



Jaguar Independent Rear Suspension Installation Guide

Introduction:

This info-sheet has been developed to provide vehicle modifiers with the necessary information and geometrical principles critical to the correct and safe installation of the Jaguar independent rear suspension system (IRS).

Over the years a large number of Jaguar independent rear suspension units have been installed into hot rods, AC Cobra replicas and various other hobby vehicles. Clearly, there has been confusion over some aspects of Jaguar IRS installation, which has been highlighted during the retrospective certification process. With a fairly wide variation in people's perception of the correct installation method, and with a lot of knowledge built up over time, LVVTA has set out to compile all of the relevant information on this subject in one place.

It should be pointed out at an early stage that there are many potential problems and pitfalls associated with this installation, and it is not recommended for novice, or inexperienced builders.

Jaguar IRS information:

The Jaguar IRS is a suspension system made up of precision-engineered components, which can from the factory, be shimmed to adjust toe and camber. The lower control arms are mounted directly to the differential head, while the half-shafts also perform the function of upper control arms.

In its original configuration, the Jaguar IRS was housed within a pressed steel cage, which was then mounted via v-shaped rubber mounts, to the vehicle's chassis. This OEM pressed steel cage method of attachment, due to the mounting locations being spread further apart, creates much lower stresses on the diff head attachment than when mounted without the cage.

This cage system however, is aesthetically unappealing, and most choose to discard the carrier assembly in favour of a custom mounting system. The removal of this cage assembly requires additional support for the diff head, to reinstate the rigidity required for reliable operation.

There are four widths of Jaguar IRS available - some models are much harder to find than others, and it is often necessary to narrow one of the more readily available wider units. There are also different coil/shock arrangements available, a range of alternative gear ratios, some have the optional limited slip differential (LSD) fitted, and there are various different brake options available. A lot of these parts will interchange between different units, so with some shrewd part-hunting, an ideal setup can be found.

XJ40 and later model Jaguar rear ends are **not** covered in this information sheet – see page 6 for more details.

Available widths measured from wheel flange to wheel flange:

The four widths of Jaguar IRS available are as follows:

- XJ6/XJ12 1549.4mm/61 inches
- E-Type 1320.8mm/52 inches
- Mk10 & 420G 1536.7mm/60.5 inches
- S-Type & 420 1397mm/55 inches

Geometry principles associated with Jaguar IRS installations:

- The differential head must be attached to the chassis with sufficient strength to resist all torque, cornering, and braking forces applied.
- The differential head forms the mounting platform for the entire rear suspension system, and must therefore be accurately positioned within the vehicle structure to provide stable and precise suspension geometry.
- The front of the differential, via the lower arm front pivot brace-plate, must be fixed to the chassis with a pair of strut-brace rods, or directly to a chassis cross-member, to provide a brace or support for the top mounting flange, and to resist the natural tendency of the diff to 'wind up'.
- Both the front and rear of the differential require suitably strong brace-plates, spanning between each of the lower arm pivots to resist the bending loads created by suspension and braking system loads.
- Radius rods, or some form of lateral location must be utilised to support the lower suspension arms. Without these the rear wheels will 'walk' under load and deceleration, due to the diff head 'racking' or 'twisting', and can overload the suspension arms, and inner suspension arm mountings.
- Radius rods must be positioned correctly to eliminate suspension bind and failure due to the two different arcs of the lower arm and radius rod pivots.
- Radius rods may utilise rubber, urethane or spherical rod-ends, to ensure sufficient 'compliance' and to prevent suspension bind.
- The mounting accuracy of the differential head itself sets the 'base line' for the rear wheel alignment geometry. This means that a small miscalculation when mounting the diff head can lead to a much more significant misalignment of the rear suspension, which then needs to be brought back into spec by shimming. The shimming of the lower control arms is a time-consuming process, requiring the removal of the 'dog-bone' lower control arm mount.

Jaguar IRS Installation:

General mounting requirements:

Whether solid or flexible-mounted, the differential head must be installed using the original top mounting flange, and must have as a minimum either one diagonal strut-brace rod per side, or a cross-member from the lower suspension arm inner pivot mounts to the chassis (see diagram 1). This is required to prevent the differential head torque overloading the top flange fasteners, and to provide the necessary support to counter the natural tendency of the rear end to 'wind up'.

There should also be sufficient structural support within the cross-member, chassis or sub-frame to support these loads.

The following should also be considered, and applied where possible:

- the top mounting flange should be made from a minimum of 6 mm mild steel plate; and
- the attachment should replicate the tapered seat arrangement utilised by the OE fasteners. This gives both positive location, and excellent clamping performance and reliability, much like that of a tapered-seat wheel nut. Utilising the OE Jaguar fasteners also provides the advantage of having lock-wire holes incorporated in the bolt-heads allowing them to be easily lock-wired together. Lock-wiring of these fasteners is essential; and
- if OE fasteners are not used, as a minimum, suitable studs should be secured with vibration-proof locking devices such as 'nyloc' nuts, spring washers, split-pins, or lock-wire. This is important when you consider the high loads transmitted through this area and also due to the fact that these bolts are often extremely hard to access once the vehicle body is in place; and
- fasteners should always be torqued to either the OE Jaguar or the specific fastener specifications.

Solid Mounting:

Solid mounting of a Jaguar IRS is extremely common, and provides a positive attachment platform for the rear suspension, lending itself to high-performance vehicles which require excellent handling characteristics. The drawback however, is that there tends to be higher levels of road and mechanical noise and vibration transmitted through the driveline and into the vehicle chassis. This can be offset to a degree, through the rubber mounting of the vehicle's body to its chassis.

Where solid mounting is utilised for the mounting of the top flange, a solid mounting system should also be utilised for the strut-bar rods or cross-member.

Flexible Mounting:

The differential head can be flexible-mounted, however as the diff head itself forms the mounting platform for the rear control arms, this method requires some careful planning and design, as all of the vehicle's acceleration, braking, and cornering loads will pass through these flexible mountings, which must in turn maintain the correct rear end suspension geometry. This is particularly important due to the high leverage loads applied by the control arms.

There are a variety of methods for flexible mounting; however whichever method is chosen, it is very important to ensure the strut bar rods, or support cross-member is mounted correctly to spread or share these torque loadings, thus preventing overloading of any of the individual flexible mountings.

The following should also be considered, and applied where possible:

- Where flexible mountings are utilised for the top mounting flange, flexible mounts should also be used for the strut bar rods or support cross-member.
- Urethane type bushes are recommended for the mounting of the differential, as these bushes provide less compliance or 'flex' compared to rubber bushes.

Diagram 1 on page 4 illustrates an example of strut bar rods supporting the front of the differential housing to the chassis; however an additional cross-member supporting the front of the differential housing can be used as an alternative to this method.

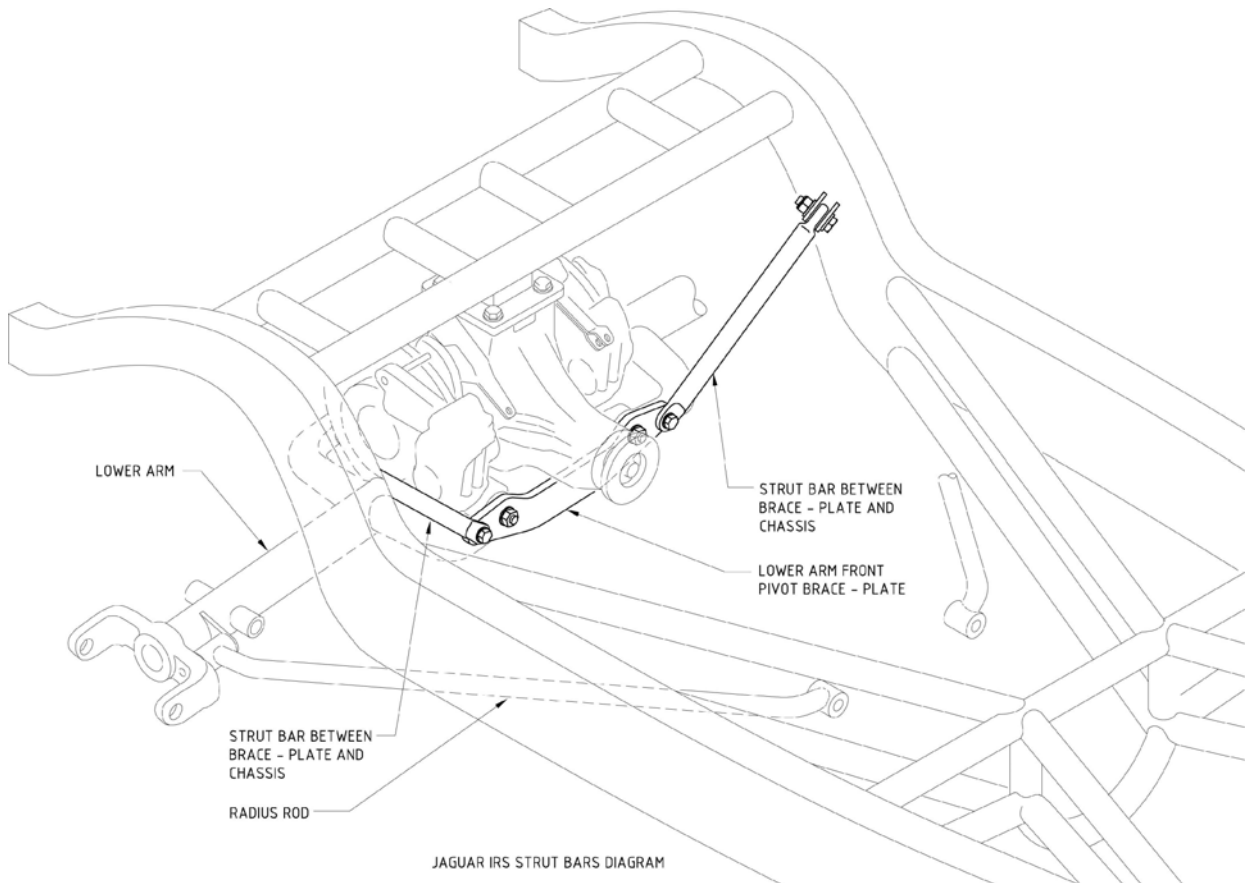


Diagram 1: Differential housing support

Radius Rods:

Radius rods must be fitted, to provide fore and aft support for the lower suspension arms, and to reduce loads on the top mounting flange. The only geometrically correct method of installation is for the forward end of the lower radius rods to intersect through an imaginary line continuing from the inner pivot, as illustrated in diagram 2.

It is possible to vary from this method, however a suitable bush is required to provide compliance, thus preventing suspension bind.

The following points should be taken into consideration:

- Compliant rubber bushes or spherical rod-ends should be used to prevent both binding and premature bush wear.
- Spherical rod ends must not be used on both ends of the radius rod unless ideal geometry as illustrated in *diagram 2* has been achieved.
- The recommended minimum outside diameter for radius rod tubing in a lightweight vehicle is $\frac{7}{8}$ " schedule 80 tube or equivalent, however a heavier or high-powered vehicle requires 1" or greater.
- Urethane type bushes are generally unsuitable in this location, as they have insufficient compliance, and can lead to bracket and control arm overloading, fatigue, and failure. However, they can be utilised where only a small amount of bush compliance is needed.

- Radius rods should be as long as possible; however the overall length of the radius rod isn't critical. As a rule, the shorter the radius rod, the more bush compliance will be needed in the front locating bushing or rod end.
- When fitted by Jaguar, these radius rods are in fact both short and parallel, however the bush which were fitted by Jaguar are very large, soft, compliant bushes, which are designed especially for the handling characteristics of this vehicle type, and due to the mounting of the complete IRS within a rubber mounted cage. If using a copy of the Jaguar setup, OE Jaguar style bushings may be utilised.

A thorough check of the IRS installation should be carried out before fully welding, including:

- removal of the coil/shocks; and
- a full suspension swing check with lower control arms and radius rods connected to ensure free movement throughout the suspension's travel range without suspension bind.

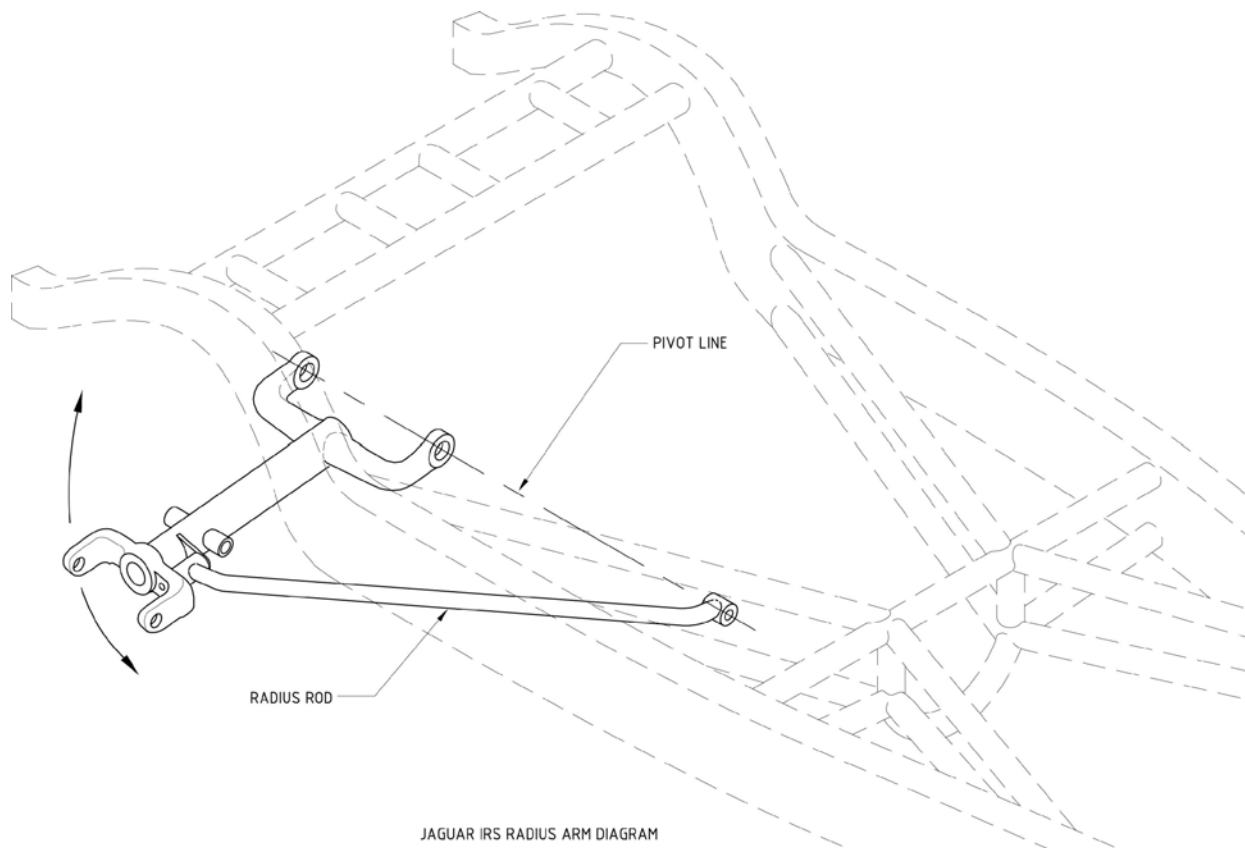


Diagram 2: Radius rod geometry

Diagram 2 illustrates the ideal geometrical setup for the radius rod where the forward end of the lower radius rods intersects through an imaginary line continuing from the inner pivot.

Any variation from this method should utilise a compliant bush to prevent suspension binding.

Watts Linkage:

A watts linkage may be utilised as an alternative to a radius rod. The watts linkage setup is preferable in that it virtually eliminates suspension bind when installed correctly, and provides good half-shaft clearance. A full suspension swing check with lower control arms and watts linkage connected is required to ensure free movement throughout the suspension's travel range.

For details relating to watts linkage assemblies, refer to chapter 6 of the NZ Hobby Car Technical Manual 6.39 'Watts linkage rods in front and rear suspensions'.

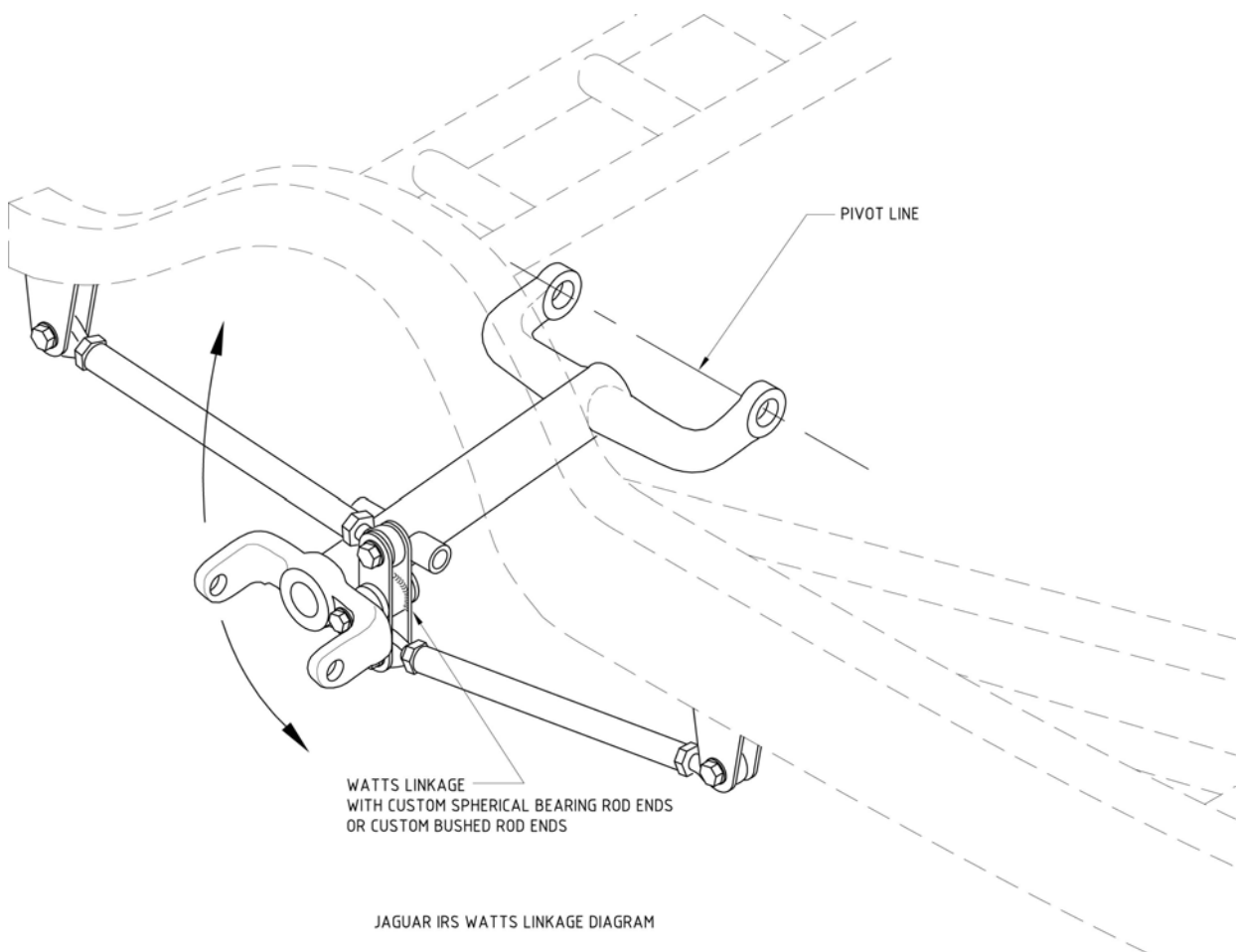


Diagram 3: Watts linkage geometry

Diagram 3 shows an example of a watts linkage setup. Note that due to chassis mounting limitations it may not be possible to achieve parallel mounting of the arms; - these should be mounted as close to parallel as is possible.

Lower suspension arms and half-shafts:

Due to the high level of skill and expertise involved in the modification of the lower control arms and half-shafts, and the high loading these critical components are subjected to under normal use,

modification of these components should only be carried out by persons who are professionally engaged in the modification of half-shafts, and in particular Jaguar independent rear suspension systems.

As a general rule, the half-shaft is cut and machined to accept a press-fit tube of 2 $\frac{3}{8}$ " diameter $\frac{5}{16}$ " wall thickness tubing. The tubing is chamfered at both ends and TIG welded directly to the back face of the UJ knuckles. The tube size is very important, as this forms the top suspension arm, and torsional twist can be huge.

Both the lower suspension arms and half-shafts are considered to be critical function components, and therefore any welding carried out must be done in accordance with the requirements specified in chapter 18 of the NZ Hobby Car Technical Manual 18.9 'Critical function welding requirements'.

Lower suspension arm inner pivots (dog-bones):

The lower suspension arm inner pivots, know as 'dog-bones' are mounted to the differential housing with two through-bolts on each side. These bolts are required to withstand the vehicle's cornering and braking loads, and there have been numerous instances of these bolts coming loose. The poor design of these bolts with short or low-profile heads for limited clearances makes it critical to torque them up properly, as once that control arm is bolted in place, these bolts are inaccessible and impossible to get to without lower suspension arm removal.

The following points should be taken into consideration:

- The dog-bone fasteners must be OE or better specification, be torqued up to OE specifications, and must be lock-wired in place to prevent fretting, fastener damage, and unpredictable alignment geometry changes whilst the vehicle is in motion.
- Urethane style automotive bushings must not be used in place of the OE needle roller bearings on the lower control arms, as the extreme loads applied under normal road use will cause unacceptable deformation, and may destroy urethane bushings.

Wheel bearings:

Wheel bearings are not pre-loaded, therefore it is important that bearings are correctly adjusted to prevent damage to the hub. Adjustment is accomplished using shims of various sizes, to achieve an end-float of .002" to .006" (.0508mm to .1524mm).

Camber:

Shims located between the drive-flange and half-shaft, and dog-bone and differential housing are used to achieve correct camber settings of $\frac{3}{4}$ deg negative, plus or minus $\frac{1}{4}$ deg.

Shock absorbers and springs:

Although these factors are largely dependant upon the available space in the vehicle to which the IRS is being installed, the upper mounting points should as closely as possible match the dimensions from the donor vehicle. If this is unachievable, the basic rule-of-thumb is that there should be a minimum distance of 21 inches (533mm) between the top spring mounts.

Inspection:

When carrying out an inspection of a Jaguar IRS installation which utilises radius rods, an LVV Certifier must remove the springs/shocks, and inspect as per the guidelines set out in Infosheet 05-2011 'Rear Suspension Radius Rod Geometry'.

XJ40 and later model Jaguar rear ends not covered in this information sheet:

Later model Jaguars (XJ40 etc) differ from the assemblies dealt with in this information sheet. The main differences are the deletion of radius rods, single shock assembly on each side, and out-board disc brakes. The diff head is also different in appearance, and utilises a pressed/cast bottom arm. The hubs also differ, being equipped with an internal hand brake. Installation for this type of IRS end should replicate the OE installation methods as closely as possible.

Application of this information sheet:

This Information Sheet takes effect as at the date of release (December 2011) for the purposes of LVV certification. LVV Certifiers should note that the principles mandated by this Information Sheet do not have to be applied to vehicles built or modified prior to the effect date, subject to the LVV Certifier being satisfied that the vehicle is safe.

If you have any queries or require any further clarification relating to this Information Sheet, please feel free to contact the Tech Team at the LVVTA office on (04) 238 4343.

Justin Hansen

Technical Team - Mechanical

Low Volume Vehicle Technical Association Inc.