

FINE TUNING LOCOMOTIVE SPEED - DCC

The steps for fine tuning locomotive speed in a DCC environment are as follows (applicable CVs are listed and described in the table that follows).

BEFORE YOU START:

Make every effort to determine the table of Configuration Values (CV) for the decoder installed in the loco. This should have come with the loco/decoder module as a sheet of values. There were originally 255 CVs defined by NMRA, however the number has increased to potentially 4096 and more. If the CVs are not available, interrogate the decoder on a programming track to find the Manufacturer ID (CV8) and Manufacturer Version No (CV7). Once these values are known, use an internet search to establish the CVs used in the particular decoder, their function, and the range of values that are available for each CV.

(Having the list of applicable CVs is very useful because not all CVs are invoked by all manufacturers, unless they are specified as required by the NMRA. Only eight CVs are classified as mandatory or strongly recommended. The rest are either optional but specific to a particular function, or available for a manufacturer to use for any particular function. Some are reserved for future use by NMRA, while the ranges 47-64 and 112-256 are available to manufacturers. Some of these (i.e. CV116 and CV117 for NCE's decoders) may be used for motor control functions, so all CVs for the particular decoder should be investigated for possible fine tuning application.)

Make sure the loco is well maintained, clean and warm from running. Turn off any momentum (set CV3 and CV4 to 0) as well as any momentum adjustment (set CV23 and CV24 to 0). If the decoder has one or more of the functions such as Kick Start (CV65), Dither or Torque Compensation (CVs vary by manufacturer), turn them off (set the appropriate CV to 0). Do as much fine tuning as you can with speed settings or speed table before making specific adjustments that might help the loco to get moving.

FIRST

Determine whether a speed table is available in the decoder (CVs 67-94). If not, speed adjustment is only available through CV2-6. Ensure Vmid (CV6) is higher than Vstart (CV2) and lower than Vhigh (CV5). Play with Vstart to get the loco to keep running at speed step 1. Do this by increasing speed then backing down to speed step 1 to ensure the loco still creeps along.

In some decoders (e.g. Tsunami) CVs 5 and 6 are not available, so a speed table must be used. If a speed table is available, and you wish to use it, perform the same adjustments using CVs 67-94. Put the decoder in 28/128 mode by setting Bit 4 in CV29 to ON (i.e. ensure a value of 16 is included in the CV29 value), set speed step 1 (CV67) to 0 and speed step 28 (CV94) to 255. Make the speed table linear. Run the loco and determine at which speed step it will continue running. Put this value in speed step 1 and adjust the rest of the speed table accordingly.

(Note that a speed table may not be appropriate for all locos, and may be an unnecessary complication. Operation of a shunter, say, may require that the earlier speed steps increase speed very little, while higher speed steps boost speed quickly for long transits. But a mainline unit may be quite realistic with fewer variations between the speed steps.)

NEXT

If the loco is still not functioning as desired on startup and at very slow speed, check to see if Kick Start, Dithering or Torque Compensation is available.

- Kick Start is optionally prescribed for CV65, and provides extra voltage when moving from a stopped state to speed step 1. Kick Start only works at this point in the operation to overcome stiction. If Kick Start is available (not all decoders allow it, and it may only be available when speed table is off), then adjust Kick Start so that moving from a stopped position to speed step 1 actually starts the loco.
- Dithering is a manufacturer specific function so check the CV table to see which CVs may be applicable. The values will be included in the manufacturer usable ranges. It was originally introduced by TCS for use on high frequency (silent running) decoders using CVs 56 and 57. Dithering, when used, applies extra short bursts of voltage at programmable frequency to make slow speed operation smooth. It works for about the first 20% of the speed table whereas Kick Start only operates when transiting from a stopped position to speed step 1. Some decoders allow both Kick Start and Dithering. It is personal choice as to which, if either, is used.
- If neither Kick Start nor Dithering is available, other functions may be invoked such as torque compensation. Check the CV table for options. NCE refers to “torque compensation” rather than dithering.

OTHER ADJUSTMENTS

Acceleration and Deceleration can be adjusted for more realistic operation if desired, and is sometimes referred to as “momentum”. Two pairs of CVs have been specified by NMRA – CV3 and 4, and CV23 and 24. The latter pair are referred to as “acceleration/deceleration adjustment”. The values applied to CV3 and CV4 determine the length of delay between speed steps as the loco accelerates (or decelerates) to reach the commanded speed. This means, if a command station has the ability to instantly demand full throttle, the loco moves up through the speed steps at a specified rate rather than instantly jumping to full speed. The value entered into CV3 and CV4 multiply the decoder’s default delay period. NMRA specifies a default setting equivalent to 0.032 seconds per speed step in 28 step mode. Entering a value of 1 means the loco would reach full speed in just under a second. A value of 10 increases this delay to 0.32 seconds per speed step, and the loco reaches full speed in about 9 seconds. Higher values are impractical for smaller, congested layouts. Useful numbers for CV3 and CV4 are from 5-10.

CVs 23 and 24 are optional parameters that can be used to further modify momentum, and were specified by NMRA anticipating additional momentum adjustment for heavy loads or when locos are in a consist. The settings add to or subtract from the values in CV3 and 4 by a value defined similarly to those for CV3 and 4. They are rarely needed and in practice are not available in an NCE command environment when using consists.

TABLE OF CVs APPLICABLE TO SPEED OPERATION

VALUE	TITLE	REQUIRED BY NMRA?	DESCRIPTION
02	Vstart	required	Used in conjunction with Kick Start (CV65) or, if available, Dithering or Torque Compensation to ensure smooth starting. When set to zero no voltage is applied, when set to 255 maximum voltage is available. Useful range 1-100.
03	Acceleration rate	required	Causes short delay between speed steps as speed accelerates. NMRA specifies .032 seconds per value between speed steps. Other decoders may use different values so check the CV sheet. Usually max value is 255, but practical values are between 5 and 10.
04	Deceleration rate	required	As per CV3, but for deceleration.
			<p>NOTE FOR NCE COMMAND SYSTEMS</p> <p>The Momentum button on NCE CABs modifies CV3 and CV4 on the fly, and the values overwrite what may have been previously set, and persist. By default, NCE CABs are programmed to modify CV3 (acceleration) by 8 times the value of the button pressed and to modify CV4 (deceleration) by half that multiplier. This can lead to large delays in acceleration and deceleration (See practical values above).</p> <p>Momentum multiplier and deceleration rate factor can be modified in the Command Station Setup (PROG 5), as well as disabling the momentum button when controlling consists.</p> <p>Decoders that provide voice confirmation will operate erratically when Momentum is changed by an NCE CAB (CV3 will change, CV4 may not). Turn off voice confirmation to solve the problem.</p>
05	Vhigh	optional	Controls the voltage applied to the motor at maximum throttle. This is specified as a fraction of the available motor voltage, maximum value is 255. If the value is 0 or 1, this function is not used by the decoder.
06	Vmid	optional	Controls the voltage applied to the motor at the mid-point of the throttle setting. It is a fraction of the total motor voltage available. It is used to create a performance curve in the decoder which translates the speed steps into motor drive voltages. If the contents are 0 or 1, Vmid is not used. Care should be taken to ensure Vmid is higher than Vstart, and lower than Vhigh otherwise erratic operation occurs.

23	Acceleration adjustment	optional	Used to provide additional adjustment to momentum. Additional acceleration rate is added to or subtracted from the value contained in CV3. It is determined by $(CV23) * 0.896 / \text{number of speed steps in use}$. Not very useful, and not available in NCE Command Systems for consist momentum.
24	Deceleration adjustment	optional	Calculated as per CV23, but uses CV4 value.
29	Configuration data	required	Basically eight binary on-off switches. Those that relate to loco motion are: <ul style="list-style-type: none"> • Bit 1 (value 0 or 1) controls loco direction. 0 for normal operation • Bit 2 (value 0 or 2) controls number of speed steps. 0 for 14 speed steps, 2 for 28/128 speed steps • Bit 4 (value 0 or 16) controls whether a speed table is used. 0 uses CVs 2, 5, 6 to determine speed, 16 uses speed table values found in CVs 67 to 94. Values are added together to achieve digital entry into CV29, together with info for Bits 3 and 5.
56,57 (say)	Dither	manufacturer specific	Dither may be programmed in manufacturer optional locations if available. TCS decoders use CV56 and 57. Dithering applies extra voltage spikes at early speed steps to assist getting the loco moving smoothly. The factory default for these two CVs is probably zero, which turns dither off. Not all manufacturers apply dither, and the CV locations will differ. CV56 is used to select a frequency. The range for this CV is 0-255, with 0 being off. The highest frequency addition of 30 extra pulses per second is obtained with a value of 1. The higher the value, the fewer additional pulses are added. Recommended start value is 5, but the optimum value is obtained through experimentation. Suggested practical range is 1 through 10. CV57 controls the amplitude of the additional pulses. The range is 0-255, with 0 being off and 255 being the highest voltage pulse. Suggested practical range is about 5 through 50, with recommended start value of 25 to 30. The optimum setting is again obtained through experimentation. Dither's extra voltage bumps are only provided in the lower 20% of the speed range, where it's needed. Dither can be used in conjunction with Vstart (CV2) and/or Kick Start (CV65) to provide additional power to make most locomotives start and run smoothly at any speed.
65	Kick start	optional	Function to help overcome motor and drivetrain stiction when a locomotive starts to move from standstill. Kick Start can provide a little extra burst of power to get the loco started when speed step 1 is first selected. This extra burst of power is provided for only a few pulses when you first access speed step 1, then the assistance from Kick Start stops. Its value is determined by experimentation. By changing the value in CV65, you change the specified extra amount of kick that will be applied to the motor when the throttle transitions from stop to the first speed step. Manufacturers can have other options for ensuring a smooth start, i.e. dither can take the place of kick start.

			If Kick Start is used in conjunction with user-loadable speed table and it is suggested the speed table be properly set up before tinkering with dither or kick start.
67 to 94	Speed table	optional	<p>The user-loadable table provides 28 CVs (67-94) for the speed table. CV67 is for speed step 1 in the 28 speed-step mode. CV68 is for speed step 2, CV69 is for speed step 3, and so on all the way up to CV95 for speed step 28.</p> <p>For fine tuning, you can use CVs 66 and 95 for forward and reverse trims. Trimming may be necessary if the loco runs at different speeds in forward and reverse for the same speed setting.</p> <p>With some decoders, the user-loadable speed table can only be used in the 14- or 28-speed-step modes. More advanced decoders can expand the speed table and use 128-speed-steps by stretching the 28 CVs, or interpolating, into 128 virtual CVs and automatically computing the in-between points.</p> <p>You don't have to use the user-loadable speed table. Using CVs 2, 5 and 6 (if available) will typically function well enough.</p>
66, 95	Forward trim, Reverse trim	optional	<p>Forward Trim specifies a scaling factor to be applied to the calculation of the motor drive voltage when the locomotive is operated in forward. Values from 1-127 are added to forward speed (interpolated as 128 steps) to bring it into line with reverse speed at the same speed step. Values of 129 to 255 add to reverse speed. Setting CV66 to 0 or 128 disables the feature.</p> <p>Reverse Trim specifies a similar scaling factor to be applied to the calculation of the motor drive voltage when the locomotive is operated in reverse. Values of 1-127 are added to reverse speed, and values of 129 to 255 are added to forward speed.</p> <p>Only one is necessary, and decoders may only include one in the available table. Or neither may be available.</p>
116,117 (say)	Torque compensation	manufacturer specific	<p>Some decoder manufacturers provide for torque compensation in preference to Kick Start and Dithering. NCE decoders use CV116 for torque kick rate and CV117 for torque kick strength. The functions operate by pulsing voltage for a defined period at a defined strength to get the loco moving. The function reduces to 0 as speed increases.</p> <p>CV116 determines how frequently the motor is kicked at low speed. 0 is off, 1 applies continuous kicks. Practical range is 1-8, and suggested values are 2-4.</p> <p>CV117 determines how hard the motor is kicked at slow speed. 0 is off, larger number applies more voltage. Practical range is 1-50, and suggested values are 4-25.</p>