DCC Concept & Layout Design

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Standard DC Control

- Voltage magnitude determines locomotive speed.
- Voltage polarity determines locomotive direction.
- For multiple independent locomotive control, track must be divided into electrical sections. All locomotives and rolling stock within a section receive the same voltage polarity signal.
  - Some areas, such as an engine terminal, may require a lot of sections.
  - Some form of control of the sections is required, either switches (toggle, rotary, etc.) or multiple throttles.

DCC Control

- Voltage on the track is a AC square wave. It is both the power and signal.
- Decoder in the locomotive “reads” the track signal and determines the power and polarity the motor is to receive.
  - The polarity of the signal can change while the train is in a section, with no change in speed or direction.
- All equipment on the layouts sees the same signal. Each decoder determines which commands are for it, based on its programmed address.


MULTIMETER
14.256
rms
VAC
15V
6.7117
kHz
Combo
30V
AUTO
Rel
Peak
Hold
rms
Average
dB
600Ω
Full
Auto
1
2
3
4
5
FREEZE

DC vs. DCC

- With DC you are really controlling the track section. Someone or something (computer) must switch the power to the track sections when multiple trains are being run on a layout. Control is more like a tower man.
- With DCC you are control the locomotive directly, so control is more like a locomotive engineer.

DCC Advantages to Layout Design

- Because locomotive control is based on a signal and not the control of a track section, it can simplify some layout control functions.
  - Eliminate or reduce the number of switches needed to control a layout.
- DCC can be used to independently control lights, etc. in rolling stock other than locomotives.
- DCC accessory decoders can be used to control fixed layout equipment such as turnouts, building lights, etc.
  - NOTE: Accessory addresses are separate from mobile decoder addresses.

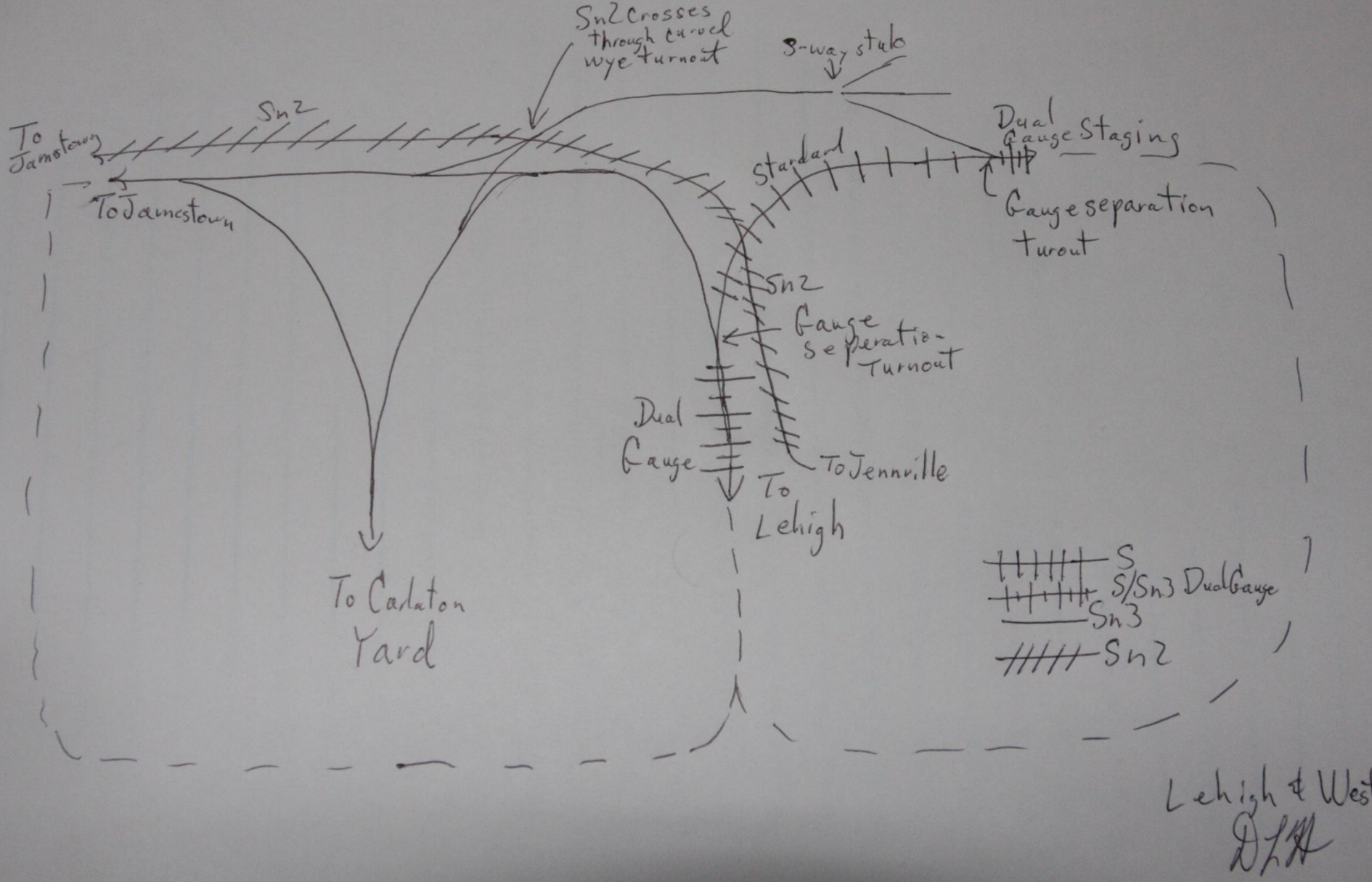
DCC Advantages to Layout Design

- Independent control of multiple switch locomotives in a yard.
- Simplified wiring of engine terminals and locomotive ready tracks.
- Helper operations.
  - Can run helpers independently. With sound decoders, can communicate with whistle signals.
  - Can rescue stalled trains with a helper.
  - With DCC controlled couplers, can uncouple while moving.

DCC Advantages to Layout Design

- Can greatly simplify the control of complicated track work.

NOTE: Detection sections are still needed for signaling/interlocking purposes.


Sn2 Crosses through curved wye turnout
3-way stub
Sn2
To Jamestown
To Jamestown
Dual Gauge Staging
Stardard
Gauge separation turout
Sn2
Gauge seperatio- Turnout
Dual Gauge
To Jennville
To Lehigh
To Carlaton Yard
S
S/Sn3 Dual Gauge
Sn3
Sn2
Lehigh & West
DLW

DCC System Parts

- Cab (Throttle) – Device used to control the layout, including locomotive speed and directions, sound functions, turnouts, etc.
- Cab Bus – Used to connect cabs to system. May support radio or infra-red communication.
  - Usually manufacturer specific (NCE Cab Bus, Digitrax LocoNet, Lenz XpressNET, etc.)

DCC System Parts (Continued)

- Command Station – The “heart” of the DCC system. Takes the inputs from the cabs on the cab bus and generates the DCC signal.
- Control Bus – Used to connect the command station to the boosters (power stations).
- Booster (Power Station) – Takes the DCC signal from the Control Bus, amplifies it, and provides a signal to the track with enough magnitude to power DCC devices on the layout. Usually also includes short circuit protection for the section it powers.

DCC System Parts (Continued)

- Track Signal – What is really covered in the NMRA Standards.
- Decoder – The DCC component installed to control the layout device. Can include:
  - Mobile decoders with or without sound functions for locomotive control.
  - Function only decoders to control lights, etc. in rolling stock.
  - Accessory decoders to control turnouts, signals, layout lighting, etc.

DCC Layout Parts (Continued)

- Note that the above parts are the “logical” components of a DCC system and several parts may be grouped together. Command stations and power stations are commonly grouped. All-in-one systems also can include the cab with the command and power stations.

Layout Wiring

- Layout wiring is simple, just run two wires around, except:
  - You still must take into account reversing sections.
  - A short anyplace (such as a train being run against a switch thrown the wrong way), shuts down the whole railroad.
  - You still need to sectionalize wiring if you need detection for signaling or an interlocking.
  - Your wiring must be of sufficient capacity for short circuit detection to work.
  - You may want to sectionalize your layout just for trouble shooting.

Wiring Capacity

- Wiring Capacity
  - Wire size must be capable of carrying the load current available. Boosters are 5 or 10 amps vs. DC power packs, which may only be 1 amp.
  - Wire size must not limit the current that flows during a short circuit to prevent the short circuit system from operating.
  - Test for adequate wiring – A short at any track location, should operate the short circuit protection. Commonly referred to as the “quarter” test by HO modelers. In S scale we need to use something bigger. A piece of metal placed on the track should operate the short circuit protection.

Recommended Wiring Sizes

Bus Wire Size	10% Drop @ 5 A	5% Drop @ 5 A 10% Drop @ 10 A	5% Drop @ 10 A
18 AWG	20’	15’	7’
16 AWG	40’	20’	10’
14 AWG	70’	30’	18’
12 AWG	100’	50’	25’
10 AWG	130’	65’	33’

Recommended Wiring Sizes

- Wire lengths shown in the recommended chart are the run length from the booster to track. Actual wire needed is twice that.
  - You can run wires in more than one direction from a booster to cut down on the length.
- In the American Wire Gauge (AWG), smaller numbers correspond to larger wire.
- Recommended track feeder size is 18 AWG to 22 AWG and length should be kept under 18 inches.
- Recommended that there be no more than 6’ between feeders.

Layout Sectioning

- Larger layouts – May need to be divided into sections so a short in one section does not shut down the entire railroad. You may want to do this just for trouble shooting purposes.
  - DCC Circuit Breakers – Devices made to detect a short circuit and interrupt it before the booster short circuit protection operates.
    - Must coordinate with booster short circuit protection.
    - Does not provide any more capacity.

Layout Sectioning Continued

- Booster – Additional boosters can be used in sections.
  - Most expensive way
  - Provides more system capacity.
- Switches – Does not help short circuit protection, but does provide trouble shooting isolation.
  - Makes an easy point to add a future DCC circuit breaker or another booster without having to modify the track wiring.

Booster Capacity

- How many boosters do you need? Add up all the loads that operate at one time.
  - Locomotives (running, idle, with sound, with smoke)
  - Rolling stock lighting
  - Accessory decoder operated equipment powered from the DCC system.
- Boosters come in 5, 8, and 10 amp sizes.
- If you need multiple boosters, you have to decide how to split them up.
  - Mainline, large yard, engine terminal, switching district, branchline, etc.

What I Do On My Layout

- I have one 10 amp booster. (I probably don't need that much, but that's what I have.)
- I ran a #12 AWG main DCC bus around the layout.
- I installed a switch for each town or area I want to sectionalize.
  - Right now I'm just in the track laying stage, so I don't have multiple people operating.
  - Allows me to easily replace the switch with a circuit breaker, etc. in the future without doing any track rewiring.
  - Did it on my old layout and hardly used it, so it worked OK for me.

What I Do On My Layout (Continued)

- From each sectionalizing switch, I run a #14 AWG sub-bus through out an area (usually a town).
  - When I need to end a bus, I terminate it on a terminal block.
- I run #22 AWG feeder drops from the track to the bus. If the distance is too long I insert a piece of #18 AWG wire between the sub-bus and the #22 drop.
  - I use #22 for my drops because I use small rail. My largest rail is Code 83 and most of is or will be Code 70 and 55. The smaller wire size works better with the smaller rail.
  - I run a feeder from every piece of rail to the bus.
    - I don't use rail joiners except for switch point hinges, so I don't really have a choice.
    - I hand lay track so I am mostly working with 3' pieces of rail.
  - I use a resistance soldering unit to solder the drop wires on the rails. I can hold the wire against the rail with the soldering tweezers.

What I Do On My Layout (Continued)

- I use solid wire for the #22 drops and stranded for the buses. I find stranded easier for me to use, but it does not matter for our purposes. To feed movable sections, where the wire flexes, stranded wire is better, and the more strands for the same size, the better. I have some more flexible wire that I use for this purpose.
- I use the Scotch “suitcase” connectors to connect the feeders to the sub-bus. They work reliably for me. If you choose to use them, you must use them only for the wire sizes and types (solid or stranded) that the particular model is rated. I also happen to have the Scotch crimping tool, but I have a lot of connections to do. (I’ve done several hundred so far.)
- I don’t solder under the layout. I use either the “suitcase connectors or terminal blocks for connections under the layout.

Reversing Sections

- Three general types:
  - Reversing loops
  - Wyes
  - Turntables
- Since we are using DCC, we don't need to worry about the polarity of the track under the train, but we still need to make sure the polarity of the track is consistent.
  - This means we can switch the polarity under the train to make the track match.

Reversing Loops

- When using DC, we had to a have a switch for the mainline polarity, plus one for the reversing loop polarity.
- With DCC we still need to switch the polarity of the reversing section. There is no need to switch the polarity of the mainline.
  - Switching the polarity of the reversing section with a switch or relay contacts still works.
  - Reversers designed for DCC that operate automatically are available. They can be used to power the reversing section.
    - They must coordinate with the booster short circuit protection.
  - A reversing booster can also be used, but is more expensive.

Wyes

- With a wye, either a leg of a wye or a tail can be the reversing section.
- If the wye has a tail that does not connect to any other part of the wye, it can be used as the reversing section. Either contacts that work with the turnout position or a DCC automatic reverser can be used.
- If a leg of the wye is the reversing section, the polarity can be switched with a switch or a DCC automatic reverser.
  - The leg of the wye that is the reversing section must be of sufficient length to hold the entire train.

Turntables

- In a turntable, the table itself is the reversing section.
  - Traditional methods such as split ring still work fine.
  - A DCC reversing device can also be used.

Questions?