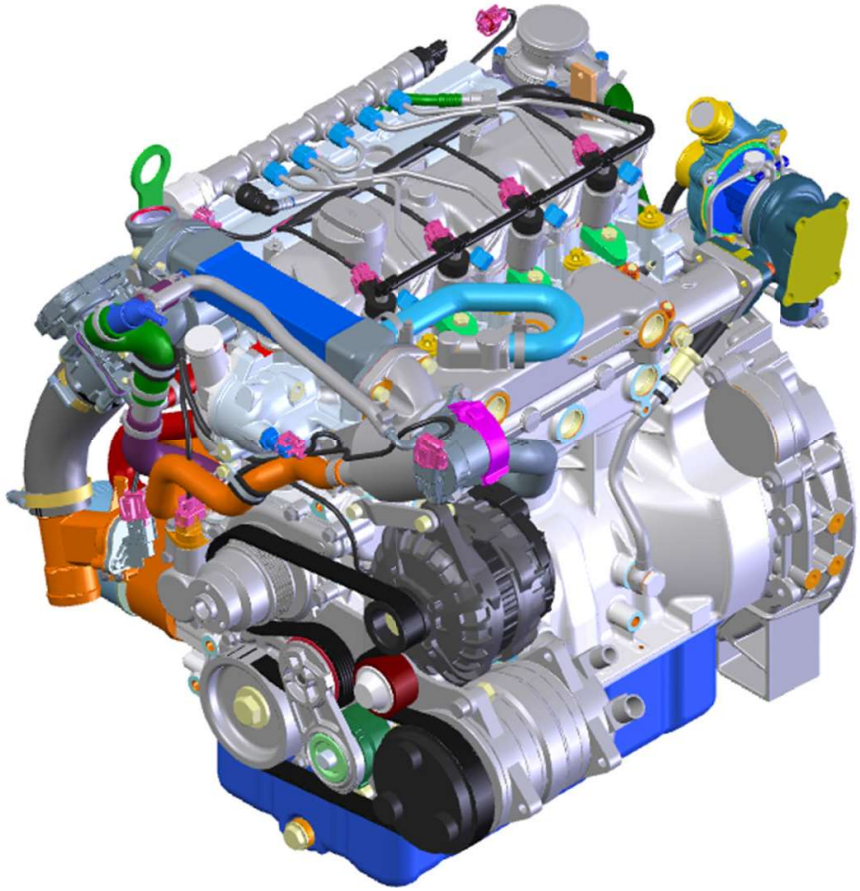
9.0.1.1 Electrical Components Hatz Engine CM1650



Note: This document is used to provide an overview of the system. For diagnosis and repair work on the Hatz engine, it is absolutely necessary that the Hatz Diagnostics software, error message list and the workshop manual are available.

table of contents

Air Filter Differential Pressure Sensor B31

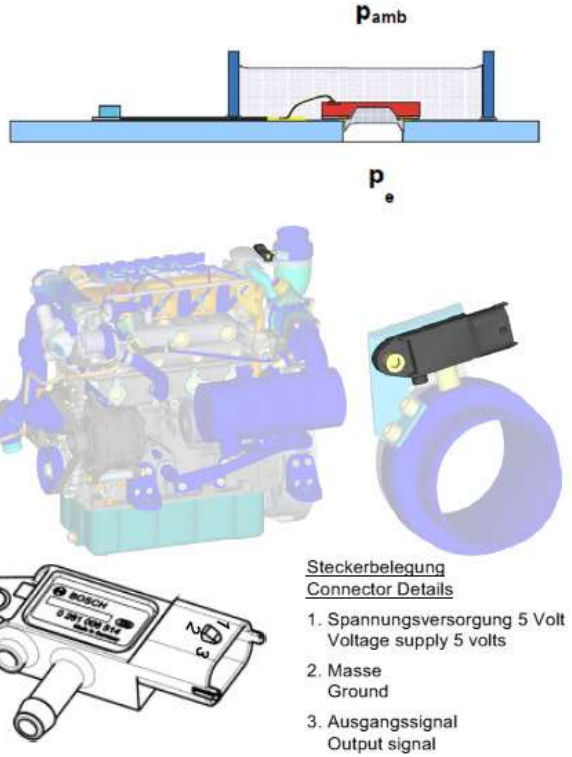
General

Air Filter Differential Pressure Sensor (relative pressure sensor):
The piezoresistive pressure sensor element and suitable electronics for signal amplification and temperature compensation are integrated on a silicon chip. The pressure pe acts on the back of the silicon membrane. The ambient pressure Pamb acts as a reference pressure from above on the active side of the silicon membrane.

Function:
This sensor is currently used for air filter/intake vacuum monitoring only and has no influence on combustion-related components such as EGR, injection, etc. Excessive intake pressure could lead to turbocharger damage, altered emissions, loss of performance, etc.

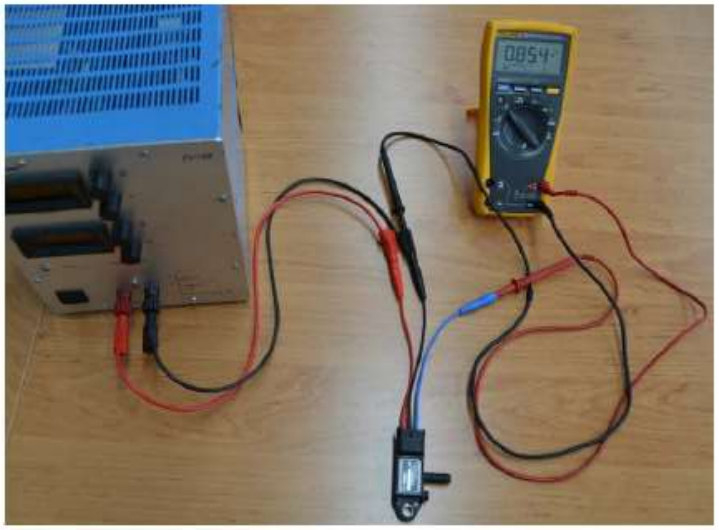
The normal operation of the sensor can be divided into 3 areas:
• No exceeding of warning or error threshold => normal engine operation
• Exceeding the warning threshold => Entry into fault memory, no power reduction, the operator is only requested to change the air filter (lamp)
• Exceeding the error threshold => Entry into fault memory, power reduction/emergency run, the operator is “forced” to react.

These warning thresholds are only activated when the engine is warm. They are in relation to the operating point of the characteristic fields and recorded in the control unit. An automatic sensor calibration was applied in the software, which takes place in the so called “run-up process” of the control unit. Furthermore, the sensor is also checked for the voltage limits (broken wire/ short circuit).If they are out of range, an entry is made in the fault memory and the error reaction (limp home/engine shut down) takes place according programming/customer requirements.



Air Filter Differential Pressure Sensor B31

Measuring structure



Druck Pressure P_{rel}			Signalausgangsspannung Signal Output Voltage U_{out}
Bar	kPa	psi	V
-0,11	-11	-1,60	4,5
-0,10	-10	-1,45	4,2
-0,09	-9	-1,31	3,8
-0,08	-8	-1,16	3,5
-0,07	-7	-1,02	3,2
-0,06	-6	-0,87	2,8
-0,05	-5	-0,73	2,5
-0,04	-4	-0,58	2,2
-0,03	-3	-0,44	1,8
-0,02	-2	-0,29	1,5
-0,01	-1	-0,15	1,2
0,00	0	0	0,8
0,01	1	0,15	0,5

Dynamic check of Air Filter Differential Pressure Sensor

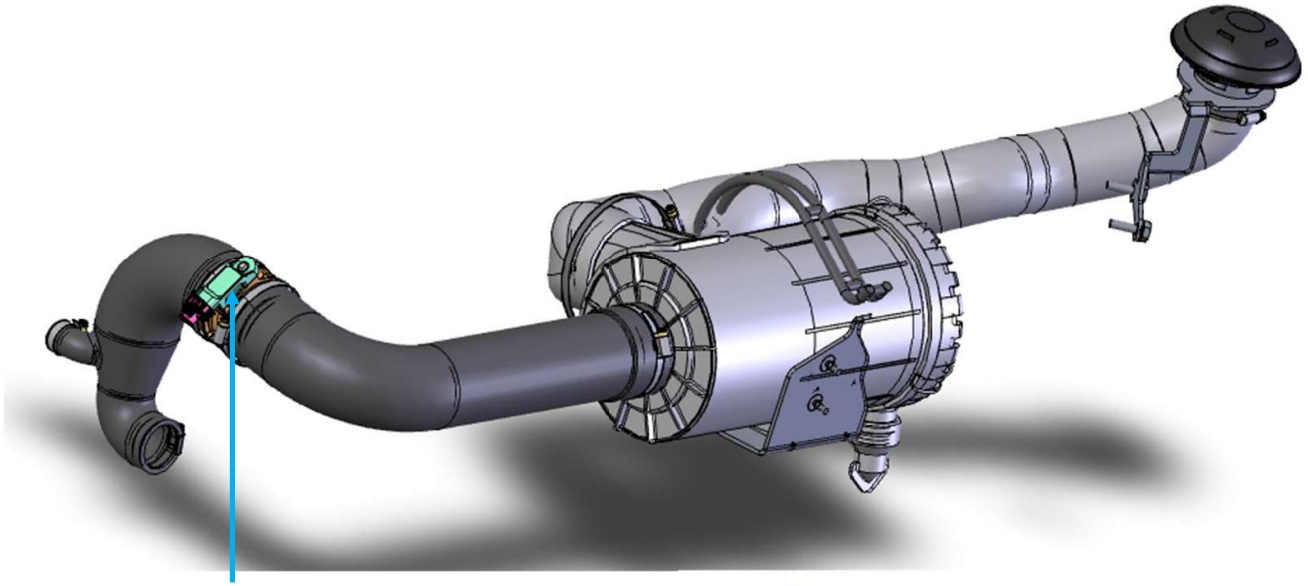
Step	Description
1	Full adaption of the Sensor
2	Switch the Ignition ON
3	Measure Voltage between Pin 2 (GND) and Pin 3 (Output Signal)
4	If this Voltage value is between 0.5V and 4.5V → Sensor OK → Air Filter OK (eg. Room Pressure relatively = 0.00 bar → Voltage value approx. 0.8V)

Static check of Air Filter Differential Pressure Sensor

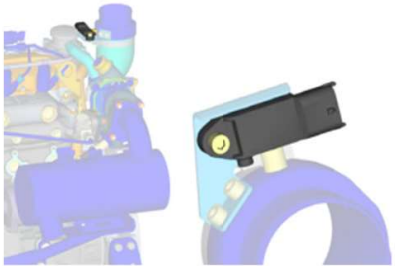
Step	Description
1	Voltage supply (5V) of the Sensor via Pin 1 (B+) and Pin 2 (GND)
2	Measure Voltage between Pin 2 (GND) and Pin 3 (Output Signal) If this Voltage value is between 0.5V and 4.5V → Sensor OK → Air Filter OK (eg. Room Pressure relatively = 0.00 bar → Voltage value approx. 0.8V)
3	Compare measured Value with figures provided in the Temperature Table (refer Table below for Static Verification of Temperature Sensor).

Air Filter Differential Pressure Sensor B31

Location of the sensor



Differential pressure sensor intake air B31
(filter contamination)



Speed Sensor Crankshaft

General

Speed Sensor Crankshaft:
The soft core of the sensor, which is surrounded by a winding, is mounted directly against a rotating encoder wheel, separated by an air gap. The soft iron core is connected to a permanent magnet. The magnetic field extends from the permanent magnet via the pole pin of stainless steel into the ferromagnetic encoder wheel. The magnetic flux through the coil depends on whether a gap or a tooth opposes the pole core. A tooth bundles the stray flux of the magnet in such a way that it is passed as a useful flow through the pole core and thus the coil. A gap, on the other hand, weakens the flow through the coil (see Figure 1). The magnetic flux changes of the useful flux induce a sinusoidal wave that is proportional to the rate of change in the sensor coil Output Voltage.

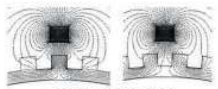


Abbildung 1: Verlauf der Magnetfeldlinien

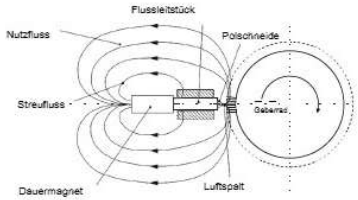
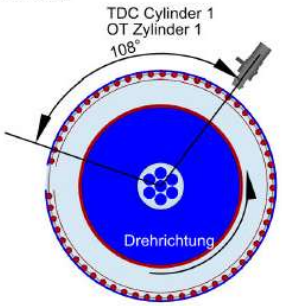
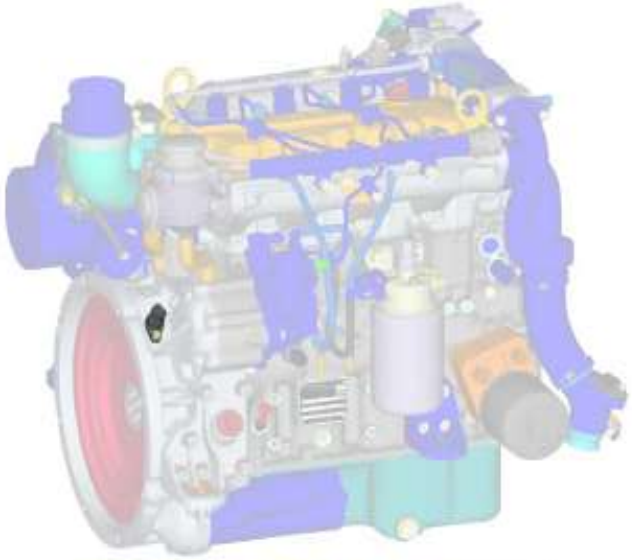


Abbildung 2: DG6 Magnetkreis mit Geberrad

Anordnung des Drehzahlgebers:

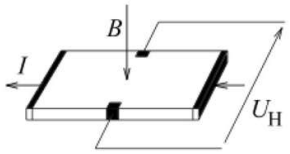




Camshaft speed sensor B6

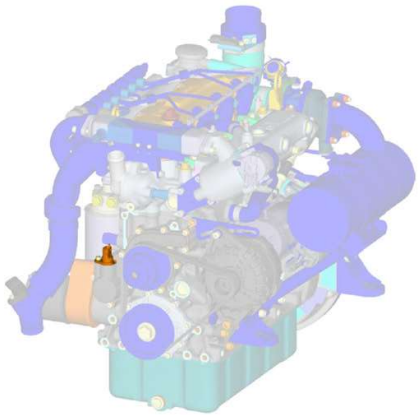
General

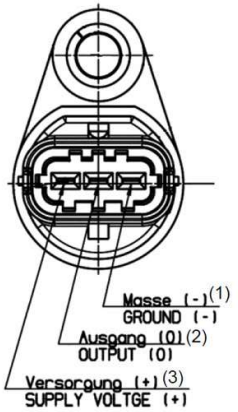
Principle of the Hall Sensor



Schaltsymbol

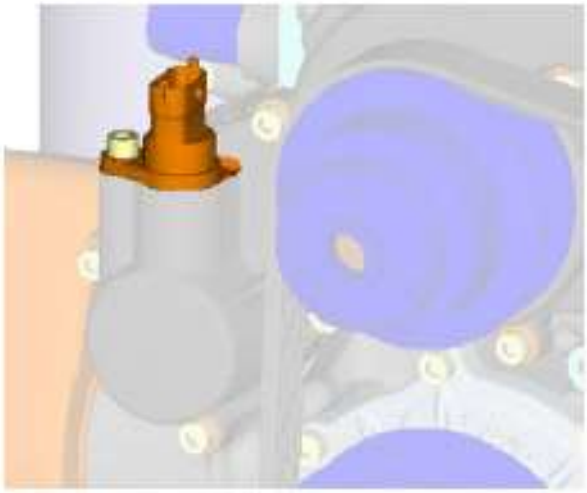
Due to a current I and a magnetic flux density B, the Hall voltage UH is produced. A Hall sensor (also Hall probe or Hall sensor, according to Edwin Hall) uses the Hall effect for the measurement of magnetic fields.
If a simple Hall sensor is traversed by a current and brought into a perpendicular magnetic field, it provides an output voltage that is proportional to the product of magnetic field strength and current (Hall effect). The signal is also temperature dependent. A Hall sensor also provides a signal when the magnetic field in which it is located is constant. This is the decisive advantage compared to a sensor consisting of magnet and coil. As soon as the magnet and the coil are not moved together, the voltage induced in the coil is zero and the magnet is not detected.





Camshaft speed sensor B6

General

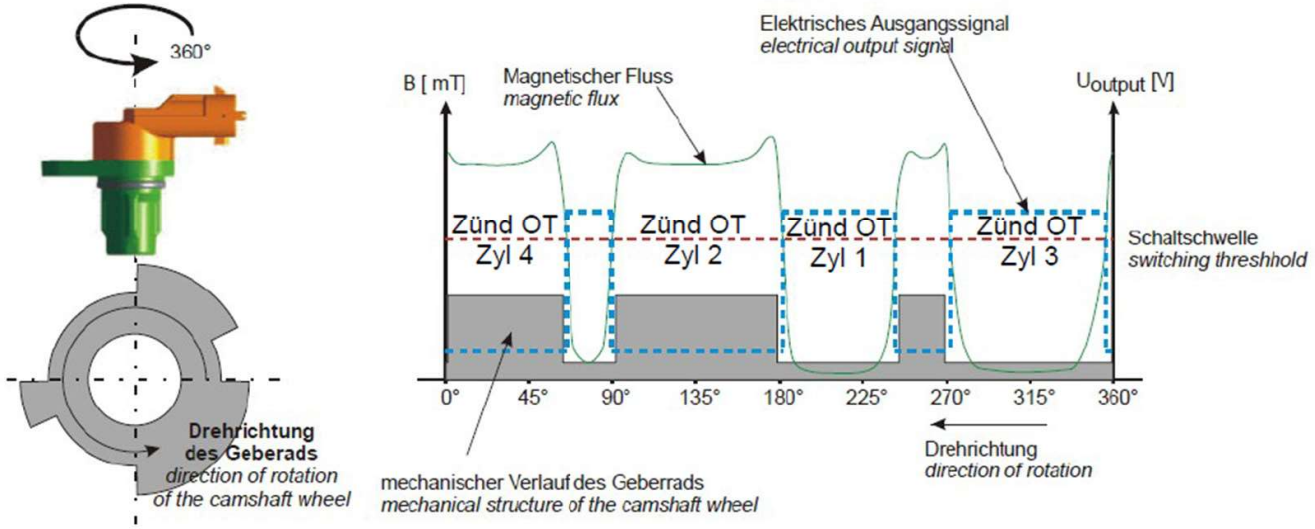


Function of the Phase Detector
The phase detector is an active Hall sensor, which must be supplied with a DC voltage. The camshaft is reduced by 1: 2 against the crankshaft. Their position indicates whether an engine piston moving toward the top dead center is in the compression or ejection stroke. The phase sensor on the camshaft (also referred to as a phase detector) outputs this information to the control unit. An impulse wheel with segments made of ferromagnetic material rotates with the camshaft. The Hall IC is located between the rotor and a permanent magnet. The permanent magnet provides a magnetic field perpendicular to the Hall element. If a segment passes the current-carrying sensor element (semiconductor wafer) of the rod sensor, it changes the field strength of the magnetic field perpendicular to the Hall element. Thus, the electrons driven by a longitudinal voltage applied to the element are more deflected perpendicular to the current direction. This results in a voltage signal (Hall voltage) Which is in the millivolt range and is independent of the relative speed between the sensor and the pulse wheel. The integrated evaluation electronics in the Hall IC of the sensor prepares the signal and outputs it as a square-wave signal.

Camshaft speed sensor B6

General

Illustration of an encoder wheel with quick start function



With the help of the TPO function (True-Power-On), the sensor can immediately recognize if there is a tooth or a gap in front of the sensor when the operating voltage is applied. This is a component of the quick start function. If the sensor fails: Function due to cable breakage or defective sensor, the control unit switches the motor into the emergency program.

Note:
3-sprocket wheels can be used from EDC17. It has an emergency stop function and a quick start function (synchronization after 90 ° Camshaft). The advantage of the 3-tooth encoder wheel lies in the fact that it can be designed smaller than a Z + 1 encoder wheel.

Fuel pressure temperature sensor B3
Oil pressure temperature sensor B9

General

Pressure Sensor (Fuel and Oil):
A piezoresistive sensor element and an appropriate electronics for signal amplification and temperature compensation are on a micro-mechanical chip. The pressure of the measured medium is via a pressure supports on the underside of the membrane sensor element. The ambient pressure is used as a reference on a ventilation in the housing on the front side of the silicon membrane.

Fuel Temperature Sensor / Oil / Coolant / Charge Air (NTC):
The temperature sensor is a sensor that a temperature in an electrical resizes. This temperature sensor is a thermistor (NTC), i.e. it reduces its resistance with increasing temperature.

Fuel pressure and temperature sensors:
Fuel pressure:
The minimum requirement of low fuel pressure is 1.5 bar at speeds from 900 rpm to 1500 rpm. From a speed of 1500 rpm, the minimum requirement increases up to a speed of max. 3000 min-1 linear to 2 bar.

Fuel temperature:
The maximum fuel temperature up to fault detection is 80 ° C, but in normal operation the power is reduced as low as 70 ° C. In certain cases of failure (e.g., defective metering unit), power is reduced as the fuel temperature rises above 50 ° C. In this case, no error entry regarding the fuel temperature will take place (error entry due to ZME).

The limit value for the error entry "fuel temperature" remains at 80 ° C.

Note: A density correction is also made in the permitted temperature range.

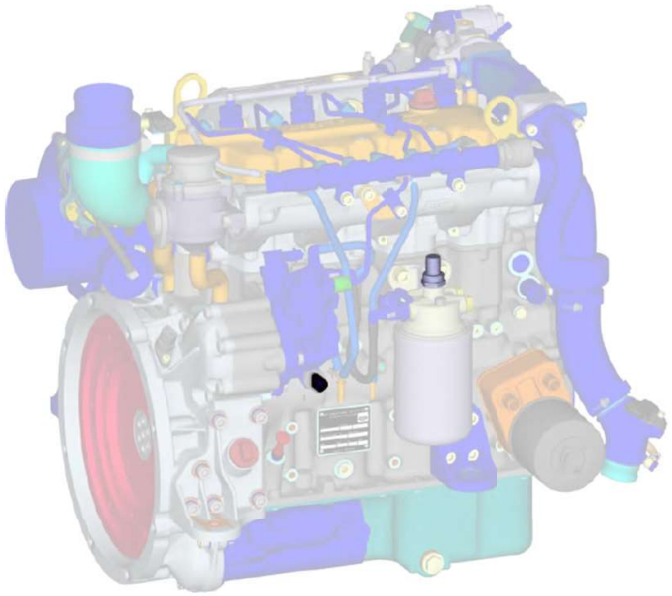
Oil pressure Temperature Sensor:
Oil pressure:
The oil pressure limits for activating the oil pressure lamp are linear at speeds of 900 min-1 to 2800 min-1 from 0.8 to 1.5 bar. The limits for activating the selected error replacement reaction, or engine shutdown, are linear from 0.25 to 0.8 bar at speeds of 900 rpm to 2800 rpm.

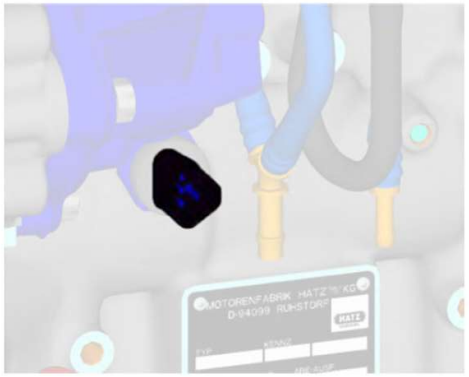
Oil temperature:
The maximum oil temperature up to fault detection is 130 ° C. Furthermore, based on the oil temperature, the internal friction of the engine is calculated and adjusted so the injected fuel quantity. This makes it possible for the engine to always deliver the desired power regardless of the engine / oil temperature and to avoid any mechanical damage.

Note: In the event of a coolant temperature failure, the oil temperature serves as a substitute value.

Fuel pressure temperature sensor B3
Oil pressure temperature sensor B9

Location of the sensors



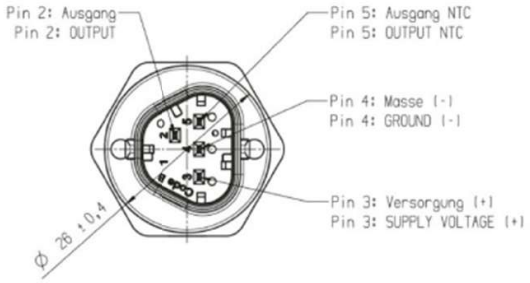


Öl

Kraftstoff

Fuel pressure temperature sensor B3
Oil pressure temperature sensor B9

Measuring structure



Dynamic checking of the Temperature Sensor (Fuel / Oil)

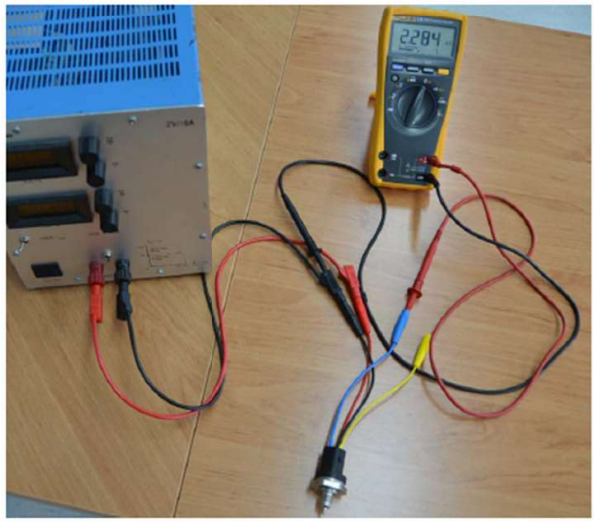
Step	Description
1	Primary Ignition of the Sensor
2	Switch the Ignition ON
3	Measure Resistor between Pin 4 (GND) and Pin 5 (Output NTC)
4	Compare measured Value with figures provided in the Temperature Table (refer Table below for Static Verification of Temperature Sensor). (eg. Room Temperature = 20 - 25°C → Value approx. 2300 Ω) → Sensor OK

Dynamic Testing of the Pressure Sensor (Fuel / Oil)

Step	Description
1	Full adaption of the Sensor (see Table below for Dynamic check of the Temperature Sensor).
2	Switch the Ignition ON
3	Measure Voltage between Pin 4 (GND) and Pin 2 (Output)
4	Compare measured Value with figures provided in the Pressure Table (refer Table below for Static Verification of Pressure Sensor). (eg. Room Pressure relatively = 0.00 bar → Voltage value approx. 0.5V) → sensor OK

Static Verification of the Temperature Sensor (Fuel / Oil)

Step	Description
1	Voltage supply (5V) of the Sensor via Pin 3 (B) and Pin 4 (GND)
2	Measure Resistor between Pin 4 (GND) and Pin 5 (Output NTC)
3	Compare measured Value with figures provided in the Temperature Table (refer Table below for Static Verification of Temperature Sensor). (eg. Room Temperature = 20 - 25°C → Value approx. 2300 Ω) → Sensor OK

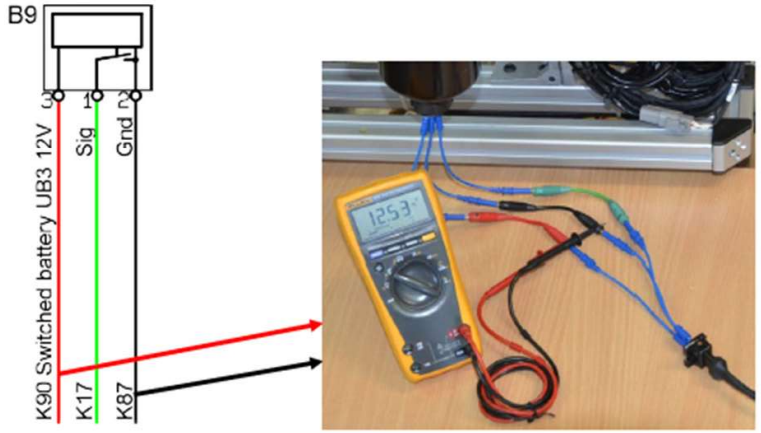


Fuel pressure temperature sensor B3
Oil pressure temperature sensor B9

Measuring structure

1. Checking the Power Supply

Step	Description
1	Full adaption of the Sensor
2	Switch the Ignition ON
3	Supply Voltage between Pin 2 (GND) and Pin 3 (B+) = Battery Voltage
4	If Voltage Value is correct → Proceed to Item 2 and Item 3 in Order



If Voltage is OK → Check the Signal Voltage, see Item 3

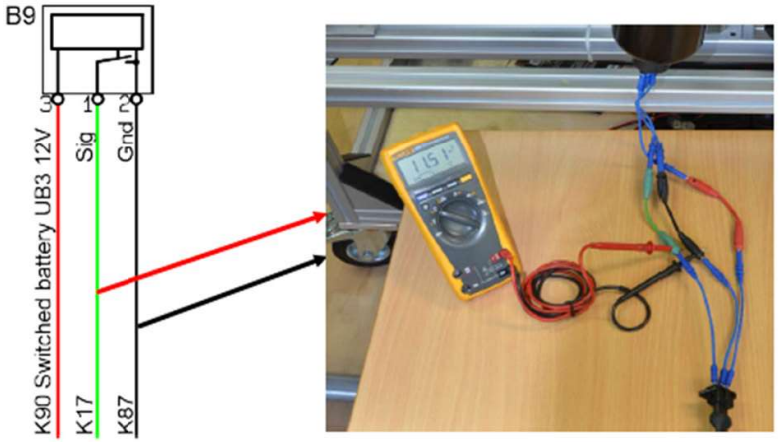
2. No Voltage Value is Displayed → Check Item 2 and Item 3

Step	Check the Cable 3
1	Ignition ON
2	Measure Voltage on Cable 3 with B- GND) = Battery Voltage
3	Battery OK → Battery Cable (B+) Defective

Step	Check the Line 2
1	Ignition ON
2	Measure Voltage on Wire 2 with B- GND) = Battery Voltage
3	Battery OK → Battery Cable (B+) Defective

3. Check the Signal Voltage

Step	Description
1	Ignition ON
2	Initiation of a Self Test (wait 5 seconds)
3	Voltage measurement between Pin 2 (GND) and Pin 1 (Signal); U >11V
4	If the Reading shows 0V the Sensor is Defective



IMPORTANT NOTE:

Be sure to avoid damage or a break in the supply line, if in doubt, connect a suitable and reliable supply voltage.

Fuel pressure temperature sensor B3
Oil pressure temperature sensor B9

Comparative values

Temperatur Temperature T		Widerstand Resistance R in Ω	
°C	°F	Min.	Max.
-40	-40	39236	51354
-30	-22	22546	28929
-20	-4	13430	16919
-10	14	8265	10238
0	32	5239	6390
10	50	3412	4102
20	68	2278	2702
25	77	1877	2213
30	86	1555	1823
40	104	1084	1256
50	122	770	884
60	140	557	633
70	158	410	462
80	176	306	342
90	194	232	257
100	212	178	196
110	230	137	152
120	248	107	119
130	266	85	95
140	284	68	76

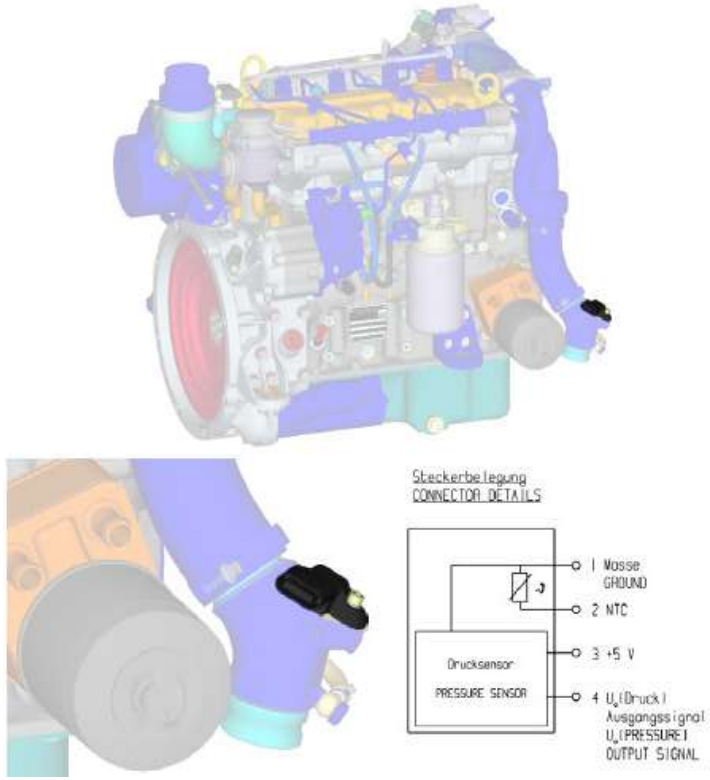
Druck Pressure P_{rel}			Signalausgangsspannung Signal Output Voltage U_{out}
Bar	kPa	psi	V
0,0	0	0	0,5
0,5	50	7	0,7
1,0	100	15	0,9
1,5	150	22	1,1
2,0	200	29	1,3
2,5	250	36	1,5
3,0	300	44	1,7
3,5	350	51	1,9
4,0	400	58	2,1
4,5	450	65	2,3
5,0	500	73	2,5
5,5	550	80	2,7
6,0	600	87	2,9
6,5	650	94	3,1
7,0	700	102	3,3
7,5	750	109	3,5
8,0	800	116	3,7
8,5	850	123	3,9
9,0	900	131	4,1
9,5	950	138	4,3
10,0	1000	145	4,5

Charging pressure and temperature sensor B32

General

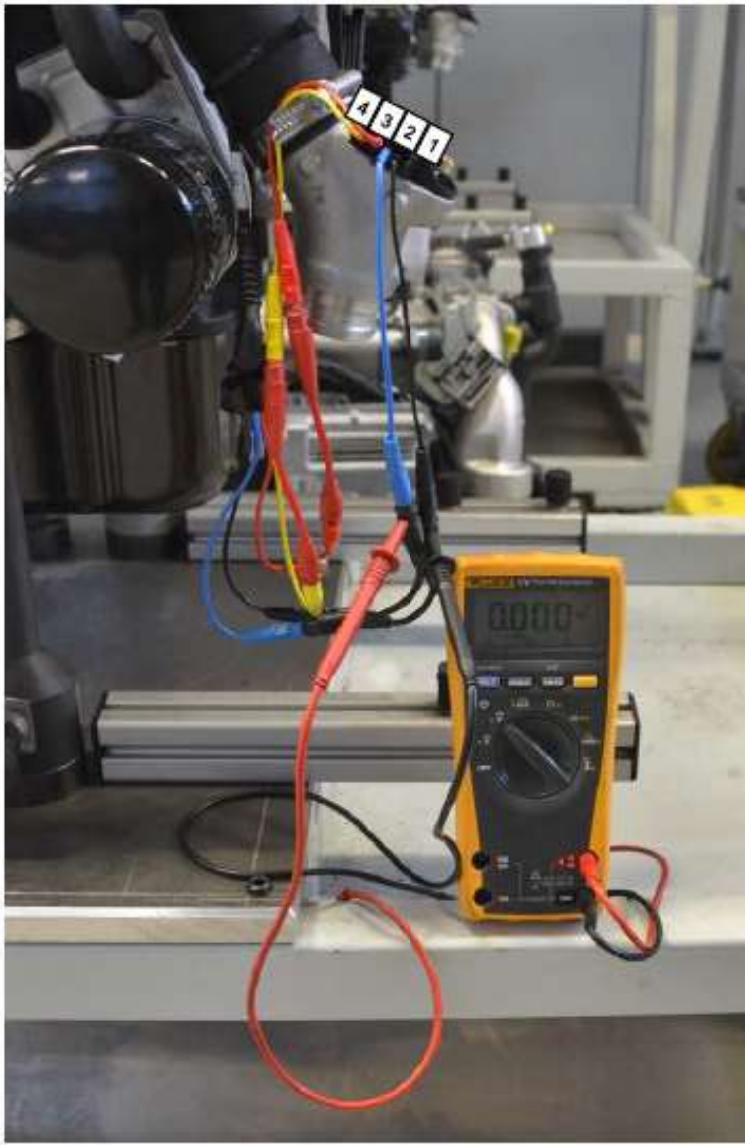
Turbocharging Pressure Sensor:
The piezoresistive pressure sensor element and suitable electronics for signal amplification and temperature compensation are integrated on a silicon chip. The measured pressure acts from above on the active side of the silicon membrane.
Fuel Temperature Sensor / Oil / Coolant / Charge Air (NTC):
The temperature sensor is a sensor that converts a temperature into an electrical variable. This temperature sensor is a thermistor (NTC), i.e. It reduces its resistance with increasing temperature.

Function
This sensor is required for the calculation of the air mass flow and for the control of combustion-relevant characteristics, such as: injection pattern, rail pressure, begin of delivery, EGR rate, injection quantity.
A too low load pressure (depending by operating stage) is currently not declared as an error. However, there may be a reduction in the injection quantity / performance if there is insufficient boost pressure to maintain exhaust emissions (smoke limitation).
The sensor values are monitored for the physical value and the voltage limits. If these limits are out of range, an entry is made in the error memory and error reaction (limp home / engine shut down), depending on customer



Charging pressure and temperature sensor B32

Measuring structure



Charging pressure and temperature sensor B32

Measuring structure

Static check of the Boost Pressure Sensor

Step	Description
1	Measure Resistor between Pin 1 (GND) and Pin 2 (Output NTC)
2	Compare measured Value with figures provided in the Temperature Table (refer Table below for Static Verification of Temperature Sensor). (eg. Room Temperature = 20 - 25°C → Value approx. 2200 Ω) → Sensor OK

Charging pressure and temperature sensor B32

Measurement structure and comparative values

Dynamic check of the Charge Temperature Sensor

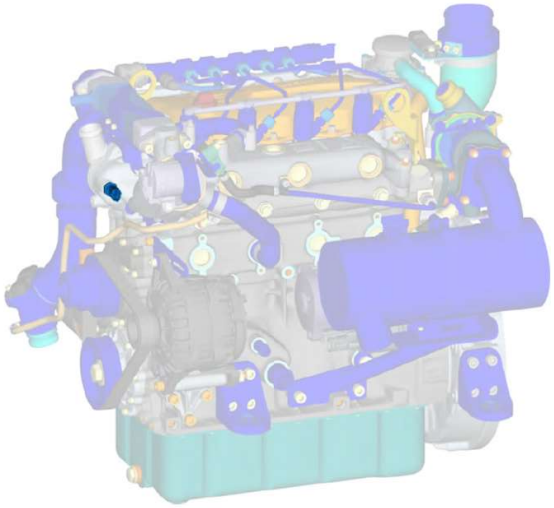
Step	Description
1	Full adaption of the Sensor
2	Switch the Ignition ON
3	Measure Voltage between Pin 1 (GND) and Pin 2 (NTC)
4	If this Voltage value is between 0.5V and 4.5V → Sensor OK (For example Room Temperature 20-25 ° C → Voltage value approx. 3V)

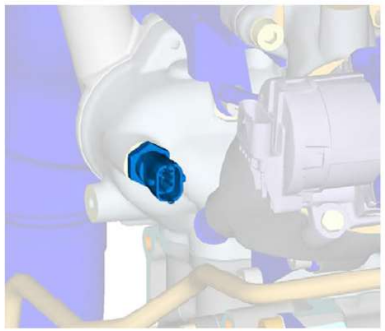
Temperatur Temperature **T**		Widerstand Resistance **R** in Ω	
°C	**°F**	Min.	Max.
-40	-40	40730	50314
-30	-22	23603	28829
-20	-4	14055	16970
-10	14	8595	10261
0	32	5420	6403
10	50	3504	4100
20	68	2323	2690
25	77	1916	2207
30	86	1591	1827
40	104	1100	1254
50	122	783	887
60	140	561	632
70	158	412	461
80	176	306	340
90	194	231	256
100	212	178	196
110	230	137	151
120	248	107	118
130	266	85	94

Coolant temperature sensor B4

General

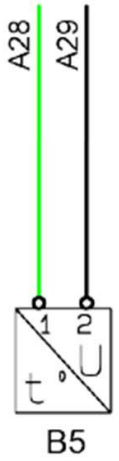
The Temperature Sensor is a sensor that converts a Temperature into an Electrical Variable. This Temperature Sensor is a NTC (Negative Temperature Coefficient Thermistor), i.e. it reduces its resistance with increasing temperature, or conducts the electric current better at high temperatures than at low temperatures.

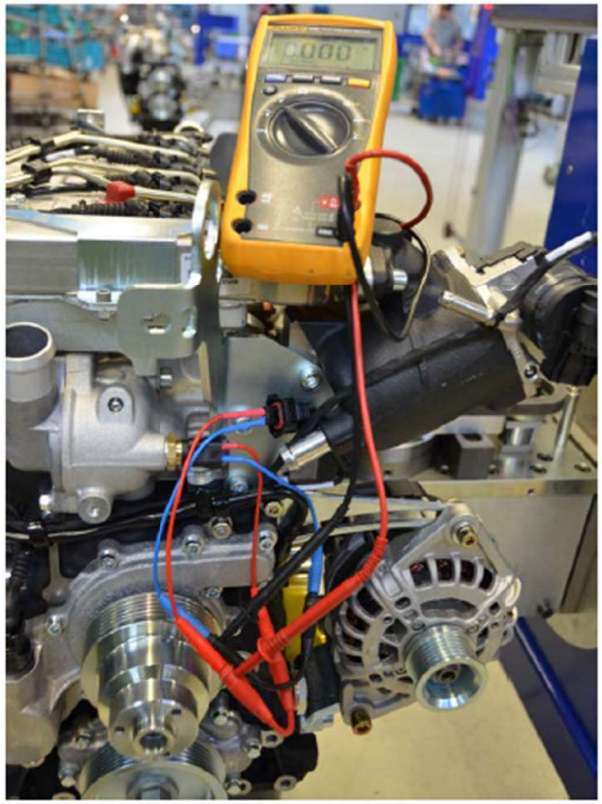




Dynamic Check of the Coolant Temperature Sensor

Step	Decsription
1	Full Adaptation of the Sensor
2	Measure Voltage between Pin 1 (Signal Input) and Pin 2 (GND)
3	If this Voltage value is between 0.5V and 4.5V → Sensor OK (For example Room Temperature 20-25 ° C → voltage value approx. 3V)





Coolant temperature sensor B4

Messaufbau

Static Check the Coolant Temperature Sensor

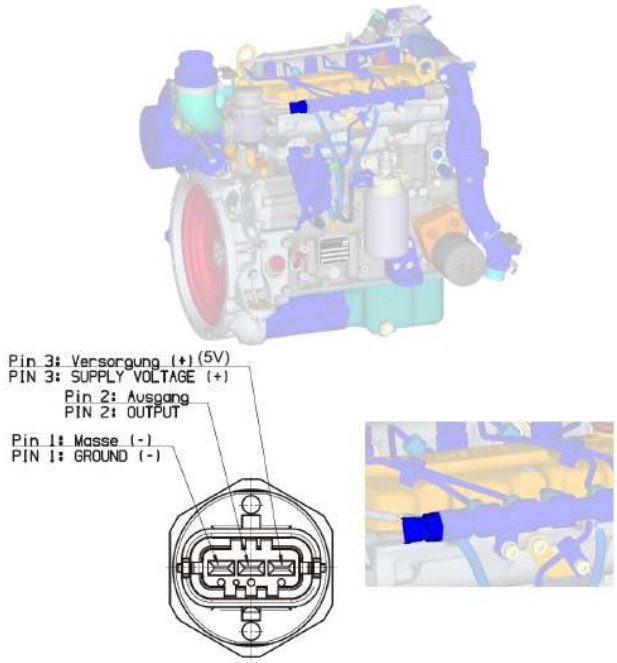
Set	Description
1	Measure Resistor between Pin 1 (Signal Input) and Pin 2 (GND)
2	Compare measured Value with figures provided in the Temperature Table (refer Table below for Static Verification of Temperature Sensor). (eg. Room Temperature = 20 - 25°C → Value is approx. 2200 Ω) → Sensor OK

Temperatur Temperature T		Widerstand Resistance R in Ω	
°C	°F	Min.	Max.
-40	-40	40481	50124
-30	-22	23575	28640
-20	-4	14093	16824
-10	14	8640	10149
0	32	5465	6324
10	50	3541	4042
20	68	2351	2648
25	77	1940	2173
40	104	1118	1231
50	122	798	869
60	140	573	618
70	158	421	450
80	176	313	332
90	194	237	249
100	212	183	190
110	230	141	148
120	248	110	116
130	266	87	92
140	284	69	74

Rail pressure sensor B1

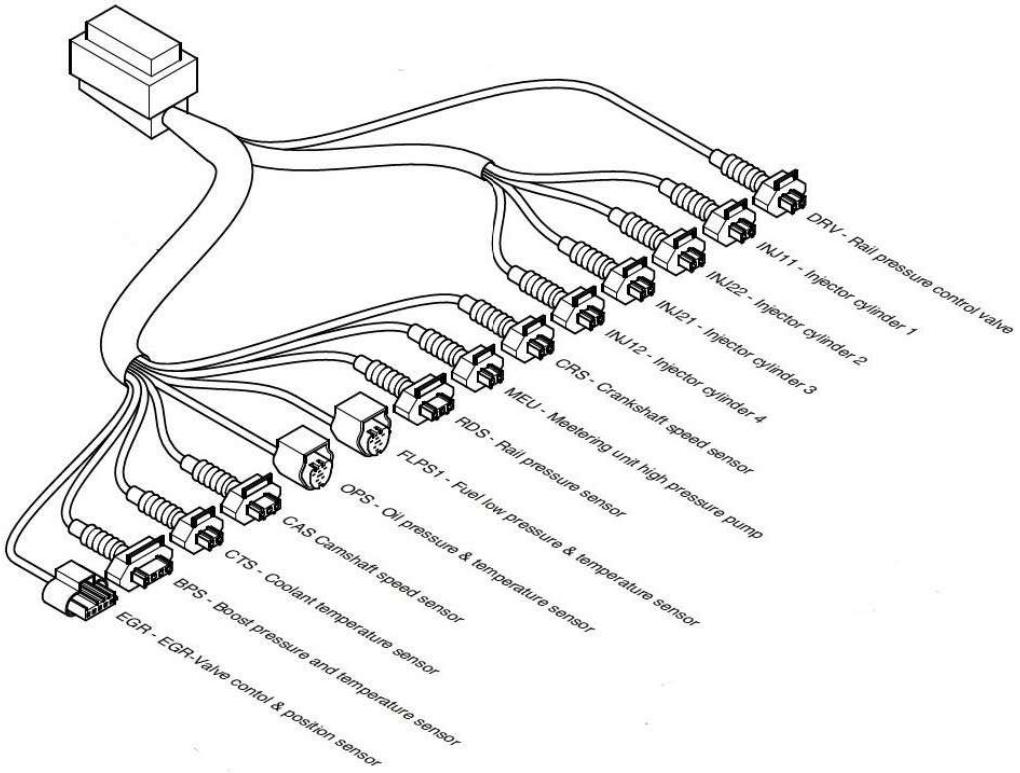
General

Rail Pressure Sensor (strain Gauge):
A thin film resistor bridge is applied to a metal membrane. Strain gauges (strain gauges) are measuring devices for the detection of stretching and compressive deformations. They change their electrical resistance even with small deformations and are used as strain sensors. The bridge is detuned when pressurized and provides a signal proportional to the pressure. This is scaled and amplified by an electronic evaluation circuit.

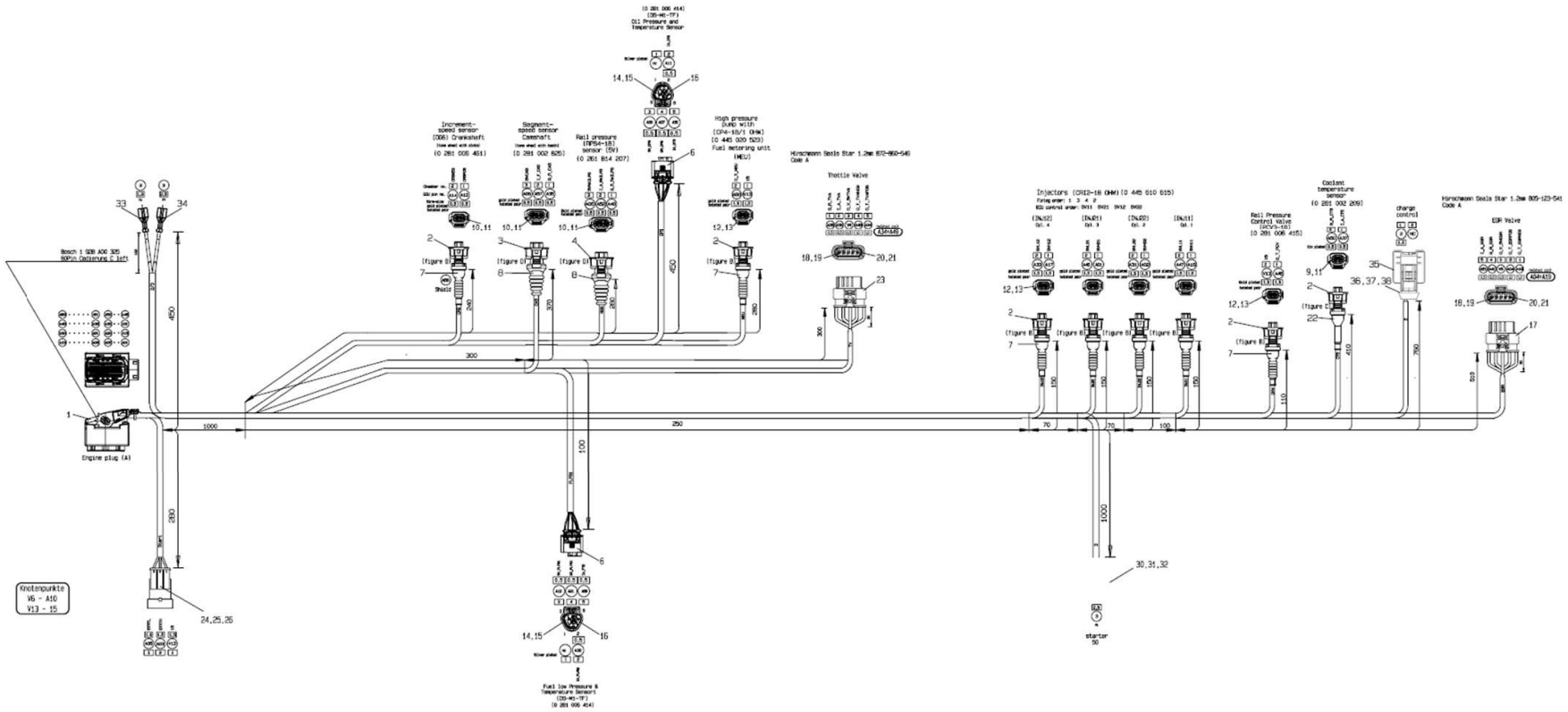


Druck Pressure P			Signalausgangsspannung Signal Output Voltage U_{out}
Bar	kPa	psi	V
0	0	0	0,5
100	10	1450	0,7
200	20	2900	0,9
300	30	4351	1,1
400	40	5801	1,3
500	50	7252	1,5
600	60	8702	1,7
700	70	10153	1,9
800	80	11603	2,1
900	90	13053	2,3
1000	100	14503	2,5
1100	110	15954	2,7
1200	120	17405	2,9
1300	130	18855	3,1
1400	140	20503	3,3
1500	150	21756	3,5
1600	160	23206	3,7
1700	170	24656	3,9
1800	180	26106	4,1
1900	190	27557	4,3
2000	200	29008	4,5

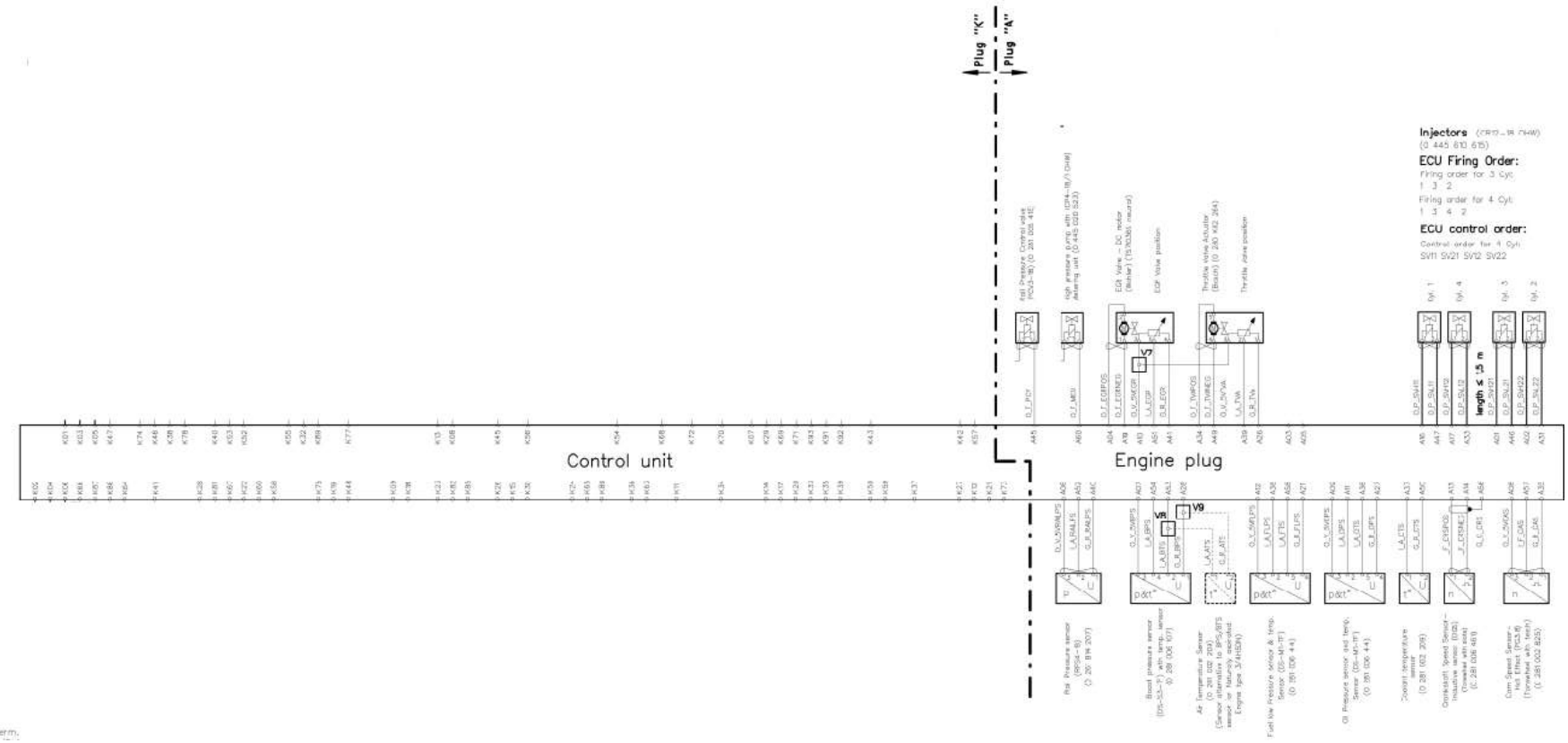
Engine cable set



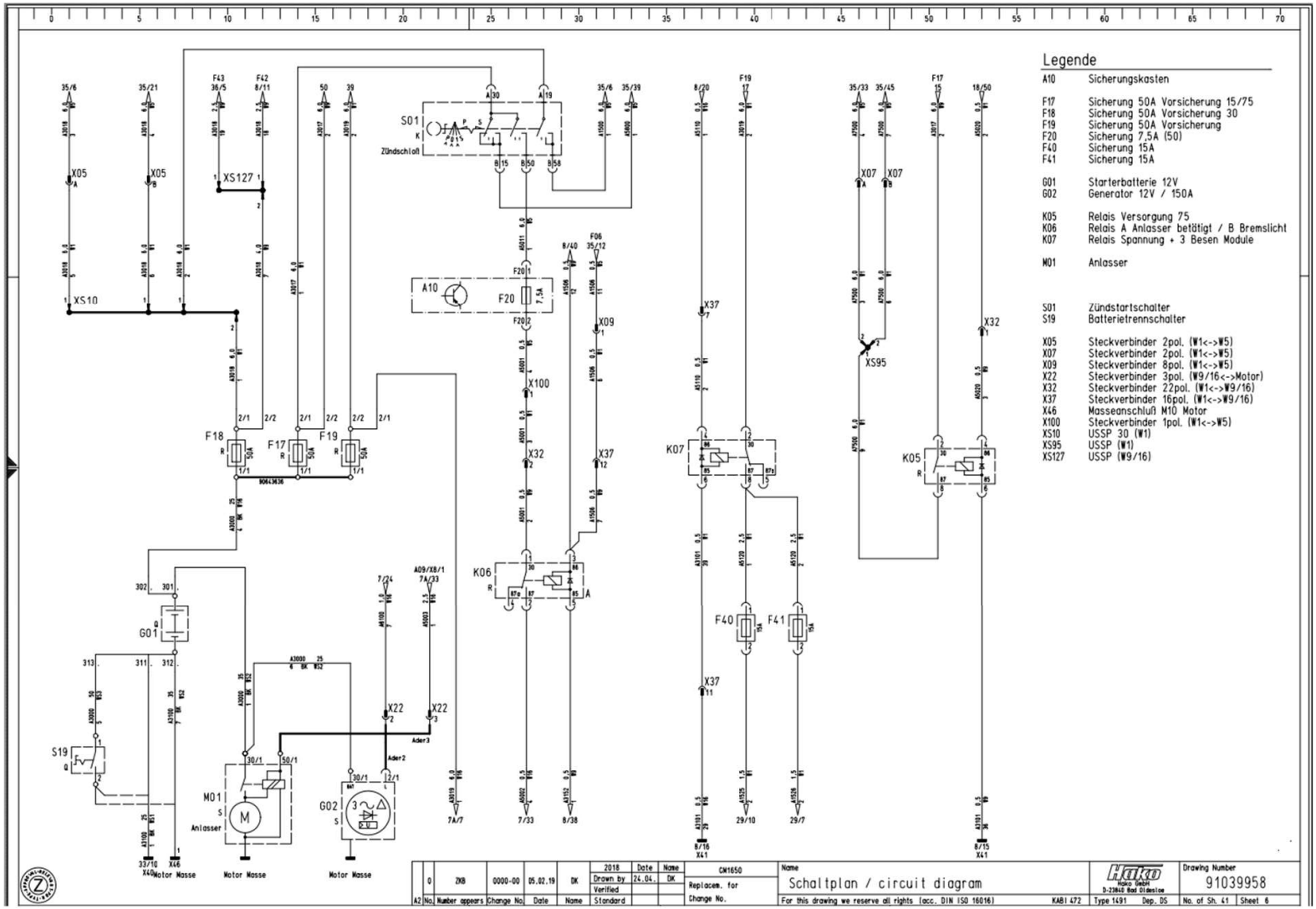
Engine cable set



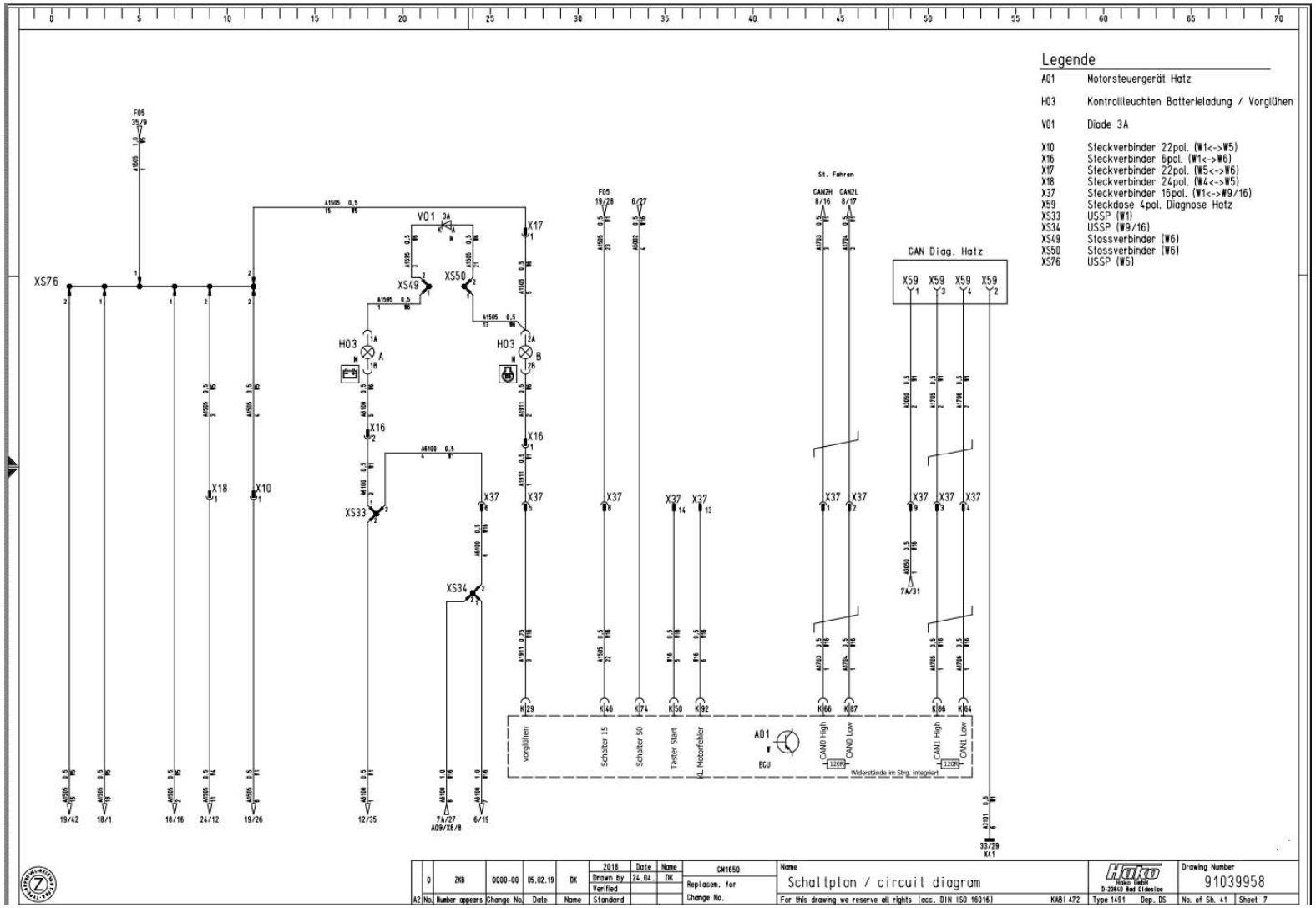
Engine cable set



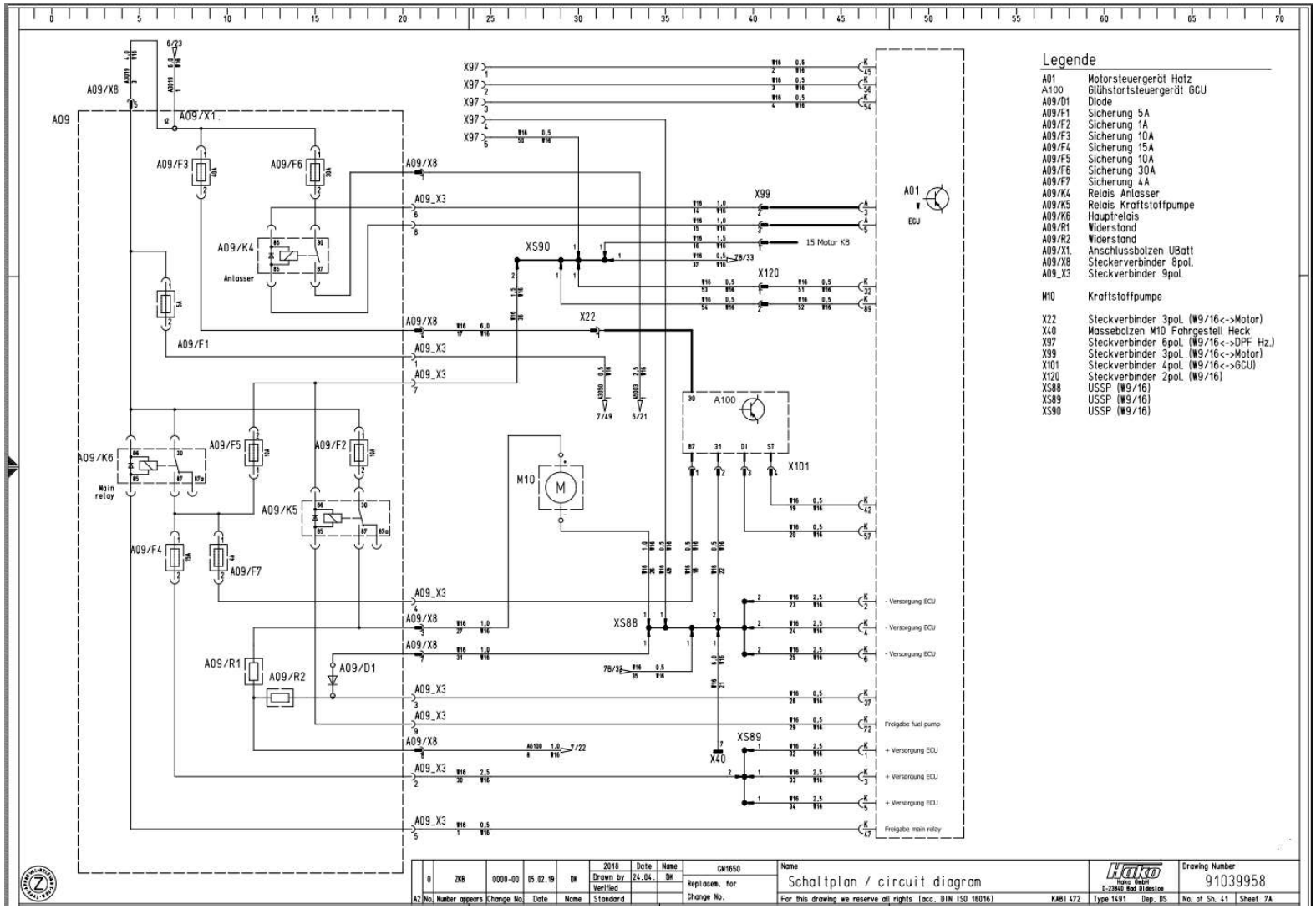
Engine electrics



Engine electrics



Engine electrics



Engine electrics