TONY'S TECH REPORT

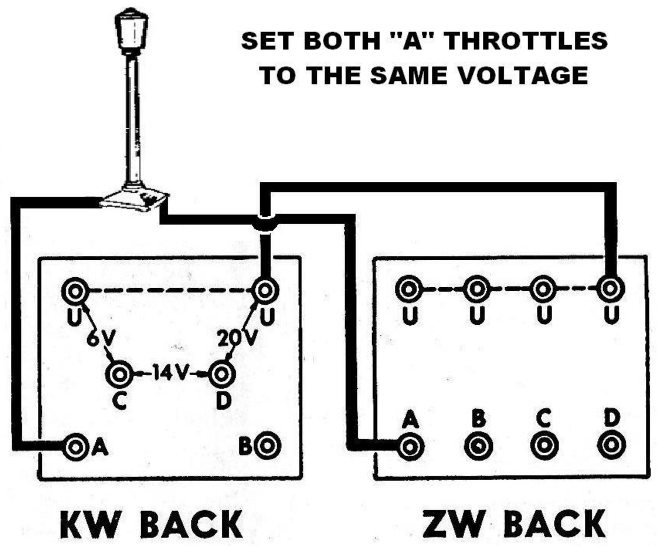
(It's time to go down the rabbit hole, Alice.)

"Red Pill or Blue Pill?"

In the movie, "The Matrix", the main character is given a choice before finding out the great truth about his existence. His choice is to swallow either a red pill (that starts him down an irreversible path to the truth) or a blue pill (that returns him back to his mundane, normal life). In a way, here you have the same choice – you can keep reading and find out some great things to do on your layout that aren't simple, or return to your single loop of track and display shelves. The choice is yours…..

Although we've covered a number of topics for building a good layout, there is still one fundamental topic we need to address – multiple power supplies. At this time, the biggest toy transformer is the current production Lionel ZW "Mark II". With four 180 power packs, the transformer can deliver over 700 Watts of reliable power even after many hours of operation. For many people, this may be enough power. But even if power is not an issue, the ZW II has only two usable throttles like the original ZW. Sure, there are four circuit controls, but two of them were never designed to be used as train throttles – they were meant to be set for accessory voltages once and that's all. As a layout gets bigger and bigger, more power is needed, but more throttles may also be needed – perhaps one for each loop. (NOTE: WITH TMCC YOU CAN BUILD A LARGE LAYOUT WITH NO THROTTLES EXCEPT FOR THE ONE ON THE REMOTE CONTROL, BUT COMBINING POWER SUPPLIES MAY STILL BE AN ISSUE – SO READ ON.)

Putting multiple power supplies together requires a specific process. First, take two transformers you want to use together and identify the COMMON connection (U on a ZW or KW) on each. If you have trouble finding the common connection, read your transformer's instructions. Next, connect (or "short" as we engineers say) the common connections using a single heavy duty wire as shown in the figure below. Then connect an 18V light bulb between two voltage connections of similar value. It is best to use two variable sources like the ZW and KW "A" connections shown in the figure.



Phasing Wiring for a ZW and KW

Now plug in both transformers into the SAME wall socket and look at the lamp. If the light is dim or off, the transformers are phased – both "A" sources are about the same voltage, so there's little or no light.

But, if the light is bright, there's a large voltage difference between the two "A" connections. How can this be if they're set to the same voltage? To put it simply, AC current (that's what's coming from PNM) is always bouncing back and forth between the two wires going to the transformer from the wall socket. When the transformers are out of phase, it means one transformer's current is bouncing one way while the other one has current bouncing the other way. The upshot is that "A" on one transformer may be 10 volts, but the other is actually MINUS 10 volts – a difference of 20 volts.

The fix is simple – unplug one of the transformers from the wall socket, turn the plug over (so you reverse the plug blades) and plug it back in to the wall. The transformers are now in phase and can operate safely together on your layout.

But what if your transformer has a polarized plug (one blade wider than the other) and you can't reverse it at the socket. First of all, if it is an older transformer, it shouldn't – Lionel didn't use polarized plugs until the 1970s and they never used a grounded plug (three prongs). If somewhere along the way, the original plug was replaced with a polarized or grounded plug, you should replace it with an un-polarized plug. If you're not comfortable doing this, find a friend who is.

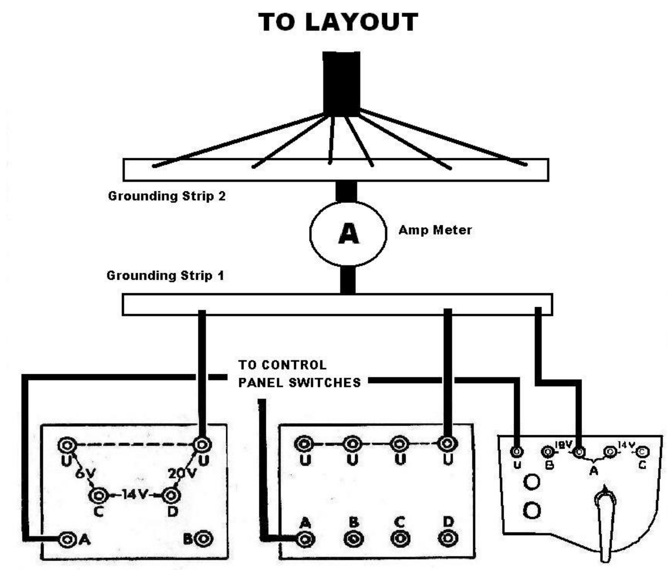
If you have a newer transformer that was manufactured with a polarized plug, the wiring should be correct to insure phasing if you use the same house circuit for all your transformers. Now this isn't always the case, and in fact, Lionel had a bit of a fiasco with one of the first batches of 180 Watt ZW II power supplies made about six years ago – the wiring was wrong and the packs could not be phased without a special adapter that Lionel had to provide…but that's another story. Don't replace a manufacturer's plug with a non-polarized one unless you have no other options.

Once you have all your transformers phased, mark their plugs in some way so you know how to plug them in correctly next time. Of course, I HIGHLY recommend a multiple outlet extension cord, a breaker bar like those used for computers, or a custom-wired house circuit to keep all your transformers powered so you can turn them on and off all together or at least only have to unplug one cord.

Now back to the layout – with all your transformers phased, all the COMMON connections serve the same purpose (and you remember from the last article how important COMMON is. Right?). So to make the best use of this, you'll want to "gang" the COMMONs on all your power supplies. The figure below shows a schematic for the way I usually gang transformers on my layout. Now, you don't have to do things exactly the way I do – this is just a guide to give you some ideas.

In the schematic, the transformer COMMON connections are all ganged into Grounding Strip 1. This is an aluminum bar with multiple screw connections for connecting wires – get it at any hardware store in the electrical section. At this bar, the transformer commons are all "shorted" and any of them now serve as common for the entire layout. It is critically important to connect each transformer to the strip with a wire sufficiently large to carry the transformer's maximum output current (we covered that in article #2).

Now for my personal touch – between Grounding Strip 1 and Grounding Strip 2 is an AC Amp Meter. I do this for two reasons – first, it serves as a good layout "diagnostic" so I can see how much current is being used and if there is a short circuit somewhere. Second, an amp meter on the control panel looks so cool! This is definitely not mandatory and can actually cause some problems – you need to find an amp meter than can carry the current of ALL the transformers AND you need to hook it up with wires that can carry the maximum output of all the transformers. On my layout, my three ganged ZWs are rated for a total of 73 amps and I use 4 12-gauge wires to carry that load.

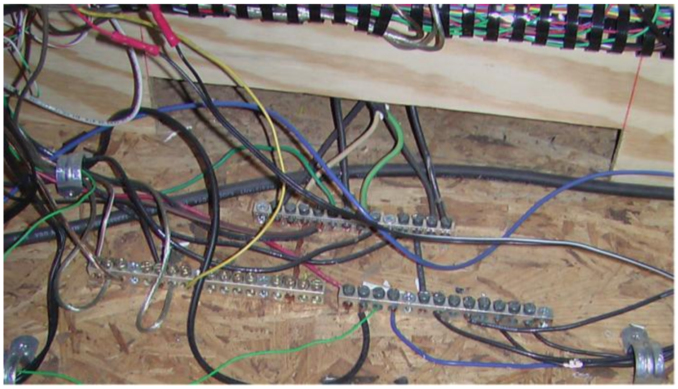


Transformer Ganging with Amp Meter

From Grounding Strip 2, several wires are used to take the current to the layout. Again, these wires have to be big enough to collectively carry the entire output of the ganged transformers. This can mean a few large wires going to grounding strips placed strategically under the layout (like I have) or many small wires going to each power connection. If you don't want the amp meter, you can simply make connections from Grounding Strip 1 to the layout and you won't need Grounding Strip 2.

The next figure shows a set of grounding strips inside my control panel (it's built like a rolling cabinet). Things are even a little more complex here than I described – these strips are actually a final gang point for all COMMON leads going to the layout. It also serves as a COMMON point for connections needed on the control panel itself (switch and UCS controllers, for example). Here, all the COMMON leads are finally ganged into five 10 gauge wires with a capacity of 150 amps. These wires then go to the layout and are dispersed to several grounding strips that serve as "substations".

From these, smaller wires go to the tracks and accessories.



Some of the Many Grounding Strips in my Control Panel

For my three ZWs, I actually don't use Grounding Strip 1 and instead take all the COMMONS directly to an amp meter. In Figure 4, you can see this meter on the control panel and the back of the meter inside the control panel. It's pretty obvious that this is one very large meter with some very heavy connections. These meters can be found at the shop I told you about in Article #1 and the connectors can be found at any hardware store.

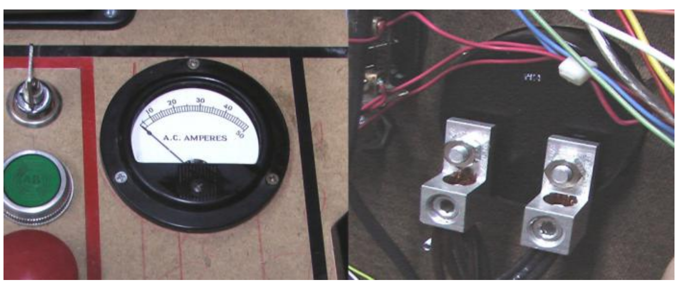


Figure 1. Amp Meter on the Control Panel and Rear Side Connectors

I need to say this again, since it is VERY IMPORTANT – GANGING TRANSFOMERS WILL BE VERY HAZARDOUS IF YOU DON'T USE THE RIGHT SIZE WIRING. We are going from the 16 to 20 gauge realm of the "train set" and are in the 10 to 14 gauge "house" wires here. Stop thinking "hobby shop" and start thinking "hardware store". Go back to Article #2 and read it again if you're not sure what wires to use.

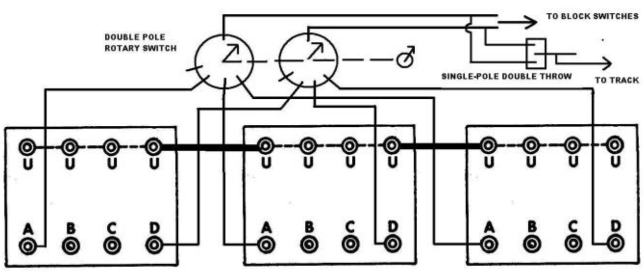
"There Are NO Instructions!"

I would like to tell you everything you need to know to build a great layout – but I can't. All I can do is teach you about technical concepts and tell you how I built MY great layout. There comes a point where the only guide for what to do next is what YOU want to do. So far, everything I've written about are the things that, except for the simplest train sets, you MUST know to operate toy trains. From here on, all I can say is - Read, Enjoy, Explore, and Choose for yourself what you want.

With this in mind, my next topic is choosing throttles. The need to choose a throttle comes from the simple reality that you have a number of loops (or routes) on your layout and some number of throttles on the transformers in front of you. Which throttle controls which loop or route? (NOTE AGAIN: A layout completely designed for TMCC doesn't need a method for choosing throttles since ALL the track should simply be powered with a large 20VAC power supply. However, if you're planning a layout that is to work in a conventional mode at all, keep reading.)

There are at least two answers to the question of choosing throttles: 1) give yourself every possible option, and 2) Give yourself every reasonable option. Both are feasible, but one is definitely cheaper. For example – let's assume that you have a layout with five loops and a well-defined train yard. And let's say you're using three ZWs to control the trains (Hey! That just happens to describe MY layout!). Three ZWs gives you six throttles for train control. So how do you choose one of the six throttles to control one of the five loops? Easy – you use a six-pole, seven-throw rotary switch!

"WAIT A SECOND!!! What the heck is that???" (you may ask). Well, in the wonderful world of electrical switches, poles and throws refer to circuits and choices. The pole number means the number of independent circuits that a single switch can control. The number of throws refers to the number of circuit paths that each independent circuit can take. A six-pole, seven-throw rotary switch means that by turning a single knob, I can control the paths of six different circuits in six different directions. BUT, instead, let's just look at two REASONABLE possible solutions to the design. First, below, we have three ZW transformers and we're going to use the A or D throttles on each one to control a loop of track or the train yard. My solution here is to use a double-pole-four-throw rotary switch that will allow the operator to choose one of the three ZW transformers to control each loop. Then, using a single-pole-double-throw switch, the operator can choose either the A or D throttle for the chosen ZW. For each block within the loop, one single-pole-double-throw switch is needed.



ZW Selection Using a Rotary Switch

But wait – why four throws when we have only three ZWs? The fourth throw is for "Off" – always a good option to have.

Second, in the next figure, we simplify the hardware by limiting the choices. Here, we limit the operator's options by using double-pole-double-throw (with a center-off position) switches to "pre-select" two of the ZWs for each loop. The thinking here is that the operator will only choose between a specific pair of ZWs for any loop. For some loops, ZW 1 and 2 will be used. For others, ZW 1 or 3 may suffice.

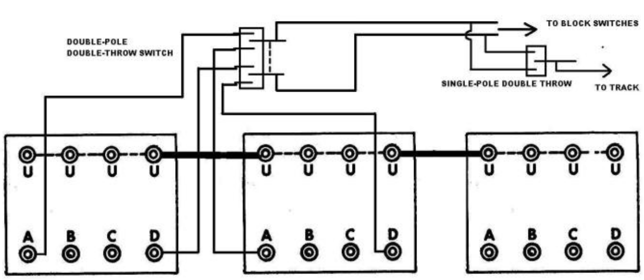


Figure 2. ZW Pre-Selecting Using Common Switches

On my layout, four of the five loops are pre-selected to use either one of my high-power (new) ZWs. The inner industrial loop and the train yard are pre-selected to use either my first high-power ZW or an older postwar ZW. With this system, I can either run one train from one throttle ANYWHERE on the layout or can neatly distribute the power requirements of five or six trains across five loops.

There is another simple reason for using a pre-selection system – cost. A good rotary switch that can carry the current needed for toy trains and matches the functions you want can cost a bit (if you can find it). On the other hand, 10 and 15 amp double-pole double-throw switches are very easy to find, especially at the surplus shops.

With all the things I have discussed so far fresh in your memory; the next step in the process is to decide how to place all these controllers and switches on a control panel. Many of you tend to be satisfied with a transformer sitting on a corner of the layout with a few switch and UCS controllers right next to it. That may be sufficient for some brokeback Department 56 layout, but a REAL railroad needs a REAL control center, and a good control center needs to be designed for the task at hand.

Below is a photo of the left side of my control panel. For those of you who haven't visited my train room, this control panel is the top of a true "control console". The console was built from the scrap wood leftover from my layout's bench work and four common furniture casters. The result is a rolling unit that is usually next to the layout, but can be disconnected and moved to the other side of the train room if needed.

Let me make a point right now – this type of control panel is a bit of "glitz and glamour" for the train room and looks rather impressive. However, it performs two critical functions that a large layout requires. First, it is a central ***ergonomic*** location for throttles and controllers. And second, the inside of the console serves as the main wiring vault where electrical connections are made. Even though it does very well in getting "oohs" and "aahs" from visitors with its various lights and dials, it also makes a layout like mine easier (if not simply possible) to operate.

Left Side of Control Panel

Ergonomics is the science of the man-machine interface. When a person is given a highly challenging technical task (like running multiple trains on a layout) good ergonomic design helps the operator make quick decisions on what actions to take and minimizes the effort in making those actions. Applying this to a control panel, I have arranged the throttles, switch controllers, and block power controls in such a way that a movement of less than one arm's length will get you to any device you need to control a train and its route.

The center of the operator's attention is the track plan which I made with colored striping material (available from any artist supply store). The different colors represent the different loops (Green – outer loop, Yellow – inner loop, Red – elevated, Silver – subway, Black – industrial, and Blue for the yard). This color scheme extends to the transformer selector switches (which are just to the left of the track plan) and the block power control switches (which are located within the lines of the track plan). All of the power switches are colored so you know which loop is affected by the switch you are going to activate. This helps eye-hand coordination much better when you reach for a switch than if everything was all one-color.

The switch controllers are located to the left of the track plan and are within a short reach. Now many of you know that some people build their control panels with buttons in the track plan for the turnouts. This definitely IS the right thing to do, but I'm too much of a traditionalist to replace my O22 controllers. And, yes, I have grabbed for the wrong controller many times (a victim of my own prejudices)!

To the right of the track plan (Figure 4) are the UCS controllers. These are also within a short arm's reach from the throttles. Like the switch controllers, they do not indicate any particular function just by looking at them (again, the price of nostalgia), but I have installed indicator lights in the track plan so that pushing either the UNLOAD or UNCOUPLE button on the UCS controller will show the UCS' location on the track plan.

Right Side of Control Panel

All the way to the left of the control panel are the accessory controllers. Here, ergonomic needs can give way to style since we are rarely under the gun to operate accessories (we can take our time deciding what to do). However, the controllers are laid out in such a way that gives a clue as to their general location on the layout.

Between the UCS controllers and accessory controllers is the power bus control area (left side of the photo). Here, there are toggle switches that can be used to turn each particular bus on or off. There are three buses for the switches, one for 18 VAC, one for 14 VAC, and one for 25 VAC. There are also buses on the layout for 5 VDC and 24 VDC. Finally, there are lighting buses for the houses, streetlights and towers on the layout. Two meters allow me to watch the status of the buses. First, there is a volt meter with a dial control that allows me to dial up the voltage of any bus. Also, there is an amp meter which lets me see what the total current load is for the transformers powering the accessories.

There are two simple but useful features to point out in the photo below. In the red circle is an indicator light and a voltage tap. The indicator light shows when the accessory transformers are on – a nice thing to know when things aren't working. The voltage tap is a panel-mount socket which is spliced into the 5 and 24 VDC power supplies. I have built a tether with the proper plug that can be attached here so I have ready access to my DC power supplies for the design projects I am doing on my work table next to the layout – very convenient. A tap for AC is just as easy to make and equally convenient for when you're working on a balky engine.

Bus Power Accessory Control Areas