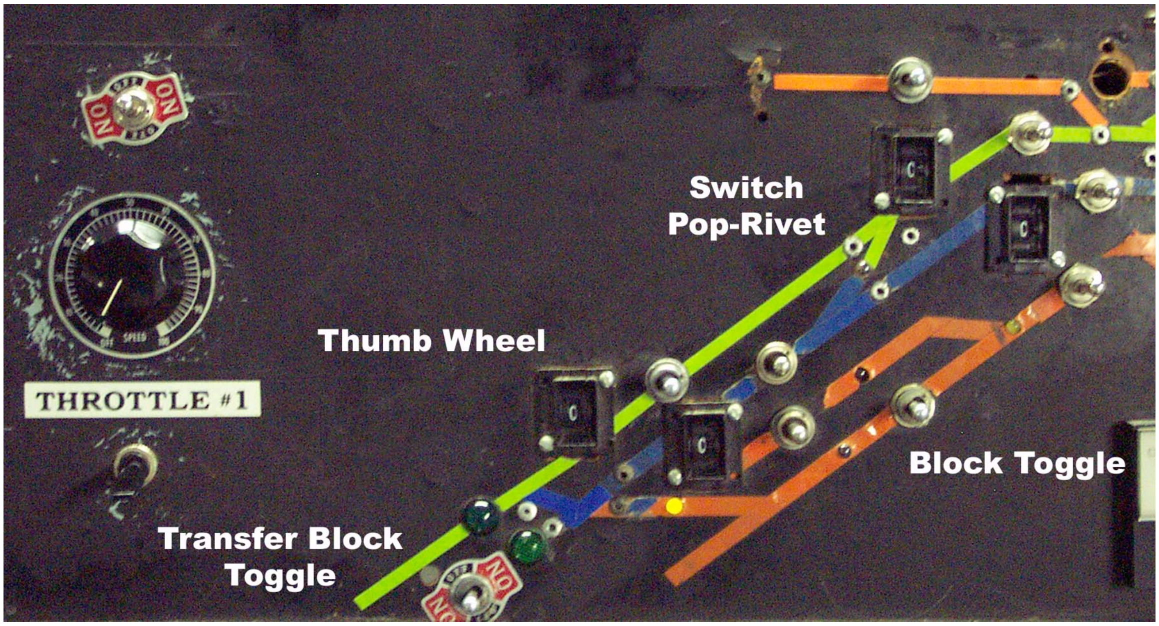
Garden State Central

Wiring Clinic

11/15/2002



Panel Basics

Each panel has 5 elements: throttle, pop-rivets, thumb wheel, block toggle & transfer block toggle.

Throttle - puts out power to run train
Pop-Rivets - connected to switch machines. Applying power to the rivets will activate a switch machine.
Thumb wheel - selects power source
Block toggle - routes power from thumb wheel to track
Transfer block - routes power from adjacent block toggle to transfer block

Thumb wheel

- Each thumb wheel has 10 positions - 9 power sources and 1 off (pos 0)
- Main thumb wheel bus line runs from Jersey City to Taylor. Carries power for thumb wheel positions 3 through 9 - currently set up as remote/walk-around throttles
- Positions 1 & 2 are for local throttles

  Exceptions:
  - Lehighton upper/lower yard - on both panels pos 1 is upper yard throttle, while pos 2 is lower yard throttle.
  - Jersey City dumper panel - pos 1 is Jersey City throttle 1, while pos 2 is dumper panel throttle.

Notes:

Block Wiring

Each town is broken up electrically in to smaller sections of track (blocks). The track is 'separated' into blocks by using insulated (plastic) rail joiners instead of metal rail joiners. This stops the power from flowing from one track to another. On the GSC, blocks 'usually' start / end on switches or groups of switches. This allows trains to be routed around each other electrically. Electrically a block can have 1000 switches in the middle. Operationally, breaking the blocks down into smaller units allows you to park a train in one section and have another one run around or by the first train. Each of our blocks is electrically controlled by a block toggle. Each toggle is positioned next to a thumb wheel. They are set up so that when you throw the toggle towards the thumb wheel, the block takes it's power from whatever control is dialed up on the thumb wheel. Example, if the thumb wheel is set to 2 and the block toggle is thrown towards it, the train in that physical section of track will be powered by local cab #2 on the panel. If it were set to 3, the block would be powered by remote cab #3.

Common Ground Wire

Every DC device we have wired up to the layout has a + and - terminal. Both wires have to be connected to anything you want to power (ie: track, switch machine, light, etc.). Instead of running both wires to each powered item, we use a simplified system with a common ground wire. The negative terminal of each item is wired to the big braided copper wire running the length of the layout. The positive terminal is run to the powered item. Example: each track has two wires running to it. One goes to the common ground (-) and the other side goes to the throttle (+) [through the thumb wheel and block toggle]. The wiring is simplified by only having to run a short ground wire from the track to the common wire, which is usually no more than 6-8" away. Now for the fun part, how you can have one throttle set up putting (-) to the ground wire and one putting (+) to the ground wire at the same time, I have no idea. Example: in WB, you have throttle 1 running east (+,-) and throttle 2 running west (-,+). It's the magic black box that somehow works.

Let's wire a block (non-transfer block)

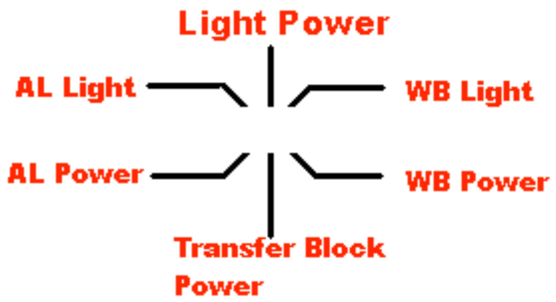
Each piece of track on the layout should have 2 feeder wires soldered to the outside of each rail. One of these wires (usually the one closest to the wall) goes to the common ground. The other wire (usually the closest to the aisle) goes to the corresponding block toggle on the panel. When the thumb wheel is set to a throttle, and the block toggle is thrown towards the thumb wheel, you get power running to the track. It can be that easy.

Common problems with this (in the following order): There are no wires from the track and we're hoping that the rail joiners conduct the power. The wire from the track does not connect to either the ground or block toggle (it was cut or just twisted on and finally let go). The block toggle is bad. The thumb wheel is bad, or the connection wire to the thumb wheel is bad.

Notes:

Transfer Blocks

Transfer blocks don't turn blocks on and off like regular block toggles. Transfer blocks decide which block toggle to get their power from. For example: Look at the transfer block between Wilkes-Barre & Allentown on the west bound track (blue). The transfer toggle decides whether to take its power from the Wilkes-Barre block to the right (west) of the transfer block or to allow the Allentown panel's last block toggle to supply the power. This way, no two power supplies can feed power to a block at the same time.

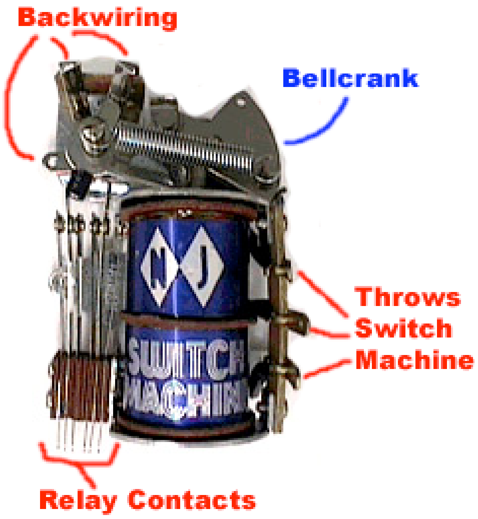


These toggles also differ in the way they're physically wired. One side of the physical toggle connections carry block power, while the other side of the toggle carry the blinking light power.

The way this was handled in the past was with "common" blocks. Each of these blocks had two power supplies going to the same piece of track. This style of wiring still exists between the Wilkes-Barre main and yard panels. The two tracks coming off the west bound main in Ashley, and the west bound passing siding in front of the main panel are powered by two separate block toggles, one on each panel. They can both put power to the block at the same time. If they are set to the same direction, you just notice that your train is moving a little faster than you thought it should. It they are in the opposite direction, you notice that the engine is barely moving and you are actually frying the two throttles at the same time. This was a cause for many throttle failures in the past.

This older method allowed for hand-offs between two panels, and allowed you to "leak" power from one panel to another, allowing you to run several panels from one throttle. Great if you were running the whole layout from one location, but scary (electrically) if several folks were running the layout at one time.

Notes:



Switch Machines

We use twin-coil switch machines on our layout. The machine is actually two round electromagnets with a long metal slug running in the center. The slug is connected to a bell crank (triangle shape) that has a spring across it and a piece of stiff wire that connects to the actual switch (track).

Each switch machine has 3 main sets of contacts. One set throws the actual switch (right side), one for backwiring (upper left) and the third is for relay contacts (bottom left).

Right Side (throws switch machine)

Let's start on the right with the actual switch contacts. There are 3 contacts, the center contact is the ground wire (common wire), while the top and bottom contacts go to the hot contacts (pop rivets on the panel). The circuit that throws the switch is completed by the switch probe on the panel. The switch probe is the + wire from the switch machine power. This probe is connected to a big silver capacitor under the layout. The capacitor is there to supply the extra 'oomph' to throw the switch machines. The power supply then re-charges the capacitor, ready for the next switch throw. When you touch the switch probe to the pop rivet, power flows to one side of the twin coil switch machine. This pulls the slug to one end of the magnet and moves the bell crank to one side. The stiff wire then pushes the actual points of the track switch to one side or the other.

You probably won't know which contact (top or bottom) will throw the switch right or left. We figure that by wiring the switch to the terminal strip then to the pop-rivet. Throw the switch and if it throws incorrectly (straight when you hit the turn rivet), merely switch the wires on the terminal strip going to the switch machine.

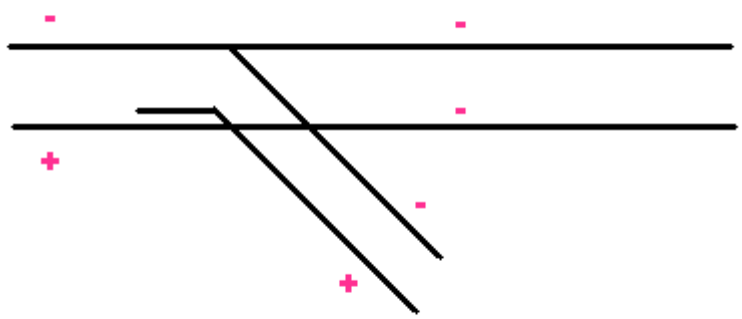
Notes:

Upper Left (backwiring)

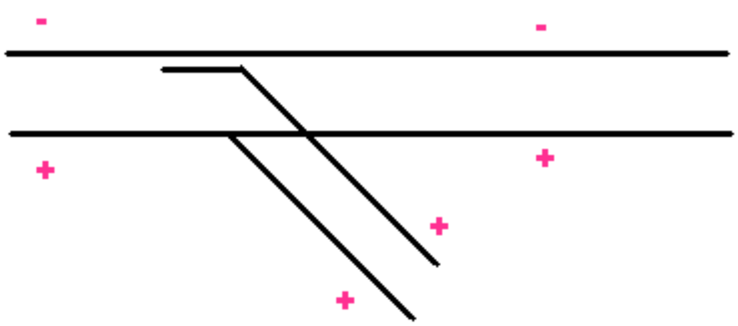
The contacts for the back wiring, on the upper left, are made up of 3 parts. The top two contacts that get power from the track block, a left contact that sends power to the frog of the track switch and a small metal tab connected to the bell crank that makes contact between the left contact and one or the other top contact. This tab moves when we throw the switch machine.

Since the center rails of our track switches are insulated from the outside rails, we need a way to route power to the center rail (frog). If we do nothing, which we often have, The frog gets it's power from the switch points. The problem with this is these points and rails get dirty from use, and do not always conduct power well. To fix this problem, we use the contact on the switch machine to route power to the frog. These contacts are much beefier than the points and do not get dirty like the track points do.

To figure out which block wire (+ or -) goes to which contact, we must first look at the way the switch machine is thrown. Look at the small tab on the switch machine that connects the left backwiring contact to one of the top contacts.



If the switch points are touching the rail closest to the wall, then the top contact that is touching the tab gets wired to same wire as the back rail (usually the ground wire).



The same holds true for touching the front rail (usually the block wire that goes to the toggle on the panel).

Because the center rails switch polarity every time you throw the switch, we put insulated rail joiners on all rails of the 2 track end of the switch. (Check the center rails of the two illustrations above).

Notes:

Bottom Left (relay wiring)

Now for the fun part of the wiring. These contacts are those six wires that you always think get in the way. These contacts are used to control relays that route power and for panel lights to indicate which way a switch is thrown.

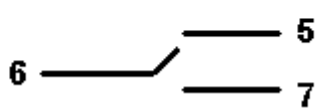
Here's how they work. Those six contacts are actually two sets of on/off switches. When you look at the contacts, you'll see two groupings of short, long and short contacts. Let's just look at one of these groupings for now. To wire a panel light to show which way a switch is thrown, you could wire one contact on a light on the panel to a power supply. The other side of the light would be wired to the first short contact on the relay wiring. Then wire the long contact next to it to the ground wire. Every time you throw the switch a small tab on the switch machine pushes the long contact to either the right or left. When the long contact moves to the left, the it touches the short contact, and completes a circuit for the light on the panel. Whenever you throw the switch this way, it will light the bulb on the panel. If you find that the light is lit when the switch is thrown the wrong way, simply move the wire that goes to the short relay contact on the left of the long contact to the short relay contact on the right of long center contact. Now the light will work when the switch is thrown in the opposite direction.

Making a relay throw when the switch is thrown is done the same way. Simply replace the light bulb on the panel with the power contacts on the relay. (See another example in the 'how we use relays' section)

Relays

Now that your head is spinning from the relay wiring on the switch machine, let's go to the actual relay. A relay is nothing more than a group toggle switches that are thrown electronically. They actually work just like the relay contacts on the switch machine. There's an electromagnet inside each of the relays. This magnet works the electrical contacts of the relay just like the switch machine physically moves the long contact between two short contacts on the switch machine relay contacts.

The majority of contacts on the relay are used to route electricity. There are 12 contacts on the bottom of the relays we use, which can be broken down into four groupings of switches. For example, let's look at contacts 5, 6 & 7.



Contact 6 acts just like the long contact on the switch machine relay wiring, while contacts 5 & 7 act like the short contacts. When there's no power applied to the relay, contacts 5 & 6 are touching, completing that circuit. After you apply power to the relay, contacts 5 & 7 are touching. Contacts 8, 9 & 10, 11, 12 & 13 and 14, 15 & 16 all work the same way. When power is applied to the relay, contacts 5 & 6, 8 & 9, 11 & 12 and 14 & 15 are all making contact. When power is removed, contacts 6 & 7, 9 & 10, 12 & 13 and 15 & 16 are making contact.

On the top of the relay there are two contacts that actually power the relay. Contacts 1 & 4 are used to power the relay. When one contact is connected to a power supply and the other contact is connected to a ground, the electromagnet throws forcing one set of contacts to touch and complete a circuit. When power is removed, the other set of contacts in the relay touches. It does not matter whether contact 1 or 4 is the hot or ground, as long as one is power and one is ground.

Notes:

Here's how we use relays.

Example 1:

On the transfer block going from Lehighton to Allentown there is a track switch on the Lehighton end of the transfer block. The track switch routes the trains from either the green track or blue track into the transfer block. We need to route the electrical power the same way that the train is routed into the transfer block.

If we do nothing, the transfer block would only look at one toggle (green or blue track) to get it's power from. By using the relay, we can have the switch decide which block to route the power from.

Under the layout we'll connect the first short switch machine relay contact to the large ground wire. Next we connect the first long switch machine relay contact to the fourth contact on the relay (relay power). The first contact on the relay is connected to the relay power supply. This circuit will throw the relay based on the position of the switch machine. When the short and long switch machine relay contacts touch, we'll complete the relay power circuit, which will activate the relay. As long as the switch is left in this position, the relay will be powered. For this example, let's say that the contacts touch when the switch is thrown for the blue track and do not make contact when the switch is thrown for the green track. To check this you'll need 2 volunteers. Put one volunteer next to the switch machine and the other next to the relay. Have the first person manually throw the switch machine by moving the bell crank back and forth. The person next to the relay should hear the relay clicking as the first person moves the switch machine.

On the relay, we've decided to use contacts 5, 6 & 7 to route power to the transfer block. We'll use contact 6 as the power out of the contact and into the 'I've got it' side of the transfer block toggle since it is the one that touches both of the other contacts in this group. Look at the track switch and see which way it is thrown. For this demonstration, we'll say that it's thrown straight for the green track. Take your meter and set it to the K setting for continuity. Place the black wire to contact 6. Now touch the red wire to contact 5. If the meter moves, contacts 5 & 6 are touching. Double check by touching contact 7. The meter should stay at 0. You now know that when the switch machine is thrown for the green track, contacts 5 & 6 touch. You would then connect a wire from the green block wire to contact 5 on the relay. Try to run a train from the green track into the transfer block. As long as the transfer block is thrown to Lehighton, you should be able to run a train. Now connect a wire from the blue block wire to contact 7 on the relay. When you throw the switch machine to line up the blue track and the transfer block, the train should run between the blue and transfer block. When you test, make sure that as you test the blue block you turn off the green block and vice-versa. This way you can guarantee that the transfer block is not accidentally taking power from the wrong block to operate.

Notes:

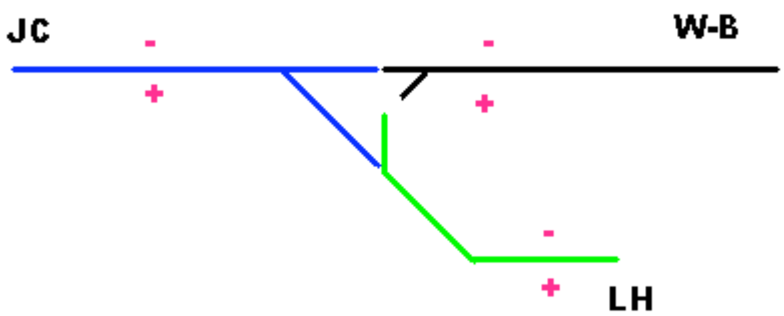
Example 2:

In Allentown, the track closest to the city that connects Allentown to Wilkes-Barre acts as a reverse loop only when the track switches are set up to route trains from Lehighton to Wilkes-Barre. In order to do this, we needed to reverse polarity on that track when running from Lehighton to Wilkes-Barre when the track switches are thrown. We set up a relay that is connected to the switch leading into the Wilkes-Barre transfer block.

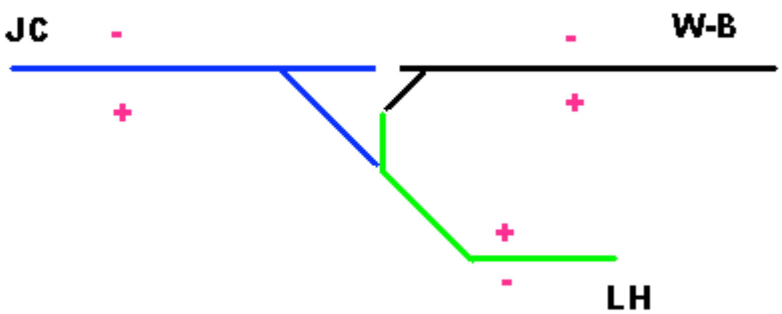
First we'll need special block wires on this section of track. Since we'll be switching polarity, we can't wire the rail closest to the wall directly to the ground wire, nor can the front rail go directly to the toggle on the panel. Instead we'll need to run one wire from the relays to the wall rail and another from the relays to the front rail.

The relay power is wired the same as in Example 1. We connected the contacts on the Wilkes-Barre transfer block to a relay under the Allentown panel.

Here's the fun part, in order to switch polarity of the track we need two sets of contacts on the relay. Let's use 5, 6 & 7 for the wall rail and 8, 9 & 10 for the aisle rail. We can run the block wire for the wall rail to contact 6 and the block wire for the aisle rail to contact 9.



We've determined that when the track switch is thrown from Jersey City to Wilkes-Barre, we want the Allentown block to be normal (ground on the wall side, hot on the aisle side). With the track switch thrown from JC to WB, you determine that relay contacts 6 & 7 and 9 & 10 are making contact. Since we want the track to be 'normal' we'll need to connect contact 7 to the big ground wire, and contact 10 to the block toggle on the panel.



When we throw the track switch to route the train from Lehighton to Wilkes-Barre, we'll now need to reverse polarity. That means we'll wire contact 5 to the block toggle and contact 8 to the big ground wire. Viola! The polarity is changed when you throw the switch machine.

That's all there is to wiring on the GSC.

Notes: