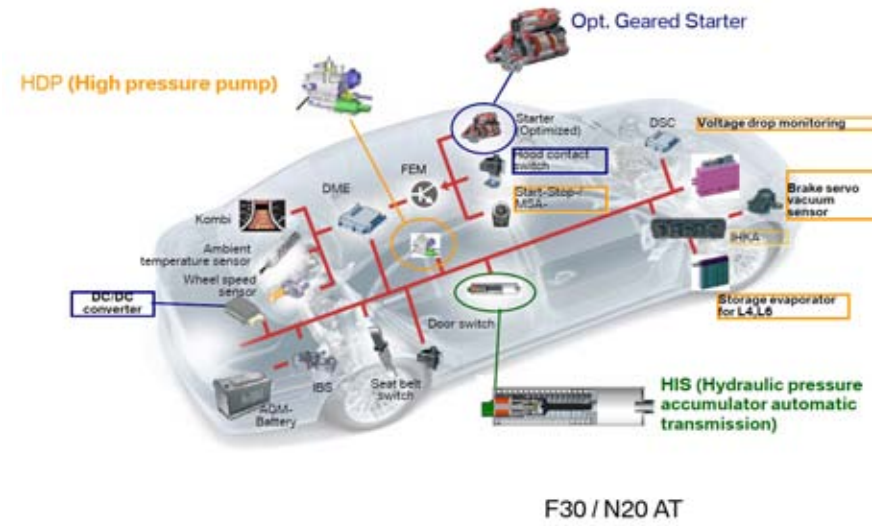
F30 Powertrain

4. Automatic Start/Stop II (MSA II)

The F30 328i (N20), 335i (N55) are available with the MSA II system (as standard equipment) with both the manual and automatic 8 speed transmission.

MSA II system highlights:

- Air conditioning function is enhanced with the cold storage evaporator.
- The hydraulic pressure accumulator allows MSA II to operate with automatic transmissions.
- Driver presence detection via driver's seat belt and driver's door switch.



MSA II System Components

4.1. System Overview

4.1.1. Automatic start/stop function - Manual transmission

When the car is stopped and the driver engages neutral and releases the clutch pedal, the automatic start/stop function switches the engine off. This means that the vehicle does not use any fuel when it is at a standstill. When the driver depresses the clutch pedal again, the engine is automatically restarted and the driver can continue driving.

4.1.2. Automatic start/stop function - Automatic transmission

The automatic engine start-stop function switches off the engine when the vehicle is brought to a standstill, the selector lever remains in the D position, and the driver depresses the brake pedal to hold the vehicle at a standstill. This means that the car does not use any fuel when it is at a standstill. When the driver releases the brake pedal again, the engine is automatically restarted and the driver can continue driving.

The description that follows therefore deals specifically with the automatic start/stop function in conjunction with the automatic transmission.

The engine will NOT automatically turn OFF if:

- Outside temperature below 37.4˚F.
- Outside temperature above 95˚F.
- Vehicle interior is not yet warmed up or cooled down.
- Engine is not yet warmed up.
- Vehicle battery state of charge very low.
- After vehicle was driven in reverse.
- Steering wheel operated after vehicle stopped.
- Stop&Go Traffic.
- GWS selector in Sport/Manual mode.

If MSA is active (ENGINE OFF), the engine will be turned ON automatically if:

- Interior temperature cannot be maintained (cooling and heating).
- Windshield fogging.
- Vehicle battery state of charge drops below a threshold.
- Steering wheel input is detected.
- Change gear lever position from D to N; D to M/S; P to D.
- The accelerator and the brake pedal are pressed at the same time.
- ECO PRO mode activated.

4.1.3. DC/DC converter

The higher frequency of starting operations in vehicles with the automatic start/stop function can lead to voltage dips in the vehicle electrical system. One DC/DC converter is installed in order to protect specific voltage-sensitive components (depending on the vehicle equipment).

The DC/DC converter supplies a constant voltage to the 30B_DC/DC terminals, also during the starting operation.

A DC/DC converter is installed only if the following options are installed:

- Harmon Kardon Surround Sound System (SA 688)
- Navigation system (optional 609)

Note: For a detailed explanation of how the DC/DC converter operates refer to the MSA I section of the ST1112 training material.

4.2. Automatic mode

The automatic start/stop function is ready for operation following every engine start.

The function is activated once the vehicle reaches a specific speed:

- Vehicles with manual transmission: > 5 km/h/3 mph.
- Vehicles with automatic transmission: > 9 km/h/5 mph.

The driver presence detection via the seat belt buckle switch and also via the door contact has been introduced as a new feature of MSA II.

When the driver leaves the vehicle, the automatic start/stop function is deactivated, in order to prevent the engine from starting automatically.

The MSA function is always reactivated if:

- the driver's seat belt is fastened and the vehicle is travelling at a speed of > 5 km/h/3 mph
- the driver's door is closed and the vehicle is travelling at a speed of > 5 km/h/3 mph*.

* > 9 km/h/5 mph - vehicles with automatic transmission

The prerequisites for deactivation of the automatic start/stop function vary, depending on which switching mode the seatbelt buckle switch and door contact are in when the automatic start/stop function is activated:

Status during activation of automatic start/stop function	Prerequisites for deactivation of automatic start/stop function
• The driver's seat belt is fastened. • The driver's door is closed.	The driver unfastens the seat belt buckle and opens driver's door.
• The driver's seat belt is **not** fastened. • The driver's door is closed.	The driver opens the driver's door.
• The driver's seat belt is fastened. • The driver's door is opened.	The driver unfastens the seat belt buckle.

The automatic start/stop function is reactivated if:

- the seat belt buckle is fastened and/or the driver's door is closed and the engine has been started
- the seat belt buckle is fastened and/or the driver's door is closed and the vehicle is travelling at a speed of > 5 km/h/3mph*.

* > 9 km/h/5mph - vehicles with automatic transmission

F30 Powertrain

4. Automatic Start/Stop II (MSA II)

4.2.1. Driving

The purpose of the automatic start/stop function is to switch the engine off when the vehicle is at a standstill. As long as the vehicle is in motion the driver will not be aware of the automatic start/stop function.

Index	Explanation
1	Vehicle moving
2	Selector lever in drive position D, driver operates accelerator pedal
3	Engine running, the driving situation is reflected by the engine speed display and fuel consumption display

4.2.2. Stopping

From the driver's point of view, the stopping process with subsequent engine stop is as follows:

Index	Explanation
1	Vehicle slows to a standstill, e.g. at a red light
2	Selector lever remains in the "D" drive position, driver depresses the brake pedal to decelerate and hold the vehicle at a standstill
3	The engine is switched off after roughly 1 second, "0" engine speed will be displayed on the tachometer with the needle reading “Ready”.

In the situation depicted above the driver holds the car at a standstill by depressing the brake pedal.

Alternatively, the driver can select selector lever position "P" and release the brake pedal. The engine remains switched off. If then the drive position "D" is subsequently engaged, the engine starts without delay.

4.2.3. Driving off

The driver indicates his intention to drive off by releasing the brake pedal.

If the driver previously held the car at a standstill by depressing the brake pedal, the engine starts as soon as the driver releases the brake pedal.

Index	Explanation
1	Driver wishes to continue the journey (e.g. green light)
2	The selector lever remains in drive position "D", driver releases the brake pedal
3	Engine is started, revolution counter and fuel consumption display revert back to normal to reflect the driving situation

If the driver moves the selector lever into position "P" after the engine was switched off automatically, the engine starts automatically if the selector lever is now moved to position "D".

During this process, the automatic engine start is not activated automatically via a signal from the brake light switch, but by the DSC control unit that monitors the brake pressure.

4.2.4. Establishing start-up readiness

If the driver wants to start the engine but not yet drive off, he can establish start-up readiness by:

- Pressing the brake pedal briefly, applying more force
- Releasing the brake pedal slightly

Both of these actions will prompt the engine to start automatically.

4.2.5. Automatic hold

If the driver has activated the "Automatic Hold" function, he/she can also release the brake pedal once the vehicle has come to a standstill. The automatic start/stop function also switches the engine off in this case. The car is held at a standstill by the DSC hydraulics. The engine only starts if the driver operates the accelerator pedal.

4.2.6. Preventing automatic engine shutdown

In order to be able to drive off quickly, e.g. at a crossing, the automatic engine shutdown can be actively prevented if within one second after the vehicle comes to a standstill the brake pedal is pressed briefly, applying more force than usual, then immediately held with the usual brake pedal force.

Index	Explanation
1	Vehicle slows to a standstill, e.g. at a red light
2	Immediately after the vehicle comes to a standstill (within one second) the brake pedal is pressed briefly, applying more force than usual, then immediately held with the usual brake pedal force
3	The engine continues running

4.3. Switch-off inhibitors

Under certain conditions it is necessary to suppress the MSA function:

- the vehicle is coasting (vehicles with manual transmission only)
- the brake vacuum is too low (vehicles with manual transmission only)
- the brake pedal is not pressed firmly enough which means the vehicle is detected as not being held sufficiently (vehicles with automatic transmission only)
- the vehicle stops on uphill/downhill gradients > 12%
- the steering angle is > 6°
- the steering wheel movement is not yet complete (as otherwise insufficient support will be provided by the power steering as a consequence)

- the vehicle was not driven at a speed of > 5 km/h/3 mph* following the previous engine shut-down
- the engine is not running at idle speed (accelerator pedal is being pressed)
- the vehicle is being driven in reverse
- the Hill Descent Control (HDC) has been activated
- the operating temperature of the engine is too low
- the carbon canister is being purged
- the fuel grade is insufficient
- the gearbox adaptation is active (vehicles with automatic transmission only)
- the hydraulic pressure accumulator is not charged yet (vehicles with automatic transmission only)
- stop-and-go traffic
- the state of charge is too low
- the ambient temperature is below +3 °C/ 37.4 °F (ice warning)
- the ambient temperature is above +35 °C/ 95 °F (with heating and air conditioning system switched on)
- the condensation sensor of the IHKA detects fogging of the windshield
- the heating and air conditioning system is switched on but the passenger compartment has not yet warmed up or cooled down to the required temperature
- the brakes have been applied via ABS.

* > 9 km/h/5 mph - vehicles with automatic transmission

4.4. Switch-on prompts

Conversely, it may be necessary to start the engine under the following conditions:

- the vehicle is not sufficiently held by the released brake pedal (vehicles with automatic transmission only)
- the steering wheel is moved
- the engine is not running at idle speed (accelerator pedal is being pressed)
- the transmission changes from "P" to "D"; the driver previously shifted from "D" to "P" when the engine was automatically switched off (vehicles with automatic transmission only)
- the transmission changes from "D" to "N" or "R" (vehicles with automatic transmission only)
- the state of charge is too low
- the ambient temperature is above +35 °C/95 °F (with heating and air conditioning system switched on)
- the condensation sensor of the IHKA detects fogging of the windshield
- the evaporator temperature is too low to ensure sufficient climate control.

4.5. Deactivation

If a deactivation condition exists, the automatic start/stop function is deactivated.

The following scenarios arise, depending on when the deactivation condition for the automatic start/stop function occurred:

- the engine continues running and is no longer stopped automatically
- the engine was stopped automatically and starts once again automatically
- the engine was stopped automatically and no longer starts automatically (the Check Control message "MSA off" appears - the start/stop button must be operated in order to the start the engine).

The following deactivation conditions may occur:

- the driver's absence has been detected
- the engine did not start when starting
- the engine compartment lid is unlocked
- a fault related to the automatic start/stop function has been detected at the engine, transmission or components involved in the automatic start/stop function
- the bus communication is faulty
- the automatic start/stop function has been deactivated via the automatic start/stop function button
- the automatic start/stop function was deactivated via the diagnosis system
- the vehicle is in transport mode
- the engine was stalled.

The individual statuses can be read out using the diagnosis system.

An easy-to-follow example of a deactivation with subsequent switch-on request:

- the automatic start/stop function is deactivated via the automatic start/stop function button in the automatic engine shutdown phase
- as a consequence, the engine starts automatically
- after this, no further automatic engine shutdowns occur, the automatic start/stop function remains deactivated.

4.5.1. Deactivation via automatic start/stop function button

F30 automatic start/stop function button location

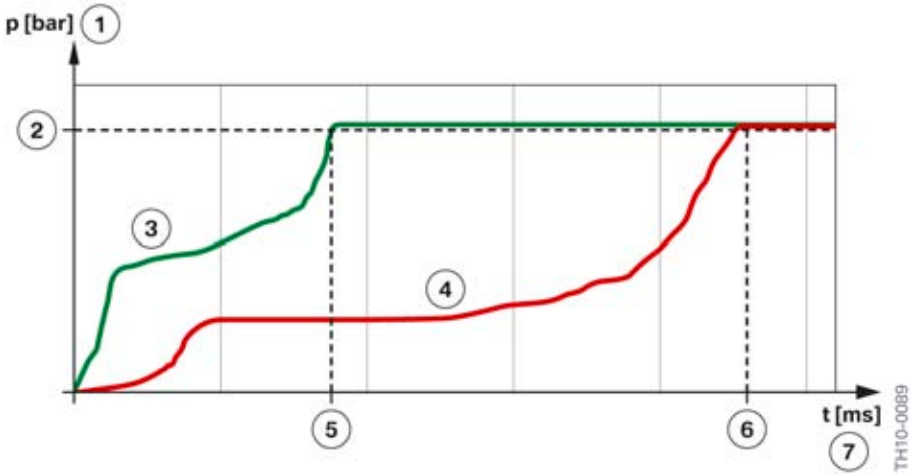
The automatic start/stop function can be deactivated manually via the automatic start/stop function button (1). The LED in the button lights up when the function is deactivated. The automatic start/stop function is reactivated each time the engine is restarted.

4.6. Hydraulic pressure accumulator

When the automatic start/stop function is activated the engine may shut off once the vehicle is at a standstill, the engine restarts automatically as the driver releases the brake to drive off.

In these engine stop phases the transmission oil pump is not driven, thus the fluid pressure supply ceases, the gearshift elements open, and there is no longer a transfer of power in the transmission. Maximum transmission oil pressure is required in order for the drive off process to take place dynamically without a noticeable delay when the automatic start/stop function is activated. However, the mechanically driven transmission oil pump cannot build up pressure quickly enough while the engine is starting.

A hydraulic pressure accumulator is therefore used in the automatic transmission for this purpose (as with F04). With the volume of transmission fluid stored in the hydraulic pressure accumulator, the shift elements can be filled as soon as the engine is started, even before the transmission oil pump has built up the necessary pressure to drive off.



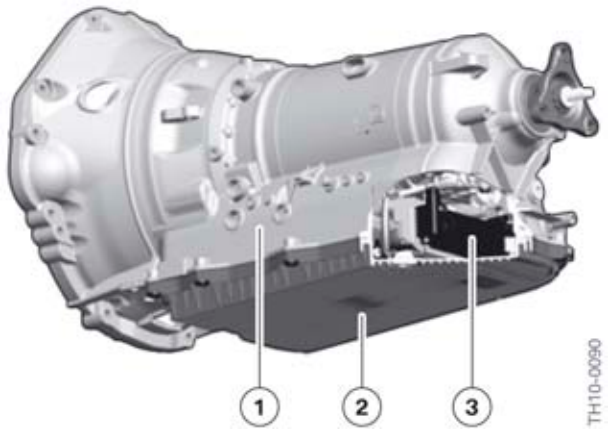
Variation in transmission oil pressure over time at engine start

Index	Explanation
1	Transmission oil pressure
2	Nominal value of the transmission oil pressure which is required to hydraulically actuate the shift elements
3	Characteristic of the transmission oil pressure **with** hydraulic pressure accumulator
4	Characteristic of the transmission oil pressure **without** hydraulic pressure accumulator
5	Point at which the automatic transmission **with** hydraulic pressure accumulator is ready to drive off
6	Point at which the automatic transmission **without** hydraulic pressure accumulator is ready to drive off
7	Time

4.6.1. Installation location

The hydraulic pressure accumulator is integrated in the automatic transmission. It is located in the transmission oil sump, in the direction of travel behind the mechatronics module.

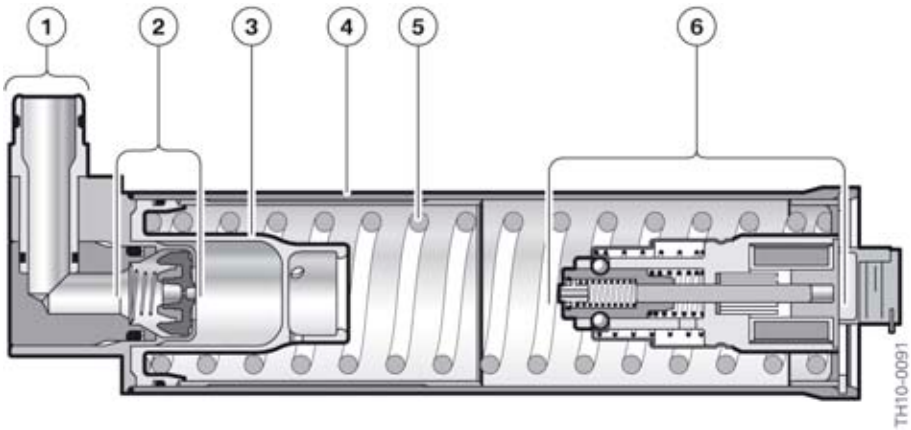
The hydraulic pressure accumulator can be replaced as a separate component.



8–speed automatic transmission cutaway

Index	Explanation
1	Transmission housing
2	Transmission oil sump
3	Hydraulic pressure accumulator

4.6.2. Design



Design of hydraulic pressure accumulator

Index	Explanation
1	Connection to hydraulic system of automatic transmission
2	Throttle and non-return valve
3	Hydraulic piston
4	Hydraulic cylinder
5	Coil spring
6	Electromechanical latch mechanism

The hydraulic pressure accumulator consists of a hydraulic cylinder. This cylinder contains a piston that moves against the force of a spring. The piston can be electromechanically locked in the tensioned end position. The electromechanical latch mechanism incorporates locking balls, a tension spring, a release spring, and a solenoid.

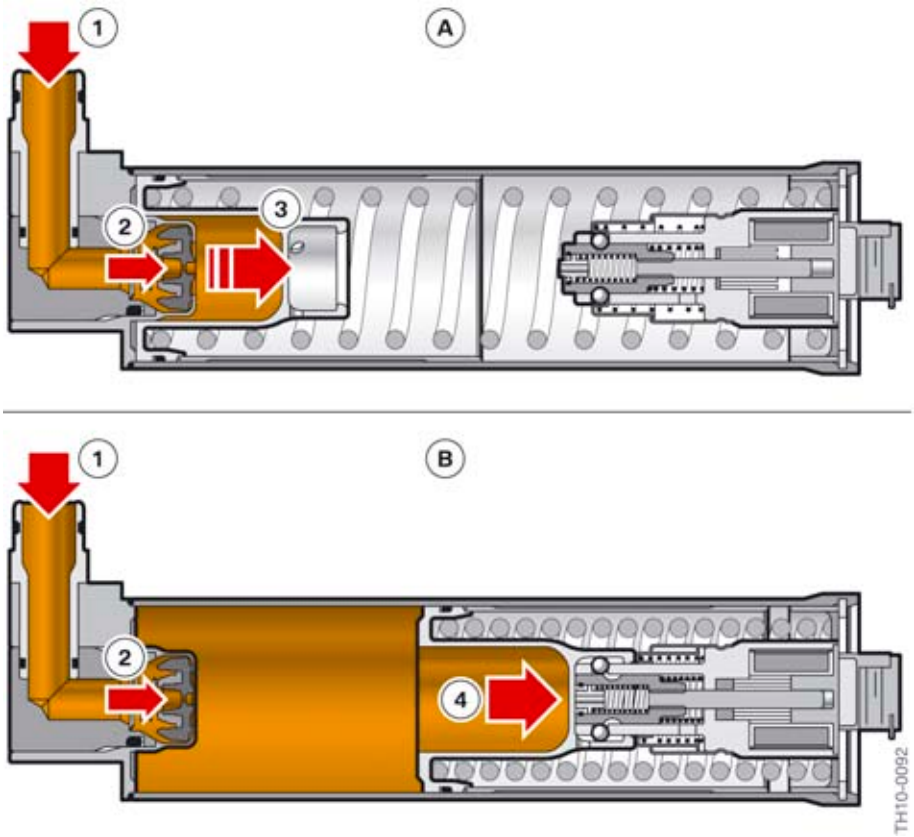
The solenoid is activated and deactivated by the EGS. A corresponding wiring harness to the hydraulic pressure accumulator is laid inside the transmission housing.

The cylinder of the hydraulic pressure accumulator is connected to the transmission's hydraulic system directly (without any valves between them). The hydraulic pressure accumulator in fact contains an element which functions as a throttle and non-return valve. The throttle limits the volumetric flow of the fluid while the hydraulic pressure accumulator is being filled. In general, this filling operation corresponds to the charging operation of the accumulator which is why the expressions "charging" or "discharging" are used in this description.

The non-return valve ensures that the transmission fluid flows into the hydraulic pressure accumulator via the throttle during charging. The transmission fluid does not flow through the throttle during the discharging process, the non-return valve now opens instead to allow an unrestricted flow of transmission fluid back into the hydraulic system. The purpose of the non-return valve is therefore not to maintain the pressure in the charged state. In the charged state, the transmission fluid in the hydraulic pressure accumulator is depressurized and the energy is stored in the tensioned spring.

4.6.3. Charging

The hydraulic pressure accumulator is therefore always charged when the engine is running and the transmission oil pump is working. During charging transmission fluid flows through the throttle into the hydraulic cylinder. In the process only a small volume is drawn from the hydraulic system so that the pressure level does not drop unintentionally. The transmission fluid pushes on the piston which acts against the spring force increasing the tension on the spring.



Charging of the hydraulic pressure accumulator

Index	Explanation
A	Discharged state - charging procedure starts
B	Charged state - charging procedure ends
1	Transmission fluid flows from the hydraulic system of the automatic transmission into the hydraulic pressure accumulator
2	Volumetric flow of the transmission fluid is limited by the throttle
3	The transmission fluid exerts force on the piston which moves and tensions the coil spring
4	Transmission fluid exerts a force on the piston so that it is held in the "charged" end position

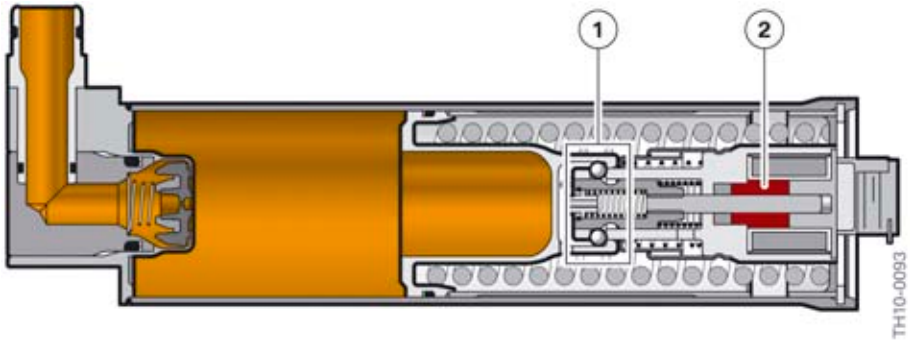
At the end of the charging process the piston travels past the latch mechanism (locking balls) until it reaches the end/stop. The transmission fluid pressure holds the piston against the spring force in the end position.

The latch mechanism does not engage yet. The hydraulic pressure accumulator is fully charged in this end position.

4.6.4. Locking

When the engine is switched off (while the hydraulic pressure accumulator is charged) the transmission oil pressure drops causing the spring to be released slightly. This allows the piston to slide into the locked position where locking balls hold the piston mechanically in place.

The now energized solenoid holds the inner slide in place so that the locking balls cannot enter the channels designated for releasing the lock. The electric power used for this is low (< 10 W) and is only required while the engine is off. Therefor the additional energy consumption of the hydraulic pressure accumulator viewed over an entire driving cycle is very low.



Charged and locked state of the hydraulic pressure accumulator

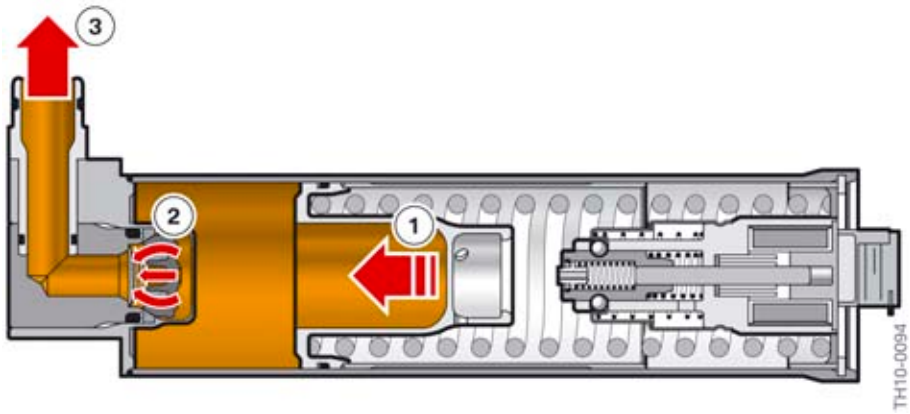
Index	Explanation
1	Mechanical latch mechanism
2	Solenoid activated

4.6.5. Discharging

When the engine is started, as the driver wants to drive off, the gearshift elements in the automatic transmission for driving off must be engaged. The hydraulic pressure accumulator supplies the transmission fluid pressure required for this during the discharging process.

As the solenoid is deactivated for discharging the inner slide (driven by a small spring) moves in the direction of the locking balls. This allows the balls to enter the channels designated for releasing the lock which in turn releases the piston. The spring (compressed during the charging process) exerts force on the piston which pressurizes the transmission fluid in the cylinder.

4. Automatic Start/Stop II (MSA II)



Discharging of the hydraulic pressure accumulator

Index	Explanation
1	The large spring pushes on the piston, which in turn, forces the transmission fluid out of the hydraulic cylinder
2	Transmission fluid can now flow through the throttle **and** the opened non-return valve
3	Transmission fluid flows from the hydraulic pressure accumulator back into the hydraulic system of the automatic transmission

The piston moves (in the graphic to the left) and thereby pushes the transmission fluid back into the transmission hydraulic system. The transmission fluid exits the cylinder through the now opened non-return valve and throttle.

The oil volume forced back into the hydraulic system of the transmission is sufficient to engage the gearshift elements needed for the driving off process. This system is designed to provide the initial fluid pressure needed for the transmission to go into “Gear” at the exact moment just before the engine is started. As soon as the engine is started, the transmission fluid pressure is then again generated by the transmission oil pump and the entire process is restarted.

4.7. Service information

For information on servicing/diagnosing the MSA II system, refer to ST1112 Automatic Start/Stop (MSA) training material.