

Hall Opposition Declaration Exhibit C



NMRA DCC Reference Manual
for
QSI Quantum[®] HO Equipped
Locomotives

Version 3.0
16 February 2005

3.3 CV 3 Acceleration Rate²⁷

Sets Quantum value of Inertia Under Acceleration

Default Value:

CV 3: Acceleration Rate Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
D7	D6	D5	D4	D3	D2	D1	D0

- Acceleration rate register can have any rate between 0 and 255. A value of "0" provides no inertia and gives the fastest response to changes in throttle position.
- When any number except "0" is entered in CV 3, the power applied to the motor increases linearly as a function of time between speed steps. The inertia in "seconds per speed step" is based on the value of CV 3 as provided by the formula below.

$$\text{Acceleration Inertia (Seconds/speed step)} = \frac{(\text{CV 3}) * 0.896}{\text{Number of Speed Steps}}$$

- Note that the value of CV 3 will provide the same inertia for all speed step choices (14, 28, and 128) for the same percentage change in throttle position. In other words, for the same value of CV 3, it will take the same amount of time to go from a dead stop to full speed for a throttle change from minimum to maximum regardless of the speed step choice. The acceleration rate can vary from a quick response measured in seconds for CV 3=0 to as long as 3.8 minutes (228 seconds) for CV 3 = 255.
- The actual acceleration is the inverse of the above inertia formula.

$$\text{Acceleration (speed steps/second)} = \frac{\text{Number of speed steps}}{(\text{CV 3}) * 0.896}$$

- The acceleration and deceleration rate values in CV 3 and CV 4 will apply if you change the direction on a moving engine. The locomotive will slow to a stop at a rate set by CV 4 and then accelerate in the opposite direction at a rate set by CV 3.

²⁷ This NMRA CV is more aptly entitled "Inertia under Acceleration" since higher values for this CV result in higher inertia values but lower acceleration rates. Using the term "Momentum" to describe CV 3 is not correct since a non-moving train has no momentum even if CV 3 is set to the maximum value. Inertia is the property of an object that resists any change to its state of rest or motion.

3.4 CV 4 Deceleration Rate²⁸

Sets Quantum Inertia Under Deceleration.

Default Value:

0

CV 4: Deceleration Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
D7	D6	D5	D4	D3	D2	D1	D0

- Deceleration rate register can have any rate between 0 and 255. A value of "0" provides no inertia and gives the fastest response to changes in throttle position.
- When any number except "0" is entered in CV 4, the power applied to the motor decreases linearly as a function of time between speed steps. The amount of seconds per speed step is based on the value of CV 4 as provided by the formula below.

$$\text{Deceleration Inertia (Seconds/speed step)} = \frac{(\text{CV 4}) * 0.896}{\text{Number of Speed Steps}}$$

- Note that the value of CV 4 will provide the same inertia for all speed step choices (14, 28, and 128) for the same percentage change in throttle position. In other words, for the same value of CV 4, it will take the same amount of time to go from full speed to a dead stop for a throttle change from maximum to minimum regardless of the speed step choice. The deceleration rate can vary from the time it takes the model engine running at full speed to stop (a second or so) for CV 4 = 0, to as long as 228 seconds (3.8 minutes) for CV 4 = 255.
- The actual deceleration is the inverse of the above formula.

$$\text{Deceleration (speed steps/second)} = \frac{\text{Number of speed steps}}{(\text{CV 4}) * 0.896}$$

- The acceleration and deceleration rate values in CV 3 and CV 4 will apply if you change the direction of a moving engine. The locomotive will slow to a stop at a rate set by CV 4 and then accelerate in the opposite direction at a rate set by CV 3.

²⁸ This NMRA name is more aptly entitled "Inertia under Deceleration" since higher values for this CV result in higher inertia values but lower acceleration rates. Using the term "Momentum" to describe CV 3 is not correct since a non-moving train has no momentum even if CV 3 is set to the maximum value. Inertia is the property of an object that resists any change to its state of rest or motion.