
# Hunslet Shunter DCC Reference Manual

Version 1.0 – initial release August 2020

Version 1.01 – minor corrections August 2020

# 1. Introduction

This manual aims to provide a reference for the integrated DCC decoder within the NGS Hunslet industrial shunter. The decoder is manufactured by CT Elektronik of Austria.

Considerable effort has gone into determining sensible default values appropriate to the shunter, and other than perhaps changing the locomotive's address, most users will probably not need change anything else. This manual is provided for those that do want to adjust things and for the merely curious.

Note – this manual may not be entirely error free.

Errors or queries can be communicated via the NGS members' discussion group at https://groups.io/g/ngs

## 2. Contents

## 3. Using the Locomotive – all you need in a few lines.

### IMPORTANT

- **Handle with care.** The photo-etched metal handrails are delicate and deformable. We strongly recommend when handling the model you hold it by the cabsides only.

- **Beware using old DC controllers.** To control the stay-alive capacitor (and the flashing light where fitted) all NGS Hunslets are fitted with a specially developed DCC decoder configured to work on both DC and DCC power. Some older controllers can send out voltage peaks higher than the DCC decoder's rated maximum of 22V. If you damage the electronics on your model with an older controller we can repair it, but you may be charged a fee.

- **Do not use any form of "Relco" electronic track cleaner – this could damage the decoder beyond repair.**

### Running on analogue (DC) layouts.

The locomotive will need the speed control turning up a little to start it moving. The lights will come on just before the loco starts to move.

The locomotive needs a clean DC supply – feedback or PWM controllers my give disappointing results. If in doubt, place the locomotive on an isolated test track and apply the terminals of a PP9 9v battery to the rails. The locomotive should run smoothly.

### Running on Digital (DCC) layouts.

The locomotive can be programmed using "Direct" mode on the Programming track.

The default locomotive address is "3".

The default functions are as follows:

F0 = head lights, on direction of travel.
F1 = cab flashing beacon, if fitted to model.
F2 = uncoupling "waltz" movement. Occurs when loco stationary, and F2 goes from "on" to "off".
F3 = yard mode, removing acceleration and deceleration from the decoder.
F7 = brighten (un-dim) the head and tail lights.

# 4. Hunslet Shunter Programming - Arranged by Topic.

## 4.1 Address, and other basic items:

The decoder can be programmed with "Direct" mode on a Programming Track, or with "Operations Mode" on the running lines.

The Short Address is set in CV1. Default is 3. Legitimate values are 1-127, within the limits set by your DCC system.
NB. Program CV1=0 to perform a decoder reset.

Long address, CV17+18. Set according to NMRA conventions, most DCC systems will do the necessary long address calculations internally to put the address into these CVs. Address range depends on limits of your DCC system.

CV29 options:
bit 0 = reverse direction of running
bit 1= 28/128 step mode (recommended, on by default)
bit 2= DC running enabled (on by default)
bit 3= not used
bit 4= use complex (28 step) speed curve (cv67-94)
bit 5= use long loco address
bit 6= not used
bit 7= not used

CV29 default = 6

Advanced Consist Address, CV19. Follows NMRA conventions. Values 1-127 for forward running, values 129-255 for reverse running. Value 0 to clear the consist.
If a consist address is set, the loco will respond to the consist address for speed and direction control.
NB, there are no consist lighting settings (CV21-22), lighting controls will be active on the locomotive's primary address, not the consist address.

Manufacturer ID (read only) CV8=117
Decoder Version (read only) CV7=11 (Identifies decoder as NGS Hunslet )

## 4.2 Basic Speed Curve:

Select this speed curve in CV29, with bit4 set to zero, (see section 3.1 above).

Simple control of speed range of locomotive. Note that "voltage reference", CV 64, may be a better option to reduce overall speed range of locomotive, and this can then fine-tune behaviour with the speed curve.

Starting speed (start volts), CV2, default = 3

Middle speed (mid volts), CV6, default = 130

Top speed (top volts), CV5, default = 20

### 4.3 Complex Speed Curve:

Select this speed curve in CV29, with bit4 set to 1, (see "basic" above).

28 CV's from CV67 to CV94, set each individually to give a complex speed curve, following NMRA DCC conventions.

### 4.4 Acceleration, Deceleration and Motor Control Parameters

Acceleration rate, CV3, default = 15

Deceleration rate, CV4, default = 15

High frequency motor control: CV137, bit 7. If bit 7 is zero, motor control is either 150Hz or 16kHz according to CV9. If bit 7 is one, then motor control is 32kHz. Setting of 32kHz is useful for some coreless motors. (CV137 is also used for Zimo HLU braking)

Motor PWM frequency: CV9. Values 13-63 for 150Hz, or values 134-191 for 16kHz. Recommend only using values 134-191.

Motor control parameter P, CV51. Proportional part of PWM feedback control calculation

Motor control parameter I, CV52. Integral part of PWM feedback control calculation

Track voltage reference, CV64. Default =160. This is a more useful way to control top-speed than the speed tables. A higher value will result in loco running slower overall.

Back-EMF influence, CV50 . How strongly the BEMF controls the motor.

Analogue (DC control) motor speed range, CV133, default 64. Controls how fast the loco initially moves, and its speed range, when running on DC control.

### 4.5 Function Mapping

See Section 6.

## 4.6 Yard Mode and Diode Braking (Lenz ABC)

Once a Yard Mode key set (in function mapping), then CV 116 bits 0,1,2 determine how the loco behaves in Yard mode.
Typically used to turn off acceleration/deceleration for fine shunting control.
The default function mapping has Yard Mode allocated to Function Key 3, and when Function Key 3 is active, it ignores the acceleration and deceleration.
CV 116, bit 0 – ignore acceleration/deceleration. Loco will drive as if CV3 and CV4 were zero.
CV116, bit 1 – half running speed.
CV116, bit 2 – reverse speed is 65% of forwards speed.
Combinations are permitted, but see Diode Braking below before calculating decimal value.

Diode Braking, (also called Lenz ABC) is a method to automatically stop a locomotive using a simple diode circuit, or a Lenz BM1 diode brake module. Brake module should be in the right hand rail in direction of travel. The decoder can work reliably with a 4+1 diode setup, rather than the usual 5+1 in a Lenz BM1.

CV116, bit 3 – diode braking is enabled
CV116, bit 4 – diode braking is not directional, ie. Loco will stop in either direction in brake zone.
CV116, bit 6 – Yard Mode Key overrides (disables) diode braking in loco.

CV162 – diode braking sensitivity, typically 25, and typical range 15-40. Determines how sensitive loco is to change in voltage in braking zone. Allows fine tuning if loco either triggers braking too often, or fails to stop in every brake zone.

## 4.7 Automatic coupling movement

A function key can be set to initiate an automatic reverse and pull forwards movement.
Typically used to back a train and release the couplings when Kadee, Microtrains, Dapol Easi-shunt, etc. couplings are fitted, but also useful for other types of coupling.
With some values set to zero, movement can be in one direction only if that is preferred by user.

The default settings have the Uncoupler Movement set to Function Key 2.

CV 147 – speed step to reverse loco in movement

CV148 – speed step to pull forwards in movement

CV149 – time spent moving reverse, in 0.1second increments

CV150 – time spent moving forwards, in 0.1second increments

CV151 – function key to initiate movement, values 1-12, value=0 means no key triggers this movement. NB, movement begins as function key goes "off", so a non-latching key is ideal for this. With many throttles this can be F2.

## 4.8 Lighting Effects

Lighting effects (flashing, etc), are controlled for each output. CV154 controls the front light, CV155 the rear light, and CV156 the cab roof light. In addition, the flashing time and brightness have settings.

The value for the effect (0-11) needs to be added to the direction parameter to get an overall value.

CV154, 155, 156, bits 0-4:
value 0 – no flashing effect
value 1 – flashing
value 2 – Blinking
value 3 – single pulse strobe
value 4 – double pulse strobe
value 5 – flashing headlamp
value 6 – ditch light left
value 7 – ditch light right
value 8 – rotary beacon
value 9 – Gyralite
value 10 – Mars Light
value 11 – Soft Start

CV154, 155, 156, bits 6,7, direction parameters:
value 0 – both directions
value 64 (bit 6) – forwards only
value 128 (bit 7) – reverse only

Default values:
CV154, headlamp = 0 (direction is controlled in function mapping)
CV155, rear lamp = 0 (direction is controlled in function mapping)
CV156, cab roof lamp = 1 (flashing, both directions).

Lighting Effect Overall Controls:

CV114 – PWM level of light effect output (ie. How bright the light "on" cycle)

CV115 – Time between effects (ie. How fast the flashing)

CV120 – Time effect "on" parameter (how much "on" to "off" in a flashing cycle).

## 4.9 Dimming of Lights

Two mechanisms to dim lights are offered, an overall dimming/brightness level, and a function-key controlled "dim/bright" option.

**Overall dimming of lights:**

Dimming level, as a percentage, CV54

Lights to dim, bit selection in CV57: bit 0 (front light), bit 1 (rear light), bit 2 (cab roof light)

**Function Key Dimming:** NB, function key brings lights up to "full brightness" from their initial "dimmer" setting.

Dimming level, as a percentage, CV119

Lights to dim, bit selection in CV118: bit 0 (front light), bit 1 (rear light), bit 2 (cab roof light)

Function key to turn off dimming: CV117, values 1-12 for function key choice, value 0 to disable feature

## 4.10 Zimo HLU Braking

Requires Zimo hardware/command station to implement HLU braking system on layout. (*refer to Zimo manuals for HLU hardware. Feature not tested by NGS development team*)

Zimo Speed L, CV59
Zimo Speed U, CV60
Zimo signal controlled acceleration reaction, CV61
HLU Brake time, CV138

Zimo/LGB Function selection, CV137:
Bit 0 = function selection 8, or 14/MAN bit
Bit 4 = HLU control on/off
Bit6 = LGB F4 impulse
(Note CV137 Bit7 is used to set general motor frequency, see Accelaration, Deceleration and Motor Control earlier in document ).

## 4.11 Miscellaneous Features

### User identification parameters

User Identity #1 (CV105). Store any information of choice here. Such as a code for the user's name, date of purchase, etc.. values 0-255

User Identity #2 (CV106). Store any information of choice here. Values 0-255

### Short circuit control

Parameters to try to limit risk of decoder damage from short circuits *(but far from total protection against abuse!)*

Function Output short circuits:
Direct Cut Off – CV139
Fast Cut Off – CV140
Slow Cut Off – CV141

Motor Output short circuits:
Direct Cut Off – CV142
Fast Cut Off – CV143
Slow Cut Off – CV144

### Error diagnosis CV (similar to feature in Lenz decoders)

CV30, read only.
Values: 0 = no error, 1= motor fault, 2 = function output fault, 3 = motor and function fault.

### Programming pulse intensity.

Can be adjusted if programming readback isn't reliable. CV111, default =255.

### Decoder Lock

Used to stop changes being made to a decoder *(not tested, use at own risk of a locked decoder!)*

CV53 = 0 no lock applied
CV53 = 66 lock the decoder
CV53 = 77 unlock the decoder.

### Alternate CV Set

CT decoders have two complete sets of CVs stored in memory, and a user can use either set, with different values applied to each. A decoder reset (with CV1=0) will only reset the currently selected CV set.
CV109 = 0 default CV set, CV109=1 alternative CV set.

## 5. NGS Hunslet Shunter Default CVs in Numerical Order

All numeric values are in decimal format.

| CV | Value | Range | Remarks |
|---|---|---|---|
| 1 | 3 | 1-127 | Decoder short address. Writing 0 resets decoder to factory default values |
| 2 | 3 | 0-255 | Vstart |
| 3 | 15 | 0-255 | Acceleration |
| 4 | 15 | 0-255 | Deceleration |
| 5 | 200 | 0-255 | Vhigh |
| 6 | 130 | 0-255 | Vmid |
| 7 | 11 | 0-255 | Decoder version – read only |
| 8 | 117 | 0-255 | Manufacturer – read only |
| 9 | 140 | See remarks | Motor PWM frequency<br>13 – 63 = 30 – 150 Hz frequency = 1953/(CV9 value)<br>134 – 191 = 16 kHz<br>See also CV137 bit 7 |
| 17 & 18 | 0 | 128-10240 | Extended address. Set according to NMRA conventions |
| 19 | 0 | 0-255 | Advanced consist address. 1-127 forward running, 129-255 reverse running. 0 to clear consist |
| 29 | 6 | 0-255 | Configuration bits:<br>Bit 0: direction<br>0 = normal (0 by default)<br>1 = reversed<br>Bit 1: Speed mode<br>0 = 14 steps<br>1 = 28 steps (1 by default)<br>Bit 2: 0 = DCC only<br>1 = DC running enabled (1 by default)<br>Bit 3: not used<br>Bit 4: 0 = use CVs 2,5 & 6 for speed curve (0 by default)<br>1 = use CV values 67-94<br>Bit 5: 0 = use short address (CV1) (0 by default)<br>1 = use long address from CVs 17 & 18<br>Bit 6: not used<br>Bit 7: not used |
| 30 | 0 | 0-3 | Decoder fault codes (read only):<br>1 = motor over current<br>2 = light over current<br>3 = motor and light over current |
| 33-46 | | | See function key mapping table below |
| 49 | 0 | 0 or 32 | 0 = enable cab roof on analogue running<br>32 = disable cab roof light on analogue running |
| 50 | 255 | 255 | Back EMF feedback control. 0 = none to 255 maximum |
| 51 | 40 | 0-255 | Proportional (static) feedback motor tuning |
| 52 | 20 | 0-255 | Integral (dynamic) feedback motor tuning |
| 53 | 0 | 0-255 | Decoder lock, to prevent accidental reprogramming<br>0 = no lock<br>66 = lock the decoder<br>77 = unlock the decoder |

| | | | |
|---|---|---|---|
| | | | Note unlock function not tested. Lock decoder at your own risk. |
| 54 | 50 | 0-100 | Dims lights 0-100%. 50 = half brightness. See also CV57 |
| 57 | 0 | 0-7 | Lights that will dim to the value set in CV55. Set the appropriate bit to 1 to dim associated light.<br>Bit 0: front light<br>Bit 1: rear light<br>Bit 2: cab roof light |
| 59 | 168 | 0-255 | Zimo speed L. See also CVs 137, 96, 97, 98 and Zimo HLU documentation |
| 60 | 84 | 0-255 | Zimo speed U. See also CVs 137, 96, 97, 98 and Zimo HLU documentation |
| 61 | 1 | 0-255 | Zimo Acceleration time. . See also CVs 137, 96, 97, 98 and Zimo HLU documentation |
| 64 | 100 | 0-255 | Control reference. 160 = 16v track voltage. Only change if you need identical speed for a given speed step on different layouts with different track voltages. Normally no need to adjust. |
| | | | Values of CVs 67-94 used when bit 4 of CV29 = 1 |
| 67 | | 0-255 | Speed step 1 |
| 68 | | 0-255 | Speed step 2 |
| 69 | | 0-255 | Speed step 3 |
| 70 | | 0-255 | Speed step 4 |
| 71 | | 0-255 | Speed step 5 |
| 72 | | 0-255 | Speed step 6 |
| 73 | | 0-255 | Speed step 7 |
| 74 | | 0-255 | Speed step 8 |
| 75 | | 0-255 | Speed step 9 |
| 76 | | 0-255 | Speed step 10 |
| 77 | | 0-255 | Speed step 11 |
| 78 | | 0-255 | Speed step 12 |
| 79 | | 0-255 | Speed step 13 |
| 80 | | 0-255 | Speed step 14 |
| 81 | | 0-255 | Speed step 15 |
| 82 | | 0-255 | Speed step 16 |
| 83 | | 0-255 | Speed step 17 |
| 84 | | 0-255 | Speed step 18 |
| 85 | | 0-255 | Speed step 19 |
| 86 | | 0-255 | Speed step 20 |
| 87 | | 0-255 | Speed step 21 |
| 88 | | 0-255 | Speed step 22 |
| 89 | | 0-255 | Speed step 23 |
| 90 | | 0-255 | Speed step 24 |
| 91 | | 0-255 | Speed step 25 |
| 92 | | 0-255 | Speed step 26 |
| 93 | | 0-255 | Speed step 27 |
| 94 | | 0-255 | Speed step 28 |
| 96 | 212 | 0-255 | Speed between FL. See Zimo HLU documentation |
| 97 | 126 | 0-255 | Speed between LU. See Zimo HLU documentation |
| 98 | 42 | 0-255 | U-stop selected speed. See Zimo HLU documentation |
| 105 | 0 | 0-255 | User CV. Any value can be written/read here. Has no effect on the decoder. |
| 106 | 0 | 0-255 | User CV. Any value can be written/read here. Has no effect on the decoder. |

| | | | |
|---|---|---|---|
| 109 | 0 | 0 or 1 | Alternate CV set. The decoder has two identical sets of CVs. Normally set 0 is in use. Setting CV109 to 1 will switch to the alternate set. The alternate set could be used for club or test use. The value of CV109 is not changed by a hard reset. (See CV1) Therefore, a hard reset only factory resets the currently in use CV set. |
| 111 | 255 | 0-255 | ACK pulse intensity. 128 = half intensity pulse. |
| 114 | 30 | 0-100 | Dims the light in lighting effects set by CV154, CV155 and CV156 |
| 115 | 30 | 0-255 | Time between lighting effects, ie how fast light flashes |
| 116 | 1 | 0-255 | Yard Mode (shunting). With the Yard Mode function enabled (default F3):<br>Bit 0 = 1 ignore acceleration/deceleration, as though CV3 and CV4 are set to 0<br>Bit 1 = 1 maximum speed is halved, for both directions<br>Bit 2 = 1 reverse speed is 65% of forward speed. This is enabled regardless of the state of F3<br><br>Diode braking (Lenz ABC). Brake module should be set up in the right hand rail of direction of travel.<br>Bit 3 = 1 diode braking enabled<br>Bit 4 = 1 diode braking not directional, loco will brake in either direction in brake zone.<br>Bit 5 must always be set to 0<br>Bit 6 = 1 Yard mode (F3) disables diode braking in loco<br>Bit 7 must always be 0 |
| 117 | 7 | 0-12 | Function key to turn off dimming, ie to full brightness from initial dim value. Value = function key number. eg 7 = F7<br>0 disables feature. |
| 118 | 3 | 0-7 | Defines which lights are dimmed by the function key defined in CV117<br>Bit 0 =1 front light<br>Bit 1 = 1 rear light<br>Bit 2 = 1 cab roof light |
| 119 | 25 | 0-100 | Value to dim to for lights controlled by CV118. 25 = 25% |
| 120 | 6 | 0-255 | Ratio of on to off in a flashing light cycle |
| 133 | 64 | 0-255 | Speed control for DC use. This CV only has an effect when the loco is being operated under DC (analogue) control. It determines both the slow speed running and maximum speed of the loco. The default 64 means that effectively only a quarter (64/256) of the controller's voltage is applied to the motor. This allows for very slow speed running when the locomotive gets enough voltage to start, and limits the maximum speed to a realistic low value. The DCC speed CVs and speed tables have no effect in DC mode. |
| 137 | 0 | 0-255 | For Zimo controllers only (bits 0 to 6)<br>Bit 0: 8 or 14 functions<br>Bit 1: Loco number off( 0) or on (1)<br>Bit2: not used<br>Bit3: not used<br>Bit 4: Zimo HLU signal control enabled<br>Bit 5: not used<br>Bit 6: Evaluate LGB pulses via F4<br>Bit 7: motor frequency: |

| | | | |
|---|---|---|---|
| | | | 0 = use value in CV9<br>1 = use 32kHz |
| 138 | 26 | 0-255 | HLU brake time. See Zimo HLU documentation |
| 139 | 20 | 0-255 | Shutdown threshold for lights output over current |
| 140 | 16 | 0-255 | Fast shutdown threshold for lights output over current |
| 141 | 12 | 0-255 | Slow shutdown threshold for lights output over current |
| 142 | 70 | 0-255 | Shutdown threshold for motor output over current |
| 143 | 60 | 0-255 | Fast shutdown threshold for motor output over current |
| 144 | 50 | 0-255 | Slow shutdown threshold for motor output over current |
| 147 | 50 | 0-126 | Speed step for coupling release – loco in reverse |
| 148 | 50 | 0-126 | Speed step for coupling release – loco moving forwards |
| 149 | 25 | 0-126 | Time spent moving in reverse for coupling release. 10 = 1 second. |
| 150 | 40 | 0-126 | Time spent moving forwards for coupling release. 10 = 1 second. |
| 151 | 2 | 0-12 | Function key number to initiate automatic uncoupling. 0 disables. Best to use a non latching function key. |
| 154 | 0 | 0-139 | Light effect for front headlight<br>In bits 0-4<br>Value 0: no effect<br>Value 1: flashing<br>Value 2: blinking<br>Value 3: single pulse strobe<br>Value 4: double pule strobe<br>Value 5: flashing headlamp<br>Value 6: ditch light left<br>Value 7: ditch light right<br>Value 8: rotary beacon<br>Value 9: gyralite<br>Value 10: mars light<br>Value 11: soft start<br>Note for values 5 to 9 brightness goes between value of CV114 and maximum.<br><br>Bits 6 & 7 direction control of lighting effect:<br>Both 0: both directions<br>Bit 6: 1 bit 7: 0 forwards only<br>Bit 6: 0 bit 7: 1 reverse only<br>For front and rear headlights both are 0, direction controlled by function mapping. |
| 155 | 0 | 0-139 | Light effect for rear light. See text for CV154 |
| 156 | 1 | 0-139 | Light effect for cab roof lamp. Set to 1, flashing in both directions. See text for CV154. |
| 162 | 25 | | Diode Braking, diode sensitivity |
| 163 | | | F0F extended function mapping for Yard Mode |
| 164 | | | F0R extended function mapping for Yard Mode |
| 165 | | | F1 extended function mapping for F1 |
| 166 | | | F2 extended function mapping for F2 |
| 167 | | | F3 extended function mapping for F3 |

## 6. Hunslet Function Key Mappings

FL: Front Light
RL: Rear Light
CRL: Cab Roof Light
YM: Yard Mode (shunting function)
-- : No function

| CV | Function | Locomotive Direction | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit2 | Bit 1 | Bit 0 | Default Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | F0 | forwards | -- | -- | -- | -- | -- | CRL | RL | FL* | 1 |
| 163 | F0 | forwards | | | | | | | | YM | |
| 34 | F0 | reverse | -- | -- | -- | -- | -- | CRL | RL* | FL | 2 |
| 164 | F0 | reverse | | | | | | | | YM | |
| 35 | F1 | | -- | -- | -- | -- | -- | CRL* | RL | FL | 4 |
| 165 | F1 | | | | | | | | | YM | |
| 36 | F2 | | -- | -- | -- | -- | -- | CRL | RL | FL | 8 |
| 166 | F2 | | | | | | | | | YM | |
| 37 | F3 | | -- | -- | -- | -- | -- | CRL | RL | FL | 16 |
| 167 | F3 | | | | | | | | | YM* | |
| 38 | F4 | | -- | -- | YM | -- | -- | -- | -- | -- | 2 |
| 39 | F5 | | -- | -- | YM | -- | -- | -- | -- | -- | 4 |
| 40 | F6 | | -- | -- | YM | -- | -- | -- | -- | -- | 8 |
| 41 | F7 | | -- | -- | YM | -- | -- | -- | -- | -- | 16 |
| 42 | F8 | | -- | -- | YM | -- | -- | -- | -- | -- | 0 |

Red text and (*) indicates default output operated by function key. Bit positions in red* are 1, all others are 0.

With factory settings the function keys have the following functionality:

F0 with locomotive travelling forwards: front light
F0 with locomotive travelling backwards: rear light
F1: cab roof light
F2: automatic coupling movement, when loco stationary and function goes from “on” to “off”
F3: enable Yard Mode (slow speed shunting)
F7: brighten (un-dim) head and tail lights

Not all models of the shunter have all lights fitted.

Example: To make F2 turn on all three lights

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Value to Write to CV |
|---|---|---|---|---|---|---|---|---|---|
| CV36 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7 |

## 7. Calculating CV Values

Many CVs are used to set configurations by setting or resetting a bit. The set bits are added up according to their binary weighting to obtain an overall decimal number to enter into the CV.

Firstly, terminology. A bit is binary 1 if it is on, or set. Likewise it is binary 0 if it is off or reset.

All CVs are a maximum of 8 bits. Bits are numbered, by convention, from 7 to 0. Bit zero is the least significant, bit 7 the most significant.

When set, each bit has a decimal value of twice its predecessor:

Bit 0 = 1
Bit 1 = 2
Bit 2 = 4
Bit 3 = 8
Bit 4 = 16
Bit 5 = 32
Bit 6 = 64
Bit 7 = 128

So, for example, if bits 3 and 5 were set (with the others 0) the decimal value would be the sum of the set bits, ie 8 + 32 = 40, so 40 would be the decimal value to write to the CV.

## 8. Understanding CV133 – Analogue Control

At first it may appear a little odd to have a DCC CV be used to configure the performance of the shunter under DC, or analogue, operation. Unlike many N locomotives, the Hunslet shunter has a permanently fitted DCC decoder, so the decoder is in circuit between the track and the motor at all times. With DCC it is fairly obvious how things work – the decoder receives power from the DCC signal and acts upon control packet embedded within this signal. The decoder is permanently powered by the DCC signal.

With DC control the track voltage varies between 0 and around 12v, the locomotive's speed being dependent on the voltage. But how does this voltage get from the track to the motor via the decoder? Consider the controller's speed knob being slowly increased, so that the voltage rises from 0 up to 12v. Between 0 and around 4v nothing happens. There is not enough voltage being applied to the decoder to make its circuits function. At around 4v the decoder powers on. As there is no DCC signal present it switches to DC mode. This, in simplified terms, applies the track voltage to the motor terminals. So, the motor goes from seeing 0v to suddenly seeing 4v. This makes the locomotive suddenly set off at a relatively high speed, so giving the user very little slow speed control. This is obviously not ideal for a shunter.

This problem can be overcome by applying the track voltage to the motor for only some of the time. The switching of the track voltage through to the motor is done at a high frequency, so the neither the user nor the motor notices when the motor is powered or not powered. So, when the decoder wakes up at 4v track voltage, if this is only passed to the motor for 25% of the time, the motor will see an average voltage of 1v. This is about the right voltage to overcome the frictional losses within the mechanism and to slowly move off. This is what the setting in CV133 achieves. It determines the percentage of time that the motor receives track power. The CV can be set between 0 and 255. 255 = 100%. So a setting of 64 means the motor is on for 25% of the time.

CV133 affects the on to off time for all track voltages, so it similarly reduces the maximum voltage applied to the motor. 12v track voltage, with CV133 = 64, gets reduced by a quarter to 3v. This happily coincides to the shunter's scale speed being just above the Hunslet's maximum prototypical speed.

If the user is happy with the shunter's slow speed performance and realistic maximum speed there should be no reason to change the value of CV133. Clearly, if the user wants to change CV133 they must have access to a DCC programmer.

# 9. JMRI DecoderPro Screenshots

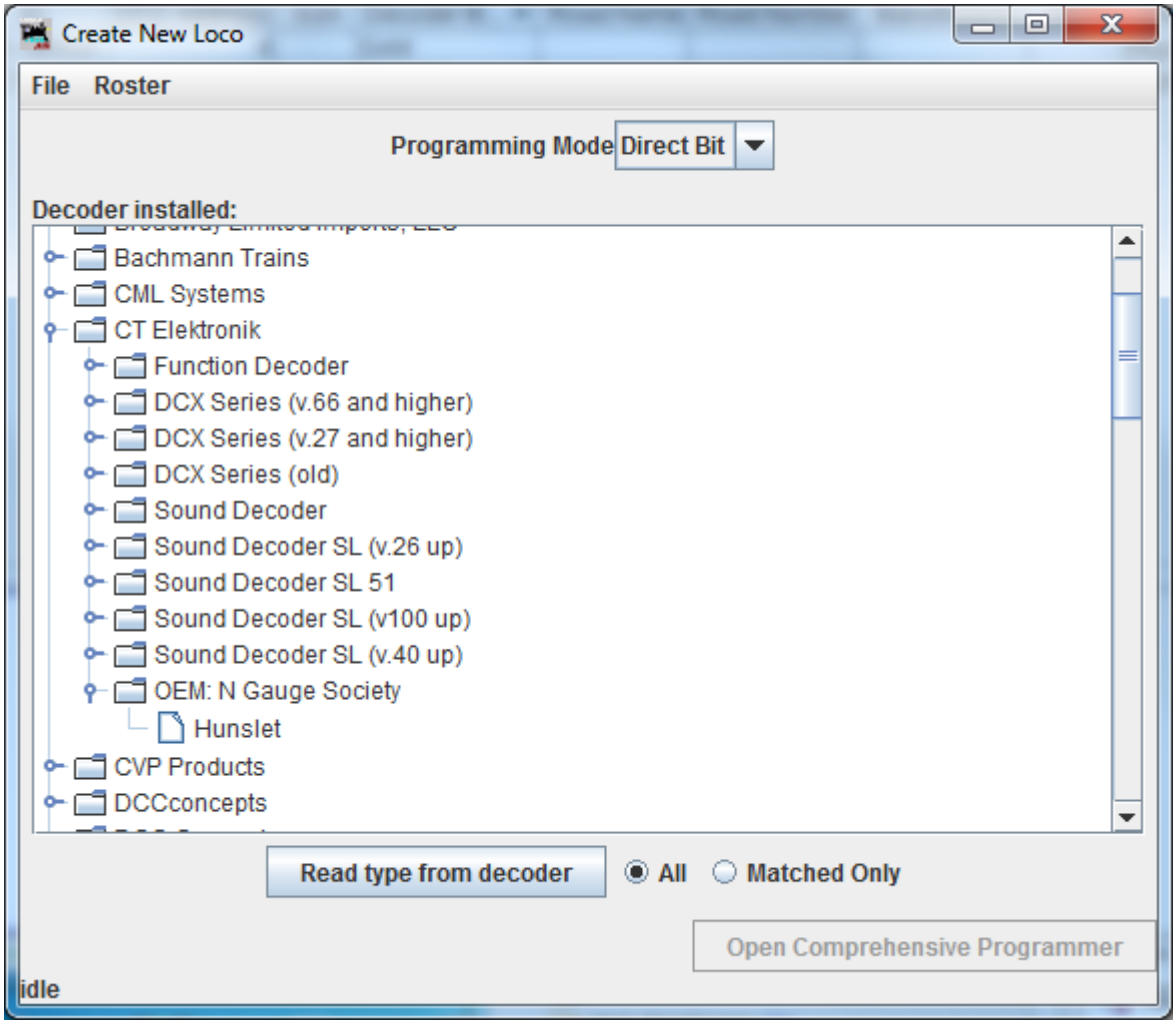
JMRI (https://www.jmri.org/) is free open source software that both allows a user to control a DCC model railway from a computer, and also to program decoders. The programming part of the software suite is called DecoderPro. The software interfaces with many popular DCC hardware controllers. Alternatively a low cost USB to programming track interface module, called a SPROG can be obtained here https://www.sprog-dcc.co.uk/sprogii

The graphical presentation of the decoder's configuration makes programming a decoder considerably easier than manually calculating and setting individual CVs.

The latest stable production release of JMRI has built in support for the Hunslet shunter. He following screen shots show the programming screens for the Hunslet.

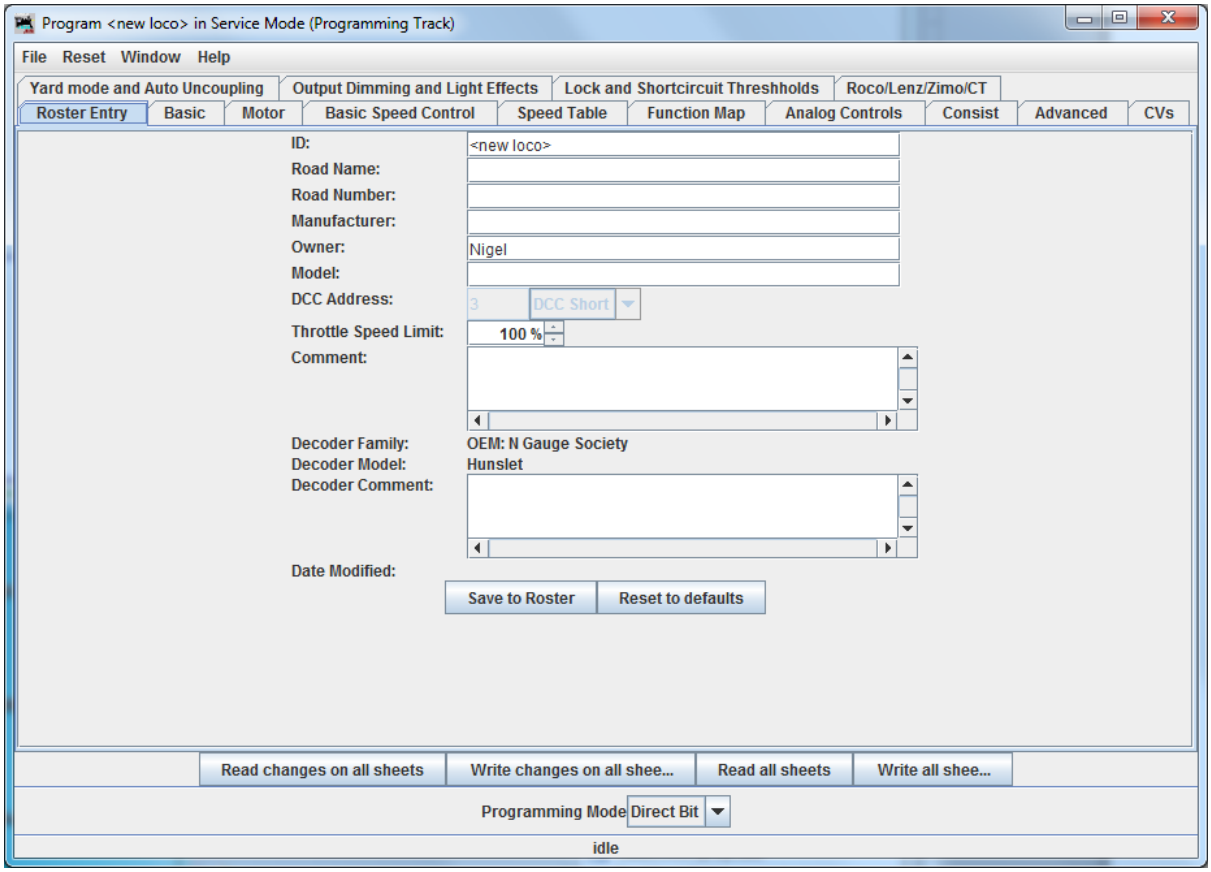
## 9.1 Decoder Selection screen.

CV7 is factory set to 11, and the "read type from decoder" button should automatically select the correct decoder.



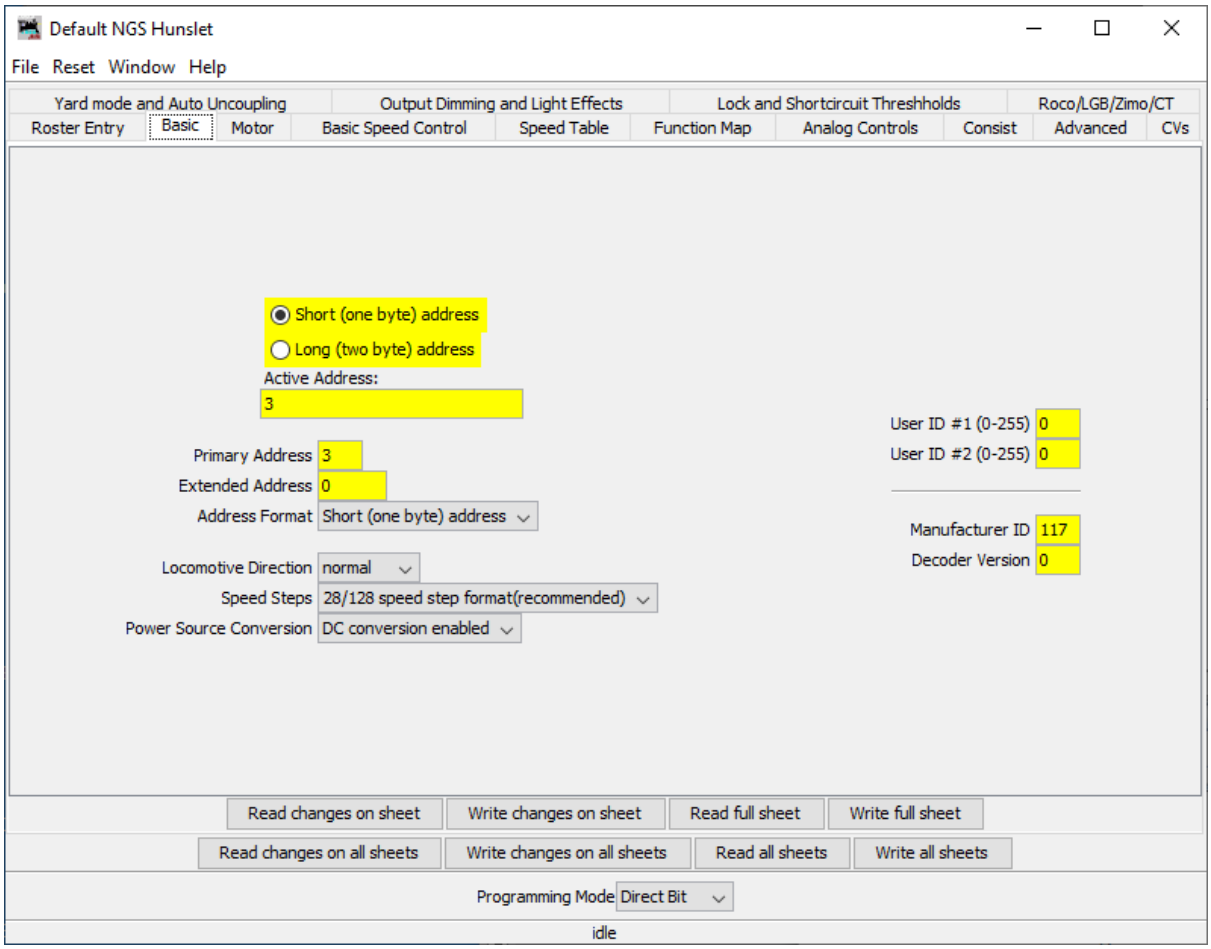
## 9.2 Roster Entry Front Screen

Not much significant, other than the Decoder Family and Decoder Types are passed through.



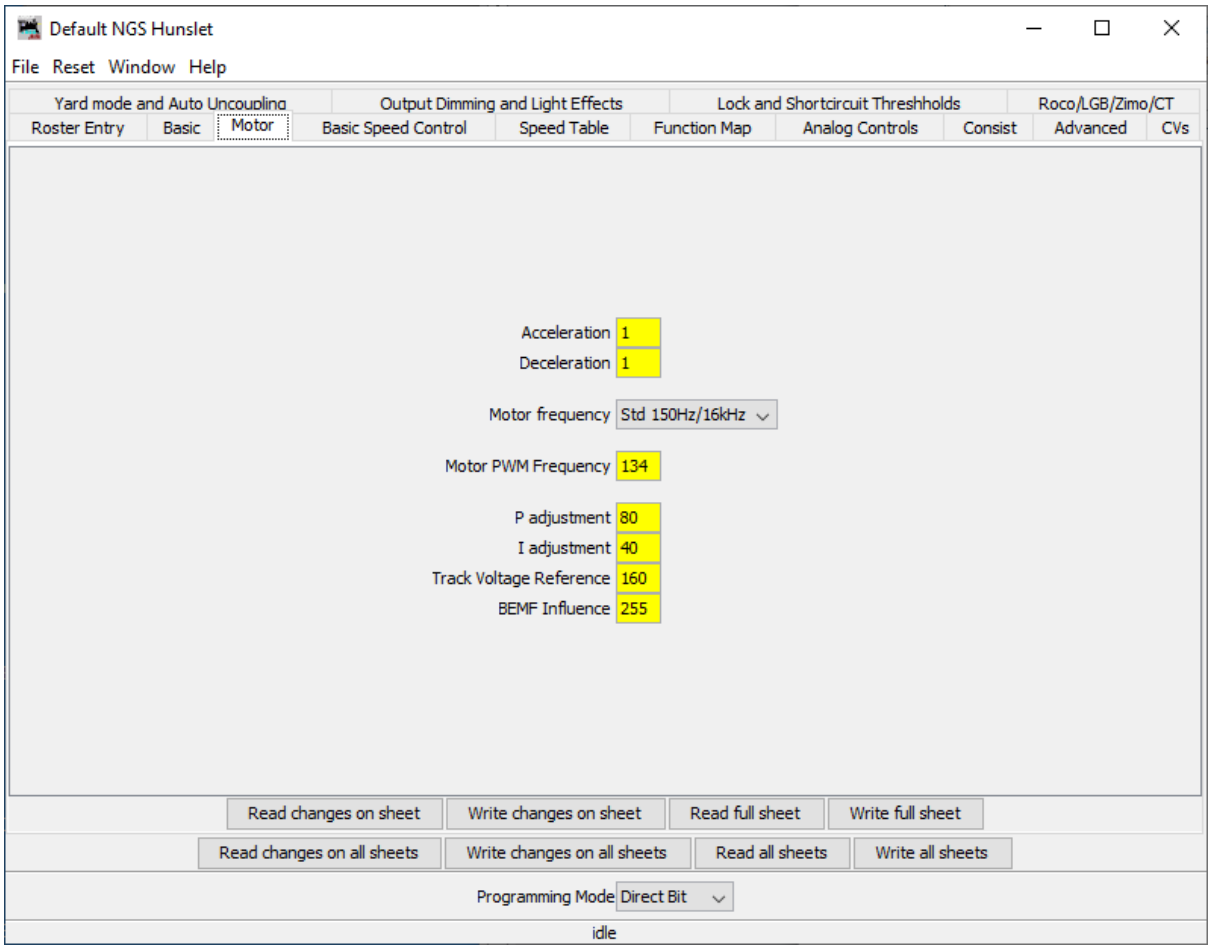
## 9.3 Basic settings

Setting of address, and related factors.



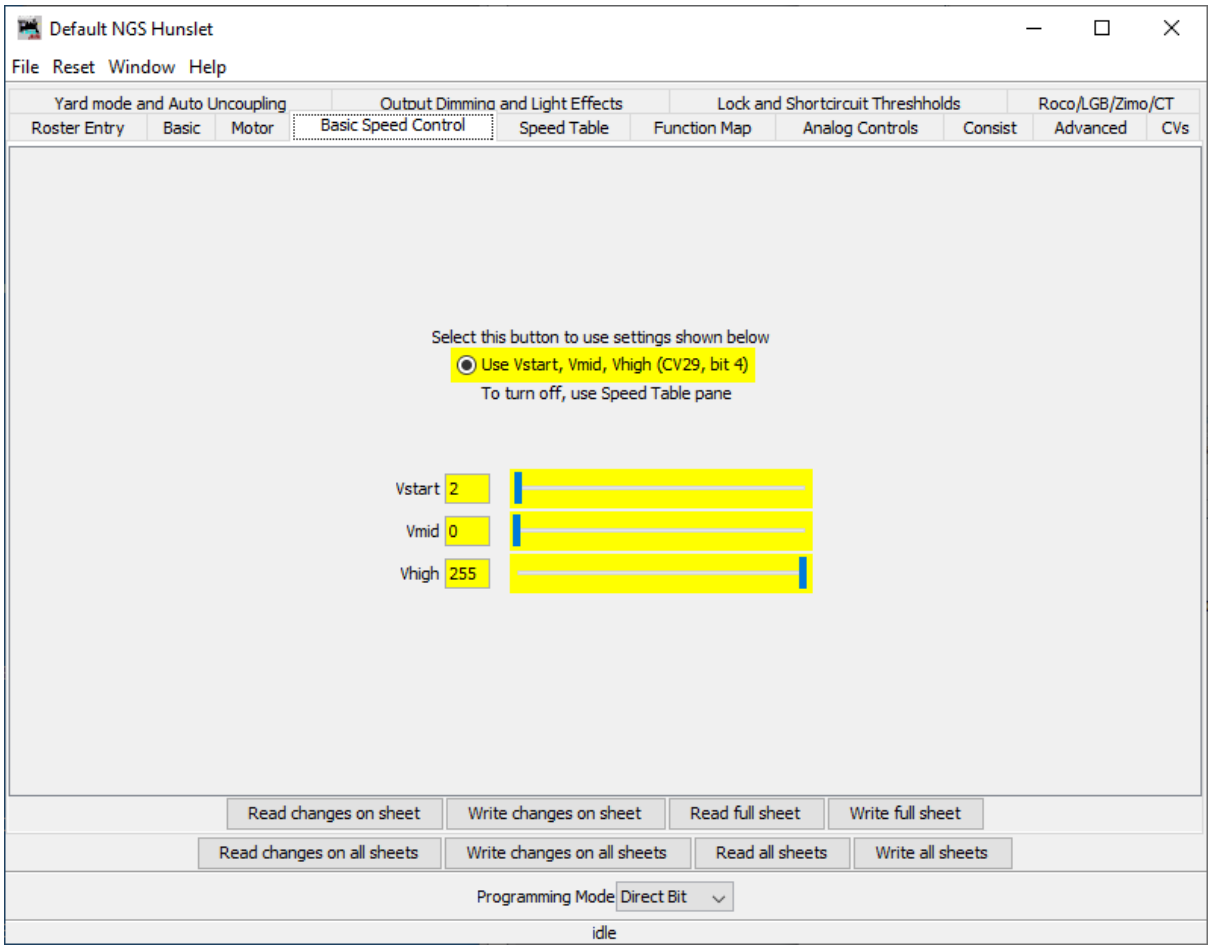
## 9.4 Motor

Acceleration, Deceleration settings, and settings related to regulation of the motor.



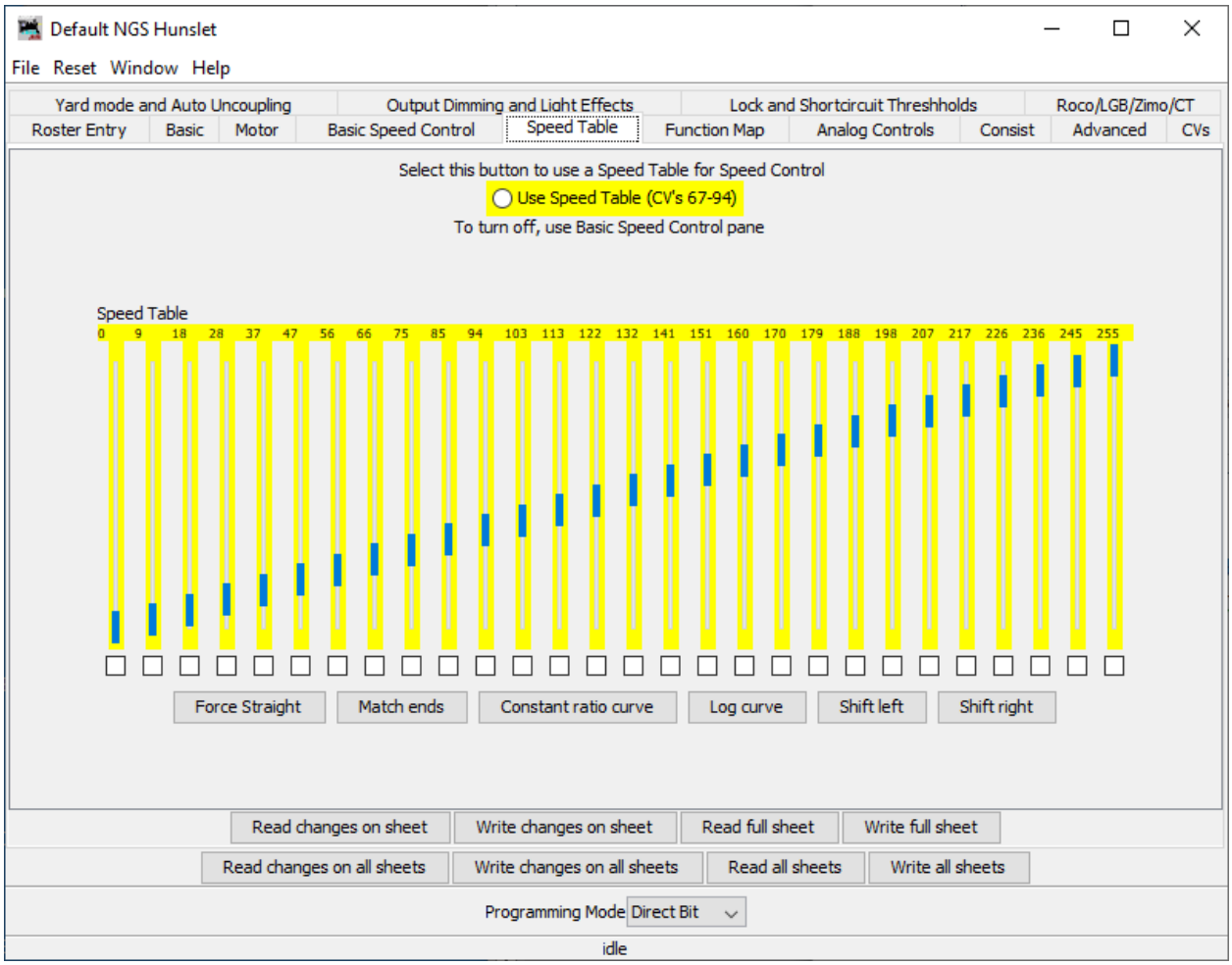
## 9.5 Basic Speed Control

Settings to select the basic speed curve, and to set the three values



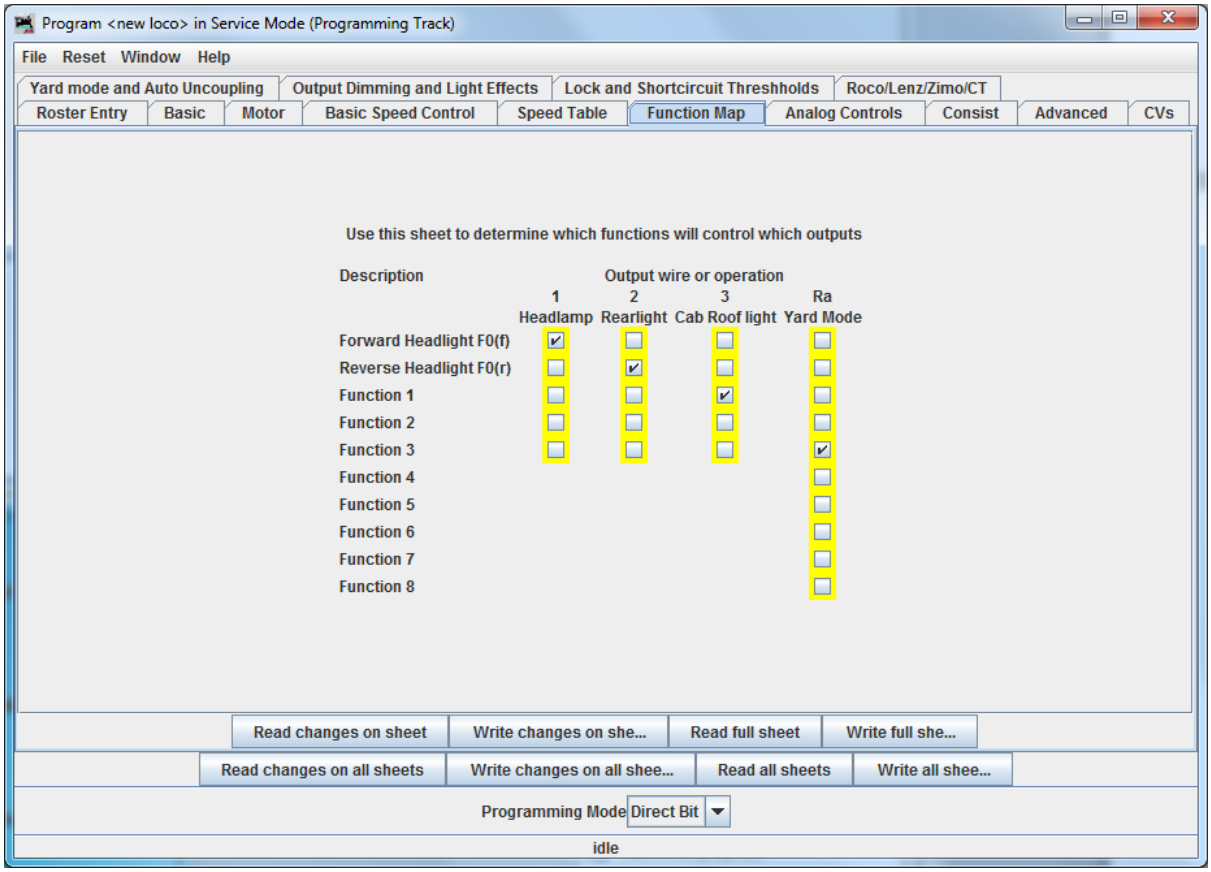
## 9.6 (Advanced) Speed Table

Settings to select the 28 point Speed Curve, and to adjust the 28 values.



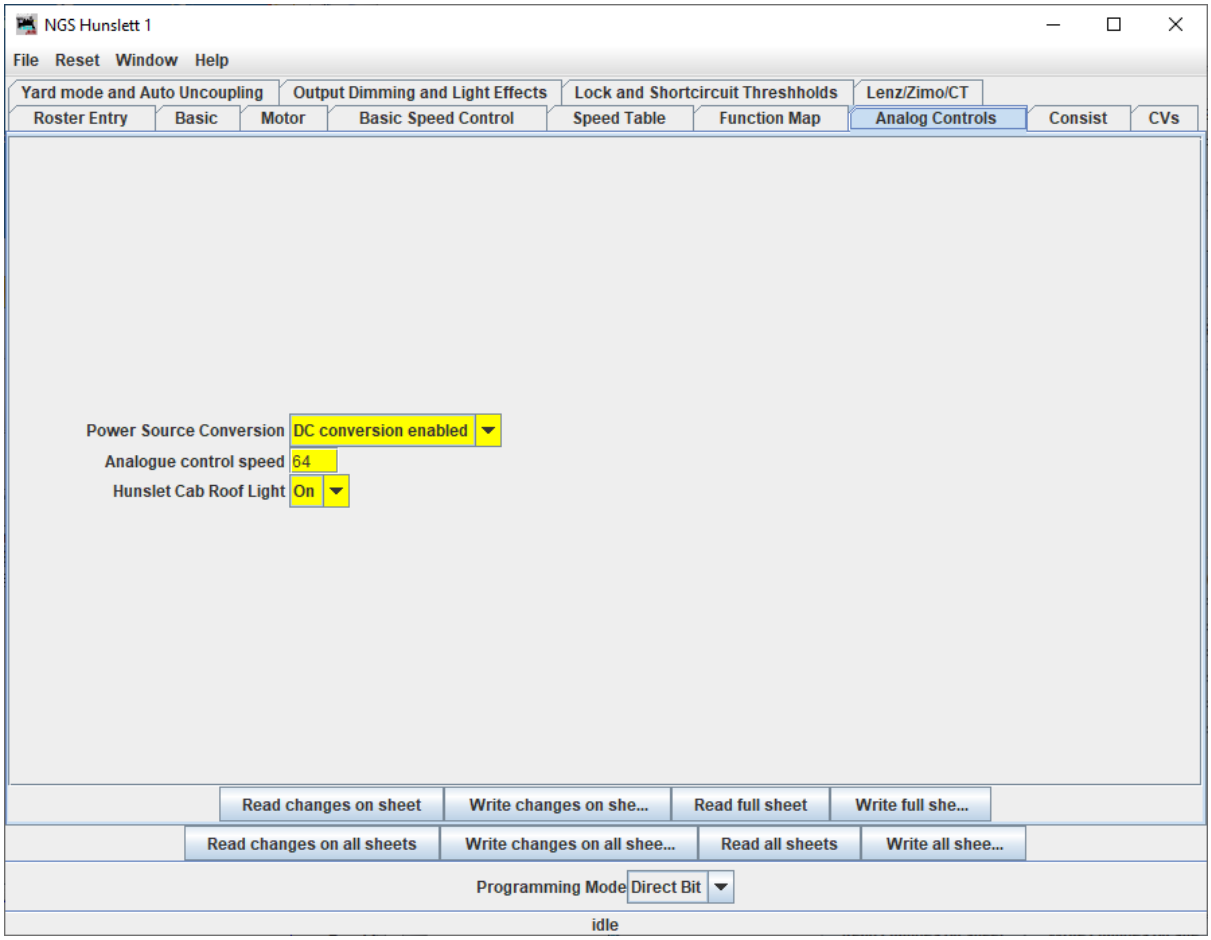
## 9.7 Function Map

Hunslet specific naming of the outputs on the decoder, for the front, rear and cab roof light, and Yard Mode key. Shows the function keys (Headlight, Fn1 to Fn8) which can be mapped to the outputs.



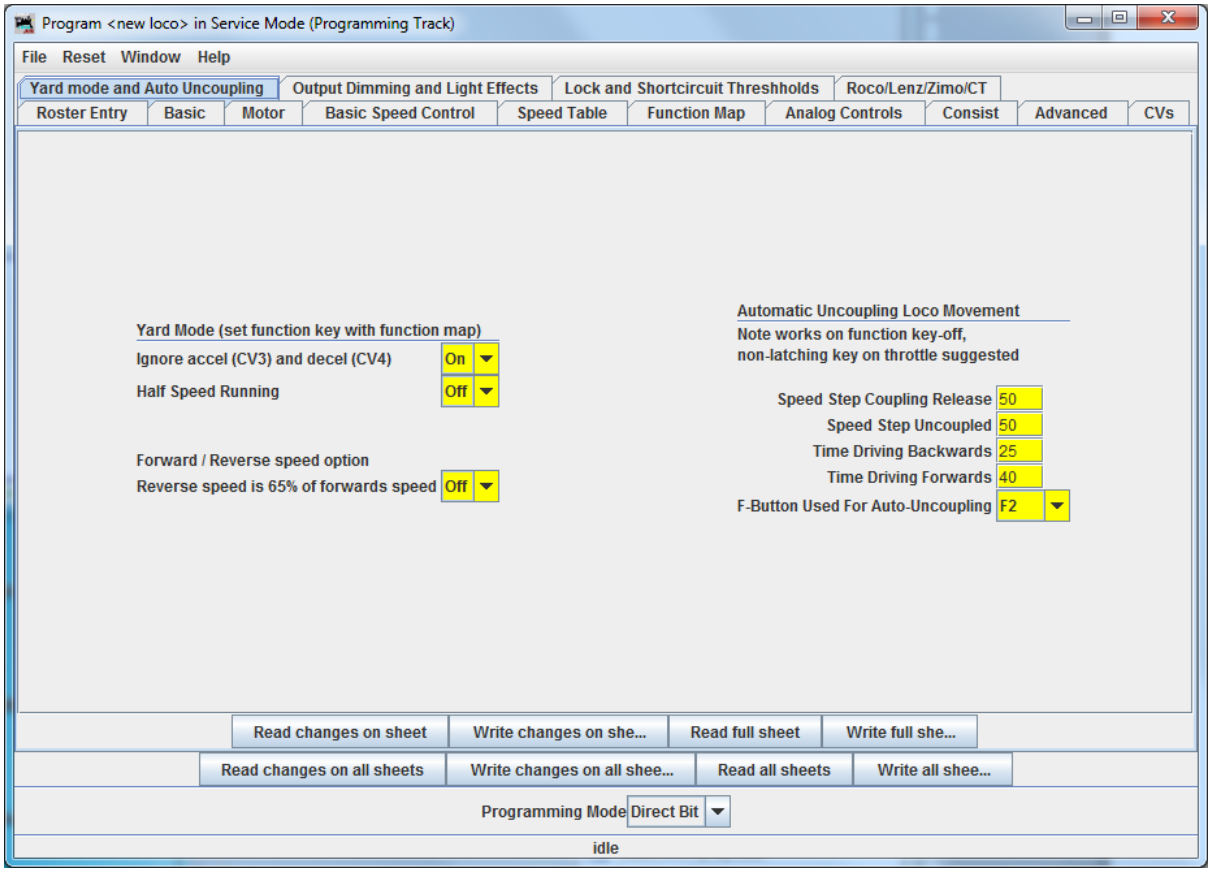
## 9.8 Analogue Controls

Settings relevant to Analogue (DC) running; the speed control for analogue (see section 7 above) and whether the Cab Roof Light operates under analogue (DC) control.



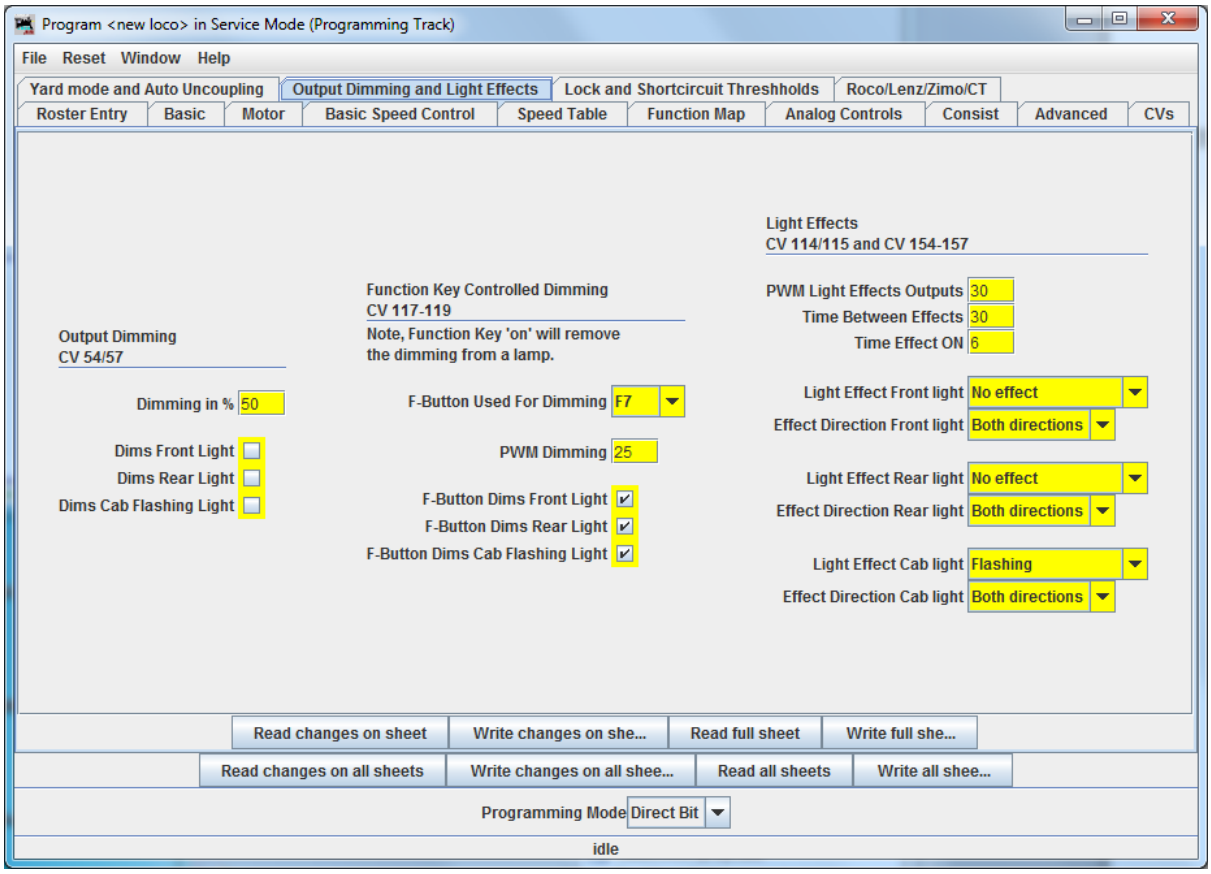
## 9.9 Yard Mode and Auto Uncoupling

Simplified from standard CT decoder as there are fewer wiring options on customised NGS decoder. Shows the Yard Mode settings (left) and the Automatic Uncoupler movement settings (right).



## 9.10 Output dimming and flashing effects

Changes to brightness (dimming) of lights, and light flashing effects.



## 9.11 Zimo and Lenz Braking Functions