MERCEDES-BENZ
1991

ASD, ASR, ADS, 4MATIC

Automatic suspension and drivetrain systems

The 1991 model year signals the debut of the optional Automatic Locking Differential (ASD), Automatic Slip Control (ASR) and Adaptive Damping System (ADS) on selected models. They join 4MATIC,™ introduced last year on two 300 Class models. These technologically highly advanced drivetrain and suspension systems, working in various combinations with ABS antilock braking, offer the 1991 Mercedes-Benz model line an impressive gathering of behavioral qualities and well-engineered hardware designed to provide a new measure of increased traction and stable, comfortable handling.

As a group, these systems have very difficult goals. Fundamentally, ASD, ASR and 4MATIC must act to reduce wheelspin of the driven wheels whenever road surface traction falls below the tires' grip. Furthermore–and this is the remarkable quality in these Mercedes-Benz systems–they must immediately and automatically go into action without help from the driver, must continue to act as long as needed during periods of reduced traction... and then automatically disengage when no longer needed.

A tall order–yet these ingenious new drive systems have achieved their difficult goals.

The key to all of these systems is the word *automatic.* They must provide their benefits immediately, far more quickly than the driver could react, in most cases. In operation, some of these systems–ASD and ASR, for instance–function differently from each other to achieve many of the same goals... yet whether one's car is equipped with ASD or ASR, either will be of great benefit in controlling wheelspin and consequent reduced driver control. The result is a significantly heightened level of power transmission to the pavement when slickness increases due to rain, mud, snow or ice.

Finally, the 4MATIC system, first made available during 1990, completes the list of Mercedes-Benz traction enhancements, providing the highest level of traction improvement in a fully automatic on-demand all-wheel-drive system.

ASD–Mercedes-Benz Automatic Locking Differential

Similar in some ways to the well-known concept of the limited-slip differential, ASD is a fully automatic on-demand system that has substantial advantages over limited-slip. Chiefly, it automatically adjusts itself from an unlocked to a locked differential, and vice versa. This allows the system to effectively respond directly to the low-speed traction needs of the vehicle.

ASD is primarily a start-up system, when traction is at a premium. Once engaged, ASD remains on only up to about 19 mph, when it automatically switches off. This prevents differential locking at higher speeds, which could cause unpredictable vehicle behavior and instability.

ASD makes use of the same fast-reacting wheel sensors that engage the ABS antilock braking system. And ASD not only engages differential locking immediately after one wheel begins to slip but also *releases* the differential as soon as normal traction is regained–or else immediately upon the driver's touching the brake pedal with his foot. By releasing the ASD lockage automatically upon use of the brake, open-differential stability and optimum directional control are ensured in normal traction conditions.

When you study this system, of course, the key advantage is its automatic actuation. The driver need not make any demanding decisions about engaging ASD at this instant, or the next. Rather, up to about 19 mph, ASD

is *always on duty,* ready to respond in a split second. In normal circumstances, therefore, ASD waits in the wings, always ready to assist the driver at the first sign of wheelslip at low speeds. Indeed, it often engages so quickly that it is in operation before the driver realizes traction enhancement is needed.

And ASD even maximizes this advantage! A warning light is provided in the speedometer, which indicates to the driver when ASD has gone into operation. This instantly indicates that poor traction conditions have caused wheelslip, providing the driver with important information for modifying his or her driving decisions.

Technically speaking, the way ASD accomplishes its complex mission is fascinating. The automobile's limited-slip rear differential operates hydraulically to lock the differential. The hydraulic system that initiates this locking is activated by the same wheel-speed sensing system that is used in the car's ABS system. Like ABS, ASD reads relative rotation speed of the wheels,but only front to rear. If the sensor detects incipient wheelslip, immediately the ASD system swings into action. An electronic signal is sent to the system's hydraulic pump. Hydraulic pressure engages the differential clutch discs, immediately locking the differential.

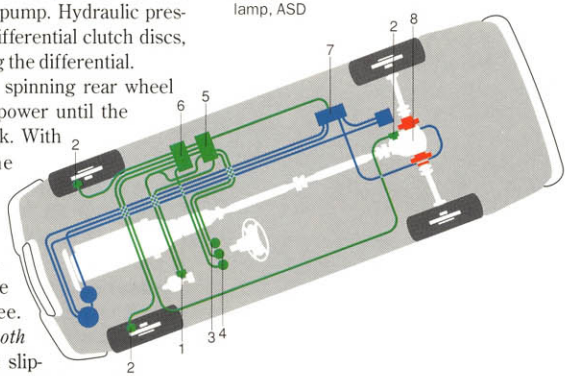
Without ASD, a spinning rear wheel squanders engine power until the driver throttles back. With ASD, however, the locked differential apportions power equally to both wheels within a fraction of a second of one wheel breaking free.

And should *both* wheels come upon slippery pavement, ASD ensures uniform power transmission side to side, and thus symmetrical rear-wheel thrust. When the slippery surface has been passed over, the wheel sensors then detect the absence of wheelspin. The differential clutches are immediately released. The ASD-equipped automobile is once again in limited-slip differential drive, benefiting from all the advantages in excellent steering sensitivity and

The wheel sensors detect an absence of wheelspin. The differential clutches release, and the ASD-equipped automobile is once again in limited-slip differential drive.

ASD

1. Brake switch
2. Wheel speed sensor
3. Function indicator lamp, ASD
4. Malfunction indicator lamp, ASD
5. Control unit, ASD
6. Control unit, ABS
7. Hydraulic unit, ASD
8. Hydraulically actuated locking differential



vehicle stability of the Mercedes-Benz front-engine/rear-drive format.

ASD is optionally available only on the 1991 Mercedes-Benz 190 E 2.3 with either manual or automatic transmission, all diesels, the 190 E 2.6 with manual five-speed transmission and the 300 SL with manual five-speed transmission.

ASR–Mercedes-Benz Automatic Slip Control

Like ASD, the primary purpose of ASR Automatic Slip Control is to prevent the driven wheels from spinning without traction. However, the methodology and complexity of ASR is vastly different from ASD.

Like ASD, ASR uses wheel sensors to detect incipient wheelslip in either or both driven wheels. Then, ASR acts to reduce wheelslip by employing one or both brakes or retarding the throttle or both, depending on vehicle speed at the time.

Under 24 mph: From a standstill until approximately 24 mph, ASR reduces wheelslip first by applying the brake to the spinning wheel until the system determines that traction has been regained. If wheelslip continues despite the braking, the ASR control unit will signal the engine to reduce power.

Above 24 mph: From about 24 mph to the vehicle's top operating speed, ASR will react to rear wheelslip by first throttling back. If this fails to sufficiently reduce wheelslip, ASR will apply the brake to the affected wheel.

To understand the full importance of ASR, consider this. ASR comes into operation without the driver's needing to make any split-second decisions whatever. Quite the contrary, an ASR lamp in the instrument cluster illuminates, informing the driver that it has been engaged, and that wheel slippage now present suggests that traction conditions have deteriorated to potentially threatening levels. Driving decisions should therefore be moderated accordingly.

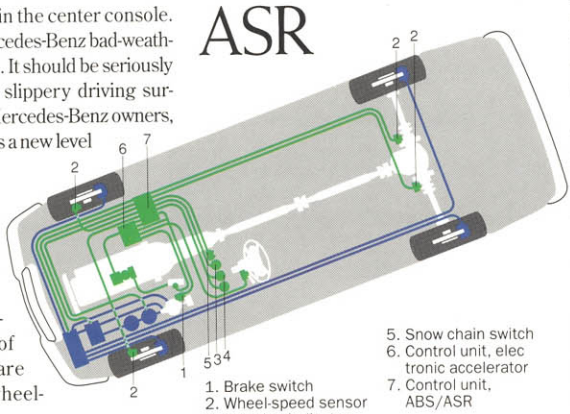
And most impressive of all, with ASR the automobile will only accelerate at a rate commensurate with the threshold of rear wheelslip–no faster.

In addition, since a small amount of slip is advantageous when snow chains are being used, ASR provides a special mode for this,

activated by a switch in the center console.

Truly, ASR is a Mercedes-Benz bad-weather safety breakthrough. It should be seriously considered wherever slippery driving surfaces are an issue for Mercedes-Benz owners, for ASR will give drivers a new level of operational control.

ASR is an option on all 1991 Mercedes-Benz six-cylinder and eight-cylinder gasoline-engine cars with automatic transmissions except, of course, those that are equipped with all-wheel-drive 4MATIC.

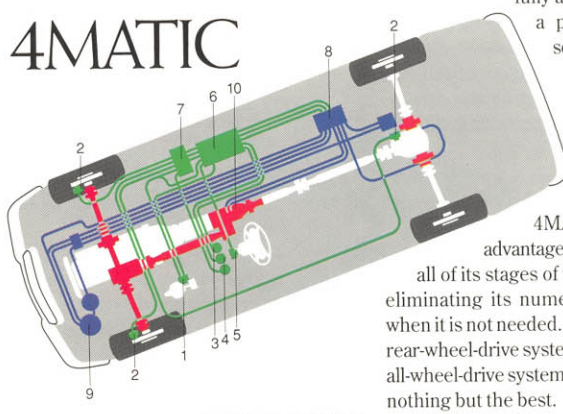


4MATIC–Mercedes-Benz Electronic All-Wheel Drive

Mercedes-Benz 4MATIC provides the highest range of tractive combinations of the Mercedes-Benz Driving Dynamics Concept. To characterize it, 4MATIC is fundamentally different from most other four-wheel-drive systems. It is designed to provide the clear advantages of four-wheel drive–but only when these qualities are advantages. At all other times–*automatically*–4MATIC reverts to a conventional two-wheel-drive unit, offering the advantages that only this economical, stable format, with its fine road feel and steering sensitivity, can provide.

4MATIC's multiple-drive functions rest on complex electronic microcircuitry. By reading wheel rotation fore and aft, as well as side to side, the system self-generates on-off signals. Intensely complex, and equally intensely effective, 4MATIC can escalate its drive-traction capabilities from simple two-wheel drive to simple all-wheel drive. Beyond that, it can lock its center differential, binding front and rear drive-wheels to the same rotational speed. And for maximum traction, it can lock the rear differential, thus uniting the rotation speed and drive-force of all four wheels.

This escalating wheel locking follows a highly logical sequence, based on individual wheel slippage. The monitoring process is ingenious and wholly automatic. Thus the driver may devote full attention to controlling the vehicle. And to help, a caution lamp signals immediately that 4MATIC is engaged. This is a warning that traction has seriously eroded.



With clever 4MATIC, therefore, front-wheel drive is engaged *only* when it will improve driving characteristics. Otherwise, the 4MATIC vehicle operates as a conventional front-engine/rear-drive automobile with a limited-slip differential for best control and road feel in normal driving conditions.

Yet 4MATIC is never far away. During certain fast cornering, it engages automatically. And to optimize traction and climbing ability, the 4MATIC always engages front-wheel drive when pulling away from a standing stop–though the caution light will not come on misleadingly in these circumstances.

Moreover, locked or not, 4MATIC can always be braked safely. ABS function is not shed or compromised. Indeed, 4MATIC is shed to maximize ABS braking. And whenever traction starts to improve, the 4MATIC system immediately and automatically begins to disengage.

The wonderful plus of 4MATIC is that it's fully automatic. And if only a part of the locking sequence is necessary, 4MATIC stops at that point, its warning light cautioning the driver nonetheless.

In short, then, 4MATIC provides all the advantages of all-wheel drive– in all of its stages of wheel lockage–while eliminating its numerous disadvantages when it is not needed. 4MATIC, indeed, is a rear-wheel-drive system and a sophisticated all-wheel-drive system–the best of each, and nothing but the best.

ADS–Mercedes-Benz Adaptive Damping System

The year 1991 signals the introduction of the Mercedes-Benz Adaptive Damping System. Available only on the 300 SL and 500 SL, this self-adjusting hydropneumatic system permits a broad flexibility of suspension behavior over varying surfaces. It responds

automatically to varying styles of normal and enthusiastic driving, as well as to vehicle load. This system is a fundamental improvement over nonadjusting, fixed-rate suspension systems. What distinguishes it is the ability to spontaneously respond again and again, input by input, to the changing needs of driver and road surface alike.

With ADS, the road surface, vehicle speed, suspension dynamics and steering angle are monitored. In response, this system acts as an adaptive shock-absorbing system, and as a side effect, it helps keep the chassis horizontal in most driving and load conditions. Additionally, through the use of the driver-selected "Sport" and "Comfort" settings, the suspension's behavior can be manually adjusted for driving style and road surface conditions.

It goes without saying, such a versatile system will be complex. ADS must constantly monitor vertical wheel acceleration, the ABS system's wheel-speed sensors, chassis height, longitudinal body oscillation and steering angle–all with the purpose of stiffening or softening the suspension moment to moment, maintaining a level, smoothly controlled chassis attitude over the wheels.

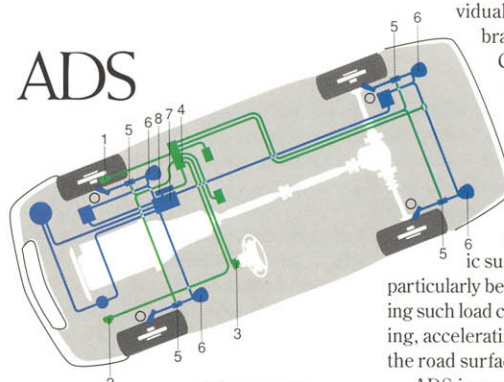
To do this, the system employs four partially load-bearing hydraulic suspension units, one at each wheel. These operate in conjunction with normal steel springs of reduced weight-bearing capacity. Since the adjustable hydraulic units are carrying part of the load, they are able to significantly alter the total suspension capacity, responding to ADS's signals. At the same time, the advantage of the system is that it can automatically level the car, increasing both vehicle stability and occupant comfort.

But the ADS system has another objective. Since a conventional fixed-rate suspension system is necessarily a compromise–stiff enough for maximum vehicle loading, yet supple enough to be driven enthusiastically over rough roads–any single suspension rate will be less than ideal in a good number of driving conditions.

Yet with constantly recalibrating ADS–though it is not a fully automated so-called active suspension, per se–the suspension can be virtually all things to all drivers, all roads.

Each wheel unit has four response settings. The ADS brain, set at "Comfort," juggles all four at each wheel for correct support; at "Sport," it uses three.

ADS



1. Acceleration sensor for wheel
2. Acceleration sensor for body
3. Steering angle sensor
4. Control unit for electronic damping
5. Damper valve
6. Gas-filled pressure reservoir
7. Hydraulic distributor unit
8. Valve unit

On the one hand, it can provide softer damping, for a more comfortable ride in moderate driving. Yet it will also provide appropriate firmness to control pitching and wallowing on rougher roads.

ADS is also calibrated to automatically stiffen to the appropriate degree under hard acceleration. Similarly, when lateral control is needed in vigorous cornering, it hardens the suspension to control roll. Yet when none of these signals is received by ADS's control center, the suspension softens, for a gentle, comfortable ride.

To make ADS more readily accessible to the driver, and more immediately versatile in a broad variety of motoring conditions, it is provided with a selector for Sport and Comfort suspension-damping modes. These switch modes go well beyond providing a rigidly defined pair of suspension rates. To the contrary, each of these two modes is calibrated to incorporate three or four basic suspension settings–four for Comfort, three for Sport–in a range from soft to firm. Each wheel unit responds to road conditions individually, and the electronic ADS brain, whether set at Sport or Comfort, is engineered to constantly juggle these settings at each wheel's suspension. In this way, each wheel is readjusted, moment to moment within .05 seconds, for the currently most correct hydropneumatic suspension rate. The system is particularly beneficial when it is counteracting such load changes as occur during braking, accelerating and cornering, and when the road surface varies.

ADS is a genuinely important optional addition to the 300SL and 500SL. It advances stability, dynamic control and comfort. Then what could be more appropriate than fitting this system to those twin paragons of serious contemporary motoring, the Mercedes-Benz SLs? These are two of the most acutely competent "drivers' cars" in the world today, and ADS is an additional provision that ensures they will shine in every driving condition, following the driver's every mood.