Servo Systems Documentation

Lyric's *A Christmas Carol*

Lyric Theatre of Oklahoma

Drafted by C. Augustus Mathews, Winter 2023

IMPORTANT DISCLAIMERS

- ***READ THIS GUIDE CAREFULLY BEFORE INSTALLING OR OPERATING.***
- ***DO NOT HAVE ANY PERSONAL ITEMS OR BODY PARTS IN OR AROUND THESE MECHANISMS DURING OPERATION. THESE ARE STRONG MECHANISMS AND WILL DESTROY OR INJURE WHATEVER MAY BE IN THEIR PATHS.***
- ***IF ANY SERVOS ARE UNPLUGGED, ENSURE THEY ARE PLUGGED BACK INTO THE CORRECT SLOT ON THE CONTROLLER. IF THEY ARE NOT, YOU RISK SHEARING THE TEETH OFF OF THE SERVO HORN, RENDERING IT USELESS.***

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Servo Extension Cable

YXQ 1M Servo Extension Cables (Found Here)

Servo Travel Tuner

ServoCity Servo Travel Tuner (Found Here)

Window Servos

BETU 270° Digital Servo (Found Here)

Clock Servos

ServoCity Multiturn Digital Servo (Found Here)

Steel Servo Horns

Just ‘Cuz Robotics Steel Servo Horn (Found Here)

Servo Bracket

JINOARC Aluminium Servo Mount Bracket (Found Here)

Window Mechanism Arms and Hardware

- Machine screws are all #4-40 Machine Screws (w/ nuts for all except for those on the servo horn)
- Arms are all cut from steel (⅛” thick, ½” wide, 6” long) .
    - On the active mechanism (*i.e.,* utilizing a servo), there are two arms. One connects the servo horn to the central pivot. Another connects the central pivot to the dual L-bracket hinge. *(See Fig. 1 and Fig. 2 for an example of this mechanism)*
    - On the passive mechanism (*i.e.,* utilizing no servos), there are two dual-bracket hinges and a central pivot point. Similarly to the active mechanism, there are two arm connecting these points. *(See Fig. 3 for an example of this mechanism)*
- Hinge is made from two L-brackets mirroring each other and straddling the arms. L-brackets are ideally ¾” L-brackets, but 1” brackets will work equally well.
- The bolt of the central pivot and the hinges are held in place by Gorilla Glue so as to not allow it to unscrew itself during operation. Any super glue that can bond metals will do.

- The servo is held to the frame adjacent to the window shutter via a servo mount. *(See Fig. 4 for an example of the mechanism attached to the frame)*
- On the small window, there is one active mechanism at the top of each shutter and one passive mechanism at the bottom. *(See Fig. 5)*
- On the tall window, there is one active mechanism at the center of each shutter and two passive mechanisms— one above and one below the active mechanism. *(See Fig. 6)*

Clock Mechanism

- The clock itself is an LED tape lightbox.
- The clock face is made of plastic; a hole is drilled in the center of the face. *(See Fig. 7 & Fig. 8)*
- The back has a hole cut out for the LED Tape power and a hole in the center for the servo to reach the clock face. The servo is attached via woodblock and bracket to the back facing.
- The mechanism is fabricated like so:
    - The servo's steel horn is ground down to where it is basically just the ring around the servo teeth. It is then attached to the servo teeth.
    - Two ¼" nuts, held in place by allthread rod, are welded directly to the horn. It is CRUCIAL that the allthread is not welded as well. It MUST be removable. It is also crucial that the nuts are as centered as possible.
    - The servo is mounted on a bracket, then that bracket is mirrored by another bracket, which is then attached to a block of wood, which is attached to the backing of the clock. *(See Fig. 9)*

Controller and Programming Notes

- There is one controller per window, and one for the clock as well. The windows each take two DMX addresses, while the clock needs only one.

- Each servo should be patched as an Elation Barndoor.
    - 0 will represent closed, while FL represents fully open.
    - Travel limits, servo speed, and servo acceleration are programmable in the controller themselves. Reference the ServoDMX manual, found on the page linked on **Pg. 2**, can provide more detailed instructions regarding this process
    - For our production, I will have tested and set limits and parameters prior to installation. Please let me know if the following parameters need to change.
        - SPEED: 3/16 (~19%)
        - ACCELERATION: 16/16 (100%)

- The window controllers controls two servos each.
    - The first servo matches the controller's DMX address. The second will be the address that immediately follows, *e.g.* if the controller's DMX address is 1, the first servo will be Addr. 1 and the second will be Addr. 2.
    - Looking at each window from behind, the left shutter is moved by servo one and the right shutter is moved by servo two.

- The clock controller controls one servo.

- The small window controller's DMX Addresses are Addr. 129 and Addr. 130.

- The large window DMX Addresses are Addr. 131 and Addr. 132.

- The clock's DMX address is Addr. 133.

- The multiturn clock servo does not move in even increments (*i.e.*, you do not have a set ratio of input:degrees). Patching the clock to a scroll wheel will be useful for making accurate adjustments.

REFERENCE FIGURES

Fig. 1: Active Window Mechanism from Above

Fig. 2: Active Window Mechanism from Below

Fig. 3: Passive Window Mechanism

Fig. 4: Active Window Mechanism
Servo Mounted on Window Frame

Fig. 5: Small Window Setup
All writing except "Top" is irrelevant. Ignore it.

Fig. 6: Tall Window Setup

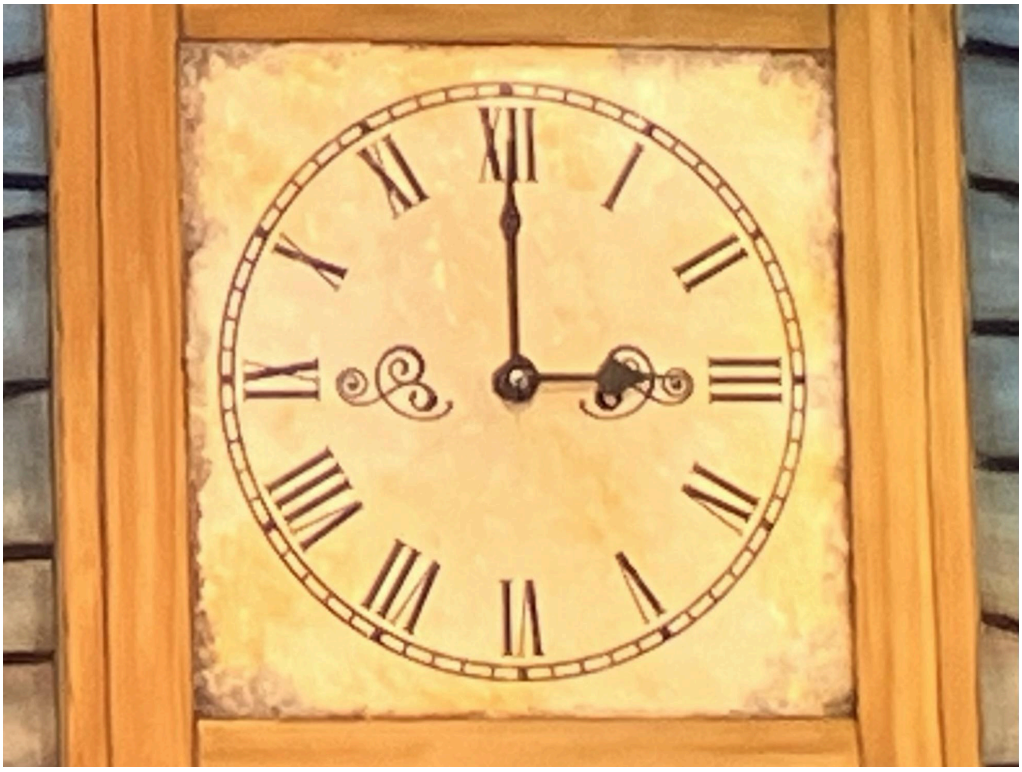

Fig. 7: Clock Face (Exterior)

Fig. 8: Clock Face (Interior)

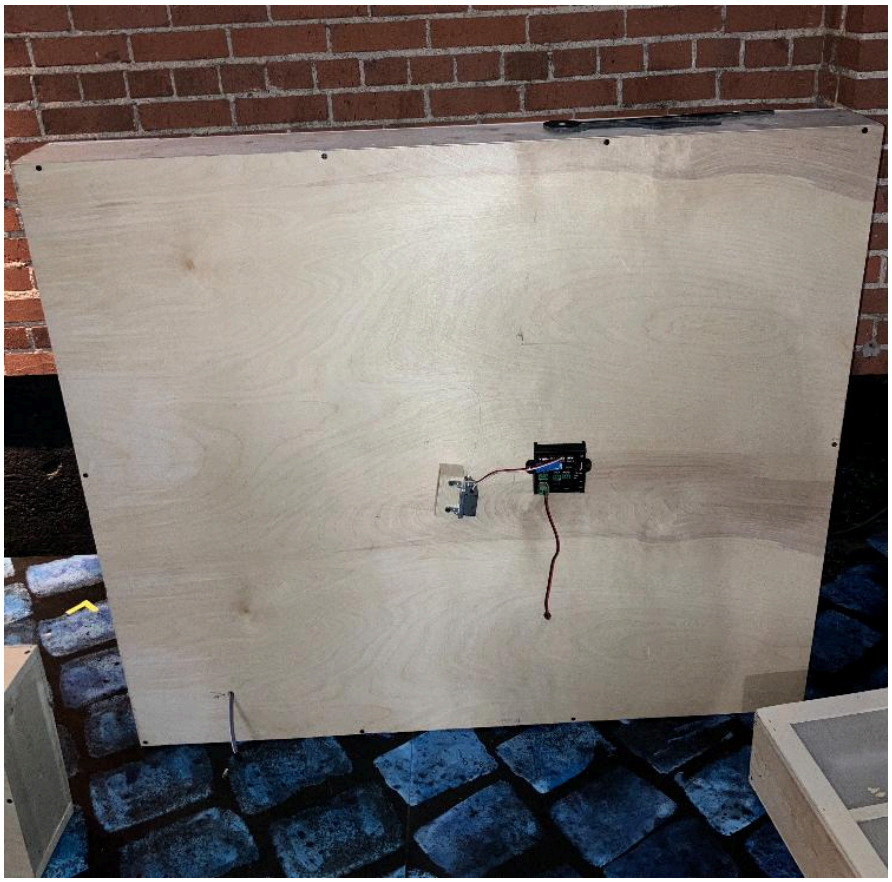

Fig. 9: Servo and Controller Attached to Clock Backing