

FB/EK HOLDEN KINGPIN SUSPENSION DISK BRAKE CONVERSION GUIDE

Background

There are many ways to fit disk brakes to an FB/EK Holden. Most of the ways start by upgrading the front end from kingpin to balljoint, and many require 14" (or larger) wheels. The aim of this document is to fit disk brakes to an FB/EK Holden to:

1. Retain the factory kingpin suspension,
2. Retain the factory-sized 13" wheels,
3. Provide dual-circuit, boosted brakes,
4. Retain the factory bonnet hinges,
5. Minimise equipment under the bonnet,
6. Minimise welding operations and provide a largely bolt-on solution (note that some machining is required, and simple welds for relocating the caliper hose clamps), and
7. Achieve large diameter (226mm) ventilated disks. This compares well with the HR (253mm solid disks), HK/T/G (270mm solid disks) and the HQ (276mm ventilated).

Fitting disk brakes to an early Holden is likely to require engineering approval. It is strongly recommended that you check with your state's registration authority and with your engineer prior to starting this process.

Parts Required

The process uses two separate kits. The first kit is the Castlemaine Rod Shop kit DB005 (LH-UC disk and caliper to early Holden kingpin front end. The kit can be seen here: <https://www.rodshop.com.au/db005-holden-disc-brake-conversion.html>. Note that the Castlemaine Rod Shop also do a similar kit (DB006) to install HQ-WB discs. The DB005 kit contents are as follows:



1. Instructions.
2. Two kingpin caliper brackets (DB BR 02 - CRS1325).
3. Two $\frac{7}{16}$ "-20UNFx2" grade 8 bolts.
4. Two $\frac{7}{16}$ "-20UNFx1 $\frac{3}{4}$ " grade 8 bolts. These are $\frac{1}{4}$ " too short for the process described below, and do not protrude threads through the FB/EK Holden steering knuckle. These should be discarded and replaced with two $\frac{7}{16}$ "-20UNFx2" grade 8 bolts.
5. Four $\frac{7}{16}$ "-20UNFx1 $\frac{1}{2}$ " grade 8 bolts. Only two of these are used in the process described below.
6. Two $\frac{7}{16}$ "-20UNFx $\frac{3}{4}$ " grade 5 bolts.
7. Two $\frac{7}{16}$ "-20UNFx $\frac{3}{4}$ " bolts with heads machined down to $\frac{3}{16}$ " thickness. These do not need their heads machined down to use in the process described below. They can be used, but unmachined bolts would do the same job.
8. Two thick spacers, 0.984"OD x $\frac{5}{16}$ " thick (DB SAS 02 – CRS0070).
9. Four thin spacers, $\frac{7}{8}$ "OD x 0.197" thick (DB CS 02 – CRS0071). These are not used in the process described below.
10. Ten $\frac{7}{16}$ " spider washers.

The second kit used in this process is the Hoppers Stoppers 266mm vented rotor brake upgrade kit for CRS/Stubtech dropped stubs drilled for Torana brakes, for HX-HZ PBR alloy calipers only. The disk brake kit contents are as follows:



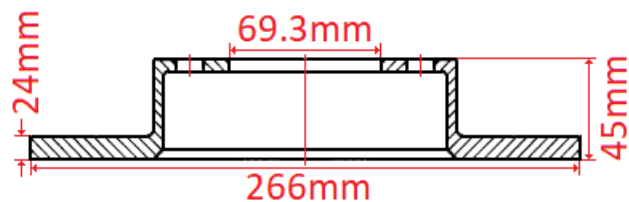
1. Instructions.
2. Two DR221 or DR/DBA425 rotors, machined down to 266mm and redrilled to suit the 5x4 $\frac{1}{4}$ "PCD early Holden stud pattern.

3. Two HX-HZ PBR calipers (Holden part numbers VS14657 and VS14658 for left hand and right hand respectively).
4. Inner and outer Holden wheel bearings.
5. Two grease caps.
6. Two grease seals.
7. Four $\frac{7}{16}$ "-20UNFx3" bolts, nuts and spring washers.
8. Four 2mm thick spacers. These are not used in the process described below.
9. Four 4mm thick spacers. These are not used in the process described below.
10. Two HR Holden front wheel hubs in early Holden pattern (or another pattern if ordered)
11. Two HX-HZ Holden brake hoses (385 cut length – 430 long IM10 + IF01) hoses.
12. Ten $\frac{1}{2}$ "-20UNFx2" countersunk bolts, nuts and washers (I believe these are grade 10.9).

Note that the two brake hoses (item 11 above) do not have the correct end fittings for the process described below. The correct fittings are shown in the image to the right. The length of the brake hoses may also change dependant on how you choose to run the hose. It is recommended that the brake hoses are substituted with more appropriate hoses once hose routing is finalised.



A caution here on the DR221 rotors. As noted above, the rotors are originally intended for 4x4 $\frac{1}{2}$ "PCD Mitsubishi cars (1985-1991 Magnas and 1989-1990 Gallants), and have been redrilled by Hoppers Stoppers to suit the 5x4 $\frac{1}{4}$ "PCD early Holden stud pattern. NCOP Section LG Brakes Section 2.5 Modification of Components indicates that the re-drilling of rotors to suit different stud patterns must not be undertaken unless in accordance with the manufacturers' specifications. Some engineers will take offence here, others will not. It is strongly recommended to check with your engineer prior to embarking on this process.



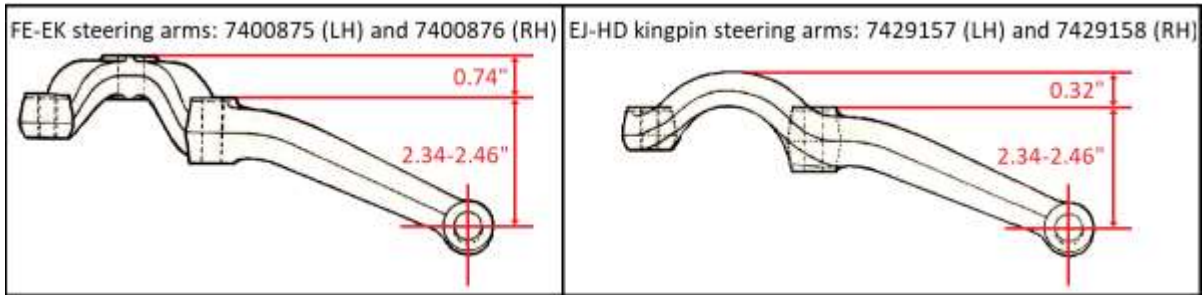
You will also need a pair of EJ-HD Holden kingpin steering arms. Holden steering arms changed over the years, as per the part numbers below:

- FX-FJ steering arms: 7400187 (LH) and 740186 (RH)
- FE-EK steering arms: 7400875 (LH) and 7400876 (RH)
- EJ-HD kingpin steering arms: 7429157 (LH) and 7429158 (RH)
- HD-HR balljoint steering arms: 7423653 (LH) and 7423654 (RH)

The earlier FX-FJ steering arms are very different to the FB/EK design (the king pin bushes are in the upright, and the king pin retaining cotter pin is in the stub axle) and are not an option for this modification. Similarly, the later balljoint steering arms have a very different bolt spacing to the FB/EK design and are also not an option. This leaves just two options: FE-EK steering arms, or EJ-HD steering arms.

The FB-EK steering arms will not work with this modification. The FB/EK brakes are semi-Huck (also known as leading/trailing), which use a pivot point at the bottom of the brake shoe assembly. This pivot point is provided by a bolt, which passes through the bottom of the FB/EK steering arm and brake backing plate. It is this pivot-point area of the steering arm that clashes with the brake rotor. The amount of fouling is too large to be corrected by grinding or spacing.

Luckily, the steering arm design was changed in the EJ Holden due to a change in brake design. The EJ Holden saw a design change to Bendix brakes (also known as dual-servo) instead of semi-Huck. Dual servo brakes do not require the lower pivot point, and hence the EJ-HD Holden steering arms (and brake backing plates) were modified to remove it. The diagram below shows the difference in arms:



The EJ-HD kingpin steering arms will clear the brake rotor. This is however not a perfect fit. The EJ-HD kingpin steering arms still clash with the lower control arms, as shown by the green and purple arrows in the diagram to the right. To get the parts to fit without clashing, the steering arms must be machined down, and some material bent/ground from the control arms. This is captured in the document below. Whilst the control arms are easy to modify, the steering arm machining is a precise process. You will need a machine shop (or a fairly serious home milling setup) to undertake the steering arm machining.



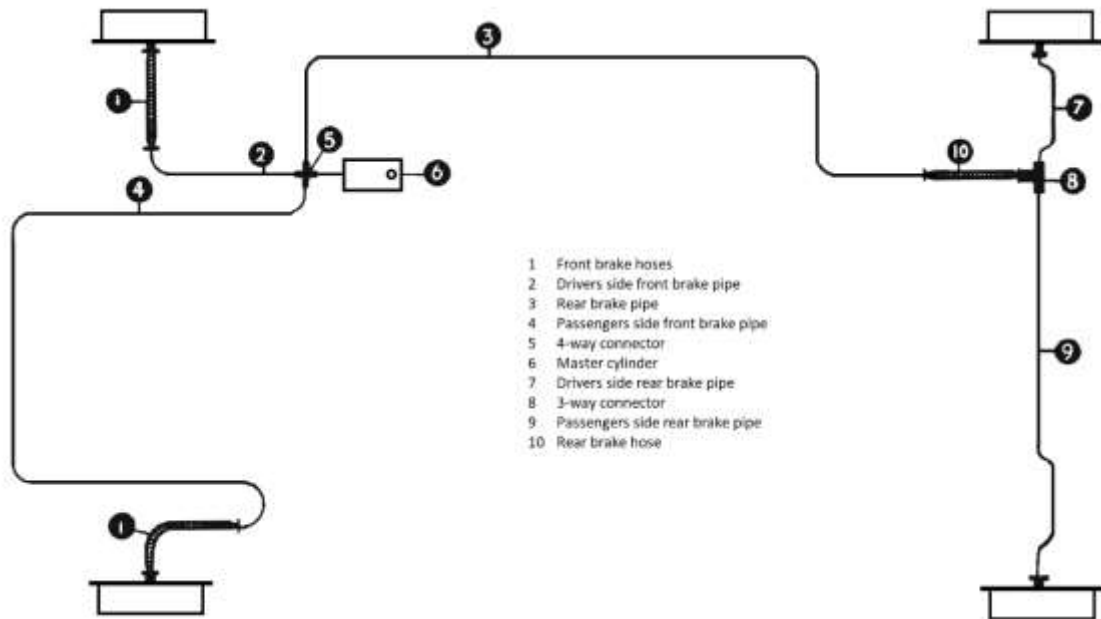
The process below will not allow fitment of the standard FB/EK steel wheels. The standard wheel hoops are stepped... the new disk brake calipers clear the inboard part of the wheel hoop, but will not clear the narrower outboard part. However, 13"x6" or 13"x7" Sampson Magnum wheels will fit as the Magnum wheel hoops are not stepped. The photos to the right shows the Sampson Magnum wheel with a rotor and caliper in place... this realistically is about as big a rotor, and as tight a caliper as you can get into a 13" wheel.



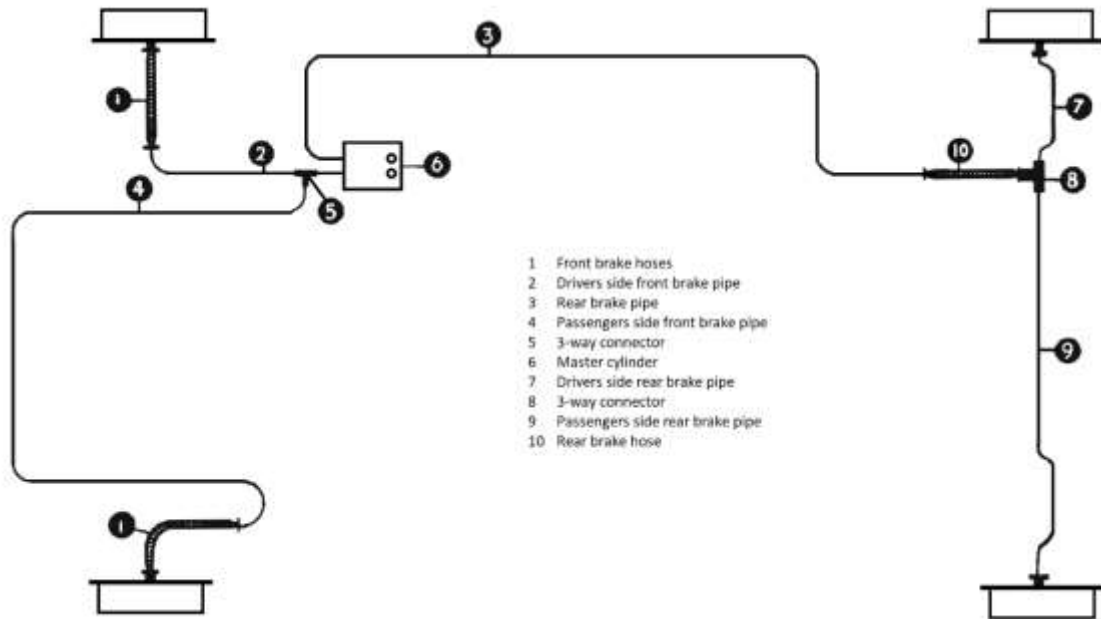
The hubs provided in the kit are fitted with S141 wheel studs. These are 7/16"-20UNF thread as per early Holden. For the Sampson Magnum wheels however the studs are too long, and prevent the mag wheel nuts from seating. The studs can either be trimmed back 1/2", or can be replaced with the shorter S140 studs (you could also use open-ended wheel nuts, but these are just wrong on the mag wheels). To remove the studs, support the hub and place an old wheel nut onto the stud until it is level with the end of the stud. Tap the studs out of the hub with a ballpeen hammer. The new studs will tap back in. This task can also be done more gracefully with a hydraulic press if one is available, as per the photo above right.



The original FB/EK brake master cylinder is a single circuit unit, as shown in the diagram below.



The front and rear brakes are fed pressure by the same line... a leak in the line means that you have neither front nor rear brakes. Most registration authorities require dual-circuit brakes as part of any substantive vehicle modification, as per the diagram below.



This is captured for example under NCOP Section LG Brakes Section 2.1:

When the brake system of an early model vehicle is modified, a dual or split circuit brake system should be fitted. Disc brakes are highly recommended on the front and generally should be power assisted.

, and under NCOP Section LA Engine Section 4 (Mandatory Safety Equipment upgrades for Pre-ADR Vehicles):

The following vehicle safety systems must be upgraded in order to provide for the increase in vehicle performance. These are the minimum standards required, but where any ADR applies, the ADR takes precedence:

- Split or dual braking system

The dual-circuit braking system provides two supplies of fluid – one to the front brakes, and one to the rear. A fluid leak in one circuit allows the other circuit to still function, giving some braking ability. The process below uses a Protex JB1217 master cylinder to achieve dual-circuit brakes. The Protex unit has a 1" bore as per



SCORE	PART No.	REP/ISS/ATT
25.40	JB1217	K7867X

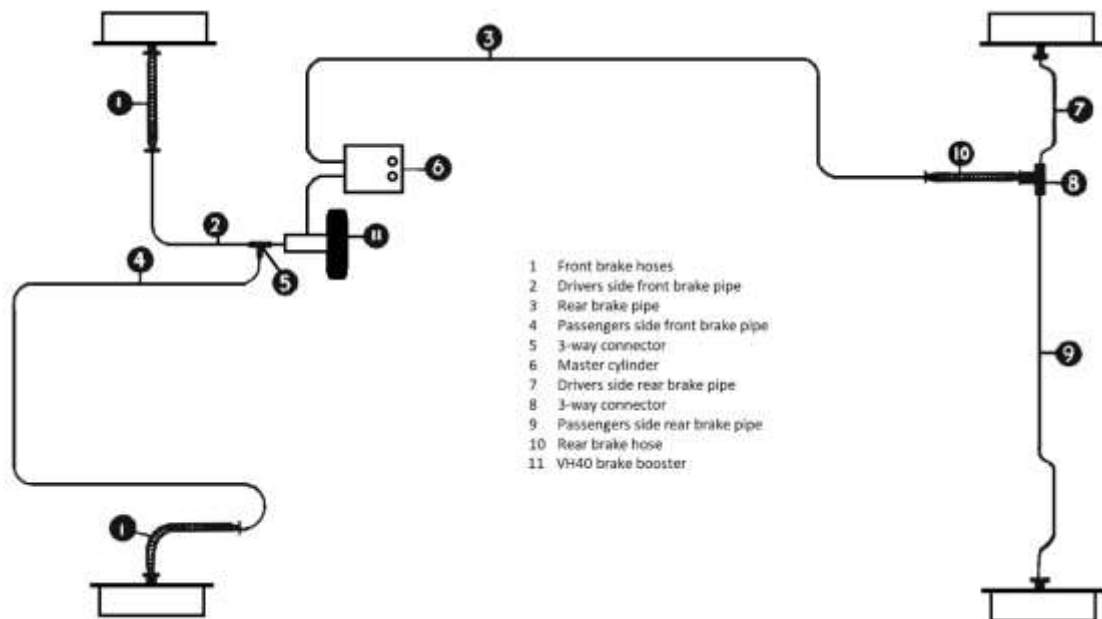
Specifications	31-0009
Bore Size	M32x1.5
Fluid Port	M10x1.5
Rear Port	

the original FB/EK Holden master cylinder, making it compatible with the standard rear drum brakes. The Protex unit is very close to a bolt-up fit, and clears the standard FB/EK bonnet hinges. A warning though that the pipe threads on the Protex unit ports are M10x1.0 inverted flare. Two flare nuts of this size will be required, with care needed to prevent them getting mixed up with the other (imperial) flare nuts used in an early Holden.

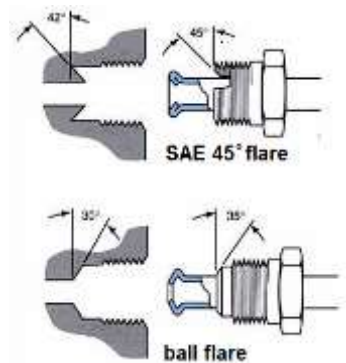
In converting from single-circuit to dual-circuit brakes, some piping changes are required (for example the two front brake pipes, items 2 and 4 in the diagrams above). This is achieved in $\frac{3}{16}$ " tube and associated $\frac{3}{8}$ -24UNF flare nuts. The flare nuts from the old piping can be reused, or new ones purchased. A 3-way connector is required to replace the 4-way connector as shown in the two diagrams above as items number 5, and the image to the right. The three-way connector suits $\frac{3}{16}$ " inverted flares. The rear brake pipe (item 3 in the diagram above) can be replaced in its entirety. However, this is a long run of pipe, and an easier solution is to reuse the old rear brake pipe and use a $\frac{3}{16}$ " inverted flare coupler as per the image to the right to join to a short run of new pipe. These two fittings are readily available from either a brake shop or eBay.



It is possible, though unlikely, that the unboosted disks will meet a brake performance test. It is recommended that a brake booster be used, which is aligned to the NCOP guidance above. A PBR VH40 booster is suitable for use, and will need to be purchased separately. The VH40 booster can be remotely mounted. The remote mounting removes the hassle associated with getting a mastervac booster to fit onto the firewall without fouling the FB/EK Holden driver's side bonnet spring. The VH40 is plumbed in to boost the front brakes only, as per the diagram below.



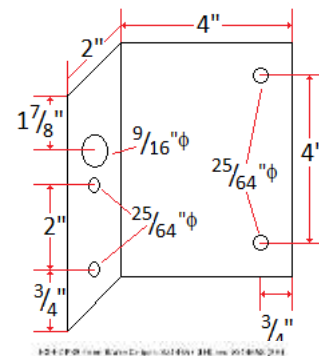
The VH40 booster takes $\frac{3}{8}$ -24 UNF "long" flare nuts to suit $\frac{3}{16}$ " brake tube. Two flare nuts of this size will be required, with care needed to prevent them getting mixed up with the other (metric) flare nuts used on the new master cylinder. Note however that the VH40 booster is not machined as an inverted flare (i.e. a standard SAE 45° double flare is not suitable). Instead, a ball flare needs to be made on the end of the flare nuts. The ball flare is the first part of the SAE 45° double flare (i.e. use the die to flare the $\frac{3}{16}$ " tube end, but stop after the first step... do not use the cone to push the tube into a double flare). Sometimes adaptors are fitted to the VH40 booster ports so that a normal SAE 45° double flare can be used. Check your VH40 booster carefully to see what end fitting you have, as per the image to the right. If the port has a little pyramid/cone in it, it's the SAE 45° double flare. If it just looks like it has been made with a drill, then it is a ball flare.



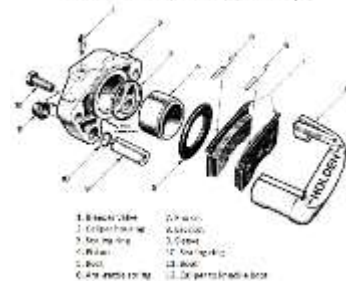
Some vacuum hose will be required to plumb the booster back to manifold vacuum. The length required will depend on how you route the hose around the engine bay, though around three metres of $15/32$ " vacuum hose should do the trick. The tapping on the passenger's side of the FB/EK Holden inlet manifold is suitable for this vacuum connection. As the VH40 booster operates, it will draw in air. The VH40 assembly has a small air filter to prevent dirt getting into the booster. This is suitable when the booster is located under the bonnet of the car. For this document however the booster will be located under the front mudguard. This environment is a lot dustier, and the factory filter will block quickly. To remedy this, the booster snap ring is taken off (item 1 in the image above right), and the cover plate (item 2) removed. The remote filter plate (item 3) and snapping are refitted. Some vacuum hose is then run to the remote filter (item 4) located in a cleaner position in the engine bay. The remote filter plates are available from Resleeve Engineering (Peter Brown, 0407847167, resleeveengineering@gmail.com), or can be made up from a small piece of plate and an elbow (welded or brazed together). A crankcase/rocker cover breather (like the K&N Crankcase Vent Filter KN 62-1600RD shown to the right) is suitable for the end of the hose. Around 1.5 metres of $1/2$ " vacuum hose is suitable to plumb the remote breather.



A simple metal bracket will be required to mount the VH40 booster under the guard, as per the diagram to the right above. Two $5/16$ -UNF $\times 3/4$ " bolts, washers and spring washers will be required for the bracket. Note that the VH40 booster bonnet mounting studs may not be in the correct orientation when purchased. This can be corrected by partial disassembly of the booster, turning the bonnet and reassembly.



The kit uses the HX-HZ PRB alloy calipers. These are similar to the LX Torana calipers. The HX-HZ units will retract to allow a 1.1" thick rotor - the 0.95" thick Mitsubishi rotors supplied in the kit are a good fit. The Torana calipers however, when fitted with new Bendix pads, will only retract 0.7", and hence cannot be used with this rotor. It would be possible to use the Torana calipers by fitting slimmer or worn pads. Approximately $1/8$ " would need to be removed from each Bendix pad... this is 60% of the usable pad thickness (i.e. LX Torana calipers can be used, but will require the brake pads to be machined to only 40% of their starting thickness).



One subtle problem with the HX-HZ brake calipers is that the hose location (near the centre of the caliper) is troublesome. Even if the fittings are swapped to angled ones, the hose location makes the brakes hoses want to run through the front suspension coil springs. This is not a good thing. To allow the calipers hoses to be routed safely, the hose and bleeder locations on the calipers will be swapped. Luckily the threads are the same ($3/8$ -24UNF). However, the old hose location (now the bleeder hole) does not have a seat cut into it (deep down the hole) to fit a bleed screw. Machining a seat (without stuffing up the thread) would not be easy. To solve this, the bleed screw (in the old hose location) is replaced with a port plug. The Earls 581403 -3AN port plug is suitable once the rubber o-ring on the port plug with a copper brake washer, which will need to be purchased separately. The port plug is cross-drilled so that it can be bled without fully removing the plug, just like a brake bleeder. Note that this is using a fuel fitting in brake service – check with your engineer that they are comfortable doing this (though note that the Earls threads are far stronger than the original HX-HZ Holden brake caliper threads).



The caliper hoses will require caliper hose clamps to be fabricated from some steel, ready to fix to the subframe. Aeroflow make a clamp (AF230-01) though care needs to be taken that this matches the brake hose fittings you choose. The Aeroflow clamp is made to be bolted or screwed in place, though welding to the subframe is likely to be required. A pair of brake hose springs and clips (Rare Spares brake hose springs and clips, EH-HG, LC, LJ (front), part number BP1004) are likely to be required to prevent the hoses rubbing on the wheels or other components.



Installation

1. Remove the brake fluid reservoir lid, place some plastic (e.g. a ziplock bag) over the bottle then retighten the lid. This closes off the vent hole. As the brake fluid tries to drain, it will pull a vacuum against the plastic and get hung up in the piping. This minimises the amount of mess that is made once the brake lines are disconnected. Another helpful tool is to cut the end off an old brake hose and block the end with a bolt/tek screw. The tool then acts as a blank on the end of the disconnected line.



2. Jack the front of the car up and put it on stands.
3. Disconnect the front brake line hoses at the subframe by undoing the tube flare nut, pulling back the tube then removing the retaining clip. Block the steel pipe ends off if you are able to using the tool shown in step 1.



4. Remove the front wheels and prise off the hub grease caps. Remove the split pins, spindle nuts and spindle washers. Discard the old split pins and give the caps, nuts and washers a clean-up in fuel or kero.



5. Remove the front brake drums. It may be necessary to back off the brake adjustment (using the adjusters through the brake backing plate) if the brake shoes are holding the drum on.

6. Remove and discard the front wheel hubs, inner and outer bearings and grease seals. Wipe the grease off the steering knuckle spindles with a piece of rag to save spreading it everywhere.



7. Remove and discard the $\frac{3}{4}$ " AF nut from the back of the brake shoe's lower pivot point, then remove and discard the four $\frac{9}{16}$ " AF bolts which hold the brake backing plate to the steering knuckle.



8. Remove and discard the brake backing plate, brake shoe and brake slave cylinder as a single unit. Put a bowl or icecream container under the steering knuckle with some kero or fuel in it and give the steering knuckle and kingpin a clean-up.



9. Remove and discard the split pins from the tie-rod ends, then remove the $\frac{3}{4}$ " AF castellated nuts. Reinstall the nuts upside down until it is just flush with the top of the tie-rod end thread. Support the



steering arms as close as possible to the tie-rod end. This can be done with an 11" length of wood, though the wood normally has too much "give" to allow the tie-rod end taper to be broken. A bottle jack makes a better, firmer support. With the support in place, tap the top of the castellated nuts with a ballpein hammer to break the tapered joints. Two or three sharp taps should break the taper and allow the threaded end of the tie-rod ends to come out of the steering arms. Remove and discard the FB/EK steering arms.

10. The four backing plate holes on each spindle are $\frac{3}{8}$ " diameter (to allow the $\frac{9}{16}$ " AF bolts you just removed to pass through). Drill the four bolt holes out on each side of the car (total of eight holes) with a $\frac{25}{64}$ " drill bit, then tap the eight holes with a $\frac{7}{16}$ -20UNF tap.



11. Drill the steering arm bosses out to $\frac{29}{64}$ " to allow the $\frac{7}{16}$ -20UNF bolts to pass through them. Mill the two mounting bosses evenly until the shorter boss has only 1mm of boss left. The part that is being machined is circled in purple in the image to the right. CAUTION: do not fully remove the bosses, or countersink the arms. This will leave an edge that will act as a stress raiser and may cause the steering arms to fail. Limit the machining such that the 1mm of boss depth remains. This is not a task for the home mechanic – the tolerance for flatness between the two bosses is 0.010"... too fine to manage with a grinder or file.



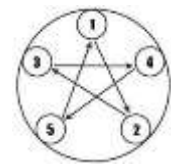
12. Mount the kingpin caliper brackets to the backing plates, along with the steering arms. The brackets go towards the front (bonnet side) of the rotor, as per the image to the right. The brackets cannot be used at the rear (boot side) of the rotor as the lower caliper mounting bolt will foul the steering arm. The thick spacer (0.984"OD x $\frac{5}{16}$ " thick) goes between the steering arm and steering knuckle. Use two $\frac{7}{16}$ -20UNF x $\frac{3}{4}$ " bolts in the top two holes, with spider washers. One of these has the head machined down $\frac{3}{16}$ " thickness... it does not matter if this is used for the front or rear bolt. Use a $1\frac{1}{2}$ " bolt and spider washer in the front lower hole, and a 2" bolt and spider washer in the rear lower hole. The four bolt ends should just protrude outwards from the steering knuckle by a few threads. Tighten all four bolts to 35ftlb (dry threads). Notice in the photo to the right above that the bottom left bolt does not protrude enough... this is what happens if you don't replace the two $1\frac{3}{4}$ " bolts that come in the kit with longer 2" bolts.



13. With the brackets in place, move the steering knuckle forwards and backwards, noting how the steering arm hits the corner of the lower control arm. Mark the contact point with paint, move the steering away and then use a grinder to gently remove the corner of the control arms. Remove only enough from the control arms to provide adequate clearance, blending in the ground area.



14. Mount the rotors onto the new front wheel hubs using the ten ½"-20UNFx2" countersunk bolts, nuts and washers (five per rotor). Tighten the bolts up by tightening every second bolt, moving around the hub as per the diagram to the right. Work up from finger tight to 85ftlb in a couple of steps (say 0, 20, 50, 85 ftlb). 85ftlb is suitable for the dry phosphate-to-steel... as supplied – reduce this to 76ftlb if the nuts/bolts have been lubricated. Tightening the bolts can be difficult without a helper – try holding the allen key in a vice with the rotor supported on some timber.



15. Pack the inner and outer bearings with wheel bearing grease, and grease up the grease seal. Install the grease seal, inner bearing, rotor/hub assembly, outer bearing, washer and castellated nut. Use your hand to spin the rotor/hub assembly backwards and forwards whilst slowly tightening the castellated nut. Stop tightening when there is just a noticeable change in the feel of the rotor/hub spinning. This seats the new seal and bearings properly. Back off the castellated nut slowly, pushing/pulling the rotor/hub assembly inwards and outwards. Stop loosening when you can just feel the rotor/hub developing end-play. Slowly tighten the nut again until the end play just disappears. Now the bearings have correct clearance. Fit a new split pin into the castellated nut. If the pin cannot be inserted (because the steering knuckle spindle hole does not line up with the castellated nut), loosen the castellated nut just enough to line up the next hole. Fit the grease cap.
16. This is where the project starts to look like a real car. Spend at least two minutes turning the rotors around and grinning.



17. Fit pads, anti-rattle shims and anti-rattle springs to the brake calipers. Install the port plug and copper washer into the old brake hose hole on each caliper while the calipers are still on the bench. Note that the photo to the right shows the rubber washer on the port plug – make sure the rubber washer is replaced with a copper brake washer. Plug off the brake hose holes (the old bleeder holes) or cover them with masking tape. This will stop dirt or grinding dust getting into the calipers. Leave the brake hoses off for now to avoid damaging them with the grinder.



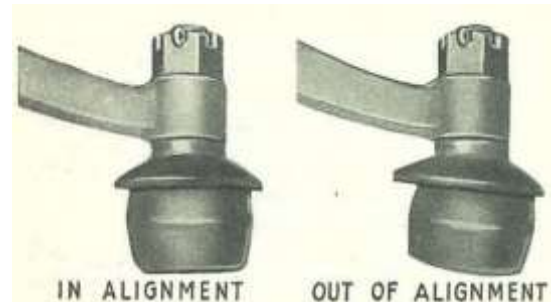
18. Using the $\frac{7}{16}$ "-20UNFx3" bolts, nuts and spring washers, mount the calipers to the caliper brackets. In most cars, you need to take care not to mix up the left and right side caliper (the bleed screw should be uppermost). As we cannot bleed these in place it is not as important here. Having said that, putting them on the correct side might lower the number of times someone tells you are doing it all wrong, and that they are on the wrong side. Tighten all four bolts to 35ftlb (dry threads).



19. With the calipers in place, move the steering knuckle forwards and backwards, noting how the calipers hit the lower control arm. Mark the contact point with paint (as per the yellow marks in the photos to the right) then use a hammer to bend the lower control arm upper leading surface. A grinder will again be required to remove some material from the corner of the lower control arm. Bend or grind only enough to provide adequate clearance, blending in the bent or ground areas.



20. Connect the steering arms to the tie-rod end and fit new split pins. Ensure that the tie rod ends are in alignment with their ball studs (Fig. 3-19) and that the tie rod balls are central in the retainer slots of the steering arms.



21. Fit the hoses to the calipers. Fit the new caliper hose clamps to the hoses temporarily using the c-clips. Fit the brake line springs to the hoses. Route the hoses to the subframe, and mount the caliper hoses clamps in place temporarily using a builders G-clamp. Move the steering knuckle forwards and backwards, noting how the hose moves. Move the caliper hose



clamps and brake line springs around until the hose is free to travel without getting caught on anything. Mark the position of the caliper hose clamps and brake line springs, then remove the builders G-clamp. Drill a small hole to mount the end of the brake line springs, and weld the caliper hose clamps in place.

22. Final fit the brake hoses with c-clips and mount the brake line springs.



23. Hold the VH40 bracket under the driver's side inner guard, using the existing $\frac{9}{16}$ " diameter hole in the guard to locate it. Mark, centre punch and drill the two $\frac{25}{64}$ " holes in the inner guard then use the two $\frac{5}{16}$ -UNFx $\frac{3}{4}$ " bolts, washers and spring washers to mount the bracket VH40 bracket. Note that the bracket shown in the photo has an extra hole drilled in it (above the wiring) compared to the dimensioned drawing above. This was an error on my part... that hole is too high, and interferes with the bonnet drip rail.



24. Remove the circlip in the front of the VH40 booster, and remove the cover plate. Install the remote breather onto the VH40 booster. It will pivot around freely, allowing you to line it up later with the direction you want the hose to run.



25. Cap off the VH40 booster brake fluid, vacuum and breather ports to stop dirt raining down from under the guards and getting into the booster. I've used some fancy plugs in the photo, but some masking tape will do equally well. Mount the VH40 booster onto the bracket using the two booster bonnet studs.



26. Connect the vacuum hose between the engine manifold and the VH40 booster, using hose clamps to secure it. This may require drilling another hole in the inner guard depending on how the hose is routed.



27. Connect the remote breather hose to the VH40 booster, using a hose clamp to secure it. Route the hose into a clean location in the engine bay. This may require drilling another hole in the inner guard depending on how the hose is routed. Fit the filter to the end of the hose and secure it in place.
28. Remove and discard the brass joiner block (4-way connector) under the driver's side subframe. Bend and plumb a new $\frac{3}{16}$ " brake line from the booster outlet to where the brass joiner block used to be. This may require drilling another hole in the inner guard depending on how you choose to route the brake line. Note that this new booster outlet line will have a $\frac{3}{8}$ -24 UNF "long" flare nut with a ball flare on the booster end and a standard $\frac{3}{8}$ -24 UNF flare nut and SAE 45° double flare on the other end.

29. Use a $\frac{3}{16}$ " SAE 45° double flare brass coupler to join the old brake line (from the rear of the car) to the new booster outlet line.



30. Remove and discard the $\frac{3}{16}$ " brake line from where the brass joiner block used to be through to the old brake drum hose clamps. The drivers side is short, but passengers side runs under the radiator... it will come out with patience, or with sidecutters if you are not so patient. The old brake drum hose clamps can be left in place on the subframe, or can be carefully ground off for neatness.
31. Bend and plumb new $\frac{3}{16}$ " brake lines from the caliper hose ends through to where the brass joiner block (4-way connector) used to be. Note that these two new lines will have a standard $\frac{3}{8}$ -24 UNF flare nut and SAE 45° double flare on either end.
32. Connect the two new front brake lines together using a three-way SAE 45° double flare connector. Leave the third hole on the connector empty for the time being until the master cylinder is in place (cover it up with some masking tape to stop dirt getting in).

33. Remove and discard the two old $\frac{3}{16}$ " brake lines from the old brake master cylinder. Some duct tape over the ends of the lines can prevent brake fluid slopping everywhere. Undo the two $\frac{9}{16}$ " AF bolts from the front of the old master cylinder and remove and discard the cylinder.



34. From inside the car undo the brake pushrod locknut and fully unscrew the pushrod. Chances are the threads are mangled with dust and crap and will need some WD40 (and perhaps a pair of multigrips) to get the pushrod out.



35. Shorten the pushrod by grinding or filing approximately 0.4" from the round end. Round the end of the pushrod to a spherical shape. 0.4" is a good starting point, but you will probably need a little more depending on how your dash and pedal assembly has moved over the years. While the pushrod is out of the car, clean and lubricate the threads... you will be thankful soon 😊

36. Expand the existing master cylinder hole in the firewall to suit the diameter of the new Protex booster. This can be done with a file or diegrinder. It can also be done with a holesaw, though there is no centre location to locate the holesaw pilot drill. This can be overcome by using a scrap of steel mounted between the master cylinder bolt holes as a bridge. The bridge is mounted from behind (inside the dash), and has a pilot hole drilled in the middle. The holesaw can then be used from under the bonnet to cut the firewall. Note that the photo to the right shows this bridge made from wood... steel is a better choice, as the wood flogs out quickly due to the force on the holesaw.



37. Bench-bleed the new master cylinder.

38. Refit the pushrod and locking nut. Bolt up new master cylinder using the two $\frac{9}{16}$ " AF bolts from the old master cylinder. You may need a helper to hold the pushrod up in place as the master cylinder is put in. Adjust the pushrod so that there is $\frac{1}{8}$ " of brake pedal free travel (and admiring how



easy it is to adjust the pushrod when it has clean threads like it did in 1960). Tighten the locknut. Note that if you cannot get $\frac{1}{8}$ " of brake pedal free travel you may need to grind a little more off the pushrod. Go slowly... it's easy to grind off a little more, but a lot harder to add extra later.

39. Bend and plumb two new $\frac{3}{16}$ " brake lines from the master cylinder outlets to the VH40 booster inlet and the front brake three-way SAE 45° double flare connector. Note that these two new lines will have a standard $\frac{3}{8}$ -24 UNF flare nut and SAE 45° double flare on one end and an M10x1.0 flare nut and SAE 45° double flare on the other end. Be careful not to mix up the two types of flare nuts when fitting them to the tube... they look similar, and it breaks your heart to have to cut them off and rebend the line when you mix them up.



40. Remove the plastic sheet from the brake fluid reservoir and bleed the rear brake drums.

41. The front brake calipers are a little harder to bleed as the bleeder (now a port plug instead of a bleed nipple) is no longer at the high point. Undo the two $\frac{7}{16}$ "-20UNFx3" bolts and remove a caliper from the rotor. Place a block of wood between the pads, ensuring it is a moderately firm fit. Turn the caliper and hold it up so that the port plug is at the highest point. Bleed the caliper whilst it is held in this location. Remove the block of wood and reinstall the caliper, checking that the brake hose spring was not dislodged. Repeat for the other caliper.



42. Given the changes in steering arms, it is recommended that a wheel alignment is carried out.