Case Study - Texas & Southwestern

The Texas & Southwestern is a small N-Scale model railroad that features a Zephyr. The case study is broken down into several sections which detail the various facets of the construction and operation of this railroad.

- Background- *The idea behind the railroad.*
- The Railroad- *Planning the railroad*
- Track Plan
- Powering the Railroad- *Zephyr makes things easy.*
- Wiring the Railroad- *Hooking things up for reliable operation.*
- Reverse Loop- *AR1 makes things easy, but a little change in thinking is sometimes necessary.*
- Programming Track- *A convenient feature.*
- Zephyr Heat Problem- *Things don't always go smoothly.*
- Train Operations- *Realistic train operation keeps things interesting.*
- The Future- *There's always room for improvement.*

Santa Fe, All the Way!

Texas & Southwestern - Background

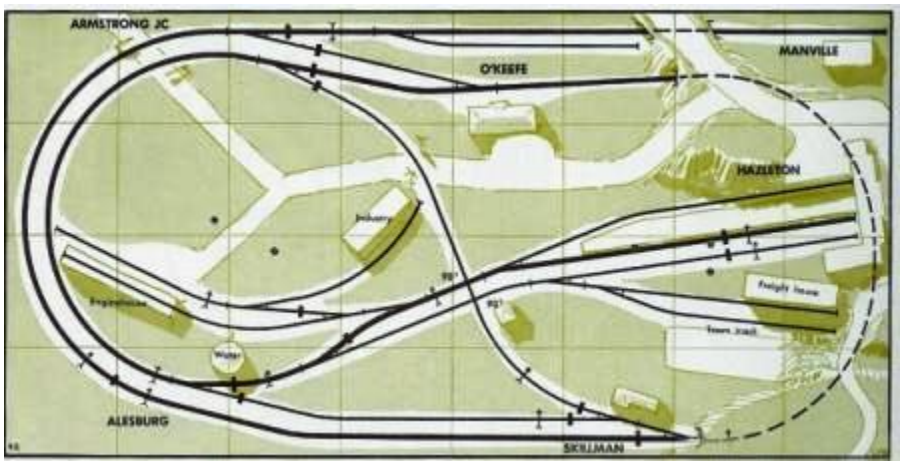
With this section, we will talk about the practical realities of building a model railroad with DCC. We chose Dallas, Texas as our locale, in part because so many great model railroaders came from Dallas, names that may not be familiar to you but people who helped make the hobby into what it is today.

Texas is big; any Texan will tell you so. But even when allowing for Texan pride, the ordinary outsider develops an appreciation for Texas size. From the piney woods of Lufkin in the east to the rough mountains of Big Bend, from the high plains of Pampa to the palm trees of Brownsville, Texas is big. Within this great state are a varied number of regions, all with their own unique character. And, for many coming to Texas from the outside world, their port of entry was Dallas. Dallas was big city New York; to the immediate west, Fort Worth was cowboys and cattle. To the south was Houston and ships. Southwest from Dallas was sleepy San Antonio. But Dallas was the first port of call for arriving visitors, and it was the stopping point for a wide variety of railroad passenger trains at two stations. Some famous named trains called there; their names are now becoming distant memories. They were trains such as The Texas Special, the Texas Chief, the Sam Houston Zephyr, the Lone Star Limited, the Bluebonnet, the Texas Rocket, the Sunbeam and the Texas Eagle, to name but a few. Amtrak still calls at Dallas Union Station, which at one time accommodated forty plus trains stopping there daily.

Our model railroad pays homage to the memory of those trains, and the countless freight trains that worked there, too. This railroad also pays homage to a great group of model railroaders who called Dallas home. Some of their names are still familiar, such as scenery expert Bill McClanahan. Others, such as C. B. Baird, Clint Grant and Terry Walsh formed the nucleus of an active group of model railroaders in Dallas who encouraged and assisted each other, leading to a large number of well executed model railroads. They all contributed to the development of our enjoyable hobby, and we honor them with this railroad. The layout's name itself refers to McClanahan's Texas & Rio Grande. Let us introduce you to the Texas & Southwestern.

Texas & Southwestern - The Railroad

Based upon a layout designed by the late, great John Armstrong which appears in the classic book,*101 Trackplans for Model Railroads* [Kalmbach Publishing, 400-12012, still in print], this railroad combines different elements to offer varied model railroad operations.



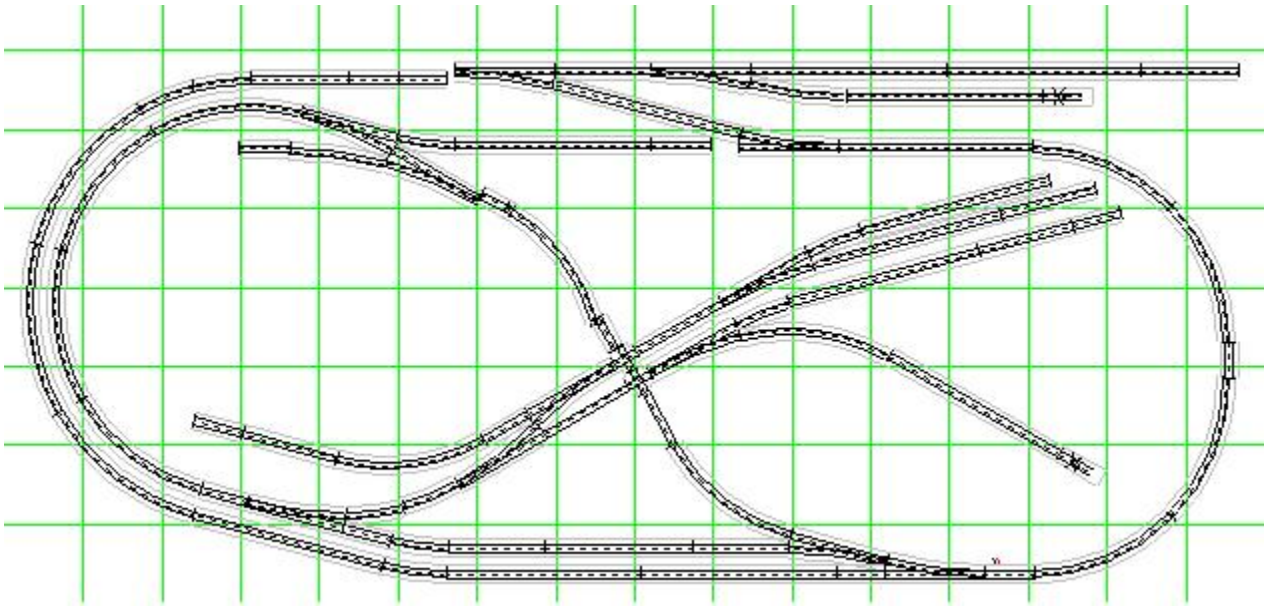
At the center right of the railroad is the Union Passenger Station. From this station, trains can operate *out & back*, which is to say that a passenger train leaves the station, goes out onto the circular main line and eventually comes back into the station after passing through the reverse loop. Another passenger train can operate *point to point*, meaning that the train goes out of the station, operates along the circular main line and then goes into another station area, located at the upper right of the plan. The railroad also offers continuous running, with trains simply running on the circular main line, with some variety being introduced through operation on the different tracks. Trains also can stop at the suburban station located at the area identified as "Skillman". The Texas & Southwestern also can handle freight train operations, especially freight car forwarding, using individual destination waybills for freight cars being picked up at the interchange, located at the top right of the plan, and being delivered to the grain mill and the warehouse adjacent to the Union Station. These cars are later picked up and returned to the interchange, where they are exchanged for other cars. This allows you to exchange freight cars on the railroad, making for a variety of different colors and car types. Our industries primarily require covered hopper cars and box cars, but other car types such as tank cars can be used also. Armstrong's original plan, named the Pennsylvania & Potomac, was drawn to fit in a 48" by 96" space in H0-scale. Although N-scale is about 50% of the proportion of H0, because of track geometry issues, this layout is not exactly ½ the size of the H0 railroad. As with any other model railroad, concessions have been made to the reality of actually building something. Dallas, Texas had many more tracks that we have built here, but the look and feel of the area has been captured. Here, the track plan is first set out to test for fit and arrangement:

The observant have already noted that we eliminated several tracks for the purposes of simplicity. Kato Unitrack shows its real utility here, with the track plan quickly snapped together and able to operate on a carpeted floor. Of course, we will be doing more than that. Here, the layout is fitted to its supporting frame of 1/2" MDF. The layout surface is covered with a sheet of HomasoteTM, a recycled paper product, which absorbs the noise of model trains rolling over the railroad. Building locations are still being determined at this point.

As with every model railroad, concessions to reality have been made. For one, the Dallas Union Station had considerably more tracks than the meager three of our railroad. The terminal building itself was to one side of the tracks, not above them as on our little pike. And, there are some other little concessions along the way because this is, after all, a model railroad. That said, what is important here is that a good model railroad captures the flavor of the place it represents, and, as we go along, little details will be added to make this world real. In short, the Texas & Southwestern is an interesting model railroad to operate, which helps draw the operator into this small world. Each side of our model railroad has a Universal Panel, which allows four or more operators to work this model railroad at one time. With one operator handling signals and track switch operations, there is enough capacity for three other operators to run trains, although each may have to wait for other trains, as it is with the prototype railroads.

Texas & Southwestern - Track Plan

In response to a request, here is a semi-official track plan of the Texas & Southwestern:



The railroad uses Kato Unitrack:

- 249mm radius curves
- 282mm radius curves
- Seven #4 *Right* turnouts, configured to be "*non current routing*"
- Five #4 *Left* turnouts, configured to be "*non current routing*"
- Two 90° crossings

- A variety of straight tracks, including the 20-091 *Short Track Assortment*
- Three 20-050 *Adjustment Tracks*
- Several 24-818 Terminal joiners to supply power to the railroad and to connect the AR1 to the reversing segment
- Insulated Unijoiners were used to define the reversing segment.*Alert readers will note that the tracks do not seem to align up properly. In practice, these minor misalignments can be worked out without problem. The Adjustment Tracks can also be used to correct minor misalignment.*

Texas & Southwestern - Powering the Railroad

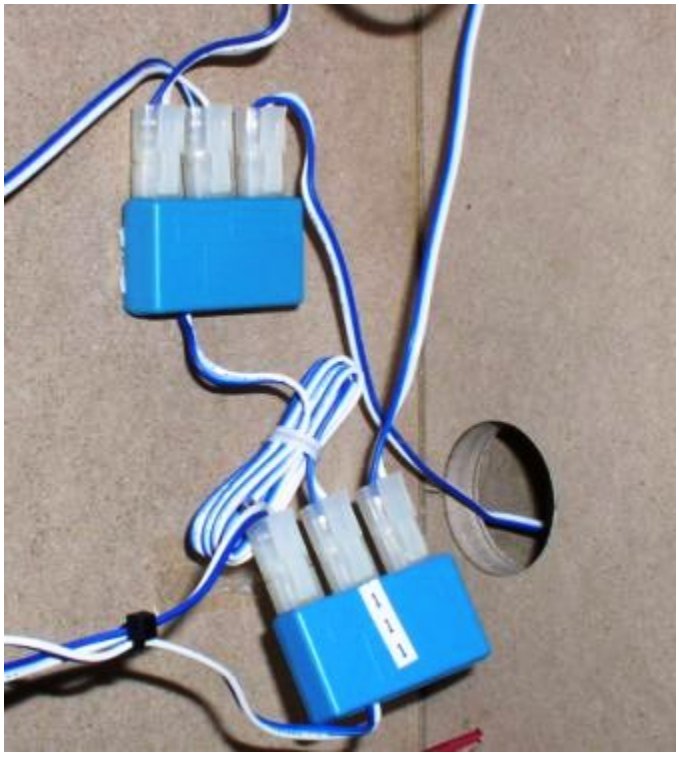
Good DCC practice means good planning for the electrical needs of the railroad. Here, we talk about the power needs of the Texas & Southwestern.

Anticipating Power Consumption The core of the Texas & Southwestern's DCC control system will be the DCS50 Zephyr, which is very appropriate for a small railroad. Zephyr has 10 "slots", memory

locations in the command station each holding an active decoder address. Rated at 2.5 Amps, the Zephyr should also be enough to handle the power needs of the railroad, but if more power is needed, then T&SW can easily be expanded with an additional booster and power supply. The power needs of the T&SW were estimated in this way:

- 5 locomotives - *It was assumed that the railroad would have five locomotives present at any given time*
- 4 passenger cars illuminated with LED's - *It was assumed that there would be four passenger cars, more than enough for a small railroad.*
- Kato Unitrack turnouts - *The Texas & Southwestern has twelve Unitrack turnouts, but only one operates at any given time.***The Basis of the Calculation** The T&SW's power needs were estimated in this way:
- **Locomotive Power** - *A typical N-Scale locomotive consumes 300 MA when in operation. When idle, the locomotive decoder still draws 5 MA and the headlights draw 50MA if they are conventional light bulbs or 15MA if they are LED's. So, we assumed that each locomotive would draw 350MA*
- **Passenger Car Lighting** - *It was assumed that each car would draw 15MA, using LED internal lighting kits*
- **Turnouts** - *It was assumed that each turnout would draw 200MA when in operation.*
- **DCC Devices** - *The T&SW has twelve turnouts, each controlled by a DS51K1. Each DS51K1 was assumed to draw 5MA when the railroad is in operation. The railroad also includes an AR1 Auto Reversing Unit, which is assumed to draw 30MA when the railroad is in operation.***The Calculation**
- **Locomotives** - 5 locomotives at 350MA each = 1750MA
- **Passenger Cars** - 4 passenger cars at 15MA each = 60MA
- **Turnouts** - Only one turnout operates at any given time, so 200MA
- **DCC Devices** - 12 DS51K1's at 5MA each, one AR1 at 30MA; 12 x 5 = 60MA, plus 30MA = 90MA1750MA 60MA 200MA 90MA 2100MA Total The total power consumption of the railroad is estimated to be 2100MA, or 2.1 Amps. The total power capacity of the Zephyr is 2.5 Amps, with the Zephyr drawing its own power needs from the same PS315 power supply. So, by estimation, the Zephyr and its power supply should be sufficient for powering the Texas & Southwestern. *It should be noted that the DCS50's 2.5 Ampere rating is "peak", meaning that the Zephyr can handle a 2.5 Amp load for a period of time, but it should not be operated at 2.5 Amps continuously because of heat build up in the unit. If your power consumption is continuously around the rated power of the booster, you should consider dividing your railroad up into power districts and adding additional boosters.*

Things Change At the same time, things change and estimates are just that, estimates. When the railroad was built, it was anticipated that it might be necessary to add a booster & power supply and train detection for signaling at a later date. So, when the tracks were placed, the railroad was divided up into smaller isolated segments, and all were joined together by using Kato 24-827 3-Way Extension Cords.

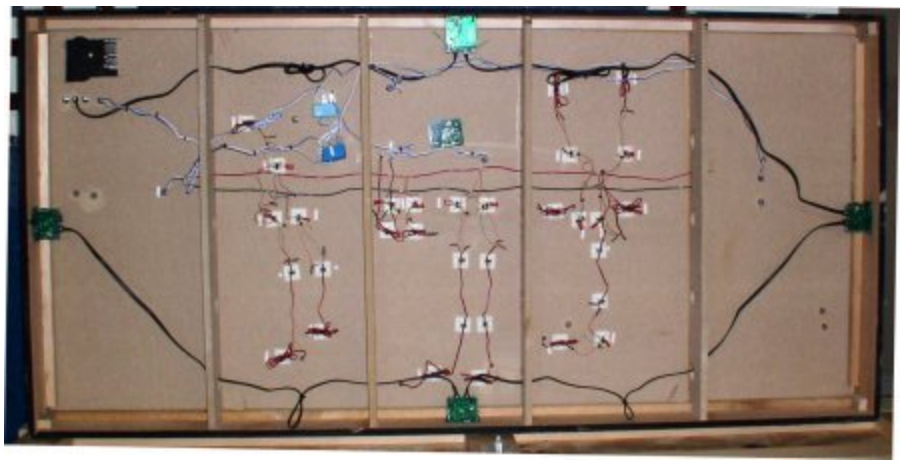


If, at a later date, the layout owner wanted to add train detection for signaling, it is a minor matter of disconnecting the various segments and the reconnecting them to BD4s or a BDL168. Likewise, if the railroad's power needs continue to grow, it is also easy to disconnect the track connections and then reconnect them as needed.

Case Study: Texas & Southwestern - Wiring the Railroad

This section discusses the installation of the physical wiring of the Texas & Southwestern.

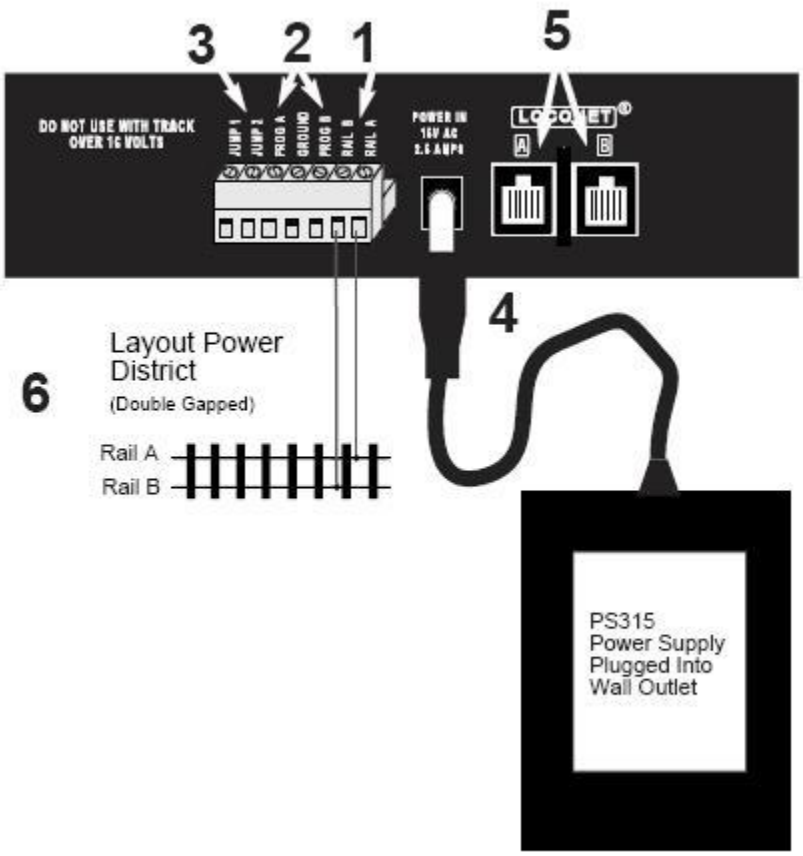
Underneath the completed Texas & Southwestern are various wires and cables which allow you to operate your railroad.



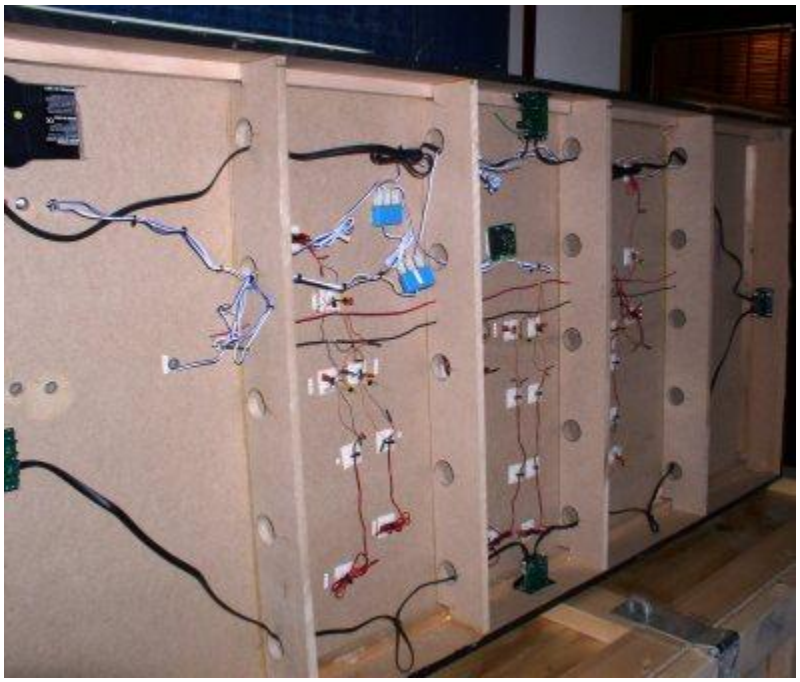
Initially, seeing all these wires can be intimidating, but as you will note, they have been grouped and bundled so that identifying the individual wires is easy. There are two groups of wires under the railroad; one group, the *power bus*, delivers power to the tracks and to the stationary decoders that operate the track switches. The other group of wires is the black cable for *LocoNet* and its devices.

Power Bus: The Zephyr is fitted into one corner of the railroad and the various wires are fed through to the bottom of the railroad.

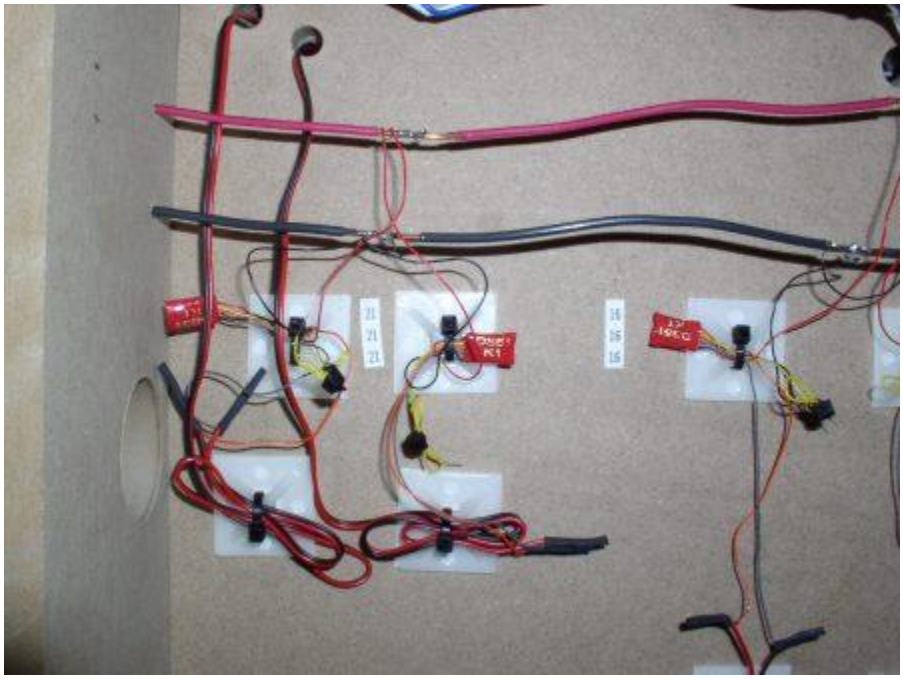
The power bus connects the terminals of the DCS50 Zephyr to the tracks of the railroad and the stationary decoders that are used to operate the track switches.



Please note that the protocol used for DCC wiring and the standard colors that Kato uses for its devices are not the same. Clear labeling and tidy wire bundles minimize this possible source of confusion.

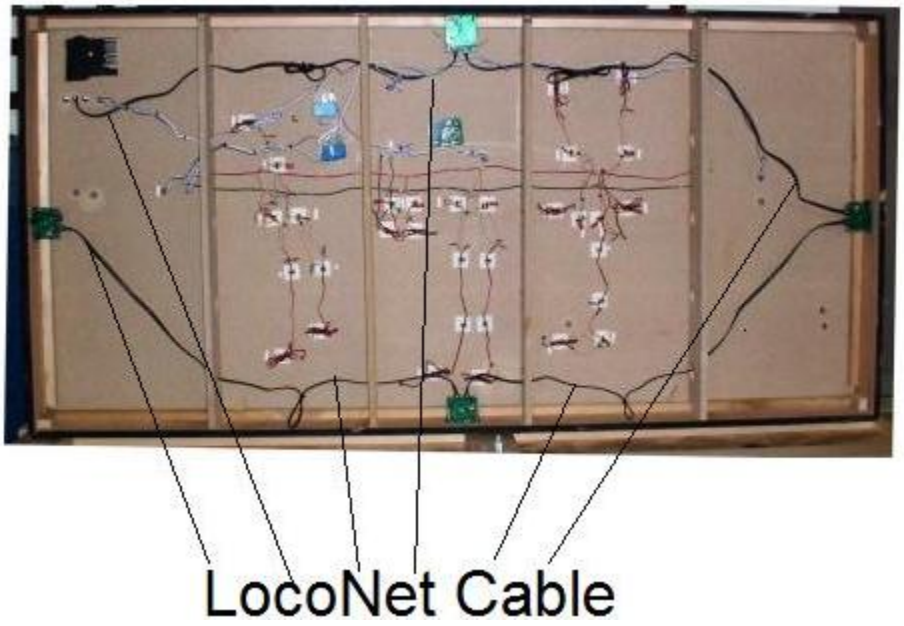


In this bottom view, the blue/white cables are the power bus cables coming from the Zephyr (*upper left*). As noted in other text, these cables have been split into groups should it later be necessary to subdivide the railroad to add an additional power booster and power supply. In the middle of the railroad is a smaller power bus which uses red and black wires; the stationary DS51K1 decoders are attached to this bus.



In a close up view, three DS51K1's are first connected to the power bus and then to the turnout which they control. The red and black wires of the DS51K1 are connected to the power bus, while the orange and gray wires are connected to the Kato turnout. Again, a possible source of confusion is that the orange and gray wires of the Digitrax decoder are soldered to the Kato turnout wires, which are red and black. Once the decoders are in place, the turnouts are programmed and small numerical tags are placed to identify each of the DS51K1's. The power bus is also connected to the AR1 Autoreverser, which is discussed separately.

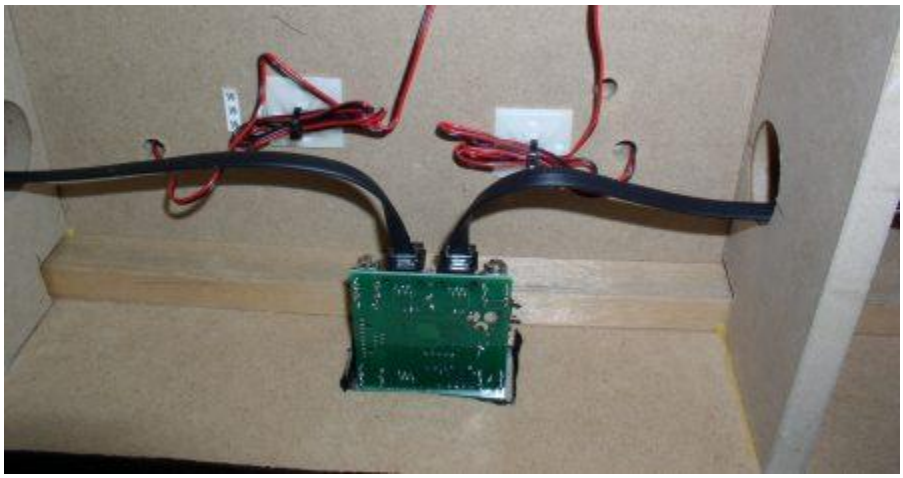
LocoNet: The other key component is the LocoNet. LocoNet allows the addition of throttles, a computer interface and other useful devices.



The black cable is the LocoNet cable, which is connected to the back of the Zephyr and the is daisy-chained to the other LocoNet devices; in this case, it is four Universal Panels.

Universal Panels: The Universal Panels allow individual operators to plug into LocoNet to operate trains. From the front, the Universal Panels provide a clean appearance.

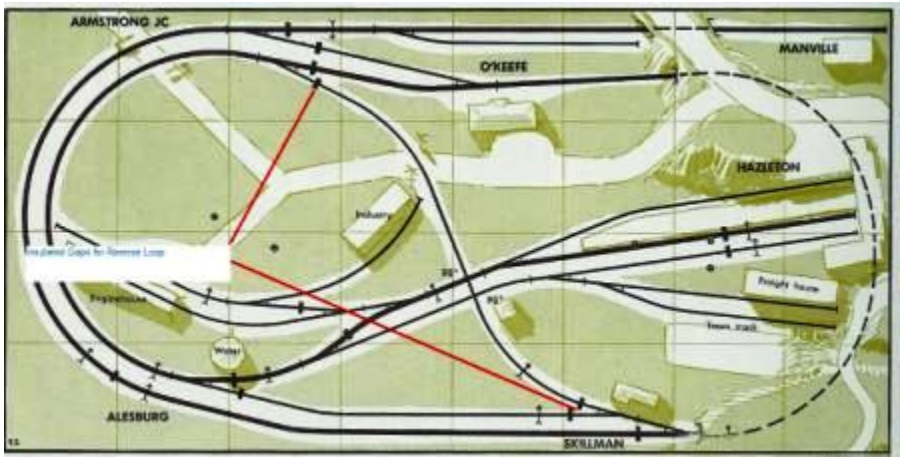
The Texas & Southwestern is fitted out with three UP5s and a UR91. The UR91 allows for tetherless operation, either via infrared or via simplex radio (Use UR92 for infrared or duplex radio operation). Care should be exercised when installing the universal panels to avoid damaging the front graphics. The LocoNet cable is first connected to either LocoNet port of the Zephyr, then connected to one socket of a Universal Panel. The next segment of LocoNet cable is connected to the other socket and then is connected to the next LocoNet device. LocoNet can be arranged in a free-form fashion, but it must never be connected back upon itself by returning to the LocoNet ports of the Zephyr.



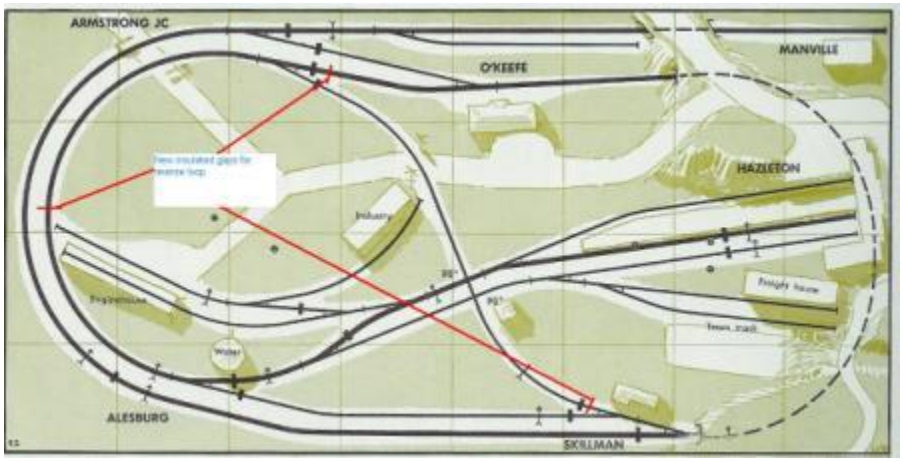
The AR1 Autoreverser is discussed separately, under "Reverse Loops".

Texas & Southwestern - The Reverse Loop

*The Texas & Southwestern has a reversing loop, and DCC insures reliable and simple operation of trains in the reverse loop. This reverse loop is handled with a Digitrax AR1 Auto Reversing Controller. The automated features of the AR-1 make for seamless train movements, but an issue quickly arose.*Because a reverse loop in a traditional DC-powered model railroad environment required manual operation, the track insulating gaps for the loop were usually located for the convenience of the operators. So the track gaps of the original track plan were situated to keep this inconvenience to a minimum. Note also all the other insulated track gaps that were required for traditional DC operation.



Initially, the two gaps for the reverse loop were established at the points marked on the original track plan. Several other gaps were also placed, with an eye toward the possible need for future power expansion or train detection; these segments of track were then joined together with Kato 24-827 three-way extension cords and then connected to the Zephyr. The reverse loop is managed by an AR1 Automatic Reverse Section Controller. When a train enters into the reversing segment, the AR1 senses track power phase between the reversing section and the rest of the railroad and then automatically matches the two. As originally constructed, the reverse loop was defined by insulated joiners at the original points specified in the track plan. The AR1 was connected to the reverse loop and the power bus, and everything worked well when locomotives were operated to test the wiring. However, when lighted passenger cars were added to the locomotive, passage through the reverse loop resulted in a short circuit. This happens because the passenger cars have electrical pickups in their wheels and the train was long enough to cause electrical bridging between the main railroad and the automated reverse loop. So, the automated reversing segment was lengthened so that the longest train would be entirely within the reverse loop.

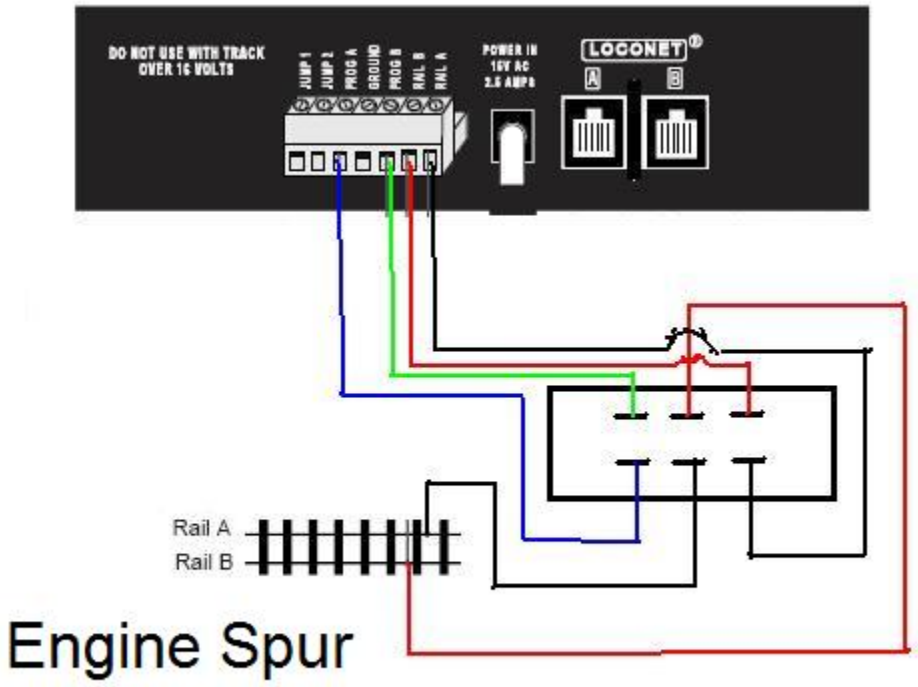


Because of the automated feature of the AR1, it does not matter if a train operating on the regular portion of the oval (*from O'Keefe to Skillman*) has to pass through the reversing area. The train operator never knows that the AR1 is in operation.

Texas & Southwestern - Programming Track

One special feature on the Texas & Southwestern is a built-in programming track.

The programming track is located in a short section of track in the small engine terminal of the T&SW. This track has both rails insulated from the rest of the railroad. It uses a Double Pole Double Throw (DPDT) toggle switch to select what purpose this section of track is used for. When the toggle switch is set in one direction, the track has DCC power on it. When the toggle switch is aligned in the other direction, the track is now connected to the programming terminals of the Zephyr. The diagram below shows how the programming section works:

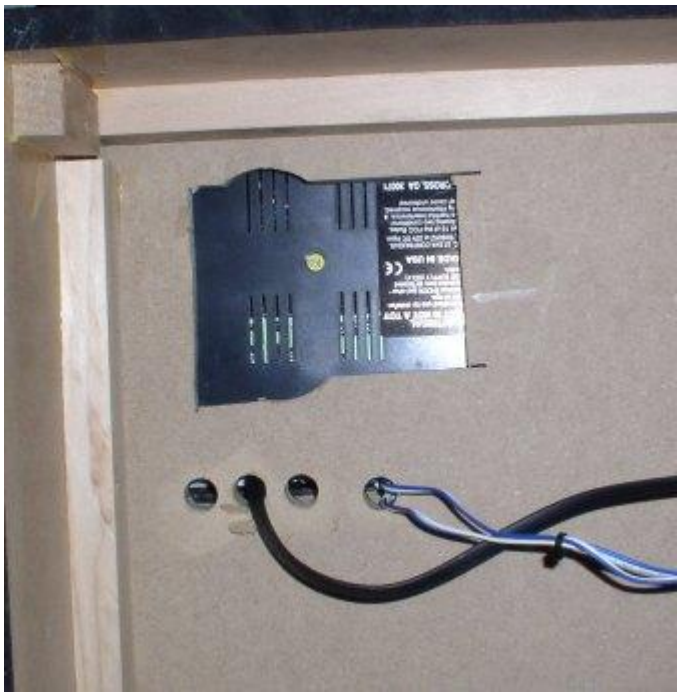


Note: *The wire colors shown are for illustrative purposes only.*

Texas & Southwestern - Zephyr Heat Build Up

From the start, the Texas & Southwestern was built with DCC in mind. The T&SW was built from the ground up by an individual with considerable model railroad experience, but an issue arose that defied explanation. The T&SW was meant to be operated with a DCS50 Zephyr, and the layout support structure was enlarged slightly to fit the Zephyr into one corner of the railroad.

As it turned out, the cozy corner space for the Zephyr turned out later to be a bit too cozy. The bottom of the Zephyr has ventilating slots to help cool the unit's electronics. As the layout was being wired and tested, it became apparent that something was not right. Initially, everything worked smoothly but after a while, the trains would begin to operate erratically. After some thought, the layout builder realized that the Zephyr was not getting proper cooling and that the erratic operation was due to excess heat build up in the DCS50 Zephyr. The problem was solved by opening the shelf below the Zephyr so that air would flow easily around the unit.



Not a very clean opening, but only visible to those with access to the bottom of the layout. With the benefit of reflection, it would seem better to place the Zephyr on a shelf located in the same position, with at least two sides and a portion of the bottom open to allow free flow of cooling air for the Zephyr.

Texas & Southwestern – Operations

A model railroad continues to be interesting if there are opportunities for growth and for operation. Extra detail can be added, scenery can be enhanced, but in the end, if the railroad is interesting to operate, it will continue to be a source of enjoyment for its owner for many years. The Texas & Southwestern has many opportunities for interesting train operations. The Texas & Southwestern is both a passenger railroad and a freight railroad.

Passenger Point to Point Our trusty RDC (*rail diesel car*) allows for one train to operate in a point to point fashion. In fact, all trains operate in a point to point fashion, but because the RDC has a control cab at each end, "turning the train around" just means that the engineer gets up, removes the reverse handle and then walks to the other end of the RDC. The reverse handle goes into the control stand and then he waits for the high sign from the conductor. The Santa Fe only had two RDC's, which initially ran in Los Angeles - San Diego service. In our imaginary world, DC192 ended up in Dallas.

DC192 stops at Skillman on the way to Dallas after leaving Manville

Passenger Out & Back Other longer passenger trains leave Dallas, make several laps around the railroad and then return to Union Station.

Santa Fe PA Number 52 leads a small passenger train out of the Union Station.

It continues around the inner loop and crosses over onto the outer loop.

The train will continue several laps before it crosses onto the return loop.

Eventually, Santa Fe 52 and train enters the reverse loop.

And home.

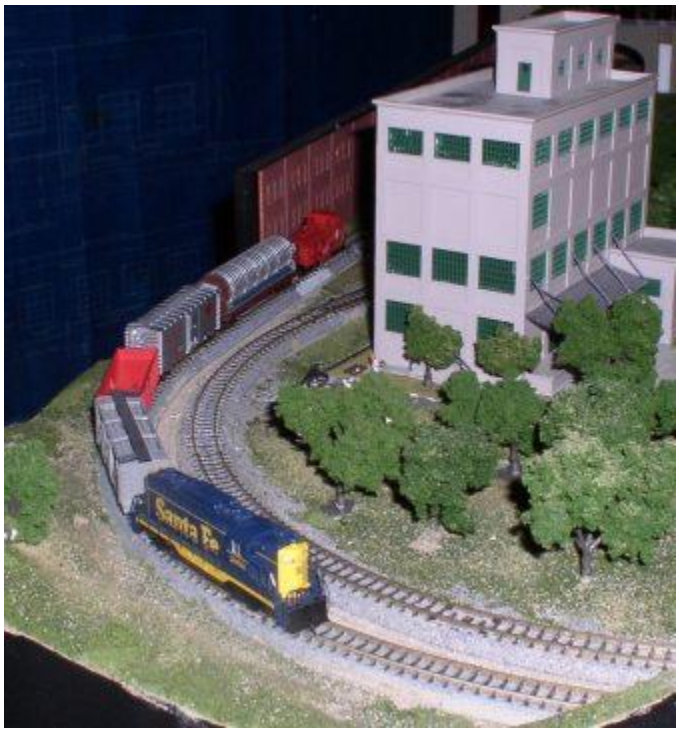
Way freight Likewise, there are opportunities for freight trains also. Here, a way freight drops off and picks up cars at an interchange with the Fort Worth & Denver City.

The caboose is dropped off and the Geep swings into the clear.

Four freight cars are dropped off at the interchange.

Four new cars are picked up and the Geep again swings into the clear.

The cab is picked up and our way freight continues on.



A brief stop at Skillman to handle the paperwork and our train continues on.

Freight Continuous Running And if you just want to watch the trains run, the Texas & Southwestern has plenty of opportunity.

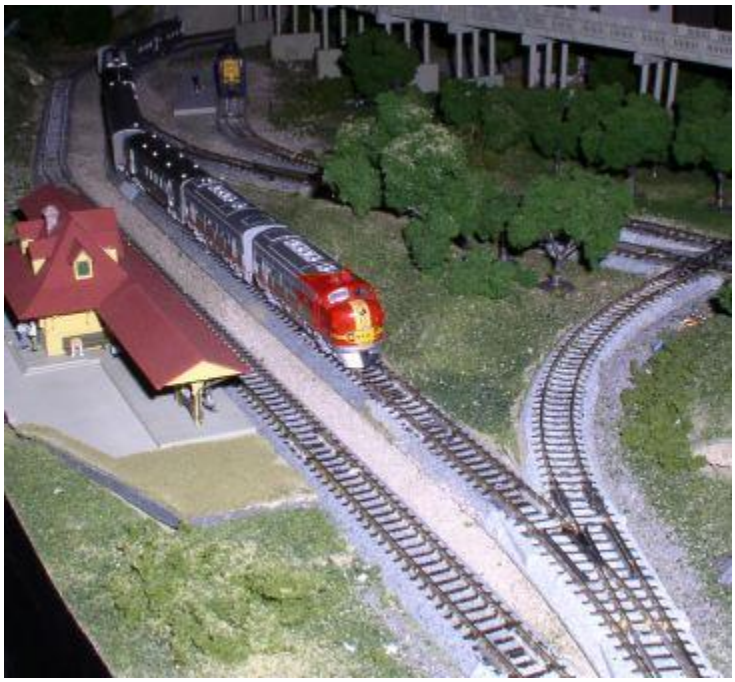
Highball!

Texas & Southwestern - Future Expansion

As originally conceived, the Texas & Southwestern was set up with a very simple DCC system. The railroad uses a DCS50 Zephyr as its command station and booster. The Zephyr is connected to a central power bus, and all tracks, stationary turnout decoders and the automated reverse loop unit are connected to it. Likewise, the LocoNet connections are a series of simple cable connections starting at the Zephyr and ending at the last Universal Panel. The T&SW works well with this arrangement, but there are additional devices that will enhance the operation of this railroad.

Digitrax PM42 Power Management System Should the railroad continue to grow, one possible addition would be a PM42 Power Manager. As originally wired, the T&SW's Zephyr was connected directly to a power bus which served the track, turnout decoders and AR1 Auto Reversing Controller. In most cases, this has been sufficient, but a small problem emerged. Whenever there was a short circuit on the railroad (usually at a misaligned track switch), the entire system would shut down. Once shut down, it was not possible to operate the track switches or the trains. So, when a train stalled at an improperly positioned turnout, it was not possible to back the train away from the turnout to operate that turnout. The PM42 Power Manager connects a single booster (in this case, the Zephyr) and divides its power output into 4 power sub-districts for improved operation by preempting booster shutdown when a short circuit is detected by the PM42. For small railroads such as the Texas & Southwestern, the PM42 improves operations without adding further power supplies. In addition, each of the PM42's power nodes can be set up for auto-reversing. On the Texas & Southwestern, the PM42 could be configured so that the track power is monitored by one node of the PM42. The power bus for the turnouts could be connected the second node of the PM42. The reverse loop could be connected to the third node of the PM42, which has been configured for Auto-reversal, replacing the AR1. By doing so, a short circuit in one power district does not affect the other power districts because the PM42 isolates each electrical function of the railroad.

Signals: The Texas & Southwestern offers good opportunities for signals. The railroad would need to be divided up into detection sections, each connected to either one BDL168 or several BD4s. Once the presence of trains is detected, a computer program such as Railroad & Co. would be necessary for signaling logic. Once the logic was applied, an SE8C or similar device would be used to drive the signals themselves.



Many thanks to Mr. Riley O'Connor for sharing the Texas & Southwestern with us.