Rebuilding
**GM's Gen IV**
Engine
4.8L • 5.3L • 6.0L

Brought To You By:
**ENGINE & PERFORMANCE WAREHOUSE**
Shortly after GM introduced the LS1 in the ’97 Corvette, they created a whole new family of small block truck engines based on the LS1, including the 4.8L, 5.3L, 6.0L and the 6.2L that each came with a number of variations over the years. In fact, GM built nearly 30 different versions of these truck engines during the past ten years. They all share a common architecture and quite a few common parts, but there are significant differences between the Generation III (Gen III) and Generation IV (Gen IV) engines along with plenty of variations from year to year. Just to put it all in perspective, there were seven different 5.3L engines in 2005 – along with the 4.8L and a couple of 6.0L motors.

Sorting them out has been a challenge, but after six months of research along with a bunch of cores, some take-out motors and a pile of new parts, we think we have figured out most of the combinations and where they were used, but we may have missed something, so let us know if you have some information to share.

The key to cataloging the Gen IV engines is an understanding of the changes that GM made to the Gen III engines to make them more suitable for truck applications. They needed more torque, more power and better fuel economy along with lower emissions, so they modified the block and several other components to accommodate cylinder deactivation (they call it active fuel management or AFM) and variable valve timing (VVT). Here’s an overview of the technology and what’s involved:

- **AFM:** The Gen IV blocks were cast with eight oil ports in the valley to accommodate the lifter oil management assembly (LOMA) that deactivates the lifters for every second cylinder in the firing order under light loads. The knock sensors and cam sensor were moved to make room for the LOMA, because it was bolted on top of the valley. A powerful new ECM was added in ’07, so the crank reluctor wheel was upgraded to 58 teeth and the cam gear had four notches instead of one so the sensors could provide more immediate and accurate information to the computer.

And, the special “De-Ac” collapsible lifters were added for the four cylinders that were going to be deactivated. This is amazing technology, because the four cylinders are deactivated in 45 milliseconds, in firing order sequence, when the exhaust valves are closed… at the same time the injectors are turned off and the position of the throttle blade is changed.

This process is reversed during reactivation except that the torque converter is momentarily unlocked to allow it to...
absorb the torque spike that occurs when the four cylinders come back on line. That's why AFM is only available with an automatic transmission. AFM improves fuel economy up to 20% depending on the application, because operating the engine on four cylinders reduces pumping losses and increases thermal efficiency.

As amazing as it is, AFM is not without problems that can affect engine builders. We’ll talk about noisy lifters and oil consumption later.

Variable valve timing (VVT) is sometimes called, “eliminates the compromise inherent in conventional fixed valve timing and allows a mix of low rpm torque over a broad range of engine speed and free breathing, high-rev horsepower, when needed,” according to GM. In other words, VVT lets the engine breathe better across the full spectrum of rpm and loads, while creating a wider, smoother power band.

The cam phaser can advance or retard the cam by up to 62 degrees, “ according to GM. In other words, VVT lets the engine breathe better across the full spectrum of rpm and loads, while creating a wider, smoother power band.

GEN III Blocks

The LS1 that was installed in the ’97 Corvette was the first Gen III motor (the 265 was Gen I and the LT1 was Gen II). GM says it’s part of the small block family, but the only thing it has in common with the earlier engines is the bore spacing and the shape of the bell housing.

Soon after the car motors were introduced, GM replaced the old 360 and 350 truck motors with the new 4.8L, 5.3L and 6.0L engines that all used the LS architecture. There were both cast iron and aluminum blocks used from ’99 through ’06, but the cast iron blocks were usually found in 2WD pickups and the aluminum blocks were used in the 4WD pickups and SUVs along with the Chevy SSR. They can all be identified by the two knock sensors in the valley and the cam sensor that’s located in the back of the block near the bell housing.

The first Gen IV truck engine was introduced in ’05 in the mid-sized SUVs, including the Trailblazer and Envoy along with some other models that shared the same platform. The new 5.3L came with AFM and an aluminum block that incorporated several changes. The most noticeable difference was the addition of the eight oil ports in the valley that supplied oil from the LOMA to the “De-Ac” lifters, so the two knock sensors were moved from the valley to the sides of the block and the cam sensor was moved up to the front cover in order to make room for the oil ports and the lobe oil management assembly. The cast iron Gen IV block for the 4.8L/5.3L showed up in ’07, along with the cast iron 6.0L that was followed by an aluminum version of the 6.0L in ’08. The 4.8L/5.3L cast iron block is a GH3 Hummer didn’t have AFM.

• A 5.3L engine was used in the L59 and L69 engines still came without AFM in ’10 and ’11.
• The Gen IV 6.0L engine all got VVT beginning in ’07, but the 4.8L/5.3L and 6.0L/6.2L engines were only available with AFM.
• All of the 5.3L engines got VVT in ’10, but the L94 and LMF engines were only available with AFM in ’08 and ’09.

The VVT motors have an electric solenoid that modulates the oil to the phaser so it can advance or retard the cam.

The three bolt gear with a 1X sensor was replaced by the 1 bolt gear or phaser that had a 4X sensor in ’07.

There's one bolt hole on the rear cover for the FW D (right) that's relieved to clear the smaller Buick bell housing.

Note the difference in the shape of the teeth on the cam gear. This asymmetrical design reduces chain noise.

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There are long and short LS rods that came with and without pin bushings, but all of the Gen IV rods are bushed. It’s easy to tell them apart because the Gen III press-fit rods have rounded edges on one side of the
beam and there's no bushing.
• 4.8L: These engines all have the long rod that measures about 4.70˝ from bore-to-bore. They're powdered metal with a cracked cap and no identification.
• 5.3L and 6.0L: All of these engines use the short, bushed rod that measures about 4.520˝ from bore-to-bore. They're all powdered metal and most of them have "GKN" and "3847" on the big end of the rod. Rebuilders need to be aware that the bushed rods weigh 30 grams more and the pin bore in the press-fit rods is about .002˝ larger than the one for the bushed rods, so you can't play mix and match if you're short of the bushed rods.

Pistons
Installing the right pistons in the right motor can be a challenge, because there are flat tops and dished pistons that came with and without the valve reliefs that are required for the engines that have variable valve timing (VVT), so it's easy to make a mistake. Here's our cheat sheet for the Gen IV motors:

Oil Pumps
The Gen IV engines have used two different oil pumps that have three different springs for the relief valve. They're all powdered metal and most of them have "GKN" and "3847" on the big end of the rod. Rebuilders need to be aware that the bushed rods weigh 30 grams more and the pin bore in the press-fit rods is about .002˝ larger than the one for the bushed rods, so you can't play mix and match if you're short of the bushed rods.

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'10-'11 Flat Tops with 2 reliefs 19208675
5.3L '05-'09 Flat Tops 89060486
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6.0L '05-'09 LS2 Flat Tops 19178305
'07-'11 Dished 89017369
(Ex Hybrids) w/2 reliefs
10-11 L1 Flat Tops 19209296
(Ex Hybrids) w/2 reliefs
12-09 HP Flat Tops 19209296

The rings for these engines are pretty straightforward because there haven't been many changes made since the advent of the Gen III truck engines in '99.
• 4.8L: One set covers all the 4.8L engines from '99-'11. The rings are 1.5mm/1.5mm/3.0mm.
• 5.3L: The same set covers all of the 5.3L engines from '99-'11, because the bore is the same as the 4.8L and the rings are still 1.5mm/1.5mm/3.0mm.
• 6.0L: There have been two ring sets for the 6.0L from '99-'11.
• The rings in the first set that fits from '99-'04 are 1.5mm/1.5mm/3.0mm.
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Be sure to match the pistons and rings for each application.

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The shield that fits over the AFM relief valve in the pan deflects the oil down and away from the crank so it doesn't end up on the walls.

The Gen IV engines without AFM had a flat cover (left) that sealed off the valley and the oil ports. The lifter oil management assembly (right) was used on the engines with AFM.

There are four solenoids on the lifter oil management assembly that are connected to the eight oil ports that control the "De-Ac" lifters.

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PREDICTIVE ENGINEERING

EXHAUST HEADER

OIL PAN

WATER OUTLET

The challenges of a technology-driven engine can prove...
The only difference between them was the spring for the relief valve. The original 12571885 pump that was used for a couple of applications in ’05–’07 had a red spring that relieved the oil pressure at 43 lbs.

Based on our research, we believe that GM originally intended to build these early 5.3L Gen IV engines with both AFM and VVT, so they increased the pressure and the volume to make sure the pump could supply enough oil for both of them, but they apparently decided they didn’t need the higher oil pressure because this pump was replaced by the 12612289 that had a 33 lbs. relief valve in ’08.

We recommend replacing all the factory oil pumps with aftermarket pumps because the original design has several flaws that can lead to problems.

The 12612289 is the latest version of the big pump. It has bigger housing with the extra capacity, but it has the yellow spring that reduces the maximum oil pressure from 43 lbs. down to 33 lbs. It’s used on all of the truck engines with an aluminum block that have AFM or VVT or both. It’s the Melling M365.

The LFA and LZ1 Hybrids came with a variable displacement oil pump that supposedly saves two horsepower. It’s available under p/n 12625823 for the LFA and p/n 12623423 for the LZ1.

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The intake rockers had to be offset by 6.0 mm to clear the large, rectangular ports on the 823/ 536 heads that were installed on the 6.0L Gen IV engines beginning in ’07.

The cam for the ’05–’06 Gen IV engines had three bolts for the cam gear, the ’07–’09 engines without VVT had a single bolt and the all of the engines with VVT had the single bolt along with the two “ears” that supplied oil to the phasers.

The second journal was grooved and had a hole that fed oil into the hollow core for the engines with VVT.

The cam for the ’05–’06 Gen IV engines came with either flat top or dished pistons that had valve relief for VVT, but the ones for the LS2 didn’t have relief because it didn’t have VVT.

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Timing Components

There have been several changes made to the timing components over the years. This can create a problem for rebuilders, because the chains, gears and tensioners are not interchangeable even though they may fit several different applications. Here are the correct gear and sensor combinations:

• All of the Gen III motors had the cam sensor located on the back of the cam so they used a “plain” gear with lots of holes in it that was bolted to the front of the cam with three small capscrews.

Note: GM and most vendors have consolidated their timing gears/sets by replacing the “plain” gear with the ’05–’06 Gen IV gear that has a single notch in it and three capscrews. It works fine.

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SEALED POWER® DIGITAL DIAMOND PROFILE® (DDP) PISTONS

THE MOST ADVANCED TECHNOLOGY YET!

Cast and machined in Federal-Mogul’s world-class facility in South Bend, Indiana, these pistons are the only Chevy small block replacement piston you’ll ever need. The perfect choice for classic automotive enthusiasts, this piston lets the rebuilder equip a vintage small block with the most advanced piston technology available, keeping that classic engine “classic” while outfitting it with today’s best means of delivering ready, reliable power.
The cam sensor was moved to the cam gear and front cover in '05 in order to make room for the oil ports that were required for AFM. The cam gear had a single notch (1X) on it through '06, because these engines still used the old ECM, and it was bolted to the cam with three small cap screws, just like the Gen III motors.

When GM switched to the new ECM in '07, they changed the cam gear on the 4.8L and 5.3L. It was held on with one large bolt and it had four notches (4X) on it so it could provide a more accurate signal to the computer. It also provided a backup signal and limp-home capability in case the crank sensor failed. This gear was used up through '09 on all of these engines, because none of them had VVT and the phaser with the 4X sensor attached to it.

The cam gear on the 6.0L engines was changed in '07, too, but all of these engines came with VVT so the cam gear was an integral part of the cam phaser assembly that had a stamped-steel plate with four notches (4X) attached to the front of it. This same assembly was used on all the 4.8L and 5.3L motors when they got VVT in 2010.

Here’s a recap of the cam gears and sensors for the Gen IV motors:

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Tensioners

GM has used either a chain damper or a tensioner on all the Gen IV engines, depending on the application. They both fit all the Gen IV blocks, but they’re not interchangeable.

- The 12588670 is the wedge shaped guide that was used on the '05-'06 LH6 and the LS2 along with '05-'07 1st design LS4, because they all had 1X cam gear with the three bolt cam.

- The 12585997 is a blade style, spring-loaded tensioner that was used for all '07 and up Gen IV motors that had the 58X crank reluctor wheel and the 4X cam gear or the phaser. This tensioner must be used on all of these engines because GM created some initial slack in the chain by modifying the tooth profile so the chain sat deeper in the gear, but that created a noise problem, so the powdered metal gears have an asymmetrical pattern on the teeth that reduces the noise by eliminating the common harmonic frequency. Look at the picture of the 4X gear that's on page 37 and you will see that the teeth aren’t symmetri-

The lifter guides for the AFM engines have one notch that indexes on a tab in the block to ensure that it’s installed in the right location. The ones for the engines without AFM have two notches because the lifters are all the same so they can fit in any location.

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The 6.0L Gen IV motors get the 823/5364 castings with the big rectangular intake ports instead of the ones with the smaller cathedral port that were used on all the rest of the Gen IV engines.

cal because they all vary in size and width. The bottom line is that you must use the correct chain/gear/tensioner combination for each application or you will have a noisy timing set that will fail prematurely.

• You must use an A FM cam in the AFM motors, because the ramps on the AFM cylinders are longer so they can take a “De-Ac” lifter apart, you will see why there’s a problem, because there’s a complete miniature lifter assembly inside the outer roller body where the plunger used to be, so there’s not enough oil in the downward upper chamber to refill the lower chamber after the engine has been shut off long enough to let the lifter leak down. GM couldn’t change the physical size of the lifter to fix this problem because it had to fit inside the roller body, so they reduced the leak down rate of the lifter and opened up the oil holes in both the lifter and the plunger to make sure they could refill the upper and lower chambers immediately after start-up. These changes eliminated the problem they had with noisy lifters, so we recommend installing all new “Delphi II De-Ac” lifters in every AFM engine. It’s not worth taking a chance on the original Eaton or Delphi lifters if you have to replace them under warranty when the engine gets 30,000 or 40,000 miles on it. The “Delphi II” lifters are available from GM for about $50 apiece or a little less from at least one supplier in the aftermarket. Be sure to specify the latest “Delphi II” lifters when you order new ones wherever you get them. The correct GM part number is 12695956, according to our Chevy Dealer.

Lifter Guides

There have been three different lifter guides used for the Gen IV engines and they’re unique to each application so they’re not interchangeable.

• All the engines without AFM have a universal guide that accommodates four regular lifters and fits in any location because it has two notches on the guide that match any of the locator tabs on the block. It has the part number, 12595365, molded right on it.

The AFM engines have two different lifter guides that have two big holes for the “De-Ac” lifters and two small holes for regular lifters. The 12571596 is for the front cylinders on both sides and the 12571608 is for the back two cylinders on both sides. GM designed them so you can’t physically interchange them because they each have a single notch that fits over the single raised tab in the block which locates the guide and the lifters correctly.

Heads

There have been several different head castings used on the Gen III and Gen IV motors. The intake and exhaust ports have been changed along with the valve sizes and springs. The chart on page 46 lists all the heads that we have seen by year, RPO and VIN code, including the ones for the Gen III motors, and describes each one by part number, casting number, port configuration and valve size. Once you see them all together, the patterns become more obvious.

Head Gaskets

GM made a slight modification to the coolant passages in the head gaskets that were used on the 796/1264243 heads with “Dee” shaped exhaust ports, so be sure to use the latest design on the Gen III L33/VIN B and all of the 4.8L/5.3L Gen
IV motors. The Gen IV blocks have 8 oil ports in the valley for AFM instead of the two knock sensors that were located in the valley on the Gen III motors.

### GEN III AND GEN IV LS TRUCK HEADS

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>Cast Material</th>
<th>Valve Diameter</th>
<th>Valve Height</th>
<th>Valve Lift</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.8L/4.8L</td>
<td>Cast Iron</td>
<td>2.00&quot;</td>
<td>1.55&quot;</td>
<td>E &quot;Dee&quot;</td>
<td>1.65</td>
</tr>
<tr>
<td>5.3L/5.3L</td>
<td>Aluminum</td>
<td>2.00&quot;</td>
<td>1.55&quot;</td>
<td>E &quot;Dee&quot;</td>
<td>1.65</td>
</tr>
<tr>
<td>6.0L/6.0L</td>
<td>Cast Iron</td>
<td>2.00&quot;</td>
<td>1.55&quot;</td>
<td>E &quot;Dee&quot;</td>
<td>1.65</td>
</tr>
<tr>
<td>6.2L/6.2L</td>
<td>Aluminum</td>
<td>2.00&quot;</td>
<td>1.55&quot;</td>
<td>E &quot;Dee&quot;</td>
<td>1.65</td>
</tr>
</tbody>
</table>

### Rocker Arms and Supports

- **All of the Gen III and Gen IV 4.8L and 5.3L motors came with intake straight and exhaust rockers along with all the Gen III 6.0L engines and the Gen IV LS2 that was used in some trucks. They were bolted to a rocker support that was mounted on the square pedestals that were machined on the heads.**

- **When GM installed the 823/5343 heads on the Gen IV 6.0L engine in 2007, they had to offset the intake rockers by 0.050" so the pushrods would clear the big, rectangular intake ports found on these castings. The rocker support (p/n 12569167) was modified to fit the rounded pedestals that were machined on these heads.**

### Pushrods

- The Gen IV engines use the same pushrods that were used for all the Gen III engines.

### The LOMA and Valley Covers

- **The “lifter oil management assembly” (LOMA) that contains the solenoids that control the “Do-Ac” lifters covers up the valley on the engines with AFM. The early ones were bolted together as an assembly, but the later ones are riveted so they can’t be disassembled. GM offers a perimeter gasket (p/n 20017604) to service the LOMA, but that means you have to cut the gasket and reuse the existing inner port that seals the oil ports and that’s pretty suspect based on the limited number of samples we’ve seen on cores. The only alternative is to install a new LOMA assembly or tell the installer that he has to put a new one on in order to validate the warranty. They cost about $280 apiece, but it may be worth spending what it avoids a problem with the AFM lifter, because you will be blamed even though it’s not your fault.**

- If the engine comes without AFM, there’s a plain cover (p/n 12598833) and a perimeter gasket (p/n 12610141) plus eight “O” rings that seal off the valley and the oil ports. There’s no provision for the PCV on the one that’s used on the trucks, but some of the cars use one that has a PCV baffle, so be sure to use the right one for the application.

### Front Covers

- The Gen IV motors have three different front covers, two for the trucks and one for the cars.

- **All the Gen IV truck engines, except those with VVT, use a 1260326 casting with a hole for the cam sensor that’s offset toward the driver’s side.**

- **The Gen IV motor with VVT still has the hole for the cam sensor offset to the driver’s side, but it also has a large hole in the center for the solenoid that regulates the oil pressure for the cam phaser.**

### Pushrod problems

- **Either a 12556105, a 12587100, a 12598301 or a 12573014 casting. They are all very similar to the Gen III rear cover (p/n 1259287) and appear to be inter-changeable.**

- **The FW D cars use the 12587100 casting. It’s similar to the RW D cover, but it was modified to provide more clearance around one of the bolt bosses for the smaller FW D bell housing.**

### Problems with The LS Motor

- There are a couple of problems with the Gen IV motors that may affect how you rebuild the AFM motors, especially the ones with aluminum blocks.

- **Lifter noise after a two-hour shutdown can be an issue with the engines that have AFM. If the ticking lasts more than 10 seconds after startup and it’s diagnosed as lifter noise, GM is replacing the lifters with the latest “Delphi II” lifters (p/n 1263956) that we described earlier. We recommend using one of the new “Delphi II” “Do-Ac” lifter in these engines to avoid the possibility of a warranty.**

### Conclusion

- That’s pretty much the story about the Gen IV engines. It’s interesting to see how GM has taken a building-block approach to this family that has allowed them to mix and match a variety of castings and components to create 28 engines that are all tailored to different needs and applications.

- Unfortunately, that means there are 28 different truck engines that we all need to rebuild, so it’s going to be real complicat-ed for everyone in the industry, but it can be done if we identify each RPO and rebuild it exactly the way GM built it in the first place. Hopefully this information will make it easier for everyone to do that, but the mora of the LS story is, “Don’t guess and don’t take any short cuts.”

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**Doug Anderson is Manager of Technical Services for Grooms Engines, located in Nashville, TN. He has authored numerous technical articles on engine rebuilding for Engine Builder magazine for more than 20 years. Anderson has also made many technical presentations on engine building at AERA and PERA conventions and seminars. To find Doug’s other articles for Engine Builder magazine, visit our website at www.enginebuildermag.com.**
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GM LS Engine
Rebuilds

Oil Pump Part Numbers Available for GM LS
M295  10295
M355  10355
M365

Watch the Melling video about how to select the proper performance pump.
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