DECODER INSTALL BEST PRACTICES

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LEARNING OBJECTIVES

- By the end of this session, you should understand what are best practices for decoder installs (and why).
- You should have an idea of how to deal with older as well as more modern locomotive installs.

ESTABLISHING NORMS

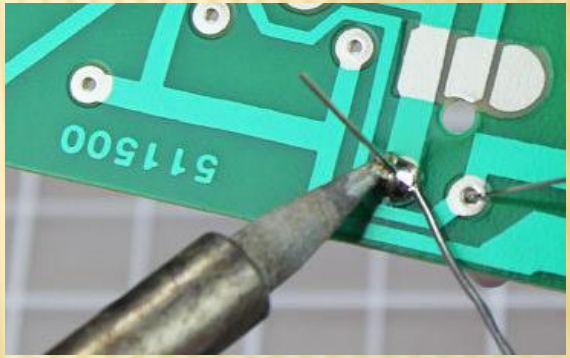
- I encourage you to ask questions at any point, I will also (hopefully) leave time at the end for questions.
- I have installed many decoders, but I am always open to new ideas.
- I understand electrical and electronics basics, but I am self taught in electronics.
- I encourage you to try all of this yourself.

BEST PRACTICES: SOLDERING SKILLS

- **DO** purchase, if you don't already have one, a quality low wattage adjustable soldering iron with a pointed tip.
- **DO** use electronics rated or rosin core solder.
- **NEVER** use acid core solder.
- **DO** use small gauge solder.

BEST PRACTICES: SOLDERING SKILLS

- **DO** know the difference between a good solder joint and a cold-solder joint (shiny vs. hazy surface).
- **DO** keep a wet sponge or copper brillo nearby to clean the tip of your iron frequently.
- **OK**: Liquid flux rated for electronics.
- RECOMMENDED: acquire solder wick to remove solder / excess solder.



BEST PRACTICES: WIRE

- **DO** use appropriately sized wire (28 or 36 gauge)
- **DO** follow wiring color coding (makes things much easier)
  - Basically Black, Red (track power), Blue, White, Yellow (common, headlight, rear light), Gray, Orange (motor -, motor +) other colors are nice (purple for speakers and other colors for functions).
- Note: many manufacturers DO NOT use standard wire colors! Always check the wiring (particularly in steam locomotives).
- **DO** use stranded not solid wire.

BEST PRACTICES: TAPE / HEAT SHRINK TUBING

- Heat shrink tubing is preferred.
- Electrical tape is ‘ok’ but has long term issues.
- **DON’T** use masking tape, blue tape, scotch tape.
- **Best**: Kapton tape (strength, heat resistance, stable adhesive over time, thin-ness.

BEST PRACTICES: LIGHTS / LEDS

- Know your model
  - Athearn Blue Box 12-volt bulb
  - Original Proto2000 1.5-volt bulb
  - Recent Proto2000 LED (some not white)
  - Athearn Genesis 1.5-volt bulb
  - Bachmann Yellow-ish LED (yuck)
  - Bowser LED
  - Original Atlas 12-volt bulb
  - More recent Atlas LED (sometimes questionable color)

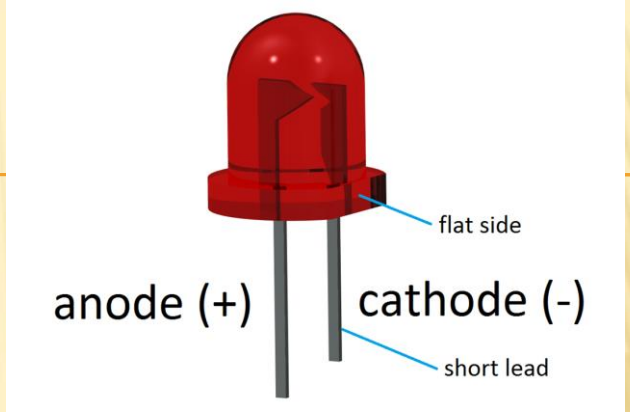
BEST PRACTICES: LIGHTS / LEDS

- Recommend you replace light bulbs with LEDs
  - Why? Because an LED has a MUCH longer lifespan than a bulb, and lower in-rush current.
  - Exception: I haven't been replacing Athearn Genesis because they use 2 bulbs in headlights, but I fully expect to end up replacing them at some point.
  - Recently, Athearn has started shipping models with LEDs (yeah!) and has made these LED assemblies available as a part (ATHG67145, ATHG67144, ATHG67143)
- LEDs require a resistor when used with full voltage (14v) install. 1/8 watt is sufficient but ¼ watt is easier to find. 1000 ohms is a good value with a white LED and 14 volts.
- White LEDs now come in temperatures (i.e., warm white, bright white, etc.) They are sometimes specified in Kelvins.

BEST PRACTICES: LIGHTS / LEDS

- Bulbs come in multiple form factors (grain of rice, grain of wheat, etc.).
- LEDs do as well T1 (3mm), T1 ¾ (5mm), SMD (3528 is a nice size to glue to the back of a headlight lens, 0603 is tiny for classification lights).
- If you model the steam era then you want warm white, diesel era probably bright white.
- Be careful of cheaper white LED sources, LED may have a blue tint.

ALL ABOUT LEDS



- White LEDs typically run on 3 - 3.3 volts
- Use 1000-ohm resistor (Brown-Black-Red)
- Typically, the long leg is the anode (plus) and will be connected to the blue wire of the decoder.
- Typically, the short leg is the cathode (minus) and will be connected to the resistor and then to the function (white, yellow, etc.)
- If you are not happy with the brightness (and to a lesser extent color) you can drop the resistor ohms (don't go lower than say 470 ohms (Yellow-Violet-Brown))
- Above values are for T1 size LED, other LEDs might be different (although 1K ohms should work for all sizes)
- Resistor Calculator: https://ohmslawcalculator.com/led-resistor-calculator

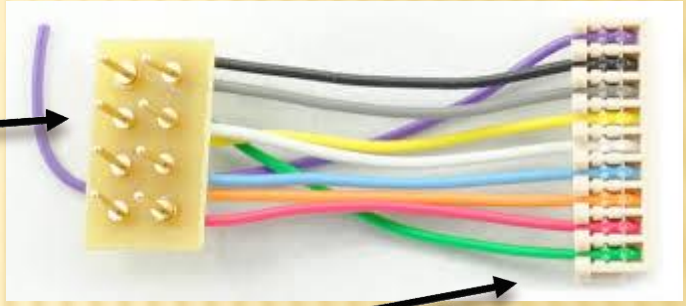
LED EXAMPLES

KNOW YOUR DECODER: OUTPUT VOLTAGES

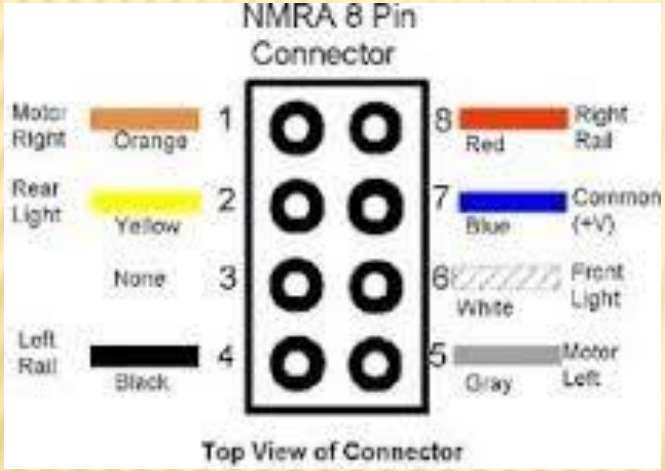
- Blue wire is function common (+ v)
- White, Yellow, Green, Brown are function specific (- v)
- Most decoders have limits on amperage you can draw from function outputs (usually an aggregate value) another reason to avoid bulbs.
- Generation 1 and many Generation 2 decoders output track voltage on the function outputs (nominally 12 - 14v for HO, 12v for N)
- Some Gen 2 and most Gen 3 decoders output voltages around 3 volts on function outputs (LED levels), some have option to bypass to full voltage.
- Starting with some Gen 2 and most Gen 3 you can get a decoder tailored for your specific locomotive model.

KNOW YOUR DECODER: TYPES OF CONNECTIONS

- Direct Connect
- 8 pin connector (also known as an NMRA connector)
- 9 pin connector (also known as a JST connector)
- 21 pin connector



KNOW YOUR DECODER: CONNECTIONS



Pin	Function	Colour
7	Rev. Light	Yellow
8	Fwd. Light	White
16	Common	Blue
18	Motor -	Grey
19	Motor +	Orange
21	Left Power	Black
22	Right Power	Red

A WORD ABOUT PINCH CONNECTORS

- Pinch connectors were / are used on a number of manufacturers boards
  - Atlas, Proto2000, etc.
- Wires will fatigue at the pinch and fail over time.
- Replace board or solder wires to board and eliminate the pinch connector.

KNOW YOUR DECODER: POWER PICKUP AND MOTOR CONNECTIONS

- Motor MUST BE ISOLATED FROM FRAME!
  - Athearn (Blue Box), early Proto2000 (Brown Box) and older Walthers must be reworked to eliminate the connection between the motor and the frame as well as the upper connection (metal strip on Blue Box).
  - This is generally true of any locomotive that was only ever offered as DC only (although some older models have been reworked).
- If the motor had a connection to the frame, you need to create a good connection to the frame for the decoder.
- Also note that you will need to make sure the decoder is insulated from the frame.

POWER PICKUP: TRADITIONAL EXAMPLES

- Athearn Blue Box
- Atlas / Kato wire
- Early Proto 2000

KNOW YOUR MODEL: POWER PICKUP

- How does your model pickup power? All 8 or 12 wheels (diesel) or both sides and tender (steam) is best. Anything less will sooner or later be an issue.
- Locomotives that use a brass or copper strip in the truck to rub the wheel axle (Kato, Atlas, Bowser, others?) will eventually need to be replaced or repaired based in wear from usage.
- Early bowser six-axle locomotives (C-628, AS616) only picked up from the outer axles, Bowser now sells replacement strips to pickup power from all axles.

KNOW YOUR MODEL: POWER PICKUP EXAMPLES

- Bowser ALCo C-628
- Atlas / Roco ALCo S-2
- Bachmann ALCO S-4

KNOW YOUR MODEL: POWER PICKUP

- Older models will always need to attention to power pickup / transmission when installing a decoder (Athearn bus bar, Atlas / Kato copper wire bus, etc.)

KNOW YOUR DECODER: MOTOR CONNECTIONS

- Motor connections use the Orange and Gray wires (if they are reversed your locomotive will run backwards). This can be corrected with CV21.
- Match your decoder amperage rating to your motor.
  - Most standard form factor decoders are rated about 1 to 1.25 amps peak draw (ESU Select, Pilot; Tsunami, TCS, Economi 200)
  - Small form factor decoders are generally rated less than one amp (ESU micro, Economi 100, etc.)
- Older Athearn (Blue Box) and some early Proto2000 (Brown Box) locomotives draw well over 1 amp (as much as 1.5 amps or more).
- The best solution for these motors is to replace the motor (A-line; Northwest Short Line).
- Another solution to protect your decoder is to use a PolyFuse rated at about 1 amp wired in-line with one of the motor leads.

FRAME AND MOTOR PREP EXAMPLES

MOTHERBOARDS

- With the arrival of 21 pin decoders (shipping in newer Athearn, Bowser, Bachmann, Rapido, etc. locomotives) motherboards are becoming standard.
- Several sources (NixTrainz, Athearn, TCS, SoundTraxx and others) now offer after-market motherboards that can be installed in older locomotives.
- Motherboards can greatly simplify your decoder install and wiring issues (including eliminating the need for resistors on your LEDs, and the inclusion of Keep-Alive electronics.

KEEP ALIVE

- Keepalive capacitors can be added to a decoder and will continue to supply power when contact with the track power is lost.
  - This is especially useful for short wheelbase locomotives (think 0-4-0 steam engine or a GE 44 tonner) and dead frogs or dirty track.
- The capacitors are charged while the locomotive has power and supply power to the locomotive if / when power is lost.
- Attention should be paid to the run time after power loss as a locomotive will continue to run until capacitor power is lost. This could easily allow the locomotive to run through a dead section protecting an open bridge for instance.
- Run time is dependent on the current draw of the locomotive and the size of the capacitors.
- Keepalive solutions are made by TCS, NCE, ESU, SoundTraxx and Digitrax.
- Some TCS and SoundTraxx decoders can be purchased with Keepalive already installed.
- Some (newer) decoders come with a keepalive connection already on the board.

WHAT TO DO WHEN THINGS GO WRONG

- Letting the smoke out of your decoder is bad (and expensive).
- Search online for an article or YouTube video on an install on your model locomotive.
- Check the decoder manufacturers web site for installs matching your install (i.e., an Athearn Blue Box install will probably suffice for many early models).
- **ALWAYS** Check your wiring before applying power.
- Make sure you have checked your voltages and have installed resistors where needed.
- Ask a friend
- **DID I SAY ALWAYS CHECK YOUR WIRING?!!**

RANDOM THOUGHTS

- Brass Locomotives are a special case since the entire mechanism is conductive and many (older) locomotives have Pittman style open frame motor (large current draw).
- Internal connectors can make it easier to separate the shell from the frame / motor, but how often are you going to take a locomotive apart once the decoder is installed anyway?

FINAL THOUGHTS

BUT WAIT! ALL THIS TALK ABOUT DECODERS AND YOU HAVEN'T TALKED ABOUT DECODERS?!!!

- Decoder preferences are like DCC system preferences everyone thinks theirs is better!
- Manufacturers (in no particular order):
  - SoundTraxx (www.soundtraxx.com)
  - ESU LokSound (www.esu.eu)
  - TCS (https://tcsdcc.com)
  - Digitrax (www.Digitrax.com)
  - NCE (www.ncedcc.com)
  - MRC (www.modelrectifier.com)
  - Zimo

FINAL THOUGHTS

- Locomotive manufacturers choose different decoder manufacturers:
  - Athearn Genesis: MRC, SoundTraxx (some SoundValue)
  - Athearn RTR: SoundTraxx
  - Atlas: proprietary (non-sound), QSI, SoundTraxx (briefly), ESU LokSound
  - Bachmann: proprietary (non-sound), SoundTraxx SoundValue
  - Bowser: SoundTraxx, ESU LokSound
  - Broadway Limited: QSI, Proprietary
  - Intermountain: ?,LokSound
  - Walthers: QSI, SoundTraxx (some SoundValue)

FINAL THOUGHTS

- Why is that important? Consisting
- So given the above I only buy and install SoundTraxx and LokSound decoders because I want to consist with bought new sound equipped locomotives.
- That doesn't mean that's all I have on my layout, I currently have the above plus TCS (non-sound), Atlas proprietary (non-sound), QSI (Atlas and Walthers)…
- Settling on one or two simplifies your install and maintenance tasks.

USEFUL LINKS & REFERENCES

Decoder Manufacturers:

Digitrax http://www.digitrax.com

North Coast Engineering (NCE): https://www.ncedcc.com/

Train Control Systems (TCS): http://www.tcsdcc.com/

SoundTraxx: http://www.soundtraxx.com/

ESU LokSound: http://www.esu.eu/en/start/

NixTrainz: www.nixtrainz.com

There are groups.io sites for all the major manufacturers and you can get answers to decoder related questions.

Commercial Sites:

SBS4DCC (Good Deals on DCC items, tell Bryan Scott sent you!): http://www.sbs4dcc.com/

Tony's Train Exchange: https://tonystrains.com

Walthers: https://www.walthers.com/

Digi-Key: www.digikey.com Sparkfun: www.sparkfun.com Adafruit: www.adafruit.com

All Electronics: www.allelectronics.com Jameco: www.jameco.com Mouser: www.mouser.com

DecoderPro:

JMRI: http://jmri.org

QUESTIONS?

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