

# 10 Operating principle of the electronically adjustable suspension

## - suspension

### Introduction

Ohlins electronically adjustable suspension is used on the Sport and Touring versions of the Multistrada 1200. This is a "passive" system, meaning that suspension adjustments are not made automatically in relation to the dynamic conditions of the vehicle.

While the motorcycle is moving, the rider may select between four different riding modes (Sport, Touring, Urban, Enduro). Each riding mode is associated to a specific suspension set-up (see 6 - 6 "[Introduction to the electrical system of the Multistrada 1200](#)").

The rider may select different usage scenarios for the suspension set-up while the motorcycle is moving (the respective menu offers four different combinations: rider only, rider alone with luggage, rider and passenger, rider and passenger with luggage).

The rider CANNOT modify the settings associated to each riding mode, which include the suspension set-up, while the vehicle is in motion. This is only possible when the motorcycle is stationary.

On both the front and rear suspension, hydraulic compression and rebound damping is adjusted by electric actuators (with 31 progressive settings). Spring preload in both stanchions of the front fork is adjusted conventionally, whereas spring preload for the rear shock absorber is adjusted by an electric actuator (the rear shock absorber may be compressed by up to 8 mm, with sixteen different positions settable for the electric actuator, meaning that each subsequent position corresponds to half a millimetre of spring compression). Changes to the hydraulic damping settings are not accompanied by audible clicks. Therefore, to ascertain whether the dampers are working correctly, set to one extreme of their travel first and then to the other, comparing the different damping actions achieved by compressing and releasing the front and rear suspension repeatedly (by bouncing on the suspension). Note, however, that the system will indicate any malfunction of the electrically adjustable suspension via the DDS and via the dashboard service display.

### Fork

The left hand stanchion (viewed from the rider's position) contains the compression damper, with 31 setting positions (first position -> damper completely closed clockwise -> maximum damping, 31st position -> damper completely opened anticlockwise -> minimum damping).

Operating principle:

-At the bottom end of the rod is a piston with reeds mounted on its upper surface.

When the fork is compressed, the stanchion and piston move together and the oil must deflect the reeds in order to flow to the top of the piston (hydraulic damping).

At the top end of the fork is a stepper motor connected to a link with a conical needle at the bottom end.

-As the stepper motor turns, it raises or lowers the link and, as a result, the conical needle.

As the conical needle moves up or down, it increases or decreases the aperture area of the By-pass at the centre of the piston. The oil flowing through this By-pass has no effect on the reeds. Raising the conical needle opens the By-pass and reduces the hydraulic damping effect. Conversely, lowering the conical needle increases the damping effect.



Top end of the left hand fork stanchion, which contains the electric stepper motor adjusting hydraulic compression damping.

The right hand stanchion (viewed from the rider's position) contains the rebound damper, with 31 setting positions (first position -> damper completely closed clockwise -> maximum

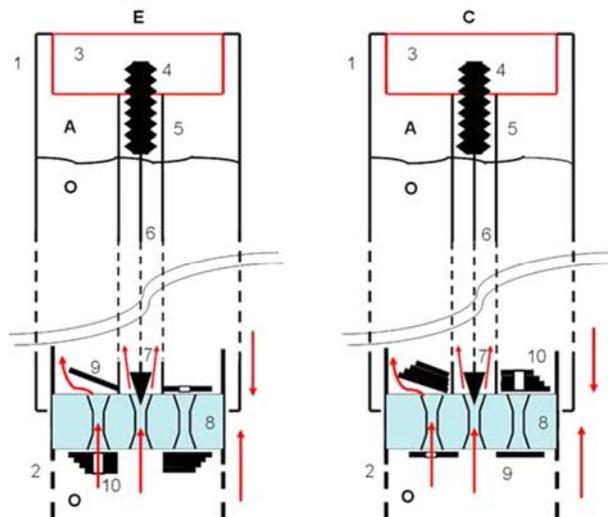
damping, 31s position -> damper completely opened anticlockwise -> minimum damping).  
 Operating principle:

- At the bottom end of the rod is a piston with reeds mounted on its lower surface.
- When the fork extends, the stanchion and piston move together and the oil must deflect the reeds in order to flow to the bottom side of the piston (hydraulic damping).
- At the top end of the fork is a stepper motor connected to a link with a conical needle at the bottom end.
- As the stepper motor turns, it raises or lowers the link and, as a result, the conical needle.
- As the conical needle moves up or down, it increases or decreases the aperture area of the By-pass at the centre of the piston. The oil flowing through this By-pass has no effect on the reeds. Raising the conical needle opens the By-pass and reduces the hydraulic damping effect. Conversely, lowering the conical needle increases the damping effect.



Top end of the right hand fork stanchion, which contains the electric stepper motor adjusting hydraulic rebound damping.

The spring preload of the two fork stanchions may be adjusted by turning the hexagonal nut at the top ends of the stanchions themselves (tightening the nut increases preload, loosening the nut decreases preload).



The drawing illustrates how the fork operates during compression.

E fork leg with hydraulic rebound damping

C fork leg with hydraulic compression damping

A air

O oil

1 sleeve

2 fork leg

3 electric actuator

4 screw

5 pushrod

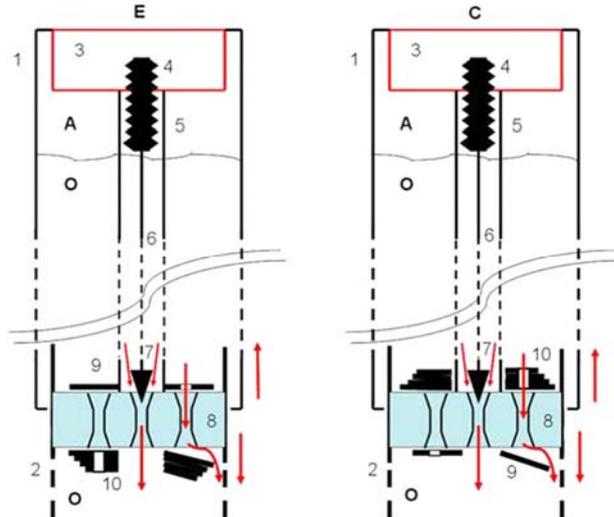
6 driving gear

7 conical needle adjusting By-pass aperture area

8 piston

9 unidirectional valve

10reeds



The drawing illustrates how the fork operates during extension.

E fork leg with hydraulic rebound damping

C fork leg with hydraulic compression damping

A air

O oil

1 sleeve

2 fork leg

3 electric actuator

4 screw

5 pushrod

6 driving gear

7 conical needle adjusting By-pass aperture area

8 piston

9 unidirectional valve

10 reeds

### Rear shock absorber

The Öhlins rear shock absorber uses TTX technology, which reduces the influence that the hydraulic rebound damper has on the hydraulic compression damper and vice versa. There are two passages in the duct connecting the volume of the shock absorber with the volume of the oil reservoir: one allows oil to flow from the reservoir to the tube (rebound), the other allows oil to flow from the tube to the reservoir (compression). Each of these passages has a bypass that reduces the hydraulic damping effect when its area is increased, or increases the hydraulic damping effect when its area is reduced. These By-passes are adjusted by a conical needle actuated by an electric stepper motor (with 31 different setting positions: first position -> damper completely closed clockwise -> maximum damping, 31st position -> damper completely open anticlockwise -> minimum damping). Spring preload is adjusted by a hydraulic press, consisting of: a sealed hydraulic circuit containing oil, an electric pump with position sensor and a hydraulic actuator.

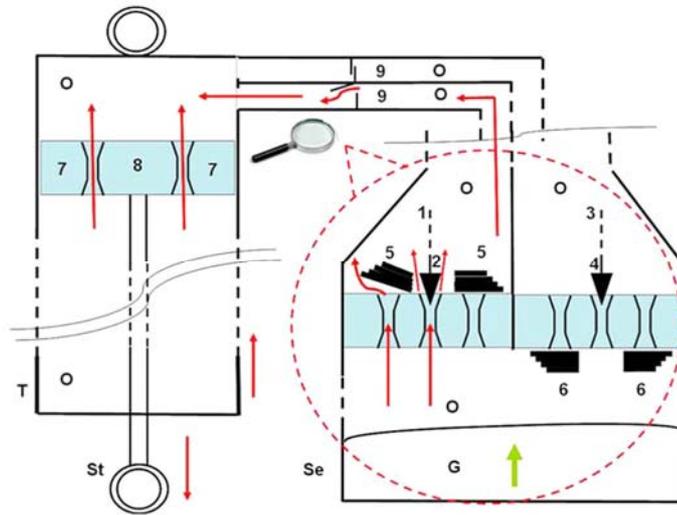
As the electric pump of the hydraulic press pressurises the oil, the actuator increases the load applied to the shock absorber spring (compressing and preloading the spring).

As the electric pump of the hydraulic press releases oil pressure, the load applied to the shock absorber spring is reduced (the spring extends).

The maximum spring compression applicable by the hydraulic press is 8 mm. The preload actuator has 16 different setting positions, with each subsequent position equivalent to ½ mm of travel.



The image shows the rear Öhlins shock absorber with the wires (on the right) carrying power to the electric actuators. These actuators adjust the hydraulic dampers in the duct connecting the volume of the shock absorber tube with the reservoir. The electric pump of the hydraulic press is visible on the left, while the hydraulic actuator adjusting the spring preload can be seen on the spring itself.



The drawing shows how the rear shock absorber works during extension.

St stanchion

T shock absorber tube

Se reservoir

G gas

O oil

1link connected to the two electric actuators

2conical needle adjusting By-pass aperture area

3link connected to the two electric actuators

4conical needle adjusting By-pass aperture area,

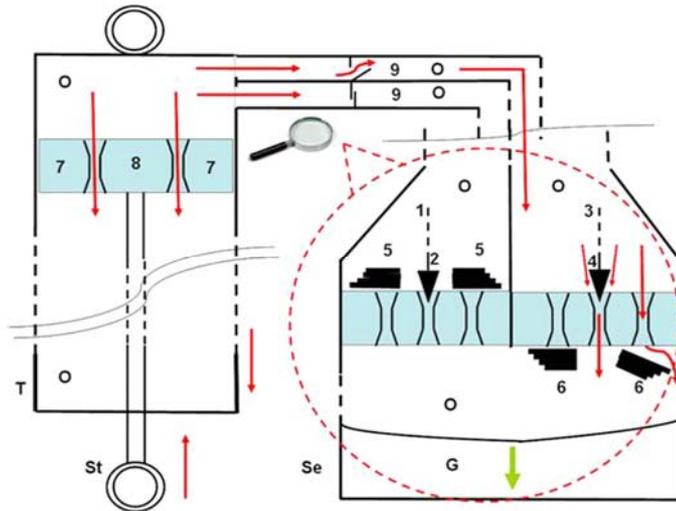
5reeds

6reeds,

7orifice

8piston

9unidirectional valve



The drawing shows how the rear shock absorber works during compression.

St stanchion

T shock absorber tube

Se reservoir

G gas

O oil

1link connected to the two electric actuators

2conical needle adjusting By-pass aperture area

3link connected to the two electric actuators

4conical needle adjusting By-pass aperture area,

5reeds

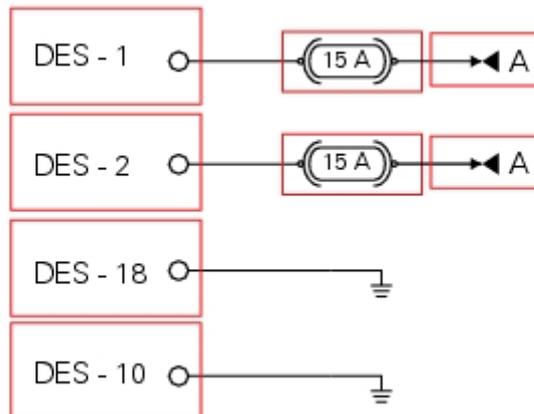
6reeds

7orifice

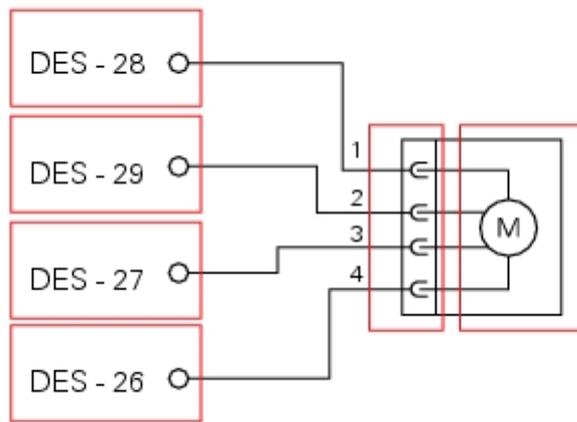
8piston

9unidirectional valve

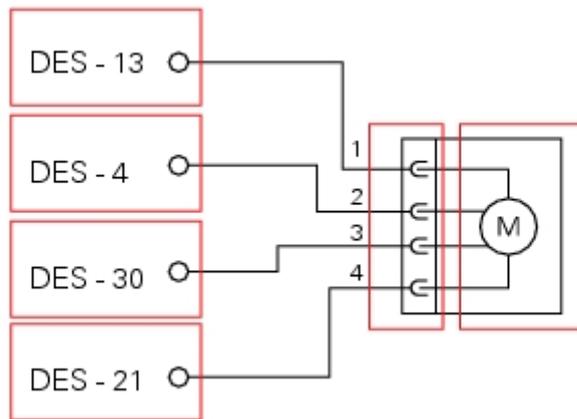
Wiring diagrams and connection layout



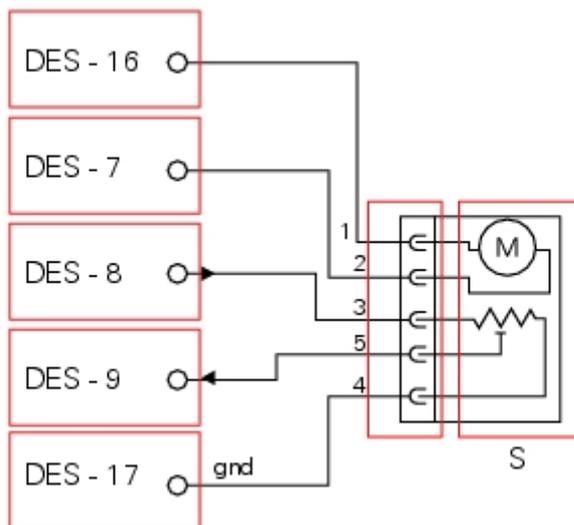
DES 18 and DES 10 ground, black – Bk, DES 2 and DES 1 A KEY ON power (+15 from Hands free relay 30) red/black – R/Bk.



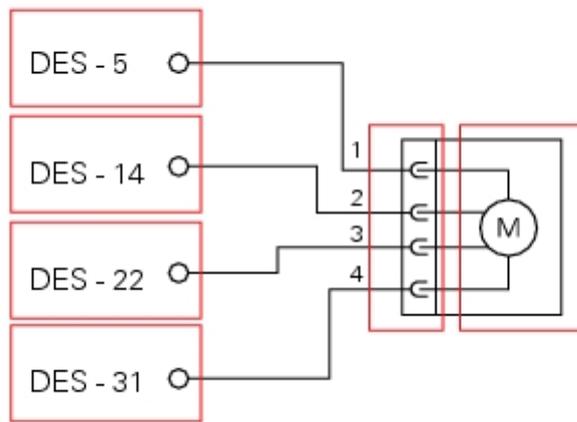
M rear shock absorber compression damping actuator. 1 purple/white – V/W, 2 purple/green V/G, 3 purple/blue – V/B, 4 purple/yellow – V/Y.



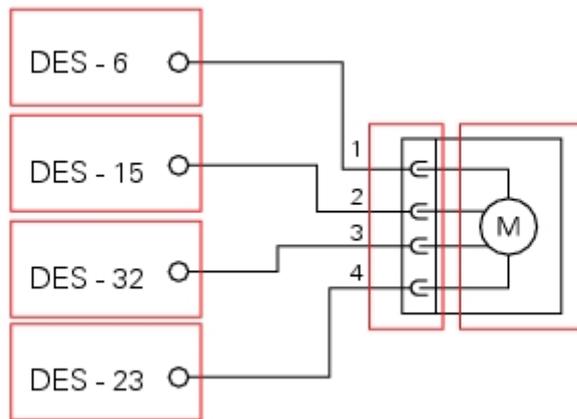
M rear shock absorber rebound damping actuator. 1 yellow/white – Y/W, 2 yellow/pink Y/P, 3 yellow/light blue – Y/Lb, 4 yellow/green Y/G.



M rear shock absorber preload actuator, S rear shock absorber preload actuator position sensor. 1 red/yellow - R/Y, 2 red/blue – R/B, 3 red/yellow – R/Y (5V), 4 black – Bk, 5 grey – Gr (Signal).



M front fork compression damping actuator (left hand stanchion). 1 orange/blue – O/B, 2 orange/green - O/G, 3 orange/yellow - O/Y, 4 orange/purple O/V.



M front fork rebound damping actuator (right hand stanchion). 1 blue/yellow – B/Y, 2 blue/yellow – B/Y, 3 blue/purple – B/V, 4 blue/green – B/G.

**Connections**



Front fork stanchion hydraulic damping connections.



Rear shock absorber hydraulic damping connections.



Rear shock absorber spring preload actuator connection.



**Note**

At each KEY ON, the hydraulic suspension damping actuators are driven to their upper and lower travel limits and then into the position stored in the control unit memory. Therefore, in the event of work on the suspension or replacement of suspension components, the actuators are automatically positioned correctly.

After disconnecting and then reconnecting the battery, the full preload excursion of the shock absorber spring is performed at KEY ON.

The stanchion fork oil seals may be replaced.

**Fault codes relative to electronically adjustable suspension**

Front suspension hydraulic compression damping
<p>DDS: Suspension front compression diagnosis -&gt; Stepper motor calibration (stepper motor positioning error).</p> <p>Dashboard: the error "DES front compression" (front suspension compression damping) is shown on the service display. The EOBD warning light activates:</p> <p>The actuator has not calibrated correctly at KEY ON. The system disables actuator control until the next KEY -OFF -&gt; KEY ON. -Perform a KEY OFF -&gt; KEY ON with the vehicle stationary and check if the fault is still indicated.</p>
<p>DDS: Suspension front compression diagnosis -&gt; Cable breakage (electrical wires broken or connection disconnected).</p> <p>Dashboard: the error "DES front compression" (front suspension compression damping) is shown on the service display. The EOBD warning light activates:</p> <p>The electrical connection on the front suspension compression damping actuator is disconnected or the electrical wires are broken. The system disables electric actuator control. -Restore electrical connection, switch the motorcycle off and then on again.</p>

DDS: Suspension front compression diagnosis -> Short circuit.

Dashboard: the error "DES front compression" (front suspension compression damping) is shown on the service display.

The EOBD warning light activates:

-Short-circuit on actuator electric wires. The system disables electric actuator control.

-Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension front compression diagnosis -> Over temperature.

Dashboard: the error "DES front compression" (front suspension compression damping) is shown on the service display.

The EOBD warning light activates:

The excessive temperature of the internal control unit circuits may also be caused by an actuator short-circuit, indicated by the error described previously.

-Try switching the motorcycle off and then on again. Contact Ducati if the fault persists.

#### Front suspension hydraulic rebound damping

DDS: Suspension front rebound diagnosis -> Stepper motor calibration (stepper motor positioning error).

Dashboard: the error "DES front rebound" (front suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

The actuator has not calibrated correctly at KEY ON. The system disables actuator control until the next KEY -OFF -> KEY ON

-Perform a KEY OFF -> KEY ON with the vehicle stationary and check if the fault is still indicated.

DDS: Suspension front compression diagnosis -> Cable breakage (electrical wires broken or connection disconnected).

Dashboard: the error "DES front compression" (front suspension compression damping) is shown on the service display.

The EOBD warning light activates:

The electrical connection on the front suspension compression damping actuator is disconnected or the -electrical wires are broken. The system disables electric actuator control.

-Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension front rebound diagnosis -> Short circuit

Dashboard: the error "DES front rebound" (front suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

-Short-circuit on actuator electric wires. The system disables electric actuator control.

-Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension front rebound diagnosis -> Over temperature

Dashboard: the error "DES front rebound" (front suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

The excessive temperature of the internal control unit circuits may also be caused by an actuator short-circuit, indicated by the error described previously.

-Try switching the motorcycle off and then on again. Contact Ducati if the fault persists.

### Rear suspension hydraulic compression damping

DDS: Suspension rear compression diagnosis -> Stepper motor calibration (stepper motor positioning error)

Dashboard: the error "DES rear compression" (rear suspension compression damping) is shown on the service display.

The EOBD warning light activates:

The actuator has not calibrated correctly at KEY ON. The system disables actuator control until the next KEY -OFF -> KEY ON.

-Perform a KEY OFF -> KEY ON with the vehicle stationary and check if the fault is still indicated.

DDS: Suspension rear compression diagnosis -> Cable breakage

Dashboard: the error "DES rear compression" (rear suspension compression damping) is shown on the service display.

The EOBD warning light activates:

The electrical connection on the rear suspension compression damping actuator is disconnected or the -electrical wires are broken. The system disables electric actuator control.

-Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension rear compression diagnosis -> Short circuit.

Dashboard: the error "DES rear compression" (rear suspension compression damping) is shown on the service display.

The EOBD warning light activates:

Short-circuit on actuator electric wires. The system disables electric actuator control.

Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension rear compression diagnosis -> Over temperature.

Dashboard: the error "DES rear compression" (rear suspension compression damping) is shown on the service display.

The EOBD warning light activates:

The excessive temperature of the internal control unit circuits may also be caused by an actuator short circuit, indicated by the error described previously.

Try switching the motorcycle off and then on again. Contact Ducati if the fault persists.

### Rear suspension hydraulic rebound damping

DDS: Suspension rear rebound diagnosis -> Stepper motor calibration (stepper motor positioning error)

Dashboard: the error "DES rear rebound" (rear suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

The actuator has not calibrated correctly at KEY ON. The system disables actuator control until the next KEY -OFF -> KEY ON.

-Perform a KEY OFF -> KEY ON with the vehicle stationary and check if the fault is still indicated.

DDS: Suspension rear rebound diagnosis -> Cable breakage

Dashboard: the error "DES rear rebound" (rear suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

The electrical connection on the rear suspension rebound damping actuator is disconnected or the electrical -wires are broken. The system disables electric actuator control.  
-Restore electrical connection, switch the motorcycle off and then on again

DDS: Suspension rear rebound diagnosis -> Short circuit

Dashboard: the error "DES rear rebound" (rear suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

-Short-circuit on actuator electric wires. The system disables electric actuator control.  
-Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension rear rebound diagnosis -> Over temperature

Dashboard: the error "DES rear rebound" (rear suspension rebound damping) is shown on the service display.

The EOBD warning light activates:

The excessive temperature of the internal control unit circuits may also be caused by an actuator short-circuit, indicated by the error described previously.

Try switching the motorcycle off and then on again. Contact Ducati if the fault persists.

#### Rear suspension spring preload

DDS: Suspension preloader adjuster diagnosis -> Calibration (preload actuator positioning error).

Dashboard: the error "DES Pre-load" (rear suspension pre-load) is shown on the service display. The EOBD warning light also activates

No spring preload actuator positions are memorised. This occurs when the motorcycle is switched on with a -completely new control unit.

Perform a suspension reset (KEY OFF -> disconnect battery cables -> KEY ON). The spring preload is set to -maximum, the error is cancelled and then the spring preload is set to its minimum value.

-Contact Ducati if the fault persists.

DDS: Suspension preloader adjuster diagnosis -> Cable breakage

Dashboard: the error "DES Pre-load" (rear suspension pre-load) is shown on the service display. The EOBD warning light activates:

The electrical connection on the rear suspension spring preload actuator is disconnected or the electrical -wires are broken. The system disables electric actuator control.

-Restore electrical connection, switch the motorcycle off and then on again.

DDS: Suspension preload adjuster diagnosis -> Short circuit / Mechanical failure

Dashboard: the error "DES Pre-load" (rear suspension pre-load) is shown on the service display. The EOBD warning light activates.

Short circuit on the electric actuator cables, mechanical actuator fault. The system disables electric actuator -control

-Restore electric connection/check the actuator, then switch the motorcycle off and on again.

DDS: Suspension preloader adjuster diagnosis -> Under voltage / Over temperature

Dashboard: the error "DES Pre-load" (rear suspension pre-load) is shown on the service display. The EOBD warning light activates:

The excessive temperature of the internal control unit circuits or insufficient power voltage may also be -caused by an actuator short circuit, indicated by the error described previously.

-Try switching the motorcycle off and then on again. Contact Ducati if the fault persists.

DDS: Suspension preloader adjuster diagnosis -> Sensor failure (spring preload sensor fault).

Dashboard: the error "DES Pre-load" (rear suspension pre-load) is shown on the service display. The EOBD warning light activates:

This error may be caused by a sensor fault or a problem in its electrical wiring. The system disables electric-actuator control.

-Switch off the motorcycle and check the sensor and its electrical wiring. Switch the motorcycle on again.

#### Electronically adjustable suspension control unit

DDS: Suspension ECU generic diagnosis -> Memory fault

Dashboard: the error "DES generic" (suspension generic error) is shown on the service display. The EOBD warning light activates:

No parameters in memory or memory fault.

Adjusting the rear damping and spring preload calibration may not be possible.

Try switching the motorcycle off and then on again. Contact Ducati if the fault persists.

DDS: Suspension ECU generic diagnosis -> Over voltage

Dashboard: the error "DES generic" (suspension generic error) is shown on the service display. The EOBD warning light activates:

-System power supply voltage has exceeded 18 V.

When the power supply voltage exceeds 18 V, the hydraulic damping and spring preload actuators for the rear suspension are no longer controlled.

-If the voltage drops below 18 V, normal system operation is restored.

-Diagnose the battery charging circuit. Contact Ducati.

DDS: Suspension ECU generic diagnosis -> Under voltage.

Dashboard: the error "DES generic" (suspension generic error) is shown on the service display. The EOBD warning light activates:

System power supply voltage has dropped below 8 V (this may occur during engine start, if the battery is not correctly charged).

When the power supply voltage drops below 8 V, the hydraulic damping and spring preload actuators for the rear suspension are no longer controlled.

-If the voltage returns above 11 V, normal system operation is restored.

-Diagnose the battery charging circuit. Contact Ducati.

DDS: Suspension ECU generic diagnosis -> CAN Dashboard not available (dashboard not receiving information via CAN line)

Dashboard: the error "DES generic" (suspension generic error) is shown on the service display. The EOBD warning light activates:

-No information relative to the suspension is transmitted over the CAN line.

-The actuators remain frozen in their current positions and no adjustment is possible to the actuators.

-Normal system operation is restored if messages are received again over the CAN line.

-Check for CAN line faults. Contact Ducati if the fault occurs frequently.

DDS: Suspension ECU generic diagnosis -> CAN Vehicle speed not available (vehicle speed information not received over CAN line).

Dashboard: the error "DES generic" (suspension generic error) is shown on the service display. The EOBD warning light activates:

-If no vehicle speed information is transmitted over the CAN line, the actuators remain frozen in their

current positions and no adjustment is possible to the actuators.

-Normal system operation is restored if speed information transmission resumes on the CAN line.

-Check for wheel speed sensor faults and CAN line faults. Contact Ducati if the fault occurs frequently.