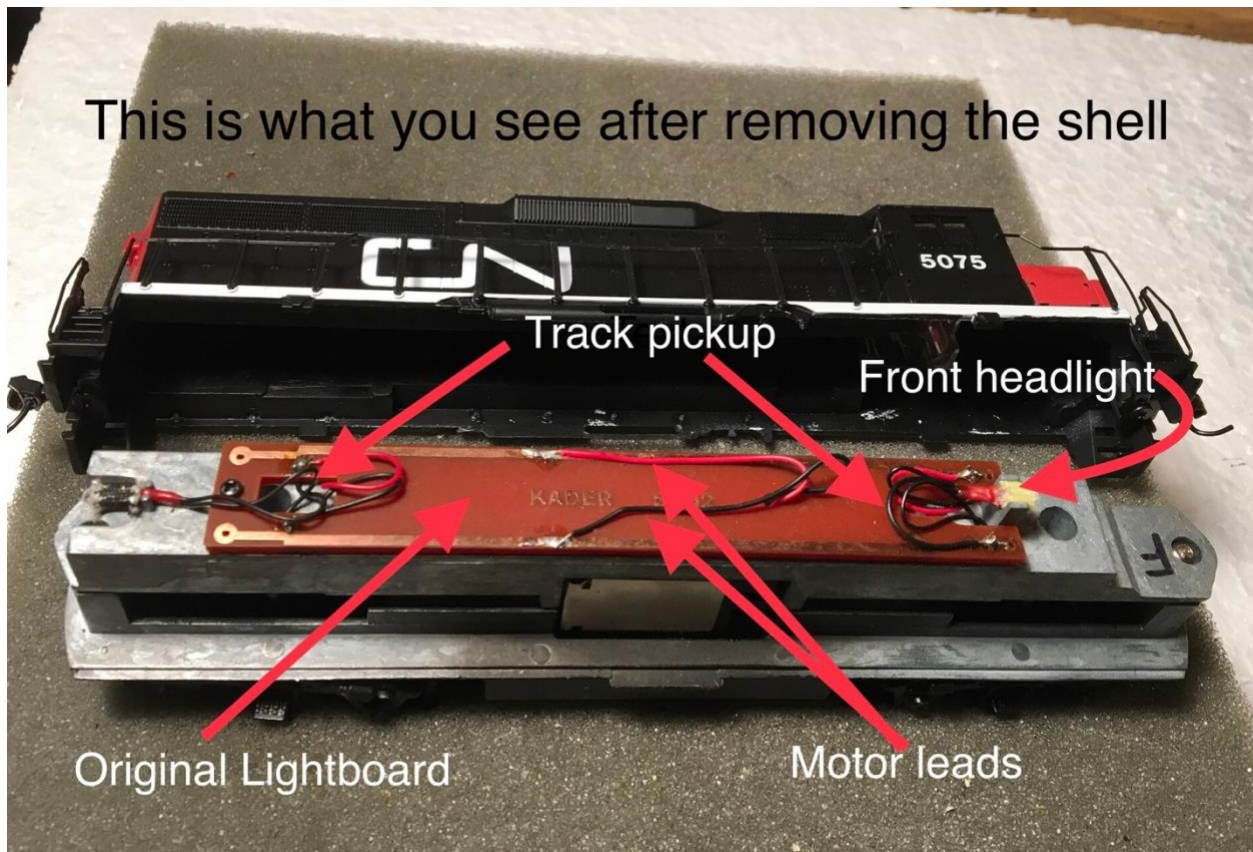**SoundTraxx Tsunami2-1100 Decoder installed in a Bachmann GP40 HO Diesel .. CN 5075**

Having been gifted a Bachmann GP40 HO DC locomotive, I decided to add sound when converting to DCC. Bachmann's GP40 runs smoothly, and has good tractive effort thanks to an abundantly weighted metal chassis, and a reasonably good can motor with flywheels. There are some idiosyncrasies to make yourself aware of prior to commencing wiring. As I understand 'convention', when running a locomotive forward, the right rail and right track pickups are positive in DC, and the left rail and track pickups are negative. If you run your locomotives short hood forward, note that Bachmann has used red wires for the left rail and left track pickups and conversely black wires for the right rail and right sided pickups. On my model the engine ran short hood forward and is wired in accordance with the NMRA convention of DC right rail positive in forward direction. Note that Bachmann connected the black wires to the black wire of the motor and the red wires to the red wire from the motor. The point being that in this model, if you are running it short hood forward, remember that Bachmann's original black wires represent the positive connections, and the red wires the negative. In other words the red track pickup +ve wire from the decoder will connect to the black track pickup connections (in this case also +ve) from the locomotive's trucks. This caution also applies to the motor leads from the decoder to the motor terminals. Bachmann has a red wire connected to the negative motor terminal, and black to the positive motor terminal.(See wiring schematic on page 9.)

This is what you see after removing the shell

Track pickup

Front headlight

Original Lightboard

Motor leads

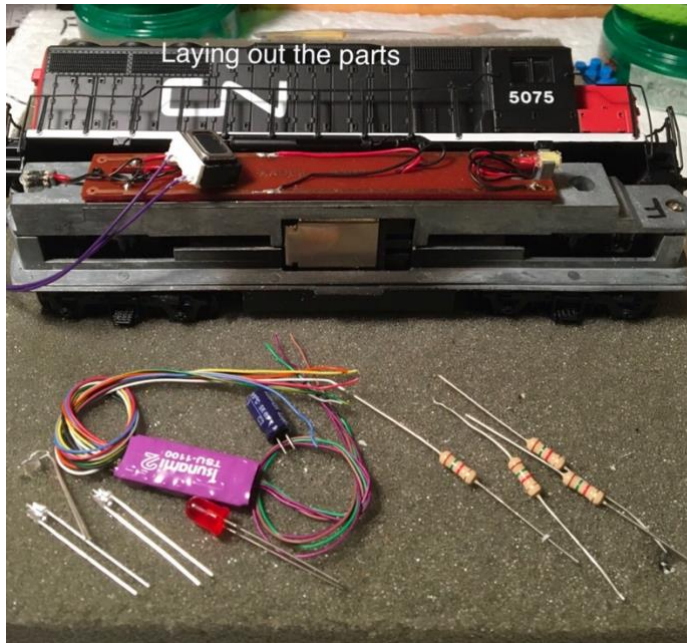(Double-tap on any image In iOS PDF files to enlarge image)

To remove the shell, disengage the long metal lugs on the chassis from the slots on the mid sides of the plastic shell, and gently encourage the shell to lift up. You do not need to remove the couplers first. These attachments are visible and labelled in the photo on page 10.

For this project I elected to use a mini speaker from Train Control Systems. The TCS microWow mini speaker is 1 watt and 8 ohms impedance and therefore a good match for the TSU-1100 decoder. It also requires a baffle, which was constructed using a piece of LEGO block.
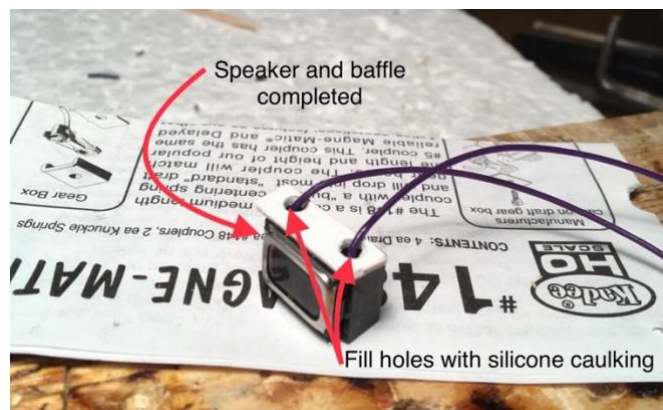
I used a piece of styrene for one side of the baffle which was cut to be just a little greater in height than the total height of the speaker baffle assembly to protect the diaphragm from being encroached upon by any protuberances arising from the roof of the shell, after replacing the shell. The speaker was placed on top of the chassis at rear, and holes drilled in the exhaust fan above to let the sound out. For a discussion re SoundTraxx mini speakers see my previous article 'SoundTraxx Tsunami2 TSU-1100 Decoder Installation Into HO P2K GP9.'
It's now a good idea to plan where you are going to place the parts.

Tsunami2-1100 Decoder installed into a Bachmann GP40 HO Diesel .. CN 5075
(Double-tap on any image In iOS PDF files to enlarge image)

Laying out the parts

The Parts List:
SoundTraxx Tsunami2 TSU-1100 EMD Diesel Sound Decoder PN. 885001
Tsunami 220μF Replacement Capacitor PN. 810128 (included)
SoundTraxx soundtraxx.com
TCS Wow Micro Speaker 1 watt 8 ohm 13.6 x 9.6mm PN 1698
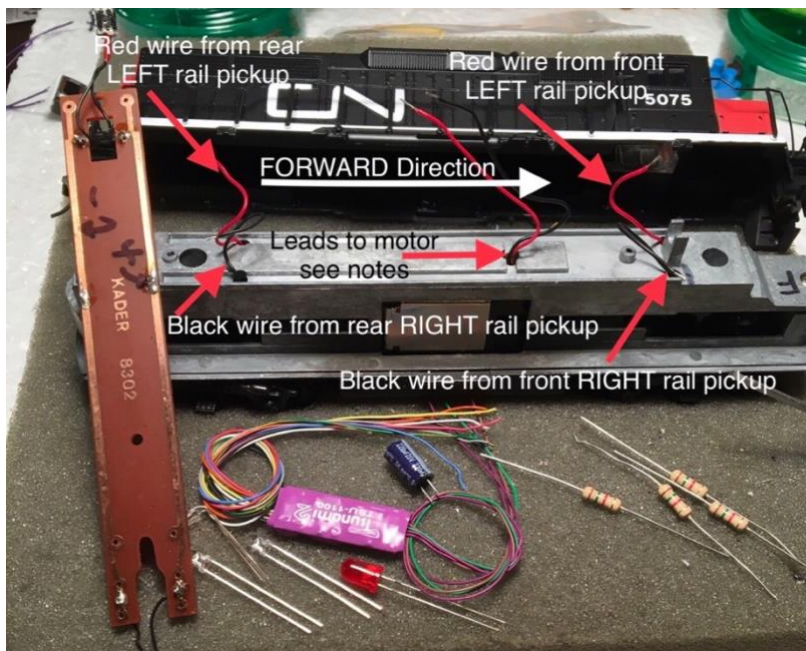Train Control Systems www.tcsdcc.com
3mm LEDs Golden white x 3
5mm Red LED X1
1.5 K ohm ½ watt resistors x 4
Ultra-Flexible Wire 30 AWG, colour coded SoundTraxx P.N.810142 – 810152
Heat Shrink tubing, Kapton tape

Tsunami2-1100 Decoder installed into a Bachmann GP40 HO Diesel .. CN 5075
(Double-tap on any image In iOS PDF files to enlarge image)

The original lightboard is removed and discarded.

It is worthwhile spending some time to ascertain **where best to place the parts**. My goal in decoder installations is to always maximize component capabilities within the available space without compromising the locomotive's inherent weight, for example by removing part of the chassis to make more room for a component. This is why I chose the TSU-1100 with it's included small capacitor. There was no room in this model for a larger stay-alive capacitor. I elected to place the capacitor in the cab. This still left room for the rotary beacon and the forward LED headlight and a cabin light, and the engineer!

Placing the parts to get a rough idea of where everything fits
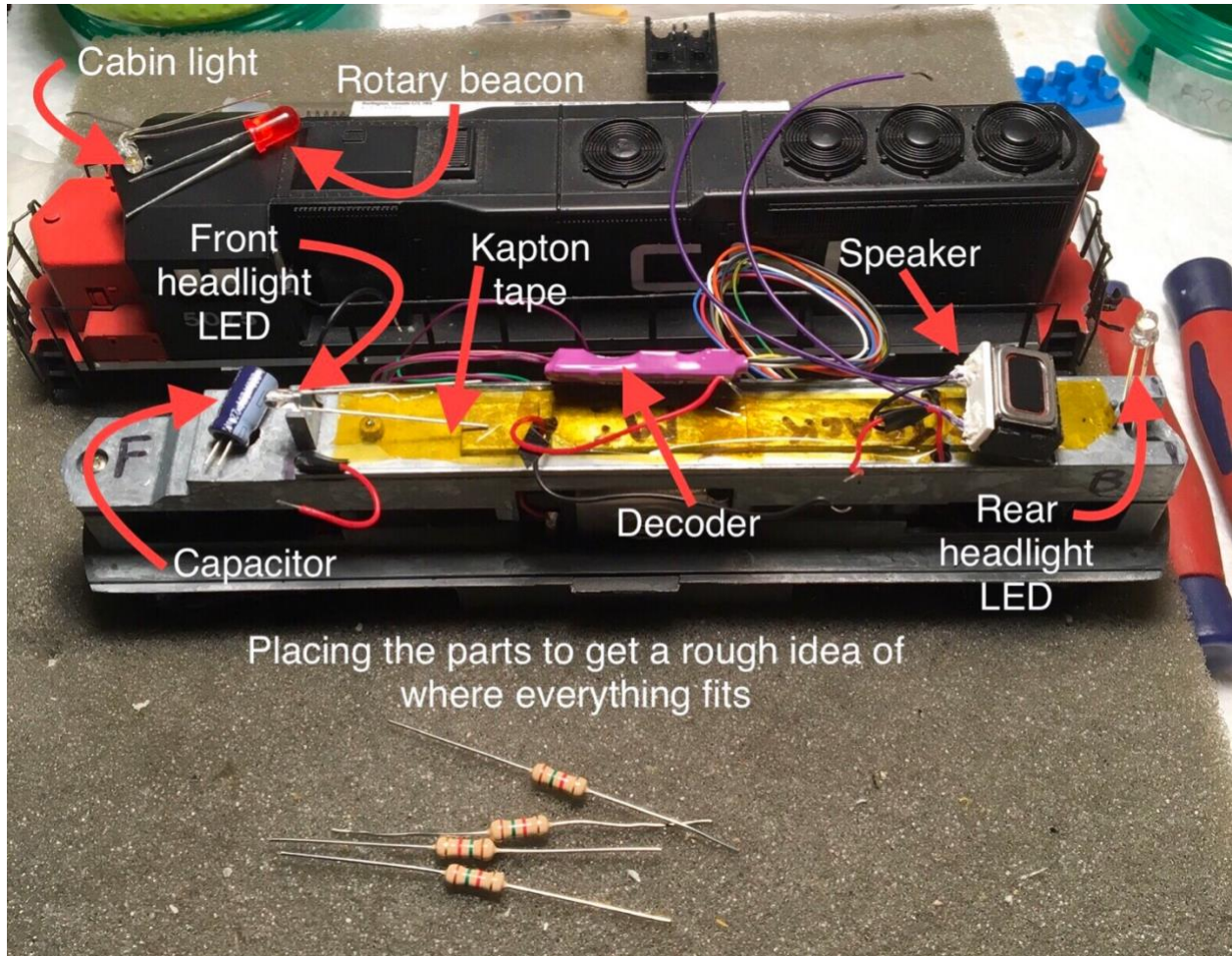
There are some ways of saving space in tight decoder installations. It is important in my view to use the most flexible smallest diameter wire as is available. I use 30AWG ultra flexible stranded wire which comes colour coded to match NMRA decoder wiring conventions, and is available from most decoder manufacturers and electronics suppliers. Heat shrink tubing is also a great space saving asset. In most of my decoder installations I have used surface mount SMD resistors, (see a previous article..Installing a Tsunami2 PNP SoundTraxx Decoder into an Alco

RS3 HO locomotive) and ideally if you have them available use SMD LEDs as well. In this model there was enough room for larger resistors, so I was able to use standard ½ watt resistors. However to save space I mount these resistors on a wood platform constructed from a piece of tongue depressor, placing the resistors on one side, and making the wire connections on the other. When mounting **the resistor board** use Kapton tape to isolate the metal chassis from any contact with the resistor leads.

To make working on the solder connections easier, place a piece of double sided sticky foam tape on the working surface and adhere the board to it. Do the same when soldering

The resistor board. See text

Double-sided foam sticky tape

Cut off excess resistor lead after making solder connection
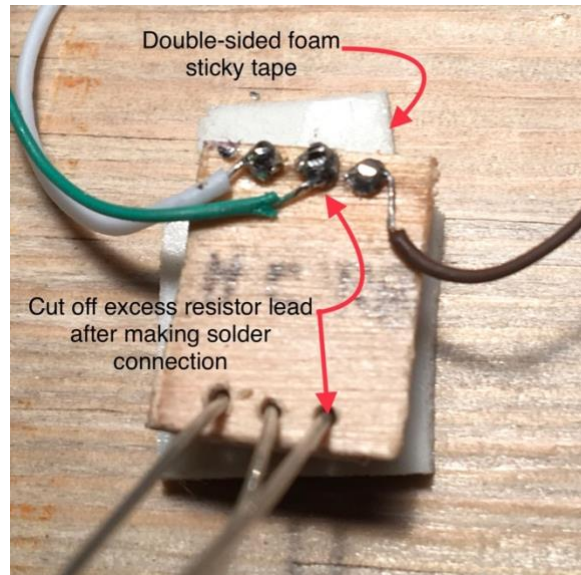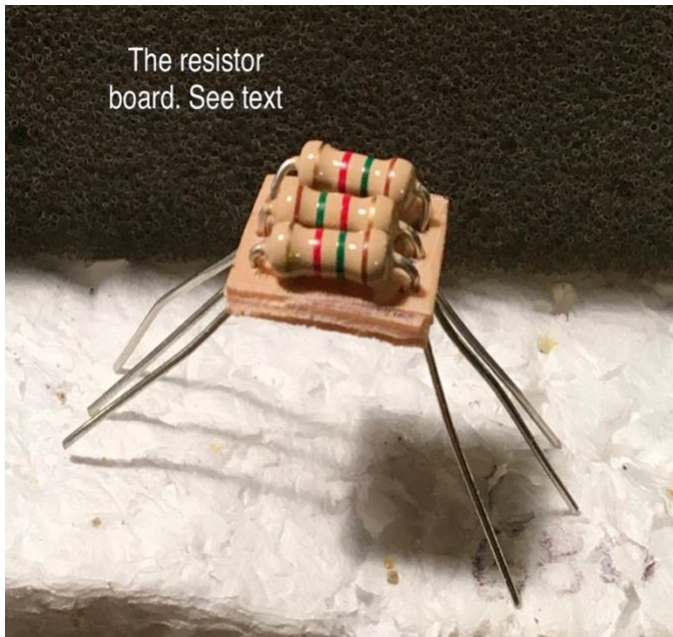
connections to the capacitor. See page 8.

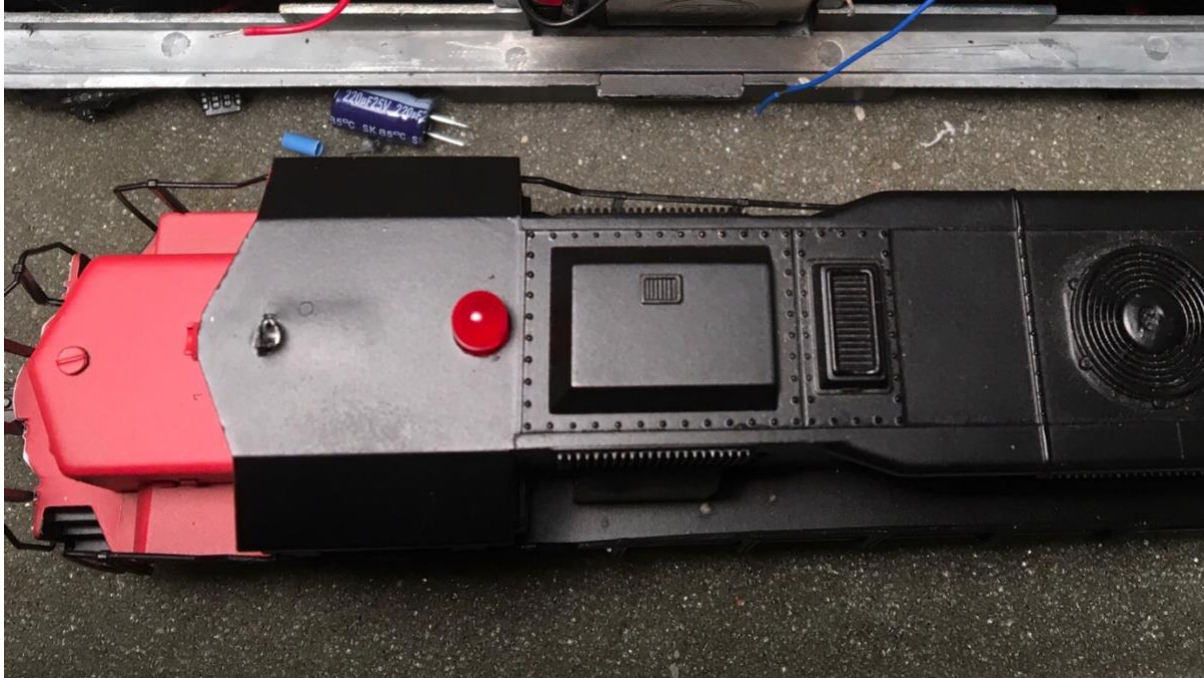(Double-tap on any image In iOS PDF files to enlarge image)

To mount **the rotary beacon,** carefully start a pilot hole using a pin vise at the appropriate
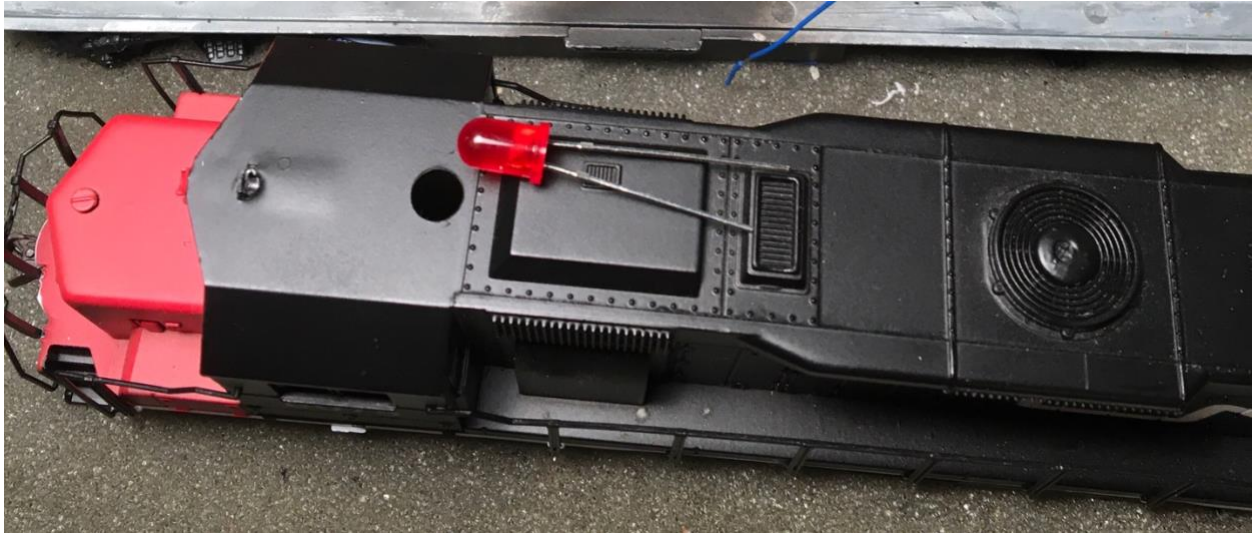

position on the roof of the cab, and gradually increase the diameter of the hole to a snug fit for the red LED.

Note that I removed the horn from the roof of the shell to prevent damaging it while working

on inserting the rotary beacon. Placing the front headlight LED, and cabin light LED as well as wiring the rotary beacon requires some advanced planning. The following photos show how I accomplished this, keeping in mind it is too risky to make solder connections in the close confines of the cab without damaging the plastic shell with the soldering iron. I pre-fitted all the

components and made all the solder connections outside the shell prior to mounting them in the cab.
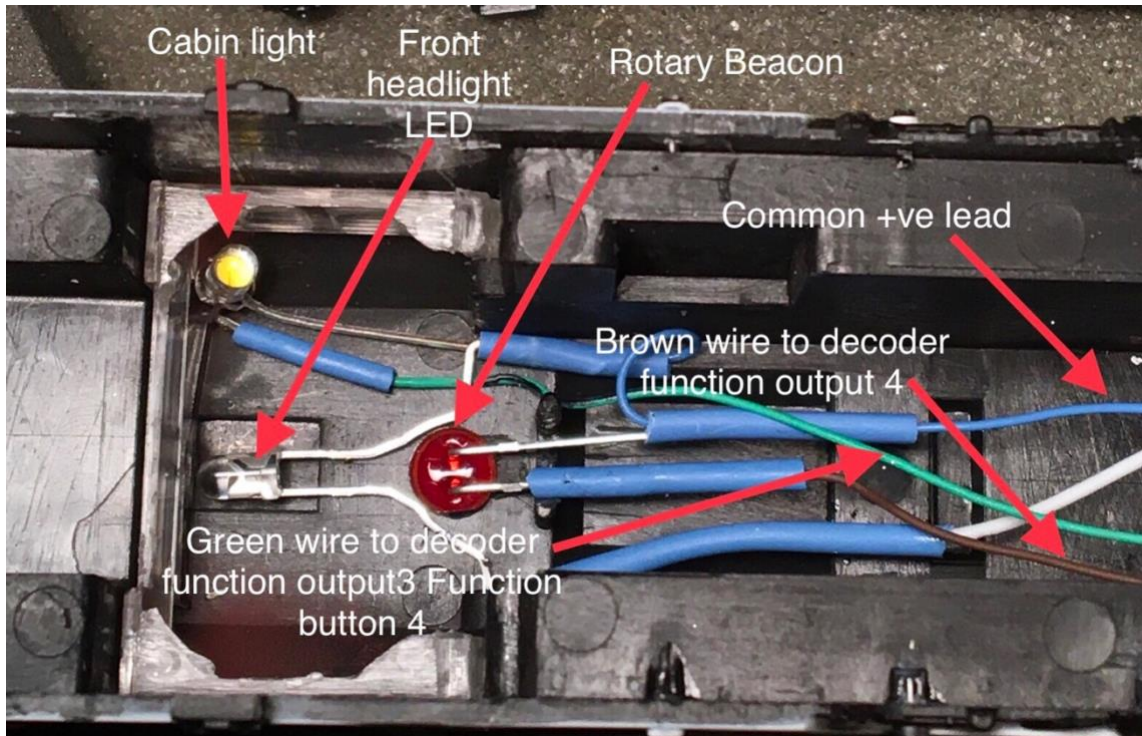
The front headlight LED, the cabin light and rotary beacon are installed under the roof of the cabin. There also has to be room for the capacitor. I even managed to squeeze in the engineer!
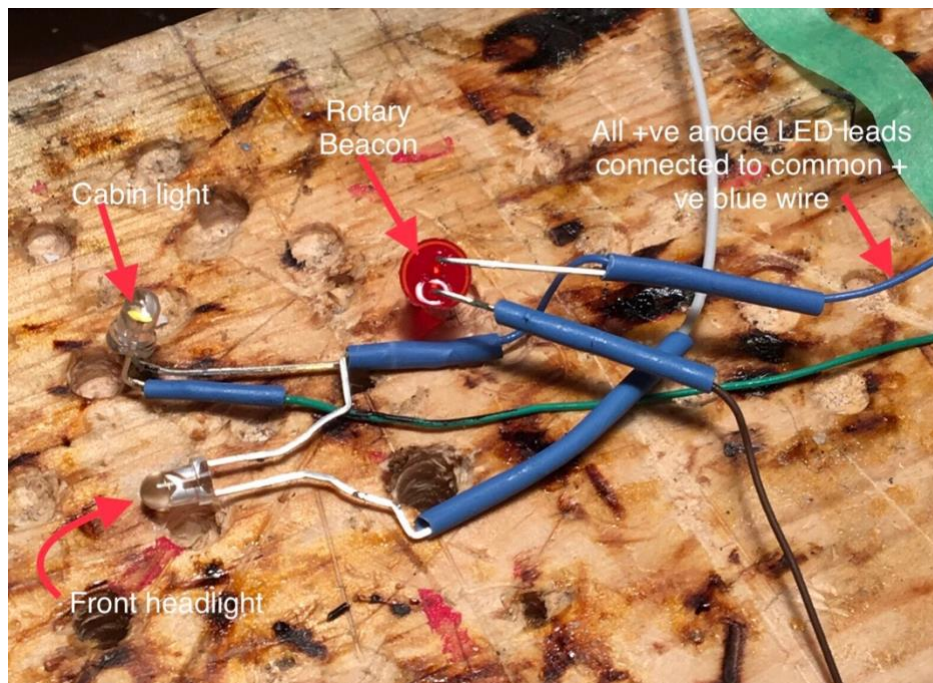
A word about **connecting LEDs**. All LEDS have a polarity that must be adhered to when making connections. By the usual conventions the short lead is the negative cathode connection. Generally the cathode is the 'flag', or largest element in the bulb. Some LEDs will have a flattened surface on the side of the cathode. In some cases however the larger element might be the anode, depending on the manufacturer as was the case with my red LED. LEDs are of course diodes and conduct current and therefore light only when connected using the correct polarity. It is therefore always wise to test the LEDs prior to soldering connections.

The capacitor also has a polarity. It's negative connection is marked on the side of the capacitor with a wide white stripe. The negative lead connects to the green / yellow striped lead from the decoder, and the positive lead connects to the +ve blue common wire connections. (See wiring schematic on page 9.)
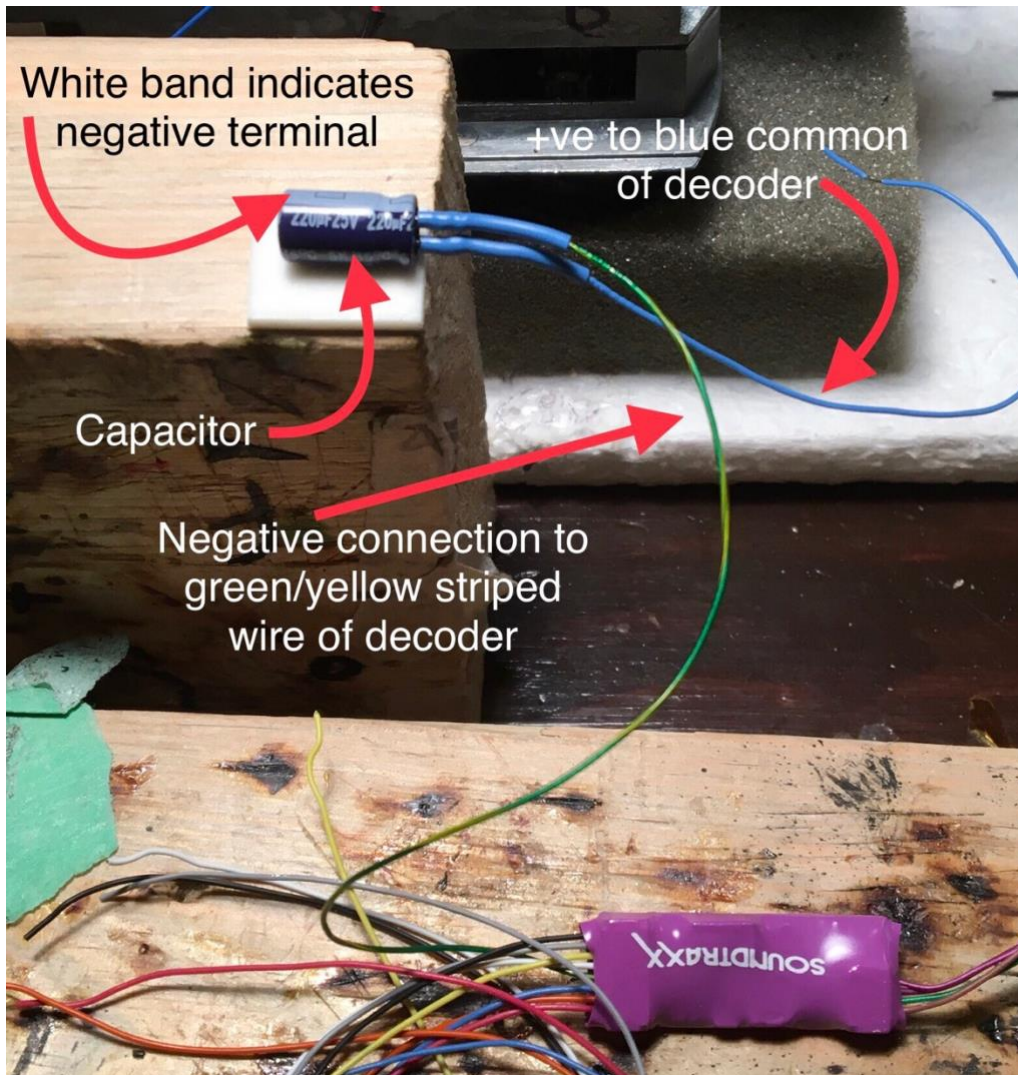
The **wiring schematic** as supplied by SoundTraxx:
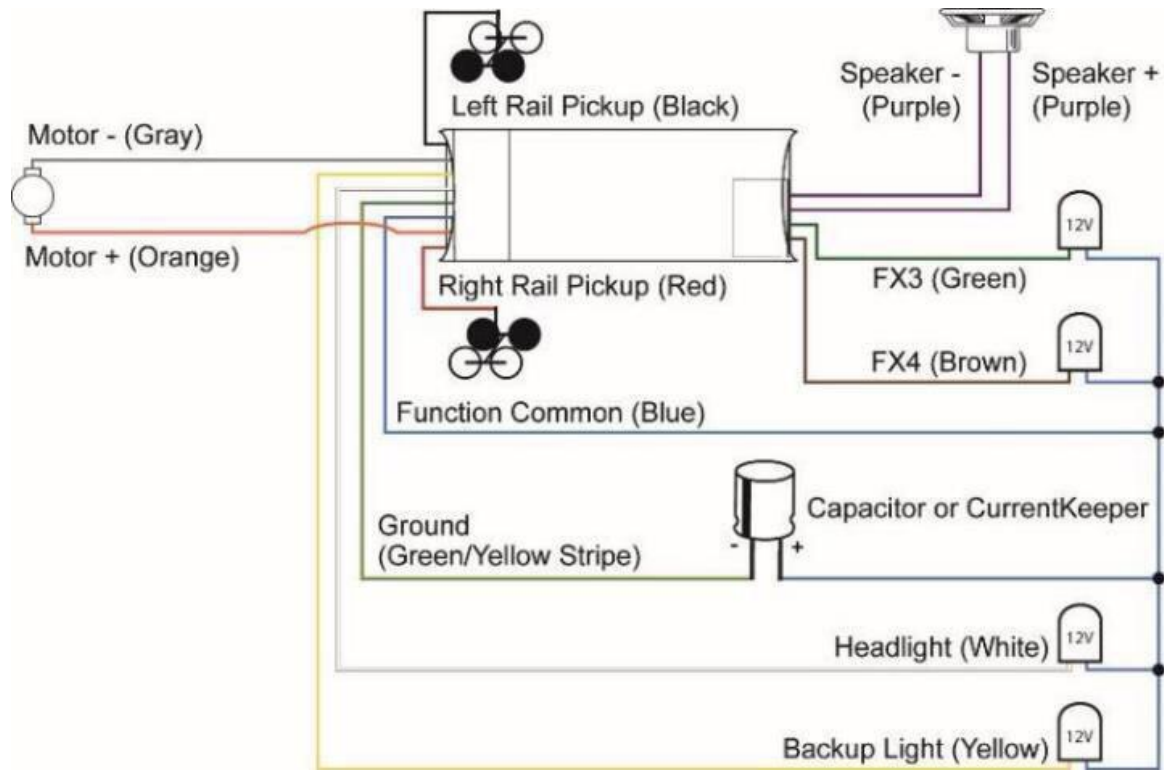

WIRING SCHEMATIC FOR SOUNDTRAXX TSUNAMI2 TSU-1100 SOUND DECODER

The wire leads from the decoder are all colour coded, following standard NMRA conventions

Yellow wire lead from cathode of rear LED Headlight buried in channel of chassis

Tsunami2-1100 Decoder installed into a Bachmann GP40 HO Diesel .. CN 5075
(Double-tap on any image In iOS PDF files to enlarge image)

It's now time to complete the wiring connections to the decoder. One criticism I have of my own work in some of the decoder installations I have done is to leave too much wire attached to the decoder. It can be psychologically difficult for some of us to ruthlessly shorten the length of these leads for such excuses as you 'might want to take this decoder out and place it in another loco etc'. After all this work, it probably won't happen! The point being, it is always a good idea to be as frugal as possible in keeping the length of wires to only what is needed in the interests of conserving space. Remember you have to get the shell back on. At the same time I like to leave the wires to components under the roof of the shell as long as possible to facilitate removing the shell in the future for maintenance.. all a happy compromise..

See what I mean about too much wire! This photo also shows where the lugs on the metal chassis are located relative to the retaining slots on the side of the plastic shell.
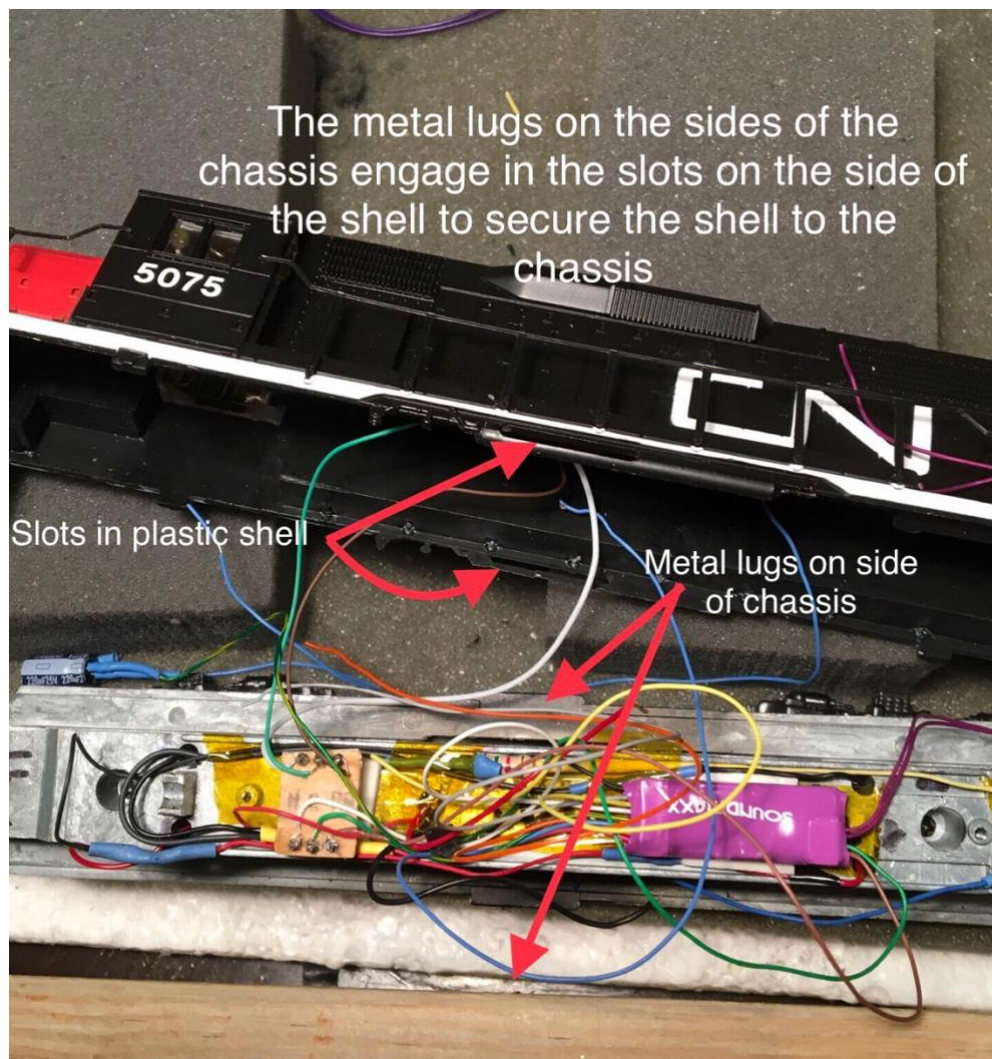
My final connections are secured with Kapton tape. In replacing the shell take caution that no wires are pinched between the side of the chassis and the plastic shell.
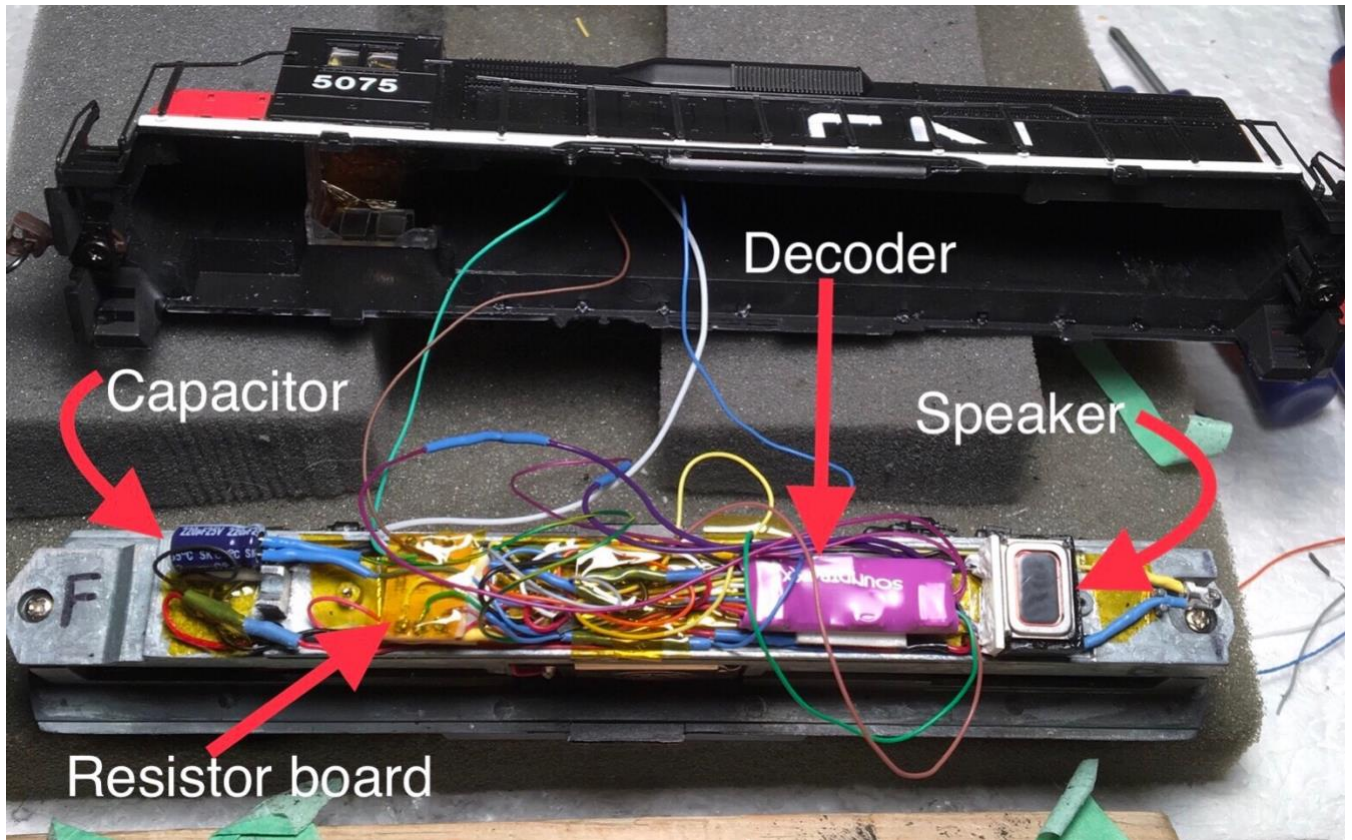
Now time to program some CVs!

I use an NCE PH Pro 5 Amp Command Station and a Pro Cab r throttle for most of my CV programming. My system also has a serial connector to a laptop so I am also able to use Decoder Pro. There are some caveats when using an NCE PH Pro that need to be considered when programming indexed CVs. Indexed CVs can be read using Program track mode, but must be written using Program on Main (POM). The comments below apply to my own locomotives choices. Yours will differ. Consult the Tsunami2 User Guide for this information.

Date: Dec 1 2019
CV 128 Master Volume Level .. factory Value 192 Left at 192 to protect Speaker.
Manufacture: 141
Decoder version: 071
Address: Long 5075 Short 3 Long address activated
DC mode disabled
Set up Config:

Direction bit = normal
Speed steps equal 28
Speed table standard

CV 2 Start Voltage 0
CV 6 Mid voltage 128
CV 5 Max Voltage 255
Acceleration 75
Deceleration 75
Function mapping No

CV 128 = 192 (Master Volume)
CV 129 = 200 Air horn volume (makes less distortion) Factory Value was 225
CV 120 = 0 (Default?)
CV 120 = 28 is Air Horn. Leslie S3L should I change the air horn from default?
Stopped here Dec 3 2019

Calibrated DDE:
CV 114 = 47
CV 32 = 2
CV 512 = 16
Calibrate indexed CVs 2.503 and 504 = 255
Done Date: Dec 6 2019 (Works)

Current settings for DDE and Hyperdrive2 Motor Control CVs:
Dynamic Digital Exhaust DDE
These are the pertinent CVs:
DDE Control CVs
CV 2.503: DDE Load Offset
CV 2.504: DDE Load Slope
For steam:
CV 2.505: Side Rod Clank Low Volume Limit
CV 2.506: Side Rod Clank High Volume Limit
For diesel:
Prime mover low and high volume limits are added to the volume level in CV 131 (Prime Mover
Primary Mixer Channel)
CV 2.507: DDE Prime Mover Low Volume Limit Default = 0
CV 2.508: DDE Prime Mover High Volume Limit Default = 255
Time constants: Determine how quickly the DDE processor reacts to changes in load and speed
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

First **calibrate DDE:** (Active)

(Soundtraxx recommend you automatically calibrate Dynamic Digital Exhaust load compensation settings before adjusting throttle and braking control CVs.)

CV 31 = 16 (default) CV Index 1 (This should not be changed)

When using an NCE Power Pro 5 amp command station, you

MUST USE OPS MODE PROGRAMMING ON MAIN

(You can read indexed CVs on the Programming track but don't write CVs on the Programming track..write values using Program on Main if using the PH PRO 5Amp)

Ensure CV 114 (Engine Exhaust Control) is set to a value of 47 .

CV 32 = 2 (Changes to indexed CVs Page 2)

CV 2.512 = 16 DDE Load Sensitivity (after you change to indexed CV page 2 by setting CV 32 to 2, you now just enter 512..which is now indexed CV 2.512)

Now 'calibrate' the specific loco Motor by putting it on a straight and level track (loco only ... no freight cars) and running down the track at speed steps set to 1 and then 25 - 40 or whatever you anticipate to be your normal fastest running speed, and entering the appropriate values into CVs 503 and 504.

calibrate the nominal low-speed load level.

CV 2.503 = 255 at Speed Step 1 (DDE Load Offset)

calibrate the nominal high-speed load level.

CV 2.504 = 255 at Speed Step 25 -40 (DDE Load Slope)

To increase or decrease sensitivity after calibration just enter a value that is more or less than 16 into CV 2.512

CV 2.507 = ? Default Value = 0 (Prime Mover)

Try CV 2.507 =175 Date:Dec 7 2019 (sounds better..more obvious)Effect is to have engine go almost to quiet from still idle stop at least in reverse..if rolling downhill.. .not so in forward.in forward it revs up! ..(going up hill on programming track...move to a track where loco goes downhill on forward and same .i..e no sound hardly rolling forward downhill) .up until SS 10, then engine roar comes in.

CV 2.508 = 255   Default Value = 255

CV 2.509 = 215   Default Value = 215. (Time) 0=instant response

From User Guide Advanced Programming: pg. 53

Mover Primary Mixer Channel). Increase and decrease prime mover volume limits with CVs 2.507 and 2.508 to set the engine's maximum power level.

Adjusting DDE Volume Limits

CV 2.507 (DDE Prime Mover Low Volume Limit) is used to determine the maximum volume decrease of the prime mover sound effect when the motor is operating at low speeds. CV 2.508 (DDE Prime Mover High Volume Limit) is used to determine the maximum amplification level of the prime mover sound effect when the motor is operating at high speeds. The prime mover

low and high volume limits are added to the volume level in CV 131 (Prime Mover Primary Mixer Channel).

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.
The lower the value in 2.509, the sooner the sound response occurs after the motor detects the change in load. The higher the value in 2.510, the longer the sound response persists after the motor detects the change in load. (My own interpretation.. not stated this way in the manual)

Try CV 2.509=175? Date: Dec 6 2019 left at Default value 215
CV 2.510 = 215   Default Value = 215

DDE response to Active and Passive changes the loco's motor reacts to. The 'Active' change is simply the operator sending more voltage to the motor by increasing speed steps on the throttle. 'Passive' changes are experienced by the motor sensing an increased 'load', either from the force necessary to pull a longer consist, or the increased 'friction' or gravity, the motor sees as the locomotive climbs a grade, or traverses a tight curve in the track. The CVs that control these effects are CV 2.511 (Default Value = 10.)   (Throttle Sensitivity), and CV 2.512 (Default Value = 0.) (Load Sensitivity).
CV 2.511 = 75 Default Value = 10.   (Throttle Sensitivity)
(a value of 0 into CV 2.511 will disable DDE throttle sensing)
CV 2.512 = 255 Default Value = 0. (Load Sensitivity)
Left CVs 2.511 at 75 and 2.512 = 255 as this seems to sound best. Date: Dec 6 2019
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. This is how a SoundTraxx Tsunami2 decoder currently comes from the factory. Setting CV 2.512 to 255 indicates that the prime mover sound effect will be most sensitive to changes in motor load.

BEMF Intensity = CV 212 x (1 – (speed step ÷ CV 10)) ÷ 255
When CV 10 is set to 0, only the value in CV 212 is used.
CV 10 = 126 did not seem to work well. Should CV 10 be set to its default of 0.
CV 10 = 0 as of Dec 7 2019

Now set the appropriate **Motor Control CVs.**
(Most of these settings are as suggested in the manual).

CV 209 = 48. (Default) Kp Coefficient
Values from 0 to 255 may be entered to specify a gain factor for the proportional coefficient of the PID motor control equation to optimize back-EMF control algorithms to complement a given installation.
CV 210 = 25 or 30? (25) Ki Coefficient affects DDE. Original =16
CV 210=25 Date: Dec 7 2019 ...does this make start more jerky???
To specify a gain factor for the integral coefficient of the PID motor control equation.

(Double-tap on any image In iOS PDF files to enlarge image)

CV 211 = 255? (Slow Speed Compensation)
When CV 211 is set to a value of 255, the effect is applied across the first nine speed steps;also advances the starting point at which the PWM (Pulse Width Modulation) is applied to the motor. This helps compensate for motors that are more difficult to start... suggest setting CV 211 to the lowest value that will still improve low-speed operation. Default Value = 180.
CV 211=180 (Date: Dec 7 2019)

CV 212 = 255 (BEMF Feedback Intensity - 255. ..0 disables load compensation) what is default? (Date: May 4 2019)
Default Value = 255
Setting CV 212 to a value of 0 will disable load compensation.

Date Dec 7 2019: CVs 10 and 212 left at default values of 0 and 255 respectively.

CV 215 = 120 (Back EMF Reference Voltage Default = 150) ...for track voltage of 12 Volts..check this (Dec 7 2019)? THIS MADE A BIG DIFFERENCE IN DDE EFFECT..NOW MORE PRONOUNCED! after changing from 150 to 120.
CV 217 = 10 (BEMF Enable - Auto-Stop Enable)

CV 217: Motor Control Register
Default Value = 10
Setting bit 1 (BEMF) to 1 (weighted value = 2) will enable back-EMF motor control.
Setting bit 3 (STP) to 1 (weighted value= 8) will enable the auto-stop feature. Therefore a value of 8+2=10 in CV 217 enables back-EMF motor control, and Auto-Stop. When auto-stop is enabled, direction commands will bring the motor to a full stop for a duration of 500ms before the decoder changes locomotive direction.

So I assume on Tsunami2 decoders Back EMF and Auto Stop are enabled from the factory by default.

Train Braking: Independent Brake, Train Brake, Dynamic Brake.

Independant Brake - the brake in the locomotive itself.
CV 117- 140 (manual suggests 178) Independent Brake
Train Brake - the braking of the entire consist, via air pressure, or lack thereof, in the air hoses connecting each freight car in the consist. Deceleration takes much longer than the Independant brake.
CV 118- 100 Train Brake. Manual suggests value of 100 for more gradual braking rate for Train Brake.
The Dynamic brake used on a down grade to maintain constant speed.
CV 116 - 140 Dynamic Brake. Manual suggests value of 60 for a gradual braking rate. Applying dynamic brakes will not bring the locomotive to a stop.

Used Dec Pro to **change function button 7 from Dimmer to Independant or Train Brake for locomotive CN5075.** Used Function Mapping Screen. These CVs are indexed (CV 1.273) so have to use Program on Main because NCE does not allow writing to indexed CVS on the Programming track. So before going to CN5075 file, change Decoder Pro to Program on Main. Then went to CN5075 listing and opened Function Mapping tab. Changed Dimmer to Disable and Brake to Function 7 button. Click on Write sheet..it writes all highlighted values which in this case was all the highlighted squares for forward...reverse etc. When finished says OK. Worked. Now save changes to roster file on computer. Note that Function 11 does not do anything now. Will check on Decoder Pro what it says Function 11 is set to? Dimmer is 'Disabled' and F11 does not appear anywhere. So I set Dimmer to F11. Note that if you are on Program on Main, the Read buttons are faded out as you can only Read CVS when on the Programming track. So to Read CVS move loco to program Track. Throw toggle switch to Programming track (DCC). This connects the Hillside station siding track to the Programming track output on the PH Pro Command Station. You don't have to use the Cab to go to Program on Programming track menu (4), as Decoder Pro does this for you when you click on the read button for any particular CV. If you go to the Programming sheet and make a change, Decoder Pro will only write the 'change', if you press on 'Write changes on sheet'. If you have not made a change yet then you tap on write full sheet which takes longer of course. Is this what you use if making changes to CVS offline then boot up Decoder Pro connected to the Command Station?

Enabling Automatic Effects
This is not done as yet on CN5075
Date:
REMEMBER YOU CAN ONLY WRITE INDEXED CVs USING PROGRAM ON MAIN!
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. Add 1
Reverse-Driving: Effect is turned on when the locomotive is moving in the reverse direction. Add 2
CV 1.407: **Forward Whistle Signal** Default: 0?
For example bit 0 of CVs 1.385-1.512 references FWDD Forward-Driving:
FWDD: Forward-Driving
Setting bit 0 to off or on:
0 = Effect activated by function key only
1 = Effect active when moving in forward direction
Weighted value of bit 0 is '1', so entering a value of 1 into CV1.407 sets bit 0 to on, so that Forward Whistle Signal (two toots) blows when locomotive moves forward.
CV 1.407=1 Date:Jun 1 2019

CV 1.408: **Reverse Whistle Signal** Default: 0 means only activated by the function button.
Bit 1 of CV 1.385 - 1.512 references REVD Reverse-Driving.
Bit 1 has a weighted value of 2.
Set bit 1 of CV 1.408 to 1 (on) by adding 2 to CV 1.408 which will turn on the reverse whistle (3 toots) when loco starts up in reverse.
CV 1.408=2 Date: Jun 1 2019

CV 1.409: **Stop Whistle Signal.** Default: 0
Added value of 12 to the Stop whistle signal to set bit 2 FWDS Forward-Standing (add value of 4) and set bit 3 REVS Reverse-Standing on by adding value of 8 so total value put in CV 1.409 = 12, to have Stop whistle blow automatically on stopping either from forward OR reverse. Disable these automatic functions so they only operate from the function keys by changing the values of the appropriate CVs to 0.
CV 1.409 = 12 Date: Jun 1 2019

Programmed FX4 Function 25 CV 52 =135. **Western Cullen Rotary Beacon**. Date Dec 8 2019 (7 + 128 = 135) 128= LED Compensation
(Original Value was 15)

FX3 = **Cabin light** Function button F24

(Not yet done on CN5075)
For consisting
Make sure you have enabled SEND FUNCTION COMMANDS TO CONSIST ADDRESS in SETUP COMMAND STATION.
- Configure the bits in CV21/22 in every loco so that only those functions applicable to whole-of-consist are on. Leave the rest off.
For CV21 turn everything on except bell and whistles. Brakes, mute, motor RPMs dynamic brake all on.
8+16+32+64+128=248
CV 21 = 248
put value 248 into CV 21 on loco CN5075
CV 22 = 3 so that headlight button on consist turns rear loco's lights on/off too. Note prototypically no lights bell whistles would be on the rear loco, only motor rpms and mute?

Doug Dyer
Victoria BC

CN Spiritwood Subdivision