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EXCLUSIVE: WE TEST GM'S BADDEST SMALL-BLOCK CRATE ENGINE, THE LS7

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HOT ROD WHERE IT ALL BEGAN

600-HORSE LS7

Exclusive First Dyno Test of the 427ci LS7 Crate Engine. How Detuned Is It? We Answer the Question With a Cam and Header Swap.

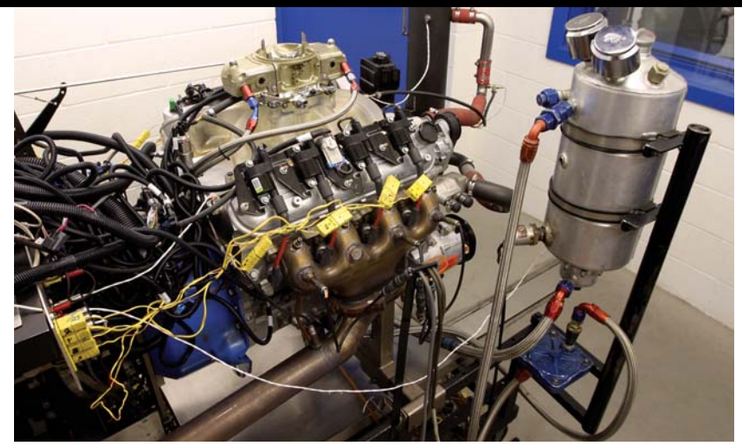
By Matt King

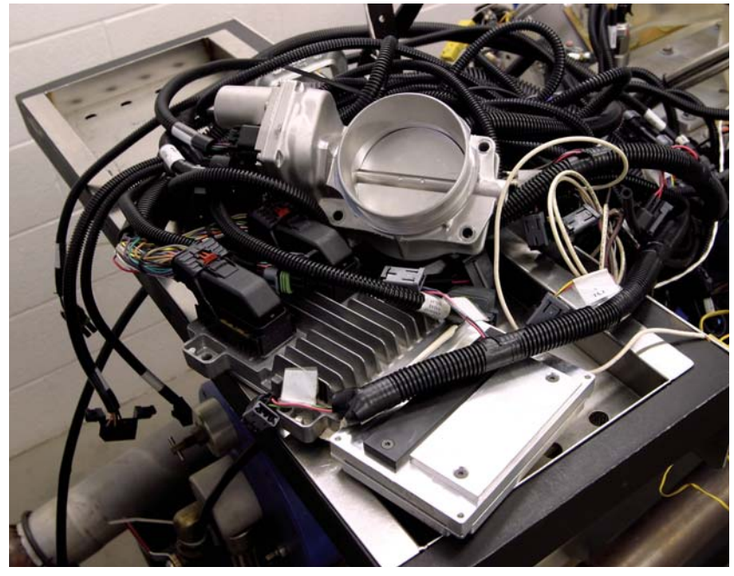
Photography: Matt King, David Freers

When General Motors revealed the '06 Corvette Z06's 505hp LS7 V-8 engine last year, our first question was, "How detuned is it?" After all, despite its 500-plus horses, the latest and greatest 7.0L small-block only makes 1.18 hp from each of its 427 ci, which seems tame for an engine with massive CNC-ported cylinder heads and 11.0:1 compression that spins to seven grand.

But let's give it a break and take a closer look at that power rating. Modern factory engines are built to pass mind-boggling durability standards that few race engines and virtually no backyard-built hot-rod mills could ever hope to pass. For example, GM's standard durability test consists of nearly 300 hours of operation at wide-open throttle, with the engine cycling back and forth between peak horsepower and torque under maximum load. The LS7 also has to pass a thermal shock test that flushes engine coolant ranging from about 250 degrees F to –40 degrees F through the block while it's running. Even in the elite, low-volume Corvette Z06, the LS7 must be serviceable, warrantable, and tame enough to power your boss' secretary's daily driver.

One other important factor accounts for its seemingly tame rating as well. The 505hp rating is generated under SAE J-1349 testing conditions, which correct measured power output to more real-world temperature and atmospheric pressure conditions than the familiar Standard Temperature and Pressure factor used by racers and magazines that corrects to a generous 60 degrees F and denser air conditions. SAE numbers are generally about 5 percent lower than STP. Indeed, the tests we conducted with an as-delivered GMPP LS7 crate engine on a Super Flow 901 dyno at Thompson Racing Engines in Redford, Michigan, generated 546 hp at 6,100 rpm and 514 lb-ft of torque





> **Top and above:** Plumbing the LS7's dry-sump oiling system is simple with off-the-shelf fittings, but engine swappers will have a real challenge dealing with the electronics. Even when testing GM's prototype carbureted intake manifold, the electronic throttle-body had to be connected to the wiring harness to communicate to the ECU. Until GMPP releases a rumored stripped-down street-rod-type wiring harness, the only solution will be to adapt an aftermarket EFI system. As of press time, we understand both ACCEL and Big Stuff systems are capable of interfacing with the Gen IV LS7's 60-minus-2 crank-position sensor. > **Right:** Engine builder Paul "Colonel" Poholsky sauces up one of the two GM Racing HOT cams we tested in an LS7 at Katech Engine Development. The "little" one made 554 hp, and the "big" one grazed 600. And those are SAE numbers—add about 5 percent for "magazine" horsepower.

> Steel lash caps prevent galling the tips of the titanium intake valves.

> To reduce the danger of coil bind with the higher-lift GM cam, offset titanium valvespring retainers were swapped for the stock steel retainers. The resulting increase in installed height from 49.75 to 50.75 mm also reduced the seat pressure from 101 pounds to 87 pounds, but the reduced mass of the titanium retainers easily offsets any loss of high-rpm valve control.

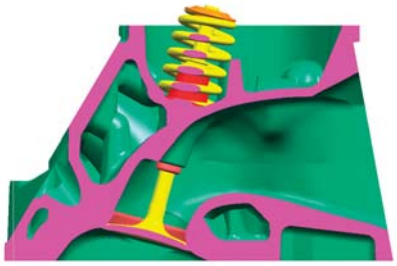
> The LS7's roller fulcrum rocker arms are similar in design to those used on previous Gen III and IV small-blocks, but the intake rockers are offset by 7 mm to provide increased port clearance around the pushrod. They also bolt directly to cast-in bosses in the heads rather than to a separate bolt-on stand as is used on other Gen III/IV engines. Also note the beefy stock 3/8-inch pushrods that are used to ensure maximum valvetrain stiffness. That used to be big-block stuff!

at 4,900 rpm with stock LS7 manifolds but without catalytic converters or stock mufflers and exhaust using the STP factor. That means 522 hp and 492 lb-ft using the SAE factor. So in "magazine numbers," the LS7 is really making 1.27 hp/ci, which is decent for a mildly cammed pump-gas engine. And as you'll see, with more cam and better headers, it gets a whole lot more decent.

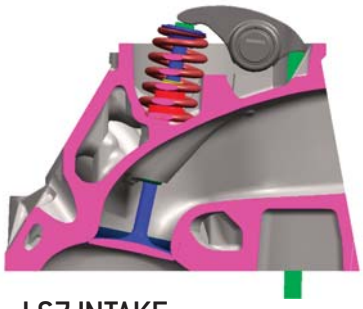
The LS7 shares the same basic architecture of the latest Gen IV iterations of the small-block, but it's pumped up with a 4.125-inch bore and a 4.00-inch stroke. Major deviations from the base C6 Corvette's 6.0L LS2 include a revised valve angle of 12 degrees compared to 15 degrees for the rest of the Gen III/IV family, offset intake valve location and rockers arms, pedestal-mount roller-rockers arms replacing the standard Gen III/IV stand-mounted rockers, and completely revised intake- and exhaust-port shape and location. The LS7 cylinder heads feature fully CNC-ported high-flow cylinder heads (see Flow Chart) with raised intake ports that replace the familiar LS1/LS2 "cathedral" ports. The redesign to a traditional race-style rectangular-port design was made possible by the offset-intake-valve pushrods. To achieve the LS7's 7,000-rpm redline, the highest ever for a production pushrod V-8, lightweight titanium intake and sodium-filled exhaust valves are used, along with ovate-wire conical beehive-style valvesprings. Forged titanium connecting rods for lighter reciprocating mass swinging from a forged crankshaft ensure long-term high-rpm durability, and oil control under sustained high lateral acceleration loads is maintained by a semidry-sump oiling system. Taken as a whole, the LS7 is an impressive package for a mass-production factory engine. And to top it off, production Z06 Corvettes routinely achieve 25-plus miles-per-gallon fuel economy with reports of as high as 30 mpg under sustained highway cruising.

When GM Performance Parts announced it would release the LS7 as a limited-edition crate engine, we saw our chance to get an answer to our initial reaction. Although availability will be limited (fewer than 150 will be sold through select GMPP dealers) and the $16,795 list price (as of press time) isn't cheap, we got dibs on one of the first and lined up some key help from within GM to see what an LS7 can do when released from the confines of a Z06's engine compartment. Through connections at GM Powertrain, we spent an afternoon touring the airflow research laboratory at the GM Technical Center and interviewing several of the key engineers responsible for the development of the valvetrain and cylinder heads. Through those same hookups we got the exclusive inside scoop on the development of a pair of GM Performance Parts HOT cams that are scheduled for catalog release by the time you read this (see Cam Specs chart). Along the lines of GMPP's famous HOT cam for the Gen II LT4 engines, these latest versions are designed to work with stock valvesprings and piston-valve reliefs, so the swap is a simple, line-up-the-dots affair, at least with the smaller of the two. The larger Stage 3 cam, which increases peak valve lift to 0.630 inch, requires swapping a different set of valvespring retainers to increase the spring's installed height. The change is necessary to avoid coil bind with the higher lift, but the reduced mass of the replacement titanium retainers results in improved high-rpm valve control, according to GM Powertrain engineer Tony Roma, who arranged the testing of the cams.

Combined with a pair of 1¾-to-1⅞-inch step headers, the Stage 3 cam made exactly 600 hp at 6,800 rpm and 526 lb-ft of torque at 4,800 rpm, or 1.40 hp/ci with the SAE correction factor at Katech Engine Development. That's a 90hp gain over the stock cam with the same headers, and it's a damn good answer to our question.

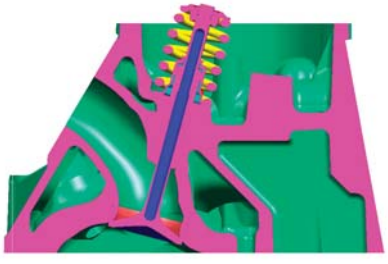


LS6 INTAKE

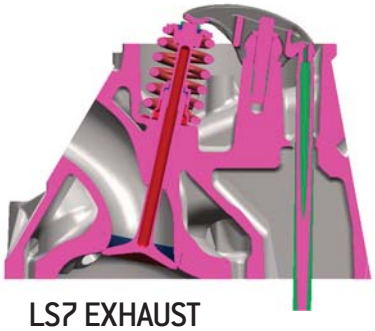


LS7 INTAKE

> The chart below compares the port cross-sectional area of the LS7 and LS6 cylinder heads. Note how much the LS6 head's pushrod pinch-restricts the port area compared to the LS7.



LS6 EXHAUST



LS7 EXHAUST

> By replacing the standard Gen III/IV bolt-on rocker-arm stands with pedestals cast directly into the head, GM cylinder head designers were able to remove the large divot in the top of the intake ports created by the boss for the rocker-stand holddown bolts. The redesign also allowed the intake-port roof to be raised to straighten the air-charge path from the manifold into the cylinder.

FLOW CHART

The following cylinder head flow data comparing the LS7, LS6, and LS1 heads was provided by GM Powertrain from data generated in its airflow research lab at the Warren Technical Center. These tests were conducted on a flowbench pulling 7 kpa depression drop, which is equivalent to the conventional 28 inches of water depression, but the flow numbers are recorded in the metric measurement of grams of air per second. Although there isn't a simple conversion factor to convert grams per second into cubic feet per minute, the charts nonetheless provide an excellent comparison of these heads' flow characteristics in relation to one another. The most impressive thing to note is that the LS7's exhaust port flows more peak air than the LS6's intake port. To put the LS7's peak intake flow into context, on a Superflow 600 flowbench, it flows about 360 cfm at 0.600-inch lift, which is 15.25 mm.

EXHAUST PORT AIR-FLOW (GRAMS/SEC)

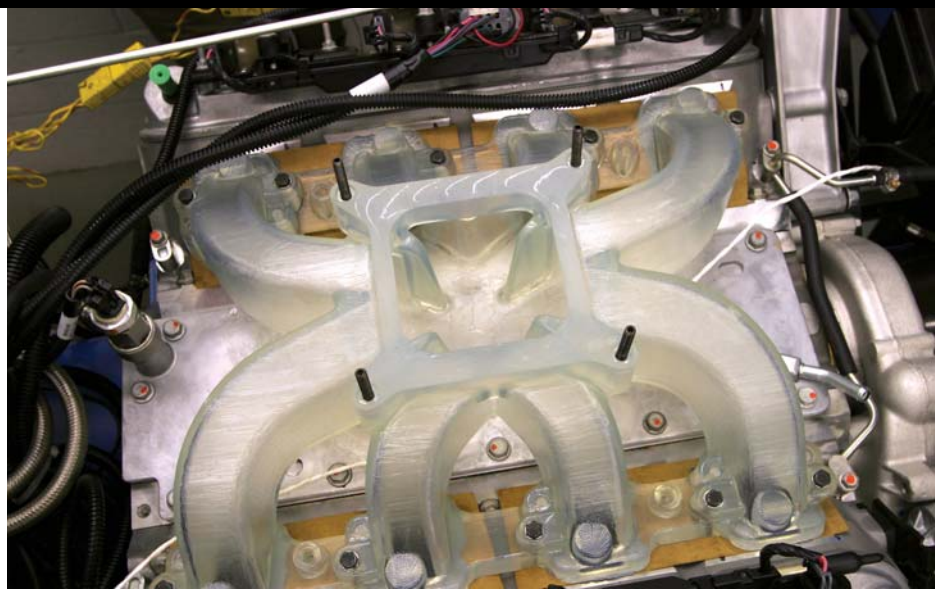
Lift (mm)	LS7	LS6	LS1
1	11.2	11.2	10.5
2	25.3	24.3	23.8
3	38.5	40.7	40.2
4	51.0	53.9	52.0
5	65.0	65.9	62.4
6	79.7	78.2	71.2
7	96.5	87.2	82.4
8	111.9	95.0	90.6
9	122.8	101.6	97.4
10	129.6	106.5	103.2
11	134.9	110.1	107.6
12	138.8	113.6	111.6
13	141.5	117.0	115.4
14	143.7	120.8	118.5
15	145.6	122.7	120.1
16	147.3	124.0	—
17	148.7	124.8	—

INTAKE PORT AIRFLOW (GRAMS/SEC)

Lift (mm)	LS7	LS6	LS1
1	15.3	14.0	13.4
2	32.8	28.1	28.1
3	47.2	43.5	42.0
4	63.8	59.5	56.4
5	82.3	76.2	73.0
6	105.2	90.2	86.9
7	125.5	103.1	98.3
8	141.1	114.1	108.0
9	153.4	122.6	116.8
10	166.5	132.1	123.1
11	177.4	138.2	126.8
12	185.8	140.1	129.7
13	193.3	142.3	128.4
14	199.6	139.8	129.4
15	204.3	142.9	128.8
16	206.0	139.1	—
17	195.7	139.3	—

A CARBURETED LS7

The very cool photo on this month's cover is of a stereo lithography prototype carbureted intake manifold that GM Racing developed for the LS7 crate engine. Although GM Racing asked us not to quote specific power numbers, the results of the testing with the open-plenum single-plane carbureted intake manifold running a 1,050-cfm Race Demon RS 4150-style carburetor were near-perfect overlays of the EFI manifold's horsepower and torque curves. This manifold is also expected to fit the soon-to-be-released L92 6.2L small-block's cylinder heads, which share the LS7 head's raised rectangular-port location and offset intake valves but retain the standard Gen III/IV 15-degree valve angles, which makes them a very attractive alternative to the LS7 heads for 4.00-inch and smaller bore engines. The cast-aluminum production version of this manifold should be available now through GMPP dealers. **HRM**



> Despite its delicate appearance, the clear-resin stereo lithography intake manifold proved very tough on the dyno, shrugging off a couple of wicked backfires from a computer-related timing glitch. We've been told that similar manifolds have even passed 24-hour in-car durability tests.

STOCK LS7 CAM

Rocker ratio: 1.8:1
Intake lift (at valve): 0.593 inch
Exhaust Lift (at valve): 0.588 inch

GROSS CAM TIMING (DEGREES)

	OPEN	CLOSE	DURATION
Intake	8 BTDC	89 ABDC	277
Exhaust	80 BBDC	35 ATDC	295

TIMING AT 0.050-INCH LIFT (DEGREES)

	OPEN	CLOSE	DURATION
Intake	18 ATDC	49 ABDC	211
Exhaust	52 BBDC	2 BTDC	230

DYNO RESULTS

Stock Cam with 1¾-inch to 1⅞-inch x 17-inch primary header to 2.5-inch merge collector

RPM	SAE HP	SAE LB-FT
2,813	232	434
3,214	269	439
3,624	312	453
4,029	363	473
4,824	455	495
5,203	485	490
5,593	509	478
5,977	518	455
6,176	518	441
6,373	519	428
6,567	510	408

STAGE 2 CAM

Rocker ratio: 1.8:1
Intake lift (at valve): 0.583 inch
Exhaust lift(at valve): 0.583 inch

GROSS CAM TIMING (DEGREES)

	OPEN	CLOSE	DURATION
Intake	35 BTDC	75 ABDC	290
Exhaust	79 BBDC	46 ATDC	305

TIMING AT 0.050-INCH LIFT (DEGREES)

	OPEN	CLOSE	DURATION
Intake	5 ATDC	42 ABDC	227
Exhaust	47 BBDC	12 BTDC	239

DYNO RESULTS

Stage 2 Cam with 1¾-inch to 1⅞-inch x 17-inch primary header, 2.5-inch merge collector

RPM	SAE HP	SAE LB-FT
2,808	215	401
3,205	271	444
3,622	327	474
4,021	379	495
4,417	425	505
4,812	465	508
5,208	503	507
5,599	531	498
5,989	551	483
6,186	554	471
6,374	554	457
6,574	551	440

STAGE 3 CAM

Rocker ratio: 1.8:1
Intake lift (at valve): 0.630 inch
Exhaust Lift (at valve): 0.630 inch

GROSS CAM TIMING (DEGREES)

	OPEN	CLOSE	DURATION
Intake	34 BTDC	80 ABDC	294
Exhaust	91 BBDC	64 ATDC	335

TIMING AT 0.050-INCH LIFT (DEGREES)

	OPEN	CLOSE	DURATION
Intake	6 ATDC	47 ABDC	233
Exhaust	63 BBDC	33 BTDC	276

DYNO RESULTS

Stage 3 Cam with 1¾-inch x 26-inch primary header with 2.5-inch merge collector

RPM	SAE HP	SAE LB-FT
3,255	281	453
3,647	321	462
4,055	382	495
4,451	430	508
4,873	488	526
5,245	525	526
5,628	558	520
6,019	584	509
6,389	596	490
6,803	600	463

SOURCES

GM PERFORMANCE PARTS; 800/577-6888 (nearest dealer); www.gmgoodwrench.com

KATECH ENGINE DEVELOPMENT; www.katechengines.com

THOMPSON RACING ENGINES; Redford, MI; 313/538-0044