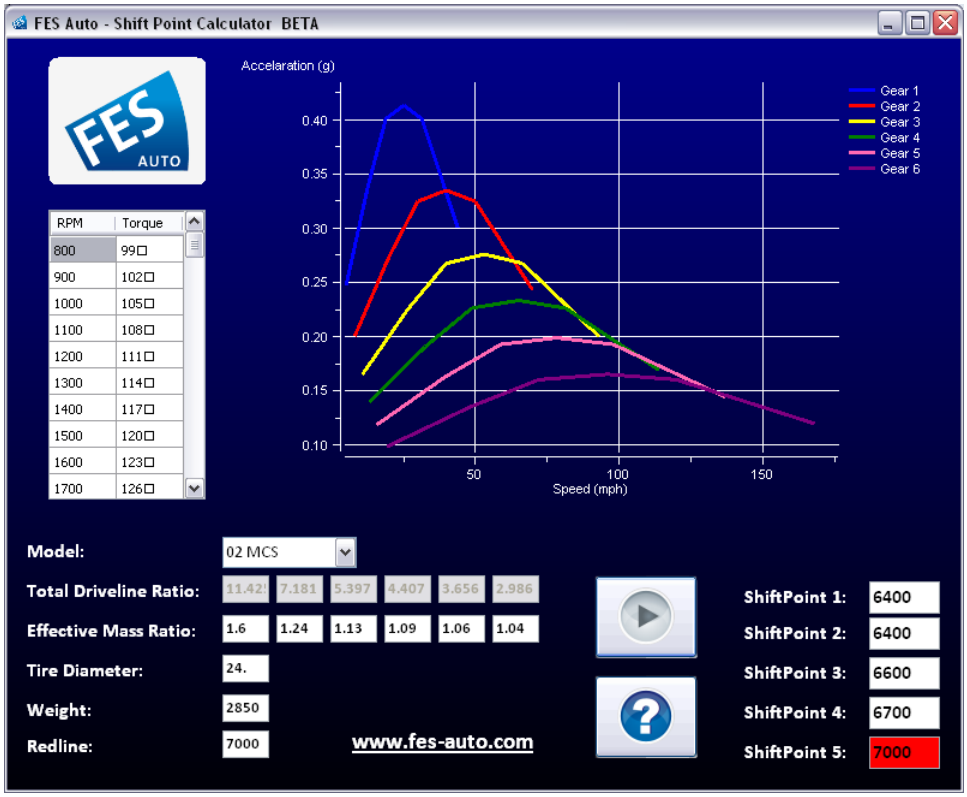
Shift Point Calculator

Beta Release 3/15/2009

Many people think that shift-lights are only to keep from hitting redline and damaging ones engine. This isn't the case. A good shift light will indicate the optimal RPM to change gears that maximizes thrust at the wheels as a function of speed. If one thinks about this a bit, the best RPM doesn't always have to be the same for each gear transition. The FES TrackCoach™ ProShift has inputs for both RPM and Speed, making it one of the only shift lights on the market that can fully support thrust optimization no matter the gear.

The Trust Curve:

If you plot the torque at the wheels as a function of vehicle speed for all gears, a curve is generated like what is shown in the upper right of the shift point calculator.



These overlapping curves are the vehicle acceleration for each gear. For the car illustrated, staying in first, second and third gear to red-line will result is slower acceleration than shifting a the optimal shift RPMs. This utility calculates the optimal shift point based on the engine torque curve, the overall drive

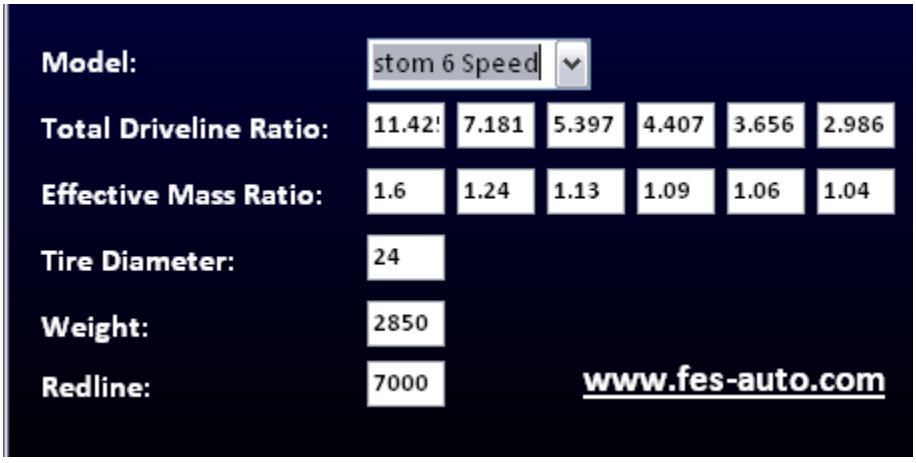
ratios and something called the effective mass. The tire diameter and vehicle (loaded) weight are used to calculate the acceleration (but don't affect the shift points).

The Math:

Cars have transmissions and differentials (transaxles in front wheel drive speak) to best match the engine output to the speed that the car is going. For the car illustrated above (a 2002 Mini Cooper S with a stock engine), the total drive ratio is about 12:1 in first gear. This has the effect of multiplying the engine torque by 12, but spinning the wheels only 1/12th as fast. But it's a bit more complicated than that. All that rotating stuff in the driveline (and the engine for that matter too) takes energy to spin. It actually takes a lot of energy! This is where the factor "effective mass" comes in. This scaler is used to take into account that all the stuff (like the flywheel, clutch assembly, crankshaft and engine driven accessories) have mass and take energy to spin. The reason that this number changes for each gear is that all this stuff spins at different speeds relative to the wheels depending on what gear is selected. What's really a pain here is that no one publishes these numbers, so we've estimated them. Anyway, if the numbers aren't available for the car under consideration, use the FES estimates or just put "1" in all the fields. Actually, play with these numbers: it's surprising what a difference they make! (And by the way, one of the main reasons we made yet another shift point calculator is that pretty much everyone we've come across ignores this very, very important phenomenon.)

How to use the calculator: set up.

Right now, gear ratios are included for several versions of Mini Cooper. There is also a "custom" field in case the car under consideration isn't included. Input the diameter of the tire, the fully loaded weight, and engine red-line and the set up is done!



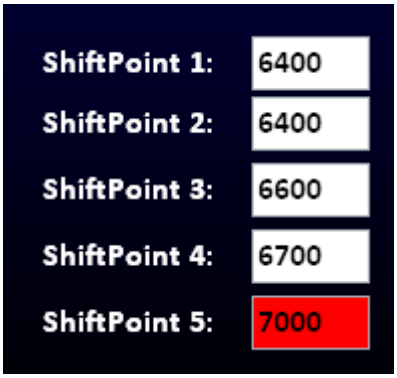
Data Input:

Future versions of the calculator will read output files generated by most of the common types of chassis dynamometers, but for now, it's cut and paste from Excel or a text editor (Notepad or the like). The only requirement is that the RPM and torque be in two columns, RPM first. If you only have a print out of a dyno plot, create the table by hand (it doesn't need to be too fine, every 50-200 RPM or so is

OK). For the paste to work, the upper left cell has to be all grey. If you see a text cursor there, just click on the neighboring torque field then back onto the upper left RPM field.

Running the application:

Just hit the “run” button!  The torque curve is calculated, and the shift points are displayed in a table. If the best shift point is above red-line or the curves of two adjacent gears don’t cross, the cell will be highlighted in red and the red-line value will be displayed.



Have fun and enjoy! If you have any questions or comments, please e-mail them to info@fes-auto.com