2002 Volvo V70 X/C

- Replacing the following
  - Struts
    - Strut mounts
    - Spring seats
    - Bump stops and gaiters
  - Control Arms
  - Ball Joints
  - Axle assemblies
  - Sway bar end links

Please note: The torque specifications given here aren't necessarily correct. I did my best to track down correct values on forums and Volvo documents, but sometimes I substituted values for other years or non-AWD wagons if I couldn't find the right one.j

Step 1: Lift and secure the car

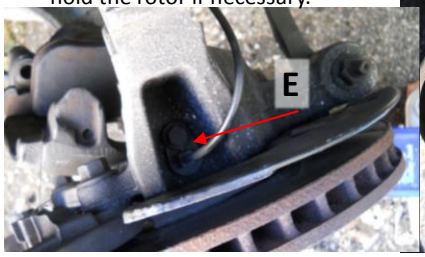
Use a jack under the reinforced jacking points here. Chock those back wheels!

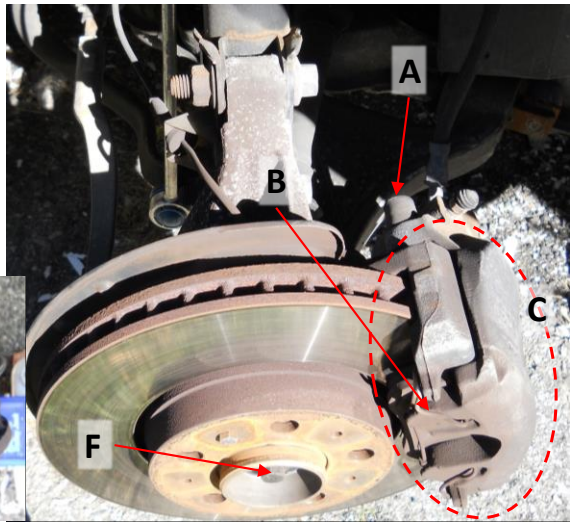
Place jack-stands here, as shown in Volvo owners manual

Remove front wheels. I placed them under the car as a safety measure while working under the engine.

Step 2: Remove axle bolt, brake calipers, ABS sensor

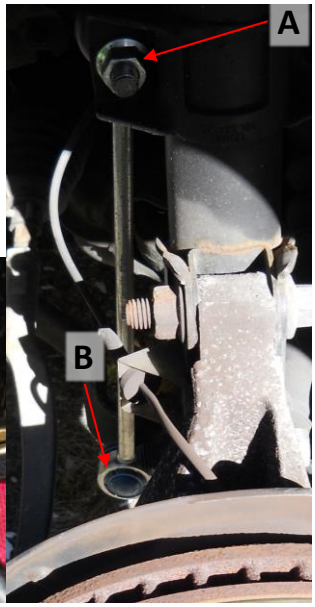
A. Remove locating pins from brake back of calipers with allen key
B. Remove spring. Be careful not to bend it out of shape!
C. Lift caliper and pads free from rotor. Set pads out of the way and zip/wire-tie the caliper to the control arm for now.
D. Remove ABS sensor wire from bracket
E. Unscrew ABS sensor from steering knuckle with 10mm socket. Remove sensor and move it out of the way. Also remove the sensor wire from the plastic bracket on the strut.
F. Use an impact driver/breaker bar to remove the axle bolt. Stick a screwdriver into the brake vents to hold the rotor if necessary.





Step 3: Remove sway bar end-links

A. Remove the top sway bar link nut.
B. Remove the lower sway bar link nut.
   - It is necessary for both top and bottom to prevent the ball joints from spinning and the boot from tearing when loosening the nut. I found that the OEM links had a torx socket at the end of the stud, while the aftermarket links have flats behind the strut bracket that you can grab with a thin 16mm wrench. Either way, keep the stud from spinning when breaking loose the nut.
C. Remove sway bar end link.



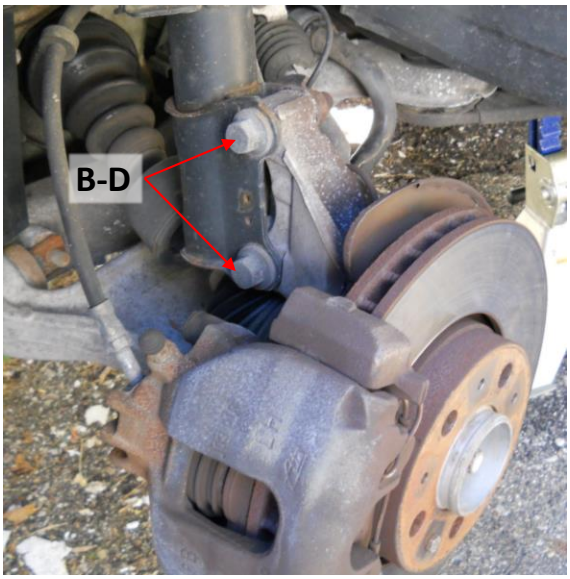
Step 4: Measure the camber

A. Use calipers to measure the distance between the back of the strut (above the brackets) and the flat on the front of the knuckle. Write down the measurements for both left and right sides. The top hole of the knuckle has some play, which allows the knuckle to be angled in and out. You'll use these measurements to re-set the camber when you install the new struts.

Step 5: Loosen strut-to-knuckle bolts

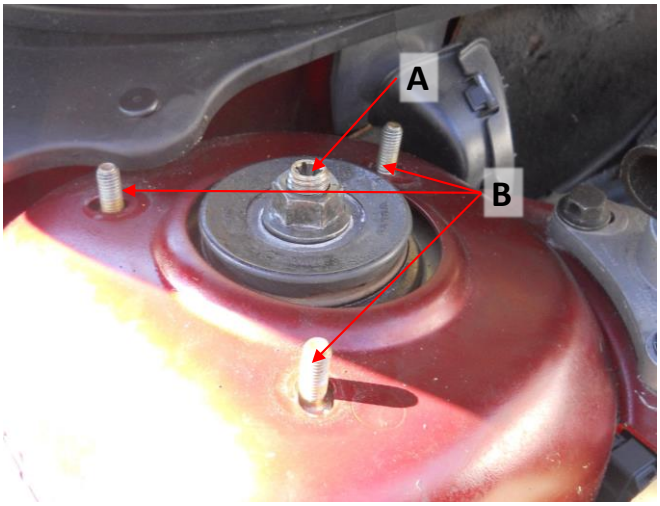
A. Place jack under control arm/ball joint to support it when strut is removed. This wasn't really necessary for me- I actually had to push the control arm further down to remove the strut.a
B. Spray strut-to-knuckle bolts liberally with penetrating oil. Give it plenty of time to soak. PB-blaster works nicely.
C. Crack strut-to-knuckle bolts with an 18mm socket on the bolt head and a 21mm socket on the nut. I used a breaker bar and impact driver.
D. Remove strut-to-knuckle bolts and pry the strut apart from the knuckle. The strut should be hanging from the three shock mount nuts on the shock tower now

* Note: Ignore the brake caliper. It should be removed at this point. My pictures aren't all in order.



Step 6: Remove strut

A. Crack the nut on the end of the strut. Use an impact driver or counterhold the stud with a torx bit.
B. Remove the three shock mount nuts from the engine compartment. CAREFUL: The strut will be loose at this point. Hold on to it. It's best if you can get somebody else to loosen the three nuts while you hold the strut. It weighs about 25 lbs, so be ready to catch it.
C. Ease the strut out of the wheel well. Avoid snagging the brake line or the CV boot.



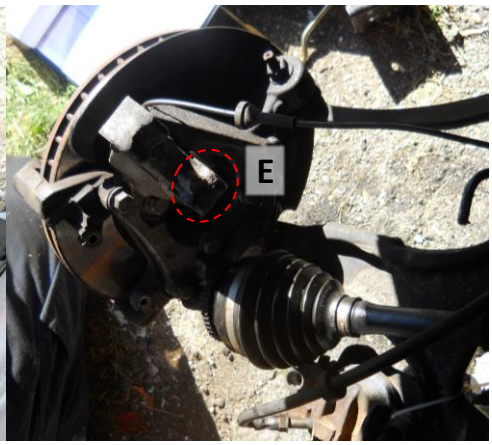
Step 6b: Support knuckle

I found it helpful to support the steering knuckle. I used a tie-down looped up though the now-vacant shock towers.

This probably isn't necessary, but it kept the knuckle more stable for ensuing tasks.

Step 7: Disconnect CV joint

A. Turn steering wheel all the way toward the side you want to remove the axle from first (passenger side pictured). This will give you more clearance at the front of the knuckle, where the tie-rod won't get in the way of the axle removal. *Alternatively, just disconnect the tie rod ends first.*
B. Make sure the axle nut is removed from center of the hub.
C. With the steering knuckle turned out, compress the axle. In this way, you can pull the splined end of the CV joint out of the hub. Set the freed end of the axle on the control arm.
D. Repeat this on the other side.
E. According to the Vida printout, there should be a rubber seal between the joint and the hub. I had one on the driver side, but the passenger side was missing. Keep these for reinstallation.

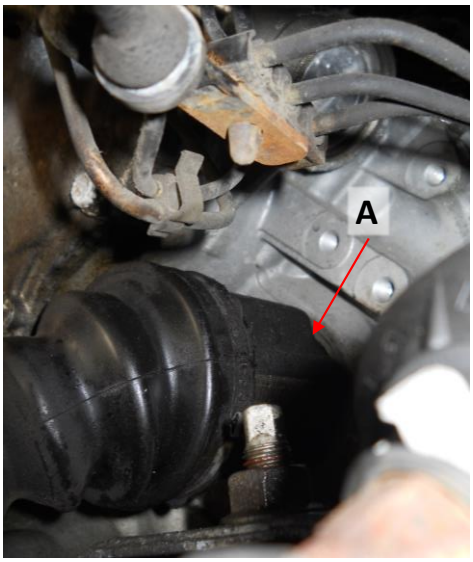


Step 8: Remove drip pan

A. Remove the drip pan from beneath the engine bay. You should be able to see where the axles go into the transmission now.
B. Lay down some cardboard/cushioning and slide under the engine bay on your back. It's a tight fit, especially if you've got low jack-stands like I did. Bring a 12mm socket with an extension and a screwdriver.

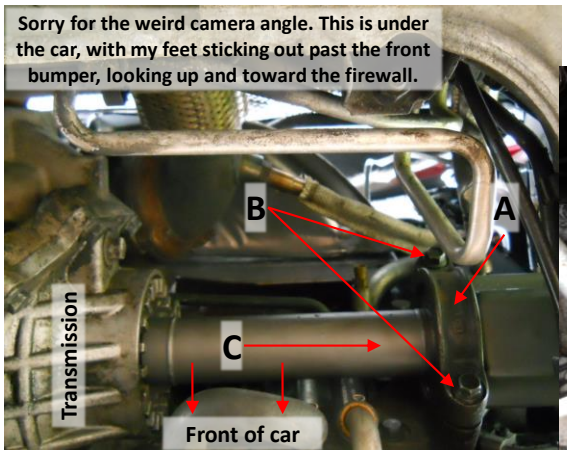
Step 9: Remove driver side axle

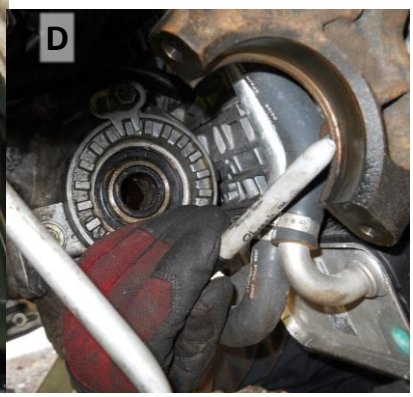
A. The driver side axle is held into the transmission with a sort of snap-ring, so it's a bit stubborn coming out. Rather than pulling on the shaft, I used a pry-bar to pry the inner joint out of the tranny.
B. Once the axle is loose, carefully pull it out past the hub and set it aside.



Step 10: Passenger side axle

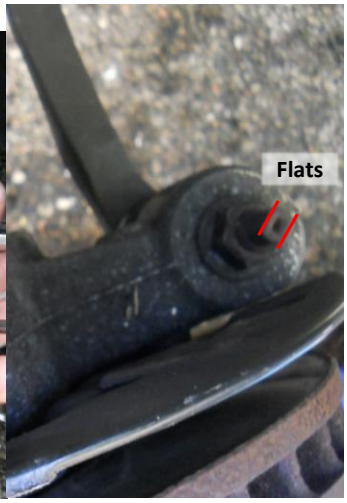
A. The passenger side axle is held in with a carrier bearing.
B. Loosen the 12mm cap screws and remove the cap of the carrier bearing holder.
C. The axle should now pull out from the transmission very easily. It's quite long, so keep easing it out past the hub. Try to pull on the shaft inside of the inner joint, and support it's weight in the middle of the shaft to avoid separating either of the joints.
D. Here's a shot (post removal) looking in from the passenger side wheel well at the carrier bearing holder and transmission to give some perspective.





Step 11: Unfasten tie rod ends

A. Like the sway bar links, the tie rod ends have a ball joint where they attach to the steering knuckle, which might want to rotate as you remove the nut. Crack the nut with a breaker bar and watch the stud to see if it wants to spin.
B. If it does want to spin, the end of the stud has flats that can be gripped with a small wrench or pair of pliers. Hold the stud while using a wrench to loosen the nut. I found that the go-thru socket wrench from Harbor Freight did pretty well for this and other fasteners that required me to hold the stud stationary.



Step 12: Detach ball joints from control arm

A. Now use a (21mm?) go-thru socket or wrench to remove the nut attaching the ball joint to the control arm. Use an allen key in the end of the stud to keep it from spinning.
B. The hub should now be free to remove. Lift the hub off of the control arm and set it aside.

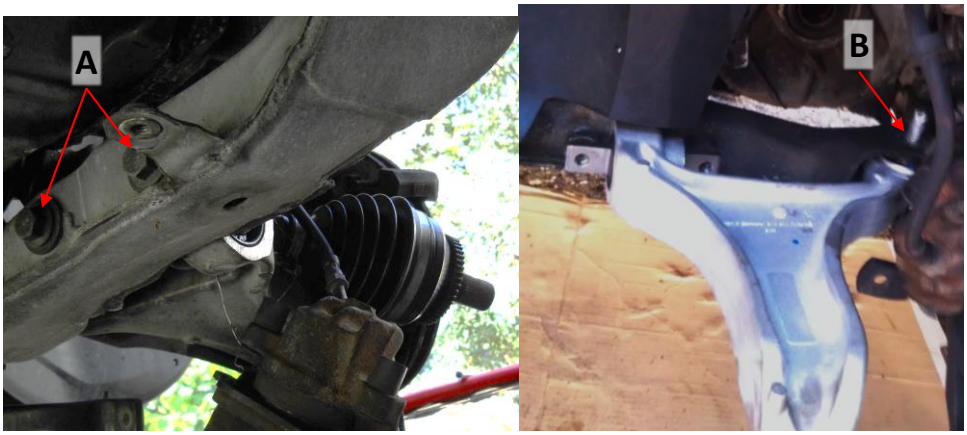
Step 13: Remove Ball Joints

A. Remove the two cap screws securing the ball joint to the steering knuckle.
B. Use a pickle-fork (pictured) or just a big screwdriver. Tap it in between the steering knuckle and the ball joint mounting plate. Evenly tap around the ball joint until it comes out of the steering knuckle.

Step 14: Remove control arms

**I don't have the best pictures here, so bear with me.

A. There are two horizontal bolts that go through the sub-frame and attach to the control arm. The best way to get at these is with a socket on a 3/8" breaker bar. The low profile makes it easier to squeeze the tool between the subframe and the transmission.
B. There is one vertical bolt/nut that goes through the subframe as well. Hold the bolt head from below while you crack the nut with a long breaker bar. This is a *very* tight fastener. Again, some penetrating oil will make the job a little easier.
C. Once these fasteners are out, the control arm should pop out.

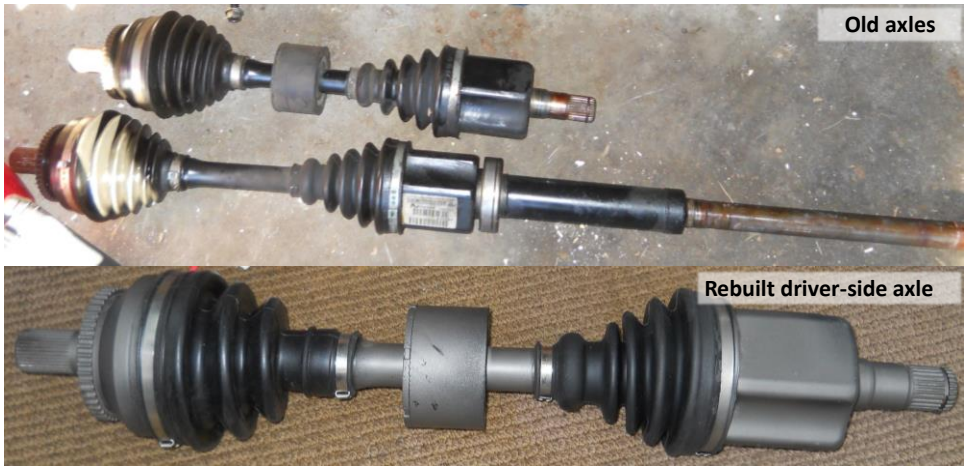


Reassembly

- Make sure you have the following for reassembly (per side)
  - Ball joints (new), including:
    - 2 cap screws
    - cone-shaped nut
  - Axles (new or rebuilt), including:
    - New axle bolt
    - Rubber seals between CV joint and hub
  - Struts (new), including:
    - Upper spring seats
    - Strut mounts
    - Bump stop and dust boot
    - Strut mount cap
    - Retainer nut (weird cross-shaped nut)
    - New strut mount locknuts (3X)
    - Two strut-to-knuckle bolts with locknuts
  - Control arms (new or w/ replaced bushings), including:
    - Two horizontal bolts with locknuts.
      - Note, the driver and passenger sides have different length bolts here (105mm and 115 mm). Make sure when you order your parts that you get the correct length bolt for each side.
    - One vertical bolt with locknut.
  - Sway bar end links (new)

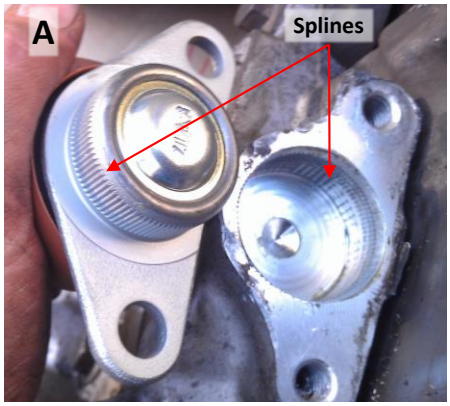
Axle Rebuild/Replacement

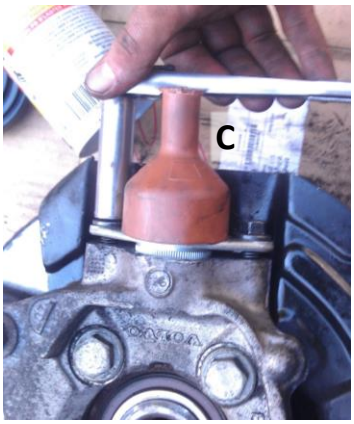
- New axles from Volvo were quoted at ~$600/side, so I went another route
- I've heard bad things about the remanufactured/aftermarket axles you get from chain autoparts stores, so I opted to have my OEM axles rebuilt at a reputable shop.
- I took them into Axle of Dearborn/Detroit Axle for a rebuild. It took about 45 minutes and cost me $55/side, which is a lot better than the cost of new units from Volvo.



Step 15: Install new ball joints

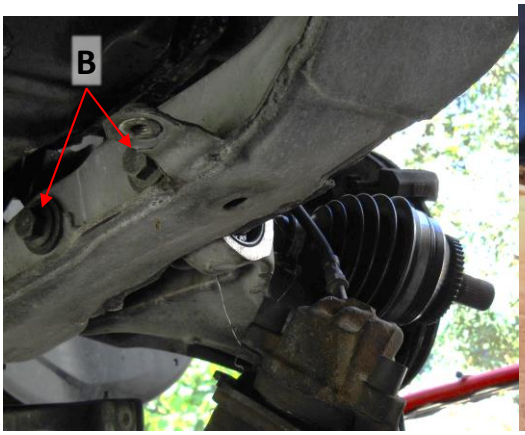
A. Place the new ball joint into the steering knuckle carefully. MAKE SURE THAT THE BOLT HOLES LINE UP. As you can see in the picture below, both the ball joint and receptacle are splined, so once you start pressing it in, you can't rotate it.
B. I saw one forum post where the guy used a loaner ball-joint-press from Autozone/O'Reilly. I tried the press, but I couldn't get it to seat the joint completely. It seemed to be designed for the type of joint that press into the control arm rather than into the steering knuckle.
C. I used the press to get the ball joint initially seated. Then I installed the cap screws and evenly tightened them down, tapping the mounting plate with a hammer every once in a while to seat the joint. Tighten to **30 ft-lb (40 N-m).**

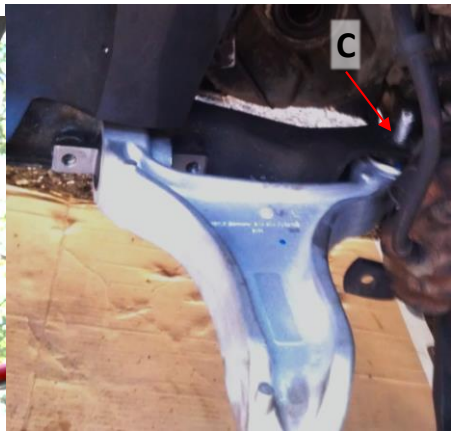




Step 16: Install new control arms

**I don't have the best pictures here, so bear with me.
A. Installation is the reverse of removal
B. Tighten the horizontal bolts to **47 ft-lb (65 N-m) plus 105°**
C. Tighten the vertical nut to **77 ft-lb (105 N-m), plus an additional 180°** (Yikes! Grab your breaker bar and pipe.)





Step 17: Rebuild strut assembly

Very good supplements for strut replacement can be found at the end of the guide

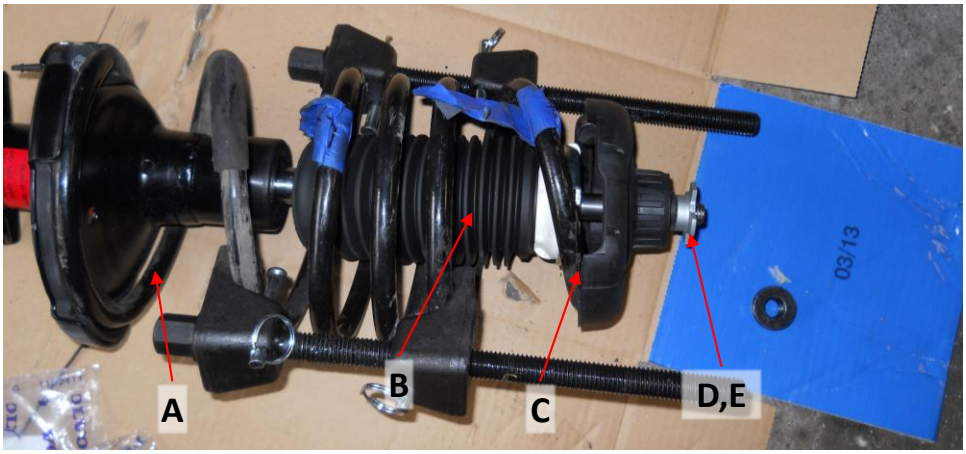
A. Get yourself some Macpherson strut spring compressors (free loaner from O'Reilly pictured).
B. Tighten both compressors equally (an impact driver helps a lot with this part).
C. Compress the spring until there's a little freedom to move the spring between the upper and lower spring seats.
D. Once the spring is a bit loose, spin off the nut from the end of the strut and remove the rubber cap beneath.

Step 17a: Rebuild strut assembly

A. Remove the cross-shaped retaining nut. If necessary, hold the end of the stud as pictured.
B. You can get a specialty tool from IPD or FCP-Euro for this oddball of a nut, but I found that a pair of channel locks did just fine. Counterhold stud with a torx bit.

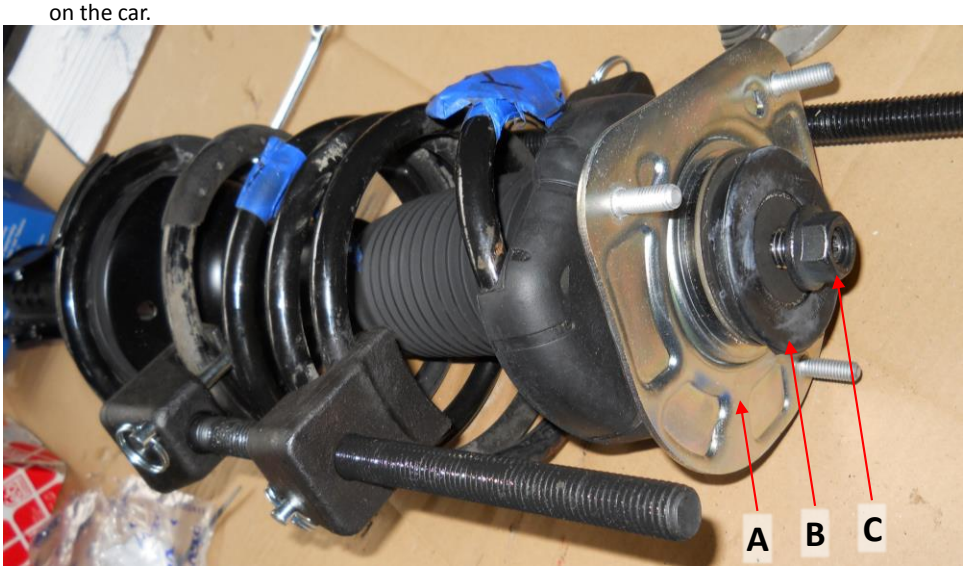
Step 17b: Rebuild strut assembly

A. Slide the spring over the new strut. Make sure the coil seats properly in the groove of the spring seat.
B. Insert dust boot and bump-stop over strut.
C. Place upper spring seat over strut. Make sure that the coil seats properly in this one too.
D. Spin a new cross-shaped retaining nut onto the stud at the end of the strut.
E. The torque spec on the retaining nut is 52 ft-lb (70 N-m). I did a "best-guess" torque-job using channel locks and the allen key, as shown in the last picture.



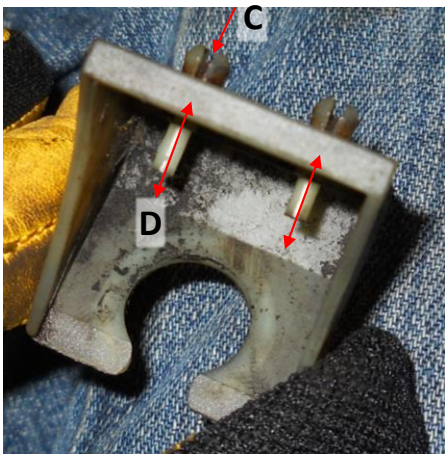
Step 17c: Rebuild strut assembly

A. Put the strut mount on top of the upper spring seat.
B. Place the strut mount cap over the strut mount bearing. Make sure that the grooved side is facing down toward the strut mount bearing.
C. Tighten the strut mount nut somewhat, but wait to torque it **(52ft-lb / 70N-m)** until it's back on the car.



Step 17d: Rebuild strut assembly

A. The ABS sensor wire bracket needs to be either re-used or replaced on the new strut.
B. To re-use the ABS wire bracket, stick a small flathead screwdriver through the strut bracket.
C. Push the flat of the screwdriver between the plastic tabs tabs holding on the bracket. This allows you to push the two plastic peg shown here. The ABS sensor wire bracket can now be pulled off of the strut.
D. Place the bracket onto the new strut (same side) and push the plastic pegs flush. This locks the ABS sensor wire bracket onto the strut.

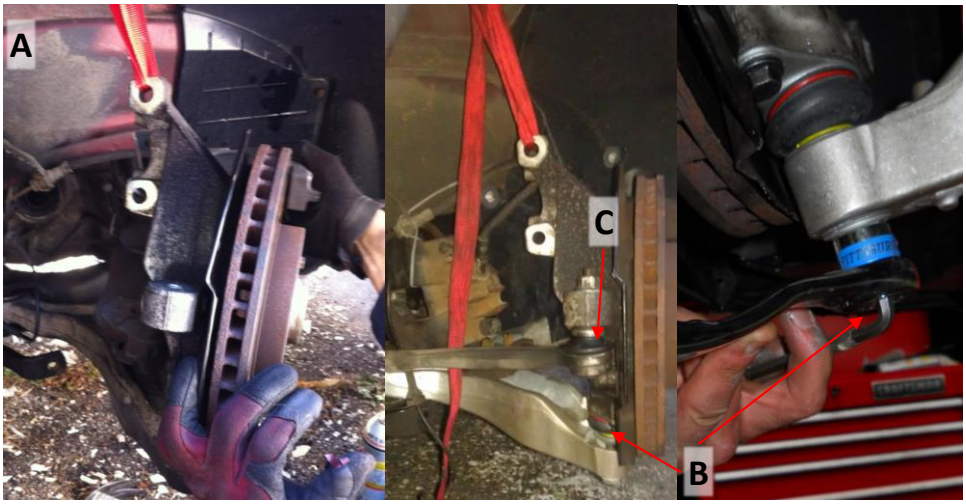


First side done

From left to right: Old strut, New strut, New shock assembly, old shock assembly
Repeat this process on the other side

Step 18: Reinstall steering knuckle

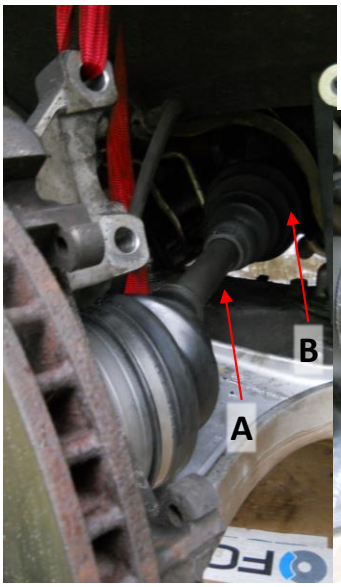
A. Lift steering knuckle into place and slide ball joint stud through control arm. Again, it helps to support the knuckle with a strap (or patient friend) while you get it seated.
B. Install new cone-shaped nut and tighten to **37ft-lb (50 N-m)** plus additional 40°. **Make absolutely sure** that the stud does not spin, otherwise you'll tear the boot and ruin your new ball joint. Hold the stud with a 7mm allen key while you do the final tightening.
C. Install tie rod end. Hold flats on stud while tightening nut to **55 ft-lb (70 N-m).**

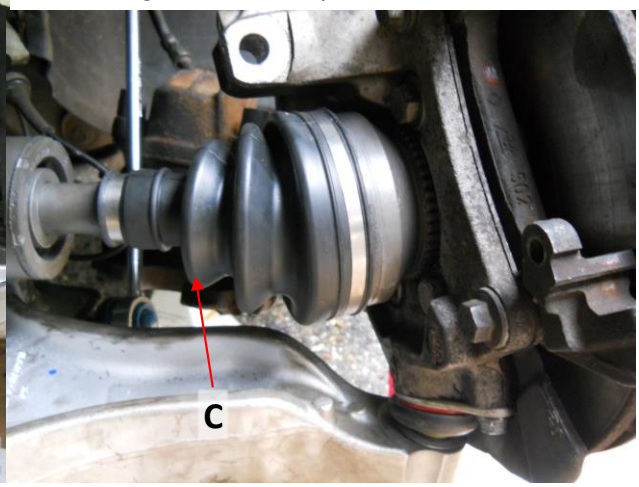


Step 19: Reinstall axle (driver side)

Installation is reverse of removal

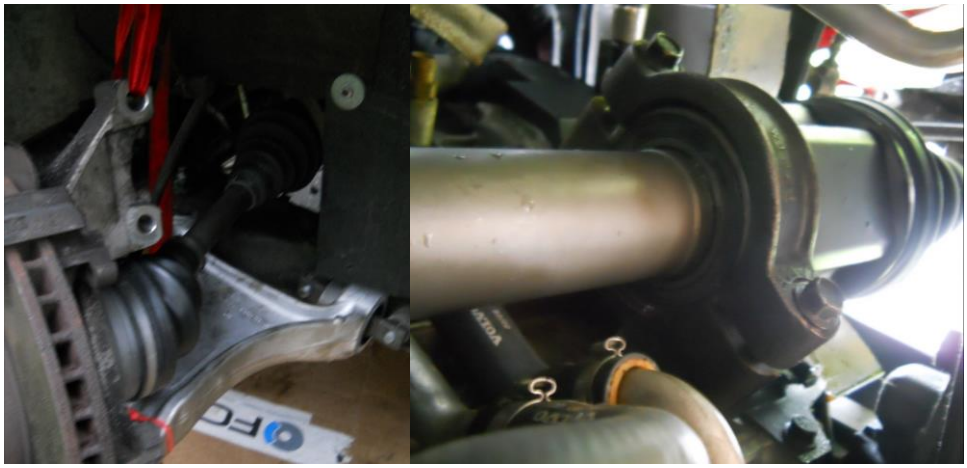
A. Slide axle in past newly-installed knuckle.
B. Push on inner joint until the retaining ring snaps into the transmission. Check that it's secured by pulling on the inner joint.
C. Compress axle joints and fit the teeth on the outer joint into the back of the hub. Remember that there's a rubber seal that goes between the joint and hub.





Step 20: Reinstall axle (passenger side)

A. Maneuver the long axle shaft into the transmission. It should slide in easily (no retainer ring here)
B. Reinstall carrier bearing cap.
C. Tighten cap screws to **18 ft-lb (25 N-m)**
D. As on the driver side, compress the axle joints and seat the teeth into the back of the hub.
E. Reinstall the plastic drip-pan.

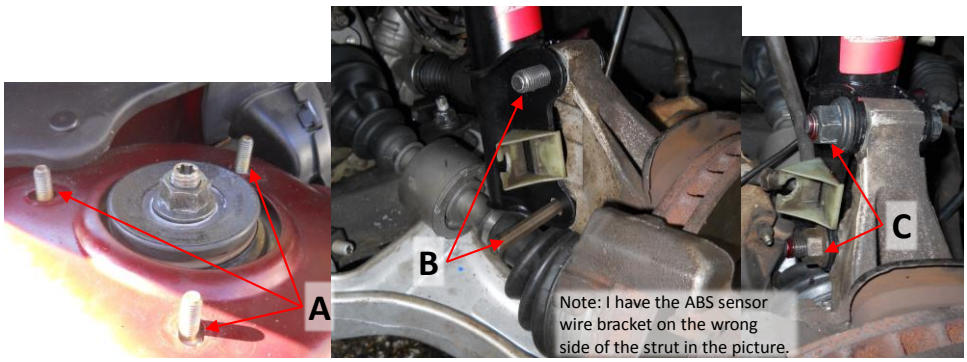


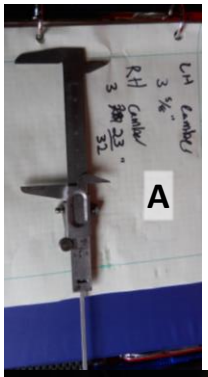
Step 21: Reinstall struts

There are probably many ways to go about this, so do what's easiest for you. Just be sure you're careful not to damage the CV boot on the axle when muscling the strut around.

A. Ease the new strut into the wheel well and slide the strut mount studs through the holes in the shock tower. Spin on three new locknuts by hand, but don't tighten them down yet. This will support the weight of the strut, but give you some play to maneuver the bottom of the strut around.
B. Line up the holes in the strut bracket and knuckle. You may have to push the knuckle down to do this. I used a center-punch as a locating pin, then slid a new bolt into the top.
C. Install new nuts and bolts in the top and bottom. *Lightly* tighten both.

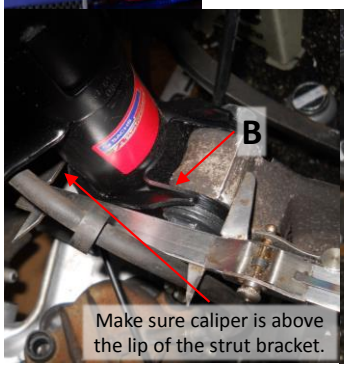
I forgot to order new locknuts, so I doused the threads with Loctite (the red goop) and reused the old ones.





Step 21a: Reinstall struts

A. Now's the time to use those camber measurements you wrote down earlier. Pick a side and set your caliper to the corresponding measurement.
B. Check the measurement from the flat on the knuckle to the back of the strut.
C. Use a pair of channel locks to squeeze and pry the top of the knuckle in or out until desired measurement is achieved.
D. Tighten both strut-to-knuckle fasteners to **77 ft-lb (105 N-m) plus 90°**.

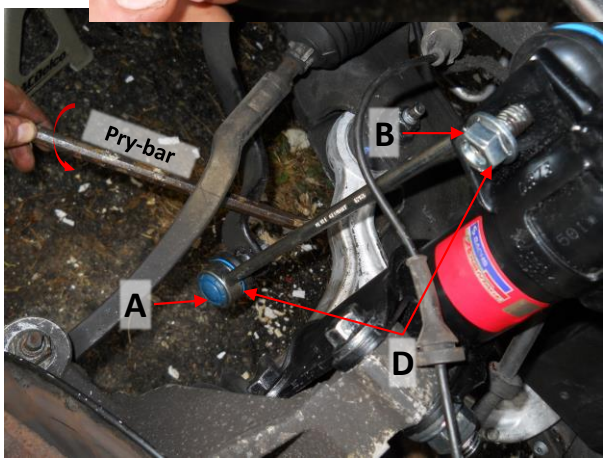


Step 21b: Reinstall struts

A. Now go back to the strut tower. Tighten the three flanged locknuts (the ones finger tightened ealier) and torque them to **18 ft-lb (25 N-m)**
B. Tighten the center strut retaining nut using a torx bit. Torque to **52 ft-lb (70 N-m).**

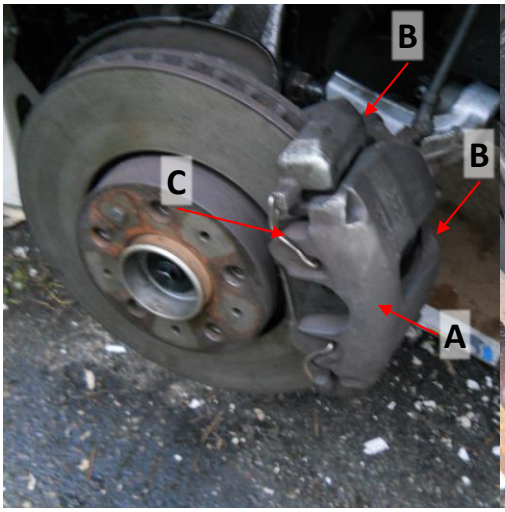
Reinstall Sway Bar End Links

A. Slide the lower stud of the sway bar end link into the sway bar and finger-tighten the nut
B. To get the upper stud into the strut bracket, I had to put a pry-bar over the sway bar and beneath the control arm. Pushing down on the sway bar this way, I was able to slide the stud through the bracket and finger-tighten the nut.
C. Just like in removal, you need to hold the stud to keep it from spinning and tearing the boot. Use a thin 16mm wrench to hold the flats.
D. Tighten the lower and upper nuts (while holding the studs) to
   - **60 ft-lb (80 N-m)- Upper**
   - **45 ft-lb (60 N-m)- Lower**



Reinstall Brake Caliper and ABS sensor

A. Reinstall pads and caliper. If desired, lube up the ears and the backs of the pads with some caliper grease. Be careful not to get any on the rotor.
B. Install locating pins. Also put some caliper grease on these. Tighten to **74 ft-lb (100 N-m)**
C. Replace retaining spring.
D. Install new axle bolt. I found two torque values online. I tightened to **22 ft-lb (30 N-m) +90°**
E. Replace ABS sensor and tighten to **7 ft-lb (10 N-m).** Snap the wire into the plastic bracket.



Replace wheels and lower the car!

A. Using a jack, bring each alternating jackstand down one notch at a time.
B. Go slowly and make sure no odd noises ensue
C. Take a short test drive
D. If everything seems okay, get yourself into the shop for an alignment *stat*.
E. Enjoy the ride!

Other references I used

I pieced together my info from a number of other sources.

- Torque specs: http://forums.swedespeed.com/showthread.php?66457
- Strut replacement guide: http://members.shaw.ca/heeeeee/strut/index.htm
- Very good guide on tie rods, control arms, and ball joints: http://www.volvoxc.com/forums/showthread.php?17294-DIY-front-control-arm-tie-rod-ends-and-ball-joint
- Excellent website covering all aspects of maintenance on P2 Volvos: http://www.freewebs.com/howardsvolvos/
- Repository of how-to documents: http://www.volvoxc.com/resources/how-to/