Construction Notes2mm Finescaling kit for a Graham Farish WD 2-8-0

1. Introduction

This kit has been designed to convert a Graham Farish (Grafar) WD 2-8-0 loco chassis to 2mm finescale. It includes etched replacement parts for most of the valve gear, and a tender chassis. The original loco chassis and motor are retained for the conversion. Significant dismantling and modification to the original model, as described below, is involved, and this will INVALIDATE ANY WARRANTY you may have. I cannot be held responsible for any damage to your model incurred during the conversion process.

Two options for the conversion are catered for. The quick option (option 1) retains the Grafar valve gear with replacement driving wheels and an etched tender chassis. The only difficulty I see with this option is soldering the Grafar return crank to the brass or nickel silver crankpin on the third axle. When I tried it, I found it hard to get the joint to solder properly, although it seemed to hold eventually. How strong and durable the joint was, I cannot say, and I would not recommend this option. The more involved option (2) replaces the Grafar valve gear with finer scale etched parts. It is not possible to change to option 2 after having undertaken option 1, as it will not be possible to fit flanged crankpins under option 2 if the driving wheel crankpin holes have been drilled out for large diameter crankpins under option 1.

Parts required to complete are: -

Graham Farish WD 2-8-0	1
Pony truck wheels	2x 6.5mm solid disc
Driving wheels	8 x 9 mm
Tender wheels	8 x 6 or 6.5mm solid disc
Crankpins	8 flanged recommended for driving wheel, plus 2 non-flanged for thecrosshead/ connecting rod
Crankpin cap washers	6
Motion pins minimum	2 packs, or use 0.25mm nickel silver rod
Frame bushes minimum	18
Axle muffs	2 small diameter, 7 large diameter
Thin double-sided PCB (0.25mm thick)	2 sq. inches should suffice
Couplings	own choice
Brass/ nickel silver rod 1.4mm diameter	3”
16 BA washers	2

Tools required include: -

Soldering iron and solder, flux
Needle files – flat, round
Modelling knife
Broaches
12BA tap
Back to back gauges
Wet and dry paper, glass fibre brush
Set of jewellers screwdrivers
Chassis frame assembly jig
Tweezers
Flat-nosed pliers
Lathe or Minidrill (both optional)
Vice

I recommend you read and understand these instructions before you begin assembly. There are a few small and delicate parts on the etch. It’s best to leave parts on the etch until required. All folds are made with the half-etched line inside the fold unless otherwise stated. Traces of tabs holding parts in the etch should be removed with a needle file prior to assembly. It is recommended that work done is cleaned periodically to remove all traces of flux. A supplementary drawing is provided to assist you with the conversion.

2. Dismantling the Grafar Loco

As already mentioned, dismantling the model will INVALIDATE ANY WARRANTY you may have. As you progress through these steps, make a note of how things went together, and keep all the bits safely, labelled if you think necessary. Refer to the Grafar instruction sheet for additional guidance. Note that there are a few delicate plastic parts on the model, so be as gentle as possible as you take the model apart.

2.1 I started by removing the tender wheels, retained by a keeper plate with three screws between the axles and one either side of the tender chassis behind the front axle. Once the screws have been removed, the keeper plate can be

unclipped from the tender chassis block. The tender top is removed by undoing four screws in the corners of the plastic chassis. Take the tender top off, to reveal the PCB connection for the electrical circuits. Unscrew the PCB from the tender chassis block and unsolder the leads to the loco chassis, noting to which side they are attached.
2.2 Unclip the drawbar from the loco chassis, trying not to damage the phosphor bronze clip.
2.3 Remove the pony truck, then the fixing screws for the keeper plate, and unclip the keeper plate.
2.4 Undo the two screws retaining the coupling rods and connecting rods to the driving wheels and remove the set of driving wheels.
2.5 Undo the screws behind the drawbar peg and through the cylinder block and remove the loco body.
2.6 Undo the cylinder assembly securing screw, gently ease the motion brackets away from the chassis block, and remove the cylinders, and valve gear etc.
2.7 Undo the six hexagonal screws retaining the coupling rods over the driving wheels, remove the driving wheels from their axles and keep the wheel bearings safe. Also remove the plastic gear from the third axle.
2.8 If you have chosen option 2, file the top of the lugs retaining the union links until they can be separated from the crossheads. Do the same for the connecting rod connections to the crossheads. Leave a trace of these lugs remaining as you will need to drill a hole through the centre of the base of the lug to attach the replacement valve gear parts.

3. Tender chassis
3.1 Start by removing the tender frames from the fret and open out the bearing holes with a round file until frame bearings just fit. Note that the fold down tabs bend out away from the centre of the frames, so solder bearings in each hole on the inside of the frames, the opposite side to the fold line. File the outside of the bearings flush with the frames.
3.2 Open out each bearing until a tender wheel axle can be inserted and spun freely with minimum play.
3.3 Cut six rectangular pieces of 0.25mm thick PCB pads shaped and positioned as shown in the supplementary drawing, so that the pads are clear of the small holes in the frames intended for 'Simpson' springing. Solder the pads to the frames, clean up any excess solder and check that they are electrically isolated from the frames.
3.4 Bend the three frame spacers along the fold lines and solder to the PCB pads as shown in the drawing. Check the spacers are at right angles to the frame, as viewed end on.
3.5 Solder frames together using a loco frame assembly jig inserted through the outer axle holes, and then check that the spacers are electrically isolated from the frames. Check after soldering that the frames are square to each other. This can be done using lengths of axle steel through the outer axle holes, viewed from one end of the chassis.
3.6 If you want to employ 'Simpson' springing, open out the relevant axle holes to 1.6mm diameter, bend six 9mm lengths of thin (c. 0.1mm) phosphor bronze wire into 'L' shapes, with the longer leg about 7.5mm long. Insert the short leg into the hole in the frame, hold the long leg over the middle of the wheel bearing, and solder the short leg to the frame.
3.7 There are four supports for the rear of the tender, though only two are needed. These supports stop the rear end of the tender slipping inside the opening of the plastic footplate/ chassis. Two are on the fret next to the spacers, the others between the motion brackets. Bend two of them into 'L' shapes and solder level with the top of the frames centrally between the third and fourth axles, as shown in the drawing.
3.8 Using 3.2mm diameter muffs, reduce the length of the muffs so they fit between the bearings in the frames. Ream the muffs until the tender wheels fit firmly inside them. Drill 1mm diameter holes through the muffs 1.5mm either side of centre, then assemble the tender wheels and muffs in the frames. Set the back-to-back using back-to-back gauges. Check the wheel sets rotate freely and add superglue in the 1mm holes to fix the axles to the muffs.
3.9 Bend the fold-down tabs to a right angle to the frames and strengthen the fold with a fillet of solder. Open out the holes until the Grafar screw from the tender keeper plate just passes through the hole.
3.10 Solder a 25mm length of wire to the inside of each frame above the third axle from the front. This wire will be connected to the PCB DCC board later to link the tender chassis to the rest of the electrical circuitry.
3.11 The PCB DCC board is screwed to the front of the tender chassis block, and provides an electrical connection from the loco via the phosphor bronze wires passing round the lugs on the bottom of both chassis, back to the motor. It is necessary to retain this arrangement, but the tender chassis block gets in the way of the etched tender chassis. Therefore you will need to modify the tender block. Start by separating the two halves of the block and applying epoxy adhesive to the inside surfaces for the first 15mm from the front. Now screw the two halves of the block back together and leave the epoxy to cure.
3.12 Cut the block in two, retaining the front 15mm. The remains of the rear of the front axle channel will need to be filed away until the surface is flush with the underside of the plastic footplate/ chassis unit. When you think you have filed enough away, re-fit the remaining chassis bloc, screw the etched chassis to the footplate unit, and screw the tender body back on using screws through the holes in the remains of the chassis block. Everything should go back together without having to be forced, and with the front wheels of the chassis able to turn freely. If this is not the case, look closely to see if more filing of the chassis block is needed, then dismantle and file the block as necessary. It doesn't matter if the sides of the chassis block just touch the inside faces of the front of the etched chassis as long as they don't face the chassis frames apart.

4. Valve gear assembly (option 2 only).
(Refer to supplementary drawing for general arrangement of the various parts of valve gear. If you have never assembled valve gear before, the chapter on the subject in Pete Wright's book is well worth reading).

4.1 Solder together pairs of coupling rods, connecting rods, combination levers and radius rods (a single layer will bend too easily), fluted sides being on the outside. When the parts have been soldered together, clean up any excess solder, and remove any traces of attachment tabs remaining on the parts. Do this for the single layer parts too. Form 'kinks' in the combination levers, expansion links and return crank as shown in the drawing. These bends provide clearance past adjacent parts of the motion when the loco is moving.
4.2 The valve gear can be joined together using 0.31mm nickel silver rod or Association rivets. I will describe the former method, using the link between the combination lever and the union link as an example. Before starting, open out the small holes of the items to be joined, and any washers, with a broach or 0.35mm drill, and file the areas around the holes smooth with a needle file. The bottom end of the combination lever is attached over the top of the union link. First then, put a 10mm length of rod vertically in a vice. Place a piece of greaseproof paper over the rod, then place the union link (small hole) upside down on the rod. Hold the union link down and solder to the rod. Place this assembly back in the vice, right way up, then put a piece of greaseproof paper on the rod over the union link. Put the combination lever on the rod, then another piece of greaseproof paper, and finally a small etched washer. Hold the washer down on the union link etc and solder the washer to the rod with a quick dab of your soldering iron. Check that the combination lever rotates, even if stiffly. Remove the assembly from the vice and carefully pull the two bits of greaseproof paper away from the joint. Rinse flux residue away with cold water, dry the assembly and clean up with a glass fibre brush. File the back of the joint flush and file the top of the rod until no more than 0.25mm protrudes above the washer. If you solder the joint up solid, you will need to dismantle the parts, clean them thoroughly to remove all traces of solder and start again. The following parts are joined together in similar fashion:

- Combination lever top end on top of the front end of the radius rod
- Eccentric rod front end on top of the expansion link
- Eccentric rod rear end on top of the return crank narrow end

You should end up with two separate sub-assemblies for each side: the union link, combination lever and radius rod, and the expansion link, eccentric rod and return crank.

5. Pony truck
5.1 Open out the holes in the pony truck side frames and solder frame bearings, shaped as shown in the supplementary diagram, in place on the inside of the frames. File the outside of the bearings flush with the outside of the frames. Ream the bearing holes so that a wheel spins freely in the holes.
5.2 Solder appropriately shaped pieces of 0.25mm PCB to the pony truck side frames. Form right angle bends in the pony truck spacer using the half-etched fold lines and solder the spacer to one of the side frames. Mount this on a loco frame assembly jig, then add the other side frame and the remaining part of the jig. Then solder the spacer to the side frames and with the frame spacer jig removed check that the side frames are in line with each other as viewed from the side.
5.3 Insert a small diameter muff, prepared as for the tender axle muffs, between the frames and then insert the pony truck wheels into the muff, set the gauge, and check that the wheels rotate freely. If so, glue the wheels in the muff.
5.4 Bend the guard irons as shown in the supplementary drawing.

6. Re-assembly
Option 1
6.1 Solder 8 Association axle bearings onto a length of 1.5mm brass rod and turn the flanges down to c. 2.9mm so that a Grafar bearing just slides over them. Remove the bearings and solder them inside the Grafar bearings, with the Assoc bearing flange flush with the outside edge of the Grafar bearing. An alternative approach is to open out the Grafar bearings to 3.2mm diameter, preferably using a pillar drill.
6.2 Reduce three large diameter and one small diameter Assoc muffs to 4mm in length, drill 1mm holes 1mm either side of centre line right through the muffs, and ream them until the Assoc driving wheels are a firm fit inside the muffs.
6.3 Open out the hole in the Grafar gear to 2.3mm diameter so that the gear is a firm push fit on the small diameter muff, taking care not to damage the gear. Then fit the gear centrally on the muff and superglue in place.
6.4 Solder the eight driving wheel overlays to the driving wheels, lining up the holes in the overlays with the holes in the driving wheels with a dressmaker's pin. Note that the slightly larger pair of crescents on the overlays are for driving wheels third axle from the front of the loco. Before you solder the overlays in place check that they are concentric with the driving wheels.
6.5 Open out the crankpin holes in the drivers gradually to a diameter of 1.4mm, and solder 5mm (6mm for the third axle) lengths of 1.4mm rod into the holes, the rod flush with the back of the wheel. Check that the rods are square in their holes.
6.6. Assemble the driving wheels on the muffs with the bearing assemblies either side of the muffs, and the raised ridge on the bearing nearer the centre. Note the third axle carries the gear. Set the back to backs of the four sets of drivers and drop into the slots in the loco chassis. Check the wheels spin freely. For the geared axle, use one of the outer chassis holes for test purposes.
6.7 Remove the drivers, and quarter approximately by eye. I used a Bill Bedford quartering jig. It's awkward to use as the bearings next to the muffs get in the way, but it helps get the quartering almost right. An alternative would be to use the Association quartering jig, but I have never used one so I don't know if it would be of any use. Put the drivers back in the

chassis, but with the geared axle, just for quartering purposes, in a non-geared axle hole and line up the crankpins on one side of the chassis, then turn the wheels on the other side until the crankpins are in a line on that side. Attach the coupling rods temporarily (note the longer wheelbase between the third and fourth axles), and check that the rod on each side is horizontal.

6.8 Switch the geared axle back to its own axle hole, re-attach the rods and keeper plate and apply power to the motor via the leads running along the top of the chassis block. Run the motor slowly and observe the position of the crankpins in the coupling rod holes at any point where binding occurs. Open out the crankpin holes where binding occurs, and re-test. If all appears OK on one side of the chassis, repeat the process as you inspect the other side until the driving wheels rotate without any binding. Rather than do all axles at once, an alternative is to quarter two axles at a time: do the geared axle and one next to it first, then the other adjacent axle, and then the front axle and the geared axle. Then insert all four sets of drivers in the chassis, add the keeper plate and test the running under power.

6.9 Once you are happy with the quartering, the coupling rods can be attached, with retaining washers on the front, second and rear wheel crankpins only. Extra-large washers are provided, next to the driving wheel overlays. Put one of the etched washers over the front and rear pins, a piece of greaseproof paper over the first, second and fourth pins, then the coupling rod, then for the first, second and fourth pins, more greaseproof paper, and another washer. Set up all three wheels like this then solder the top crankpin washers to the crankpins while holding the washers down, but not too firmly. Check the wheels rotate after each washer is soldered to its pin, then remove the greaseproof paper and do the other side of the chassis.

6.10 Rinse the three soldered crankpins with water to remove any traces of flux and dry thoroughly. Avoid getting any water near the motor. Trim the crankpins to about 0.5mm above the washers, except the front axle where the crankpin will need to be filed flush with the washer to clear the crosshead as the wheels and motion rotate and clean up any stray solder with a glass fibre brush. Test the running under power again. If there is any hesitancy in the running, I suggest running slowly under power after applying CIF to the crankpins. Gradually increase the motor speed and change the direction of running now and then. Gradually the running should improve, and when it is satisfactory, carefully clean all traces of the CIF away. Be careful not to get any CIF or water near the motor or gear wheel.

6.11 Now re-attach the cylinder block and motion bracket to the Grafar chassis. Place a piece of greaseproof paper on the third crankpin of the third axle, then a 16 BA washer, then another piece of greaseproof paper, and finally the return crank.

6.12 Position the return crank so that the join between it and the eccentric rod is just forward (c. 1mm) of the centre of the driving wheel boss when the crankpin is in the bottom centre position. Have a look at prototype photographs if you need to clarify this. Then solder the return crank to the crankpin with the upper end of the return crank held angled outwards away from the driving wheel. Check driving wheels still rotate back and forth slightly, then rinse the joint with water, dry and clean up any excess solder. If you have soldered the join up solid, you will need to unsolder the return crank and connecting rod, thoroughly clean away all traces of solder from the crankpin, connecting rod and return crank and start again.

6.13 That is all the work unique to option 1. Please refer to Para 6.30 for the next step.

Option 2

6.14 Repeat steps 6.1 to 6.3 inclusive from option 1 above.

6.15 Solder the eight driving wheel overlays to the driving wheels, using flanged crankpins inserted through the holes in the overlays into the holes in the driving wheels to locate the overlays. Note that the slightly larger pair of crescents on the overlays are for driving wheels third axle from the front of the loco. Before you solder the overlays in place check that they are concentric with the driving wheels. Solder the crankpins into the holes in the wheels.

6.16 Assemble the driving wheels on the muffs with the bearing assemblies either side of the muffs, and the raised ridge on the bearing nearer the centre. Note the third axle carries the gear. Set the back to backs of the four sets of drivers and drop into the slots in the loco chassis. Check the wheels spin freely. For the geared axle, use one of the outer chassis holes for test purposes.

6.17 Remove the drivers, and quarter approximately by eye. I used a Bill Bedford quartering jig. It's awkward to use as the bearings next to the muffs get in the way, but it helps get the quartering almost right. An alternative would be to use the Association quartering jig, but I have never used one so I don't know if it would be of any use. Put the drivers back in the chassis, but with the geared axle, just for quartering purposes, in a non-geared axle hole and line up the crankpins on one side of the chassis, then rotate the wheels on the other side until the crankpins are in a line on that side. Attach the coupling rods temporarily (note the longer wheelbase between the third and fourth axles), and check that the rod on each side is horizontal.

6.18 Switch the geared axle back to its own axle hole, re-attach the rods and keeper plate and apply power to the motor via the leads running along the top of the chassis block. Run the motor slowly and observe the position of the crankpins in the coupling rod holes at any point where binding occurs. Open out the crankpin holes where binding occurs, and re-test. If all appears OK on one side of the chassis, repeat the process as you inspect the other side until the driving wheels rotate without any binding. Rather than do all axles at once, an alternative is to quarter two axles at a time: do the geared axle and one next to it first, then the other adjacent axle, and then the front axle and the geared axle. Then insert all four sets of drivers in the chassis, add the keeper plate and test the running under power.

6.19 Once you are happy with the quartering, the coupling rods can be attached, with retaining washers on the front, second and rear wheel crankpins only. Put washers over all four pins, then greaseproof paper on the first, second and fourth pins, then the coupling rod, then for the first, second and fourth pins, more greaseproof, and then one of the small

etched washers. Set up all three wheels like this then solder the top crankpin washers to the crankpins while holding the washers down, but not too firmly. Check the wheels rotate after each washer is soldered to its pin, then remove the greaseproof paper and do the other side of the chassis.
6.20 Rinse the six crankpins with water to remove any traces of flux and dry thoroughly. Avoid getting any water near the motor. Trim the crankpins to about 0.5mm above the washers, except the front axle where the crankpin will need to be filed flush with the washer to clear the crosshead as the wheels and motion rotate and clean up any stray solder with a glass fibre brush. Test the running under power again. If there is any hesitancy in the running, I suggest running slowly under power after applying CIF to the crankpins. Gradually increase the motor speed and change the direction of running now and then. Gradually the running should improve, and when it is satisfactory, carefully clean all traces of the CIF away. Be careful not to get any CIF or water near the motor or gear wheel.
6.21 This step can be done with the crosshead still attached between the slidebars, or with the crosshead removed. You can remove the crossheads by gently prising the slidebars apart slightly and letting the crosshead fall out. Mark the centre of the remains of the two lugs on each crosshead and drill right through the crosshead with a 0.35mm drill. Open out the hole for the connecting rod to 0.5mm and check an Association crankpin will pass through the hole. File the head of the crankpin down to a thickness of about 0.25mm and insert it into the crosshead from the outer face. Put the connecting rod front end over the end of the crankpin, then a piece of greaseproof paper, then an Association crankpin washer, and solder the washer to the crankpin. Check that the connecting rod can swing freely. File the crankpin and washer until about 0.25mm is left sticking out from the inside face of the crosshead. Repeat all this for the other connecting rod and crosshead.
6.22 Bend a 10mm long piece of 0.31mm rod into an 'L' shape, the shorter leg about 2mm long. Insert the rod through the small hole in the crosshead with the longer leg protruding on the outside. Place the union link part of the union link/ combination lever/ radius rod assembly over the rod, then a piece of greaseproof paper, and finally a small washer. Hold the washer down against the crosshead and solder the washer to the rod. Check the union link swings against the crosshead and remove the greaseproof paper. Rinse any remaining flux from the joint and trim the rod until about 0.25mm is left above the washer. Cleanup any solder residue with a glass fibre brush. Secure the rod behind the crosshead with a smear of epoxy. Repeat for the other union link and crosshead assembly. If necessary, replace the crosshead between slidebars, checking the crosshead moves back and forth smoothly along the slidebars, and is securely held between them
6.23 Bend the motion bracket etches into the same shape as the Grafar ones with the fold lines on the inside of the bends and add a fillet of solder to the inside of the bends. Check the assembly fits in the holes in the Grafar chassis. Insert a 10mm length of 0.31 mm rod in the hole in the side of the motion bracket, with say 8mm on the inside, and solder the rod in the hole, checking it is in square. Put a piece of greaseproof paper over the rod on the inside of the motion bracket, then put the expansion link over the pin, then another piece of greaseproof paper, and then, the radius rod over the pin, with the radius rod projecting forward through the opening near the top of the face of the motion bracket. The Grafar version should clarify this if necessary. Hold the radius rod firmly against the expansion link, with the radius rod parallel to the side of the motion bracket, and solder the radius rod to the pin, then check that the expansion link can swing back and forth inside the motion bracket. Solder the motion bracket to the radius rod where it passes through the opening in the motion bracket. File the pin flush with the outside of the motion bracket and solder a small disc with cosmetic rivets on it over the pin centrally on the motion bracket. Check again that the expansion link is free to move. Remove the greaseproof paper and clean up as usual, then repeat the procedure for the other motion bracket etc.
6.24 You should now have the crosshead connected to the union link, combination lever and radius rod, and all this connected to the motion bracket, and parts attached to this in 6.22 above. The final stages of assembly of the motion can now be dealt with. Insert the motion brackets into the holes in the Grafar loco chassis. Clearance between the upper end of the combination lever and the slidebars is limited and it is worth filing the inside face of the cosmetic plastic valve spindle guide away slightly so that the join between the combination lever and the radius rod is kept as far away from the centre of the chassis as possible. Now screw the cylinder block back onto the Grafar loco chassis. Ensure the joint of the combination lever and radius rod is behind the valve spindle guide at the rear of the plastic cylinder moulding. Glue the motion bracket in place with a drop of superglue. Place a 16BA washer on the crankpin of the third driving wheel, then place a piece of greaseproof paper over the crankpin. Then the connecting rod, another piece of greaseproof paper and finally the return crank.
6.25 Position the return crank so that the join between it and the eccentric rod is just forward (c. 1mm) of the centre of the driving wheel boss when the crankpin is in the bottom centre position. Have a look at prototype photographs if you need to clarify this. Then solder the return crank to the crankpin with the upper end of the return crank held angled outwards away from the driving wheel. Check driving wheels still rotate back and forth slightly. If you have soldered the join up solid, you will need to unsolder the return crank and connecting rod, thoroughly clean away all traces of solder from the crankpin, connecting rod and return crank and start again.
6.26 If the driving wheels are now moveable, remove the greaseproof paper, rinse the join with water to remove any flux residue, and clean up the join with a glass fibre brush and a needle file. The crankpin should be filed almost flush with the return crank so that the top of the crankpin passes under the inside of the return crank as the wheels rotate.
6.27 Repeat 6.25 and 6.26 for the other side of the chassis.
6.28 The running of the chassis can now be tested again. Run the loco slowly under power. If the wheels stop rotating suddenly, it's likely some part of the valve gear is catching. Cut the power and inspect the valve gear carefully to identify the problem. Possible causes could be the front wheel crankpin catching the inside of the crosshead, the crankpin on the

second wheel catching the connecting rod, the bottom of the expansion link catching against the connecting rod, the third wheel crankpin catching the return crank or the combination lever catching the crosshead. It's possible to correct any of these possibilities by filing or sanding away with wet and dry paper the relevant parts to create more clearance. If the wheels rotate without any obvious catching, but with a degree of stiffness, you can try further cleaning of the soldered joints with a glass fibre brush. A likely candidate causing stiffness is the joint between the return crank and the third wheel crankpin. Some modellers frown on this, but an alternative method to free up the running is to put small amounts of CIF on the soldered joint of the valve gear and crankpins, and run the chassis under power, slowly at first, then gradually increasing the speed, and reversing the direction of movement now and then. You must be careful to keep any moisture away from the motor while running the chassis and when you clean the CIF away, which must be done thoroughly to avoid continuing wear in any of the joints.

6.29. Once you are happy with the running of the chassis, lubricate all the joints, the gear wheel and the axle bearings with lubricating oil and re-test the running. The oiling round should make a difference to the smoothness of running.

6.30 Now the loco and tender chassis can be re-united. Firstly, file two recesses on the inside of the plastic tender footplate/chassis unit level with the third axle box to provide room for the wire connection from the etched chassis to the PCB DCC board. Drill two 1.5mm diameter holes through the footplate 4mm behind the front body fixing holes and 3mm inside the sides of the plastic footplate. Insert the remains of the Grafar chassis block in place at the front of the plastic unit and screw the etched tender chassis to the plastic unit.

6.31 Thread the two wires from the etched chassis inside the plastic chassis and solder the wires to the circular metal bases through which the screws to the chassis block pass. Rinse with water, dry and clean up excess solder so that the holes are clear for the screws, then screw the PCB DCC board onto the chassis block.

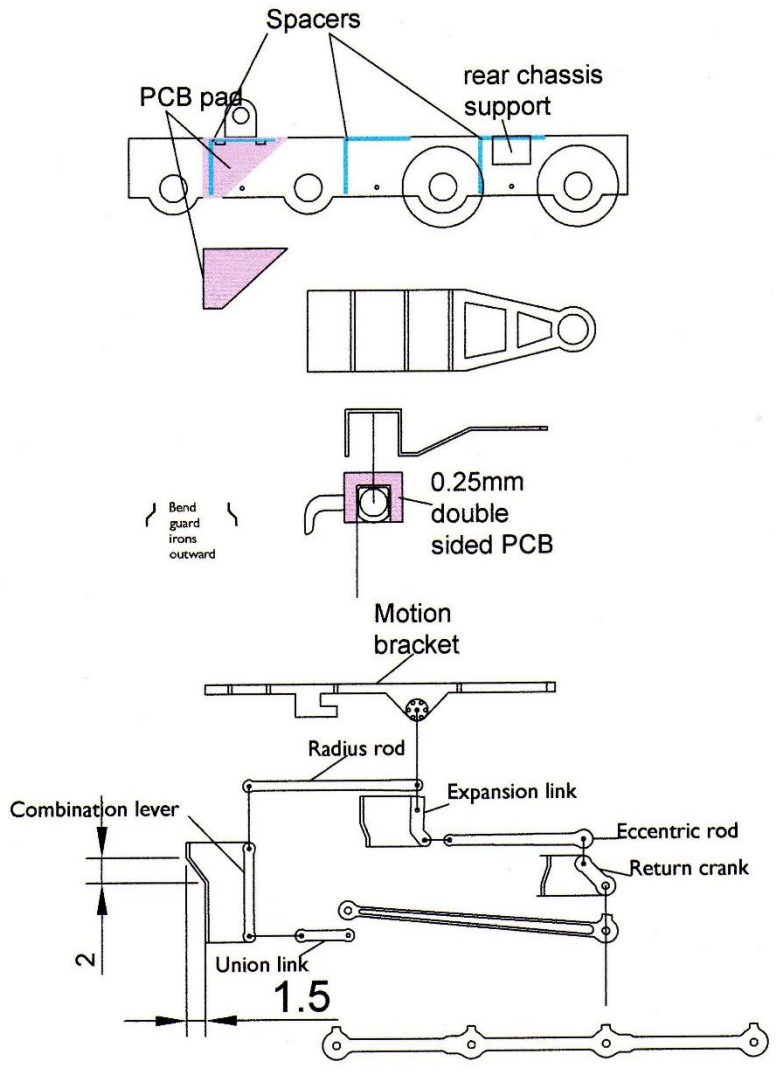
6.32 Re-clip the drawbar to the loco and tender and thread the wires from the loco through the holes in the plastic footplate. Solder the wires to the tags on the PCB DCC board located behind the chassis block securing screws, then rinse and dry the joints.

6.33 Screw the tender body back in place, then the loco body and finally the pony truck. And that's all the construction work done.

7. Painting etc

7.1 The tender chassis, tender wheels and loco driving and pony truck wheels and pony truck can be painted after any soldering work has been completed and prior to final assembly. You may find that the valve gear paintwork gets chipped during final assembly so you might consider painting the valve gear once it's assembled and fully tested.

7.2 Once all the paintwork has been completed, you can re-attach any other bits you may have removed, and the various accessories included with the model.



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