



TOP TEN TUNING TOOLS

Late-model powertrains are controlled by sophisticated factory electronics and computers. The mainstream use of these powerful systems has forced an exciting evolution of aftermarket tools developed specifically to give DIY'ers the ability to accurately redefine (aka 'tune') how these advanced systems command their engines and transmissions. The 'tuning' market has become a tech-niche loaded with 'must have' tools, meters, gauges, and gizmos. What used to be limited to OEM engineers and budget-less research centers has now become available, affordable, and commonplace for the self-tuner. As this latest evolution of late-model tuning unfolds, we at GMHTP took a snapshot in time of what we consider the current top ten tuning tools available today.

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PHOTOGRAPHY BY THE AUTHOR

1. THE TUNER & EXPERIENCE

Even though experience is not a material item, it certainly must be considered a valuable 'tool.' By way of experience, good tuners generally know the cause and effect of changes, prior to making them. The collective summary of both good and bad experiences can help seasoned tuners optimize tunes quickly, safely, and correctly. When experience helps nail down a tune quickly, the powertrain is only subject to endure very limited operation under less than optimal conditions. The extended operation of a powertrain under poor control, while a newbie 'learns' to tune, does nothing to preserve an engine. Knowing the safe limits of an engine and practical targets for a tune allow experienced tuners to steer clear of dangerous operations such as delivering too much spark, or too little fuel, or fouling up transmission commands. There's a vast range of opportunity between simply getting a tune to work and getting a tune successfully optimized for the best possible performance. The experienced tuner can typically tell if there's more to be gained, or not; whereas a learning tuner may falsely believe his tune is peaked, when in actuality it is not.

Hiring an experienced tuner is one sure way to utilize this top tuning tool. However, learning from an experienced tuner is also an effective option, and probably more realistic for DIY'ers. Tuning for the first time can be a daunting and risky venture, but it can also be a greatly rewarding experience and something to build on. The only way to gain experience is by tackling the tune yourself. Befriending an experienced tuner to help you learn the process will minimize risk and serve as a great way to bounce ideas off first, before 'testing' them on your powertrain. The tuning process can be progressive as well, starting with simple changes first to get comfortable; and then working up to more advanced tuning as you learn and gain invaluable 'experience' for yourself.



Over the past decade, chassis dynos have worked their way into almost all tuning shops. Ease of use and speed of setup has made these wheel dynos the choice of most shops. The Superflow chassis dyno at SLP Performance Parts is one of the finest examples of how shops utilize the dyno to tune.

2. DYNAMOMETERS

Tuning on a dyno is arguably the best place to complete the process. Above all else, tuning on a dyno is typically the safest place to tune, both for the powertrain and for the people tuning. From a powertrain standpoint, dyno controls can usually be configured to run only within a defined set of safe operational limits; any operation outside of those limits results in a safe and controlled abort of the test. Tuning on a dyno also eliminates the obvious personal hazards (and legality concerns) inherent with tuning on public roads, or at dangerous speeds on a racetrack. Functionally, dynos can easily control load at precisely commanded points. This allows tunes to be evaluated quickly and easily under virtually all operating points—a task not so easy to replicate with no control over load, such as when tuning on streets or race tracks. In addition to offering safe operation and accurate control, dynos are the most effective tool for quantifying performance and measuring gains from tuning changes. Finally, dynos operate under controlled conditions, limiting variables that can otherwise prove challenging to control.



Old Bridge Township's Raceway Park is the preferred proving ground for GMHTP tuning, along with sister Primedia mags. Besides being a great tool, as a place to legally 'throw down' and speed, E-town is generally packed with fellow and knowledgeable tuners.

3. THE STREET AND TRACK

The dynamic response of a vehicle under load in its intended environment (street, track, or both) is practically impossible to duplicate anywhere other than in that environment itself, making the street and track invaluable tuning tools. Even after dialing in a seemingly perfect tune on a dyno, real feedback from street or track testing almost always calls for further tune tweaking and improvement. The dyno is great for creating a tune and establishing bragging specs, but the streets and tracks are for finishing tunes—and are where races are won and lost. For many, access to a dyno is not practical, so the street and track is the only option. Typically, it is possible to complete a tune entirely in the absence of a dyno, especially for a highly experienced tuner; but, it will certainly take more time, more testing, and more effort. At GMHTP, we only condone safe and legal street and track testing, done within the limits of the law and with the benefit of the appropriate safety equipment.

4. WIDEBAND O2 METER

A little over fifteen years ago, if you wanted to accurately measure the real-time air/fuel ratio (AFR) by content of oxygen in an exhaust stream, it would cost you around ten thousand dollars for the equipment. A more popular and economical approach was to independently measure the intake airflow and fuel flow, and compute the resultant AFR—although outside of the dyno cell, this was highly impractical. Thanks to advances in sensor and meter technologies, modern units can offer superior accuracy and be had for only a few hundred bucks. Because of its high-benefit-to-low-cost ratio, the modern wideband is not only a top ten tuning tool, it is a must-have tuning tool. Widebands are used as feedback devices, delivering a quantified measurement of an engine's nearly instantaneous ratio of air and fuel consumption. The wideband's output is typically conditioned to display the AFR or an equivalency ratio, ER (ratio of actual to stoichiometric). For gasoline engines, the typical target for AFR during light load and cruise is around 14.7:1 (1.0:1 ER), or 14.7 parts of air for every 1 part of fuel—the corresponding stoichiometric ratio for the chemical reaction of gasoline combustion in air. Under load, naturally aspirated engines typically make peak power around a richer (more fuel) AFR of 13.0:1 (0.88:1 ER). Forced induction engines require a much richer ratio yet, sometimes going as rich as 10:0:1



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(0.68 ER). These targets are used to set fuel delivery maps appropriately. By sampling the AFR at each operating point, a tuner can adjust the commanded fuel delivery at point to result in exactly the desired AFR.



There is no easier way to get a peak inside your tailpipe than with FA.S.T.'s trick dual-sensor wideband air/fuel meter (pn 170402, \$613.27). The FA.S.T. unit is plug-and-play, with an easy to use interface. The uniquely 'blue' backlit LCD display is equally easy to view in daylight and at night. The unit is available as both a single (pn 170401, \$466.60) or dual sensor kit—with various cable lengths to suit all tuners, dynos, or motorcycles. The easy self-calibrating operation allows users to accurately start metering exhaust as fast as they can plug the unit in.



Trying to juggle meters, laptops, shifters, and steering wheels is often a challenge—a dangerous one at that. To help trim the chaos, FA.S.T. offers an optional suction-cup mount (pn 170493, \$56.61) for the AFR meter. The articulating piece allows mounting the AFR meter on the windshield like a radar detector, safely out of a tuner's hand, yet perfectly in view.

FA.S.T.'s meter has a stand-alone, built-in data-logger as well, to enable recording for future review. For advanced tuners, the FA.S.T. unit can be configured to output an analog signal for use with other tuning tools or control systems. And with two sensors operating, the box can do a few trick things, like average both signals together. In FA.S.T. fashion, the units ship complete, including a hard plastic storage tote and a detailed instruction manual. There is more on the way, too. A discussion with FA.S.T.'s Jay Rohrback and ZEX's Matt Patrick tipped us off about an optional new rpm module (170536) that will allow indexing the meter readings with the exact corresponding rpm. Ron Tumpaugh, FA.S.T.'s electrical engineering whiz, also mentioned he is hard at work on a new 'E85' (an 85-percent ethanol, 15-percent gasoline mix) version to complement the existing meter's gasoline and methanol calibrations.



The FA.S.T. AFR meter ships complete with one weld-in bung for each sensor. FA.S.T. offers six-packs (pn 307018, \$12.73 each, or \$76.38 per six) of extra bungs for future use in other pipes. The stainless steel bungs include matching stainless plugs as well, to seal off after use.



With a name like 'Exhaust Gas Technologies,' you'd only expect to find the latest tools for monitoring the hot stuff inside headers. EGT's Redline 2-5/8 inch, 4-channel gauge module (pn RG-4TA, \$379.00) is a sophisticated meter you'd expect to pay much more for. The Redline instrument is a modular tool, which can be loaded up with several cool options, depending on one's needs and budget. EGT offers an attractive billet aluminum mounting pod (pn BM6061T6, \$79.00) specific for the Redline gauge. For those who can't watch the gauge indefinitely, EGT has a red LED warning light and mount (pns RLED, \$22.00 and RLEDB, \$11.00) that can be configured to catch the eye at any set 'danger' temperature. The Redline unit is also a stand-alone data-logger. The PC-downloading cable and software (pn CD, \$31.00) is offered optionally for those who need it. Finally, EGT can make practically any custom length and type thermocouple probe to suit each application's requirements. The base stinger four-piece probe kit (pn 4018U-76-R-RG-Quad, \$200.00) is a premium quality setup built to last in the brutal environment around headers and includes four standard length (76 inch) probes. According to EGT's Rick Lawler, probes can be made a custom length for \$20.00 per probe.



If drilling holes and welding bungs in tubing is not your forte, there's still an effective way to utilize an AFR meter. We sketched out plans on a napkin for a simple clamp-on tube that can be slipped in a tailpipe and allow mounting the wideband sensor temporarily. Within fifteen minutes, our local fabrication guru Ken Estelle, buzzed one together for us in his home garage.

5. EXHAUST GAS TEMPERATURE METER

Exhaust gas temperature (EGT) meters are one of the most widely overlooked tuning tools available, despite being one of the simplest and most effective. EGT is widely known as an effective and inexpensive means to monitor every cylinder's status. Things such as failing valve springs, faulty injectors, and leaking head gaskets are easily spotted through EGT readings. Turbo tuners, like Cal Hartline of Hartline Performance, also rely heavily

on EGT for their measurement of a turbo's available and consumed energy, and because unlike wideband sensors, EGTs will survive in the incredibly hot environments around turbos. Hartline uses EGTs both in individual cylinder runners and around his turbos. On his race tunes he'll see temps as high as 1700F in the primaries—well beyond the safe range of AFR sensors. Much like the evolution of widebands, modern EGT probes and meters are now economically attainable and practical for street use. EGT is also proportional to AFR within functional tuning ranges; leaner mixtures cause higher EGT and richer mixtures cause lower EGT. By monitoring AFR with a wideband in one cylinder's primary and equipping all the primaries with EGT probes, it's then possible to extrapolate the approximate AFR (using the correlated relationship measured between EGT and AFR from the wideband equipped primary) of each individual cylinder based on its respective EGT reading. Beyond use as a tuning tool, EGTs can serve other functions too, such as evaluation of exhaust components or even engine components such as camshafts or intake manifolds.

6. PERFORMANCE METERS

Not too long ago, accurate measurement of performance required racetrack electronics, a radar gun, or fifth wheel sensor—none of which are cheap, or readily available. Through the



creative use of electronic accelerometers and global positioning (GPS), economically viable end-user type performance meters have become fairly common. Meters range in price from around \$100 for a basic unit, up to several thousand dollars for a race-quality system. Performance meters are a great way to quantify gains (or losses) from tuning, especially when outside the track. The accelerometer-type meters typically allow for some type of calibration to be performed, and the accuracy can often be increased further by adjusting the calibration so that meter data matches

Entry-level performance meters can be a good starting point for quantifying dynamic performance. This Gtech Pro meter was found on eBay for \$49.95. More sophisticated (and better accuracy) meters can be found as well, depending on one's budget and needs.

EGT offers both clamp-on type and weld-on type bungs for mounting probes. The clamp-on mount can be used anywhere a hole can be drilled and the clamp will fit. For the more permanent mount, weld-on bungs can be buzzed to the desired locations.



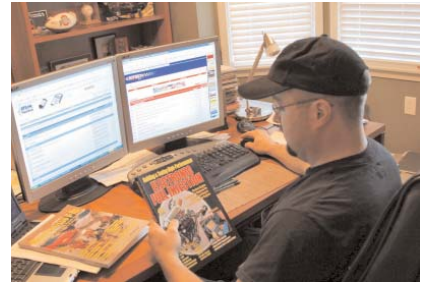
EGT's Redline gauge is a trick-looking digital LCD-type display pod. The screen is large enough for easy reading, even in remote mountings. A backlight enables low-light or night viewing with ease. The included four-button remote control can also be mounted (or not). The touch-pad remote controls recording, holding, and switching between sensors.



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measured track data. Logged performance meter data can be downloaded to PC and evaluated using advanced software and algorithms. These logs can also be correlated to tuning logs to help dial in dynamic tuning changes. In addition to being a slick tuning tool, performance meters can measure G-forces, lap times, and braking performance too. We'll take a performance meter over the infamous 'butt dyno' any day.



7. INFORMATION EXCHANGE

Information exchange is again not a material item, but it still makes our list of top ten tuning tools because it's a near limitless resource. Thanks to the Internet, information exchange is just plain easy in today's day and age. Plenty of good books exist on tuning as well, and often these are easier reads than sifting through loads of Internet searches. By way of Internet message forums, tuners can find quick access to another top 10 tuning aide: experienced tuners. Tuning forums provide the pipeline to share experiences and exchange information between many different tuners rich with various backgrounds and knowledge. While we're confident the good outweighs the bad, it's still prudent to remember that information farmed online should be treated like what it usually is: an opinion. Everyone has one and some are better than others. Through careful research though, underlying themes and positive direction can usually be sifted from the forum discussions.

8. SOFTWARE AND HARNESES

Put away your timing light, distributor wrenches, carb tools, and vacuum gauges ... if you even know what they are or that they exist. Tuning any late-model performance vehicle is going to require some sort of setup capable of interfacing with the electronic powertrain control system. Typically, these systems consist of a communication module, connection cables, and a tuning program. Custom tunes are flashed into controllers through either an ALDL/OBD connection or through a special benchtop harness. Non-flash controller vehicles (aka 'chip' cars) will use an eraser and burner, rather than the module—but the process is similar. During the past decade or so, the market for electronic tuning tools has burst wide open with options. A varying degree of systems exist to satisfy different budgets and levels of desired tuning complexity. Unless you're burning chips, practically all flash-based tuning systems nowadays require pay-per-vehicle licensing. These electronic tuning systems are an invaluable tuning tool quite simply because without them you really couldn't tune anything. Even adjustments in fuel pressure would eventually be cancelled out by fuel trims.



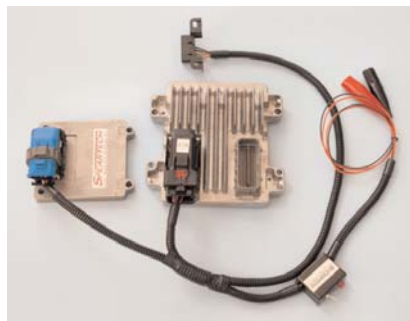
Custom tuning modern controllers typically requires software and a connection harness. The photo shows the typical out-of-car setup for flashing an E67 ECM and T42 TCM through a Speartech harness (\$185) and HP Tuners interface (\$499).

9. SCANNER / LOGGER, LAPTOP AND AC INVERTER

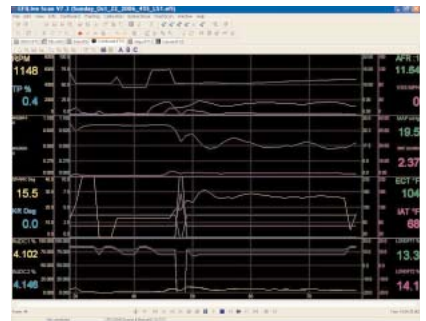
Powertrain controllers are simply lookup tables or algorithm calculators—like any computer, they couldn't function (generate sensible outputs) without receiving operational data (input) from the sensors guiding them. Understanding how these inputs are used by the controller to generate the appropriate outputs is critical, yet often very complex. Scanners, which read and report sensor data (inputs) and operational commands (outputs like spark advance) in real-time, enable tuners to watch and learn how these inputs and outputs are interacting. The instantaneous sensor readings (inputs) at any moment can be used to locate the corresponding point in the tuning maps (output command source). The tuner thereby learns where in the maps to make the appropriate changes to the tune. Watching, comprehending, and remembering scanner readings becomes overwhelming very quickly. Loggers are used to record scanner data for future review. Typically, most scanners are capable of recording, or logging, as well. Some scan loggers operate as stand-alone tools, yet most offer PC interface. The most practical interface is with a laptop computer. Laptops are the computer of choice for most tuners, simply because of their ease of mobility. To keep them running indefinitely in a car, a power connection can be made with an AC inverter. Without the inverter, the laptop's battery-power can be disappointingly short-term, and the screens are typically too dim to view in daylight.



Communicating, reading, and re-flashing late-model flash-based controllers can be done using the appropriate interface module. Several tuning options exist allowing users to shop for an interface that suits their needs and budget. Three Gen IV systems GMHTP has tested include HP Tuners (\$499), EFI Live (\$749), and LS2-Edit (\$550), as shown from left to right.



Speartech Fuel Injection Systems is the leading source for harnesses, offering up-to-date harnesses for all the latest GM applications, such as the E38 ECM and T42 TCM harness (\$185) shown. Re-flashing a computer is safest when done outside of a vehicle, away from the rest of a vehicle's potentially damaging electronics on the shared LAN. Speartech's harnesses also enable remote tuners to work with customer's PCMs, long distance, away from the vehicle.



10. REAL-TIME TUNING OR EMULATION

The one nice thing we remember about “old-school” tuning was that making changes caused immediate effects, all while an engine ran. There was no ‘downtime’ between tuning changes, unless it required hardware changes. With electronic powertrain controllers, applying changes generally requires some sort of reprogramming—and a shutdown of the engine to make the change. This guess (tune and reprogram while the engine is off) and test (restart and evaluate changes) type tuning does work, but may take dozens (or probably more, depending on complexity) of tries to perfect. ‘Real-time’ tuning allows making instantaneous changes while an engine runs.

Moates.Net’s ‘Roadrunner’ real-time LSI flash emulator is an excellent choice for advanced tuning needs. The unit is very affordable, with DIY kits starting at \$489. The plug-and-play version shown, with blue-tooth wireless communication can be had for \$694.



SOURCE

FA.S.T. / COMP CAMS

Dept. GMHTP
3400 Democrat Road
Suite 110
Memphis, TN 38118
www.fuelcirsipark.com
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EXHAUST GAS TECHNOLOGIES

Dept. GMHTP
1381 North Kraemer Blvd
Anaheim, CA 92806
www.exhaustgases.com
800/348-4678

SPEARTECH FUEL INJECTION SYSTEMS

Dept. GMHTP
3574 East State Road 236
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www.spearstech.com
765/378-4908

CARPUTING LLC

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EFI LIVE

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