Scale Rails

Electrical/Electronic Wiring and Troubleshooting Clinic

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Topics

1. Basic AC and DC circuits
2. Using a meter - Voltage AC/DC, Current AC/DC, Ohms
3. Test Lights
4. Basic electrical formulas
5. LED basics
6. Reading Resistors
7. Building wiring
8. Track wiring – feeders, buses, rail joiners
9. Turnouts – Tortoise, switches, LED’s
10. Troubleshooting Track Problems

Basic AC and DC Circuits

- AC (Alternating Current) is the power supplied to our homes (Westinghouse).
  - Arrives as 120/240 VAC to our homes and small businesses.
  - Large businesses use three phase power (208 or 480 VAC).
  - Requires a transformer or switching power supply to lower to levels we use for our train systems.
- DC (Direct Current) is the power used to operate electronics (Edison).
  - Batteries, inverters, Wall warts, Regulated power supplies are examples.
  - Most devices operate with a negative ground just like our cars.
  - Common voltages are 1.5, 5, 12, (24, 48)

Using a Meter

- Most digital meters are designed to measure
  - AC (0-2000 VAC)
  - DC (0-2000 VDC)
  - Ohms (0-10 Meg Ohms)
  - Ohms (short test) (tone)
  - Some can test diodes.
  - **Current (0-250 MA and 0-10 Amps) be careful!!!**
    - Never leave meter set to current setting (MA) or leave probes in Current positions. Can result in blown fuse or damage to meter. Always double check.
  - Warning: Working with voltage beyond 24V is dangerous.

Test Lights

- Purpose: Test for presence of voltage.
- Types:
  - Neon (Use only with AC) (120-240 VAC)
  - Incandescent (each bulb has voltage limits). Most common is 12-18 Volts. Works on AC or DC.
  - LED (Requires LED with resistor in series). A LED with a 2.2K resistor will let you test up to 24 Volts AC or DC. If you only want to test 12-15 Volts then use a 1.5K resistor.

Basic Electrical Formulas

- V=IR
  - **Voltage**(V) equals **Current(I)** * **Resistance (R)**
  - What value resistor do you use with an LED?
  - R=V/I
  - DC Power supply is ~12V. 15ma (.015) is good for LED's.
  - 12V-(~1.5V for each LED in series)/15ma =10.5/.015=700 ohms.
  - 1 K (1000 ohms) is a common value.
- Watts=I*V or I^2*R
  - How many Amps is a circuit drawing?
    - Take the average hairdryer (1800 watts).
    - I=W/V=1800/120=15 amps
  - What wattage resistor should you use (¼ or ½ watt)?
    - W=I^2*R=.015*.015*1000 = .22 watts (suggest ½ watt)

LED Basics

- LED's are polarity sensitive (+ and – lead), + is the long lead.
- LED's are a constant voltage device. This means you must limit the current they draw to avoid killing them.
- Stated another way. As you raise the voltage across the LED, the voltage will rise until it hits the turn-on threshold of that LED (~1.5 VDC). Once it turns on, it will draw as much current as possible until either the power supply gives up or the LED dies. Usually the LED will die first. LED's like 15ma max (.015 amps).
- LED's can never be put in parallel but can be put in series. Standard LED's must always have a current limiting resistor. The series method can be used in lighting buildings and passenger cars. Try a max of four in series. So that's 4X1.5volts=6 volts drop across the LED's. Then 12-6=6 volts across the resistor. So then the resistor value is R=V/I or 6/.015=400 ohms. 390 and 470 are common values.

Reading Resistors

- Resistors have four bands of color.
- Hold the resistor with the silver or gold band to your right.
- Starting from left to right.
  - The first band is a number
  - The second band is a number
  - The third band is the number of zero's
  - The fourth band is tolerance (accuracy). Gold = 5%, Silver=10%
- Band colors to numbers.

  0 = Black 1 = Brown 2 = Red 3 = Orange 4 = Yellow

  5 = Green 6 = Blue 7 = Purple 8 = Gray 9 = White

•Example: You want a 1000 ohm resistor (1K) (K=Kilo=1000)(M=Meg=1,000,000)

  •1=Brown, 0=Black, 2 zeros = Red (Brown-Black-Red)

•Example: You have a Resistor (Red-Red-Red) What value is it?

  •Red=2, Red=2, Red=2 Zeros=2200 ohms or 2.2K

•Common resistors are 10, 22, 33, 47, 68, 100, 150, 220, 270, 330, 470, 560, 680, 760, 1K, 1.2K, 1.5K, 2.2K…

Building Lighting

- LED's
  - Suggest using warm white LED's. Greatly reduces the power demands on the Wall warts.
  - Cheapest way to buy LED's is Christmas lights (<$.20/each).
  - You can put LED's in series but never in parallel.
  - You can usually put four in series with 12VDC, remember to add a resistor.
  - Some of the LED's have resistors built in already. LED's run best drawing between 10-15 ma. I bought a set at Target and put four in series without a resistor. They drew 8 ma at 12-13 VDC.

Track Wiring

- Never rely on rail joiners to conduct power! Will break down over time.
- Soldering rail joiners will conduct power but can cause trouble when the track expands or contracts with temperature changes.
- **Always** install feeders on each section of **track** and all **turnouts**. 22 gauge stranded wire is a good choice. Keep the two colors consistent at all times.
- Use 12-14 gauge stranded wire for buses.
- Make the feeders and the buses the same color if possible.
- Good idea to put a short tester across the two rails while connecting track. This will show a problem quickly.
- **Avoid using power routing turnouts. I feel they should be burned and then be careful where you put the ashes. Never use them on any part of a reversing loop**.
- DCC Insulated frog turnouts can be used. Suggest using Electro-frog turnouts for best results. Power the Frog off the tortoise switch contacts. Like Fast Tracks.
- Suggest powering each major track section from a separate electronic circuit breaker. Makes finding track shorts easier.
- Currently find DCC Specialties products the easiest to work with.
- Block switches can be added to power off tracks but not necessary in DCC.

Wiring turnouts

- Suggest using Electro-Frog turnouts.
- Electro-Frog turnouts (DCC) friendly require no additional gaps to prevent shorts unlike the power routing turnouts.
- Always connect two feeder wires to the turnout stock rails to prevent future power problems.
- Suggest adding jumper wires on the exit rails A to A and B to B. Some manufactures put in tack welded jumpers but they seem to fail.
- Suggest using a Tortoise switch machine to operate the turnout.
- Parts needed to operate the turnout.
  - 12 VDC supply, wall-wart ($5). Can operate many.
  - Tortoise switch machine ($15-18)
  - DPDT toggle switch, no center off ($1.50-2.00).
  - Two bi-color R/G LED's ($.40)
- See handout for wiring diagram.
- Use Tortoise switch contacts to power frog.

Troubleshooting Track Problems

- Problem: Loco stops on turnout or open track.
  - While loco is stopped. Don't touch. Get your meter and set to AC volts for DCC and DC volts for DC power.
  - First measure the track power on each side of the loco.
  - If zero:
    - Next measure across each the rail joiners. You should find voltage across one of the rail joiners. This is the problem rail.
    - Fix for problem two ways.
      - Add feeders to fix the problem. Preferred. Both rails.
      - Or Solder a wire across the rail joiner. Do the rail joiner on the other side too, it will fail soon.
  - If not zero:
    - Then check for dirty track. Check the frog power if so equipped.
    - If frog power is zero, then check for bad tortoise contacts. Rare.
  - If problem still exists, check to see if loco has dual power pickups. One set may be not working.