S70B56 ENGINE

DME M1.7 / EML Engine Timing

(850CSi)

Course Contents / Background Information

BMW AG

Service Training

INTRODUCTION

As of September 1992, the 850CSi will be on the market. With even greater performance and sportiness, it will further improve the image of the BMW 8 Series. Instead of the M70 engine, the technically revised S70B56 engine will be installed in this vehicle.

INNOVATIONS in the 850CSi (Start of series: 09/92)

- **S70B56 Engine**

- **Transmission**
  - E transmission (6-gear manual transmission like the 850i / automatic transmission not installed)
  - Final drive transmission 2.93:1
  - Final drive oil cooling

- **Running Gear**
  - Tauter running gear set-up with bodywork lowered by approx. 15 mm
  - Servotronic with motorsport-specific characteristic curve and direct steering gear ratio
  - Locking differential
  - Automatic stability control and traction (ASC+T), dynamic stability control (DSC) as special equipment
  - Light-metal forged wheels, 2-part:
    Front wheels: 8Jx17 Front tyres: 235/45 ZR 17
    Rear wheels: 9Jx17 Rear tyres: 265/40 ZR 17
  - Driving dynamics system (Active rear axle kinematics [AHK] with motorsport-specific tuning, electrically adjustable steering column, without electronic damper control [EDC])
  - Fortified brake system

- **Equipment**
  - Altered rear diffusor and altered front apron lower section with adapted licence plate support
  - M outside rear-view mirror
  - Metallic colours
  - Lettering 850CSi
  - Individually foldable seat backrests in rear and ski sack
  - M interior (2-colour)
  - Leather fittings

ENGINE S70 B56

Objectives of the technical revision of the M70 engine to create the S70B56 engine:
- Greater power and torque for the engine
- Enhanced image of the 8 Series
- Making full use of the potential of the M70 series engine

The power and torque of a four-stroke spark-ignition engine can be improved in the following manner:

1. Increased capacity
   - Larger stroke
   - Larger bore
   - Combination of above two features

2. Increased compression
   - Increased thermal efficiency

The tried and tested concept of the M70 series engine was retained for the technical revision of the engine for the S70B56:
- High performance
- Extremely smooth running
- Good economy
- Exhaust quality complying with modern norms
- Compact design
- Low weight
- Reduced maintenance demands

Through a capacity increase of 11.8 % and an increase of compression to 9.8, engine power has been increased by 27 % and torque by 22.2 %.

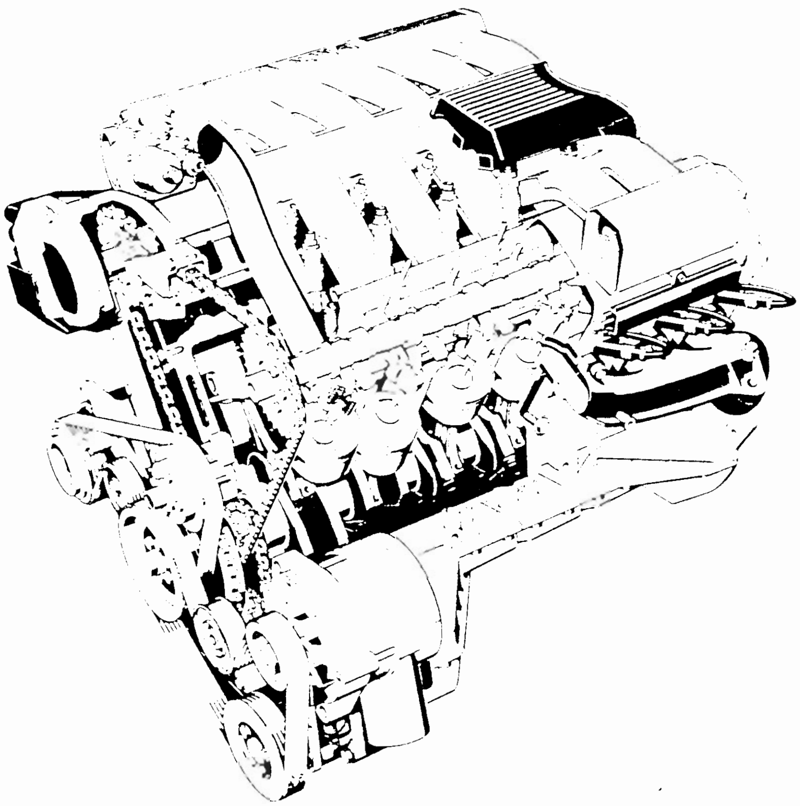


Fig. 1: S70B56 Engine

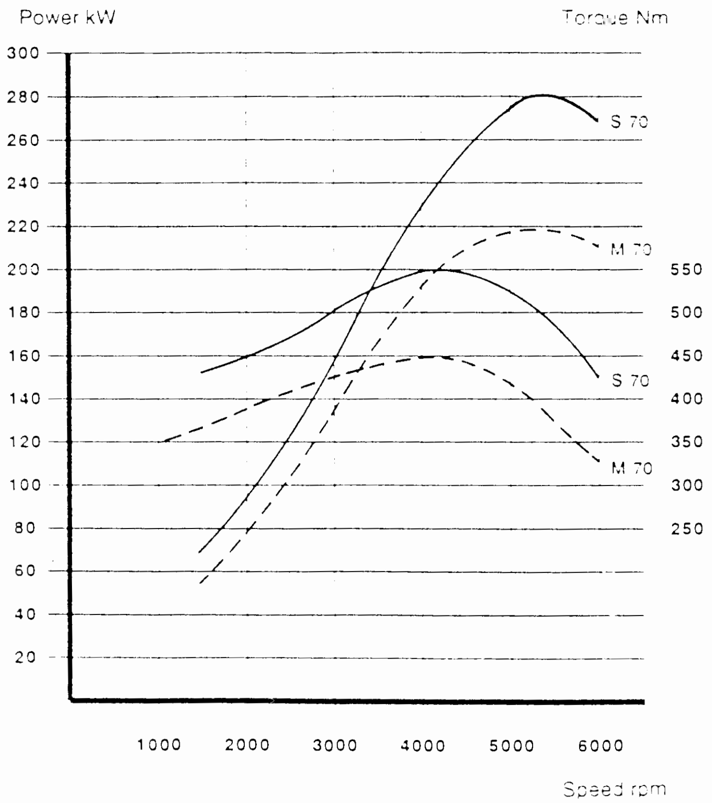


Fig. 2: Power and torque diagram comparing S70B56 and M70B50

TECHNICAL DATA
Engine Data Comparison S70B56 / M70B50

		S70 (B56)	M70 (B50)
Engine design		V-engine (60°) 12 cylinders	
Capacity	dm^3	5.576	4.988
Stroke	mm	80	75
Bore	mm	86	84
Power at engine speed	kW/HP rpm	280/380 5300	220/300 5200
Torque at engine speed	NM 1/min	550 4000	450 4100
Permissible max. speed	1/2	6000-6400 (Gear-dependent)	6000±40
Idle speed	1/min	750±50	700±50
Compression	:1	9.8	8.8
Firing order		1-7-5-11-3-9-6-12-2-8-4-10	
Valve diameter Intake Exhaust	 mm mm	 42 36 (Natrium-filled)	
Valve stroke Intake Exhaust	 mm mm	 11.0 11.0	 10.6 10.6
Valve opening Intake Exhaust	 ° Crankshaft ° Crankshaft	 256 256	 248 248
Distribution angle Intake Exhaust	 ° Crankshaft ° Crankshaft	 110 112	 104 108
Fuel		Super unleaded	Normal unleaded

DESIGN ALTERATIONS

Changes were made to the S70B56 engine with respect to the M70 in order to improve performance.

CRANKCASE

The crankcase consists of a light-metal alloy (AlSi). The cylinder banks are arranged at an angle of 60° to each other, as with the M70. The cylinder running surfaces are uncoated.

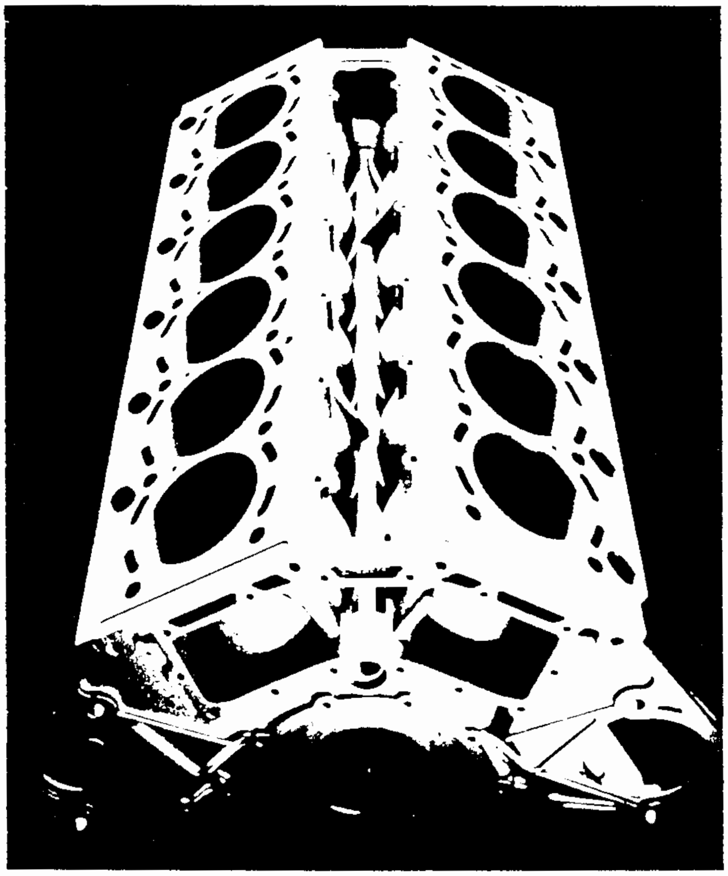


Fig. 1: S70B56 crankcase

		S70	M70
Capacity	cm^3	5576	4988
Bore	mm	86	84

CRANKSHAFT AND CONNECTING ROD

The forged crankshaft, supported in 7 main bearings, has a throw angle of 120° (high bending strength). The stroke is 80 mm.

The crankshaft main bearings (three-metal bearings) are 22.6 mm wide and have a diameter of 75 mm (as with the M70).

The thrust bearing is installed on the coupling side.

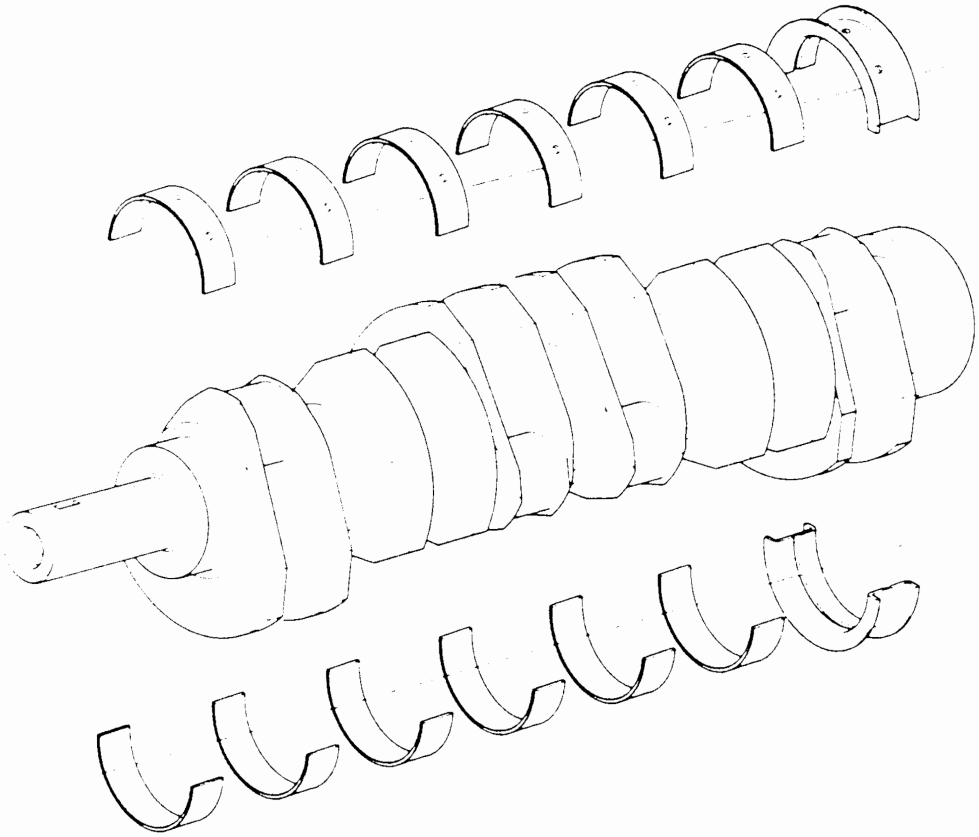


Fig. 2. Crankshaft and main bearings

The flywheel and connecting rod of the M70 B50 are installed in the S70B56.

PISTONS AND PISTON RINGS

New light-design pistons made of aluminium alloy with a Ferrostan coating are installed in the S70B56.
The combustion chamber cavity is set at an angle to the spark plug.
The pistons for cylinders 1-6 and 7-12 differ.

Cylinders 7-12 **Cylinders 1-6**

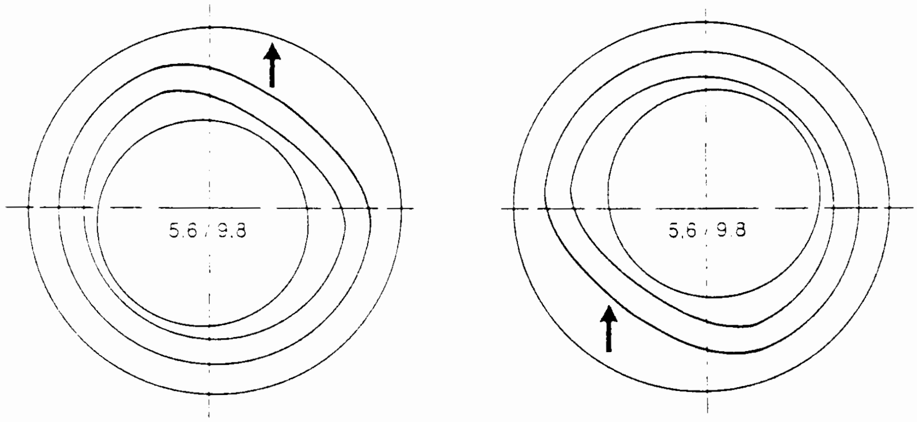


Fig. 3: S70B56 piston (combustion chamber cavity)

INSTALLATION INSTRUCTIONS FOR PISTONS:

Cylinders 1-6:	combustion chamber cavity facing forward and out
Cylinders 7-12:	combustion chamber cavity facing back and out

Piston rings:

1st ring groove:	rectangular ring with inside bevel and chromium-plated running surface
2nd ring groove:	taper-faced compression ring
3rd ring groove:	bevelled spring-loaded oil ring (oil control ring)

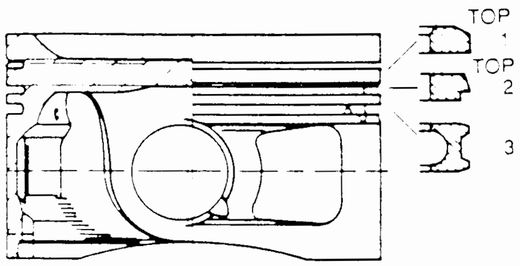


Fig. 4: Pistons and piston rings

CYLINDER HEAD, VALVES AND CAMSHAFT

Cylinder heads 1-6 and 7-12 and the valves correspond to the M70 series engine (2-valve engine). The hydraulic valve clearance compensation elements and valve levers from the M70 are installed in the S70B56 engine unchanged.

The two upper camshafts, supported in 7 main bearings, control the intake and exhaust valves. The valve timing differs from the M70.

Valve opening time		256° crankshaft
Distribution angle:	Intake	110° crankshaft
	Exhaust	112° crankshaft
Valve stroke:	Intake	11 mm
	Exhaust	11 mm

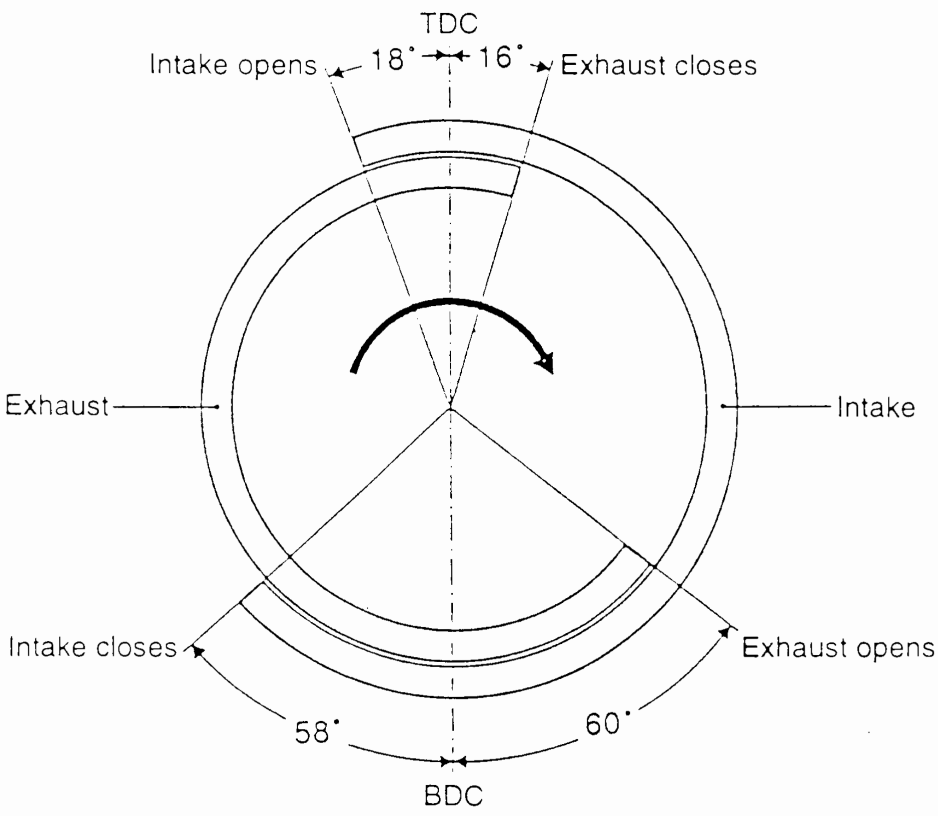


Fig. 5: S70B56 timing diagram

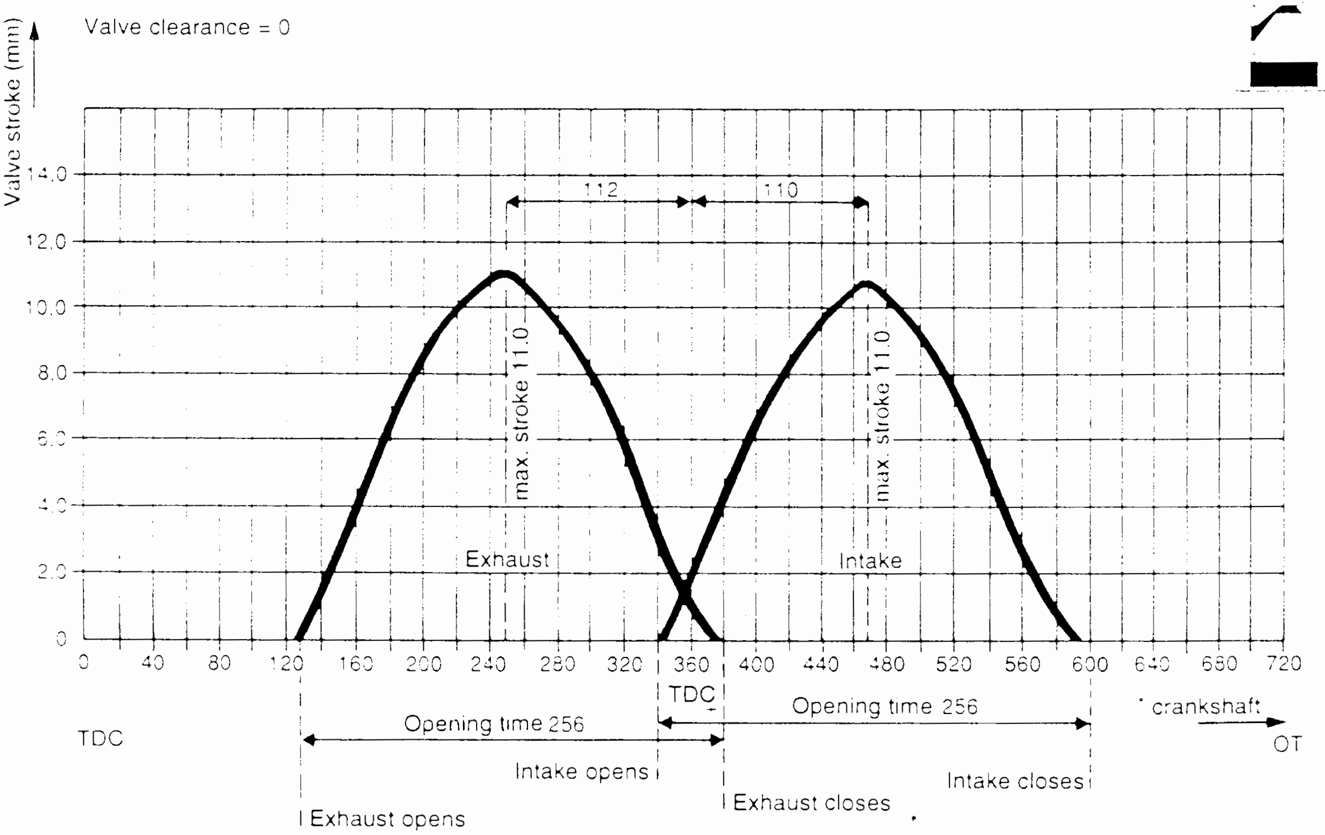


Fig. 6: Theoretical valve stroke characteristics

CAMSHAFT DRIVE

The camshaft drive has not been altered with respect to the M70 series engine.

MOUNTED COMPONENTS

The auxiliary assemblies of the S70B56 engine (air condition compressor, water pump, alternator, tandem hydraulic pump) are driven by means of ribbed V-belts (i.e. as with the M70 series engine).

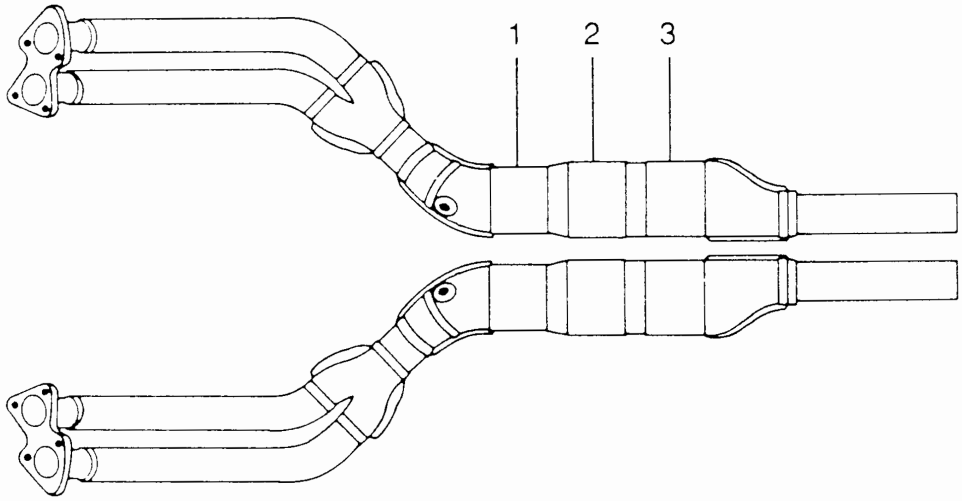
The cooling, oil, fuel and intake systems also have been taken over from the M70 without alteration.

EXHAUST SYSTEM

A double-flow exhaust system with metal catalytic converter and twin-walled preliminary pipes is installed in the S70B56 engine.

The twin-walled preliminary pipes serve purposes of noise reduction and insulation.

The two metallic catalytic converters each consist of 3 consecutive wound elements. The outside casing is in each case formed by a chrome-nickel alloy jacket.



1/2/3 = Wound element

Fig. 7: Exhaust pipe with catalytic converter

CATALYTIC CONVERTERS ON METAL SUPPORT BASE

With the S70B56 engine, the metal catalytic converter is now installed in series for the 3rd time, after the S14B25 and S38B38 engines.

Technical Features

The metal carrier is manufactured using the wire-wrapping technique. Relatively thin (0.04 mm), even and corrugated metal bands are wound against each other in a spiral to form round elements. Along the axis in the wound element, there are free gas penetration channels. By means of different toothed rollers, the corrugation can be varied and the required number of cells (surface unit) thus adjusted.

The wound element, when ready, is installed in a metal cylinder with a wall thickness of 1.5 mm. All the cells of the wound element are filled and compacted with high-temperature solder. The metal cylinder too is provided with a coat of high-temperature solder before assembly with the wound element.
The metal carrier (wound element or matrix with jacket) is soldered in a vacuum at temperatures of approx. 1200°.
At present, CrNI or Cr steel is used as material for jacket and matrix.

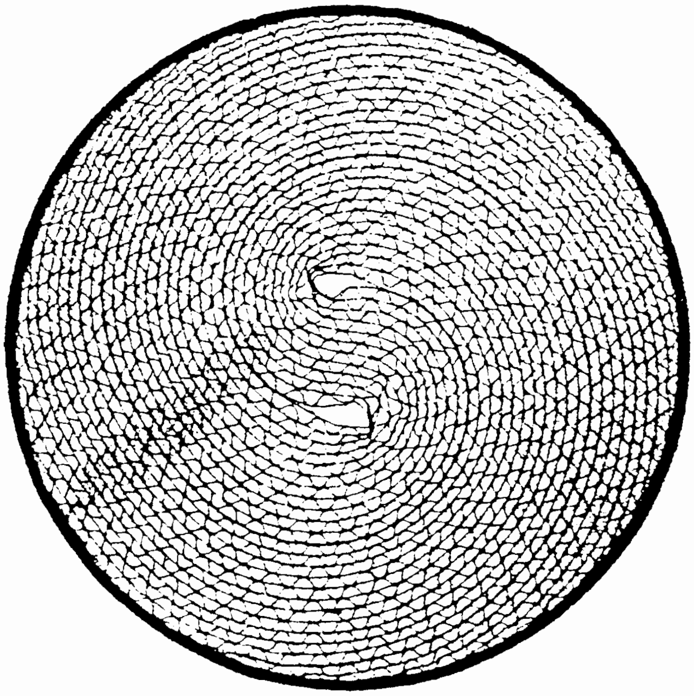


Fig. 8: Wound element of metal catalytic converter - cross-section

Advantages with respect to ceramic versions

- Lower exhaust back pressure with compact design

The small wall thickness of the matrix results in minimum pressure loss. With the same catalytic converter output, the size can be reduced by 15 %. In other words, with the same size as for ceramic monoliths, by means of reducing the back pressure a considerable increase in torque and performance and improved catalytic reactions can be achieved.

- Low specific thermal conductivity

For a temperature rise from 0°C to 100°C, a metal carrier requires only approx. half as much heat energy as a ceramic carrier. The operating temperature is therefore reached faster and the catalytic converter shows improved start-up behaviour.

- High temperature resistance and mechanical stability

Under certain engine conditions, partially unburnt fuel quantities get into the channels of the carrier bodies and oxidize. Channel walls made of ceramic substratum may then overheat and, at temperatures of approx. 1400°C - 1600°C, even melt. Even at temperatures of approx. 1000°C, part of the intermediate layer of the ceramic catalytic converter may vitrify, thus reducing the catalytic effect.

With metal catalytic converter carriers, the "overheating" is dissipated to colder parts of the catalytic converter or the exhaust system.

The high temperature resistance, even under conditions of high shock load, allows the catalytic converter to be installed near the engine and extends its service life.

Furthermore, the metal catalytic converter offers, in the event of unfavourable underfloor conditions, a significantly larger penetration cross-section, because an elastic substratum or a matrix mounting system is not necessary. (Ceramic carrier: wire mesh or aluminium silicate mat).

SILENCER

The intermediate and rear silencers of the S70B56 are manufactured in the shell-structure method, as with the E31. They function according to the absorption/reflection principle.

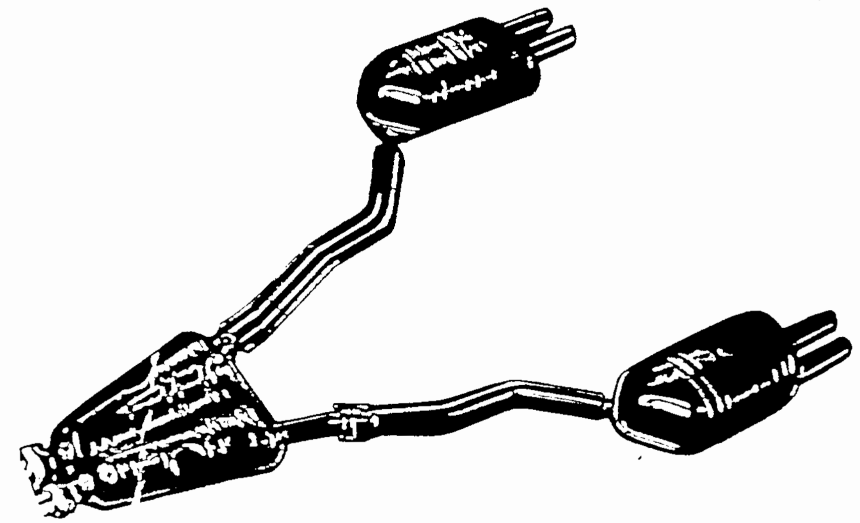


Fig. 9: Silencer system

SOUND ABSORPTION HOOD

As an optical finish to the engine, the design of the sound absorption hood has been altered.

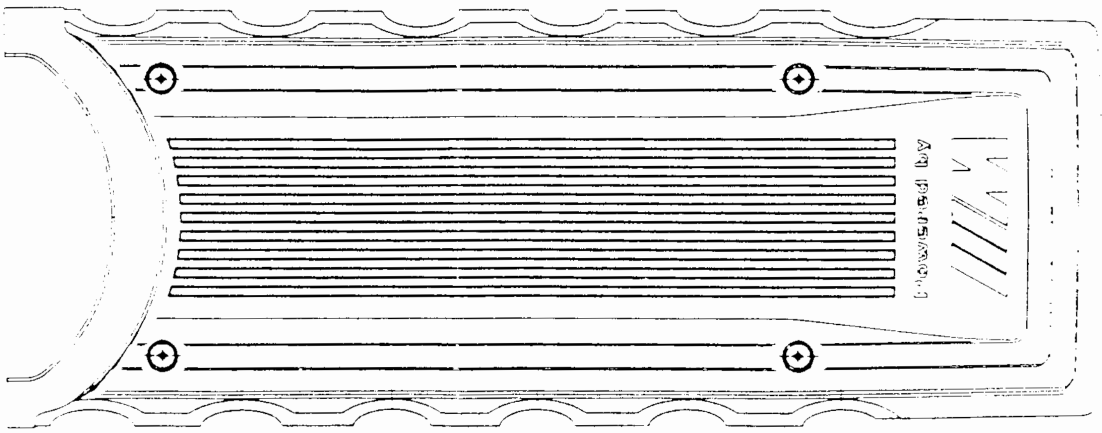


Fig. 10: Sound absorption hood

S70B56 ENGINE TIMING CONCEPT

SYSTEM OVERVIEW

The engine timing of the S70B56 is similar to that of the M70 series engine, i.e. by means of a system connection of electronic assemblies.

This system connection includes:

- A DME M1.7 digital engine electronics system for each of cylinders 1-6 and 7-12 for injection and ignition timing.
- The electronic engine power control (EML) for the electronic control of the throttle valves with an EML performance characteristics switch
- The automatic stability control (ASC+T) with integrated engine drag torque control (MSR)

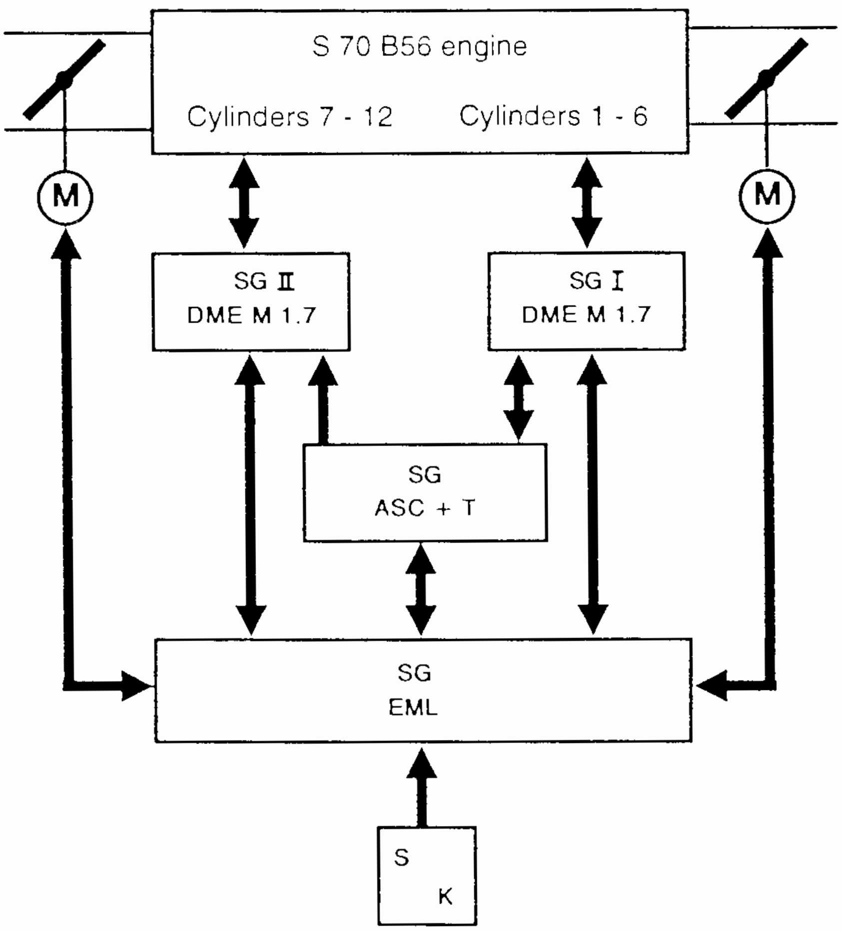


Fig. 1: Engine timing system connection

DIGITAL ENGINE ELECTRONICS DME M1.7

In the S70B56 engine, the Bosch DME M 1.7 is used.

FEATURES:

- Ignition by distributor
- Semi-sequential injection in groups of 3 cylinders
- No knock control
- 2 Hot-wire air-mass flow meters
- Use of 2 control units (for both cylinder banks of the V-12), which work independently of each other (DME control unit I for cylinders 1-5, DME control unit II for cylinders 7-12)
- Corresponding transmitters and assemblies are duplicate (temperatur sensor, pulse transmitter, engine speed, cylinder detection, lambda sensor, etc.); both engine temperature sensors are installed in a common housing
  Exception: Only 1 relay for the lambda sensor heating
- To distinguish between both control units for diagnosis, on the DME control unit I, Pin 85 is connected to ground
- The output signals for the lambda sensor heating relay (Pin 37), the air-conditioning compressor cut-out (Pin 48) and the TD signal (Pin 74) are provided only by the DME control unit I
- Storage of maximum 30 errors for the self-diagnosis: ordered according to priority

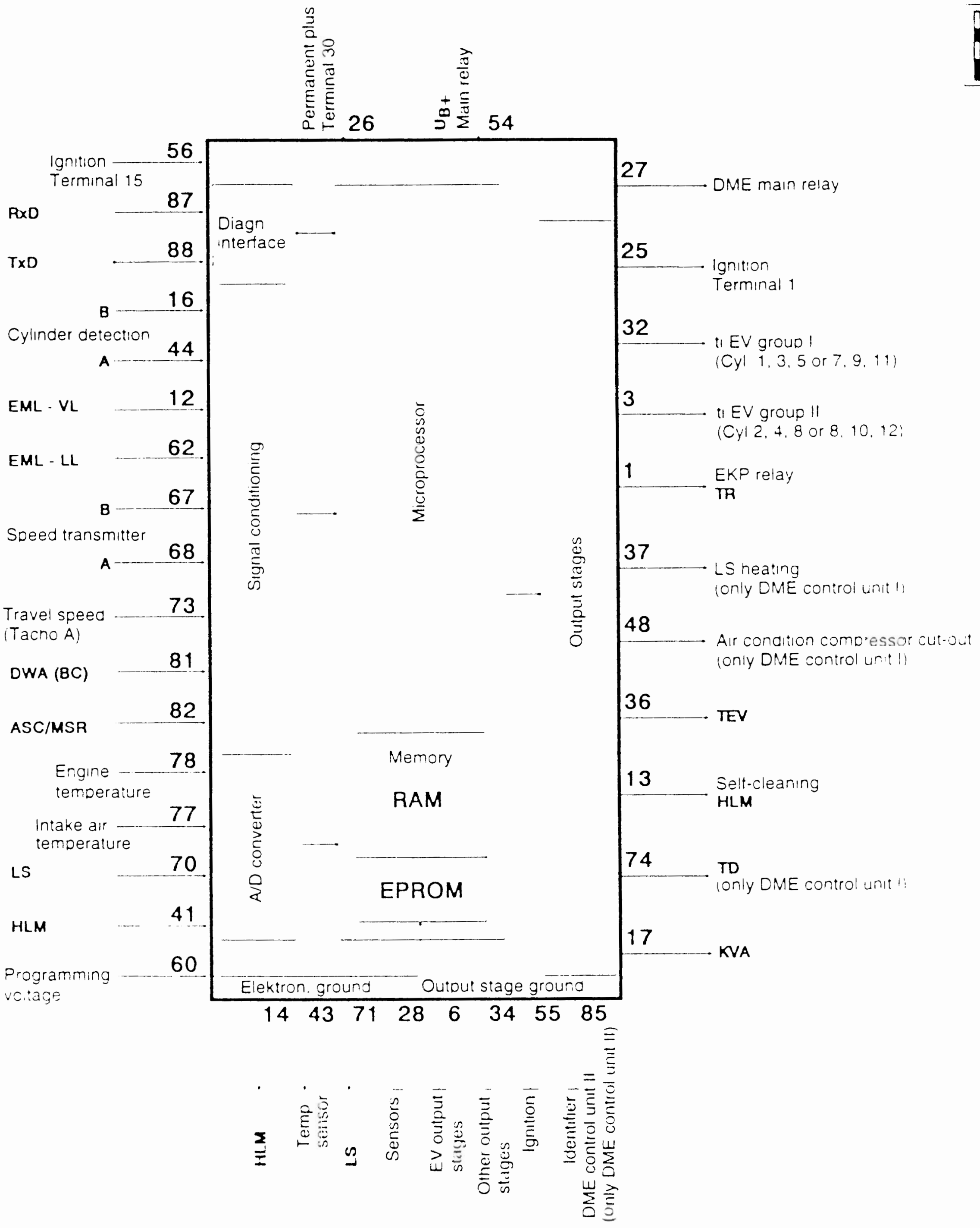


Fig. 2 DME M1.7 block diagram (pin assignment for S70B56)

UB	Battery voltage	LL	Idle signal
EV	Fuel injector	VL	Full-load signal
EKP	Electric fuel pump	RxD	Activation line diagnosis
LS	Lambda sensor	TxD	Data line diagnosis
TEV	Tank ventilation valve	ASC	Autom. stability control
HLM	Hot-wire air-mass flow meter	MSR	Engine drag torque control
TD	Speed signal (1 x per ignition)	DWA	Anti-theft alarm system
KVA	Fuel consumption indicator	BC	On-board computer
ti	Injection signal		

MAIN FUNCTIONS OF THE DME M1.7

Injection Timing

In each case, 3 fuel injectors are activated by an output stage (Pins 3 and 32) (Injection cycle in groups - semi-sequential injection). The DME control unit calculates the correct injection time on the basis of the speed input signals (Pin 67), air quantity (Pin 41), engine temperature (Pin 78) and intake air temperature (Pin 77). The mixture alteration is achieved through the fuel injector open period.

Ignition Timing

Taking into consideration the engine speed, engine temperature, overrun shutoff, signals from EML (VL/LL) and ASC (MSR), the DME control unit determines the spark advance angle (ignition point) and transmits the value to the ignition coil via the ignition output stage (Pin 25).

Cold Start Timing

Depending on the engine temperature, an increased fuel quantity is injected twice per cylinder group in the start-up phase up to 5 crankshaft rotations.
There is then a reduction in fuel quantity, as a function of temperature and speed.
In the warming-up phase up to 70° C engine temperature, the injection times are correspondingly altered, as a function of speed and temperature.

Speed Control

The DME control unit distinguishes between idle, partial-load and full-load operation on the basis of the VL (Pin 12) and LL (Pin 62) signals from the EML control unit.

Catalytic Converter Protection Function (ignition circuit monitoring)

The ignition circuit is monitored by the cylinder detection sender (Pin 16) on ignition line 6 (or 12). If it detects no ignition signal on ignition line 6 (or 12), the fuel supply to the relevant cylinder bank is cut out by shortening the injection signal.

The sender monitors the entire primary side of ignition, and cylinder 6 or 12 on the secondary side.

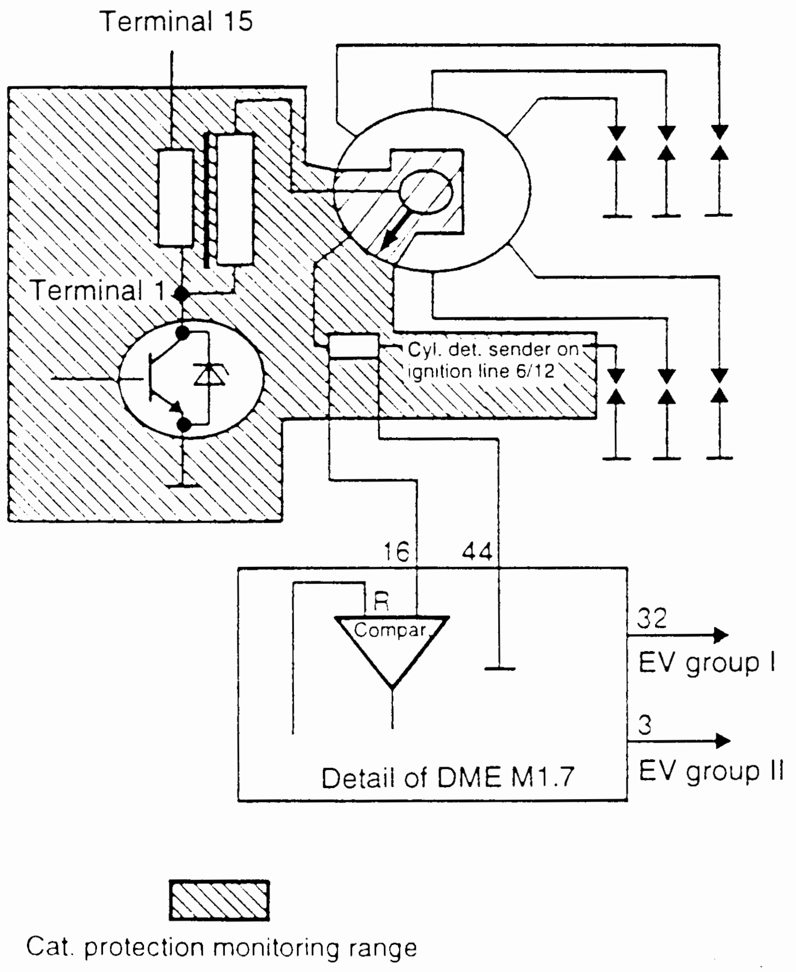


Fig. 3: S70B56 catalytic converter protection

Adaptive Lambda Sensor Control

In order to maintain maximum catalytic converter efficiency, the ideal air/fuel ratio (lambda = 1) is aimed at for combustion.

A heated lambda sensor measures the remaining oxygen in the exhaust gas and forwards a corresponding voltage value to the DME control unit (Pin 70).

There, the mixture composition is accordingly corrected by altering the injection times.

In the event of failure of a lambda sensor, timing is effected by the DME control unit with the fixed-programmed performance characteristics values.

Since a temperature of min. 300° C is necessary for the operating readiness of the lambda sensors, both heating resistors in the lambda sensors are supplied with voltage via one relay. The DME control unit assumes the relay actuation function (Pin 37).

The mixture formed in the intake duct requires some time until it reaches the lambda sensor as exhaust gas. This period is reduced as load and speed increase. For this reason, the reaction time for lambda sensor control is load- and speed-dependent.

Mixture deviations detected by the lambda sensor lead to the storage of adaptation values (learned correction values). Through the adaptations, the injection can be approximated to the desired value in advance, thereby achieving a reduction in the reaction times.

If, for example, the basic injection values of the DME performance characteristics are too low to maintain the ideal fuel/air mixture, then the lambda sensor control would constantly have to increase the injection time. In this case, an adaptation value is learnt which already corrects the basic injection value. The lambda sensor control then only looks after the fine tuning.

Adaptive Tank Ventilation

The fuel tank ventilation line is connected to an activated-carbon filter, in which the fuel vapours produced in the tank are collected. The activated-carbon filter is connected with the two air collectors by means of two other lines.

A tank ventilation valve is located in each of these two lines. When a tank ventilation valve is opened, fresh air is drawn in through the activated-carbon filter as a result of the underpressure in the air collector. The fresh air flushes out the fuel collected in the filter, carrying it to the engine for combustion.

As this additional mixture influences combustion to a considerable degree, the tank ventilation valve consists of a non-return valve and an electrically controllable valve.

When de-energized, at first the tank ventilation valve remains closed, because of the non-return valve, which prevents the build-up of fuel in the air collector when the vehicle is not running.

As the underpressure in the air collector increases, the non-return valve opens. It is actuated electrically (pulsing/Pin 36), as a function of speed and load and separately for both cylinder banks.

The ventilation cycle begins as soon as the lambda sensor control is active. After completion of one cycle, the valve is closed for approx. 1 minute (rest phase).

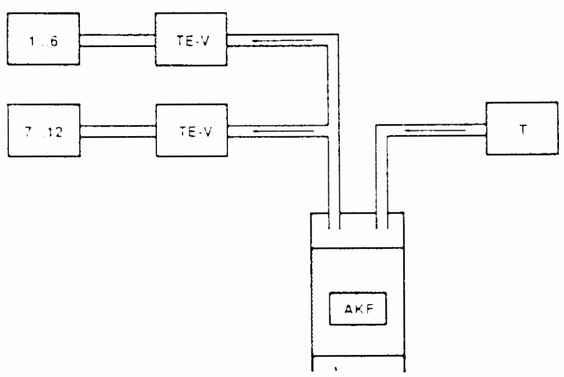


Fig. 4 S70B56 tank ventilation

1..6 Engine, cylinders 1..6
7..12 Engine, cylinders 7..12
TE-V Tank ventilation valve
AKF Activated-carbon filter
T Tank

Moving-Off Lock

If the moving-off lock is activated on the on-board computer (code entered) or the anti-theft alarm system has been activated, an input signal (Pin 81) to the DME control unit leads to ignition and injection cut-out.

Air Condition Compressor Cut-out and Overheating Protection

In the event of acceleration with full load (< 120 km/h), the power supply for the air condition compressor magnetic coupling is interrupted for 2 seconds by means of the air condition compressor cut-out relay. Full engine power is thus available for the acceleration process.

Actuation is effected by means of the DME control unit I (Pin 48).

If the engine coolant temperature rises above 114° C, the air condition compressor switches to cycle operation (20 seconds on, 20 seconds off).

If the temperature rises above 120°C, the compressor is switched off completely.

Self-Diagnosis

The self-diagnosis system detects errors on the DME and stores these errors. The error search is also supported by call status and component activation by the self-diagnosis system.

In the event of failure of the engine temperature sensor, intake air temperature sensor, air-mass flow meter or lambda sensor, the relevant DME control unit provides suitable replacement values. As soon as normal operation is again possible, the replacement values are cancelled.

SPECIAL FEATURES OF THE DME M1.7 IN THE M70B56 ENGINE

The following are installed in the 850CSi:

- 6-gear manual transmission
- ASC+T
- Metal catalytic converter

There are at present no plans for a separate US version.

For this reason, the following pins are not assigned on both DME control units:

Inputs

Pin 63/64	EGS control unit (converter lockup clutch and ignition timing tap)
Pin 65	Transmission selector control switch (driving position P/N)
Pin 76	Idle CO potentiometer HLM (without catalytic converter)
Pin 83	ASC / Ignition suppression

Outputs

Pin 8	Error lamp CARB

AIR-MASS FLOW METER

On the S70B56 engine, the design of both hot-wire air-mass flow meters has been altered. They have been adapted to the altered engine power.

- Shortened platinum wire length -> altered resistance value
- Large-mesh plastic protective grille fitted

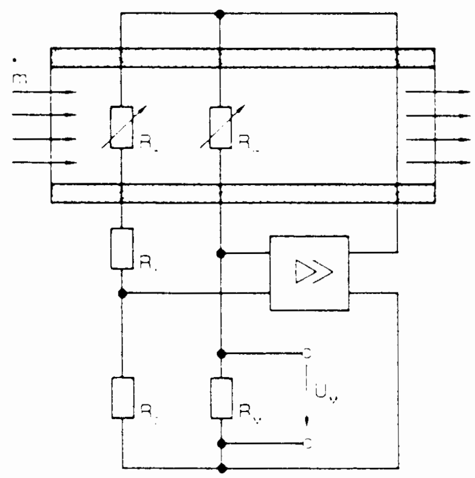


Fig. 5. Hot-wire air-mass flow meter (HLM) - Function diagram

m	Air mass	R_M	Measuring resistor
R_K	Compensation resistor	U_M	Measurement voltage
R_H	Hot-wire resistor (platinum wire)	R_1 R_2	Voltage divider

Operation of the Hot-Wire Air-Mass Flow Meter

In operation, a heated platinum wire is exposed to the intake air flow in the inner tube of the hot-wire air-mass flow meter. Heat from the hot wire is absorbed by the air flow , and compensated for by heating-current control. At the same time, the electric current flows through a measuring resistor whose voltage drop is directly proportional to the air mass drawn in (Pin 41). Air temperature fluctuations are detected by means of a compensation resistor and taken into consideration for the measurement. Approx. 5 seconds after the engine is switched off, the hot wire is electrically heated briefly in order to burn off any contaminants (Pin 13, DME control unit).

SPARK PLUGS

In the S70B56 engine, new spark plugs with a two-element electrode (metal alloy) are installed to prevent glow ignition.

Designation: Bosch F8 LCR 2

ELECTRONIC ENGINE POWER CONTROL (EML)

The EML serves for electronic control of the two throttle valves in the engine air intake system.

Most important assemblies:

- EML control unit
- Pedal value sender (PWG)
- Throttle valves with servomotor (DK)

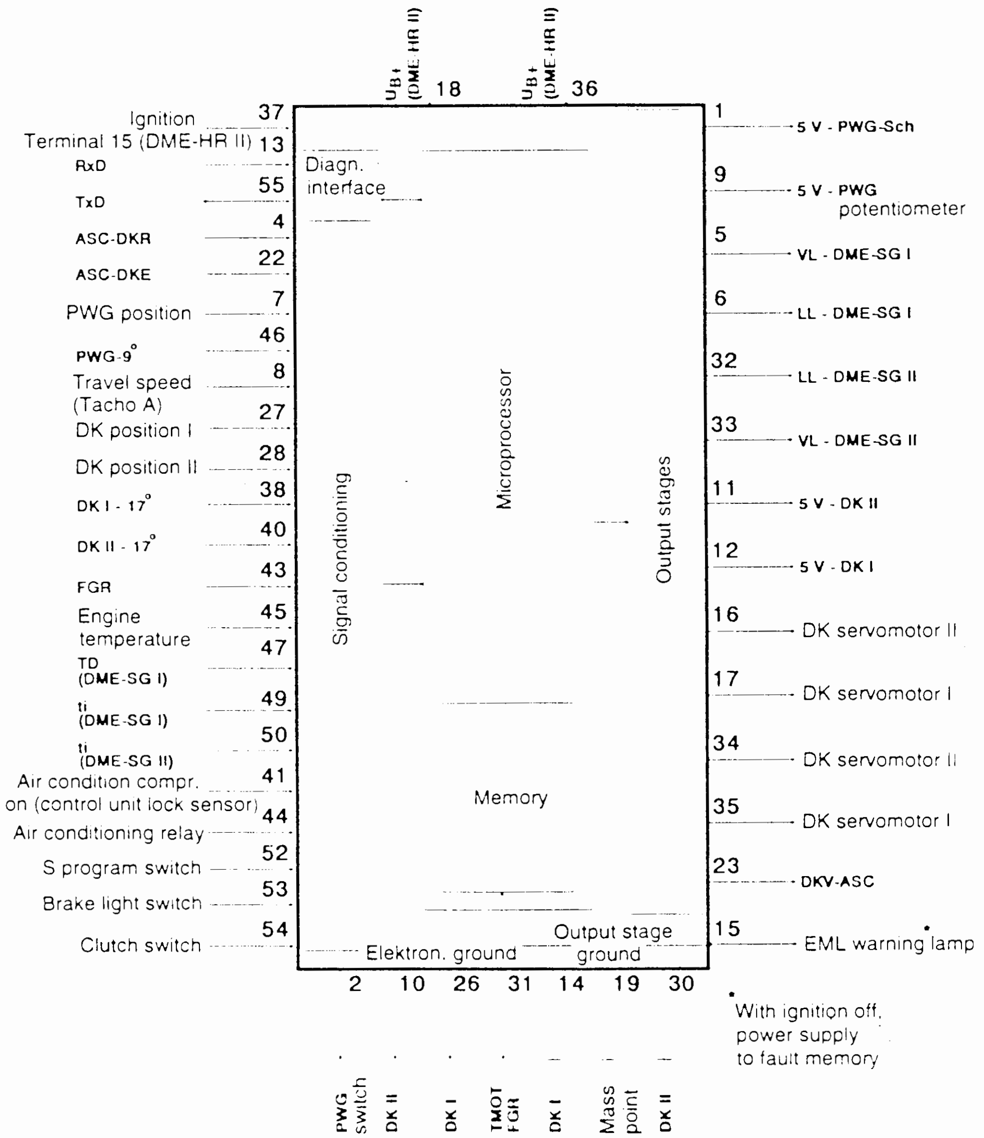


Fig. 6: Electronic engine power control (EML) (Pin assignment for S70B56)

DKR	Throttle valve reduction
DKE	Throttle valve increase
DKV	Throttle valve specification
FGR	Cruise control

PEDAL VALUE SENDER (PWG)

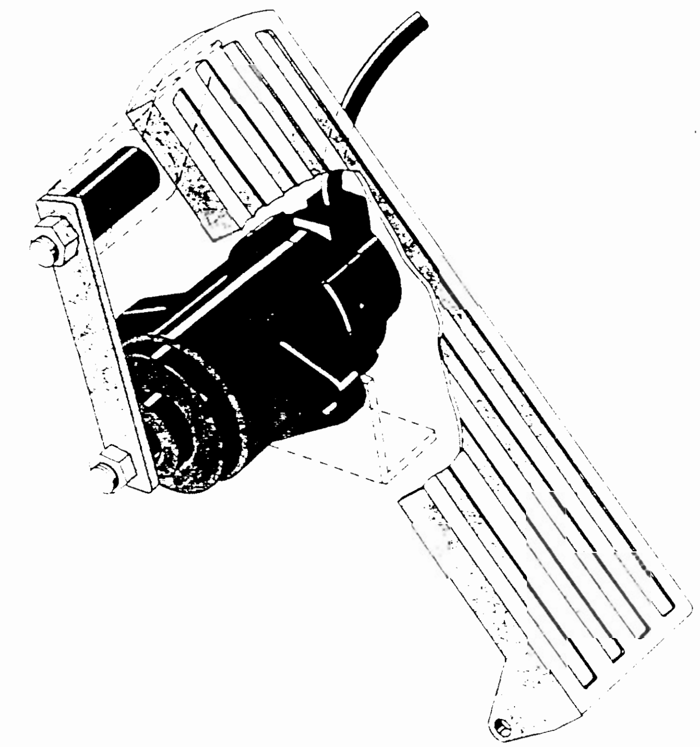


Fig. 7: Accelerator pedal with pedal value sender

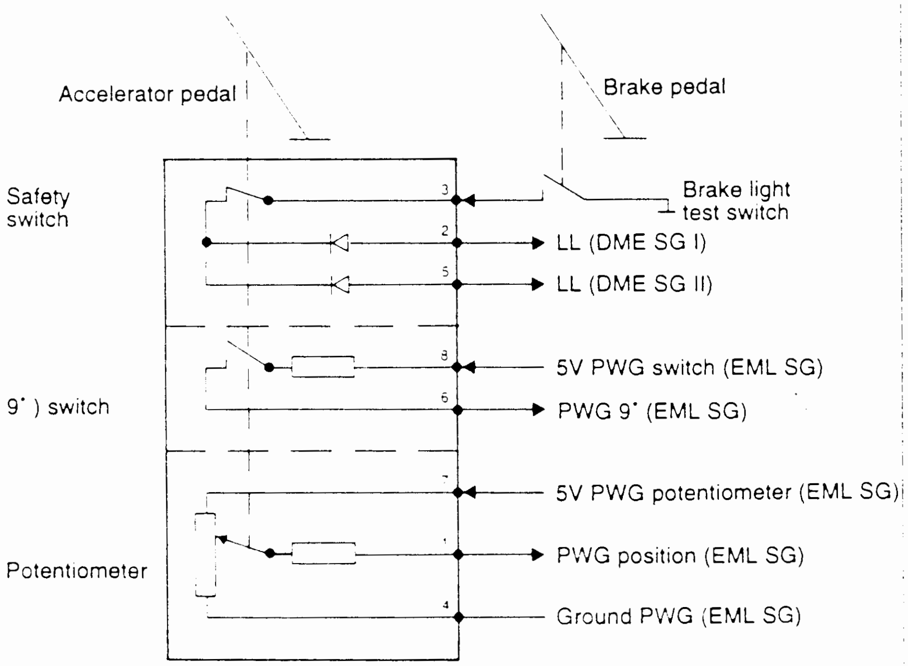


Fig. 8: Diagram of pedal value sender

The pedal value sender is supplied with a voltage regulated at 5 V by the EML control unit (Pin 1 - Switch, Pin 9 - Potentiometer). The electric functions of the pedal value sender include a potentiometer, a switch for monitoring the potentiometers and a switch for the external safety path.

Important:
The 5 V component supply voltage coming from the EML control unit is not absolutely short-circuit-proof.

The potentiometer (voltage divider) of the pedal value sender divides the voltage as a function of the angle of rotation. The partial voltage returned by the potentiometer is converted by an analog/digital converter of the EML control unit to a form which can be processed by the microcomputer and transformed to angular degrees. The valid angle range is from approx. minus 4.7° to approx 100.8°.

The EML control unit carries out a switch range test and compares the switch-on point of the switch (typical value: approx 9° pedal value sender angle) with the angle position of the pedal value sender potentiometer. If the EML control unit detects too great a deviation, the power is limited and the EML warning lamp (Pin 15) lights up.

The switch for the external safety path opens at approx. 2.5°. The switch output is connected in series with a diode and brought out.

EML THROTTLE VALVES (DK)

The two EML throttle valves are each opened against spring tension by means of a servomotor (d.c. motor) by the output stages in the EML control unit. The appropriate output stage pulses the servomotor with square-wave voltage which has a fixed frequency. By altering the ratio of the on and off period, the different positions of the EML throttle valve are achieved.

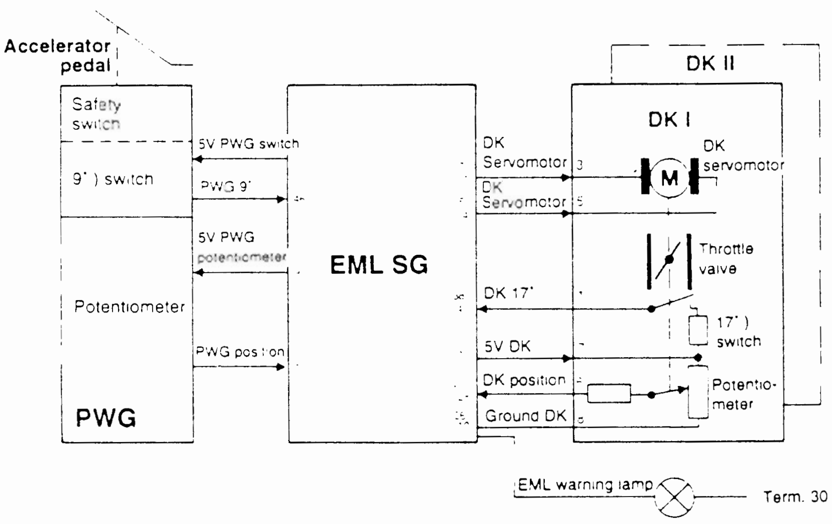


Fig. 9: EML function sequence

When the ignition is switched on, the EML is activated. On the instrument cluster, the EML warning lamp lights up for a period of 1 second.

If the accelerator pedal is actuated when the engine is running, the 9° switch of the pedal value sender closes. At the same time, an accelerator pedal position signal is sent via the potentiometer to the EML control unit (pedal value sender position: Pin 7). The EML control unit sends an exactly determined actuating current to the throttle valve servomotors (Pins 17 (16), 35 (34). When the throttle valve is opened, the 17° switch is opened.

A potentiometer (signal potentiometer) integrated in the throttle valve actuator sends signal to the EML control unit on the completed movement of the throttle valve (throttle valve position: Pin 27 (28).

Both switches (9° and 17°) serve for logic monitoring - they have no influence on the operation of the pedal value sender or the throttle valves.

In the event of replacement of the EML control unit or the EML throttle valve, or if the control unit is de-energized, the information for the lower throttle valve stop is deleted or wrong. The EML control unit therefore learns the stop again and again. With this learning, the EML creates the connection between the mechanical stop and the throttle valve potentiometer angle. The learning process presupposes that the vehicle is in overrun, the water temperature is detected to be > 80° C and the engine speed is > 2180 rpm. If these conditions are fulfilled, the throttle valve is slowly moved by the throttle valve servomotor towards the lower mechanical stop. When the stop is reached, the EML stores the learning value. This learning procedure is carried out with each vehicle start-up until a new learning value can be stored.

IDLE CONTROL

The engine idle speed is maintained constant at the desired speed by control of the throttle valve opening, with the pedal value sender inoperative.

The working range of the idle controller is dependent on the coolant temperature detected by the EML coolant temperature sensor (Pin 45).

The desired idle speed is influenced by the coolant temperature (at low temperatures, the desired idle speed is raised).

When the engine is started, the throttle valve opening is increased to a value equal to start opening, as a function of the temperature.

The idle control starts at an engine speed of < 1600 rpm. Apart from this condition, either the engine speed must be < the desired engine speed or the road speed < 8 km/h.

In order to reduce the intake pipe vacuum in the event of overrun shutoff, the throttle valve opening is increased as a function of engine speed.

ENGINE SPEED LIMITATION

The EML control unit limits the engine speed by closing the throttle valve opening before the limit speed is reached. With the S70B56 engine, the limitation is gear-dependent.

The gear-dependent limit speeds are in the range of 6000-6400 min^{-1}. The respective limit speed is recognised by DME control unit I by means of the TD signal (Pin 47).

The gear-dependent speed limitation guarantees:
- the maximum speed (250 km/h) is reached in 6th gear
- acceleration of the vehicle from 0 to 100 km/h with one gear shift

ROAD SPEED LIMITATION

The EML control unit limits the road speed by closing the throttle valve opening before top road speed is reached.

The EML forms the current road speed on the basis of the road speed signal (Tacho A - Pin 8) from the instrument cluster.

THROTTLE VALVE SYNCHRONISATION

The two throttle valves are synchronised by the EML at idle speed.

The ti signals from the two DME control units (Pins 49, 50) are used for this synchronisation. The EML control unit can set a maximum difference of ± 1.7°.

It begins the synchronisation when:
- the EML coolant temperature sensor records > 80° C
- the engine speed is < 1200 rpm
- the pedal value sender is not actuated
- 20 minutes have passed since start-up
- the two ti signals before the DME control units are available and plausible
- the EML warning lamp does not light up
- the throttle valve stop has been learnt

The synchronisation lasts approx. 3 minutes and is repeated after approx. 20 minutes at the earliest. If the learning values have been deleted as a result of a long interruption (approx. 10-15 mins.) of the power supply (control unit or battery disconnected), then the condition "20 minutes have passed since start-up" does not apply.

Important:
The output stage of the EML control unit for the throttle valve servomotor is not short-circuit-proof.

The EML control unit detects the position of the throttle valve by means of the throttle valve potentiometer, and sets the throttle valve to the determined position by means of the throttle valve servomotor.

The throttle valve potentiometer (voltage divider) is supplied with a voltage of 5 volts by the EML control unit. It divides this voltage as a function of the angle of rotation. The partial voltage returned by the potentiometer is converted by an analog/digital converter to a form which can be processed by the microcomputer and transformed to angular degrees. The valid angle range is from approx. -3° to approx +94°.

The EML control unit carries out a switch range test and compares the switch-off point of the switch (approx 17°) with the angle position of the throttle valve potentiometer. If the EML control unit detects too great a deviation, the power is limited and the EML control lamp lights up.

A further test of the two switches, pedal value sender switch and throttle valve switch, is the switch plausibility test. The control unit logic checks whether one of the following conditions has been fulfilled:

- Pedal value sender switch closed (closes at approx. 9°)
- Throttle valve switch closed (opens at approx. 17°)
- Cruise control (FGR) active

If one of these conditions is not fulfilled, all three cutoff paths available to the EML control unit are activated.

The cutoff paths of the EML control unit all result in engine power limitation or cutout of the throttle valve (throttle valve is closed by means of the servomotor or the return spring). The various cutoff paths are activated according to the component error occurring.

The control unit can activate three various cutoff paths:

- Transmit idle speed (LL) signal to the DME. When idle speed signal is transmitted to the DME, it switches over to overrun cutoff at a speed of > approx. 1500 rpm.

- Switching off the opening circuit of the throttle valve servomotor output stage. When this opening circuit is switched off, the throttle valve can only be closed by means of the return spring or the closing circuit of the throttle valve servomotor output stage.

- Power limitation through limitation of the throttle valve opening. When the throttle valve opening is limited, the throttle valve opening speed is also limited.

A further cutoff path that bypasses the EML control unit is the external safety path (safety switch in the pedal value sender). It signals idle speed (LL) to the two DME control units in the event of the pedal value sender not being actuated and the brake pedal being depressed. This ground signal is transmitted by the brake light test switch via the safety switch in the pedal value sender (switch opens at approx. 2.5°) to the DME control units.

CRUISE CONTROL

The cruise control (FGR) is activated with the FGR switch. The road speed signal (Tacho A) from the instrument cluster is used for control. The various switch positions of the FGR switch are detected by the EML control unit (Pin 43) through various voltage values.

Beside the various switch positions, the EML control unit also detects "interruption" and "ground contact".

SAFETY TEST

After the ignition is switched on, the EML control unit tests its components that are important for operation (safety test), and lights up the EML warning lamps for approx. 2 seconds.

> It is checked whether the EML warning lamp can be activated if an error occurs. If an error occurs, the EML warning lamp lights up. If the EML warning lamp cannot be activated on account of defective lamps or lines, the EML reduces power.

Errors that affect the engine's performance or the vehicle handling are recorded by the safety system and effective measures are initiated to prevent the development of critical operating conditions.

The basic principle is the constant monitoring of the pedal value sender and the throttle valve actuator to ensure functions that are logically coordinated.

PROVISION OF REPLACEMENT VALUES

The EML control unit provides replacement values for the engine speed signal, the road speed signal and the engine temperature.

> **Engine Speed Signal**
>
> The EML control unit forms the current speed on the basis of the engine speed signal (TD - Pin 47) coming from the DME control unit I. If this signal corresponds to a speed of > 6900 rpm, a speed of 4000 rpm is used for calculating the performance characteristics. The EML control unit recognises the speed range of > 600 rpm as applicable for calculation of the performance characteristics.

Road Speed Signal

The EML forms the current road speed on the basis of the road speed signal (Tacho A - Pin 8) coming from the instrument cluster. The EML recognises the range 0 to 280 km/h as applicable. If the signal corresponds to a speed of over 280 km/h, a speed of 32 km/h is used for the function.

Engine Temperature

The EML detects the engine temperature by means of its own temperature sensor (Pin 45). Here, the EML recognises the range -40° C to +140°C as applicable. Outside of this range, a replacement value of approx. 40°C is used for the function.

FAULT MEMORY PRIORITY

The EML control units stores a maximum of 5 faults. When the fault memory is full, a newly occurring fault with greater priority takes the place of an already stored fault with lower priority.

Note: When the battery is disconnected or the instrument cluster is removed, the fault memory in the EML control unit is deleted.

SPECIAL FEATURES OF THE EML IN THE S70B56 ENGINE

As the B50CSi is equipped only with 6-gear transmission, the following pins on the EML control unit are not assigned:

Inputs
Pin 42 Transmission selector control switch (driving position P/N)

Outputs
Pin 20 Kick-down signal to the EGS control unit

PERFORMANCE CHARACTERISTICS SWITCH

For the S70B56 engine, an EML performance characteristics switch is to be installed in combination with the 6-gear transmission.

For this purpose, a sport/comfort (S/K) switch is installed in the vehicle's centre console on the driver's side. Like the program switch of the EGS, it acts directly on the EML control unit (Pin 52).

By means of this switch, corresponding performance characteristics for the throttle valve control are selected in the EML control unit.

The performance characteristics for the sport and comfort program have been altered as against the EML of the M70 engine.

Important:
The encoding of the EKM in the 850CSi is carried out as with automatic transmission, despite being equipped with manual transmission, so that in the event of changeover to the S program, the "S" is correspondingly displayed in the instrument cluster. (There is no display "K", as the 850i instrument cluster does not yet provide for this.)

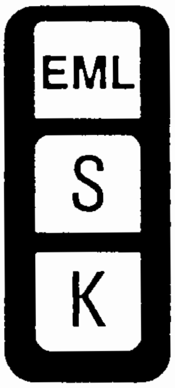
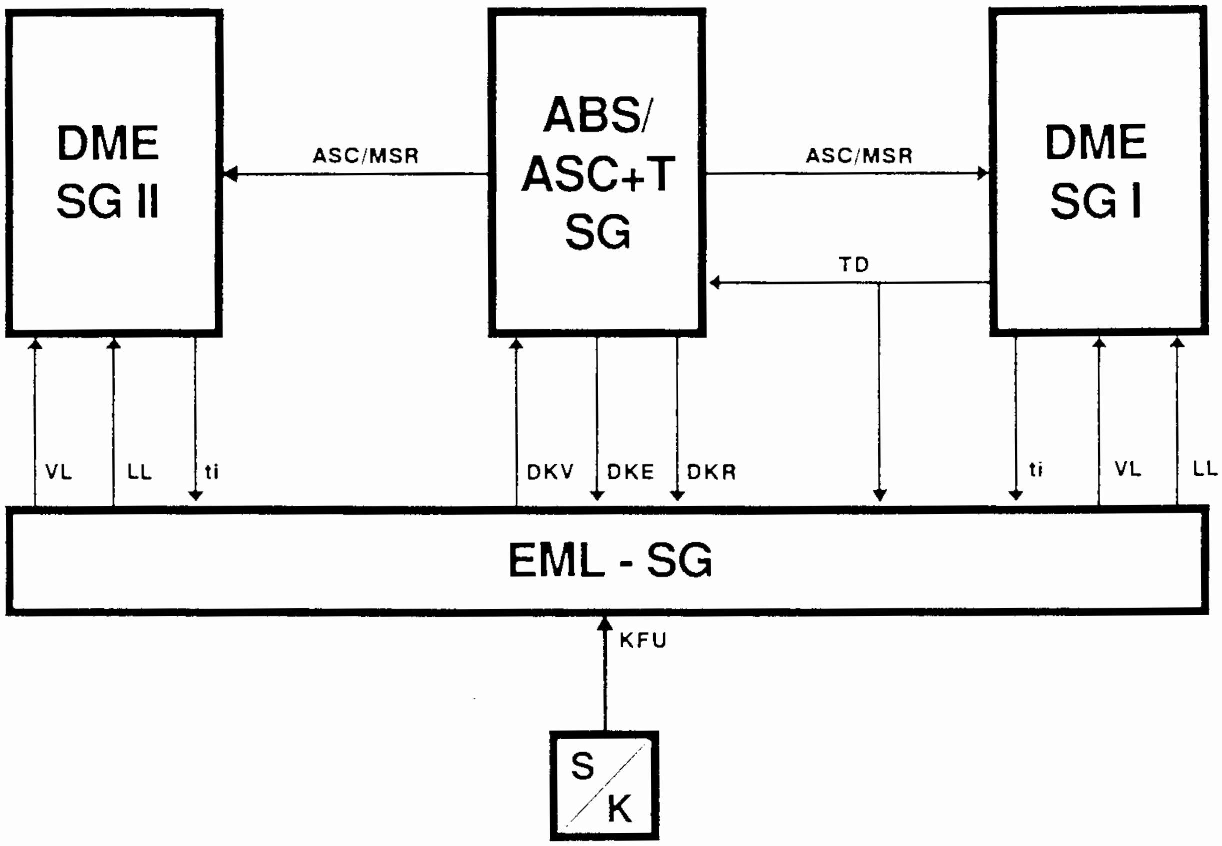


Fig. 10: EML performance characteristics switch

INTERFACES BETWEEN THE CONTROL UNITS



KFU Performance characteristics switch

Fig. 11: Signal exchange between the control units

Interface DME-ASC+T

ASC+T receives engine speed signal TD from DME control unit I.

In the event of control thorugh ASC+T to reduce engine torque, both DME control units receive the signal ASC/MSR from control unit ASC+T and then adjust the ignition time to a later point.

If there is an increase in drive wheel slip when the vehicle is in overrun, the overrun cutoff is deactivated by the ASC/MSR signal through the DME control unit.

Interface ASC+T-EML

The EML control unit has a connection through 3 lines to the ASC control unit.

The EML control unit constantly notifies the ASC+T of the present throttle valve angle with (driver specification) via the DKV line.

If, in a specific driving situation, there is impermissibly high drive slip, ASC+T determines the maximum transferable driving torque and for the duration of the control continously signals the required throttle valve position to the EML.

If the throttle valve angle is to be reduced, the EML receives this information via the DKR line. If ASC+T desires an increase in the throttle valve angle (engine drag torque control), this is signalled to the EML via the DKE line.

In order to allow an exact exchange of information, when the ignition is switched on synchronisation takes place between the EML and ASC control units on these three lines (DKV, DKR, DKE). If this synchronisation does not take place, throttle valve actuation by means of the ASC control unit is not possible.

Interface EML - instrument cluster

For the operation of the cruise control (FGR) and to receive the stored information in the EML control unit, the EML has a line connection (3 lines) to the instrument cluster.

The EML is notified of the current road speed from the instrument cluster by means of the Tacho A signal. In order to be able to keep the stored information in the EML control unit when the ignition is off, the EML memory is supplied with power (Pin 15).

The power is supplied by means of two special lamps soldered in the instrument cluster (EML warning lamps). The two lamps are connected to the EML by means of two separate lines.

DIAGNOSIS DME M1.7 /
EML OF THE S70B56 ENGINE

The DME M1.7 and the EML are diagnosable.

Procedure in accordance with test program (diskette) and test plan (ETM).