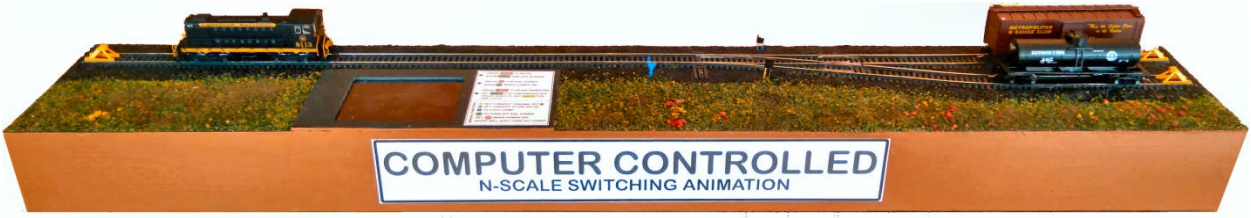
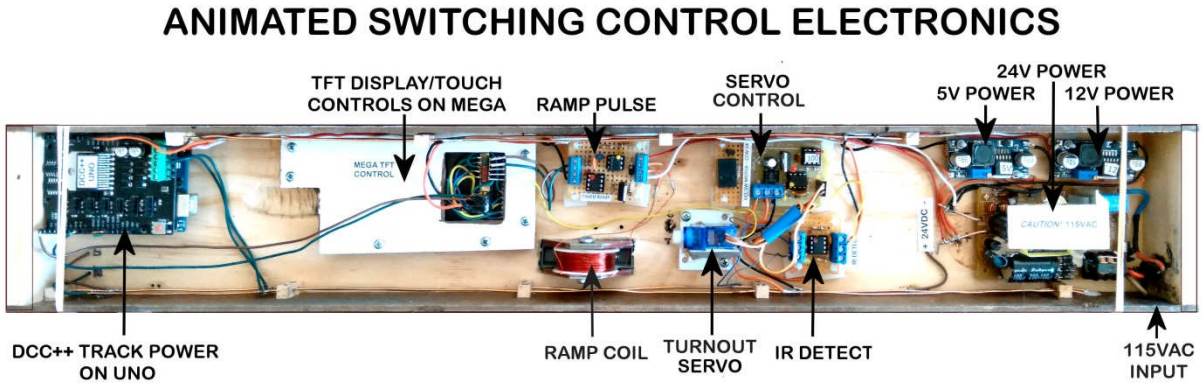
COMPUTER CONTROLLED
N-SCALE SWITCHING ANIMATION

By F. Miller, MMR

This little layout was developed as a fun project to demonstrate the capabilities of Arduino micro-controllers in animating Model Railroads and using Touch Panel controls. The layout is a simple set of sidings suitable for switching two cars between sidings. This project makes use of micro-controllers to operate the layout and Locomotive switching activities. One Arduino Mega, one Arduino UNO and three ATTINY85s are used to complete the automation.



The layout is powered by DCC delivered through a self-contained DCC++ Base Unit (Arduino UNO). The turnout is controlled by DCC Command Activated Servo Switch Machine (ATTINY 85 Micro-Controller). An electric Uncoupling Ramp is activated with ATTINY85 Micro & MOSFET Transistor. One IR Detection circuit is activated with an ATTINY 85 Micro-Controller.

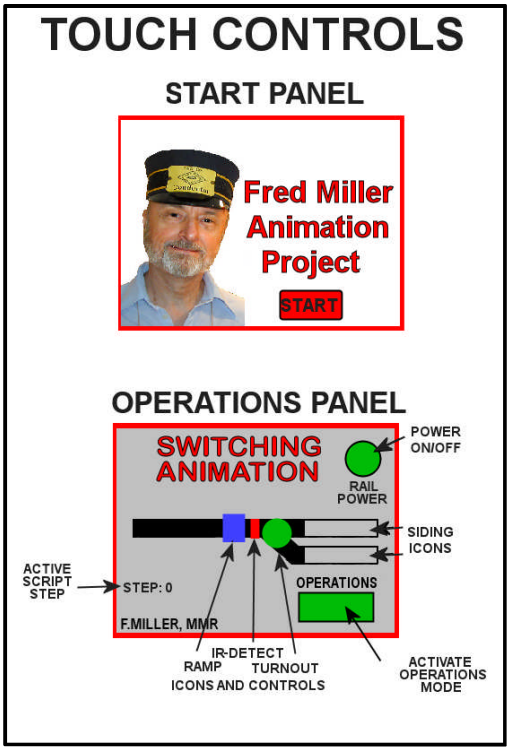


A single self-contained 24VDC adapter supplies power for the uncoupling ramp coil. The 24V is also reduced by a 5VDC Buck Converter to power the Arduino circuitry and a 12VDC Buck Converter to supply rail power.

The electronics for the Turnout Servo, Powered Uncoupling, IR Detection, Automation Controller and DCC++ Command Station are described later in this document.

Animation Controls

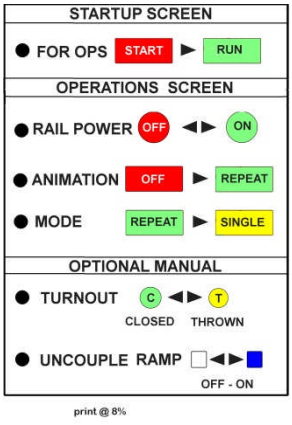
The Animation Controls are initiated with a series of 'touch' spots on a TFT (Thin Film Transistor) Touch display panel operated by the Arduino MEGA micro-controller. The two pre-drawn panel images are read from SDHC files.



The Animation Controls use a 'script' or schedule stored in the memory of the Arduino MEGA. The micro-controller program (called a sketch) can activate various activities. For example:

- Set Turnout positions to THROW or CLOSED
- Run a Locomotive Eastbound or Westbound at a specified speed for a specific time
- Perform an uncoupling action at the Uncoupling Ramp
- Pause operations for a specified time delay.

The Animation Controls can operate the switching Script repeatedly, or run through the steps only once.

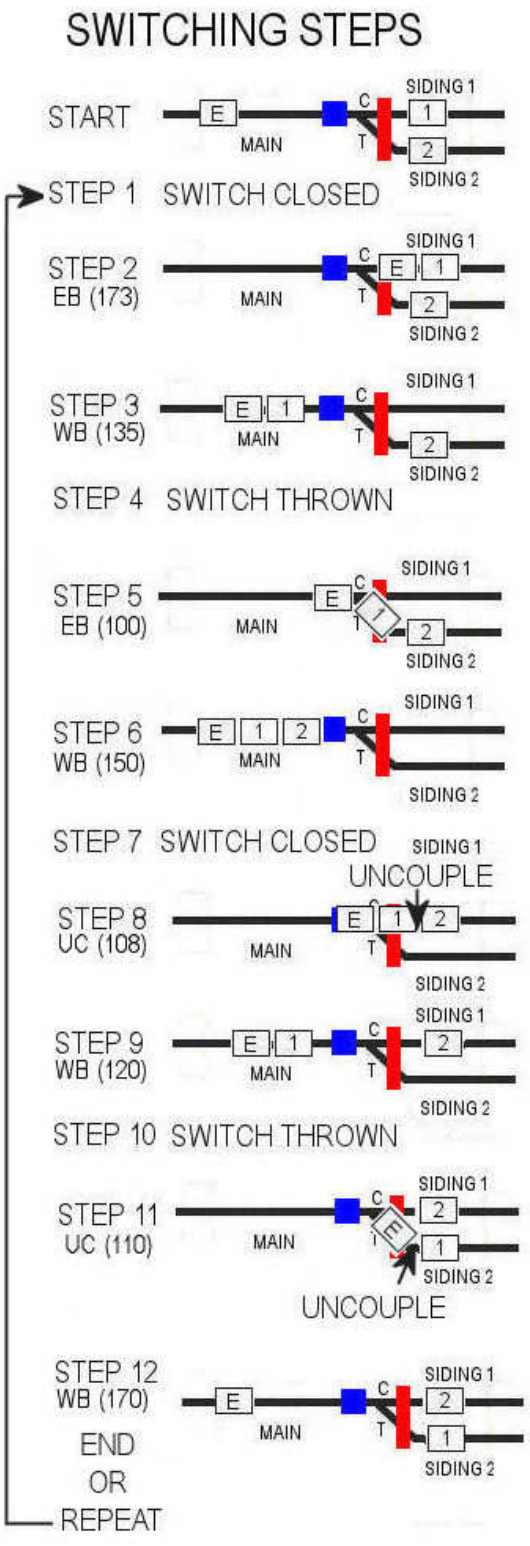


The Operations Panel is displayed by pressing on the 'START button' in the initial power-up screen. Then the Rail Power can be activated and the switching 'schedule' started using the touch 'buttons' The animation will step through each action and then repeat the schedule, unless the Mode switch is set back to SINGLE, in which case the schedule will terminate before restarting at the next first step.

The Turnout and uncoupling ramp functions are activated from within the switching schedule. However they can also be manually activated by pressing on the touch screen icons. The Rail Power can be deactivated at any time by pressing the touch screen 'button'. NOTE: if a short is detected, the Rail Power will be automatically disconnected.

The Schedule

The switching schedule, stored in the MEGA memory, activates the following steps in sequence. The schedule assumes the Loco is positioned in the far West and cars in Siding 1 and 2.



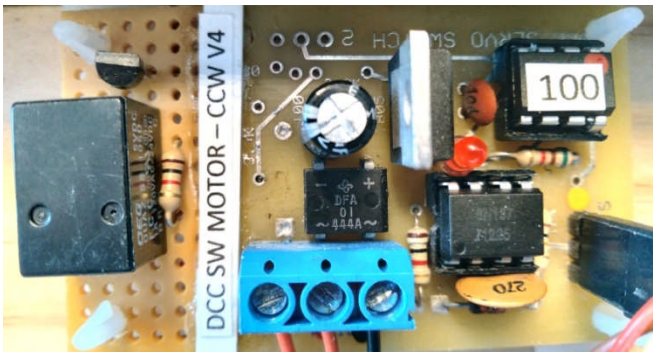
1. Set Turnout to CLOSED position (to access Siding 1).
2. Run Loco Eastbound (Reverse) at slow speed and duration to couple onto car in Siding 1.
3. Run Loco Westbound (Forward) at slow speed and time to position the Engine and Car west of the turnout.
4. Set Turnout to THROWN position (to access Siding 2).
5. Run Loco Eastbound (REVERSE) at slow speed and duration to couple onto car in Siding 2.
6. Run Loco Westbound (Forward) at slow speed and time to position the Engine and two cars west of the turnout.
7. Set Turnout to CLOSED position (to access Siding 1).
8. Run Loco Eastbound (REVERSE) at slow speed, activating uncoupling ramp when IR detection is sensed at car 2. The Loco initiates a Forward/Reverse motion to disengage the couplers, and then resume eastbound travel to spot car in Siding 1.
9. Run Loco Westbound (Forward) at slow speed and time to position the Engine and Car west of the turnout.
10. Set Turnout to THROWN position (to access Siding 2).
11. Run Loco Eastbound (REVERSE) at slow speed, activating uncoupling ramp when IR detection is sensed at car 1. The Loco initiates a Forward/Reverse motion to disengage the couplers, and then resume Eastbound (REVERSE) travel to spot car in Siding 2.
12. Run Loco Westbound (Forward) at slow speed and time to position the Engine at original far west position.

Depending upon Mode setting, the above schedule will be repeated, or all operations will cease.

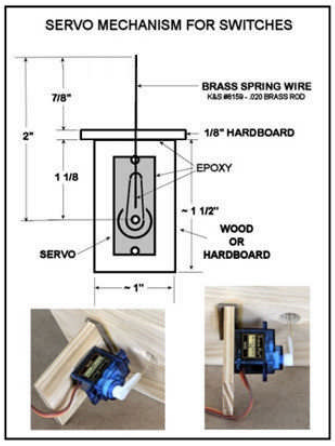
NOTE: the Loco will sound appropriate signals for direction movement and ring the bell during Reverse (Eastbound) motion. Coupler clanks and hisses will also be sounded when switching. A 'pause' is also issued between each Loco motion step.

Turnout Controls

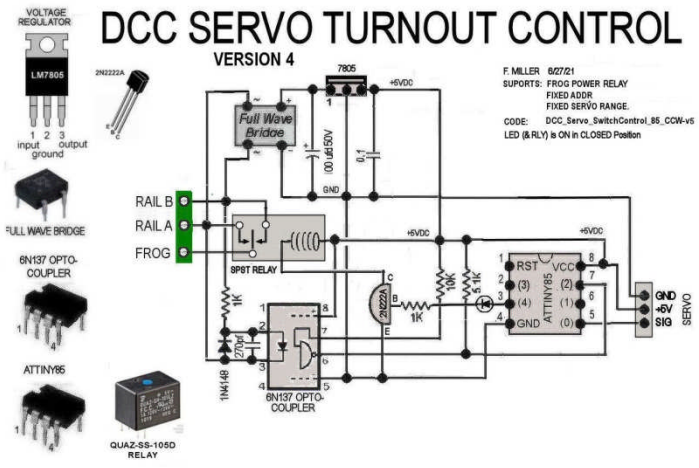
The turnout points are controlled by DCC Switch Commands issued from the Animation Controls (MEGA and DCC++ UNO). The turnout mechanism is a small Servo Motor operated by a circuit running in an ATTINY85 Micro controller. The DCC Switch Commands are presented on the rails from the DCC++ unit. This circuit is powered from the rails.



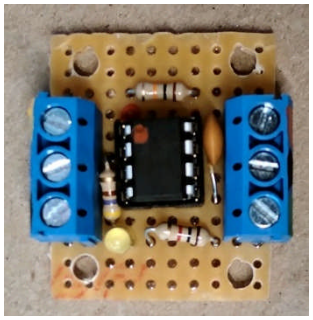
The turnout control board runs the servo motor at a slow speed, not snap action. Half-way through the motion, a relay is reversed to apply applicable rail power to the turnout's isolated switch frog.



The software running on the ATTiny85 micro-controller was developed in the standard Arduino IDE environment and then down loaded to the smaller micro-controller. The Switch Address and the servo positions and direction are 'hard-coded' in the software and matched to the specific turnout.

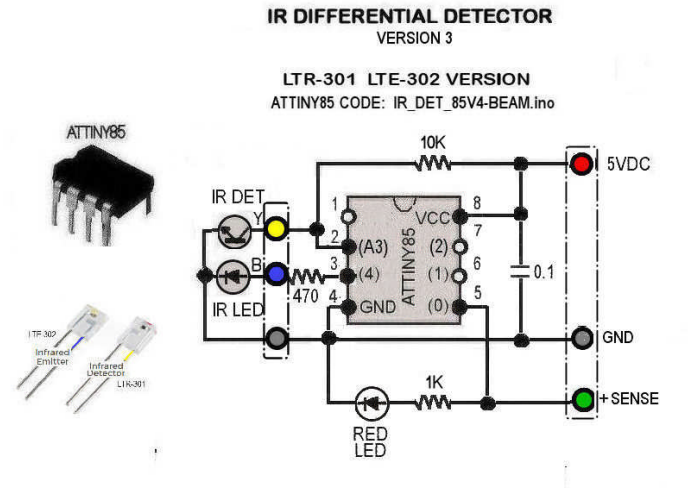


Detection Circuits

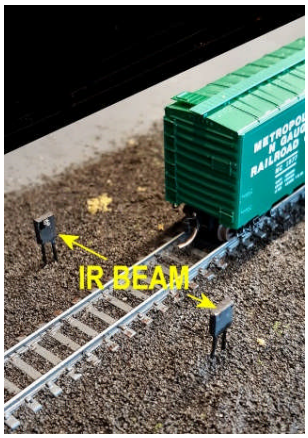


The Animation Control logic needs to monitor locomotive/car positioning while operating the uncoupling ramp on the Switching layout. This position detection is provided by an IR-Detection circuit. An interruption of the IR beam across the track signals a detection situation. An ATTINY85 circuit runs the IR LED emitter and IR transistor

receiver in such a way that spurious light does not affect the detection. (The circuit compares received IR energy in both an energized and quiescent IR LED emitter. When the difference reaches a threshold, the detection is signaled.)



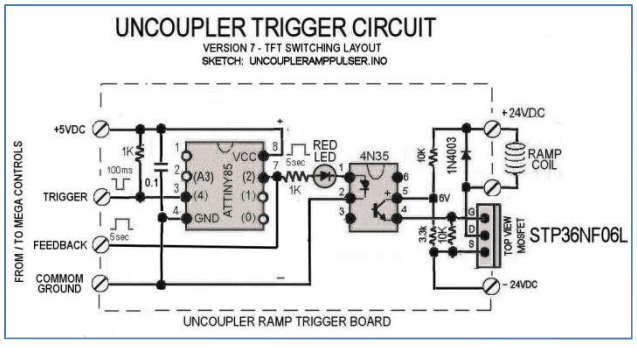
The IR detection circuit is powered by the 5VDC supply used for all of the Arduino based circuits. The IR LED Emitter (LTE-302) and the IR transistor Receiver (LTR-301) are very small units, easily hidden in the scenery or buildings surrounding the detection site

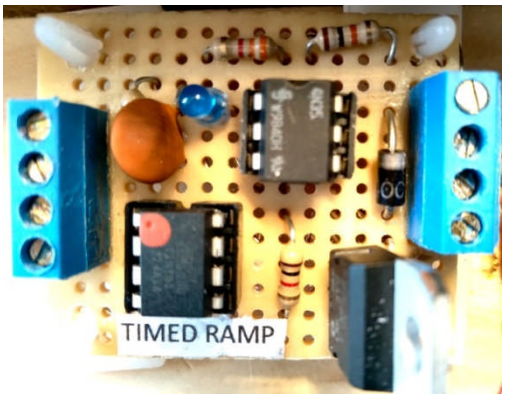


Color coded wires are soldered directly to the LED and Transistor leads and the wires are passed through the layout down to the detector circuit boards. The IR LED and IR transistor are painted black and mounted across one or two tracks facing each other. For reliable detection the small bubble on the IR detector unit is painted to offer a minimal spot opening.

<u>Powered Uncoupler Ramps</u>

The Kadee® #309 Magne-Electric Uncouplers, when mounted under the rails, provides a solution to inadvertent magnetic uncoupling of the MicroTrains couplers which would result from the traditional magnet bars. This powered uncoupler requires several amps of DC current at 24

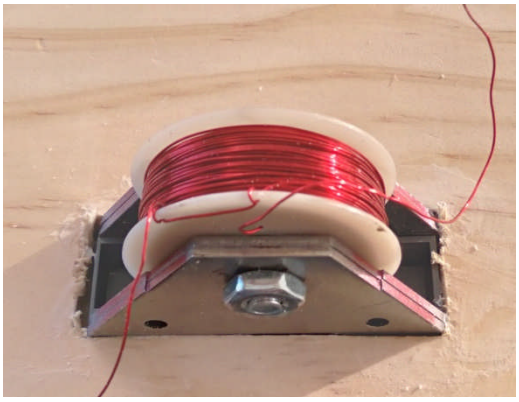




volts, enough to overheat the coils if left on.

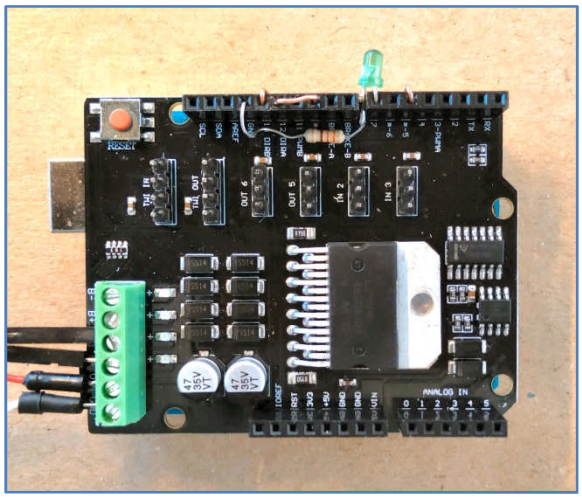
A separate 24 VDC power source is provided to power the uncoupler coils however the ATTINY85 controlling circuit is powered by the 5VDC supply used for all of the Arduino based circuits.

The uncoupling circuit gives only a 10 second burst of the required power to prevent overheating. Activation of the ramp is accomplished from the MEGA software, or the touch spot on the control panel. The uncoupling circuit 'debounces' the input pulse to eliminate false triggers from noise. Feedback is provided to the Animation Controls (MEGA) to signal the ON or OFF condition.

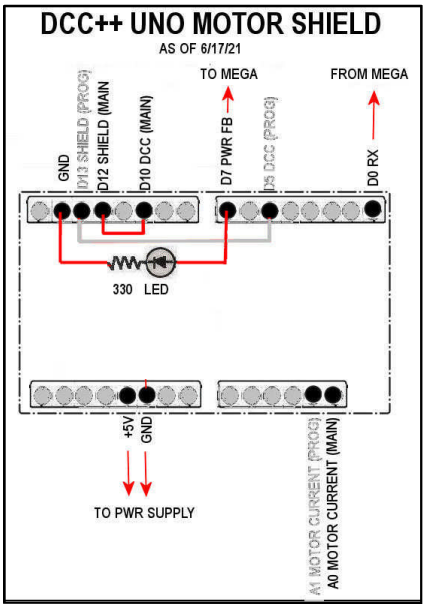


The outer plates on the coil assembly are reversed to better match N scale rail separation.

DCC++ COMMAND STATION



I use an Arduino project called DCC++ BASE STATION which makes use of an Arduino UNO microcontroller and a plug-in Motor Control Arduino "shield." The software is readily available on the Internet but I made various changes to suit my needs.



The UNO circuit is controlled by input serial commands. My implementation sends those commands from the Arduino MEGA control board. The DCC++ software operates the Motor Control shield to place DCC commands on an output DCC Rail Power supply. The power ON state lights a LED and feedback interfaces back to the MEGA board to signal power ON/OFF.

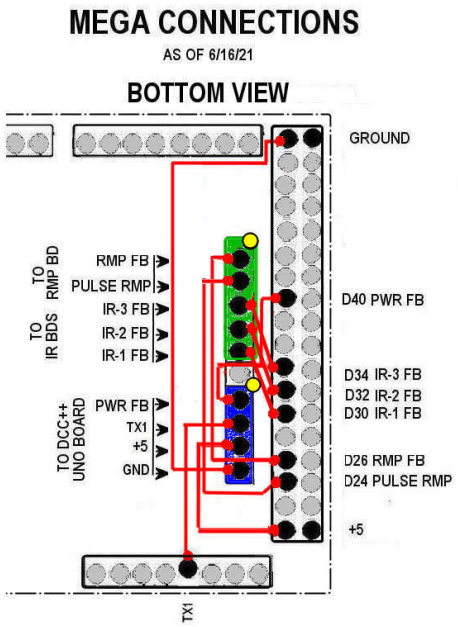
My modifications eliminate 'programming track' support and other generalized functions but enhance the DCC Function commands in addition to the Power ON/OFF and current sensing functions.

TFT/Touch MEGA Control

As noted above, the Animation Control is carried out by a program (sketch) in the Arduino Mega. The TFT /Touch pad mounted on top of the MEGA provides the controlling interface.

Bottom view of Mega showing interface connections

Top view of MEGA with TFT/Touch shield inserted



Simulated buttons are displayed on the TFT and 'touch' presses on those areas results in a 'button-press' function.

The two pre-drawn panel images are stored on a SDHC card and read through the card reader slot of the TFT board.

Connections are made from the MEGA to the DCC++ UNO board as well as command and feedback lines from

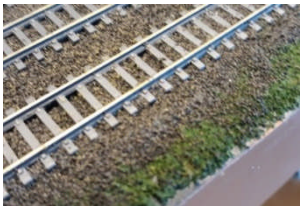
- Uncoupling Ramp
- IR Detection
- Turnout Servo

Layout Construction

The switching layout is constructed on a 4" by 24" enclosed platform. Atlas Code 55 N-scale track is used. The Atlas Track Planning program was used to select and position the track elements.

LAYOUT Parts List

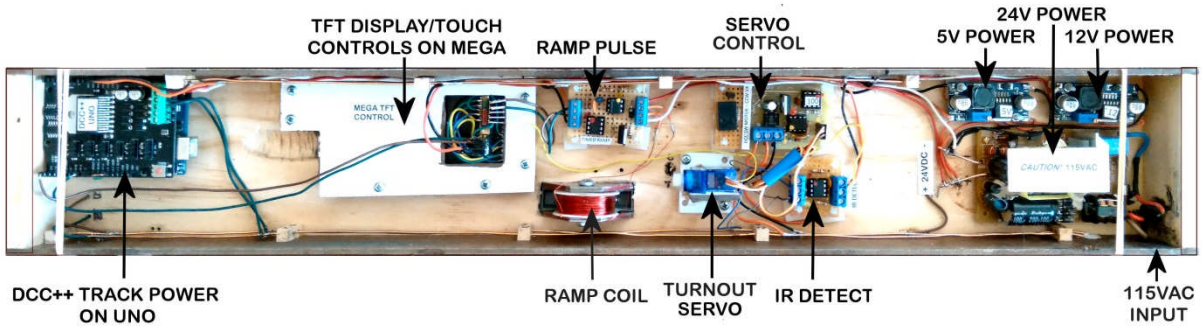
No.	Image	Number	Name	Scale	Producer	Pcs.
1		2002	6"	N	Atlas	2
2		2004	3"	N	Atlas	2
3		2005	2"	N	Atlas	2
4		2007	1"	N	Atlas	1
5		2011	1/2 10"	N	Atlas	1
6		2051	#5 R	N	Atlas	1
					Total:	9

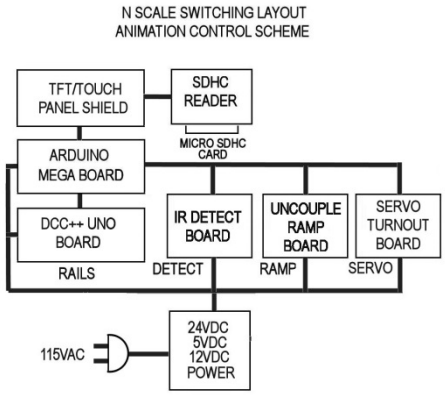


All of the track work is ballasted in cinders (Woodland Scenics #B76-Fine Cinders). Some surrounding territory is covered in fine grass and earth (Woodland Scenics #T45 & T42). A scattering of bushes (Woodland Scenics FC148) is also used to blend areas. The cinders and fine grass are positioned dry, and then mist sprayed with 70% alcohol. Water-diluted Carpenters glue is then dribbled into the ballast and ground cover.

The Arduino Mega with attached TFT/Touch pad is mounted on the layout base for easy access from the top of the layout. As noted before, all electronics are contained within the layout base. Only the 115VAC cable is plugged in through an external connection. The electronics for the Layout box is completely self-contained.

ANIMATED SWITCHING CONTROL ELECTRONICS





N-Scale Rolling Stock

An Atlas Gold Series S2 Diesel Equipped with LokSound® Select Sound is used as the locomotive power for the switching layout. Two MicroTrains 40' Box cars round out the roster. The cars have MicroTrains couplers and retaining springs on each axle to offer good uncoupling performance. The cars are also weighted to almost 2oz (beyond NMRA standards).