





### Further notes re CV29

**Bit0 (Add 1 to activate)** is used to control the default direction of the locomotive. This is useful if the decoder has been retro fitted to a non-DCC fitted locomotive and a wiring error has been made re connection to the motor. Other uses are where the model railway layout requires reversed direction operation.

**Bit1 (Add 2 to activate)** is used to set the decoder to detect the correct location of the direction command for lighting control, i.e. whether the decoder is expecting 14 or 28/128 Speed Steps. It is not usual to edit this feature as the decoder will handle this function automatically in most cases.

**Bit2 (Add 4 to activate)** is used to control whether the decoder will operate on both DC and DCC layout control. By default both forms of power are enabled. It is recommended if only running on a DCC controlled layout to turn off DC operation, i.e. CV29 = 2 if only changing this feature of CV29.

**Bit5 (Add 32 to activate)** The decoder stores Short Addresses in CV1 and Long Addresses in CV17 and CV18. Bit5 is used to tell the decoder where to find its allocated address, i.e. for Long Addresses Bit5 is enabled.

This feature is usually handled automatically, it is not usually necessary to edit the value of this Bit.

### Please Note

If a decoder is returned to default settings, i.e. address 03, etc., if Bit5 is turned 'on' to make the decoder operate in 'Long Address' mode, the decoder will respond to address 100. Turning Bit5 to the 'off' state will return the decoder to 'Short Address' mode, i.e. address 03.

If the decoder has been previously used with both Short and Long Addresses toggling this Bit on/off allows the decoder to use either the short or long address previously programmed.

### CV150-154: Motor Control Method

Motor speed control is achieved using a controlled loop system (algorithm) where the decoder checks the speed of the motor and compares the retrieved current speed information of the motor with the 'desired' speed setting.

For example, if the locomotive is climbing a hill, the tendency is for the locomotive to slow down compared to the desired speed set from the controller. The control system will detect this and try to compensate the speed drop by increasing the drive to the motor. Similarly, when a locomotive moves off from standstill, the control system will try to compensate for the tendency for the locomotive to remain static (inertia at rest).

The control algorithms employed are referred to as PIDs. This refers to Proportional - Integral - Differential. Further explanation is outside the scope of these notes but from the point of view of this note it is the P and I factors that interest us, as follows. How the decoder reacts and controls the compensation system for speed drops etc. can be adjusted. Adjustment of the motor drive characteristics is carried out with the following CVs.

CV150 allows the selection of one of two base motor control algorithms. The CV value range is 0-1.

This corresponds with: CV150=0 Algorithm 1 is in control.  
CV150=1 Algorithm 2 is in control.

Each of the two algorithms can be further adjusted by use of their associated CVs.

For more information visit [www.hornby.com](http://www.hornby.com)



### Motor control Algorithms: Description

#### Algorithm 1 (CV150=0)

This algorithm is a non-linear curve which offers lower controlled speed in the low speed end of the curve. This is similar to the Hornby decoder type R8249. CVs 151 & 152 offer control of the P and I factors of the Algorithm 1. Generally speaking, the higher the setting for these two values the motor control becomes 'Stronger' but at the cost of losing fine control. By default this algorithm is set with the P and I values set to 8.

#### Algorithm 2 (CV150=1)

This algorithm is a linear curve which offers higher controlled speed in the low speed end of the curve. This is similar to some Lenz type decoders. CVs 153 & 154 offer control of the P and I factors of Algorithm 2. By default this algorithm is set with P and I values of 215 and 115 respectively.

**Note that CV10 (BEMF cut off) also affects motor control performance.**

## 6. CV Table 2: Engine Sound Transition Configuration

The locomotive's engine sounds will rev up and down and hold at different rev levels (or Notches) depending on the speed step applied from the controller. The system is designed to operate with 128 speed steps (0-127).

Please ensure that your controller is set to support 128 speed stepping (0-127). Not all controllers have the ability to display actual speed step values, in practice this doesn't really affect your driving experience. For the purpose of explanation we will refer to speed steps to explain how the 'engine sounds' react to different throttle levels etc.

### The TTS Diesel Sound System... How it works

The decoder in your locomotive is designed to operate at 4 different rev levels. These are the 4 rev levels. Each rev level above 'IDLE' are referred to as 'NOTCH'.

#### The rev levels...

**IDLE** (Standing or smallest amount of engine revs.)

**NOTCH 1** (Slow Engine Speed)

**NOTCH 2** (Medium Engine Speed)

**NOTCH 3** (Fast Engine Speed)

The way that the locomotive engine sound responds is controlled by the throttle on your controller i.e. as you increase the actual speed of your locomotive on the track, so the sound responds accordingly. The way the locomotive sounds change can also be controlled by use of certain controller functions (F#). However, for the moment, we will examine how the engine sound automatically responds under just throttle control.

Take a look at the CV table on page 10...

The table indicates configuration of the speed step value that triggers the play of the next NOTCH in the sequence i.e. NOTCH 1 through to NOTCH 3. These are referred to as Trigger Thresholds - TT.

To add further 'realism' to the driving experience we have also added a CV associated with each TT. This is the Trigger Threshold Window - TTW.

In each case, the TTW CV sets a value that is added to the TT value. This creates a window of speed steps values that are used to control the engine sound in a specific way i.e.

- When the speed step transmitted from the controller falls in to the range between TT and TT + TTW the engine sound will NOTCH up and then immediately NOTCH down. Please note that once the speed step transmitted is in this range no further automatic NOTCH Up/Down action will occur until, after the speed step has increased/decreased and then re-entered the TTW.
- This process limits the engine transition lag between minute throttle changes.
- If the speed step transmitted exceeds TT+TTW then the engine will NOTCH up and remain at that NOTCH.

### Engine Sound Transitions Configuration

CV	Default	Range	Explanation
	Value	Speed Range	CV Description
CV210	5	5-15	Trigger Threshold 1 - NOTCH 1
CV211	5	5-14	Trigger Threshold Window - 1 This value is added to the setting of CV210 This gives a range of 10 (derived by 5+5) to 29 (derived by 15+14)
CV212	30	25-45	Trigger Threshold 2 - NOTCH 2
CV213	5	5-14	Trigger Threshold Window - 2 This value is added to the setting of CV212 This gives a range of 30 (derived by 25+5) to 59 (derived by 45+14)
CV214	60	60-80	Trigger Threshold 3 - NOTCH 3
CV215	5	5-15	Trigger Threshold Window - 3 This value is added to the setting of CV214 This gives a range of 65 (derived by 60+5) to 95 (derived by 80+15)

### Acceleration

Here are some examples using zero as a starting point of how the system responds using the default settings set out in the table above...

- You turn the throttle up until you hear the brake release sound and the locomotive just moves. The speed step applied is less than 5.  
Decoder plays the following sequence of engine sounds...  
IDLE Only - explanation... if the brakes are released the loco will crawl with the engine idling.
- You turn the throttle up from zero to speed step 8.  
Decoder plays the following sequence of engine sounds...  
IDLE - Transition to NOTCH 1 - then back to IDLE.
- You turn the throttle up from zero to speed step 12.  
Decoder plays the following sequence of engine sounds...  
IDLE - Transition to NOTCH 1 - Remains in NOTCH 1.
- You turn the throttle up from zero to speed step 33.  
Decoder plays the following sequence of engine sounds...  
IDLE - Transition to NOTCH 1 - Transition to NOTCH 2 - then back to NOTCH 1.
- You turn the throttle up from zero to speed step 66.  
Decoder plays the following sequence of engine sounds...  
IDLE - Transition to NOTCH 1 - Transition to NOTCH 2 - NOTCH 3 - Remains at NOTCH 3  
Note: When the locomotive moves off, brake release sounds are played automatically.

### Deceleration

So far we have talked about Acceleration. Deceleration follows different rules. Basically, at any given speed step the appropriate NOTCH or IDLE sound will be playing. On first decrement of the Speed Step the NOTCH playing will transition to the NOTCH below it.

The second decrement of the speed step will cause the system to transition to the next NOTCH downwards. This process will repeat until the sound playing is 'IDLE' and it is not possible to go any lower.

If the throttle is increased after a deceleration event, the acceleration rules will apply as described previously.

### Manual Control

In addition to the 'automatic' engine control described previously the decoder also supports "manual" engine control via Function numbers F5, F6, F7 and F8.

#### F5 NOTCH UP

F5 is a momentary action control that will force the engine sound to increase to the next NOTCH in the NOTCH sequence. This is possible when IDLE, NOTCH 1 and NOTCH 2 are playing.

**Example:** If the loco is playing the IDLE sound then pressing F5 once will increase from IDLE to NOTCH 1.

#### F6 NOTCH DOWN

F6 is a momentary action control that will force the engine sound played to decrease to the next NOTCH in the NOTCH sequence. This is possible when, NOTCH 3, NOTCH 2 and NOTCH 1 are playing.

e.g. If the loco is playing NOTCH 2 sound pressing F6 once will decrease from NOTCH 2 to NOTCH 1.

#### F7 RETURN TO IDLE

F7 is designated as momentary control action. Once triggered the engine sound will decrease from whatever Notch is currently playing to IDLE playing all engine sound transitions as the engine rev rate drops.

No other control engine function is available until the engine reaches IDLE.

#### F8 THRASH

F8 is a Toggle function. F8 simulates what happens when the driver 'stamps' on the locomotive's throttle, i.e. the driver applies a lot of power in a sudden burst to overcome a heavy loading situation e.g. when negotiating an incline or moving off with a very heavy load in tow.

The 'Thrash' function increases the current NOTCH by 2 steps. It locks the loco at the new NOTCH until 'toggled' off. When toggled back to 'off' the NOTCH sound played will be appropriate to the current speed of the locomotive. This is to accommodate any acceleration of the locomotives speed during the 'locked' Thrash setting.

**Note:** F7 'Return to Idle' override F8 'Thrashing'. If F7 is pressed you must ensure F8 is then disabled in order to return to normal engine control...

#### Example:

- If the loco is playing IDLE, when F8 is toggled on the engine sound will transition and play NOTCH 2
  - If the loco is playing NOTCH 1, when F8 is toggled on the engine sound will transition and play NOTCH 3
  - If the loco is playing NOTCH 2, when F8 is toggled on the engine sound will transition and play NOTCH 3 (one step!)
  - If the loco is playing NOTCH 3, when F8 is toggled on there will be no action
- For further information re driving your locomotive and getting the most out of the sound system see page 3.

For more information visit [www.hornby.com](http://www.hornby.com)



## 7. CV table 3: Spot Sounds Volume Configuration

The volume level of the locomotive 'engine' sounds and each 'spot' sound (e.g. horns etc) is controlled by its own dedicated CV. See table below.

We have set all volume CVs to a default value of 4. This will allow you to hear all sounds clearly. However, how you may want to set the relative balance of the individual sounds differently. It may depend on whether you want to 'hear' the locomotive at a "distance, close up, or possibly when in the driving cab."

In the table below we have added some suggestions re volume levels you may wish to try. These are based on how the locomotive may realistically sound from a scale distance of approximately 15 metres. Remember, these are only suggestions that act as a starting point if you wish to experiment with the relative volume level of each sound...it's up to you!

### Volume Settings (Mixer Section)

See 'The Mixer Section' re CV explanations etc.

CV	Default Value	Value Range	F# and Description	Sound Volume Description	Suggested Volumelevels
CV161	4	0-8	F1 Volume	Locomotive Engine Start up/Shut down	4
CV162	4	0-8	F2 Volume	Horn High-Low	6
CV163	4	0-8	F3 Volume	Horn Low-High	6
CV164	4	0-8	F4 Volume	Brake Squeal	1
CV165				Intentionally unused	
CV166	4	0-8	F10 Volume	Horn High Two Bursts	6
CV167	4	0-8	F11 Volume	Door Slam	3
CV168	4	0-8	F12 Volume	Fan	1
CV169	4	0-8	F13 Volume	Horn Long High	6
CV170	4	0-8	F14 Volume	Horn Short Two Bursts	6
CV171	4	0-8	F15 Volume	Primer	1
CV172	4	0-8	F16 Volume	Slow flange squeal	2
CV173	4	0-8	F17 Volume	Spirax Valve	2
CV174	4	0-8	F18 Volume	Horn Short Low	6
CV175	4	0-8	F19 Volume	Horn Short High	6
CV176	4	0-8	F20 Volume	Wagons Buffering	2
CV177	4	0-8	F21 Volume	Wagons Clanging	2
CV178	4	0-8	F22 Volume	Coupling 1	1
CV179	4	0-8	F23 Volume	Guard's Whistle	4
CV180	4	0-8	F24 Volume	Coupling 2	1
CV182	Not Readable	0-8		Quick Set Volume level	

**Note:** For each sound there are 9 possible settings i.e. 0-8. 0 is no sound, while 8 is full volume.

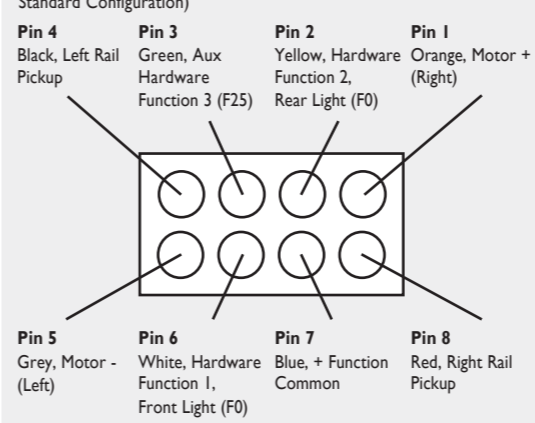
The sound set of the loco has been balanced in the factory so that sounds play at the correct volumes relative to each other. However, individual sounds may be fine-tuned in volume by the user to suit by adjusting their associated CV... Please see table above.

For more information visit [www.hornby.com](http://www.hornby.com)



## 8. Decoder Plug and Socket connection specification

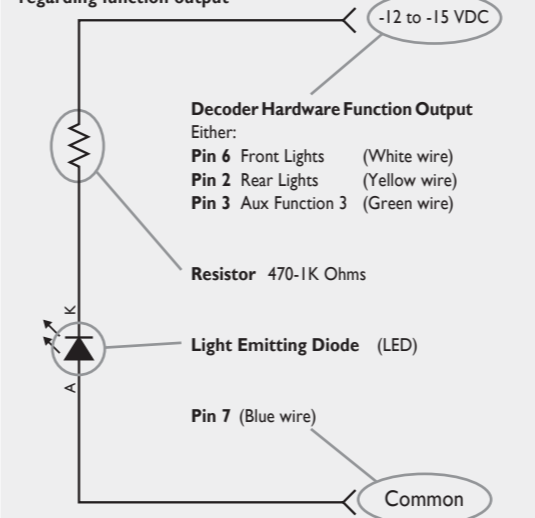
### Decoder Plug / Socket configuration viewed from above (NMRA Standard Configuration)



### Decoder Current Limits

- Function Output current limits are 100mA per function hardware connection.
- Total Current Draw from decoder is 800mA (motor + functions).
- Decoder can handle 1A peak for short durations. (No Function Load).

### Typical example of the configuration of lighting connections regarding function output



#### Please note

The Hornby TTS 'Class 20' is not fitted with lights or any aux connected items. The above is standard information for the TTS series of Hornby decoders. If your locomotive is equipped with incandescent light bulbs ('Grain of Rice') please ensure that they are rated a current level below 100mA at 12-15VDC. Most bulbs of this type are rated at approximately 65mA.

## 9. Glossary of Function Sounds

Most function sounds are self explanatory. The following additional explanations may be of interest.

**Compressor:** Charges the air tanks so they are full of compressed air to work the brakes.

**Fan:** Sometimes called a 'scavenger' fan, this sucks in air from outside the loco to help keep the engine room cool.

**Primer:** A pump used to remove air from the fuel lines and fill them with diesel, otherwise the engine would not start.

**Spirax:** A valve fitted to an air tank that makes a ticking noise when the engine is not running to let out any condensation to prevent the tank from freezing.

## 10. Troubleshooting

- No Sound**  
Turn on sound / Start Engine (F1).  
The decoder does not support DC running with sound. Reset Decoder.  
Reset Controller.
- Jerky Running**  
Reset Decoder.  
Clean Rails / Wheels / Pickups.
- No Control or Response from the Locomotive**  
Check Decoder Address.  
Reset Decoder.  
Reset Controller.  
Clean Rails / Wheels / Pickups.
- Locomotive engine does not automatically/manually Notch Up or Down**  
Is F8 'Thrash' turned on permanently?.. Return F8 to OFF.  
**Note:** see page 3 re 'momentary/toggle' control functions.  
Is the locomotive engine returning to idle after activating F7? (Normal control will resume after approximately 20 seconds.)  
Please ensure F7 is turned off after operation.  
**Note:** see page 3 re 'momentary/toggle' control functions.

For Customer Care contact:  
**+44 (0)1843 233525**  
or via website:  
[www.hornby.com](http://www.hornby.com)

