



**Tsunami™ Digital Sound Decoder**

# **Technical Reference**

Software Release 1.00

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# Primary CVs

## CV 1

### Primary Address Control

#### Description

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

<b>Bit 7</b>								<b>Bit 0</b>
0	A6	A5	A4	A3	A2	A1	A0	

**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 CV 1 can only be changed in operations mode if the extended address is enabled.

**Default Value:** 3  
**Related CVs:** See also CV 29, Consist Address, Extended Address



# Primary CVs

## CV 2 Vstart

### Description

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

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

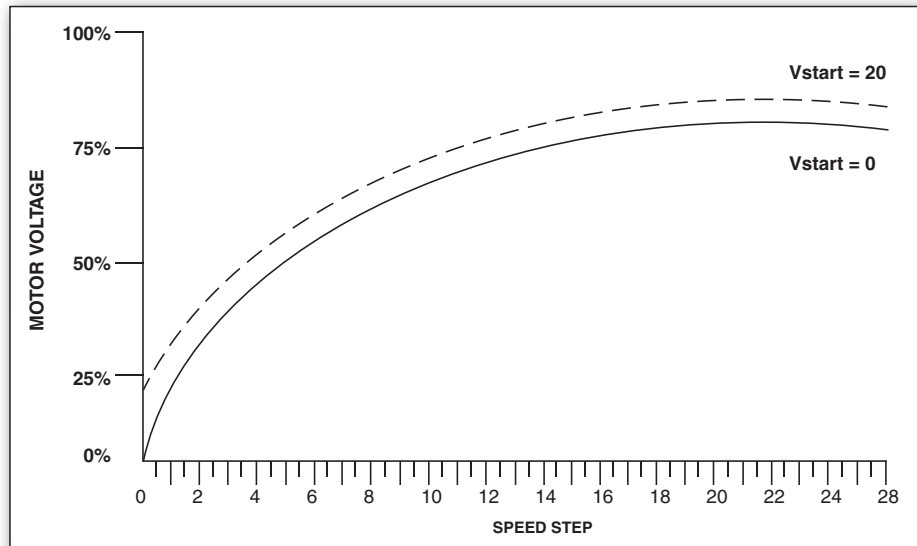
**D0-D7:** Motor Start Voltage

Vstart may contain any value from 0 to 255. The starting voltage applied to the motor may be computed as:

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

where CV 2 is the contents of the Vstart register. A value of 0 corresponds to a zero starting voltage. A value of 255 corresponds to the maximum available voltage (100%).

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:** 0



# Primary CVs

## CV 3

### Baseline Acceleration Rate

#### Description

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

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

**D0-D7:** Baseline Acceleration Rate

Acceleration rate may be computed as:

$$\text{seconds/speed step} = \text{CV 3} \times 0.896 \div \text{Number of speed steps}$$

When this CV is set to 0, the locomotive speed will respond nearly instantly to increases in the throttle setting, equivalent to no momentum. 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.

**Default value:**

0

**Related CVs:**

See also Baseline Braking Rate, Consist Acceleration Rate, Consist Brake Rate.



# Primary CVs

## CV 4

### Baseline Braking Rate

#### Description

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

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

**D0-D7:** Baseline Braking Rate

Braking rate may be computed as:

$$\text{seconds/speed step} = \text{CV 3} \times 0.896 \div \text{Number of speed steps}$$

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.

**Default value:**

0

**Related CVs:**

See also Baseline Acceleration, Consist Acceleration Rate, Consist Brake Rate.



# Primary CVs

## CV 7

### Manufacturer Version ID (Read Only)

#### Description

Contains 8-bit software version identifier.

Bit 7

Bit 0

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

**D0-D7:** Version Code

64 = Tsunami Steam Decoder, V1.0

65 = Tsunami Diesel Decoder, V1.0

This CV is read only and cannot be modified.



# Primary CVs

## CV 8

### Manufacturer ID

#### Description

Contains the NMRA issued Manufacturer ID code assignment for SoundTraxx/Throttle Up! (141):

Bit 7

Bit 0

1	0	0	0	1	1	0	1
---	---	---	---	---	---	---	---

Writing a value of 8 to this CV will reset all CVs to their default value. All other write operations will be ignored.





# Primary CVs

## CV 10

### BEMF Cutout

#### Description

This is used to gradually reduce the effect of the BEMF Control as locomotive speed is increased. This CV contains a value from 0-127 that corresponds to the speed step at which the intensity of BEMF control will be reduced to zero.

Bit 7

Bit 0

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

**D0-D7:** BEMF Cutout

This CV can alternatively contain a value from 128-255 which will cause the BEMF intensity to decrease to a percentage between 0 and 50% of the BEMF intensity set by CV 212 as:

$$\text{Full Speed BEMF Intensity} = (\text{CV 212} - 128) \div 128$$

**Default value:** 0



# Primary CVs

## CV 11

### Packet Time Out Value

#### Description

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

Bit 7

Bit 0

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

**D0-D7:** Packet Time-out Value

The time out period is computed in seconds as:

$$\text{Time Out Period} = \text{CV 11} \times 0.25$$

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:** 0



# Primary CVs

## CV 12

### Power Source Conversion

#### Description

Defines the type of power source the decoder should switch to whenever a DCC signal is not present and the APS bit of CV 29 (bit 2) is set.

Bit 7

Bit 0

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

D0-D7:

Alternate Power Source

0 = No Alternate Power Source Available

1 = Analog Power Supply

Default value: 1



# Primary CVs

## CV 13

### Analog Function Enable 1

#### Description

Defines whether functions 1-8 are active during analog mode operation. If the bit is set, the corresponding function will be mapped to the output as defined by CVs 33-46.

Bit 7

Bit 0

F8	F7	F6	F5	F4	F3	F2	F1
----	----	----	----	----	----	----	----

F1-F8:

Analog Function Enable Bit

0 = Function is disabled for analog operation

1 = Function is enabled for analog operation

Default value: 0



# Primary CVs

## CV 14

### Analog Function Enable 2

#### Description

Defines whether functions 9-12 are active during analog mode operation. If the bit is set, the corresponding function will be mapped to the output as defined by CVs 33-46.

Bit 7						Bit 0	
		F12	F11	F10	F9	F0 (r)	F0 (f)

**F0 (f):** F0 Forward Enable Bit  
 0 = Function is disabled for analog operation  
 1 = Function is enabled for analog operation

**F0 (r):** F0 Reverse Enable Bit  
 0 = Function is disabled for analog operation  
 1 = Function is enabled for analog operation

**F9-F12:** Analog Function Enable Bit  
 0 = Function is disabled for analog operation  
 1 = Function is enabled for analog operation

**Default value:** 3



# Primary CVs

## CV 15

### CV Unlock Register

#### Description

Contains a value from 0-7 that is used to unlock access to the decoder's CVs in a multi-decoder installation.

CV 15 may always be written or verified regardless of the decoder's lock status. An acknowledgment will only be generated, however, when the decoder is unlocked.

Bit 7					Bit 0		
0	0	0	0	0	D2	D1	D0

**D0-D2:** Unlock Code

#### *Locked State*

If CV 15 does not match CV 16, all read and write operations to the decoder will be ignored and no acknowledgment is generated.

#### *Unlocked State*

Access to the decoder's CVs occurs only when CV 15 = CV 16.

**Note:** CVLCKE Bit in CV 30 must be set to enable the lock feature in CVs 15 and 16.

**Default value:** 0

**Related CVs:** See also Error Information/Alternate Mode Selection.



# Primary CVs

## CV 16

### CV Lock ID Code

#### Description

Contains a value from 0-7 that sets the unlock code that must be programmed into CV 15 in order to access the decoder's CVs in a multi-decoder installation.

CV 15 may always be written or verified regardless of the decoder's lock status. An acknowledgment will only be generated, however, when the decoder is unlocked.

Bit 7					Bit 0		
0	0	0	0	0	ID2	ID1	ID0

ID0-ID2: CV Lock Code

**Note:** CVLCKE Bit in CV 30 must be set to enable the lock feature in CVs 15 and 16.

**Default Value:** 0

**Related CVs:** See also Error Information/Alternate Mode Selection.



# Primary CVs

## CV 17,18 Extended Address

### 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

Bit 7								Bit 0
A15	A14	A13	A12	A11	A10	A9	A8	

#### CV 18 Extended Address LSB

Bit 7								Bit 0
A7	A6	A5	A4	A3	A2	A1	A0	

**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
4. Program CV 18 to 240

**Note:** Most command stations will handle these computations automatically





# Primary CVs

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 to CV 18. The decoder will ignore commands that attempt to program these registers out of order or with values outside the allowed range of 0xC000 to 0xE7FF.

These CVs may be changed in service mode at any time, but in operations mode only when CV 29, bit 5 is cleared (i.e., CV 1, Primary Address is enabled).

**Default Value:** CV 17 = 192, CV 18 = 03 (Long Address 0003)  
**Related CVs:** See also Primary Address, CV 29, Consist Address.



# Primary CVs

## CV 19

### Consist Address

#### Description

Contains address and direction data for consist operation:

Bit 7								Bit 0
CDIR	A6	A5	A4	A3	A2	A1	A0	

**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. 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 0 or 128 disables consist addressing. Setting CV to a value between 1 and 127 enables consist addresses 1 to 127 with the locomotive oriented facing forward in the consist. Setting CV to a value between 129 and 255 enables consist addresses 1 to 127 with the locomotive oriented facing backwards in the consist.

**Default Value:** 0  
**Related CVs:** See also Primary Address, Consist Function Active, Consist F0 Function Active.



# Primary CVs

## CV 21

### Consist Function Group 1

#### Description

Defines which Group 1 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:

<b>Bit 7</b>								<b>Bit 0</b>
<b>F7</b>	<b>F6</b>	<b>F5</b>	<b>F4</b>	<b>F3</b>	<b>F2</b>	<b>F1</b>	<b>F0</b>	

- 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



# Primary CVs

to 2 and the same register in all other engines to 0, only the whistle on the lead locomotive will blow when the command to turn on Function 2 is sent to the consist.

**Default Value:**

0

**Related CVs:**

See also Consist Address, Consist F0 Function Active.  
Consist F0 Function Active.



# Primary CVs

## CV 22

### Consist Function Group 2

#### Description

Defines which Group 2 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:

<b>Bit 7</b>							<b>Bit 0</b>
		<b>F12</b>	<b>F11</b>	<b>F10</b>	<b>F9</b>	<b>F0 (r)</b>	<b>F0 (f)</b>

- Bit 0:** F0(f), Function 0, Forward enable Bit  
0 = function is disabled for consist operation.  
1 = function is enabled for consist operation.
- Bit 1:** F0(r), Function 0, Reverse enable Bit  
0 = function is disabled for consist operation.  
1 = function is enabled for consist operation.
- Bit 2:** F9, Consist Function 9 Enable Bit  
0 = function is disabled for consist operation.  
1 = function is enabled for consist operation.
- Bit 3:** F10, Consist Function 10 Enable Bit  
0 = function is disabled for consist operation.  
1 = function is enabled for consist operation.
- Bit 4:** F11, Consist Function 11 Enable Bit  
0 = function is disabled for consist operation.  
1 = function is enabled for consist operation.
- Bit 5:** F12, Consist Function 12 Enable Bit  
0 = function is disabled for consist operation.  
1 = function is enabled for consist operation.
- Bit 6:** Reserved.
- Bit 7:** Reserved.

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 1 and the same register in all other engines to 0, only the headlight in the lead engine will be on and only when the consist is moving forward.

- Default Value:** 0
- Related CVs:** See also Consist Address, Consist Function Active.



# Primary CVs

## CV 23

### Consist Acceleration Rate

#### Description

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

Bit 7								Bit 0
sign	D6	D5	D4	D3	D2	D1	D0	

**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:

$$\text{seconds/speed step} = (\text{CV 3} + \text{CV 23}) \times 0.896 \div \text{Number of speed steps}$$

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 will increase the decoder's base acceleration rate. Values between 128 and 255 will decrease the decoder's base acceleration rate.

**Default value:** 0

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



# Primary CVs

## CV 24 Consist Braking Rate

### Description

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

<b>Bit 7</b>								<b>Bit 0</b>
<b>sign</b>	<b>D6</b>	<b>D5</b>	<b>D4</b>	<b>D3</b>	<b>D2</b>	<b>D1</b>	<b>D0</b>	

**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:

$$\text{seconds/speed step} = (\text{CV 4} + \text{CV 24}) \times 0.896 \div \text{Number of speed steps}$$

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 4 and CV 24 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 will increase the decoder's base braking rate. Values between 128 and 255 will decrease the decoder's base braking rate.

**Default value:** 0

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



# Primary CVs

## CV 25

### Speed Table Select Register

#### Description

Used to select one of 15 Speed Curves:

Bit 7								Bit 0
MIDSPD	D6	D5	D4	D3	D2	D1	D0	

**D0-D6:** Table Identifier/Speed Step Value  
**MIDSPD:** 0 = Factory Speed Table Select  
 1 = Mid Range Speed (Not used)

When MIDSPD = 0, D0-D6 defines which preset factory speed table is used.

- 0 = Disabled, Speed Curves not used
- 1 = Disabled, Speed Curves not used
- 2 = Linear Speed Curve
- 3 = Logarithmic Curve 1
- 4 = Logarithmic Curve 2
- 5 = Logarithmic Curve 3
- 6 = Logarithmic Curve 4
- 7 = Logarithmic Curve 5
- 8 = Logarithmic Curve 6
- 9 = Logarithmic Curve 7
- 10 = Exponential Curve 1
- 11 = Exponential Curve 2
- 12 = Exponential Curve 3
- 13 = Exponential Curve 4
- 14 = Exponential Curve 5
- 15 = Exponential Curve 6
- 16 = User Defined Speed Table defined by CVs 67-94.

CV 25 may be programmed with any value between 0 and 31. Values between 2 and 15 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.

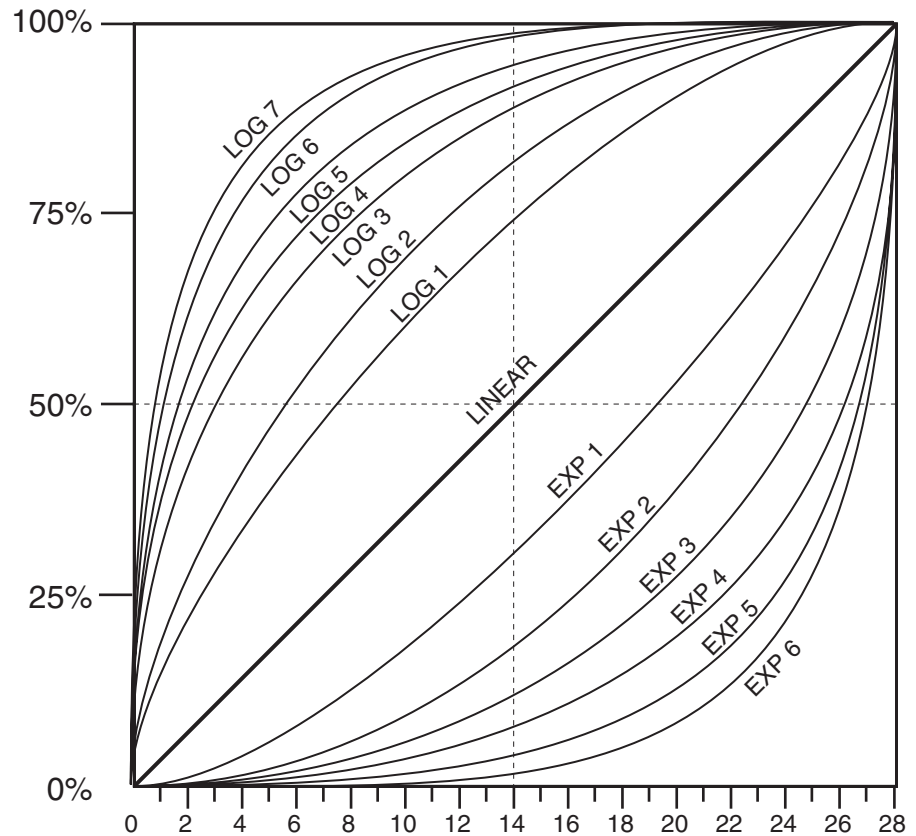
Setting this CV to a value of 16 will enable the speed curve programmed into CVs 67-94. This curve may be programmed by the user to get virtually any response desired.





# Primary CVs

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).

**Default value:** 0  
**Related CVs:** See also CV 29, Loadable Speed Table.



# Primary CVs

## CV 29

### Configuration Register 1

#### Description

CV 29 contains miscellaneous decoder configuration bits:

Bit 7	Bit 0
0	0
EAM	STE
ACK	APS
F0	DIR

- Bit 0: DIR, Direction Bit  
0 = normal operation  
1 = direction bit in Speed/Direction instruction is inverted before processing.
- Bit 1: F0 Location  
0 = F0 state is controlled by bit 4 of Speed/Direction Instruction (14 Speed Step Mode)  
1 = F0 state is controlled by bit 4 of Function Group 1 Instruction (28 and 128 Speed Step Modes)
- Bit 2: APS, Alternate Power Source enable  
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 set by CV 2, 4 and 6.  
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 has little use for steam operation.

The F0 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



# Primary CVs

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 APS bit must be set to 1 in order to activate an alternate power mode as set in CV 12. To activate Analog Mode Operation, you must also set CV 12 to 1.

The DSD does not support advanced acknowledgment and the ACK bit will always read as 0.

**Default value:**

2

**Related CVs:**

See also Extended Address, Loadable Speed Table.



# Primary CVs

## CV 30

### Error Information/Alternate Mode Selection

#### Description

Contains manufacturer defined error codes and provides feedback in the event an operational failure occurred within the DSD. It is also used to re-configure the decoder for non-NMRA compliant options:

<b>Bit 7</b>						<b>Bit 0</b>	
					<b>GRP23</b>	<b>CVCLR</b>	<b>CVLCKE</b>

- Bit 0:** CVLCKE, CV Lock Enable  
0 = Normal operation.  
1 = Enables CV Lock as set in CVs 15 and 16.
- Bit 1:** CVCLR, CV Clear  
0 = Normal operation.  
1 = All CVs will be reset to default values at next power cycle.
- Bit 2:** GRP23, Function Group 2 and 3 Exchange  
0 = System Normal, DSD processes group 2 and 3 function commands according to the NMRA standard.  
1 = Function Group 2 (F5-F8) assignments are swapped with Function Group 3 (F9-F12)
- Bits 3-7:** Reserved.

**Default value:** 0  
**Related CVs:** See also CV Unlock Register, CV Lock ID Code.



# Function Output CVs

## CV 33-46

### Function Output Map

CVs 33-46 allow the user to customize which DSD outputs or sound effects are controlled by which function keys. Each function input, F0 through F12, is assigned a unique CV that allows the corresponding function control to be redirected to up to fifteen different DSD function outputs or sound effects. This allows a single function key to control more than one output if desired.

The F0 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:

Function Mapping Table																
Function Key	Control CV	HL	BL	WH	BEL	FX5	FX6	DYN	SHW	STM	WS	DIM	MUT	INJ	BRK	CPL
F0 (f)	33	<b>1</b>	2	4	8	16	32	<b>64</b>	128							
F0 (r)	34	1	<b>2</b>	4	8	16	32	<b>64</b>	128							
F1	35	1	2	4	<b>8</b>	16	32	64	128							
F2	36	1	2	<b>4</b>	8	16	32	64	128							
F3	37				1	2	4	8	<b>16</b>	32	64	128				
F4	38				1	2	4	8	16	<b>32</b>	64	128				
F5	39				1	<b>2</b>	4	8	16	32	64	128				
F6	40				1	2	<b>4</b>	8	16	32	64	128				
F7	41							1	2	4	8	<b>16</b>	32	64	128	
F8	42							1	2	4	8	16	<b>32</b>	64	128	
F9	43							1	2	4	<b>8</b>	16	32	64	128	
F10	44								1	2	4	8	16	<b>32</b>	64	128
F11	45								1	2	4	8	16	32	<b>64</b>	128
F12	46								1	2	4	8	16	32	64	<b>128</b>

*Bold Numbers indicate default settings.*



# Function Output CVs

## CV 33

### F0(f) Output Location

#### Description

Maps the F0(f) function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

<b>Bit 7</b>				<b>Bit 0</b>			
<b>SHW</b>	<b>DYN</b>	<b>FX6</b>	<b>FX5</b>	<b>BEL</b>	<b>WH</b>	<b>BL</b>	<b>HL</b>

- Bit 0:** HL, Head light output  
0 = Output is unaffected by F0(fwd).  
1 = Output is activated when F0(fwd) is on.
- Bit 1:** BL, Backup light output  
0 = Output is unaffected by F0(fwd).  
1 = Output is activated when F0(fwd) is on.
- Bit 2:** WH, Whistle Sound Effect  
0 = Sound is unaffected by F0(fwd).  
1 = Sound is activated when F0(fwd) is on.
- Bit 3:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F0(fwd).  
1 = Sound is activated when F0(fwd) is on.
- Bit 4:** FX5, Effect 1 output  
0 = Output is unaffected by F0(fwd).  
1 = Output is activated when F0(fwd) is on.
- Bit 5:** FX6, Effect 2 output  
0 = Output is unaffected by F0(fwd).  
1 = Output is activated when F0(fwd) is on.
- Bit 6:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F0(fwd).  
1 = Sound is activated when F0(fwd) is on.
- Bit 7:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F0(fwd).  
1 = Sound is activated when F0(fwd) is on.

**Default Value:** 65  
**Related CVs:** See also CVs 34-46



# Function Output CVs

## CV 34

### F0(r) Output Location

#### Description

Maps the F0(rev) function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

Bit 7							Bit 0
SHW	DYN	FX6	FX5	BEL	WH	BL	HL

- Bit 0:** HL, Head light output  
0 = Output is unaffected by F0(rev).  
1 = Output is activated when F0(rev) is on.
- Bit 1:** BL, Backup light output  
0 = Output is unaffected by F0(rev).  
1 = Output is activated when F0(rev) is on.
- Bit 2:** WH, Whistle Sound Effect  
0 = Sound is unaffected by F0(rev).  
1 = Sound is activated when F0(rev) is on.
- Bit 3:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F0(rev).  
1 = Sound is activated when F0(rev) is on.
- Bit 4:** FX5, Effect 1 output  
0 = Output is unaffected by F0(rev).  
1 = Output is activated when F0(rev) is on.
- Bit 5:** FX6, Effect 2 output  
0 = Output is unaffected by F0(rev).  
1 = Output is activated when F0(rev) is on.
- Bit 6:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F0(rev).  
1 = Sound is activated when F0(rev) is on.
- Bit 7:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F0(rev).  
1 = Sound is activated when F0(rev) is on.

**Default Value:** 66  
**Related CVs:** See also CVs 33, 35-46



# Function Output CVs

## CV 35

### F1 Output Location

#### Description

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

<b>Bit 7</b>	<b>SHW</b>	<b>DYN</b>	<b>FX6</b>	<b>FX5</b>	<b>BEL</b>	<b>WH</b>	<b>BL</b>	<b>HL</b>	<b>Bit 0</b>
--------------	------------	------------	------------	------------	------------	-----------	-----------	-----------	--------------

- 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:** WH, Whistle Sound Effect  
0 = Sound is unaffected by F1.  
1 = Sound is activated when F1 is on.
  
- Bit 3:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F1.  
1 = Sound is activated when F1 is on.
  
- Bit 4:** FX5, Effect 1 output  
0 = Output is unaffected by F1.  
1 = Output is activated when F1 is on.
  
- Bit 5:** FX6, Effect 2 output  
0 = Output is unaffected by F1.  
1 = Output is activated when F1 is on.
  
- Bit 6:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F1.  
1 = Sound is activated when F1 is on.
  
- Bit 7:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F1.  
1 = Sound is activated when F1 is on.

**Default Value:** 8  
**Related CVs:** See also CVs 33-34, 36-46





# Function Output CVs

## CV 36

### F2 Output Location

#### Description

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

<b>Bit 7</b>	<b>SHW</b>	<b>DYN</b>	<b>FX6</b>	<b>FX5</b>	<b>BEL</b>	<b>WH</b>	<b>BL</b>	<b>HL</b>	<b>Bit 0</b>
--------------	------------	------------	------------	------------	------------	-----------	-----------	-----------	--------------

- 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:** WH, Whistle Sound Effect  
0 = Sound is unaffected by F2.  
1 = Sound is activated when F2 is on.
- Bit 3:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F2.  
1 = Sound is activated when F2 is on.
- Bit 4:** FX5, Effect 1 output  
0 = Output is unaffected by F2.  
1 = Output is activated when F2 is on.
- Bit 5:** FX6, Effect 2 output  
0 = Output is unaffected by F2.  
1 = Output is activated when F2 is on.
- Bit 6:** DYN, Dynamo Sound Effect (Steam)  
0 = Sound is unaffected by F2.  
1 = Sound is activated when F2 is on.
- Bit 7:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F2.  
1 = Sound is activated when F2 is on.

**Default Value:** 4  
**Related CVs:** See also CVs 33-35, 37-46



# Function Output CVs

## CV 37

### F3 Output Location

#### Description

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

<b>Bit 7</b>						<b>Bit 0</b>	
<b>DIM</b>	<b>WS</b>	<b>STM</b>	<b>SHW</b>	<b>DYN</b>	<b>FX6</b>	<b>FX5</b>	<b>BEL</b>

- Bit 0:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F3.  
1 = Sound is activated when F3 is on.
  
- Bit 1:** FX5, Effect 1 output  
0 = Output is unaffected by F3.  
1 = Output is activated when F3 is on.
  
- Bit 2:** FX6, Effect 2 output  
0 = Output is unaffected by F3.  
1 = Output is activated when F3 is on.
  
- Bit 3:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F3.  
1 = Sound is activated when F3 is on.
  
- Bit 4:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F3.  
1 = Sound is activated when F3 is on.
  
- Bit 5:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F3.  
1 = Sound is activated when F3 is on.
  
- Bit 6:** WS, Water Stop  
0 = Sound is unaffected by F3.  
1 = Sound is activated when F3 is on.
  
- Bit 7:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F3.  
1 = Lighting outputs set up as "Dimmable Headlights" are dimmed when F3 is on.

**Default Value:** 16  
**Related CVs:** See also CVs 33-36, 38-46



# Function Output CVs

## CV 38

### F4 Output Location

#### 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
DIM	WS	STM	SHW	DYN	FX6	FX5	BEL

- Bit 0:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F4.  
1 = Sound is activated when F4 is on.
- Bit 1:** FX5, Effect 1 output  
0 = Output is unaffected by F4.  
1 = Output is activated when F4 is on.
- Bit 2:** FX6, Effect 2 output  
0 = Output is unaffected by F4.  
1 = Output is activated when F4 is on.
- Bit 3:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F4.  
1 = Sound is activated when F4 is on.
- Bit 4:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F4.  
1 = Sound is activated when F4 is on.
- Bit 5:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F4.  
1 = Sound is activated when F4 is on.
- Bit 6:** WS, Water Stop  
0 = Sound is unaffected by F4.  
1 = Sound is activated when F4 is on.
- Bit 7:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F4.  
1 = Lighting outputs set up as "Dimmable Headlights" are dimmed when F4 is on.

**Default Value:** 32  
**Related CVs:** See also CVs 33-37, 39-46



# Function Output CVs

## CV 39

### F5 Output Location

#### 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
DIM	WS	STM	SHW	DYN	FX6	FX5	BEL

- Bit 0:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F5.  
1 = Sound is activated when F5 is on.
- Bit 1:** FX5, Effect 1 output  
0 = Output is unaffected by F5.  
1 = Output is activated when F5 is on.
- Bit 2:** FX6, Effect 2 output  
0 = Output is unaffected by F5.  
1 = Output is activated when F5 is on.
- Bit 3:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F5.  
1 = Sound is activated when F5 is on.
- Bit 4:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F5.  
1 = Sound is activated when F5 is on.
- Bit 5:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F5.  
1 = Sound is activated when F5 is on.
- Bit 6:** WS, Water Stop  
0 = Sound is unaffected by F5.  
1 = Sound is activated when F5 is on.
- Bit 7:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F5.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F5 is on.

**Default Value:** 2  
**Related CVs:** See also CVs 33-38, 40-46



# Function Output CVs

## CV 40

### F6 Output Location

#### 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	
DIM	WS	STM	SHW	DYN	FX6	FX5	BEL

- Bit 0:** BEL, Bell Sound Effect  
0 = Sound is unaffected by F6.  
1 = Sound is activated when F6 is on.
- Bit 1:** FX5, Effect 1 output  
0 = Output is unaffected by F6.  
1 = Output is activated when F6 is on.
- Bit 2:** FX6, Effect 2 output  
0 = Output is unaffected by F6.  
1 = Output is activated when F6 is on.
- Bit 3:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F6.  
1 = Sound is activated when F6 is on.
- Bit 4:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F6.  
1 = Sound is activated when F6 is on.
- Bit 5:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F6.  
1 = Sound is activated when F6 is on.
- Bit 6:** WS, Water Stop  
0 = Sound is unaffected by F6.  
1 = Sound is activated when F6 is on.
- Bit 7:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F6.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F6 is on.

**Default Value:** 4  
**Related CVs:** See also CVs 33-39, 41-46



# Function Output CVs

## CV 41

### F7 Output Location

#### Description

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

Bit 7							Bit 0
BRK	INJ	MUT	DIM	WS	STM	SHW	DYN

- Bit 0:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F7.  
1 = Sound is activated when F7 is on.
  
- Bit 1:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F7.  
1 = Sound is activated when F7 is on.
  
- Bit 2:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F7.  
1 = Sound is activated when F7 is on.
  
- Bit 3:** WS, Water Stop  
0 = Sound is unaffected by F7.  
1 = Sound is activated when F7 is on.
  
- Bit 4:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F7.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F7 is on.
  
- Bit 5:** MUT, Audio Mute  
0 = Sound is unaffected by F7.  
1 = Sound is muted when F7 is on.
  
- Bit 6:** INJ, Injector Sound Effect  
0 = Sound is unaffected by F7.  
1 = Sound is activated when F7 is on.
  
- Bit 7:** BRK, Brake Squeal/Brake Release  
0 = Sound is unaffected by F7.  
1 = Sound is activated when F7 is on.

**Default Value:** 16  
**Related CVs:** See also CVs 33-40, 42-46



# Function Output CVs

## CV 42

### F8 Output Location

#### 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
BRK	INJ	MUT	DIM	WS	STM	SHW	DYN

- Bit 0:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F8.  
1 = Sound is activated when F8 is on.
- Bit 1:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F8.  
1 = Sound is activated when F8 is on.
- Bit 2:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F8.  
1 = Sound is activated when F8 is on.
- Bit 3:** WS, Water Stop  
0 = Sound is unaffected by F8.  
1 = Sound is activated when F8 is on.
- Bit 4:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F8.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F8 is on.
- Bit 5:** MUT, Audio Mute  
0 = Sound is unaffected by F8.  
1 = Sound is muted when F8 is on.
- Bit 6:** INJ, Injector Sound Effect  
0 = Sound is unaffected by F8.  
1 = Sound is activated when F8 is on.
- Bit 7:** BRK, Brake Squeal/Brake Release  
0 = Sound is unaffected by F8.  
1 = Sound is activated when F8 is on.

**Default Value:** 32  
**Related CVs:** See also CVs 33-41, 43-46



# Function Output CVs

## CV 43

### F9 Output Location

#### Description

Maps the F9 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

Bit 7				Bit 0			
BRK	INJ	MUT	DIM	WS	STM	SHW	DYN

- Bit 0:** DYN, Dynamo Sound Effect  
0 = Sound is unaffected by F9.  
1 = Sound is activated when F9 is on.
- Bit 1:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F9.  
1 = Sound is activated when F9 is on.
- Bit 2:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F9.  
1 = Sound is activated when F9 is on.
- Bit 3:** WS, Water Stop  
0 = Sound is unaffected by F9.  
1 = Sound is activated when F9 is on.
- Bit 4:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F9.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F9 is on.
- Bit 5:** MUT, Audio Mute  
0 = Sound is unaffected by F9.  
1 = Sound is muted when F9 is on.
- Bit 6:** INJ, Injector Sound Effect  
0 = Sound is unaffected by F9.  
1 = Sound is activated when F9 is on.
- Bit 7:** BRK, Brake Squeal/Brake Release  
0 = Sound is unaffected by F9.  
1 = Sound is activated when F9 is on.

**Default Value:**

8

**Related CVs:**

See also CVs 33-42, 44-46





# Function Output CVs

## CV 44

### F10 Output Location

#### Description

Maps the F10 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

Bit 7							Bit 0
CPL	BRK	INJ	MUT	DIM	WS	STM	SHW

- Bit 0:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F10.  
1 = Sound is activated when F10 is on.
- Bit 1:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F10.  
1 = Sound is activated when F10 is on.
- Bit 2:** WS, Water Stop  
0 = Sound is unaffected by F10.  
1 = Sound is activated when F10 is on.
- Bit 3:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F10.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F10 is on.
- Bit 4:** MUT, Audio Mute  
0 = Sound is unaffected by F10.  
1 = Sound is muted when F10 is on.
- Bit 5:** INJ, Injector Sound Effect  
0 = Sound is unaffected by F10.  
1 = Sound is muted when F10 is on.
- Bit 6:** BRK, Brake Squeal/Brake Release  
0 = Sound is unaffected by F10.  
1 = Sound is activated when F10 is on.
- Bit 7:** CPL, Coupler Sound Effect  
0 = Sound is unaffected by F10.  
1 = Sound is activated when F10 is on.

**Default Value:** 32

**Related CVs:** See also CVs 33-43, 45-46



# Function Output CVs

## CV 45

### F11 Output Location

#### Description

Maps the F11 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

Bit 7							Bit 0
CPL	BRK	INJ	MUT	DIM	WS	STM	SHW

- Bit 0:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F11.  
1 = Sound is activated when F11 is on.
- Bit 1:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F11.  
1 = Sound is activated when F11 is on.
- Bit 2:** WS, Water Stop  
0 = Sound is unaffected by F11.  
1 = Sound is activated when F11 is on.
- Bit 3:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F11.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F11 is on.
- Bit 4:** MUT, Audio Mute  
0 = Sound is unaffected by F11.  
1 = Sound is muted when F11 is on.
- Bit 5:** INJ, Injector Sound Effect  
0 = Sound is unaffected by F11.  
1 = Sound is muted when F11 is on.
- Bit 6:** BRK, Brake Squeal/Brake Release  
0 = Sound is unaffected by F11.  
1 = Sound is activated when F11 is on.
- Bit 7:** CPL, Coupler Sound Effect  
0 = Sound is unaffected by F11.  
1 = Sound is activated when F11 is on.

**Default Value:** 64  
**Related CVs:** See also CVs 33-44, 46



# Function Output CVs

## CV 46

### F12 Output Location

#### Description

Maps the F12 function to any of eight DSD auxiliary function outputs as defined by a 1 in the corresponding bit position:

Bit 7							Bit 0
CPL	BRK	INJ	MUT	DIM	WS	STM	SHW

- Bit 0:** SHW, Short Whistle Sound Effect  
0 = Sound is unaffected by F12.  
1 = Sound is activated when F12 is on.
- Bit 1:** STM, Steam Release/Cylinder Cocks  
0 = Sound is unaffected by F12.  
1 = Sound is activated when F12 is on.
- Bit 2:** WS, Water Stop  
0 = Sound is unaffected by F12.  
1 = Sound is activated when F12 is on.
- Bit 3:** DIM, Headlight Dimmer Function  
0 = Lighting outputs are unaffected by F12.  
1 = Lighting outputs set up as “Dimmable Headlights” are dimmed when F12 is on.
- Bit 4:** MUT, Audio Mute  
0 = Sound is unaffected by F12.  
1 = Sound is muted when F12 is on.
- Bit 5:** INJ, Injector Sound Effect  
0 = Sound is unaffected by F12.  
1 = Sound is muted when F12 is on.
- Bit 6:** BRK, Brake Squeal/Brake Release  
0 = Sound is unaffected by F12.  
1 = Sound is activated when F12 is on.
- Bit 7:** CPL, Coupler Sound Effect  
0 = Sound is unaffected by F12.  
1 = Sound is activated when F12 is on.

**Default Value:** 128  
**Related CVs:** See also CVs 33-45



# Miscellaneous CVs

## CV 47

### Analog Whistle Control

#### Description

Contains a value between 0 and 255 that selects the use of the Analog Whistle Control:

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

**D0-D7:** Analog Whistle Control

This CV is used when the user wishes to activate an Analog Function for controlling the whistle with either a pressure or position response rather than responding to the press of a key or button.

When this CV is set to 0, the Analog Whistle Function is disabled. The value in CV 47 should match the value set by the command station manufacturer for an Analog Function in order to enable this feature.

**Default value:**

0

**Related CVs:**

See also Reverb Control, Whistle Reverb Effect Send Level



# Lighting Effect CVs

## CV 49-52

### Hyperlight Effect Select

#### Description

Used to set the Hyperlight lighting effect and control mode for their respective output:

- CV 49, Headlight Effect Select
- CV 50, Backup Light Effect Select
- CV 51, FX5 Effect Select
- CV 52, FX6 Effect Select

Bit 7

Bit 0

LED	R17	XING	PHSE	EF3	EF2	EF1	EF0
-----	-----	------	------	-----	-----	-----	-----

Bits 0-3:

EF[0..3] Effect Type Select

- 0 = On/Off output
- 1 = Rule 17 Dimmable headlight
- 2 = Mars Light
- 3 = Pyle Gyalite
- 4 = Oscillating Headlight
- 5 = Single Flash Strobe
- 6 = Double Flash Strobe
- 7 = Western Cullen D312 Rotary Beacon
- 8 = Prime Stratolite
- 9 = Type I Ditch Light
- 10 = Type II Ditch Light
- 11 = FRED (End of Train flasher)
- 12 = Engine Exhaust Flicker
- 13 = Firebox Flicker
- 14 = Smart Firebox Flicker
- 15 = Dyno-Light

Most of the effects are self-descriptive. However a few need some additional notes:

**Dimmable Headlight** - The function output is normally an on/off output. If the output is on, the output level will be reduced about 60% whenever the dimmer function is on.

**Type I and Type II Ditch Lights** - These are identical when operating. However, if the grade crossing logic is enabled, the Type I ditch light will revert to a steady on state when it is not flashing whereas the Type II lights will turn off.



# Lighting Effect CVs

**Engine Exhaust** - This effect produces a random flicker whose intensity is proportional to the engine RPMs. It is best used by placing a red/orange lamp under the model's exhaust port, out of direct view. As the engine is revved up, it will glow brighter, imitating unmuffled exhaust gases and sparks.

**Dyno-Light** - This effect for steam locomotives synchronizes the lamp brightness to the "output" of the dynamo such that the lamp brightness gradually increases as the dynamo builds up speed.

**Bit 4:** PHSE, Phase Select Bit  
0 = Phase A  
1 = Phase B

**Phase Select Bit** - Alters the timing of the effect so that it is 180 degrees out of phase with the other effects. This allows you to have two light effects that blink back and forth if desired. Set one effect to phase A and the other to phase B.

**Bit 5:** XING, Grade Crossing Logic Enable  
0 = Crossing Logic disabled  
1 = Crossing Logic enabled when Horn function is on.

**Grade Crossing Logic Bit** - Causes the lighting effect to become active only when the horn has been sounded (and the corresponding lighting function key is also on). A typical use would be to cause the ditch lights to flash at a grade crossing. The grade crossing logic can be used with almost all the Hyperlight effects. The on/off, dimmable headlight, FRED, engine exhaust, and firebox flicker effects will not be affected. The other effects will either turn off (strobes and beacons) or revert to a steady on state (mars light, ditch lights, etc.) as appropriate to prototype practice.

**Bit 6:** R17, Rule 17 Mode  
0 = Rule 17 Mode disabled  
1 = Rule 17 Mode enabled

**Rule 17 Mode** - Converts the headlight and backup light to independent, non-directional lights. When this mode is active, the headlight is controlled as if it were FX5 and the backup light as FX6 and vice-versa.

**Bit 7:** LED, LED Compensation Enable  
0 = Incandescent Compatible Lighting Outputs enabled  
1 = LED Compatible Lighting Outputs enabled

**LED Compensation** - Improves lighting effect contrast when using LEDs instead of incandescent lamps.

**Default Value:** 15 (CV 49, 50), 1 (CV 51, 52)  
**Related CVs:** See also CV 59, CV 60



# Lighting Effect CVs

## CV 59 Flash Rate

### Description

CV 59 is used to adjust the Hyperlight effect's flash rate.

Bit 7

Bit 0

				FR3	FR2	FR1	FR0
--	--	--	--	-----	-----	-----	-----

**Bit 0-3:**

FR0-3, Flash Rate Select

Sets the overall flash rate of the Hyperlight effects.

0 = Maximum Flash Rate

:

15 = Minimum Flash Rate

**Default Value:** 3

**Related CVs:** See also CVs 49-52, CV 60



# Lighting Effect CVs

## CV 60

### Crossing Hold Time

#### Description

CV 60 is used to adjust the hold time for grade crossing logic.

Bit 7

Bit 0

				HT3	HT2	HT1	HT0
--	--	--	--	-----	-----	-----	-----

Bit 0-3:

HT0-3, Hold Time Select

Sets the time an effect will stay on after the horn button is released (if it is set up to do so) and has a range of zero to 15 seconds.

0 = Minimum Hold Time = 0

:

15 = Maximum Hold Time = 15 Seconds

**Default Value:**

4

**Related CVs:**

See also CVs 49-52.





# Misc. Control CVs

## CV 61

### F11 Braking Rate

#### Description

Contains a value between -127 to +127 corresponding to the decoder's brake deceleration offset:

Bit 7

Bit 0

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

**Bits 0-6:** D0-D6, F11 Braking value

**Bit 7:** sign  
0 = positive value  
1 = negative value

The F11 braking rate is added to or subtracted from the decoder's base braking rate when the F11 button is pressed. The throttle is set to 0, forcing the decoder to decelerate to a stop.

A value of +0 or -0 disables this feature.

**Default value:** 0



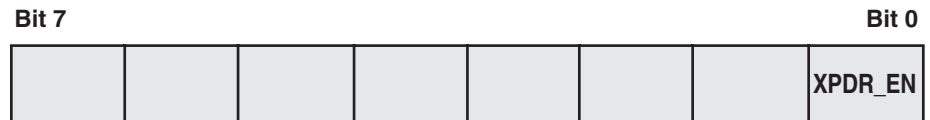
# Misc. Control CVs

## CV 62

### Transponding Control

#### Description

Compensates for incompatibilities that may occur when using some methods of transponding.



- Bit 0:** XPNDER\_EN, Transponder Mode Enable  
0 = Normal Operation  
1 = Decoder configured for compatibility with external transponding devices.
- Bits 1-7:** Not used

**Note:** Power to the decoder must be cycled before any changes to this register will take effect.

**Default value:** 0



# Misc. Control CVs

## CV 63

### Analog Mode Motor Start Voltage

#### Description

CV 63 contains a value between 0 and 255 corresponding to the voltage difference between when the decoder first powers up and when the locomotive starts to move.

Bit 7

Bit 0

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

**D0-D7:** Analog Mode Motor Start Voltage Value

CV 63 may be set to any value between 0 and 255 corresponding to tenths of a volt. Thus, a setting of 23 adds 2.3 volts to Tsunami's default start voltage of 7.5 volts.

Normally, Tsunami will power up in Analog mode around 5 volts or so and the engine will begin moving around 7.5 volts. Under certain circumstances you may experience a condition where the decoder cycles back and forth between start up sounds and locomotive movement. The problem is usually due to a poorly regulated power pack output. The sudden increase in load due to the motor starting causes the track voltage to droop which in turn resets the sound decoder. By increasing the setting of CV 63, you can adjust the decoder so that when the motor starts, the track voltage will be sufficiently high so that any droop that occurs will not turn off or reset the decoder.

**Default Value:** 20



# Misc. Control CVs

## CV 64

### Analog Mode Maximum Motor Voltage

#### Description

Contains a value between 0 and 255 corresponding to the maximum average voltage Tsunami can apply to the motor when operating in analog mode.

Bit 7

Bit 0

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

**D0-D7:** Analog Mode Maximum Motor Voltage

CV 64 may be set to any value between 0 and 255 corresponding to tenths of a volt. A setting of 180 therefore sets the maximum average motor to 18.0 volts.

CV 64 allows you to set the maximum average voltage that will be applied to the motor when operating in analog mode. This is useful for limiting a locomotive's top speed as well as providing some margin of safety against burning out a motor whose voltage rating may be lower than your power pack's maximum output

**Caution:** Tsunami only limits the average voltage to the motor. The peak voltage applied to the motor will still be the same as the track voltage.

**Default value:** 180



# Speed Table CVs

## CV 66

### Forward Trim

#### 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.

Bit 7

Bit 0

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

**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

**Related CVs:** See also Reverse Trim CV 95, CV 29, CV 25.



# Speed Table CVs

## CV 67-94

### Loadable Speed Table

#### 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.

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

**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	Speed Step	Value
CV 67	(Speed Step 1):	9
CV 68	(Speed Step 2):	18
CV 69	(Speed Step 3):	27
CV 70	(Speed Step 4):	36
CV 71	(Speed Step 5):	45
CV 72	(Speed Step 6):	55
CV 73	(Speed Step 7):	64
CV 74	(Speed Step 8):	73
CV 75	(Speed Step 9):	82
CV 76	(Speed Step 10):	91
CV 77	(Speed Step 11):	100
CV 78	(Speed Step 12):	109
CV 79	(Speed Step 13):	118
CV 80	(Speed Step 14):	127
CV 81	(Speed Step 15):	137



# Speed Table CVs

CV 82	(Speed Step 16):	146
CV 83	(Speed Step 17):	155
CV 84	(Speed Step 18):	164
CV 85	(Speed Step 19):	173
CV 86	(Speed Step 20):	182
CV 87	(Speed Step 21):	191
CV 88	(Speed Step 22):	200
CV 89	(Speed Step 23):	209
CV 90	(Speed Step 24):	219
CV 91	(Speed Step 25):	228
CV 92	(Speed Step 26):	237
CV 93	(Speed Step 27):	246
CV 94	(Speed Step 28):	255

**Related CVs:** See also CV 25, CV 29.



# Speed Table CVs

## CV 95

### Reverse Trim

#### 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.

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

**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

**Related CVs:** See also Forward Trim CV 66, CV 25, CV 29.





# User ID CVs

## CV 105

### User Identifier #1

#### 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.

When the decoder is reset to default values, this CV is preset to the software's minor revision code.

**Default Value:** Varies  
**Related CVs:** See also User Identifier #2.



# User ID CVs

## CV 106

### User Identifier #2

#### 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.

When the decoder is reset to default values, this CV is preset to the software's default CV value configuration.

**Default Value:** Varies  
**Related CVs:** See also User Identifier #1.



# Sound Control CVs

## CV 112 Sound Configuration 1

### Description

This CV is used to configure select sound effects. A 1 in the corresponding bit position enables the selected sound effect:

<b>Bit 7</b>	<b>Bit 0</b>
<b>CAM</b>	<b>AECS</b>
<b>SR1</b>	<b>SR0</b>
<b>AP2</b>	

**Bit 0:** AP2, Air Pump 2 Enable  
 0 = Single Air Pump  
 1 = Dual Air Pump

**Bits 1-3:** Reserved.

**Bits 4-5:** SR1,SR0, Slip Rate Control  
 00 = Zero Slip Rate  
 01 = Slow Slip Rate  
 10 = Medium Slip Rate  
 11 = Fast Slip Rate

These bits control the variation or timing syncopation when articulated exhaust is enabled to simulate slipping drive wheels or a double-header.

**Bit 6:** AECS, Articulated Exhaust Control  
 0 = Rod Engine Chuff  
 1 = Articulated Exhaust Chuff

This bit alters the exhaust timing to sound like a simple articulated engine when Auto Exhaust is activated.

**Bit 7:** CAM, Cam Enable  
 0 = Auto Exhaust Chuff Enable  
 1 = Cam Synchronized Exhaust Enabled  
 (DCC mode only, exhaust will be controlled by CV 116 when in Analog Mode)

**Default Value:** 0



# Sound Control CVs

## CV 113

### Quiet Mode Timeout Period

#### Description

When the Quiet Mode Timeout Period is set to a non-zero value, sounds become active only when the decoder is addressed. When the locomotive has been stopped and all functions have been turned off, the sound effects will turn off automatically after the timeout period has elapsed as set by CV 113.

Bit 7

Bit 0

Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0
----	----	----	----	----	----	----	----

**Q0-Q7:**

Quiet Bit Time Out Period

0 = Sound turns on a few seconds after power is turned on.

1-255 = Quiet Mode Timeout period

$$\text{Timeout period (seconds)} = \text{CV 113} \times 0.25$$

**Default Value:** 0.



# Sound Control CVs

## CV 114

### Bell Ring Rate

#### Description

This CV contains a value from 0 to 15 and is used to control the speed at which the bell rings:



**Bit 0-3:** BR0:BR3, Bell Ring Rate  
Controls the ringing rate of the bell sound.

0 = Fastest Ring Rate  
:  
15 = Slowest Ring Rate

**Bits 4-7:** Reserved.

**Default Value:** 4



# Sound Control CVs

## CV 115

### Whistle Select

#### Description

This CV is used to select the available whistles. It also allows the user to choose an alternate whistle to be controlled by the Short Whistle Function in place of the short whistle.

<b>Bit 7</b>							<b>Bit 0</b>
<b>ALTWH</b>		<b>AWH2</b>	<b>AWH1</b>	<b>AWH0</b>	<b>WH2</b>	<b>WH1</b>	<b>WH0</b>

**Bits 0-2:** WH0:WH2, Whistle/Airhorn Selection

- 000 = Whistle 1
- 001 = Whistle 2
- 010 = Whistle 3
- 011 = Whistle 4
- 100 = Whistle 5
- 101 = Whistle 6
- 110 = Whistle 7
- 111 = Whistle 8

**Bits 3-5:** AWH0:AWH2, Alternate Whistle/Airhorn Selection

- 000 = Whistle 1
- 001 = Whistle 2
- 010 = Whistle 3
- 011 = Whistle 4
- 100 = Whistle 5
- 101 = Whistle 6
- 110 = Whistle 7
- 111 = Whistle 8

**Bit 6:** Reserved.

**Bit 7:** ALTWH, Alternate Whistle Enable  
0 = Short Whistle Function  
1 = Replace Short Whistle with alternate whistle as selected by AWH0:AWH2.

**Default Value:** 0



# Sound Control CVs

## CV 116

### Engine Exhaust Control

#### Description

This CV specifies the Auto-Exhaust Synchronization Rate.

Bit 7

Bit 0

EX7	EX6	EX5	EX4	EX3	EX2	EX1	EX0
-----	-----	-----	-----	-----	-----	-----	-----

**Bits 0-7:** EX0:EX7, Auto Exhaust Rate  
 Controls the chuff rate of the steam exhaust.  
 0 = Slowest Chuff Rate  
 :  
 255 = Fastest Chuff Rate

For Auto-Exhaust synchronization, the chuff rate will be generated in proportion the throttle setting. The CV is loaded with any value between 0 and 255. 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:

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

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.

**Default Value:** 80



# Sound Control CVs

## CV 119

### Effect Processor Select

#### Description

This CV selects an Effect Processor which may be programmed via CVs 120 to 127, which are then used for individual controls (see Page 95). This CV is used in situations where a cab cannot access CVs numbered above 128.

Bit 7

Bit 0

EF7	EF6	EF5	EF4	EF3	EF2	EF1	EF0
-----	-----	-----	-----	-----	-----	-----	-----

Bits 0-7:

EF0-7, Effect Processor Select

- 0 = Foreground Sound Mixer
- 1 = Background Mixer 1
- 2 = Background Mixer 2
- 3 = Seven Band Equalizer
- 4 = Reverb Control Mixer
- 5 = Reverb Mixer
- 6 = Dynamic Digital Exhaust Mixer 1
- 7 = Dynamic Digital Exhaust Mixer 2
- 8 = Automatic Sound Control 1
- 9 = Automatic Sound Control 2
- 10 = Advanced Motor Control





# Sound Control CVs

## CV 128

### Master Volume Control

#### Description

This CV sets the overall volume of all sound channels.

Bit 7

Bit 0

VOL7	VOL6	VOL5	VOL4	VOL3	VOL2	VOL1	VOL0
------	------	------	------	------	------	------	------

**Bits 0-7:** VOL0:VOL7, Master Volume Control  
0 = Minimum volume  
255 = Maximum volume

**Default Value:** 192 (75%)



# Sound Control CVs

## CV 129-136

### Sound Effect Mixer

#### Description

The Foreground Sound Mixer sets the volume of the individual sound channels as follows:



**Bits 0-7:** MIX0:MIX7, Mixer Level

0 = Minimum Sound Level (0%)  
 255 = Maximum Sound Level (100%)

- CV 129: Whistle Volume
- CV 130: Bell Volume
- CV 131: Exhaust Volume
- CV 132: Air Pump Volume
- CV 133: Dynamo Volume
- CV 134: Blower Volume
- CV 135: Rod Clank Volume
- CV 136: Steam Release Volume

**Default Value:** Varies



# Sound Control CVs

## CVs 137-152

### Background Sound Mixer

#### Description

The Background Sound Mixer sets the volume of the individual sound channels as follows:

Bit 7							Bit 0
MIX7	MIX6	MIX5	MIX4	MIX3	MIX2	MIX1	MIX0

**Bits 0-7:** MIX0:MIX7, Mixer Level  
 0 = Minimum Sound Level (0%)  
 255 = Maximum Sound Level (100%)

- CV 137: Coupler Volume
- CV 138: Glad Hand Release Volume
- CV 139: Brake Squeal Volume
- CV 140: Brake Release Volume
- CV 141: Sniffer Valve Volume
- CV 142: Power Reverse Volume
- CV 143: Pop Valve Volume
- CV 144: Not used
- CV 145: Blower Draft Volume
- CV 146: Water Stop Volume
- CV 147: Injector Volume
- CV 148: Fireman Fred's Shovel Volume
- CV 149: Fireman Fred's Wrench Volume
- CV 150: Fireman Fred's Oil Can Volume
- CV 151: Fireman Fred's Grease Gun Volume
- CV 152: Not used

**Note:** Changes to some background sound CVs may not result in an immediate change in volume level. Turn the sound effect off and back on to load the new setting.



# Sound Control CVs

## CVs 153-160

### Seven Band Equalizer

#### CV 153 Equalizer Control

##### Description

The Seven Band Equalizer selects one of six equalizer presets or selects a user adjustable profile as defined by CVs 154 through 160.

Bit 7

Bit 0

					EQ2	EQ1	EQ0
--	--	--	--	--	-----	-----	-----

Bits 0-2:

EQ0:EQ2 access the following Equalizer Presets:

- 0 = **Flat (off)**  
Equalizer is disabled.
- 1 = **Tiny Speaker**  
Preset for use with speakers under 1"
- 2 = **Small Speaker**  
Preset for use with speakers from 1" to 2"
- 3 = **Medium Speaker**  
Preset for use with speakers from 2" to 4"
- 4 = **Large Speaker**  
Preset for use with speakers over 4"
- 5 = **Edgeport Speaker**  
Preset for use with SoundTraxx Edgeport speaker. Improves the low end and flattens the mid-range peak.
- 6 = **Boom Box**  
Increases bass and treble response by +dB
- 7 = **User Adjustable**  
This setting allows the cut/boost level of each band to be individually adjusted using CVs 154-160

Default Value: 0



# Sound Control CVs

## CV 154-160 Cut/Boost Controls

Bit 7

Bit 0

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

**Bits 0-7:** D0:D7 adjust the Cut/Boost level of each band:  
0 = -12dB (Cut)  
127 = 0dB (Flat)  
255 = +12dB (Boost)

These CVs have a range of +/- 12dB. Values from 0 to 127 reduce the output from -12dB to 0dB. Values from 128 to 255 increase the output from 0dB to +12dB. Each CV from 154 to 160 controls a different frequency band as follows:

CV 154: 62 Hz Cut/Boost  
CV 155: 125 Hz Cut/Boost  
CV 156: 250 Hz Cut/Boost  
CV 157: 500 Hz Cut/Boost  
CV 158: 1K Hz Cut/Boost  
CV 159: 2K Hz Cut/Boost  
CV 160: 4K Hz Cut/Boost

**Default Value:** 0



# Sound Control CVs

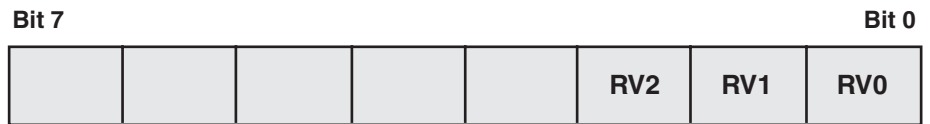
## CVs 161-164

### Reverb

#### Description

The Reverb features one of six reverb presets or selects a user adjustable profile as defined by CVs 162 through 164.

#### CV 161 Reverb Control



**Bits 0-2:** RV0:RV2, Reverb Preset Select

- 0 = Reverb Disabled
- 1 = Additional Reverb for Whistle Functions
- 2 = Light Reverb in Exhaust
- 3 = Medium Reverb in Exhaust
- 4 = Heavy Reverb in Exhaust
- 5 = Reserved
- 6 = Reserved
- 7 = User Adjustable

This setting allows the reverb level to be individually adjusted using CVs 162-164.

**Default Value:** 0



# Sound Control CVs

## CV 162 Reverb Output Level

Bit 7

Bit 0

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

**Bits 0-7:** D0:D7 adjust the reverb output level:

Contains a value between 0 and 255 (n) that specifies a percentage of the reverb output ( $n/255$ ) that is to be mixed back into the original audio signal.

**Default Value:** 128 (50%)



# Sound Control CVs

## CV 163 Reverb Delay

Bit 7

Bit 0

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

**Bits 0-7:** D0:D7, Reverb Delay Time

This CV specifies the total reverb delay time from 0 to 64mS. The delay time is calculated as:

**Delay = n x 0.25mS where n = the CV value from 0 to 255**

**Default Value:** 255 (64mS)





# Sound Control CVs

## CV 164 Reverb Gain

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

**Bits 0-7:** D0:D7, Reverb Feedback Gain

Contains a value between 0 and 255 (n) that specifies a percentage of the reverb output (n/255) that is to be mixed back into the delay line.

Note: High feedback levels may result in very high audio levels and can potentially damage speakers.

**Default Value:** 64 (25%)



# Sound Control CVs

## CVs 169-176

### Reverb Mixer

#### Description

The Reverb Mixer determines the volume level of select sound effects to be applied to the reverb effect.

Bit 7

Bit 0

RMX7	RMX6	RMX5	RMX4	RMX3	RMX2	RMX1	RMX0
------	------	------	------	------	------	------	------

**Bits 0-7:** RMX0:RMX7 sets the percentage of selected signal level to mix into the reverb input from 0 to 255.  
0 = Minimum volume  
255 = Maximum volume

- CV 169: Whistle Reverb Effect Send Level
- CV 170: Bell Reverb Effect Send Level
- CV 171: Exhaust Reverb Effect Send Level
- CV 172: Air Pump Reverb Effect Send Level
- CV 173: Reserved
- CV 174: Reserved
- CV 175: Reserved
- CV 176: Reserved

**Default Value:** 0



# DDE Control CVs

## CVs 177-189

### Dynamic Digital Exhaust Control Registers

#### Description

These CVs control how the DDE processor modifies the sound envelope in response to changes in the locomotive load.

#### CV 177 Throttle Gain

Bit 7

Bit 0

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

#### Bits 0-7:

D0:D7, DDE Throttle Gain

This CV contains a value between 0 and 255 that specifies the DDE sensitivity to the difference between the throttle setting and actual locomotive speed. A value of 0 will disable this input.

**Default Value:** 10



# DDE Control CVs

## CV 178 Motor Load Gain

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Motor Load Gain

Contains a value between 0 and 255 (n) that specifies the DDE sensitivity to changes in the motor load. A value of 0 will disable this input.

**Default Value:** 32



# DDE Control CVs

## CV 179 DDE Attack Time Constant

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Attack Time Constant

Contains a value between 0 and 255 (n) that sets the attack time constant. This determines the amount of time needed before the DDE processor will begin reshaping the audio signal once the motor or throttle input signal has begun to change.

Larger CV values correspond to increasing time constants, which will yield a faster response to throttle/motor load changes.

**Default Value:** 10



# DDE Control CVs

## CV 180 DDE Release Time Constant

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Release Time Constant

Contains a value between 0 and 255 (n) that sets the release time constant. This determines the amount of time needed before the DDE processor will stop reshaping the audio signal after the motor or throttle input signal has returned to normal.

Larger CV values correspond to increasing time constants, which will yield a faster response to throttle/motor load changes.

**Default Value:** 10



# DDE Control CVs

## CV 181 DDE Exhaust Low Volume Limit

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Exhaust Low Volume Limit

0 = 0dB

255 = -12dB

Contains a value between 0 and 255 (n) that sets the maximum attenuation level of the exhaust sound when the locomotive is under light load. The attenuation level may be set between 0 and -12dB of the original mixer setting.

**Default Value:** 255



# DDE Control CVs

## CV 182 DDE Exhaust High Volume Limit

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Exhaust High Volume Limit

0 = 0dB

255 = +12dB

Contains a value between 0 and 255 (n) that sets the maximum attenuation level of the exhaust sound when the locomotive is under heavy load. The attenuation level may be set between 0 and +12dB of the original mixer setting.

**Default Value:** 255





# DDE Control CVs

## CV 183 Side Rod Clank Low Volume Limit

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, Side Rod Clank Low Volume Limit

0 = 0dB

255 = -12dB

Contains a value between 0 and 255 (n) that sets the attenuation level of the side rod clank sound when the locomotive is under heavy load. The attenuation level may be set between 0 and -12dB of the original mixer setting.

**Default Value:** 255



# DDE Control CVs

## CV 184 Side Rod Clank High Volume Limit

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, Side Rod Clank High Volume Limit

0 = 0dB

255 = +12dB

Contains a value between 0 and 255 (n) that sets the maximum volume level of the side rod clank sound when the locomotive is under light load. The gain level may be set between 0 and +12dB of the original mixer setting.

**Default Value:** 255



# DDE Control CVs

## CV 185 DDE Filter Initial Frequency

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Filter Initial Frequency

This CV contains a value between 0 and 255 that specifies the initial frequency of the DDE filter bank. Larger values correspond to high frequencies..

**Default Value:** 42



# DDE Control CVs

## CV 186 DDE Filter Control Gain

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Filter Control Gain

This CV contains a value between 0 and 255 that determines the sensitivity of the DDE filter bank to changes in load and speed. Larger values correspond to increasingly greater sensitivities.

**Default Value:** 64



# DDE Control CVs

## CV 187 DDE Filter Damping

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, DDE Filter Damping

This CV contains a value between 0 and 255 that sets the overall damping ratio of the DDE Filter Bank.

**Default Value:** 255



# DDE Control CVs

## CV 188 DDE Tracking Coefficient

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

**Bits 0-7:** D0:D7, DDE Tracking Coefficient  
This CV contains a value between 0 and 255 that sets the no load sense level for the DDE controller when back-EMF is disabled, as a percentage of the track voltage.

$$\text{Tracking Coefficient} = \text{CV Value} \div 128$$

**Default Value:** 102 (80%)



# Automatic Sound Control CVs

## CVs 193 - 200

### Automatic Sound Control

#### Description

These CVs allow the user to set the parameters for the Automatic Sound Control features.

#### CV 193 Bell-On Set Point

Bit 7

Bit 0

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

#### Bits 0-6:

D0:D6, Bell-On Set Point

This CV contains a value between 0 and 127 that specifies throttle speed step where the automatic bell will first turn on.

**Default Value:** 15



# Automatic Sound Control CVs

## CV 194 Bell-Off Set Point

Bit 7

Bit 0

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

**Bits 0-6:**

D0:D6, Bell-Off Set Point

This CV contains a value between 0 and 127 that specifies throttle speed step where the automatic bell will turn off.

**Note:** If CV 194 is set to a value equal or lower than CV 193, the automatic bell will not turn on.

**Default Value:** 19





# Automatic Sound Control CVs

## CV 195 Grade Crossing Whistle Sensitivity

Bit 7

Bit 0

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

**Bits 0-7:** D0:D7, Grade Crossing Whistle Sensitivity  
This CV contains a value between 0 and 255 that specifies the positive rate of throttle change needed to activate the automatic grade crossing whistle. The CV setting is interpreted as:

$$\text{CV Value} = \text{Speed Steps per Second} \div 10$$

**Default Value:** 4



# Automatic Sound Control CVs

## CV 196 Brake Squeal Sensitivity

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7, Brake Squeal Sensitivity

This CV contains a value between 0 and 255 that specifies the negative rate of throttle change needed to activate the automatic brake squeal. The CV setting is interpreted as:

$$\text{CV Value} = \text{Speed Steps per Second} \div 10$$

**Default Value:** 3



# Automatic Sound Control CVs

## CV 197 Analog Mode Automatic Sound Configuration

Bit 7				Bit 0			
			ABD	BRK	BELL	WHSIG	WHXNG

**Bit 0:** WHXNG, Automatic Grade Crossing Whistle Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 1:** WHSIG, Automatic Whistle Signal Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 2:** BELL, Automatic Bell Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 3:** BRK, Automatic Brake Squeal Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 4:** ABD, Automatic Steam Blow Down Enable (Steam)  
0 = Effect disabled  
1 = Effect enabled

**Default Value:** 0



# Automatic Sound Control CVs

## CV 198 Digital Mode Automatic Sound Configuration

Bit 7								Bit 0
			ABD	BRK	BELL	WHSIG	WHXNG	

**Bit 0:** WHXNG, Automatic Grade Crossing Whistle Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 1:** WHSIG, Automatic Whistle Signal Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 2:** BELL, Automatic Bell Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 3:** BRK, Automatic Brake Squeal Enable  
0 = Effect disabled  
1 = Effect enabled

**Bit 4:** ABD, Automatic Steam Blow Down Enable (Steam)  
0 = Effect disabled  
1 = Effect enabled

**Default Value:** 0



# Automatic Sound Control CVs

## CV 201-208

### Event Probability Generator

#### Description

These CVs set the occurrence probability for the Fireman Fred Events random automatic sound features.

The CV contains a value between 0 and 255 that specifies the probability that the selected sound effect will occur the next time the locomotive is stopped. A setting of 0 disables the effect since it has a 0% chance of occurring. A setting of 255 forces the effect to occur with every stop.

Bit 7

Bit 0

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

**Bits 0-7:** D0:D7, Event Probability  
 0 = Minimum Probability (0%)  
 255 = Maximum Probability (100%)

- CV 201: Event Probability: Fireman Fred Shovels Coal
- CV 202: Event Probability: Fireman Fred Fills the Tender
- CV 203: Event Probability: Fireman Fred Turns His Wrench
- CV 204: Event Probability: Fireman Fred Uses His Grease Gun
- CV 205: Event Probability: Fireman Fred Uses His Oil Can
- CV 206: Event Probability: Fireman Fred Uses the Injectors
- CV 207: Event Probability: Fireman Fred Uses the Firebox Blower
- CV 208: Event Probability: Pop Valve Blow Off

**Default Value:** Varies



# Advanced Motor Control CVs

## CVs 209 - 214

### Advanced Motor Control Features

#### CV 209 Kp Coefficient

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7 sets the Kp Coefficient

The CV contains a value between 0 and 255 that specifies a gain factor for the proportional part of the PID motor control equation.

**Default Value:** 25



# Advanced Motor Control CVs

## CV 210 Ki Coefficient

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7 sets the Ki Coefficient

The CV contains a value between 0 and 255 that specifies a gain factor for the integral part of the PID motor control equation.

**Default Value:** 20



# Advanced Motor Control CVs

## CV 212 Motor Control Intensity

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7 sets the Motor Control Intensity

The CV contains a value between 0 and 255, interpreted as  $n/32$  that is fed back from the control loop.

**Default Value:** 255





# Advanced Motor Control CVs

## CV 213 Motor Control Sample Period

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7 sets the Motor Control Sample Period. The CV contains a value between 0 and 31, that specifies the time period in mS (milliseconds) between measurements.

**Default Value:** 15



# Advanced Motor Control CVs

## CV 214 Motor Control Sample Aperture Time

Bit 7

Bit 0

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

**Bits 0-7:**

D0:D7 sets the Motor Control Sample Aperture Time. The CV contains a value between 0 and 255 that specifies a gain factor for the derivative part of the PID motor control equation.

**Default Value:** 15



# Effect Processor Select CVs

## Using the Effect Processor Select

### Description

Because there are so many sound effects, the Tsunami decoder uses a relatively large number of CVs! In some cases, however, a command station may not support CVs numbered above 128. If this is the case with your command station, Tsunami uses something rather akin to pages in a book to program these CVs. Different Mixers and Control sets reside on different pages, so the before anything else you need to choose the correct page using CV 119, Effect Processor Select.

### CV 119 Effect Processor Select

CV 119 selects an Effect Processor which may be programmed via CVs 120 to 127, which are then used for individual controls as shown in the table. Choose the Effect Processor you want and program CV 119 accordingly:

0	=	Foreground Sound Mixer
1	=	Background Mixer 1
2	=	Background Mixer 2
3	=	Seven Band Equalizer
4	=	Reverb Control Mixer
5	=	Reverb Mixer
6	=	Dynamic Digital Exhaust Mixer 1
7	=	Dynamic Digital Exhaust Mixer 2
8	=	Automatic Sound Control 1
9	=	Automatic Sound Control 2
10	=	Advanced Motor Control
11	=	Reserved

Once you've programmed CV 119, program CVs 120 to 127 with the desired values as shown in the tables on the following pages.

**Note:** Tsunami will remember the value programmed into CV 119. To prevent inadvertent modifications of another effect, it is always wise to check the value in CV 119 before changing CVs 120-127. When you have completed your modifications, you might also want to set CV 119 to an unused value such as 12 or higher in case you forget to change it next time.



# Effect Processor Select CVs

<b>Effect Processor Selection and Programming</b>		
<b>CV 119 = 0</b>	<b>Description</b>	<b>Range of Values</b>
CV 120	Whistle Volume	0 - 255
CV 121	Bell Volume	0 - 255
CV 122	Steam Exhaust Volume	0 - 255
CV 123	Airpump Volume	0 - 255
CV 124	Dynamo Volume	0 - 255
CV 125	Blower Volume	0 - 255
CV 126	Side Rod Clank Volume	0 - 255
CV 127	Steam Release Volume	0 - 255
<b>CV 119 = 1</b>	<b>Description</b>	<b>Range of Values</b>
CV 120	Coupler Volume	0 - 255
CV 121	Glad Hand Release Volume	0 - 255
CV 122	Brake Squeal Volume	0 - 255
CV 123	Brake Release Volume	0 - 255
CV 124	Snifter Valve Volume	0 - 255
CV 125	Power Reverse Volume	0 - 255
CV 126	Pop Valve Volume	0 - 255
CV 127	Not Assigned	0 - 255
<b>CV 119 = 2</b>	<b>Description</b>	<b>Range of Values</b>
CV 120	Blower Draft Volume	0 - 255
CV 121	Water Stop Volume	0 - 255
CV 122	Injector Volume	0 - 255
CV 123	Fireman Fred's Shovel Volume	0 - 255
CV 124	Fireman Fred's Wrench Volume	0 - 255
CV 125	Fireman Fred's Oil Can Volume	0 - 255
CV 126	Fireman Fred's Grease Gun	0 - 255
CV 127	Volume	0 - 255



## Effect Processor Select CVs

<b>CV 119 = 3</b>	<b>Seven Band Equalizer</b>	<b>Range of Values</b>
CV 120	Equalizer Preset Selection	0 - 7
CV 121	62 Hz Cut/Boost	0 - 255
CV 122	125 Hz Cut/Boost	0 - 255
CV 123	250 Hz Cut/Boost	0 - 255
CV 124	500 Hz Cut/Boost	0 - 255
CV 125	1K Hz Cut/Boost	0 - 255
CV 126	2K Hz Cut/Boost	0 - 255
CV 127	4K Hz Cut/Boost	0 - 255
<b>CV 119 = 4</b>	<b>Reverb Control Mixer</b>	<b>Range of Values</b>
CV 120	Reverb Preset Selection	0 - 7
CV 121	Reverb Output Level	0 - 255
CV 122	Reverb Delay Time	0 - 255
CV 123	Reverb Gain	0 - 255
CV 124	Not Assigned	-
CV 125	Not Assigned	-
CV 126	Not Assigned	-
CV 127	Not Assigned	-
<b>CV 119 = 5</b>	<b>Reverb Mixer</b>	<b>Range of Values</b>
CV 120	Whistle Reverb Effect Send Level	0 - 255
CV 121	Bell Reverb Effect Send Level	0 - 255
CV 122	Exhaust Reverb Effect Send Level	0 - 255
CV 123	Airpump Reverb Effect Send Level	0 - 255
CV 124	Not Assigned	-
CV 125	Not Assigned	-
CV 126	Not Assigned	-
CV 127	Not Assigned	-



## Effect Processor Select CVs

<b>CV 119 = 6</b>	<b>DDE Mixer 1</b>	<b>Range of Values</b>
CV 120	DDE Throttle Gain	0 - 255
CV 121	DDE Motor Load Gain	0 - 255
CV 122	DDE Attack Time Constant	0 - 255
CV 123	DDE Release Time Constant	0 - 255
CV 124	DDE Exhaust Low Volume Limit	0 - 255
CV 125	DDE Exhaust High Volume Limit	0 - 255
CV 126	DDE Rod Clank Low Volume Limit	0 - 255
CV 127	DDE Rod Clank High Volume Limit	0 - 255
<b>CV 119 = 7</b>	<b>DDE Mixer 2</b>	<b>Range of Values</b>
CV 120	DDE Initial Frequency Filter	0 - 255
CV 121	DDE Filter Control Gain	0 - 255
CV 122	DDE Filter Damping	0 - 255
CV 123	Not Assigned	-
CV 124	Not Assigned	-
CV 125	Not Assigned	-
CV 126	Not Assigned	-
CV 127	Not Assigned	-
<b>CV 119 = 8</b>	<b>Automatic Sound Control 1</b>	<b>Range of Values</b>
CV 120	Bell-on Set Speed Step	0 - 255
CV 121	Bell-off Set Speed Step	0 - 255
CV 122	Grade Crossing Sensitivity	0 - 255
CV 123	Brake Squeal Sensitivity	0 - 255
CV 124	Automatic Analog Sound Enable	0 - 255
CV 125	Automatic Digital Sound Enable	0 - 255
CV 126	Phantom Function Output 1	0 - 255
CV 127	Phantom Function Output 2	0 - 255

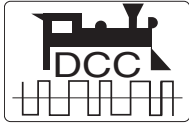


## Effect Processor Select CVs

<b>CV 119 = 9</b>	<b>Automatic Sound Control 2</b>	<b>Range of Values</b>
CV 120	Fireman Fred Coal Shovelling	0 - 255
CV 121	Fireman Fred Tender Filling	0 - 255
CV 122	Fireman Fred Turns Wrench	0 - 255
CV 123	Fireman Fred Uses Grease Gun	0 - 255
CV 124	Fireman Fred Uses Oil Can	0 - 255
CV 125	Fireman Fred Uses Injectors	0 - 255
CV 126	Fireman Fred Uses Firebox Blowers	0 - 255
CV 127	Pop Valve Blow Off	0 - 255
<b>CV 119 = 10</b>	<b>Advanced Motor Control</b>	<b>Range of Values</b>
CV 120	Kp Coefficient	0 - 255
CV 121	Ki Coefficient	0 - 255
CV 122	Kd Coefficient	0 - 255
CV 123	Motor Control Intensity	0 - 255
CV 124	Motor Control Sample Period	0 - 255
CV 125	Motor Control Sample Aperture Time	0 - 255
CV 126	Not used	-
CV 127	Not used	-



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