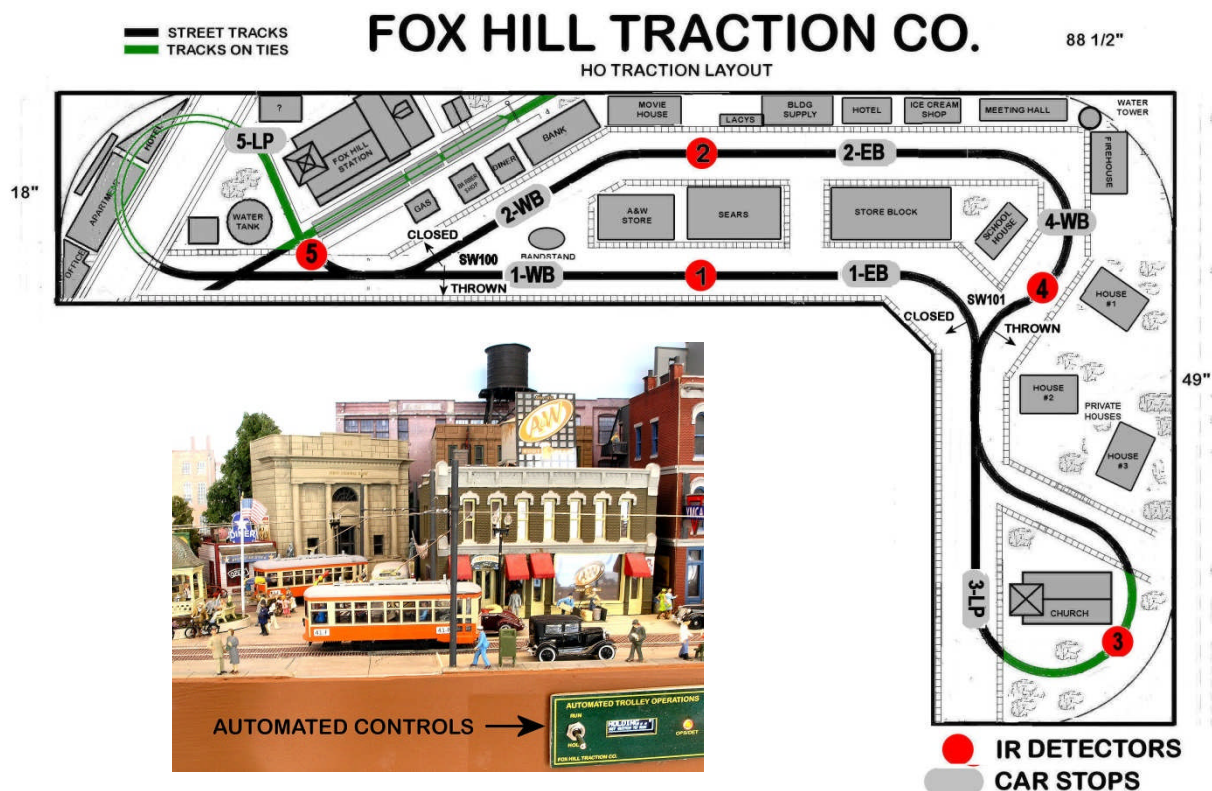


## AUTOMATED TROLLEY OPERATIONS

By Fred Miller, MMR

The original article appeared in the Sept 2019 issue of the East Penn Newsletter. It is used here with permission.

I enjoy running my DCC powered streetcars around my small HO Scale layout with a throttle or my K-1 Controller (see another article about the K-1 Controller). However, I find it is also fun to sit back and watch multiple cars maneuver through my urban and suburban streets without my hands-on participation. The combination of DCC and Arduino micro-controllers makes this feasible. My DCC system and decoder equipped streetcars are based on Digitrax LocoNet. Readily available software “libraries” and custom programming can make the micro-controlled animation system quite feasible. This article describes my adventures into this exciting capability.



My small shelf traction layout is designed around two loops connected by mostly street running tracks. I have located Infrared (IR) detectors at five locations around the layout. This enables an automated control system to recognize the location of streetcars and bring them to a slow stop at seven locations. Travel around the loops is one direction which means single point spring switches (turnouts) are appropriate. Two other switches are controlled by Servo/LocoNet custom devices. My detector circuit sends the IR detection to a Digitrax DS64 Stationary Decoder. That decoder passes detection activity to the Digitrax Command Station via LocoNet and my animation circuit is alerted to the sensing. A brief overview of my IR detectors, servo operated turnout devices and other circuits used on my layout appears later in this article. A separate article on each with further details is also available.

The automatic trolley operations are controlled by a program (sketch) running in an Arduino Pro Mini micro-controller. One or two cars of the three are kept operating following a “schedule” contained in the sketch. The two servo powered switches are also operated at an appropriate time in the “schedule.” Streetcars are realistically accelerated and decelerated at the designated station stops surrounding the

IR detection spots. My cars are controlled by Digitrax SFX Sound Decoders with custom software and sounds including gongs, passenger buzzers, controller clicks, door opening/closing sounds and random coin clicks and announcements. See brief overview and separate articles related to my Birney Street Car sound projects.

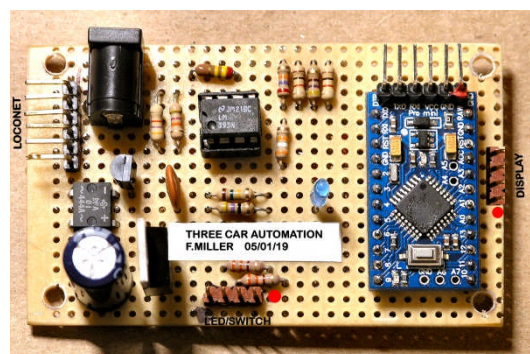
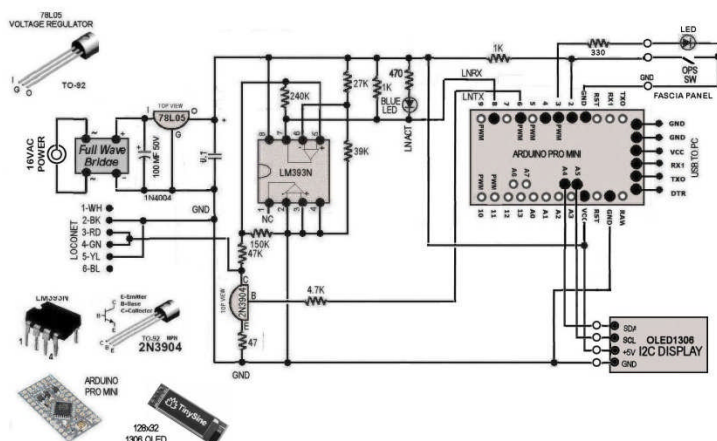
#### FASCIA STRIP CONTROL PANEL



The micro-controller activity is monitored and controlled by a small panel on my layout fascia strip. The panel includes a toggle switch to activate or hold the scheduled activity. A display panel indicates the steps currently underway and an LED provides some additional operating information.

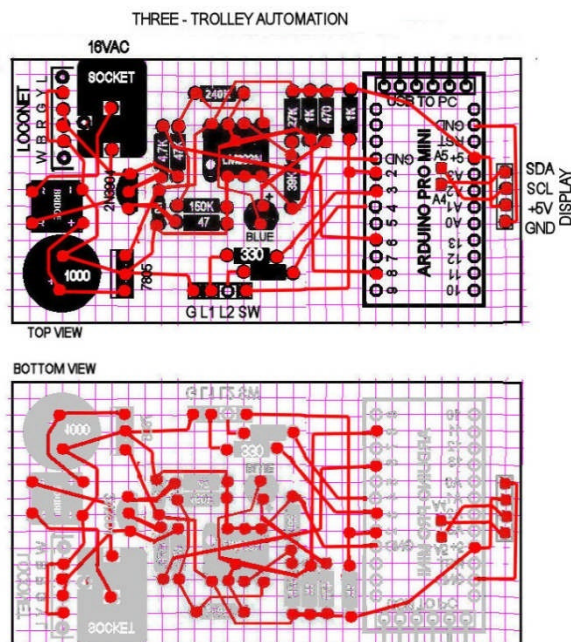
The circuit for the interface between the Arduino Pro Mini and the LocoNet includes provision for decoding/encoding LocoNet commands, a small power supply and the controls for the display.

#### THREE-CAR TROLLEY ANIMATION



As is my usual process, I developed and tested the Arduino sketch (program) on an Arduino Pro Mini (or UNO) with a breadboard for easy component placement. When the sketch and breadboard circuit were operating satisfactorily, I used a graphics program to lay out the components for a “perf board” mounting. That graphical representation was then “wired” (in RED) and flipped to provide a parts mounting and soldering aid.

After appropriate testing of voltages and Pro Mini operations, the wiring side of the perf board was then coated in 5-minute epoxy to secure and insulate the wiring.





The display panel, although not essential to the operation of the automation, does provide useful information about the current status of the operations. Messages indicate switch and car movement activity as the “schedule” progresses.

The schedule repeats over and over unless the controlling toggle switch is set to ‘HOLD’. The three-car “schedule” I have implemented has 41 steps, each of which determines switch activity (throw a switch to Normal or Reverse position), car operations (run a specific car to the Station Stop associated with an IR Detector). The car operations step also indicates whether this operation is concurrent with a following car operation, or sequential. When concurrent operations are indicated, another step is included to ensure both cars have come to a stop before proceeding to the next scheduled step.

SAMPLE DISPLAY SCREENS	
FOX HILL TRACTION	START UP
HOLDING... <sup>1</sup> SET SWITCH TO RUN	WAITING...
REPEATING OR SET TO HOLD	END SCHEDULE
S W 101 SET TO R <sup>1</sup>	SW 101 TO REV
S W 100 SET TO N <sup>5</sup>	SW100 TO NORM
ADD C 43 MOVE TO 5 <sup>10</sup>	CAR 43 TO SENSOR 5
ADD C 42 MOVE TO 4 <sup>1</sup>	CAR 42 TO SENSOR 4



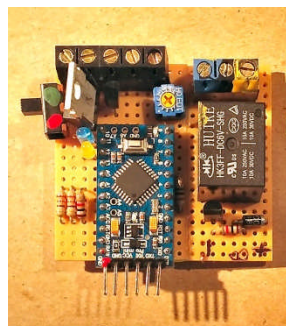
## OVERVIEW OF FOX HILL TRACTION CO. ELECTRONICS

(See separate articles on these topics for further details)

---

### SUN CONTROLS

A microcontroller circuit manages the overhead LED lighting (Sun) by timing the day-night sequence with fading controls. A Fascia strip toggle starts the animated sequence or 'holds' at full ON at power-up. An Amber and Blue LED shows status with blinking during transitions.

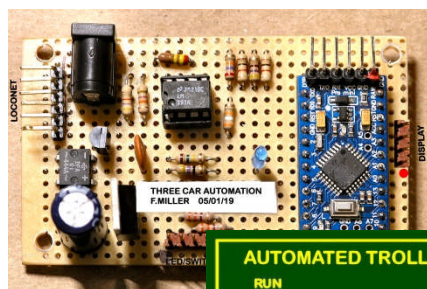


---

### TROLLEY AUTOMATION

In addition to conventional DCC Throttle controls, a microcontroller circuit operates a 'schedule' for trolleys, each running independently through the city stopping as appropriate. Slow stops/starts and sounds are provided as well as applicable turnout controls.

(See Switch Controls & IR Detection, below)



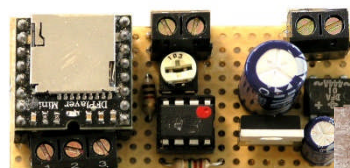
three  
tracks



---

### SOUND CONTROLS

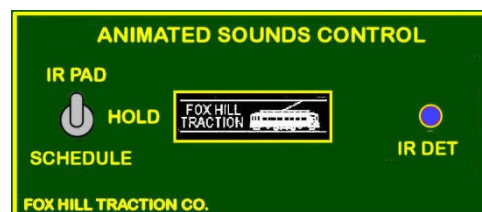
Individual layout sounds are 'played' with microcontroller management. Sounds are initiated either with a fascia strip touch plate or the Sound Animation board.



---

### SOUND ANIMATION

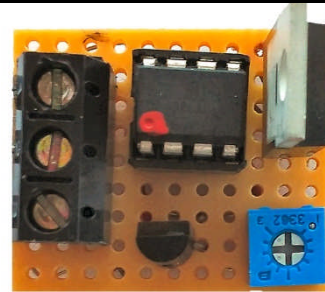
A microcontroller circuit operates a 'schedule' of individual sounds by triggering the above Sound Control boards so that one or two sounds are always playing. The sounds can also be activated with a remote IR pad.



---

### NIGHT-TIME MOON (BLUE) LIGHTING

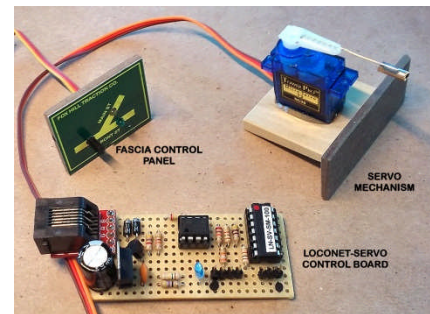
A blue LED strip over the layout provides a night-time moon-like lighting. This strip is always on but only noticeable during night time. A small micro-controller sets the LED strip brilliance.



---

### TURNOUT CONTROLS

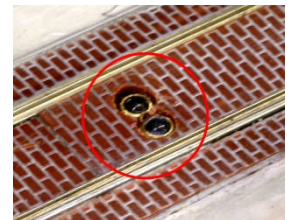
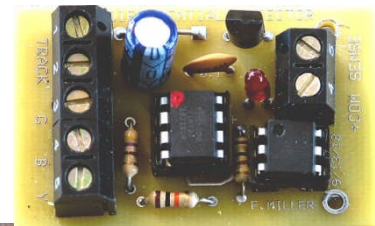
The track switch machines are operated using small Servos in two ways: (1) by a conventional DCC system "switch" command; and (2) with a Push-Button on a panel mounted on the fascia strip. (The Push-Button sends a LocoNet message to the Command Station which is bounced back to the Servo Control Board as a DCC "switch" command



---

### IR CAR DETECTION

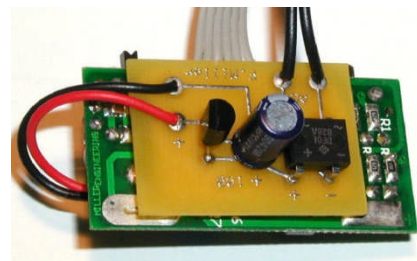
The detection circuit uses TCRT5000 IR LED and IR Detector pairs, each mounted in a brass tube so that a passing car 'bounces' the IR signal. A special microcontroller (ATTINY85) circuit removes ambience noise, making the circuit sensitive in low and high ambient light, sun, etc.



---

### ANIMATED SIGN POWER

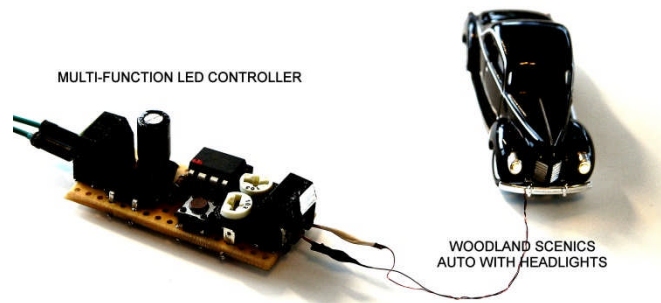
All lighting (buildings, street lights, etc.) are powered from a 6VAC power bus. The dozen commercial animated signs, which normally run on three AAA batteries, are powered with a small circuit which provides 5VDC from the 6VAC layout bus.





## AUTOMOBILE LIGHTS

A small microcontroller circuit animates the head/tail lights in an automobile. Two adjustments are provided to: (1) set the light brilliance, and (2) set the time ON and OFF (varying from 0.1 to 5 minute cycles). The circuit is powered from the AC lighting bus.

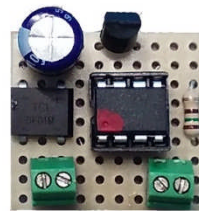


---

## CAMPFIRE FLICKER

The flickering campfire is modeled using a bright miniature yellow LED with some red nail polish. An ATTINY85 microcontroller is programmed to control a variety of seemingly random flashes representing the sputtering campfire.

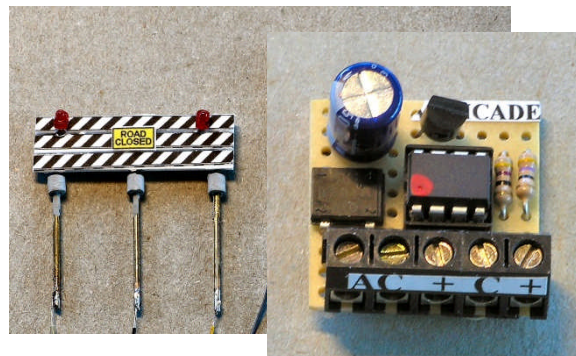
Note – same circuit is used for Balloon Flame Heater simulation



---

## FLASHING ROAD BARRIER

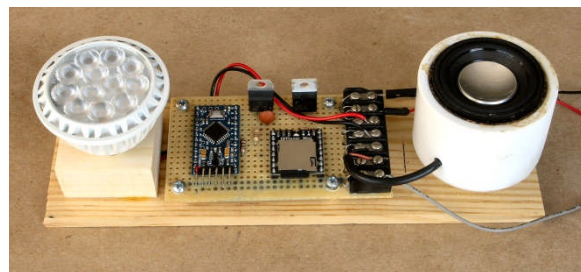
A micro-controller (ATTINY85) is programmed to control alternating blinking LEDs with brightness fading gradually ON and OFF, simulating incandescent lights.



---

## THUNDER STORM

When activated ("touch plate" or Sound Animations) the microcontroller software cycles through several thunder-lightning sequences. Each sequence plays a different thunder rumble and lightning flashes of random ON and OFF periods



---

## SOUNDS FOR BIRNEY STREETCAR

A custom sound project was prepared for the Spectrum® Birney cars. Operational decoder software and prerecorded trolley sounds were loaded into a Digitrax SFX SDN144PS decoder. The decoder and a custom speaker were installed in each of the three streetcars.

