
Scope

This section of the manual is designed to provide the advanced user with additional insight into the operation and capabilities of the SoundTraxx Digital Sound Decoder. By necessity, it is somewhat technical in nature and assumes a working knowledge of the NMRA DCC Standards and RPs as well as a familiarity with binary and hexadecimal number systems.

The novice user should not be dissuaded from studying this section as it will help add to his knowledge of DCC technology and enable him to take greater advantage of its capabilities.

Copies of the NMRA DCC Standards and Recommended Practices may be obtained by contacting:

Technical Department
NMRA Headquarters
4121 Cromwell Road
Chattanooga, TN 37421 USA
Phone: (615) 892-2846

As always, our Technical Support staff will be happy to answer any specific questions you may have regarding the SoundTraxx DSD.

Applicable Standards

The SoundTraxx DSD has been designed to meet the requirements of the following NMRA Standards and RPs as defined by September, 1996:

Standard S-9.1	DCC Electrical Standard
Standard S-9.2	DCC Communication Standard
RP-9.1.1	Electrical Interface and Wire Color Code
RP-9.2.1	DCC Extended Packet Format
RP-9.2.2	DCC Configuration Variable
RP-9.2.3 (Tentative)	DCC Service Mode
RP-9.2.4	DCC Fail-Safe Operating Characteristics

Bit Timing

The DSD uses a quartz crystal timing reference and will recognize DCC packet bits that fall within the following timing constraints:

- “1” Bit, 52 μ S to 64 μ S
- “0” Bit, 90 μ S to 12000 μ S

Packets containing bits that fall outside of this range will be rejected.

Addressing Modes

The DSD recognizes the following address modes and ranges as defined by RP-9.2.1:

- Broadcast Address 00
- Decoder Addresses 01-127
- Consist Addresses 01-127
- Extended Addresses 0xC000 - 0xE7FF

Packets contain addresses outside of these ranges will be ignored.

Command Instructions

The DSD will process valid packets containing the following instruction codes as defined by RP-9.2.1:

000 Decoder and Consist Control

All currently defined forms of this instruction are processed except 00000110b, Set Advanced Acknowledgment. This instruction is ignored.

001 Advanced Operation Instructions

The DSD will process only the 128 Speed Step Control form (00111111b) of this instruction. All other sub-instructions will be ignored.

010 Reverse Speed and Direction Instruction

The DSD will process all forms of this instruction.

011 Forward Speed and Direction Instruction

The DSD will process all forms of this instruction.

100 Function Group One

The DSD will process all forms of this instruction.

101 Function Group two

The DSD will process all forms of this instruction.

110 Reserved Instruction

The DSD will process all forms of this instruction.

111 Configuration Variable Access

The DSD will parse both the short form and long form of this instruction.

Only short form instructions formatted as 11110010b (CV 23 access) or 11110011b (CV 24 access) will be processed. All other short form instruction will be ignored.

All long form instructions will be processed. However, attempts to write to the following CVs in operations mode will be ignored:

CV 1	Primary Address
CV 7	Mfg. Version ID
CV 8	Mfg. ID
CV 17	Extended Address MSB
CV 18	Extended Address LSB

Write operations to other CVs may be ignored if an attempt is made to write illegal values. See individual CV descriptions for details on illegal values.

The DSD will send a basic acknowledgment upon successfully processing an operations mode CV access instruction provided the locomotive is stopped. Otherwise, no acknowledgment is sent.

Programming Modes

The DSD will supports all six programming modes defined in RP-9.2.1 and RP-9.2.3:

- Address Mode
- Register Mode
- Service Mode
- Direct Mode
- Ops Mode Long Form
- Ops Mode Short Form

Not all CVs can be programmed using all modes. Table A lists all CVs supported by the DSD, their applicable programming mode address as well as the factory default values.

When entering service mode, the DSD will turn off all auxiliary functions and sounds to reduce its current draw to as low a level as possible.

If the DSD receives an instruction packet to read or write a CV not listed in Table A, the instruction packet will be ignored and no acknowledgment will be generated.

Upon completion of a paged mode operation, the DSD will reset the page register to 01.

The address query instruction is *not* supported by the DSD.

Miscellaneous Operating Notes

Consist operation is enabled whenever the consist address (CV 19, bits 0:6) is loaded with a non-zero value. Per the NMRA standard, when the consist address is enabled, the DSD will no longer parse speed/direction packets sent to its primary address. Additionally, the DSD will ignore long form CV access instructions sent to its consist address. Because the DSD instruction parser assigns a higher priority to the consist address, this can cause unexpected behavior under certain conditions:

When the DSD is set up for 14 speed step mode with the consist address active, the DSD outputs will no longer respond to FL function commands sent to the primary address. This may be remedied by using a different speed step mode or enabling FL consist functions (see CV 22).

If the consist address is set to the same value as the primary address, the DSD will no longer process long form operations mode CV access instructions sent to the primary address. As a result, the user will be required to use service mode CV access instructions to clear the consist address. If the extended address is enabled (see CV 29), this will not be a problem.

Analog Mode Operation

The DSD does *not* support Analog Mode operation and will remain inoperative when placed on a conventional DC track.

CVs Support

The following table lists all CVs used by the DSD. Details regarding each CV can be found on subsequent pages.

Table A.
CVs Used by the Digital Sound Decoder

CV#	Name	Default Value	Program Mode Address		
			Direct Mode	Register Mode	Paged Mode Page:Register (Note 1)
1	Primary Address	3	01 (0x01)	0	1:0
2	Vstart	7	02 (0x02)	1	1:1
3	Acceleration Rate	0	03 (0x03)	2	1:2
4	Braking Rate	0	04 (0x04)	3	1:3
7	Version ID	06	07 (0x07)	6	2:3
8	Manufacturer ID	141 (0x8D)	08 (0x08)	7	3:0
9	Motor PWM Period	180 (0xB4)	09 (0x09)		3:1
11	Time Out Period	0	11 (0x0B)		3:3
17	Extended Address MSB	192 (0xC0)	17 (0x11)		5:1
18	Extended Address LSB	03	18 (0x12)		5:2
19	Consist Address	0	19 (0x13)		5:3
21	Consist Func. Active	0	21 (0x15)		6:1
22	Consist FL Active	0	22 (0x16)		6:2
23	Consist Acceleration	0	23 (0x17)		6:3
24	Consist Deceleration	0	24 (0x18)		7:0
25	Speed Table Select	0	25 (0x19)		7:1
29	Configuration Data #1	02	29 (0x1D)	4	8:1
30	Error Information	0	30 (0x1E)		8:2
33	FL(f) Output Location	1	33 (0x21)		9:1

CV#	Name	Default Value	Program Mode Address	
			Direct Mode	Paged Mode Page:Register (Note 1)
34	FL(r) Output Location	2	34 (0x22)	9:2
35	F1 Output Location	4	35 (0x23)	9:3
36	F2 Output Location	8	36 (0x24)	10:0
37	F3 Output Location	2	37 (0x25)	10:1
38	F4 Output Location	4	38 (0x26)	10:2
39	F5 Output Location	8	39 (0x27)	10:3
40	F6 Output Location	16 (0x10)	40 (0x28)	11:0
41	F7 Output Location	4	41 (0x29)	11:1
42	F8 Output Location	128 (0x80)	42 (0x2A)	11:2
49	Hyperlight Config.	0	49 (0x31)	13:1
50	Sound Volume	8	50 (0x32)	13:2
51	Background Snd Config	190 (0xBE)	51 (0x33)	13:3
52	Foreground Snd Config	70 (0x46)	52 (0x34)	14:0
53	Snd Config. Byte #3	0	53 (0x35)	14:1
54	Auto Exhaust Rate	94 (0x5E)	54 (0x36)	14:2
55	Exhaust Tone	08	55 (0x37)	14:3
56	Exhaust Volume	255 (0xFF)	55 (0x38)	15:0
66	Forward Trim	128 (0x80)	66 (0x42)	17:1
67	Speed Step 1	0 (0x00)	67 (0x43)	17:2
68	Speed Step 2	9 (0x09)	68 (0x44)	17:3
69	Speed Step 3	18 (0x12)	69 (0x45)	18:0
70	Speed Step 4	28 (0x1C)	70 (0x46)	18:1
71	Speed Step 5	37 (0x25)	71 (0x47)	18:2
72	Speed Step 6	47 (0x2F)	72 (0x48)	18:3
73	Speed Step 7	56 (0x38)	73 (0x49)	19:0
74	Speed Step 8	66 (0x42)	74 (0x4A)	19:1
75	Speed Step 9	75 (0x4B)	75 (0x4B)	19:2
76	Speed Step 10	85 (0x55)	76 (0x4C)	19:3
77	Speed Step 11	94 (0x5E)	77 (0x4D)	20:0
78	Speed Step 12	103 (0x67)	78 (0x4E)	20:1
79	Speed Step 13	113 (0x71)	79 (0x4F)	20:2
80	Speed Step 14	122 (0x7A)	80 (0x50)	20:3
81	Speed Step 15	132 (0x84)	81 (0x51)	21:0
82	Speed Step 16	141 (0x8D)	82 (0x52)	21:1
83	Speed Step 17	151 (0x97)	83 (0x53)	21:2
84	Speed Step 18	160 (0xA0)	84 (0x54)	21:3
85	Speed Step 19	170 (0xAA)	85 (0x55)	22:0
86	Speed Step 20	179 (0xB3)	86 (0x56)	22:1
87	Speed Step 21	188 (0xBC)	87 (0x57)	22:2
88	Speed Step 22	198 (0xC6)	88 (0x58)	22:3
89	Speed Step 23	207 (0xCF)	89 (0x59)	23:0
90	Speed Step 24	217 (0xD9)	90 (0x5A)	23:1
91	Speed Step 25	226 (0xE2)	91 (0x5B)	23:2
92	Speed Step 26	236 (0xEC)	92 (0x5C)	23:3
93	Speed Step 27	245 (0xF5)	93 (0x5D)	24:0
94	Speed Step 28	255 (0xFF)	94 (0x5E)	24:1
95	Reverse Trim	128 (0x80)	95 (0x5F)	24:2
105	User Identifier #1	0	105 (0x69)	27:1
106	User Identifier #2	0	106 (0x6A)	27:2

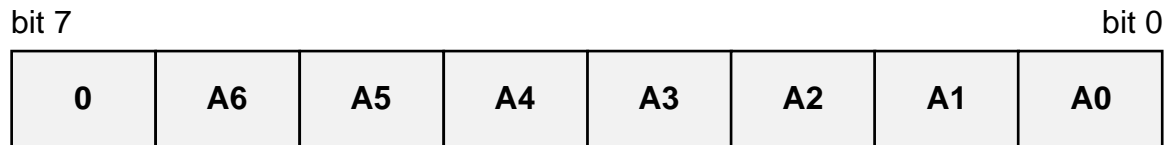
Note1: Paged mode address is shown as PP:RR where PP is the page number and RR is the data register 0-3.

CV 1 PRIMARY ADDRESS CONTROL

<input checked="" type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input type="checkbox"/> Ops Mode Long Form

Description

Contains the decoder's primary address between 1 and 127:



Bit 0-6: A0-A6, Decoder Address

Bit 7: Not used. Must be set to 0!

The decoder will process all valid instruction packets containing an address that matches the value contained in this register when CV 29, bit 5 is set to 0.

Programming this register with a new value will automatically clear the Consist Address (CV 19) to 0 and clear the Extended Address Enable bit in CV 29 (bit 5).

The decoder will ignore commands that attempt to program this register with values outside the range of 1 to 127.

Note that this CV cannot be changed in operations mode.

Default Value: 03

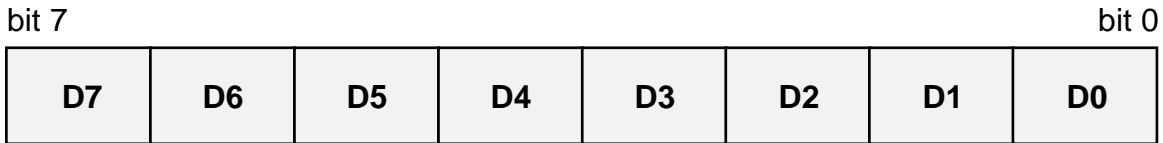
Related CVs: See also CV 29, Consist Address, Extended Address

CV 2 VSTART

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Vstart defines the initial voltage level applied to the motor at speed step 1 as a fraction of available supply voltage:



D0-D7: Motor Start Voltage

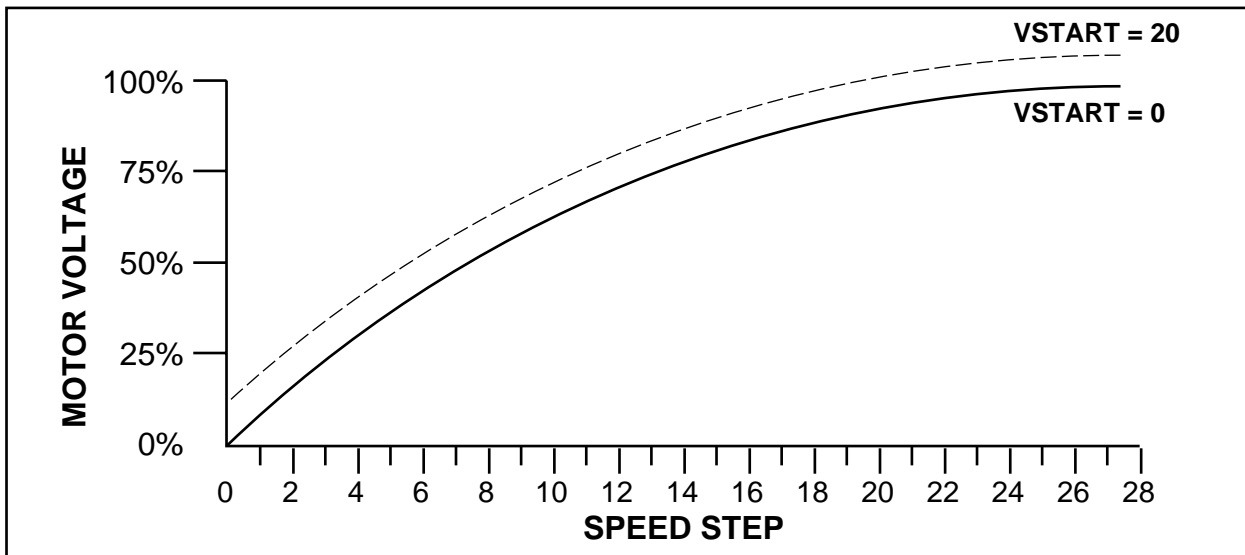
Vstart may contain any value from 0 to 255 (0 - 0xFF).

The starting voltage applied to the motor may be computed as:

$$\text{Starting Voltage} = \text{Supply Voltage} \times \frac{\text{CV2}}{255}$$

where CV 2 is the contents of the Vstart register. A value of 0 corresponds to a zero starting voltage and 255 corresponds to the maximum available voltage.

For speed steps greater than 1, the DSD will continue to sum the initial starting voltage level into the throttle computations which has the effect of offsetting all points on a given speed curve by the level set by Vstart as illustrated in the figure below.



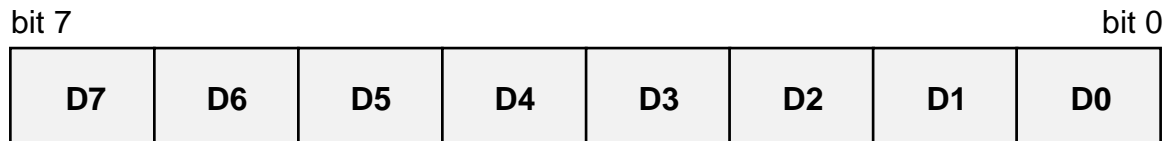
Default value: 07

CV 3 BASELINE ACCELERATION RATE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value between 0 and 255 (0 - 0xFF) that sets the decoder's acceleration rate:



D0-D7: Baseline Acceleration Rate

Acceleration rate may be computed as:

$$\text{seconds/speed step} = \frac{\text{CV 3} * 0.896}{\text{Number of Speed Steps}}$$

When this CV is set to 0, the locomotive speed will respond nearly instantly to *increases* in the throttle setting. When set to 255, it will take approximately 3.8 minutes to accelerate to full speed from a standing stop.

It is recommended that this CV be set to a nonzero value when operating the DSD in 14 or 28 speed step modes as the throttle will interpolate between speed steps during acceleration to produce a smoother overall response. The Dynamic Digital Exhaust sound effect will also be more prevalent with higher acceleration settings.

Default value: 0

Related CVs: See also Baseline Braking Rate, Consist Acceleration Rate, Consist Brake Rate.

CV 4

BASELINE BRAKING RATE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value between 0 and 255 (0 - 0xFF) that sets the decoder's braking rate:



D0-D7: Baseline Braking Rate

Braking rate may be computed as:

$$\text{seconds/speed step} = \frac{\text{CV 4} * 0.896}{\text{Number of Speed Steps}}$$

When this CV is set to 0, the locomotive speed will respond nearly instantly to *decreases* in the throttle setting. When set to 255, it will take approximately 3.8 minutes to brake to a stop from full speed.

It is recommended that this CV be set to a nonzero value when operating the DSD in 14 or 28 speed step modes as the throttle will interpolate between speed steps during braking to produce a smoother overall response. The Dynamic Digital Exhaust sound effect will also be more prevalent with higher braking rates.

Default value: 0

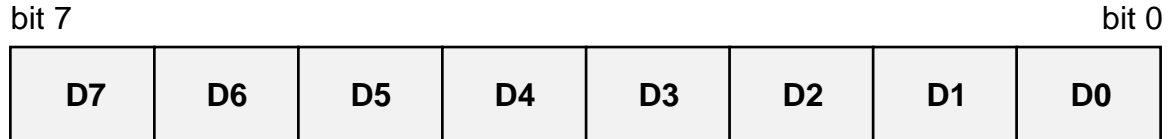
Related CVs: See also Baseline Acceleration, Consist Acceleration Rate, Consist Brake Rate.

CV 7
MANUFACTURER
VERSION ID (Read Only)

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains 8 bit software version identifier.



D0-D7: Version Code

- 06 = DSD-050 Steam Decoder, Release 1.2
- 07 = DSD-150 Steam Decoder, Release 1.2
- 09 = DSD-150 Diesel Decoder, Release 1.0
- 11 = DSD-150 Diesel Decoder, Release 1.1
- 14 = DSD-150 Diesel Decoder, Release 1.2

This CV is read only and cannot be modified.

CV 8

MANUFACTURER ID

(Read Only)

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains the NMRA issued Manufacturer ID code assignment for Throttle Up!:

bit 7							bit 0
1	0	0	0	1	1	0	1

This value is read only and fixed at 141 (0x8D).

CV 9 PWM PERIOD

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Determines the PWM period of the motor drive signals:

bit 7								bit 0
D7	D6	D5	D4	D3	D2	D1	D0	

D0-D7: PWM Period

The motor PWM period in microseconds is computed as:

$$\text{Period} = (255 - \text{CV9}) * 204.8$$

This CV may be programmed with any value between 0 and 230 corresponding to a PWM period range of 52.2µS to 5.12µS. The motor drive frequency can be found by taking the reciprocal of the period. The drive frequency can thus be programmed from 19.1 Hz to 195 Hz.

The decoder will ignore commands that attempt to program this register with values greater than 230.

The correct value for this register will vary depending upon the locomotive the DSD is installed in and it may take some experimentation to find the optimal value. Generally, the selected value will require a trade-off decision between motor torque and audible noise. Lower numbers will produce more torque but may cause the motor and driveline to resonate and buzz loudly. On smaller engines that lack traction, sufficient torque can be produced to cause the drive wheels to slip. Higher numbers, on the other hand, will tend to reduce the buzzing noise but there may be some loss in power, especially at low speeds. The following values are provided as a guide line to help establish a starting point for determining the best PWM period value:

<u>Scale</u>	<u>CV9 Value</u>
N, HOn3	180-200
HO, S	175-185
O	160-175
G	120-160

Note: CV 9 also affects the modulation period of the Hyperlight effects. When using the Hyperlight effects, it is recommended that CV 9 be programmed with values greater than 155 as an annoying flicker may otherwise result.

Default Value: 180 (0xB4), Corresponds to 65Hz drive frequency.

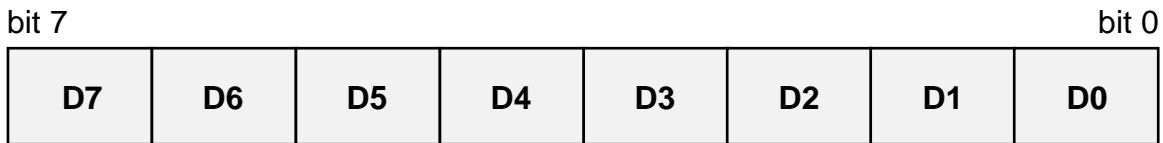
CV 11

PACKET TIME OUT VALUE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value between 0 and 255 corresponding to the time period that is allowed to elapse between receipt of a valid packet addressed to the DSD before a throttle shutdown occurs.



D0-D7: Packet Time-out Value

The time out period is computed in seconds as:

$$\text{Time Out Period} = \text{CV11} \times 10$$

A CV value of 0 disables the time out period and the locomotive will run indefinitely without receiving another packet.

For all other values, the DSD maintains an internal timer which is reset every time the DSD receives a valid broadcast address packet or other valid packet whose address matches its primary address or, if enabled, the extended address or consist address.

In the event no valid packets are received within the prescribed time period, the DSD will bring the locomotive to a stop at the rate set by CV 4 and CV 24. The state of the auxiliary function outputs will remain unchanged.

Default value: 00

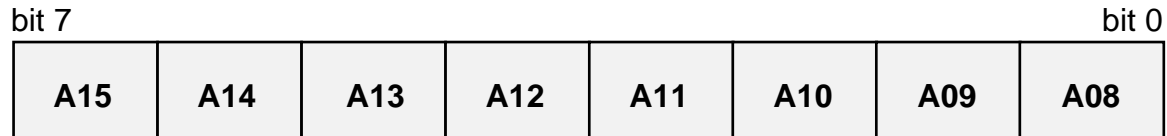
CV 17,18 EXTENDED ADDRESS

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input type="checkbox"/> Ops Mode Long Form

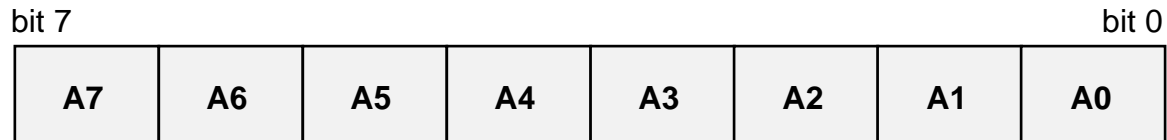
Description

CV 17 and 18 make up a 'paired' CV, meaning that the two CV registers taken together hold one piece of data, in this case, the 14 bit extended decoder address:

CV 17 Extended Address MSB



CV 18 Extended Address LSB



A0-A15: Extended Address Value

The extended address allows the decoder to be assigned one of 10,179 addresses ranging from 0xC000 to 0xE7FF (Note however, that most command stations will only recognize addresses 0000 through 9999.). The extended address will only be recognized by the decoder when CV 29, bit 5 is set to 1. Once this bit is set, the decoder will no longer recognize its primary address until CV 29, bit 5 is cleared.

CV 17 contains the most significant byte and must be loaded with values within the range of 0xC0 and 0xE7. CV 18 contains the least significant byte and may contain any value.

To determine the extended address value, add the desired four digit address to the number 49152. Divide this number by 256 and record the quotient and the remainder. CV 17 is then programmed with the quotient value and CV 18 is programmed with the remainder value.

Example: Compute CV 17 and 18 register values for extended address 7152.

1. Add 7152 to 49152: Sum = 56304.
2. Divide 56304 by 256: Quotient = 219 Remainder = 240
3. Program CV 17 to 219 (0xDB)
4. Program CV 18 to 240 (0xF0)

Note: Most command stations will handle these computations automatically when setting the extended address. However, it's still nice to know how to derive them.

Because CV 17 and 18 make up a paired CV, programming order is important. CV 17 must be written to first, followed by a write CV 18. The decoder will ignore commands that attempt to program these register out of order or with values outside the allowed range of 0xC000 to 0XE7FF

Note that these CVs cannot be changed in operations mode.

Default Value: 0xC003

Related CVs: See also Primary Address, CV 29, Consist Address.

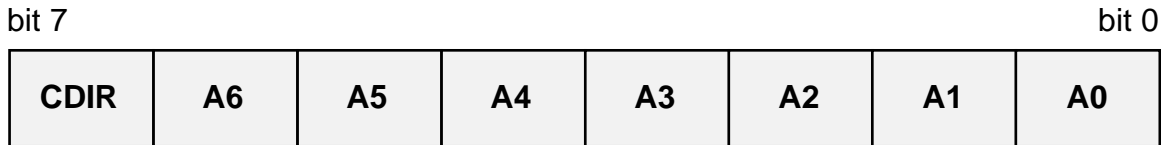
CV 19

CONSIST ADDRESS

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains address and direction data for consist operation:



Bit 0-6: A0-A6, Consist Address Value

Bit 7: CDIR, Consist Direction
0 = Normal Direction
1 = Reverse Direction

The CDIR bit defines orientation of the locomotive within a consist and specifies whether the direction bit in a speed/direction data packet should be inverted.

Bits A0-A6 assigns the consist address from 0 to 127 (0-0x7F).

If A0-A6 = 00, consist commands are ignored. Otherwise, if the decoder receives a valid command packet whose address matches the consist address, the packet will be processed as any other packet with the following exceptions:

Long Form CV Access instructions will be ignored.

The direction bit in a speed/direction or advanced operation packet is inverted if CDIR = 1.

Only the auxiliary functions enabled in CV 21 and CV 22 are allowed to change.

When the consist address is active, speed/direction and advanced operations packets sent to the decoder's primary address (or extended address, if enabled) will be ignored. All other instruction packets sent to the decoder's primary (or extended) address including CV access and function control will continue to be processed as normal.

In summary, setting CV 19 to 00 or 128 (0x80) disables consist addressing. Setting CV to a value between 1 and 127 (0x01-0x7F) enables consist addresses 1 to 127 (0x01-0x7F) with the locomotive oriented facing *forward* in the consist. Setting CV to a value between 129 and 255 (0x81-0xFF) enables consist addresses 1 to 127 with the locomotive oriented facing *backwards* in the consist.

Default Value: 00

Related CVs: See also Primary Address, Consist Function Active, Consist FL Function Active.

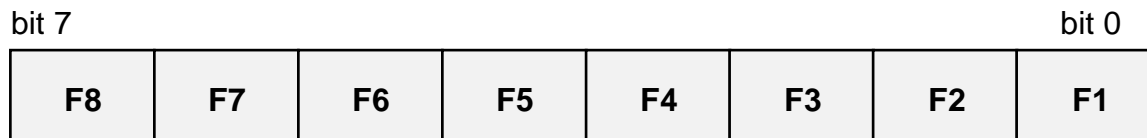
CV 21

CONSIST FUNCTION ACTIVE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Defines which functions may be controlled by packets sent to the decoder's consist address. Disabled functions may be controlled only from decoder's primary or extended address:



- Bit 0:** F1, Consist Function 1 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 1:** F2, Consist Function 2 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 2:** F3, Consist Function 3 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 3:** F4, Consist Function 4 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 4:** F5, Consist Function 5 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 5:** F6, Consist Function 6 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 6:** F7, Consist Function 7 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.
- Bit 7:** F8, Consist Function 8 Enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.

This register is useful for differentiating the lead engine in the consist from the other engines. For example, by setting this register in the lead locomotive to 02 and the same register in all other engines to 00, only the whistle on the lead locomotive will blow when the command to turn on Function 2 is sent to the consist.

Default Value: 00

Related CVs: See also Consist Address, Consist FL Function Active.

CV 22

CONSIST FL

FUNCTION ACTIVE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Defines whether the FL function may be controlled by packets sent to the decoder's consist address. Disabled functions may be controlled only from decoder's primary or extended address:

bit 7						bit 0	
0	0	0	0	0	0	FL(r)	FL(f)

Bit 0: FL(f), FL Forward enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.

Bit 1: FL(r), FL Reverse enable Bit
0 = function is disabled for consist operation.
1 = function is enabled for consist operation.

This register is useful for differentiating the Headlight and Backup Light functions in the lead engine of the consist from the other engines. For example, by setting this register in the lead locomotive to 01 and the same register in all other engines to 00, only the headlight in the lead engine will be on and only when the consist is moving forward.

Default Value: 00

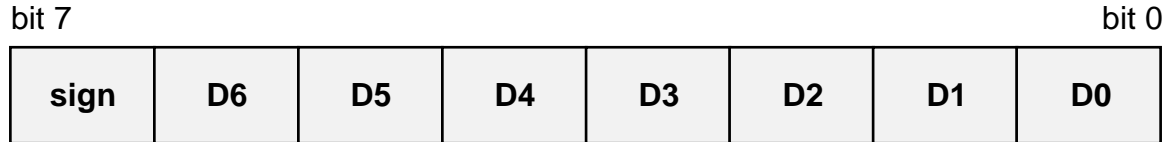
Related CVs: See also Consist Address, Consist Function Active.

CV 23 CONSIST ACCELERATION RATE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input checked="" type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value between -127 to +127 corresponding to the decoder's consist acceleration offset:



Bits 0-6: D0-D6, Consist Acceleration value

Bit 7: Sign
0 = positive value
1 = negative value

When the consist address is active, the consist acceleration rate is added to or subtracted from the decoder's base acceleration rate depending on the sign bit. The acceleration is then computed as:

$$\text{seconds/speed step} = \frac{(\text{CV3} + \text{CV 23}) * 0.896}{\text{Number of Speed Steps}}$$

If the sum of CV 3 and CV 23 is negative, then the acceleration rate is set to 0 (i.e., acceleration is instant.) If the sum of CV 3 and CV 23 exceeds 255, then the acceleration rate is set to the maximum value of 255.

This CV has no effect when the consist address is set to 0.

In summary, a CV value between 0 and 127 (0x7F) will *increase* the decoder's base acceleration rate. Values between 128 (0x80) and 255 (0xFF) will *decrease* the decoder's base acceleration rate.

Default value: 0

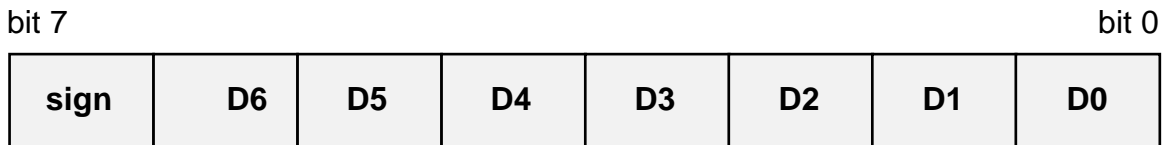
Related CVs: See also Baseline Acceleration Rate, Baseline Braking Rate, Consist Brake Rate.

CV 24 CONSIST BRAKING RATE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input checked="" type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value between -127 to +127 corresponding to the decoder's consist braking offset:



Bits 0-6: D0-D6, Consist Braking value

Bit 7: Sign
0 = positive value
1 = negative value

When the consist address is active, the consist braking rate is added to or subtracted from the decoder's baseline braking rate depending on the sign bit. The braking rate is then computed as:

$$\text{seconds/speed step} = \frac{(\text{CV4} + \text{CV 24}) * 0.896}{\text{Number of Speed Steps}}$$

If the sum of CV 4 and CV 24 is negative, then the braking rate is set to 0 (i.e., braking is instant.)
If the sum of CV 3 and CV 23 exceeds 255, then the braking rate is set to the maximum value of 255.

This CV has no effect when the consist address is set to 0.

In summary, a CV value between 0 and 127 (0x7F) will *increase* the decoder's base braking rate. Values between 128 (0x80) and 255 (0xFF) will *decrease* the decoder's base braking rate.

Default value: 0

Related CVs: See also Baseline Acceleration Rate, Baseline Braking Rate, Consist Acceleration Rate.

CV 25 SPEED TABLE SELECT REGISTER

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Used to select one of 15 Speed Curves:

bit 7								bit 0
0			USER	TBL3	TBL2	TBL1	TBL0	

Bits 3-0: TBL3:TBL0, Preset Speed Curves Select Bits

- 0000 = Speed Curves not used
- 0001 = Speed Curves not used
- 0010 = Linear Speed Curve
- 0011 = Logarithmic Curve 1
- 0100 = Logarithmic Curve 2
- 0101 = Logarithmic Curve 3
- 0110 = Logarithmic Curve 4
- 0111 = Logarithmic Curve 5
- 1000 = Logarithmic Curve 6
- 1001 = Logarithmic Curve 7
- 1010 = Exponential Curve 1
- 1011 = Exponential Curve 2
- 1100 = Exponential Curve 3
- 1101 = Exponential Curve 4
- 1110 = Exponential Curve 5
- 1111 = Exponential Curve 6

Bit 4: USER, User Loadable Speed Table Select

- 0 = Enable Speed curve defined by TBL3:TBL0
- 1 = Enable Speed curve defined by CVs 67-94.

Bits 5-6: Not Used. These bits are ignored.

Bit 7: Mid Range Speed Step

This bit is not implemented and always reads as 0.

CV 25 may be programmed with any value between 0 and 31 (0x1F). Values between 02 and 15 (0x0F) allow the user to select from one of 14 predefined speed curves as depicted below. The logarithmic curves provide a shallower speed response as the throttle is increased. These curves are useful for locomotives that require a high starting voltage to get moving or matching a highly geared locomotive to one that has less gearing. The exponential curves are useful for slowing

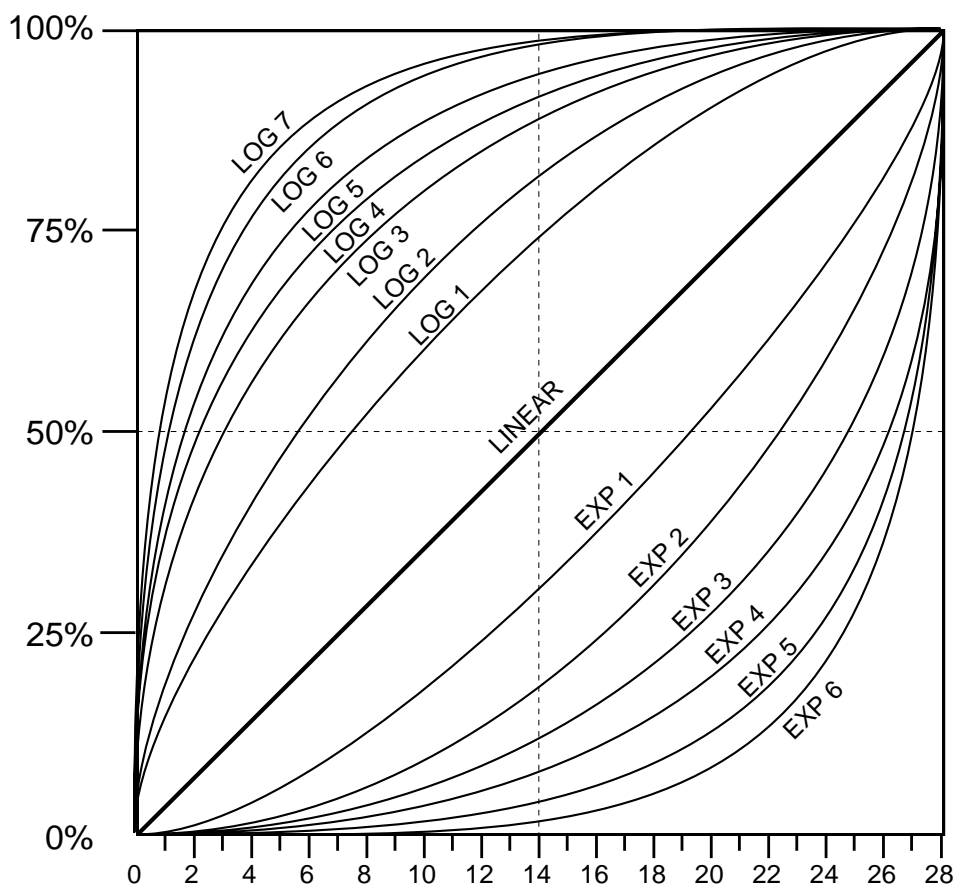
down locomotives that have a “slot car” response.

Setting this CV to a value between 16 and 31 (0x10-0x1F) will enable the speed curve programmed into CVs 67-94. This curve may be modified by the user to get virtually any response desired.

Note that in order for the selected curve to be active, bit 4 of CV 29 must also be set to 1. If CV 29, bit 4 is 0, the throttle response will be linear (straight line).

The speed curves can be used in 14, 28 and 128 speed step modes.

Bit 7 is defined by the NMRA RPs as the Mid Range Speed Step select bit. The DSD does not implement this feature and will ignore commands that attempt to program this bit with a 1 (i.e., data values between 128-255 or 0x80-0xFF).



Default value: 0

Related CVs: See also CV 29, Loadable Speed Table.

CV 29 CONFIGURATION REGISTER 1

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input checked="" type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

CV 29 contains miscellaneous decoder configuration bits:

bit 7							bit 0
0	N/A	EAM	STE	ACK	APS	FL	DIR

- Bit 0:** DIR, Direction Bit
0 = normal operation
1 = direction bit in Speed/Direction instruction is inverted before processing.
- Bit 1:** FL, FL Location
0 = FL state is controlled by bit 4 of Speed/Direction Instruction (14 Speed Step Mode)
1 = FL state is controlled by bit 4 of Function Group 1 Instruction (28 and 128 Speed Step Modes)
- Bit 2:** APS, Alternate Power Source enable (not used)
0 = NMRA Digital Only
1 = Alternate Power Source enabled as set by CV 12
- Bit 3:** ACK, Advanced Acknowledge Mode enable (not used)
0 = Advanced Acknowledge mode disabled.
1 = Advanced Acknowledge mode enabled.
- Bit 4:** STE, Speed Table Enable
0 = Speed Table not used.
1 = Use custom speed table selected by CV 25.
- Bit 5:** EAM, Extended Address Mode enable
0 = Decoder responds to Primary Address in CV 1
1 = Decoder responds to Extended Address in CV 17-18
- Bit 6:** Reserved for future use.
- Bit 7:** Multifunction Decoder - Always reads as 0.

When the DIR bit is set, the locomotive and headlight will run in a direction opposite to the speed/direction instruction received. This bit is mostly useful for diesel locomotives that are run long

hood forward and have little use for steam operation.

The FL bit should be cleared to 0 if you are using the decoder in 14 speed step mode. If you are using 28 or 128 speed step modes, this bit should be set to 1.

The STE bit must be set to 1 in order to enable any of the speed curves selected using CV 25. Otherwise, the DSD will provide a linear (straight-line) throttle response.

The EAM bit must be set to 1 in order to activate extended address capability. Note that once this bit is set, the decoder will respond to commands sent to the extended address only and commands sent to the primary address will be ignored. This can be a problem if you are using a command station that does not support extended addressing and the bit gets accidentally set. In such a case, you must connect the DSD to a programming track to gain access to the CV and clear the bit.

The DSD does not support advanced acknowledgment or alternate power conversion and the ACK and APS bits will always read as 0.

Default value: 0X02

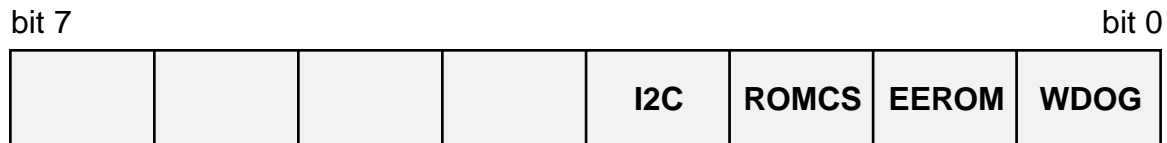
Related CVs: See also Extended Address, Loadable Speed Table.

CV 30 ERROR INFORMATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains manufacturer defined error codes and provides feedback in the event an operational failure occurred within the DSD:



- Bit 0:** WDOG, Watch Dog Timer Reset
0 = System normal.
1 = Watchdog time-out occurred.

- Bit 1:** EEROM, EEROM Data Corrupted
0 = System normal.
1 = CV Data in EEROM has become corrupted. All CVs will be reset to default values.

- Bit 2:** ROMCS, Program Checksum Failure
0 = System Normal
1 = Program Checksum Test Failed

- Bit 3:** I2C, I2C Bus Acknowledge Failure
0 = System Normal
1 = No acknowledge detected from I2C bus.

If the DSD is operating properly, all error bits should read as 0. If an error is detected, it is usually a good idea to reset the decoder (tip the locomotive) and verify the error has recurred.

A WDOG error usually occurs when the DSD experiences a large electrical glitch or static electricity discharge. It is not cause for concern unless it occurs frequently (several times within an operating session) in which case you should contact the factory for further assistance.

An EEROM error indicates that the CV data somehow became corrupted. If such an event occurs, the DSD will reset all CV data to the default settings, flash both headlights for 30 seconds, and resume normal operation. If this occurs, reprogram the CVs as needed. If the problem recurs repeatedly, this could indicate a problem with the DSD. Contact the factory for further assistance. This bit can also be used to deliberately reset all other CV values to their default values with a single operation. This is done by programming CV 30 with 02 in service mode and turning power to the DSD off and back on. *Note: This bit can be programmed only in service mode. Writing any data value during operations mode will clear all error bits to 0.*

A ROMCS error indicates a hardware failure has occurred and will usually be accompanied by strange sound-ing noises. Contact the factory for further assistance.

An I2C error also indicates a hardware failure and the DSD will be unable to remember any changes made to the CV settings. Contact the factory for further assistance.

CV 33-42

FUNCTION OUTPUT MAP

General Discussion

CVs 33-42 allow the user to customize which DSD outputs or sound effects are controlled by which function keys. Each function input, FL through F8, is assigned a unique CV that allows the corresponding function control to be redirected to up to eight different DSD function outputs or sound effects. This allows a single function key to control more than one output if desired.

This feature is especially useful when the DSD is used with a controller that has less than eight function keys as the user can select which DSD outputs and sounds are important and re-map them to the available function keys. Some outputs or sounds can be sensibly tied to another output thus freeing up a function. For example, the dynamo sound could be configured to turn on whenever the headlight or backup light was on.

It is also possible to control a given output with more than one function key. In this case, the output will be turned on when any of the corresponding function inputs are active. The output will turn off only when all relevant inputs have also been turned off.

The FL function has two CVs - one for forward direction and one for reverse. Function outputs mapped to these registers will be directional unless the same output is mapped to both CVs.

Note that all function inputs cannot be mapped to all outputs. The matrix below graphically indicates which inputs can control which outputs:

CV	FUNCTION INPUT	DSD OUTPUT														
		Mute					Coupler	Dynamo	F5 Output	Hiss	Bell	Whistle	F1 Output	Backup Light	Headlight	
33	FL (Fwd)															d
34	FL (Rev)													d		
35	Function 1												d			
36	Function 2											d				
37	Function 3										d					
38	Function 4									d						
39	Function 5								d							
40	Function 6							d								
41	Function 7						d									
42	Function 8	d														

Note: d = default setting.

CV 33

FL(f) OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the FL(fwd) function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
DYNO	F5	HISS	BELL	WHSTL	F1	BL	HL

- Bit 0:** HL, Head light output
0 = Output is unaffected by FL(fwd).
1 = Output is activated when FL(fwd) is on.
- Bit 1:** BL, Backup light output
0 = Output is unaffected by FL(fwd).
1 = Output is activated when FL(fwd) is on.
- Bit 2:** F1, Function 1 Output
0 = Output is unaffected by FL(fwd).
1 = Output is activated when FL(fwd) is on.
- Bit 3:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by FL(fwd).
1 = Sound is activated when FL(fwd) is on.
- Bit 4:** BELL, Bell Sound Effect
0 = Sound is unaffected by FL(fwd).
1 = Sound is activated when FL(fwd) is on.
- Bit 5:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by FL(fwd).
1 = Sound is activated when FL(fwd) is on.
- Bit 6:** F5, Function 5 Output
0 = Output is unaffected by FL(fwd).
1 = Output is activated when FL(fwd) is on.
- Bit 7:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by FL(fwd).
1 = Sound is activated when FL(fwd) is on.

A value of 00, sets FL(fwd) to control HL output.

Default Value: 1

Related CVs: See also CVs 33-42.

CV 34

FL(r) OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the FL(rev) function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
DYNO	F5	HISS	BELL	WHSTL	F1	BL	HL

Bit 0: HL, Head light output
0 = Output is unaffected by FL(rev).
1 = Output is activated when FL(rev) is on.

Bit 1: BL, Backup light output
0 = Output is unaffected by FL(rev).
1 = Output is activated when FL(rev) is on.

Bit 2: F1, Function 1 Output
0 = Output is unaffected by FL(rev).
1 = Output is activated when FL(rev) is on.

Bit 3: WHSTL, Whistle Sound Effect
0 = Sound is unaffected by FL(rev).
1 = Sound is activated when FL(rev) is on.

Bit 4: BELL, Bell Sound Effect
0 = Sound is unaffected by FL(rev).
1 = Sound is activated when FL(rev) is on.

Bit 5: HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by FL(rev).
1 = Sound is activated when FL(rev) is on.

Bit 6: F5, Function 5 Output
0 = Output is unaffected by FL(rev).
1 = Output is activated when FL(rev) is on.

Bit 7: DYNO, Dynamo Sound Effect
0 = Sound is unaffected by FL(rev).
1 = Sound is activated when FL(rev) is on.

A value of 00 sets FL(rev) to control BL output.

Default Value: 2

Related CVs: See also CVs 33-42.

CV 35

F1 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F1 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7	DYNO	F5	HISS	BELL	WHSTL	F1	BL	bit 0
-------	------	----	------	------	-------	----	----	-------

- Bit 0:** HL, Head light output
0 = Output is unaffected by F1.
1 = Output is activated when F1 is on.
- Bit 1:** BL, Backup light output
0 = Output is unaffected by F1.
1 = Output is activated when F1 is on.
- Bit 2:** F1, Function 1 Output
0 = Output is unaffected by F1.
1 = Output is activated when F1 is on.
- Bit 3:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by F1.
1 = Sound is activated when F1 is on.
- Bit 4:** BELL, Bell Sound Effect
0 = Sound is unaffected by F1.
1 = Sound is activated when F1 is on.
- Bit 5:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by F1.
1 = Sound is activated when F1 is on.
- Bit 6:** F5, Function 5 Output
0 = Output is unaffected by F1.
1 = Output is activated when F1 is on.
- Bit 7:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F1.
1 = Sound is activated when F1 is on.

A value of 00 sets F1 to control F1 output.

Default Value: 4

Related CVs: See also CVs 33-42.

CV 36

F2 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F2 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
DYNO	F5	HISS	BELL	WHSTL	F1	BL	HL

- Bit 0:** HL, Head light output
0 = Output is unaffected by F2.
1 = Output is activated when F2 is on.
- Bit 1:** BL, Backup light output
0 = Output is unaffected by F2.
1 = Output is activated when F2 is on.
- Bit 2:** F1, Function 1 Output
0 = Output is unaffected by F2.
1 = Output is activated when F2 is on.
- Bit 3:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by F2.
1 = Sound is activated when F2 is on.
- Bit 4:** BELL, Bell Sound Effect
0 = Sound is unaffected by F2.
1 = Sound is activated when F2 is on.
- Bit 5:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by F2.
1 = Sound is activated when F2 is on.
- Bit 6:** F5, Function 5 Output
0 = Output is unaffected by F2.
1 = Output is activated when F2 is on.
- Bit 7:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F2.
1 = Sound is activated when F2 is on.

A value of 00 sets F2 to control the WHISTLE sound effect.

Default Value: 8

Related CVs: See also CVs 33-42.

CV 37

F3 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F3 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
		CPLR	DYNO	F5	HISS	BELL	WHSTL

- Bit 0:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by F3.
1 = Sound is activated when F3 is on.
- Bit 1:** BELL, Bell Sound Effect
0 = Sound is unaffected by F3.
1 = Sound is activated when F3 is on.
- Bit 2:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by F3.
1 = Sound is activated when F3 is on.
- Bit 3:** F5, Function 5 Output
0 = Output is unaffected by F3.
1 = Output is activated when F3 is on.
- Bit 4:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F3.
1 = Sound is activated when F3 is on.
- Bit 5:** CPLR, Coupler Sound Effect
0 = Sound is unaffected by F3.
1 = Sound is activated when F3 is on.
- Bit 6:** Reserved
- Bit 7:** Reserved

A value of 00 sets F3 to control the BELL sound effect.

Default Value: 2

Related CVs: See also CVs 33-42.

CV 38

F4 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F4 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
		CPLR	DYNO	F5	HISS	BELL	WHSTL

- Bit 0:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by F4.
1 = Sound is activated when F4 is on.

- Bit 1:** BELL, Bell Sound Effect
0 = Sound is unaffected by F4.
1 = Sound is activated when F4 is on.

- Bit 2:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by F4.
1 = Sound is activated when F4 is on.

- Bit 3:** F5, Function 5 Output
0 = Output is unaffected by F4.
1 = Output is activated when F4 is on.

- Bit 4:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F4.
1 = Sound is activated when F4 is on.

- Bit 5:** CPLR, Coupler Sound Effect
0 = Sound is unaffected by F4.
1 = Sound is activated when F4 is on.

- Bit 6:** Reserved

- Bit 7:** Reserved

A value of 00 sets F4 to control the HISS sound effect.

Default Value: 4

Related CVs: See also CVs 33-42.

CV 39

F5 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F5 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7								bit 0
		CPLR	DYNO	F5	HISS	BELL	WHSTL	

- Bit 0:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by F5.
1 = Sound is activated when F5 is on.
- Bit 1:** BELL, Bell Sound Effect
0 = Sound is unaffected by F5.
1 = Sound is activated when F5 is on.
- Bit 2:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by F5.
1 = Sound is activated when F5 is on.
- Bit 3:** F5, Function 5 Output
0 = Output is unaffected by F5.
1 = Output is activated when F5 is on.
- Bit 4:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F5.
1 = Sound is activated when F5 is on.
- Bit 5:** CPLR, Coupler Sound Effect
0 = Sound is unaffected by F5.
1 = Sound is activated when F5 is on.
- Bit 6:** Reserved
- Bit 7:** Reserved

A value of 00 sets F5 to control the F5 function output.

Default Value: 8

Related CVs: See also CVs 33-42.

CV 40

F6 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F6 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
		CPLR	DYNO	F5	HISS	BELL	WHSTL

- Bit 0:** WHSTL, Whistle Sound Effect
0 = Sound is unaffected by F6.
1 = Sound is activated when F6 is on.

- Bit 1:** BELL, Bell Sound Effect
0 = Sound is unaffected by F6.
1 = Sound is activated when F6 is on.

- Bit 2:** HISS, Cylinder Blowdown/Hiss Sound Effect
0 = Sound is unaffected by F6.
1 = Sound is activated when F6 is on.

- Bit 3:** F5, Function 5 Output
0 = Output is unaffected by F6.
1 = Output is activated when F6 is on.

- Bit 4:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F6.
1 = Sound is activated when F6 is on.

- Bit 5:** CPLR, Coupler Sound Effect
0 = Sound is unaffected by F6.
1 = Sound is activated when F6 is on.

- Bit 6:** Reserved

- Bit 7:** Reserved

A value of 00 sets F6 to control the DYNAMO sound effect.

Default Value: 16 (0x10)

Related CVs: See also CVs 33-42.

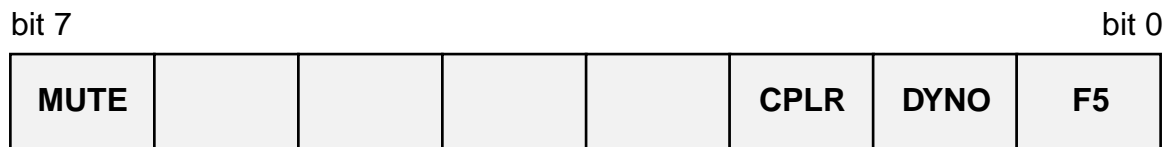
CV 41

F7 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F7 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:



- Bit 0:** F5, Function 5 Output
0 = Output is unaffected by F7.
1 = Output is activated when F7 is on.

- Bit 1:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F7.
1 = Sound is activated when F7 is on.

- Bit 2:** CPLR, Coupler Sound Effect
0 = Sound is unaffected by F7.
1 = Sound is activated when F7 is on.

- Bit 3:** Reserved

- Bit 4:** Reserved

- Bit 5:** Reserved

- Bit 6:** Reserved

- Bit 7:** MUTE, Audio Mute Function
0 = Sound is unaffected by F7.
1 = Sound is muted when F7 is on.

A value of 00 sets F7 to control the COUPLER sound effect.

Default Value: 4

Related CVs: See also CVs 33-42.

CV 42

F8 OUTPUT LOCATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Maps the F8 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

bit 7							bit 0
MUTE					CPLR	DYNO	F5

- Bit 0:** F5, Function 5 Output
0 = Output is unaffected by F8.
1 = Output is activated when F8 is on.
- Bit 1:** DYNO, Dynamo Sound Effect
0 = Sound is unaffected by F8.
1 = Sound is activated when F8 is on.
- Bit 2:** CPLR, Coupler Sound Effect
0 = Sound is unaffected by F8.
1 = Sound is activated when F8 is on.
- Bit 3:** Reserved
- Bit 4:** Reserved
- Bit 5:** Reserved
- Bit 6:** Reserved
- Bit 7:** MUTE, Audio Mute Function
0 = Sound is unaffected by F8.
1 = Sound is muted when F8 is on.

A value of 00 sets F8 to control the MUTE function.

Default Value: 128 (0x80)

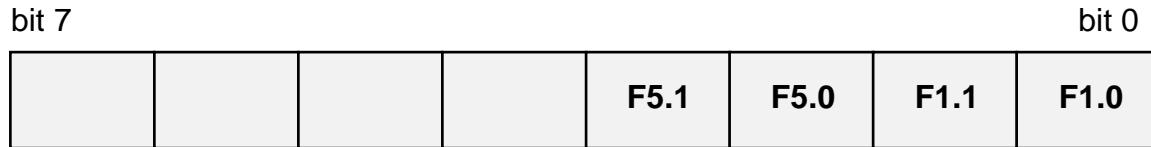
Related CVs: See also CVs 33-42.

CV 49 HYPERLIGHT CONFIGURATION

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Used to reconfigure the F1 and F5 lighting outputs to one of four Hyperlight lighting effects:



- Bits 1-0:** F1.1:F1.0, Function 1 Output Configuration
00 = Standard On/Off output
01 = Mars Light Effect
10 = Firebox Flicker Effect
11 = Synchronized Firebox Flicker - Turns on and off with sound effect of firebox door opening and closing.
- Bits 2-3:** F5.1:F5.0, Function 5 Output Configuration
00 = Standard On/Off output
01 = Mars Light Effect
10 = Firebox Flicker Effect
11 = Synchronized Firebox Flicker - Turns on and off with sound effect of firebox door opening and closing.
- Bit 4-7:** Reserved

Note: the selected lighting effect will not turn on until the appropriate function key is on as well.

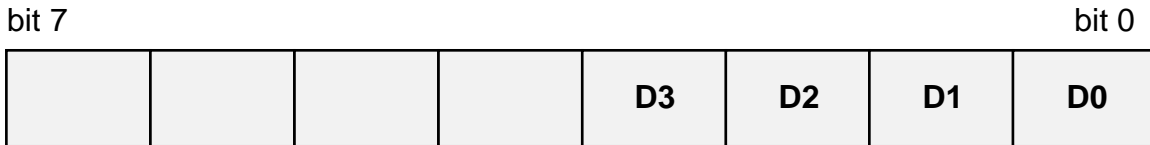
Default Value: 0, F1 = On/Off Output, F5 = On/Off Output

CV 50 VOLUME CONTROL

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value between 0 and 15 (0x0F) to used to set the overall volume level of the DSD sound effects:



Bits 0-3: D0-D3, Volume Control

Bit 4-7: Reserved

Setting this CV to 15 will provide maximum volume. A setting of 0 will mute all sound effects.

Default Value: 08 (0x08), 50% Volume

CV 51

BACKGROUND SOUND CONFIGURATION BYTE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

This CV is used to selectively enable the DSD's various background sound effects:

bit 7							bit 0
AUTO	ABD	POP	PGG	FRED	BLWR	APUMP	RTC

Bit 0: RTC, Real Time Clock Mode
 0 = Background sound effects are spaced at scale time intervals ranging typically between 2-20 minutes.
 1 = Background sound effects are spaced at real time intervals ranging typically between 20 minutes to several hours

Bit 1: APUMP, Airpump Sound Enable
 0 = Airpump sound effect is turned off.
 1 = Airpump sound effect is turned on.

Bit 2: BLWR, Blower Sound Enable
 0 = Blower sound effect is disabled.
 1 = Blower sound effect is enabled.

Note: Blower sound is always on. This bit enables the effect of increasing blower draft while the engine is idle.

Bit 3: FRED, Fireman Fred Sound Enable
 0 = Fireman Fred sound effect is disabled.
 1 = Fireman Fred sound effect is enabled.

Bit 4: PGG, Pneumatic Grease Gun Sound Enable
 0 = Grease Gun sound effect is disabled.
 1 = Grease Gun sound effect is enabled.

Bit 5: POP, Boiler Pop Valve Blowoff Sound Enable
 0 = Pop Valve sound effect is disabled.
 1 = Pop Valve sound effect is enabled.

Bit 6: ABD, Automatic Cylinder Blow Down Enable
 0 = Blow down effect is activated by function key.
 1 = Blow down effect is activated by engine stops.

Bit 7: BGND, Background sound effect global enable
 0 = All background sound effects are disabled.
 1 = All selected background sound effects are enabled.

Default Value: 190 (0xBE), All sound effects are enabled. Auto-Blowdown is disabled.

CV 52 FOREGROUND SOUND CONFIGURATION BYTE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

This CV is used to configure the DSD's foreground sound effects:

bit 7	bit 0						
RNG3	RNG2	RNG1	RNG0	APS	CAM	DDE	AECS

Bit 0: AECS, Articulated Exhaust Cadence Select
 0 = Exhaust Timing emulates 2 cylinder locos and shays.
 1 = Exhaust Timing emulates articulated locos.

Bit 1: DDE, Dynamic Digital Exhaust Enable
 0 = DDE sound processor is disabled.
 1 = DDE sound processor is enabled.

Bit 2: CAM Enable
 0 = Exhaust Chuff is synchronized to throttle.
 1 = Exhaust Chuff is synchronized with cam.

Bit 3: APS, Dual Airpump Select
 0 = Single Airpump sound effect.
 1 = Dual Airpump sound effect.

Note: CV 51, Bit 1 must be set for this sound to be heard.

Bit 4-7: RNG3:RNG1, Bell Ring Rate
 Controls the ringing rate of the bell sound.
 0000 = Fastest Ring Rate
 1111 = Slowest Ring Rate

Default Value: 70 (0x46), Auto-Exhaust Cadence = 2 Cylinder Loco
 Dynamic Digital Exhaust Enabled
 Single Airpump
 Exhaust Cam Enabled
 Bell Ring Rate = 100 (mid speed).

Related CVs: See also Auto Exhaust Sync Rate (CV 54).

CV 53

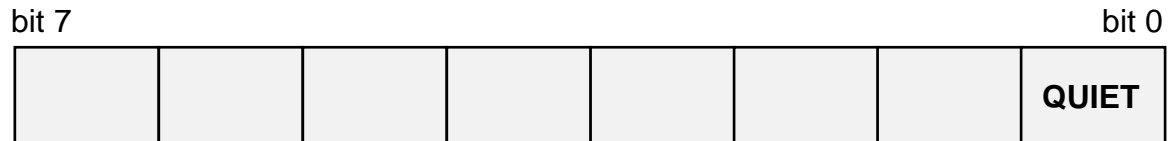
SOUND CONFIGURATION

BYTE #3

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

This CV controls the power-up state of the sound effects:



Bit 0: QUIET
0 = Sound turns on a few seconds after power is turned on.
1 = Sound turns on only when the DSD receives a packet with a matching address.

Bits 1-7: Reserved

The Quiet bit is used for "noise control" when many DSD equipped engines are on a layout. When set to 1, locomotives not in use will remain quiet until they are called into service.

Default Value: 0

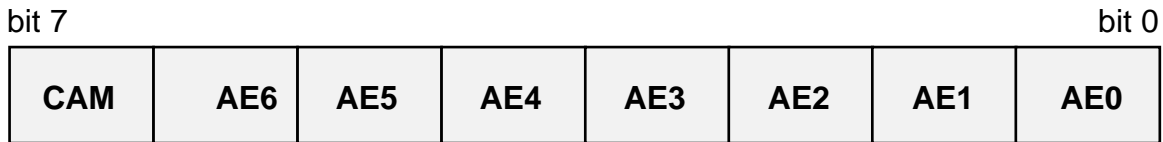
CV 54

AUTO EXHAUST SYNC RATE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

This CV contains a value n between 0 and 255 that specifies the chuff synchronization rate as a proportion of the throttle for Auto-Exhaust operation.



Bits 0-7: AE7:AE0, Auto Exhaust/Cutoff Control Rate

For Auto-Exhaust synchronization, the chuff rate will be generated in proportion the throttle setting. To select Auto-Exhaust mode, the CV is loaded with any value between 0 and 255 (0xFF). Higher values will yield higher chuff rates for a given throttle setting. A value of 0 will disable the exhaust sound.

The correct synchronization rate may be computed as:

$$\text{CV Value} = 115.9 \times \frac{\text{SPD}}{\text{DIA}}$$

Where SPD is the locomotive's speed in scale miles-per-hour at maximum throttle and DIA is the locomotive's driver wheel diameter in scale inches. For geared engines, the CV value should also be multiplied by the locomotive's gear ratio.

When using cam synchronization, this CV will control the exhaust cutoff rate. To get optimal performance over the entire throttle range, the CV value should be calculated using the formula above.

Default Value: 94 (0x5E)

Related CVs: See also Foreground Sound Configuration.

CV 55

EXHAUST TONE CONTROL

- | | |
|--|--|
| <input type="checkbox"/> Address Mode | <input checked="" type="checkbox"/> Direct Mode |
| <input type="checkbox"/> Register Mode | <input type="checkbox"/> Ops Mode Short Form |
| <input checked="" type="checkbox"/> Paged Mode | <input checked="" type="checkbox"/> Ops Mode Long Form |

Description

This CV contains a value between 0 and 63 that sets tone of the exhaust chuff:

bit 7

bit 0

		TONE5	TONE4	TONE3	TONE2	TONE1	TONE0
--	--	-------	-------	-------	-------	-------	-------

Bits 0-5: TONE5:TONE0, Exhaust Tone Control

Bits 6-7: Reserved

This CV controls the overall tone of the exhaust chuff. Higher values increase the high-frequency component of the sound.

Default Value: 08

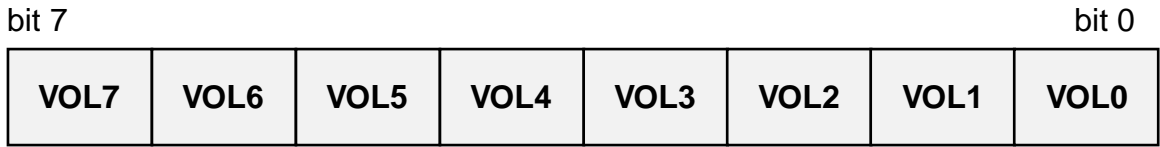
CV 56

EXHAUST VOLUME CONTROL

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

This CV contains a value between 0 and 255 that controls the exhaust chuff volume:



Bits 0-7: VOL7:VOL0, Exhaust Volume Control

This CV controls the overall volume of the exhaust chuff when the Dynamic Digital Exhaust processor is disabled. Higher values will increase the volume level. When the DDE processor is on, this CV will have no effect.

Default Value: 255 (0x255)

See Also: Foreground Sound Configuration

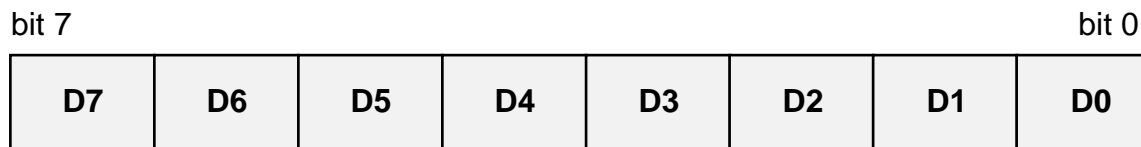
CV 66

FORWARD TRIM

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value, n, between 0 and 255 that specifies a scaling factor interpreted as N/128 by which the forward drive voltage is multiplied.



D0-D7: Forward Trim Scalar

The forward trim scalar allows the decoder's overall throttle response in the forward direction to be adjusted up or down for the purpose of matching one locomotive's speed curve to another. See graph below.

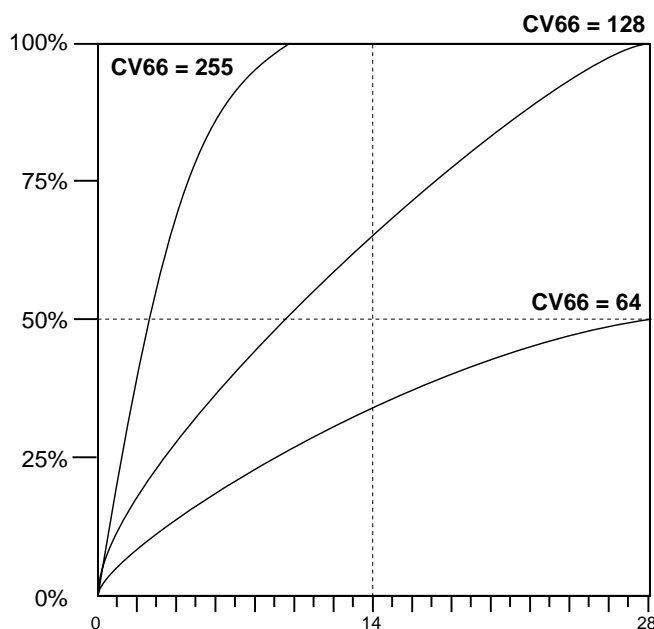
A trim value of 128 (0x80) yields a scaling factor of 1.0 which will have no net effect on the speed response.

Trim values between 129 and 255 (0x81-0xFF) have the effect of increasing the motor voltage by a factor ranging between 1.01 to 1.99.

Trim values between 1 and 127 (0x01-0x7F) will decrease the motor voltage by a factor between 0.008 and 0.99.

A trim value of 0 disables the trim scalar computation.

This CV is used only when speed tables are enabled (CV 29, Bit 4 = 1). Otherwise, this CV will have no effect.



Default Value: 128 (0x80)

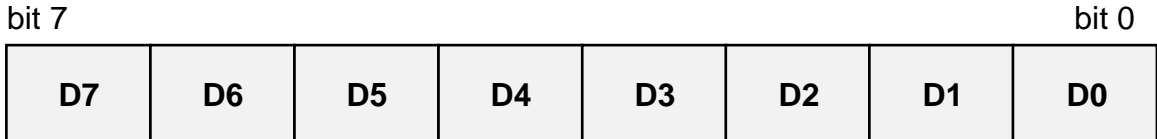
Related CVs: See also Reverse Trim, CV 29.

CV 67-94 LOADABLE SPEED TABLE

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

The loadable speed table is made up of 28 CVs. Each CV contains a value, n, between 0 and 255 that specifies the percentage of the maximum throttle voltage interpreted as n/255 that is to be applied to the motor when the speed step in use corresponds to that CV.



D0-D7: Speed Table Data

The loadable speed table may be used in the 14, 28 and 128 speed step modes. When 14 speed step mode is in effect, the DSD will use a curve defined by every other speed table value starting with speed step 1.

When 28 step mode is enabled, the DSD will simply use one table value for each speed step.

When 128 step mode is enabled, the DSD will interpolate 4-5 points between each speed table entry to build a 128 point curve.

Note that the DSD will not use the loadable speed table until bit 5 in *both* CV 25 and CV 29 are set to 1.

Default values: The default values provide a linear (straight line) response. Individual CVs are loaded as follows:

CV 67	(Speed Step 1):	0 (0x00)
CV 68	(Speed Step 2):	9 (0x09)
CV 69	(Speed Step 3):	18 (0x12)
CV 70	(Speed Step 4):	28 (0x1C)
CV 71	(Speed Step 5):	37 (0x25)
CV 72	(Speed Step 6):	47 (0x2F)
CV 73	(Speed Step 7):	56 (0x38)
CV 74	(Speed Step 8):	66 (0x42)
CV 75	(Speed Step 9):	75 (0x4B)
CV 76	(Speed Step 10):	85 (0x55)
CV 77	(Speed Step 11):	94 (0x5E)
CV 78	(Speed Step 12):	103 (0x67)
CV 79	(Speed Step 13):	113 (0x71)
CV 80	(Speed Step 14):	122 (0x7A)

CV 81	(Speed Step 15):	132 (0x84)
CV 82	(Speed Step 16):	141 (0x8D)
CV 83	(Speed Step 17):	151 (0x97)
CV 84	(Speed Step 18):	160 (0xA0)
CV 85	(Speed Step 19):	170 (0xAA)
CV 86	(Speed Step 20):	179 (0xB3)
CV 87	(Speed Step 21):	188 (0xBC)
CV 88	(Speed Step 22):	198 (0xC6)
CV 89	(Speed Step 23):	207 (0xCF)
CV 90	(Speed Step 24):	217 (0xD9)
CV 91	(Speed Step 25):	226 (0xE2)
CV 92	(Speed Step 26):	236 (0xEC)
CV 93	(Speed Step 27):	245 (0xF5)
CV 94	(Speed Step 28):	255 (0xFF)

Related CVs: See also CV 29, Speed Table Select Register.

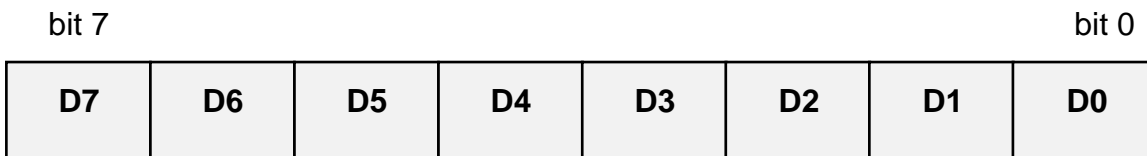
CV 95

REVERSE TRIM

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Contains a value, n, between 0 and 255 that specifies a scaling factor interpreted as N/128 by which the reverse drive voltage is multiplied.



D0-D7: Reverse Trim Scalar

The reverse trim scalar allows the decoder's overall throttle response in the reverse direction to be adjusted up or down for the purpose of matching one locomotive's speed curve to another.

A trim value of 128 (0x80) yields a scaling factor of 1.0 which will have no net effect on the speed response.

Trim values between 129 and 255 (0x81-0xFF) have the effect of increasing the motor voltage by a factor ranging between 1.01 to 1.99.

Trim values between 1 and 127 (0x01-0x7F) will decrease the motor voltage by a factor between 0.008 and 0.99.

A trim value of 0 disables the trim scalar computation.

This CV is used only when speed tables are enabled (CV 29, Bit 4 = 1). Otherwise, this CV will have no effect.

Default Value: 128 (0x80)

Related CVs: See also Forward Trim, CV 29.

CV 105

USER IDENTIFIER #1

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Provides storage for user supplied data such as purchase date, serial numbers, spouse's birthday, etc. This CV otherwise has no effect on the DSD operation.

bit 7

bit 0

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

D0-D7: User Identifier data

This CV may be programmed with any value between 0 and 255 (0x00-0xFF).

Default Value: 0

Related CVs: See also User Identifier #2.

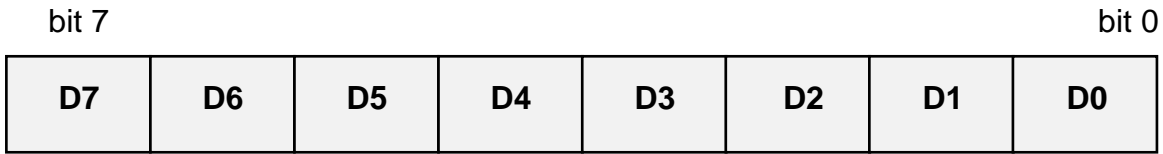
CV 106

USER IDENTIFIER #2

<input type="checkbox"/> Address Mode	<input checked="" type="checkbox"/> Direct Mode
<input type="checkbox"/> Register Mode	<input type="checkbox"/> Ops Mode Short Form
<input checked="" type="checkbox"/> Paged Mode	<input checked="" type="checkbox"/> Ops Mode Long Form

Description

Provides storage for user supplied data such as purchase date, serial numbers, spouse's birthday, etc. This CV otherwise has no effect on the DSD operation.



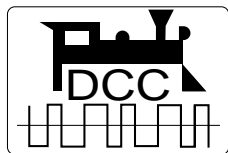
D0-D7: User Identifier data

This CV may be programmed with any value between 0 and 255 (0x00-0xFF).

Default Value: 0

Related CVs: See also User Identifier #1.

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Revision B



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