Hornby Class 43 HST Upgrade and OO/EM Conversion

Conversion Note by Patrick Hunt, 16 May 2022

Introduction

This note covers the conversion of the original Hornby Class 43 HST to fit the most recent drive mechanism and bogies as well as upgraded running lights, DCC sound and several other minor modifications. Most of the changes are to the chassis with only a few modifications to the body shell. There is an option to convert to EM if so required.

The key features of the conversion are:

- Both power car bogies driven using a centrally mounted motor with power collection from all wheels.
- OO or EM Gauge.
- Hornby TTS Class 43 (Valenta) Sound Decoder with MegaBass speakers.
- Bespoke Stay Alive Circuit
- Improved running lights with separate white and red and a direction sensitive and switchable cab light.
- Improved body shell removal and retention.

The motor, driven bogies for the power car and dummy bogies for the dummy car are all (currently) available as spares. The wheel sets on the new bogies are finer scale, to RP25/110 standards and more prototypical. For the driven bogies, as the final drive gear is mounted on the shaft, these can be converted to EM simply by using a longer 2mm axle. For the dummy bogies with standard 26mm pinpoint axles, some fettling is required on the inside of the bogie frames to ensure sufficient clearance. The disc callipers and rail guards on the bogies remain as is with slight medications to the callipers if regauging to EM.

For the power car, an aluminium subframe is manufactured and fitted to the existing chassis to mount the motor unit. An additional raft combination on hex standoff pillars accommodates the DCC circuits and loudspeaker. Two bogie carrier plates are manufactured to provide mounting arrangement at the correct height for the 2 driven bogies. The solution for the dummy car is the similar. Revised body shell retention is implemented to simplify access to the chassis.

It is highly recommended that a spare chassis be obtained to undertake the conversion, they are available for around £2.25 each (2022 prices). Much of the cost of the conversion can be recouped from the onward sale of either the surplus power and dummy bogies on their own or a complete chassis with bogies.

Before undertaking the conversion, it would be wise to obtain the new bogies and motor unit required for the conversion. The parts are (currently) easily obtained but costs vary widely depending on the source with the total for all parts ranging from £40 up to £80 (2022 prices).

For the powered car a motor, X9863 and 2 driven bogie assemblies are required, X9868 for the rear and a combination of X9922 and X9867 for the front. For the unpowered car, X9865 for the rear and X9866 for the front are used. Oddly, for both powered and unpowered cars, the front bogies are supplied as a frame and rear bogies minus frames are used to make up the required combination.

Colour Matching

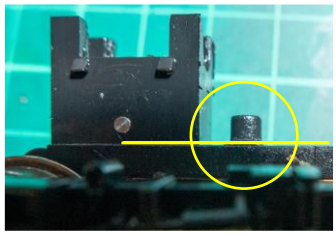
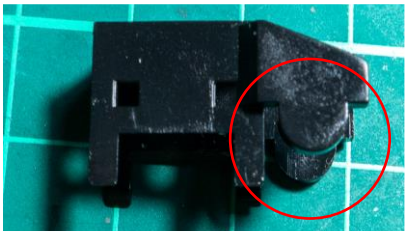
The blue on the early 1980s Hornby HSTs is slightly lighter than that uses on the correct length Mk3 coaches made by Hornby from around 2002 onwards. Later 5 pole HST variants, such as those included in the set R2296, are a much closer match. In bright conditions, with a stationary formation of old power cars and new Mk3 coaches, the difference might be noticeable but with the formation at speed in a normally lit environment, it may attract less attention. Over time the newer body shells of the original design will come up as spares but there is always the option of airbrushing an older spare body shell, there are plenty available, to match the newer Mk 3 coaches.

Powered Car Modifications

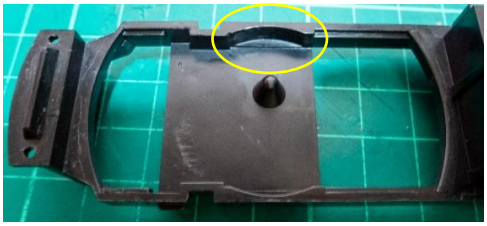
Advisory: It is necessary to make several modifications to the chassis. These should be undertaken prior to the final fitting of the new bogies and motors to avoid damage and the ingress of debris from the conversion work.

Power Bogies and Mounting Arrangements

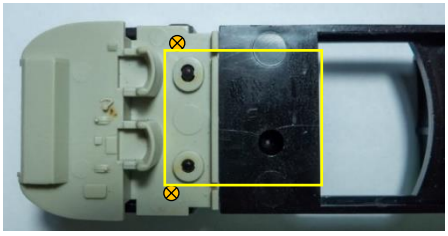
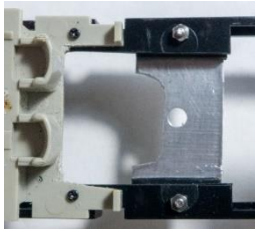
The new power bogies interface with the chassis via a mounting spigot some 3mm in diameter and 3mm tall, yellow circle. The chassis mounting plate, some 2mm thick is held in place by a clip which fits over the worm gear housing and locks the bogie housing in place with 2 protrusions on the lower part of the clip, red circle, limiting upward movement of the chassis mounting plate. The bogie mating face, yellow line, is 15mm above the rail head.

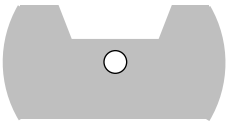
On the original chassis at the bogie pivot points, a semi-circular lip, 30mm in diameter, exists at 3.4mm from the bottom edge for the rear bogie (left image) and around 4.9mm from the bottom edge for the front bogie (right image).



The gearbox on the powered bogies extends 18mm from the bogie pivot point and has a maximum width of 13mm reducing to 10mm and a maximum height above the mating face of 18mm. To provide clearance for the front bogie, a rectangular section 25mm long and 21mm wide (yellow rectangle on left image) is cut out of the front part of the chassis and cab insert. The cab insert is critical to alignment and seating of the body shell so, **before cutting**, the cab insert is secured with M1 x 3mm self-tapping screws on either side as indicated. The cut-out and cab insert securing arrangement is shown below.

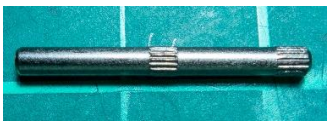
A common bogie mounting plate, made of 2mm thick aluminium, is used which is 30mm long x 15mm wide with 30mm radius ends to match the existing bogie cut out and lip arrangement. A trapezoid cut out 15mm x 12mm is made to a depth of 4.5mm to avoid fouling the gearbox leaving 3mm from cut out edge to the centre line of the mounting plate.



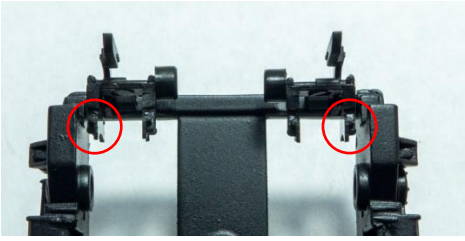
For the rear bogie, the bogie mounting plate is fitted directly to the semi-circular lips of the chassis and secured with M1 x 5mm machine screws and nuts. For the front bogie, two 15mm x 5mm shims made from 1.5mm plastic sheet are fitted to both sides to achieve the correct nominal height and secured using M1.4 x 8mm machine screws and nuts.

Power Bogies EM Conversion (Optional)

The 13.4mm diameter wheels on the bogies are to RP25/110 standard with a 2.8mm tyre width, a flange of 0.7mm and a back-to-back of 14.4mm. The face-to-face measurement is 20.2mm. Converted to EM gauge the back-to-back measurement required is 16.45mm, to satisfy the check gauge requirement, with a face-to-face measurement of 22.2mm. The bogie frame inside measurement is a minimum of 24.3mm giving 1mm clearance either side after conversion. An M2 x 1mm shim is be fitted either side of the axle to limit side play. It will be necessary to knurl the one axle end and the centre portion to grip the wheel and gear respectively.

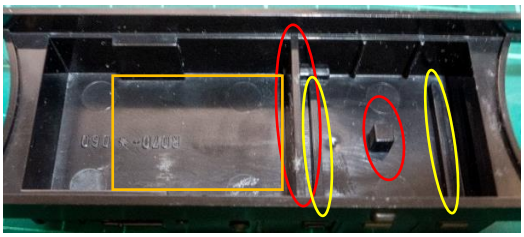


The disc callipers and rail guards are tack glued in place into square locating holes. The disc callipers foul the outer face of the EM gauged wheel set and so, with the wheels removed, the outer callipers, red circles, are trimmed back as there is insufficient room for the outer calliper even if relocated.

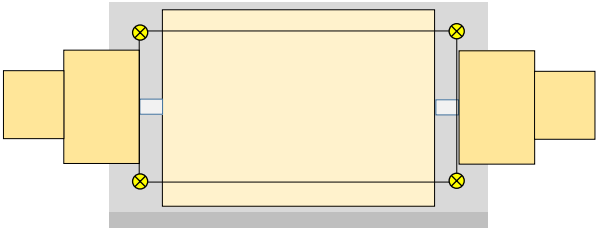


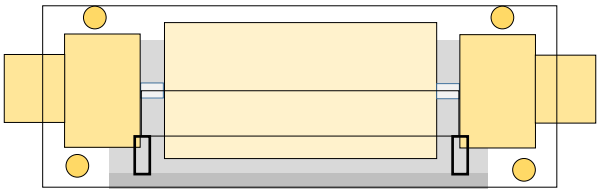
Motor Mounting

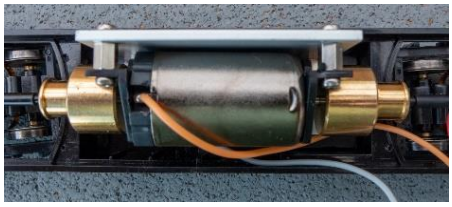
As there is insufficient clearance to mount conventionally, the motor is mounted on its side on a raft within the chassis void. The central rib and chassis weight locating lug (red ovals) are removed and a 2mm thick plasticard base inserted into the forward void (orange rectangle) to match the height of the 2mm ribs (yellow ovals). The usable void is 23.8mm x 68mm. The before and after view of the chassis is on the right.



An L shaped aluminium raft 68mm long, 20mm wide and 30mm tall is secured to the new chassis base using two M2 x 8mm countersunk machine screws into two M2 tapped holes in the aluminium raft. The motor is mounted on the raft using four M2 x 5mm hex standoff pillars.

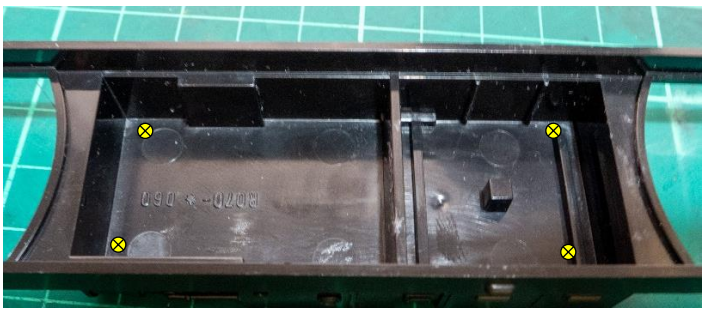




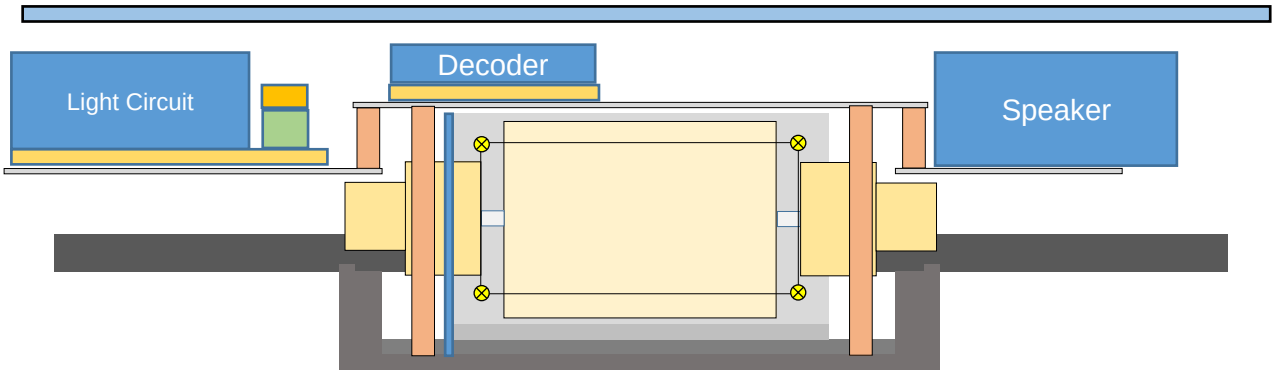


PCB, Decoder and Speaker Mounting

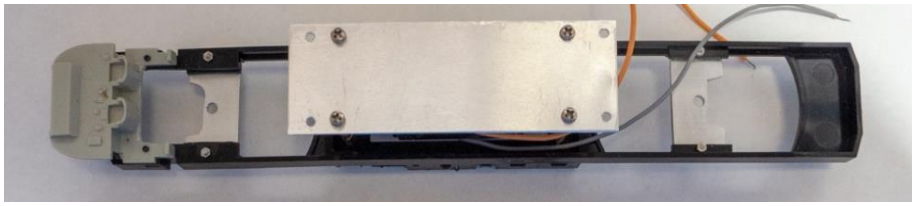
An additional raft combination is mounted on the chassis for the NEM652 socket, lighting circuit, DCC decoder and speaker. Combinations of standoff pillars are mounted on the chassis as indicated below to achieve a height of 33mm from the bottom of the void.

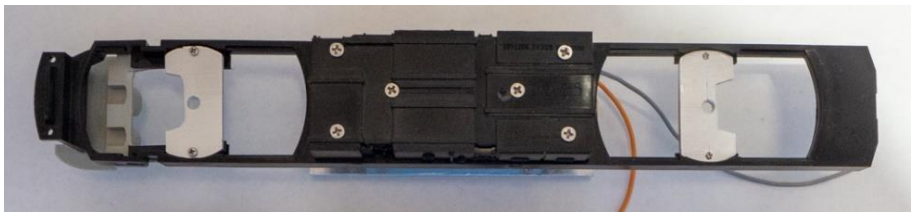


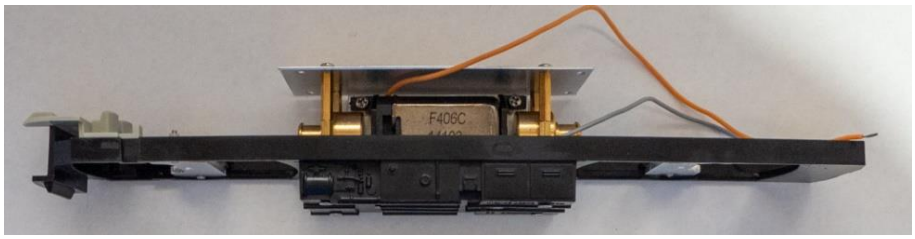
The decoder raft is 80mm x 28 mm x 0.7mm aluminium and mounted on the 33mm standoffs. Attached to the decoder raft are a 30mm x 28mm x 0.7mm aluminium raft for the speaker and a 50mm x 30mm x 0.7mm raft for the NEM862 interface and additional electronics.



The 3 images below show the top, bottom and side views respectively of the powered car chassis with motor fitted.

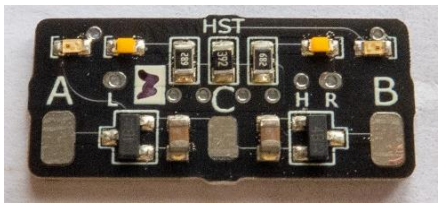






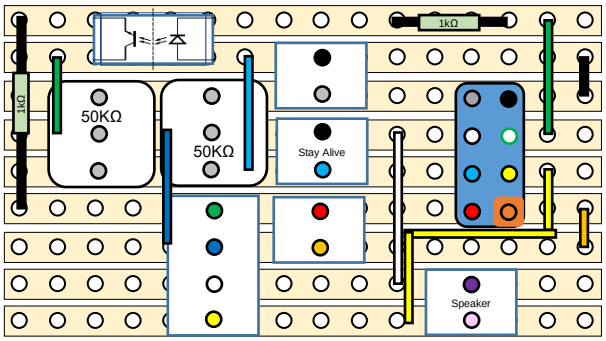
Lighting Circuits

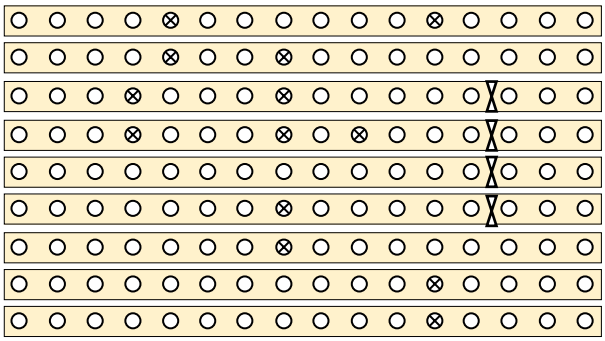
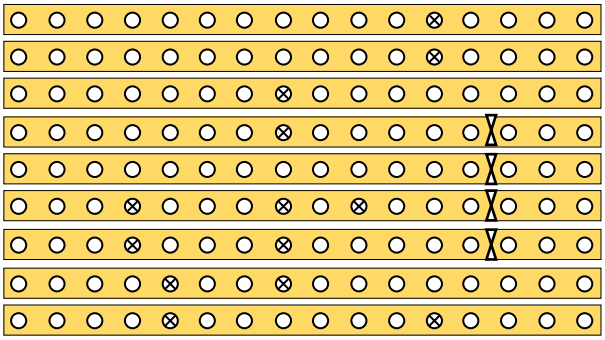
For the lighting circuit, a Black Cat HST lighting module is used, below left. It is used as supplied with a connection, C, made to a variable (blue) supply on the bespoke PCB so that the brilliance can be adjusted. Connections A and B on the lighting module are connected go to the yellow and white connections respectively on the bespoke PCB. Blinkers are fitted between the white and red LEDs to avoid overspill into the separate light pipes on the modified light cluster; see below middle and right.



PCB Circuit (Optional)

A single PCB is used with provides a NEM862 socket for the decoder, adjustable illumination for the running lights and the direction sensitive cab light (using Aux 3). The circuits for the power and dummy cars are identical, the yellow and white connections for the running lights are simply reversed. Speaker connection terminals are on the PCB but a micro plug and socket between decoder and speaker could be used. If the existing TTS decoder speaker is to be used, then no separate connections are required. Connection for a stay alive are included. The layout (upper left), track cuts (upper right) and PCB underside (lower right) where the track cuts are made are shown below. Circuit and a parts list are at the end of the note.

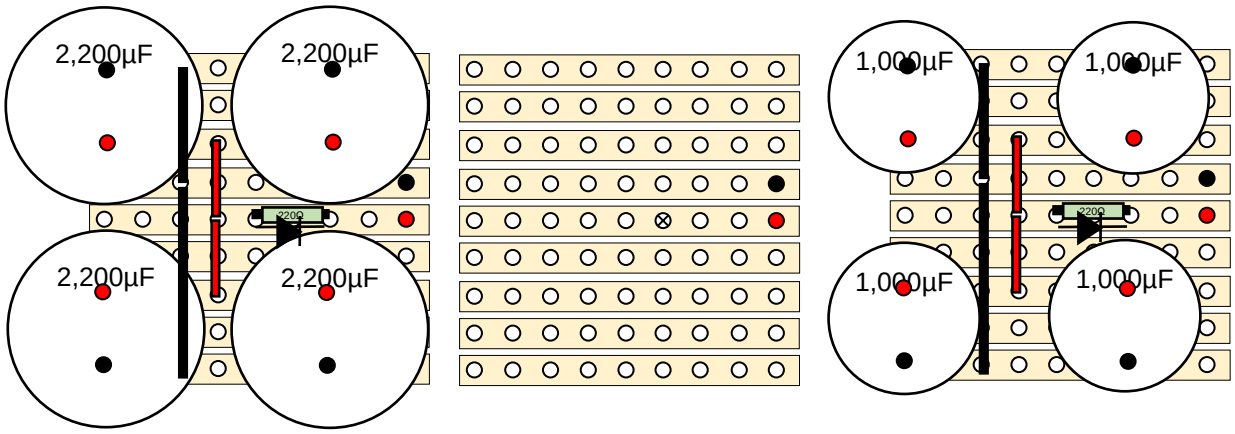


The opto-coupler on the PCB is used to convert the Aux 1 (Green) current sink into a switchable power feed for the cab light, with adjustable brilliance, which uses the white or yellow current sink to provide directional switching of the cab light.

Stay Alive (Optional but Recommended)

It is recommended that a stay alive circuit be fitted as I have found the Hornby HTS TTS decoders to be a little finicky, despite the new HST bogies having all wheel pickup, with the decoder frequently reinitiating. There is sufficient room to fit a bespoke stay alive circuit in the rear of the powered car consisting of four 2,200µF capacitors with a 220Ω charging resistor and a 1N4001 discharge diode; left below. For the unpowered car a similar arrangement is fitted but with four 1,000µF capacitors, right below, there being no motor drive so a lower storage capacity is adequate. The PCB is common.



The stay alive is connected to the decoder via screw clamp terminals on the main PCB where a blue connection for positive is already available. Only one additional lead for negative is therefore required to be soldered on to the TTS decoder which is then connected to the negative screw clamp terminal along with the negative lead from the stay alive module. This allows the stay alive to be isolated simply by removing the positive lead so that decoder adjustments are not affected by stay alive. The stay alive is mounted on its side facing forward in the chassis void behind the rear bogie. As the rear of the PCB is visible in the rear and side windows it may be advisable to place thin black tape over the windows to hide the PCB.

Videos of how to construct and then fit a similar stay alive circuit to a Hornby TTS decoder along with downloadable diagrams can be found on the Strathpeffer Junction website at https://www.strathpefferjunction.com/.

Choice of charging resistor. On a layout with one or two locomotives fitted with stay alive circuits the switch on surge current will be low but with 5 or 6 locomotives it will be appreciable, hence the reason for a 220Ω rather than a 100Ω resistor. Indeed, a 1KΩ resistor might be more appropriate if many locomotives are on a layout. The charging time for the power car stay alive with a 100Ω resistor would be 4.5 seconds with a peak current of 180mA; assuming an 18V DCC supply. If there are 20 locomotives on a layout, then the peak start-up current will be 3.6 amps. With a 1KΩ resistor the charging time is 45 seconds and the peak charging current 18mA, around 360mA for 20 locomotives. There is no difference in stay alive discharge time whatever the resistor value. Given all the other devices that might be connected to the DCC bus, it would be wise to limit large surge currents at switch on. The stay alive will likely only discharge for fractions of a second intermittently so the longer charge time is adequate. If it is discharging more frequently then there are major pickup and/or track issues. Stay alive circuits are an ‘emergency’, not alternative, power source..!!

Power Car Body Shell Modifications and Securing Arrangements

Several modifications are made to the body shell. To provide room for the front power bogie and electronics raft the entire cab bulkhead is removed and a thin false bulkhead glued to the rear of the cab insert seats. The set of internal ribs near the rear side lugs are removed to provide clearance for the electronic rafts. For this conversion, due to the need to frequently access the chassis. all 5 locating lugs on the chassis, 2 on each side and one at the rear are removed. A single retaining screw is used through the existing rear lug hole to secure the body shell to the chassis. The locating lugs could be retained if required.

If desired, the side and rear lug holes are flush filled, and once dry, the infill painted over with Phoenix Paints Signal Yellow (P134), front side, Rail Blue (P132) rear side and the inside of the gangway is painted Rail White (P149) to match the more modern Hornby coaches. Overhead flashes are added to the power car rear.

Light Cluster Modifications

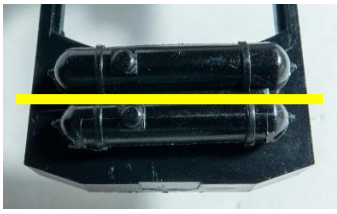
The light cluster arrangement requires significant modification to reflect prototypical early lighting arrangements where the red running lights are on the outside.

For the conversion, separate red and white running lights are fitted to both cars. The holes for the inner (warm white) lights, also used to secure the glazing, are in approximately the correct position. Two additional 1.5mm holes, red circles, are drilled for the outer (red) lights 3.5mm out from the existing 1.6mm holes to align with the outer lens mouldings on the glazing. The inside of the lighting recess on the front of the body shell can be painted matt black if desired.

Depending on how the Black Cat lighting module is fitted, the light pipes on the glazing bar might need shortening; it is a matter of test fitting and shortening if so required. Once trimmed to fit, two 1.5mm diameter lengths of light pipe are trimmed to match the length of the existing light pipes on the glazing and the inserted into the newly drilled outer holes. Once again, fine tuning may be required. Once a perfect fit is obtained the outer light pipes can be secured in place using an appropriate glue.

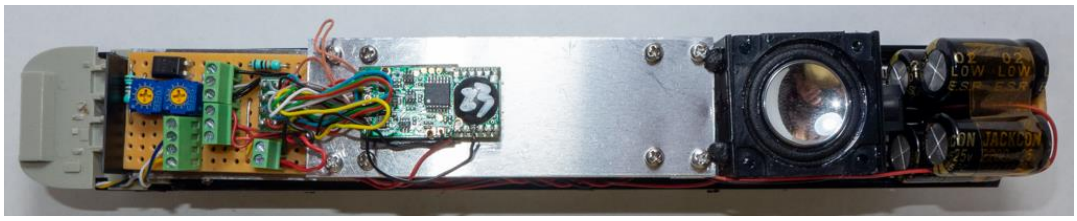
HST Air Tanks

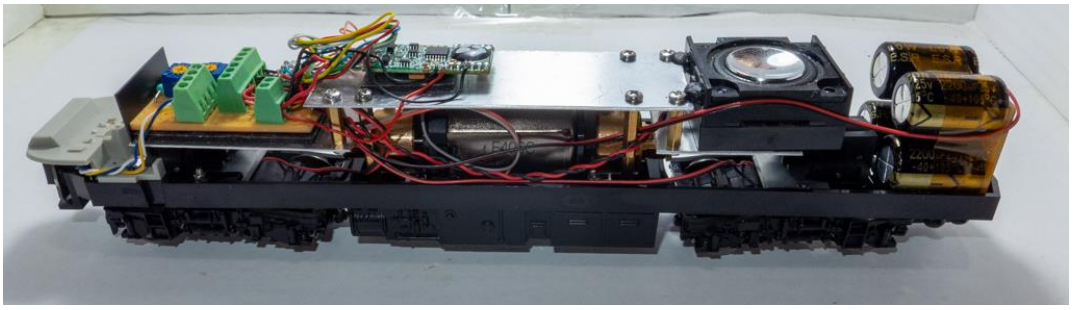
The Hornby original has the 2 air cylinders at the rear of the power cars moulded onto the coupling hook; see below left.

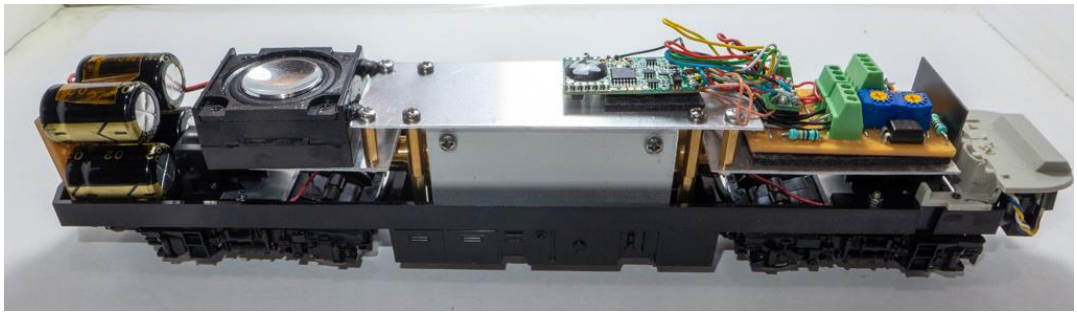


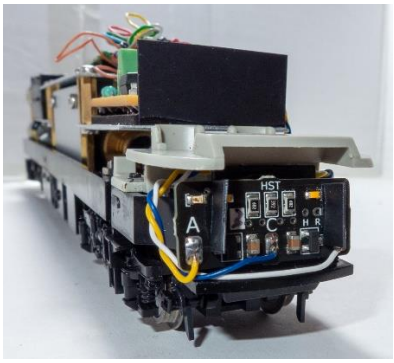
These are not present on the new bogies as they are moulded on the new chassis. The original coupling bar arrangement is modified by removing the coupling bar and bogie mounting arrangement to leave just the cylinders. The cylinders are glued onto the chassis at the ends of the power and dummy cars, see above right. The centre of the two tanks, yellow line, should align with the centre of the rear door windows.

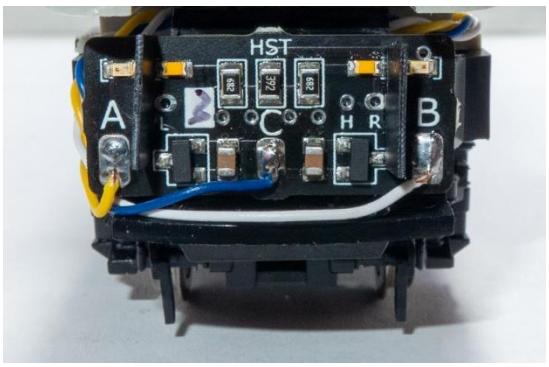
Completed Power Car











Load Testing

The power car was load tested on an EM gauge test track with a minimum radius of 32” with 7 of the latest Mk3 coaches (Farewell Tour) and the dummy power car.

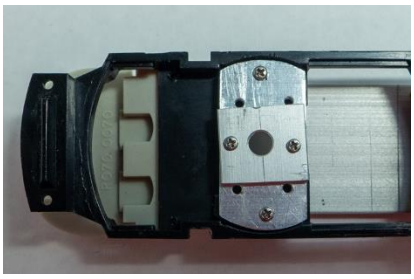
During load testing some wheel slip was noticed on the curved section of the track. Removing the weight from the dummy power car improved matters but there was still some occasional slippage.

It may be necessary to add a little extra weight to the power car to increase traction and there is space in the void where the motor is mounted should this be necessary.

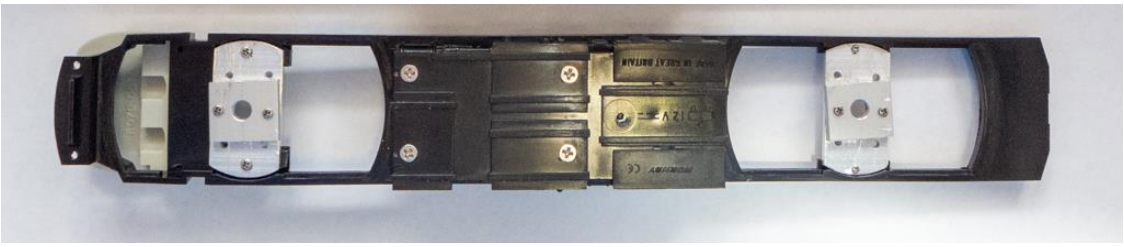
Unpowered Chassis Modifications

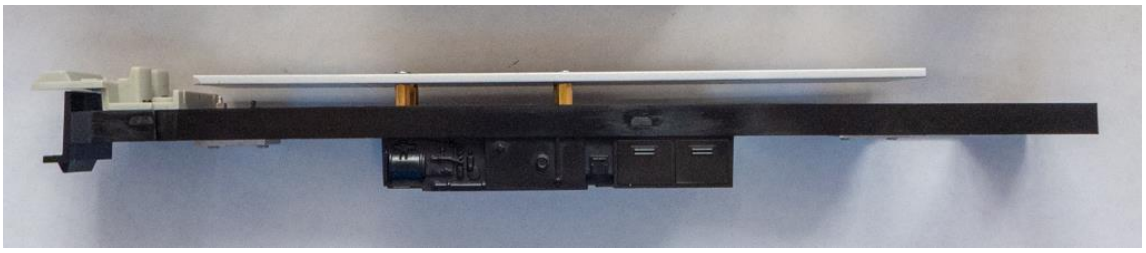
In the original Hornby HST, the chassis design is common to both powered and unpowered cars. However, the new unpowered bogies have a different mounting arrangement to those of the power car.

A similar aluminium bogie mounting plate to that used for the power car, without the cut outs, is used but with an additional 2mm thick 15m x 12mm aluminium mating face secured with M1 x 5mm machine crews and nuts to provide the correct height from the rail head to mating face. The top aluminium mounting plate has a 6mm hole drilled in the centre and the bottom mating face has a 4mm hole drilled in it to allow the spigot to be inserted and retained.

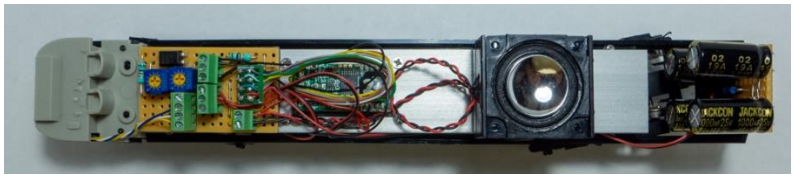


The common electronics and speaker raft is mounted on four 20mm hex stand offs using similar mounting arrangement to the chassis as used in the power car. The raft is 120mm x 25mm x 2mm. Retention of the chassis weight is optional.





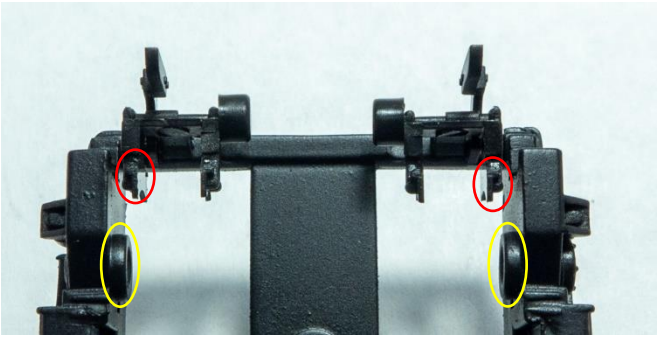
There is little modification to the chassis other than to remove the centre part of the plate with the dimple up to the cab insert and remove the body shell locating lugs. The body shell retains the forward bulkhead, but the rear most set of internal ribs are removed to provide clearance for the 25mm wide electronic raft. The body shell retaining arrangement and lights are the same as that used for the power car.



Bogies EM Conversion (Optional)

The 2mm axles are 25.5mm pinpoint and the tyres 2.8mm in width. Regauged for EM, with a back-to-back of 16.45mm, the face-to-face width is 22.05mm. The bogie opening is only 22.4mm as manufactured.

The pinpoint axle bearing stands 1mm proud from the bogie internal side, yellow oval, and this is reduced to under 0.5mm to ensure a good rolling fit whilst maintaining as much depth as possible. It is case of setting the wheel back-to-back to 16.45mm and then removing a little of the axle box protrusion and test fitting, repeating until free running and adequate clearance is achieved.



As with the power bogies, the pickups are adjusted to suit the wider gauge. The outer disc callipers, red ovals, are trimmed back as they were for the power cars.

Note: For the Mk3 coaches the original wheels are replaced with Alan Gibson 12mm coach wheels with disc brakes as the tyre width is 2.3mm and the face to face is 21.1mm. No fettling of the axle boxes is required as there is just enough clearance, but the Hornby pinpoint axles are 24.8mm vs. 25.8mm for the Alan Gibson axles and so the pinpoint is reduced a little to ensure free running. However, the Alan Gibson wheels are not suitable for the unpowered bogies as they are the wrong size (12mm vs. 13.4mm) and in any case there is very little metal contact area on the back of the wheel for the power pickups.

DCC Decoder Set Up

Advanced consist is not possible with Hornby TTS decoders and so basic consist has to be used where the DCC decoders in the power and dummy cars are set to the same DCC address. This cause some complications as sounds, such as horns, are not direction sensitive and so both decoders will react when such sounds are activated. For my use the power and dummy cars will be in a fixed rake going in one direction, power car leading, and so the volume of specific individual sounds on the dummy car decoder are set to zero. The CVs adjusted are:

- CV162, CV163, CV169, CV170, CV174, CV175 - Horn
- CV167 – Cab Door Slam
- CV173 – Drivers Safety Device (Cab)
- CV176 – Windscreen Wipers
- CV177 – AWS Test
- CV178 – Fire Bell Test
- CV180 – Guard to Driver Buzzer

The white and yellow lighting connections in the dummy car are reversed so that when in forward motion the red running lights are illuminated.

Motor Hum

When using the Hornby TTS Decoder with sound off, the hum of the motor at low speed, due to the decoders low pulse width modulation frequency, is (annoyingly) noticeable. If sound is not going to be fitted, then ESU LokPilot 5 Basic, Zimo or LaisDCC decoders are far better options.

Parts List

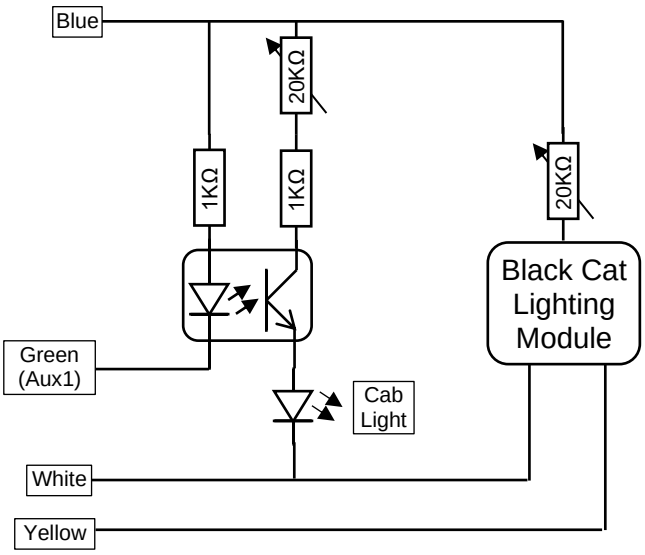
The following parts are required for this conversion and assumes the two chassis of the donor model are being sold on as complete units with power and dummy bogies but minus cab inserts:

- Hornby Spares:
  - X9922 – Drive Unit Power Car x 2
  - X9867 – Front Bogie Assembly Frame Power x 1
  - X9868 – Rear Bogie Assembly Power x 1
  - X9866 – Front Bogie Frame Dummy x 1
  - X9865 – Rear Bogie Assembly Dummy x 2
  - X9863 – Motor Assembly
  - S9684 – Original HST Chassis
  - S9695 – Original HST Coupling Bar and Cylinders (for Cylinders)
- Silver Steel or Nickle Silver Axle 2mm x 22.5mm x 4 (for EM conversion)
- Aluminium L Profile 30mm x 20mm x 2 mm thick – 50mm long
- Aluminium Strip 28mm wide 0.7mm thick – 30mm, 50mm, 80mm long
- Aluminium Strip 25mm wide 2mm thick - 150mm long
- Plastic Card, 1.5mm and 1mm
- Stand Off 4mm Hex 5mm, Female-Female x 4 (Motor Mount)
- Stand Off 3mm Hex 10mm Female-Female x 4 (Power Car Sub Rafts)
- Stand Off 3mm Hex 13mm Male-Female x 4 (Power Car Main Raft)
- Stand Off 3mm Hex 20mm Male-Female x 8 (Power and Dummy Car Main Raft)
- Light Pipe 1.5mm x 10mm x 4
- Black Cat HST Lighting Board x 2
- Veroboard 25mm x 64mm cut to 9 x 16 and 9 x 9 for bespoke circuits
- Wire DCC 32 AWG, Colours Various.
- MegaBass DCC Sound Speakers (8 ohm) 28x32x15mm x 2
- Hornby R7140 TTS Digital Sound Decoder - Class 43 HST (Valenta) - Twin Pack
- Screws, Glues and Paints, various as described. Loctite 243.
- 3M Double Coated Tissue Tape for PCB, Decoder and Black Cat module mounting.
- Black Tack as required.
- NEM Couplings as required.

PCB and Stay Alive Circuits

DCC Termination and Lighting PCB

The power to the Black Cat lighting module is adjustable so that the brilliance can be adjusted. The Green connection is used to enable a variable power supply to the cab light which can use either the white (power car) or yellow (dummy car) directional connections.

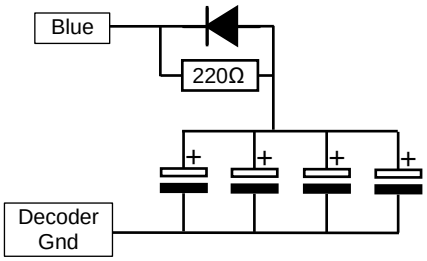


Parts for PCB as follows:

- 1KΩ ¼ Watt resistors x 2
- 20KΩ variable resistors x 2
- Warm White LED x 1
- Opto-Coupler (FOD817 or equivalent) 4 pin DIP x 1
- Black Cat HST Lighting Module
- Vero Board, 0.1” pitch, 9 by 16 hole
- Presi-Dip 0.1" Pitch 8 Way 2 Row 0.76mm mating (decoder socket) x 1
- PCB Screw Clamp Terminal Blocks, 4 way x 1, 2 way x 1, 3 way x 2

Stay Alive Circuit

The stay alive circuit consists of bank of four 2,200µF or 1,000µF electrolytic capacitors which are charged via a 220Ω ¼ watt resistor and discharge through an 1N4001 diode (50V 1A).



Parts for PCB as follows:

- 220Ω ¼ Watt resistor
- 1N4001 diode
- 2,200µF / 1,000 µF Electrolytic Capacitor x 4 (Power Car / Dummy Car)
- Vero Board, 0.1” pitch, 9 by 9 hole

Tools

The following tools were used for material working for this project:

- Junior Hacksaw (32 tpi), Maruyoshi Super Fine saw (0.16mm kerf, 42tpi)
- Files including Bastard, 2nd Cut, Smooth, Key Files and Needle Files as required.
- Steel Rule, Scriber, Small Set Square, Spring Divider, Centre Punch.
- Pin vice and 1mm, 1.5mm, 2mm HSS drills.
- Drill with 4mm, 6mm HSS drills.
- Countersink.
- Good metal jawed vice with soft jaw protectors
- Wheel Puller, Gear Puller
- Pillar drill or modelling equivalent such as Proxxon, Dremel with various milling, routing, grinding and cutting attachments.
- Vernier Callipers.
- Back-to-Back Gauges

Materials Sourcing

The 2mm aluminium bars and profiles are available from B&Q and Wickes. Light pipe, brass standoffs, plastic card and 0.7mm aluminium sheet are available, at relatively low cost, from eBay and Amazon.

Cutting Aluminium Strip

There are two ways to cut thin aluminium strip, the hard way with a hacksaw or, the easy way with a Stanley knife and sharp edge. If the aluminium is scored on both sides of where a cut is required and then bent backward and forwards around the score line on a sharp edge, a break will occur which requires little in the way of clean up. Few of the dimensions are highly critical so there is some latitude for small errors.