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 %.

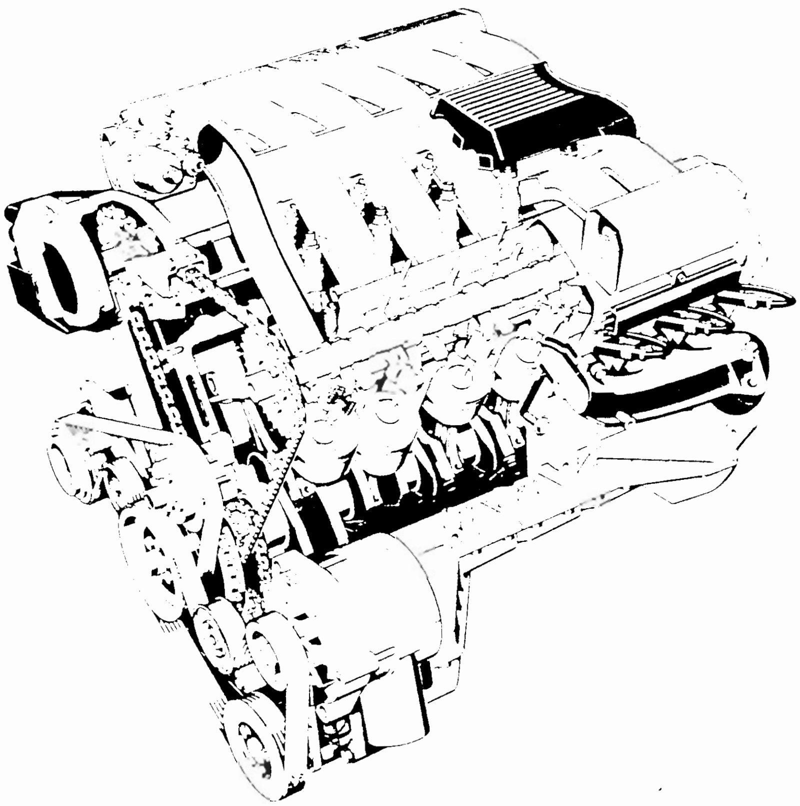


Fig. 1: S70B56 Engine

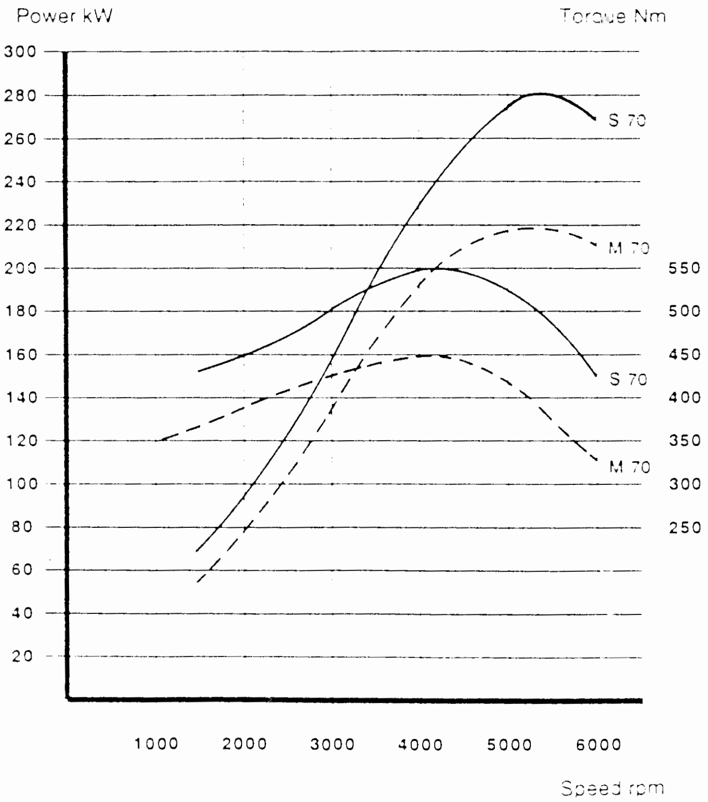


Fig. 2: Power and torque diagram comparing S70B56 and M70B50

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.

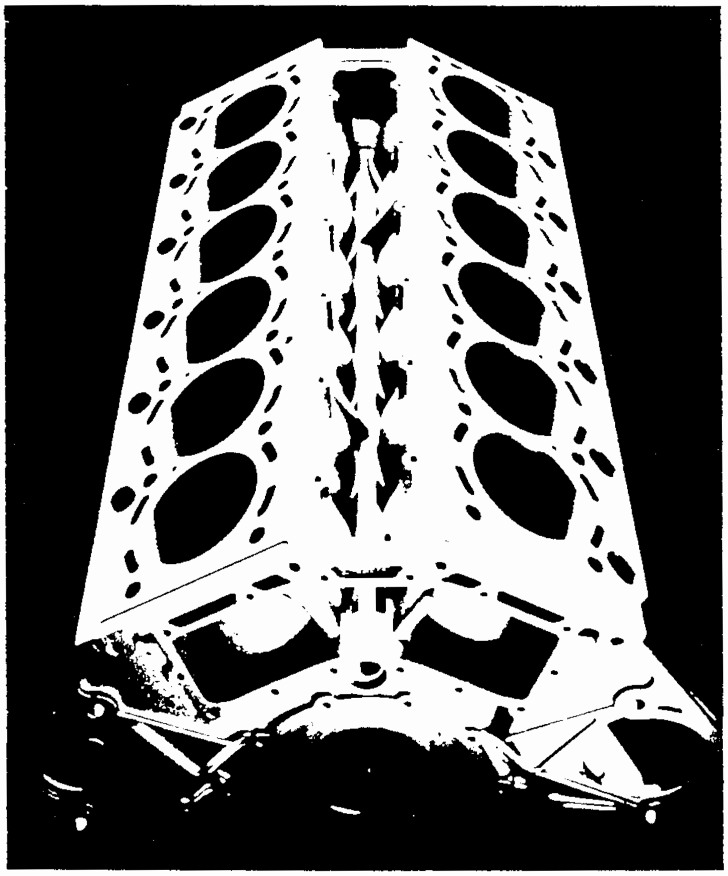


Fig. 1: S70B56 crankcase

		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.

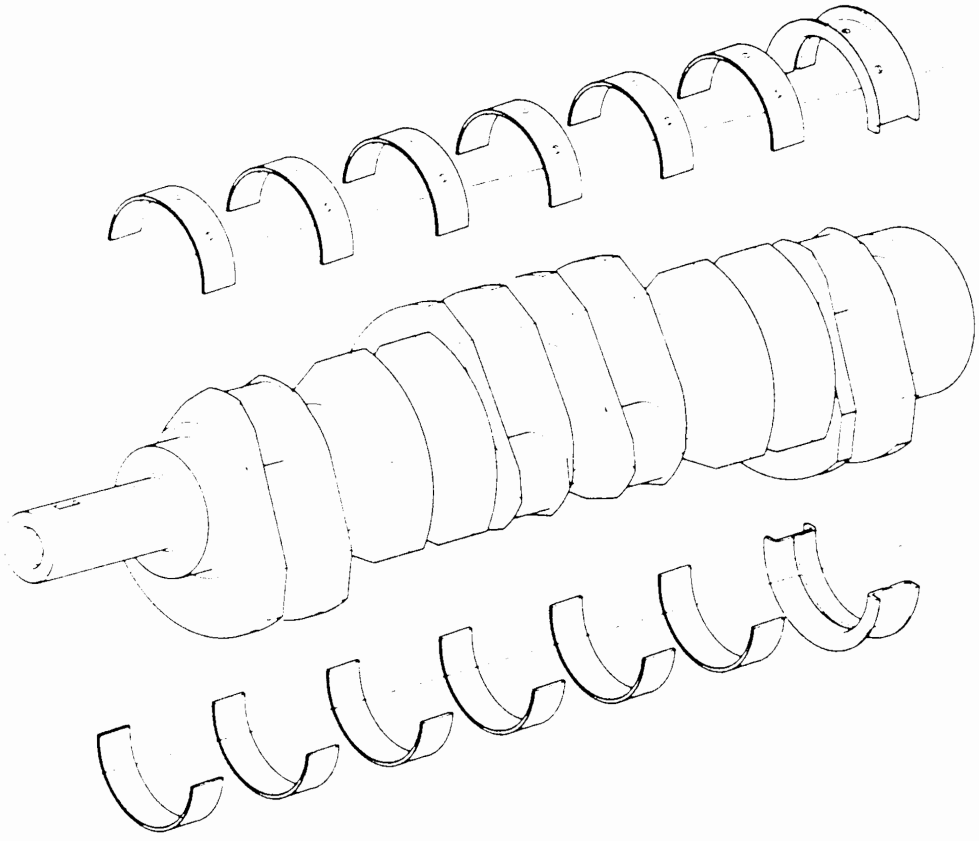


Fig. 2. Crankshaft and main bearings

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.

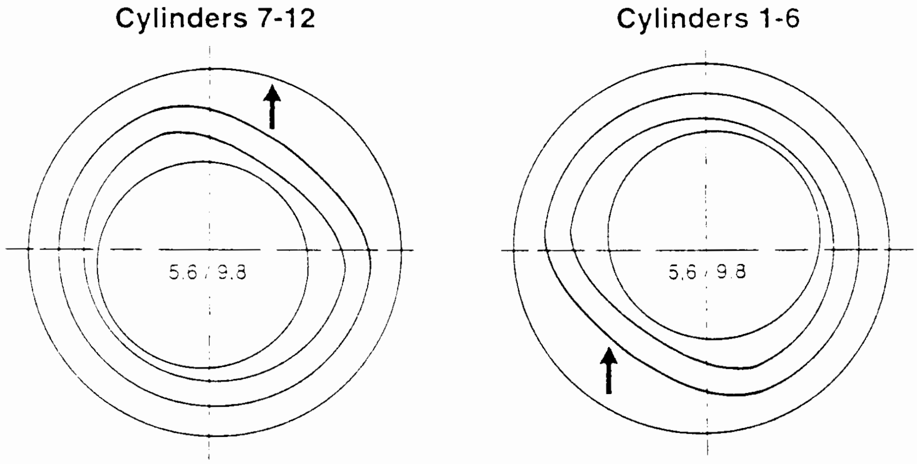


Fig. 3: S70B56 piston (combustion chamber cavity)

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)

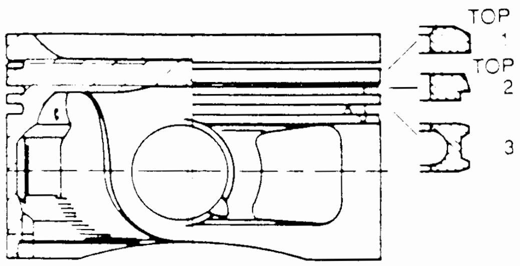


Fig. 4: Pistons and piston rings

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

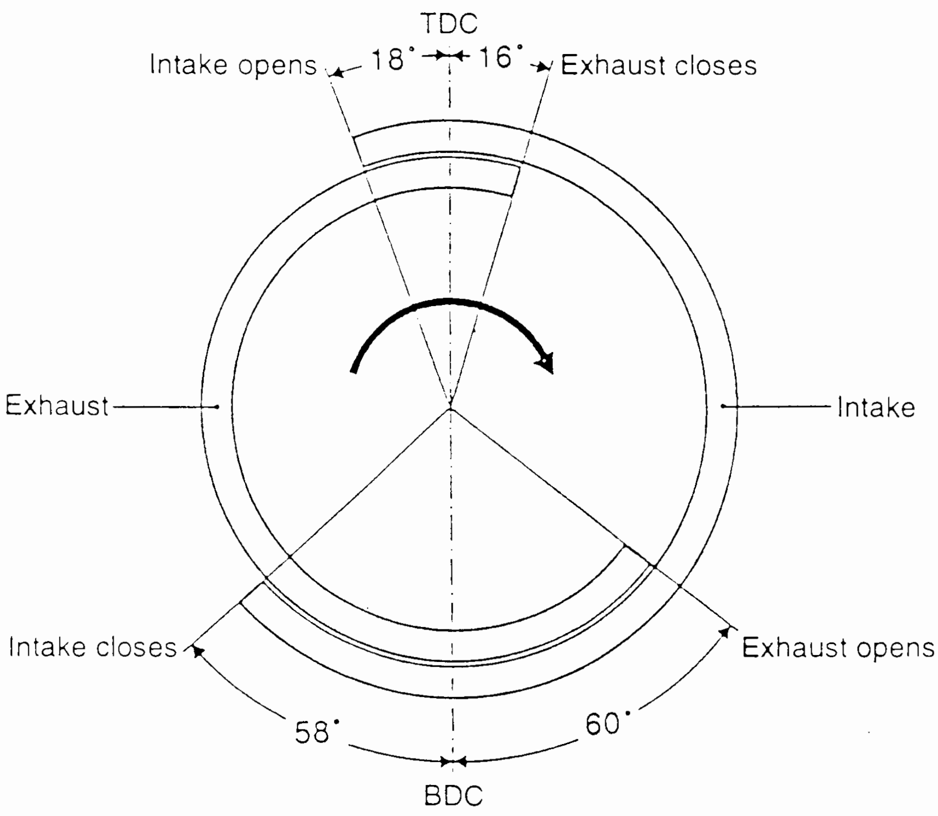


Fig. 5: S70B56 timing diagram

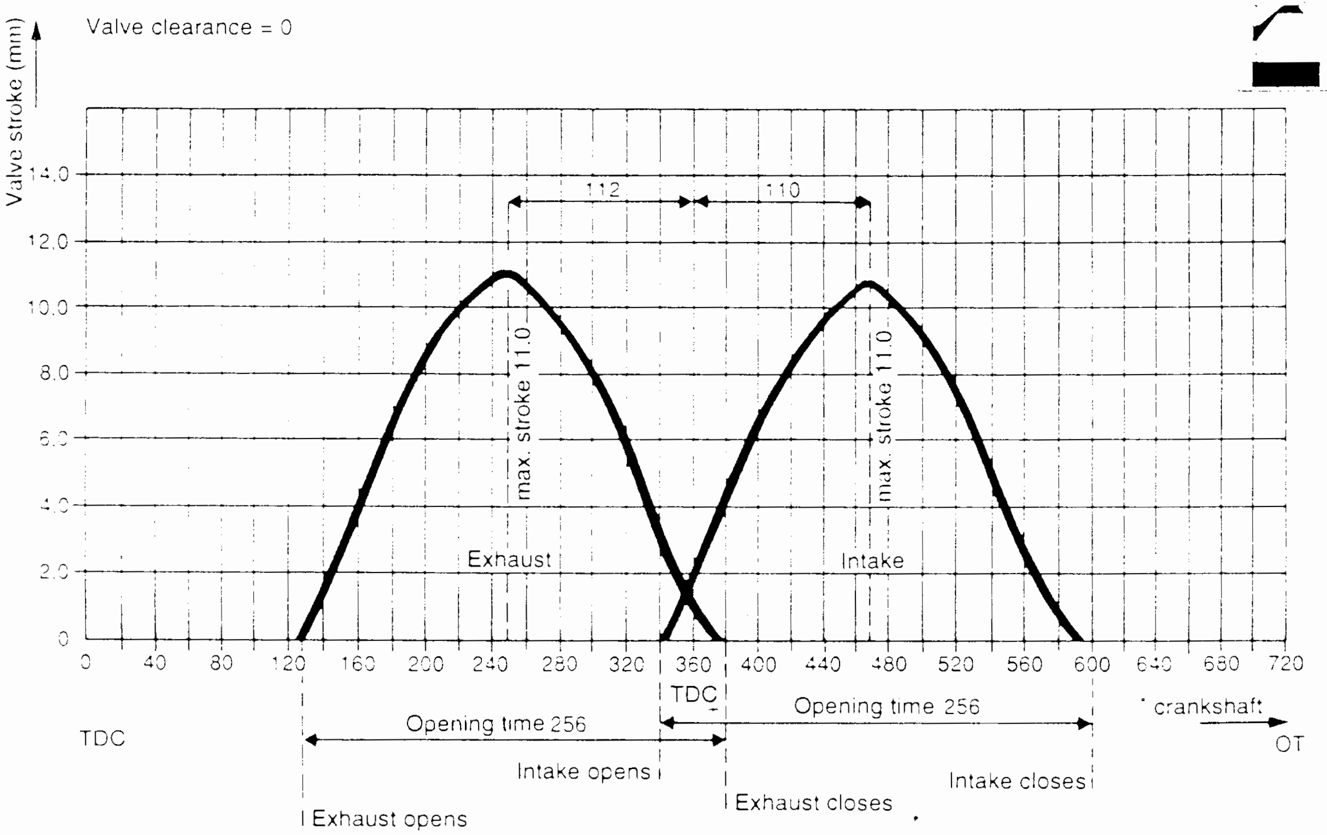


Fig. 6: Theoretical valve stroke characteristics

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).

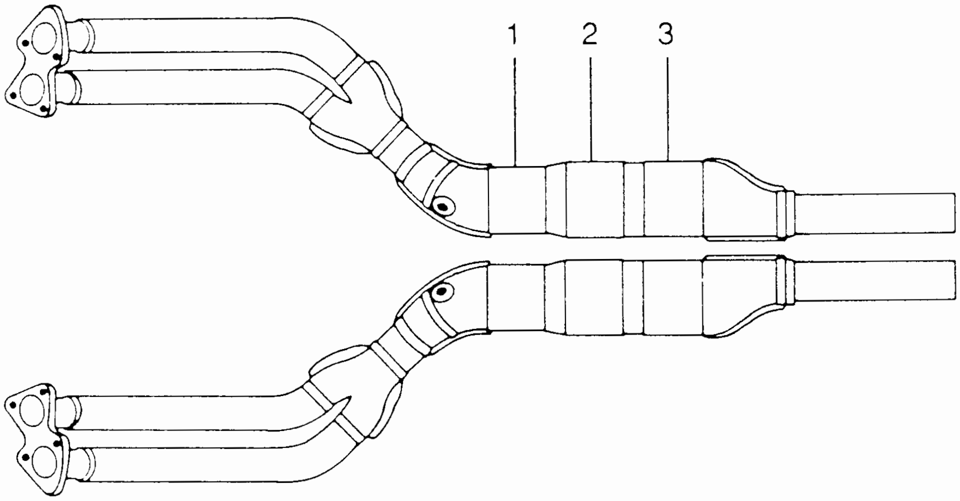
The cooling, oil, fuel and intake systems also have been taken over from the M70 without alteration.

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.

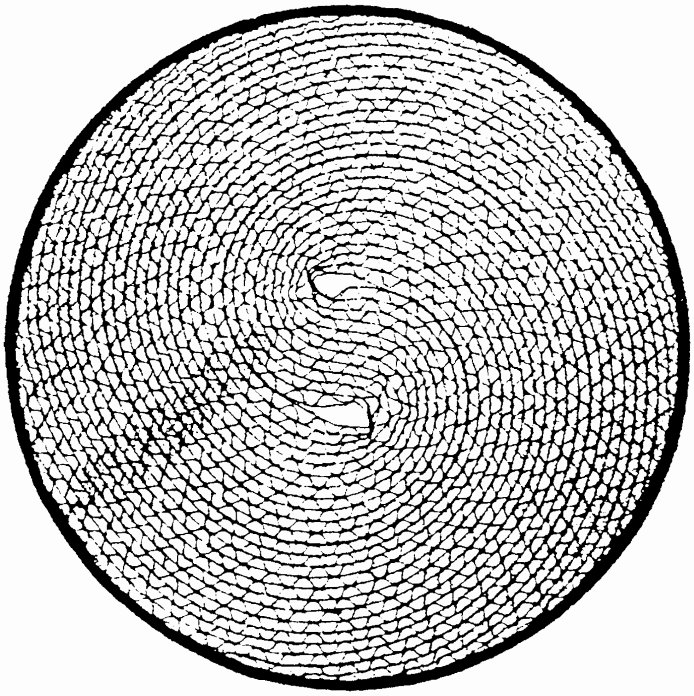


Fig. 8: Wound element of metal catalytic converter - cross-section

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.

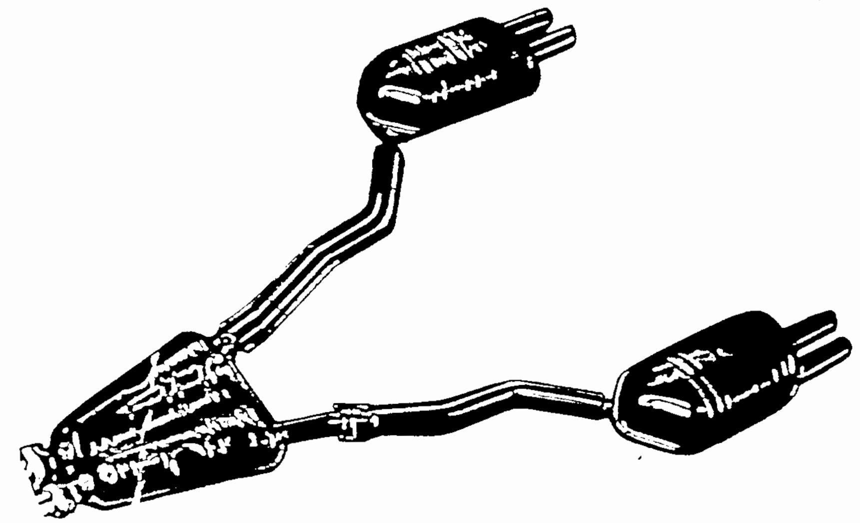


Fig. 9: Silencer system

SOUND ABSORPTION HOOD

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

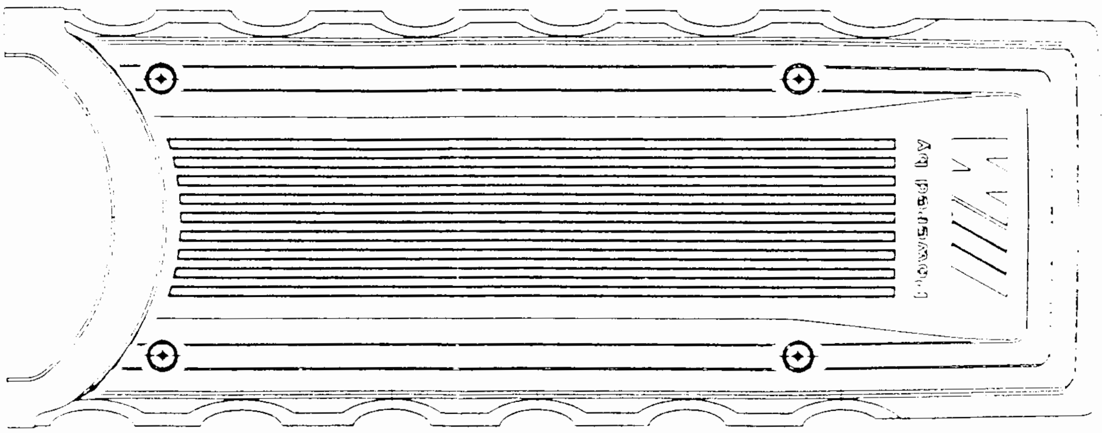


Fig. 10: Sound absorption hood

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)

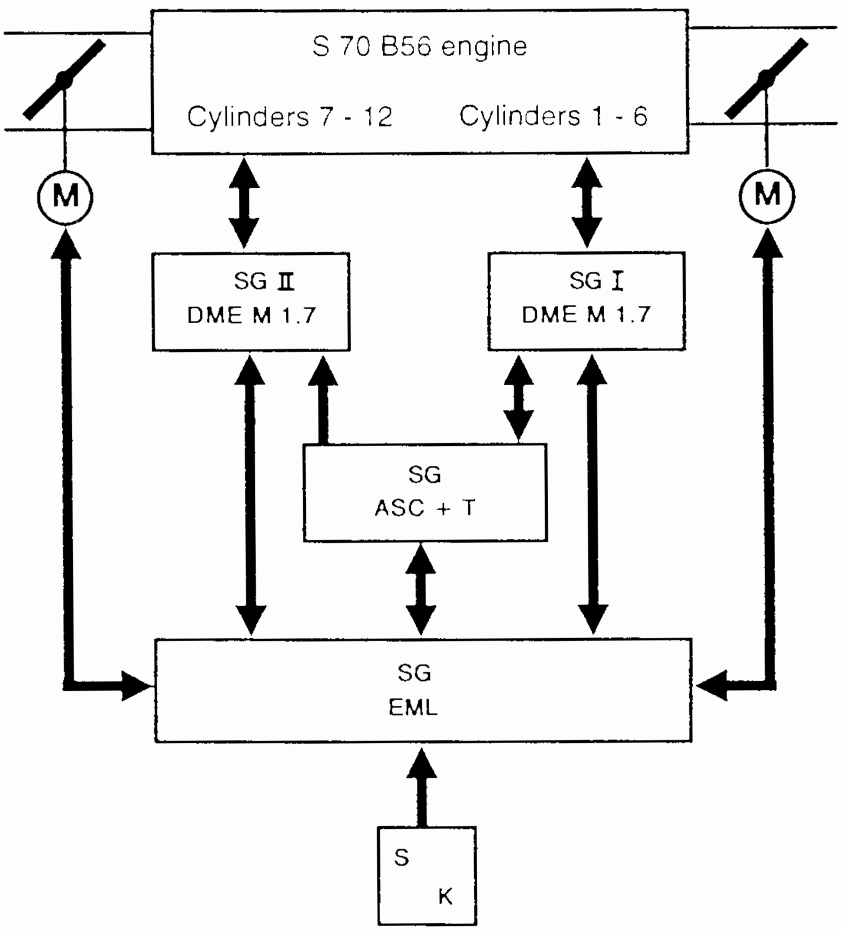


Fig. 1: Engine timing system connection

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

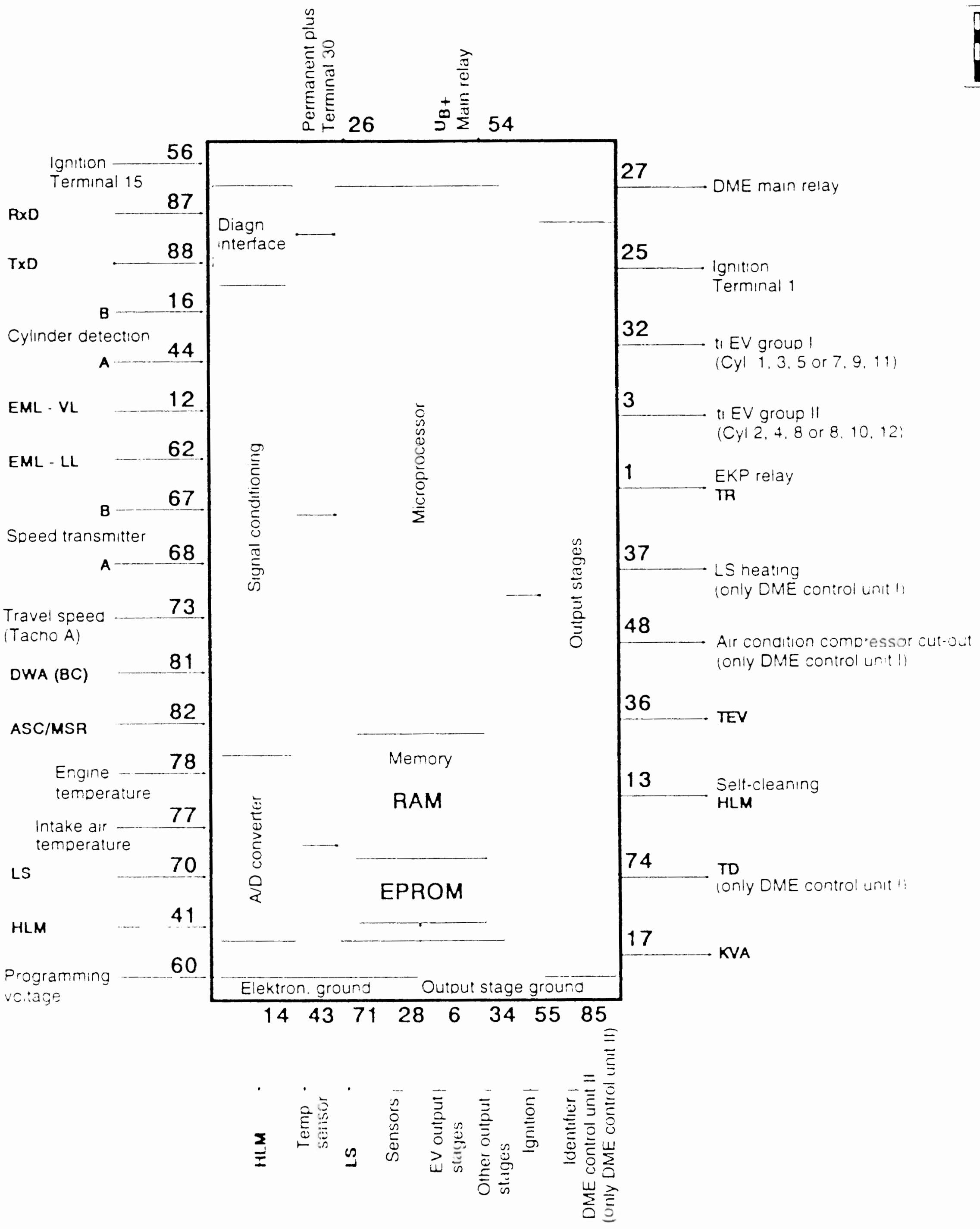


Fig. 2 DME M1.7 block diagram (pin assignment for S70B56)

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.

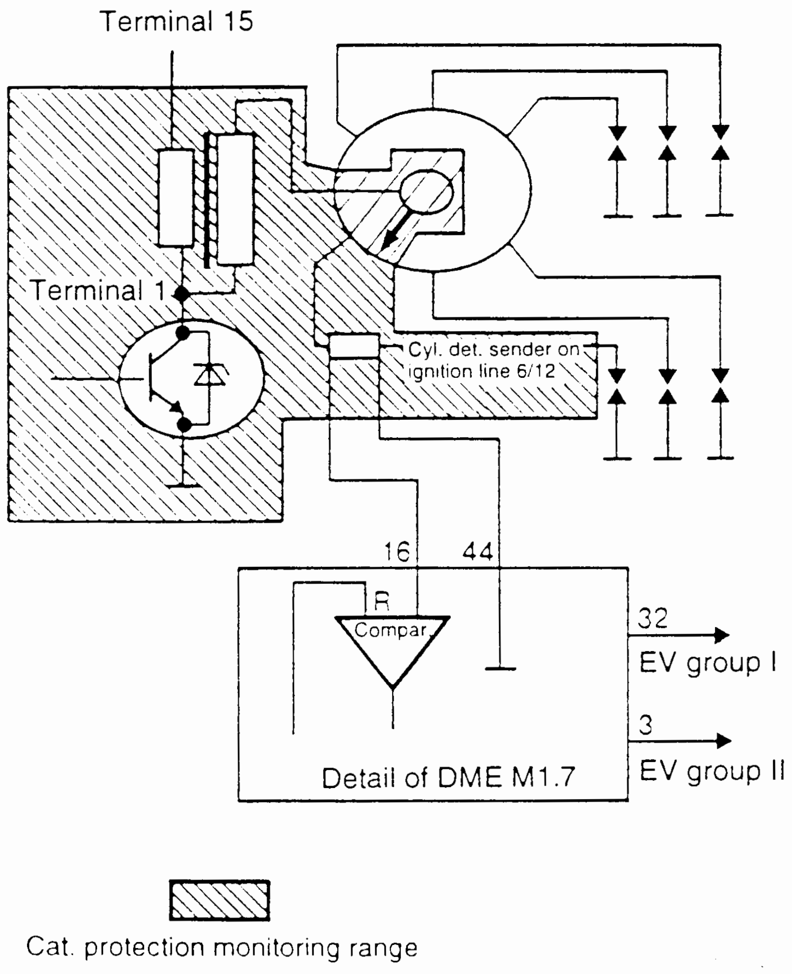


Fig. 3: S70B56 catalytic converter protection

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).

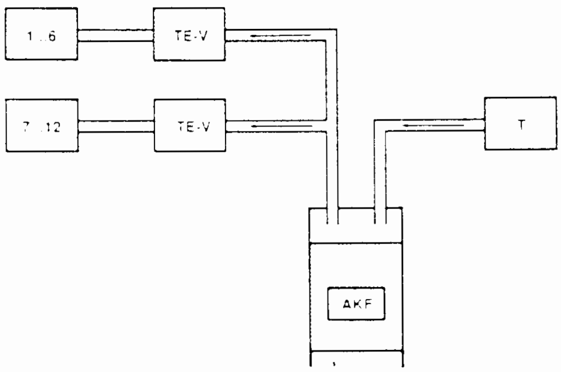


Fig. 4 S70B56 tank ventilation

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

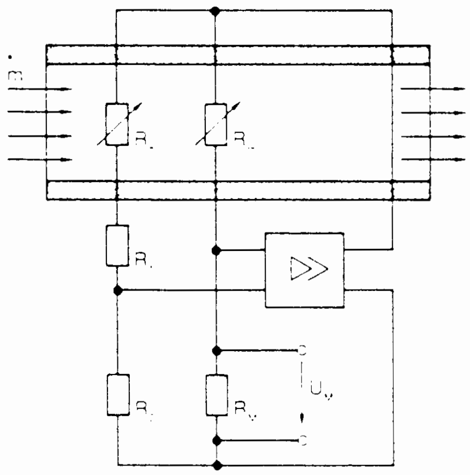


Fig. 5. Hot-wire air-mass flow meter (HLM) - Function diagram

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