


Tsunami²[™]

Tsunami2[™] Digital Sound Decoder
Electric User's Guide

Software Release 1.0

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All Aboard!

Overview

Congratulations on purchasing your SoundTraxx Tsunami2 Digital Sound Decoder (DSD) for electric locomotives and trolleys! Tsunami2 is the newest wave of SoundTraxx innovation and builds upon the previous generation of Tsunami to offer the highest quality sound for model railroading. This user's guide shows you how to operate Tsunami2 and customize each decoder setting to fit your preferences, while providing some helpful troubleshooting tips along the way.

We suggest referring to the user documents listed below as you read this user's guide.

Tsunami2 Installation Guide

Provides instructions and strategies for successful sound installations.

Tsunami2 Electric Technical Reference

Offers a list of all included CVs and details making adjustments to settings.

Tsunami2 Electric Quick Start Guide

Gives an overview of the decoder's default settings and highlights some of the features.

Tsunami2 Electric Sound Selection Reference

Lists each included sound effect for configuring a prototypical operating experience.

These documents can be downloaded from our website at www.soundtraxx.com.

All Aboard!

Using Tsunami2

The Tsunami2 Digital Sound Decoder is designed to enhance your model railroading experience by giving you a wide variety of innovative features and incredibly realistic sound for your models. Some of the features discussed in this user's guide include Dynamic Digital Exhaust for electric locomotives, Hyperdrive2 advanced motor control, Flex-Map function mapping technology, two volume mixers, independent and train brake functions, and Motorman Omura sound effects. Tsunami2 also provides selectable airhorns, bells, air compressors, couplers, and traction motors to allow more versatility in creating your ideal model railroading experience.

You can start using Tsunami2 right out of the package without making any adjustments. However, you may adjust settings at any time by making changes to Configuration Variables (CVs). Most DCC decoder and command station manuals call this "programming", though this is misleading and sounds scarier than it is. At no point are you required to learn programming! This user's guide will walk you through operating and programming Tsunami2 to its full capacity.

Default Function Assignments

The first time you operate your Tsunami2 decoder, you will be able to activate features and sound effects by simply pressing the appropriate key on your cab or command station console. These are "default" function assignments. The effects listed in Table A are assigned to function keys F0-F28 by default. This section describes how to activate each effect with function keys.

Note: You can assign any effect to function keys labeled as "Not Assigned" in Table A with Flex-Map function mapping CVs. Refer to "Configuring Function Mapping" for more information about customizing function assignments.

Note: Pressing function keys F0-F28 will toggle functions "on" and "off" and activate effects.

Turn On the Lights

Ensure your locomotive is in the forward direction, then turn on F0 to illuminate the headlight. Reverse the locomotive direction to turn off the headlight and turn on the backup light. Pressing F0 a second time will turn off the headlight and backup light outputs.

Turn on F7 to dim the headlight or backup light before passing oncoming trains, or while waiting on a siding. Press F7 again to return the headlight and backup light outputs to full brightness.

Table A. Default Functions	
Function Key	Effect
F0(f)	Headlight
F0(r)	Backup Light
F1	Bell
F2	Airhorn
F3	Short Airhorn
F4	Pantograph Extend, Retract
F5	Stop Request Bell
F6	Pneumatic Doors
F7	Dimmer
F8	Mute
F9	Grade-Crossing Signal
F10	Not Assigned
F11	Independent/Train Brake
F12	Brake Select
F13	Couple/Uncouple
F14	Switching Mode
F15	Handbrake
F16	Not Assigned
F17	Not Assigned
F18	General Service
F19	Not Assigned
F20	Steam Generator
F21	Sander Valve
F22	Cab Chatter
F23	All Aboard/Coach Doors
F24	FX3 Function Output
F25	FX4 Function Output
F26	FX5 Function Output
F27	FX6 Function Output
F28	Not Assigned

All Aboard!

Ring the Bell

Turn on F1 to ring the bell. Press F1 again to stop ringing the bell. The bell is generally rung before moving the locomotive, when approaching crossings, to alert people or equipment near the track, and as a warning signal when necessary.

Blow the Airhorn

Signaling can make your operating sessions more fun! Engineers signal to notify passengers, crew, and other trains of common locomotive movements, such as stopping, moving forward, backing up, and approaching grade crossings. Tsunami2 provides three functions for signaling. Use F2, F3, and F9 to signal prototypically while you operate, as described below.

Press and release F2 to blow the “long” airhorn. Contrary to most function keys, the duration of the airhorn blast is determined by how long you press F2. In other words, the airhorn blast will start when you press F2, and stop when you release F2. Press F3 to issue the single “toot” of the “short” airhorn. The short airhorn will be the same length every time you press F3, unlike the long airhorn.

Note: Function key F2 on the NCE Power Cab command station is on/off or “latching”, i.e., pressing F2 to turn on the function will start the airhorn blast, and pressing F2 again to turn off the function will stop the airhorn blast. To issue momentary airhorn blasts with the NCE Power Cab, press and release the “Horn/Whistle” button instead of using F2.

To issue the long-long-short-long grade-crossing signal automatically, turn on F9 as your locomotive approaches a grade crossing. Refer to Table B to view some more common signals.

Table B. Whistle Signals		Long = – Short = •
Signal	Description	
--•–	Approaching a grade crossing: hold final blast until crossing is occupied	
•	Applying brakes	
--	Releasing brakes, proceeding forward	
•••	When moving, stop; when stopped, back up	
••••	Request signal from trainman	
–•••	Signal flagman to protect rear	
–•	Warning signal: use when approaching areas with obstructed views and when approaching/passing passenger/freight trains	
–	Approaching stations, junctions, and railroad crossings at grades	

Extend and Retract the Pantograph

The pantograph mounted on the roof of an electric train extends to collect power from an overhead catenary wire. The spring-loaded extension pushes a contact shoe up against the underside of the overhead wire to draw electricity and deliver it to the rails.

With the throttle set to zero, turn on F4 to extend the pantograph and deliver power to the locomotive. When the pantograph function is turned on during operation, you will hear the contactor camshaft changing position, the generator running, the air compressor building and releasing pressure, the poppet valve popping off, and the blower fans blustering. These sound effects are active during operation to indicate power has been received and distributed from the overhead wire.

All Aboard!

Decrease the throttle and bring your locomotive to a stop. Then turn off F4 to retract the pantograph and mute the automatic sound effects. Keep in mind that, in reality, an electric train cannot move when disconnected from the overhead wire. Refer to “Modifying Sound Effects” for more information regarding the interlock feature.

Ring the Stop Request Bell

Turn on F5 to ring the stop request bell before stopping at the station.

Open and Close Doors

Turn on F6 to open the pneumatic doors while your train is stopped at the station. Before departing, turn off F6 to close the doors.

Ring the Trolley Bell

Turn on F10 to issue the single “ding!” of the trolley bell. When the trolley begins to move forward, ring the trolley bell twice by pressing F10 twice. When the trolley begins to move in the reverse direction, ring the trolley bell three times. Configure automatic trolley bell signals with SoundTraxx’s Flex-Map technology. Refer to “Configuring Function Mapping” for more information.

Apply the Independent Brake

The engineer generally applies the brakes on the locomotive during switching operations and to control slack between units. You can use the independent brake function to simulate applying the locomotive brake independently from the rest of the train.

Turn on F11 to apply the independent brake before bringing your locomotive to a stop. The locomotive brakes typically squeal just before the wheels stop turning. You can simulate applying the independent brake prototypically by turning on F11 as your locomotive decelerates to a stop. Press F11 again to release the independent brake before departing. Refer to “Configuring Throttle and Braking” to set the independent brake rate and allow the independent brake function to reduce speed when activated.

Apply the Train Brake

You can apply the brakes on all locomotives and cars at the same time to control the speed of the entire train at a consistent rate. In the real world, air hoses are fastened to each unit’s brake pipe to form a single braking system, referred to as the “train brake” or “automatic brake.” The train brake function allows you to simulate applying each unit’s brake at once to reduce train speed.

First turn on F12 to select the train brake in place of the independent brake. The air compressor will cycle on to simulate charging the train line, and indicate that the train brake is selected. Next, turn on F11 to simulate applying the train brake. While the train brake function is turned on, pressing F11 again will turn the air compressor back on, and confirm the train brake has been released.

You can use F11 to activate the train brake only when the F12 brake select function is turned on. Turn off F12 to reselect the independent brake for F11 and disable the train brake. Refer to “Configuring Throttle and Braking” to set the train brake rate and allow the train brake function to reduce speed when activated.

Mute Sound Effects

Turn on F8 to mute all sound effects when you need to silence your train. The mute function allows a quick way to turn off sound effects for a phone call, for instance. Press F8 again to return all sound effect volume levels to their prior settings.

All Aboard!

Couple and Uncouple

Turn on F13 to engage the sound of the coupler as you add cars to your train. When you uncouple, press F13 a second time to open the knuckle and separate the glad hands.

Use Switching Mode

To improve throttle control for switching operations, turn on F14 to override all momentum CVs and reduce the current throttle setting by 50%. Press F14 again to reset locomotive speed to the prior speed step and reactivate all momentum CV settings. For more information about momentum CVs, refer to “Configuring Throttle and Braking.”

Tie Down the Handbrake

Turn on F15 while your locomotive is stopped to set the handbrake. Press F15 again to release the handbrake before moving.

Perform General Service

While your locomotive is stopped, turn on F18 to inspect the engine and perform general service. After the cab door opens, Motorman Omura tightens nuts and bolts with his wrench and uses his hammer to check the frame as needed. Press F18 again before departing to stop performing general service and close the cab door.

Turn on the Steam Generator

Turn on F20 to stimulate the steam generator passing steam throughout the length of the train from the feedwater supply tank. Steam generators are generally used to heat drinking water and provide climate control to passenger cars. Press F20 again to turn the steam generator off.

Open the Sander Valve

When your wheels need a little extra traction, turn on F21 to open the sander valve and deposit sand onto the rails. Press F21 again to close the sander valve.

Listen to Cab Chatter

Turn on F22 to hear railroad radio transmissions being exchanged from inside the cab. The radio will play messages at random while F22 is turned on. Press F22 again to turn off the function and mute the radio. To issue a new radio message, toggle the cab chatter function from off to on by pressing F22 twice.

Announce “All Aboard!”

Turn on F23 before leaving the station to issue the conductor’s “all aboard!” announcement. After the coach doors slam shut, increase the throttle and depart the station.

Turn On FX3-FX6 Lighting

If you have additional lights wired to the FX3-FX6 function outputs, use function keys F24-F27 to activate them. Depending on board format, Tsunami2 offers up to six lighting outputs to support Hyperlight effects. To select Hyperlight effects for lighting outputs, refer to “Configuring Lighting Outputs.”

Make an Emergency Stop

Press the emergency stop button to issue the emergency brake application and bring your train to an immediate stop.

All Aboard!

Automatic Sound Effects

Tsunami2 plays a variety of sound effects automatically. Automatic sound effects respond prototypically to aspects of operation, such as certain functions, speed settings, and motor load changes.

Traction Motors

With the pantograph extended, the whine of the traction motors is automatically adjusted by auto-notching and Dynamic Digital Exhaust as you operate. Refer to “Configuring the Decoder,” “Configuring Sound Effects,” and “Configuring Dynamic Digital Exhaust” to modify automatic traction motor sound effects.

Contactors Camshaft

The contactor camshaft will change its position at fixed speed points when the pantograph is extended. Retract the pantograph to mute the contactor camshaft.

Generator

The electrical generator will produce energy when the pantograph is extended. Retract the pantograph to mute the generator.

Air Compressor

The air compressor maintains air pressure during operation. It will cycle to charge the train line when F12 is turned on and off. It will also operate for a longer period of time when the coupler function is turned on and every third time the independent brake is applied.

Poppet Valve

The “pop!” of the poppet valve is active in the background when the pantograph is extended. Retract the pantograph to mute the poppet valve. Refer to “Configuring Sound Effects” to adjust the poppet valve release rate.

Blower Fans

The blower fans will engage and play continuously when the pantograph is extended. Retract the pantograph to mute the blower fans.

Clickety-Clack

The “clickety-clack” of the locomotive running across rail joints is synchronized in proportion to locomotive speed. To adjust the clickety-clack sound effect, refer to “Configuring Sound Effects.”

Electrical Arcing

The occasional “zap!” of the pantograph losing contact with the overhead wire can be heard when operating the locomotive above speed step 10 in 128 speed step mode. The pantograph must be extended to hear this sound effect.

Motorman Omura

Each time the engine is brought to a stop, Motorman Omura may attend to a randomly selected task (or tasks), including tightening nuts and bolts, checking the frame and more.

All Aboard!

CV Programming Tutorial

Configuration Variable (CV) is the industry-adopted term for a decoder's user-adjustable memory locations. CVs allow you to adjust various decoder properties and customize your operating experience. The address, audio settings, motor control, lighting effects, and function assignments are just some of the properties you can adjust with CVs. You can modify CVs at any time and the decoder will save your settings even when the power is turned off. If reading about CV programming already has your head spinning, this tutorial will help you understand how CVs work.

At first glance, you may feel overwhelmed by the large number of CVs offered by Tsunami2. Don't worry! You don't need an engineering degree to customize your decoder's settings. Making adjustments is easy, and you can customize settings one CV at a time by referring to this user's guide and the *Tsunami2 Electric Technical Reference*. When in doubt, you can always reset the decoder to factory defaults. Refer to "Resetting CVs" for more information.

Bits and Bytes

All the bits, bytes, and other symbols used in decoder manuals, and differences between command stations can make CV programming difficult to understand. Put simply, each CV contains a value that can be changed, and changing the value of a CV will modify a specific decoder setting. However, knowing a little more about how CV values are represented will help you make the right adjustments. CV values can be represented in the three numeric formats listed below:

Decimal

Decimal representation is the format you will probably use most often. Decimal values are represented using numerals 0-9. Each CV contains a decimal value from 0 to 255.

Binary

Like computers, binary is the numbering system used in Digital Sound Decoders. Binary values are called "bits" and can be represented as either 0 or 1. Each CV contains eight bits, or one "byte." Each CV contains a binary value from 00000000 to 11111111, which easily converts to decimal form.

Hexadecimal

Referred to as "hex," hexadecimal values are represented using characters A-F and numerals 0-9. Each CV contains a hex value from 00 to FF. Hex allows you to represent decimal numbers using fewer digits if your command station has a limiting interface.

Programming by the Bits

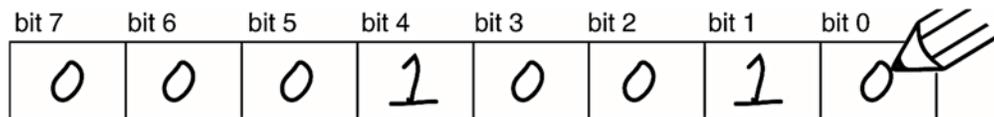
Each CV is made up of eight bits and can be set to decimal values from 0 to 255 or binary values from 00000000 to 11111111. Most CVs contain a single piece of data easily represented in decimal, binary, or hex.

Some CVs use individual bits to control specific features, allowing up to eight features to be controlled using a single CV. You can set each bit to a binary input of 0 or 1 to modify a specific setting. For this reason, "programming by the bits" allows you to make basic adjustments that are on/off, disabled/enabled, etc. Because most DCC systems don't use binary representation, programming by the bits requires you to convert binary values into decimal (or hex) values.

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This user's guide represents CV values in decimal form to expedite programming. However, binary is occasionally used to represent CV values in the *Tsunami2 Electric Technical Reference* for CVs that are programmed by the bits. For instance, CV 29 (Configuration Data 1) is programmed by the bits and controls important decoder settings, such as the locomotive direction, the decoder's speed step mode, alternate power source, and speed table setting.

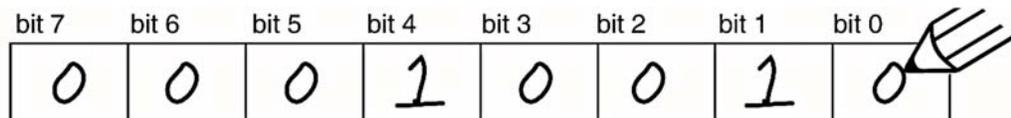
A CV is illustrated below and shows a binary value for each bit. Bits 1 and 4 are set to 1, and bits 0, 2, 3, 5, and 6 are set to 0, which is a binary value of 00010010.



Refer to Appendix A to locate the binary value 00010010 and convert it to a decimal value of 18 (0x12 in hex). Entering a value of 18 into the CV would then adjust the settings contained by each bit according to the binary input 00010010.

Binary-Decimal Conversions

You can convert binary values into decimal form without the conversion chart as well. It helps to know the decimal value contained in each bit set to 1. The decimal value of each bit doubles sequentially (1, 2, 4, 8, 16, etc.) from bit 0 to bit 7. Add the decimal values together for each bit set to 1. The sum is the total decimal value of the CV.



<i>When bit is set to 1, value =</i>	128	64	32	16	8	4	2	1								
<i>Therefore:</i>	0	+	0	+	0	+	16	+	0	+	0	+	2	+	0	= 18

Follow the steps below to convert the binary value 00010010 to decimal form:

1. Identify the bits set to 1; 00010010 indicates bits 1 and 4 are set to 1.
2. Convert bit 1 to its decimal value; bit 1 converts to 2
3. Convert bit 4 to its decimal value; bit 4 converts to 16
4. Add the decimal values of bits 1 and 4; $2 + 16 = 18$
5. Enter a value of 18 into the corresponding CV to adjust settings according to the binary value 00010010.

You can also convert by multiplying binary and decimal values and adding them together:

- | | |
|-----------------------------------|--|
| 1. Bit 0 = 0; $0 \times 1 = 0$ | 4. Bit 4 = 1; $16 \times 1 = 16$ |
| 2. Bit 1 = 1; $2 \times 1 = 2$ | 5. Bits 5-7 = 0; $0 \times 1 = 0$ |
| 3. Bits 2-3 = 0; $0 \times 1 = 0$ | 6. $0 + 2 + 0 + 0 + 16 + 0 + 0 + 0 = 18$; $00010010 = 18$ |

All Aboard!

Introduction to Programming

This section details CV programming modes, reading CVs, accessing indexed CVs, resetting CVs to factory defaults, and locking and unlocking CVs. Due to the varying CV programming methods used by DCC systems, we cannot provide comprehensive instructions that address every command station and must assume you understand the capabilities of your system on some level. Consult your DCC system manual or contact the manufacturer if you need more detailed programming instructions.

Configuration Variable Control CVs

CV 8: Manufacturer ID
CV 15: CV Unlock Code
CV 16: CV Lock ID
CV 30: Error Information
CV 31: CV Index 1
CV 32: CV Index 2
CVs 1.257-1.512: Indexed CV Page 1
CVs 2.257-2.512: Indexed CV Page 2

The sections of this user's guide are categorized according to each part of decoder operation, from basic to advanced programming, and allows you to configure one group of CVs at a time. When you're comfortable programming one set of CVs, move on to the next category and explore each setting Tsunami2 has to offer. Refer to the *Tsunami2 Electric Technical Reference* to for a list of CVs detailing each adjustable setting.

Programming Modes

Tsunami2 supports Operations Mode and Service Mode programming.

Operations Mode

Referred to as "Ops Mode" or "programming on the main," Operations Mode allows you to program CVs during operation even when other locomotives and rolling stock are present. Being able to program during operation simplifies re-creating prototypical scenarios. For example, you can increase the momentum of a locomotive after it couples to a train. However, because data cannot be read back from the decoder, programming on the main will not allow you to verify CV values.

Service Mode

Service Mode programming usually requires connecting the model to a dedicated programmer or placing it on a separate programming track. Tsunami2 supports four types of Service Mode instructions:

Address Mode: CV 1 may be modified

Register Mode: CVs 1, 2, 3, 4, 7, 8, and 29 may be modified

Paged Mode: A page register is used to modify any CV indirectly

Direct Mode: All CVs may be directly modified

Reading CVs

Some command stations that permit you to read the value of a CV and verify its setting in Service Mode programming. If you have trouble reading or verifying CVs, there may be a problem within the command station's design rather than with the decoder. Tsunami2 will display CV values on the screen of your command station for verification.

Try another programming mode if you experience difficulties programming or reading CVs. Many of the newer DCC systems automatically select the appropriate programming mode and only require you to enter the CV number and desired value. However, some DCC systems may restrict the number of available CVs. If you're having difficulty determining the programming modes supported by your DCC system, refer to the manual or contact the manufacturer.

Note: *Tsunami2 does not require a programming track booster, such as the PTB-100.*

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Indexed CVs

The term “indexed CVs” tends to cause confusion and consternation. Simply put, indexed CVs are located on ‘pages’ to help manage the total number of CVs. This is required by the NMRA DCC Standard and works like this:

The standard (S-9.2.2) requires that CVs exceeding CV 256 be contained within “indexed CV pages”. An individual set of CVs from 257-512 is contained within each indexed CV page. Pages are indicated in user documentation by a preceding number. For example, CV 257 on indexed page 1, would be represented as 1.257. CV 257 on indexed page 2 would be represented as 2.257 and so on. This preceding number is also the value to enter into CV 32 to select that page.

Indexed CVs are accessed with the use of two CVs: CV 31 enables indexing when set to a value of 16 (the default value) and CV 32 selects the desired indexed page.

Because of the number of features and options contained within Tsunami2 decoders, three pages of indexed CVs are provided:

To access CVs 1.257-1.512:

1. Ensure CV 31 is set to a value of 16.
2. Enter a value of 1 into CV 32 to select Indexed CV Page 1.
3. Select CVs 257-512 from your command station.

To access CVs 2.257-2.512:

1. Ensure CV 31 is set to a value of 16.
2. Enter a value of 2 into CV 32 to select Indexed CV Page 2.
3. Select CVs 257-512 from your command station.

To access CVs 3.257-3.512:

1. Ensure CV 31 is set to a value of 16.
2. Enter a value of 3 into CV 32 to select Indexed CV Page 3.
3. Select CVs 257-512 from your command station.

To make things easier, Tsunami2 CVs are grouped by like function as follows:

CVs 1.257-1.512 are used for configuring Flex-Map function mapping CVs. CVs 1.257-1.384 are used for function mapping CVs and CVs 1.385-1.512 are used for automatic effect configuration. Refer to “Configuring Function Mapping” for more information.

CVs 2.257-2.512 are used for adjusting alternate mixer channel volume levels and configuring Dynamic Digital Exhaust CVs. CVs 2.289-2.320 are for alternate mixer CVs and CVs 2.503-2.512 for DDE control CVs. Refer to “Configuring Throttle and Braking,” “Configuring Sound Effects” and “Configuring Dynamic Digital Exhaust” for more information.

CVs 3.257-3.512 are used for adjusting the clickety-clack rate of the clickety-clack and rail joints sound effects. Refer to “Configuring Sound Effects” for more information.

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Resetting CVs

Occasionally, something goes wrong and Tsunami2 will not respond as expected. Usually, this is caused by one or more CVs inadvertently being programmed to the wrong value. The CVs can be quickly reset to their factory default values. Follow the steps below to perform either a full or partial CV reset:

1. Turn on track power to the decoder. If you have a SoundTraxx CurrentKeeper™ or another device that maintains power, allow at least one minute before turning the power back on.
2. Enter one of the following values into CV 8 (Manufacturer ID) to perform a full or partial CV reset:

CV 8: Manufacturer ID
8 = Reset All CVs
9 = Reset CVs 1-128
10 = Reset CVs 129-256
11 = Reset CVs 1.257-1.512
12 = Reset CVs 2.257-2.512
13 = Reset CVs 3.257-3.512

3. Wait about 10 seconds after returning power to the decoder. The headlight and/or backup light will flash 16 times to indicate CVs have been successfully reset. Tsunami2 will respond to primary address 3 after all CVs, or CVs 1-128 have been reset.

Note: Continue cycling power to the decoder if the CV reset is unsuccessful. If you are unable to reset CV values, continue to “Locking and Unlocking CVs” to verify the decoder is not locked.

Locking and Unlocking CVs

The CV Lock/Unlock feature allows you to program a decoder without the danger of overwriting the programming in another. This is 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 decoder or the other.

CV 15, CV Unlock Code
CV 16, CV Lock Code
CV 30, Error Information

To use the CV Lock feature implemented in CVs 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.

CVs 15 and 16 are used for locking and unlocking the decoder. CV 15 is the Unlock Code and may be programmed to any value from 0 to 255 regardless of whether the decoder is locked or unlocked. CV 16 is the Lock Code and may be set to any value from 0 to 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 cannot be programmed in either Operations Mode or Service Mode. Further, a locked decoder cannot be reset to its factory defaults until it is unlocked. Tsunami2 decoders are shipped from the factory with all CVs unlocked, that is, CV 15 and 16 are both set to 0.

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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 use the CV Locking feature for a multi-decoder installation in one model, each decoder must first have its Lock Code set in CV 16 prior to the installation of any other decoders. Otherwise, all the decoders will have the same Lock Code and the feature will not work. 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.

Follow the steps below to lock and unlock CVs:

1. Enter a value of 1 into CV 30 (Error Information) to enable the CV lock/unlock feature.
2. Enter a value from 0 to 7 into CV 16 to set the lock code.
3. To unlock CVs, set CV 15 to the same value as CV 16.
4. To lock CVs, set CV 15 to a different value than CV 16 to lock CVs.

Note: CV 8 (Manufacturer ID) cannot be used to reset CVs to factory defaults when CVs are locked, i.e., when CV 30 is set to 1 and CVs 15 and 16 are not set to the same value.

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: Using CV Lock/Unlock

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 (CV Unlock Code) 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 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 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 from 0 to 7. If you have tried setting CV 15 to all eight values from 0 to 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.

To reiterate, follow the steps below to unlock CVs and determine the lock code:

All Aboard!

1. Place the model on the programming track and enter a value of 0 into CV 15.
2. Try reading the value of CV 16. If the value is not read back, CVs are locked.
3. Enter a value of 1 into CV 15 and try reading the value of CV 16 again.
4. If the value is not read back, enter a value of 2 into CV 15 and try again.
5. Enter values 3-7 into CV 15 until the value of CV 16 is read back and CVs are unlocked.

If you still can't identify the lock code, there may be a problem with the installation, programming track, or decoder. Contact SoundTraxx customer support if this occurs.

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 (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 0, 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: 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 properly (i.e., making sound and responding to throttle 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.

Basic Programming

Configuring the Address

Like all DCC decoders, Tsunami2 responds to primary address 3 right out of the package. Address control CVs allow you to set primary and extended addresses or your choice, which can be useful when matching the decoder's address with the number on the locomotive, for instance.

Address Control CVs

CV 1: Primary Address

CVs 17-18: Extended Address

Setting Addresses

Tsunami2 recognizes either the primary address (also known as the short address) in CV 1 or the extended (long) address in CVs 17-18 (Extended Address). 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, so 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.

Programming Notes: *You can set the primary and extended addresses in Service Mode at any time. Some DCC systems also allow you to set the address in Operations Mode according to the following restrictions:*

- *If the decoder's primary address is enabled (bit 5 of CV 29 set to 0), only the extended address can be changed in Operations Mode.*
- *If the decoder's extended address is enabled (bit 5 of CV 29 set to 1), only the primary address can be changed in Operations Mode.*

Primary Address

Enter a value from 1 to 127 into CV 1 to set the primary address. All SoundTraxx decoders are set to primary address 3 by default.

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 decoder to accept the new data (see the *Tsunami2 Diesel 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.

After setting the extended address, set bit 5 of CV 29 (Configuration Data 1) to 1 to enable its usage. If bit 5 of CV 29 is set to 0, the decoder will continue to respond to the primary address. Continue to "Configuring the Decoder" for more information about CV 29.

Basic Programming

Configuring the Decoder

After setting the address, we recommend you adjust the settings of CV 29 (Configuration Data 1). CV 29 controls a variety of important settings. It determines locomotive direction, speed-step mode, alternate power source, speed tables, and the decoder address.

Decoder Configuration CVs CV 29: Configuration Data 1

Configuring CV 29

Add the values of all bits set to 1 in CV 29 and enter the sum into the CV to adjust settings. For information about CVs and entering CV values, refer to “CV Programming Tutorial.”

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	EAM	STE	0	APS	F0	DIR

+1 = Bit 0 (DIR) set to 1
+2 = Bit 1 (F0) set to 1
+4 = Bit 2 (APS) set to 1
+16 = Bit 4 (STE) set to 1
+32 = Bit 5 (EAM) set to 1

DIR: Locomotive Direction

Bit 0 (DIR) is used to determine locomotive direction. Setting bit 0 to 1 will invert direction commands, and the decoder will interpret forward as reverse, and reverse as forward. 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 dismantling the locomotive a second time.

F0: F0 Location (Speed-Step Mode Select)

Bit 1 (F0) is used to determine the number of speed steps within the throttle range. 14, 28, and 128 speed-step modes are available, and 28/128 speed-step mode has been enabled by default. Select the highest number of speed steps supported by your command station for the most refined throttle operation.

APS: Alternate Power Source (Analog Mode)

Setting bit 2 (APS) to 1 will allow the decoder to use an analog power source when a DCC signal is not present. Entering a value of 1 into CV 12 (Alternate Power Source) will enable analog mode (disabled by default). Refer to “Configuring for Analog Mode Operation” for more information.

STE: Speed Table Enable

Setting bit 4 (STE) to 1 will select a linear or 28-point custom speed table in place of the 3-point speed table. Refer to “Configuring Throttle and Braking” for more information.

EAM: Primary or Extended Address

Bit 5 (EAM) is used for selecting the active address. Setting bit 5 to 1 will enable the primary address. Set the primary address with CV 1 (Primary Address). CVs 17 and 18 (Extended Address) are used to set the extended address. Set bit 5 of CV 29 to 1 to enable the extended address. Refer to the previous section, “Configuring the Address,” for more information about setting the extended address.

Refer to Table C on the following page to view decimal values for CV 29.

Basic Programing

Table C. CV 29 Reference					
Address Type	Speed Table	Analog Mode	Speed Steps	Direction	CV 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 (CV 17:18)	No	No	14	Normal	32
Extended (CV 17:18)	No	No	14	Reversed	33
Extended (CV 17:18)	No	No	28/128	Normal	34
Extended (CV 17:18)	No	No	28/128	Reversed	35
Extended (CV 17:18)	No	Yes	14	Normal	36
Extended (CV 17:18)	No	Yes	14	Reversed	37
Extended (CV 17:18)	No	Yes	28/128	Normal	38
Extended (CV 17:18)	No	Yes	28/128	Reversed	39
Extended (CV 17:18)	Yes	No	14	Normal	48
Extended (CV 17:18)	Yes	No	14	Reversed	49
Extended (CV 17:18)	Yes	No	28/128	Normal	50
Extended (CV 17:18)	Yes	No	28/128	Reversed	51
Extended (CV 17:18)	Yes	Yes	14	Normal	52
Extended (CV 17:18)	Yes	Yes	14	Reversed	53
Extended (CV 17:18)	Yes	Yes	28/128	Normal	54
Extended (CV 17:18)	Yes	Yes	28/128	Reversed	55

Note: Values in Table C are shown in decimal format. If your command station requires hex inputs, you will need to convert. Refer to Appendix A for conversions.

Basic Programming

Configuring Throttle and Braking

You can use throttle and braking control CVs to customize the decoder's throttle and braking settings to your operating preferences. This section details setting acceleration and deceleration rates, automatically calibrating Dynamic Digital Exhaust (DDE) load compensation, setting braking rates for the independent and train brake functions, adjusting speed table settings, and enabling motor trim scaling factors.

If this is overwhelming at first glance, don't worry! You don't have to adjust all of the throttle control CVs. This section guides you through adjusting the decoder's throttle and braking one group of CVs at a time to allow you to decide what works best.

Setting the Start Voltage

Tsunami2 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:

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

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.

Setting Momentum Rates

Tsunami2 provides two CVs to simulate the momentum due to train weight. CV 3 (Baseline Acceleration Rate) controls how fast the locomotive responds to increases in throttle settings. CV 4 (Baseline Deceleration Rate) controls how fast the locomotive will respond to decreases in the throttle setting.

Both CVs can be programmed with any value from 0 to 255, with 255 corresponding to the slowest acceleration or deceleration 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. Setting acceleration and deceleration rates can allow the speed of the locomotive to match the sound effects regulated by Dynamic Digital Exhaust.

When using 14 or 28 speed-step mode, configuring acceleration and deceleration rates will improve the decoder's throttle response. This allows the locomotive to speed up and slow down without lurching from one speed step to the next.

Throttle and Braking Control CVs

CV 2: Vstart
CV 3: Baseline Acceleration Rate
CV 4: Baseline Deceleration Rate
CV 5: Vhigh
CV 6: Vmid
CV 25: Speed Table Enable
CV 29: Configuration Data 1
CV 32: CV Index 2
CV 66: Forward Motor Trim
CVs 67-94: Custom Speed Table
CV 95: Reverse Motor Trim
CV 117: Independent Brake Rate
CV 118: Train Brake Rate
CV 2.503: DDE Load Offset
CV 2.504: DDE Load Slope
CV 2.512: DDE Load Sensitivity

Basic Programming

Calibrating DDE Load Compensation

Tsunami2 features a cutting-edge new version of our already revolutionary Dynamic Digital Exhaust! We highly recommend you automatically calibrate Dynamic Digital Exhaust settings before adjusting throttle and braking control CVs. This will create an amazingly accurate representation of prototypical operation. Although traction motor sound effects respond to the demand on the motor by default, you can automatically calibrate DDE according to the specifics of your installation and model. This will allow the decoder to produce more prototypical traction motor responses when encountering changes in both grade and number of cars, during operation. To adjust all DDE settings provided by Tsunami2, refer to “Configuring Dynamic Digital Exhaust.”

Follow the steps below to automatically calibrate DDE load compensation:

1. Ensure CV 31 (CV Index 1) is set to a value of 16 (default).
2. Enter a value of 2 into CV 32 to select Indexed CV Page 2. This allows you to adjust DDE control CVs by accessing CVs 2.503-2.512 from your command station.
3. Set CV 512 (DDE Load Sensitivity) to a value of 16.
4. We suggest running the locomotive at a moderate speed for a minute or two before continuing. If there is any build-up of lubrication or oil in the motor, this will provide better results during the calibration procedure.
5. Set the throttle to speed-step 1.
6. When your locomotive is on level track, enter a value of 255 into CV 503 (DDE Load Offset) to automatically calibrate the nominal low-speed load level.
7. Increase the throttle to an appropriate moderate speed for your layout (generally between speed-step 25 and speed-step 40).
8. When your locomotive is on level track, enter a value of 255 into CV 504 (DDE Load Slope) to automatically calibrate the nominal high-speed load level.

Note: If, after the calibration is complete, you feel the need to increase or decrease the sensitivity, you can do this with CV 2.512.

Setting Braking Rates

Although you can activate the independent brake and train brake sound effects with function keys by default, CV 117 (Independent Brake Rate), and CV 118 (Train Brake Rate) allow you to use the independent brake and train brake functions (F11) to reduce locomotive speed and simulate actually applying brakes during operation. We recommend setting CV 3 (Baseline Acceleration Rate) to a minimum value of 45 before setting braking rates to allow for smoother operation when the brakes are applied and released.

Braking Rate CV Values
0 = CV 4 + 0 (Disabled)
1 = CV 4 + 1
↓
127 = CV 4 + 127
128 = CV 4 + 0 (Disabled)
129 = CV 4 - 1
↓
255 = CV 4 - 127

The values of CVs 117 and 118 are added to the value of CV 4 (Baseline Deceleration Rate) and determine how quickly your locomotive decelerates when brakes are applied. Enter values from 0 to 127 into CVs 117 and 118 to set longer braking rates, and enter values from 129 to 255 to set shorter braking rates. The independent brake and train brake functions will not reduce locomotive speed when CVs 117, and 118 are set to values of 0 or 128.

Note: When consisting with active momentum and braking rates, ensure the values of CVs 3, 4, 117, and 118 are the same for all units.

Basic Programming

Set the Independent Brake Rate

The independent brakes on prototype locomotives are applied separately from the rest of the train, generally during switching operations and to control slack between units. CV 117 determines the deceleration rate that will bring the locomotive to a stop when the independent brake function is turned on. Turning off the independent brake function will release brakes and allow the locomotive to accelerate back to the prior throttle setting. Enter a value from 0 to 255 into CV 117 to set the independent brake rate:

$$\text{Seconds/Speed Step} = (\text{CV 4} + \text{CV 117}) \times 0.896 \div \text{Number of Speed Steps}$$

Note: *The brake select function (F12 by default) must be turned off for the independent brake rate to be activated with the independent brake function.*

Set the Train Brake Rate

On a prototype locomotive, the train brake controls the brakes for each unit in the train and is the braking method most commonly used to reduce speed. CV 118 determines the deceleration rate that will bring the locomotive to a stop when the train brake function is turned on. Turning off the train brake function will release brakes, cycle the air compressor for 15 seconds, and allow the locomotive to accelerate back to the prior throttle setting. Enter a value from 0 to 255 into CV 118 to set the train brake rate:

$$\text{Seconds/Speed Step} = (\text{CV 4} + \text{CV 118}) \times 0.896 \div \text{Number of Speed Steps}$$

Note: *The brake select function (F12 by default) must be turned on for the train brake rate to be activated with the train brake function.*

Example: Prototypical Braking

Tsunami2 has more ways to prototypically operate your model, and the independent and train brake functions are a great example! The steps below will guide you through setting recommended momentum and braking rates and using the dynamic brake, independent brake, and train brake functions prototypically while you operate:

1. Enter a value of 45 into CV 3 to allow the locomotive to accelerate in sequence with the exhaust chuff sound effects regulated by Dynamic Digital Exhaust.
2. Enter a value of 75 into CV 4 to set the deceleration rate that allows the locomotive to coast to a stop without any of the brakes being applied.
3. Because independent brakes are most often applied when running only a locomotive, you may want to set CV 117 to a value of 178 for a more rapid braking rate.
4. Because an entire train takes longer to bring to a stop than just a locomotive, you may want to set CV 118 to a value of 100 for a more gradual braking rate.
5. When running a light locomotive or a consist of only locomotives, apply the independent brake with the independent brake function (F11 by default). The brake select function (F12 by default) must be turned off for the independent brake to be applied.
6. When running a complete train, apply the train brake with the train brake function (F11 by default). The brake select function must be turned on for the train brake to be applied. Turning on the brake select function will cycle the air compressor to simulate charging the train line.

Basic Programming

Setting the 3-Point Speed Curve

By default, track voltage is distributed to the decoder with no variation in a straight line and the decoder responds instantly to the throttle setting. You can designate the amount of voltage applied at the first, middle, and last speed step with CV 2 (Vstart), CV 5 (Vhigh), and CV 6 (Vmid) to compensate for track power or throttle control inefficiencies. First, set bit 4 (STE) of CV 29 to 0. Then enter values from 1 to 255 into CVs 2, 5, and 6 to set the 3-point speed curve. Each value is equivalent to roughly 0.5% of the total supply voltage. Use the calculations below to determine starting, mid-point, and maximum voltage settings:

$$V_{start}, V_{mid}, V_{high} = \text{Supply Voltage} \times \text{CV Value} \div 255$$

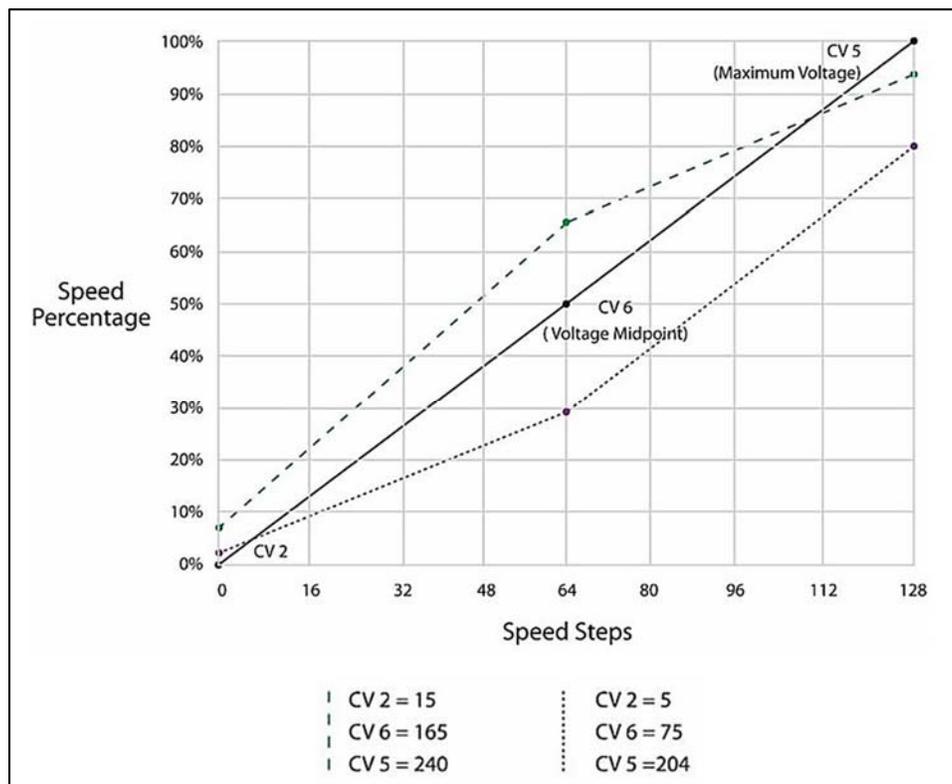
Note: Use CV 218 (Analog Mode Motor Start Voltage) to set the starting voltage level for analog mode operation. Refer to “Configuring for Analog Mode Operation” for more information.

If your system supports Operations Mode, refer to the steps below for an alternative method of setting the 3-point speed curve:

1. Place the unit on the mainline and set the throttle to speed-step 1, and then increase the value of CV 2 until the model responds to your preferred starting voltage.
2. Set the throttle to a medium speed step, and then increase the value of CV 6 until the model responds to your preferred mid-speed voltage.
3. Set the throttle to the maximum speed step, and then increase the value of CV 5 until the model responds according to your preferred high-speed voltage level.

Use the 3-Point Speed Curve

The figure shown below gives an example of how CVs 2, 5, and 6 can be used to change voltage levels during operation.



Basic Programming

Setting the Custom Speed Table

Tsunami2 offers a custom speed table with 28 adjustable speed points. The 28-point custom speed table is disabled by default. However, you can enable it with CV 25 (Speed Table Enable) and CV 29 (Configuration Data 1), and then adjust each speed point with CVs 67-94 (Custom Speed Table). This allows you to speed-match one locomotive to another, set a prototypical speed range, compensate for design flaws in the driveline, or improve switching operations by setting more speed steps to lower speeds and fewer speed steps to higher speeds.

CVs 67-94 correspond to speed points 1-28. Table D shows default values for CVs 67-94, which create a linear speed table when the custom speed table is enabled. Enter values from 0 to 255 into CVs 67-94 adjust each speed point from 0% to 100% of the maximum throttle setting.

The decoder interpolates between speed steps for more refined throttle control when 28/128 speed-step mode is active. Each speed point of the custom speed table corresponds to a number of speed steps. In 14 speed-step mode, each speed point is equivalent to 0.5 speed steps. In 28 speed-step mode, each speed point is equivalent to one speed step. In 128 speed-step mode each speed point is equivalent to 4.5 speed steps.

Note: All 28 speed points of the custom speed table must be set when using 14, 28, or 128 speed-step mode to prevent an unpredictable response from the motor when accelerating and decelerating.

Follow the steps below in reference to Table D to enable the 28-point custom speed table and adjust each speed point with CVs 67-94:

1. Designate each speed point of the 28-point speed table as a percentage from 0% to 100% of the maximum speed.
2. Enter each speed point's percentage into the equation below to determine values for CVs 67-94:

$$\text{CV Value} = 255 \times (\% \div 100)$$

3. Enter CV values for speed points 1-28 into CVs 67-94 to configure the 28-point custom speed table.
4. Set bit 4 (STE) of CV 29 to 1 to enable speed tables.
5. Enter a value of 16 into CV 25 to enable the 28-point custom speed table.

Table D. 28-Point Speed Table Settings

CV	Value	% of Throttle
67	9	4
68	18	7
69	27	11
70	36	14
71	45	18
72	55	22
73	64	25
74	73	29
75	82	32
76	91	36
77	100	39
78	109	43
79	118	46
80	127	50
81	137	54
82	146	57
83	155	61
84	164	64
85	173	67
86	182	71
87	191	75
88	200	78
89	209	82
90	219	86
91	228	89
92	237	93
93	246	96
94	255	100

Basic Programing

Setting Motor Trim

CV 66 (Forward Motor Trim) and CV 95 (Reverse Motor Trim) are used to “trim” the forward and reverse drive voltages when the 28-point custom speed table is enabled. Setting motor trim can help compensate for speed differences between forward and reverse directions. For instance, if the throttle setting is the same in both directions and the locomotive appears to be moving faster in reverse, you can use CVs 66 and 95 to correct the speed difference.

Entering values from 0 to 255 into CVs 66 and 95 will multiply the forward and reverse drive voltages by a scaling factor. Enter values from 1 to 127 to decrease speed. Enter values from 129 to 255 to increase speed. Entering a value of 0 or 128 into CVs 66 and 95 will set the scaling factor to 1 and will not modify the decoder’s drive voltage.

Note: *Bit 4 (STE) of CV 29 (Configuration Data 1) must be set to 1 for the motor trim scaling factors in CVs 66 and 95 to modify forward and reverse drive voltages.*

Motor Trim Values
0 = Disabled
1 = Voltage × 0.008
↓
127 = Voltage × 0.99
128 = Disabled
129 = Voltage × 1.008
↓
255 = Voltage × 1.99

Basic Programming

Configuring Lighting Outputs

Tsunami2 provides up to six lighting outputs (depending on the board format). Lighting output control CVs allow you to enable Hyperlight effects, Grade-Crossing Logic, phase offset, and LED Compensation Mode for each lighting output, determine lighting output direction, adjust the flash rate of flashing Hyperlight effects, and set lighting output brightness levels.

Enabling Hyperlight Effects and Features

You can use CVs 49-54 to enable Hyperlight lighting effects and features for the headlight, backup light, and FX3-FX6 lighting outputs. This section details each Hyperlight effect and feature and shows you how to customize lighting outputs to fit your operating preferences.

On/Off Output

The on/off lighting effect provides on/off control for the corresponding function.

Dimmable On/Off Headlight

The output set to the dimmable headlight will be reduced to the brightness setting in CV 63 when you turn on the dimmer function (F7 by default).

Mars Light

The Mars light warning beacon follows the famous figure-eight sweep pattern and oscillates more rapidly than the Gyalrite.

Pyle-National Gyalrite

The Pyle-National Gyalrite follows a wide sweep pattern that oscillates at a slower rate than the Mars light.

Oscillating Headlight

The dual-oscillating headlight generates two beams that follow each other in a tight, circular sweep pattern.

Single-Flash Strobes 1 and 2

The xenon single-flash strobe 1 effect flashes once during each flash rate timing cycle. The xenon single-flash strobe 2 flashes once during each flash rate timing cycle at a slightly different rate. Setting both single-flash strobes to the same lighting output allows each strobe to flash in-and-out of sequence. CV 59 is used to modify the flash rate timing cycle.

Lighting Output Control CVs

CV 49: Headlight Configuration
 CV 50: Backup Light Configuration
 CV 51: FX3 Configuration
 CV 52: FX4 Configuration
 CV 53: FX5 Configuration*
 CV 54: FX6 Configuration*
 CV 57: Forward Direction Enable
 CV 58: Reverse Direction Enable
 CV 59: Hyperlight Flash Rate
 CV 60: Grade-Crossing Hold Time
 CV 61: Brightness Register 1
 CV 62: Brightness Register 2
 CV 63: Dimmer Level
 CV 64: Master Brightness Level

*Available on select formats

Table E. Hyperlight Effect Select

Value	Lighting Effect
0	On/Off Output
1	Dimmable On/Off Headlight
2	Mars Light
3	Pyle-National Gyalrite
4	Oscillating Headlight
5	Single-Flash Strobe 1
6	Double-Flash Strobe
7	Western-Cullen Rotary Beacon
8	Prime Stratolite
9	Ditch Light I
10	Ditch Light II
11	FRED
12	Engine Exhaust Flicker (Steam)
13	Firebox Flicker (Steam)
14	Smart Firebox Flicker (Steam)
15	Dyno-Light (Steam)
16	Auto-Dim Forward
17	Auto-Dim Reverse
18	Brake Light
19	On/Off – Brightness 1
20	On/Off – Brightness 2
21	Emergency Gyalrite
22	Electrical Arcing (Electric)
23	Ash Pan Flicker (Steam)
24	Reserved
25	Single-Flash Strobe 2

+32	Phase Offset (Phase B)
+64	Grade-Crossing Logic
+128	LED Compensation Mode

Basic Programming

Double-Flash Strobe

The xenon double-flash strobe effect emits two rapid flashes of light during each flash rate timing cycle. CV 59 is used to modify the flash rate timing cycle.

Western-Cullen D312 Rotary Beacon

The Western-Cullen D312 Rotary Beacon effect follows a revolving reflector and bulb assembly flash-pattern.

Prime Stratolite

The Stratolite is a new version of the rotary beacon. Four individual lamps are arranged in a circular pattern and flash electronically in the clockwise direction. The Stratolite flashes in a mechanical “stepped” fashion, unlike the smooth motion of the rotary beacon.

Ditch Lights I and II

Ditch lights I and II flash together by default. When Grade-Crossing Logic is enabled, ditch light I assumes a steady “on” state before and after the crossing hold timer countdown. Conversely, ditch light II will remain off before and after the crossing hold timer countdown. To configure alternating ditch lights, set one lighting output to ditch light I or II and enable Grade-Crossing Logic, and then set a second lighting output to the same ditch light and enable Grade-Crossing Logic and phase offset.

FRED (Flashing Rear End Device)

The FRED effect is a flashing red taillight that indicates the rear of the train.

Auto-Dim Forward and Reverse

The auto-dim forward effect will automatically dim lighting outputs to the dimmer level in CV 63 when in the forward direction, and the auto-dim reverse effect will automatically dim lighting outputs to the dimmer level in CV 63 when in the reverse direction.

Brake Light

The brake light effect is dimmed to the brightness setting in CV 63 when active. The brake light brightness level will be automatically set to 100% when you turn on the independent or train brake function (F11 by default).

On/Off Brightness 1 and 2

The on/off brightness 1 and 2 effects will set lighting outputs to the brightness levels of CVs 61 and 62, respectively.

Emergency Gyalite

The emergency Gyalite follows the same oscillating sweep pattern as the Gyalite, and will automatically disable all active lighting effects.

Electrical Arcing

The electrical arcing effect produces a simulated “shower of sparks” in time with the electrical arcing sound effect to simulate the pantograph breaking contact with the overhead wire. This effect only works above speed step 10 in 128 speed step mode.

Phase Offset

Add a value of 32 to the value of flashing Hyperlight effects to set the corresponding lighting output to Phase B from Phase A. Flashing effects set to Phase B will flash opposite of flashing effects set to Phase A, i.e., Phase A turns off when Phase B turns on, and Phase A turns on when Phase B turns off.

Basic Programming

Grade-Crossing Logic

Grade-Crossing Logic allows you to set up lighting functions, the bell, and airhorn to automatically simulate encountering grade crossings. Add a value of 64 to enable Grade-Crossing Logic. Turning on the long airhorn function (F2 by default) or the grade-crossing signal function (F9 by default) will start the crossing hold timer countdown and allow lighting effects to assume a flashing state. Shown in Table F, flashing Hyperlight effects will return to an on or off state after the countdown ends. Practice activating Grade-Crossing Logic as your locomotive approaches a grade crossing. You can adjust the crossing hold timer countdown from 0 to 15 seconds by entering a value from 0 to 15 into CV 60 (Grade-Crossing Hold Time).

Table F. Flashing Effect On/Off State

Hyperlight Effect	On/Off State
Mars Light	On
Gyalite	On
Oscillating Headlight	On
Single-Flash Strobe 1	Off
Single-Flash Strobe 2	Off
Double-Flash Strobe	Off
D312 Rotary Beacon	Off
Prime Stratolite	Off
Ditch Light I	On
Ditch Light II	Off
FRED	Off

To allow the bell to ring during the crossing hold timer countdown, enable the grade-crossing bell in CV 122 (Bell Select). Refer to “Configuring Sound Effects” for more information about the grade-crossing bell.

LED Compensation Mode

The brightness of an incandescent bulb is determined by voltage, whereas an LED’s brightness is determined by current. LED Compensation Mode alters the method of sending current to the LED to balance the LED and incandescent brightness levels. Add a value of 128 to enable LED Compensation Mode for the corresponding lighting output.

Note: *Enabling LED Compensation Mode will not change the output voltage. Resistors may still be necessary depending on the board format.*

Adjusting Lighting Output Settings

After configuring Hyperlight effects and features with CVs 49-54, adjust CV 57 (Forward Direction Enable), CV 58 (Reverse Direction Enable), CV 59 (Hyperlight Flash Rate), CV 61 (Brightness Register 1), CV 62 (Brightness Register 2), CV 63 (Dimmer Level), and CV 64 (Master Brightness Register) to customize lighting output direction, the Hyperlight flash rate, and brightness levels.

Enable Lighting Output Direction

CV 57 determines the lighting outputs active in the forward direction, and CV 58 determines lighting outputs active in the reverse direction. Table G shows values used to enable lighting outputs for the forward and reverse directions. To enable lighting outputs for the forward direction, add the values of your preferred lighting outputs and enter the sum into CV 57. To enable lighting outputs for the reverse direction, add the values of your preferred lighting outputs and enter the sum into CV 58.

Table G. CVs 57-58 Values

Lighting Output	CV Value
Headlight	+1 to enable
Backup Light	+2 to enable
FX3 Output	+4 to enable
FX4 Output	+8 to enable
FX5 Output	+16 to enable
FX6 Output	+32 to enable

The headlight is disabled in the reverse direction and the backup light is disabled for the forward direction by default, i.e., CV 57 is set to 61 by default and CV 58 is set to 62 by default.

Basic Programming

Set the Hyperlight Flash Rate

Adjust the flash rate of flashing Hyperlight effects from the fastest setting to the slowest setting by entering a value from 0 to 15 into CV 59.

Adjust Brightness Registers 1 and 2

Adjust the brightness level of lighting outputs set to the on/off brightness 1 effect from 0% to 100% by entering a value from 0 to 255 into CV 61. Adjust the brightness level of lighting outputs set to the on/off brightness 2 effect from 0% to 100% by entering a value from 0 to 255 into CV 62.

Adjust the Dimmer Level

Adjust the brightness level of the dimmer function (F7 by default) from 0% to 100% by entering a value from 0 to 255 into CV 63. The dimmer level is set to 60% brightness by default.

Adjust the Master Brightness Level

Adjust the brightness level of all lighting outputs from 0% to 100% by entering a value from 0 to 255 into CV 64. CV 64 adjusts the brightness levels of lighting outputs set to on/off brightness 1 or on/off brightness 2 from the brightness levels of CV 61 and CV 62, respectively. This does not eliminate the need for resistors. Due to the nature of certain lighting effects, values below 100 may diminish its overall effectiveness.

Example: Alternating Ditch Lights

This example details using CV 51 (FX3 Configuration) and CV 52 (FX4 Configuration) to enable alternating ditch lights for Grade-Crossing Logic. Follow the steps below to set ditch lights to the FX3 and FX4 lighting outputs and allow them to alternate during the crossing hold timer countdown after Grade-Crossing Logic is activated:

1. Add CV values for Grade-Crossing Logic and ditch light I. Add 64 for Grade-Crossing Logic and 9 for ditch light I:

$$64 + 9 = 73$$

2. Enter a value of 73 into CV 51 to set the FX3 lighting output to ditch light I (Phase A) and enable Grade-Crossing Logic. Add a value of 128 for LED Compensation Mode if desired.
3. Add the CV values for Grade-Crossing Logic, phase offset, and ditch light I. Add 64 for Grade-Crossing Logic, 32 for phase offset, and 9 for ditch light I:

$$64 + 32 + 9 = 105$$

4. Enter a value of 105 into CV 52 to set the FX4 lighting output to ditch light I with phase offset (Phase B) and enable Grade-Crossing Logic. Add a value of 128 for LED Compensation Mode if desired.

As your locomotive approaches a grade crossing, turn on the long airhorn function (F2 by default) to activate Grade-Crossing Logic. Ditch lights will assume a steady “on” state during the airhorn blast, and then the FX3 ditch light (Phase A) will flash opposite of the FX4 ditch light (Phase B) when the crossing hold timer countdown begins. Ditch lights will revert to a steady “on” state after the crossing hold timer countdown ends.

Basic Programming

Example: Headlight and Backup Light Direction

This example details using CVs 57 and 58 to configure the directionality of the headlight and backup light outputs. Follow the steps below to turn the headlight and the backup lights on regardless of direction:

1. Note the bit definitions and the decimal value of each bit for CVs 57 and 58 (See Table G.). Bits 0-5 correspond to lighting outputs.
2. Setting all bits (0-5) to 1 in CV 57 will enable all lights in the forward direction. To do this, simply add the decimal values of all the outputs:

$$1 + 2 + 4 + 8 + 16 + 32 = 63$$

3. Enter a value of 63 into CV 57 to enable all lights in the forward direction.
4. Setting all other bits (0-5) to 1 in CV 58 will enable all lights in the reverse direction. To do this, simply add the decimal values of all the outputs:

$$1 + 2 + 4 + 8 + 16 + 32 = 63$$

5. Enter a value of 63 into CV 58 to enable all lights in the reverse direction.

Basic Programing

Configuring Sound Effects

Sound control CVs allow you to fully customize the decoder's sound effects to fit your preferences. All sound effects included in Tsunami2 are recordings from actual locomotives and simulate the reality of operating an electric locomotive.

This section shows you how to:

1. Select different airhorns, bells, air compressors, and couplers in place of the default sound effects.
2. Customize electric traction motor features, such as auto-start, auto-notching and engine interlock.
3. Modify aspects of automatic sound effects, including the clickety-clack rate and scale, poppet valve release rate, coach door count, and Fireman Ed probability settings.
4. Adjust the volume levels of primary and alternate sound effect mixer channels, and enable quiet mode.

Sound Control CVs

CV 112: Sound Configuration 1
CV 113: Quiet Mode Time-Out Period
CV 114: Engine Exhaust Control
CV 120: Airhorn Select
CV 121: Auxiliary Airhorn Select
CV 122: Bell Select
CV 124: Air Compressor Select
CV 126: Coupler Select
CV 128: Master Volume
CVs 129-160: Primary Mixer Volume Levels
CVs 2.289-2.320: Alternate Mixer Volume Levels

Selecting Sound Effects

You can select alternate airhorns, bells, air compressors, and couplers with sound effect select CVs.

Select the Primary Airhorn

Enter a value from 0 to 41 into CV 120 (Airhorn Select) to select your desired primary airhorn. Turn on the long airhorn function (F2 by default) to blow the airhorn and press the function key again to stop the airhorn blast.

CV 120: Airhorn Select

0 = Primary airhorn 1 (default)
1 = Primary airhorn 2
↓
41 = Primary airhorn 42

Select the Alternate Airhorn

Use CV 121 (Auxiliary Airhorn Select) to select an alternate airhorn in place of the primary airhorn. The alternate airhorn is disabled by default. However, when enabled, turning on the short airhorn function (F3 by default), and then turning on the long airhorn function (F2 by default) will issue the alternate airhorn sound effect; turn off the long airhorn function to stop the airhorn blast.

CV 121: Auxiliary Airhorn Select

0 = Disabled (default)
1 = Alternate airhorn 1
2 = Alternate airhorn 2
↓
42 = Alternate airhorn 42

Remember, you can activate the alternate airhorn with the long airhorn function *only* when the short airhorn function is turned on. Set CV 121 to a value from 1 to 42 to select the alternate airhorn; the alternate airhorn is disabled when CV 121 is set to a value of 0.

Note: CV 121 is set to 0 by default disable the alternate airhorn. By default, the short airhorn function will issue the short airhorn blast and the long airhorn function will issue the airhorn 1 sound effect.

Basic Programming

Select the Bell

Each decoder version has a selection of bells at varying ring rates. Refer to the Sound Selection Reference for the decoder to determine the correct values. Enter the desired value into CV 122 and turn on the bell function (F1 by default) to ring the bell. Press the function key again to stop the bell from ringing. Add a value of 128 to enable the grade-crossing bell. Enabling the grade-crossing bell in CV 122 allows the bell to ring during the crossing hold timer countdown after activating Grade-Crossing Logic with the airhorn function (F2 by default). For more information about Grade-Crossing Logic, refer to “Configuring Lighting Outputs.”

Select the Air Compressor

Enter a value from 0 to 3 into CV 124 (Air Compressor Select) to select your desired air compressor. The air compressor plays automatically during operation.

CV 124: Air Compressor Select

0 = Air compressor 1
1 = Air compressor 2
2 = Air compressor 3
3 = Air compressor 4

Select the Coupler

Enter a value from 0 to 2 into CV 126 (Coupler Select) to select your desired coupler. Activate the coupler selected in CV 126 with the couple (F13 by default) and uncouple (F13 by default). Add a value of 128 to invert the uncouple function polarity. Inverting the uncouple function polarity allows the uncouple sound effect to be activated when you turn off the uncouple function.

CV 126: Coupler Select

0 = Medium coupler (default)
1 = Heavy coupler
2 = Link-and-pin coupler

Inverted Uncouple Polarity: CV 126 + 128

The uncouple function polarity must be inverted in CV 126 in order to activate the uncouple sound effect by turning off the uncouple function. For example, when the couple and uncouple functions are mapped to the same function key and the uncouple function polarity is inverted in CV 126, turning on the couple function with the function key will activate the couple sound effect, and turning off the uncouple function with the function key will activate the uncouple sound effect. If the couple and uncouple functions are not mapped to the same function key and the uncouple function polarity is not inverted in CV 126, turning on the couple function will activate the couple sound effect, and turning on the uncouple function will activate the uncouple sound effect. To map effects to function keys F0-F28, Refer to “Configuring Function Mapping.”

Customizing the Traction Motor Sounds

CV 114 (Engine Exhaust Control) is used to customize traction motor sound effects to fit your operating preferences.

CV 114: Adjust Auto-Notching Sensitivity

Add a value from 1 to 15 to CV 114 to adjust the number of speed steps within each traction motor notch from 1 to 15. Auto-notching is set to 4 speed steps by default.

Auto-Notching Sensitivity

CV 114 + 0 = Auto-notching disabled
CV 114 + 1 = 1 speed step
CV 114 + 2 = 2 speed steps
↓
CV 114 + 15 = 15 speed steps

CV 114: Enable Engine Interlock

Add a value of 16 to CV 114 to enable engine interlock. When engine interlock is enabled, you must turn on the Pantograph Extend, Retract function to energize the system before setting the locomotive into motion. Similarly, you will be unable to de-energize the system during movement. In other words, the locomotive must be stopped before you extend or retract the pantograph. Engine interlock is disabled by default.

Basic Programming

CV 114: Enable Auto-Start

Auto-Start is enabled from the factory in CV 114 to allow the pantograph to automatically extend and energize the system when the decoder receives track power. For DCC operation, the pantograph will not extend when the decoder receives track power when auto-start is disabled. For analog mode (DC) operation, the pantograph will automatically extend and energize the system when the decoder receives track power regardless of CV 114.

Adjusting Volume Levels

Volume control CVs allow you to set the master volume level for all sound effects, set the volume of each sound effect, and enable quiet mode.

Adjust the Master Volume Level

CV 128 (Master Volume) is used to adjust the volume level of all enabled sound effects, i.e., all mixer channels. Values from 0 to 255 may be programmed into CV 128 to set the volume level from 0% to 100%.

Adjust Primary Mixer Volume Levels

CVs 129-160 (Primary Mixer Volume Levels) are used for setting the volume level of each sound effect, similar to a modern sound studio mixing board. Like CV 128 (Master Volume), values from 0 to 255 may be programmed into mixer channel CVs to adjust volume levels. For the best sound quality, run the mixer as “hot” as possible by optimizing the volume levels. First determine the sound effect that should be the loudest and set the corresponding CV to around 225. The airhorn, for instance, usually creates the loudest sound. Then, adjust the volume levels of the remaining of the sound effects relative to the airhorn. When you have all the sound effects to their respective volume levels, adjust the overall volume level with CV 128 as needed.

Adjusting volume levels calls for a certain level of prudence to avoid “clipping” or “limiting,” which occurs when the sum of two or more signals exceeds the capacity of the output channel. Clipping is the clicking or popping sounds you may have heard through a pair of broken headphones. To avoid clipping, consider the sounds you play at the same time and make sure their volume levels aren’t set too high. For example, the airhorn should be as loud as possible without causing clipping. If you start to hear some distortion, lower the volume level accordingly.

Note: *Be sure that your speaker is rated to match the audio amplifier of your decoder. Ratings for each format are available on the packaging and at www.soundtraxx.com. Failure to do so could cause severe damage to your speaker.*

Refer to Table I on the next page to view default values for CVs 128-160.

Basic Programing

Table I. Primary Mixer Volume Levels		
CV	Sound Effect	Default Value
129	Airhorn	225
130	Bell	85
131	Contactora Camshaft	200
132	Air Compressor	100
133	Pantograph	100
134	Blower Fans	30
135	Generator	20
136	Traction Motor	240
137	Coupler	128
138	Train Brake Apply/Release	128
139	Independent Brake Apply	100
140	Independent Brake Release	70
141	Trolley Bell	85
142	Stop Request Bell	128
143	Poppet Valve	60
144	Steam Generator	50
145	Cab Doors	128
146	Trolley Doors	200
147	Reserved	0
148	E-Brake App.	70
149	Glad Hand Release	150
150	All Aboard/Coach Doors	192
151	Reserved	0
152	Reserved	0
153	Clickety-Clack	150
154	Sander Valve	10
155	Electrical Arcing	55
156	Air Conditioner	20
157	Wrenches	50
158	Reserved	0
159	Reserved	0
160	Cab Chatter	60

Basic Programming

Adjust Alternate Mixer Volume Levels

Tsunami2 includes an alternate volume mixer that can be selected in place of the primary volume mixer. This allows you two volume levels for each sound effect, which can be useful if you need quieter or louder volume settings for different operating situations, such as one group of settings for your home layout and another for your club layout. CVs 2.289-2.320 are used to set the alternate volume levels of each sound effect. Turning on the alternate mixer function will set sound effect volume to alternate mixer channel volume levels in place of the primary mixer channel volume levels in CVs 129-160. The default values for alternate mixer sound effects are set to half of the primary mixer default values. Follow the steps below to enable the alternate mixer in place of the primary mixer:

1. Ensure CV 31 (CV Index 1) is set to a value of 16.
2. Enter a value of 1 into CV 32 (CV Index 2) to select Indexed CV Page 1 as the active indexed CV page.
3. Enter a value of 28 into CV 284 to map the alternate mixer function to function key F28.
4. Turn on the alternate mixer function with F28 to enable the alternate mixer volume levels in CVs 2.289-2.320 in place of the primary mixer volume levels in CVs 129-160.
5. To adjust the alternate volume level of each sound effect, enter a value of 2 into CV 32 to select Indexed CV Page 2 as the active indexed CV page.
6. Adjust CVs 289-320 to set each sound effect to your preferred volume level.
7. Turn off the alternate mixer function with F28 to re-enable the primary mixer volume levels in CVs 129-160.

Note: To access Indexed CV Page 1 and Indexed CV Page 2 with CVs 257-512, CV 31 (CV Index 1) must be set to a value of 16 (default) and CV 32 (CV Index 2) must be set to a value of 1 or 2.

Refer to Table J on the next page to view default values for CVs 2.289-320.

Basic Programming

Table J. Alternate Mixer Volume Levels		
CV	Sound Effect	Default Value
2.289	Airhorn	112
2.290	Bell	42
2.291	Contactora Camshaft	100
2.292	Air Compressor	50
2.293	Pantograph	50
2.294	Blower Fans	15
2.295	Generator	10
2.296	Traction Motor	120
2.297	Coupler	64
2.298	Train Brake Apply/Release	64
2.299	Independent Brake Apply	50
2.300	Independent Brake Release	35
2.301	Trolley Bell	42
2.302	Stop Request Bell	64
2.303	Poppet Valve	30
2.304	Steam Generator	25
2.305	Cab Doors	64
2.306	Trolley Doors	100
2.307	Reserved	0
2.308	E-Brake App.	35
2.309	Glad Hand Release	75
2.310	All Aboard/Coach Doors	96
2.311	Reserved	0
2.312	Reserved	0
2.313	Clickety-Clack	75
2.314	Sander Valve	5
2.315	Electrical Arcing	27
2.316	Air Conditioner	10
2.317	Wrenches	25
2.318	Reserved	0
2.319	Reserved	0
2.320	Cab Chatter	30

Enable Quiet Mode

You can enable quiet mode and set the quiet mode time-out period with CV 113 (Quiet Mode Time-Out Period). When CV 113 is set to a non-zero value, all sound effects will automatically turn off after the time-out period elapses when the throttle is set to zero and all functions are off. Entering values from 0 to 255 into CV 113 will set the time-out period from 0.25 seconds to 63.75 seconds. Use the equation below to calculate the quiet mode time-out period:

$$\text{Time-Out Period} = \text{CV 113} \times 0.25$$

Basic Programming

Configuring Automatic Sounds

With corresponding automatic sound CVs, you can configure auto-effects for DCC and analog mode operation. Auto-sound CVs can help compensate for lack of function control in analog mode. This is most useful in DCC mode if you have limited function control. You can enable automatic effects if you're unable to activate them with function keys.

Enabling Automatic Sound Effects

CV 197 (Analog Mode Auto-Sound Enable) is used for enabling automatic sound for analog mode, and CV 198 (DCC Mode Auto-Sound Enable) is used for enabling automatic sound for DCC mode. The CV values and sound effects for both registers are identical, e.g., the value for enabling the auto-bell in analog mode is the same as the auto-bell value for DCC.

Table U shows values for CVs 197 and 198 used to enable automatic effects. For each auto-sound effect you want to enable, add the CV values together and program the sum into CV 197 for analog mode, or into CV 198 for DCC mode. Refer to "CV Programming Tutorial" for more information regarding calculating CV values.

Table U. Auto-Sounds	
Value	Sound Effect
2	Auto-Bell
4	Auto-Brake

Enable the Auto-Bell

In addition to CVs 197 and 198, you will need to set CVs 193 (Auto-Bell On Set Point) and 194 (Auto-Bell On Time) to configure the auto-bell sound effect. CV 193 is used to determine the speed step at which the bell sound effect will be automatically turned on and CV 194 (Auto-Bell On Time) is used to adjust the duration in seconds that elapses before the bell sound effect will be automatically turned off. CV 193 may be programmed with values from 1 to 127 to set the auto-bell speed step from 1 to 127, i.e., each value corresponds to a speed step (1 = speed-step 1; 2 = speed-step 2; 108 = speed-step 108, etc.). Then program CV 194 to determine when the bell will stop ringing. Program a value from 1 to 255 into CV 194 to set the duration from 1 to 255 seconds.

Enable the Auto-Brake

You can adjust the auto-brake sensitivity with CV 196 (Brake Sensitivity). In DCC mode, the decoder interprets this as the rate of throttle decrease. In analog mode, the decoder interprets it as the rate of voltage decrease. Values from 1 to 255 determine the brake sound effect's sensitivity. A value of 1 will activate the brake in response to decreases of 0.10 speed steps/second. A value of 255 will activate the brake in response to decreases of 25.5 speed steps/second:

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

We suggest using trial and error when determining the auto-brake sensitivity. In other words, program CV 196 with higher and lower values and then increase and decrease the throttle setting until the auto-brake is activated according to your preferences. A value of 0 will trigger the brakes whenever the locomotive is decelerating.

Note: *The best results when using the Auto-Brake feature will occur with some momentum programmed in CV 3 Baseline Acceleration Rate and CV4 Baseline Deceleration*

Basic Programming

Modifying Automatic Sound Effects

Sound control CVs additionally allow you to modify automatic sound effects, such as the coach door slams that occur after the conductor's "all aboard!" announcement, the release rate of the poppet valve, the clickety-clack rate, and the various Fireman Ed tasks that occur when the locomotive is stopped.

Adjust the Coach Door Count

Enter a value from 0 to 15 into CV 195 (Coach Door Count) to adjust the random number of coach door slams that occur with the all aboard/coach doors function. Turn on the all aboard/coach doors function while the locomotive is stopped to activate the conductor's "all aboard!" announcement, followed by the random number of coach doors slams determined by the value of CV 195.

CV 195: Coach Door Count
0 = 0 door slams
1 = 1 door slam
↓
5 = 5 door slams (default)
↓
15 = 15 door slams

Adjust the Poppet Valve Release Rate

Enter a value from 1 to 255 into CV 200 (Poppet Valve Release Rate) to adjust the frequency of each "pop!" of the poppet valve from the fastest rate to the slowest rate. The poppet valve releases more frequently in humid environments and less frequently in arid environments. CV 200 is set to a value of 25 by default.

CV 200: Poppet Valve Release Rate
0 = Disabled
1 = Fastest release rate
↓
255 = Slowest Release Rate

Basic Programming

Customize the Clickety-Clack

Follow the steps below to adjust clickety-clack CVs:

1. Ensure CV 31 (CV Index 1) is set to a value of 16.
2. Enter a value of 3 into CV 32 (CV Index 2) to select Indexed CV Page 3 as the active indexed CV page, and enable access to clickety-clack CVs.
3. Refer to the following information when accessing CV 3.257 and CV 3.258 from your command station to customize the clickety-clack sound effect.

You can set the number of axles per truck and number of trucks per car with CV 3.257 (Clickety-Clack Rate) to adjust the clickety-clack rate according to the specifics of your model. This allows you customize the clickety-clack sound effect to simulate various prototypes.

CV 3.257: Clickety-Clack Rate
1 = 2 axles/truck, 1 truck/car
2 = 3 axles/truck, 1 truck/car
5 = 2 axles/truck, 2 trucks/car (default)
6 = 3 axles/truck, 2 trucks/car

For example, a bobber caboose has one truck with two axles, whereas some passenger cars have two trucks with three axles. To simulate a bobber caboose, enter a value of 1 into CV 3.257. For a passenger car, enter a value of 6 into CV 3.257.

CV 3.258 (Clickety-Clack Sound Scalar) allows you to fine-tune the frequency of clickety-clack and flat spots sound effects by setting the proportion between speed step and scale speed. Scale speed is calculated in feet per second (ft/s). Higher values allow faster scale speeds and increase the clickety-clack frequency, and lower values allow slower scale speeds and reduce the clickety-clack frequency.

CV 3.258: Clickety-Clack Sound Scalar
0 = Disabled
1 = 0.01ft/s
↓
128 = 1ft/s (default)
↓
255 = 2ft/s

Enter a value from 1 to 255 into CV 3.258 to adjust the scale speed from 0.01ft/s to 2ft/s. A value of 0 will disable the clickety-clack sound effects. You can also use the equation below to calculate scale speed:

$$\text{Scale Speed (ft/s)} = (\text{Speed Step} \times \text{CV 3.258}) \div 100$$

Adjust Motorman Omura Event Probability

Motorman Omura keeps busy when the locomotive is stopped by performing tasks, such as opening the cab door, turning on the air conditioner and chatting on the radio. A new Motorman Omura task occurs every 10-30 seconds after the locomotive has been stopped for two minutes and the general service function (F18 by default) is turned off.

You can use CVs 201-208 (Motorman Omura Probability CVs) to adjust the frequency of each Motorman Omura task scheduled to occur while the locomotive is stopped. Entering values from 0 to 255 into CVs 201-208 will adjust the probability for the associated tasks from 0% to 100%. Refer to Table H to view each event probability CV and corresponding default values.

Event Probability CV	Default
CV 201: Cab Doors Event Probability	128
CV 202: Reserved	0
CV 203: Reserved	0
CV 204: Reserved	0
CV 205: Cab Chatter Event Probability	64
CV 206: Reserved	0
CV 207: Air Conditioner Event Probability	128
CV 208: Reserved	0

Basic Programming

Example: Adjusting Motorman Omura Event Probability

Motorman Omura performs his various tasks after two minutes of the locomotive being stopped, when the general service function (F18 by default) is turned off. Every 10-30 seconds, Motorman Omura might open and close the cab door, chat on the radio or turn on the AC. The probability that each of these sound effects occur is determined by CVs 201-208. Entering values from 0 to 255 into CVs 201-208 will adjust the probability of each task from 0% (disabled) to 100%. Follow the steps below to configure Motorman Omura probability CVs:

1. To allow Motorman Omura to enter and exit the cab when the locomotive is stopped, enter a value of 100 into CV 201.
2. To allow Motorman Omura to hear more cab chatter on the radio, enter a value of 130 into CV 205.
3. To allow the air conditioner to turn on often enough to keep the crew from overheating, enter a value of 150 into CV 207.

Sound Configuration Example

The following example details using sound control CVs to customize electric sound effects to fit your operating preferences.

Example: Modifying Electric Sound Effects

This example shows you how to customize sound effects, such as the airhorn, bell, air compressor, coupler, all aboard/coach doors, and poppet valve, with the following sound control CVs:

CV 112: Sound Configuration 1	CV 124: Air Compressor Select
CV 114: Engine Exhaust Control	CV 126: Coupler Select
CV 120: Airhorn Select	CV 195: Coach Door Count
CV 121: Auxiliary Airhorn Select	CV 200: Poppet Valve Release Rate
CV 122: Bell Select	

1. You can select a different primary airhorn for the long airhorn function (F2 by default) with CV 120. Entering a value from 0 to 41 into CV 120 will select airhorns 1-42. To select airhorn 15, enter a value of 14 into CV 120.
2. You can use CV 121 to enable the alternate airhorn. Entering a value from 1 to 42 into CV 121 will select airhorns 1-42 for the alternate airhorn. When an alternate airhorn is selected in CV 121, turning on the short airhorn function (F3 by default), and then turning on the long airhorn function (F2 by default) will issue the alternate airhorn selection. To select airhorn 1 for the alternate airhorn, enter a value of 1 into CV 121.
3. You can select different bells and bell ring rates, and enable the grade-crossing bell with CV 122. Most bell selections (excluding bell 10, as the Graham White Electronic Bell only has one ring rate) have four ring rate options: slow, medium-slow, medium-fast, and fast. Entering values from 0 to 44 into CV 122 will select each ring rate for bells 1-13. Adding a value of 128 to CV 122 will enable the bell selection to ring during the crossing hold countdown, after Grade-Crossing Logic is activated. Refer to "Configuring Lighting Outputs" for more information about Grade-Crossing Logic.
 - a. A value of 31 will select bell 8 with a fast ring rate for the bell function (F1 by default), and a value of 128 will enable bell 8 for the grade-crossing bell. To determine the value of CV 122, add the values together:

$$31 + 128 = 159$$

Basic Programming

- b. To select bell 8 with a fast ring rate for the bell function and enable the grade-crossing bell, enter a value of 159 into CV 122.
4. You can select a different air compressor with CV 124. Entering a value from 0 to 3 into CV 124 will select air compressors 1-4. To select air compressor 4, enter a value of 3 into CV 124.
5. You can select a different coupler with CV 126. Entering values from 0 to 2 into CV 126 will select the medium, heavy, and link-and-pin couplers. To allow the uncouple sound effect to be activated when the couple/uncouple function (F13 by default) is turned off, add a value of 128 to CV 126.
 - a. A value of 1 will select the heavy coupler and a value of 128 will allow the couple and uncouple sound effects to be activated with the same function key. To determine the value of CV 126, add the values together.
 $1 + 128 = 129$
 - b. To select the heavy coupler and invert the uncouple function polarity, enter a value of 129 into CV 126.
6. You can adjust the number of coach door slams that occur with the all aboard/coach doors function (F23 by default) with CV 195. Entering a value from 1 to 15 into CV 195 will set the coach door count from 1 to 15. To simulate eight coach doors, enter a value of 8 into CV 195.
7. You can adjust the frequency of the poppet valve release with CV 200 to simulate more arid or humid operating environments. Entering a value from 1 to 255 into CV 200 will set the poppet valve release from the fastest rate to the slowest rate. Enter a value of 150 into CV 200 to simulate an arid environment.

Advanced Programming

Configuring Audio Control

Tsunami2 features a high-pass filter and 7-band equalizer, allowing you to adjust frequency responses according to your installation. You can use audio control CVs to fine-tune sound responses by setting the high-pass filter cutoff frequency, selecting preset equalizer frequency responses for a range of speaker sizes, and customizing the cut/boost settings of the equalizer's frequency levels, and setting up reverb. Audio control CVs can also be used to make two identical engines sound a little different, lending you a bit more realism.

Audio Control CVs

CVs 161-192: FX Bus Mixer
CV 224: High-Pass Filter Cutoff Frequency
CV 225: Equalizer Control Register
CV 226: 62Hz Cut/Boost
CV 227: 125Hz Cut/Boost
CV 228: 250Hz Cut/Boost
CV 229: 500Hz Cut/Boost
CV 230: 1kHz Cut/Boost
CV 231: 2kHz Cut/Boost
CV 232: 4kHz Cut/Boost
CV 233: Reverb Control Register
CV 234: Reverb Output Level
CV 235: Reverb Delay Time
CV 236: Reverb Feedback Level

Adjusting the High-Pass Filter

CV 224 (High-Pass Filter Cutoff Frequency) is used to set the cutoff frequency of the high-pass output filter. The audio output of the decoder includes bass frequencies that may not be reproduced by the speaker(s) in many installations.

However, power is still applied to the speaker, regardless of whether or not the sound can be heard. This power has a significant impact on the 'hold-up' time of the decoder when it encounters track power glitches (such as turn-outs and dirty track). You can improve the hold-up by setting this CV to increasingly higher values. Start with a low value, increasing it until a change in the audio signal is observed, and then decreasing it by a small percentage (i.e. 10%).

Cutoff Frequency Values
0 = Disabled
1 = 20Hz
↓
20 = Default value
↓
255 = 1kHz

Adjusting the high-pass filter doesn't require any modification to the volume settings. Entering a value from 1 to 255 into CV 224 will adjust the high-pass filter cutoff frequency from 20Hz to 1kHz. A value of 0 will disable the high-pass filter.

About the 7-Band Equalizer

An equalizer, also called an "EQ," is similar to what you might use on a home stereo system to "boost" and "cut" sound levels. Equalizers are typically used to adjust the amplitude of audio signals at specific frequencies, which can correct the sound response of a device. If you aren't familiar with "dB," it stands for "decibel," a logarithmic unit used to measure power or intensity. In this case, dB is used to measure sound pressure and pertains to frequency response. A speaker is limited to the lowest frequency that can be reproduced. This is determined primarily by the size of the speaker. For example, reproducing a low frequency sound at a high volume requires moving more air, and hence, a larger speaker diaphragm.

Also keep in mind that the electromagnet underneath the speaker-cone will react to even the deepest bass. This means that a small speaker will still technically respond to low frequency signals, but you might not be able to hear the sound very well because not enough air is able to move through the speaker. In this case, though you may be able to hear it better, turning up the volume isn't likely to improve the low frequency sound quality, and could cause clipping if the speaker-cone is being pushed beyond its physical capabilities. Removing the inaudible, low frequency sound, or "cutting" frequency levels, will allow the speaker to operate within the limitations of its audio range.

Advanced Programming

Setting EQ Frequency Levels

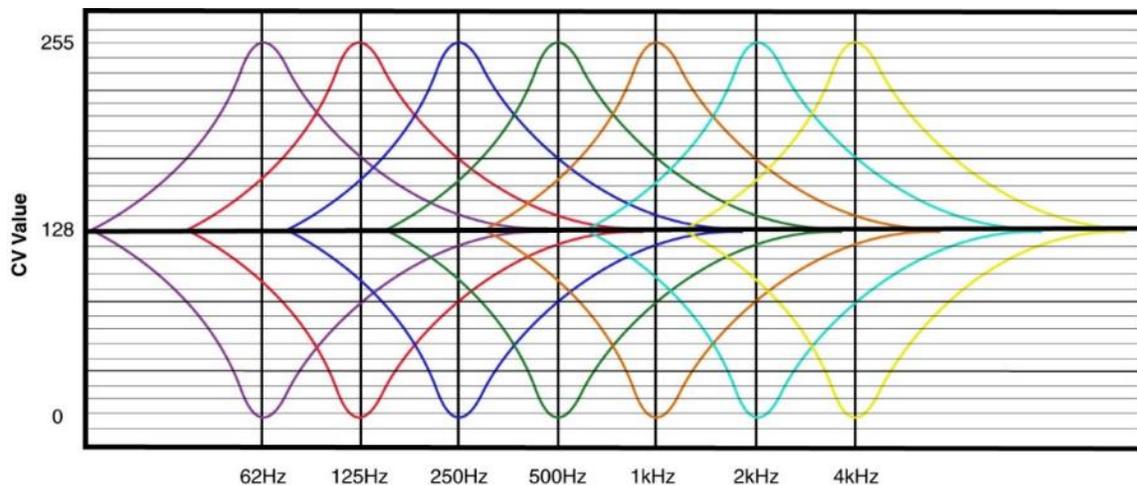
CV 225 (Equalizer Control Register) is used primarily for setting the frequency levels of the equalizer to accommodate a range of speaker sizes. Enter a value from 1 to 4 into CV 225 to select preset cut/boost levels to match the diameter of your speaker diaphragm (smaller than 1" to larger than 4"). When CV 225 is set to a value of 7, you can enter values from 0 to 255 into CVs 226-232 (Cut/Boost Controls) to adjust the cut/boost of each band's frequency level from +12dB to -12dB. CVs 226-232 are set to values of 128 by default, which indicates a flat response (0dB).

Refer to Table K on the next page to configure EQ Frequency Level CVs 225-232.

Advanced Programming

CV Value	Description	62Hz CV 226	125Hz CV 227	250Hz CV 228	500Hz CV 229	1kHz CV 230	2kHz CV 231	4kHz CV 232
0	Flat	0dB 128						
1	Micro Speaker (smaller than 1")	-12dB 0	-12dB 0	+7.12 200	+3dB 160	+1.5dB 140	+0.8dB 132	0dB 128
2	Small Speaker (1" to 2")	-6dB 60	-3dB 96	+4.1dB 168	+3dB 160	0dB 128	0dB 128	+0.8dB 132
3	Medium Speaker (2" to 4")	-3dB 96	+4.1dB 168	+2.3dB 148	+1.1dB 136	0dB 128	0dB 128	0dB 128
4	Large Speaker (larger than 4")	+6dB 192	+3dB 160	+1.5dB 140	0dB 128	0dB 128	0dB 128	0dB 128
7	Custom EQ Levels	+/-12dB 0-255						

The graph below indicates the minimum-to-maximum frequency response for each band. Notice the overlap from one frequency band to the next. Keep in mind that adjusting the response with one CV will raise or lower the sounds of nearby frequencies as well.



Making adjustments while sounds are playing is the easiest way to set the EQ because you can listen to each response. Because of this, we recommend programming this feature on the mainline. Start with CV 226 and make adjustments until you're satisfied with each band's frequency response. Depending upon the speaker you're using, adjusting the lowest frequency bands may have little or no effect. If this is the case, the audio frequencies are out of the speaker's range, and we suggest that you set the CV to 0 (-12dB).

CV Value	Cut/Boost
255	+12dB
224	+9dB
192	+6dB
160	+3dB
128	0dB
96	-3dB
64	-6dB
42	-9dB
0	-12dB

Note: Setting the cut/boost levels in CVs 226-232 to values that are too high may result in poor sound responses or damage the speaker. Ensure that equalizer settings do not exceed your speaker's power rating to avoid this.

Advanced Programming

Setting Reverb

The reverb effect allows you to add a bit of reverb and presence to sound effects. CV 233 (Reverb Control Register) allows you to preset reverb for sound effects or select user-adjustable reverb. CV 234 (Reverb Output Level), CV 235 (Reverb Delay Time), and CV 236 (Reverb Feedback Gain Level) are used to set up reverb for the sound effects assigned to CVs 161-192 (Reverb Mixer).

Note: *Making big adjustments within reverb control CVs can easily result in unpleasant results. We recommend you take your time and experiment with small changes first when configuring this feature.*

Reverb Control Register

CV 233 allows you to select reverb presets or user-adjustable reverb. Setting CV 233 to reverb presets will automatically adjust CVs 234-236.

User-adjustable reverb works by simulating the effect created when a sound wave is heard with a delayed version of the sound that has been reflected off another hard surface. The decoder's reverb is designed to produce an effect due to early sound reflections off a nearby surface such as a rock cut or canyon wall. User-adjustable reverb provides three controls plus a reverb mixer.

CV Value	Reverb Preset
0	Disabled
1	Short Reverb (default)
2	Medium Reverb
3	Long Reverb
4	Short Echo
5	Long Echo
6	Reserved
7	User-Adjustable

Reverb Output Level

CV 234 determines the amount of reverb signal that is mixed back with the original audio signal, and may be set to a value from 0 (minimum) to 255 (maximum).

Reverb Delay Time

CV 235 determines the overall reverb delay time from 0 to 255 milliseconds. CV 235 may be set to a value from 0 (zero delay) to 255 (maximum delay). The reverb delay time is calculated as:

$$\text{Delay Time} = \text{CV 235} \times 1\text{ms}$$

Longer delay times correspond to a greater distances between the sound source and the reflecting surfaces and will generally result in increased reverb.

Reverb Feedback Level

This CV specifies the percentage of the reverb's output that is mixed back into the input and creates the effect of multiple sound reflections, each diminishing in amplitude over time. CV 236 may be set to a value from 0 to 255 to adjust the amount of feedback from 0% to 100%.

Note: *High feedback settings (greater than a value of 200) should be avoided, as they can result in high audio levels that can potentially damage miniature speakers. Adjust this CV starting with a low initial value and increase in small steps.*

Reverb Mixer

Adjusting CVs 161-192 allows you to apply the reverb effect to desired sound effects. There are reverb inputs for each sound effect that control the percentage of the original audio level that will be mixed into the reverb. Each send level may be set from 0 to 255 to adjust the percentage from 0% to 100%. CVs 161-192 are listed on the following page.

Advanced Programming

CVs 161-192: Reverb Mixer		
CV	Sound Effect	Default Value
161	Airhorn	96
162	Bell	0
163	Contactora Camshaft	0
164	Air Compressor	0
165	Pantograph	0
166	Blower Fans	0
167	Generator	0
168	Traction Motor	0
169	Coupler	0
170	Train Brake Apply/Release	0
171	Independent Brake Apply	0
172	Independent Brake Release	0
173	Trolley Bell	0
174	Stop Request Bell	0
175	Poppet Valve	0
176	Steam Generator	0
177	Cab Doors	0
178	Trolley Doors	0
179	Reserved	0
180	E-Brake App.	0
181	Glad Hand Release	0
182	All Aboard/Coach Doors	0
183	Reserved	0
184	Reserved	0
185	Clickety-Clack	0
186	Sander Valve	0
187	Electrical Arcing	0
188	Air Conditioner	0
189	Wrenches	0
190	Reserved	0
191	Reserved	0
192	Cab Chatter	0

Adjust Reverb Control CVs

Setting up the reverb involves a bit of trial and error and is best done while the sounds are playing, using Operations Mode programming to make the adjustments. Start by setting CV 233 to 7 to enable the user-adjustable reverb. Next, set CVs 234-236 to a nominal value. We like to start with the default settings of 128 for CV 234, 255 for CV 235, and 64 for CV 236. Then determine the sounds you wish to apply reverb to and set the corresponding reverb mixer CV to a value from 128 to 192. If you are using multiple reverb inputs, each can be set to a different value so that more or less reverb is added to a particular sound effect as desired.

With the default reverb control settings, you should notice a definite amount of reverb added to the sound and can begin making adjustments. Adjusting CV 234 will vary the amount of reverb output signal that is mixed back with the original signal. Remember, in real life, the reflected signals that create the reverberation are usually lower in volume than the original signal. Generally, you will want just enough output to notice the effect without overwhelming the original signal.

Advanced Programming

Adjusting CV 235 will vary the delay time corresponding approximately to the extra distance a reflected sound wave needs to travel in order to reach the listener. Thus, the further away a reflecting surface is from the listener, the longer the delay time becomes.

Adjusting CV 236 simulates the effect of multiple sound reflections taking place. When set to 0, only one reflection occurs and this does not make for a very interesting effect. Ordinarily, we would call this an echo, but the maximum delay time for the reverb isn't long enough for an effect that might be heard across a mountain range, for example.

Increasing the value of CV 236 will increase the number of reflections and add a "springiness" to the sound. Like any sound effect, it is possible to over-adjust a particular setting and create an artificial sounding effect. Make adjustments in small steps and let your ears be the judge!

Advanced Programming

Configuring Dynamic Digital Exhaust

Dynamic Digital Exhaust (DDE) is one of the most fun effects featured in Tsunami2.

When the locomotive encounters a grade, DDE responds to this by elevating the volume of the traction motor sound effects to simulate the locomotive exerting more power. Similarly, the demand on the motor is lifted when the locomotive starts drifting downhill, which reduces the traction motor volume.

DDE Control CVs

CV 2.503: DDE Load Offset

CV 2.504: DDE Load Slope

CV 2.507: DDE Traction Motor Low Volume Limit

CV 2.508: DDE Traction Motor High Volume Limit

CV 2.509: DDE Attack Time Constant

CV 2.510: DDE Release Time Constant

CV 2.511: DDE Throttle Sensitivity

CV 2.512: DDE Load Sensitivity

CVs 2.503-2.512 are used to adjust parameters of the DDE processor. DDE control CVs allow the engine sound effects to be modified in response to motor process load and/or speed during operation. You may need to modify default settings to fit the specifics of your installation and locomotive. This section details using DDE control CVs to fine-tune your operation.

Note: To access Indexed CV Page 2 with CVs 257-512, CV 31 (CV Index 1) must be set to a value of 16 (default) and CV 32 (CV Index 2) must be set to a value of 2.

Calibrating DDE Load Compensation

CV 2.503 (DDE Load Offset) is used to set the DDE processor's nominal low-speed load level, and serves as a reference point for the minimum amount of load required to move the model. Entering values from 1 to 254 into CV 2.503 will set the DDE load offset. Entering lower values into CV 2.503 will result in greater load levels. Entering greater values into CV 2.503 will result in lower load levels. Entering a value of 0 into CV 2.503 will disable the DDE load offset.

CV 2.504 (DDE Load Slope) is used to set the DDE processor's nominal high-speed load level, and serves as the reference point for track speed. Entering values from 1 to 254 into CV 2.504 will set the DDE load slope. Entering lower values into CV 2.504 will result in greater load levels. Entering greater values into CV 2.504 will result in lower load levels. Entering a value of 0 into CV 2.504 will disable the DDE load slope.

We highly recommend automatically calibrating the DDE load offset and DDE load slope. Enter a value of 255 into CV 2.503 at speed-step 1, then enter a value of 255 into CV 2.504 at the average operating speed for your layout will automatically calibrate DDE load compensation. Ensure the locomotive is on level track when entering values of 255 into CVs 2.503 and 2.504. Refer to "Configuring Throttle and Braking" to automatically calibrate DDE load compensation.

Follow the steps below:

1. Ensure CV 31 (CV Index 1) is set to a value of 16 (default).
2. Enter a value of 2 into CV 32 to select Indexed CV Page 2. This allows you to adjust DDE control CVs by accessing CVs 2.503-2.512 from your command station.
3. Set CV 512 (DDE Load Sensitivity) to a value of 16.
4. We suggest running the locomotive at a moderate speed for a minute or two before continuing. If there is any build-up of lubrication or oil in the motor, this will provide better results during the calibration procedure.
5. Set the throttle to speed-step 1.

Advanced Programming

6. When your locomotive is on level track, enter a value of 255 into CV 503 (DDE Load Offset) to automatically calibrate the nominal low-speed load level.
7. Increase the throttle to an appropriate moderate speed for your layout (generally between speed-step 25 and speed-step 40).
8. When your locomotive is on level track, enter a value of 255 into CV 504 (DDE Load Slope) to automatically calibrate the nominal high-speed load level.

Note: *If, after the calibration is complete, you feel the need to increase or decrease the sensitivity, you can do this with CV 2.512.*

Adjusting DDE Volume Limits

CV 2.507 (DDE Traction Motor Low Volume Limit) is used to determine the maximum volume decrease of the traction motor sound effect when the motor is operating at low speeds. CV 2.508 (DDE Traction Motor High Volume Limit) is used to determine the maximum amplification level of the traction motor sound effect when the motor is operating at high speeds. The traction motor low and high volume limits are added to the volume level in CV 136 (Traction Motor Primary Mixer Channel). Increase and decrease traction motor volume limits with CVs 2.507 and 2.508 to set the motor's maximum power level.

Entering a value from 0 to 255 into CV 2.507 will add -0dB to -12dB to the traction motor volume level in CV 136 and set the DDE traction motor low volume limit. Entering a value from 0 to 255 into CV 2.508 will add +0dB to +12dB to the traction motor volume level in CV 131 and set the DDE traction motor high volume limit.

Adjusting DDE Time Constants

CV 2.509 (DDE Attack Time Constant) and CV 2.510 (DDE Release Time Constant) are used to determine how quickly the DDE processor reacts to changes in load and speed. CV 2.509 determines the duration of time that elapses from when the decoder receives a new throttle command (or senses a change in load) to the time the DDE processor begins to reshape the audio signal. CV 2.510 determines the duration of time that elapses between changes in the way the DDE processor reshapes the audio signal based upon increasing or decreasing throttle commands or changes in load.

Entering a value from 1 to 255 into CVs 2.509 and 2.510 will adjust the DDE attack and release time constants from minimum to maximum. Entering a value of 0 into CVs 2.509 and 2.510 will set both DDE time constants to an "instant" response.

Adjusting DDE Sensitivity Levels

CV 2.511 (DDE Throttle Sensitivity) is used to adjust the correlation between the throttle setting and the traction motor sound effect. Simply put, when the throttle setting is much greater than the current locomotive speed, the load is very high. Conversely, when the throttle is much less than the current locomotive speed, the load is very low. As such, the DDE processor modifies the volume of sound effects in response to the throttle only when acceleration and deceleration rates are set in CV 3 (Baseline Acceleration Rate) and CV 4 (Baseline Deceleration Rate). You may enter a value from 0 to 255 into CV 2.511 to adjust the DDE throttle sensitivity level. Entering a value of 0 into CV 2.511 will disable DDE throttle sensing. Setting CV 2.511 to 255 indicates that the cadence and volume of the engine RPM sound effects will be most sensitive to the throttle setting.

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CV 2.512 (DDE Load Sensitivity) is used to adjust the correlation between motor load and traction motor sound effects. As the motor is impeded during operation, the DDE processor and back-EMF circuitry will adjust the volume of traction motor sound effects according to the value of CV 2.512. You may enter a value from 0 to 255 into CV 2.512 to adjust the DDE load sensitivity level. Entering a value of 0 into CV 2.512 will disable DDE load sensing and sound effects will not be modified when the motor is impeded. Setting CV 2.512 to 255 indicates that the traction motor sound effect will be most sensitive to changes in motor load.

Note: *DDE Load Sensing is disabled if Back EMF is disabled in CV 217.*

Advanced Programming

Configuring Function Mapping

Function mapping CVs allow you to reassign any effect to any function key, enable effects to respond automatically to direction and movement changes, map an effect to the emergency stop button, and gives you the option of using NMRA “Legacy” function mapping. It’s easy to customize function assignments to fit any operating preference with Flex-Map function mapping technology!

Function Mapping CVs

CV 31: CV Index 1
CV 32: CV Index 2
CVs 33-46: Function Status CVs
CV 57: Forward Direction Enable
CV 58: Reverse Direction Enable
CVs 1.257-1.385: Effect Map Registers
CVs 1.385-1.512: Effect Auxiliary Map Registers

Note: To access Indexed CV Page 1 with CVs 257-512, CV 31 (CV Index 1) must be set to a value of 16 (default) and CV 32 (CV Index 2) must be set to a value of 1 (default).

Function Mapping with Flex-Map Technology

To complement the decoder’s wide range of effects, Tsunami2 puts you in control of all function assignments. Flex-Map CVs determine default function assignments for Tsunami2, and allow you to customize function keys and effects according to a simple and versatile format.

Customize Function Assignments

CVs 1.257-1.384 (Effect Map Registers) are used for function mapping. Each effect corresponds to a CV. The value of each CV determines the F0-F28 function key used to control that effect. Follow the steps below to use CVs 1.257-1.384 for customizing function assignments:

1. Ensure CV 31 (CV Index 1) is set to a value of 16.
2. Enter a value of 1 into CV 32 (CV Index 2) to select Index CV Page 1 as the active indexed CV page and enable access to CVs 1.257-1.384.
3. Access CVs 257-384 from your command station.
4. Enter a value from 0 to 28 into CVs 257-384 to map the corresponding effect to function keys F0-F28.
5. Enter a value of 255 to disable the corresponding effect.

Value = Function Key
0 = F0
1 = F1
↓
28 = F28
29-254 = Reserved
255 = Effect Disabled

Refer to Table L on the next page for a list of CVs 1.257-1.384 and corresponding effects.

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Table L. CVs 1.257-1.384

Effect Map Registers

CV 1.257: Headlight
CV 1.258: Backup Light
CV 1.259: FX3 Effect
CV 1.260: FX4 Effect
CV 1.261: FX5 Effect
CV 1.262: FX6 Effect
CVs 1.263-1.272: Reserved
CV 1.273: Dimmer
CV 1.274: Mute
CV 1.275: Independent/Train Brake
CV 1.276: Half-Speed
CV 1.277: Momentum Override
CV 1.278: Grade-Crossing Signal
CV 1.279: Forward Whistle Signal
CV 1.280: Reverse Whistle Signal
CV 1.281: Stop Whistle Signal
CV 1.282: Reserved
CV 1.283: Brake Select
CV 1.284: Alternate Mixer
CV 1.285: Forward Trolley Bell
CV 1.286: Reverse Trolley Bell
CVs 1.287-1.296: Reserved
CV 1.297: Airhorn
CV 1.298: Bell
CV 1.299: Pneumatic Doors
CV 1.300: Short Airhorn
CV 1.301: Pantograph
CV 1.302: Reserved
CV 1.303: Stop Request Bell
CV 1.304: Cab Chatter
CV 1.305: Couple
CV 1.306: Uncouple
CV 1.307: Reserved
CV 1.308: Handbrake
CV 1.309: Sander Valve
CV 1.310: Reserved
CV 1.311: All Aboard/Coach Doors
CV 1.312: Steam Generator
CV 1.313-1.314: Reserved
CV 1.315: Trolley Bell
CVs 1.316-1.320: Reserved
CV 1.321: E-Brake App.

Table M. Default Function Assignments

F0-F28	Effect	CV	Value
F0(f)	Headlight	CV 1.257	0
F0(r)	Backup Light	CV 1.258	0
F1	Bell	CV 1.298	1
F2	Airhorn	CV 1.297	2
F3	Short Airhorn	CV 1.300	3
F4	Pantograph	CV 1.301	4
F5	Stop Request Bell	CV 1.303	5
F6	Pneumatic Doors	CV 1.299	6
F7	Dimmer	CV 1.273	7
F8	Mute	CV 1.274	8
F9	Grade-Crossing Signal	CV 1.278	9
F10	Trolley Bell	CV 1.315	10
F11	Independent/Train Brake	CV 1.275	11
F12	Brake Select	CV 1.283	12
F13	Couple	CV 1.305	13
F13	Uncouple	CV 1.306	13
F14	Half-Speed	CV 1.276	14
F14	Momentum Override	CV 1.277	14
F15	Handbrake	CV 1.308	15
F16	Not Assigned	Not Assigned	16
F17	Not Assigned	Not Assigned	17
F18	General Service	CV 1.302	18
F19	Not Assigned	Not Assigned	19
F20	Steam Generator	CV 1.312	20
F21	Sander Valve	CV 1.309	21
F22	Cab Chatter	CV 1.304	22
F23	All Aboard/Coach Doors	CV 1.311	23
F24	FX3 Output	CV 1.259	24
F25	FX4 Output	CV 1.260	25
F26	FX5 Output	CV 1.261	26
F27	FX6 Output	CV 1.262	27
F28	Not Assigned	Not Assigned	28

Advanced Programming

Enabling Automatic Effects

To provide more versatility, Flex-Map function mapping CVs allow you to configure automatic effects that respond to direction and movement. Follow the steps below to enable automatic effects with CVs 1.385-1.512 (Effect Auxiliary Map Registers):

1. Ensure CV 31 is set to a value of 16.
2. Enter a value of 1 into CV 32.
3. Access CVs 385-512 from your command station and refer to the descriptions and CV values below to enable automatic effects.

Forward-Driving: Effect is turned on when the locomotive is moving in the forward direction.

Reverse-Driving: Effect is turned on when the locomotive is moving in the reverse direction.

Forward-Standing: Effect is turned on when the locomotive is stopped in the forward direction.

Reverse-Standing: Effect is turned on when the locomotive is stopped in the reverse direction.

Note: CVs 1.385-1.512 can be set to allow any combination of auto-effect enable. For instance, a value of 10 will allow the effect to turn on in the reverse direction regardless of movement, and a value of 3 will allow the effect to turn on when the locomotive is in motion regardless of direction.

Table N. Auto-Effect Enable	
CV Value	Active When
1	Forward-Driving
2	Reverse-Driving
3	Driving
4	Forward-Standing
5	Forward
6	Forward-Standing, Reverse-Driving
7	Forward, Reverse-Driving
8	Reverse-Standing
9	Reverse-Standing, Forward-Driving
10	Reverse
11	Reverse, Forward-Driving
12	Standing
13	Standing, Forward-Driving
14	Standing, Reverse-Driving
15	Continuously Active

Mapping Effects to the Emergency Stop Button

Any effect can be mapped to the emergency stop button with CVs 1.385-1.512. Follow the steps below to map an effect to the emergency stop button:

1. Ensure CV 31 is set to a value of 16.
2. Enter a value of 1 into CV 32.
3. Enter a value of 16 into CVs 385-512 to map the corresponding effect to the emergency stop button.

Note: Mapping a function to the E-Stop button will not change the Emergency Stop functionality. It will still stop the motor regardless of the effect that has been mapped to it.

Refer to Table O on the next page for a list of CVs 1.385-1.512 and corresponding effects.

Advanced Programming

Table O. CVs 1.385-1.512

Effect Auxiliary Map Registers

CV 1.385: Headlight
 CV 1.386: Backup Light
 CV 1.387: FX3 Effect
 CV 1.388: FX4 Effect
 CV 1.389: FX5 Effect
 CV 1.390: FX6 Effect
 CVs 1.391-1.400: Reserved
 CV 1.401: Dimmer
 CV 1.402: Mute
 CV 1.403: Independent/Train Brake
 CV 1.404: Half-Speed
 CV 1.405: Momentum Override
 CV 1.406: Grade-Crossing Signal
 CV 1.407: Forward Whistle Signal
 CV 1.408: Reverse Whistle Signal
 CV 1.409: Stop Whistle Signal
 CV 1.410: Reserved
 CV 1.411: Brake Select
 CV 1.412: Alternate Mixer
 CV 1.413: Forward Trolley Bell
 CV 1.414: Reverse Trolley Bell
 CVs 1.415-1.424: Reserved
 CV 1.425: Airhorn
 CV 1.426: Bell
 CV 1.427: Pneumatic Doors
 CV 1.428: Short Airhorn
 CV 1.429: Pantograph
 CV 1.430: Reserved
 CV 1.431: Stop Request Bell
 CV 1.432: Cab Chatter
 CV 1.433: Couple
 CV 1.434: Uncouple
 CV 1.435: Reserved
 CV 1.436: Handbrake
 CV 1.437: Sander Valve
 CV 1.438: Reserved
 CV 1.439: All Aboard/Coach Doors
 CV 1.440: Steam Generator
 CV 1.441-1.442: Reserved
 CV 1.443: Trolley Bell
 CVs 1.444-1.448: Reserved
 CV 1.449: E-Brake App.

Table P. CVs 1.385-1.512 Defaults

CV	CV Value
----	----------

CV 1.449	16
----------	----

Advanced Programming

Flex-Map Function Mapping Examples

The following examples detail using CVs 1.257-1.512 for function mapping, enabling automatic effects, and mapping an effect to the emergency stop button. Before accessing CVs 257-512, ensure CV 31 is set to a value of 16, and enter a value of 1 into CV 32.

Example: Mapping Electric Functions

You may want to use CVs 1.257-1.384 to map the grade-crossing signal to F4, stop request bell to F10, and trolley bell to F9. Doing so will allow you to activate airhorn functions with F2, F3, and F4 and bell functions with F9 and F10. The following example details mapping the grade-crossing signal (F9 by default), pantograph extend, retract (F4 by default), and trolley bell (F10 by default) functions with CV 1.278 (Grade-Crossing Signal Map Register), CV 1.301 (Pantograph Map Register), and CV 1.315 (Trolley Bell Map Register):

1. To map the grade-crossing signal next to the long airhorn (F2 by default) and short airhorn (F3 by default), enter a value of 4 into CV 278.
2. To map the dynamic brake next to the independent/train brake (F11 by default), enter a value of 10 into CV 299.
3. To map the straight-to-eight function to F9, enter a value of 9 into CV 301.
4. Activate airhorn functions with F2, F3, and F4.
5. Activate brake functions F11, and F12.
6. Activate straight-to-eight with F9.

Example: Setting Up Automatic Signals

You may want to use CVs 1.384-1.512 to enable automatic forward, reverse, and stop whistle signals. The following example details setting CV 1.407 (Forward Whistle Signal Auxiliary Map Register), CV 1.408 (Reverse Whistle Signal Auxiliary Map Register), and CV 1.409 (Stop Whistle Signal Auxiliary Map Register) to enable automatic whistle signals:

1. Enter a value of 1 into CV 407 to enable automatic forward signals when the locomotive is forward-driving.
2. Enter a value of 2 into CV 408 to enable automatic reverse signals when the locomotive is reverse-driving.
3. Enter a value of 12 into CV 409 to enable automatic stop signals when the locomotive is standing (regardless of direction).

Example: Mapping the Emergency Gyalite to the Emergency Stop Button

You may want to map the emergency Gyalite to add a lighting effect to the emergency brake application effect. The following example details setting the emergency Gyalite to the FX3 lighting output, and mapping the FX3 effect to the emergency stop button:

1. Enter a value of 21 into CV 51 (FX3 Configuration) to set the emergency Gyalite to the FX3 lighting output. Refer to “Configuring Lighting Outputs” for more information.
2. Enter a value of 255 into CV 259 (FX3 Effect Map Register) to disable function control for the FX3 lighting output.
3. To map the emergency Gyalite to the emergency stop button, enter a value of 16 into CV 387 (FX3 Effect Auxiliary Map Register).

Advanced Programming

NMRA Legacy Function Mapping

CVs 33-46 (Function Status CVs) are function mapping CVs stated in the NMRA Standards for DCC Configuration Variables (S-9.2.2). CVs 35-46 are used to assign effects to function keys F1-F12, and CVs 33 and 34 are used to assign effects to the F0 function key. If the same effect is selected for both reverse and forward F0 functions, that effect will turn on when the F0 function key is turned on regardless of locomotive direction.

Note: CVs 33-46 are set to values of 0 by default, are a secondary method of function mapping, and are not used to determine Tsunami2's default function assignments. CVs 1.257-1.512 (Extended Function Mapping CVs) provide default function assignments for 28 function keys and offer comprehensive function mapping support for all of Tsunami2's effects in an uncomplicated and versatile format. However, mapping an effect to a function key (F0(f), F0(r), or F1-F12) using CVs 33-46 will override the corresponding function assignment mapped within CVs 1.257-1.384.

Table Q. Function Output Map																
Function Key	CV	HL Output	BL Output	Airhorn	Bell	FX3 Output	FX4 Output	Pneum. Doors	Short Airhorn	Pantograph	General Service	Dimmer	Mute	Trolley Bell	Ind./Train Brake	Coupler
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

Advanced Programming

Configuring Hyperdrive2

Tsunami2 features Hyperdrive2 advanced motor control, providing high-frequency pulse-width modulation (PWM) for silent motor control and a back-electromotive force (back-EMF) sensor to improve low-speed operation and maintain constant speeds. Load compensation and a proportional-integral (PI) control loop allows Tsunami2 to sense motor load in response to back-EMF measurements.

Setting Engine Recovery Speed

Use CV 119 (Max Engine Recovery Speed) to designate the speed the motor will resume after momentary power losses. The recovery speed can be determined as a fixed speed step (absolute limiting) or a fraction of the throttle setting (proportional limiting).

The traction motor will start at speed-step 0 after power losses when CV 119 is set to a value of 0 or 128. CV 119 is set to a value of 204 by default. Entering a value from 1 to 127 will designate the recovery speed as a fixed speed step from 1 to 127 (absolute limiting). If the recovery speed step in CV 119 is greater than the last speed step before power loss, the decoder will resume the throttle setting being received by the command station.

CV 119: Max Engine Recovery Speed
0 = Disabled
1 = Speed-step 1
↓
127 = Speed-step 127 (absolute limiting)
128 = Disabled
129 = 1% of throttle setting (proportional limiting)
↓
255 = 100% of throttle setting (proportional limiting)

Entering a value from 129 to 255 will designate the recovery speed as a fraction of the current throttle setting (proportional limiting). Higher values indicate higher speed settings. The decoder calculates the recovery speed after power losses as:

$$\text{Recovery Speed} = (\text{CV 119} \times \text{Speed Step}) \div 127$$

Adjusting Low-Speed Operation

CV 211 (Low-Speed Compensation) is used to compensate for irregularities (if any) that occur during low-speed operation. You may enter values from 0 to 255 into CV 211 to specify the “gain value” that will be applied to the PID motor equation at low speeds.

Increasing the gain value will allow the motor to operate smoother at lower speeds. When CV 211 is set to a value of 255, the effect is applied across the first nine speed steps; the gain value has a decreasing effect upon the motor as speed steps increase. This helps compensate for motors that are more difficult to start.

In the event that you have an efficient motor that already spins at minimal voltages, it is possible that setting the gain value too high could elevate the locomotive’s minimum speed, and/or cause a stutter at low speeds while the control loop attempts to slow the motor. If you notice this, reduce the value of CV 211. We suggest setting CV 211 to the lowest value that will still improve low-speed operation.

Advanced Motor Control CVs

- CV 10: EMF Feedback Cutout
- CV 119: Max Engine Recovery Speed
- CV 209: PID Kp Parameter
- CV 210: PID Ki Parameter
- CV 211: Low-Speed Compensation
- CV 212: BEMF Feedback Intensity
- CV 215: BEMF Reference Voltage
- CV 216: Motor Speed-Step Deadband
- CV 217: Motor Control Register
- CV 220: Constant Brake Distance

Advanced Programming

Control Loop Coefficients

Tsunami2 compensates for load changes in response to back-EMF voltage readings that compare motor load to locomotive speed. When a variation between them occurs, a proportional-integral (PI) control loop adjusts the motor voltage to compensate for the difference so that the locomotive's speed remains consistent. Adjust the PI control loop with CV 209 (PID Kp Parameter) and CV 210 (PID Ki Parameter).

Kp Coefficient

CV 209 is used for adjusting the proportional gain of the control loop, and compensates for dynamic changes in the motor load based on the contrast between the throttle setting and motor speed. CV 209 may be programmed with a value from 0 to 255. Higher values indicate higher levels of compensation. However, values that are too high may lead to inconsistencies in motor control.

Ki Coefficient

CV 210 is used for adjusting the integral gain of the control loop, and compensates for static changes in motor load by applying a correction based on the integral difference between the throttle setting and the current motor speed. CV 210 may be set to a value from 0 to 255. Higher values indicate higher levels of compensation and a more sensitive control loop. We suggest setting CV 210 to the lowest value that still provides optimal performance; setting CV 210 to values that are too high may lead to oscillations in locomotive speed.

Note: *Setting CVs 209 and 210 to values of 0 will disable the control loop.*

Strategy for Optimizing Hyperdrive2

Finding the right combination of CV settings requires some experimenting and patience. Be aware that these settings will inherently vary between locomotives. If you happen to make an adjustment to an advanced motor control CV that compromises operation in some way, you can reset CV settings with CV 8 (Manufacturer ID). Refer to "Introduction to Programming" for more information.

Use your CV settings as starting points when configuring other locomotives. Adjusting a particular setting can actually degrade performance, and therefore changes should be made in small increments until you find your preferred result. And remember, the decoder's default settings should provide satisfactory performance for most situations.

Example: Adjusting the Control Loop

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

1. Make sure all the Hyperdrive2 CVs are set to default values.
2. Set CV 2 (Vstart), CV 5 (Vhigh), and CV 6 (Vmid) to 0.
3. With the locomotive on level track, set the throttle to speed-step 20.
4. Increase the value of CV 209 until the locomotive's speed becomes varied and choppy.
5. Reduce the value of CV 209 until speed is consistent, smooth, and without variance.
6. Increase the value of CV 210 until you notice the locomotive's speed begin to oscillate.
7. Reduce the value of CV 210 until the oscillation stops.

Advanced Programming

Setting the Load Compensation Curve

CV 10 (EMF Feedback Cutout) and CV 212 (Back-EMF Feedback Intensity) are used to control the amount of load compensation applied to the motor across the throttle range. CV 212 can be set to a value from 0 to 255 to determine the amount of load compensation that is initially applied to the motor. A value of 0 disables load compensation altogether, while a value of 255 corresponds to 100% compensation. CV 10 determines the degree that the load compensation is reduced as the throttle speed is increased.

When CV 10 is set to 0, the amount of load compensation is constant over the entire speed range, according to the value of CV 212. Setting CV 10 between 1 and 127 will determine the speed step at which the load compensation is reduced to 0. Setting CV 10 between 128 and 255 will select a partial load compensation reduction at full speed. The minimum load compensation level at speed-step 128 is calculated and illustrated as follows:

$$\text{BEMF Intensity} = \text{CV 212} \times (1 - (\text{speed step} \div \text{CV 10})) \div 255$$

In general, you will want to have full load compensation at low speeds that will gradually reduce to 0 at top speed. Set CV 10 to 126 to achieve this. When operating in a consist, you may need to reduce the value in CV 212 to reduce the low speed load compensation, and therefore avoid pitting the locomotives against each other.

BEMF Reference Voltage

CV 215 (BEMF Reference Voltage) allows you to change the reference voltage for the back-EMF to match the voltage on your track. By matching the back-EMF reference voltage of the decoder with your track voltage, your locomotive will run smoother and more consistently. CV 215 may be programmed with any value from 60 to 255 to set the back-EMF reference Voltage from 6 to 25.5 volts.

If you are planning to consist the model with other models equipped with SoundTraxx decoders (such as Tsunami or MC1 and MC2 DCC Mobile Decoders), make sure that the value entered in CV 215 is equal to the observed voltage of the track output from your command station, so that the reference voltage is identical to your other decoders. To set this CV, simply take the observed voltage on your track and multiply it by 10 to calculate the programming value. For example, 12.5 Volts would be represented as a CV value of 125.

Setting the Motor Speed-Step Deadband

CV 216 (Motor Speed-Step Deadband) determines the speed step at which voltage is first applied to the motor to set the locomotive in motion. Entering values from 1 to 126 into CV 216 will set the motor speed-step deadband from speed-step 1 to speed-step 126. Setting CV 216 to higher values will allow the locomotive to remain stationary as the throttle is increased from zero.

Example: Motor Speed Step Deadband and Automatic Whistle Signals

Refer to the following example to configure automatic forward-driving and reverse-driving whistle signals using CV 216:

1. To enable automatic forward-driving whistle signals, set CV 1.407 (Forward Whistle Signal Auxiliary Map Register) to a value of 1.
2. To enable automatic reverse-driving whistle signals, set CV 1.408 (Reverse Whistle Signal Auxiliary Map Register) to a value of 2.

Advanced Programming

3. To allow forward-driving and reverse-driving whistle signals to be issued after the throttle is increased from zero and before the locomotive begins to move, set CV 216 to a value of 3. The locomotive will begin to move when the throttle is increased from speed-step 3.

Enabling Back-EMF and Auto-Stop

Back-EMF is enabled by default to better regulate the operation of the motor. Disabling back-EMF control will deactivate all back-EMF regulated automatic features, such as Dynamic Digital Exhaust. Enter a value of 8 to enable auto-stop. Enabling auto-stop will bring the locomotive to a stop for 500ms before changing direction.

Setting the Constant Braking Distance

CV 220 determines the fixed distance over which the locomotive will decelerate to a stop after setting the throttle to zero. Constant Brake Distance enables the train to be stopped in a set fixed distance regardless of speed.

Entering a value from 1 to 255 into CV 220 will adjust the constant brake distance from minimum to maximum. Entering a value of 0 into CV 220 will disable the constant brake distance feature, as will disabling Back-EMF in CV 217.

The Constant Brake Distance feature is only activated when the throttle is set to speed step 0. The value entered in CV 220 is a portion of available stopping distance and not a unit of time or distance. Each model may require different values in CV 220 to obtain the same stopping distance due to difference in gear ratios, motor RPMs and driveline disparities.

The feature works best with CV 3 Baseline Acceleration Rate and CV 4 Baseline Deceleration Rate are set to values greater than 0. This added momentum allows the throttle to be quickly reduced to speed step 0, enabling the Constant Brake Distance feature, while the locomotive continues to travel at speed.

When activated, the feature will override all braking rates set in CV 116, CV117 and CV 118 along with the Baseline Deceleration Rate in CV 4. Any throttle increase in from speed step 0 will turn off the feature and the locomotive will accelerate back to the desired speed step set by the throttle.

Advanced Programming

Configuring Advanced Consist Operation

A consist is made up of several units that are coupled together to operate as a complete train. In model railroading, “Advanced Consisting” means that the decoder is used to configure the consist, instead of the command station. Consists allow an easy way for a single operator to run a multi-unit diesel lash-up, for example. You can use advanced consist CVs to determine the decoder’s consist address, set consist acceleration and deceleration rates, enable function keys F0-F28, and configure automatic effects.

Advanced Consist CVs

CV 19: Consist Address
CV 21: Consist Function Enable 1
CV 22: Consist Function Enable 2
CV 23: Consist Acceleration Rate
CV 24: Consist Deceleration Rate
CV 245: Consist Function Enable 3
CV 246: Consist Function Enable 4
CV 247: Consist Function Enable 5

Setting the Consist Address

Entering a value from 1 to 127 into CV 19 (Consist Address) will set the consist address from 1 to 127 for all units in the forward direction. Entering values from 129 to 255 into CV 19 will set the consist address from 1 to 127 for all units in the reverse direction (more common in diesel operations). Because the consist address is specific to direction, ensure all units are correctly oriented. Entering a value of 0 or 128 into CV 19 will disable the consist address.

After setting the consist address, the decoder will still respond to the active primary or extended address for all commands except speed and direction data. The decoder will not recognize programming commands sent to the consist address in Operations Mode, and will only respond to programming commands sent to the decoder’s primary or extended address.

Enabling Consist Functions

CV 21 (Consist Function Enable 1), CV 22 (Consist Function Enable 2), CV 245 (Consist Function Enable 3), and CV 246 (Consist Function Enable 4) allow you to enable functions for advanced consist operation when a valid consist address is active in CV 19.

Note: You can enable the effects mapped to function keys in CVs 1.257-1.384 (Effect Map Registers) for advanced consist operation with CVs 21, 22, 245, and 246. Refer to “Using Tsunami2” to default function assignments for F0-F28, and refer to “Configuring Function Mapping” to customize Flex-Map function mapping CVs.

Follow the steps on the next page to enable functions for advanced consist operation.

Advanced Programming

Consist Function Enable 1-4

The following procedure details enabling effects mapped to F0(f), F0(r), and F1-F28 for advanced consist operation:

1. Circle the CV values associated with your preferred F0-F28 function keys.
2. For each CV, add the values together and record the sum in the space provided. You should have four total CV values for enabling your preferred function keys when finished.
3. Enter each value into CVs 21, 22, 245, and 246 to enable your preferred functions for advanced consist operation.

CV 21: Consist Function Enable 1

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	F8	F7	F6	F5	F4	F3	F2	F1
CV Value	128	64	32	16	8	4	2	1

CV 21 Value = _____

CV 22: Consist Function Enable 2

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	0	0	F12	F11	F10	F9	F0(r)	F0(f)
CV Value	0	0	32	16	8	4	2	1

CV 22 Value = _____

CV 245: Consist Function Enable 3

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	F20	F19	F18	F17	F16	F15	F14	F13
CV Value	128	64	32	16	8	4	2	1

CV 245 Value = _____

CV 246: Consist Function Enable 4

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	F28	F27	F26	F25	F24	F23	F22	F21
CV Value	128	64	32	16	8	4	2	1

CV 246 Value = _____

Advanced Programming

Setting Consist Momentum Rates

CVs 23 (Consist Acceleration Rate) and 24 (Consist Deceleration Rate) are used to set the acceleration and deceleration rates for consists when a valid consist address is active. Like CVs 3 (Baseline Acceleration Rate) and 4 (Baseline Deceleration Rate), CVs 23 and 24 are used to determine the time it will take the consist to accelerate to full speed from a stop and come to a stop from full speed. Values from 0 to 255 may be programmed into each CV, though they are interpreted by the decoder as values from -127 to +127. Furthermore, values from 0 to 127 are interpreted as 0 to +127, whereas values from 128 to 255 are interpreted as 0 to -127.

Consist acceleration and deceleration values from -127 to +127 are then added to the baseline acceleration and deceleration rates. In other words, the value of CV 23 is added to the value of CV 3 to create the consist acceleration *offset*, and the values of CVs 24 and 4 are added to create the consist deceleration *offset*. For example, if the value of CV 3 is 100, programming CV 23 with a value of 200 would adjust, or *offset*, the consist acceleration rate by -73, making the combined value of CVs 3 and 23 equal to 27.

When the sum of CVs 23 and 3 equals 255, it will take approximately 3.8 minutes for the consist to accelerate to full speed from a complete stop. Likewise, when the sum of CVs 24 and 4 is 255, it will take 3.8 minutes to come to a complete stop from full speed. Programming values of 0 and 128 into CVs 23 and 24 will have no effect on acceleration or deceleration. Also, if the sums of CVs 23 and 3 and CVs 24 and 4 are each equal to 255, programming CVs 23 and 24 with positive values will not change the consist acceleration or deceleration rate because CV registers cannot contain values exceeding 255. Similarly, if CVs 3 and 4 are set to 0, programming CVs 23 and 24 with values from 128 to 255 (0 to -127) will have no effect because CV registers cannot contain negative values.

Enabling Consist Automatic Effects

To provide more versatility, CV 247 (Consist Function Enable 5) can be used in conjunction with Flex-Map function mapping CVs to allow automatic effect configuration for advanced consist operation. Automatic effects will respond to direction and movement when enabled. Table [...] shows the CV values for configuring effects to respond according to the following circumstances:

Forward-Driving: Effect is turned on when the consist is moving in the forward direction.

Reverse-Driving: Effect is turned on when the consist is moving in the reverse direction.

Forward-Standing: Effect is turned on when the consist is stopped in the forward direction.

Reverse-Standing: Effect is turned on when the consist is stopped in the reverse direction.

Emergency Stop: Effect is turned on when the consist receives an Emergency Stop command.

Note: CV 247 can be set to allow any combination of auto-effect enable. For instance, a value of 10 will allow the effect to turn on in the reverse direction regardless of movement, and a value of 3 will allow the effect to turn on when the consist is in motion regardless of direction.

Table R. CV 247 Auto-Effect Enable	
CV Value	Active When
1	Forward-Driving
2	Reverse-Driving
3	Driving
4	Forward-Standing
5	Forward
6	Forward-Standing, Reverse-Driving
7	Forward, Reverse-Driving
8	Reverse-Standing
9	Reverse-Standing, Forward-Driving
10	Reverse
11	Reverse, Forward-Driving
12	Standing
13	Standing, Forward-Driving
14	Standing, Reverse-Driving
15	Continuously Active
16	Emergency Stop Button pressed

Miscellaneous Features

Configuring Analog Mode Operation

Although Tsunami2 is designed to be operated in DCC, you can still use a conventional powerpack on a DC layout. The decoder operates entirely in response to track voltage when analog mode is enabled. Keep this in mind when configuring analog mode operation to take full advantage of the features offered by Tsunami2.

Note: *Analog mode is disabled by default.*

Analog Mode CVs

CV 12: Alternate Power Source
CV 13: Analog Mode Function Enable 1
CV 14: Analog Mode Function Enable 2
CV 29: Configuration Data 1
CV 218: Analog Mode Motor Start Voltage
CV 219: Analog Mode Engine Start Voltage
CV 241: Analog Mode Function Enable 3
CV 242: Analog Mode Function Enable 4
CV 243: Analog Mode Function Enable 5

Enabling Analog Mode

To enable analog mode, first enter a value of 1 into CV 12 (Alternate Power Source), then set bit 2 (APS) of CV 29 (Configuration Data 1) to 1. This will allow the decoder to receive an analog power source when a DCC signal is not available. For more information about adjusting the settings of CV 29, refer to “Configuring the Decoder.”

Operating in Analog Mode

When analog mode is enabled, the decoder will be inoperative until track voltage is received from the powerpack. Increasing the throttle setting to roughly 6 Volts will deliver enough voltage to power the decoder’s internal circuitry and activate automatic sound effects while the locomotive is stopped. Increasing the throttle setting to roughly 8 Volts will set the locomotion in motion. You may use the throttle to control locomotive speed from this point. Keep in mind that you can only change direction when the locomotive is stopped. To improve low-voltage operation, the decoder automatically adjusts motor processes and sound effect volume in response to back-EMF voltage measurements to compensate for changes in motor load. Refer to “Configuring Hyperdrive2” for more information about motor control.

Note: *Do not exceed the input voltage rating of the decoder as stated on the product packaging. This will permanently damage the decoder! Decrease the throttle setting to zero immediately if this occurs. Refer to “Troubleshooting” to view each error code.*

Enabling Analog Mode Functions

When operating in analog mode, the effects mapped to function keys F0-F28 will turn on automatically when track voltage is received, and will stay on until track voltage is removed. CV 13 (Analog Mode Function Enable 1), CV 14 (Analog Mode Function Enable 2), CV 241 (Analog Mode Function Enable 3), and CV 242 (Analog Mode Function Enable 4) allow you to enable functions in analog mode. The decoder will automatically turn on all functions enabled for analog mode when track voltage is received.

Note: *You can enable the effects mapped to function keys in CVs 1.257-1.384 (Effect Map Registers) for analog mode operation with CVs 13, 14, 241, and 242. Refer to “Using Tsunami2” to default function assignments for F0-F28, and refer to “Configuring Function Mapping” to customize Flex-Map function mapping CVs.*

Follow the steps on the next page to enable functions for analog mode operation.

Miscellaneous Features

Analog Mode Function Enable 1-4

The following procedure details enabling effects mapped to F0(f), F0(r), and F1-F28 for analog mode operation:

1. Circle the CV values associated with your preferred effects mapped to function keys F0-F28.
2. For each CV, add the values together and record the sum in the space provided. You should have four total CV values for enabling your preferred function keys when finished.
3. Enter each value into CVs 13, 14, 241, and 242 to enable your preferred functions for analog mode operation.

CV 13: Analog Mode Function Enable 1

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	F8	F7	F6	F5	F4	F3	F2	F1
CV Value	128	64	32	16	8	4	2	1

CV 13 Value = _____

CV 14: Analog Mode Function Enable 2

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	0	0	F12	F11	F10	F9	F0(r)	F0(f)
CV Value	0	0	32	16	8	4	2	1

CV 14 Value = _____

CV 241: Analog Mode Function Enable 3

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	F20	F19	F18	F17	F16	F15	F14	F13
CV Value	128	64	32	16	8	4	2	1

CV 241 Value = _____

CV 242: Analog Mode Function Enable 4

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Function	F28	F27	F26	F25	F24	F23	F22	F21
CV Value	128	64	32	16	8	4	2	1

CV 242 Value = _____

Miscellaneous Features

Enabling Analog Mode Automatic Effects

To provide more versatility, CV 243 (Analog Mode Function Enable 5) can be used in conjunction with Flex-Map function mapping CVs to allow automatic effect configuration for analog mode operation. Automatic effects will respond to direction and movement when enabled. Table T shows the CV values for configuring effects to respond according to the following circumstances:

Forward-Driving: Effect is turned on when the locomotive is moving in the forward direction.

Reverse-Driving: Effect is turned on when the locomotive is moving in the reverse direction.

Forward-Standing: Effect is turned on when the locomotive is stopped in the forward direction.

Reverse-Standing: Effect is turned on when the locomotive is stopped in the reverse direction.

Note: CV 243 can be set to allow any combination of auto-effect enable. For instance, a value of 10 will allow the effect to turn on in the reverse direction regardless of movement, and a value of 3 will allow the effect to turn on when the locomotive is in motion regardless of direction.

CV Value	Active When
1	Forward-Driving
2	Reverse-Driving
3	Driving
4	Forward-Standing
5	Forward
6	Forward-Standing, Reverse-Driving
7	Forward, Reverse-Driving
8	Reverse-Standing
9	Reverse-Standing, Forward-Driving
10	Reverse
11	Reverse, Forward-Driving
12	Standing
13	Standing, Forward-Driving
14	Standing, Reverse-Driving
15	Continuously Active

Set the Analog Mode Start Voltage

CV 218 (Analog Mode Motor Start Voltage) can be used to set the track voltage level at which power is applied to the motor to avoid the “motor-boating” effects that sometimes occur when using marginal powerpacks.

Entering a value of 0 into CV 218 will set the starting voltage to 6V. Entering a value of 255 into CV 218 will set the starting voltage to the maximum setting. Set CV 218 to the lowest value that still achieves desired results. The motor will not start when the voltage level in CV 218 is set to an excessively high value.

Note: Starting the motor at too low a voltage can cause the voltage from the powerpack to sag, resulting in a condition where the decoder loses power when attempting to power the motor.

$$\text{Starting Voltage} = (\text{CV 218} \div 10) + 6\text{V}$$

Set the Analog Mode Engine Start Voltage

CV 219 is used to adjust the voltage level applied to activate engine exhaust sound effects in analog mode. The engine exhaust start voltage is calculated as a fraction of the minimum voltage required to power the decoder (6V). Starting voltage is calculated as:

$$\text{Starting Voltage} = (\text{CV 219} \div 10) + 6\text{V}$$

Entering a value of 0 into CV 219 will set the engine exhaust start voltage level to 6V. Entering a value of 255 into CV 219 will set the engine exhaust start voltage level to the maximum setting.

Miscellaneous Features

CV 218 (Analog Mode Motor Start Voltage) determines the voltage level applied to start the motor in analog mode. Set CV 218 to a value greater than the value of CV 219 to ensure engine exhaust sound effects are activated prior to motor start. If the engine exhaust start voltage level in CV 219 is greater than the motor start voltage level in CV 218, engine exhaust sound effects will be activated when the motor start voltage is reached.

Note: *Tsunami2 performs better in analog mode when a higher quality, electronically regulated powerpack is used to supply filtered DC power. Using older rheostat-style or pulse powerpacks will make operation erratic and should not be used to power Tsunami2-equipped installations in analog mode. If your powerpack has a pulse power switch, make sure that it is turned off.*

Troubleshooting

Sorting Out Decoder Difficulties

If you have any difficulties operating your Tsunami2 Digital Sound Decoder, refer to this section first before doing anything else. We find that most problems are caused by errant CV values and can be easily corrected. If you are unable to locate the CV that is causing the problem, try resetting the CV values back to their defaults. Refer to “Resetting CVs and Starting Over” in the “Introduction to Programming” section for more information.

The locomotive was running, but isn’t anymore

- The decoder’s address has been accidentally changed.
- CV 19 (Consist Address) has been inadvertently set.
- CV 29 (Configuration Data 1) has been programmed to select other address.
- CV 3 (Baseline Acceleration Rate) and/or CV 4 (Baseline Deceleration Rate) have been set to values that are too high.
- Broken motor wire or track pickup wire.

Tip: *Check the decoder’s pilot light to confirm that track power is present.*

The locomotive isn’t running, and never has

- Refer to the information above.
- The decoder has been wired incorrectly.

The locomotive is running, but isn’t producing sound

- The mute function (F8 by default) is turned on.
- Another function has been remapped to the mute function.
- Volume control CVs (CVs 128-160) have been set to zero.
- The speaker wire is broken.
- The speaker is burned-out.

The locomotive is running in a consist, but without sound and lighting

- The consist functions are disabled. Refer to “Consist Function Enable” under the section “Configuring for Advanced Consist Operation” to set functions for consist operation.

The lights are flickering on and off

- The decoder is set to 14 speed-step mode, while the command station is set to 28 or 128 speed-step mode.

The lights aren’t working

- The decoder is set to 28 or 128 speed-step mode, while the command station is set to 14 speed-step mode.
- The function mapping CVs have been improperly configured.
- Lightbulbs are burned-out.
- If you’re using 1.5 volt micro-bulbs, the resistor value is too large.
- The lamp wires are broken.

Troubleshooting

The locomotive is sitting and both headlights are flashing

- Refer to the following section, “Diagnostic Lamps.”

Sound works for a while, and then stops working

- The amplifier is overheating. Lower the volume.
- The decoder is overheating. Lower the track voltage.
- The speaker is damaged. Replace speaker.

A “crackly” sound is coming from the speaker

- The volume has been set too high for the speaker to successfully reproduce the audio signal.
- The speaker is not baffled properly.
- The speaker wire is loose.
- The speaker is damaged.

The decoder cannot be programmed

- The programming track has insufficient power. Try using Operations Mode.
- All CVs are locked. Refer to “Locking and Unlocking CVs” in the “Introduction to Programming” section for more information regarding unlocking CVs.

Diagnostic Lamps

There are a blue and a red LED on the circuit board that may help you identify and resolve problems.

Pilot Light

The blue pilot light indicates that the decoder is receiving power. If this light is not illuminated, it may indicate an improperly wired decoder. It could also indicate a loose wire, poor track pickups, no output from the command station, or another wiring problem on your layout.

Fault Light

When the decoder encounters a fault, the red fault light and all installed lighting will flash an allotted number of times to report an error code. The number of times the light flashes corresponds to a specific error.

Note: *The fault light is connected in series with the decoder’s FX6 output (F27 by default) and will illuminate in a steady “on” state when that function is on. This is not an error code but can be used to check for proper operation of the fault light on a decoder.*

Troubleshooting

Error Codes

Error codes indicate problems that are easily solved. The decoder's error codes are shown below for reference.

Error 9: Over-Temperature Fault

An over-temperature fault indicates the core temperature of the decoder has exceeded its capacity. An onboard temperature sensor is employed to send an error code and deactivate sound and motor processes when the core temperature reaches 80° C (176° F). Sound and motor settings resume when the core temperature cools to 5.5° C (42° F). 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

Voltage is monitored during normal operation to automatically deactivate sound and motor processes when voltage exceeds the decoder's voltage limit. Settings resume when the voltage is reduced to within limits and will vary between decoder models.

Note: *The decoder's absolute maximum voltage input varies with decoder model, generally between 22 and 27 volts! Refer to the decoder's packaging for actual voltage limits as exceeding these limits may cause permanent damage to the decoder.*

Error 12: Motor Overload Fault

The motor current is monitored during normal operation to automatically deactivate motor processes when the current exceeds 150% of the decoder's rating. Power is returned to the motor after 100ms. The motor remains inactive if current-overload persists.

Error 16: CV Reset

This error code indicates that a CV reset has occurred and all settings have been set to default.

Additional Error Codes

Although rare, the decoder may also report the following error codes, which cannot be remedied and require factory repair:

Error 5: EEROM Checksum Failure

If you're still having difficulties, please contact our customer service department:

SoundTraxx Customer Service Department
141 Burnett Drive
Durango, CO 81301
Telephone: (970) 259-0690
Fax: (970) 259-0691
Email: support@soundtraxx.com

Appendix A: Decimal-Hex-Binary Conversions

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: Tsunami2 Electric CV Reference

Primary CVs	Sound Control CVs
CV 1: Primary Address CV 2: Vstart CV 3: Baseline Acceleration Rate CV 4: Baseline Deceleration Rate CV 5: Vhigh CV 6: Vmid CV 7: Manufacturer Version (Read-Only) CV 8: Manufacturer ID CV 10: EMF Feedback Cutout CV 11: Packet Time-Out Value CV 12: Alternate Power Source CV 13: Analog Mode Function Enable 1 CV 14: Analog Mode Function Enable 2 CV 15: CV Unlock Code CV 16: CV Lock ID CVs 17-18: Extended Address CV 19: Consist Address CV 21: Consist Function Enable 1 CV 22: Consist Function Enable 2 CV 23: Consist Acceleration Rate CV 24: Consist Deceleration Rate CV 25: Speed Table Enable CV 29: Configuration Data 1 CV 30: Error Information CV 31: CV Index 1 (Read-Only) CV 32: CV Index 2 CV 33: F0(f) Output Location CV 34: F0(r) Output Location CV 35: F1 Output Location CV 36: F2 Output Location CV 37: F3 Output Location CV 38: F4 Output Location CV 39: F5 Output Location CV 40: F6 Output Location CV 41: F7 Output Location CV 42: F8 Output Location CV 43: F9 Output Location CV 44: F10 Output Location CV 45: F11 Output Location CV 46: F12 Output Location	CV 112: Sound Configuration 1 CV 113: Quiet Mode Time-Out Period CV 114: Engine Exhaust Control CV 116: Reserved CV 117: Independent Brake Rate CV 118: Train Brake Rate CV 119: Max Engine Recovery Speed CV 120: Airhorn Select CV 121: Auxiliary Airhorn Select CV 122: Bell Select CV 123: Reserved CV 124: Air Compressor Select CV 126: Coupler Select CV 128: Master Volume CVs 129-160: Primary Mixer Volume Levels CV 193: Auto-Bell On Set Point CV 194: Auto-Bell On Time CV 195: Coach Door Count CV 196: Brake Squeal Sensitivity CV 197: Analog Mode Auto-Sound Enable CV 198: DCC Mode Auto-Sound Enable CV 200: Poppet Valve Release Rate
	Advanced Motor Control CVs
	CV 209: PID Kp Parameter CV 210: PID Ki Parameter CV 211: Low-Speed Compensation CV 212: BEMF Feedback Intensity CV 213: BEMF Sample Period CV 214: BEMF Sample Aperture Time CV 215: BEMF Reference Voltage CV 216: Motor Speed Step Deadband CV 217: Motor Control Register CV 218: Analog Mode Motor Start Voltage CV 219: Analog Mode Engine Start Voltage
	Audio Control CVs
	CV 224: High-Pass Filter Cutoff Frequency CV 225: Equalizer Control Register CVs 226-232: Cut/Boost Controls
	Analog Function Enable CVs
	CV 241: Analog Mode Function Enable 3 CV 242: Analog Mode Function Enable 4 CV 243: Analog Mode Function Enable 5
	Consist Function Enable CVs
	CV 245: Consist Function Enable 3 CV 246: Consist Function Enable 4 CV 247: Consist Function Enable 5
	Indexed CV Page 1
	CVs 1.257-1.384: Effect Map Registers CVs 1.385-1.512: Effect Auxiliary Map Registers
	Indexed CV Page 2
	CVs 2.289-2.320: Alternate Mixer Volume Levels CV 2.503: DDE Load Offset CV 2.504: DDE Load Slope CV 2.507: DDE Traction Motor Low Volume Limit CV 2.508: DDE Traction Motor High Volume Limit CV 2.509: DDE Attack Time Constant CV 2.510: DDE Release Time Constant CV 2.511: DDE Throttle Sensitivity CV 2.512: DDE Load Sensitivity
Lighting Effect CVs	
CV 49: Headlight Effect Select CV 50: Backup Light Effect Select CV 51-54: FX3-FX6 Effect Select CV 57: Forward Direction Enable CV 58: Reverse Direction Enable CV 59: Hyperlight Flash Rate CV 60: Grade-Crossing Hold Time CV 61: Brightness Register 1 CV 62: Brightness Register 2 CV 63: Dimmer Level	
Speed Table CVs	
CV 66: Forward Motor Trim CVs 67-94: Custom Speed Table CV 95: Reverse Motor Trim	
User Information CVs	
CV 105: User Identifier 1 CV 106: User Identifier 2	

Appendix C: License Agreement

Please read this license agreement carefully before opening your Tsunami2 Digital Sound Decoder packaging. Breaking the seal on the packaging indicates you have accepted the license terms detailed herein. If you received the Tsunami2 Digital Sound Decoder pre-installed from your dealer, using the product indicates your acceptance of the license terms detailed herein. If you do not agree with the terms, return the unopened package to the dealer within thirty (30) days to receive a refund of purchase.

SoundTraxx Software License Agreement

SoundTraxx provides the computer software/firmware embedded within the Tsunami2 Digital Sound Decoder and any modifications, updates, revisions or enhancements received by you from SoundTraxx or its dealers and licenses its use within the terms set below:

- A. You are granted a nonexclusive, nontransferable license to use the software/firmware included with your Tsunami2 sound system only with the Tsunami2 sound system hardware that you purchased.
- B. Title and ownership of the software/firmware, sound recordings, documentation and accompanying materials, if any, and all associated intellectual property rights remain with SoundTraxx.
- C. The structure, organization, and code of the software/firmware are the valuable properties of SoundTraxx. You may not make copies of the hardware, software/firmware, code, or any portions thereof. You are not to modify, adapt, translate, reverse engineer, de-compile, disassemble or create derivative works based on the hardware or software/firmware.
- D. Unauthorized copying of the software/firmware or documentation, or failure to comply with the above restrictions, will result in automatic termination of this Agreement. This Agreement does not grant you any intellectual property rights.

Appendix D: Service and Warranty Policy

90-Day Safety-Net Service Warranty

All SoundTraxx Digital Sound Decoders are tested thoroughly during production and are warranted to be operational and free of manufacturing defects before shipment. However, in the event an error occurs during installation, SoundTraxx will cover the repair under the conditions of our Safety-Net Service Warranty. If you damage the Digital Sound Decoder or it fails to operate within the first ninety (90) days, SoundTraxx will repair or replace the product free-of-charge under the following conditions:

- A. The original sales receipt confirming purchase from an authorized SoundTraxx dealer must accompany the product. The date-of-purchase shown on the receipt must be within the last 90 days. SoundTraxx will return the original receipt with your repaired unit.
- B. The product must show no signs of damage of which resulted from unauthorized repairs or modifications. This includes, but is not limited to:
 - Removal of the shrink tubing from the decoder
 - Drilled or enlarged circuit board holes
 - A cut or trimmed circuit board
- C. The Digital Sound Decoder must be returned properly packaged and insured, with postage paid; SoundTraxx is not responsible for products lost or damaged in transit.

Limits of Liability

The foregoing shall constitute the sole and exclusive remedy of any owner of this product for breach of warranty including the implied warranties of merchantability and fitness. IN NO EVENT SHALL SOUNDTRAXX BE LIABLE FOR SPECIAL OR CONSEQUENTIAL DAMAGES OR FOR THE REPRESENTATIONS OF RETAIL SELLERS.

Visit www.soundtraxx.com/support to view complete warranty information.

Contacting Support

Our service department is available Monday-Friday, from 9am to 5pm (Mountain Time).

SoundTraxx Customer Service Department
141 Burnett Drive
Durango, CO 81301, USA
Phone: (970) 259-0690
support@soundtraxx.com

Appendix E: Declaration of Conformity

Declaration of Conformity

We, Throttle Up! Corp., dba SoundTraxx, declare in sole responsibility that the following products:

Product Description

Tsunami2 Digital Sound Decoder

Model Numbers

TSU-1100, TSU-2200

Part Numbers

886001, 886002

comply with the following directive:

2014/30/EU Electromagnetic Compatibility (EMC Directive)

and that the following standards have been applied:

EN 55014-1:2006 + A1: 2009 Part 1: Emissions