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 **Spectrum® Steam Sound User's Guide**

 **Spectrum® Technical Reference**



Tsunami® Digital Sound Decoder

Spectrum® Steam Sound User's Guide

Software Release 1.00

 **Main Menu**

 **Spectrum® Steam Sound User's Guide
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All Aboard!

Overview

Congratulations on the purchase of your SoundTraxx® Tsunami® Digital Sound Decoder™. This **User's Guide** will walk you through the various aspects of programming your Tsunami decoder, as well as some tips on troubleshooting. For the power user, the Tsunami **Technical Reference** will provide a list of all the CVs available for use with Tsunami decoders and their exact function and make-up for those who wish to have a complete reference for advanced programming techniques.

Technical Bulletins and Application Notes covering various topics are also published from time to time, and these may be downloaded free of charge from our website at www.soundtraxx.com.



Operation

Using Your Tsunami Digital Sound Decoder

Your SoundTraxx Tsunami has been shipped with all CVs pre-programmed so you can begin using your locomotive immediately without having to worry about what adjustments to make. Function Assignments are as follows:

Steam Decoders

<i>Function Key</i>	<i>Effect</i>
F0	Headlight/Backup Light/Dynamo
F1	Bell
F2	Whistle
F3	Short Whistle
F4	Steam Release
F5	Dynamo
F6	Water Stop
F7	Coupler Clank
F8	Mute the Sound
Direction Button	Johnson Bar
Throttle	Exhaust Chuff, Snifter Valve, Brake Squeal

While these are the default settings, you may wish to make changes to the function mapping later. For now, simply set your controller to Locomotive 3, place the locomotive on the mainline and away you go! Now that you have control of your decoder, let's see what happens!

Turn on the Lights

Press F0 on your cab to turn on the Headlight. Reverse locomotive direction and the headlight turns off as the backup light turns on.

Ring the Bell

Engineers are required to ring the bell during yard movement. To ring the bell, press F1 on your cab. This is an on/off function, i.e. once on, the bell will continue to ring until you turn it off. Press F1 again to turn it off.

Blow the Whistle

Engineers are required to blow various whistle signals to warn of the approaching train as well as notify both passengers and train crew to the planned movement of the locomotive. Some of these are signals for grade crossings, stopping, moving forward, backing up and more.

Learning and using the various whistle signals can add a lot of fun to your operating sessions! Some of the more common signals are indicated here.



Operation

To activate the Whistle, press F2 on your cab: the longer you press the key, the longer the whistle will blow. While this allows you to make short or long signals, F3 is designated as a 'short' whistle so your shorts will have that nice, crisp, 'toot' regardless of how responsive your cab controls are...try a grade crossing whistle!

Whistle Signals	
Note:	● = Short Blast — = Long Blast
— — ● —	Approaching Grade Crossing. (Hold final blast until crossing is reached.)
● —	Approaching a bridge or tunnel
●	Stop, set brakes
— —	Release brakes and proceed forward
● ● ●	Backup
● ● ● ●	Request signal from Trainman
— ●	Warning whistle, used when approaching points where view is obstructed.

Blow Down the Boiler

If your steam engine's been sitting in the station awhile, there's bound to be some particle buildup in the boiler. Press the F4 key to open the blowdown valve and blow out the sediment. Press the F4 key again to close the blowdown valve.

Automatic Steam Sound Functions

Some sound effects happen in response to an action other than pressing a function key. The blowers will automatically simmer in the background to help vent the steam and keep up a good draft.

Airpumps

Brakes on trains operate using air pressure. When the engineer activates the brakes, he is releasing air pressure, forcing the brake shoes against the wheels and causing the train to slow down. When the engine stops the air pressure is build up using a compressor, also called an airpump. The air pumps will pound out a steadily slowing cadence that simulates the build up of air pressure in the main reservoir. Deceleration of the locomotive while applying the brakes will cause the air pump to resume pumping.

Snifter Valve

Just as you start to move the engine, you'll hear the Pffffffft! of the snifter valve.

More Automatic Sound Functions on Next Page



Operation

Johnson Bar

Changing the locomotive direction will automatically activate the sound of the Johnson Bar being thrown one way or the other.

Exhaust Chuff and Rod Clank

The exhaust chuff and rod clank sounds are automatically generated whenever the locomotive is set into motion. Both effects may be optionally configured to vary in volume in response to load changes using Tsunami's Dynamic Digital Exhaust setting (see "Step 8: Configuring the DDE").

Brake Squeal/Release

The sound of the brakes squealing is activated automatically whenever the locomotive is slowed down or brought to a stop.

Activating other Functions and Effects

Depending on the number of function keys provided on your cab, you might have additional functions immediately available for you to activate.

Mute the Sound

Pressing F8 on all Tsunami decoders will gradually mute all sound effects - great for a quick answer of the telephone! Pressing it a second time will allow you to hear the sounds again.

Dynamo

Pressing F5 turns the Dynamo on and off. As the Dynamo turns on, it will spool up in an accelerating whine and settle down into a soft buzz when it reaches full power.

Water Stop

All steam engines require water! The Water Stop initiates a sequence of events beginning with the fireman opening a rather squeaky water hatch, followed by the sound of water filling the tender. This effect is activated when the engine is stopped by pressing F6 and can be stopped by pressing F6 again. If the locomotive is started while the effect is running, the effect will automatically turn off.

Coupler Clank

Pressing F7 will activate the coupler clank sound effect, see how well you can time the effect to the actual coupling of the locomotive to the train!

As you see, no programming is necessary to begin enjoying your DSD! However... after you have had a chance to play with your decoder for a little while, you may wish to make some changes such as selecting a new address or altering a sound effect. The following section will introduce you to CVs and how and why you might wish to change them.



Basics of Programming

Programming the CVs

What is a CV?

CV stands for Configuration Variable, which is the industry-adopted term for a decoder's user-programmable memory locations. CVs allow you to customize individual decoder properties such as the address, momentum, throttle response, sound volume and much more. Once a CV has been programmed, the setting will be permanently remembered even after the power has been turned off. A CV can be modified as often as necessary by simply reprogramming it with a new value.

With the large number of CVs available, first inspection of the available options may cause confusion and little panic! Relax. As you have already seen the DSD has been shipped with all CVs pre-programmed so you can begin using your locomotive immediately without having to worry about what adjustments to make.

The following paragraphs break the sound decoder's CVs into various subsystems so it is only necessary to change a few CV's at a time. As you become comfortable with it's operation, move onto a new section and begin exploring the options and capabilities found there. For more technically inclined users, detailed information on any CV can be found in the **Tsunami Technical Reference**.

Bits and Bytes

One of the most confusing aspects of programming a CV is figuring out what all the different bits, bytes and x's found in the various decoder manuals mean. The problem is compounded further by differences in each command station manufacturer's user interface. For users unfamiliar with such terms, a short math lesson (ugh!) is in order before proceeding:

Each decoder CV stores a numeric value that can be represented in one of three forms:

Decimal - This is the form everyone is familiar with and we use in our day-to-day lives. Numbers are represented as a sequence of digits composed of the numerals 0,1,2,3,4,5,6,7,8, and 9.

Hexadecimal - Also referred to as simply "hex", this is a more specialized number representation that, in addition to 0 through 9, also uses the characters A-F. It has the advantage that a given decimal number can be more compactly represented. For example, the decimal number 127 converts to a simple 7F in hex (one less digit). This allows user interfaces with a limited number of digits (i.e., the LCD on your cab) to display a wider range of numbers.

Binary - Binary numbers get their name from the fact they use only two digits 0 and 1 called 'bits' and is the fundamental number system used by all computers including the ones found inside a digital decoder. Because there



Basics of Programming

are only two bit values, it takes more digits to represent a number using binary. The decimal number 127, for example, is written as 01111111 in binary notation. A 'byte' is a binary number made up of eight bits. And a 'nibble' is half a byte or four bits. Really! We didn't make that up.

Coincidentally, each CV is made up from one byte or eight bits and can store any number between 0 and 255. Most of the CVs contain a single piece of data that can be easily represented in any of the three forms, i.e., CV 3, the acceleration rate, can be loaded with any value from 0 to 255 and it always affects the same thing - the acceleration rate.

On the other hand, some CVs use individual bits to control different features. This allows up to eight individual features to be controlled by a single CV and is done to conserve the number of CVs. As the bit variables can take on only one of two values (0 and 1) they are usually used for simple variables that are either On or Off, enabled or disabled or something similar. Unfortunately, bit variables are difficult to represent in any form other than binary and still preserve any meaning. Because most DCC system user interfaces don't use binary representation, these numbers are the most difficult to work with and require a tedious series of additions to convert to the decimal or hex form used by most systems.

We have tried to use the decimal number system in this manual when describing the proper values to program into a given CV; however, you will occasionally find values listed in the Technical Reference in binary, hex and decimal values. Hex numbers can be distinguished from a decimal number by noting a 0x prefix. Thus 0x10 is the hex version of sixteen and not ten as one might guess. Binary numbers are represented using a 'b' suffix. 100b is really the number four and not one hundred. To further assist the math-impaired, we have provided a handy-dandy conversion table in Appendix A that allows one to quickly convert between decimal, hex and binary.

When working with individual bits such as in CV 29, we suggest the following procedure for determining the correct value to program. Referring to the CV description, write down the value desired for each individual bit. Consider for example, the case of CV 29. We would like to set this CV so that speed tables are enabled and the 28 speed-step mode is in effect. Referring to the Technical Reference, we see that bit 4 and bit 1 should be set to 1 and all other bits are cleared to zero. Remembering that we are dealing with binary, write down the individual bit values and we get:

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	0	0	1	0	0	1	0

We then look up the binary value 00010010b in Appendix A and see that it corresponds to the decimal value 18 (0x12 in hex). This is the value to use when programming the CV.



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If you don't have the conversion chart available, you can also calculate the value in the following manner. Reading from right to left, each bit has a decimal value associated with it, beginning with a 1 and doubling this value as you go from bit 0 to bit 7. This value is only counted when the bit is a '1'. Looking at the figure below, you can see that using this method, bit 1 has a value of 2 and bit 4 has a value of 16. Adding these two numbers together gives the correct decimal value of 18.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
	0	0	0	1	0	0	1	0
When bit is set to 1, value =	128	64	32	16	8	4	2	1
Therefore:	0 + 0 + 0 + 16 + 0 + 0 + 2 + 0 = 18							

Programming Methods

There are two methods for changing the sound decoder's CVs:

Service Mode Programming - This programming mode usually requires the locomotive to be placed on a special programming track or connected to a dedicated programmer. Tsunami is an advanced line of decoders and support four types of service mode instructions:

Address Mode - Can change CV 1 (Primary Address) only.

Register Mode - Can change CVs 1,2,3,4,7,8 and 29 only.

Paged Mode - Uses a page register to indirectly modify any CV.

Direct Mode - Can directly change any CV.

Operations Mode Programming - Sometimes called 'Ops Mode' or 'Programming on the Main', this programming mode allows the CVs to be changed while the locomotive is operating on the layout even when other locomotives are present. The neat thing about this mode is that the CVs can be changed in the middle of operation allowing the engineer for example, to increase the momentum rate of a locomotive after it couples to a train. The main disadvantage of operations mode programming is that the CV data cannot be read back to verify its value.

Reading CVs

Certain command stations also allow you to read a CV during Service Mode Programming, which is useful to verify its current setting. If you have trouble reading or verifying CVs, the problem may be due to the design of your command station and not the DSD itself. Tsunami and all other decoders communicate back to the command station using what's called an acknowledgment pulse, which is defined in NMRA RP-9.2.3 as "an increased load on the programming track of at least 60mA for at least 5ms." Like most decoders, the DSD generates the acknowledgment pulse by momentarily applying power to the motor. You can often visually verify that the Tsunami is properly responding to your programmer by observing a slight twitch in the



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motor shaft when a read or write command is given.

If your DSD is otherwise working properly (i.e., responds properly on the mainline to speed and direction commands) but your command station is having troubles reading CV data from the DSD, it may be due to incompatibilities between the electrical requirements of the DSD (which are different from conventional decoders due to the added audio circuitry) and the electrical characteristics of your programming track. In such an event, we suggest you simply go ahead and program the data into the CVs anyway. Usually the DSD will accept the data and function properly when placed back on the main track.

Another option is to use a Programming Track Booster, such as SoundTraxx PTB-100 (P.N. 829002). The PTB-100 amplifies the programming track signals to levels that work best with Tsunami. It is easy to install (see below) and inexpensive. An advantage to using the PTB-100 is that it also provides short circuit detection and some helpful diagnostics. It works well with all other SoundTraxx decoders, too.

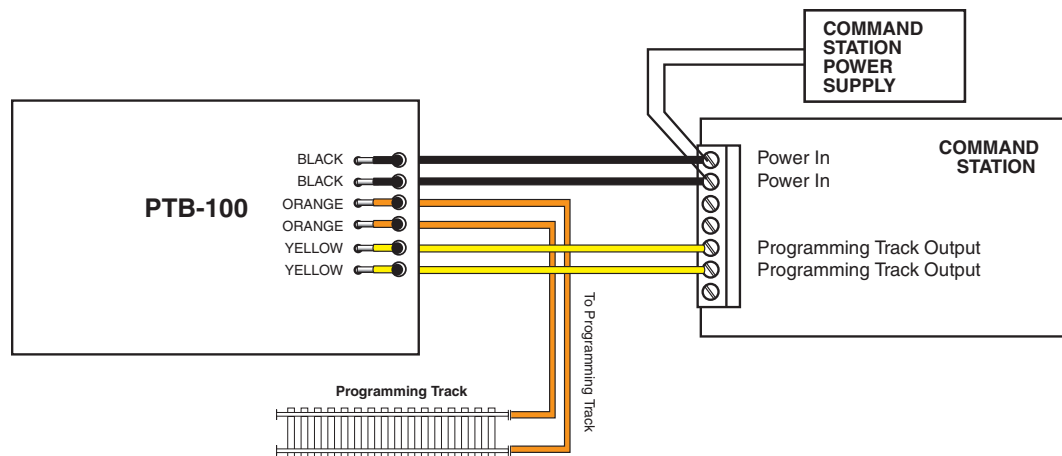


Figure 1 - General Wiring Diagram for the SoundTraxx PTB-100

Finally, if you continue to experience difficulties, try a different programming mode. If your system supports it, the best way to program the CVs is Operations Mode, as it allows you to immediately see or hear the results of your changes. It is important, however, to realize that not all programming modes will program all CVs. Additionally, the specific programming mode you use will depend upon the type of DCC system you are using. Some of the newer DCC systems can automatically select the proper programming mode so all you need to do is specify the CV number and its new value. On the other hand, some systems support only a few of the programming modes and may restrict which CVs you can program. If in doubt, refer to your DCC system's manual or contact the manufacturer to determine which methods they support.



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Programming Procedure

As each DCC system is different, the procedure for programming a CV will vary depending upon the system. Unfortunately, we cannot provide detailed instructions to cover every command station and have to assume that you have some level of understanding regarding it's capabilities and operating procedures. For specific programming procedures, please consult your DCC system manual.


Locking and Unlocking CVs

The CV Lock/Unlock is a relatively new feature available in some DCC decoders which allows you to program a decoder without the danger of overwriting the programming in another. This especially useful in installations where multiple decoders are used. For example, if you have installed a function decoder in addition to the sound decoder, you may wish to lock the CVs after programming to prevent accidentally programming one or the other.

To use the CV Lock feature implemented in CV 15 and 16, Bit 0 of CV 30 must first be set to 1 (the default value is 0). This is to avoid inadvertently locking the decoder when the CV Lock feature is not needed.

CV 15 and 16 are used for locking and unlocking the decoder. CV 15 is the Unlock Code and may be programmed to any value between 0 and 255 regardless of whether the decoder is locked or unlocked. CV 16 is the Lock Code and may be set to any value between 0 and 7 but only when the decoder is unlocked. Attempts to program CV 16 with a value greater than 7 will be ignored.

The decoder is unlocked when the value in CV 15 matches the value in CV 16. Otherwise the decoder is locked and can not be programmed in either operations mode or service mode. Further, a locked decoder can not be reset to its factory defaults until it is first unlocked. Tsunami decoders are shipped from the factory with all CVs unlocked, that is, CV 15 and 16 are both set to 0.

 Note that if the decoder is unlocked, changing the value in CV 16 will instantly lock the decoder. You must then set CV 15 to the same value as was just programmed into CV 16 to unlock the decoder again.

If you decide to use the CV Locking feature for a multi-decoder installation, each decoder installed inside that locomotive must first have its Lock Code in CV 16 set prior to installation of any other decoders. Otherwise, all the decoders will have the same Lock Code and the feature will not work. The easiest way to go about this is to first install one decoder and program its Lock Code. Then install the next decoder and program its Lock Code. Since the first decoder is now locked it will be unaffected by the programming of the second decoder (unless you accidentally set the Lock Code of the two decoders to the same value. If this happens you will need to disconnect one decoder and start over). Continue in this manner until all decoders have been installed and their Lock Codes have been set.



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It is a good idea to set up a standardized system so you don't forget the Lock Code settings. You might, for example, set all motor decoders to a CV Lock Value of 1, sound decoders to a value of 2 and function decoders to a value of 3. Keeping CV 15 set to 0 will guarantee the decoder stays locked until you are ready to begin programming.

Example: Let's say you will be installing motor decoder, a sound decoder and a function decoder in one locomotive. Using the previously described system, you would first install the motor decoder and set its Lock Code by programming CV 16 to 1. Since CV 15 is currently set to 0 (the default value), the decoder is immediately locked. Now install the sound decoder and set its Lock Code by programming CV 16 to 2. Since CV 15 is still set to 0, this decoder is also immediately locked. Now install the function decoder and set its Lock Code by programming CV 16 to 3. At this point, all three decoders are installed and locked. Starting with the motor decoder, set CV 15 (the Unlock Code) to 1 to unlock and program the motor decoder. When you are finished set CV 15 to 2 and program the sound decoder. Finally, set CV 15 to 3 and program the function decoder. When you are done, set CV 15 back to 0 to lock all the decoders.

If You Forget the Lock Code

As there are only eight possible combinations, you can easily determine a forgotten Lock Code setting using trial and error with the following procedure:

Place the locomotive on the Programming Track and set CV 15 to 0. Then try to read the value in CV 16. If CV 16 does not read back, the decoder is locked. Set CV 15 to 1 and try reading CV 16 once more. Again, if CV 16 does not read back, the decoder is still locked. Program CV 15 to 2 and try reading CV 16 again. Continuing in the manner, you should eventually find the value stored in CV 16 as it can only be programmed between 0 and 7. If you have tried setting CV 15 to all eight values between 0 and 7 and the decoder still does not respond, there may be a problem with the installation, the program track or the decoder itself and further investigation will be required.

If you do not have access to a programming track with read-back capabilities (or are uncertain as to whether it is working properly) you can also use operations mode to discover the Lock Code by alternately programming CV 15 and setting another CV to a value where there is a known response. For example, changing CV 128, the master volume control, will provide auditory feedback as to whether the decoder is unlocked by virtue of a change in sound level. Thus, you would begin by setting CV 15 to 0 and then setting CV 128 to 0. If the volume does not fall to zero, the decoder is locked. Then set CV 15 to 1 and try programming CV 128 again. Repeat this process until you find a value for CV 15 that results in a change in sound volume as you change CV 128.

Troubleshooting Tip

Be aware that even if you are not planning to use the CV Lock feature, it can still be accidentally activated by inadvertently programming CV 15 or 16 with a non-default value. If you have a decoder that is otherwise working



Basics of Programming

(i.e., making sound and responding to throttle function commands) but has suddenly stopped accepting CV changes, then first run through the procedure under *"If you Forget the Lock Code"* to determine if the decoder has been locked.

Resetting the CVs or Starting Over

Occasionally, something goes wrong and Tsunami will not respond as expected. Usually, this is caused by one or more CVs being programmed to the wrong value. The CVs can be quickly reset to their factory default values using the following procedure.

1. Program CV 30 to 2 (or CV 8 to 8) using either Service Mode or Operations Mode
2. Place locomotive on a powered section of track. If locomotive is already on the mainline, cycle power to the decoder by turning power to the track off and then back on.
3. After power is restored to the track there should be no indication of activity. If sound comes on immediately upon restoring power, the decoder did not reset. Repeat steps 1 and 2.
4. Once the six-second period has elapsed, the sound should come on and the headlight and backup light will blink 16 times indicating that the CVs were successfully reset.
5. Tsunami should now respond to short address 3 just as it did when it was first unpacked.
6. If you cannot get the decoder to reset, check to see that it has not been inadvertently locked (see *"If You Forget the Lock Code"* in the previous section).



Basic Programming

Step 1: Configuring the Address

The first group of CVs you will want to change are those that set Tsunami's address:

CV 1, Primary Address
CV 17:18, Extended Address

Tsunami may be set up to recognize either the primary address (also called the short address), which provides a range of 1 to 127 or the extended (long) address, which has a range of 1 to 9999! Whether you use the primary or extended address will first depend on whether or not your DCC system uses extended addressing (not all of them do - if in doubt, see your command station owner's manual.) Second, it will depend on your preferences and the numbering scheme you use for setting your decoder addresses. The extended address has the advantage that you can use all four digits of a locomotive's road number for the decoder address making it easy to remember. Be aware that some DCC systems do not support the full range of available addresses.

Primary Address

To use the primary address, simply set CV 1 to the desired address between 1 and 127.

Programming Notes: Both the primary and extended address may be changed at any time using service mode.

Some DCC systems will also allow the decoder address to be modified using operations mode programming (consult your system manual for details). Please note that when programming in operations mode, the following restrictions apply:

If the decoder's primary address is enabled (i.e., CV 29, bit 5 is 0), only the extended address may be changed using operations mode programming.

If the decoder's extended address is enabled (i.e., CV 29, bit 5 is 1), only the primary address may be changed using operations mode programming.

Extended Address

The extended address is actually made up of two CVs, 17 and 18. Unless you are an experienced user, you should not try to program these CVs individually as a specific protocol is required in order for the DSD to accept the new data (See the Technical Reference for details). Since most command stations that support extended addressing will automatically generate the correct protocol, simply follow their instructions for setting the extended address.



Basic Programming

Once the extended address is stored in CV 17 and 18, bit 5 of CV 29 must be set to 1 so the decoder will recognize the extended address format. Otherwise, the decoder will continue to respond only to its primary address. See the next section, Configuring the Decoder.



Basic Programming

Step 2: Configuring the Decoder

The next CV you will want to change is **CV 29, Decoder Configuration Byte**. CV 29 is one of those complicated bit variables mentioned earlier and is used in conjunction with other CVs to set a multitude of decoder characteristics including Locomotive Direction, Speed Step Mode Selection, Speed Table Enable and Alternate Power Mode Enable.

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

Locomotive Direction - Causes the decoder to invert direction commands so that the locomotive runs in reverse when it receives a command to move forward and vice-versa. This operating mode is most useful for setting up diesel engines that ran with the long hood section forward. However, it is also useful for electronically correcting installations where the motor wires were accidentally reversed and avoids tearing apart the locomotive a second time.

Speed Step Mode Selection - As it is a digital system, Tsunami splits the throttle voltage over its minimum and maximum range into discrete speed steps. Tsunami can be configured so there are 14, 28 or 128 individual speed steps. The largest number of steps will give the smoothest throttle response. Since not all DCC systems have the ability to control 28 or 128 speed steps, your choice will depend upon the technical capabilities of your command station.

Speed Table - Sets the decoder to use the speed table specified by CV 25 (see “Configuring the Throttle”).

Primary or Extended Address - Sets the decoder to recognize its primary address in CV 1 or extended address in CV 17:18 (see “Configuring the Address”).

Alternate (Analog) Power Mode - Enables the decoder to work with an alternate power mode (such as DC operation) as set by CV 12 when a DCC signal is not present.

To assist the novice user, we have created Table A on the next page that lists the correct value for CV 29 to get the desired operating modes.

To use the table, simply find the row that has the modes you want and program CV 29 with the listed value.

The advanced user should refer to the Technical Reference for more details. Remember, table values are in decimal. If your command station uses Hex (Hexadecimal), you will need to convert the value shown using Appendix A.



Basic Programming

Table A. Quick-Reference Table for CV 29 Values

Address Type	Use Speed Tables?	Analog Mode?	Speed Steps	Locomotive Direction	CV 29 Value
Primary (CV1)	No	No	14	Normal	0
Primary (CV1)	No	No	14	Reversed	1
Primary (CV1)	No	No	28/128	Normal	2
Primary (CV1)	No	No	28/128	Reversed	3
Primary (CV1)	No	Yes	14	Normal	4
Primary (CV1)	No	Yes	14	Reversed	5
Primary (CV1)	No	Yes	28/128	Normal	6
Primary (CV1)	No	Yes	28/128	Reversed	7
Primary (CV1)	Yes	No	14	Normal	16
Primary (CV1)	Yes	No	14	Reversed	17
Primary (CV1)	Yes	No	28/128	Normal	18
Primary (CV1)	Yes	No	28/128	Reversed	19
Primary (CV1)	Yes	Yes	14	Normal	20
Primary (CV1)	Yes	Yes	14	Reversed	21
Primary (CV1)	Yes	Yes	28/128	Normal	22
Primary (CV1)	Yes	Yes	28/128	Reversed	23
Extended (CV17:18)	No	No	14	Normal	32
Extended (CV17:18)	No	No	14	Reversed	33
Extended (CV17:18)	No	No	28/128	Normal	34
Extended (CV17:18)	No	No	28/128	Reversed	35
Extended (CV17:18)	No	Yes	14	Normal	36
Extended (CV17:18)	No	Yes	14	Reversed	37
Extended (CV17:18)	No	Yes	28/128	Normal	38
Extended (CV17:18)	No	Yes	28/128	Reversed	39
Extended (CV17:18)	Yes	No	14	Normal	48
Extended (CV17:18)	Yes	No	14	Reversed	49
Extended (CV17:18)	Yes	No	28/128	Normal	50
Extended (CV17:18)	Yes	No	28/128	Reversed	51
Extended (CV17:18)	Yes	Yes	14	Normal	52
Extended (CV17:18)	Yes	Yes	14	Reversed	53
Extended (CV17:18)	Yes	Yes	28/128	Normal	54
Extended (CV17:18)	Yes	Yes	28/128	Reversed	55



Basic Programming

Step 3: Configuring the Throttle

There are seven CVs that characterize the Tsunami's throttle response and 28 more used to create a custom speed table:

- CV 2, VStart
- CV 3, Acceleration Rate
- CV 4, Braking Rate
- CV 25, Speed Table Select
- CV 29, Configuration Data
- CV 66, Forward Trim
- CV 95, Reverse Trim
- CV 67-94, Loadable Speed Table

This may sound like a lot of CVs but don't worry; it's not necessary to change all of them if you don't want to. We've already talked about speed step selection in CV 29 (Step 2).

Set the Start Voltage

Tsunami provides CV 2, Vstart, to set the starting voltage that is applied to the motor at Speed Step 1 and is used to compensate for inefficiencies in the locomotive's motor and driveline. CV 2 may be programmed with any value between 0 and 255 with each step in value being about 0.5% of the maximum available motor voltage. To calculate the value of CV 2, you can use the formula:

$$\text{CV 2} = 255 \times \frac{\text{Desired Starting Voltage}}{\text{Maximum Motor Voltage}}$$

If your DCC system supports Operations Mode Programming, an alternative method for setting Vstart is to turn your throttle to the first speed step and then use the operations mode programming feature to increase the value in CV 2 until the locomotive just begins to move.

Set the Acceleration and Braking Rates

Tsunami provides two CVs to simulate the momentum due to train weight. CV 3, Acceleration Rate, controls how fast the locomotive responds to increases in throttle settings and CV 4, Braking Rate, controls how fast the locomotive will respond to decreases in the throttle setting.

Both CVs can be programmed with any value between 0 and 255 with 255 corresponding to the slowest acceleration or braking rate. Lower settings yield a more responsive locomotive, which is useful for switching. When both CVs are set to 0, the locomotive will respond nearly instantly to any throttle changes. A setting of 255, on the other hand, will require several minutes for a locomotive to reach full speed from a standing stop!

Tsunami's Dynamic Digital Exhaust feature will be more dramatic if you use



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larger values for these CVs; we therefore suggest setting CV 3 and CV 4 to a minimum value of 16 or higher.

If you are using 14 or 28 Speed Step modes, setting CV 3 and CV 4 to any value greater than 0 will also improve the Tsunami's throttle response. While it is accelerating or braking, Tsunami interpolates between speed steps so in effect, your locomotive will respond as if it were being controlled with 128 speed steps. No more sudden lurching from one speed step to another!

Select the Speed Table

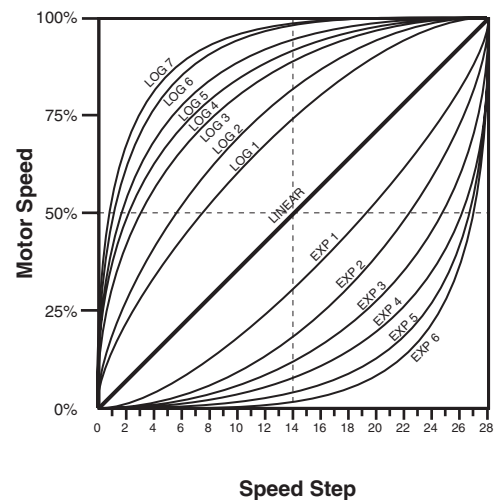
Tsunami provides 14 preset and one loadable speed table that can be used for several purposes:

1. Matching the Auto Exhaust chuffing rate to locomotive speed.
2. Speed matching one locomotive to another.
3. Changing the feel of the throttle. For example, you could configure a switching locomotive so there are more speed steps available at lower speeds for switching and fewer steps at high speeds where the locomotive is seldom operated.
4. Compensating for an improperly designed driveline so the locomotive will operate within its prototypical speed range.

Preset Speed Tables

CV 25, Speed Table Select, is used to select which speed curve will be used by the DSD. CV 25 may be programmed with any value between 2 and 15 to select one of the preset speed curves shown in Table B, below.

CV 25	Speed Curve Type
2	Straight Line
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 Loadable Speed Table





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The exact throttle response for each curve is shown graphically. The logarithmic curve provides a rapid throttle response at low speeds, while the exponential curve provides a rapid throttle response at higher speeds.

In order for the speed table selection in CV 25 to take effect, bit 4 of CV 29 must be set to 1. Refer to the previous section “Configuring the Decoder” or the Technical Reference to determine the correct value for CV 29.

Set the User Loadable Speed Curve

The User Loadable Speed Table allows you to create virtually any throttle response curve you can imagine. You will first need to design and program the Loadable Speed Table. The Loadable Speed Table consists of 28 data points contained in CVs 67 through 94, each defining the percentage of motor voltage applied at a given speed step. Each data point can contain a value of 0 to 255 corresponding to 0 to 100% of available motor voltage.

In 28 speed-step mode, each data point directly corresponds to a speed step. In 128 speed-step mode, each data point corresponds to every four and a half speed steps. The motor voltage for intermediate steps is interpolated by Tsunami to produce a smooth curve. In 14 speed-step mode, alternate (odd numbered) data points correspond to speed steps 1-14. Important: all 28 data points must be programmed even for 14 speed-step mode or an unpredictable throttle response may occur while accelerating or braking.

To create a speed curve, begin by assuming that Tsunami will be operated in 28-speed step mode. Don't worry if you are using another mode - Tsunami will automatically take care of the translation between modes.

1. Start by making a table containing 28 entries - one entry for each speed step.
2. For each entry, record the desired throttle response as a percentage of full speed, i.e., 0 to 100%.

CV#	Speed Step	% Full Speed	CV Value
67	1	4	9
68	2	7	18
69	3	11	27
70	4	14	36
71	5	18	45
72	6	22	55
73	7	25	64
74	8	39	73
75	9	32	82
76	10	36	91
77	11	39	100
78	12	43	109
79	13	46	118
80	14	50	127
81	15	54	137
82	16	57	146
83	17	61	155
84	18	64	164
85	19	67	173
86	20	71	182
87	21	75	191
88	22	78	200
89	23	82	209
90	24	86	219
91	25	89	228
92	26	93	237
93	27	96	246
94	28	100	255



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3. Compute and record the CV value for each step using the following formula:

$$\text{CV Value} = 255 \times \frac{\text{Percentage of Full Speed (from Step 2)}}{100}$$

4. Program CV 67 with the value computed in step 3 for the first data entry (Speed Step 1).
5. Program CV 68 with the value computed in step 3 for the second data entry (Speed Step 2).
6. Repeat step 5 for each of the remaining 26 CVs from CV 69 to CV 94 until they have been programmed with their respective values.
7. Set CV 25 to 16 to select the user loadable speed table.
8. Set bit 4 of CV 29 to 1 to enable speed table use. Refer back to the previous section “Configuring the Decoder” to determine the correct value for CV 29.

Table C may be followed as an example and lists the CV values for a straight-line response.

Adjust the Forward and Reverse Trim

Tsunami provides two CVs for adjusting or ‘trimming’ the forward and reverse speeds.

CV 66, Forward Trim
CV 95, Reverse Trim

These CVs multiply all data points in the speed tables by a factor of $n/128$ (n is the CV value) allowing the overall speed curve to be adjusted up or down without reloading all 28 data points again. These CVs will not have any effect when the speed tables are disabled (i.e., CV 29, bit 4 = 0)

These CVs may contain any value between 0 and 255. Trim values between 129 and 255 will increase speed curve values between 100% and 200% in approximately 1% steps. Trim values between 1 and 127 will decrease speed curve values between 1% and 99%. A value of 128 yields a scaling factor of 1.0 and has no effect on the speed curve.

Using different values for the forward and reverse trim will yield different forward and reverse speeds.



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Step 4: Configuring for Consist Operation

The DSD supports advanced consist operations, which use five related CVs:

- CV 19, Consist Address
- CV 21, Consist Function Control 1
- CV 22, Consist Function Control 2
- CV 23, Consist Acceleration Rate
- CV 24, Consist Braking Rate

Consists Explained

A consist is a group of locomotives that are set up to respond to throttle commands as a single unit. Consists make it easy for one operator to run a double headed steam train or a multi-unit diesel lash-up for example. The consist CVs allow the DSD to recognize a new address assigned to the consist without changing its primary or extended addresses. Additionally, they allow each locomotive in the consist to be run as a single unit but with different function properties allowing for example, only the horn to blow on the lead engine.

Consist Address

Each locomotive in the consist is assigned the same consist address by programming CV 19 with the consist address between 1 and 127. If a locomotive is facing backwards in the consist (common in diesel operations), it should be programmed with the same consist address plus 128. If the forward facing locomotives are set to consist address 60 for example, the backwards engine must be set to $60+128 = 188$. Failure to do this will turn the consist into an angry pushme-pullyou as all locomotives will try to move forward from the perspective of their own cab and a few pulled couplers might result!

To deactivate the consist address and restore normal operation, CV 19 must be reprogrammed to 0.

Note that when the consist address is set, the DSD will continue to respond to instructions sent to its primary or extended address except for speed and direction data.

The DSD will not respond to operations mode programming commands sent to its consist address. These commands must always be used with the primary or extended address.

Consist Function Enable

CV 21 and 22 allow you to define how each engine individually responds to function commands sent to the consist address. When the consist is enabled, CV 21 controls which of functions 1-8 are active and CV 22 controls the F0 function for forward (F0(f)) and reverse (F0(r)), as well as functions 9-12.



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CV 21 and 22 take effect only when the consist address is set. When function commands are used with the DSD's primary or extended address, all functions will continue to work regardless of the settings of CV 21 and 22.

Use Table D to calculate the correct value for CV 21, and Table E to calculate the correct value for CV 22. Begin by looking at Table D and determining which functions you want active in the consist and circle the number below it. When you are done, add up all the circled numbers in the row and program the total into CV 21.

Table D. Consist Function Control 1								
CV#	F1	F2	F3	F4	F5	F6	F7	F8
21	1	2	4	8	16	32	64	128

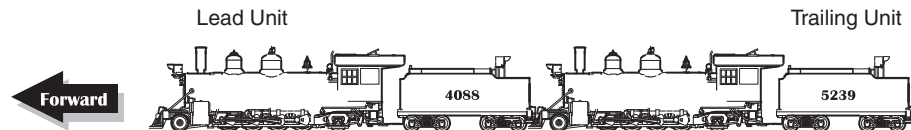
Now look at Table E and do the same: add up all the circled numbers in the row and program CV 22 with the sum.

Table E. Consist Function Control 2						
CV#	F0(f)	F0(r)	F9	F10	F11	F12
22	1	2	4	8	16	32

Note that each DSD in the consist will require a different set of values for CV 21 and 22 depending upon your requirements.

Consist Example:

Consider a double-header consisting of two engines, #4088 and #5239. Let's suppose we wish to operate these two engines as a single unit with consist address 40.



Engine Address	4088	5239
Direction	Normal	Normal
CV 19 (Consist Address)	40	40
CV 21	135	128
CV 22	17	18

You might want the audio mute (F8) function to work on both engines. However, you will likely want the headlight (F0(f)), whistle (F2) short whistle (F3) and bell (F1) to only work on the lead engine, #4088, and the backup light (F0 (r)) to work only on #5239.



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Engine 4088.

This is the lead engine. Program CV 19 to 40, the new consist address. Using Table D, program CV 21 with the sum of the value corresponding to F1, F2, F3 and F8:

$$\text{CV 21} = 1 + 2 + 4 + 128 = 135$$

Then using Table E, determine the value for CV 22:

$$\text{CV 22} = 1$$

Engine 5239.

Program CV 19 with the new consist address, 40. As this engine will only have the reverse light and mute functions active, different values are required for CV 21 and 22. Using Table D, program CV 21 with the value corresponding to F8:

$$\text{CV 21} = 128$$

Then using Table E, determine the value for CV 22:

$$\text{CV 22} = 2$$

Consist Inertia Control

CVs 23 and 24 can be used to increase or decrease the locomotive's acceleration and braking response whenever it is part of a consist (i.e., CV 19 is programmed with a valid address).

CV 23 controls the consist acceleration rate and CV 24 controls the consist braking rate. When the consist address is active a new acceleration rate is calculated by adding the value in CV 23 to the baseline acceleration rate in CV 3. Similarly, a new braking rate is calculated by adding CV 24 to the baseline braking rate in CV 4. When the consist address is set to 0, CV 23 and 24 have no effect.

Both CV 23 and 24 may be set to any value between -127 and +127. A positive value will produce a slower throttle response while a negative value will result in a quicker throttle response.

If the sum of consist and baseline rate exceeds 255, then the final rate is set to the maximum value of 255. If the sum of consist and baseline rate is negative, then the final rate is set to the minimum value of 0.

To set a positive value, simply program the CV with the desired number between 0 and 127. To set a negative value, first change the sign of the value back to positive and then add 128. Thus, to set -5, program the CV with $5 + 128 = 133$. Note that a setting of 128 is the same as 0 and has no effect.



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Step 5: Function Mapping

Function Mapping Explained

Function mapping allows the DSD to be reconfigured so that sound effects and function outputs can respond to a different function key input. This is especially useful for users who have throttles with less than thirteen function keys as now they can pick and choose what effects they can control instead of being restricted to an arbitrary assignment.

There are 14 function mapping CVs - twelve CVs, 35-46 are used to assign output control to function keys 1 through 12 respectively.

The other two CVs, 33 and 34 are both for the F0 function. CV 33 controls which outputs are on when F0 is on and the locomotive is moving forward. CV 34 controls which outputs are on when F0 is on and the locomotive is moving in reverse. If the same output is selected in both CV 33 and CV 34, that function will turn on when the F0 function is on regardless of locomotive direction.

Not all keys can control all outputs or effects. The table below shows which functions can be mapped to which outputs. Note that a function key can be set up to control more than one output.

Function Key	Control CV	HL	BL	WH	BEL	Not Used	Not Used	DYN	SHW	STM	WS	DIM	MUT	Not Used	BRK	CPL
F0 (f)	33	1	2	4	8	16	32	64	128							
F0 (r)	34	1	2	4	8	16	32	64	128							
F1	35	1	2	4	8	16	32	64	128							
F2	36	1	2	4	8	16	32	64	128							
F3	37				1	2	4	8	16	32	64	128				
F4	38				1	2	4	8	16	32	64	128				
F5	39				1	2	4	8	16	32	64	128				
F6	40				1	2	4	8	16	32	64	128				
F7	41							1	2	4	8	16	32	64	128	
F8	42							1	2	4	8	16	32	64	128	
F9	43							1	2	4	8	16	32	64	128	
F10	44								1	2	4	8	16	32	64	128
F11	45								1	2	4	8	16	32	64	128
F12	46								1	2	4	8	16	32	64	128

Bold Numbers indicate default settings.



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An output can be also be controlled by more than one function key. In the second case, if an output is mapped to two function keys, either key will turn that output on, however, the output will not turn off until both function keys have been turned off.

To determine the correct CV value,

1. Find the column in the Function-Mapping Table corresponding to the function or sound effect output you wish to control.
2. Next locate the row corresponding to the function key you wish to use for controlling the selected output.
3. Note the number located in the box at the intersection of the row and column you have selected.
4. Program the CV listed in the row chosen in step 2 with the value found in step 3.

Example, Swapping the Bell and Short Whistle functions:

Some DCC systems label Function 3 on their cab as the Bell control. However, Tsunami's default Bell control is Function 1. Fortunately, we can use function mapping to re-assign the controls so that the label on the cab matches the utility in the decoder. Since F3 controls the Short Whistle, we will simply swap it with F1 as follows:

Using Table F, we first re-assign Function 3 to the Bell. First, find the column corresponding to the Bell. Then find the row for Function 3. Note the value, 1, found in the box intersected by the row and column. Finally, program this value into the CV controlling Function 3, in this case CV 37.

Next, re-assign Function 1 to the Short Whistle following the same procedure. Locate the column corresponding to the Short Whistle. Then find the row for Function 1. Note the value, 128, found in the box intersected by the row and column and program this value into CV 35, the CV controlling Function 1.

Function Swapping

The functionality of F5 through F8 can be swapped with F9 through F12 by setting CV 30 to 4. This is the default setup as it provides best compatibility with 8 function cabs or controllers. When CV 30 is set to 4, the mapping of a swapped function is programmed using the CV corresponding to the original function. In other words, to remap F5 when function swapping is active, you must set the CV for F9 (i.e. CV 43).



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Step 6: Configuring the Lighting Outputs

Tsunami has two function outputs used for controlling the locomotive lights.

Each can be set for a variety of effects or as simple on/off lights. In addition, you can use the Grade Crossing Logic to automatically activate the selected lighting effect when you blow the whistle.

Tsunami provides six CVs for customizing the lighting effects:

- CV 49, Headlight Configuration
- CV 50, Backup Light Configuration
- CV 59, Lighting Effect Flash Rate
- CV 60, Grade Crossing Effect Hold Time.

Setting the Hyperlight Effects

Each lighting output has a corresponding CV that determines its operating characteristics:

Bit 7	Bit 0			
LED	R17	XING	PHSE	HYPERLIGHT SELECTION

Hyperlight Select - Each output can be programmed to one of several Hyperlight™ Lighting Effects as listed in Table G. Most effects are self-descriptive and primarily warning beacons used for diesel locomotives. Some effects, such as the Mars Light, were used in some steam engines as well.

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.

Mars Light - This effect simulates the sweeping figure-8 pattern of this popular warning beacon.

Pyle National Gyalite - The Gyalite is similar to the Mars Light, but generates a slow, wide, oval headlight sweep pattern.

Dual Oscillating Headlights - Similar in appearance to the common twin-sealed-beam headlight, the oscillating headlight uses a moving reflector to sweep the headlight beam in a tight circular motion.

Single and Dual Strobes - The Strobe effects simulate the white-hot burst of light associated with the Xenon Strobe.

Western-Cullen D312 Rotary Beacon - This effect provides a spectacular rendition of the revolving reflector and bulb assembly of the prototype



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warning beacon found atop many diesels of the 60's and 70's.

Prime Stratolite - The Stratolite was a newer version of the rotary beacon, with the prototype consisting of a revolving reflector with four individual lamps arranged in a circular pattern which are electronically flashed in a clockwise sequence. The Stratolite flashes in a rather mechanical 'stepped' fashion, as opposed to the smooth motion of the Rotary Beacon.

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.

Exhaust Flicker - This effect produces a random flicker whose intensity increases with locomotive speed. This effect is best used by placing a red/orange LED in the firebox or in the smokestack. As the locomotive increases speed, it will glow brighter, imitating an increase in sparks and exhaust gases.

Firebox Flicker - This effect produces a random flicker whose intensity resembles a burning fire and can be used with a lamp placed in the firebox area. The effect is improved when two lights are used, one yellow and one red or orange and each connected to a separate function output.

Smart Firebox Flicker - This effect produces a random flicker whose intensity is synchronized with the sound of Fireman Fred shoveling coal. Whenever Fred 'opens' the firebox door and begins shoveling, the lighting effect increases in brightness and then returns to a subdued level when the firebox doors are 'closed'.

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.

Phase Select - 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.

Grade Crossing Logic - Causes the lighting effect to become active only when the whistle 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, Dyno-Light, FRED, exhaust flicker, and firebox flicker effects will not be affected. The other effects will either turn off (stobes and beacons) or revert to a steady on state (mars light, ditch lights, etc.) as appropriate to prototype practice.

Rule 17 Headlight Operation - Converts the headlight and backup light to independent, non-directional functions. When enabled, the headlight is



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controlled as if it were FX5, Function 5 and the backup light as FX6, Function 6.

LED Compensation Mode - Tsunami's lighting effects can be used with either incandescent bulbs or LEDs. However, because of their differences in brightness characteristics, some lighting effects will appear less life-like when initially set up with an LED. To correct this, Tsunami's LED compensation mode should be enabled which will improve the contrast of the lighting effect by automatically adjusting the function output level to correct for the different brightness characteristics of an LED.

To set the Hyperlight configuration CVs, proceed as follows:

1. First find the CV value in Table G on the next page for the desired lighting effect and operating mode.
2. If you wish to enable Rule 17 Mode, add 64 to the table value shown, otherwise, proceed to Step 3.
3. If you're using incandescent bulbs, skip to Step 4. If you are using LEDs, enable the LED Compensation Mode by adding 128 to the sum computed in Step 2.
4. Program the sum computed in Step 3 into the CV corresponding to the appropriate function output. Use CV 49 to set the headlight and CV 50 for the backup light.

Setting the Flash Rate and Hold Time

CV 59 is used to adjust the flash rate of the Hyperlight effect and has a range of 0-15 with 15 being the slowest flash rate. When the Grade Crossing Logic feature is enabled, CV 60 is used to adjust the length of time (in seconds) an effect will remain active after the whistle key is released. CV 60 can be programmed with any value between 0 and 15.

Example, Mars Light with Grade Crossing Logic

In this example, we will configure the headlight output for use with an incandescent bulb as a Mars Light with Grade Crossing Logic enabled. Following the steps outlined above, we proceed as follows:

1. We first look up the initial CV value in Table G for a Mars Light under the column labeled 'Crossing Logic On' and find it is 34 for Phase A and 50 for Phase B. Since we are only setting up one light, we do not care about the Phase and choose to the value for Phase A, 34.
2. Since we are not using Rule 17, we skip to Step 3.
3. Since we are not using LEDs, we skip to Step 4.
4. CV 49 (Headlight Configuration) is programmed with the value found in Step 1 or 34.

Lastly, we need to set the grade crossing hold time to about six seconds by programming CV 60 to 6.



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Effect Type	CV Value			
	Crossing Logic Off		Crossing Logic On	
	Phase A	Phase B	Phase A	Phase B
On-off	0	16	32	48
Dimmable	1	17	33	49
Mars Light	2	18	34	50
Gyalite	3	19	35	51
Oscillating Headlight	4	20	36	52
Single Flash Strobe	5	21	37	53
Double Flash Strobe	6	22	38	54
D312 Rotary Beacon	7	23	39	55
Prime Stratolite	8	24	40	56
Type I Ditch Light	9	25	41	57
Type II Ditch Light	10	26	42	58
FRED	11	27	43	59
Exhaust Flicker	12	28	44	60
Firebox Flicker	13	29	45	61
Smart Firebox Flicker	14	30	46	62
Dyno-Light	15	31	47	63



Sound Programming

Step 7: Modifying the Sound Effects

One of the great things about Tsunami Digital Sound Decoders is the ability to adjust the various sound effects to suit your ear and respond in the manner that you prefer.

Audio Mixer Controls

The Tsunami sound decoder provides up to 25 independent controls for setting the volume levels of each sound effect much like that of a modern sound studio mixing board. To set the sound level for a particular effect, set the corresponding CV to any value between 0 (zero volume) and 255 (maximum volume).

For the best sound quality, you will want to run the mixer as “hot” as possible (audio jargon for maximizing the volume level). First determine which sound you want to be the loudest (usually the whistle) and set its volume level to around 225. Then adjust all the other sound levels relative to the whistle volume. Finally, use the Master Volume Control, CV 128, to set the overall volume of the decoder to the desired level.

A certain level of prudence is needed when adjusting the mixer levels to avoid a condition known as ‘clipping’ or ‘limiting’ which occurs when the sum of two or more signals exceeds the capacity of the output channel. As its name implies, clipping results in the lopping off of the sound signal peaks and manifests itself as distortion accompanied with a level of clicking or popping sounds.

To avoid a clipping condition, consider which sounds are likely to be played at the same time and take care to ensure that their corresponding mixer levels are not set too high. For example, the whistle and exhaust chuff are usually heard together and you will likely want both to be as loud as possible. Rather than simply crank both sounds up to the maximum level, start with one mixer channel near, but not quite at maximum (this provides a little extra ‘headroom’) and then gradually bring up the second mixer channel setting to the desired level. If you start to hear some distortion, simply back down one mixer channel or the other until the distortion goes away.

Your Tsunami sound decoder has a 96dB dynamic range which is plenty for most audio work and as long as you keep the sound levels balanced in a prototypical fashion, you should have no problems.

Note that the **Primary Mixer CVs** are real time controls, meaning that any changes to their settings will be immediately reflected in the sound level. On the other hand, the **Secondary Mixer** levels are *not* real time. If you change their setting while the respective sound effect is playing, you will not hear a change in volume until the sound is turned off and started again.



Sound Programming

CV 128, Master Volume Control

Primary Audio Mixer CVs are as follows:

- CV 129, Whistle mixer level
- CV 130, Bell mixer level
- CV 131, Exhaust mixer level
- CV 132, Airpump mixer level
- CV 133, Dynamo mixer level
- CV 135, Rod clank mixer level
- CV 136, Steam hiss mixer level

Secondary Mixer CVs:

- CV 137, Coupler Clank mixer level
- CV 139, Brake squeal mixer level
- CV 140, Brake release mixer level
- CV 141, Snifter valve mixer level
- CV 142, Johnson Bar/Power reverse mixer level
- CV 146, Water stop mixer level

Whistle Selection and Control

Tsunami uses three CVs to adjust and control the whistle:

- CV 115, Whistle Select
- CV 129, Whistle Volume
- CV 47, Playable Whistle Control

As set from the factory, Tsunami uses Function F2 to control the primary whistle and Function F3 to control a shorter signal whistle. Each Tsunami decoder comes with up to three whistles pre-installed. To select a particular whistle, simply program CV 115 with any value

between 0 and 7 as indicated in Table H. Refer to the SoundTraxx website for a detailed list of which whistles are contained in your particular decoder.

Whistle Number	CV Value
Whistle 1	0
Whistle 2	1
Whistle 3	2

Whistle Volume

CV 129 sets the whistle volume and may be set between 0 and 255. See Audio Mixer for more details.

Dual Whistle Mode

On occasion, a locomotive was equipped with two different whistles. The Southern Pacific, in particular, was noted for its practice of equipping some locomotives with an air horn. Tsunami has the ability to select between two



Sound Programming

different whistles, if desired, using the Dual Whistle Mode feature. When this mode is enabled, Function F2 continues to work as the primary whistle control. Function F3 becomes the whistle select key. When F3 is OFF, F2 controls Whistle Selection A and when F3 is ON, F2 controls Whistle Selection B. Note that when the dual whistle mode is enabled, the signal (short) whistle is unavailable.

To activate the dual whistle mode, program CV 115 as follows:

1. Select Whistle 'A' and find the corresponding CV Value from Table H.
2. Select Whistle 'B' and find the corresponding CV Value from Table H.
3. Multiply the CV value for Whistle B by 8 and add it to the value for Whistle A.
4. Add 128 to the sum computed in step 3 and program this value into CV 115.

Example:

Let's set up the decoder with Whistle 1 on 'A' and Whistle 3 on 'B'.

1. As noted in Table H Whistle 1 would be selected with a CV setting of 0.
2. Similarly, Whistle 3 is selected with a CV value of 2 as shown in Table H.
3. The CV value from step 2 is multiplied by 8 and added to the CV value from step 1 to get:

$$(2 \times 8) + 0 = 16$$

4. Then 16 is added to 128 to get the final value for CV 115:

$$CV\ 115 = 16 + 128 = 144$$

Playable Whistle

Tsunami has a unique feature called a Playable Whistle which allows you to set the whistle for a pressure or position response to an analog control. This could be a pressure-sensitive key, thumbwheel or some other analog control, depending on your command station.

In some cases, each cab must be individually set up to use this feature; you will need to see the documentation that came with your command station for this information, as well as the value to program into CV 47. The default value for CV 47 is 0, which disables the playable whistle function.

Hint: the effect of the playable whistle is greatly enhanced if you enable the Whistle Reverb by setting CV 161 to 1.

Note: Once you've programmed the decoder to respond to the playable whistle function, if you switch to different cab not programmed in this manner you will find that F2 and F3 will no longer respond.



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Bell Control

By default, Tsunami uses Function F3 to turn the bell on and off. There are two CVs to adjust the bell:



CV 114, Bell Ring Rate
CV 130, Bell Volume

Bell Ring Rate

The bell ring rate may be adjusted over 16 steps to simulate the sound of an air-rung bell or a hand-rung bell by setting CV 114 between 0 and 15. A setting of 0 yields the fastest ring rate (like an air-ringer) while higher values produce increasingly slower ring rates. The default setting for CV 114 is four, but as each Tsunami decoder features a different bell recording you may find that tweaking this value a bit improves the overall sound effect on some models.

Bell Volume

CV 139 sets the bell volume and may be set between 0 and 255. See Audio Mixer for more details.

Exhaust Control

Tsunami provides several CVs for setting up the Steam Exhaust Chuff sound effect:

CV 112 Exhaust Configuration
CV 116 Auto Exhaust Rate
CV 131 Exhaust Volume
CV 135 Side Rod Clank Volume

In addition, there are the Dynamic Digital Exhaust (DDE) CVs covered in a later section.

Auto Exhaust

Tsunami's auto-exhaust feature simply produces an (adjustable) exhaust chuff cadence that is proportional to the locomotive speed. Since there is no mechanical switch to worry about, the installation is much easier and ideal for use in locomotives where space is extremely limited.

Articulated Mode

Tsunami provides an auto-exhaust mode to simulate the cadence of a simple* articulated locomotives. When this mode is enabled, the exhaust sound will have chuff-chuff-pause rhythm simulating two cylinder sets that are out of sync with each other. You can also set a variable wheel slip rate that causes the two sets of exhaust chuffs to go in and out of sync with each other as if one set of drivers were continuously slipping**. It is also useful for generating a double-header sound effect, especially if the second engine is not equipped with a sound system.

Once you have determined which Exhaust Mode you want, use Table L



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to find the proper value to program into CV 112. Note that you will also have to decide on how many airpumps to set (see next section) before finalizing a value for this CV.

Table I. CV 112, Exhaust Mode Selection		
Exhaust Mode	Wheel Slip Rate	CV Value
Conventional Rod Engine	None	0
Articulated Engine	None	64
Articulated Engine	Slow	80
Articulated Engine	Medium	96
Articulated Engine	Fast	112

*Compound articulated engines recycled the steam from one cylinder set, the high-pressure side, into the second cylinder set, the low-pressure side, and thus produce the same exhaust cadence as a simple two-cylinder engine. You can readily identify a compound type engine by the observing that the low-pressure cylinder are substantially larger in diameter than the high-pressure cylinders.

**Technically, this did not likely occur often in prototype practice except perhaps when a train was first started as it would result in rapid wear of the slipping drive wheels but it does make for an interesting sound effect.

CV 116, Auto Exhaust Rate

CV 116 is used to adjust the exhaust chuff rate when using Auto-Exhaust synchronization. Auto-Exhaust automatically generates an exhaust chuff rate proportional to the throttle setting. Since every locomotive is different, CV 116 is used to match up the Auto-Exhaust rate to the locomotive speed and may be loaded with any value between 0 and 255. Higher values will yield higher chuff rates for a given throttle setting. A typical synchronization rate may be computed as:

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

where SPD is the locomotive's top speed in scale miles-per-hour at full throttle and DIA is the locomotive's driver wheel diameter in scale inches, and Gear Ratio is the gear ratio for shays and other geared engines. For conventional steam engines, use a Gear Ratio = 1. The driver diameter can be easily measured with a scale ruler but remember to convert the measurement to scale inches.

If you don't know your locomotive's top speed, you can also estimate it and still get pretty good results. A good rule of thumb is to use 45 MPH for freight locomotives and 70 MPH for passenger engines.

Hints for Setting Engine Exhaust Chuff Rate

Because most locomotives do not respond linearly (i.e., straight line) to the



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throttle settings, it can sometimes be difficult finding the magic auto-exhaust chuff rate setting that works across the locomotive's full speed range. We have two procedures for setting the chuff rate that have worked well. The first method is easy to implement and produces good results that should satisfy all but the stodgiest of nitpickers. The second method takes more effort but produces more accurate results.

Method 1

Begin by setting the starting voltage (CV 2) such that the engine begins to barely move at speed step 1. Then increase the throttle setting until the engine is moving at 10-15 scale MPH. Then adjust CV 116 up or down until the chuff rate corresponds to approximately four chuffs per wheel revolution.

Method 2

This procedure uses the loadable speed curve to compensate for the locomotive's non-linearities. Begin by setting CV 25 = 16, CV 29 = 18 (50 if you are using a long address- see Table A) and CV 116 to the value calculated from the formula above. Set your command station to use 28 speed-step mode. Set the throttle to speed step 1 and adjust the first entry in the speed table, CV 67 until the locomotive speed matches the chuff rate. Increase the throttle to speed step 2 and adjust the second entry in the speed table, CV 68 until the locomotive speed once again matches the chuff rate. Repeat this process until you have adjusted the locomotive speed across all 28 speed steps using CVs 67-94.

Exhaust and Rod Clank Volume Control

CV 131 controls the exhaust chuff volume while CV 135 controls the side rod clank volume. Either CV can be set between 0 and 255. See Audio Mixer for more details. If you are installing the Tsunami in a geared engine, you may wish to disable the rod clank by setting CV 135 down to zero.

If you are using the DDE feature, remember that these CVs set the baseline (i.e., zero-load) volume level so take care not to set either volume level too high or too low as it will limit the range over which the DDE module can make adjustments. For example, if you maximize the exhaust chuff volume with CV 131, the DDE will not be able to increase it further when the engine is subjected to a greater load.

Airpump Control

There is one CV to adjust the Airpump:

CV 132, Airpump Volume

Airpump Volume

CV 132 sets the Airpump volume and may be set between 0 and 255. See Audio Mixer for more details.



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If you are modeling a locomotive that did not have an airpump at all, you can turn the airpump off by setting the volume down to zero.

Dynamo Configuration

The Dynamo volume is set using CV 133 which may be set to any value between 0 and 255 as discussed under Audio Mixer.

By default, Tsunami Steam decoders map the Dynamo sound control to the Headlight and Backup Light functions. See Function Mapping for information on how to change the Dynamo control over to another function. If you prefer to turn the Dynamo off altogether, you must also reconfigure the headlight and backup light to use a different effect (see Lighting Effects) as the Dyno-Light lighting effect will not turn on when the Dynamo sound is disabled.

Using the Quiet Mode

Tsunami's Quiet Mode is used to turn the sound on only after the decoder is placed into service. It will also automatically turn the sound effects off when the decoder is not being used. This is particularly useful when you have a large number of sound equipped engines on your layout and don't wish to have them turn all at once!

To activate the Quiet Mode, simply program CV 113 to any non-zero value between 1 and 255. This value sets the amount of time in tenth second increments, that the decoder will wait before it turns the audio off. Thus, a setting of 120 corresponds to 12.0 seconds.

When the Quiet Mode is active, the decoder will remain quiet when it is first powered up and then automatically turn on the audio whenever it receives a non-zero speed command or any function is turned on (except Mute). It will automatically mute the audio when the locomotive speed is returned to zero, all functions are turned off and the time set in CV 113 has elapsed.

Setting CV 113 to 0 disables this feature and the sounds will turn on immediately when the decoder is powered up and remain turned on for the duration of the operating session.



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Step 8: Configuring the Dynamic Digital Exhaust (DDE)

One of the more exciting features found in Tsunami is the Dynamic Digital Exhaust or DDE. With the DDE properly set up, the timbre and volume of the exhaust chuff as well as the side rod clank will vary in response to changes in the locomotive load. Now, when your locomotive is climbing a steep grade, the exhaust chuff will be deep and powerful only to turn into a soft hissing when drifting downgrade! The DDE is also sensitive to throttle changes much in the same way that an automobile's exhaust note changes when the accelerator pedal is pressed down or let up.

As every locomotive and installation is different, the DDE may not work perfectly straight out of the box even using Tsunami's default settings and some care and patience will be needed on your part to get the desired results. In the text that follows, you will be guided through each of the DDE's features a step at a time such that you should be able to achieve satisfactory results in relatively short order.

Important: The DDE effect will work best when Tsunami is used in conjunction with as large a speaker as possible. Small speakers (especially those under 1" diameter) have a limited bass response and cannot reproduce the low frequency effects the DDE is capable of creating.

DDE Control CVs

The first step is to become acquainted with the DDE CVs. There are 12 of them:

CV 177, DDE Throttle Sensitivity
CV 178, DDE Load Sensitivity

CV 177 is used to set the DDE's sensitivity to changes in the throttle position and CV 178 set the sensitivity to changes in the motor load. Either CV can be set between 0 and 255 with larger numbers equating to a greater sensitivity to a given throttle/load change.

A value of 0 disables the corresponding DDE control input. Setting both CV 177 and 178 to 0 disables the DDE altogether.

Take care to not make the DDE overly sensitive, especially to the motor load signal. Doing so may result in "saturation" of the DDE effect whereby the DDE will simply appear to be unresponsive. This is because even a slight load signal can be amplified to a point that sends the DDE to the extreme end of its settings and thus any additional increase in motor load will have no further effect on the sound.

CV 179, DDE Attack Time Constant
CV 180, DDE Release Time Constant



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The Attack and Release Time Constant CVs determine how quickly the DDE reacts to a change in load or throttle. The Attack CV sets how fast the effect turns on when the load or throttle is increased while the Release CV set how fast the effect turns off when the load/throttle is decreased.

Each CV may be set between 1 and 255 with higher values producing faster response times. Generally, you will want to set CV 179 and 180 to the same value. Be careful not to set these CVs too high as it will allow the DDE to react to even minor changes in load such as occurs when traversing a turnout or slight change in track radius. This can result in rapid or erratic changes of the chuff volume and is quickly solved by lowering the attack and release CV settings.

- CV 181, DDE Exhaust Low Volume Limit
- CV 182, DDE Exhaust High Volume Limit
- CV 183, DDE Side Rod Clank Low Volume Limit
- CV 184, DDE Side Rod Clank High Volume Limit

These four CVs determine how much the exhaust and side rod clank sound volumes will be boosted or cut in response to the motor load and throttle.

Each CV may be set anywhere between 0 and 255. A setting of 0 results in no change to the volume level while a setting of 255 corresponds to roughly a 12dB or 4X increase or decrease in volume level.

It is important to remember that these CVs do not set the actual volume level but rather control the percentage of change. The baseline volume level of exhaust or rod sound effects must still be set with the audio mixer level CVs (CV 131 for exhaust chuff and CV 134 for the rod clank).

Be careful not to set the baseline volume level too high or too low as the DDE cannot increase or decrease the volume beyond its maximum or minimum settings of 0 and 255 regardless of how high you set CV 181 thru 184. In other words, even though the DDE can increase the exhaust volume by up to 4 times (400% or +12dB), if the mixer level is set to 255, no further increase will occur. Similarly, if the mixer is set to 128, then the maximum volume change possible with the DDE is 255/128 or about 199% (+6dB).

- CV 185, DDE Baseline Frequency
- CV 186, DDE Control Gain
- CV 187, DDE Filter Damping

These CVs influence the DDE's ability to modify the exhaust chuff pitch and timbre.

CV 185 sets the baseline or 'no load' timbre of the exhaust chuff and can be set between 1 and 255. Lower values will give the exhaust chuff a 'boomier' sound but only to the extent that your speaker can handle the increased bass levels.

CV 186 determines how much the exhaust chuff pitch/timbre will vary in



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response to a load or throttle change. This CV can be set between 0 and 255 with larger numbers equating to a greater sensitivity to a given change.

CV 187 sets the damping factor of the DDE's filter bank and can be used to modify the exhaust chuff's overall tonal shape. Normally, this CV should be set between 200 and 255. Lower settings may be used but you will find that the exhaust chuff will begin to take on an unpleasant and 'alien' characteristic as the CV value is reduced.

CV 188, DDE Tracking Coefficient

When load compensation is disabled, the DDE senses the load on the motor load by comparing the motor's back-emf signal to a zero-load reference level as set by CV 188. The setting for CV 188 is based on the motor's efficiency level, typically 70% to 80%) and may be calculated as:

$$\text{CV 188} = \text{Motor Efficiency} \times 128$$

Thus, a 75% efficient motor would use a CV setting of:

$$\text{CV 188} = 0.75 \times 128 = 96$$

Determining a motor's efficiency requires instrumentation not available to the average hobbyist so it must be determined via trial and error as will be discussed shortly.

Now that you have some idea of what each of the DDE control CVs does, the next step is get familiar with the range of sounds that are possible by actually trying the DDE out. As the DDE is easier to setup to respond to throttle changes, it is best to start there.

Throttle Controlled DDE

The DDE responds to changes in the throttle by comparing the throttle setting to the current locomotive speed. The greater the difference between the two, the greater the change in the exhaust and side rod sound that will be heard.

When the throttle is increased, the locomotive will begin to accelerate. During this period of acceleration, the exhaust chuff will grow deeper and louder while the rod clank volume will become lower. Likewise, if the throttle is decreased, the locomotive will begin to reduce speed. During this period of braking, the exhaust chuff will drop while the rod clank volume will increase. As the locomotive's speed approaches the throttle set point, the exhaust and rod clank volume will gradually return to their normal values as set by the audio mixer.

For this effect to work, some nominal value must be programmed into the acceleration and braking rate CVs (CV 3 and CV 4). Otherwise, the locomotive speed will quickly follow the throttle setting and the braking and acceleration periods will be so short that the DDE will be unable to work its 'magic'.



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For the purposes of setting up the DDE, we suggest you start with the DDE CVs set to their default values. Set the exhaust (CV 131) and rod clank (CV 135) volume levels to their default values of 128 and 32 respectively. Then set CV 3 and 4 to a value of 40 to enable the momentum. For the time being, disable the DDE by setting CV 177 and CV 178 to zero. **Note:** The value for CV 3 and CV 4 is selected for demonstration purposes only. Once you have the DDE 'tuned up', you can go back and set CV 3 and CV 4 to a lower or higher value as desired.

Next, place your locomotive on a section of track that is sufficiently long enough for it to "stretch its legs" and get up to speed without worry of running into something. If you have them, a set of stationary test track rollers also works well. Crank the throttle up and take note of the exhaust chuff volume and tone.

Bring the engine to a stop and re-enable the DDE by setting CV 177 to 10. Crank the throttle up again this time to a speed step somewhere around 40 or so. Now, as the engine accelerates, the exhaust chuff should have considerably more volume and a deeper tone.

Allow the engine to get up to speed and notice that the exhaust sound gradually returns to its previous level. Then quickly turn the throttle down. You should hear a sudden drop in the exhaust chuff volume along with a reduction in bass level and an increase in the rod clank volume. As the engine slows, the sound levels will gradually return to their normal level. This is the basic Throttle Controlled DDE action. Once you have the DDE responding to the throttle, you can begin experimenting with the various CVs.

Throttle Sensitivity

Try changing CV 177, Throttle Sensitivity to a value of 1 (low sensitivity). Turn up the throttle to speed step 40 and allow the engine to reach 'cruising' speed. You can modulate the exhaust sound volume by turning the throttle up or down but observe that a relatively large throttle change is needed to get a big change in volume. Now set CV 177 to 50 and again, bring the locomotive up to speed. Note that this time, with a high sensitivity setting, only a slight wiggle of the throttle around step 40 is needed to bring about a large change in exhaust volume.

Attack and Release Times

As previously mentioned, CV 179 and CV 180 control how fast the DDE can react to a load or throttle change. Try setting these CVs to 250 for a very fast attack/release time. Set the throttle around 40 and allow the engine to reach speed. Vary the throttle above and below speed step 40 and you will hear the volume levels change almost instantly in response to changes in the throttle setting. Now set CV 179 and 180 to a more moderate value of 5 and try again. This time when the throttle is changed, you should hear the sound transition more gradually from one level to another and very rapid changes of the throttle are almost ignored.

Volume Limits

Hopefully you've noticed that when the engine is accelerating, the exhaust



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volume increases and the rod clank volume decreases. And when the engine is braking, the opposite occurs - the exhaust volume decreases and the rod clank volume increases. You can use CVs 181 thru 184 to limit how much the volume levels will increase or decrease. During acceleration, CV 182 controls the rise in exhaust volume and CV 183 controls the drop of rod clank volume. A value of 255 for either CV produces the maximum amount of volume change. Lower values result in correspondingly smaller levels of change and a value of zero results in no change at all.

When the locomotive is braking, CV 181 determines the reduction of exhaust volume and CV 184 controls the rise of rod clank volume. As with the other two Volume Limit CVs, a value of 255 results in the maximum amount of volume change. Thus, the upper and lower volume limits of a given effect can be independently adjusted. You could for example, set CV 183 and CV 184 to zero so the rod clank volume is always constant. Setting CV 181 to 250 and CV 182 to 64 results in an exhaust sound that increases volume four times under acceleration but only drops 30% during braking. Try experimenting with different settings to see what the results are.

DDE Timbre and Cutoff Control

By changing the value in CV 185, you can change the tone or timbre of the exhaust chuff. A lower CV setting results in a deeper chuff.

Note that the exhaust cutoff automatically increases as the throttle increases. This helps keep the individual exhaust chuffs crisp and distinct as the chuff rate increases. You can control how much change to the basic chuff occurs by varying the setting of CV 186. A low value results in only minimal change and maintains a strong deep chuff regardless of locomotive speed. At higher speeds however, the chuffs may begin run into each other resulting in a strange whirring sound. This can be corrected by programming a higher value into CV 186. In general, the faster you are planning on operating your engine or the higher you have set CV 116 (Auto Exhaust Rate), the higher a setting you will need for CV 186 to maintain the proper exhaust cutoff over the locomotive's speed range. Try setting CV 186 with different values and observe the effect on the exhaust sound over a range of throttle settings. When properly set, you will get a nice clear exhaust bark over the entire speed range of your locomotive starting with a deep "woof-woof-woof" at low speeds that gradually transitions to a light "chi-chi-chi" sound at high speeds.

Load Sensitive DDE

The DDE and its effect on the exhaust sound can also be varied by changes in the locomotive's load such as the number of cars being pulled or the grade being climbed. The DDE accomplishes this by measuring the motor's back-emf voltage which is proportional to the locomotive speed. When the locomotive load increases, the motor speed drops as does the back-emf voltage drops and the DDE interprets this change by increasing the exhaust chuff volume and deepening the exhaust tone. When the load is reduced as might happen when going downhill, the motor speed rises along with the



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back-emf voltage and the DDE lowers the exhaust volume (and raises the side rod clank volume).

Before you can use the Load Sensitive DDE feature, you will need to decide if you are going to use Tsunami's load compensation feature or not (see next section) as the set up procedure is slightly different depending on your choice. On most locomotives, the Load Sensitive DDE effect will be more dramatic when load compensation is disabled. This is because load compensation, by design, keeps the motor speed stable and thus the DDE does not detect much of a load change.

Setting the DDE with Load Compensation On

If you decide to keep the load compensation enabled, then setting up the DDE to react to load changes is mostly a matter of adjusting CV 178, Motor Load Sensitivity. You can demonstrate that the feature is working by setting the throttle to some nominal speed and slowing down the motor by rubbing your finger against the flywheel (or a driver wheel if you can't reach the flywheel). As the motor slows down, you should hear the exhaust chuff deepen and increase in volume. Increasing the setting of CV 178 will make the exhaust sound more sensitive to a given change in the motor load and speed.

You will likely find that in practice, your finger is able to exert a much greater load on the motor than will be experienced when the locomotive is simply running around the layout. This is due in part to the relatively high gear ratios and light weights found in the average model locomotive. On a layout, when too great a load is encountered the locomotive will slow down only slightly and then the wheels will break loose and simply start spinning away. Thus, Tsunami only senses a slight change in the motor load.

This means to get a reaction in the DDE, you will need a relatively high setting for CV 178. As you increase the sensitivity setting, you may also notice the DDE starts to react to minor variations in track or even slight binds in the locomotive mechanism. To counter these effects, you will need to reduce the attack and release time constant settings in CV 179 and 180 which will slow the DDE's reaction time enough to ignore minor 'hiccups' in the motor load.

The following procedure may be helpful in finding the correct DDE settings:

1. Use the throttle Controlled DDE setup described above to find the desired settings for CVs 181-184 and CVs 185-186. Set CV 179 and 180 to about 30 for a relatively quick attack and release time.
2. Set CV 178 to an initial value of 5 and use the 'finger test' to see how the DDE reacts to a large motor load change.
3. Once you are satisfied the DDE is reacting to the motor load, place the locomotive on your layout, connect up a medium size train and drive it around and listen for a response to changes in grade and load. If no response is forthcoming, increase the setting of CV 178 by about 5. Continue to increase CV 178 until you can detect a change in the exhaust sound.



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4. Once you have found a setting for CV 178, adjust CV 179 and 180 to smooth out the change in sound and tone levels if needed. Usually, this means reducing the CV setting.

Setting the DDE with Load Compensation Off

To get the DDE to respond properly when the load compensation is turned off, you must also find the proper setting for CV 188 which sets the reference point for the back emf voltage when no motor load is present.

When properly set, you will get a much wider variation in the exhaust sound, particularly on down-grades. The following procedure may be helpful in finding the correct DDE settings:

1. Use the throttle Controlled DDE setup described above to find the desired settings for CVs 181-184 and CVs 185-186. Set CV 179 and 180 to about 30 for a relatively quick attack and release time. Set CV 178 to an initial value of 5.
2. Turn off the load compensation by setting CV 212 to 0.
3. Set CV 188 to an initial value of 100. While running the locomotive light (i.e., not pulling any cars) on flat level track, gradually reduce the setting of CV 188 until you hear a drop in exhaust volume and perhaps a reduction in the bass tones. At this point you can fine tune the setting in CV 188 up or down to establish what you would like the exhaust sound to be for the no-load condition.
4. Once you have established the setting for CV 188, connect up a medium size train and drive it around and listen for a response to changes in grade and load. If no response is forthcoming, increase the setting of CV 178 by about 5. Continue to increase CV 178 until you can detect a change in the exhaust sound due to a change in the load.
5. Once you have found a setting for CV 178, adjust CV 179 and 180 to smooth out the change in sound and tone levels if needed. Usually, this means reducing the CV setting.

Tip: You will have better luck adjusting the DDE by adjusting one CV at a time and only in small steps. Making big adjustments to several CVs at once will usually only make it more difficult to find the optimum setting.



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Step 9: Setting Up the Hyperdrive

Tsunami's Hyperdrive system features high-frequency PWM drive for silent motor control along with load compensation (or back-emf) to improve low speed operation and maintain constant speed regardless of changes to the motor load.

The PWM frequency is fixed at 22.000Khz and there are no adjustments.

Tsunami uses back EMF and a PI control loop to sense and control motor speed. There are four CVs associated with the load compensation feature:

- CV 10, Back EMF Cutout
- CV 209, Kp Coefficient
- CV 210, Ki Coefficient
- CV 212, BEMF Feedback Intensity

Control Loop Coefficients

Tsunami compensates for load changes by comparing the locomotive's speed, as measured by the motor's back-emf voltage, with the current throttle setting. When a difference is detected, the motor voltage is adjusted up or down so that locomotive speed stays constant. This is done using a P-I (proportional-integral) control loop that is tuned using two CVs:

CV 209, Kp, controls the Proportional gain of the control loop and compensates for dynamic changes in the motor load by applying a correction based on the difference between the throttle setting and the current motor speed. This CV may be set between 1 and 255. Higher values produce an increasing level of compensation. However, setting this value too high can lead to irregular and rough performance.

CV 210, Ki, controls the Integral gain of the control loop and compensates for static motor load by applying a correction based on the historical (or integral) difference between the throttle setting and the current motor speed. This CV may be set between 0 and 255. Higher values produce an increasing level of compensation and set the 'snappiness' of the control loop. However, setting this CV value too high can lead to oscillations in locomotive speed and we suggest you use the lowest possible setting that still provides optimal performance.

Note: Setting both Kp and Ki to zero will cause the motor to stop.



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Strategy for CV Optimization

Finding the right combination of CV settings requires a certain amount of experimentation and patience to get the best performance. Be aware that these settings will also vary from one locomotive to another. Take notes of your CV settings so you can use them as starting points when configuring other locomotives.

Overdoing a particular setting can actually degrade performance so changes should be made in small increments (+/- 10 or so) until the desired performance is attained. The default settings should provide satisfactory performance when used with most HO and N scale motors.

We suggest the following procedure to help fine tune the CV settings:

1. Begin with each CV set to its default value: CV 10 = 0, CV 209 = 25, CV 210 = 20, and CV 212 = 255. In addition, set CV 2 (Vstart) to 0.
2. With the locomotive on level track, set the throttle to around speed step 20.
3. Adjust the value in CV 209 (Kp) with increasingly higher values just until you begin to notice some jerkiness in the locomotive speed. Reduce the setting in CV 209 to the value just before the jerkiness started.
4. Adjust the value in CV 210 (Ki) with increasingly higher values until you begin to notice some oscillation in the locomotive speed whenever the throttle setting is changed. Reduce the setting in CV 210 to the value just before the oscillation started.

Note: When using load compensation, it is unnecessary to set large values into CV 2 (Start Voltage). This is because the load compensation algorithm will automatically adjust the motor power up to reach desired throttle setting. Therefore CV 2 can usually be set to 0 when load compensation is enabled.

Setting the Load Compensation Curve

Tsunami provides two degrees of freedom for controlling the amount of load compensation applied to the motor over the throttle range using CV 10, Back-Emf Cutout and CV 212, Back-Emf Feedback Intensity.

CV 212 sets the amount of load compensation that is initially applied to the motor and may be set anywhere between 0 and 255. A value of 0 disables load compensation altogether while a value of 255 corresponds to full (100%) compensation.

CV 10, Back-Emf Cutout, determines the degree by which the load compensation is reduced as the throttle speed is increased.

When CV 10 is set to 0, the amount of load compensation set by CV 212 is constant over the entire speed range. Setting CV 10 between 1 and 127 will determine the speed step at which the load compensation is reduced to zero as illustrated in the graph on the next page.

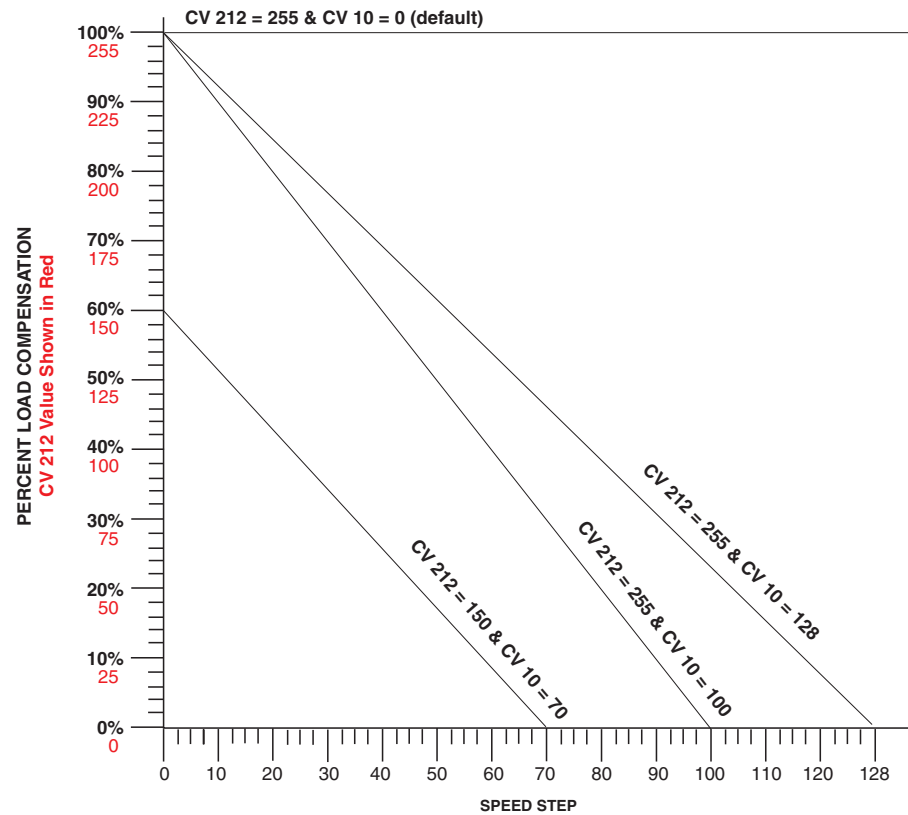
Setting CV 10 between 128 and 255 selects a partial reduction of load



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compensation at full speed such that the minimum load compensation level at speed step 128 is:

$$\text{Full Speed Load Compensation} = \frac{\text{(CV 10 - 128)}}{128}$$

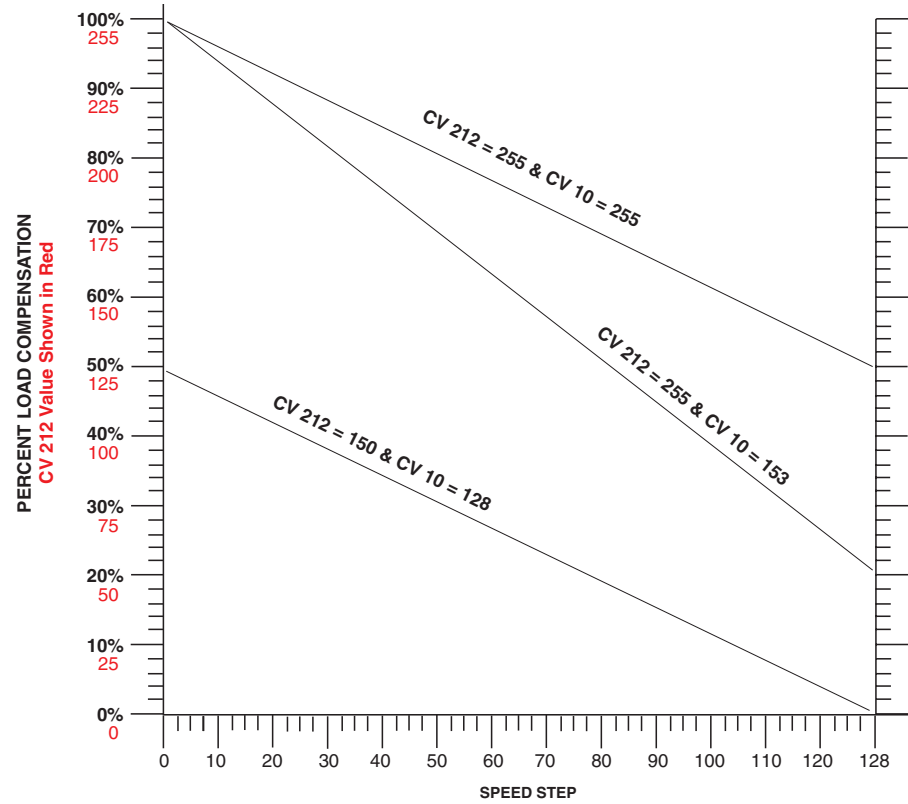


In general, you will want full load compensation at low speeds which gradually reduces to zero load compensation at full throttle and may be achieved by setting CV 10 to 126.

When operating in a consist, you may need to reduce the value in CV 212 which will reduce the low speed load compensation and avoid working the locomotives against each other due to slightly different running characteristics.



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Miscellaneous Features

Step 10: Floobydust - Configuring Tsunami's Miscellaneous Features

F11 Train Brake

By now you've no doubt discovered that Function F11 (or some other function depending on function mapping) can be used to turn Tsunami's brake squeal sound on and off. What you may not realize is that F11 can also be used to slow your train down as if the brakes really are applied!

To achieve this effect, you will need to first program some momentum into Tsunami using CV 3 and CV 4 to set the acceleration and braking rate respectively. The exact value is unimportant but should be large enough to produce a noticeable delay in the throttle response. A setting of 20 or so will do the trick. The reason for programming CV 3 (acceleration rate) is so the train does not immediately resume its old speed when the F11 function is released.

Next, program CV 61 (F11 Brake Rate) to adjust the rate at which the train will slow down when F11 is turned on. A value of 1 to 128 is added to the value programmed in CV 4 which has the effect of slowing the train more gradually than by simply turning the throttle down. Values of 129 thru 255 translate to -1 thru -127 which have the opposite effect as they subtracted from the setting in CV 4 and slow the train more aggressively than turning the throttle down (as a brake would be expected to do).

Be careful not to set F11 too high - if you do, the net braking rate will be zero and you will have effectively turned F11 into an emergency stop button!

Note that setting CV 61 to a value of 0 or 128 has no effect on the brake rate and basically disables this feature.

DC Braking

The DC Braking feature allows you to configure Tsunami to bring the locomotive to a gentle stop whenever DC power is present on the track. In this manner you can implement an inexpensive 'braking section' for stopping locomotives in front of a red block signal. This is done by using a relay or other switch to supply a section of track ahead of the signal with DC when the signal is red and DCC power when the signal is green. Then, configure Tsunami decoder as follows:

1. Set CV 11, Packet Time Out Value. CV 11 determines the amount of time, in 0.25 second increments, that elapses between when Tsunami first detects the loss of the DCC control signal and when it begins to bring the locomotive to a stop. For DC Braking, we suggest using a small value of 1 or 2 corresponding to a detection time of a 1/4 to 1/2 second.
2. Set CV 3 (Acceleration Rate) and CV 4 (Braking Rate). Since you won't want your train to come to a sudden stop, you'll need to set these CVs so



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your train slows down and starts up smoothly. Be sure to pick a braking rate value that's high enough to bring the train to a smooth stop but not so large that it over runs the length of the braking section and starts up again! See Step 3, 'Configuring the Throttle', for more information.

3. Disable Analog Mode. This prevents Tsunami from taking off at full speed when it encounters DC power. Analog mode can be disabled two ways. Program CV 12 (Alternate Power Mode) to 0 or select a proper value for CV 29 where Analog Mode is off. See Step 2 and Table A for selecting the proper value for CV 29.

Now, whenever Tsunami encounters a DC powered section of track it will slow to a stop and wait. Lighting and sound functions will remain on as they were prior to entering the braking section. When DCC power is restored, the decoder will accelerate back to its current throttle setting.

Automatic Sound Functions

Tsunami provides the ability to generate several sound functions automatically. This is especially useful when your controller lacks a sufficient number of function keys to control all of Tsunami's sound effects or when using Tsunami on a (DC powered) where there are no function controls at all!

There are six CVs associated with the Automatic Sound Functions:

- CV 193, Automatic Bell On Set Point
- CV 194, Automatic Bell Off Set Point
- CV 195, Grade Crossing Whistle Sensitivity
- CV 196, Brake Squeal Sensitivity
- CV 197, Analog Mode Automatic Sound Configuration
- CV 198, Digital Mode Automatic Sound Configuration

Automatic Sound Configuration Register

CV 197 selects which automatic sound functions are enabled when the decoder is operating in analog or DC mode. CV 198 similarly configures the automated sound functions for DCC operation.

There are five automated sound functions available:

Automatic Whistle Signals - Whenever the locomotive is stopped or started, Tsunami will produce the correct whistle signal appropriate for the direction of travel:

- One short toot = Stop
- Two Medium Toots = Forward
- Three Short Toots = Reverse

Automatic Grade Crossing Signal - When enabled, Tsunami will play a grade crossing signal (two long whistle blasts followed by a short and another long) triggered by a sudden upward spike in the throttle.



Miscellaneous Features

Automatic Bell - Tsunami can be programmed to turn the bell on and off at preset speed points such as might occur when passing through a yard or station platform.

Automatic Steam Release - This feature causes a short steam release to sound whenever Tsunami is brought to a stop.

Automatic Brake Squeal - The brake squeal is activated by slowing the train down by a predetermined amount.

These functions may be enabled by referring to Table M below and circling the numbers corresponding to the sound function you want to enable. Then add up the circled numbers and program this value into CV 197 (analog mode) and or CV 198 (DCC mode). You can configure Tsunami so some or all automated sounds work in one mode and not the other in any combination as needed.

Table J. Automatic Sound Function Enable CV 197 (Analog Mode) or CV 198 (DCC Mode) Suggested Settings				
Automatic Steam Blowdown	Automatic Brake Squeal	Automatic Bell Enable	Automatic Whistle Signal	Automatic Grade Crossing Enabled
16	8	4	2	1

Then go on to set CVs 193-196 to fine tune the operation of each enabled function.

Automatic Bell Set Points

CV 193 and 194 determine the speed steps (or equivalent throttle voltages when operating in analog mode) at which the automatic bell turns on and off respectively and may be set anywhere between 1 and 126 corresponding to the speed step of the same value. CV 194, the bell off set point, must be set to a value greater than CV 193 or else the bell will not turn on.

Example: Set CV 193 to 5 and CV 194 to 10. With these settings the bell will initially be off when the engine is stopped. As the locomotive speed is increased, the bell will turn on once the throttle setting reaches speed step 5. The bell will remain on so long as the engine is operated between speed steps 5 and 10. Increasing the throttle beyond speed step 10 or below speed step 5 will turn the bell back off. Once the bell has been turned off, it can be turned back on by lowering the speed to the same setting as in CV 193.

Crossing Whistle Sensitivity

The automatic grade crossing whistle is activated whenever Tsunami senses a sudden increase in the throttle setting (or track voltage in analog mode) as set by the value in CV 195. This CV can be set to any value between 0 and 126 but for practical purposes, you will likely want a value between 3 and 10. Too low a setting will result in the whistle going off at every speed increase and too high a setting will require an extreme change in the throttle to trigger the sound.



Miscellaneous Features

A CV setting of 5, for example, requires you to quickly increase the throttle by at least five speed steps before the whistle will sound off.

Tip: Use the momentum CVs 3 and 4 to help minimize any sudden changes in locomotive speed when the throttle is turned up. A quick flick of the throttle knob (i.e., turn it up and then immediately back down) will usually be sufficient to activate the whistle without causing any undo change in actual speed.

Brake Squeal Sensitivity

The automatic brake squeal is activated whenever Tsunami senses a sudden decrease in the throttle setting (or track voltage in analog mode) as set by the value in CV 196. This CV can be set to any value between 0 and 126 but as with CV 195, you will want to use a value between 3 and 10. Too low a setting will result in the brakes squealing with speed decrease and too high a setting will require an extreme change in the throttle to trigger the sound.

As an example, a CV setting of 3, requires you to quickly lower the throttle by at least three speed steps before the brake squeal comes on

Analog Mode

While Tsunami is first and foremost a DCC decoder, it may be used on a DC powered layout, within certain limitations, by enabling the Analog Mode feature. First set CV 12 to 1 and then set CV 29 to a value that enables analog mode as well as any desired DCC parameters such as the address range and so forth as discussed under Step 2, 'Configuring the Decoder' earlier in this manual.

Analog Mode Operation

When analog mode is enabled, you may control your locomotive using an ordinary power-pack though operation will be a bit different than when running non-decoder equipped locomotives.

With the power pack's throttle set to zero, Tsunami will be silent as it has no power. The throttle must be turned up to around 5 volts or so to provide sufficient voltage to power up Tsunami's internal circuitry. At this point, you will begin to hear the background sounds such as the blower and airpump start.

Increasing the throttle further to around 7.5 volts or so will set the locomotive in motion, increasing speed as the throttle is increased. Note that the direction can only be changed when the locomotive is stopped. Load compensation is also disabled when operating in analog mode, as is the cam-synchronized exhaust chuff. When in analog mode, the Tsunami always reverts to auto exhaust using the chuff rate setting in CV 116.

When operating in analog mode, be careful not to exceed Tsunami's input voltage rating of 27 volts. When your track voltage exceeds 21 volts, Tsunami will automatically shut down and begin flashing Error Code 10 on both its diagnostic light as well as the headlight and backup light. When you see this



Miscellaneous Features

condition, back down on the throttle immediately.

Important: Tsunami will work best in analog mode when using a high quality, electronically regulated power pack, preferably one that supplies smooth, filtered DC power. Older rheostat style power packs and pulse power packs will result in erratic and unreliable operation and should not be used with the Tsunami sound decoder. If your power pack provides a Pulse power switch, leave it in the 'Off' position.

Depending on the quality of the power pack's track voltage, some automatic sound functions such as the grade crossing whistle may require a higher sensitivity setting than needed for DCC operation to avoid continual triggering of the sound effect.

Analog Mode Options

In addition to CV 12 and CV 29 discussed earlier, there are four other CVs related to analog mode operation:

Analog Function Enables

CV 13, Analog Function Enable 1

CV 14, Analog Function Enable 2

These CVs allow you to force a function input to the ON state whenever Tsunami switches over to analog mode. This is most useful for turning on lighting effects when running on a DC powered layout. Sound functions may be turned on in analog mode as well but this is less useful as they will either run continuously or sound just once when the decoder is powered up - instead, use automatic sound functions discussed earlier to generate sound effects.

To enable any of Functions F1 thru F8, refer to Table N below and circle the numbers corresponding to the function inputs you want to enable. Then add up the circled numbers and program this value into CV 13.

Table K. Analog Function Enable 1								
CV#	F1	F2	F3	F4	F5	F6	F7	F8
13	1	2	4	8	16	32	64	128

Similarly, to enable Function F9 thru F8 or F0, refer to Table O below and circle the numbers corresponding to the function inputs you want turned on. Then add up the circled numbers and program this value into CV 14.

Table L. Analog Function Enable 2						
CV#	F0(f)	F0(r)	F9	F10	F11	F12
14	1	2	4	8	16	32



Miscellaneous Features

Note that when you enable a particular function input for analog mode operation, it has the same effect as pressing the equivalent function key on your DCC cab. Tsunami's function mapping settings will ultimately determine which output or sound effect is activated by the enabled function. Assuming you have not changed the default function mapping, then enabling the F0(f) function in analog mode will not only turn on the headlight, but the dynamo sound as well.

Analog Mode Motor Control Parameters

CV 63, Analog Mode Motor Start Voltage

CV 63 allows you to increase the voltage difference between when the decoder first powers up and when the locomotive starts to move.

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.

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.

CV 64, Analog Mode Maximum Motor Voltage

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

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.

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.



Miscellaneous Features

Transponding

If you are using Tsunami on a layout equipped with Digitrax transponding block detection, you will need to configure Tsunami for transponding-friendly operation. Be aware that the Tsunami itself does not transpond - you will need to install an external transponding decoder in your locomotive to achieve this functionality.

Simply program CV 62 to 1 to configure Tsunami for compatibility with external transponding devices. To disable transponding compatibility (default mode), program CV 62 to 0.

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



Troubleshooting

Troubleshooting

If you should have any difficulties with the operation of your Tsunami Digital Sound Decoder, first check this section for hints on trouble shooting. We have found that most problems are caused by an errant CV value and are easily corrected. When all else fails, try resetting the CV values back to their defaults (see the section 'Basic Programming') and try again.

Locomotive doesn't run but was working

- Address has been accidentally changed.
- Consist address (CV 19) was accidentally set.
- CV 29 has been changed to select other address.
- Acceleration and braking CVs set to very high values.
- Broken motor wire or track pickup wire.

Locomotive never ran

- See all the above.
- Decoder wired incorrectly.

Locomotive runs but makes no sound

- Mute function (F8) is on.
- Another function is re-mapped to the Mute function.
- Sound Volume CVs have been set to zero.
- Speaker wire is broken.
- Speaker is burned out.

Locomotive runs in a consist but lights and sound effects don't work

- Consist functions are disabled. Set CV 21 and 22 to activate desired functions (see Step 4, 'Configuring for Consist Operation').

Lights flicker on and off

- Decoder is in 14 speed step mode and command station is set to 28 speed steps.

Lights do not work

- Decoder is in 28/128 speed step mode and command station is set to 14 speed steps.
- Function mapping is improperly set.
- Burned out light bulbs.
- If using 1.5 volt micro-bulbs, resistor value is too large.
- Broken lamp wires.

Tip: Check the decoder's Diagnostic Codes to confirm that the decoder is responding to the headlight command when locomotive is going forward.

Locomotive just sits and flashes both headlights.

- See next section, 'Diagnostic Codes'.



Troubleshooting

Sound works for a while then quits

Amplifier is overheating, lower sound volume.
Decoder is overheating, lower track voltage.
Speaker is damaged. Replace speaker.

Speaker sounds 'crackly'.

Sound volume is too high for speaker.
Speaker is not properly baffled.
Speaker wire is loose.
Speaker is damaged.

Decoder will not program.

Insufficient power on program track - try using Ops Mode or PTB-100 Programming Track Booster.
CVs are locked - see 'Basic Programming'.

Diagnostic Codes

Fault Light

During normal operation, the Tsunami monitors a number of its input signals and if a fault is found, reports an error code by flashing the headlight and backup light (if connected). The number of times the light flashes corresponds to the number of the error code. Error codes whose conditions can usually be solved by the user are as follows:

Error 9 - Over temperature fault

An over-temperature fault indicates the core temperature of the decoder has exceeded safe limits. When this error occurs, motor control and sound will be shut off and the error code will continue to flash until the temperature has fallen back to a safe level. An Over-temperature fault is usually due to inadequate ventilation or using a motor load that exceeds the decoder's rating.

Error 10 - Over voltage fault

An Over-voltage fault indicates that the track voltage is greater than 22 volts. When this error occurs, motor control and sound will be shut off and the error code will continue to flash until the voltage is brought below 22 Volts. **Note:** *Tsunami's absolute maximum voltage input is 27 volts! Track voltages exceeding 27 volts may cause permanent damage to the decoder.*

Error 11 - Motor Connection Fault

This error indicates a faulty motor connection has been detected and typically occurs when the motor lead is shorted to a track pickup wire. The motor will not respond until the error is corrected.

Error 12 - Motor Overload Fault

This error indicates the motor load has exceeded the decoder's current



Troubleshooting

rating.

Error 16 - CVS reset to default

This code is informational only and indicates that all CVs have been reset to their factory defaults.

On rare occasion, the Tsunami Decoder may also report the following error codes which cannot be remedied by the user and require a return to the factory for repair:

Error 1 - COP Fault

Error 2 - Software Fault

Error 5 - EEROM Checksum failure

Error 6 - Lower Calibration Voltage Error

Error 7 - Upper Calibration Voltage Error



Appendix A

Decimal-Hex-Binary Conversion Table

DECIMAL	HEX	BINARY (76543210)	DECIMAL	HEX	BINARY (76543210)	DECIMAL	HEX	BINARY (76543210)	DECIMAL	HEX	BINARY (76543210)
0	00	00000000	64	40	01000000	128	80	10000000	192	C0	11000000
1	01	00000001	65	41	01000001	129	81	10000001	193	C1	11000001
2	02	00000010	66	42	01000010	130	82	10000010	194	C2	11000010
3	03	00000011	67	43	01000011	131	83	10000011	195	C3	11000011
4	04	00000100	68	44	01000100	132	84	10000100	196	C4	11000100
5	05	00000101	69	45	01000101	133	85	10000101	197	C5	11000101
6	06	00000110	70	46	01000110	134	86	10000110	198	C6	11000110
7	07	00000111	71	47	01000111	135	87	10000111	199	C7	11000111
8	08	00001000	72	48	01001000	136	88	10001000	200	C8	11001000
9	09	00001001	73	49	01001001	137	89	10001001	201	C9	11001001
10	0A	00001010	74	4A	01001010	138	8A	10001010	202	CA	11001010
11	0B	00001011	75	4B	01001011	139	8B	10001011	203	CB	11001011
12	0C	00001100	76	4C	01001100	140	8C	10001100	204	CC	11001100
13	0D	00001101	77	4D	01001101	141	8D	10001101	205	CD	11001101
14	0E	00001110	78	4E	01001110	142	8E	10001110	206	CE	11001110
15	0F	00001111	79	4F	01001111	143	8F	10001111	207	CF	11001111
16	10	00010000	80	50	01010000	144	90	10010000	208	D0	11010000
17	11	00010001	81	51	01010001	145	91	10010001	209	D1	11010001
18	12	00010010	82	52	01010010	146	92	10010010	210	D2	11010010
19	13	00010011	83	53	01010011	147	93	10010011	211	D3	11010011
20	14	00010100	84	54	01010100	148	94	10010100	212	D4	11010100
21	15	00010101	85	55	01010101	149	95	10010101	213	D5	11010101
22	16	00010110	86	56	01010110	150	96	10010110	214	D6	11010110
23	17	00010111	87	57	01010111	151	97	10010111	215	D7	11010111
24	18	00011000	88	58	01011000	152	98	10011000	216	D8	11011000
25	19	00011001	89	59	01011001	153	99	10011001	217	D9	11011001
26	1A	00011010	90	5A	01011010	154	9A	10011010	218	DA	11011010
27	1B	00011011	91	5B	01011011	155	9B	10011011	219	DB	11011011
28	1C	00011100	92	5C	01011100	156	9C	10011100	220	DC	11011100
29	1D	00011101	93	5D	01011101	157	9D	10011101	221	DD	11011101
30	1E	00011110	94	5E	01011110	158	9E	10011110	222	DE	11011110
31	1F	00011111	95	5F	01011111	159	9F	10011111	223	DF	11011111
32	20	00100000	96	60	01100000	160	A0	10100000	224	E0	11100000
33	21	00100001	97	61	01100001	161	A1	10100001	225	E1	11100001
34	22	00100010	98	62	01100010	162	A2	10100010	226	E2	11100010
35	23	00100011	99	63	01100011	163	A3	10100011	227	E3	11100011
36	24	00100100	100	64	01100100	164	A4	10100100	228	E4	11100100
37	25	00100101	101	65	01100101	165	A5	10100101	229	E5	11100101
38	26	00100110	102	66	01100110	166	A6	10100110	230	E6	11100110
39	27	00100111	103	67	01100111	167	A7	10100111	231	E7	11100111
40	28	00101000	104	68	01101000	168	A8	10101000	232	E8	11101000
41	29	00101001	105	69	01101001	169	A9	10101001	233	E9	11101001
42	2A	00101010	106	6A	01101010	170	AA	10101010	234	EA	11101010
43	2B	00101011	107	6B	01101011	171	AB	10101011	235	EB	11101011
44	2C	00101100	108	6C	01101100	172	AC	10101100	236	EC	11101100
45	2D	00101101	109	6D	01101101	173	AD	10101101	237	ED	11101101
46	2E	00101110	110	6E	01101110	174	AE	10101110	238	EE	11101110
47	2F	00101111	111	6F	01101111	175	AF	10101111	239	EF	11101111
48	30	00110000	112	70	01110000	176	B0	10110000	240	F0	11110000
49	31	00110001	113	71	01110001	177	B1	10110001	241	F1	11110001
50	32	00110010	114	72	01110010	178	B2	10110010	242	F2	11110010
51	33	00110011	115	73	01110011	179	B3	10110011	243	F3	11110011
52	34	00110100	116	74	01110100	180	B4	10110100	244	F4	11110100
53	35	00110101	117	75	01110101	181	B5	10110101	245	F5	11110101
54	36	00110110	118	76	01110110	182	B6	10110110	246	F6	11110110
55	37	00110111	119	77	01110111	183	B7	10110111	247	F7	11110111
56	38	00111000	120	78	01111000	184	B8	10111000	248	F8	11111000
57	39	00111001	121	79	01111001	185	B9	10111001	249	F9	11111001
58	3A	00111010	122	7A	01111010	186	BA	10111010	250	FA	11111010
59	3B	00111011	123	7B	01111011	187	BB	10111011	251	FB	11111011
60	3C	00111100	124	7C	01111100	188	BC	10111100	252	FC	11111100
61	3D	00111101	125	7D	01111101	189	BD	10111101	253	FD	11111101
62	3E	00111110	126	7E	01111110	190	BE	10111110	254	FE	11111110
63	3F	00111111	127	7F	01111111	191	BF	10111111	255	FF	11111111



Appendix B

List of Configuration Variables (CVs)

The following is a quick reference list of CVs used by Tsunami. See the Tsunami Technical Reference for detailed information about their uses.

CV 1	Primary Address Control	CV 106	User Identifier #2
CV 2	Vstart	CV 112	Sound Configuration 1
CV 3	Baseline Acceleration Rate	CV 113	Quiet Mode Timeout Period
CV 4	Baseline Braking Rate	CV 114	Bell Ring Rate
CV 7	Manufacturer Version ID (Read Only)	CV 115	Whistle Select
CV 8	Manufacturer ID	CV 116	Engine Exhaust Control
CV 10	BEMF Cutout	CV 119	Effect Processor Select
CV 11	Packet Time Out Value	CV 128	Master Volume Control
CV 12	Power Source Conversion	CV 129	Whistle Volume
CV 13	Analog Function Enable 1	CV 130	Bell Volume
CV 14	Analog Function Enable 2	CV 131	Exhaust Volume
CV 15	CV Unlock Register	CV 132	Air Pump Volume
CV 16	CV Lock ID Code	CV 133	Dynamo Volume
CV 17,18	Extended Address	CV 135	Rod Clank Volume
CV 19	Consist Address	CV 136	Steam Release Volume
CV 21	Consist Function Group 1	CV 137	Coupler Volume
CV 22	Consist Function Group 2	CV 138	Reserved
CV 23	Consist Acceleration Rate	CV 139	Brake Squeal Volume
CV 24	Consist Braking Rate	CV 140	Brake Release Volume
CV 25	Speed Table Select Register	CV 141	Snifter Valve Volume
CV 29	Configuration Register 1	CV 142	Johnson Bar/Power Reverse Volume
CV 30	Error Information/Alternate Mode Selection	CV 143	Pop Valve Volume
CV 33	FL(f) Output Location	CV 146	Water Stop Volume
CV 34	FL(r) Output Location	CV 147	Injector Volume
CV 35	F1 Output Location	CV 173	Reserved
CV 36	F2 Output Location	CV 174	Reserved
CV 37	F3 Output Location	CV 175	Reserved
CV 38	F4 Output Location	CV 176	Reserved
CV 39	F5 Output Location	CV 177	DDE Throttle Gain
CV 40	F6 Output Location	CV 178	DDE Motor Load Gain
CV 41	F7 Output Location	CV 179	DDE Attack Time Constant
CV 42	F8 Output Location	CV 180	DDE Release Time Constant
CV 43	F9 Output Location	CV 181	Exhaust Low Volume Limit
CV 44	F10 Output Location	CV 182	Exhaust High Volume Limit
CV 45	F11 Output Location	CV 183	Side Rod Clank Low Volume Limit
CV 46	F12 Output Location	CV 184	Side Rod Clank High Volume Limit
CV 47	Analog Whistle Control	CV 185	DDE Filter Initial Frequency
CV 49-52	Hyperlight Effect Select (for FL(f), FL(r), Function 5, 6)	CV 186	DDE Filter Control Gain
CV 59	Flash Rate	CV 187	DDE Filter Initial Frequency
CV 60	Crossing Hold Time	CV 188	DDE Tracking Coefficient
CV 61	F11 Braking Rate	CV 193	Automatic Bell-On Set Point
CV 62	Transponding Control	CV 194	Automatic Bell-Off Set Point
CV 63	Analog Mode Motor Start Voltage	CV 195	Grade Crossing Whistle Sensitivity
CV 64	Analog Mode Max Motor Voltage	CV 196	Brake Squeal Sensitivity
CV 66	Forward Trim	CV 197	Analog Mode Automatic Sound Configuration
CV 67-94	Loadable Speed Table	CV 198	Digital Mode Automatic Sound Configuration
CV 95	Reverse Trim	CV 209	Kp Coefficient
CV 105	User Identifier #1	CV 210	Ki Coefficient
		CV 212	Motor Control Intensity
		CV 213	Motor Control Sample Period
		CV 214	Motor Control Sample Aperture Time



Appendix C

License Agreement

License Agreement

Please read carefully this license agreement before opening the package which contains the Tsunami Sound Decoder. Breaking the seal on the package indicates your acceptance of these license terms. If you have received the Tsunami Sound Decoder pre-installed from your Dealer, then use of the product indicates your acceptance of the agreement. If you do not agree with the terms, you should return the package unopened to the dealer from whom you received the package within thirty (30) days and your money will be refunded.

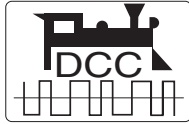
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Tsunami® Digital Sound Decoder

Spectrum®

Technical Reference

Softare 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:

Bit 7								Bit 0
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

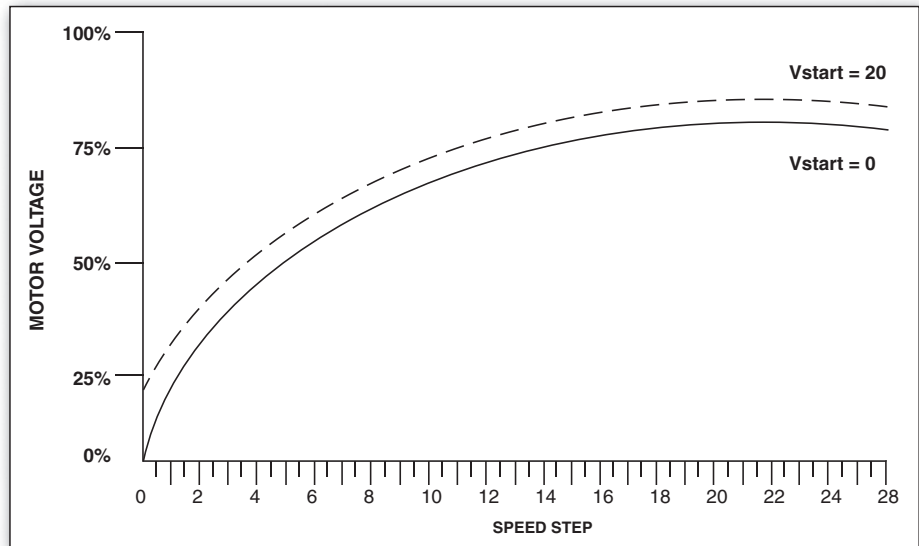
D0-D7: Motor Start Voltage

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:

Bit 7								Bit 0
F7	F6	F5	F4	F3	F2	F1	F0	

- 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:

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

- 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:

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

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.

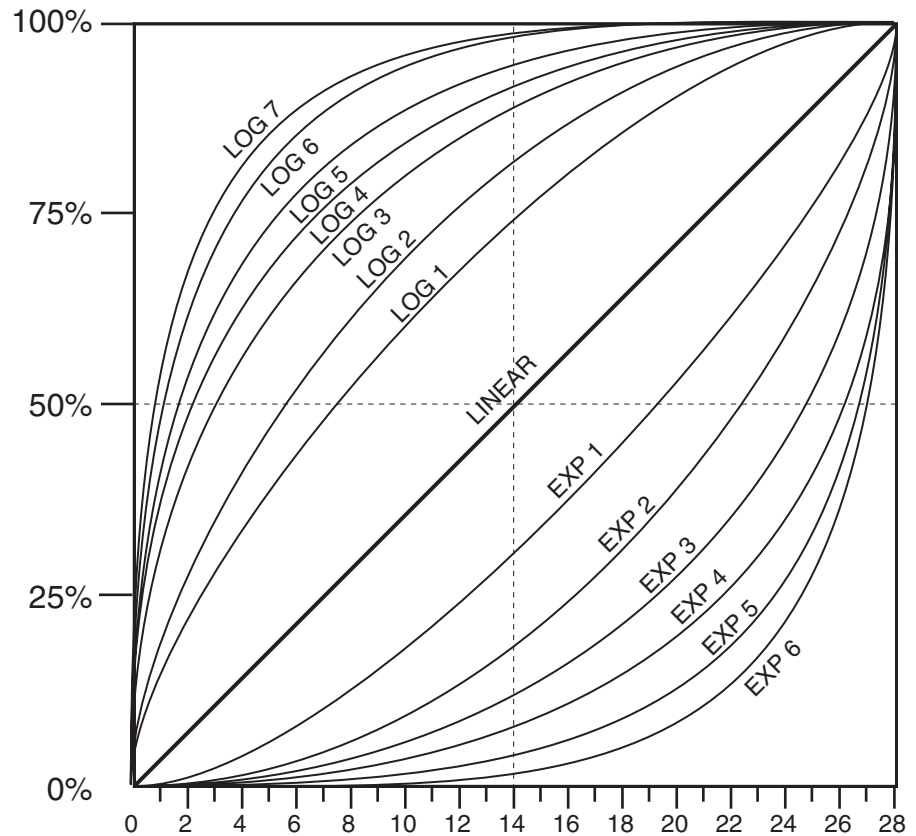
CV 25 may be programmed with any value between 0 and 31. Values between 2 and 15 allow the user to select from one of 14 predefined speed curves as depicted below. The logarithmic curves provide a shallower speed response as the throttle is increased. These curves are useful for locomotives that require 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:

Bit 7						Bit 0	
					GRP23	CVCLR	CVLCKE

- 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	1	2	4	8	16	32	64	128							
F0 (r)	34	1	2	4	8	16	32	64	128							
F1	35	1	2	4	8	16	32	64	128							
F2	36	1	2	4	8	16	32	64	128							
F3	37				1	2	4	8	16	32	64	128				
F4	38				1	2	4	8	16	32	64	128				
F5	39				1	2	4	8	16	32	64	128				
F6	40				1	2	4	8	16	32	64	128				
F7	41							1	2	4	8	16	32	64	128	
F8	42							1	2	4	8	16	32	64	128	
F9	43							1	2	4	8	16	32	64	128	
F10	44								1	2	4	8	16	32	64	128
F11	45								1	2	4	8	16	32	64	128
F12	46								1	2	4	8	16	32	64	128

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:

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

- 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:

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

- 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:

Bit 7							Bit 0
SHW	DYN	FX6	FX5	BEL	WH	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:** 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:

Bit 7						Bit 0	
DIM	WS	STM	SHW	DYN	FX6	FX5	BEL

- 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



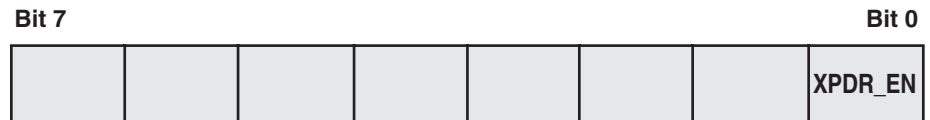
Misc. Control CVs

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:

Bit 7	Bit 0
CAM	AP2
AECS	
SR1	
SR0	

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

Timeout period (seconds) = CV 113 x 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.

Bit 7							Bit 0
ALTWH		AWH2	AWH1	AWH0	WH2	WH1	WH0

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:

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 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

Bit 7

Bit 0



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.

Tracking Coefficient = CV Value÷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

Effect Processor Selection and Programming		
CV 119 = 0	Description	Range of Values
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
CV 119 = 1	Description	Range of Values
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
CV 119 = 2	Description	Range of Values
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

CV 119 = 3	Seven Band Equalizer	Range of Values
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
CV 119 = 4	Reverb Control Mixer	Range of Values
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	-
CV 119 = 5	Reverb Mixer	Range of Values
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

CV 119 = 6	DDE Mixer 1	Range of Values
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
CV 119 = 7	DDE Mixer 2	Range of Values
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	-
CV 119 = 8	Automatic Sound Control 1	Range of Values
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

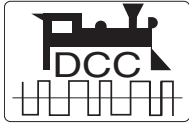


Effect Processor Select CVs

CV 119 = 9	Automatic Sound Control 2	Range of Values
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
CV 119 = 10	Advanced Motor Control	Range of Values
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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