Service - Manual

Automatic Transmission

ZF-ASTronic

- ZF 12 AS 2302 / 2530 / 2531
- ZF 16 AS 2602

899501708

Index

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2.2.3 Technical data, 16-speed
Direct drive
For more information, refer to type sheet

Number of forwards gears:		16
Number of reverse gears:		2
Ratio step:		20.5 ± 2.2 %
Ratio range:	Forward gears	17.03 - 1.0
	Reverse gears	15.77 - 13.07

Max. input torque (traction / coasting)*:	2200 Nm
Input speed:	max. 2500 rpm (traction) max. 2800 rpm (coasting)
Length:	953 mm
Oil volume:	12 l
Weight:	256 kg**

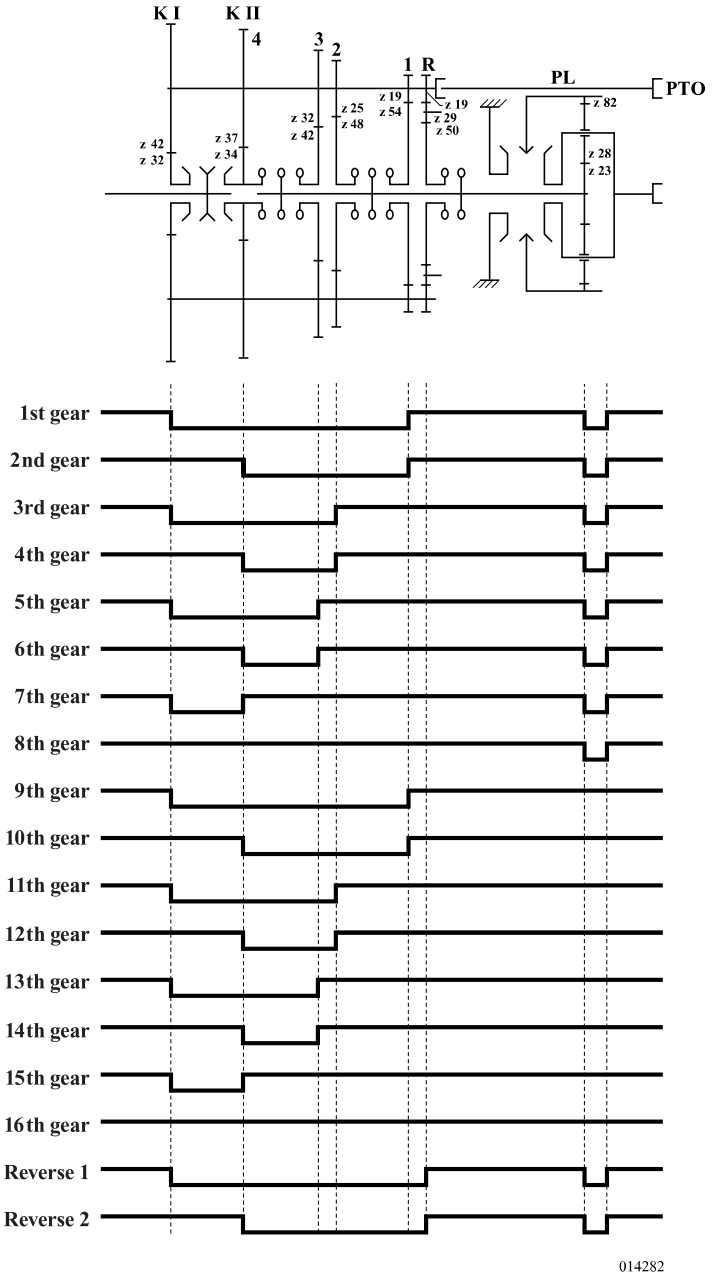
Centre of gravity: refer to installation drawing (Section 4.1.1)

* Approximate value: depends on type of vehicle and vehicle data as well as the prevailing operating conditions
** Without peripherals, oil fill, PTOs, Intarder, clutch, release fork, release shaft, release bearing, push rod and clutch actuator.
Weight: release fork, release shaft, release bearing, push rod and clutch actuator approx. 10 kg

16-speed, direct drive

Gear	Ratio i	Gear step	Inertia torque [1] kgm²
1st gear	17.029		0.100
		1.206	
2nd gear	14.120		0.139
		1.227	
3rd gear	11.504		0.102
		1.206	
4th gear	9.539		0.143
		1.213	
5th gear	7.864		0.107
		1.206	
6th gear	6.521		0.149
		1.184	
7th gear	5.506		0.115
		1.206	
8th gear	4.565		0.162
		1.224	
9th gear	3.730		0.120
		1.206	
10th gear	3.093		0.169
		1.227	
11th gear	2.520		0.146
		1.206	
12th gear	2.089		0.207
		1.213	
13th gear	1.723		0.201
		1.206	
14th gear	1.428		0.287
		1.184	
15th gear	1.206		0.309
		1.206	
16th gear	1.00		0.443
Reverse 1	15.768		
		1.206	
Reverse 2	13.074		
N K1	–	–	0.098
N K2	–	–	0.137

Powerflow diagram



1) Values relate to input end

3 Description of function

3.1.7 Activating PTOs (PTO)

PTOs can only be operated via constants I (K1) *(refer to powerflow diagram, Section 2.2)*. With direct drive transmissions, only gears with GV can therefore be shifted into the low position, with overdrive transmissions, only gears with GV can be shifted into high position. Depending on the application, PTOs can be operated in stationary or stationary / mobile mode. Stationary mode is only available when the transmission is in Neutral. Shifts are not permitted.

In stationary / mobile mode with the PTO activated at a standstill with a direct drive transmission (DD), gears 1, 3, 5 (with 16-speed version, also 7th gear) as well as RL (reverse low) can be shifted and selected for setting off. With overdrive (OD), gears 2, 4, 6 and RH (reverse high) are available. A gear cannot be selected during travel for as long as PTOs are still engaged. Gearshifts can also not be implemented during travel.

3.1.7.1 Engaging PTO

The PTO request is activated by pressing the PTO switch. The PTO selected must be disengaged at this point. If a second PTO is fitted, it may only assume two statuses: ‘engaged’ or ‘disengaged’. If these conditions are satisfied, the PTO request is confirmed and the engagement procedure initiated. While the PTO is being engaged, the TCU specifies fuel injection specification fill 0 % (= load reduction) to the EDC.

The engagement procedure proceeds as follows:

1. If that the GV is not in the K1 setting, it is shifted into K1.
2. The PTO is engaged. To do this, the clutch opens and the transmission brake reduces the transmission input speed.
3. The output of the electronic control unit for mechanical engagement of the PTO is activated.
4. As soon as the PTO is successfully engaged, this is shown on the display and the clutch is subject to closed loop control when in stationary PTO mode and when in stationary / mobile mobile, the clutch is closed once the accelerator has been depressed.

3.1.7.2 Disengaging PTO

The PTO can be disengaged both when the vehicle is at a standstill and during travel with a gear selected or in the Neutral position. If the PTO is disengaged during travel and with a gear selected, the load is reduced before mechanical disengagement. A shift inhibit is set at the same time. To disengage, the clutch is opened and the PTO mechanically disconnected. The shift inhibit is then cancelled. When the ignition is switched off (terminal 15) during PTO operations, the PTO is automatically disengaged.

3.1.8 Ignition off

If the ignition is switched off, or the voltage switched via the ignition key falls (terminal 15) below a defined threshold value, a check is undertaken to determine whether the transmission is in Neutral and whether the clutch is closed. If this is not the case, the transmission undertakes an enforced shift to Neutral and the clutch is closed. The clutch is opened for the shift to Neutral. The clutch then closes at a defined speed. If while at a standstill the transmission cannot be shifted to Neutral, the clutch remains open. The driver is informed acoustically of this malfunction. Once a defined delay period has passed, the battery voltage (terminal 30) of the electronic control unit (TCU) is disconnected via the disengagement relay. The TCU is only switched off when the vehicle is at a standstill.

3.5 Diagnosis

3.5.1 Error memory

If the ZF-*AS* TRONIC system has detected an error, an error response and/or substitute function is activated and the error saved in the error memory (RAM). During the ECU run-down (after "ignition off"), the error memory contents are copied into the non-volatile memory (EEPROM).

When the error first arises, not only the error number but various ambient conditions, such as speeds, present function status, gear, operating hours, etc. can also be saved. After this, only the frequency at which the error arises is counted.

Up to 10 different errors can be saved in the error memory. If the error memory is full, non-active errors are overwritten. If an error no longer arises after a defined number of ECU resets, the error is deleted.

3.5.2 On-board diagnosis

If an error is in place, the error number can be called up on the display in the vehicle. Further vehicle operations are not permitted in the instance of serious system errors (stop + screwdriver).

In order to call up the present error number, depending on the present application, the rotary switch is e.g. moved to the Neutral position and the control lever held in the «+» direction.
If the service brake is pressed at the same time, all errors saved in the error memory are displayed.
If the service brake is not pressed, only the errors presently in place are displayed.

3.5.3 Off-board diagnosis

ZF can provide the OEM with the following diagnosis tools for troubleshooting on the ZF-*AS* TRONIC in the workshop:

TESTMAN, ZF diagnosis system for PC applications incl. ZF diagnosis adapter DPA 04 and connection cable with ISO and/or SAE connection;
☞ *For description, refer to type sheet 6008 757 103.*

All the necessary, transmission-specific data for a rapid and comprehensive diagnosis can be called up using the ZF **TESTMAN** diagnosis system.

The "diagnosis" function includes:
- reading present error;
- reading error memory;
- deleting error memory;
- reading identification block.

The "Test inputs and outputs" function includes:
- system test when at standstill;
- system test during travel;
- test device (displays all digital inputs and outputs);
- displaying digital and analogue parameters e.g. speeds, current strengths and voltage levels.

When undertaking specific troubleshooting, this device allows staff trained by ZF to rapidly find the error in the transmission system. Once the error has been detected, the diagnosis system proposes remedial measures. Communication occurs in the form of a serial interface. Each screen page can be printed out or saved for error documentation. The diagnosis software is available in all major languages.

Terminal tester
A terminal tester, complete with adapter for 20 and/or 18-pin plug connections is available for the electrical troubleshooting of input and output signals of the vehicle interface to the ZF-*AS* TRONIC.

4.1.9 Transmission installation angle

The longitudinal transmission inclination must not exceed 5°. The ZF-*AS* TRONIC can endure a total inclination (vehicle inclination incl. transmission inclination) of 17° without any damage. This corresponds to a gradient of:

- 21 % at 5° transmission inclination
- 30 % at 0° transmission inclination

Greater gradients may only be travelled briefly.

F should be contacted if the vehicle application is associated with frequently occurring, greater gradients and with other transmission combinations.

The transmission installation angle (transverse) may be up to 3°. ZF should be contacted if this value is exceeded.

	Installation angle (longitudinal)	Gradient % (longitudinal)			Camber of road (transverse)
		Uphill incline	Downhill incline	Time	
Rear installation (bus)	0°	30 %	30 %	permanently	10 % (20 % with longitudinal gradient of 0 %)
		50 %	50 %	≤ 1 min	
	up to 5°	21 %	40 %	permanently	
		40 %	60 %	≤ 1 min	
Front installation (truck)	0°	30 %	30 %	permanently	
		50 %	50 %	≤ 1 min	
	up to 5°	40 %	21 %	permanently	
		60 %	40 %	≤ 1 min	

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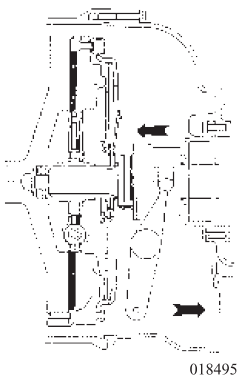
4.4.2.2 Power supply connector to vehicle

The vehicle end connector on the transmission actuator represents the connection to the vehicle power supply. The mating connector needed is shown in the connector overview in Section 4.4.6. As an option, ZF can also supply a connection cable from this connector into the vehicle's dry compartment. The requirement and purpose of the individual lines are explained in more detail per pin.

Pin 20-pin	Pin 18-pin	Name	Explanation
1	1	VPI	voltage supply, term. 15, 24 volt (ignition lock) (supply for computer core and communication interfaces) Fuse, at least 3 Amperes, maximum 10 Amperes
2	2	SDDK	serial interface for communication in accordance with ISO/DIS 14230 Connection for ZF diagnosis tester.
3	3	CANF2-H	ZF's own CAN interface (CAN high signal), line colour: red, interface between transmission electronics and ZF components.
4	4	VPE1	voltage supply, term. 30, + 24 volt, (permanent positive) (supply for computer core and communication interfaces and digital outputs). Once the ignition, term. 15, has been switched off, the electronics are supplied via this pin for a brief overrun period. During this period, any error present are written into the memory and/or the transmission is transferred into a defined status. Once the ignition is OFF, permanent positive (term. 30) must be retained for at least 8s to ensure the aforementioned functions. Fuse 10 Amperes.
5	5	VPE2	redundant supply connection (refer to VPE1, pin 4)
6	6	CANF2-L	ZF's own CAN interface (CAN low signal), line colour: black, interface between transmission electronics and ZF components.
7	7	SDEF	input frequency signal. Redundant recording of output speed by tachograph.
8	8	CANF1-H	vehicle and/or system CAN interface (CAN high), line colour: yellow, interface between transmission electronics and vehicle electronics (e.g. EDC, ABS ASC, Intarder etc.) Communication interface in accordance with SAE J1939 and/or ISO 11898
9	9	SD	serial communication interface for connection of electronic components such as ZF display
10	10	SDP	serial communication interface with power output stage (500 mA).
11	11	ADVP1	digital output, 24 volt, to supply ZF components such as display, warning buzzer and/or warning lamp. Trigger output for ZF E module (wake up function). Output remains switched on after ignition "OFF" incl. overrun period of transmission electronics so that system functions remain active (e.g. ZF E module, warning, display and diagnosis functions); $I_{max.}$ consumption: 390 mA This output is electrically connected to the ADVP output, transmission end connector.
12	12	CANF1-L	vehicle and/or system CAN interface (CAN low), line colour: green, interface between transmission electronics and vehicle electronics (e.g. EDC, ABS, ASC, Intarder etc.) Communication interface in accordance with SAE J1939 and/or ISO 11898

You must be able to feel and hear the fork snapping into place.



- By pressing the fork towards the engine, check whether the connection has snapped in correctly.
- Secure cover back onto underside of housing 1.

4.7.6 EOL (End Of Line) programming

The ZF-*AS* TRONIC software can be programmed by the vehicle manufacturer to reduce supply and/or service variants of the ZF-*AS* TRONIC.

For the EOL (end of line) programming of ZF-*AS* TRONIC-specific vehicle variants outside the ZF organization, the vehicle manufacturer and ZF must agree on the program variants needed as well as the documentation, production and service process requirements.

The transmission software can be adapted to the relevant vehicle configuration by the vehicle manufacturer by means of vehicle parameter setting (e.g. PTO configurations).

The ZF-*AS* TRONIC is programmed using serial data transfer.

The following description is a summary of the requirements relating to ZF documentation and/or ZF Service.

☞ *The detailed requirements can be found in ZF TKI 6009 774 005*

Documentation of EOL (End Of Line) programming

The delivery status of the ZF-*AS* TRONIC is documented by ZF using the vehicle manufacturer's order number.

Furthermore, all EOL programming / parameter setting and modifications made outside the ZF organization which result over the service life of a control unit must be fully comprehensible to ZF.
A database is used for ZF documentation.
The "vehicle manufacturer – ZF" transfer of data should be defined using appropriate procedures.

ZF-*AS* TRONIC-specific data which has to be documented by ZF is discussed with the OEM.

ZF external programming equipment

ZF-*AS* TRONIC-specific data present for EOL programming has to be forwarded to ZF. A standardized procedure should be defined for this purpose.

Automated power-shift gear ZF-ASTronic

Short description - gear box system

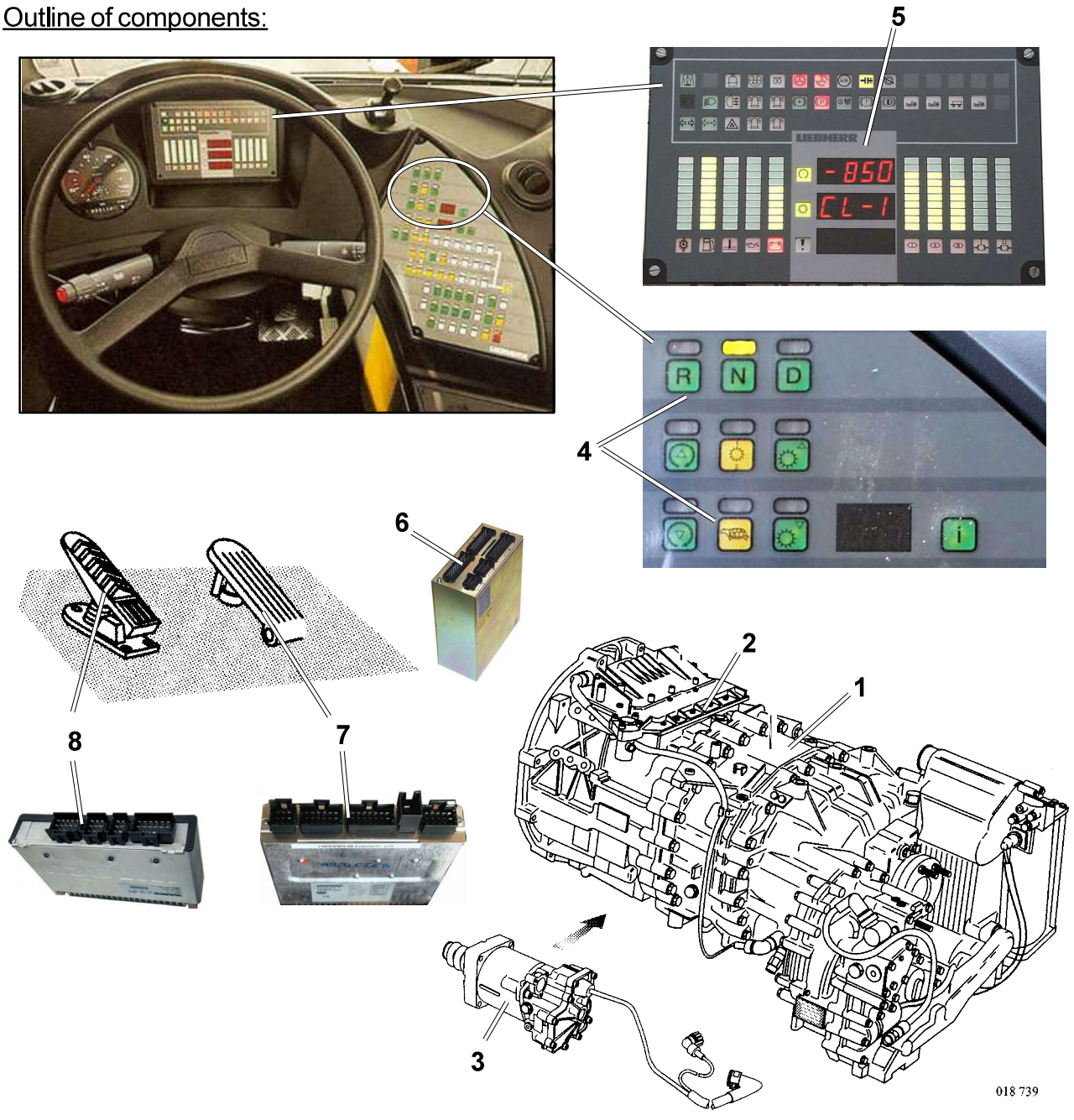
The gear ox system **„ZF-ASTronic“** consists of the gear unit (1) and the components required for the automation of the system (see outline),.

The components gear box ECU = gear box actuator (2) and clutch actuator (3) are integrated into the gear box.

Additionally, peripheric components such as wie displacement control keys (4), display (5), Liebherr E/A module (6), engine ECU with gas pedal (7) and ABV ECU with brake pedal (8) fare installed into the carrier.

The integration of the ZF-ASTronic into the entire carrier system is realized by the networking of the electronic systems of the carrier by means of a **„CAN bus“**.

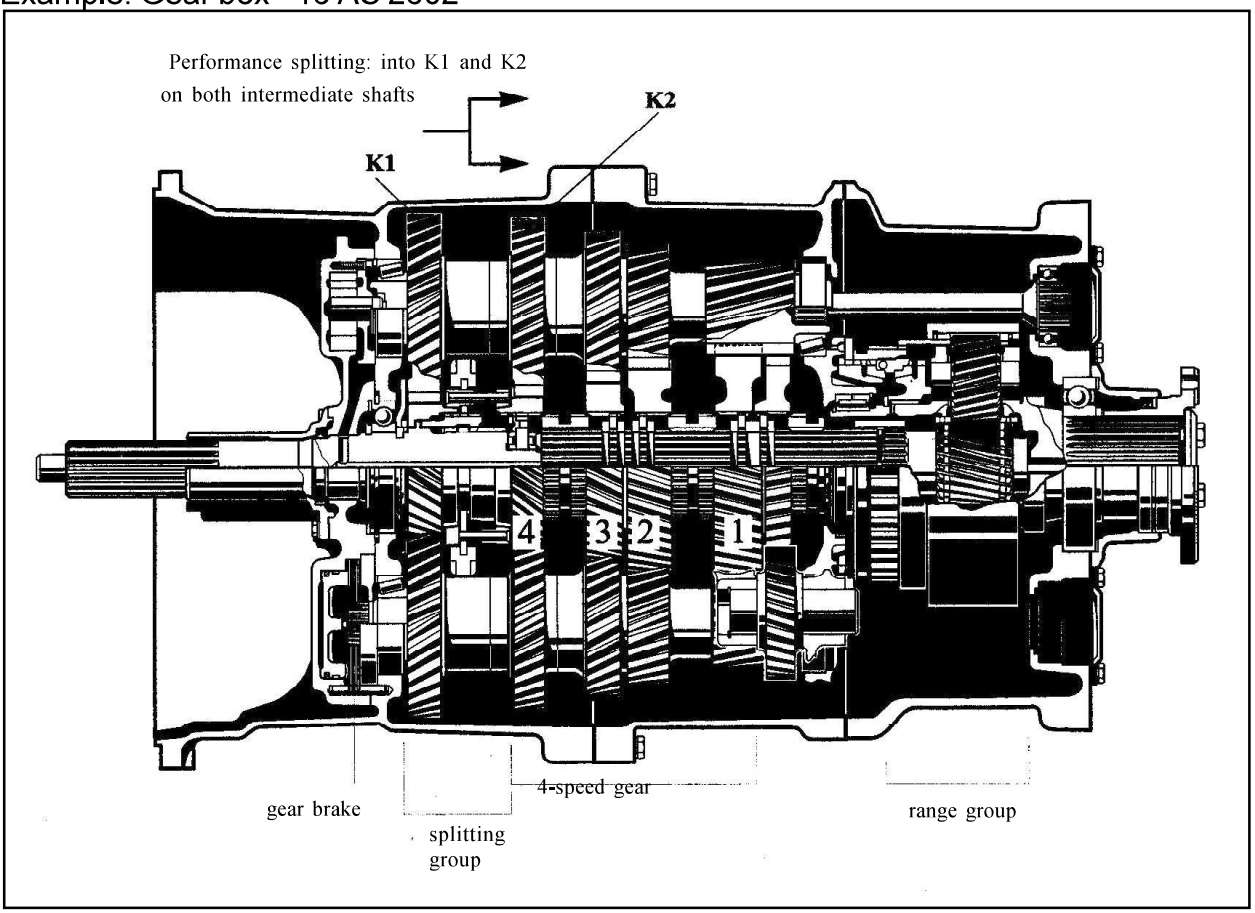
Outline of components:



Automated power-shift gear ZF-ASTronic

Description of the gearbox design

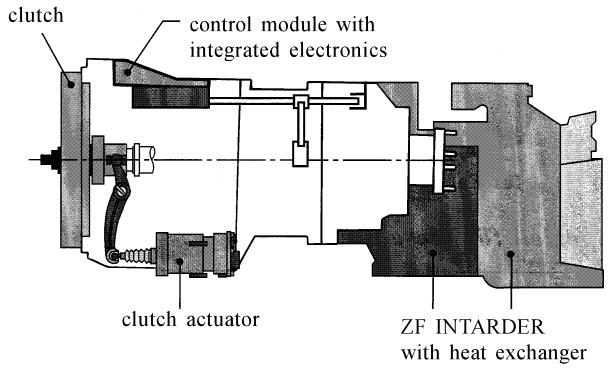
Example: Gear box - 16 AS 2602



The ZF-ASTRONIC gear box consists of a four-speed section at the l6-speed version and a three-speed section at the12-speed version as well as of a splitting group (GV) and a secondary range group (GP) in planetary version.

The gear unit is designed in the 2-intermediate shaft version. This compact and weight-reduced design permits an advantageous torque splitting, for reduced load exposure of the teething and consequently for a high efficiency.

The 4(3) speed gear section is a claw-type control design.
The synchronisation is realized by the EDC and the gear brake.
The intermediate and range group are synchronized.



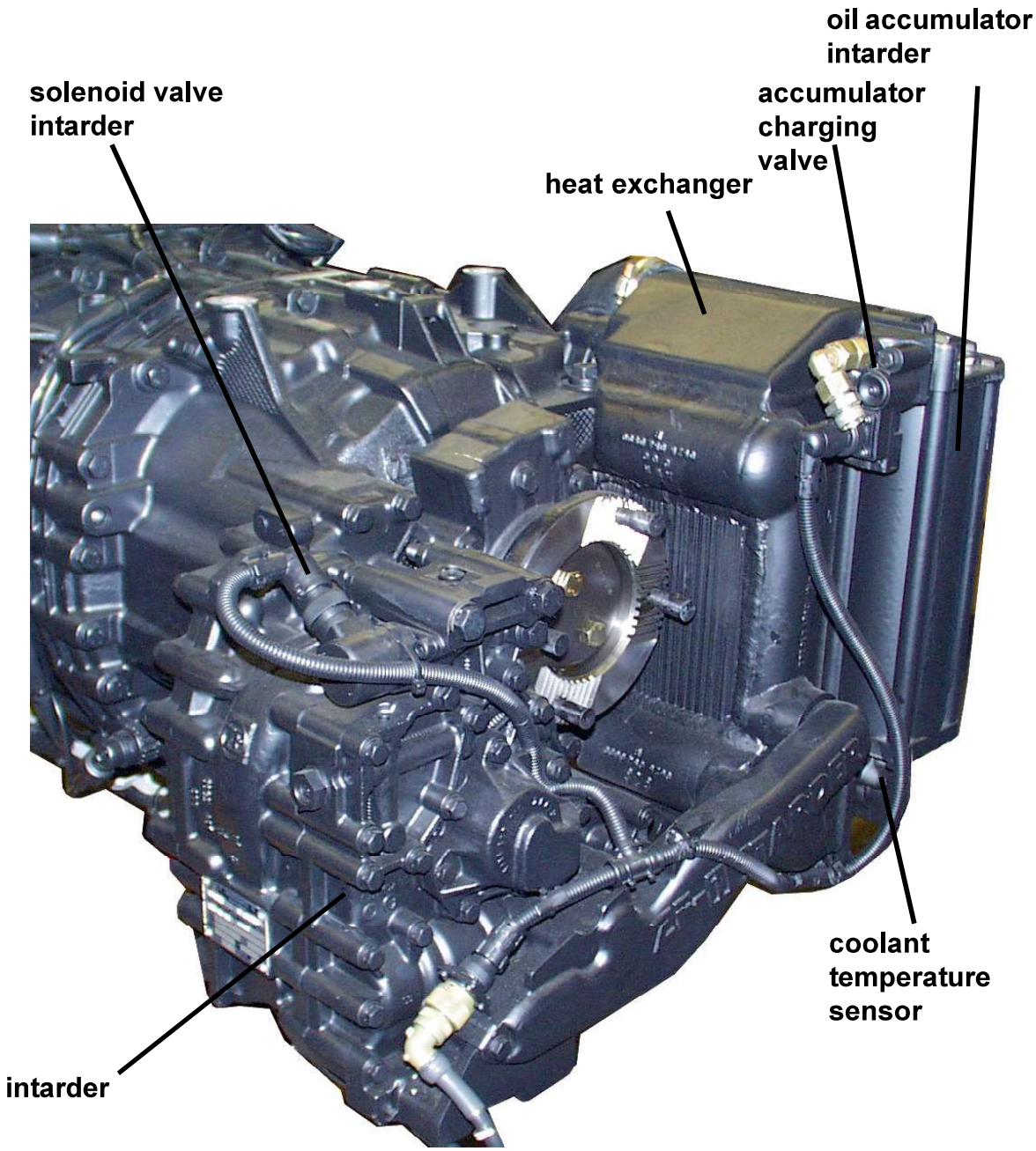
Automated power-shift gear ZF-ASTronic

Description - intarder

Purpose:

The intarder is an abrasionproof sustained-action brake with 5 brake steps, integrated into the gear box, which relieves the service brakes.

Design intarder:



3.1 Basic function

3.1.8 Ignition off

If the ignition is switched off, or the voltage switched via the ignition key falls (terminal 15) below a defined threshold value, a check is undertaken to determine whether the transmission is in Neutral and whether the clutch is closed. If this is not the case, the transmission undertakes an enforced shift to Neutral and the clutch is closed. The clutch is opened for the shift to Neutral. The clutch then closes at a defined speed. If while at a standstill the transmission cannot be shifted to Neutral, the clutch remains open. The driver is informed acoustically of this malfunction. Once a defined delay period has passed, the battery voltage (terminal 30) of the electronic control unit (TCU) is disconnected via the disengagement relay. The TCU is only switched off when the vehicle is at a standstill.

Special scenario: If the ignition is switched off during travel, a shift to Neutral is not undertaken. The gear selected remains selected, the clutch remains closed. Only once the speed falls below a defined threshold speed value does the clutch open and the transmission shift to Neutral (enforced neutral switch).

During the ignition off phase, error memory data and driving mode information is saved from the volatile memory area (RAM) into the non-volatile memory area (EEPROM).
It is therefore important to ensure that the permanent positive supply (terminal 30) is not switched off at the same time as the switched positive supply but remains on for a defined period *(refer to Section 4.4.2.2.)*.

Automated power-shift gear ZF-ASTronic

Description of the CAN bus

The linear CAN bus

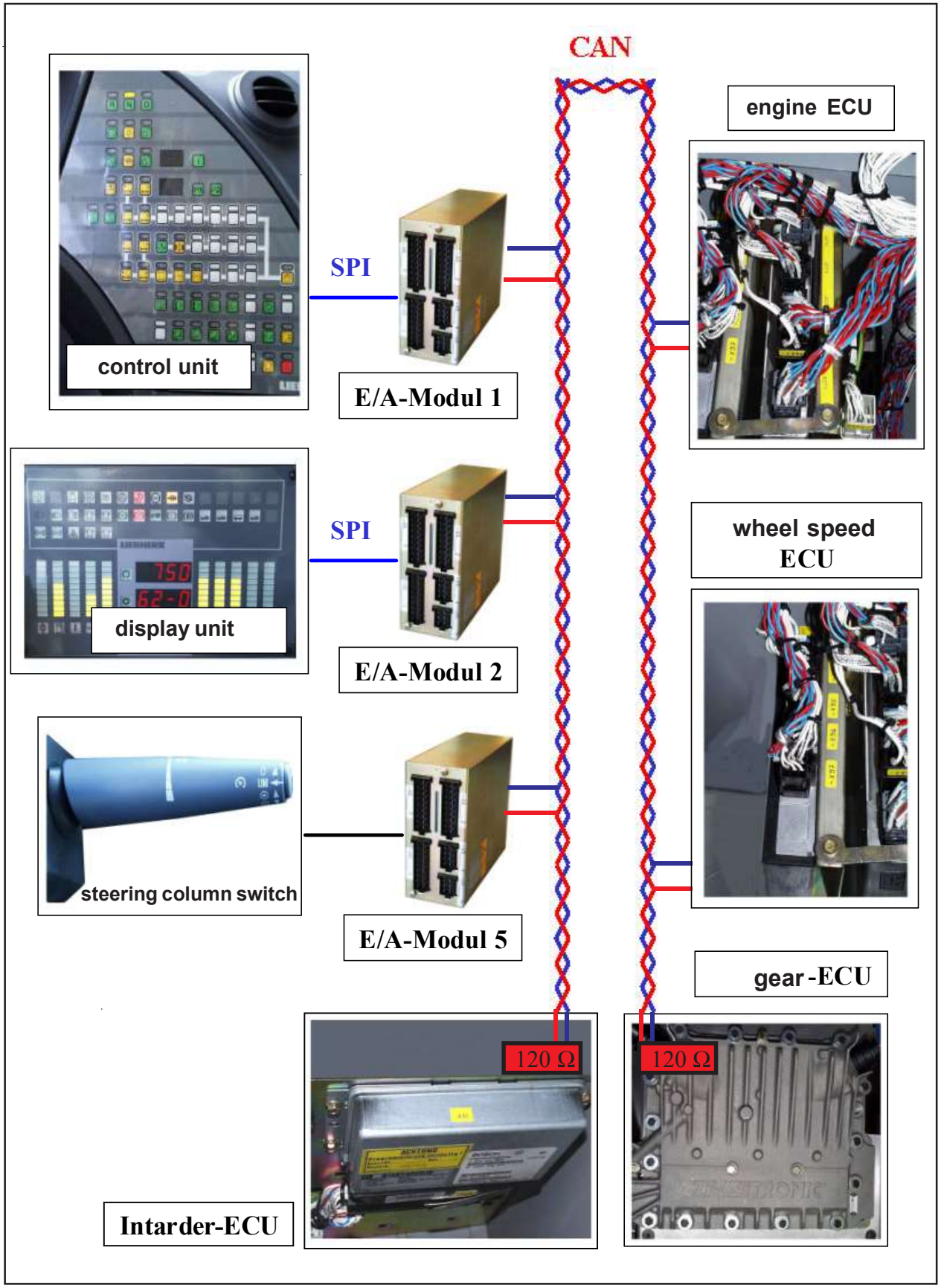


Abb. 04-07

Fehler-Nr.	Fehlertext / Reaktion / Behebung	Stecker	Blatt	K	W
939150	engine V8: valve clearance service report interval 1 attained/exceeded report check and return	X27		E	1
939250	engine V8: fuel injection valves service report interval 1 attained/exceeded report check and return	X27		E	1
939350	engine V8: coolant service report interval 1 attained/exceeded report check and return	X27		E	1
971020	gear ASTRONIC: Main cut-off valve Y10 short circuit to ground Travel: Switching blocked - condition: Clutch opens, neutral switching blocked - automatic blocked RESET - otherwise replace gear-change	X4		E	1
971021	gear ASTRONIC: Main cut-off valve Y10 short circuit to supply voltage Switching blocked RESET - otherwise replace gear-change	X4		E	1
971022	gear ASTRONIC: Main cut-off valve Y10 interruption Travel: Switching blocked - condition: Clutch opens, neutral switching - system not available RESET - otherwise replace gear-change	X4		E	2
971120	gear ASTRONIC: Solenoid valve Y1 gear brake short circuit to ground Increased switch times - sporadic upshift locking - automatic blocked RESET - otherwise replace gear-change	X4		E	1
971121	gear ASTRONIC: Solenoid valve Y1 gear brake short circuit to supply voltage Switching blocked RESET - otherwise replace gear-change	X4		E	1
971122	gear ASTRONIC: Solenoid valve Y1 gear brake interruption Increased switch times - sporadic upshift locking - automatic blocked RESET - otherwise replace gear-change	X4		E	1
971220	gear ASTRONIC: Solenoid valve Y2 splitter short circuit to ground Travel: Switching blocked - condition: Clutch opens, neutral switching - system not available RESET - otherwise replace gear-change	X4		E	2

Example: elec. circuit diagram, LTM 1100/2 - chassis

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