

2mm Finescale Chassis Kit for Dapol LMS Ivatt tank: Construction Notes

1. Introduction

This kit has been designed to fit a Dapol Ivatt tank loco body and includes all parts for the loco chassis.

Parts required to complete are: -

Bogie wheels	4 x 6mm
Driving wheels	6 x 10mm
Crankpins	8 (6 flanged recommended for driving wheels)
Crankpin cap washers	2
Motion pins	minimum 2 packs
Frame bushes	minimum 14
Wheel muffs	minimum 6 including one gear muff
Gears	1 x 30:1 gear set and one 100 DP 21:1 and 28:1 spur gear For metric gears use M 0.3 25:1 and 16:1 spur gears
Axle steel	3" or so
Cross head strip	Type A
Lil pins (or similar)	2
PCB frame spacer	1" or so
Motor	Assumed Faulhaber 1016 or Mashima 9/16, but others may be used*
Thin double-sided PCB (say 10 thou thick)	2 sq. inches should suffice
Steel wire or brass rod 8 thou and 10 thou	3" of each
Screws and nuts 12BA cheesehead	6
Couplings	own choice

Tools required include: -

Soldering iron and solder, flux
Needle files – flat, round
Riffler file
Modelling knife
Broaches
Wet and dry paper, glass fibre brush
Set of jewellers screwdrivers
Chassis frame assembly jig
Tweezers
Razor saw
Flat nosed pliers
12 BA tap
Minidrill and burrs

I recommend you read and understand these instructions before you begin assembly. There are a number of small and delicate parts on the etch. Its best to leave parts on the etch until actually 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. It is desirable, though not essential, to have a lathe to turn dummy cylinder and valve covers. These parts can be fabricated using other means such as brass rod of appropriate diameter. The cylinder covers are 3.5mm diameter, .5mm thick. The valve ends are 2.5mm diameter, 1.25mm deep and the two front covers have a spindle extension 1mm long and .5mm diameter.

* A mounting bracket for a Mashima 9/16 was added to the etch as an afterthought. There are a couple of minor, correctable, errors on this part (see separate diagram sheet). If you want to use a Mashima motor it will be necessary to remove part of the top of the sides of the motor so it fits under the firebox of the plastic loco body. I found the performance of the Mashima in this chassis to be disappointing compared to the Faulhaber 1016 and I recommend you use the latter motor.

2. Locomotive chassis

Frames

2.1 Start by removing the loco frames and open out axle holes with a round file until frame bearings just fit. Solder bearings in each hole on the inside of the frames.

2.2 Open out each bearing until a driving wheel axle can be inserted and spun freely with minimum play, especially the middle axle which carries the worm wheel.

2.3 Remove loco frame spacers (5 in total) and bend up as per loco frame diagram (Fig 1).

2.4 Cut pieces of double-sided PCB for each spacer, slightly larger than the spacer in question, and solder all five to one of the frames, in the positions of the spacers indicated in fig 1

2.5 Solder spacers onto PCB in accordance with the positions shown in fig 1. Note that if you are using a Faulhaber motor, the front bottom edge of spacer #4 must be flush with the bottom of the mainframes and the rear end higher by about .5mm. Check that each spacer is square to the frame horizontally and vertically. Repeat 2.4 for the other frame.

2.6 Solder frames together using loco frame assembly jig or lengths of axle steel inserted through the outer axle holes. In either case 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 or temporarily fitting driving wheels and checking that the chassis doesn't wobble when set on true track or a sheet of glass.

2.7 Solder a 12 BA nut over the hole in spacer #1, ensuring accurate alignment. Repeat this for the rear most hole in spacer #4.

2.8 If you are using a Faulhaber 1016 motor fold up the motor mount (the spacer like part with the curved ends), add a fillet of solder along each bend, and solder 12 BA nuts over the two holes. Then epoxy the motor to the motor mount in the position shown in fig 1.

If you are using a Mashima 9/16, note the corrections shown in fig 3, then bend up the folds in the bracket, and add a fillet of solder inside the bends, before soldering 12 BA nuts over the two holes in the rectangular section of the mount. The motor can then be screwed to the front of the mounting plate using the screws supplied with the motor.

2.9 At this point I recommend that the cylinder and valve gear assembly is dealt with as the presence of wheels, gears etc makes fitting the cylinder and valve gear assembly more fiddly. See separate section below.

2.10 Drill two holes (c 1mm diameter) centrally through the circumference of a gear muff, and then ream the muff to take 1.5mm axle steel.

2.11 Mount a 30:1 worm wheel centrally on the muff and a 21:1 spur gear the other side of the raised part of the muff. Cut two 4mm lengths of axle steel, fill the axle hole in the muff with a small amount of epoxy at either end. Then hold the muff between the frames in line with the holes in the frame above and between the front and middle driving wheel holes. Insert the pieces of axle steel until about flush with the frames and check the gear muff rotates freely and that no epoxy has escaped between the frames and the muff. Leave to dry and then re-check for free rotation.

2.12 Solder together pairs of coupling rods (a single layer will bend too easily).

2.13 Solder crankpins in their holes in driving wheels, and then the driving wheels can be fitted into the frames, with the 28:1 spur gear glued off-centre, to line up with the 21:1 gear, on the middle axle. Check that the gear meshes with the other spur gear and that the gears etc rotate freely.

2.14 Quarter the drivers one pair at a time, ensuring the chassis can run smoothly down a gentle slope with the coupling rods fitted and held in place with rings of wire insulation material. When satisfied, glue the axles in the muffs. It is vital that the chassis runs smoothly now – when you fit the valve gear you want to be sure any uneven running is not due to poor quartering so eliminate this possibility now. You can also test the worm gear meshing at this stage by fitting the motor (with worm attached) on its mounting plate on to the long spacer (#4) including shim packing. Run the motor and check that the meshing is satisfactory, and the wheels rotate smoothly.

2.15 You can attach the driving wheel balance weights now. The larger ones go on the middle driving wheels. Refer to drawings or photographs for positions. I find epoxying in place is the best method.

Pony Trucks

2.16 Open out the holes in the pony truck side frames and solder frame bearings in place on the inside of the frames. You might find it useful to file flats at right angles to each other on two adjacent sides of the bearing so that there is room on the pony truck spacer for a slightly bigger piece of PCB to be used.

2.17 Solder appropriately shaped pieces of 10 thou PCB to the four pony truck side frames. Form bends in the pony truck spacers, and solder each 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.

2.18 Insert 1mm rod through the holes in the small squares either side of the main part of the side frames, and check that the rods line up when viewed front on. 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. If satisfied, remove the rod and the little alignment squares. Repeat this for the other pony truck.

2.19 For each pony truck insert a muff between the frames and then insert the pony truck wheels into the muff, checking that the wheels rotate freely. If so glue the wheels in the muff.

2.20 Finally attach the pony trucks to the main frames and check the wheelbase distance between the pony truck wheel and the nearest driving wheel. This should be 17mm for the front pony truck and 16mm for the rear one. If there is a significant difference, you can correct this by repositioning the spacer in the main frames, or elongating the hole in the pony truck spacer in the appropriate direction and then soldering a washer to the pony truck spacer over the elongated end of the hole.

Brake gear

2.21 The brake gear can now be attached if desired. Firstly solder lengths of 10 thou rod or wire through the small holes in front of each driving wheel. It's easier to bend up 'L' shaped lengths of rod and solder one of the legs to the inside face of the frames. The rod should protrude from the frames on each side just less than the outer face of the driving wheels. Then solder pairs of brake hangers together to form six sets and solder the six brake blocks to the brake hangers. Open the holes in the brake hangers to take the 10 thou rod. Place a brake assembly on the front piece of rod and solder in place checking the whole assembly is inside the outer face of the driver. Repeat for the other two brakes, and then repeat for the other side.

2.22 Check the brake hanger lower holes line up with the brake pull rod holes, and thread a length of 8 thou wire through the lower hole on the front brake hanger, the two brake pull rods, and the brake hanger on the other side. Repeat for the rear brakes, and solder the hangers and pull rod to the wire. Add the wire for the middle brakes and solder in place. Check the driving wheels still rotate freely.

2.23 Finally remove the central sections of the 8 thou wire to maintain electrical isolation by carefully cutting just inside each brake hanger.

Cylinders and Valve gear

(Refer to fig 2 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).

2.24 Remove both cylinder side covers from the etch and gently tap a sewing machine needle into the half-etched holes. These represent rivets on the outside of the cover.

2.25 Solder the dummy rear cylinder end turnings in place on the rear cylinder cover. Use the holes under the cylinder cover as guides and drill holes into the cylinder ends for the slide bars and piston, then remove them and clean up the cylinder end piece.

2.26 Form right angle bends in the cylinder front cover, check the width is the same as the rear cover and add a fillet of solder inside each bend to strengthen. Using the cylinder covers as guides, form the bends in the cylinder covers and solder the ends inside the side covers with the face of each end flush with the cylinder side cover. Check the fit in the aperture over the bogie.

2.27 Cut two lengths of PCB frame spacer of not more than 3mm and solder these centrally on the inside face of each cylinder cover. It may be necessary to reduce the thickness of the PCB slightly to fit between the cylinder covers. This step will help stop the cylinder assembly collapsing when dummy cylinder and piston ends are added.

2.28 Solder the dummy cylinder and piston ends in place on the front and rear faces of the etched cylinder ends. Use the holes formed at step 2.25 to align the rear cylinder covers.

2.29 Solder the two pairs of slide bars together, the ones with a 't' going under the other pair. The 't' indicates which is the top slide bar although there is very little difference between top and bottom ones in 2mm scale. When completed, insert one pair into the holes in the cylinder as far as it will go and solder in place ensuring it is square to the cylinder in all directions Then fit the other, again checking for alignment, and that the two slide bars are parallel to each other. Also check that a length of crosshead strip will slide easily between the two slide bars. If not open them out by filing the surfaces opposite each other. If you are happy with the position of the slide bars, carefully file away the bit between the upper and lower slide bars until the rear cylinder cover is completely exposed.

2.30 Solder pairs of each item of valve gear together, fluted sides being on the outside.

2.31 Cut a length of cross head strip equal to the width of the etched cross head front. File a slot along its length wide enough to take the front end of the connecting rod. There isn't a lot of material so go easy or the edges of the cross head strip will collapse, but ensure there is room for the connecting rod to swing in the slot. The slot should be deep enough for the connecting rod to rest below the sides of the slot.

2.32 Solder the cross head strip to the cross head etch and drill a .6mm hole in the centre of the cross head strip, using the hole in the etched part as a guide. Place the connecting rod inside the crosshead assembly, secure the connecting rod by inserting a crankpin from the front of the crosshead, and solder the pin in place carefully at the back of the crosshead. You may find it useful to add a drop of oil round the crankpin inside the crosshead to stop the whole lot getting soldered up solid (easily done!). Check the connecting rod swings up and down by at least 2mm at its rear end. If the swing is much less than this in either direction it may be necessary to partly dismantle and increase the clearances slightly. File the top of the crankpin until about .5mm protrudes above the face of the crosshead.

2.33 Insert a motion pin from the rear in the bottom hole in the crosshead assembly, then place a small piece of grease proof paper over the pin, drop one end of the union link onto the pin and hold down onto the crosshead while you solder in place. Remove the greaseproof paper and check the union link swings reasonably freely.

2.34 The final operation with the crosshead is to solder a lil pin to the centre of the front edge of the crosshead to represent the piston. Check alignment and that the connecting rod is still free. If not, start again. Also check the whole assembly slides easily between the slide bars with the piston entering the cylinders in a line parallel with the slide bars.

2.35 Repeat steps 2.31 to 2.34 for the other crosshead.

2.36 Crank the combination lever ends as shown in fig 2. From the top of the combination lever, insert a motion pin through the bottom hole in the combination lever, then place a piece of greaseproof paper over the pin, and finally add the free end of the union link from one of the crossheads. Solder the pin in place, remove the greaseproof paper and check the combination lever swings freely.

2.37 Fold up the valve spindle guide 'box' and solder together the two free edges. Remove any excess solder from the inside, especially.

2.38 Place the top of the combination lever through the bottom hole in the valve spindle guide. Line the hole at the top of the combination lever up with the hole in the radius rod and then the hole in the valve spindle guide. Insert a 4mm long piece of wire, bent into an 'L' shape, through the small hole at the top rear of the valve spindle guide, the radius rod and finally the combination lever. With a quick dab of the iron solder the wire to the back of the valve spindle guide. Check the combination lever moves back and forth freely. The combination lever should now be trapped in place

2.39 The little rectangles under the bottom of the mainframe at the bottom of the etch were supposed to be the side pieces of the motion brackets, but they are too short. However, you can use lengths of scrap nickel silver from the outside of this or other etches just as easily. It helps if you use over-wide lengths to make attaching to the motion bracket easier. Use the motion bracket **(note that this item is very fragile so handle gently)** to help in bending to shape then solder round the outside edge of the motion bracket, having first folded the triangular bracket, carrying the expansion link, at right angles to the main motion bracket. Try to solder the edging as centrally as possible round the motion bracket, then file the edging so that no more than about .25mm protrudes either side of the face of the motion bracket.

2.40 Bend up the motion bracket/ slide bar support unit, noting the slide bar support is left at a slight angle (1 in 20) to the vertical rather than perpendicular, and add a fillet of solder inside the bends. Fold down the little squares at the rear of the central section, and add a fillet of solder inside the bend. These little squares are to help locate the motion bracket centrally on the frames. Solder a length of PCB frame spacer centrally along the bottom of the inside of the flat, horizontal section between the motion brackets.

2.41 Solder a motion pin through the hole in the side of the motion bracket from the outside, ensuring it is square in the hole.

2.42 With both the crosshead assemblies located in place in the cylinder assembly, fit the cylinder assembly into the aperture in the frames, then the motion bracket assembly in its cut outs in the loco frames, with the slide bars between the cut out in the slide bar support bracket. It may be necessary to remove some material from the top or bottom edges of the slide bar support aperture until the slide bars are parallel and the motion bracket assembly flat in the cut outs in the frames. When satisfied, carefully tack solder the rear ends of the slide bars to the slide bar support bracket to form a cylinder/ motion bracket unit.

Check the cross head slides smoothly between the slide bars. It may be necessary to increase the size of the slide bar support bracket aperture to ensure the crosshead can slide along the slide bars. When there is sufficient clearance, attach the coupling rod to the driving wheels, then a washer on the middle driver crankpin, then the connecting rods to the middle driver and check that the connecting rod doesn't need to be forced inwards towards the driving wheel. If this is the case, it may be necessary to ease the slide bar support end of the slide bars in towards the centre of the frames slightly, ensuring both slide bars on one side remain parallel and in line from above. Now finish the tack soldering described in the previous paragraph.

2.43 The rest of the valve gear can now be connected. It is probably a good idea to form a kink (c. 1mm) in the expansion link so that the bottom end sticks out away from the frames and clears the connecting rod as everything rotates. Similarly form kinks in the return crank. One at the crankpin end and another at the other end to keep the two end sections parallel. Using motion pins and greaseproof paper as before, solder the eccentric rod on top of the return crank and expansion link for both sides.

2.44 The various bits of valve gear can now be mounted onto the motion bracket. First locate the free end of the expansion link on the pin in the motion bracket, then place a piece of greaseproof paper on the pin. Now thread the radius rod through the rectangular hole in the slide bar support bracket and mount this on the pin in the motion bracket (this can be a fiddly operation). Arrange the radius rod so that its lower edge rests against the bottom of the slide bar support bracket aperture and solder the radius rod in place behind the pin, ensuring the expansion link swings on its locating pin when the grease proof paper is removed. If you are satisfied that everything is in order so far, solder the radius rod to the slide bar support bracket to provide extra strength and rigidity.

2.45 Repeat 2.44 for the other side.

2.46 Once you are satisfied with the cylinder/ motion bracket unit, the cylinders can be isolated electrically by sawing through the front and rear faces of the cylinder cross pieces and the first layer of copper on the PCB. Then create a gap in the motion bracket central section, again sawing through the first layer of copper on the PCB. With the unit mounted on the frames check each side of the frames is isolated from the other.

At this point you can go back to the loco frames assembly, step 2.10 above.

2.47 This section describes the final fitting of the cylinder and valve gear assembly. With the wheels and gears now in place, drop the cylinder/motion bracket assembly in place in the loco frames. You should find that the PCB block in the middle of the motion bracket cross piece fouls the worm wheel. Therefore file a slot in the PCB so that the worm wheel can rotate without touching the PCB.

2.48 Place on the rear and middle driving wheel crankpins a ten thou washer, then the coupling rod. Drop the cylinder/ motion bracket assembly in the locating slots in the loco frames. On the middle driving wheel crankpin place another ten thou washer, the connecting rod, and then a piece of greaseproof paper. Finally mount the return crank on the crankpin, pointing up to and slightly forward of the driving wheel boss. If the return crank is a tight fit open up the hole until the crank just fits, but not too much. Solder in place, with the return crank angled out away from the frames to give more clearance past the connecting rod. Check the chassis runs freely. If this is not the case, examine the valve gear closely to spot parts which may be catching on other parts. There isn't much clearance in places so it may be necessary to increase clearances by filing down the offending item. Possible problem areas include the front crankpin which needs to be filed almost flush with the coupling rod, and the expansion link

not being bent far enough away from the frames. Sometimes it's necessary to realign the slide bars away from or closer to the frames.

2.49 If the chassis is now running freely, you can solder a crankpin cap washer onto the rear driving wheel crankpin. Use a piece of greaseproof paper on the crankpin between the coupling rod and the cap washer to provide a little clearance, and then solder in place. Remove the greaseproof paper and check the driving wheels still rotate.. If the general running of the chassis now seems hampered, its worth putting some Jif, Cif or other abrasive cream on the crankpins and other valve gear joints and running the chassis up and down on a flat surface for a few minutes. This can help remove any rough spots or little bits of grease proof paper which may be trapped between parts of the valve gear. If you do this you must rinse the whole chassis thoroughly to remove all traces of the abrasive, then dry with tissue and maybe a hairdryer etc.

2.50 Repeat 2.47 - 2.49 for the other side of the valve gear etc.

3. Finishing Off

3.1 Once the loco chassis work is complete, if current is now applied to the motor, the loco should run. Possible uneven running may be due to: -

1. Lack of weight on the drivers – for test running purposes blue tack a lump of lead over the gearbox .
2. Poor gear meshing – inspect and adjust as necessary.
3. Dirty wheels/ track – its important these are spotless.
4. Lack of oil – a spot of oil on all axles, gearbox bearings and moving parts of valve gear is advisable.

3.2 It is almost inevitable that you will need to make some adjustments before reasonably smooth running is achieved, and it is a matter of trial and error until you succeed. It is important therefore that you ensured the chassis ran freely after you quartered the driving wheels, and that the valve gear does not catch on anything.

4. Painting etc

4.1 The stage at which you paint the chassis is up to you. If you've followed the instructions above, you can paint everything after assembly is complete. Alternatively the chassis and driving wheels can be painted before the driving wheels are permanently fitted. This approach is easier in some ways, but remember you may want to solder the brake gear in place as the last stage of assembly, and this may spoil the paintwork.

4.2 I use Comet two part etching primer for the undercoat and then spray everything with Carplan cellulose satin black, but this is only a personal preference.

5. Fitting Body

5.1 There are two fixing points on the loco body and the positioning of the spacers is designed to align with these. The plastic moulding for the Dapol fixing screws needs to be reduced in height slightly so that the chassis will just rest squarely on the flat underside of the body. Be careful not to touch the side of the footplate when you are doing this! The fixing holes in the etched spacers will need to be opened out to take the Dapol fixing screws and you may need to elongate the holes in the spacers one way or another to adjust the position of the chassis relative to the loco body to get the location correct.

5.2 If you are using a Faulhaber 1016 motor and find that the chassis does not quite seat down on the underside of the loco body with the motor fitted, you may need to remove part of the plastic body on the inside of the firebox and rear of the boiler, but be careful as the plastic moulding is quite thin in places.. I found a riffler file was useful for doing this, but if you don't have a riffler file try some wet and dry paper wrapped round a semi-circular ended piece of rod etc.

References

- 1 Historic Locomotive Drawings in 4mm Scale, F.J. Roche
- 2 Stanier Locomotive Classes, A.J. Powell
- 3 Loco Bits and Pieces, Pete Wright

2mm scale Finescale chassis for Dapol LMS Ivatt tan

Frame spacer and valve gear layout

Fig 1

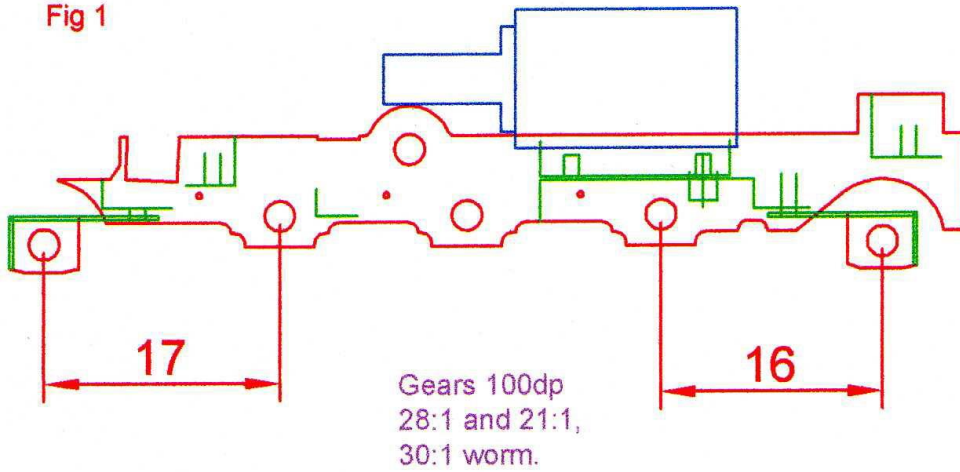


Fig 2

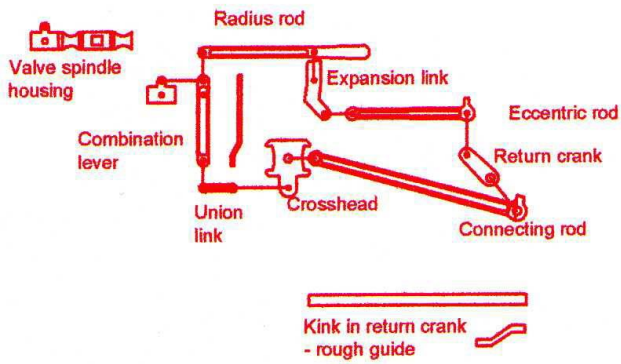


Fig 3

