DCC Decoder Programming made easier

Decoder Pro How-To

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PNW 4D HO Modular Group Breakfast

Some things in Decoders are simple!

For example, Addresses

- 2-Digit or 4-Digit numbers, right?
- Wait a minute…

Formal Definitions

Configuration Variable 1 **Primary Address**
Bits 0-6 contain an address with a value between 1 and 127. Bit seven must have a value of "0". If the value of Configuration Variable #1 is "00000000" then the decoder will go out of NMRA digital mode and convert to the alternate power source as defined by Configuration Variable #12. This setting will not effect the Digital Decoder's ability to respond to service mode packets (see RP 9.2.3). The default value for this Configuration Variable is 3, if the decoder is not installed in a locomotive or other unit when shipped from the manufacturer.

Configuration Variables 17,18: **Extended Address**
The Extended Address is the locomotives address when the decoder is set up for extended addressing (indicated by a value of "1" in bit location 5 of CV#29). CV#17 contains the most significant bits of the two byte address and must have a value between 11000000 and 11100111, inclusive, in order for this two byte address to be valid. CV 18 contains the least significant bits of the address and may contain any value.

- "two-digit address" can actually go up to 127
- Most-significant bits? Least-significant bits? I'm a CS major, and I have trouble remembering!
- Don't forget the Consist Address

http://www.nmra.org/standards/DCC/standards_rps/rp922.html#Configuration%20Variable%20General%20Definitions

RP 9.2.2: http://www.nmra.org/standards/DCC/standards_rps/rp922.html
RP 9.2.3: http://www.nmra.org/standards/DCC/standards_rps/rp923.html

Addresses redux

Hmmm… maybe these things aren't so simple after all…

There are at least five CVs associated with addresses:

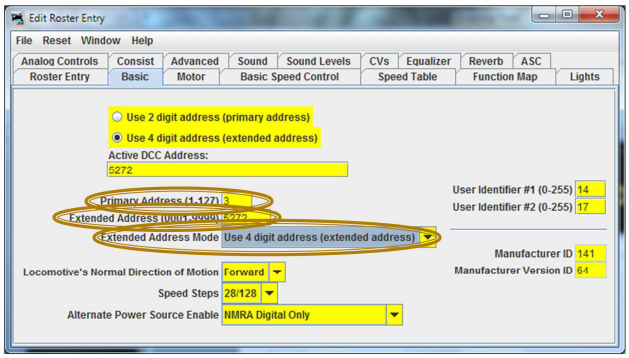
1. CV1 – Primary Address
2. CV17 & CV18 – Secondary Address
3. CV29 – Contains a "switch" telling decoder which to use
4. CV19 – Consist Address

"Most of us can read the writing on the wall; we just assume it's addressed to someone else."

Solution? Decoder Pro

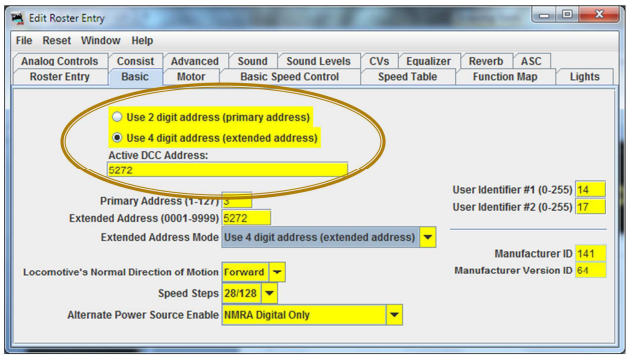
This one tab of Decoder Pro addresses four of those five values in one place.

1. Primary Address (albeit called 2-digit)
2. Extended Address
3. Which to use (more on CV29 later)



Solution? Decoder Pro

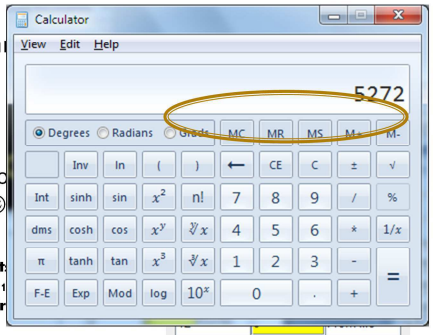
Also shows explicitly which address is currently in-use, along with radio button to select more-easily.

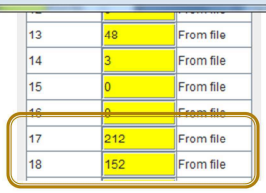


Decoding CVs with Decoder Pro…

Here, we can also see the actual values that ar
"behind" that tab:

1. CV1 = 3 (Primary Address)
2. CV17 & CV18 together:
    1. CV18 is simple: 152 What does 152 have to
    the expected value of 5272? Patience… ☺
    2. CV17 is more complex:
        1. **Definition: CV#17 contains the most significant bit
        byte address and must have a value between 11
        11100111, inclusive, in order for this two byte addr**
        So… What does it mean?
        2. First, subtract 192 (that's the equivalent of binary 11000000).
        3. Then multiply by 256
        4. And add to CV18 to get 5272
3. It's as easy as π….
4. Actually, I find it more reminiscent of Tom Lehrer's song, "New Math".





Down to brass tacks!

- But, the whole point is, you don't NEED to do that New Math… Decoder Pro does it all for you.

Lab 1

- Simple programming of a locomotive:
  - Primary Address
  - Extended Address

Lab 1a – short address vs. extended address
Put on UP 5465, and try to Identify. Note that will not only identify TYPE of decoder, but actual ROSTER entry (if one matches).
Show that Primary = 105, and set to use Primary address.
Make sure that Extended = 105, and set to use Extended. Write Changes.
Will NOT respond to throttle.
Change back to Primary address, and WILL respond to throttle.

Lab 1b – Extended address
Put on UP 5465 (previously programmed as something else that doesn't exist in roster). Will find DECODER TYPE, but not ROSTER ENTRY (of course).
Look at CV 17, 18, and 29
29: 18, so Bit 5 is off (value = 00010010)
Program in Extended = 5465; CV17 = 213, CV18 = 89, CV29 = 00110010 = 50

Definitions, first of all

- Bit = "binary digit". Just as "4" is one digit of 3.1415927, "1" is one digit of "10110110"… although perhaps it's not as easy to tell which.
- 1 = Set = On
- 0 = Clear = Off
  - Sorry, partly it's different people writing the descriptions, partly engineers who feel that if one description is good, two or three must be better.

CV29, aka, The God CV

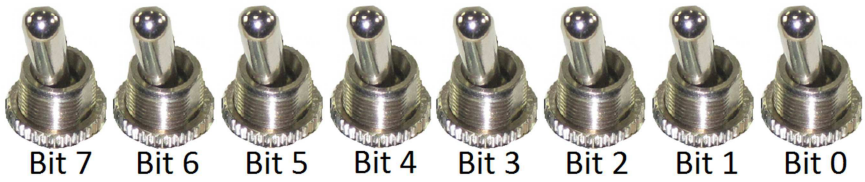
- Configuration Variable 29 Configurations Supported
- **Bit 0** = Locomotive Direction: "0" = normal, "1" = reversed. This bit controls the locomotive's forward and backward direction in digital mode only. Directional sensitive functions, such as headlights (FL and FR), will also be reversed so that they line up with the locomotive's new forward direction. See RP-9.1.1 for more information.
- **Bit 1** = FL location: "0" = bit 4 in Speed and Direction instructions control FL, "1" = bit 4 in function group one instruction controls FL. See RP-9.2.1 for more information.
- **Bit 2** = Power Source Conversion: "0" = NMRA Digital Only, "1" = Power Source Conversion Enabled, See CV#12 for more information,
- **Bit 3** = Bi-Directional Communications: "0" = Bi-Directional Communications disabled, "1" = Bi-Directional Communications enabled. See RP-9.3.2 for more information.`
- **Bit 4** = Speed Table: "0" = speed table set by configuration variables #2,#5, and #6, "1" = Speed Table set by configuration variables #66-#95
- **Bit 5** = "0" = one byte addressing, "1" = two byte addressing (also known as extended addressing) See RP 9.2.1 for more information.
- **Bit 6** = Reserved for future use
- **Bit 7** = Accessory Decoder: "0" = Multifunction Decoder, "1" = Accessory Decoder (see CV #541 for a description of assignments for bits 0-6)
- *Note If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e. the bit should always contain its default value).

"This thing reads like stereo instructions!"

NMRA, ibib.

RP 9.1.1: http://www.nmra.org/standards/DCC/standards_rps/rp911.html
RP 9.3.2: http://www.nmra.org/standards/DCC/standards_rps/rp932.html

How to think of CV29

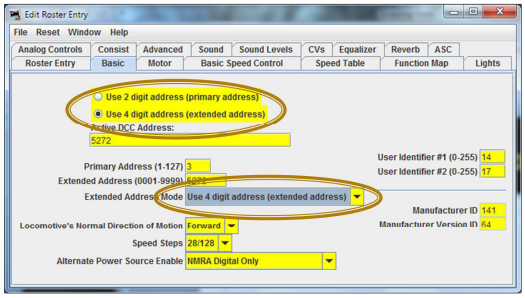


Each bit is essentially a toggle switch.

Dissecting CV29

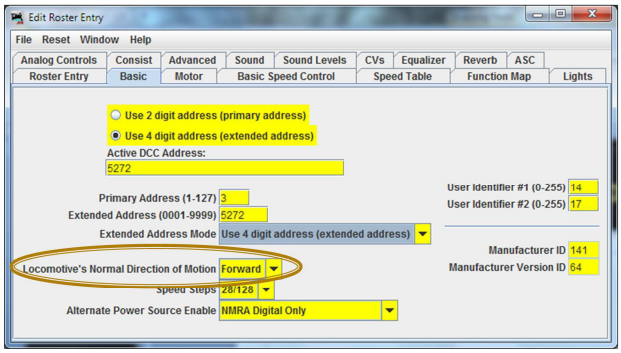
We already started:

- **Bit 5** = "0" = one byte addressing, "1" = two byte addressing (also known as extended addressing) See RP 9.2.1 for more information.



Knowing your forward from your back…

Bit 0 = Locomotive Direction: "0" = normal, "1" = reversed. This bit controls the locomotive's forward and backward direction in digital mode only. Directional sensitive functions, such as headlights (FL and FR), will also be reversed so that they line up with the locomotive's new forward direction. See RP-9.1.1 for more information.



Bit of Confusion

Bit 1 = FL location: "0" = bit 4 in Speed and Direction instructions control FL, "1" = bit 4 in function group one instruction controls FL. See RP-9.2.1 for more information.

- Huh?!
- For the most-part, this denotes 14-step vs. 28/128-step speed control.
- If this bit is off, then forward light behavior changes, plus the engineer has less-precise control.
- Most people just leave this bit set on. ☺

To Digital, or Not to Digital…

Bit 2 = Power Source Conversion: "0" = NMRA Digital Only, "1" = Power Source Conversion Enabled, See CV#12 for more information.

- If this bit is set, CV12 contains a description of what is the alternate power source. http://www.nmra.org/standards/DCC/standards_rps/rp922.html#_ftn2

Please Talk to Me

Bit 3 = Bi-Directional Communications: "0" = Bi-Directional Communications disabled, "1" = Bi-Directional Communications enabled. See RP-9.3.2 for more information.`

- http://www.nmra.org/standards/DCC/standards_rps/rp932.html

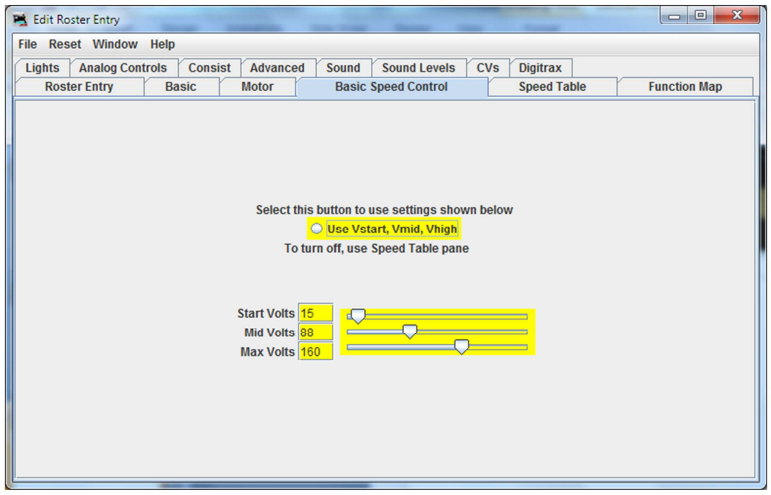
There is more to life than simply increasing its speed*

- **Bit 4** = Speed Table: "0" = speed table set by configuration variables #2,#5, and #6, "1" = Speed Table set by configuration variables #66-#95

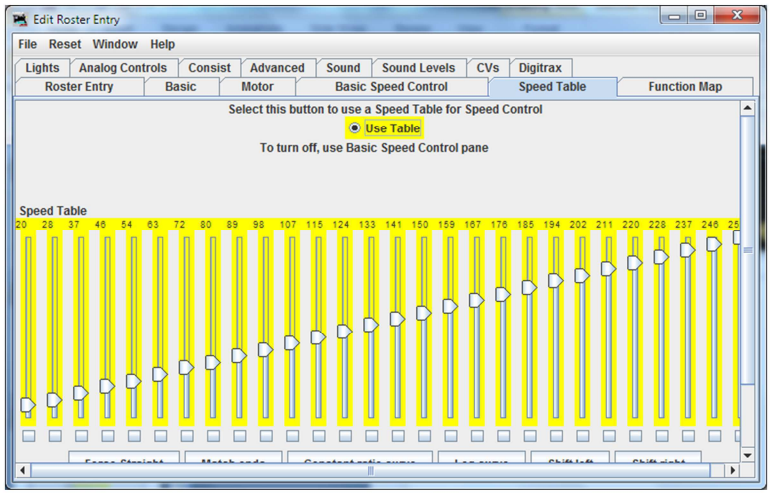
  - Oh great, refers to STILL MORE CVs. ☺
  - Simple version:
    - CV 2, 5, and 6 give a low, mid, and high matching.
    - CV 66-95 allow for far more-granular matching.

*Mahatma Ghandi

Speed Controls 101



Speed Controls 501
(Yeah, a graduate level course!)



Motor or Accessory

- **Bit 7** = Accessory Decoder: "0" = Multifunction Decoder, "1" = Accessory Decoder (see CV #541 for a description of assignments for bits 0-6)
- Yes, that's right, if it's an Accessory decoder, ALL the other bits get redefined.
- It's enough to drive you to drink… or perhaps DC.

Lab 2 – Slicing and Dicing CV29

- Bit 0 set/reset for Forward/Reverse
- Bit 1 set/reset for 14/28-step speed control
- Already saw Bit 5 for One-byte/Two-byte addresses

Go to identify MILW-18B; note that it is set to respond to address = 18, so brings up MILW-18A (I'm using Simple consisting, more about this later). Choose MILW-18B. Basic tab – normal direction = Reversed.
CV29 = 19; 00010011; respectively, set bits = [Use the speed table], [28-step speed control], [Reversed]

Set normal direction = Forward, and go back. CV29 = 18.

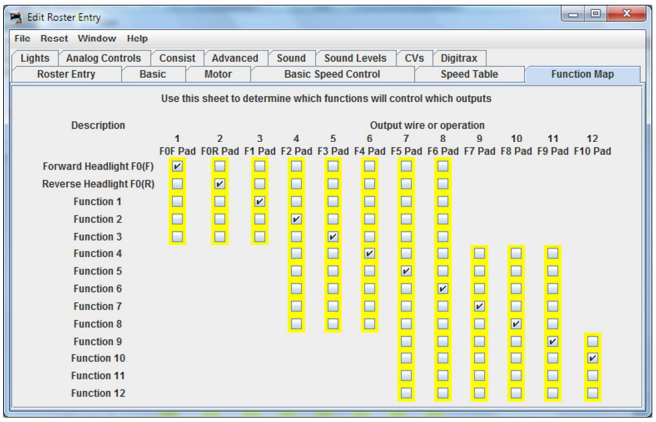
Set 14-step speed control. CV29 = 16

Function Maps and Lighting

- Configuration Variables 33-46 Output Locations 1-14 for Functions FL(f), FL(r), and F1-F12
- Contains a matrix indication of which function inputs control which *Digital Decoder* outputs. This allows the user to customize which outputs are controlled by which input commands. The outputs that Function FL(f) controls are indicated in CV #33, FL(r) in CV#34, F1 in CV #35, to F12 in CV#46. A value of "1" in each bit location indicates that the function controls that output. This allows a single function to control multiple outputs, or the same output to be controlled by multiple functions. CVs 33-37 control outputs 1-8. CVs 38-42 control outputs 4-11 CVs 43-46 control outputs 7-14. The defaults is that FL(f) controls output 1, FL(r) controls output 2, F1 controls output 3 to F12 controls output 14. The lowest numbered output is in the LSB of the CV, as shown in the table below.

Function Map tab

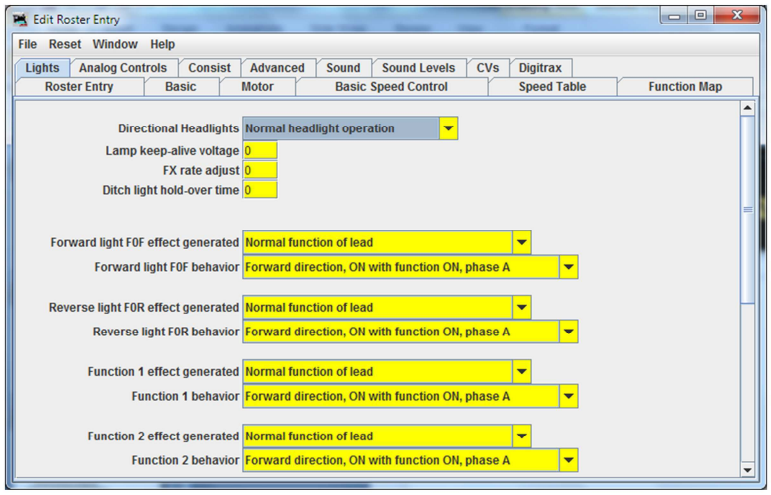
Maps the Functions (basically, the buttons you would press on the Throttle) to the Outputs. Shown are the defaults for my T55 ES44AC.



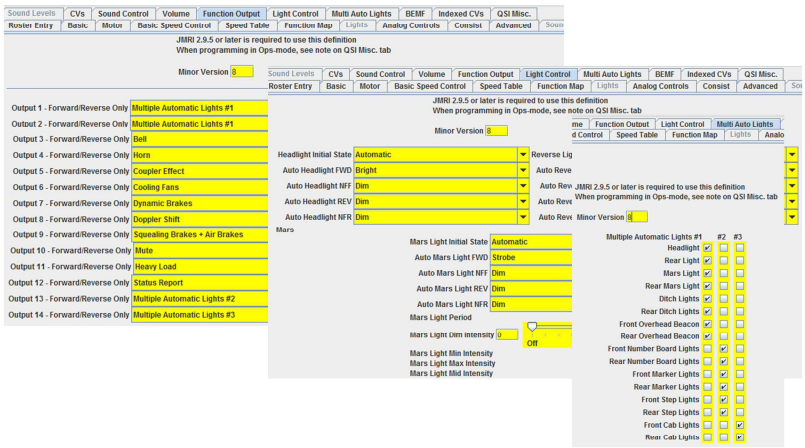
Why? Multi-purpose mapping

- Functions that are always "on", such as:
  - Firebox flicker on steam locomotives
- Functions that may be turned on or off, perhaps together
  - Flashing rooftop beacon light on some diesels
  - Marker lamps on a caboose
  - Mars Light
- Grouping functions together
  - Ditch lights (two outputs) both activated with Horn.

Special Effects – wizardry!



And Now for Something Somewhat Different…



The problem is two-fold-

1) First, each brand of decoder (this is a P2K GP-7 with QSI sound) implements special features in their own way,
2) The people who implement the definition files don't always appear to be completely consistent with each other.

That's one of the things to remember about Decoder Pro… it may be written by professionals and skilled amateurs, but there is NOT a single architectural vision about it (similar to what we've seen with NMRA-NET, unfortunately). I've heard some complaints about DecoderPro being confusing, or difficult to learn, and I suspect that this is one of the big reasons.

Making magic happen

- Effects like:
  - Mars Lights
  - Firebox flicker
  - Blinking warning light
  - Alternating ditch lights

Lab 3 – Special Effects

- Mars Light
- Alternating Ditch Lights

MILW-18B has a Mars Light- use for different effects.
UP-5465 has (I believe) twin ditch lights that can alternate.

All Together Now!

- Consisting allows us to run multiple locomotives using a single address.

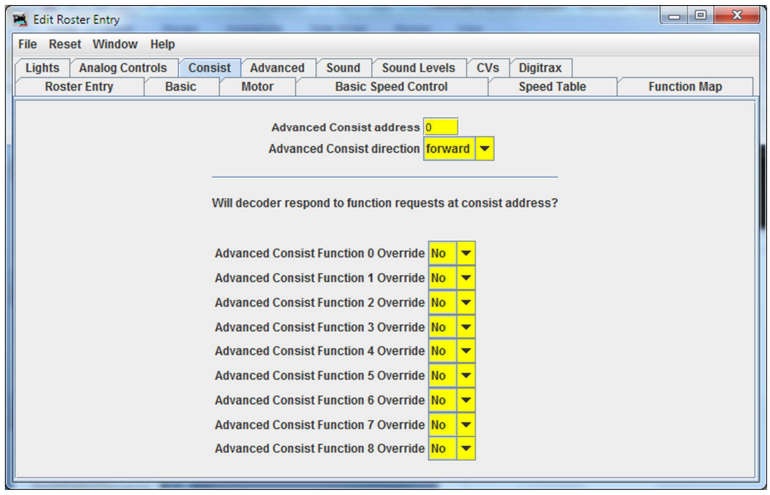
1. Basic Consisting – just program multiple locomotives with the same address
2. Universal Consisting – made up and broken within the Command Station
3. Advanced Consisting – programmed in CVs

- http://www.tonystrains.com/technews/consisting-guide.htm

Basic Consisting – simple, but inflexible
Universal Consisting – Command Station remembers the consist; sends one packet per locomotive in the consist, so can flood the net with packets. Flexible.
Advanced Consisting – programmed in CV19. Can bring consist from one system to another, but requires programming CVs to change.

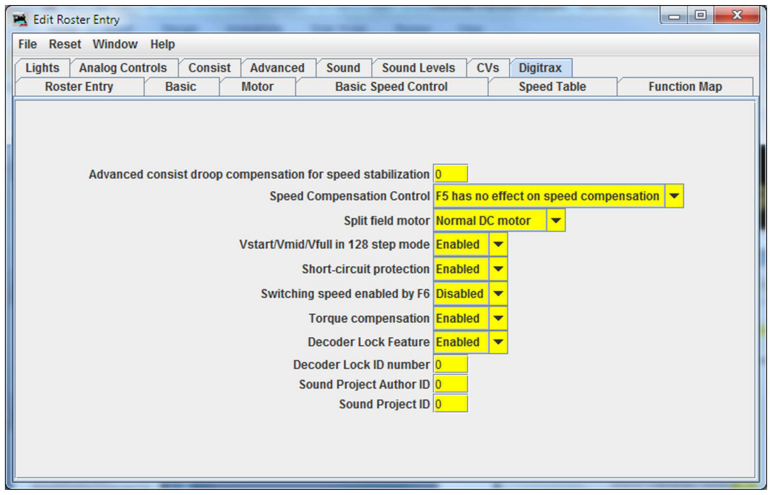
NCE variation: When setting up, we get two options- Old and New. OLD = pure Universal consisting, maximum four locomotives. NEW = interesting!… it combines Universal Consisting (using the address of the lead locomotive) with Advanced Consisting for all other locomotives in the consist. Sends only two packets (one for lead address, one for consist address) for consists. Note that breaking the Universal Consist still leaves the locomotives (APART from the lead) programmed to the Advanced Consist address.

Advanced Consisting



Note that we can make some function behavior changes (such as, turning off F0(F/R) for trailing units).

Manufacturer Custom



Questions?

Figure 1 – Roster Entry

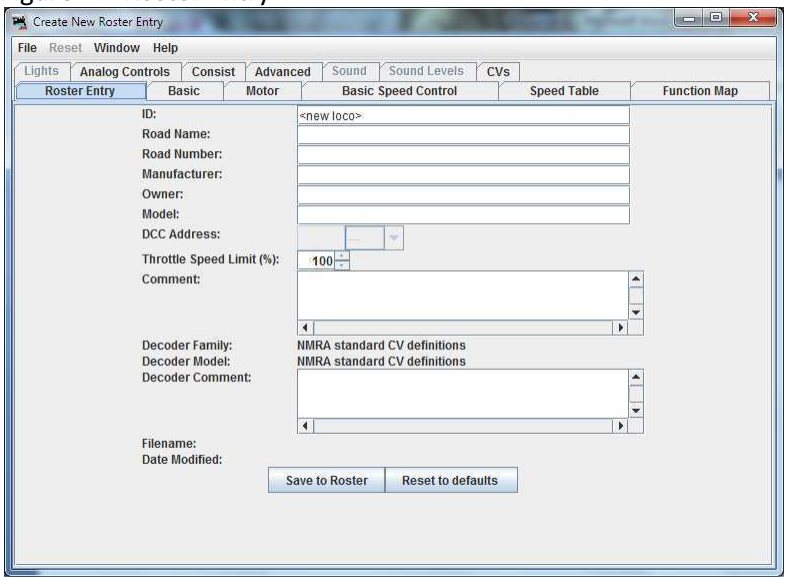


Figure 2 – Basic

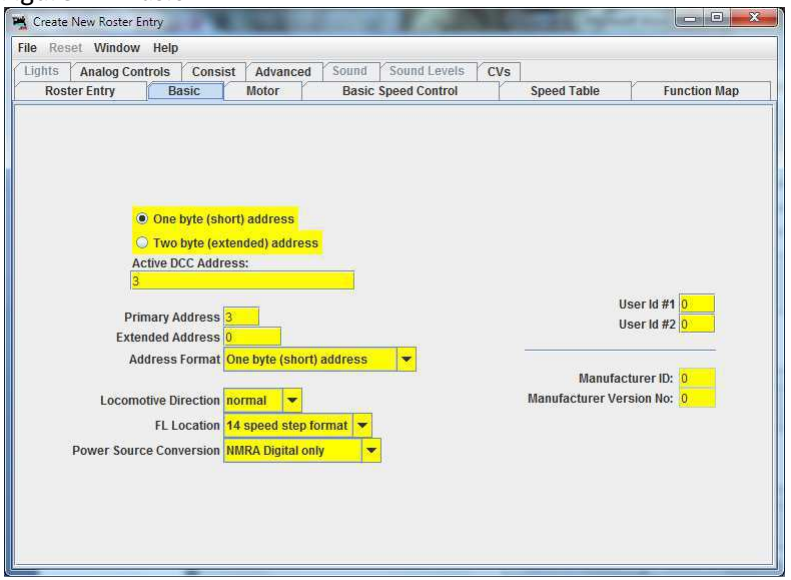


Figure 3 – Motor

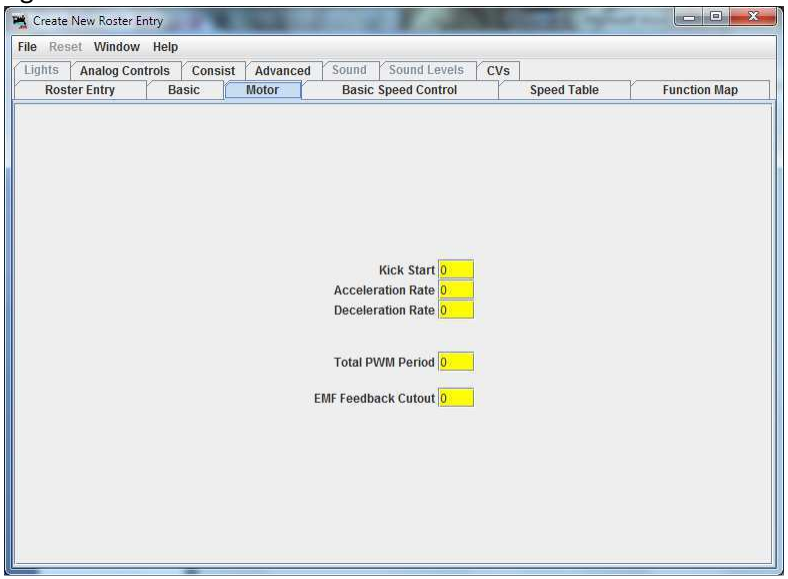


Figure 4 – Basic Speed Control

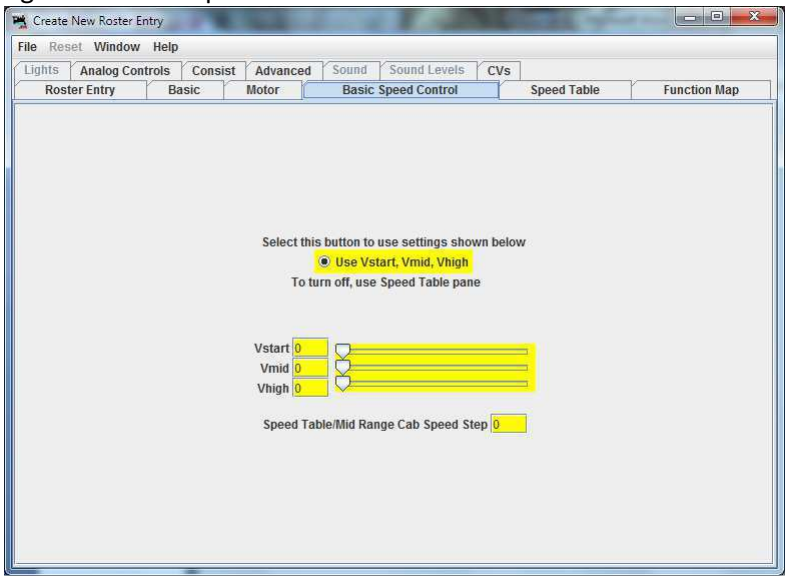


Figure 5 – Speed Table

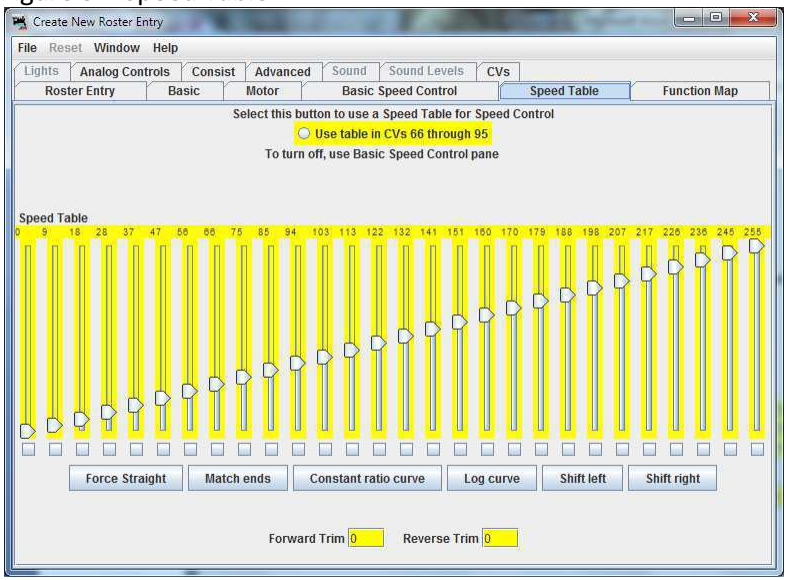


Figure 6 – Function Map

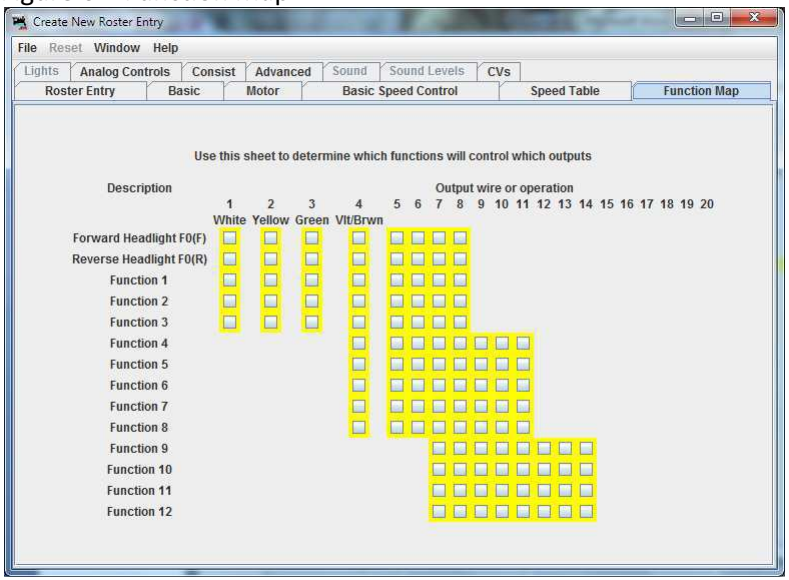


Figure 7 – Analog Controls

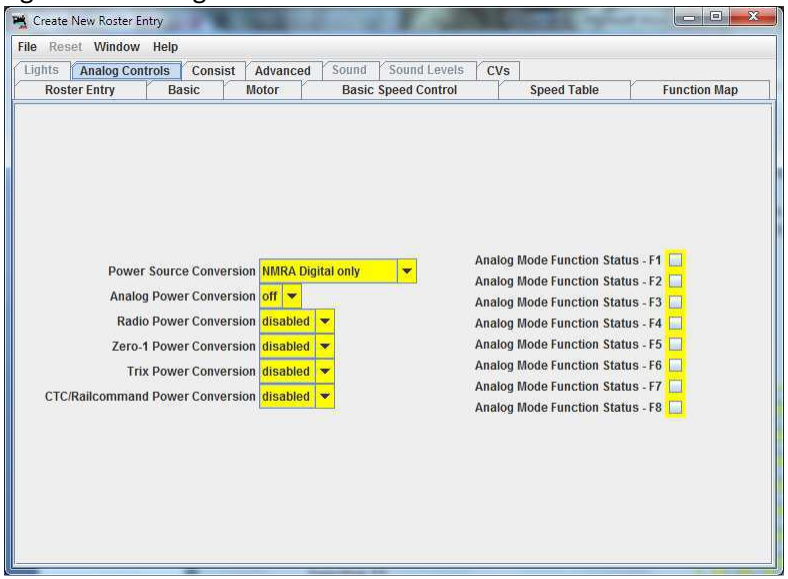


Figure 8 – Consist

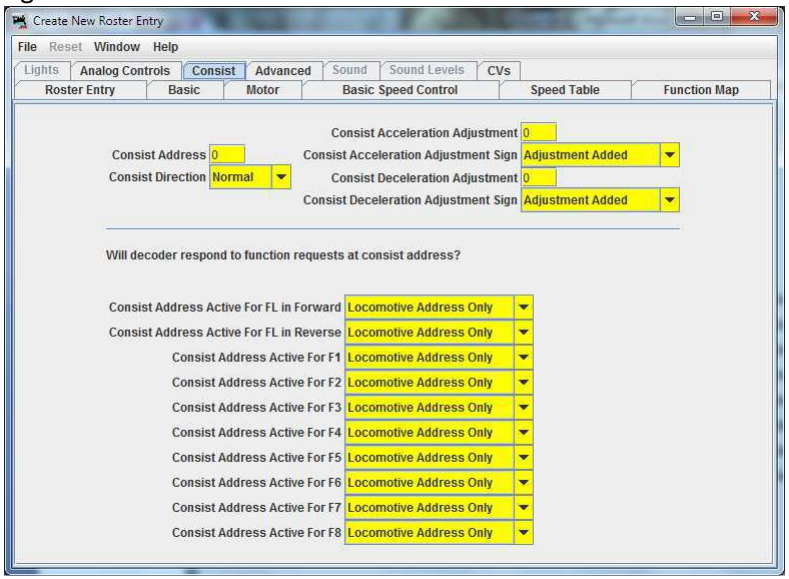
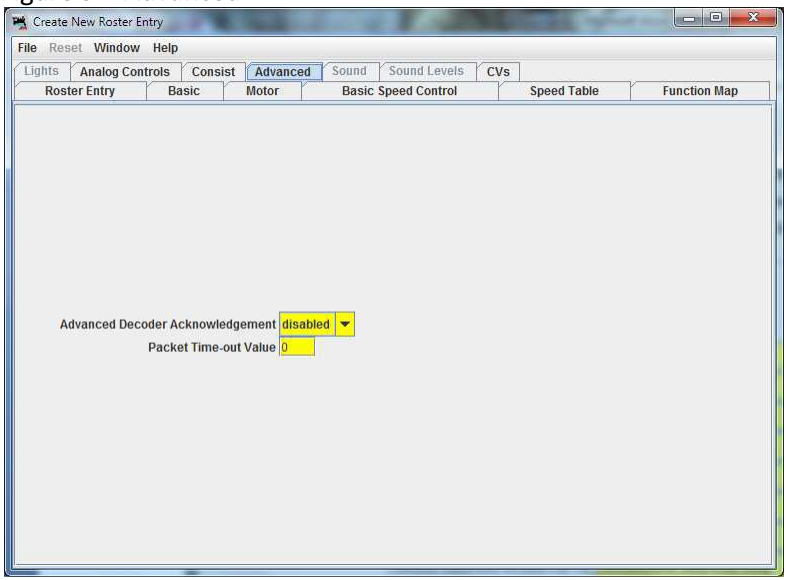


Figure 9 – Advanced



NMRA CV	Purpose	Decoder Pro Tab	Decoder Pro Label(s)
1	Primary Address	Basic	Active DCC Address Primary Address
17	Extended Address	Basic	Active DCC Address Primary Address
18	Extended Address	Basic	Active DCC Address Primary Address
29	Configuration Data	Basic	One byte (short address) Address Format Locomotive Direction FL Location Power Source Conversion
		Basic Speed Control	Use Vstart, Vmid, Vhigh
		Speed Table	Use table in CVs 66 through 95
3	Acceleration Rate	Motor	Acceleration Rate

4	Deceleration Rate	Motor	Deceleration Rate
2	Vstart	Basic Speed Control	Vstart
5	Vhigh	Basic Speed Control	Vhigh
6	Vmid	Basic Speed Control	Vmid
7	Manufacturer Version Number	Basic	Manufacturer Version No
8	Manufacturer Version ID	Basic	Manufacturer ID
9	Total PWM Period	Motor	Total PWM Period
10	EMF Feedback Cutout	Motor	EMF Feedback Cutout
11	Packet time-out Value	Advanced	Packet Time-out Value
12	Power Source Conversion	Basic	Power Source Conversion
		Analog Controls	Power Source Conversion
13	Alternate Mode Function Status	Analog Controls	Analog Mode Function Status – F1 Analog Mode Function Status – F2 Analog Mode Function Status – F3 Analog Mode Function Status – F4 Analog Mode Function Status – F5 Analog Mode Function Status – F6 Analog Mode Function Status – F7 Analog Mode Function Status – F8
15	Decoder Lock	Varies (seems to generally be on the Manufacturer-specific tab for some reason, even though NMRA Standard.)	
16	Decoder Lock		
21	Consist Address Active for F1-F8	Consist	Consist Address Active for F1 Consist Address Active for F2 Consist Address Active for F3 Consist Address Active for F4 Consist Address Active for F5 Consist Address Active for F6 Consist Address Active for F7 Consist Address Active for F8
22	Consist Address Active for FL and F9-F12	Consist	Consist Address Active for FL (x2) Consist Address Active for F9 Consist Address Active for F10 Consist Address Active for F11 Consist Address Active for F12

19	Consist Address	Consist	Consist Address Consist Direction
23	Acceleration Adjustment	Motor	Acceleration Rate
24	Deceleration Adjustment	Motor	Deceleration Rate
25	Speed Table/Mid Range Cab Speed Step	Basic Speed Control	Speed Table/Mid Range Cab Speed Step
33	Output Locations 1-14 for Functions FL(f)	Function Map	Forward Headlight F0(F) row
34	Output Locations 1-14 for Functions FL(r)	Function Map	Forward Headlight F0(R) row
35	Output Locations 1-14 for Functions F1	Function Map	Function 1 row
36	Output Locations 1-14 for Functions F2	Function Map	Function 2 row
37	Output Locations 1-14 for Functions F3	Function Map	Function 3 row
38	Output Locations 1-14 for Functions F4	Function Map	Function 4 row
39	Output Locations 1-14 for Functions F5	Function Map	Function 5 row
40	Output Locations 1-14 for Functions F6	Function Map	Function 6 row
41	Output Locations 1-14 for Functions F7	Function Map	Function 7 row
42	Output Locations 1-14 for Functions F8	Function Map	Function 8 row
43	Output Locations 1-14 for Functions F9	Function Map	Function 9 row
44	Output Locations 1-14 for Functions F10	Function Map	Function 10 row
45	Output Locations 1-14 for Functions F11	Function Map	Function 11 row
46	Output Locations 1-14 for Functions F12	Function Map	Function 12 row

65	Kick Start	Motor	Kick Start
66	Forward Trim	Speed Table	Forward Trim
67	Speed Table 0	Speed Table	Slider
68	Speed Table 9	Speed Table	Slider
69	Speed Table 18	Speed Table	Slider
70	Speed Table 28	Speed Table	Slider
71	Speed Table 37	Speed Table	Slider
72	Speed Table 47	Speed Table	Slider
73	Speed Table 56	Speed Table	Slider
74	Speed Table 66	Speed Table	Slider
75	Speed Table 75	Speed Table	Slider
76	Speed Table 85	Speed Table	Slider
77	Speed Table 94	Speed Table	Slider
78	Speed Table 103	Speed Table	Slider
79	Speed Table 113	Speed Table	Slider
80	Speed Table 122	Speed Table	Slider
81	Speed Table 132	Speed Table	Slider
82	Speed Table 141	Speed Table	Slider
83	Speed Table 151	Speed Table	Slider
84	Speed Table 160	Speed Table	Slider
85	Speed Table 170	Speed Table	Slider
86	Speed Table 179	Speed Table	Slider
87	Speed Table 188	Speed Table	Slider
88	Speed Table 198	Speed Table	Slider
89	Speed Table 207	Speed Table	Slider
90	Speed Table 217	Speed Table	Slider
91	Speed Table 226	Speed Table	Slider
92	Speed Table 236	Speed Table	Slider
93	Speed Table 245	Speed Table	Slider
94	Speed Table 255	Speed Table	Slider
95	Reverse Trim	Speed Table	Reverse Trim
105	User Identification #1	Basic	User Id #1
106	User Identification #2	Basic	User Id #2