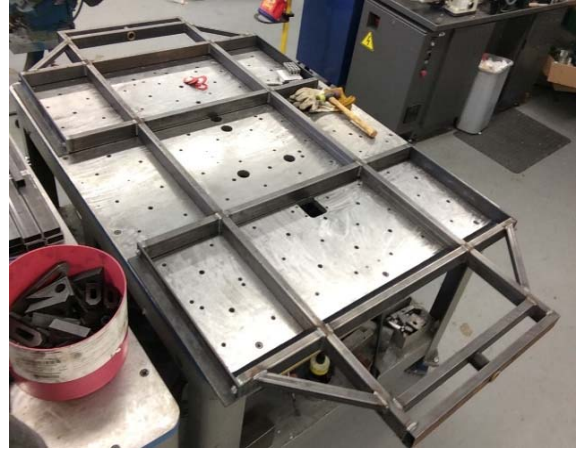


Figure 4: Steel frame that holds the slate of the pool table

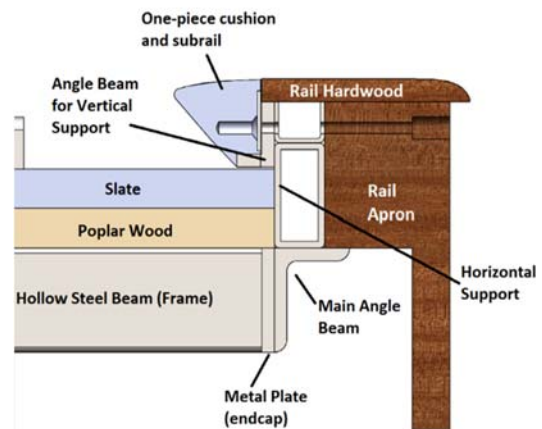


Figure 4: Section of the framing holding the slate and rail together



Figure 4: The two dollies rolled up to the pool table in order to attach and

2.1.3 Self-Leveling System

The self-leveling system uses an Orangutan X2 microcontroller which reads a signal from a 2-axis inclinometer. The microcontroller then sends signals to four Atmel VNH2SP30-E motor drivers which control four linear actuators located in the legs as shown in Figure 5. These linear actuators raise and lower the pool table. At the end of the linear actuators are the feet of the pool table which utilize press sensors to maintain contact with the ground. Each leg has a steel frame to house its linear actuator. A control panel with an LCD screen and three buttons are used to scroll through various options which allow the user to set the table to autolevel or manually adjust the table height and inclination. The table is provided already calibrated to level properly but it may be recalibrated if needed. There is also a power button and a reset button.

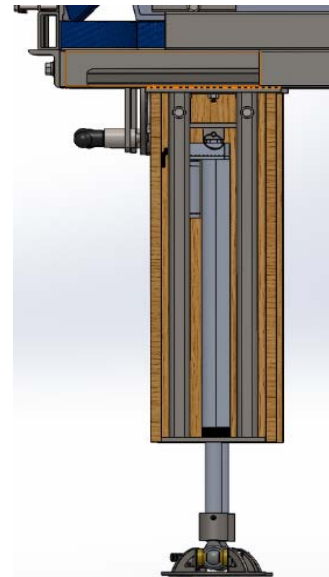


Figure 5: Leg design of the table with steel frame, linear actuator and steel foot.

2.2 Functional Diagram

Figure 6 shows a functional diagram of the system containing all the necessary components.

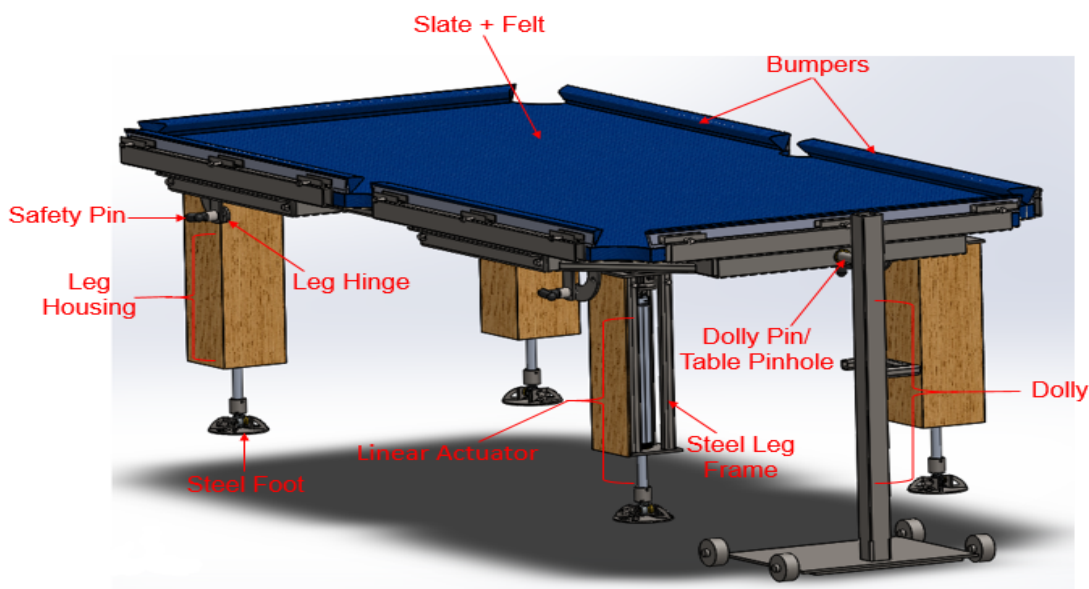


Figure 6: Functional diagram of the Self-Leveling Stow-Away Pool Table.

3. Product Specifications

Much consideration was taken in design to ensure that the product performs at top standards. The major components are the microcontroller, the linear actuators, the frame of the table, the carts and the slate and bumpers.

Table 1: Orangutan X2 specifications

Size:	3.00" × 1.86"
RAM Size:	16384 bytes
Program Memory Size:	128 Kbytes
Motor Driver:	VNH2SP30
Min/Max Operating Voltage	6 V/16 V
Max PWM Frequency:	19.5 kHz
Motor Channels:	2
User I/O Lines:	18

Table 1 shows the general specifications of the Orangutan X2 and all of the components that are included with it. It has dual VNH2SP30 motor drivers; when coupled with two more of the same motor drivers, the Orangutan X2 has the ability to control four motors at once. The microcontroller is connected to the 5 user buttons and the 20 character LCD screen as well as the four push sensors in the feet, the inclinometer, and an infrared range finder for setting the height of the table. Be careful not to connect the electrical system with a power source not comparable to the one provided or the system could be overloaded or underpowered to run the linear actuators which draw 3 amps each and may spike higher. They are strong enough to hold and lift 333lbs. each but without the right power source they will not run efficiently.

Along with the linear actuators, the frame of the table must be able support the weight of the 250 lbm slate plus the rest of the table while being rotated about its central longitudinal axis. This is why the frame, legs, and carts are made of steel.

4. Operation Instructions

5.1 Stow-Away Procedure

Before beginning the stow-away procedure, there are a few safety protocols that must be taken. First of all, remove all objects from the surface of the pool table. Second, choose an area which the pool table will be placed once in the stow-away position. Finally, make sure that the table will be able to fit. There must be a 29 inch wide and 70 inch tall clear path, free of any obstacles, for the pool table and dollies to travel along while being stowed-away.

The following steps are for placing the pool table into the stow-away position. To ensure safety, exercise caution and closely follow each step as directed:

1. Plug in the power and press the “On” button, select a manual mode, positive speed and then hold the actuate button until the table is raised so that the center of the pinhole is 32 inches above ground.
2. Roll the carts to each side of the pool table and check that the center of each pin is at the same height as the table pin holes.
3. Roll the dollies so that the pins go fully into the holes on the table and insert the pin lock.
4. Select a negative speed and hold the actuate button to retract the legs fully.
5. Rotate the table slowly until it comes in contact with the safety stops on the carts. Make sure that no one is in the way of the rotation including any of your own hands and feet.
6. Starting with top legs, pull the safety pin and push the legs inward until they are parallel with the table and the safety pin latches back into place.
7. Move the table to the desired location by grasping the column of the dolly at about the same height as the pin and pushing slowly.
8. To bring the table back out for play; perform the reverse of these steps.



Figure 7. Carts Aligned with Table

5.2 Controlling the height of the legs

5.2.1 Auto-Level

The following steps are for the auto-leveling feature of the table. Before beginning these steps make sure that all four legs of the table are locked in the folded out position and pointed towards the floor and remove any objects from the surface of the table.

1. Plug in and turn on the power. Select “Auto-level” on the control panel
2. Refrain from leaning or placing any weight on the table during the leveling process.
3. Once the table is finished leveling, make sure that it is actually level by testing with a bubble level or rolling a ball along the playing surface.
4. If the table is not level after repeated tries, the inclinometer must be recalibrated.

5.2.2 Inclinometer Recalibration & Manual Adjustment

Inclinometer recalibration should only be done if the auto-level function is malfunctioning. If issues persist after recalibration, contact the manufacturer for further assistance. The following steps are for the recalibration process.

1. On the control panel, select “Manual Mode.” This mode allows you to manually raise or lower the linear actuators. Select to control individual actuators or pairs of actuators.
2. Adjust each leg as needed until bubble levels indicate the table is level. Note that if the table is on carpet, this may have to be redone after it settles.
3. Allowing a pool ball to roll down a ramp and observing its path may be more accurate than most bubble levels. If such accuracy is desired, roll a ball from each side and raise the area of the table the ball curves toward.
4. Once the table is level, return to the main menu on the control panel and press the “Level to” button 5 times to set inclination of the pool table as the program’s new “level” position.
5. Manually controlling all four actuators at once allows for the height of the pool table to be adjusted but the DC motors in the actuators are not perfectly equal so the auto-level function should be used after the height is adjusted.

5. Troubleshooting and Regular Maintenance

The Self-Leveling Stow-Away Pool Table is designed for high reliability and long term usage. However, like with any product, the system can experience malfunctions. Luckily, these potential problems have been identified and there are troubleshooting steps to solve them. The most anticipated problem is a linear actuator malfunction.

If the linear actuators are not responsive to commands selected on the control panel, check underneath the pool table and ensure that the wire for the malfunctioning actuator is not damaged and is properly connected to the control box in the center of the bottom surface. Another issue could be that the motor for the linear actuator has burnt out. Burn out, means that the motor in one of the linear actuators has exceeded its limit of use and has been damaged. Typical signs of motor burn out are burning smell or the linear actuator becoming extremely hot. When this occurs, the best method of repair is to replace the linear actuator. Replacing the linear actuator is a complex process which requires professional help so contact the manufacturer for more information.

In order to keep the pool table and all of its components running at top standards, routine maintenance must be thoroughly conducted. Doing so will also ensure that the product is safe to operate at all times and reduce the risk of injury. Maintenance of the systems consists of three stages: lubricating all moving parts, inspecting for damages and electronic maintenance.

As mentioned previously, the stow-way process involves raising the height of the pool table and having rotate about the pins of the dollies. In order to prevent damages and ensure that the stow-away process is safe, all moving parts on the table must be regularly lubricated. This includes the pins of the dollies, the pin hole on the table and the shafts of the linear actuators in each leg of the table. The preferred lubricant to use WD-40 or any silicone based lubricant. Before lubricating any of the parts, make sure to take a clean rag a wipe all parts removing any dirt or residue which could cause friction when the system in use .For the pin holes, take a clean rag and spray it with lubricant and evenly wipe the inside surface of the hole. For the linear actuators, use control panel to raise the table to the maximum extended height and spray and wipe the exposed shaft of the actuator.

Having the table in the stow-away position, on the dollies, for an extended period of time can lead to damage of either the pool table or the dollies. The dollies and frame of the table were designed to handle the stresses caused by the heavy weight of the system, however imperfections in the

material can lead to small damages which may propagate over a long period of time. It is recommended that the pool table and dollies are inspected for any possible damages, at least once a month.

The self-leveling system consists of a many electrical components which can be prone to damage if proper care is not taken. Maintenance of this system will ensure a long product life of the system. Most of the electrical components are housed in a box located under the surface of the table. However, wires are needed to run to each of the legs and to a power outlet when the self-leveling system is in use. Because of this, be wary of these wires becoming tangled or damaged when moving the table. Also, the four linear actuators each contain a motor which can be burnt out through overuse of the system. If, while operating the linear actuators, the motors become extremely hot or emit a burning smell, halt operation immediately to prevent damage to the motor or a possible fire.

6. Spare Parts

The Self-Leveling Stow-Away Pool Table was designed with the user in mind as far as daily use goes. It is a complex system so it is provided without assembly required but should any of the parts be damaged many of them can be easily replaced if necessary. This includes the bumpers, the slate, and many of the nuts and bolts. If a bumper needs to be replaced, remove all of the bolts from the side panel and remove the panel along with the bumper. The bumpers used in the Self-Leveling Stow-Away Pool Table are made by "Replacement 7' Valley Coin-Op Rails". The bolts of the side panel are also readily available and easily replaced.

Similarly, the bolts for the feet are also easy to replace by simply unscrewing, while the table is in the stow-away position supported by the carts. Spare padding for the feet are included with purchase of the table. In order to replace the padding simply remove the old padding, peel the film off of the new padding and place it on the feet, aligning the hole in the padding with the switch on the foot so that the switch is not obstructed.

The slate of any table is often custom cut by professionals. The slate on the Self-Leveling Stow-Away Pool Table is 83in × 43in and 0.75 in thick. A sheet of birch wood with the exact same dimensions is placed under to slate for added support. In order to replace the slate, all of the bumpers and side panels must be removed by removing all of the bolts from the side panels. Once this is done, the slate and wood can be lifted out of the table and replaced. It is recommended that the wood is glued onto the slate with an even layer of silicone glue.

References

[1] "Prime-Line 1/4-20 Carriage Bolts with Nuts-GD 52103 - The Home Depot." *The Home Depot*. Web. 29 Mar. 2015. <<http://www.homedepot.com/p/Prime-Line-1-4-20-Carriage-Bolts-with-Nuts-GD-52103/202633663>>.

[2] NEED TO INCLUDE LINKS TO SITES FOR MATERIALS – BUMPERS, SCREWS ETC.