Detailed Product Catalogue: Twin Cylinder, Duel Fuel, Turbo Charged, Diesel Engine Setup with Open ECU System

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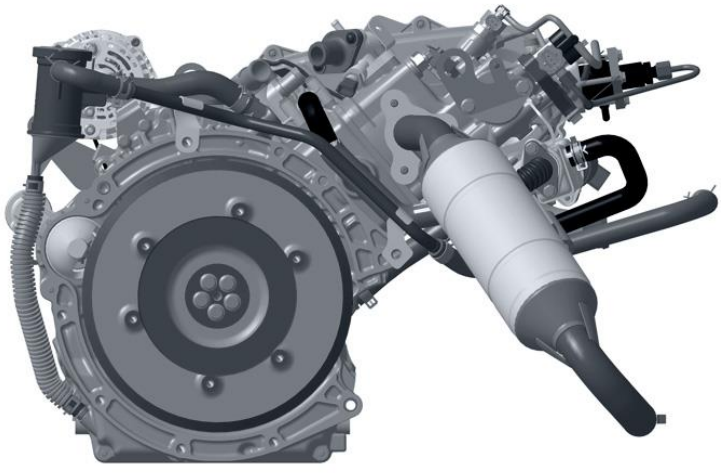
Twin Cylinder CRDI Engine



Engine Specification	
Number of Cylinder	02
Engine Displacement (CC)	900 cc
Cooling	Water
Camshaft	SOHC
Compression Ratio	18.5:1
Bore	83 mm
Stroke	84 mm
Firing Order	1-2
Fuel Injection	Common Rail Direct Injection technology with solenoid injection
Pressure control	Diesel Pressure Regulating Valve
Injection Pressure	1400 Bar Max
Aspiration	Turbo charged Turbo Charger with waste gate actuator and turbo blow off valve
Torque (Nm/Kgm)	98 Nm @1800 - 3000 RPM
EGR	Exhaust Gas Recirculation (Vacuum control)
Injector	Solenoid
Sensors/Actuators	Crank Position Sensor Cam Position Sensor Mass Air Flow Sensor Charge Air Pressure Sensor Rail Fuel Pressure Sensor Charge air pressure & Intake Air Temperature Sensor Coolant Temperature Sensor Fuel Temperature Sensor Exhaust Temperature Sensor Before DPF Differential Exhaust Pressure Sensor across DPF Accelerator Pedal Cruise Control Switch

Detailed Sensors/Actuators specification is continued in the the next pages.

Eddy Current Dynamometer with Controller

Principle of Eddy-Current Electro Brake Dynamometer

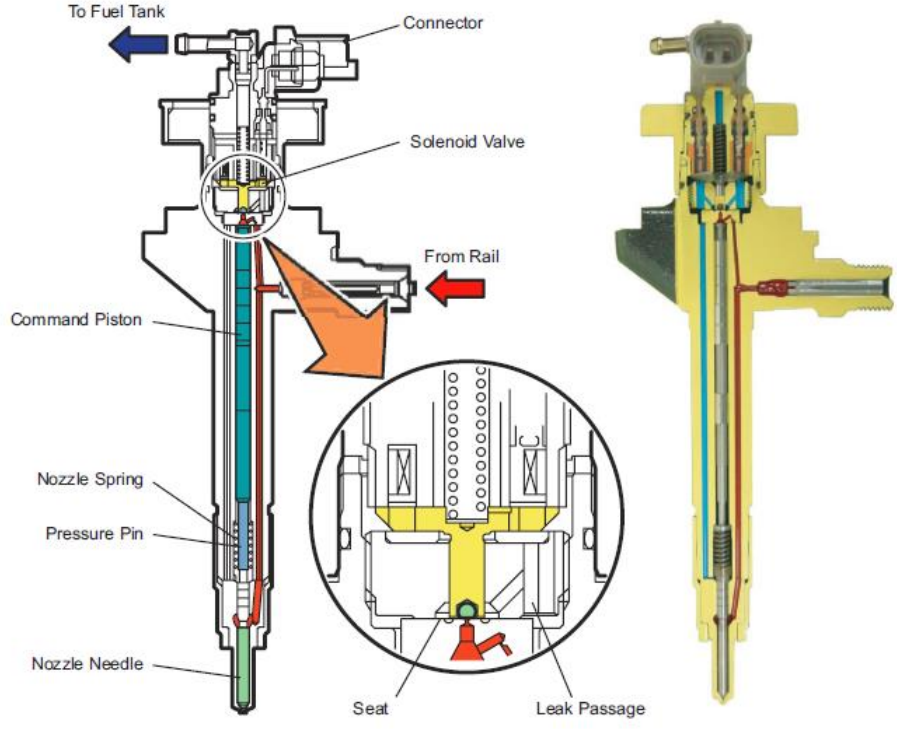
Eddy-Current Dynamometer's theory is based on Eddy-Current (Fleming's law of right hand). The construction of eddy-current electro brake as shown in the picture below, has a notched disc(rotor) which is driven by a prime mover(such as engine, etc.) and magnetic poles(stators) are located outside of it with a gap. The coil which excites the magnetic pole is wound in circumference direction. When a current runs through exciting coil, a magnetic flux loop is formed around the exciting coil through stators and a rotor. The rotation of rotor produces density difference, then eddy-current goes to stator. The electromagnetic force applies in opposite of the rotational direction by the product of this eddy-current and Vector of magnetic flux and it becomes brake.

Technical Specification	
Type	Eddy Current
Make	Technomake
Model	TME40
Cooling	Water
Torque Capacity	120 Nm @ 1800 – 3000 RPM

Solenoid Injector

General Description

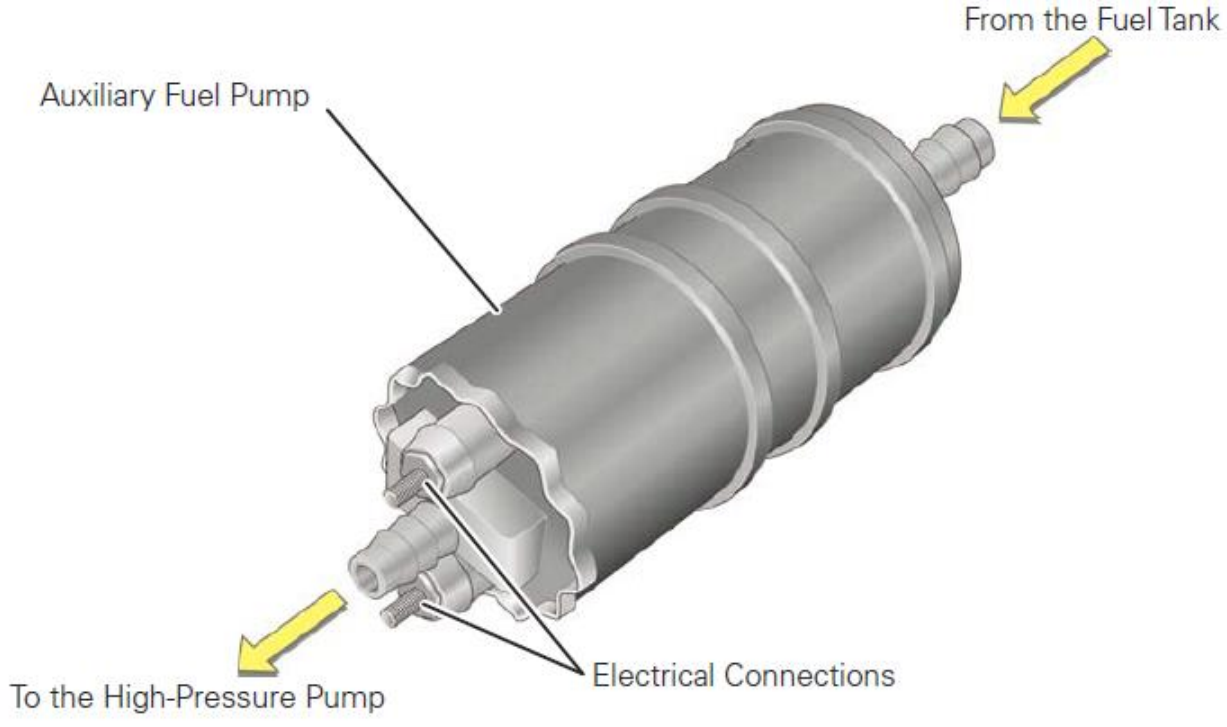
- The injector injects the pressurized fuel in the rail into the engine combustion chamber at the optimal injection timing, injection quantity, injection rate, and injection pattern, in accordance with signals from the ECU.
- Injection is controlled using a TWV (Two-Way Valve) and orifice. The TWV controls the pressure in the control chamber to control the start and end of injection. The orifice controls the injection rate by restraining the speed at which the nozzle opens.
- The command piston opens and closes the valve by transmitting the control chamber pressure to the nozzle needle.
- When the nozzle needle valve is open, the nozzle atomizes the fuel and injects it.
- Maximum injection pressure 1300Bar



CRDI Injector Specification	
Make	Bosch
Max Flow	70mm^3/inj
Fuel input	Top-feed injector
Fuel	Diesel
Operating pressure	Up to 1500 bar
Operating temperature range	-31 to 130°C
Booster supply	14 V
Booster current	20 A
Booster time	500 µs
Power supply	12 V
Pick up current	17.5 A
Pick up time	800 µs
Hold power supply	12 V
Hold current	12.5 A hysteresis 0.8 A
Coil resistance	1,500 mOhm (ambient temp.)

Feed/Auxiliary Fuel Pump

The Auxiliary Fuel Pump is a roller-cell pump. It is located in the engine compartment and has the task of feeding fuel from the fuel tank to the high-pressure pump. The Auxiliary Fuel Pump is actuated by the Engine Control unit through a fuel control module and increases the fuel pressure to approximately 73 psi (5 bar). Effects of Failure If the Auxiliary Fuel Pump fails, the engine runs at first with reduced power. An engine start up is not possible.

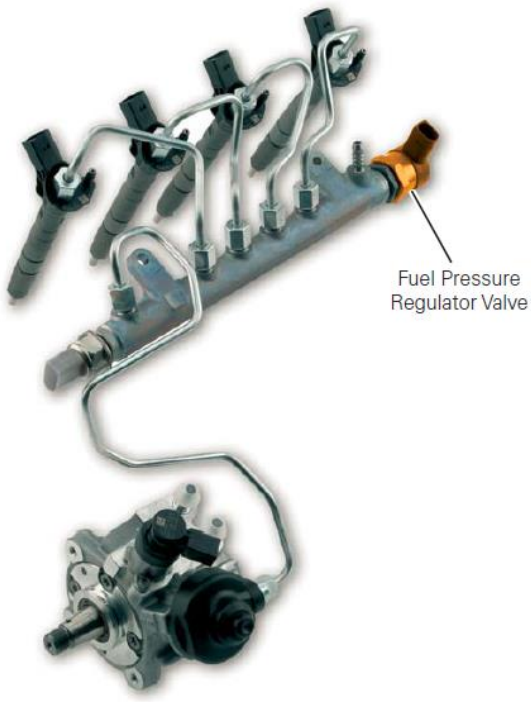


Technical Specification	
Make	Bosch
Operating pressure	72.5 PSI (5 Bar)
Minimum Current	12 Volts / 13 Amp
Minimum Flow @ Outlet	80 GPH (300 LPH)
Fuel Pump Location	Inline
High Temperature Reduction	8 GPH (30 LPH)
Length	196 mm
Diameter	60mm

CRDI Single Plunger High-pressure pump

Technical specification	
Make	Bosch
Model	cp4i pump
Max. System pressure	1500 bar
Max delivery quantity	2.2 cm3/rcam
Minimum volumetric efficiency	85%
Max number of strokes	10,500 min-1
Pressure relief valve	Integrated
Pressure regulator	Excluded

Fuel Pressure Regulator Valve/PCV



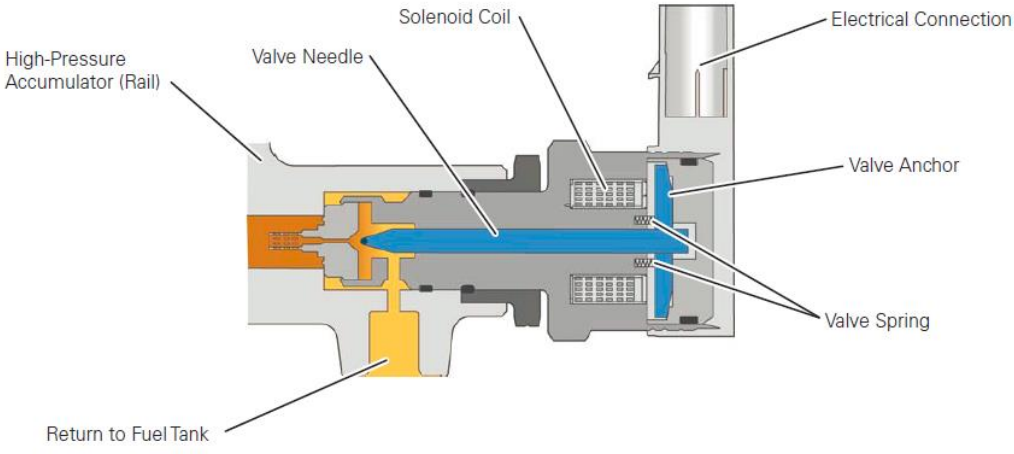
Specification

Make	Bosch
Input Signal Type	PMW
Max Operating temperature	150°C
Max Operating Pressure	1800 Bar

Fuel Pressure Regulator Valve

The Fuel Pressure Regulator Valve is located on the high-pressure accumulator (rail). Opening and closing of the Fuel Pressure Regulator Valve adjusts the pressure of the fuel in the high-pressure area. This is actuated by the Engine Control Unit with a pulse-width modulated signal.

Design

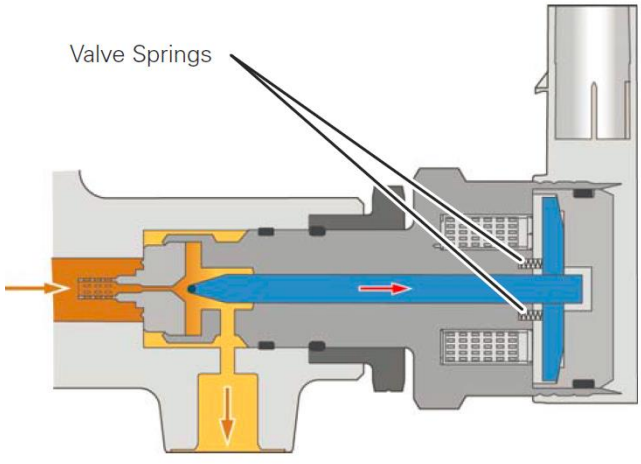


How it Works

In contrast to conventional control valves in common rail injection systems, the Fuel Pressure Regulator Valve is open in the non-energized state.

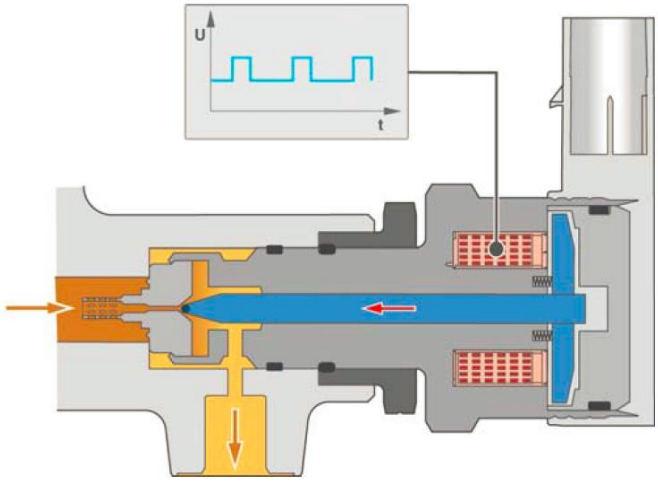
Fuel Pressure Regulator Valve in Rest Position (Engine "Off")

If the Fuel Pressure Regulator Valve is not activated, the pressure regulator valve is opened by the valve springs. The high-pressure area is connected to the fuel return. This ensures volume compensation between the high-pressure and low-pressure areas. Fuel vapour lock, which can occur during the cool-down with engine standstill in the high-pressure accumulator (rail), is avoided and the startup properties of the engine are improved.



Fuel Pressure Regulator Valve Activated (Engine "On")

To set an operating pressure of 200 to 1300 bar in the high-pressure accumulator, the Fuel Pressure Regulator Valve is actuated by the Engine Control Unit with a pulse-width modulated (PWM) signal. Upon actuation a magnetic field is generated in the solenoid coil. The valve anchor is tightened and presses the valve needle into its seat. A magnetic force opposes the fuel pressure in the high-pressure accumulator. Depending on the duty cycle of the actuation, the flow cross-section to the return line and the exhaust quantity is changed. This also allows fluctuations in the pressure in the high pressure accumulator to be compensated.



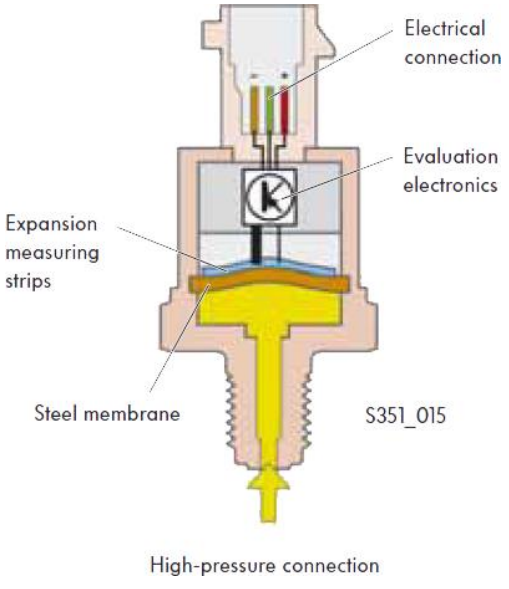
Rail Fuel Pressure Sensor

Rail Fuel pressure Sensor

The fuel pressure sender is located on the high-pressure accumulator (rail). It determines the current fuel pressure in the high-pressure area.

Function

The fuel pressure sender contains a sensor element, which is comprised of a steel membrane with expansion measuring strips. The fuel pressure reaches the sensor element via the high-pressure connection. In the event of a change in pressure, the steel membrane's deflection changes, as does the resistance value of the expansion measuring strips. The evaluation electronics calculate a voltage from the resistance value and transmit this to the Engine Control Unit. A characteristic curve stored in the Engine control unit is used to calculate the current fuel pressure.



Make	BOSCH	
Power	5 Volts DC	
Range	0 – 1800 MPa	
Calibration Data	Output Voltage	Pressure in Bar
	0.49988	0
	4.50012	1800 Bar

Fuel Temperature Sensor

Technical Specification

Mechanical Data	
Make	Bosch
Model	NTC M12
Male thread	M12x1.5
Wrench size	19 mm
Installation torque	25 Nm
Weight w/o wire	29 g
Electrical Data	
Characteristic	NTC
Nominal resistance at 20°C	2.5 kΩ ± 5 %
Characteristic	
Accuracy at 25°C	± 1.4°C
Accuracy at 100°C	± 3.4°C
Response time tau 63 in still water	< 15 s

Fuel Temperature Sensor

The fuel temperature sender is located in the fuel supply pipe to the high-pressure pump. The fuel temperature Sensor is used to determine the current fuel temperature. Sensor type : Negative Temperature coefficient(NTC)

Signal usage

The diesel direct injection system control unit J248 uses the fuel temperature sensor signal to calculate the fuel density. This serves as a correction variable to calculate the injection quantity, to regulate the fuel pressure in the high-pressure accumulator and to regulate the quantity inlet to the high-pressure pump.

Coolant Temperature Sensor

Technical Specification

Mechanical Data	
Make	Bosch
Model	NTC M12
Male thread	M12x1.5
Wrench size	19 mm
Installation torque	25 Nm
Weight w/o wire	29 g
Electrical Data	
Characteristic	NTC
Nominal resistance at 20°C	2.5 kΩ ± 5 %
Characteristic	
Accuracy at 25°C	± 1.4°C
Accuracy at 100°C	± 3.4°C
Response time tau 63 in still water	< 15 s

Coolant temperature Sensor

The coolant temperature sender is located on the right cylinder head's coolant connection. The sender provides the diesel direct injection system control unit with information on the current coolant temperature. Sensor type: Negative Temperature coefficient (NTC)

Coolant temperature Sensor Signal usage

The coolant temperature is used by the Engine control unit as a correction value for calculating the injection quantity, the charge air pressure, the injection point and the exhaust gas recirculation quantity.

Charge air pressure & Intake Air Temperature Sensor

Technical data

Parameter	min	type	max		
Feature sensor			Integrated temperature		
Pressure range kPa (p_1...p_2)			3 20		4 300
Operating temperature	ϑ_B	°C	-40		+130
Supply voltage (1 min)	U_V	V	4,5	5	5,5
Current input at U_V = 5 V	I_V	mA	6	9	12,5
Load current at output	I_L	mA	-1		0,5
Load resistance to U_V or ground	$R_{pull-up}$	kΩ	5	680	
Load resistance to U_V or ground	$R_{pull-down}$	kΩ	10	100	
Response time	$\tau_{10/90}$	ms		1	
Voltage limitation at U_V = 5 V - lower limit		V	0,25	0,3	0,35
Voltage limitation at U_V = 5 V - upper limit		V	4,75	4,8	4,85
Limit data					
Supply voltage	U_{Vmax}	V			16
Storage temperature		°C	-40		+130
Temperature sensors					
Measuring range	ϑ_M	°C	-40		+130
Measurement current		mA			1 [1])
Rated resistance at +20 °C		kΩ		2,5 ± 5 %	
Temperature/time constant	τ_{63}	s		10 [2])	

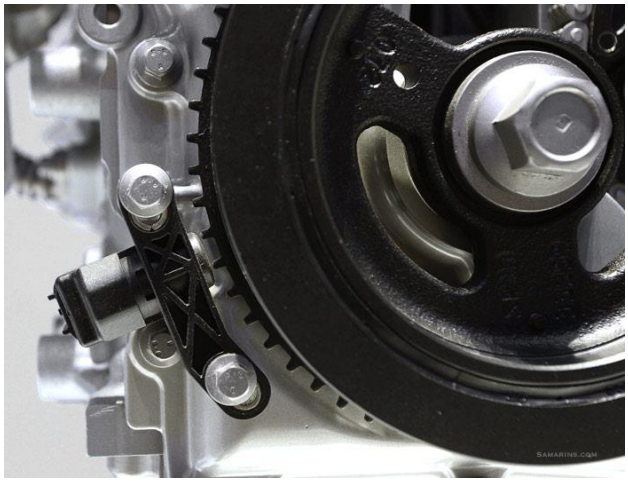
Accessories are not included in the scope of delivery of the sensor and are therefore to be ordered separately as required.

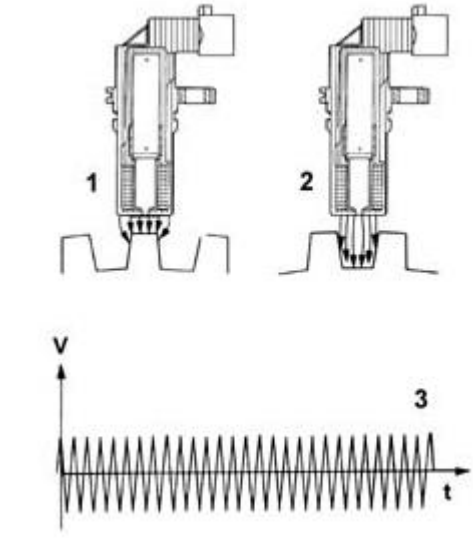
Intake air temperature sensor measures the intake air temperature and charge air pressure and is located in the intake manifold

Charge air pressure Sensor	**Intake air temperature**
This sensor is a semiconductor type sensor. It measures pressure utilizing the piezoelectric effect that when the pressure on the silicon element in the sensor changes, its electrical resistance changes. In addition, the air pressure on this sensor is switched between the pressure within the intake manifold and the atmospheric pressure, so both the intake air pressure and the atmospheric pressure are detected with one sensor.	The intake air temperature sensor detects the temperature of the intake air after it has passed the turbocharger. The sensor portion that detects the temperature contains a thermistor. The thermistor, which has an electrical resistance that changes with temperature, is used to detect the intake air temperature.

Signal usage	**Signal usage**
The diesel direct injection system Engine control unit uses the sensor signal to regulate the charge air pressure in case of turbo charged engine	The Engine control unit uses the sensor signal to calculate a correction value for the charge air pressure. Evaluation of the signal gives consideration to the influence of temperature on the density of the charge air.

RPM/Crank Position Sensor





1 - Maximum magnetic flux
2 - Minimum magnetic flux
3 - Induced alternating voltage

TECHNICAL CHARACTERISTICS

	Active	Inductive
Functional principle	differential Hall with or without direction detection	inductive
Temperature range	−40 to +150 °C	−40 to +130 °C
Air gap	0.2 – 1.8 mm	0.3 – 1.8 mm
Target wheel	steel or multipole target wheel	steel target wheel

PRODUCT VARIANT ADVANTAGES

Active	high electromagnetic compatibility (EMC), compact size, low weight, flexible design, direction detection for start-stop functionality
Inductive	high output signal at low speeds, twist insensitive mounting (TIM)
Make	Bosch
Model	D16

Specifications

It is fitted on the cylinder block/crankcase facing the flywheel on the crankshaft. It is inductive type, i.e. its operation is determined by magnetic field changes generated by the teeth passing in front of the phonic wheel (60-2 teeth)/(120-4 teeth).

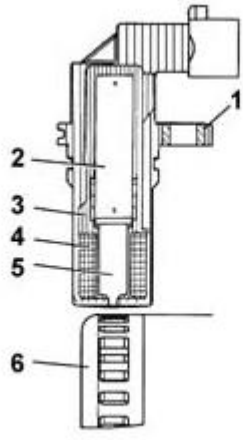
The Engine control unit uses the rpm signal for:

- Determining the engine speed of rotation
- Determining the angular crankshaft position.

Operation

The changeover from full to empty determined by the presence or absence of a gap brings about a magnetic flux change sufficient to generate an induced alternating voltage proportional to the number of teeth on the ring (or phonic wheel).

The frequency and amplitude of the voltage send to the electronic control unit provides the latter with an indication of the engine angular speed.



1 - Brass bush

2 - Permanent magnet

3 - Plastic sensor casing

4 - Coil winding

5 - Core

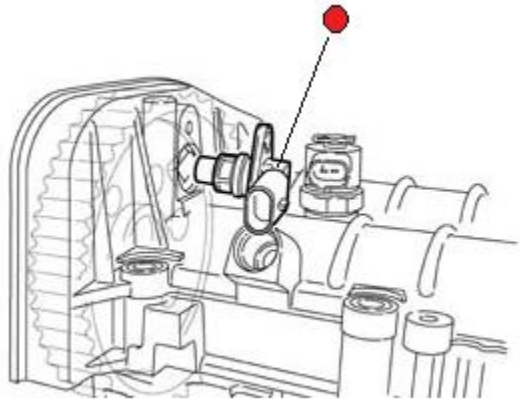
6 - Ring gear or flywheel

7 - Coaxial paired cable or electrical connection

The recommended distance (gap) between the end of the sensor and the flywheel for obtaining correct signals should be 0.8 - 1.5 mm.

This distance is not adjustable. If the gap is found to be outside the tolerance limits, check the condition of the sensor and phonic wheel.

Cam angle Sensor



TECHNICAL CHARACTERISTICS

Functional principle	single-Hall technology
Starting function	true power on (TPO)
Installation	twist insensitive mounting (TIM)
Temperature range	−40 °C to +150 °C (max. 250 hours at +160 °C)
Air gap	0.2 – 1.8 mm

Specifications

This Hall effect sensor is fitted on the cylinder head facing the camshaft drive pulley. A tooth on the pulley allows the timing sensor to indicate engine timing position. The Engine control unit uses the timing sensor signal to identify T.D.C. at the end of compression.

Operation

A current-carrying semiconductor layer immersed in a normal magnetic field (force lines at right angles to current direction) generates a potential difference known as a Hall voltage at its terminals. If current intensity remains constant, the generated voltage depends on magnetic field intensity alone. Periodic changes in magnetic field intensity are sufficient to generate a modulated electrical signal with frequency proportional to the speed of magnetic field change. To produce this change, a tooth on the inner part of the pulley periodically moves close to the sensor.

MASS AIR FLOW METER

Technical Specification	
Make	Bosch
Model	HFM6
Pulsation accuracy	± 2 %
New part tolerance	± 1.5 %
Power supply	5 V, 12 V
Permissible vibration acceleration	≤150 ms–2
Installation length L	96 mm
Connection diam. D	60 mm

Specifications

The debimeter is located on the air intake sleeve and is hot film type.

Operation

The principle of operation is based on a heated membrane positioned within a measurement channel that carries air into the engine. The hot film membrane is maintained at constant temperature (about 120°C higher than the incoming air temperature) by the heating coil. The air mass that flows through the measurement channel tends to remove heat from the membrane. Current must therefore flow through the coil to maintain the membrane at a constant temperature. This current is measured by a special Wheatstone bridge. The current is therefore proportional to the flowing air mass. The flowmeter measures the air mass directly (not the volume) to eliminate problems of temperature, altitude, pressure etc.

ACCELERATOR PEDAL MODULE

Make : Bosch APM

The accelerator pedal module comprises

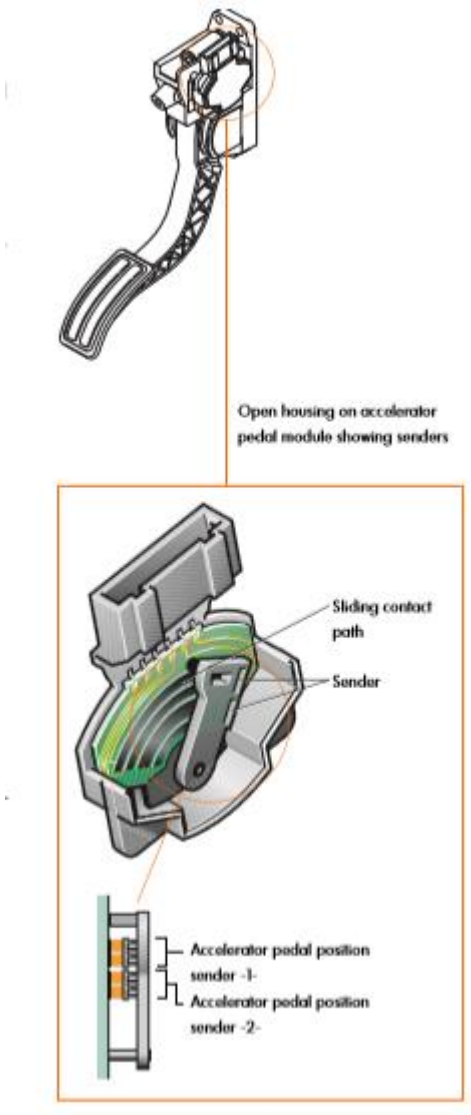
- The accelerator pedal,
- Accelerator pedal position Sensor -1
- Accelerator pedal position Sensor -2

Two sensors are used to ensure maximum safety. This system configuration is also known as a "redundant system". Redundant literally means "superfluous". In technical terms, there is redundancy when, for instance, an item of information occurs more often than is required for system operation.

Signal utilisation

The engine control unit is able to recognise the current position of the accelerator pedal from the signals supplied by the two accelerator position Sensors.

The two Sensors are sliding contact potentiometers and are mounted on a common shaft. The resistances of the sliding contact potentiometers and the voltages transmitted to the engine control unit vary with each change in the accelerator pedal position.



Diesel Particulate Filter

Design

The diesel particulate filter comprises of a honeycomb ceramic matrix made from silicon carbide, which can be found in a metal housing. The ceramic matrix itself has many microscopic channels that run parallel and are alternately connected to each other.

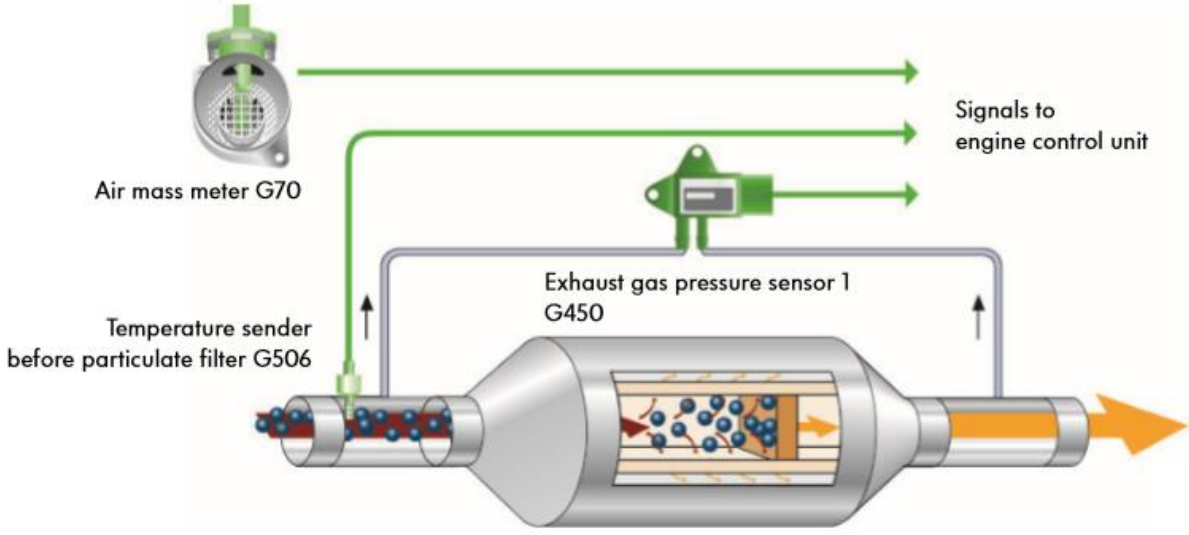
Silicon carbide is a suitable filtering material due to the following properties:

- High mechanical strength
- Very good resistance to thermal changes
- Thermal resilience and conductivity
- High resistance to wear

Regeneration

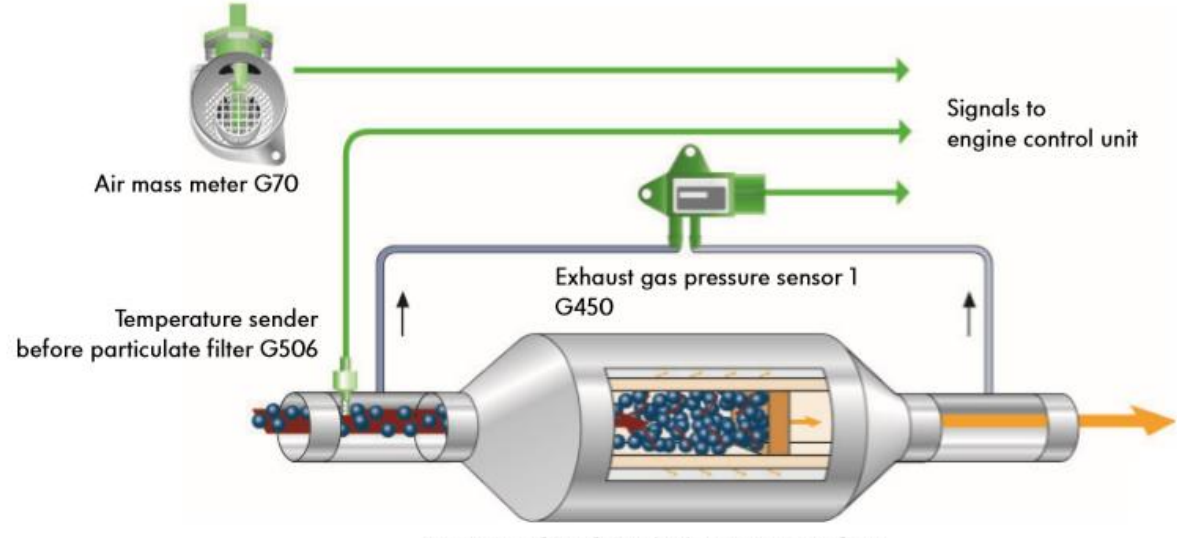
The diesel particulate filter must be cleaned of the particles of regularly to prevent it from becoming blocked and its function thereby being affected. During the regeneration phase, the particles of carbon stored in the filter are burnt off at a temperature of approx. 500°C. The actual ignition temperature of the particulates is about 600-650°C. This exhaust gas temperature can only be reached on a diesel engine at full throttle.

Particulate filter empty



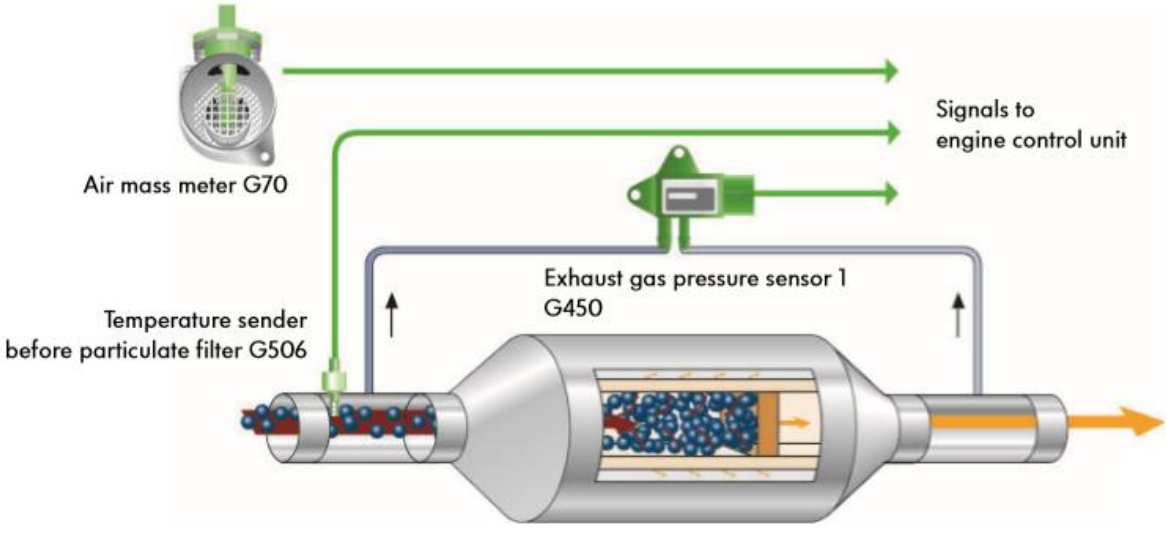
Particulate filter empty = low resistance to flow

Particulate filter full



Particulate filter full = high resistance to flow

Particulate filter full



Particulate filter full = high resistance to flow

Diesel Particulate Filter – Differential Pressure Sensor

Differential Pressure Sensor Delta-P for Particulate Filter Applications

The pressure sensor described underneath is mainly used to monitor the soot loading of a particulate filter on a diesel engine. The signal of the sensor is not sufficient to determine an optimized timing for regeneration of the DPF. It is part of a soot loading model that should be calculated permanently by the ECU. The sensor helps to determine the content of ashes remaining permanently in the filter. The soot loading model should be calculated in the background with the differential pressure as one of several inputs.

Further input values are:

- Engine load
- EGT (exhaust gas temperature)
- Back pressure

Technical Data:
Pressure measuring range (p1..p2): 100 kPa
Operating temperature: -40°C...+135°C
Energy consumption: 10 mA max.

Electrical connection:
Pin 1: supply voltage Vcc +5V stabilized provided by ECU
Pin 2: Ground
Pin 3: Output 0....+5V

Temperature sensor before Diesel Particulate Filter

The exhaust gas temperature sensor (EGTS), which is located in front of the Diesel Oxidation Catalyst (DOC) and/or in front of the Diesel Particulate Filter (DPF), detects exhaust gas temperature and converts it into a voltage and feeds back to the engine ECU with the voltage signal in order to control engine conditions to effectively reduce emission.

Model Number	:	55355404
Make	:	Generic

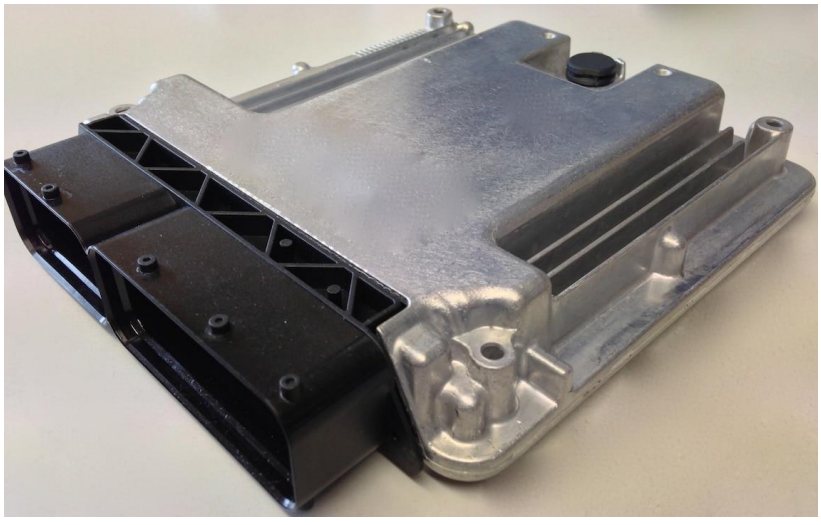
Cruise Control for Constant speed Test

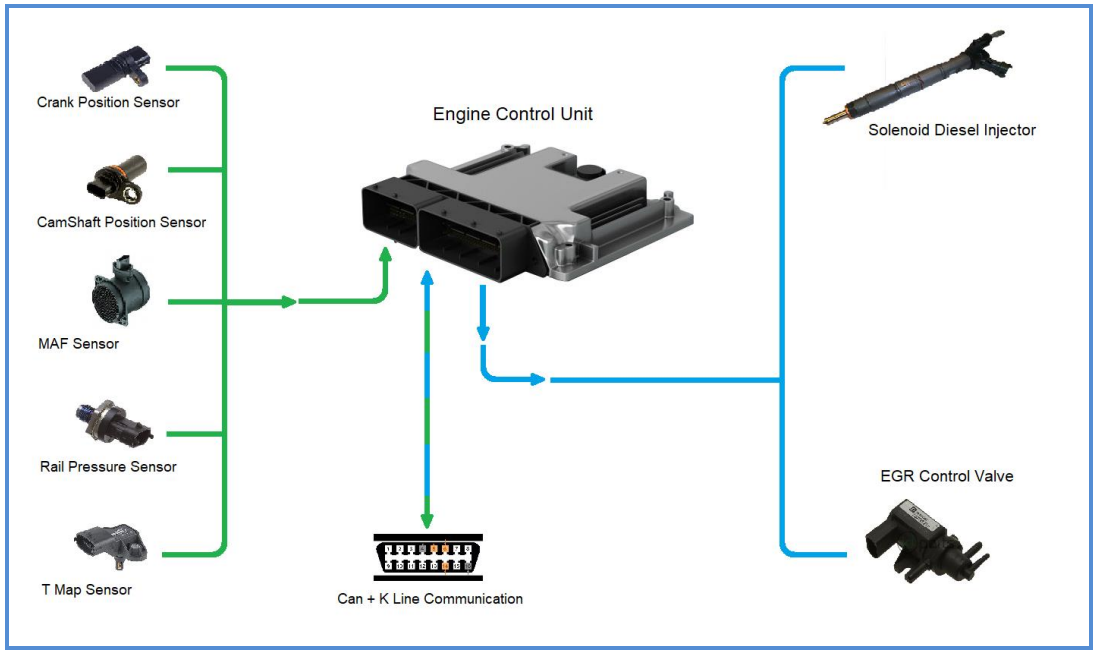
Cruise control is a system that engine have in them. The purpose of the cruise control system is to give operator the ability to automatically set their acceleration to one speed. when the accelerator is not operated, the acceleration will keep on going at the speed in which one set to for cruise control. You have the option to easily deactivate cruise control simply by stepping on the brake pedal. This will cause the acceleration to go back to manual control once again.

Exhaust Gas Recirculation (Vacuum control)

In internal combustion engines, exhaust gas recirculation (EGR) is a nitrogen oxide (NOx) emissions reduction technique used in petrol/gasoline and diesel engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders. This dilutes the O2 in the incoming air stream and provides gases inert to combustion to act as absorbents of combustion heat to reduce peak in-cylinder temperatures. NOx is produced in high temperature mixtures of atmospheric nitrogen and oxygen that occur in the combustion cylinder, and this usually occurs at cylinder peak pressure.

CRDI Open ECU Overview





The engine ECU constantly ascertains the status of the engine through signals from the sensors, calculates fuel injection quantities etc. appropriate to the conditions, actuates the actuators, and controls to keep the engine in an optimal state. The injectors are actuated by the charge circuit in the engine ECU. The ECU also has a diagnosis function for recording system troubles.

Open ECU for complete control of the engine parameters (ECU Capabilities)

- ✓ Variable Fuel Injection Quantity for Pilot Injection.
- ✓ Variable Fuel Injection Quantity for Main Injection.
- ✓ Variable Fuel Injection Quantity for Post Injection.
- ✓ Fuel Injection Timing Control(Start of injection SOI for Pilot Injection)
- ✓ Fuel Injection Timing Control(Start of injection SOI for Main Injection or separation angle among multiple injection)
- ✓ Fuel Injection Timing Control(Start of injection SOI for Post Injection or separation angle among multiple injection)
- ✓ Multiple Injections(Pilot, Main and Post injection or separation angle among multiple injection)
- ✓ EGR Flow Control
- ✓ Smoke Limitation
- ✓ Variable Rail Pressure Control (300 to 1400 Bar)(open and closed loop facility available)
- ✓ Rail pressure limitation based on fuel quantity
- ✓ Rail pressure limitation based on engine speed
- ✓ Fuel Quantity correction based on Engine temperature
- ✓ Fuel Quantity correction based on intake air temperature
- ✓ Diesel particulate filter regeneration
- ✓ Starting fuel injection quantity based on engine temperature.
- ✓ Cold start assistance
- ✓ Duel fuel control for CNG, Hydrogen, LPG and Gasoline
- ✓ Drivers Demand
- ✓ Sensor calibration
- ✓ Calibration charts are provided for Injection Quantity at various pressures
- ✓ Cruise Control for constant speed Engine test
- ✓ Throttle pedal for variable speed engine test
- ✓ Closed loop control for idling

ECU Specification

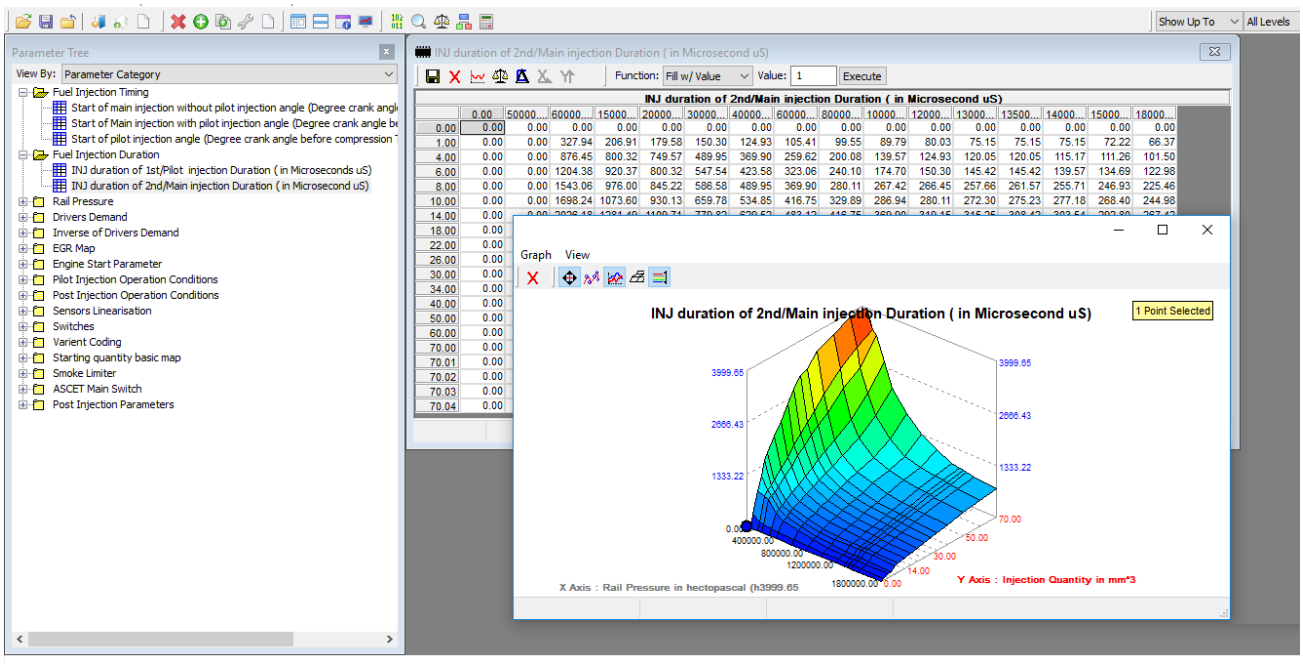
Sl No	Description	Specification
1	Operating Voltage	12 V
2	Input Voltage (limits)	11 – 16 V
3	Analog Input Pins	34
4	Analog Output Pins	8
5	Digital Input Pins	20
6	Digital Output Pins	10
7	PWM Output Pins	20
8	Peak and Signal for Solenoid injector	2
9	Pick up current	17.5 A
10	Hold current	12.5 A
11	Booster supply	14 V
12	Booster current	20 A
13	Relay outputs	4(low side)
14	H-bridge	8
15	Communication	CAN Bus
16	Memory	1024 KB

Calibration Tool with i-Connect Software (For Interacting with ECU)

The equipment is supplied along with an ECU calibration tool and ECU calibration software called i-Connect. i-connect software is a powerful windows based software used to interact with the Engine ECU using the calibration tool. The Calibration tool is integrated with drivers for CAN BUS to USB convertor module/Adaptor/dongle. CAN adapters allow to connect a PC to CAN networks in the ECU. The access is given by USB 2.0. The calibration tool has a data speed transfer rate @ 5-1010kbps and withstands temperature from -25 to 80°C.

i-tune Software with ECU data file (For Programming ECU)

i-tune



i-tune is an powerful windows based software used to tune the engine fuel injection and active emission component variables. The ECU is supplied along with a data file called CRDI V2.itune, the data file is fully loaded with engine maps. The researcher can tune the maps as desired.

Software capabilities.

- ✓ Variable Fuel Injection Quantity for Pilot Injection.
- ✓ Variable Fuel Injection Quantity for Main Injection.
- ✓ Variable Fuel Injection Quantity for Post Injection.
- ✓ Fuel Injection Timing Control(Start of injection SOI for Pilot Injection)
- ✓ Fuel Injection Timing Control(Start of injection SOI for Main Injection or separation angle among multiple injection)
- ✓ Fuel Injection Timing Control(Start of injection SOI for Post Injection or separation angle among multiple injection)
- ✓ Multiple Injections(Pilot, Main and Post injection or separation angle among multiple injection)

- ✓ EGR Flow Control
- ✓ Smoke Limitation
- ✓ Variable Rail Pressure Control (300 to 1400 Bar)(open and closed loop facility available)
- ✓ Rail pressure limitation based on fuel quantity
- ✓ Rail pressure limitation based on engine speed
- ✓ Fuel Quantity correction based on Engine temperature
- ✓ Fuel Quantity correction based on intake air temperature
- ✓ Diesel particulate filter regeneration
- ✓ Starting fuel injection quantity based on engine temperature.
- ✓ Cold start assistance
- ✓ Duel fuel control for CNG, Hydrogen, LPG and Gasoline
- ✓ Drivers Demand
- ✓ Sensor calibration
- ✓ Calibration charts are provided for Injection Quantity at various pressures
- ✓ Cruise Control for constant speed Engine test
- ✓ Throttle pedal for variable speed engine test
- ✓ Closed loop control for idling

Set idle Speed - Variable

Idle speed (or idle) is the rotational speed an engine runs at when the engine is idling, that is, when the engine is uncoupled from the drivetrain and the throttle pedal is not depressed. In combustion engines, idle speed is generally measured in revolutions per minute (rpm) of the crankshaft. At idle speed, the engine generates enough power to run reasonably smoothly and operate its ancillaries (water pump, alternator, and, if equipped, other accessories such as power steering), but usually not enough to perform useful work, such as loading the engine.

The idling speed of the engine can be varied with respect to the engine temperature with the help of the i-tune software. Below shown is the idle speed map.

Engine Idle Speed Control Map

Engine Temp in℃	-30.00	-15.00	0.00	20.25	50.25	80.25
idle Speed in RPM	1080.0	990.0	900.0	830.0	760.0	700.0

Closed loop control for idling-(Tuning will be done by Legion Brothers)

Closed loop idle control is a feature that intended to keep the idle steady and consistent regardless of internal/external physical conditions change. (AFR, MAP, CLT, IAT etc')

In order to control a changing conditions environment an PID control is implemented.

PID control

PID is a "closed loop" control algorithm (instructions for solving a task) used to adjust a control value, (eg a idle valve position). In order to process actual values (eg engine speed) to match the desired TARGET value (eg, idle speed) then adjusts the PID-algorithm control value according to these three elements.

Summary

P is used to bring the value close to the target.

I is used to bringing the error to zero.

D is used to dampen the response.

Setup process

P and I must always be used (not allowed to be zero), D is optional and not always necessary.

•Usually starting by increasing the P and I together (using the same values) until it becomes slightly unstable.

•Bring in some D to counteract that, and then fine-tune each value. Often by reducing P and increasing I.

•The overall goal is to use as high values as possible while still having a stable response.

•Then decrease all values a bit to add some safety margin to prevent overshoot or oscillation.

Please note : The PID control for the idle speed control is tuned by us(Legion Brothers), the tuning is done considering the loads of electric dynamo (Alternator for charging the battery), unexpected dynamic braking, frictional loads and environment changes.

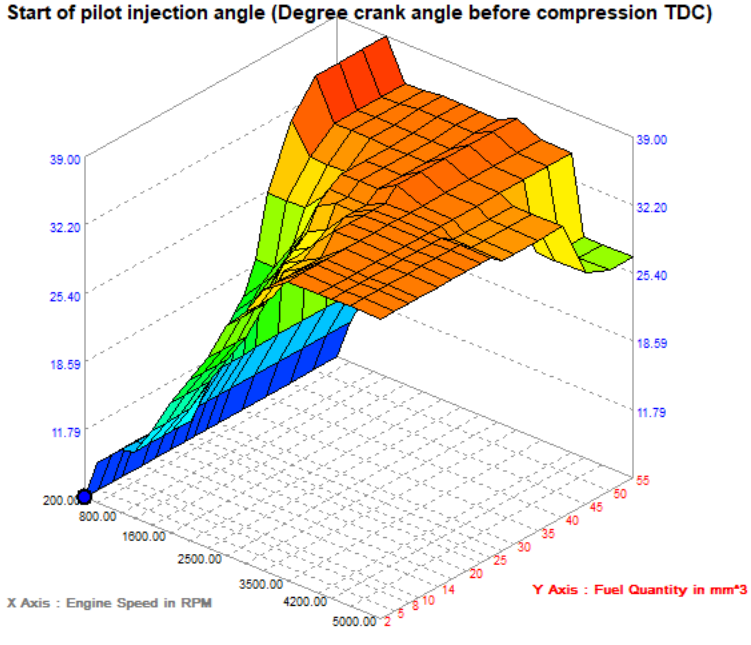
Injection start angle of pilot injection/Start of injection (SOI) pilot - Variable

Fuel injection is the introduction of fuel in an internal combustion engine, most commonly automotive engines, by the means of an injector. Injection Start angle of pilot injection is the start angle of fuel in Compression stroke of the engine. Pilot injection is carried out before the main injection. The suction start angle is specified as 360° crank angle, suction end or compression start is mentioned as 180° crank angle.

Start of pilot injection angle (Degree crank angle before compression TDC)															
	200.00	400.00	800.00	1000.00	1300.00	1600.00	1900.00	2200.00	2500.00	2800.00	3100.00	3500.00	4000.00	4200.00	4500.00	5000.00
2																
5																
8																
10																
14																
17																
20																
23																
25																
28																
30																
35																
40																
45																
50																
55																

Y Axis = Injection Quantity in mm^3, X Axis = Engine Speed in rpm, Map Content = Deg crank Angle

The table is values blurred due to confidential level

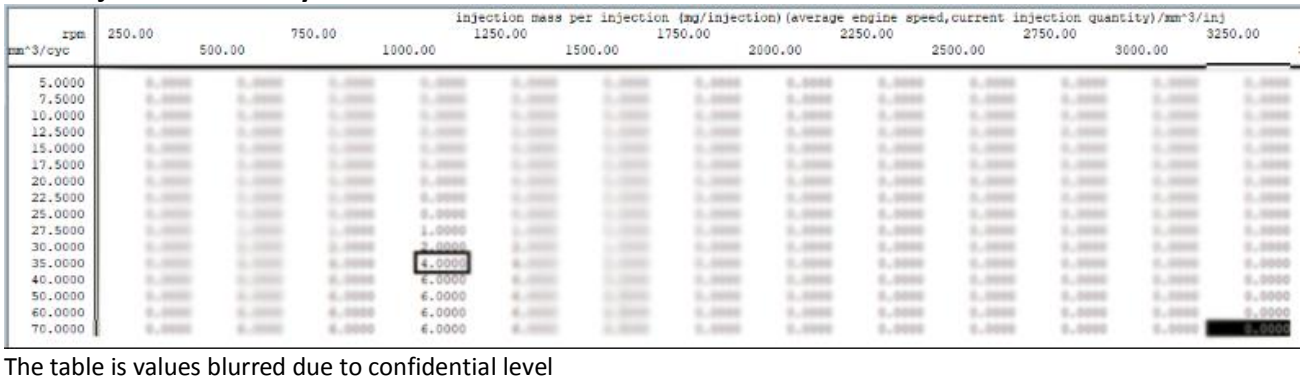


Injection Quantity Pilot, Main and post Injection – Variable

Injection quantity pilot injection is the amount of fuel that will be injected during the pilot injection phase. The fuel injection quantity table is shown below. The Y axis is the total fuel demand, X axis is the engine speed in rpm and the map content is pilot fuel injection quantity.

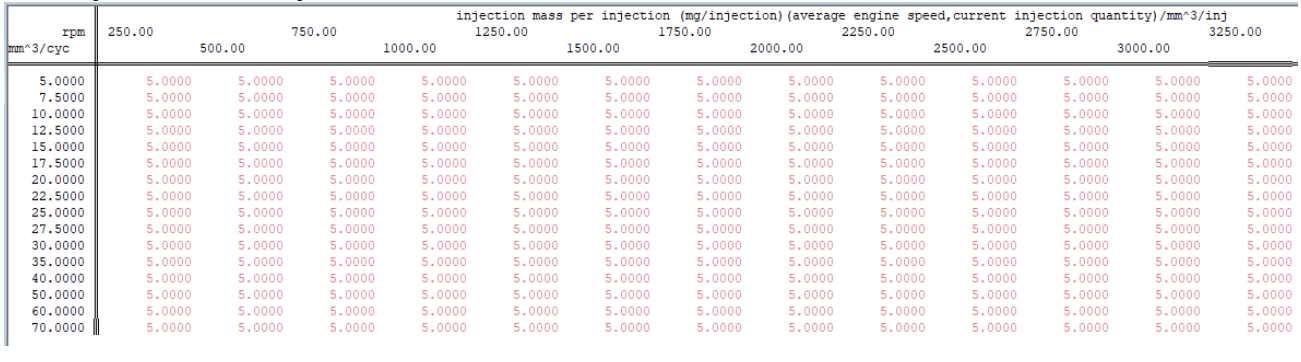
The Y axis specifies the total fuel demand by the engine including Pilot injection quantity, Main injection quantity and post injection quantity. For example when the engine total fuel demand is 35mm^3/cyc at 1000rpm, 4mm3/inj is utilised for pilot injection remaining 31mm^^{3}/cyc is utilised for the main and post injection as per the user input. Maximum injection quantity table are provided will limit the Injection quantities. The maximum injection quantity table are designed in such way that no injections will colloid with each other.

Pilot Injection Quantity Table



The table is values blurred due to confidential level

Post Injection Quantity Table



The remaining quantity is utilised for main injection.

Maximum injection Quantity table for Pilot Injection

rpm / mm^3/cyc	injection mass per injection (mg/injection)(average engine speed,current injection quantity)/mm^3/inj									
	500.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00	4500.00	5000.00
5.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
10.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
15.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
20.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
25.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
30.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
40.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
50.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
60.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000
70.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000	6.0000

Maximum injection Quantity table for Post Injection

rpm / mm^3/cyc	injection mass per injection (mg/injection)(average engine speed,current injection quantity)/mm^3/inj									
	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	3000.00	4500.00
5.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
10.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
15.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
20.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
25.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
30.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
40.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
50.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
60.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
70.0000	8.0000	7.7000	7.3000	6.5000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000

Injection start angle of Main injection - Variable

The Main Injection provides the energy for performance of the engine. It is therefore the Main factor responsible for supplying the engine torque. The injection start angle of main injection is variable.

Start of Main injection with pilot injection angle (Degree crank angle before compression TDC)

	200.00	600.00	750.00	1000.00	1300.00	1600.00	1900.00	2200.00	2500.00	2800.00	3100.00	3500.00	4000.00	4200.00	4500.00	5000.00	5100.00	5200.00	5300.00	5400.00
2.00																				
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55.00																				
60.00																				
65.00																				
70.00																				
75.00																				

Y Axis = Injection Quantity in mm^3, X Axis = Engine Speed in rpm, Map Content = Deg crank Angle

The table is values blurred due to confidential level

Injection start angle of Post injection - Variable

Post injection is a late injection (>40° after TDC) normal specified in negative values. Its purpose is to bring hydrocarbons to the oxidation catalyser for exothermic reaction. Post injection is not torque forming

Injection start angle of Post injection

rpm / mm^3/cyc	0.00	830.00	870.00	880.00	920.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00
	crankshaft angle(average engine speed,current injection quantity)/deg CrS											
0.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-160.0078	-157.9922	-157.0078	-157.0078	-159.0000	-154.9922
2.5000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-160.0078	-157.9922	-157.0078	-157.0078	-159.0000	-154.9922
5.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-160.0078	-157.9922	-157.0078	-157.0078	-159.0000	-154.9922
10.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-160.0078	-157.9922	-154.9922	-157.0078	-159.0000	-154.9922
15.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-154.9922	-154.9922	-157.0078	-156.0000	-157.9922	-162.0000	-154.9922
20.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-154.9922	-156.0000	-157.0078	-156.0000	-160.0078	-157.0078
25.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-159.0000	-154.9922	-160.0078	-160.0078	-160.0078	-154.9922
30.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-159.0000	-157.0078	-157.9922	-159.0000	-160.0078	-156.0000
35.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-160.0078	-154.9922	-157.0078	-156.0000	-160.0078	-160.0078
40.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.9922	-157.9922	-157.9922	-156.0000	-160.0078	-160.0078
45.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.9922	-157.9922	-160.0078	-154.9922	-160.0078	-160.0078
50.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.9922	-157.0078	-157.9922	-154.9922	-160.0078	-160.0078
55.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.0078	-160.0078	-157.9922	-154.0078	-160.9922	-160.0078
60.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.0078	-157.0078	-157.0078	-154.0078	-162.0000	-160.0078
65.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.0078	-159.0000	-159.0000	-154.0078	-162.0000	-160.0078
70.0000	-150.0000	-150.0000	-150.0000	-150.0000	-150.0000	-160.0078	-157.0078	-159.0000	-159.0000	-154.0078	-162.0000	-160.0078

Open Loop Fuel Rail Pressure - Variable

The fuel rail pressure can be variable from 300000 to 1350000 hpa. The fuel rail pressure is in the terms hpa

Fuel rail pressure table/map is shown below.

rail pressure in hPa(average engine speed,current injection mass)/hPa

rpm / mm^3/cyc	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	4000.00	4500.00
5.0000																
7.5000																
10.0000																
12.5000																
15.0000																
17.5000																
20.0000																
22.5000																
25.0000																
27.5000																
30.0000																
35.0000																
40.0000																
50.0000																
60.0000																
70.0000																

The table is values blurred due to confidential level

Drivers Demand

The driver torque map represents the torque requested by the driver as a function of engine speed and accelerator pedal position.

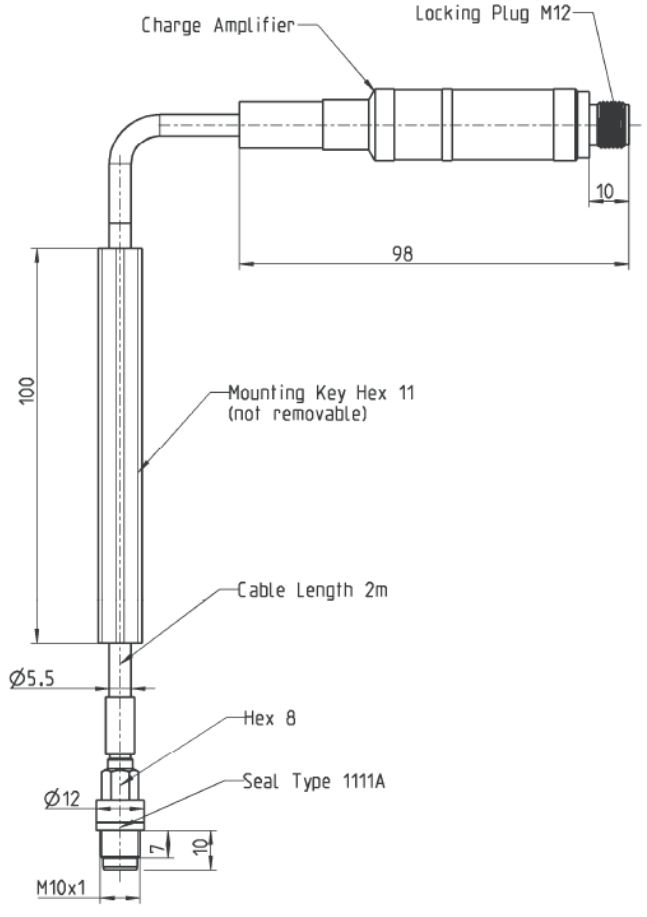
rpm / %	engine torque(average engine speed,AccPed ratio after security check)/Nm										
	0.00	400.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00	4500.00	5000.00
1.0010	[illegible]										
5.0049	[illegible]										
9.9976	[illegible]										
12.5000	[illegible]										
34.9976	[illegible]										
50.0000	[illegible]										
65.0024	[illegible]										
75.0000	[illegible]										

The table is values blurred due to confidential level

Wiring Harness

A wiring harness in the engine is a set of wires, connectors, and terminals which run all over the engine for relaying electric power and information. The harness plays an integral role in connecting a number of important components of an engine. The wiring harness is just like the central nervous and circulatory system of a human body which pass information and power throughout the body. The suitable wiring harness is used in the engine test bed.

Engine Combustion Pressure Sensor



Description

Very precise and robust pressure sensor with an inline charge amplifier for combustion pressure measurement application. Especially designed for Indian educational institutes using Kirloskar engines. The sensor will have almost an unlimited life time for combustion pressure measurement application. Optimised piezoelectric sensor for continuous cylinder pressure monitoring of gas engines. The sensor is connected to the charge amplifier with a robust integrated high temperature Viton cable. The good linearity and long term stability ensures reliable and repeatable measurements over a long period of time.

The sealing takes place at the shoulder of adapter and requires a flat and smooth machined sealing area. The charge amplifier accepts a power supply between 7 ... 32 VDC and has a range of 0...100 bar (40 mV/bar) and works with a time constant of 5 s.

6613CQ18_Spec.doc Änderung	Datum	Erzeugersystem Word 97	Europäische Projektion	Erste Proj.-Nr.	Kopie Datum

Combustion Pressure Sensor

Customer specification control sheet

gez.		En	kISTLER Kistler Instrumente AG, Winterthur Switzerland	Format	Dokumentnummer	Version	Blatt 1
gepr.				A4	6613CQ18	2	von 2
ges.							

Combustion pressure sensors is provided for any one of the cylinder

Technical data

-	Pressure range		bar	0...100
-	Calibration at 200 °C		bar	0...100
-	Sensitivity (±0,5 %)		mV/bar	40
-	Frequency range (-3 dB)		Hz	0,016...20'000
-	Linearity		%FSO	≤± 1
-	Shock		g	2000
-	Operating temperature range	mounting location viton cable connection max. short overload <1 h electronics	°C °C °C °C	-50...300 200 240 -10...110
-	Sensitivity shift	200±150 °C 200±50 °C	% %	≤± 2,5 ≤± 1
-	Thermo shock (Kistler test engine 9,5 bar pmi; 1500 1/min)		bar	≤ -0,5
-	Time constant	for cylinder measuring for calibration	s s	≈ 5 >2500
-	Signal output (at 1mA load)	max. min.	V V	4,4...5 > 0
-	Signal span		V	3,0
-	Zero line		V	1,9...2,2
-	Supply voltage		VDC	7...32
-	Supply current		mA	6
-	Output impedance		Ω	100
-	Mounting torque of sensor in adapter sensor factory mounted with Loctite, only in case of loosen sensor		Nm	15
-	Connector at sensor 8 pole male protection class valid with connected cable		DIN M12x1	IP67

Accessories (not included in scope of delivery)

- Connecting cable 1700A69

1700A69: DIN M12x1 from 8-pin to 3 wires, 10m long

Pin	Colour	Function
1	Black	Ground (GND)
5	Blue	Signal output
8	Brown	Supply voltage

Combustion Pressure Sensor

Customer specification control sheet

gez.		En	kISTLER Kistler Instrumente AG, Winterthur Switzerland	Format	Dokumentnummer	Version	Blatt 2
gepr.				A4	6613CQ18	2	von 2
ges.							

DP sensor with inline transmitter – Air Flow Measurement

SIGNAL-CONDITIONED ULTRA-LOW PRESSURE SENSOR

SMi
PRESSURE SENSORS

Product Number: SM5852-001

HIGHLIGHTS

- Fully amplified, pressure calibrated and temperature compensated in a single package
- Both analog and digital pressure output with access to temperature signal-conditioned digital analog and digital pressure output
- Available for differential, gauge & single-ended applications
- 2nd Generation ceramic package and tubes for high reliability
- Rugged and highly stable ceramic package
- Unique low-pressure die allows for a full-scale pressure range of 0-0.15 PSI (1.0 kPa)

TYPICAL APPLICATIONS

- Barometric measurement
- Medical instrumentation
- Pneumatic control
- Gas flow
- Heating, Ventilation and Air Conditioning (HVAC)

TECHNICAL FEATURES

- Amplified, calibrated, fully signal-conditioned output span of 4.0 VDC full-scale
- Analog and digital temperature compensated and calibrated pressure available
- Multi-order correction for pressure non-linearity and for temperature coefficient of span and offset (factory programmed)
- Digital read-out through I^2C interface
- Output is ratiometric with supply voltage
- Variety of versions (differential, gauge, and single-ended), depending on the pressure range

DESCRIPTION

The Silicon Microstructures SM5852 series of OEM pressure sensors combines state-of-the-art pressure sensor technology with CMOS mixed signal processing technology to produce an amplified, fully conditioned, multi-order pressure and temperature compensated sensor in a dual in-line package (DIP) configuration.

Combining the pressure sensor with a custom signal conditioning ASIC in a single package simplifies the use of advanced silicon micromachined pressure sensors. The pressure sensor can be mounted directly to a standard printed circuit board and an amplified, high-level, calibrated pressure signal can be acquired from the digital interface or analog output. This eliminates the need for additional circuitry, such as a compensation network or micro-controller containing a custom correction algorithm.

The SM5852 Series pressure sensors are based on SMI's highly stable, piezoresistive pressure sensor chips mounted on a ceramic substrate.

The model SM5852 is designed for operating pressure ranges of 0-0.15 PSI (1.0 kPa).

+1-(408) 577-0100 / sales@si-micro.com / www.si-micro.com

SIGNAL-CONDITIONED ULTRA-LOW PRESSURE SENSOR

SMI PRESSURE SENSORS

Product Number: SM5852-001

ABSOLUTE MAXIMUM RATING TABLE FOR SM5852
All parameters are specifed at VSUPPLY = 5.00 V DC supply at room temperature, unless otherwise noted.

No.	Characteristic	Symbol	Minimum	Typical	Maximum	Units
1	Excitation Voltage[a, b]	V_{SUPPLY}	4.75	5.00	5.25	V
2	Current Consumption[c]	I_{SUPPLY}		7	10	mA
3	Proof Pressure[d, e]	P_{PROOF}	10x			P_{RANGE}
4	Burst Pressure[d, e]	P_{BURST}	15x			P_{RANGE}
5	Operating Temperature[f]	T_{OP}	-40		+125	°C
6	Storage Temperature[f]	T_{STG}	-40		+150	°C
7	Media Compatibility[f, g]					

OPERATING CHARACTERISTICS FOR SM5852 - SPECIFICATIONS
All parameters are specifed at VSUPPLY = 5.00 V DC supply at room temperature, unless otherwise noted.

Gauge & Single-ended[h] Pressure Sensors

No.	Characteristic	Symbol	Minimum	Typical	Maximum	Units
8	Span (FS p_{RANGE})[a, b, d, e, i]	V_{SPAN}	3.80	4.00	4.20	V FS
9	Zero Offset[j, k]	V_{ZERO}	0.42	0.50	0.58	V
10	Total Accuracy[f, l]	ACC_{RSS}			2.0	%FS
11	Pressure Response Time[f, m]	t_{RESP}		2		ms
12	Warm-up Deviation[f, n]	ACC_{WUD}		0.4		%FS
13	Linearity[o]	NL	-1.3		1.3	%FS
14	Compensated Temp. Range	T_{COMP}	15		75	°C

Differential[b] Pressure Sensors

No.	Characteristic	Symbol	Minimum	Typical	Maximum	Units
15	Span (FS p_{RANGE})[a, b, d, e, i]	V_{SPAN}	1.90	2.00	2.10	V FS
16	Zero Offset[j, k]	V_{ZERO}	2.42	2.50	2.58	V
17	Total Accuracy[f, l]	ACC_{RSS}			2.0	%FS
18	Pressure Response Time[f, m]	t_{RESP}		2		ms
19	Warm-up Deviation[f, n]	ACC_{WUD}		0.4		%FS
20	Linearity[o]	NL	-1.3		1.3	%FS
21	Compensated Temp. Range	T_{COMP}	15		75	°C

Digital Interface Information

For digital interface guidelines and recommendations, please refer to Application Note: AN01 – 10.

Fuel measurement - Optical liquid level sensor constant volume, fully automatic

The fuel consumption of the engine is measured by time taken for a given volume of fuel. The fuel measurement system consists a glass tube burette fitted with two liquid level sensor, one at the top and other at the bottom of the burette. The time taken for the discharge of the burette is calculated by the software. Than volume flow rate is multiplied by the density to get mass flow rate. The filling and discharge and the burette is taken care by a fuel solenoid valve, controlled by software.

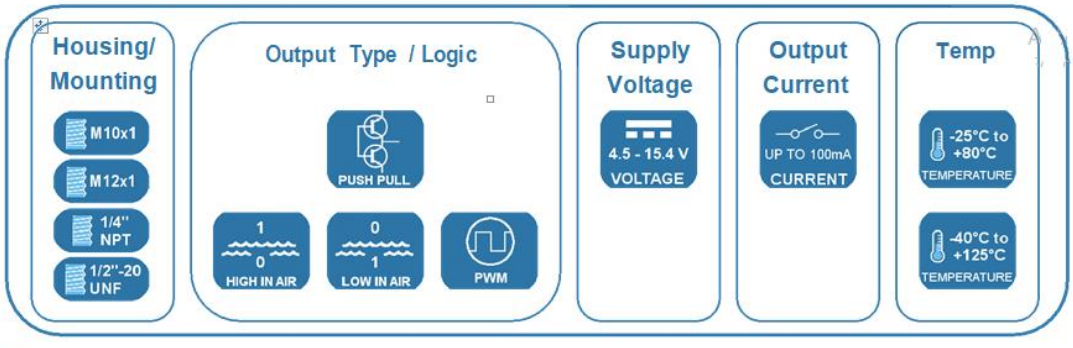
Specification of Liquid Level Sensor

DATA SHEET
Liquid Level Switches
Optomax Digital Series

SST
DESIGN • MANUFACTURE • CUSTOMISE • CONFIGURE

FEATURES

- Liquid level switches that can detect almost any liquid type; oil or water based
- Choice of material; Polysulfone (standard) or Trogamid®
- Choice of threads



BENEFITS

- Low power
- Low cost
- Compact design

OUTPUT VALUES

Output Voltage[c] (Vout):	Iout = 100mA
Output High	Vout = Vs - 1.5V max
Output Low	Vout = 0V + 0.5V max

PWM

Duty cycle in air	25% ± 10%
Duty cycle in liquid	75% ± 10%
Frequency	2kHz ± 10%

TECHNICAL SPECIFICATIONS

Supply voltage (Vs)	$4.5V_{DC}$ to $15.4V_{DC}$
or	$4.5V_{DC}$ to $5.5V_{DC}$ (PWM output)
Supply current (Is)	2.5mA max. (Vs = $15.4V_{DC}$)
Output sink and source current (Iout)	100mA
Operating temperatures	Standard: -25°C to +80°C Extended: -40°C to +125°C
Storage temperatures	Standard: -30°C to +85°C Extended: -40°C to +125°C
Housing material[a, b]	Polysulfone or Trogamid®
Sensor termination	24AWG, 250mm PTFE wires, 8mm tinned

Other sensor options available on request, email:
technical@sstsensing.com

Need help? Ask the expert
Tel: + 44 (0)1236 459 020
and ask for "Technical"

NOTES

a) Above +85°C, Trogamid is suitable for use in water based liquids. Oil based liquids can cause deformation of the sensing tip and must be tested for compatibility.
b) Before use check that the fluid in which you wish to use these devices is compatible either with Polysulfone or Trogamid®.
c) Voltages applicable to output value stated.

Data Acquisition Card

Data Acquisition Card

Analog Input	
Differential Channels	12
Resolution	12 bits
Sample Rate	250 Ks/sec
Max Voltage	5 V
Number of Ranges	4
Simultaneous Sampling	Yes
On-Board Memory	5120 samples
Analog Output	
Channels	2
Digital I/O	
Input-Only Channels	30
Output-Only Channels	12
Timing	Software
Logic Levels	TTL
Maximum Input Range	0 V - 5V
Maximum Output Range	0 V - 3.3 V
Counter/Timers	
Counters	2
Max Source Frequency	84 MHz
Resolution	12 bits
Logic Levels	TTL
Total DC output Current on all I/O lines	130mA

Rotatory Encoder

Kübler

Incremental encoders

Standard optical | **Sendix 5000** | **Resolution : 720 PPR** | **Push-pull**

Technical data

Mechanical characteristics

Maximum speed	IP65	12000 min^{-1} 6000 min^{-1} (continuous)
	IP66/IP67	6000 min^{-1} 3000 min^{-1} (continuous)
Mass moment of inertia		
	shaft version	approx. 1.8 x 10^{-6} kgm^2
	hollow shaft version	approx. 6 x 10^{-6} kgm^2
Starting torque at 20°C [68°F]	IP65	< 0.01 Nm
	IP66/IP67	< 0.05 Nm
Shaft load capacity	radial	100 N
	axial	50 N

Weight		approx. 0.4 kg [14.11 oz]
Protection acc. to EN 60529		
	without shaft seal	IP65
	with shaft seal	IP66/IP67
Working temperature range		-40°C [1] ... +85°C [-40°F [1] ... +185°F]
Material	shaft	stainless steel
Shock resistance acc. to EN 60068-2-27		3000 m/s^2, 6 ms [2]
Vibration resistance acc. to EN 60068-2-6		300 m/s^2, 10 ... 2000 Hz [3]

Electrical characteristics

Output circuit	**RS422** (TTL compatible)	**RS422** (TTL compatible)	**Push-pull**	**Push-pull** (7272 compatible)	**Push-pull** (7272 compatible, without capacitor)	**Open collector** (7273)
Order code	**1**	**4**	**5, 7**	**2**	**8**	**3**
Power supply	5 ... 30 V DC	5 V DC (±5 %)	10 ... 30 V DC	5 ... 30 V DC	5 ... 30 V DC	5 ... 30 V DC
Power consumption (no load)	typ. 40 mA max. 90 mA	typ. 40 mA max. 90 mA	typ. 50 mA max. 100 mA	typ. 50 mA max. 100 mA	typ. 50 mA max. 100 mA	100 mA
Permissible load / channel	max. +/- 20 mA	max. +/- 20 mA	max. +/- 20 mA	max. +/- 20 mA	max. +/- 20 mA	+/- 20 mA sink at 30 V DC
Pulse frequency	max. 300 kHz	max. 300 kHz	max. 300 kHz	max. 300 kHz [4]	max. 300 kHz	max. 300 kHz
Signal level HIGH	min. 2.5 V	min. 2.5 V	min +V - 1.0 V	min. +V - 2.0 V	min. +V - 2.0 V	
LOW	max. 0.5 V	max. 0.5 V	max. 0.5 V	max. 0.5 V	max. 0.5 V	
Rising edge time t_r	max. 200 ns	max. 200 ns	max. 1 µs	max. 1 µs	max. 1 µs	
Falling edge time t_f	max. 200 ns	max. 200 ns	max. 1 µs	max. 1 µs	max. 1 µs	
Short circuit proof outputs [5]	yes [6]	yes [6]	yes	yes	yes [6]	yes
Reverse polarity protection of the power supply	yes	no	yes	no	no	no
UL approval	file 224618					
CE compliant acc. to	EMC guideline 2014/30/EU RoHS guideline 2011/65/EU					

1) With connector: -40°C [-40°F], cable fixed: -30°C [-22°F], cable moved: -20°C [-4°F].
2) For MIL connectors: 2500 m/ s^2
3) For MIL connectors: 100 m/ s^2
4) Max. recommended cable length 30 m [98.43'].
5) If power supply correctly applied.
6) Only one channel allowed to be shorted-out:
at +V= 5 V DC, short-circuit to channel, 0 V, or +V is permitted.
at +V= 5 ... 30 V DC, short-circuit to channel or 0 V is permitted.

#472/5, Srigandhadakavalu, kottigepalya. Vishwaneedam post. Bangalore – 560091.Ph: 23587927 Fax: 23587927
Mob: 9740987814, 9448428695,9448451476,9845114738 Email: info@legionbrothers.com, sales@legionbrothers.com
Website: www.legionbrothers.com, www.legionbrothers.in

Temperature Measurement Location & Type

Measurement of Temperatures at different points

Type Range Signal conditioning/transmitter Location	"K" 0-300ºC Standalone Inlet water temperature in calorimeter
Type Range Signal conditioning/transmitter Location	"K" 0-300ºC Standalone Outlet water temperature in calorimeter
Type Range Signal conditioning/transmitter Location	"K" 0-1500ºC Standalone Inlet exhaust gas temperature in calorimeter
Type Range Signal conditioning/transmitter Location	"K" 0-300ºC Standalone Outlet exhaust gas temperature in calorimeter
Type Range Signal conditioning/transmitter Location	"K" 0-300ºC Standalone Inlet water temperature to engine
Type Range Signal conditioning/transmitter Location	"K" 0-300ºC Standalone Outlet water temperature from the engine cylinder
Type Range Signal conditioning/transmitter Location	"K" 0-300ºC Standalone Ambient

All temperature Sensors are "k" Type with inline signal conditioner. All the measured parameters from the sensor are connected to the computer

Dynamometer load - Strain gauge load cell with the inline transmitter

Torque is measured using a load cell transducer. The transducer is a strain gauge base. The output signal of the load cell is further amplified with the help of load cell transmitter. The output from the load cell transmitter is connected to the Data Acquisition card.

Technical Specification	
Capacity	20 Kg
Accuracy	C3
Operating Temp. Range	-20 - ＋60℃
Output Sensitivity	2.0±10%mv/v
Recommended Excitation	5 - 12VDC
Zero Balance	±5%F.S.
Max. Excitation Voltage	18VDC
Combined Error	±0.02%F.S.
Safe Overload	150%F.S.
Creep in 30 Minutes	±0.03%F.S.
Ultimate Overload	200%F.S.
Linearity Error	±0.02%F.S.
Insulation Resistance	≥5000MΩ(50VDC)
Repeatability Error	±0.015%F.S.
Output Resistance	350±3Ω
Temp. Effect on Sensitivity	±0.03%F.S./10℃

Engine Test Express Software for Engine Performance & Combustion Studies

Software (Engine Test Express)

Windows based powerful software for real time data measurement, auto zoom graphs, analog and digital display of data in the computer, store indefinite no of graphs for analysis. Facilities to export data to Microsoft excel. The data acquisition software is developed by legion brothers. Engine Combustion Analysis and performance Software, Fuel injection and control software.

Software Capabilities

1. Calculate Actual volume of Air.
2. Calculate Volumetric Efficiency.
3. Calculate specific fuel consumption (SFC).
4. Calculate brake Thermal Efficiency.
5. Calculate Brake power.
6. Heat Balance chart.
7. Calculate mechanical efficiency.
8. Calculate Frictional Power.
9. Calculate indicated Power.
10. PV and P-θ diagrams
11. Calculate 5 - 99% Mass Fraction Burnt Angle
12. Estimated End of Combustion Angle (EEOC)
13. Calculate Maximum Heat Release Rate
14. Calculate Maximum Heat Release rate crank angle
15. Calculate Maximum pressure rise rate
16. Calculate Maximum pressure rise rate crank angle
17. Calculate Maximum pressure
18. Calculate Maximum pressure crank angle
19. Calculate Start of Combustion
20. Calculate Total heat release

Intake, Exhaust and Cooling System

Exhaust Gas Calorimeter	
Type	Shell and Single Tube
Material of Construction	Mild Steel
No of Temp measuring points in test rig	6
Outer Insulation	Asbestos Cloth
Thermocouple Type	"K"
Water flow Control Valve	Gate Valve

Air Box	
Type	Square (Size: 500mm X 500mm)
Material of Construction	Mild Steel

Water Flow	
Type/Description	Acrylic Body Rotameter
Range	10-100 LPH for Engine cooling
Range	10-100 LPH for calorimeter Cooling

The engine is mounted on Sturdy base frame. The base frame is fabricated with mild steel "C" channel. The engine and the dynamometer are coupled using standard tyre coupling.

A standard air tank is fitted with a differential pressure sensor for measuring the Actual volume of air drawn into the cylinder. The thermocouple and necessary signal conditioner for the measurement of temperature at various points in the calorimeter are suitably provided.

The panel is fabricated with suitable SWG CR sheet and as per IS standard; the front portion of the panel is provided with provision for mounting computer, Printer, UPS and all instrumentations and signal conditioner related components. Power and control wiring are suitably marked using farul for easy troubleshooting. The panel is finished with powder coating.

Gas Injector for CNG, H2 and LPG

The test rig is supplied along with suitable gas injector for injecting Gaseous fuels like CNG,H2 and LPG.

Coil Resistance	2 OHM / 3 OHM
Opening Time (+ 5%)	3.0 ms / 3.2 ms
Closing Time (+ 5%)	2.5 ms / 2.7 ms
Material	Alluminium
Maximum Working Pressure	0.45 MPA
Supply Voltage	11 - 14.4V
Inlet Gas Fitting	Rubber Hose ø10mm
Outlet Gas Fitting	Calibrated Nozzles M10 X 1
Temp. Range for CNG	-40 C to + 120 C
Temp. Range for LPG	-20 C to + 120 C
Dimensions	151x46x62
Weight	0.65 Kg

CNG and Hydrogen Gas Pressure Reducer

CNG and hydrogen gas pressure reducer.

Max inlet pressure	260 bar
Different nominal outlet pressure	1,8 bar
Coil voltage	12 V DC
Coil power	15,5 W
Coil connection	AMP
Inlet connection	M12 pipe ø 6 mm
Outlet connection	Fixed fitting ø 12 mm

CNG Cylinder with CNG gas – Clients Scope

Hydrogen Cylinder with Hydrogen gas – Clients Scope

LPG Reducer

The reducer is equipped with a solenoid valve and an inlet increased filter, perfectly integrated, which facilitate its installation. The outlet gas pressure is automatically compensated in a linear way through MAP.

Different nominal outlet pressure	1 bar
Coil voltage	12 V DC
Coil power	15,5 W
Coil connection	AMP SUPERSEAL
Inlet connection	M10 pipe ø 6 mm
Outlet connection	Fixed fitting ø 12 mm

LPG Cylinder with LPG gas – Clients Scope

Flashback Arrestor

A flashback arrestor or flash arrestor is a gas safety device most commonly used in oxy-fuel welding and cutting to stop the flame or reverse flow of gas back up into the equipment or supply line. It protects the user and equipment from damage or explosions. Flashback arrestor is used as extra safety purpose for CNG, Hydrogen and LPG injection.

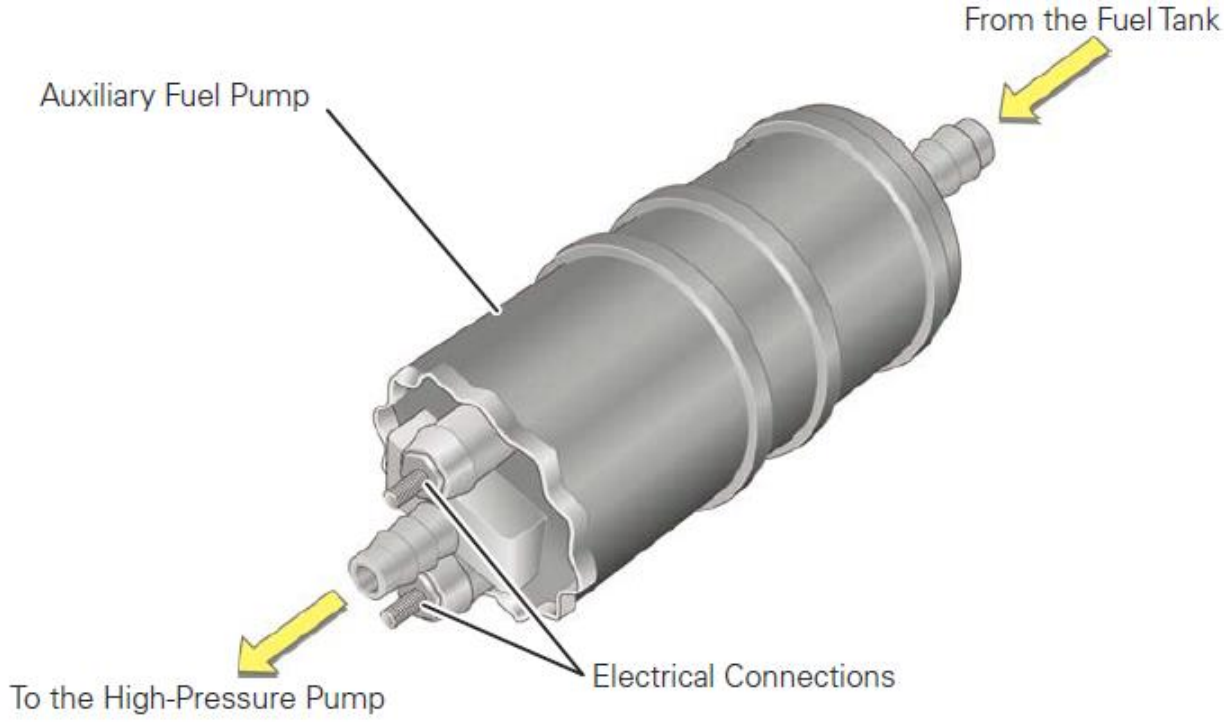
Gasoline & Ethanol Fuel injector for gasoline & Ethanol injection system

The fuel injector is installed at the intake manifold injection before the inlet valve. It injects the fuel such that it builds a homogenous mixture with the added air. Bosch Port Fuel Injectors (PFI) have a robust design and are capable of using Ethanol fuel (E100).

General technical requirements	Working temperature	-30°C-+120 °C
	Storage temperature	-40 °C -+75 °C
	Working voltage	12v-14v
	Working fuel pressure	100Kpa-450kpa
Open time		0.9ms(no-load),1ms(300Kpa load)
Close time		0.65ms
Difference between open and close time		≤2%(1000times operated at any linear pulse)
The static flow		10g(300Kpa@10s fully open flow)
Uniformity of the static and dynamic flow		<±3%
The offset of the spraying flow		<±3%
Dynamic flow linear error		<±3%
Working voltage requirements	The minimum voltage of working voltage	<7v
	The overload working voltage requirements	after24@60s: the offset of dynamic flow<±4%
Seal leakage		<0.3cc/min(400kpa)
Atomized particle (50% SMD)		70

Gasoline & Ethanol Feed Pump

The Gasoline & Ethanol Fuel Pump is a roller-cell pump. It is located in the engine compartment and has the task of feeding fuel from the fuel tank to the high-pressure pump. The Fuel Pump is actuated by the Engine Control unit through a fuel control module and increases the fuel pressure to approximately 3 bar.



Technical Specification	
Make	Bosch
Operating pressure	3 Bar
Minimum Current	12 Volts / 13 Amp
Minimum Flow @ Outlet	80 GPH (300 LPH)
Fuel Pump Location	Inline
High Temperature Reduction	8 GPH (30 LPH)
Length	196 mm
Diameter	60mm

Ethanol Fuel : Clients Scope

Laptop

Lenovo V330 - i7

Model Number: 81B0A00TIH

Processor	: Intel Core i7-8550U Processor (1.80GHz 2400MHz 8MB)
Operating System	: Windows 10
Display Type	: 14.0" FHD
Memory	:4.0GB PC4-19200 DDR4 SODIMM 2400MHz + 4.0GB PC4-17000 DDR4 Soldered 2133MHz
Hard Drive	:1TB 5400 rpm
Optical Drive	: No ODD
Warranty	:3 Years Onsite Warranty + 1 Year International Warranty
Speaker	:Stereo speakers with Dolby Audio
AC Adapter	:45W
Graphics	: Intel UHD Graphics
Bluetooth	: Bluetooth 4.1
Camera	:720P HD
Wireless	:Wifi 802.11AC

ECU Scan Tool with Software

Features

- CAN-BUS based diagnostic/Scan tool
- The program lets you to read out and clear fault codes, shows you live data, lets you to perform output test
- The program supports many control units, like Engine, Automatic Transmission, ABS, Airbag, Engine Cooling module, Instrument Cluster, Electronic Climate Control, Body Control Unit, just to name a few examples.
- Full fault code text description

➢ cam position sensor.
➢ crank position sensor.
➢ Mass air flow sensor.
➢ Coolant temperature sensor.
➢ EGR Valve functionality.
➢ Injectors.
➢ Rail pressure sensor.
➢ Diesel regulating valve.
➢ Main relay
➢ Timing Syc
➢ Differential pressure sensor
➢ Exhaust temperature sensor

- Full status information (Present, Not present, Intermittent)
- You can print out, save, or copy the fault codes to any other application. From the fault codes window, you can go directly to the measuring blocks window.
- The program shows you measuring block information on many control module, you can choose anything from the list on your own.
- The program is capable of showing 8 measuring block parameter simultaneously.

Engine Duel Fuel Operating Modes

The Engine working on various fuel combinations (as listed below) will be demonstrated and the injection signals shall be shown using digital oscilloscope.

- ✓ Engine working independently on CRDI Fuel injection system.
- ✓ Engine working on Diesel main fuel and CNG as supplementary fuel
- ✓ Engine working on Diesel main fuel and Hydrogen as supplementary fuel
- ✓ Engine working on Diesel main fuel and LPG as supplementary fuel
- ✓ Engine working on Diesel main fuel and Ethanol as Duel fuel

Instruction Manual

Self-explanatory operating manuals are provided with each system. Detailed theory as well as practical exercises is for the complete engine test bed is included in the manual.

Please Note: Higher rating and specification of product/components shall be used in due case of non-availability of specified product/components in the tender.