ZF FRIEDRICHSHAFEN Aktiengesellschaft					
Benennung: fault codes Zusatzbenennung: EP90 Forklift EST65		Nr.:	DIN A4	Seite 1 von 24	
Diese technische Unterlage darf weder kopiert noch dritten Personen ohne unsere Erlaubnis mitgeteilt werden.			2013-10-09	Sz	
		Nr.	Datum	Name	Film
K3 ZFN 904	ÄNDERUNGEN				

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Datum:	2006-02-03	2006-02-03	

Description of the fault codes for EP90 Forklift EST65

Index of changes:

date	comment	software version
2006-02-03	initial version based on ErgoPower	KPT0
2006-06-08	Fault codes for CCO/Inching, After Torque Converter Temperature	KPT2
2006-07-07	updated clutch names	KPT2
2006-09-14	add overtemp converter faultcode	KPT2
2006-11-28	add F3-Fault code description	V001
2009-05-11	add hints to fault code 0x3E	V008
2009-11-09	add fault code 0x21and 0x22	V010
2011-12-19	add fault code 0x42 and 0x43, change description of faultcode 0x2B	V011
2013-10-09	add fault code 0x44 and 0x45	V012

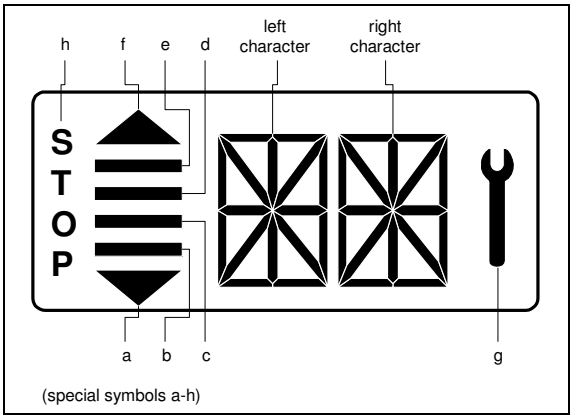
1 Introduction

1.1 Abbreviations

o.c.	open circuit
s.c.	short circuit
OP-Mode	operating mode
TCU	transmission control unit
EEC	electronic engine controller
PTO	power take off

1.2 ZF - Display:

If a fault is detected, the display shows a spanner symbol (g) for a fault. The display shows the fault code, if the gear selector is on neutral position.
If more than one fault is detected, each fault code is shown for about 1 second.



1.3 Display during operation

Symbol	meaning	remarks
1F, 1R 2F, 2R 3F, 3R 4F 5F 6F LF, LR	actual gear and direction left digit shows actual gear right digit shows actual direction limp home gear	
F or R, no gear	Clutch Cutoff	
F or R flashing	direction F or R selected while turbine speed is too high	CAUTION gear will engage if turbine speed drops
NN	not neutral, waiting for neutral after power up or a severe fault	to engage a gear, first move shift selector to neutral position and again to F or R position
**	oil temperature too low, no gear available	warm up engine / transmission
*N	oil temperature low, only one gear available	warm up engine / transmission
1 bar (special	manual mode 1st gear	

symbol)		
2 bars	manual mode 2nd gear	
3 bars	manual mode 3rd gear	
4 bars	manual mode 4th gear and also 5th and 6th gear in 6WG	
4 bars and 2 arrows	automatic mode	
Bars flashing	6 WG: converter lockup clutch open 4 WG: Downshift mode activ	difference of engine and turbine speed above a certain limit and lockup clutch not activated
Spanner	at least one fault activ	select neutral to get fault code displayed
Fault code	see faultcode list	
WS	warning sump temperature	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
WR	warning retarder temperature	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
WT	warning torque converter temperature	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
WE	warning high engine speed	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
WV	warning high output speed (velocity)	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
WL	warning high transmission input torque (load)	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
WO	warning high transmission output torque (load)	changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)
PN	direction F or R selected while parking brake engaged	transmission in neutral until parking brake is released CAUTION: vehicle starts to move after release of parking brake
EE flashing	no communication with display	checked wiring from TCU to display

1.4 Display during AEB-Mode

symbol	meaning	remarks
PL	AEB - Starter is plugged at the diagnostic plug	
ST	AEB-Starter-button is pressed	
KA..KE, KV,KR	calibrating clutch KA..KE, KV or KR resp.	KA, KB for 2 gear transmission KC, KD, KE for 3 gear transmission
_ and Kx	wait for start, initialization of clutch Kx, x: A, B, C, D, E, V, R	
≡ and Kx	fast fill time determination of clutch Kx	
= and Kx	compensating pressure determination of clutch Kx	
OK	calibration for all clutches finished	Transmissions stays in neutral, you have to restart the TCU (ignition off/on) after removing AEB-Starter
STOP	AEB canceled (activation stopped)	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
STOP and Kx	AEB stopped, clutch Kx can't be calibrated	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
Spanner and Kx	Kx couldn't be calibrated, AEB finished	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
Δ E	engine speed too low, ⇨ raise engine speed	
∇ E	engine speed too high, ⇨ lower engine speed	
Δ T	transmission oil temperature too low, ⇨ heat up transmission	
∇ T	transmission oil temperature too high ⇨ cool down transmission	
FT	transmission temperature not in defined range during calibration	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
FB	operating mode not NORMAL or transmission temperature sensor defective or storing of Calibrated values to EEPROM-has failed.	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
FO	Outputspeed_not_zero	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
FN	Shift lever not in Neutral position	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
FP	Parkbrake_not_applied	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)
STOP	AEB - Starter was used incorrect or is defective. Wrong device or wrong cable used	Transmissions stays in neutral, you have to restart the TCU (ignition off/on)

1.5 Display during Inchpedal Calibration

symbol	meaning	remarks
IP ⇓	push down the pedal slowly until endposition is reached and hold this position	
IP ⇑	Release the pedal slowly until endposition is reached	
IP ⇑ flashing	A problem occurred, release the pedal slowly until endposition is reached	If the expected enposition could not be reached, release the pedal and try again
OK	Finished inchpedal calibration successful	
FN and Stop	Shift lever not in Neutral position	Calibration is aborted
FS and Stop	sensor supply voltage AU1 is out of the specified range	Calibration is aborted
FO and Stop	Outputspeed is not zero	Calibration is aborted
SL and Stop	sensor voltage below specified rangel	Calibration is aborted
SU and Stop	sensor voltage above specified rangel	Calibration is aborted
IL and Stop	sensor position for released pedal out of specified range	Calibration is aborted
IU and Stop	sensor position for pressed pedal out of specified range	Calibration is aborted
TO and Stop	time-out calibration, pedal not moved after calibration start	Calibration is aborted
DL and Stop	angle between pedalpositions released and pressed to small	Calibration is aborted
DU and Stop	angle between pedalpositions released and pressed to big	Calibration is aborted
FI and Stop	sensor signal 1 and 2 don't match together	Calibration is aborted

2 definition of operating modes

NORMAL:

There's no failure detected in the transmission-system or the failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations. (see following table)

SUBSTITUTE CLUTCH CONTROL:

TCU can't change the gears or the direction under the control of the normal clutch modulation. TCU uses the substitute strategy for clutch control. All modulations are only time controlled. (Comparable with EST 25)

LIMP-HOME:

The detected failure in the system has strong limitations to transmission control. TCU can engage only one gear in each direction. In some cases only one direction will be possible.

TCU will shift the transmission into neutral at the first occurrence of the failure. First, the operator must shift the gear selector into neutral position.

If output speed is less than a threshold for neutral to gear and the operator shifts the gear selector into forward or reverse, the TCU will select the limp-home gear .

If output speed is less than a threshold for reversal speed and TCU has changed into the limp-home gear and the operator selects a shuttle shift, TCU will shift immediately into the limp-home gear of the selected direction.

If output speed is greater than the threshold, TCU will shift the transmission into neutral. The operator has to slow down the vehicle and must shift the gear selector into neutral position.

TRANSMISSION-SHUTDOWN:

TCU has detected a severe failure that disables control of the transmission.

TCU will shut off the solenoid valves for the clutches and also the common power supply (VPS1).

Transmission shifts to Neutral. The park brake will operate normally, also the other functions which use ADM 1 to ADM 8.

The operator has to slow down the vehicle. The transmission will stay in neutral.

TCU-SHUTDOWN:

TCU has detected a severe failure that disables control of system.

TCU will shut off all solenoid valves and also both common power supplies (VPS1, VPS2). The park brake will engage, also all functions are disabled which use ADM 1 to ADM 8.

The transmission will stay in neutral.

3 table of fault codes

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
11	5000	12	48	LOGICAL ERROR AT GEAR RANGE SIGNAL TCU detected a wrong signal combination for the gear range • *cable from shift lever to TCU is broken* • *cable is defective and is contacted to battery voltage or vehicle ground* • *shift lever is defective*	TCU shifts transmission to neutral OP-Mode: transmission shutdown	• check the cables from TCU to shift lever • check signal combinations of shift lever positions for gear range	failure cannot be detected in systems with DW2/DW3 shift lever fault is taken back if TCU detects a valid signal for the position	all
12	5010	12	46	LOGICAL ERROR AT DIRECTION SELECT SIGNAL TCU detected a wrong signal combination for the direction • *cable from shift lever to TCU is broken* • *cable is defective and is contacted to battery voltage or vehicle ground* • *shift lever is defective*	TCU shifts transmission to neutral OP-Mode: transmission shutdown	• check the cables from TCU to shift lever • check signal combinations of shift lever positions F-N-R	fault is taken back if TCU detects a valid signal for the direction at the shift lever	all
21	5090	3	32	S.C. TO BATTERY VOLTAGE AT CLUTCH CUTOFF / INCHPEDAL INPUT the measured voltage is too high: • *cable is defective and is contacted to battery voltage* • *clutch cut off / inch pedal sensor has an internal defect* • *connector pin is contacted to battery voltage*	clutch cutoff / inching function is disabled OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check the clutch cutoff / inch pedal sensor		all
22	5090	4	29	S.C. TO GROUND OR O.C. AT CLUTCH CUTOFF / INCHPEDAL INPUT the measured voltage is too low: • *cable is defective and is contacted to vehicle ground* • *cable has no connection to TCU*	clutch cutoff / inching function is disabled OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check the clutch cutoff / inch pedal sensor		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				• *clutch cut off / inch pedal sensor has an internal defect* • *connector pin is contacted to vehicle ground or is broken*				
25	5110	3	33	S.C. TO BATTERY VOLTAGE OR O.C. AT TRANSMISSION SUMP TEMPERATURE SENSOR INPUT the measured voltage is too high: • *cable is defective and is contacted to battery voltage* • *cable has no connection to TCU* • *temperature sensor has an internal defect* • *connector pin is contacted to battery voltage or is broken*	no reaction, TCU uses default temperature OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check the temperature sensor		all
26	5110	4	30	S.C. TO GROUND AT TRANSMISSION SUMP TEMPERATURE SENSOR INPUT the measured voltage is too low: • *cable is defective and is contacted to vehicle ground* • *temperature sensor has an internal defect* • *connector pin is contacted to vehicle ground*	no reaction, TCU uses default temperature OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check the temperature sensor		all
27	5120	3	76	S.C. TO BATTERY VOLTAGE OR O.C. AT RETARDER / TORQUECONVERTER TEMPERATURE SENSOR INPUT the measured voltage is too high: • *cable is defective and is contacted to battery voltage* • *cable has no connection to TCU* • *temperature sensor has an internal defect* • *connector pin is contacted to battery*	no reaction, TCU uses default temperature OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check the temperature sensor		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				voltage or is broken				
28	5120	4	74	S.C. TO GROUND AT RETARDER / TORQUECONVERTER TEMPERATURE SENSOR INPUT the measured voltage is too low: • *cable is defective and is contacted to vehicle ground* • *temperature sensor has an internal defect* • *connector pin is contacted to vehicle ground*	no reaction, TCU uses default temperature OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check the temperature sensor		all
2B	5313	12	135	INCHSENSOR-SIGNAL MISMATCH the measured voltage from CCO and CCO2 signal don't match or Brake Pedal Position is used for Inching and is not defined • *cable is defective* • *sensor has an internal defect*	During inching mode: TCU shifts to neutral while inching is switched off: no change OP-Mode: normal	• check the cable from TCU to the sensor • check the connectors • check sensor		all
31	5140	3	38	S.C. TO BATTERY VOLTAGE OR O.C. AT ENGINE SPEED INPUT TCU measures a voltage higher than 7.00 V at speed input pin • *cable is defective and is contacted to battery voltage* • *cable has no connection to TCU* • *speed sensor has an internal defect* • *connector pin is contacted to battery voltage or has no contact*	OP-Mode: substitute clutch control	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all
32	5140	4	34	S.C. TO GROUND AT ENGINE SPEED INPUT TCU measures a voltage less than 0.45V at speed input pin • *cable / connector is defective and is contacted to vehicle ground* • *speed sensor has an internal defect*	OP-Mode: substitute clutch control	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
33	5140	12	42	LOGICAL ERROR AT ENGINE SPEED INPUT TCU measures a engine speed over a threshold and the next moment the measured speed is zero • *cable / connector is defective and has bad contact* • *speed sensor has an internal defect* • *sensor gap has the wrong size*	OP-Mode: substitute clutch control	• check the cable from TCU to the sensor • check the connectors • check the speed sensor • check the sensor gap	This fault is reset after power up of TCU	all
34	5150	3	39	S.C. TO BATTERY VOLTAGE OR O.C. AT TURBINE SPEED INPUT TCU measures a voltage higher than 7.00 V at speed input pin • *cable is defective and is contacted to battery voltage* • *cable has no connection to TCU* • *speed sensor has an internal defect* • *connector pin is contacted to battery voltage or has no contact*	OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all
35	5150	4	35	S.C. TO GROUND AT TURBINE SPEED INPUT TCU measures a voltage less than 0.45V at speed input pin • *cable / connector is defective and is contacted to vehicle ground* • *speed sensor has an internal defect*	OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all
36	5150	12	43	LOGICAL ERROR AT TURBINE SPEED INPUT TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero • *cable / connector is defective and has bad contact* • *speed sensor has an internal defect* • *sensor gap has the wrong size*	OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home	• check the cable from TCU to the sensor • check the connectors • check the speed sensor • check the sensor gap	This fault is reset after power up of TCU	all
37	5160	3	40	S.C. TO BATTERY VOLTAGE OR O.C. AT INTERNAL SPEED INPUT TCU measures a voltage higher than 7.00	OP-Mode: substitute clutch control	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				V at speed input pin • *cable is defective and is contacted to battery voltage* • *cable has no connection to TCU* • *speed sensor has an internal defect* • *connector pin is contacted to battery voltage or has no contact*				
38	5160	4	36	S.C. TO GROUND AT INTERNAL SPEED INPUT TCU measures a voltage less than 0.45V at speed input pin • *cable / connector is defective and is contacted to vehicle ground* • *speed sensor has an internal defect*	OP-Mode: substitute clutch control	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all
39	5160	12	44	LOGICAL ERROR AT INTERNAL SPEED INPUT TCU measures a internal speed over a threshold and at the next moment the measured speed is zero • *cable / connector is defective and has bad contact* • *speed sensor has an internal defect* • *sensor gap has the wrong size*	OP-Mode: substitute clutch control	• check the cable from TCU to the sensor • check the connectors • check the speed sensor • check the sensor gap	This fault is reset after power up of TCU	all
3A	5170	3	41	S.C. TO BATTERY VOLTAGE OR O.C. AT OUTPUT SPEED INPUT TCU measures a voltage higher than 12.5 V at speed input pin • *cable is defective and is contacted to battery voltage* • *cable has no connection to TCU* • *speed sensor has an internal defect* • *connector pin is contacted to battery voltage or has no contact*	special mode for gear selection OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral OP-Mode: limp home	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all
3B	5170	4	37	S.C. TO GROUND AT OUTPUT SPEED INPUT TCU measures a voltage less than 1.00V at speed input pin • *cable / connector is defective and is*	special mode for gear selection OP-Mode: substitute clutch control if a failure is existing at turbine	• check the cable from TCU to the sensor • check the connectors • check the speed sensor		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				contacted to vehicle ground • *speed sensor has an internal defect*	speed, TCU shifts to neutral OP-Mode: limp home			
3C	5170	12	45	LOGICAL ERROR AT OUTPUT SPEED INPUT TCU measures a output speed over a threshold and at the next moment the measured speed is zero • *cable / connector is defective and has bad contact* • *speed sensor has an internal defect* • *sensor gap has the wrong size*	special mode for gear selection OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral OP-Mode: limp home	• check the cable from TCU to the sensor • check the connectors • check the speed sensor • check the sensor gap	This fault is reset after power up of TCU	all
3E	5180	2	72	OUTPUT SPEED ZERO DOESN'T FIT TO OTHER SPEED SIGNALS if transmission is not neutral and the shifting has finished, TCU measures outputspeed zero and turbine speed or internal speed not equal to zero. • *speed sensor has an internal defect* • *sensor gap has the wrong size*	special mode for gear selection OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral OP-Mode: limp home	• check the sensor signal of output speed sensor • check the sensor gap of output speed sensor • check the cable from TCU to the sensor • check the clutch pressure • check for slipping clutches • check the proportional valves	This fault is reset after power up of TCU	all
42	5220	9	123	EBC1 TIMEOUT Timeout of CAN-message EBC1 from EEC controller • *interference on CAN-Bus* • *CAN wire/connector is broken* • *CAN wire/connector is defective and has contact to vehicle ground or battery voltage*	clutch cutoff / inching function is disabled OP-Mode: normal	• check EBC controller • check wire of CAN-Bus • check cable to EBC controller		all
43	5230	9	143	TC1 TIMEOUT Timeout of CAN-message TC1 from EEC controller • *interference on CAN-Bus* • *CAN wire/connector is broken* • *CAN wire/connector is defective and*	TCU shifts to neutral NN (because of shifting lever)	• check TC controller • check wire of CAN-Bus • check cable to TC controller		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				has contact to vehicle ground or battery voltage				
44	5211	9	127	SPEEDLIMIT_PROP1 Timeout of CAN-message SpeedLimit_Prop1 from Vehicle controller • *interference on CAN-Bus* • *CAN wire/connector is broken* • *CAN wire/connector is defective and has contact to vehicle ground or battery voltage*	TCU keeps last valid sent Speed_Limit_Request	• check Vehicle controller • check wire of CAN-Bus • check cable to Vehicle controller		all
45	5212	9	128	SPEEDLIMIT_PROP2 Timeout of CAN-message SpeedLimit_Prop1 from Vehicle controller • *interference on CAN-Bus* • *CAN wire/connector is broken* • *CAN wire/connector is defective and has contact to vehicle ground or battery voltage*	TCU keeps last valid sent Speed_Limit_Value	• check Vehicle controller • check wire of CAN-Bus • check cable to Vehicle controller		all
54	5260	9	103	VEHICLE1 TIMEOUT Timeout of CAN-message Vehicle1 from display computer • *interference on CAN-Bus* • *CAN wire/connector is broken* • *CAN wire/connector is defective and has contact to vehicle ground or battery voltage*	TCU shifts to neutral NN (because of shifting lever)	• check vehicle controller • check wire of CAN-Bus • check cable to vehicle controller		all
57	5290	9	106	EEC1 TIMEOUT Timeout of CAN-message EEC1 from EEC controller • *interference on CAN-Bus* • *CAN wire/connector is broken* • *CAN wire/connector is defective and*	OP-Mode: substitute clutch control	• check EEC controller • check wire of CAN-Bus • check cable to EEC controller		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				has contact to vehicle ground or battery voltage				
71	5480	3	22	S.C. TO BATTERY VOLTAGE AT CLUTCH KC the measured resistance value of the valve is out of limit, the voltage at KC valve is too high. • *cable / connector is defective and has contact to battery voltage* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from TCU to the gearbox • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
72	5480	4	10	S.C. TO GROUND AT CLUTCH KC the measured resistance value of the valve is out of limit, the voltage at KC valve is too low. • *cable / connector is defective and has contact to vehicle ground* • *cable / connector is defective and has contact to another regulator output of the TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
73	5480	5	16	O.C. AT CLUTCH KC the measured resistance value of the valve is out of limit. • *cable / connector is defective and has no contact to TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
74	5490	3	23	S.C. TO BATTERY VOLTAGE AT CLUTCH KD/KA the measured resistance value of the valve is out of limit, the voltage at KD/KA valve is too high. • *cable / connector is defective and has contact to battery voltage* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
75	5490	4	11	S.C. TO GROUND AT CLUTCH KD/KA the measured resistance value of the valve is out of limit, the voltage at KD/KA valve is too low. • *cable / connector is defective and has contact to vehicle ground* • *cable / connector is defective and has contact to another regulator output of the TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
76	5490	5	17	O.C. AT CLUTCH KD/KA the measured resistance value of the valve is out of limit. • *cable / connector is defective and has no contact to TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
77	5500	3	24	S.C. TO BATTERY VOLTAGE AT CLUTCH KE/KB the measured resistance value of the valve is out of limit, the voltage at KE/KB valve is too high. • *cable / connector is defective and has contact to battery voltage* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
78	5500	4	12	S.C. TO GROUND AT CLUTCH KE/KB the measured resistance value of the valve is out of limit, the voltage at KE/KB valve is too low. • *cable / connector is defective and has contact to vehicle ground* • *cable / connector is defective and has contact to another regulator output of the TCU*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				• *regulator has an internal defect*				
79	5500	5	18	O.C. AT CLUTCH KE/KB the measured resistance value of the valve is out of limit. • *cable / connector is defective and has no contact to TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
84	5520	3	26	S.C. TO BATTERY VOLTAGE AT CLUTCH KV the measured resistance value of the valve is out of limit, the voltage at KV valve is too high. • *cable / connector is defective and has contact to battery voltage* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
85	5520	4	14	S.C. TO GROUND AT CLUTCH KV the measured resistance value of the valve is out of limit, the voltage at KV valve is too low. • *cable / connector is defective and has contact to vehicle ground* • *cable / connector is defective and has contact to another regulator output of the TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
86	5520	5	20	O.C. AT CLUTCH KV the measured resistance value of the valve is out of limit. • *cable / connector is defective and has no contact to TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
87	5530	3	27	S.C. TO BATTERY VOLTAGE AT CLUTCH KR	TCU shifts to neutral	• check the cable from TCU to the	[1)] see chapter 4	all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				the measured resistance value of the valve is out of limit, the voltage at KR valve is too high. • *cable / connector is defective and has contact to battery voltage* • *regulator has an internal defect*	OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox		
88	5530	4	15	S.C. TO GROUND AT CLUTCH KR the measured resistance value of the valve is out of limit, the voltage at KR valve is too low. • *cable / connector is defective and has contact to vehicle ground* • *cable / connector is defective and has contact to another regulator output of the TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
89	5530	5	21	O.C. AT CLUTCH KR the measured resistance value of the valve is out of limit. • *cable / connector is defective and has no contact to TCU* • *regulator has an internal defect*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check the cable from TCU to the gearbox • check the connectors from gearbox to TCU • check the regulator resistance [1)] • check internal wire harness of the gearbox	[1)] see chapter 4	all
B1	5660	2	60	SLIPPAGE AT CLUTCH KC TCU calculates a differential speed at closed clutch KC. If this calculated value is out of range, TCU interprets this as slipping clutch. • *low pressure at clutch KC* • *low main pressure* • *wrong signal at internal speed sensor* • *wrong signal at output speed sensor* • *wrong size of the sensor gap* • *clutch is defective*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check pressure at clutch KC • check main pressure in the system • check sensor gap at internal speed sensor • check sensor gap at output speed sensor • check signal at internal speed sensor • check signal at output speed sensor • replace clutch		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
B2	5665	2	61	SLIPPAGE AT CLUTCH KD/KA TCU calculates a differential speed at closed clutch KD/KA. If this calculated value is out of range, TCU interprets this as slipping clutch. • *low pressure at clutch KD/KA* • *low main pressure* • *wrong signal at internal speed sensor* • *wrong signal at output speed sensor* • *wrong size of the sensor gap* • *clutch is defective*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check pressure at clutch KD/KA • check main pressure in the system • check sensor gap at internal speed sensor • check sensor gap at output speed sensor • check signal at internal speed sensor • check signal at output speed sensor • replace clutch		all
B3	5670	2	62	SLIPPAGE AT CLUTCH KE/KB TCU calculates a differential speed at closed clutch KE/KB. If this calculated value is out of range, TCU interprets this as slipping clutch. • *low pressure at clutch KE/KB* • *low main pressure* • *wrong signal at internal speed sensor* • *wrong signal at output speed sensor* • *wrong size of the sensor gap* • *clutch is defective*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check pressure at clutch KE/KB • check main pressure in the system • check sensor gap at internal speed sensor • check sensor gap at output speed sensor • check signal at internal speed sensor • check signal at output speed sensor • replace clutch		all
B5	5680	2	64	SLIPPAGE AT CLUTCH KV TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch. • *low pressure at clutch KV* • *low main pressure* • *wrong signal at internal speed sensor* • *wrong signal at turbine speed sensor* • *wrong size of the sensor gap* • *clutch is defective*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check pressure at clutch KV • check main pressure in the system • check sensor gap at internal speed sensor • check sensor gap at turbine speed sensor • check signal at internal speed sensor • check signal at turbine speed sensor • replace clutch		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
B6	5685	2	65	SLIPPAGE AT CLUTCH KR TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch. • *low pressure at clutch KR* • *low main pressure* • *wrong signal at internal speed sensor* • *wrong signal at turbine speed sensor* • *wrong size of the sensor gap* • *clutch is defective*	TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown	• check pressure at clutch KR • check main pressure in the system • check sensor gap at internal speed sensor • check sensor gap at turbine speed sensor • check signal at internal speed sensor • check signal at turbine speed sensor • replace clutch		all
B7	5700	0	87	OVERTEMP SUMP TCU measured a temperature in the oil sump that is over the allowed threshold.	no reaction OP-Mode: normal	• cool down machine • check oil level • check temperature sensor		all
B8	5710	0	88	OVERTEMP CONVERTER TCU measured a temperature in the retarder oil that is over the allowed threshold.	no reaction OP-Mode: normal	• cool down machine • check oil level • check temperature sensor		all
B9	5720	0	89	OVERSPEED ENGINE	retarder applies if configured OP-Mode: normal	-		all
BC	5745	15	92	OVERSPEED OUTPUT TCU messures an transmission output speed above the defined threshold	No reaction OP-Mode: normal			all
C0	5751	0	183	ENGINE TORQUE OR ENGINE POWER OVERLOAD TCU calculates an engine torque or engine power above the defined thresholds	OP-Mode: normal			all
C1	5752	0	184	TRANSMISSION OUTPUT TORQUE OVERLOAD TCU calculates an transmission output torque above the defined threshold	OP-Mode: normal			all
C2	5755	15	93	TRANSMISSION INPUT TORQUE OVERLOAD TCU calculates an transmission input torque above the defined threshold	programmable :No reaction or shift to neutral OP-Mode: normal			all

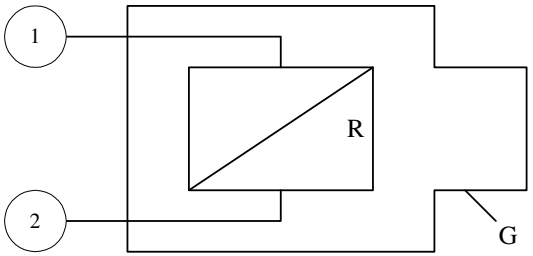
Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
C3	5760	0	91	OVERTEMP CONVERTER OUTPUT TCU measured a oil temperature at the converter ouput that is over the allowed threshold.	no reaction OP-Mode: normal	• cool down machine • check oil level • check temperature sensor		all
D1	5810	3	54	S.C. TO BATTERY VOLTAGE AT POWER SUPPLY FOR SENSORS TCU measures more than 6V at the pin AU1 (5V sensor supply)	see fault codes no. 21 to 2C	• check cables and connectors to sensors, which are supplied from AU1 • check the power supply at the pin AU1 (should be appx. 5V)	fault codes no. 21 to no. 2C may be a reaction of this fault	all
D2	5810	4	55	S.C. TO GROUND AT POWER SUPPLY FOR SENSORS TCU measures less than 4V at the pin AU1 (5V sensor supply)	see fault codes no. 21 to 2C	• check cables and connectors to sensors, which are supplied from AU1 • check the power supply at the pin AU1 (should be appx. 5V)	fault codes no. 21 to no. 2C may be a reaction of this fault	all
D3	5820	4	53	LOW VOLTAGE AT BATTERY measured voltage at power supply is lower than 10 V (12V device) lower than 18 V (24V device)	shift to neutral OP-Mode: TCU shutdown	• check power supply battery • check cables from batteries to TCU • check connectors from batteries to TCU		all
D4	5820	3	52	HIGH VOLTAGE AT BATTERY measured voltage at power supply is higher than 18 V (12V device) higher than 32.5 V (24V device)	shift to neutral OP-Mode: TCU shutdown	• check power supply battery • check cables from batteries to TCU • check connectors from batteries to TCU		all
D5	5830	2	57	ERROR AT VALVE POWER SUPPLY VPS1 TCU switched on VPS1 and measured VPS1 is off or TCU switched off VPS1 and measured VPS1 is still on • *cable or connectors are defect and are contacted to battery voltage* • *cable or connectors are defect and are contacted to vehicle ground* • *permanent power supply KL30 missing* • *TCU has an internal defect*	shift to neutral OP-Mode: TCU shutdown	• check fuse • check cables from gearbox to TCU • check connectors from gearbox to TCU • replace TCU		all
D6	5840	2	58	ERROR VALVE POWER SUPPLY VPS2 TCU switched on VPS2 and measured VPS2 is off or TCU switched off VPS2 and measured VPS2 is still on • *cable or connectors are defect and are*	shift to neutral OP-Mode: TCU shutdown	• check fuse • check cables from gearbox to TCU • check connectors from gearbox to TCU • replace TCU		all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
				contacted to battery voltage • *cable or connectors are defect and are contacted to vehicle ground* • *permanent power supply KL30 missing* • *TCU has an internal defect*				
E3	5860	3	50	S.C. TO BATTERY VOLTAGE AT DISPLAY OUTPUT TCU sends data to the display and measures allways a high voltage level on the connector • *cable or connectors are defective and are contacted to battery voltage* • *display has an internal defect*	no reaction OP-Mode: normal	• check the cable from TCU to the display • check the connectors at the display • change display		all
E4	5860	4	49	S.C. TO GROUND AT DISPLAY OUTPUT TCU sends data to the display and measures allways a high voltage level on the connector • *cable or connectors are defective and are contacted to vehicle ground* • *display has an internal defect*	no reaction OP-Mode: normal	• check the cable from TCU to the display • check the connectors at the display • change display		all
F1	5890	2	51	GENERAL EEPROM FAULT TCU can't read non volantile memoy • *TCU is defective*	no reaction OP-Mode: normal	• replace TCU	often shown together with fault code F2	all
F2	5900	13	56	CONFIGURATION LOST TCU has lost the correct configuration and can't control the transmission. • *interference during saving data on non volatile memory* • *TCU is brand new or from another vehicle*	transmission stay neutral OP-Mode: TCU shutdown	• Reprogramm the correct configuration for the vehicle (e.g. with cluster controller,...)		all
F3	5910	13	59	APPLICATION ERROR something of this application is wrong	transmission stay neutral OP-Mode: TCU shutdown	• check EP90-CAN Signals dueto consistency • replace TCU !!	This fault occurs only if an test engineer did something wrong in the application of the vehicle	all

Fault Code (hex)	SPN	FMI	Int. Code (dec)	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks	costumer
F5	5930	7	173	CLUTCH FAILURE AEB was not able to adjust clutch filling parameters • One of the AEB-Values is out of limit	transmission stay neutral OP-Mode: TCU shutdown	• check clutch	TCU shows also the affected clutch on the Display	all
F6	5930	13	174	CLUTCH ADJUSTMENT DATA LOST OR INCHPEDAL CALIBRATION DATA LOST TCU was not able to read correct clutch adjustment parameters • *interference during saving data on non volatile memory* • *TCU is brand new*	default values = 0 for AEB offsets used OP-Mode: normal no Inchmode available	• execute AEB		all

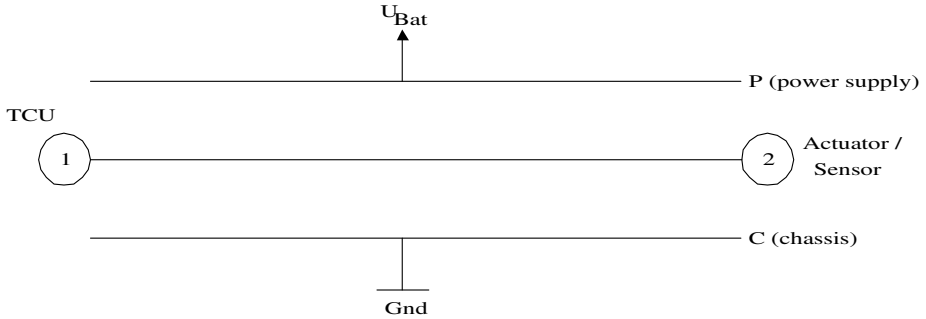
4 measuring of resistance at actuator/sensors and cable

4.1 actuator:



open circuit:	$R_{12} \approx R_{1G} \approx R_{2G} \approx \infty$		
short cut to ground:	$R_{12} \approx R$;	$R_{1G} \approx 0$, $R_{2G} \approx R$ or $R_{1G} \approx R$, $R_{2G} \approx 0$	(for s.c. to ground, G is connected to vehicle ground)
short cut to battery:	$R_{12} \approx R$;	$R_{1G} \approx 0$, $R_{2G} \approx R$ or $R_{1G} \approx R$, $R_{2G} \approx 0$	(for s.c. to battery, G is connected to battery voltage)

4.2 cable:



open circuit:	$R_{12} \approx R_{1P} \approx R_{1C} \approx R_{2P} \approx R_{2C} \approx \infty$		
short cut to ground:	$R_{12} \approx 0$;	$R_{1C} \approx R_{2C} \approx 0$,	$R_{1P} \approx R_{2P} \approx \infty$
short cut to battery:	$R_{12} \approx 0$,	$R_{1C} \approx R_{2C} \approx \infty$,	$R_{1P} \approx R_{2P} \approx 0$