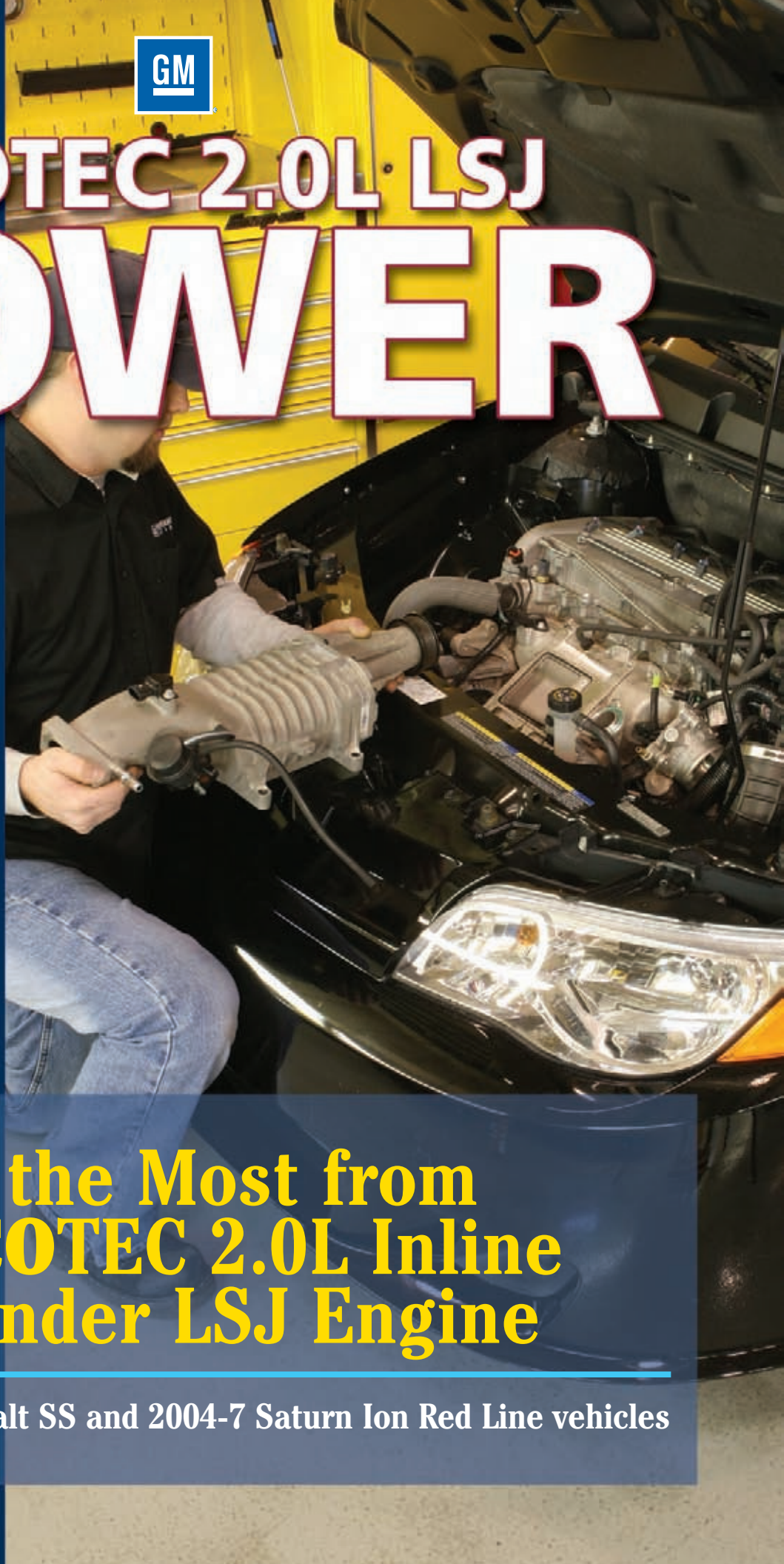
ECOTEC 2.0L LSJ POWER



- Learn Ecotec Engine History
- How to:
  Engine Removal and Installation

  Stage 1 and Stage 2 Upgrade Installation

  Performance Clutch Installation
- 300 hp LSJ Race Engine Buildup

Get the Most from the ECOTEC 2.0L Inline 4-Cylinder LSJ Engine

For 2005-7 Chevy Cobalt SS and 2004-7 Saturn Ion Red Line vehicles

ECOTEC 2.0L LSJ POWER

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This book describes parts and procedures to prepare Ecotec Engines in Cobalt SS Supercharged and Saturn Ion Red Lines. The information in this book is for experienced and knowledgeable technicians only. The procedures described require specialized tools and skills. If you do not have the appropriate training and equipment to perform these modifications safely, this work should be performed by other professionals.

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All ECOTEC Powered

The ECOTEC LSJ Story

Ecotec 2.0L Supercharged LSJ Engine

Welcome to the enthusiasts' technical resource for the 205 hp General Motors (GM) Ecotec 2.0L four-cylinder supercharged engine (RPO–LSJ). This engine, which powers the 2005-7 Chevrolet Cobalt SS Supercharged and 2004-7 Saturn Ion Red Line performance vehicles, and is also available as a crate engine (P/N 12499466), has a strong following on the street for its impressive power output and durability along with its ability to be easily upgraded in power output. The "LSJ" engine is so called because on the vehicle build sheet the Regular Production Option (RPO) designation (see sidebar for more on RPOs) for this engine is "LSJ"—which has led to enthusiasts referring to this engine as the "LSJ" engine.

There are many topics covered in this book to show you how to get the most from the Ecotec LSJ-powered vehicle. There are chapters that detail how to remove and reinstall the LSJ engine in the Cobalt and Ion, how to install the GM Performance Stage 1 and Stage 2 upgrades, how to install a performance clutch and how to build a 300+ hp ultimate performance LSJ.

This first chapter is loaded with information on the Ecotec engine family, some early motorsports usages of the LSJ engine and what to look for in the future.

Whether you are a four-cylinder engine performance enthusiast or not, chances are the performance, elegantly simple design and available power upgrades these engines respond to will impress as you learn more about the overall Ecotec engine family and especially the LSJ engine.

The Ecotec LSJ engine exclusively powers the Cobalt SS Supercharged production car. This vehicle was developed by the GM Performance Division for all around performance.

The Saturn Ion Red Line production vehicle was the first sport compact front wheel drive vehicle the GM Performance Division developed. It is the sleeper performance car of the entire GM fleet—this thing flies!

What's an ECOTEC?

Back in 1995, the GM Powertrain leadership team was developing an all-encompassing global four-cylinder gasoline platform plan. They looked across the entire GM global enterprise to determine what vehicles were planned for the future, what consumer desires were, and how they could meet those desires with one four-cylinder engine architecture. It's doubtful many of us could fathom the diverse demands these GM Powertrain folks encountered, but even more amazing is that the engine that came out of that planning, which by the way is the Ecotec four-cylinder engine design, meets the majority of those desires.

Requirements

Let's look at just a sample of those requirements: In the U.S., customers generally buy cars with automatic transmissions, are accustomed to using mostly low rpm torque to motivate the vehicle, and they expect maximum mileage while running primarily on low octane fuel—all while meeting the demanding U.S. emission requirements.

The European customer leans toward manual transmission vehicles and is more than happy to run an engine in the upper end of the powerband to take advantage of high rpm horsepower. In general, the European gasoline is of higher quality and emissions requirements aren't necessarily lower, but just different.

Then, there are locales like Canada and other parts of the world that are predominantly powered by four-cylinder vehicles that need a diverse lineup of engines to satisfy the many needs within a marketplace.

Whew! Now you get an idea how complex it is to build one four-cylinder gasoline engine architecture to meet the needs of the global economy.

Design Decisions

With all that said, the team narrowed in on a few constants. The block, cylinder head and accessory bracketry would be cast aluminum for weight savings. New technology, in the way of a "lost foam" casting technique (a GM patented technology) would be employed to maximize strength and casting accuracy, while minimizing the cost to manufacture these components. The engine architecture would utilize chain-driven dual overhead camshafts for durability, a four-valve-per-cylinder valvetrain for volumetric efficiency and cast iron cylinder bore liners would be pressed into the aluminum block to provide a rigid bore that could withstand higher cylinder pressures without flexing.

This proposed four-cylinder engine design would be able to power both front-, rear- and all-wheel drive vehicle designs, be configurable for variable valve timing, be able to handle forced induction and run on either traditional sequential intake runner-based fuel injection or direct fuel injection (where the fuel injector sprays gasoline inside the combustion chamber).

So, it's pretty obvious this engine design is basically protected for every variation known to the consumer and some that aren't yet known! Seriously, though, just about every situation the global GM team thought they'd encounter in the future was considered as this design was being schemed up.

The Build Team

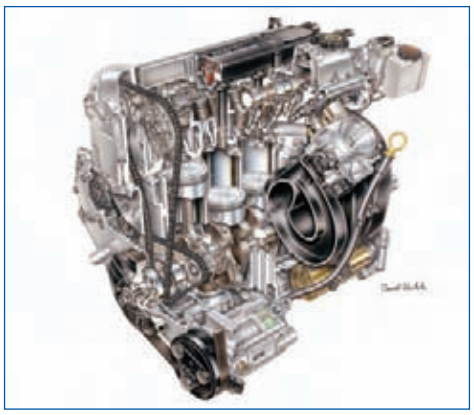
Once all the plans were laid out, finding 'neutral ground' for all the various GM entities to develop this new engine was sought. After considerable discussion, Lotus Engineering UK was engaged as the base of the engineering operations. GM leadership and engineers from GM North America and GM Europe were brought together to work as a team in developing the hardware and software for what would become the Ecotec.

They spent four years developing the basic design, testing prototype components and systems and preparing for the engine to be the global GM four cylinder architecture. Were there tough compromises? You bet, but in general, the leadership

A Sampling of the ECOTEC Family

Ecotec 2.0L Supercharged LSJ Engine

Ecotec 2.2L L61 Production Engine



Ecotec 2.2L L61 cutaway

Ecotec 2.4L Saturn Sky engine

and engineers feel the engine has been a complete success (considering the base 2.2L engine makes 140 hp and the just-released 2.0L turbo engine makes 260 hp, who would argue?).

GM has built millions of Ecotec four-cylinder engines so far to power vehicles in every corner of the world. The engine is considered a success and viewed as the next "small block" for sport compact enthusiasts to tinker with in the future. Look for more variations off this excellent four-cylinder architecture in the future, as the Ecotec family continues to expand and produce ever more horsepower!

Se Habla RPO?

In the world of the GM production cars, the Regular Production Option number, or RPO, is the alphanumeric identifier by which every option is cataloged. While most think of the RPO signaling certain suspension or appearance packages, like the Z28 Camaro or the Z71 Off Road trucks, each GM engine is also identified by an RPO.

For the Ecotec engine family, the RPOs vary from LSJ for the supercharged 2.0L engine, to the L61 base 2.2L naturally aspirated engine. For a breakdown of the many Ecotec RPOs, see the sidebar below.

A Short List on the Global Ecotec

2.2L - L61
The highest volume engine in the Ecotec family—powers vehicles across the globe.

2.4L VVT – LE5
The largest displacement and first equipped with active camshafts to enable "Variable Valve Timing."

2.0L SC – LSJ
The only supercharged Ecotec engine, and easily upgraded in power with GM Performance Stage 1, 2 and 3 upgrade kits.

2.0L Turbo – LNF
The most advanced Ecotec with a twin scroll turbocharger, intercooler, direct fuel injection.

VVT 2.2L European Z2.2xx
The European Ecotec engine family order numbers all start with a 'Z2.2' and have two more digits after the '2.2' to indicate the exact powertrain. (Example: Z2.2SE.)

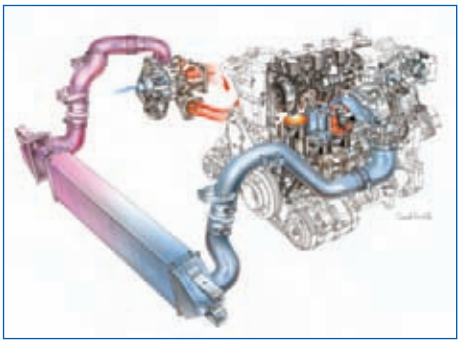
2.0L Alfa Romeo
The Ecotec also powers some non-GM vehicles, like the 2.0L Alfa Romeo.

2.0L Turbo -SAAB LK9, LQ8
The 210 hp LK9 came out in 2003 to rave reviews, the LQ8 2.0L engine makes 175 hp.

2.0L Opel Turbo – LQ8
The LQ8 powers various vehicles in Europe for Opel.

The Saturn Sky Red Line is powered by the Ecotec 2.0L (RPO:LNF) turbocharged 260 hp engine.

Ecotec 2.4L FWD engine (RPO–LE5)



Ecotec 2.0L LNF turbo system/engine cutaway drawing

How the ECOTEC 2.0L LSJ Supercharged engine was created

Back in 2001, the GM Performance Division needed a four-cylinder gasoline engine with a thick powerband to support two front wheel drive small cars they were developing. At the time, the Ecotec family consisted of some potent, naturally aspirated engines and a turbocharged engine was in the works, but nothing approached the torque and horsepower

Ecotec 2.0L Supercharged LSJ

the GM Performance Division leadership felt was needed to make their sport compact cars stand out in the U.S. marketplace. To resolve the issue, the leader of the GM Performance – Powertrain department, Jim Minneker, decided to build a 200 hp version of the Ecotec with a small team of GM engineers.

Minneker had been part of the team that built SEMA show cars in years past and had led the creation of a prototype supercharged Ecotec engine for a small car called the "Piranha". That car was fun to drive, the engine proved durable and the show car development had given him an idea of how to do a supercharged four-cylinder Ecotec.

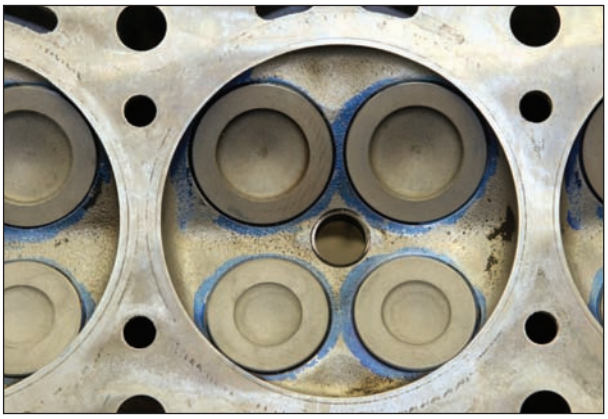
So Minneker pulled in some of the best and brightest engineers he could to execute a tight development timeline.

This team included Steve Felix, Grant Brady, Bill Duncan, and Matt Harlan, among others.

The team started with the 2.0L long block from the Ecotec Turbo engine that was soon to be released in the Saab front wheel drive cars. The forged crankshaft and connecting rods loaded in this engine make it a stout package that can handle the stresses created by the supercharger.

Next, they created an integral intake manifold/intercooler that would hold the specially-designed Eaton supercharger in place on the engine. The supercharger and intake/intercooler needed to be compact enough to fit in the tight confines normally filled with a small nylon intake manifold and throttle body. The team was able to package the blower system successfully and moved on to developing the camshaft design, engine management calibration and the overall powertrain manners in the vehicles.

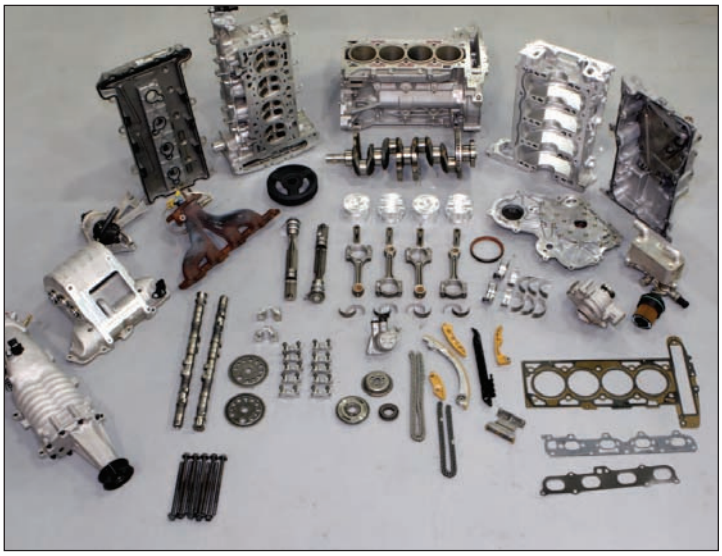
As Minneker put it, "The development program was extremely aggressive, but we were testing the limits of our capability. In general, we succeeded but knew we'd left some power on the table in the end. That's why the team continued to develop some options for increased power—and from that the Stage 1, Stage 2 and Stage 3 performance upgrade kits were developed. The team that did the original engine development—namely Bill Duncan, Steve Felix, Grant Brady and Bill Owen—took those Stage kits from a rough idea to an easy-to-install,



Ecotec LSJ Cylinder Head Combustion Chamber

honest double-digit power enhancer with production-car manners and the Stage 1 and Stage 2 kits are 50-state emissions legal! That team amazed me with what they accomplished on those kits—and the consumers that have installed them can't believe the power increase they get for their time and money. They really exceeded anything we could have imagined."

The Ecotec 2.0L Supercharged LSJ engine is a performance car enthusiast's dream come true—great power output, efficient, easy to upgrade even further and nestled into a fully integrated performance car (either the Cobalt SS Supercharged or Ion Red Line). If you haven't driven or ridden in a Stage 2-equipped ride, make that a priority. The only problem is you'll be forced to figure out how to get your hands on one of these rockets in the future.



Ecotec LSJ Component View w/ aftermarket pistons.

ECOTEC Component Comments

Engine Block

Lost foam and sand cast aluminum with pressed-in cast iron cylinder liners, four bolts per cylinder, setup up for twin balance shaft vibration cancelling system.

Main Bearing Girdle

Lost foam cast aluminum integral main caps held in place with 'torque-to-yield' fasteners.

Cylinder Head

Cast aluminum with dual overhead camshafts, design capable of supporting active camshaft phasing for variable valve timing, direct fuel injection and more...

Crankshaft

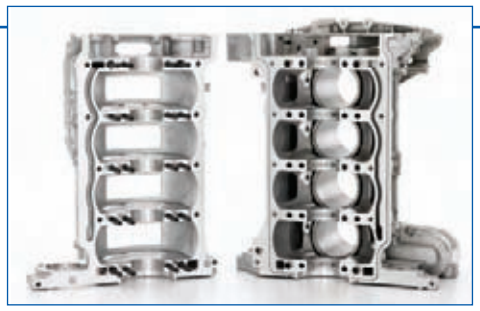
The 2.2L and 2.4L Ecotecs have a cast iron crank. The LSJ crankshaft is a forged steel design that incorporates induction heat-treated fillets for added strength, and cross-drilled, chamfered oil passages for excellent lubrication characteristics.

Connecting Rods

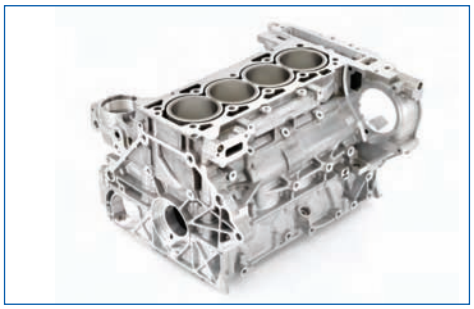
The 2.2L and 2.4L Ecotec engines come with powdered steel rods, while the 2.0L engines have forged steel, large I-beam rods.

Pistons

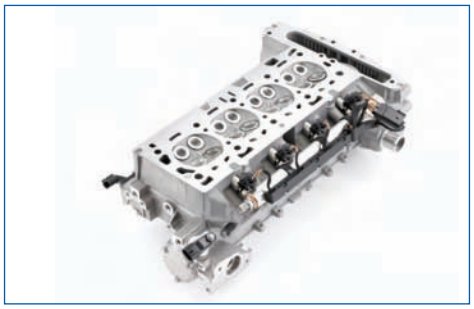
All the Ecotec engines come with eutectic cast aluminum pistons. The common pistons in the Supercharged and Turbocharged Ecotec engines have a 5.6 mm top ring land, much thicker crown & strut sections, coupled to a heavy walled 23 mm piston pin.



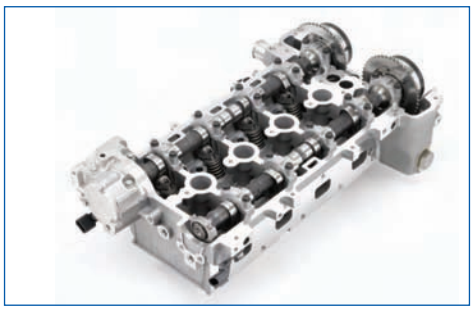
Block and Main Bearing Girdle



Engine Block



Cylinder Head Combustion Chambers



Valvetrain

Crankshaft

Piston Rings

The LSJ uses a 1.15 mm Chrom-Keramik top piston ring, a 1.45 mm napier phosphate coated second ring and a 2.5 mm dual rail with expander design oil control ring.

Valvetrain

The Ecotec cylinder head has 16 valves at 35.1 mm intake and 28 mm exhaust diameters. Valve actuation is accomplished via lightweight, direct-acting cam followers (what looks like an upside-down rocker from a pushrod engine) pivoting on stationary hydraulic lifters. The lobes of the two camshafts press on these cam followers, which in turn open and close the valves. The system is compact, durable and elegantly simple—and it works!

Crank Trigger

Early Ecotec engines used a 7x crank trigger (which means the wheel on the crank had 7 notches in it for the computer to 'read' to determine what inputs to apply to make it run), but as of 2007, all Ecotec engines have a 58x crank trigger (which is the new global standard for engine controls).

Piston and Oiler

ECOTEC 2.0L LSJ Powertrain Component Details

Displacement – 122 ci (1998 cc)
Compression Ratio – 9.5:1
Bore – 3.780 inch (96 mm)
Stroke – 3.780 inch (96 mm)
Block – 'lost foam' aluminum casting with pressed in cast iron bore liners
Head – highly accurate semi permanent mold (spm) casting process, 356 aluminum
Crank – forged steel, induction hardened counterweights, 8-bolt flywheel mount and cross drilled oil passages with inlet and outlet chamfers
Pistons/Rods – 6 mm top ring land piston, oil jet cooled, 23 mm piston pin and large I-beam rod
Valvetrain – 4-valves/cylinder, sodium filled exhaust valves, chain driven cams
Supercharger/Intercooler – helical roots blower design with integral intake manifold intercooler that uses water-to-air 'laminova' heat exchange tubes to cool intake charge
Oiling System – Large oil sump for improved oil control and engine cooling
Transmission – F35 five-speed transmission


LSJ in vehicle


Intercooler Laminovas


Supercharger


Valvetrain

The ECOTEC Turbo LNF Engine

The 2007 Solstice GXP and Saturn Sky Red Line are powered by the newest and most powerful Ecotec engine created and sold in a production vehicle. It is a 2.0L turbocharged, intercooled, direct fuel injection tour de force that makes 260 peak horsepower and 260 peak lb-ft of torque. That's about 130 hp/L!

In case that hp/L number doesn't hit you, the Ecotec LNF turbo engine puts out more horsepower per liter than any engine ever produced by GM. And to really put this in perspective, if you had a 7.0L engine with this capability, it would produce over 900 hp!

The GXP Solstice is more than a big power behemoth. The suspension is the impressive Z0K package developed by the GM Performance Division for SCCA Showroom Stock B competition. The exhaust is a true dual outlet system and the body has increased openings in the front to allow air into the air-to-air intercooler and cooling system.


Solstice GXP


The 265 hp Ecotec 2.0L LNF engine

SSB Solstice Racer

The Pontiac Solstice is the first rear wheel drive (RWD) production car using the Ecotec engine architecture. While this car has gotten rave reviews from the media and consumers for its street manners, it has shown itself to be a very capable track car. While the base 170 hp Ecotec 2.4L LE5 engine is not a firebrand power plant, it does an able job keeping the car moving on a roadcourse and is actually a great tool for teaching driver discipline—as a moment off the throttle results in a dramatic impact to tracktimes.

With this in mind, the GM Performance Division did considerable engineering to develop a road race package that can be ordered from the factory and run in the Sports Car Club of America (SCCA) Showroom Stock – B (SSB) class.

The RPO for this package is Z0K and it deletes certain heavy items like the air conditioning while adding a performance-intended suspension (that is good enough it ended up being the suspension under the higher horsepower GXP Solstice).

Racers then need to install a rollcage, safety harness, fire suppression system, higher temperature brake pads, grippy tires and a GM Performance Division-engineered hardtop (available through the SCCA). The engine remains stock, as does the suspension.

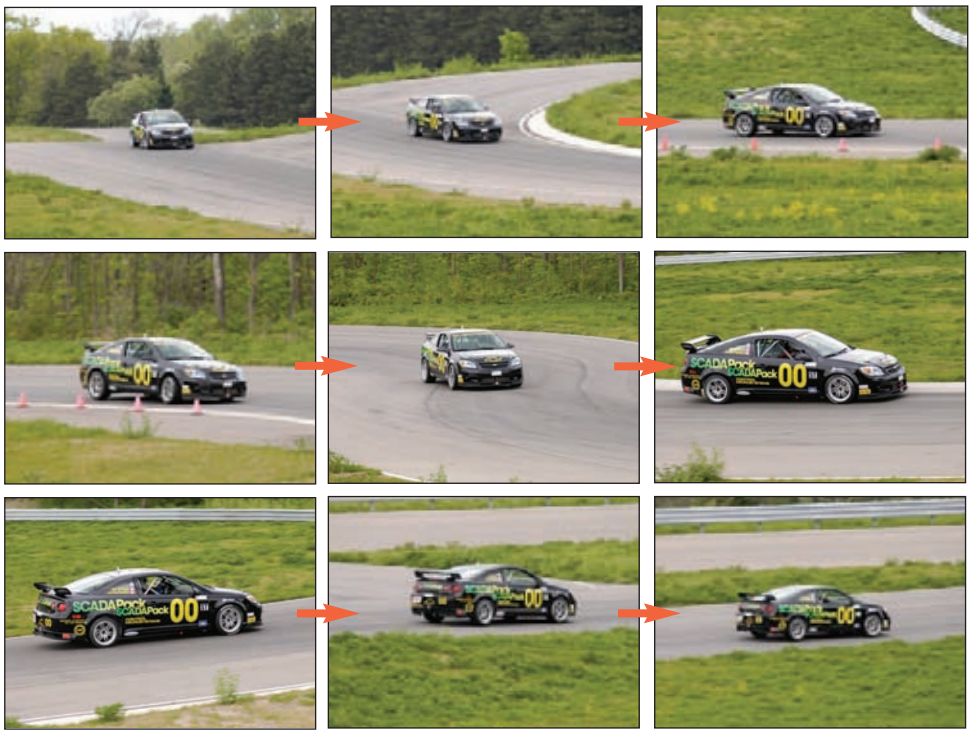
The Solstice competes with the Mazda Miata and other cars of its ilk in SSB and has shown itself to be competitive—winning some races and regional championships.

Grand Am Cup Development

Grand Am Cup races might be one of the most "real" competitive arenas in the world of motorsports for front wheel- and all-wheel-drive sedans right now. These races routinely start over 50 cars from every manufacturer you can imagine. Even better, Grand Am Cup rules are simple enough that much of the development used to go fast on the track can be translated into performance upgrades for the street.

The GM Performance Division has used their Grand Am Cup development work to help in creating the immensely popular Stage 1, Stage 2 and Stage 3 performance upgrade systems. (See Chapter 4 for more.)

These 'real' performance packages are easy to install, come complete with calibrations to take advantage of the performance parts being installed, and net honest double-digit power increases.



A Grand Am Cup Cobalt running through the low-speed Esses at the GM Milford Road Course (MRC) vehicle development track.

Time Attack Development

What you probably know is that the GM Performance Division took a heavily modified Chevy Cobalt SS Supercharged to the Super Street Magazine Time Attack event at the road race track in Buttonwillow, California, last year and netted an Overall Win the first year out. What many don't know is that this vehicle was a developmental testbed for products that would become available to the public not long afterwards. The "Time Attack Cobalt", as it became known inside GM, also assisted in the development of the GM Performance Division-supported Grand Am Cup race program.

Starting with a production Cobalt SS Supercharged, the GM Performance engineering team had the car completely gutted, a racing rollcage added along with the other required safety equipment when driving in competition (race seat, 5-point seat belts and fire suppression system). They then focused on making more power from the LSJ engine, improving the suspension, lowering the vehicle mass and improving the aerodynamics (more downforce/less drag).

The part most interesting was that the GM Performance Stage 2 (see Chapter 4 for the install on the Stage 2) and GM Performance Stage 3 (just now becoming available to the public) performance upgrade kits were refined on the Time Attack car.

Also, some wild innovations were tested on the car to determine if they would provide performance increases. One of these packages was a large tank filled with cold water to cool the inlet charge—it would heat up almost immediately and provide no substantial power increase in a short amount of track time. The other was a computer-controlled 50 hp shot of nitrous used sparingly but to excellent effect. Much of this nitrous control and calibration work made its way into the GM Performance Stage 3 performance upgrade kit that is just now becoming available.

The Time Attack Cobalt, winner of the 2006 Super Street Time Attack event.


The Attack Cobalt during testing at the GM Milford Proving Grounds Milford Road Course (MRC) development track.

The Time Attack Cobalt engine was a testbed for the Stage 1, 2 and 3 performance upgrade systems.

The Time Attack Cobalt testing also assisted the Grand Am Cup (GAC) vehicle development process—as it was much faster than the GAC cars.

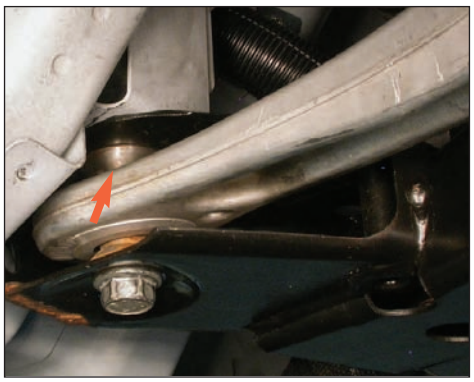

The Time Attack Cobalt Engine was handbuilt and for appearance, the block, girdle and heads were powdercoated black.

Road racing veteran and GM Performance Division Director, John Heinricy, did the development and competition driving for the Time Attack Cobalt.

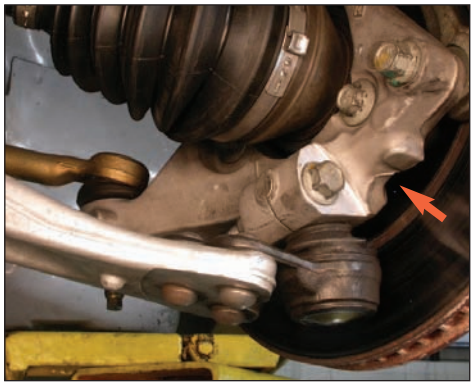
The Time Attack Cobalt Engine is more stock than many would like to believe—yet made almost 400 hp on a 140 hp shot of nitrous!

The trunk of the Time Attack Cobalt is filled with a quick-fill fuel tank, nitrous tank and battery.

The Time Attack Cobalt floorpan is as it came from the factory. The straight through exhaust has a HUGE muffler (arrow) on it near the bumper to meet the noise standards of the MRC. Notice the Ohlins shock absorber reservoirs—these shocks are awesome in their adjustability.

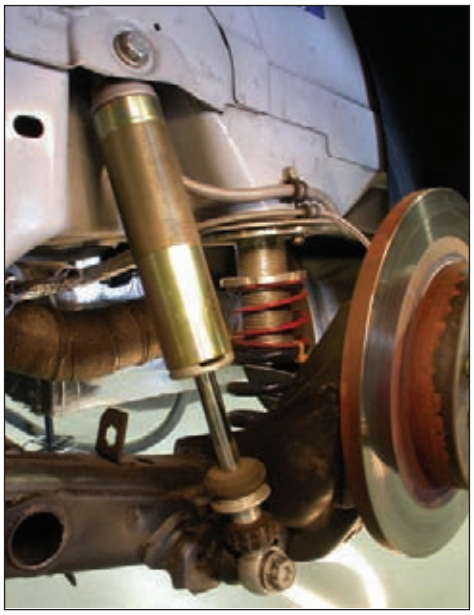


If you want your Cobalt to handle, you'll need to install these spherical rod ends (arrow) in the rear mount of the front lower A-arms.



To handle the immense power and road loads, a Pontiac Grand Am knuckle (arrow) was modified to accept the lower A-arm ball joint and installed on the Time Attack Cobalt.

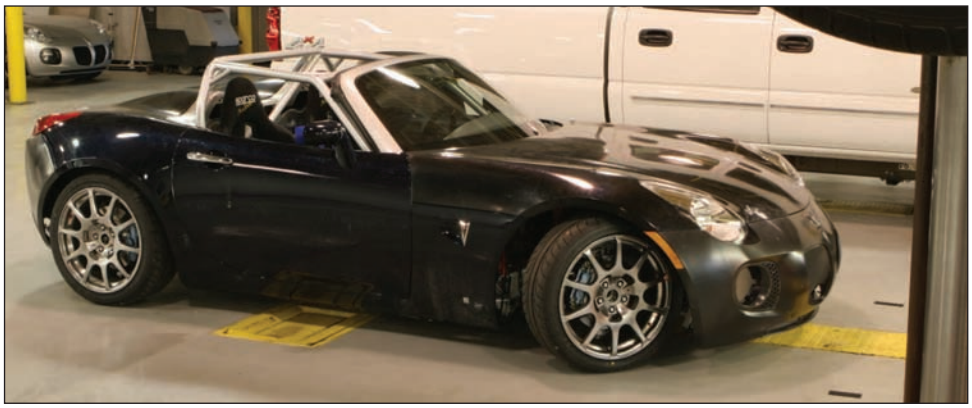
If you're building a performance Cobalt, it is a good idea to install solid engine mounts that rotate the engine forward and then shim the steering rack (shown) up to straighten the half-shafts and minimize bump steer, respectively.



The rear axle was modified by cutting off the ends and welding on Pontiac Grand Am five-lug hubs, installing a custom adjustable sway-bar and relocating the Ohlins shocks and Hyperco springs.

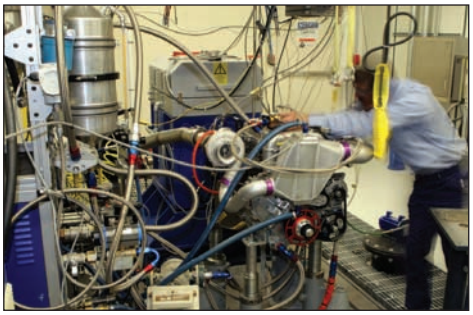
Drifting with the ECOTEC

The latest race vehicle to come out with Ecotec power is this GM Racing-supported drifting Solstice GXP being campaigned by Rhys Millen. Running an Ecotec 2.0 L turbocharged engine that makes about 600+ hp and modified to allow almost 60 degrees of turning radius (that's about double what the stock vehicle has), this drifter is loaded up and ready to run. The carbon fiber and stock sheetmetal body is shown just prior to being painted up with Red Bull livery for competition.



A stock-bodied Solstice was upgraded with a full rollcage, a fuel cell, modified steering system, permanently installed air-jacks for the rear and more.

The methanol-burning turbo Ecotec makes about 600 hp.



As with all GM Racing-developed engines, this engine package was refined on the dyno to have a wide powerband with maximum durability.

The LSJ-powered Land Speed Racer

The GM Performance Division has been running an LSJ-powered 'Lakester' land speed race vehicle at the Bonneville Salt Flats for the last few years with much success. The car has run over 200 mph with a modified Stage 3 performance upgrade on the engine.

The GM Lakester was built in partnership with SoCal Speedshop, based in Pomona, California—which would explain the SoCal red and white paint scheme.

The car features a tube chassis, all independent suspension, an innovative body design and the previously mentioned Ecotec powerplant hooked up to a transaxle transmission/differential putting the power to the rear wheels.

The engine has been breathed on with aftermarket forged aluminum pistons, more aggressive camshafts and valvesprings and a modified Stage 3 upgrade kit. Some of the pieces on this vehicle, like the multi-pass intercooler, helped to create the Stage 3 upgrade kit (See Chapter 6 for more on the Stage 3 kit) just now becoming available to the public.

The engine is controlled by the stock powertrain control module (PCM), but with a modified calibration to take advantage of the low restriction intake and exhaust and internal upgrades—and helped with the Stage 3 upgrade calibration development.

As you can see, the Ecotec LSJ engine in the Lakester looks very close to stock.

This Ecotec LSJ-powered Lakester has set multiple land speed records at Bonneville.

Crazy race turbo ECOTECs

In case you've heard about a front wheel drive (FWD) Cobalt running 250+ mph at Bonneville or a drag FWD Cobalt running over 200 mph in the quarter mile and thought, 'That can't be right…", here's your answer: Turbo. A race-intended turbo Ecotec program supported by GM Racing, GM Powertrain, GM Performance Division, and GM Performance Parts people and resources has been developing engines and vehicles for a few years now with some pretty incredible results.

Obviously, to run over two bills at a dragstrip requires serious power—and these engines deliver. In general, the turbocharged, intercooled, methanol burning 2.0L Ecotec engines started out making 600 hp in 2001 and are making over 1400 hp when in their full-competition drag race setup. The Bonneville turbo engines are detuned slightly to be able to handle wide open throttle (WOT) applications in excess of 60 seconds (that's a looonnnngggg time!) without scattering.

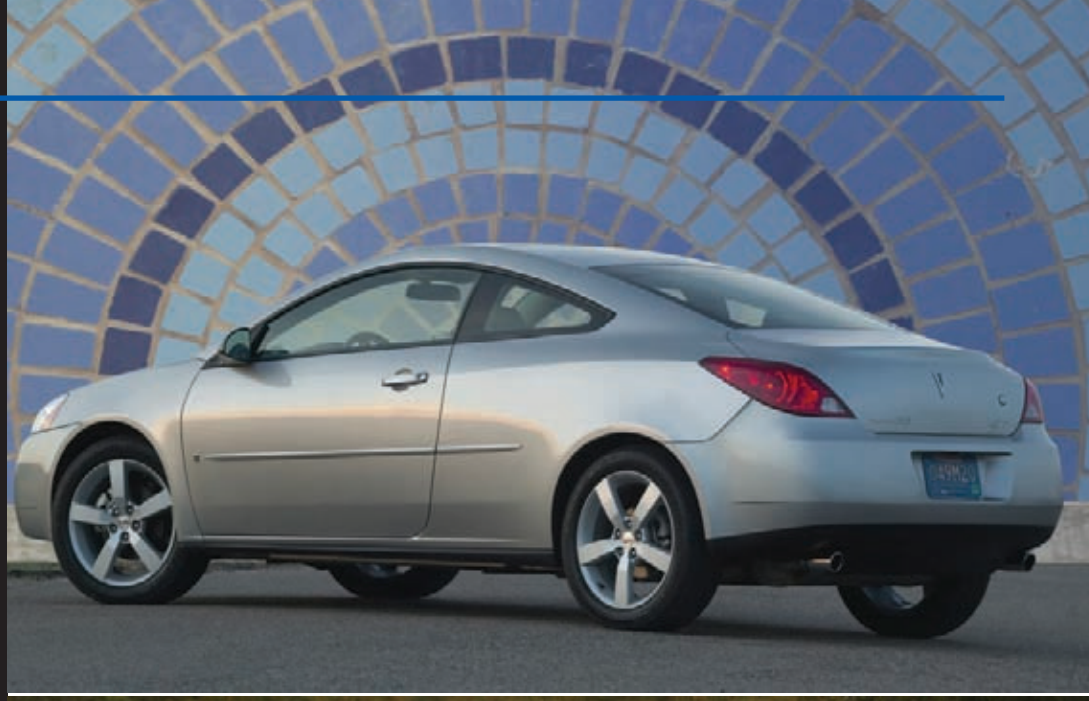
Ecotec turbo engine in Cobalt bodied racecar.

Cobalt bodied drag car with turbo engine.

This Cobalt has records over 200 mph at Bonneville.

This chopped, tube chassis land speed HHR has big turbo Ecotec power.

All ECOTEC Powered



Removing the ECOTEC 2.0L Inline 4-Cylinder Supercharged LSJ Engine from a Cobalt SS

Pulling the Ecotec 2.0L Inline 4-cylinder supercharged LSJ engine out of your Cobalt SS Supercharged just got a whole lot easier. This chapter walks through the process in brutal detail with almost 150 photos "showing" you the action. Now, you've got no excuse for not making your Cobalt SS Supercharged even faster!

Now this might seem like truly basic stuff, but we think it's important to show everything and let you decide if you need it or not: We're going to show you every little detail to removing the Ecotec 2.0L Inline four-cylinder supercharged LSJ engine from your Cobalt SS Supercharged ride. This chapter should be great news for anyone who wants to build a more powerful Ecotec LSJ engine but hasn't removed a modern engine from a GM vehicle. The next chapter in this book will show you exactly how to reinstall the engine in your Cobalt SS Supercharged.

It is recommended you read this chapter completely before beginning the activity of removing your engine, so you are aware of any special tools required or actions that need to be taken along the way, and can prepare appropriately.

Connector Conundrum

The underhood GM electrical and plumbing connections can be downright maddening if you aren't familiar with them. That's why this chapter really focuses in on how many of these connections affix themselves to their mating points—so you understand how to remove them.

In case you're wondering, these connections are designed the way they are to improve the quality of GM vehicles. They are designed to minimize the chances of them being installed halfway (they are either on or off) or upside down or any other way other than the correct way. Unfortunately, many of these connections aren't really designed to be taken off very easily without special knowledge.

But that's where this book comes in, we'll show you how to remove the many wiring connections, hoses and fittings—which should minimize the frustration and damage you cause!

To lift or not to lift

In the factory, the Ecotec LSJ engine is installed in the Cobalt SS Supercharged while bolted to the front suspension cradle. The body of the vehicle is actually lowered down onto the engine/cradle combination. If the engine was removed at the dealership, the vehicle would be lifted off the engine/cradle combination. For that reason, we're showing you what GM considers to be the easiest way to remove this engine.

Many backyard enthusiasts look at the requirement for the four-point vehicle lift as impossible, but we don't agree. We're sure you know many ways to get some 'lift time' to pull this engine—and now that you're armed with this detailed guide to performing this task, you'll be able to get the engine out and the vehicle up on a trailer in no time.

We've heard of folks lifting the engine out the top of the engine compartment, or lifting the front of the vehicle off the engine with an engine hoist, but the four-point vehicle lift is by far the most straightforward, safest and quickest method to get these engines out of the Cobalt and Ion. Use your hustling powers and get access to a lift to make your Ecotec LSJ engine buildup project happen with a minimum of stress.

Tools required

The tools required for this job include various metric sockets and open end wrenches, Impact guns or breaker bars, large pry bars, a radiator hook tool, remote hose clamp pliers and various screw- and Torx drivers. Also needed are drain pans and access to an A/C system purge station.

Bleeding off fuel pressure

It is recommended you run the engine for a few seconds without the fuel pump running to reduce the fuel pressure left in the fuel rail as the engine removal process begins. This process is shown in detail in the beginning of Chapter 4, Page 58, so refer to that before starting the engine removal process

Helpful tip:

Power wash the engine and compartment before you start or forever work in glop!

Purging the A/C system

The air conditioning (A/C) system needs to be professionally purged of freon before removing the engine. The arrow points to one of the tap-in points in the system to access the Freon. Don't just release this material into the atmosphere as it is very harmful to the environment. Purging shouldn't cost much, as the Freon can be reused by the shop doing the purging—so they end up with something they can resell.

The machine used to purge the A/C system should look something like this. The operator will tap into two places on the A/C system, start the machine and about 15 minutes later, the purging will be complete.

Prepping to begin

The 2005-2006 Chevrolet Cobalt SS Supercharged cars have become a performance enthusiast's favorite for their exquisitely sorted chassis, thick powerband, GM-developed performance parts (see Chapter 4) and affordable pricing. To remove the engine, start by placing the Cobalt on a four-point lift like this one shown here.

The Ecotec LSJ engine looks like this in its factory-installed state. In this chapter, we're going to remove the entire engine and transmission as a unit and take the transmission off the engine in preparation for tearing the Ecotec LSJ down for the addition of performance parts (like the build-up in Chapter 6).

Disconnecting battery

With any underhood work, you should start by disconnecting the ground strap on the battery located in the trunk. Wrap the end in a rag and/or push the cable end down under the spare tire to ensure it can't touch the battery while you are doing your work.

Removing inlet tube

Start the actual removal of parts by loosening the 8 mm (7 mm on Ion) inlet tube hose clamps on the molded plastic tube between the air cleaner and throttle body on the supercharger inlet.

Using a set of pliers, compress the metal clip holding the PCV tube onto the molded nipple on the inlet tube. Slide the compressed metal clip down the hose about an inch.

Using the same pliers, gently wiggle the hose off the nipple.

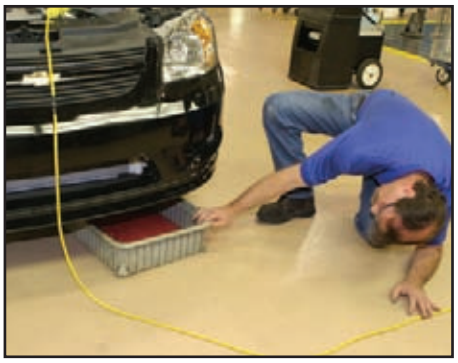
Push the inlet tube toward the air cleaner and as it releases from the throttle body flange, pull the tube up and out of the engine compartment. Save all components from this assembly (we suggest placing the many parts you're removing in marked plastic bags) in preparation for reassembly—which is shown in the next chapter.

Draining coolant

The next step is to drain the coolant out of the radiator and engine. This is accomplished by pulling the lower radiator hose, located in the front of the engine bay on the driver's side, off the nipple on the radiator.

CAUTION: Let engine cool overnight before draining.

The arrow is pointing to the compression clamp holding the lower radiator hose on the radiator. This needs to be compressed and slid back up the hose about 1 inch to make it possible to release the hose from the radiator. These tight situations are where the remote clamp pliers (like those Snap-On sells) pay for themselves (and they cost about $100).



Let's be clear about this—draining the coolant from the radiator is a messy job. You'll need a wide, shallow drain pan to catch the gush of DexCool and even then, a good amount will probably splash onto the floor. Clean it up promptly with soapy water as the DexCool is really slimy, making for treacherous work conditions as it gets tracked around by your shoes.

Removing reservoir return hose

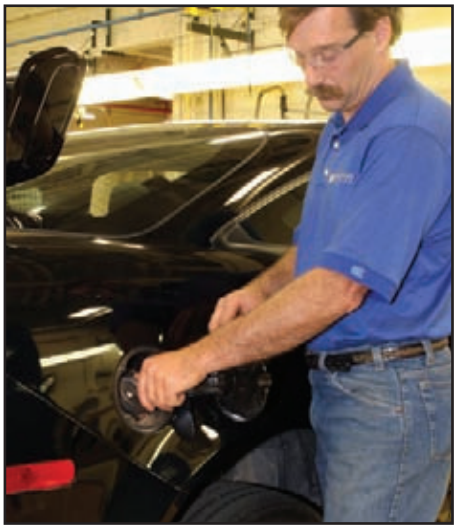
Using pliers, depress the clamp holding coolant reservoir return hose on reservoir and pull the hose off reservoir.

Removing brake booster hose

Here's the first tricky hose connection to remove. Take a look at the closeup photo to understand how to remove this—it doesn't take a lot of force and is easy to mangle, so take your time! It is removed by pushing the side tabs in until they bottom out, then pulling out the large tab before slightly wiggling the connector while carefully pulling up.

This hose does not need to be completely removed, just remove the end of the canister purge hose by depressing the gray tab on it and wiggling it off the nipple.

Disconnecting fuel line and position away from engine



Start disconnecting the fuel system by loosening the gas cap at the passenger rear of vehicle. This will help to bleed off any latent pressure in the fuel system.

With the fuel bled off and the gas cap loosened, push one of these fuel line removal tools, which are available at auto parts stores, into the collar on the fuel line to release the fuel line dry break located on the driver's side of the engine.

To minimize the amount of fuel that drips out of the fuel line, stick a 1/4-inch rubber hose plug into the fuel line opening.

To get the engine out of the vehicle, you'll need to release the fuel line completely from the engine. To do this, use a small screwdriver to pry open the plastic clip holding the flexible portion of the fuel line onto the engine.

Push the flexible portion of the fuel line behind the electrical box (top arrow) and push a 3/8-inch rubber cap over the metal fuel fitting on the engine (lower right arrow) to minimize fuel leakage from that line.

Disconnecting A/C line

Remove this 10 mm bolt holding the A/C line together underneath the throttle body and pull this fitting apart by hand. Save the bolts. Also, remove the lower A/C line on the condensor at this time.

Begin disconnecting underhood wiring

Of all the steps, this is probably the most daunting looking—because there are a gaggle of wires, connectors and control boxes scattered all over the engine bay. But don't panic—we're going to show you the steps you'll need to perform to successfully remove these components. And the next chapter will show you exactly how to reinstall all these pieces.

Start the disconnecting of most of the engine's electrical harness by removing the top of the electrical panel.

Remove the 10 mm bolt holding the positive cables onto the electrical panel.

Depress the lock tab and gently pull the white wiring plug for the electronic power steering out of electrical panel. This is in preparation for lifting the 'midplate' of the wiring panel out of the vehicle.

Remove the five 7 mm bolts holding the electrical panel together.

Pull out the lock clip on each side of electrical panel in prep for pulling the midplate off.

Gently pry the electrical panel midplate off the base by pulling up with one hand while carefully raising the panel with a screwdriver.

Flip the midplate over and pull the gray electrical connector off the backside of it.

This is what your progress should look like when the midplate is completely removed from all the electrical connectors. Notice the five wiring connectors on the Cobalt baseplate—the Ion will only have three connectors on the baseplate.

Removing PCM

Peel the Powertrain Control Module (PCM) out of the holder in front of the electrical panel.

To pull each of the three connectors, maneuver the pivot lock past the lock tab on the top connector.

Pivot the lock out before …

Pulling the connector off the PCM.

Repeat the releasing and pivoting of the lock tab on the remaining middle and lower PCM electrical connectors.

Removing Mass Air Flow (MAF) sensor connector before continuing to remove wiring

Remove the plastic closeout panels to the front fascia on each side of the vehicle by removing the six 7 mm screws and peeling up the five lock pins and pulling them out. The plastic panel will then come out of the vehicle.

Remove the five 18 mm lugnuts to take the front wheels/tires off the vehicle.

The front suspension will then hang like this. You will be removing the steering tie rod, lower ball joint, swaybar and front axle shaft later in the next steps of this process to drop the engine/trans out of the vehicle.

On the front end of the Cobalt driver-side inner fenderwell, reach under the fascia to disconnect the mass air flow (MAF) sensor electrical sensor – the connector has been removed and is shown poking out from the area where the air cleaner housing is located.

As a tip, the inner fenderwell/fascia closeout only needs to be removed to this level.

Continuing removal of electrical wiring

Continue removing the rest of the wiring system under the hood.

Remove the two 10mm bolts holding the base of the electrical panel in the vehicle.

Pry the wiring clip attached to the power wire off the metal base with pry tool.

Unbolt the two 13 mm bolts holding the electrical panel base onto the frame rail.

Pry the gray plastic wiring clip off the base of the electrical panel next to the coolant reservoir.

Pry the gray plastic wiring clip off the passenger side of the electrical panel base.

Pull the electrical panel base out of the vehicle—if it doesn't come out easily, **don't** pull harder! You've probably missed a connector or bolt. Go back and check for remaining fasteners to remove.

Accessing ground cable bolt

Remove these two 10 mm bolts holding the driver's side headlight onto the front fascia to access a ground cable that needs to be removed.

Separate the electrical connector by depressing the lock tab and gently working the two connectors apart.

Loosen the 13 mm bolt holding the ground cable in place on the vehicle.

This is the ground cable being removed from the framerail.

Continuing removal of engine bay wiring

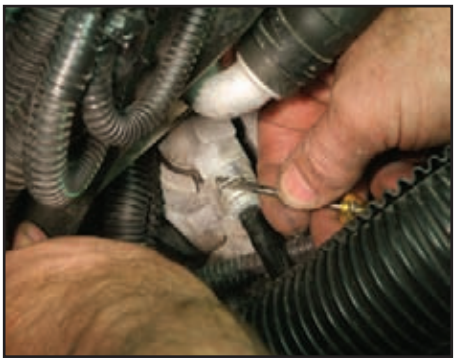
Pull the engine coolant reservoir hose off the coolant reservoir to make space for removing the electrical panel.

Separate the body-to-engine electrical connector at the firewall of the vehicle by depressing the lock tab and pulling it apart.

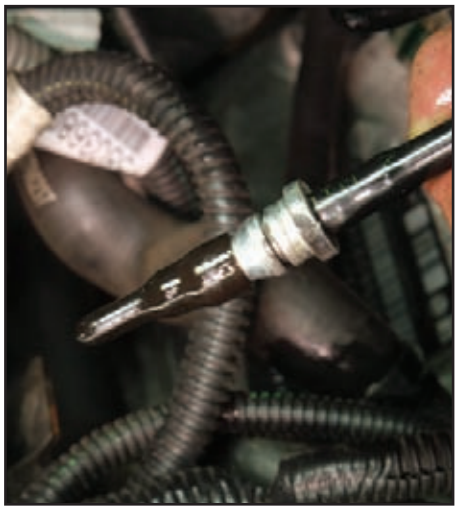
Disconnecting heater hoses

Disconnect the heater hoses on the backside of the engine by depressing the clamps, sliding them off the hose and pulling the hoses off the nipples.

Removing clutch hydraulic system fitting

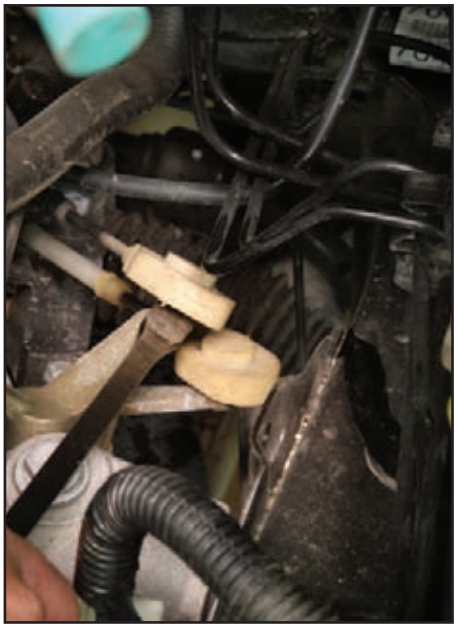


To remove the hydraulic clutch hoselock on top of the transmission, use a small screwdriver to pry the clip out of the clutch fluid distribution block. The photo on the right shows what the clip will look like once it is out of the distribution block.



Pull the hydraulic hose fitting out of clutch distribution block (left) and place a hose cap over the fitting (right) to minimize the fluid that drools out of it.

Removing shifter cables



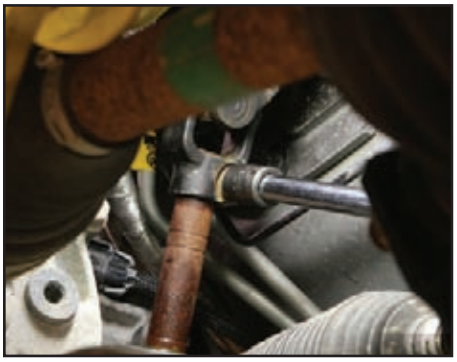
To remove the transmission shifter cables, gently pry the top transmission shifter cable fitting off the gold-colored shifter arm on the transmission.

Gently pry the lower transmission shifter cable fitting off the lower shifter arm on the transmission. After shifter cables are removed from the shift arms, remove shift cable bracket by unbolting the two 13 mm bolts from the transmission.

NOTE: Record the shifter arm locations and make sure shifter arms are in original position when reinstalling.

Disconnecting steering linkage

Locate the steering shaft U-joint that connects to the rack-and-pinion steering unit, behind the engine on the driver's side of the vehicle.

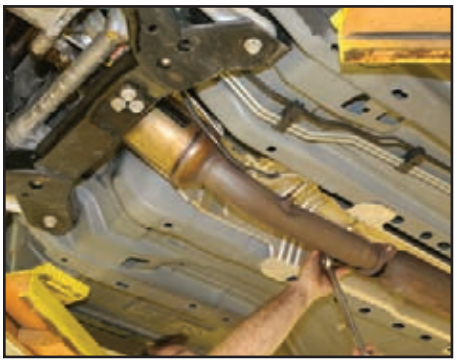


Remove the 13 mm bolt holding the U-joint onto the splined rack-and-pinion shaft.

Wiggle the U-joint off the splined shaft.

Removing exhaust components

Unbolt the three 15 mm fasteners holding the exhaust downpipe onto the exhaust manifold.



Unbolt the two 15 mm fasteners holding the downpipe on the rest of the exhaust system. Have a helper hold the downpipe slightly tilted down until the O_2 sensor is disconnected.

Separate the O_2 sensor electrical connector situated next to steering shaft on the rack-and-pinion by lifting the lock tang and gently peeling the two connectors apart.

Remove the exhaust down pipe from the vehicle.

Disconnecting front suspension components

So here's what you're going to remove next (arrows from top in clockwise direction): upper nut for front swaybar, nut for steering tie rod, lower ball joint bolt/nut and front axle nuts.

Using an 18 mm open-end wrench, remove the nut on the steering tie rod ends.

If the tie rod end just spins, hold the rod with a 5 mm socket, while loosening the nut with the open end wrench.

This is what the tie rod end looks like removed from the vehicle. (And with nut on.)

Remove the 18 mm nut holding the upper swaybar mount onto the front strut.

Sometimes the rod end for the swaybar will spin, which will require you to slide a 17 mm open end wrench between the mount and link to hold the shaft of the rod end to prevent it from spinning.

Loosen and remove the 15/16 mm bolt/nut combination holding the lower ball joints in place on the spindle upright.

Carefully pry the ball joint out of the spindle upright and let the assembly hang on the strut.

This is what the ball joint looks like removed from the spindle upright.

With a helper pressing on the brake pedal in the interior, use a 30 mm socket on a breaker bar to loosen the axle nuts. This shouldn't be super tight, but without someone holding the brakes, you're not going to get this loose.

Loosen the nut to the point that it is hanging off the axle by about a thread or two, to protect the axle threads from damage. With a large dead-blow mallet or hammer, hit the nut to release the axle splines from the hub splines—this shouldn't take an immense amount of impact to knock loose.

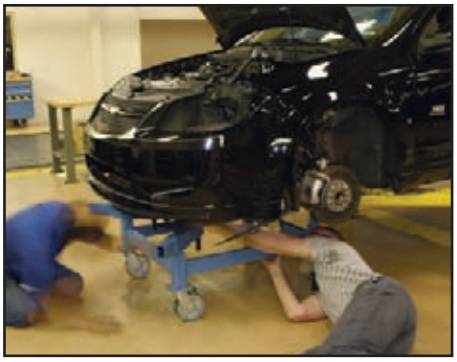
Grab the disc brake rotor with one hand and the axle with the other hand—pull the two apart until they look like this. Let the axle and front suspension pieces hang where they are, and move on to the next step.

Remove the remaining black plastic splash shield on the passenger's side of the vehicle underside, by removing the three pushpins and two 7 mm screws.

Preparing to remove engine/cradle

This cart is a super trick piece that has been custom built for these vehicles, but a moving cart with some wood blocks will work just as well to rest the engine/cradle on once it is unbolted from the vehicle.

The vehicle is lowered down until the main beams of the engine cradle just barely rest on the cart.



The act of positioning the cart and engine cradle to meet each other will require you and some help to carefully watch the vehicle as it comes down, and constantly repositioning everything until it all mates cleanly.

Now that the engine cradle is resting firmly on the cart, the four 21 mm engine cradle bolts can be removed from the vehicle. Notice that an impact wrench is being used here—you can remove these with a ratchet wrench, but these have a lot of torque on them and working on your back makes getting the appropriate amount of force on these bolts tough.

CAUTION: Removing these bolts means the cradle will be released from the vehicle! Make sure the cart is firmly under the cradle, the vehicle is safely supported, and you are using care and caution with regard to these components coming out of the vehicle.

With the engine cradle bolts removed, now is the time to recheck the mating of the cart and cradle in preparation for lifting the vehicle off the engine cradle. Also, you should go back over the wiring, bolts and other systems that needed to be disconnected to allow the engine/transmission to be removed to make sure they are, in fact, free of the engine/trans.

Back under the hood, you'll need to remove the three 16 mm bolts in the upper engine mounts on the passenger side of the engine. These are tight, so be prepared to give them some serious twist to get them out. You will also need to remove the three 16 mm bolts on the transmount on the driver's side, located under the electrical center.

Well, you're ready to lift the vehicle off the engine cradle—but be patient! Have some helpers watch for wires and other pieces that are still connected to prevent damaging anything. Literally, lift the vehicle less than 1/4-inch and inspect underneath and underhood for still-attached pieces, then lift 1/4-inch again. Keep doing this until vehicle and engine are about 6 inches separated—then you should be able to safely lift the body off.

This is what it will look like as the engine/transmission remain on the floor and vehicle is lifted off. Again, you can't be too careful to avoid damaging components still attached to the engine/transmission—inspect every corner of the engine bay as these pieces separate.

Lifting vehicle off unbolted engine/cradle

This is exactly what it looks like—the vehicle rising off the engine/trans. There is still a fair amount of work to get down to just the engine, but you're well on the way to making this happen.

Here are two views of what the engine/trans combo will look like after being removed from the vehicle. Notice how the radiator/etc. are mounted to the engine cradle, the next step is to remove the radiator.

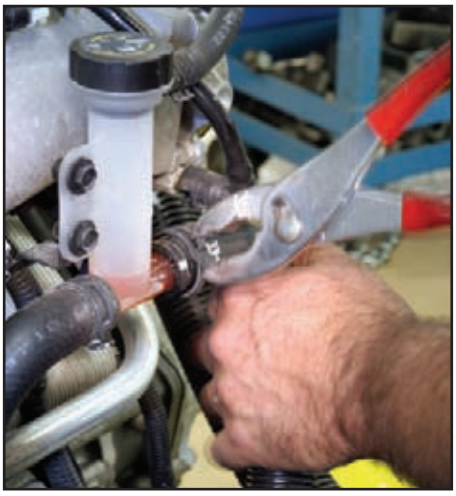
The engine/transmission are just 'sitting' on the cart, so the sooner you can get the engine hanging off a cherry picker chain the better—as is being done here. Use the factory lift plates located at each end of the Ecotec engine

Removing cradle components

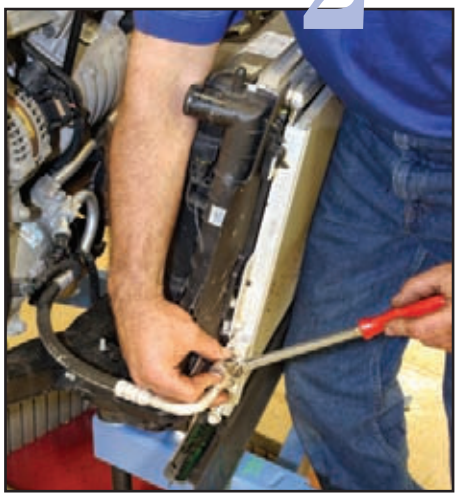
Compress the clamp holding the lower radiator hose on the radiator outlet and peel the hose off the outlet. Expect some coolant to find its way out of the radiator at this point, so have a drain pan and some rags ready to catch the remaining DexCool that comes out.

Lift the lock tab and pull coolant fan electrical connector out of the fan assembly.

The radiator/intercooler/A/C condenser assembly will be pretty floppy on the cart at this point, so it is recommended you stand in front of it and let it lean forward slightly while you remove the next few remaining items before lifting the entire assembly off the cart.



Using pliers, compress the clamp holding the intercooler return line on the fill tube mounted on the supercharger. Gently wiggle the hose off the plastic reservoir—again, be ready for some errant coolant to fall on the ground.



Remove the 13 mm bolt holding the A/C compressor hoses onto the A/C condenser.

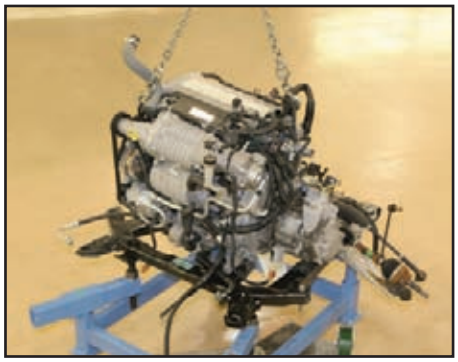
Lift the radiator/intercooler/A/C condenser assembly off the cart. Set it front-side face-down on some cardboard, and lay some cardboard on the back of the finned section to protect the fins from being damaged.

This is what the engine/trans assembly will look like with the radiator/etc. assembly removed.

Removing through-bolts on engine mounts

With the cherry-picker chain tight on the engine, remove the front engine mount 18 mm through-bolt.

Remove the rear engine mount 18 mm through-bolt to completely free the engine/transmission combo from the cradle.

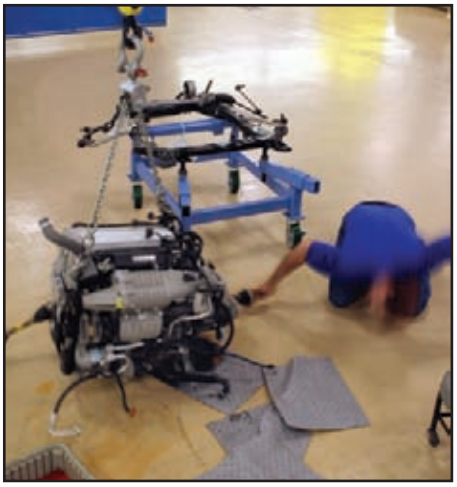


The engine/trans combo has a tendency to hang toward the driver side of the cradle, as the bolts on the mounts are removed; be aware of it wanting to angle toward this area.

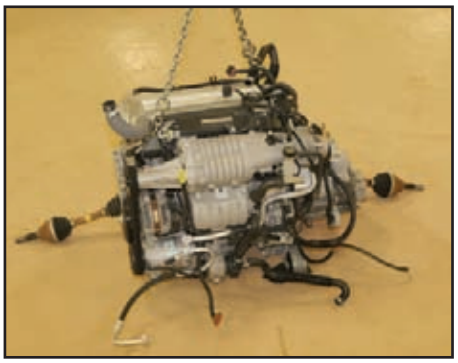
Slowly "bump" the engine/trans combo up off the cart. You'll probably need to persuade the rubber mount bushings past their metal frame brackets with a pry bar, so take your time with this activity.

The engine/trans combo will need to be lifted about one foot off the cradle to provide clearance to swing the transmission over the cradle. Make sure your cherry picker will do this before getting too far into this step.

Setting engine and trans on the ground



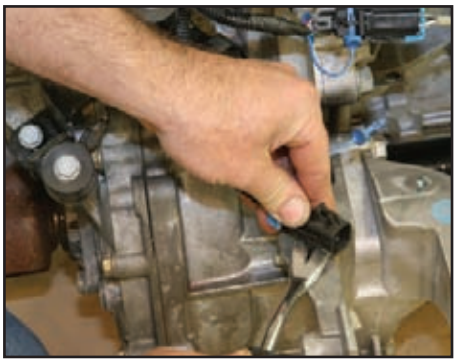
When you have clearance, move the cradle out of the way and set the engine/trans combo down onto the ground. Notice the drain pan and absorbent pads—expect some more coolant to drool on the ground.



Well, here it is—the Ecotec LSJ engine on the ground. Now, we just need to get the engine and transmission separated.

Separating the engine and transmission

The last major step to having the Ecotec LSJ engine freed up to rebuild is separating the engine and transmission—which is what you're going to learn to do in the next steps.



Peel the 'christmas tree' mount for the O_2 sensor electrical sensor out of the transmission with a connector pry tool (like this one).

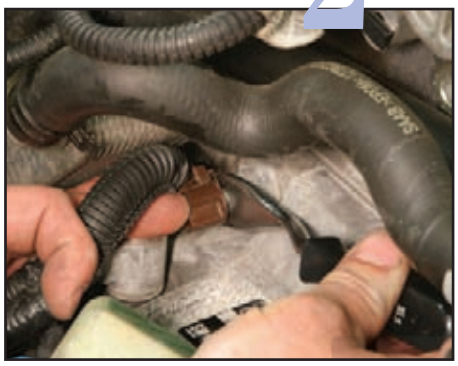
Just below the transmission cable mounts you will find the vehicle speed electrical connector. Lift the lock tab on it and pull these two ends apart.

Pull the blue lock pin out of the O_2 electrical connector, lift the lock tab and wiggle these two connectors apart.

Pry this wiring loop off the stud portion of the cam sensor.

Lift the lock tab and wiggle the bypass solenoid electrical connector off this engine-mounted connector.

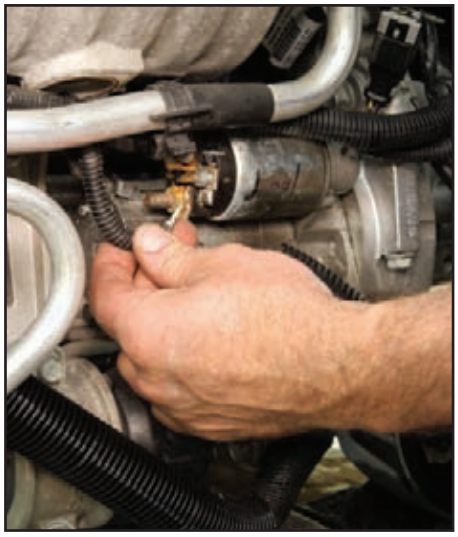
The evap purge solenoid red electrical connector lock tab is underneath, so you'll need to carefully pry it out about 1 mm and wiggle the connector off the engine.



On the driver's side of the engine (what some might call the "back" of the engine), pry this brown plastic wiring clip off one of the transmission stud/bolts.

Removing the starter

Amidst this gaggle of wiring and hoses is the starter, which many remove to separate the engine and transmission. Start by removing the intercooler inlet hose from the intake manifold (arrow points to clamp to remove) nipple.



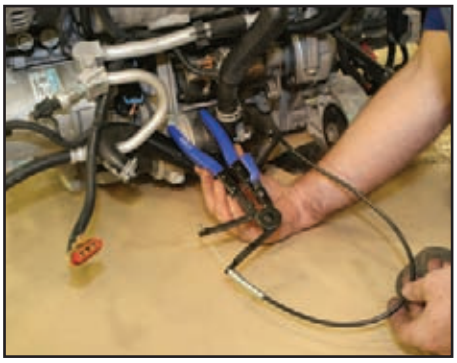
Start by removing the 8 mm nut holding the key-on power wire onto the starter solenoid and pull the key-on power wire off the solenoid.

With a deepwell 13 mm socket on a ratchet wrench, reach around behind the starter solenoid to remove the nut holding the main power cable onto the solenoid.

Lift the main power wire off the solenoid.

Loosen the first of two 15 mm starter bolts and remove it.

Loosen the remaining hidden 15 mm starter bolt by combining a three inch extension with a 15 mm deepwell "wobble" socket. You might be able to get this off with a solid socket, but the wobble definitely makes this easier. Remove the bolt in preparation for removing the starter.



Remove the intercooler feed hose from the intercooler coolant pump. This can be accomplished with a pair of pliers but if you plan on doing this type of work more than once, you should consider investing in these cool "remote pliers" from Snap-On. They allow you to relax clamps in extremely tight spaces without scraping up your knuckles.

Set the intercooler feed hose aside.

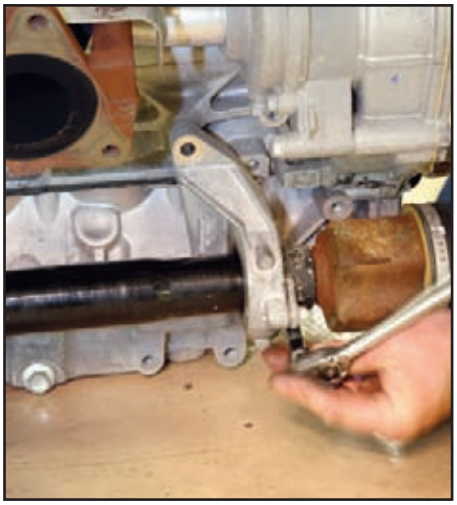
Feed the starter back and outward—this is tight, so you'll need to wiggle and jiggle it to get to this point.

With the starter removed from the engine, set it to the side and prepare to unbolt the transmission from the engine block.

Removing halfshaft mounts

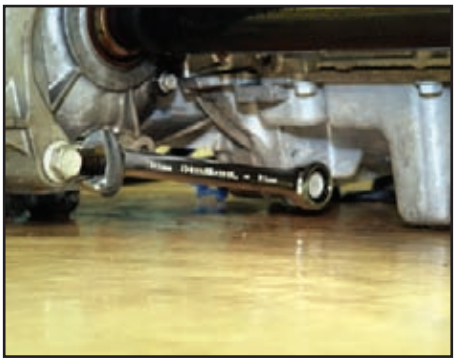
The passenger side halfshaft has a mount on the backside of the engine that needs to be unbolted at this point.

Remove the three 15 mm halfshaft mount bolts—this is one of the two upper bolts.



Remove the two lower 15 mm mount bolts while holding the mount, as it will want to fall off the engine block at this point. Lower the mount to the floor.

Remove the lower 18 mm engine-to-transmission bolt on the backside of the engine with a shallow socket (to clear the exhaust manifold).



Underneath the engine, remove this 18 mm engine-to-transmission bolt with the deepwell socket/extension/socket combo.

Disconnect the reverse light switch electrical connector located on the top of the 5-speed manual transmission.

Unbolting the engine from the transmission

Removal of these two 18 mm engine-to-transmission bolts is the reason the starter needed to be removed. Start by unbolting the hidden 18 mm fastener.

Remove the outer 18 mm engine-to-transmission bolt on the starter side of the engine.

Using an open end-wrench, remove the 18 mm engine-to-transmission bolt located underneath the starter's location.

Move to the area at the back of the engine and use a deepwell 18 mm socket to remove the bolt/stud on the top of the transmission case.

Remove the upper 18 mm engine-to-transmission bolt on the backside of the engine (note the exhaust manifold) with a deepwell socket on a short extension and ratchet wrench.