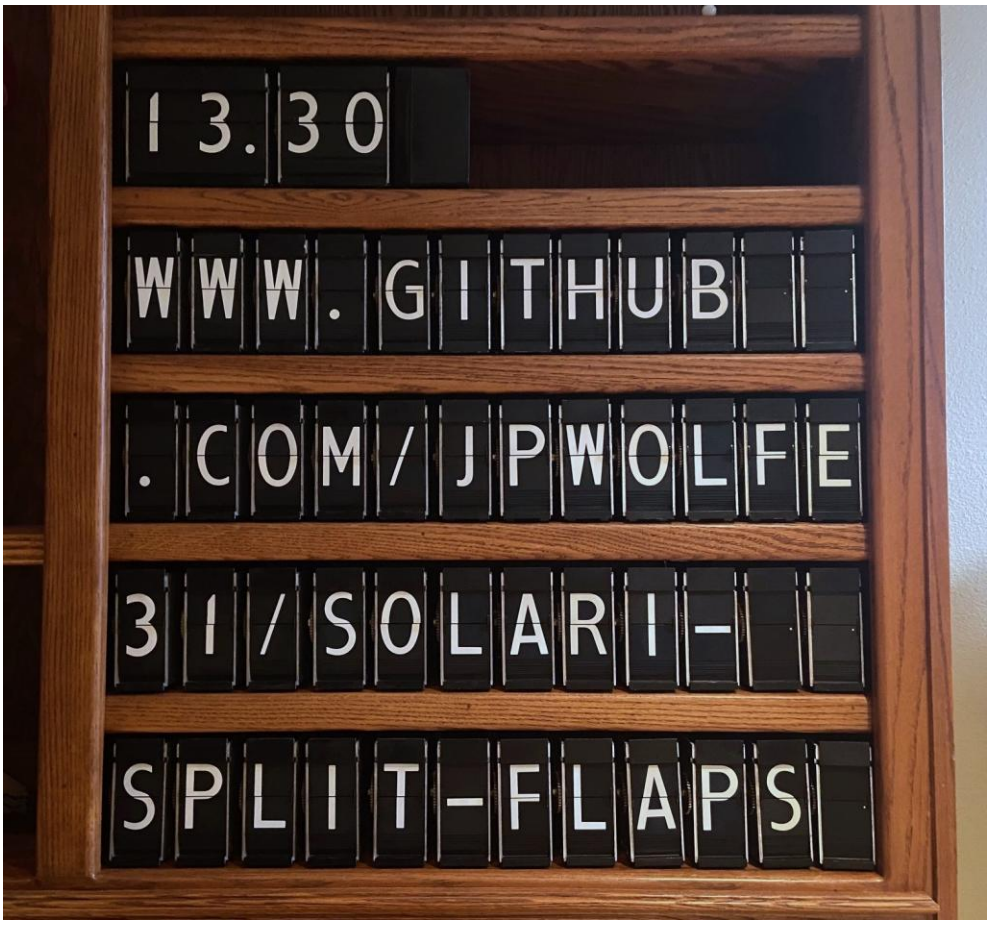
Split Flap Display Build Information

The split-flaps were acquired on eBay in April of 2023. We were told they were installed at an airport in the 1960s and removed about 20 years ago. This represents a small portion of the original display. The electronics that control the display are new and contained in the black box next to the time display. To see the display in operation go to https://www.youtube.com/watch?v=Qq5hUmP4TP0.



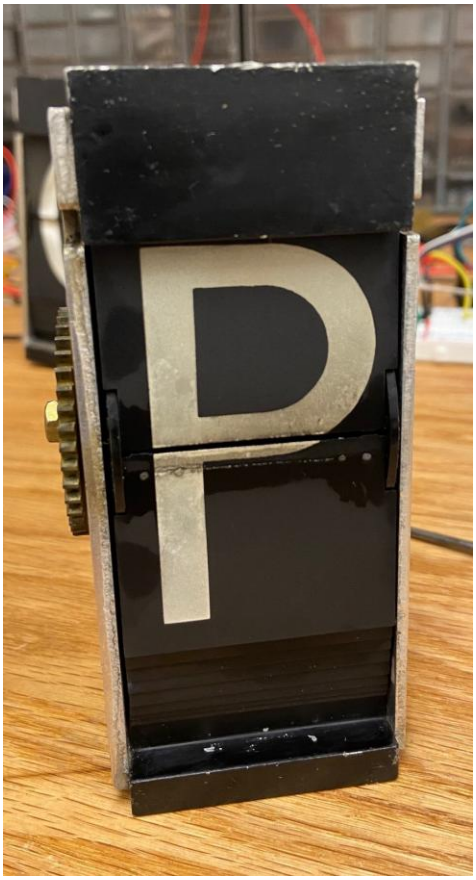
https://github.com/jpwolfe31/solari-split-flaps

These are the medium version of the Solari units and have a letter height of 2 3/8 inches.

Solari also made small and large versions, versions with more than one character per flap (up to entire city names) and versions having custom flap designs. See the uploaded Technical Description documents for more information.

The motion sensor detector that is used to activate the display is located on a shelf above the display.

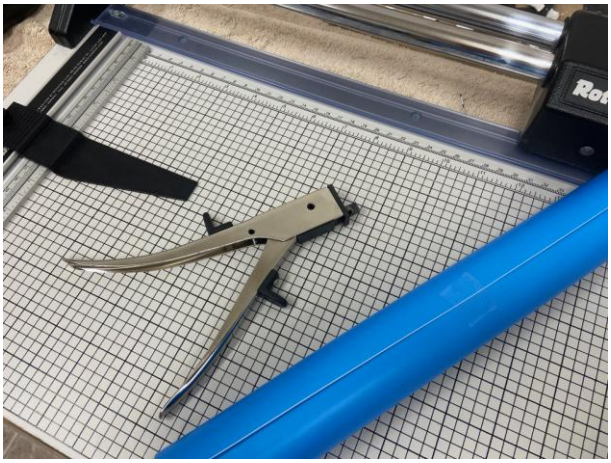
When we received the units, they were quite dirty.



We found the best way to clean the units was with 409. We removed all of the flaps from each unit, cleaned them with 409 and a magic eraser and then soaked them in full strength OXY Clean for 10 minutes or so to remove any yellow staining and brighten the white characters. It took about one hour to clean each split flap.

409 in left tray. Oxy Clean in right tray. The normally closed tweezers hold a piece of the Magic Eraser.

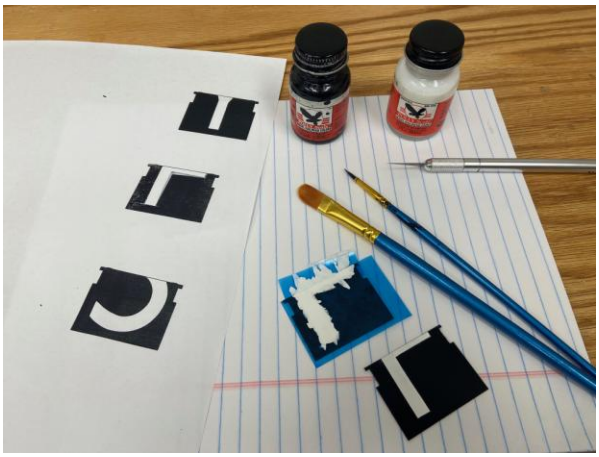
Two flaps were missing and were recreated using 20 mil (0.54mm) black pvc sheets purchased on eBay.



A rotary trimmer cut each flap to size, and a nibler made it easy to cut the indents in the flap sides. Exacto knives work too.

Blue stencil material was used to reproduce the letters. We copied the flaps first, and then using these copies, placed the stencil material on top and cut out the letter with an exacto knife.

The stencil was placed on the cut out blank flap and white paint was pooled into the letter area. It took two coats using this pooling method. To clean up, an exacto knife was used to gently scrape off any white paint that flowed under the stencil.

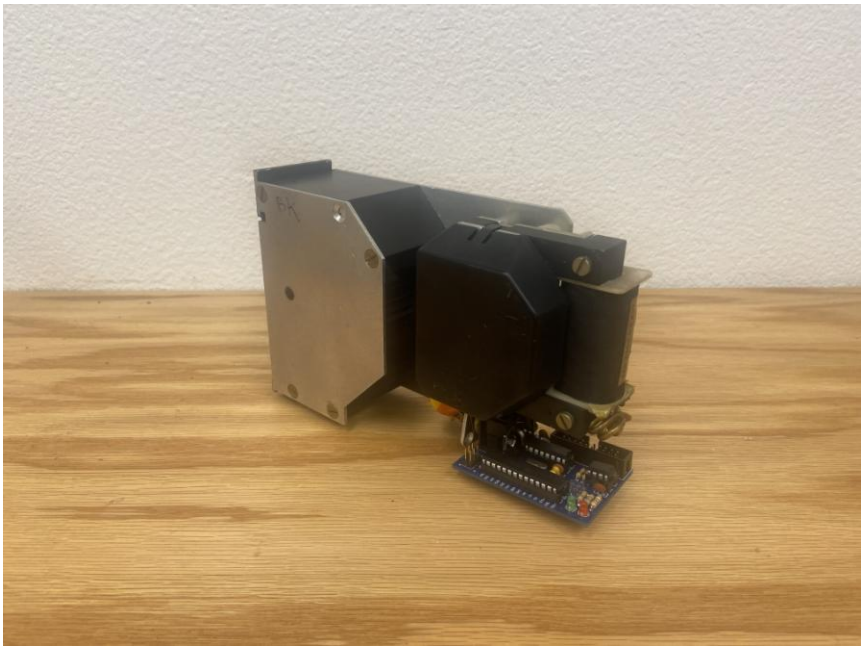


One side of the bottom F Flap being recreated.

The paints used were Polly Scale - Water Based. The white paint is Reefer White and the black paint is Engine Black. The white paint was used for the letters of course and the black paint was used to lightly touch up the chipped paint on the outer housing of the split-flaps as needed.

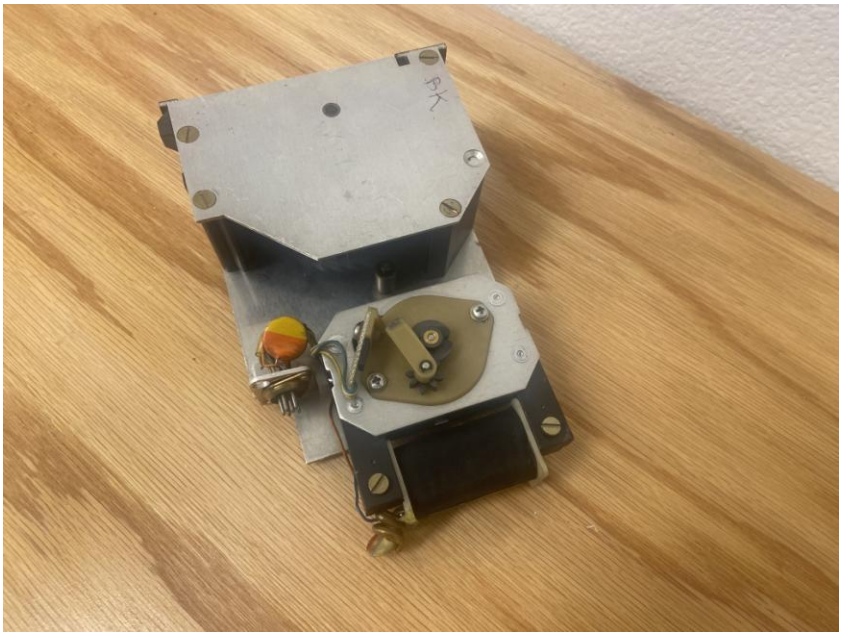
Photos of a typical medium Solari split flap.

The home and index sensors are under the black plastic cover at the rear.

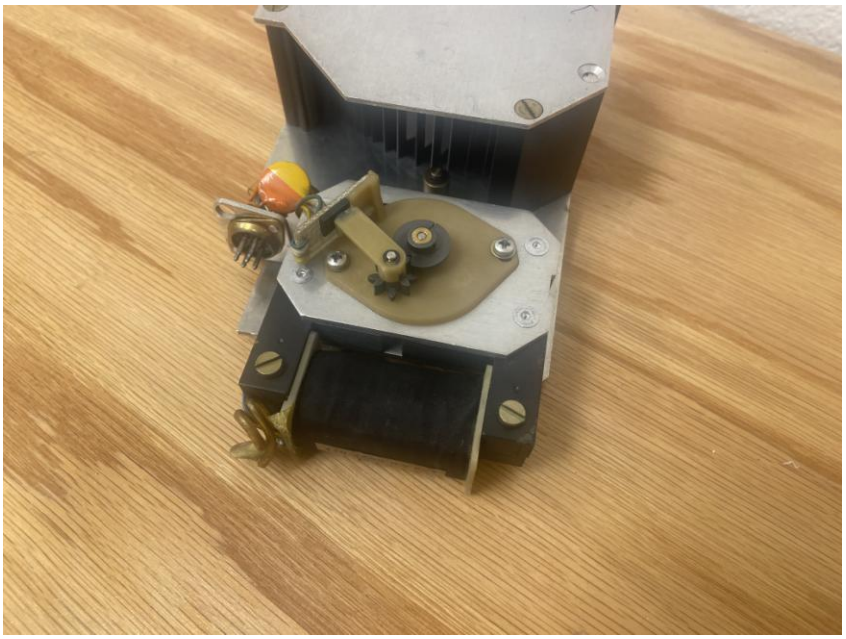


Remote board attached to split flap bottom DIN6 connector.

Gear drive between the stepper motor and the flap wheel.

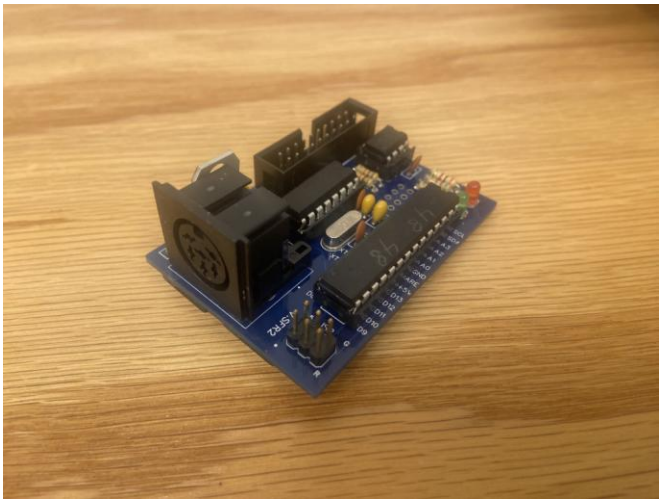


Cover removed showing the home sensor mechanism (in the number 3 position). The index sensor is located under the aluminum plate that holds the home sensor mechanism.



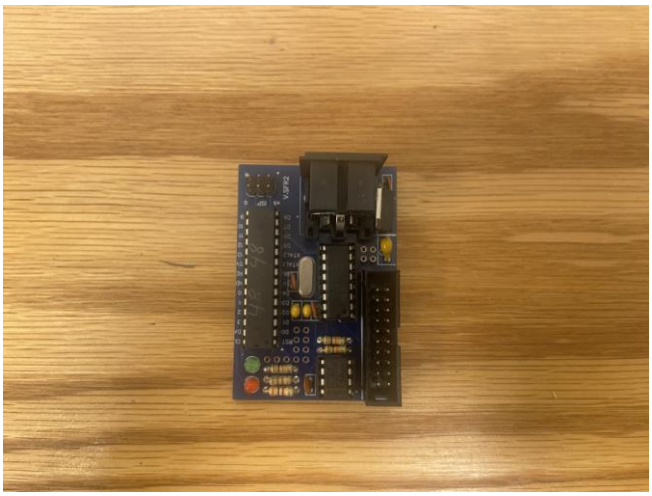
Home position with the magnet directly over the Hall sensor.

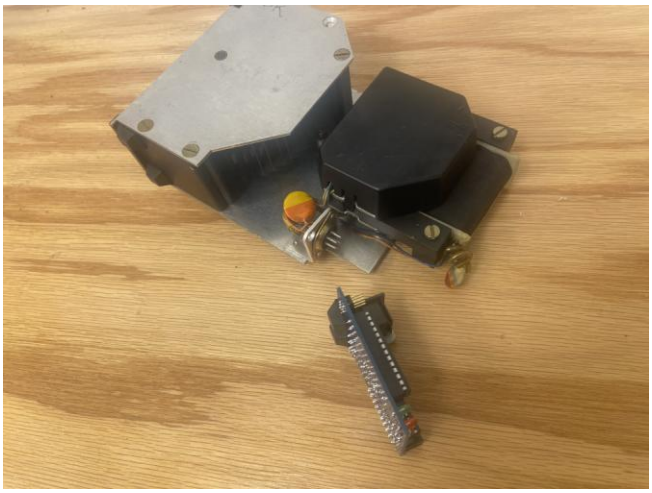
Two letter time units. Minutes are in 5 minute increments since the number of flaps per unit is only 40. Units that have more than two characters per flap usually have two motors side by side working in parallel.



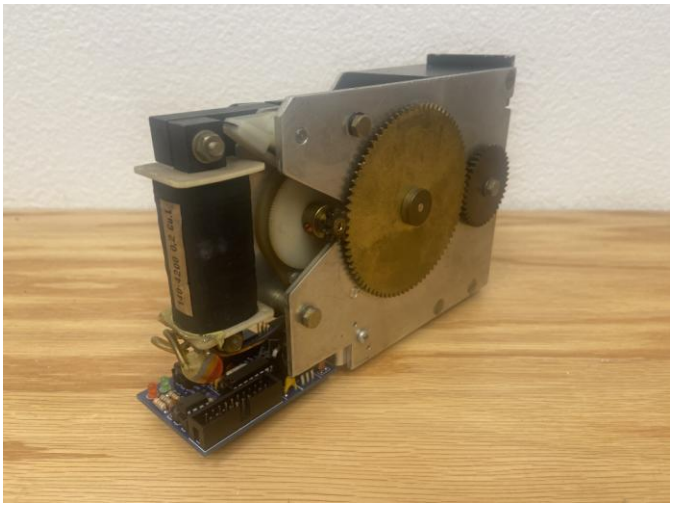
Remote board plugs into the split flap DIN 6 connector.

Each remote board is controlled by an Atmega 328P. We used a USB Tiny ISP 6 pin programmer and the ISP header on the board to first install the default Arduino bootloader which sets the fuses for 16MHz operation and then upload the actual program that replaces the bootloader.

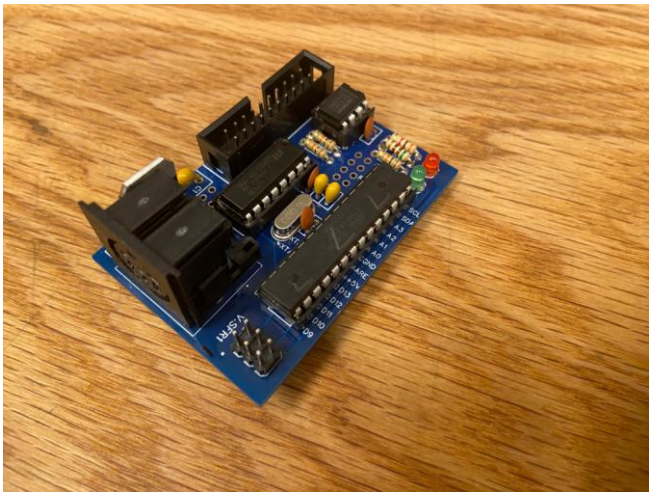




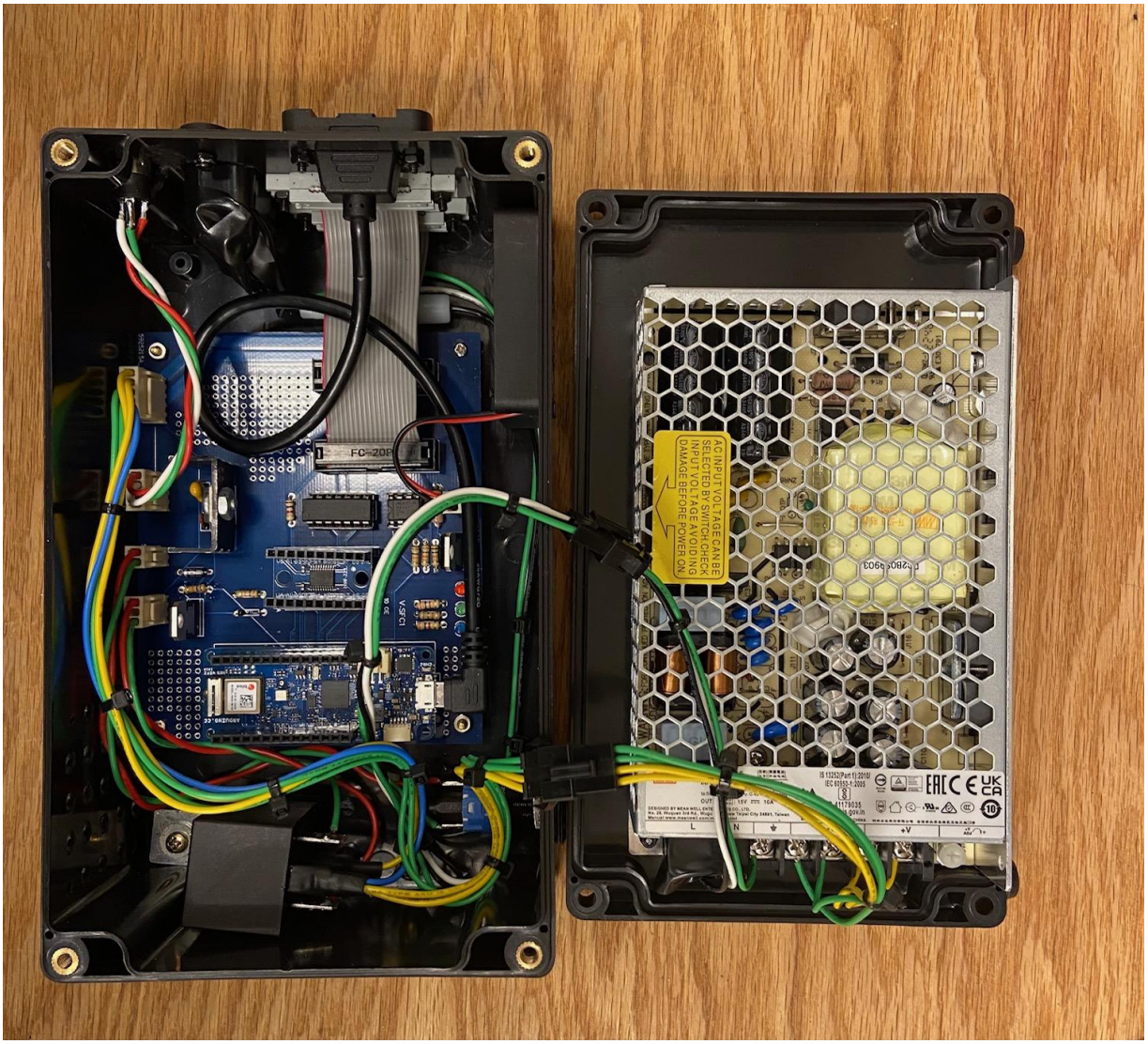
Four rubber feet hold the split flap upright on the shelves.



A 20 pin ribbon cable connects the split flaps in series. It provides 15 V power and communication.



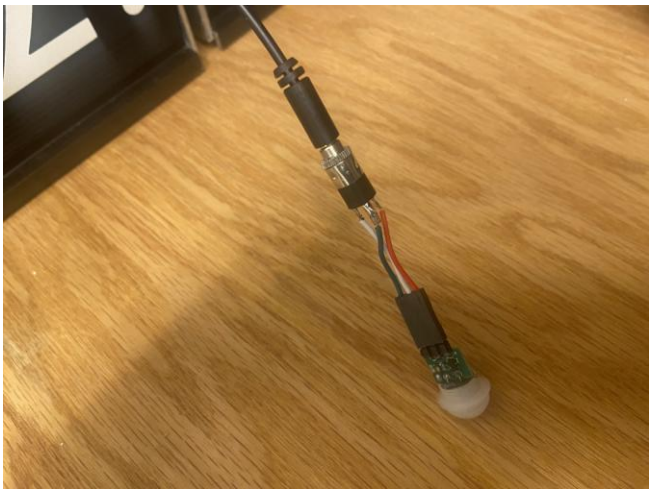
Controller box



The 15 volt 10 amp power supply is on the right attached to the case lid. The relay is shown at the bottom of the case and removes power to the split flaps after 10 minutes of non-use to conserve power. The 50 units draw between 5 and 8 amps. A fan on the top side of the case is controlled by a thermistor and cools the box as needed. An Arduino MKR WiFi 1010 operates the system. This can be programmed with a USB cable connected to the rear of the Box.

The specs that we acquired later stated that the operating voltage of the Solari split flaps was 24 volts. Designs by other individuals that we reviewed prior to that time used 12 volts. We found that 15 volts worked better by providing a bit more kick. It also still enabled the generation of the 5 volt supply on each remote board using a 7805 TO-220 device without the need for a heat sink. At 15 volts, each remote board draws approximately 100 ma when idle and 150 ma when flipping.

The Split Flap BOM lists the components used and acquisition source for the remote board, the controller board and the controller box.



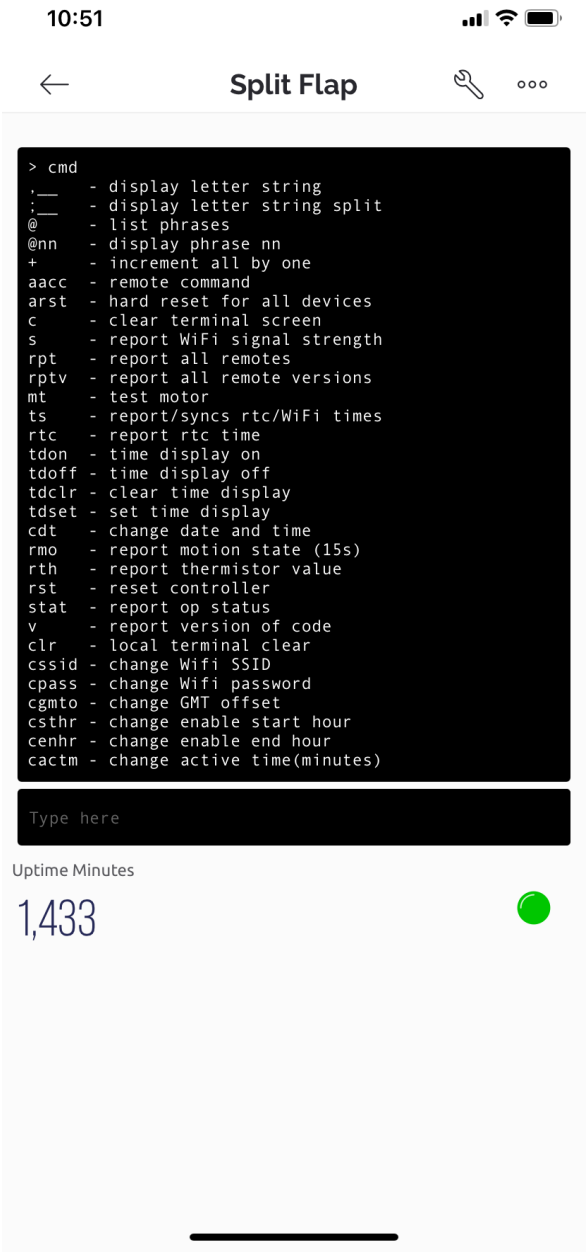
Motion sensor attached to stereo mini plug cable.

Rear of box showing 20 pin connectors in series,
USB connector for programming, AC power connector
and stereo mini plug for connecting motion sensor.

Power button and fan air outlet on top of box.

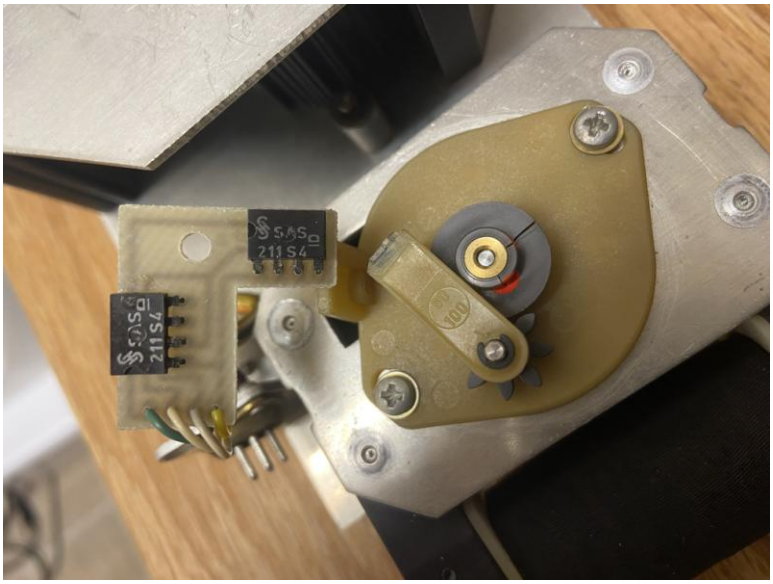
Bottom of box showing air inlet and rubber feet.

A Blynk mobile app controls the display through terminal commands.
A blinking green LED shows wifi connection status.

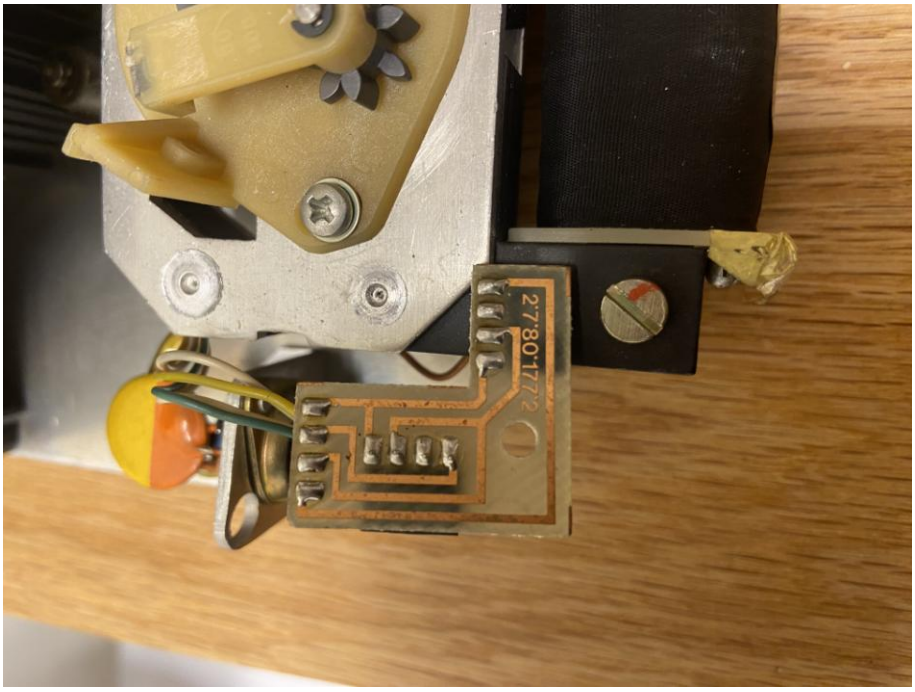


See controller code for full description of commands.

The home position can be adjusted by loosening the set screws on the shaft connector.

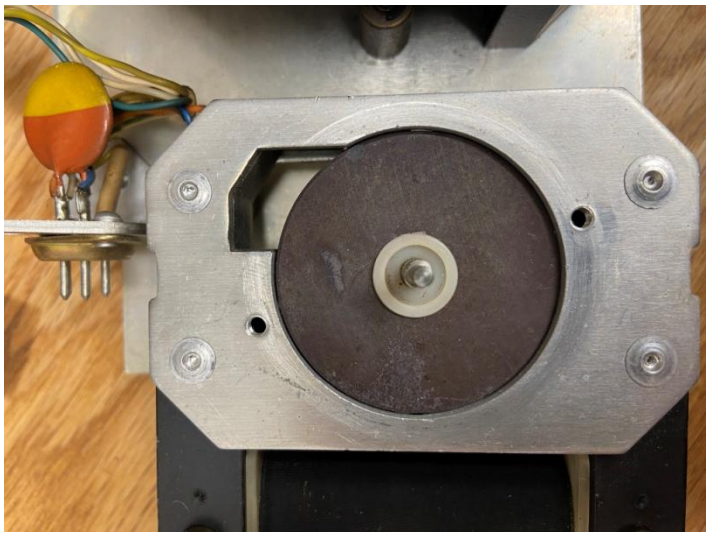


The split flap circuit board has an external hall sensor (left) for the home position and an internal hall sensor (right) that slips into the cutout in the aluminum plate under the home sensor mechanism when the board is attached in position with a screw.

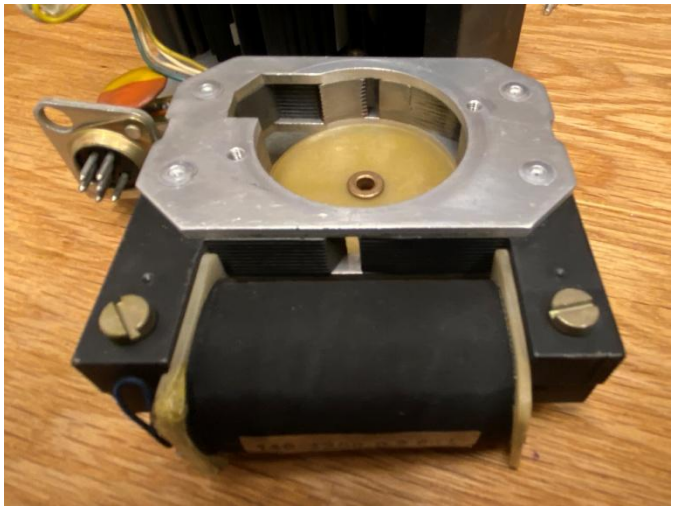


Rear side of board.

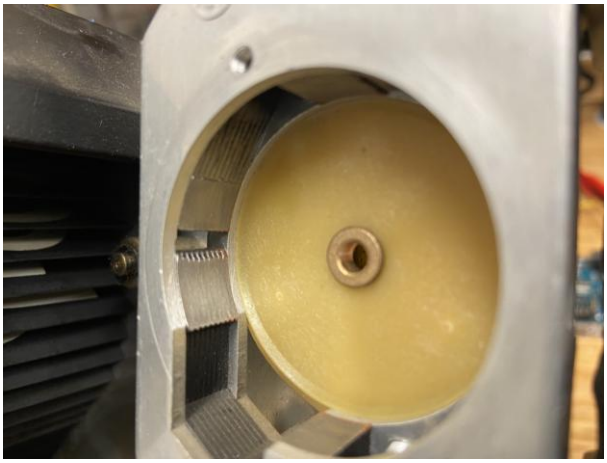

Home mechanism removed. It also holds one side of the shaft of the permanent magnet rotor.



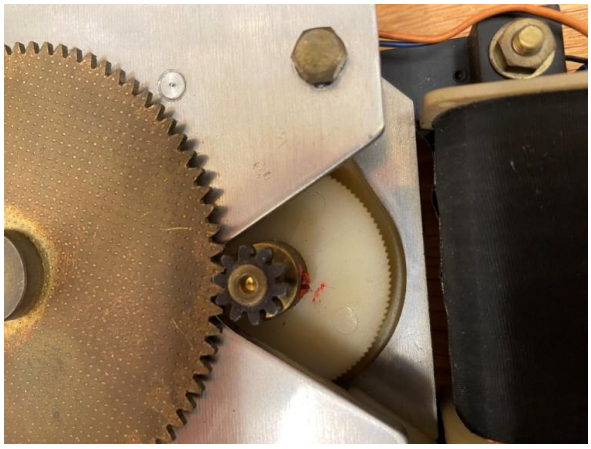
The split flap has a permanent magnet rotor. Part of the circuit board that holds the hall sensor for the Index position inserts into the space to the left of the rotor. The rotor has segments around the perimeter with alternating magnetic polarities - five north, five south. Four rotations run through all 40 of the flaps. The hall sensor for the Index activates every other segment or five times per rotation. An Index position also coincides with the Home position



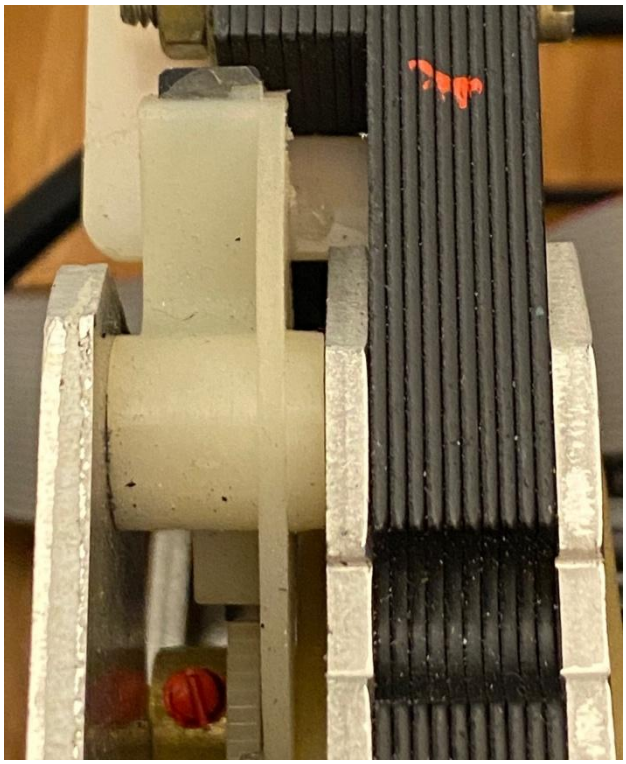
The electromagnet is covered by cloth and turns the permanent magnetic rotor one position for each reversal of polarity of the electromagnet. A L298D is used to reverse the 15 volt polarity 10 times per rotation.



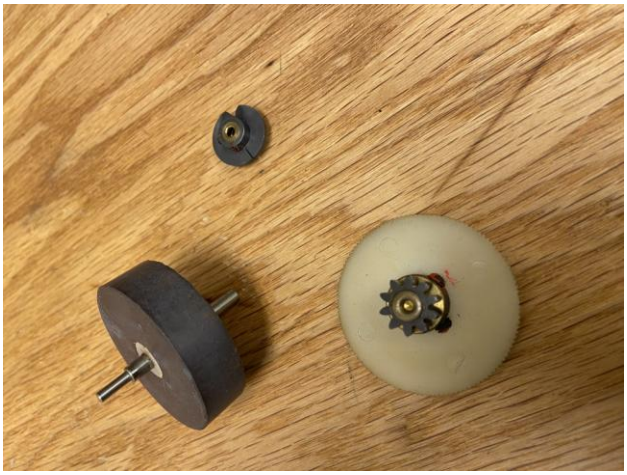
With the permanent magnet rotor removed, a small bar magnet has been attached showing the polarity at one point on the rotor. There are five positions with this polarity around the rotor that alternate with five positions with the opposite polarity.



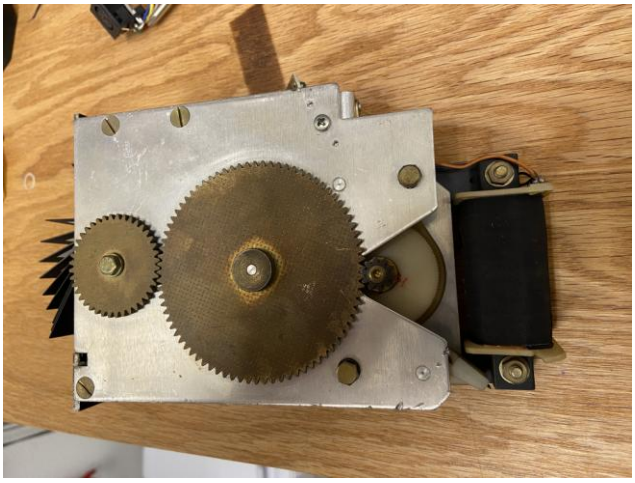
The other side of the shaft of the magnetic rotor attaches to a gear that drives the gear mechanism and flaps. The plastic sprocket wheel shown under the small gear works with a strip of spring steel that touches the sprocket teeth at an angle (not shown) to prevent the motor from turning backwards.



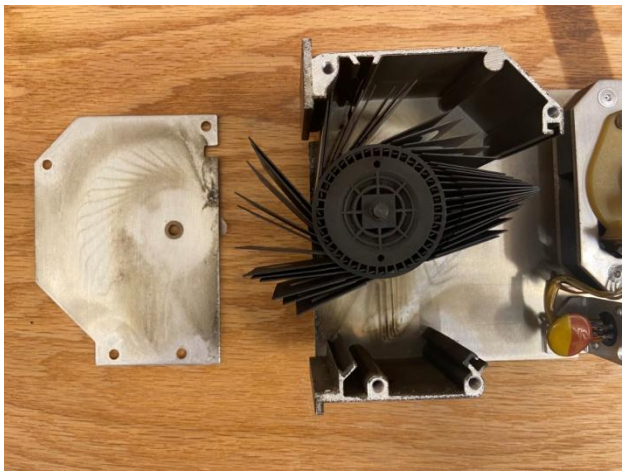
The strip of spring steel touches the sprocket teeth at an angle (above the red set screw).



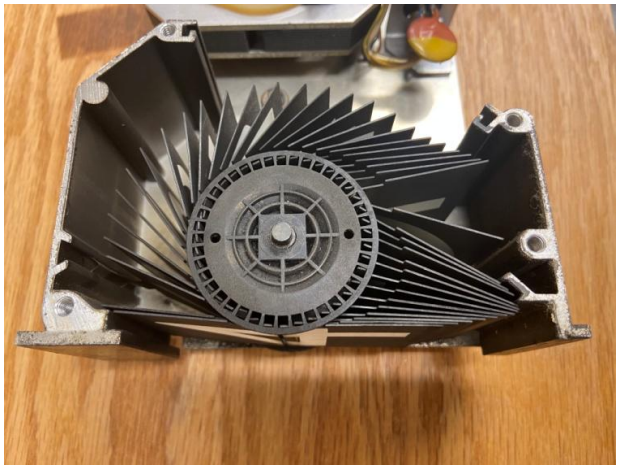
Permanent magnet rotor, home position shaft gear and rotor shaft gear attached to plastic sprocket that prevents backward rotation.



Spool gear, large intermediate gear and rotor shaft gear.



Split flap with flap cover removed.



Side view showing flap arrangement.

A flap can be removed from the front of the unit by slightly bending it to pull one of the side tabs off of the spool. The unit does not need to be disassembled to remove and replace the flaps.