



Differential Tuning

Surprisingly few tuners have addressed the issues of final drives, and the influence that they can have on both the handling dynamics and the straight-line acceleration of the car. Hartge offer a selection of differentials, which allow the full performance potential of the vehicle to be achieved. There are two specific issues to be addressed.

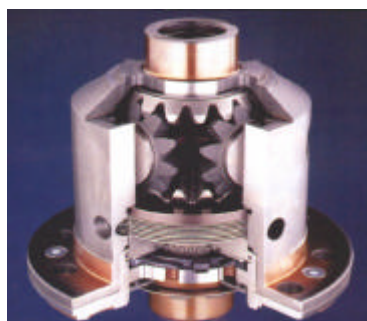
The effect of the overall gearing of the transmission cannot be easily modified from any other position than the differential. Fortunately, BMW offer realistically “stacked” gearbox ratios, which allow reasonable progression through the gearbox with even the most peaky of engines. The trick here is to ensure that the vehicle is geared for acceleration, but not at the expense of top speed capacity, or comfort and fuel consumption in the high speed cruise mode.

There are also several points along the engine speed/gear/road-speed curve which require special consideration. These points below have been derived by testing experience in many different driving environments, and should be considered as being only ideal for European users.

- 1 Second gear must allow greater than 100kph. (62mph)
- 2 Third gear must allow greater than 145kph. (91mph)
- 3 With manual gearboxes, peak power rpm should coincide with maximum speed in top gear.
- 4 With 5 speed auto transmissions, peak power rpm should coincide with maximum speed in fourth gear.

Correct selection of ratio has the effect of modifying the torque at the rear wheels. For example, on the E39 528ia, the correct ratio is 25% lower than standard. This increases the torque at the driving wheels by 25% and consequently improves the acceleration by the same amount, given the same road speed and gear. In gear acceleration times are dramatically improved, and the overall response of the vehicle becomes more aligned to the driver with sporting intentions. In engine tuning terms, this increase in torque is equivalent to an engine capacity increase to 3.7 litres, but at 1/10th of the cost!

Maximum Engine Speed	6,500.00	rpm	=	3.90E+05	rpm	
Differential Ratio	3.64			0.84	Preferred	
Wheel Size	19.00	inch				
Tyre Width	265.00	mm				
Tyre Profile	30%					
Tyre Circumference	2,015.65	mm	=	1.25E-03	miles	
Gearbox Selection	1ST	2ND	3RD	4TH	5TH	
Gearbox	3.66	2.00	1.41	1.00	0.78	
Differential	3.64	3.64	3.64	3.64	3.64	
Overall Ratio	13.32	7.29	5.13	3.64	2.88	
Max miles per hour	=	36.67	67.10	95.17	134.20	181.3
Engine rpm required for 60mph =			5,812			
Engine rpm required for 100mph =				6,930	4,844	3,550
Engine rpm cruising 85mph =						3,040



In the case of Limited Slip Differentials the above considerations apply for straight line acceleration. The LSD locking effect can be altered on original equipment utilising an up-rated LSD clutch pack, which increases the locking effect. This has the effect of allowing the driver to transmit more torque to the road in limited traction conditions, improving acceleration. Moreover, for vehicles with Hartge engines with their inherent low down rich torque characteristics, the driver can use the LSD to break traction on the rear to balance out any understeer.