DENSO EDC SYSTEM

(For BSVI H6-4V Engine)

ASHOK LEYLAND

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CONTENTS

GROUP - 12

DENSO EDC SYSTEM FOR H6 4V ENGINE

CONTENTS

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DENSO EDC SYSTEM FOR H6 4V ENGINE

12.0. MAJOR COMPONENTS OF EDC SYSTEM

12.0.1 ELECTRONIC DIESEL CONTROL

Modern engine development is driven by legislative emission requirements and growing vehicle electronic architecture in the market. Following are the legislation and market driven needs.

The EDC (Electronic diesel control) system is capable of meeting the demands outlined above.

In EDC system, the driver has no direct control over the injected fuel quantity through the accelerator pedal

The injected fuel quantity is based on

1. The vehicle response desired by the driver communicated through the accelerator pedal sensor with the help of ECU.
2. The engine operating conditions
3. The engine operating coolant temperature
4. Boost pressure
5. Engine speed

EDC system is also capable of data exchange with other electronic systems such as Automatic transmission system, Antilock Braking System, ACU etc., through CAN (Control Area Network).

BSVI EDC system comprises of following components

- Engine wiring harness
- EDC wiring harness
- Crank Speed Sensor
- Cam Speed Sensor
- Boost Pressure and Temperature Sensor
- Oil Pressure and Temperature Sensor
- Coolant Temperature Sensor
- EGR Out Temperature Sensor
- Intercooler Out Temperature Sensor
- Fuel Pressure Sensor
- Mass Air Flow Sensor
- Intake Throttle Integrated With Position Sensor
- EGR Valve Integrated With Position Sensor
- Fuel Cut-Off Valve

Exhaust After-Treatment System

- Exhaust Gas Temperature (EGT) Sensors (4 Nos)
- Nox Sensors (2 Nos)
- Differential Pressure Sensor
- Wiring Harness.

EDC system is subdivided into

1. Sensors

Detect the engine operating conditions and the driver's demand. They convert physical variables into electrical signals.

2. Electronic Control Unit (ECU)

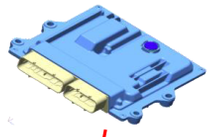
Processes the information received from the sensors. It controls the actuators through electrical output signals. It also provides interfaces with other systems like diagnostic tool, ABS etc.

3. Actuators

Convert the electrical signal from the ECU into physical variable.

EDC SYSTEM

ECU



Operating voltage : 9v to 32v
No of pins : V connector – 72
E connector – 114

Signal Input / Signal Evaluation

Signal Processing & Quantity Calculation (Torque Structure)

/ Start Of Injection / Pilot Injection & Timing)

SENSORS/SWITCHES

SENSORS :

1. Crank Speed sensor
2. Cam speed sensor
3. Boost Pressure & Temperature Sensor
4. Oil Pressure & Temperature Sensor
5. Coolant temperature sensor
6. EGR Out Temperature Sensor
7. Inter cooler out Temperature Senspr
8. Fuel Pressure Sensor
9. Mass Air Flow Sensor
10. Intake Throttle Integrated with position Sensor
11. EGR Valve Integrated with position Sensor

EATS
Exhaust GasTemp (EGT Sensors)
Nox Sensors (2 Nos)
Differential Pressure Sensor

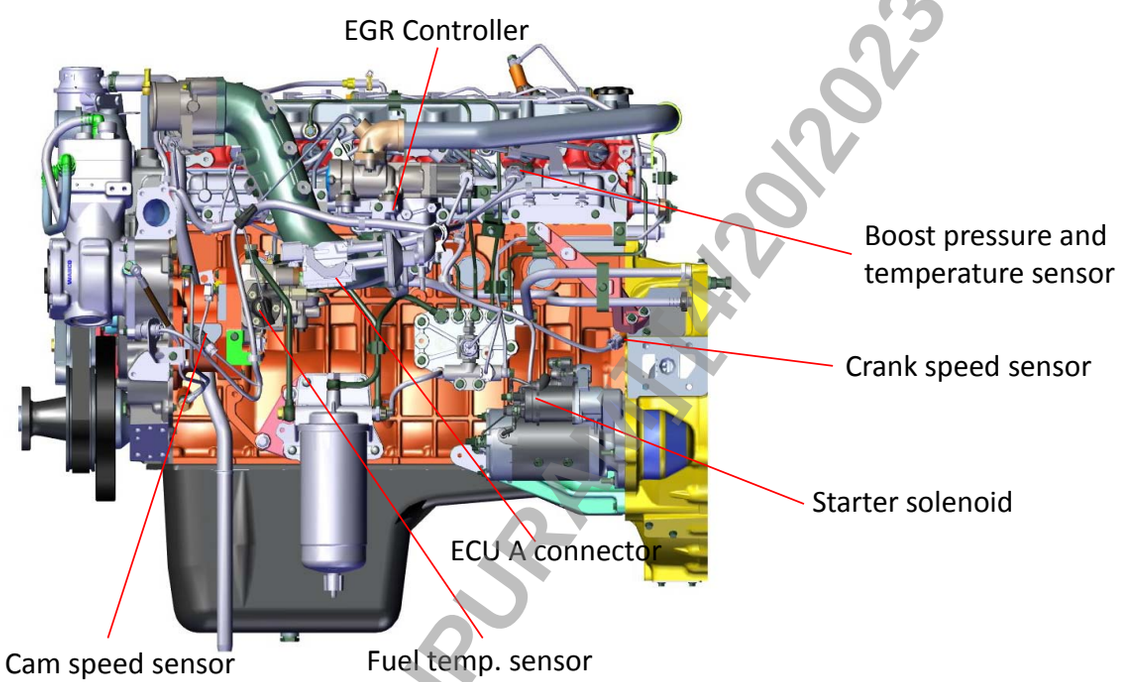
SWITCHES :

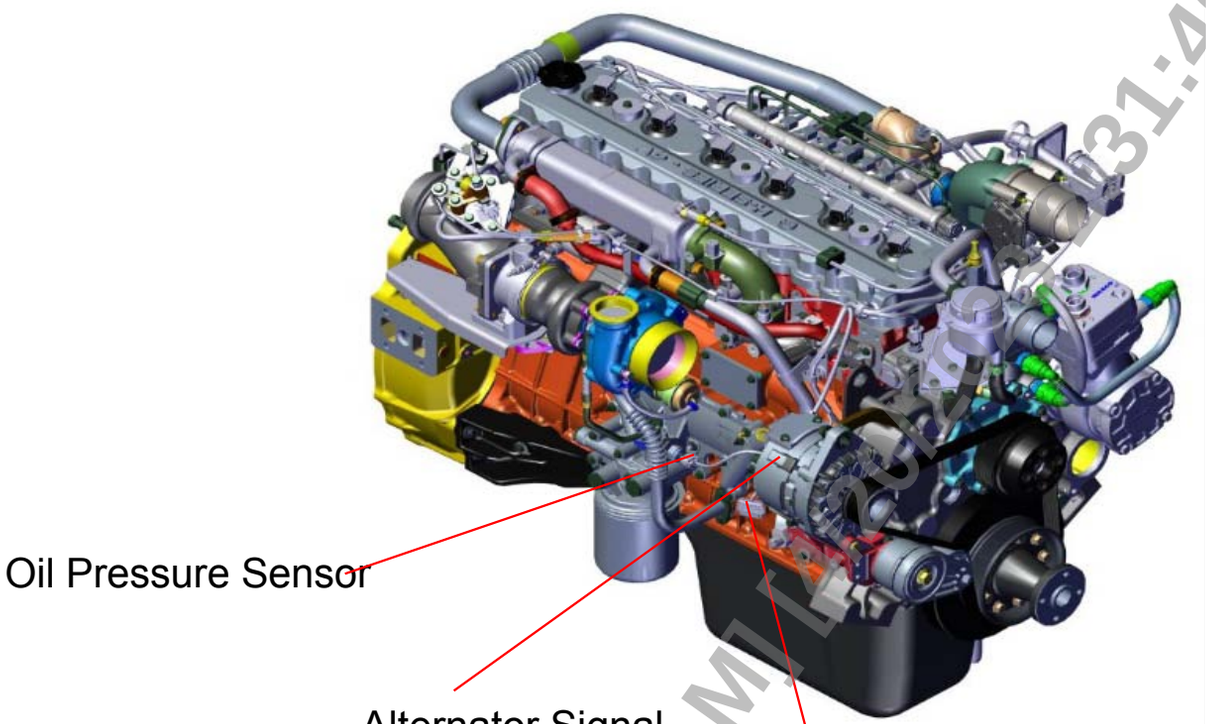
1. Main & redundant brake switch
2. Clutch signal switch
3. Parking brake switch
4. Gear neutral switch
5. Diagnostic lamp
6. Water in fuel sensor & lamp
7. AC request switch

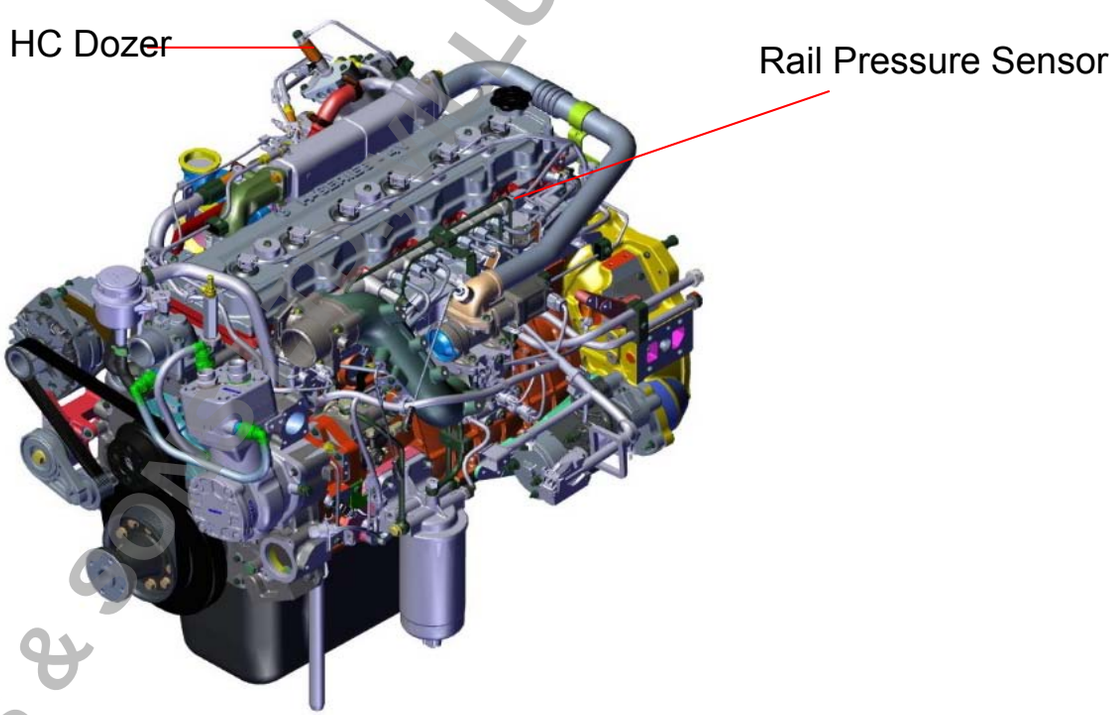
ACTUATORS

1. Injectors
2. EGR DC motor
3. Suction control Valve/ FIP meterin unit
4. ITV DC motor
5. HC Dozer
6. Fuel cut-off valve

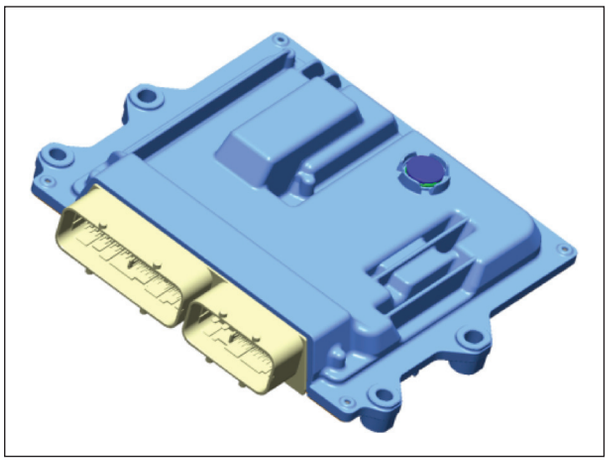
12.2 DESCRIPTION OF ENGINE COMPONENTS







Electronic Control Unit (ECU)



Operating Voltage - 9V to 32V

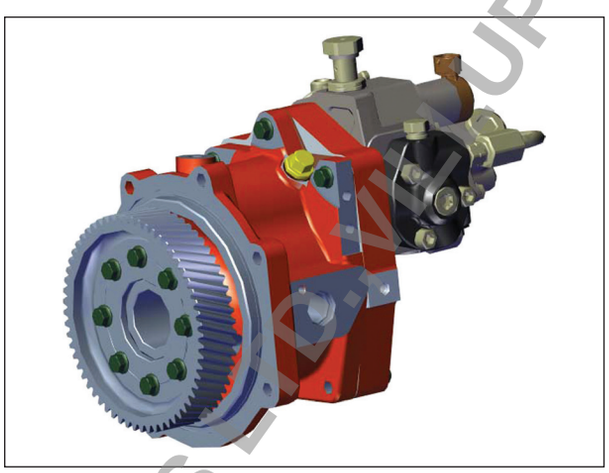
Vehicle connector - 72 pins

Engine connector - 114 pins

The ECU is the brain of the system that process the requirements thru sensors and the accelerator pedal movement with the fuel mappings already calibrated in the ECU and decides on the fuel delivery thru injectors. It operates on 24V DC.

Another function of ECU is the CAN communication to ACU.

Fuel injection pump



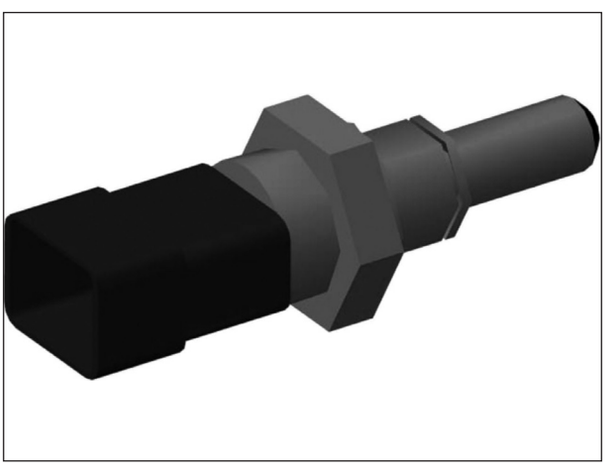
Common rail CRS pump Fuel injection pump. This pump is mechanically driven and electronically controlled by ECU. Output signals from ECU triggers the governor there by controls the fuel quantity of fuel injected and the start of injection.

Injectors

Injectors functions are controlled by an electro magnet principle of having solenoid situated at top side. When the solenoid coil is energized, it lifts the plunger and allows the high-pressure fuel from high pressure connector to injector inlet and the fuel fills inside the stem of injector and finally it delivers to the combustion chamber.

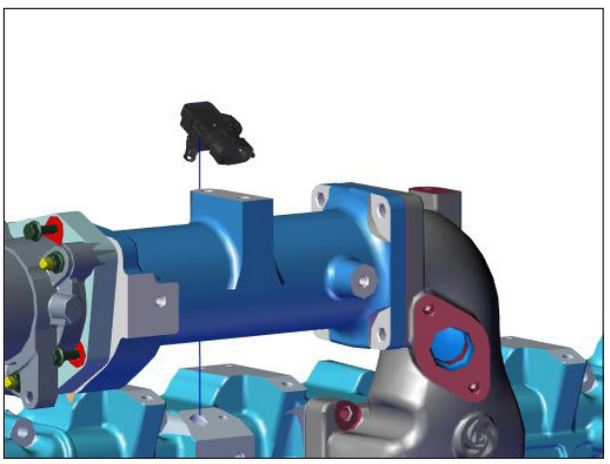
Denso Injectors are high precision and sensitive components and hence care should be taken during handling.

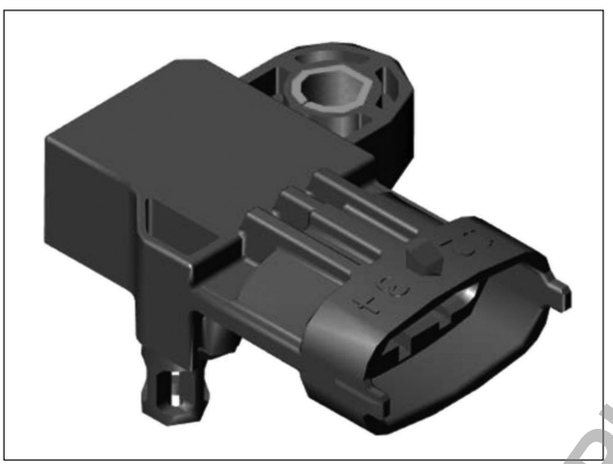
Coolant temperature sensor:



Engine Coolant Temperature Sensor - It is a thermistor, mounted on coolant return line from cylinder head. It measures the engine operating temperature.

Boost pressure & temperature sensor:



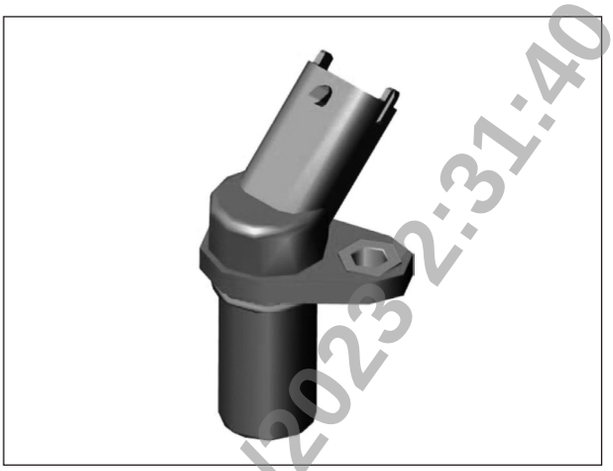


Boost Pressure sensor is mounted on the intake manifold to measure the absolute intake manifold pressure & Temperature.

Camshaft speed sensor:

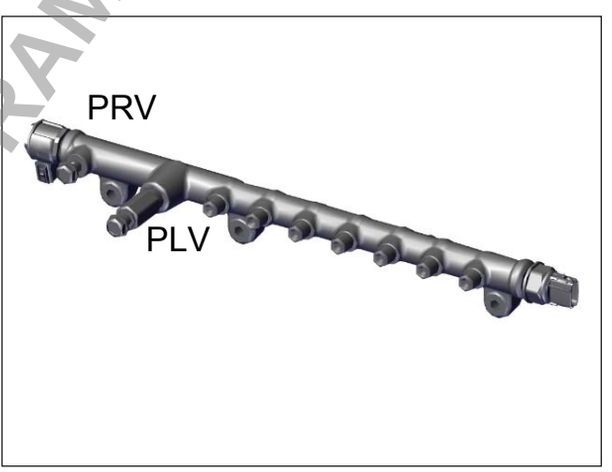
Cam speed sensor hall effective type. It is mounted on the FIP drive housing. When a trigger wheel (tooth) made of ferromagnetic material is passed by the sensor, the magnetic flow and therefore the voltage changes because of the Hall element

Engine/ Crank Speed Sensor:



Engine speed sensor is a Inductive type sensor. It is mounted on the flywheel housing along with shim plate. Electric pulses are generated when the Holes on the flywheel pass through the sensor axis. The Electric pulse - Frequency (Sine Wave) generated by the sensor is proportional to the engine speed

Rail pressure sensor:



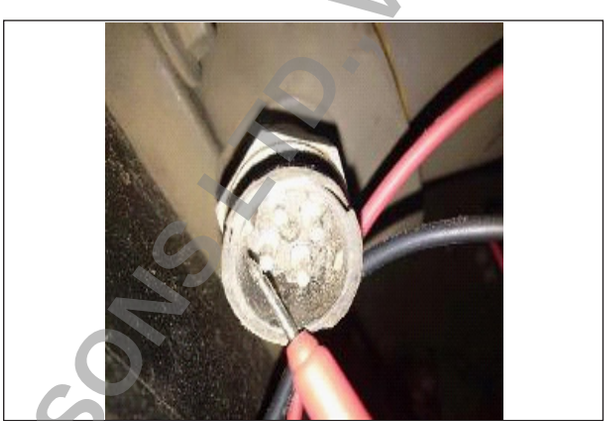
Common Rail - This To store and distribute the high pressure fuel to the injectors, the rail is connected to the pump by a single pre-bent high pressure pipe, and to the four injectors by four pre-bent high pressure pipes.

Rail pressure sensor - To limit the pressure in the HP circuit by using the Pressure Limiting Valve To return the fuel flow from the Pressure Limiting Valve to the engine low pressure circuit

Water in fuel sensor:

Water in fuel sensor located at the bottom of prefilter. When the water in fuel got settled at bowl, the sensing lead senses the presence of water and sends the alarm signals to the Dashboard. As per this alarm we have to drain the water from the bowl by turning the cork Anti Clockwise.

Vehicle Speed sensor:

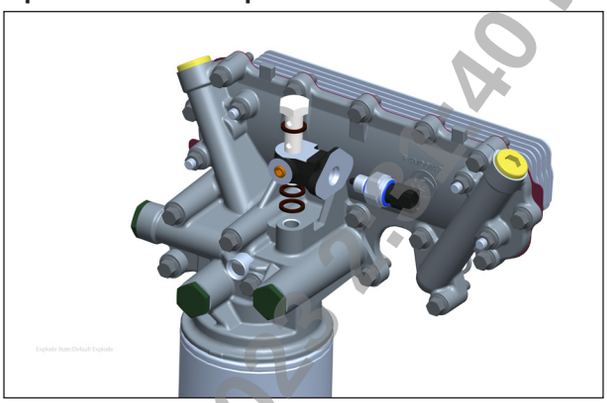


WORKING PRINCIPLE : vehicle speed sensor generates a magnetic pulse in the form of a wave proportional to the speed of the vehicle .

Vehicle speed sensor mounted on gearbox (output flange)

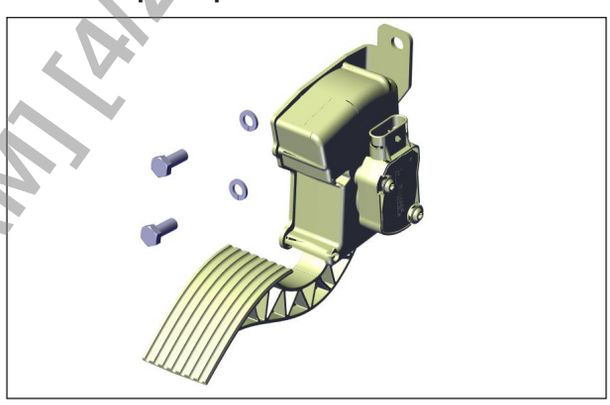
FUNCTION : to determine the speed of the vehicle and distanced travel vehicle

Oil pressure and temperature sensor:



Engine oil pressure and temperature sensor - Temperature sensing by NTC, Pressure sensing by Piezo - resistive stain gauge in MEMS technology. It is mounted on the oil cooler module

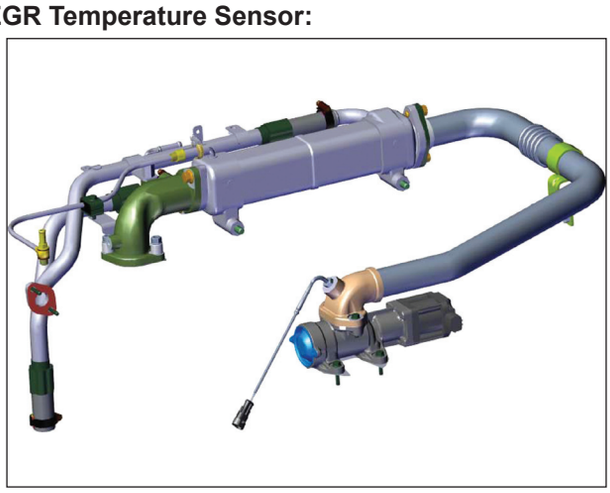
Accelerator pedal position sensor:



Accelerator pedal sensor mounted on accelerator pedal mount.

The Sensor serves to measure demand from the driver and communicates to the ECU. It detects the pedal position by means of potentiometer and transfers this information to the ECU in terms of Voltage. It consists of two hall effect sensor for measuring the position of accelerator pedal module from 0% travel position to 100% travel position.

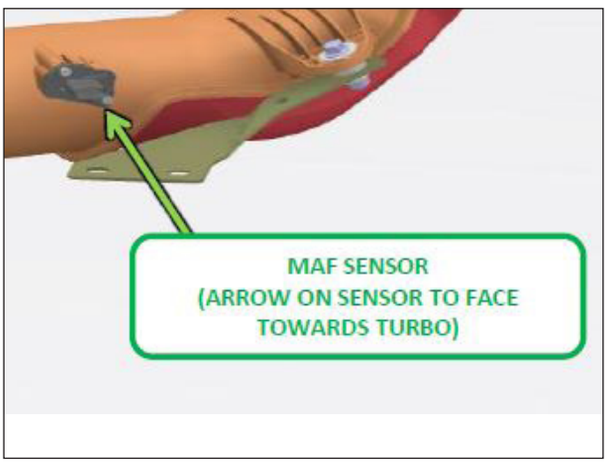
EGR Temperature Sensor:



EGR assembly passes the exhaust gas from exhaust manifold (next from turbo) to intake manifold to control the peek fire temperature.EGR cooler, reducing the hot exhaust gas IN temperature.

T EGR sensor is located downstream of the EGR and it measures the exhaust gas recirculated into the engine.

HFM Sensor:



Measures the mass flow of filtered fresh air entering the engine through the air intake system. Measures the temperature of the fresh air in the Air Intake system.

Intake Throttle valve

ITV actuator is used to regulate the air flow during thermal management to increase the exhaust gas temperature.

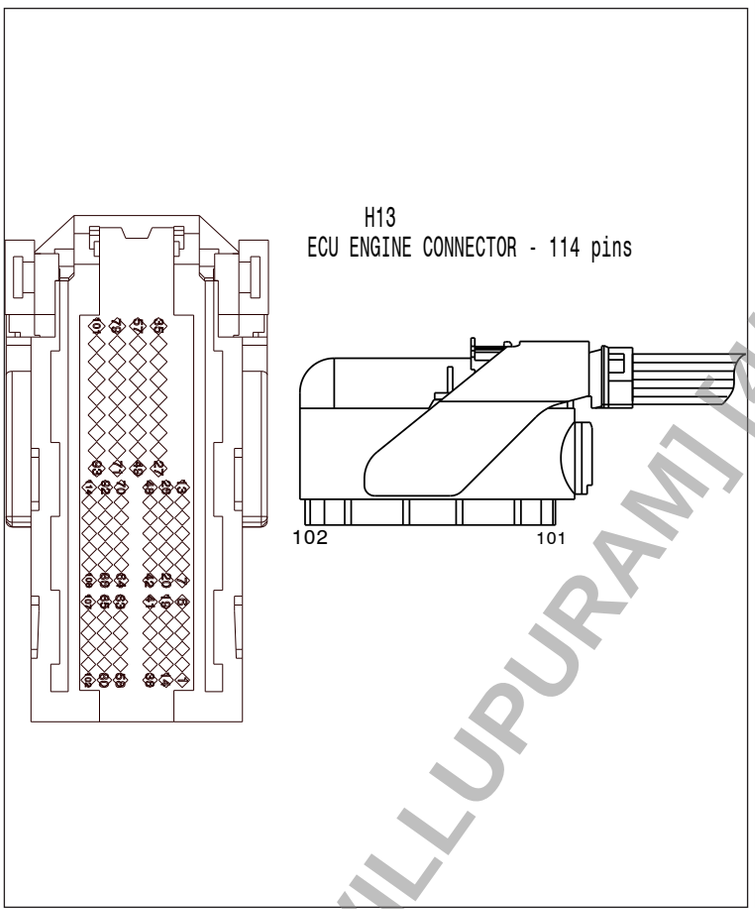
Do's and Don'ts

- Electrical tapping not allowed: Tapping should not be taken as this can severely affect the performance of the ECU and Sensors (additional current drawn by the new load will drain the battery faster).
- Care should be taken while washing the vehicle. Do not splash water directly on to the ECU, Accelerator pedal sensor and other electrical components.
- Diagnostic connector should not be left hanging loose and should be handled with care. The protective cap is to be removed only at the time of connecting diagnostic tester.
- Reverse polarity protection : Care needs to be taken while removing and connecting the battery connection during body building
- Check the battery condition regularly and keep the battery in a healthy condition.
- Ensure proper connectivity of ECU/ Sensor connectors with wiring Harness and maintain harness clamps.
- No intermittent connector in the EDC wiring system should be practiced (this is not relevant from the service point of view as the harness would have already been made and put on the vehicle and there will be no question of intermittent connector).
- Keep the ignition switch 'OFF' while removing & Fitment of the battery connections in the vehicle.
- Correct Tightening torques should be used for mounting the ECU.
- Do not relocate the ECU from the given location.
- ECU must be connected or disconnected to the wiring harness only when the ignition switch is in OFF position.
- No undue pressure to be applied on the ECU during service.
- Do not let dirt or dust get inside the actuator / sensors or EDC components. Cover them properly.
- When disconnecting the connectors, try to pull them out in a straight line, disengaging the lock by holding the housing.
- Do not try to disconnect connectors by gripping the wires or twisting them, as this could bend the contacts.

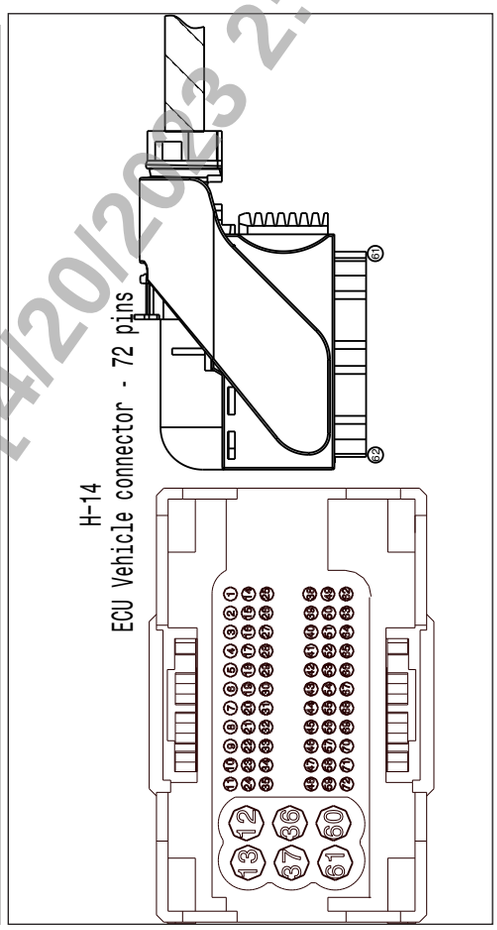
Continuity checking for sensor with respect to ECU side connector

Note:

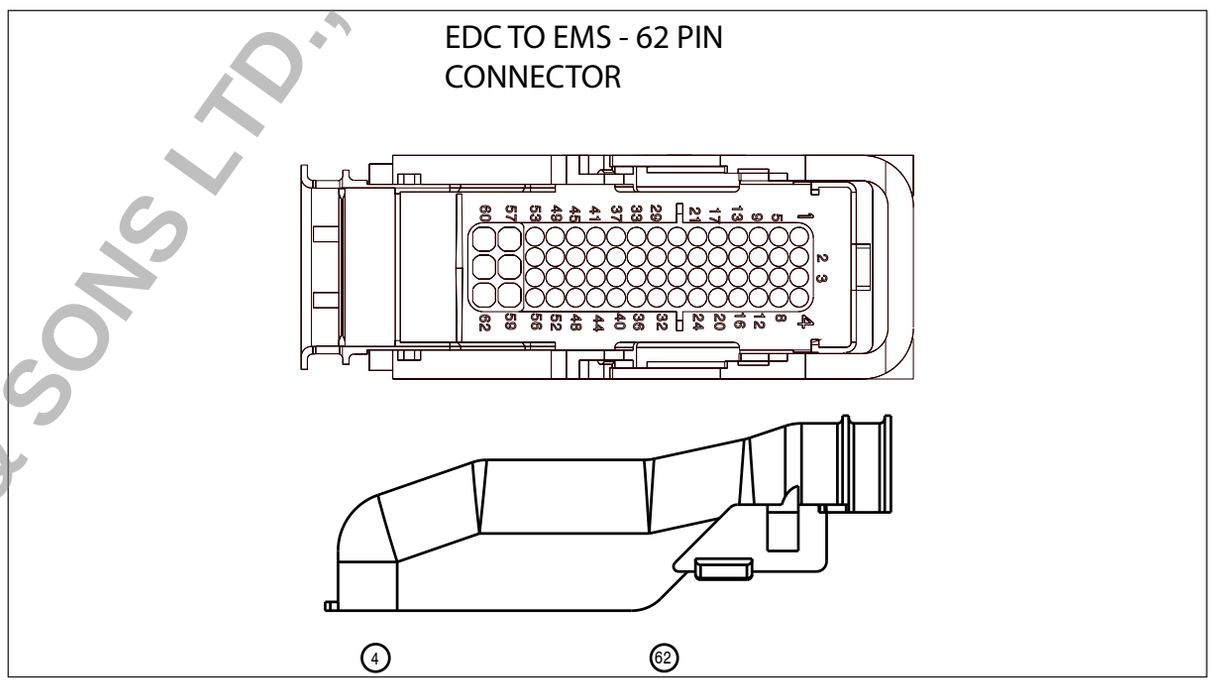
- Remove sensor side connector & ECU side connector also.
- If carefully seen we can find numbers written (Example 1 2 3) on the sensor connector.
- There are three types of ECU connectors one big and one small in size and one for Engine interface connector. Refer Below sketches.



Big Connector Engine connector

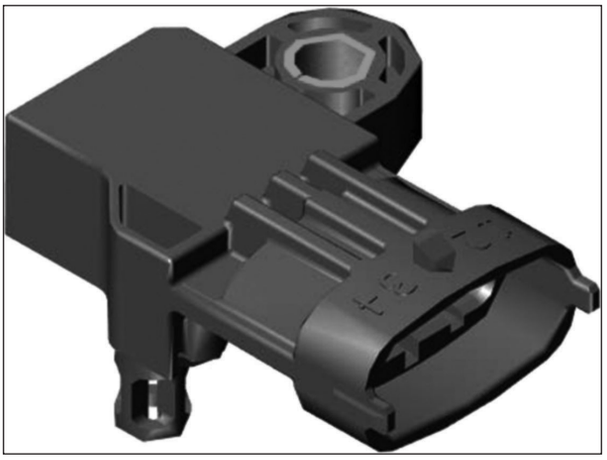


Small Connector (Vehicle connector)



Engine Inteface Connector - 62PIN

12.2.1 Boost pressure & temperature sensor



Technology used: Temperature sensing by thermistor, Pressure sensing by piezo-resistive element in MEMS (Micro-Electro Mechanical Systems) technology. [Active sensor]

Function: Measures the temperature and pressure of the fresh air in the intake manifold in order to decide quantity of fuel to be injected based on the calculated air-fuel ratio

Location: On Air Intake Manifold

Working Principle:

Sensing element is a Piezo-resistive strain gauge in a wheat stone bridge arrangement. When the element is subjected to pressure it flexes due to which the resistance of the it changes, consequently generating a voltage due to imbalance in the wheat stone bridge circuit. This voltage gives the change in resistance which in turn can be calibrated with that of the pressure that caused the deflection.

The temperature sensing element is a Negative Temperature Coefficient (NTC) type of thermistor When temperature of air increases the resistance of the sensing element decreases.

Installation:

a) The pressure sensor package is inserted into the intake manifold and is sealed by using an O-ring, ensuring leak proof. Smear lubricant on O-ring (non -acid paraffin oils) during fitment.

b) Maximum tightening torque of screws : 6 to10 Nm

Pressure sensor type – Piezoresistive, Temperature sensor type - NTC

Functionality check:

Pressure sensor: Nil

Temperature sensor: The resistance between pin 2 and 1 must be ~1.7 kOhm @30 ºC

FAULT PATH		
DTC code (Hand held diagnostic tool)	**Description**	**Reactions**
P0112	Boost temperature sensor signal voltage below lower limit	No Reaction
P0113	Boost temperature sensor signal voltage Above upper limit	
P0127	Intake Air Temperature Too High	Torque reduction - System protection
P0235	Boost Pressure sensor plausibility error	40% Torque Limitation, ITV Shutdown & EGR Shut Down
P0237	Boost pressure sensor signal voltage below lower limit	
P0238	Boost pressure sensor signal voltage above upper limit	

Specification:

Pressure sensor:

Pressure range: 50 – 400 kPa

Supply voltage: 5 V

Nominal Output Transfer Function of Pressure Sensor

Temperature sensor:

Temperature range: -40 – 130 ºC

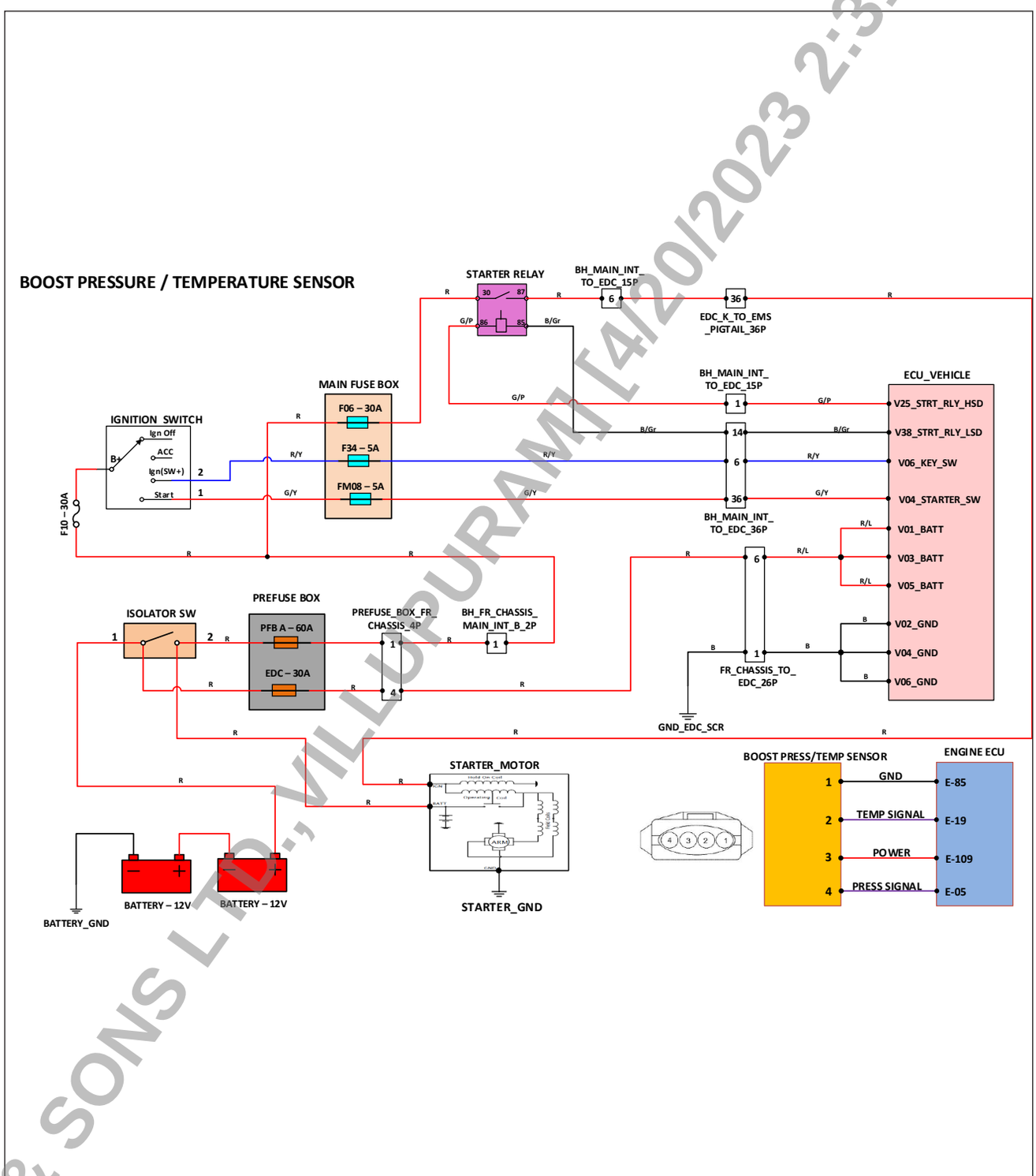
Characteristic of Temperature Sensor

Possible cause of fault and Service Recommendation:

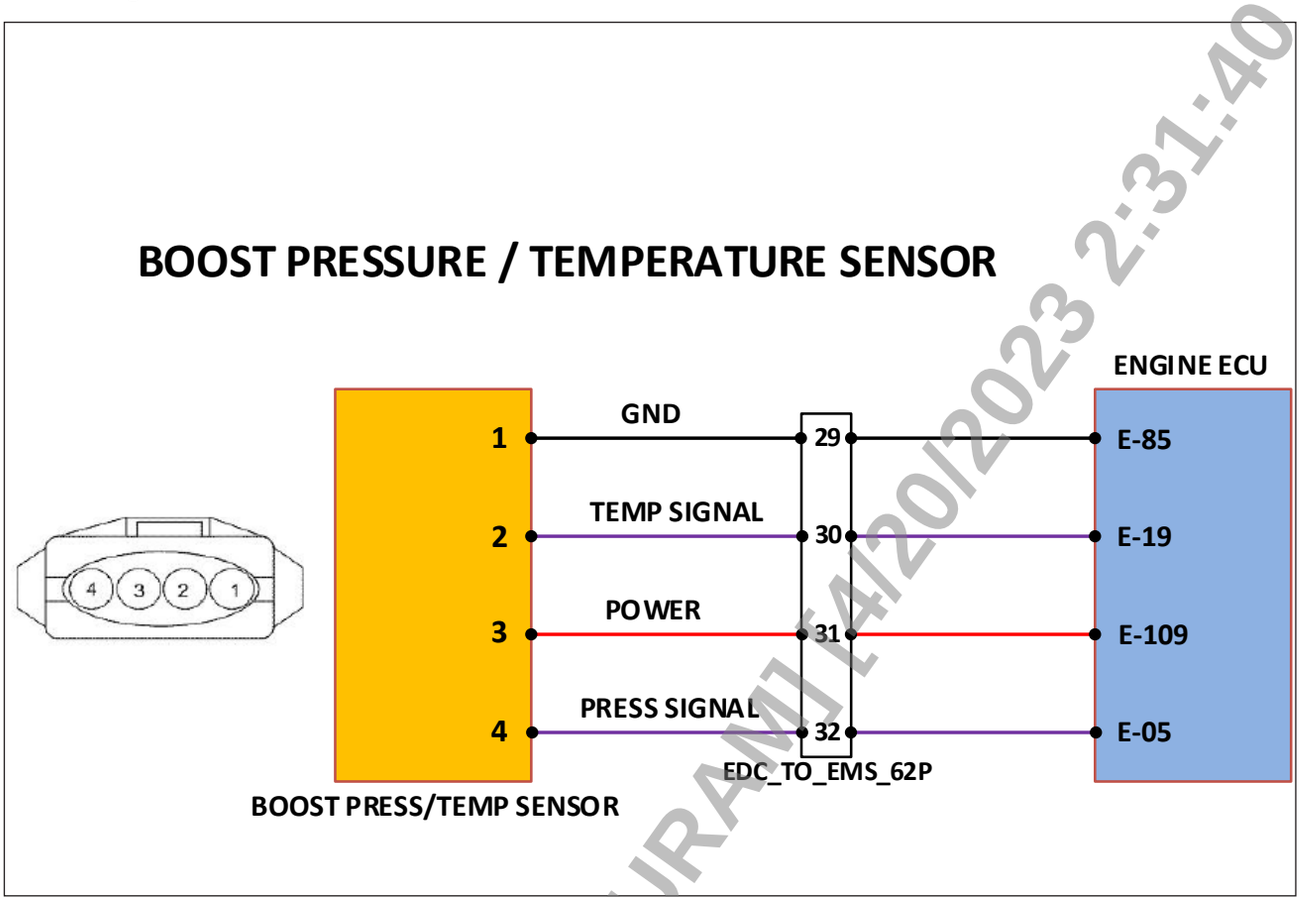
- Refer Trouble shooting using Error code

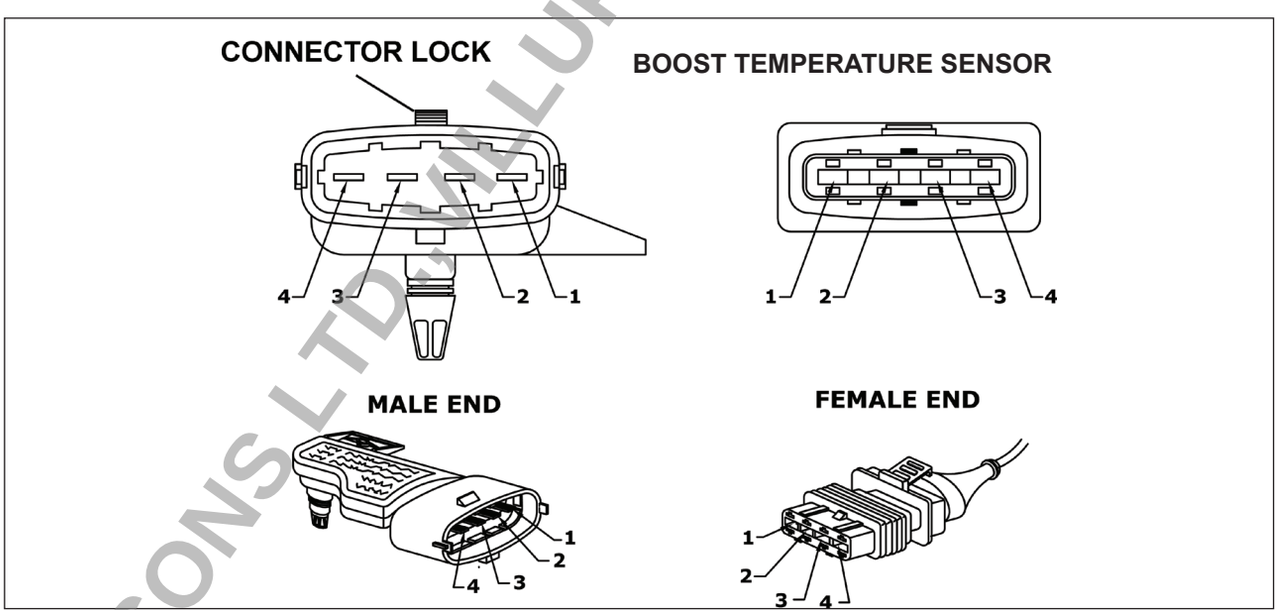
Pin configuration & Connection Details:

Circuit Diagram - TRUCK

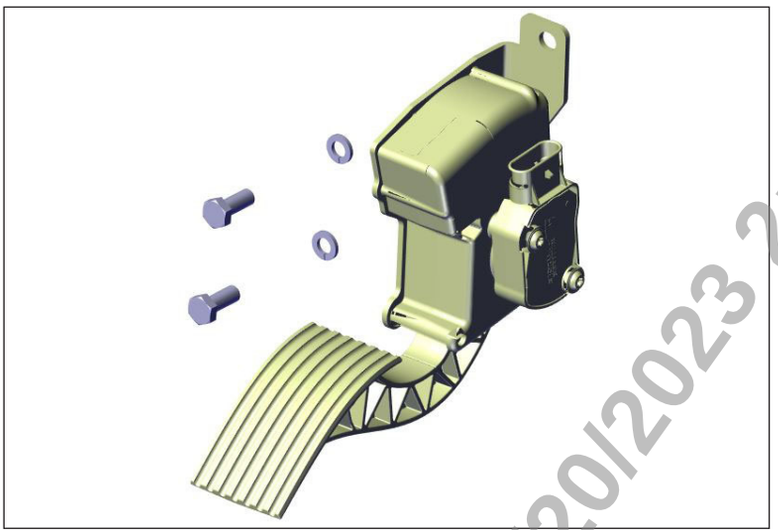


Circuit Diagram - BUS





12.2.2 Accelerator Pedal Sensor



Function and working:

It detects the pedal position by means of HALL EFFECT SENSOR and transfers this information to the ECU in terms of Voltage.

It consists of two HALL EFFECT SENSOR for measuring the position of accelerator pedal module from 0% travel position to 100% travel position. The second sensor is incorporated as redundant and reports error in case of malfunction of the first sensor. Voltage across redundant sensor is almost half of the first sensor.

Use:

The Sensor serves to measure demand from the driver and communicates to the ECU

Installation:

The accelerator pedal sensor is mounted on accelerator pedal module.

Tightening torque of the retaining screws: 9 Nm.

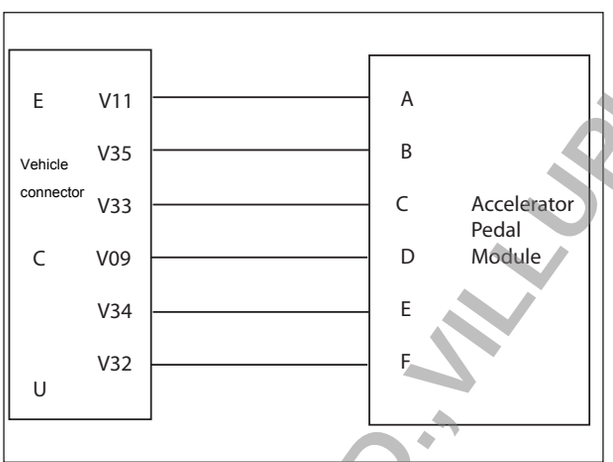
Specification:

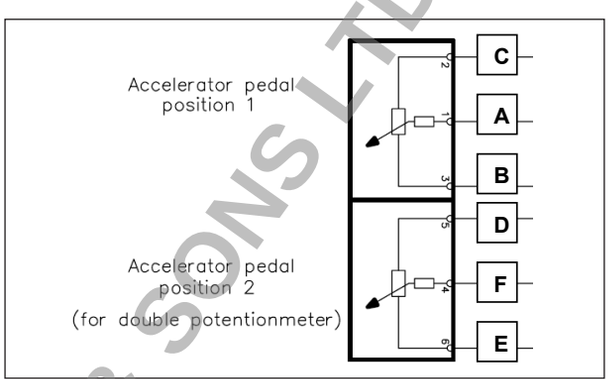
Operating voltage : 5 V DC

Temperature range : - 40 to 80°C

FAULT PATH		
DTC code (Hand held diagnostic tool)	**Description**	**Reactions**
P0122	Accelerator pedal sensor 1 signal voltage below lower limit	No reaction
P0123	Accelerator pedal sensor 1 signal voltage above upper limit	
P0222	Accelerator pedal sensor 2 signal voltage below lower limit	
P0223	Accelerator pedal sensor 2 signal voltage above upper limit	
P2135	Non-plausibility error between APP1 & APP2	Limp home function (1350rpm)

Pin Configuration & Connection Details:

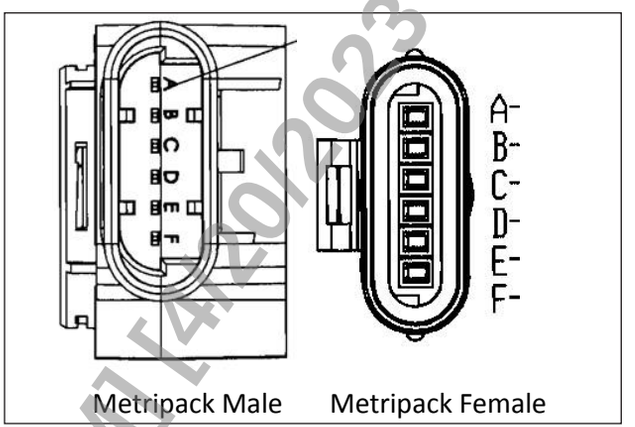




E-CONNECTOR	PURPOSE	E-CONNECTOR	PURPOSE
E11	ADV1	E34	AVCC2-V1
E33	AGND-V1	E32	AGND-V2
E35	AVCC1-V1	E09	ADV2

Pin 1, 2 & 3 Main Sensor

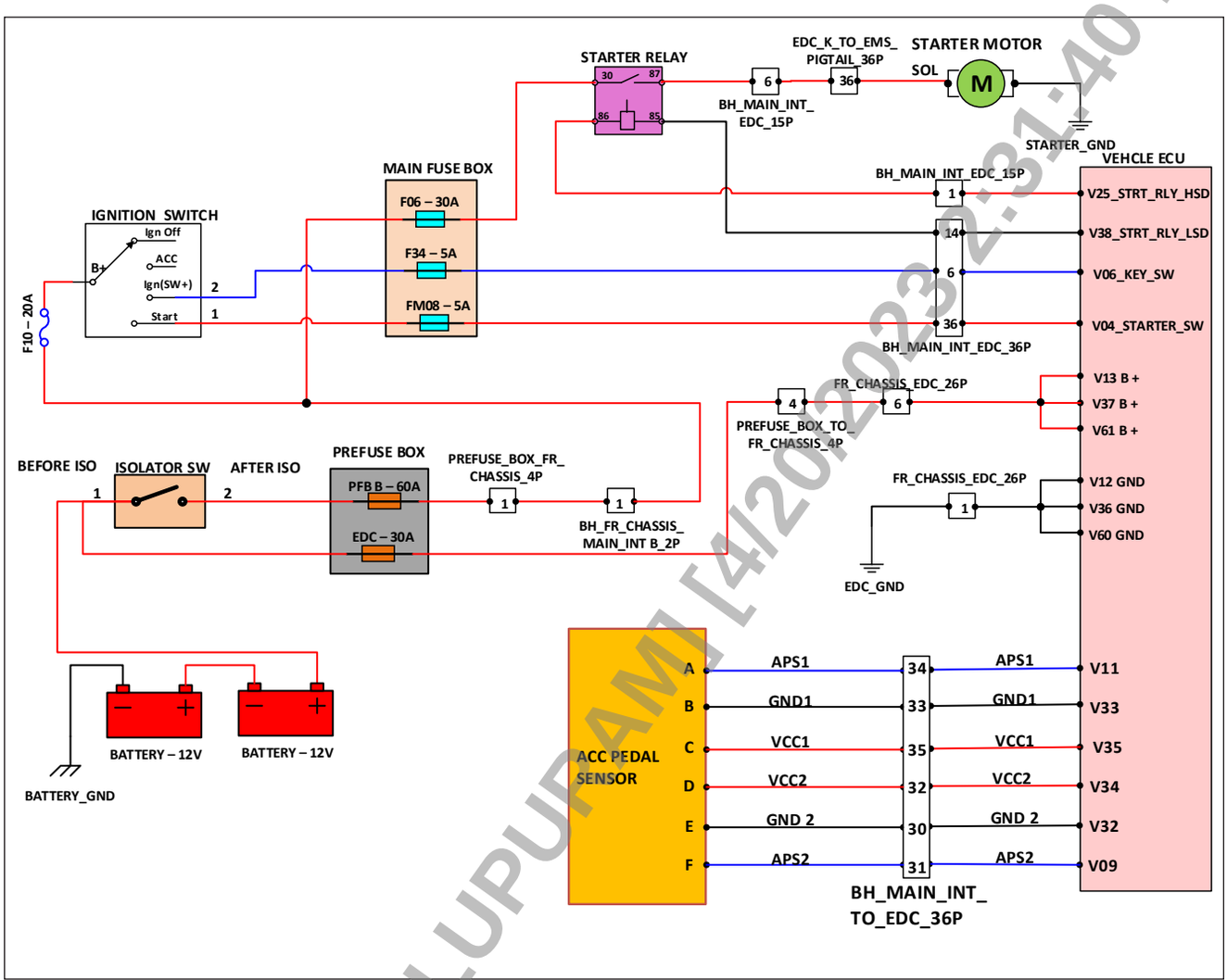
Pin 4, 5 & 6 Redundant Sensor



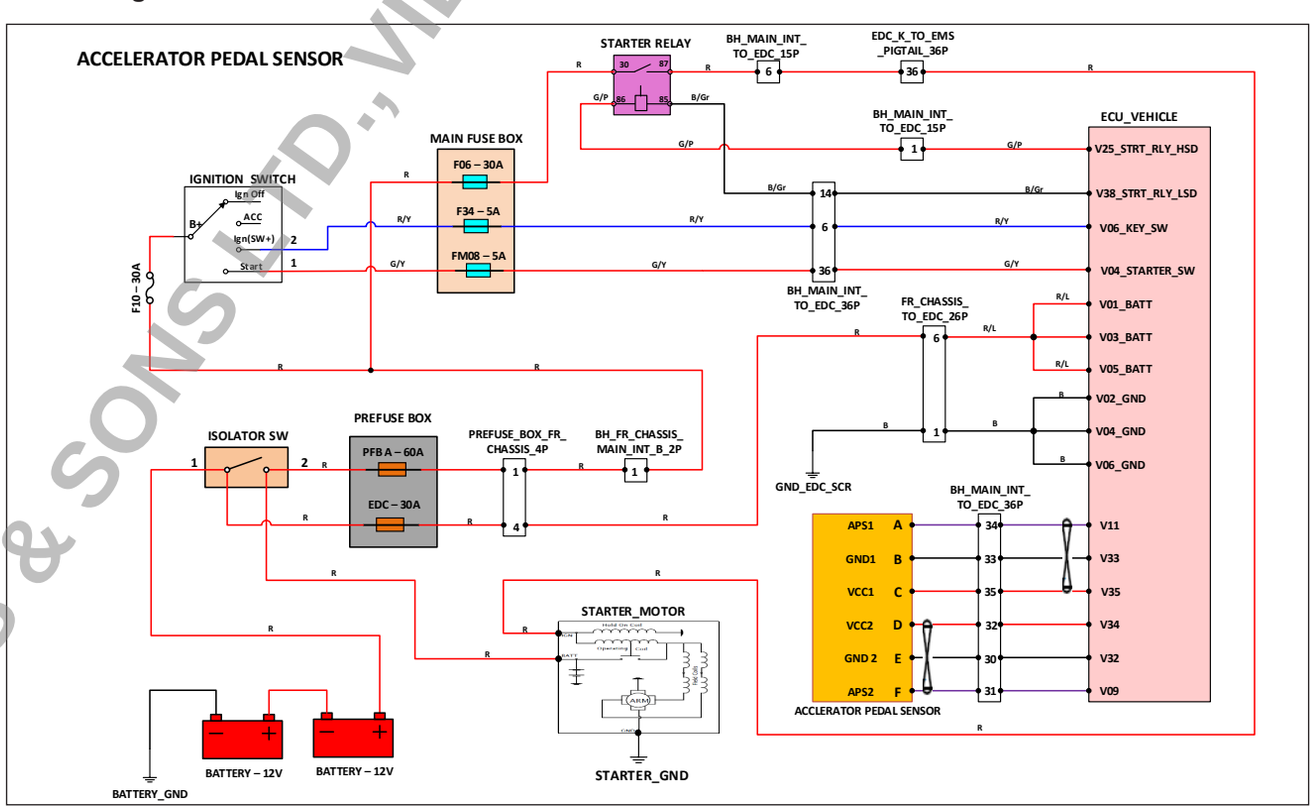
Pin A, B & C Main Sensor

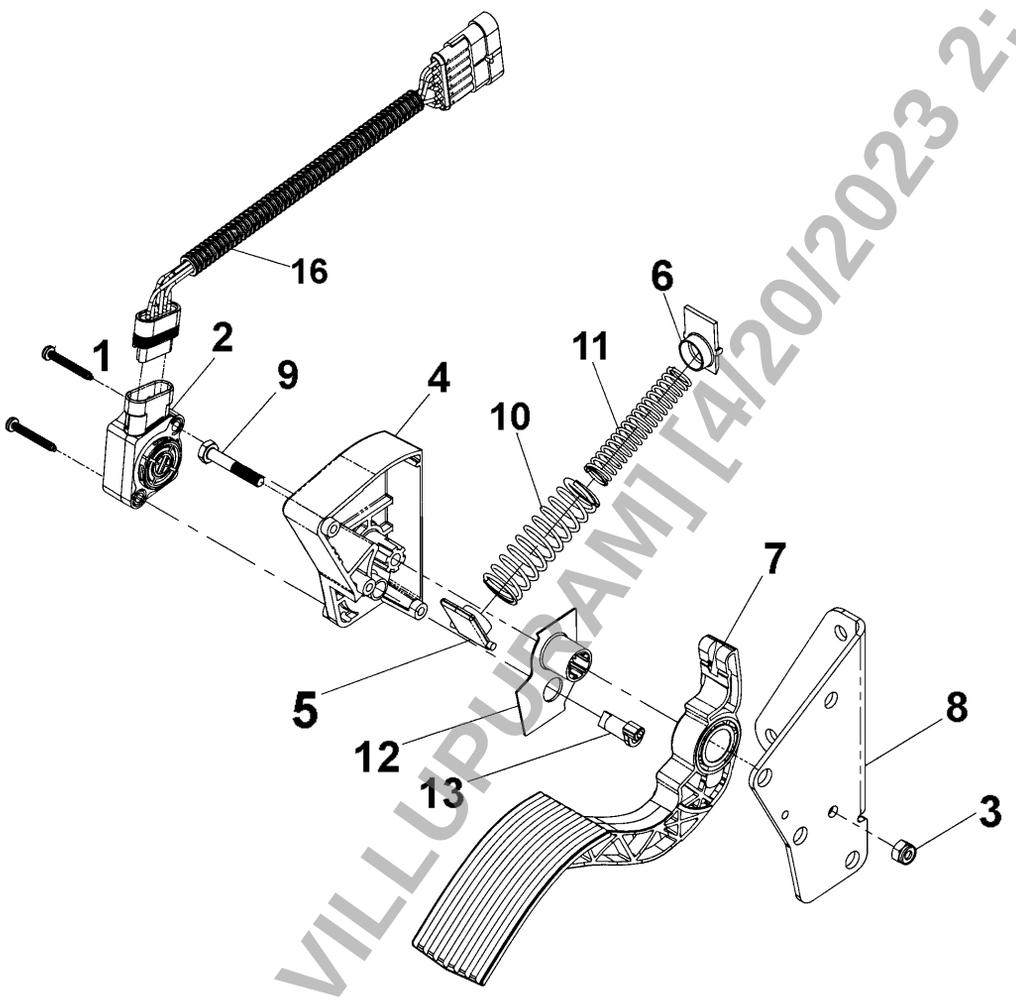
Pin D, E & F Redundant Sensor

Circuit Diagram - Bus



Circuit Diagram - Truck



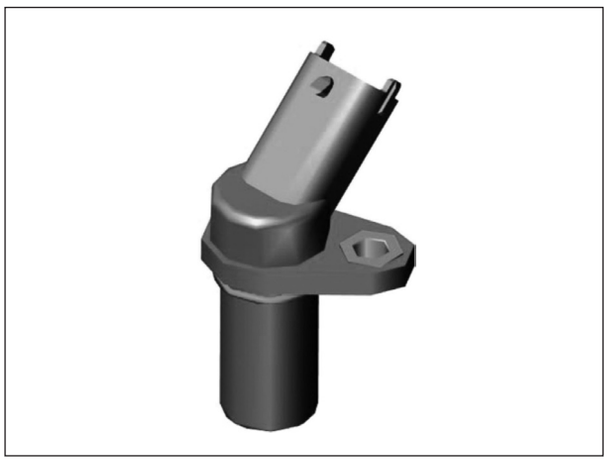


1. Check test
2. Sensor
3. Nut
4. Body
5. Fixed plug
6. Rocker
7. Lever arm
8. Bracket
9. Screw
10. Spring outer
11. Spring inner
12. Wear Liner
13. Shaft
16. Wiring Harness

PENDANT TYPE

Check continuity at wiring harness. If error occurs replace APM and check again.

12.2.3 CRANK / ENGINE SPEED SENSOR



Technology used: Inductive type/Variable reluctance type/Magnetic Pick Up(MPU) type [Passive sensor]

Function: Measure the speed of the engine and the missing tooth input is used to determine the TDC for injection.

Location: On flywheel housing

Working Principle:

When the magnetic flux linked with a coil changes an emf is produced – Faraday's law of electromagnetic induction. Here the coil is present inside the sensor wound on a permanent magnet.

The rotating flywheel cuts this magnetic field and creates a change in flux linked with the coil. This results in an emf being generated in the coil.

Specification:

Resistance of coil: 860 ohm ± 10% @Room Temperature

Inductance of coil: 370 ±60 mH @ 1 kHz

FAULT PATH		
DTC code (Hand held diagnostic tool)	**Description**	**Reactions**
P0335	Crank shaft sensor signal Error - no signal	Engine speed limitation to 1750 rpm and 25% Torque Reduction
P0336	Crank shaft sensor signal Error - disturbed signal	
P0016	Camshaft to Crankshaft offset angle exceeded	Engine Speed limitation to 1750 rpm & 25% torque reduction

Effect of fault

Engine will run in backup mode with signal from cam shaft sensor.

Possible cause of fault

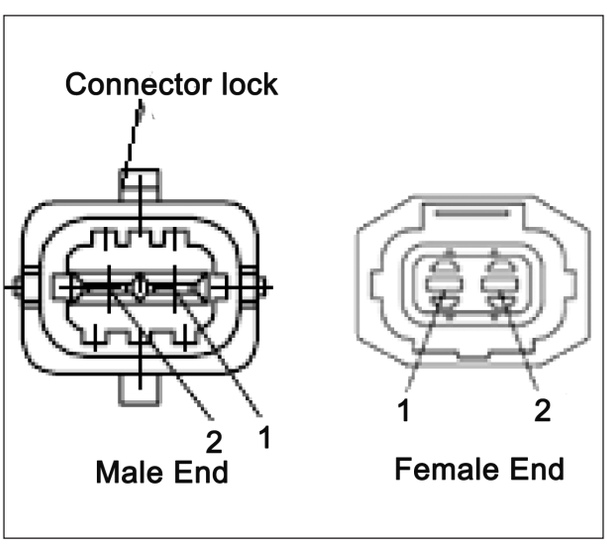
- Faulty sensor.
- Loose contact of the sensor pin with the wiring harness connector.
- Dust on the sensor pin or sensor tip got worn out due to contact with the flywheel.
- Fitment of incorrect flywheel.
- Check for Sensor mounting plate faulty or sensor mounting bolt loose.

Service Recommendation

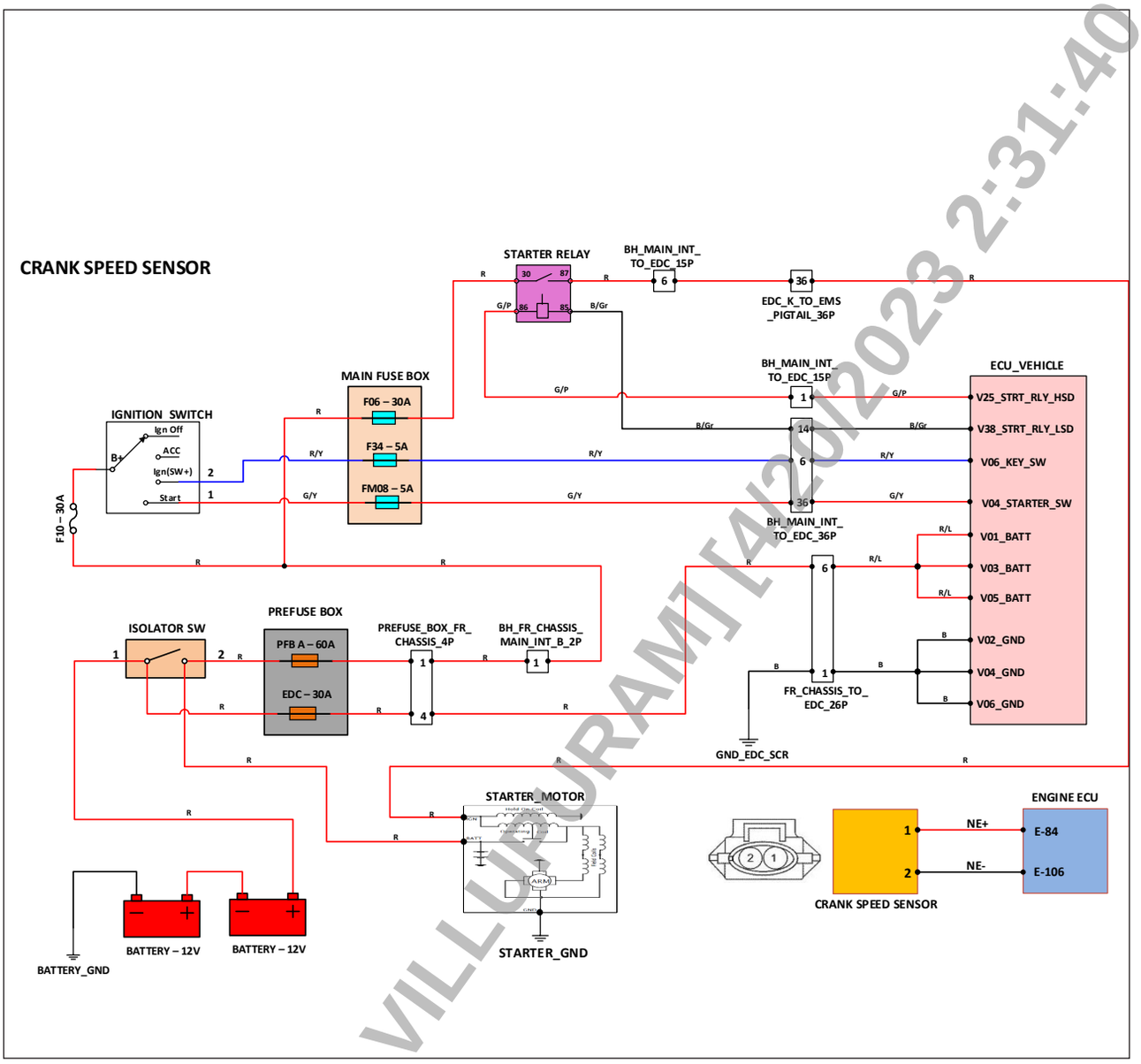
- Check the signal output in terms of rpm from diagnostic tester.
- Check the continuity of the sensor connector with the ECU connector. If found break in signal replace the wiring harness.
- Check if the sensor is offset with respect to Flywheel holes.
- Check for sensor mounting plate for specification. Ensure the air gap with the sensor and flywheel between 0.5 to 1.5 mm
- Check for resistance of the sensor across the two pins. It should read860 ohm ± 10% @ Room

  Temperature

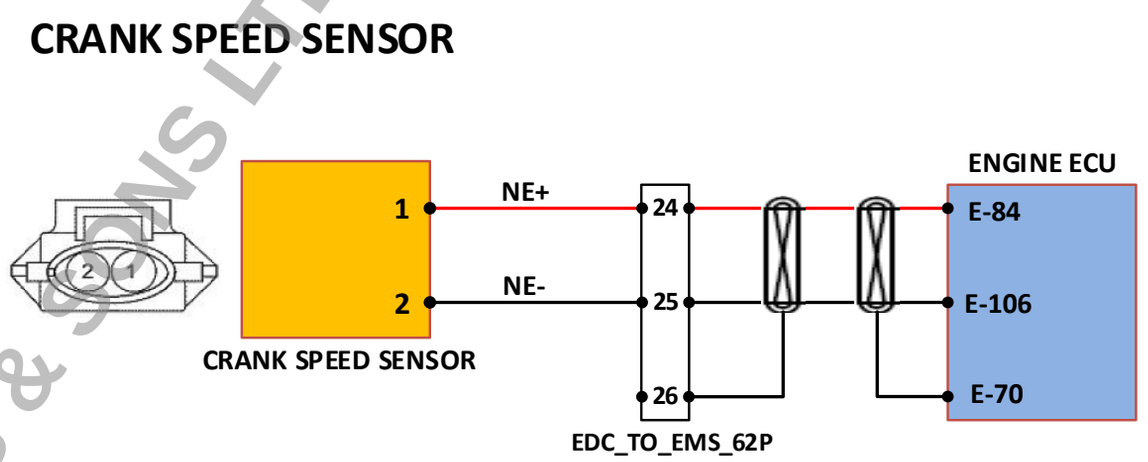
Pin configuration and connection details



Circuit Diagram - Truck



Circuit Diagram - BUS



Continuity check:

Connect pins 1 and 2 of the connector to a multimeter and check for the resistance of the coil. The resistance should be within the limit of 860 Ω ±10% (774 to 946)

12.2.4 Camshaft Speed Sensor

Technology used: Hall effect [Active sensor]

Function: To measure the speed of the camshaft and determine the firing cylinder

Location: On Fuel Injection Pump

Working Principle:

If a certain type of crystal is carrying a current in a transverse magnetic field , then a voltage will be produced at right angles to the supply current. The magnitude of the voltage is proportional to the supply current and to the magnetic field strength.

This voltage is given as digital input to ECU with the help of the hall chip

Specification:

Operating Voltage : 5 V

FAULT PATH		
DTC code (Hand held diagnostic tool)	**Description**	**Reactions**
P0341	Cam shaft sensor signal Error - disturbed signal	Engine Speed limitation to 1750 rpm`
P0340	Cam shaft sensor signal Error - no signal	

Effect of fault:

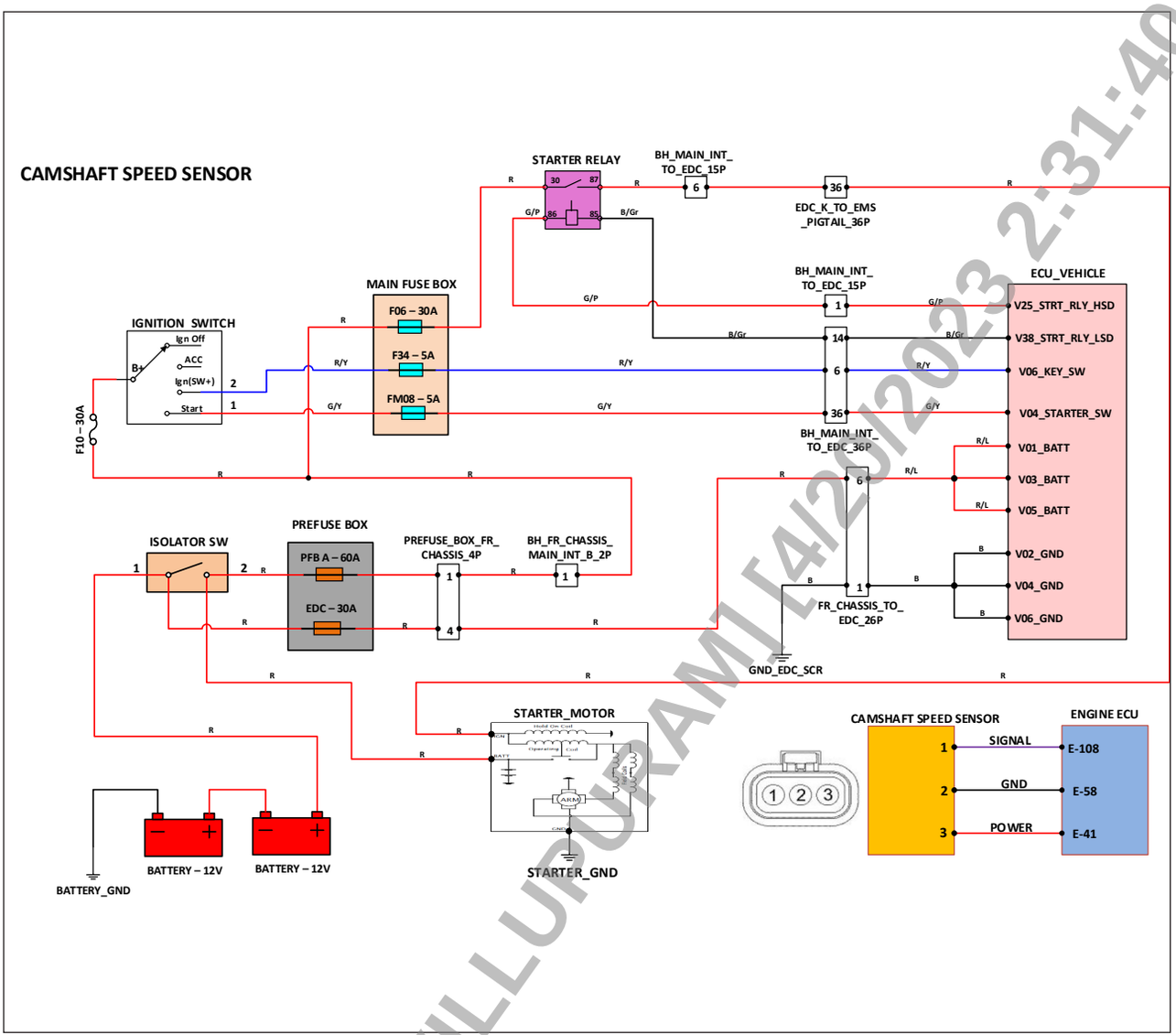
Engine RPM limited to 1750 if cam sensor fails / WH problem.

Long starting time and Engine starts & runs with cam shaft sensor signal

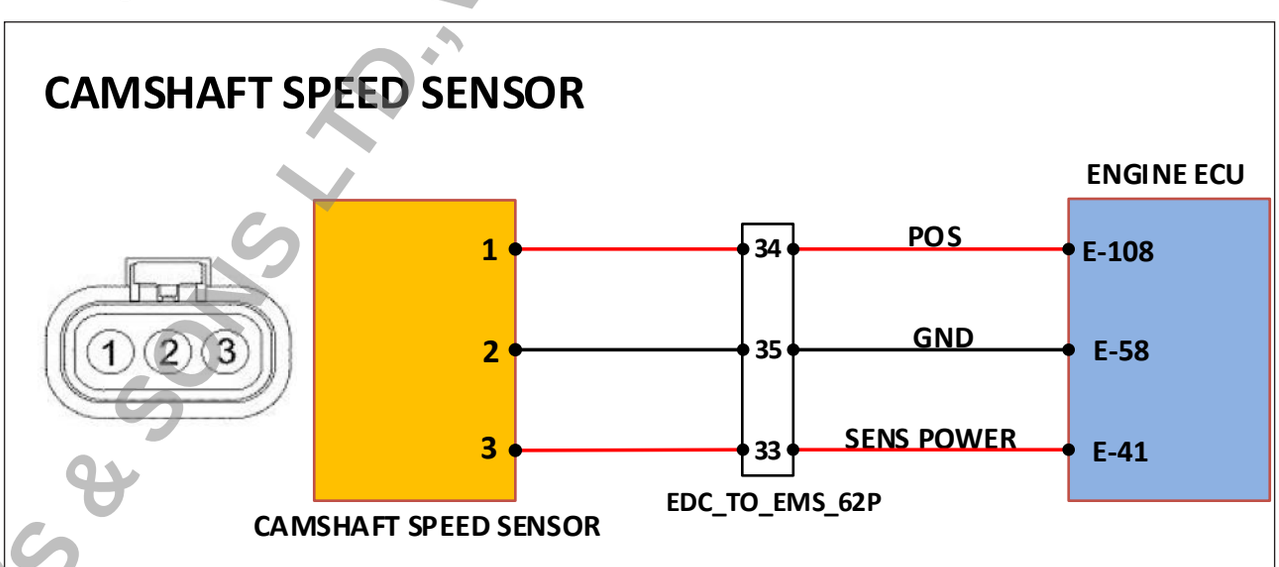
Possible cause of fault and Service Recommendation:

Refer Chapter: Trouble shooting using error code

Circuit Diagram - TRUCK



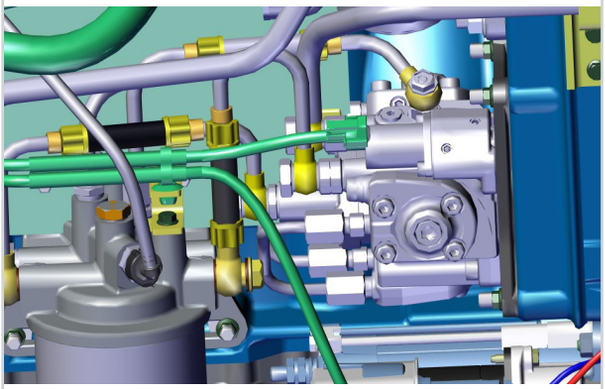
Circuit Diagram - BUS



Continuity check:

Connect pins 1 and 2 of the connector to a multimeter and check for the resistance of the coil. The resistance should be within the limit of 860 Ω ±10%(774 Ω to 946 Ω)

12.2.5 Fuel Metering Unit / Suction control valve



Function and working:

It is mounted on the integrated on FIP and it regulates fuel from low pressure circuit to rail as per engine quantity and pressure requirement defined in the ECU. It is controlled by PWM signal from the ECU.

Fuel metering unit / Suction control valve(SCV) is used to regulate the fuel delivery to common rail with the input of Rail pressure sensor (closed loop system).

Effect of Fault

Failure in metering unit system - 40% Torque limitation.

PRV open or Rail pressure limitation to 800-1000 bar in all engine operating range.

Fuel Metering Unit actuator test:

Step – 1: Connect scan tool

Step – 2: Go to actuators test

Step – 3: Select metering unit from the list.

Step – 4: Increase the duty cycle to 40% in engine idling condition.

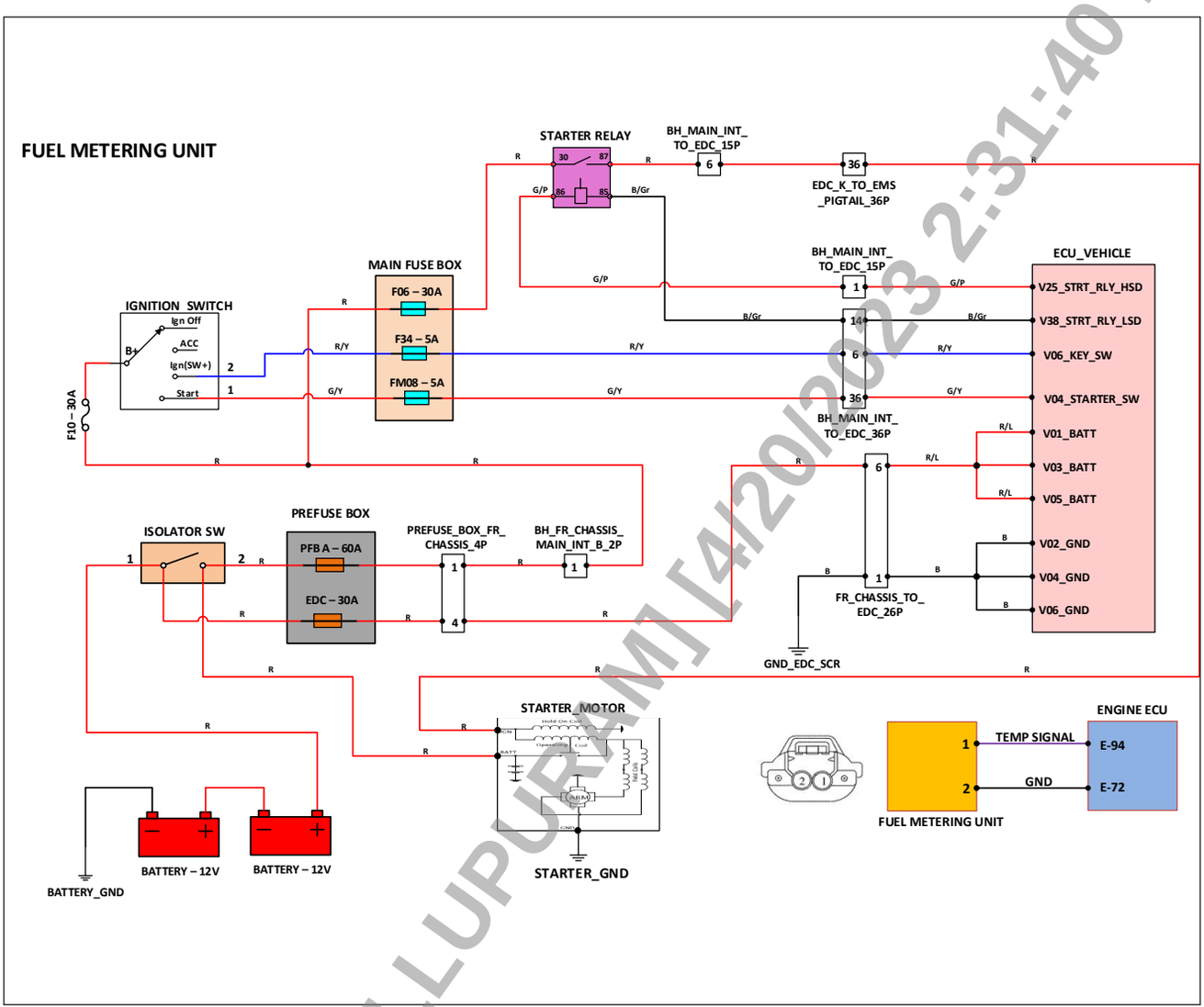
Step – 5: Engine should shut off.

FAULT PATH		
Error Code (Hand held diagnostic tool)	**Description**	**Reactions**
P0090	Metering unit output open load error	40% Torque Limitation & EGR Shut Down
P0254	Metering unit high side short circuit to battery error	
P0002	High Fuel delivery for high (positive) current trim & High Fuel delivery for low (negative) current trim	40% Torque reduction
P228C	Maximum positive deviation of rail pressure exceeded (Actual Rail pressure below the set point)	40% Torque Limitation & EGR Shut Down
P228D	Maximum negative rail pressure deviation with metering unit on lower limit is exceeded (Actual Rail pressure exceeded the set point)	40% Torque Limitation
P0088	Maximum rail pressure exceeded	25% Torque Limitation
P1218	Supply pump protection limit exceeded	
P000F	PRV open	40% Torque Limitation & EGR Shut Down
P1110	PRV reached maximun allowed opening count	

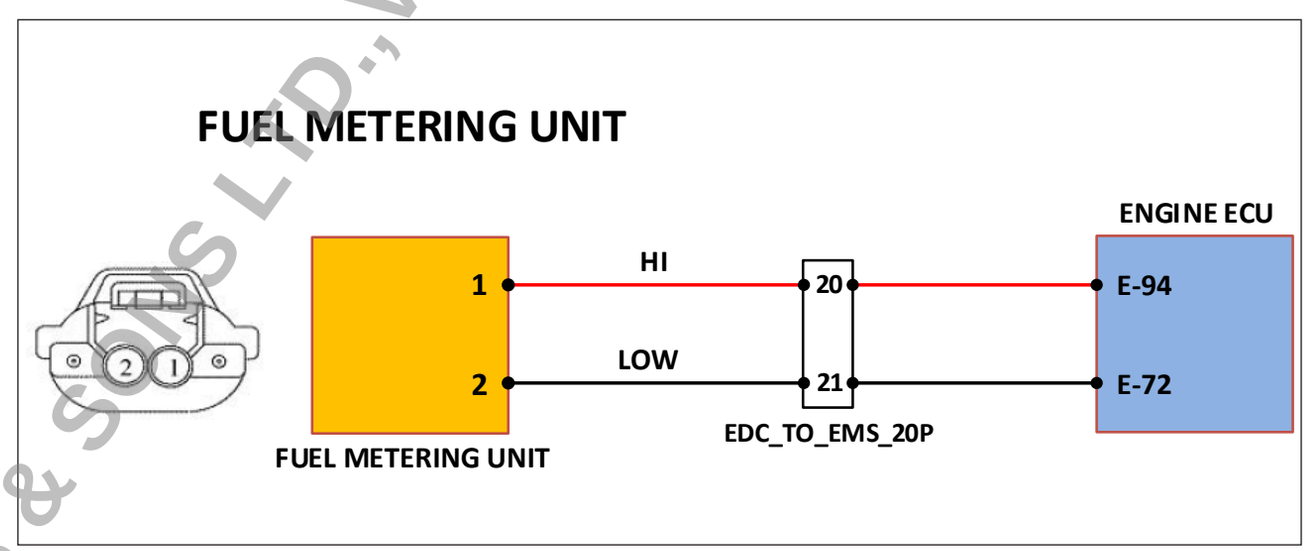
THINGS TO BE ENSURED DURING FIE PART REPLACEMENT IN SERVICE

S.NO	PART SERVICE OR REPLACED	ACTIVITY TO BE CARRIED OUT
1	New pump replacement or SCV replacement.	Previously stored pump learning value to be cleared using service tool through pump learning clear function.
2	New ECU replacement	Engine to be run in idle condition with coolant temperature >50*c in order to enable ECU to perform pump learning.
		Injector QR code to be updated to ECU memory using service tool through adjustment parameter.
		PLV count and timer value from the previous ECU to be updated using service tool through adjustment parameter.
		Engine hours and vehicle kms values from the perivous ECU to be updated using service tool through adjustment parameter.
		SQL updation to be carried out through actuator test in service tool.
3	New Rail replacement or New PLV replaced.	PLV count and timer value to be reset to "0" using service tool through adjustment parameter.
4	New injector replacement	New Injector QR code to be updated to ECU memory using service tool through adjustment parameter.
		Current SQL value in the ECU to be cleared using service tool through actuator test.
5	SQL update activation	Require Denso recommendation for SQL updation frequency.
6	Repeated PLV(PRV) open error (P000F)	To distinguish from PLV deterioration and other errors condition, check PLV opening pressure by Fuel Leak check function (F016) through Diagnostic tool. If the PLV opening pressure is less than the threshold as per the calibrated value 200MPa, PLV replacement to be done.
7	PLV max allowed count error (P1110)	Replace Rail or PLV.

Circuit Diagram - TRUCK



Circuit Diagram - BUS



12.2.6 Injectors

Function and Working of Injector terminal

- Solenoid injector will deliver the calculated fuel & pressure into the engine with respect to engine operating range based on electrical input from ECU.

To delivery high pressure fuel based on ECU signal

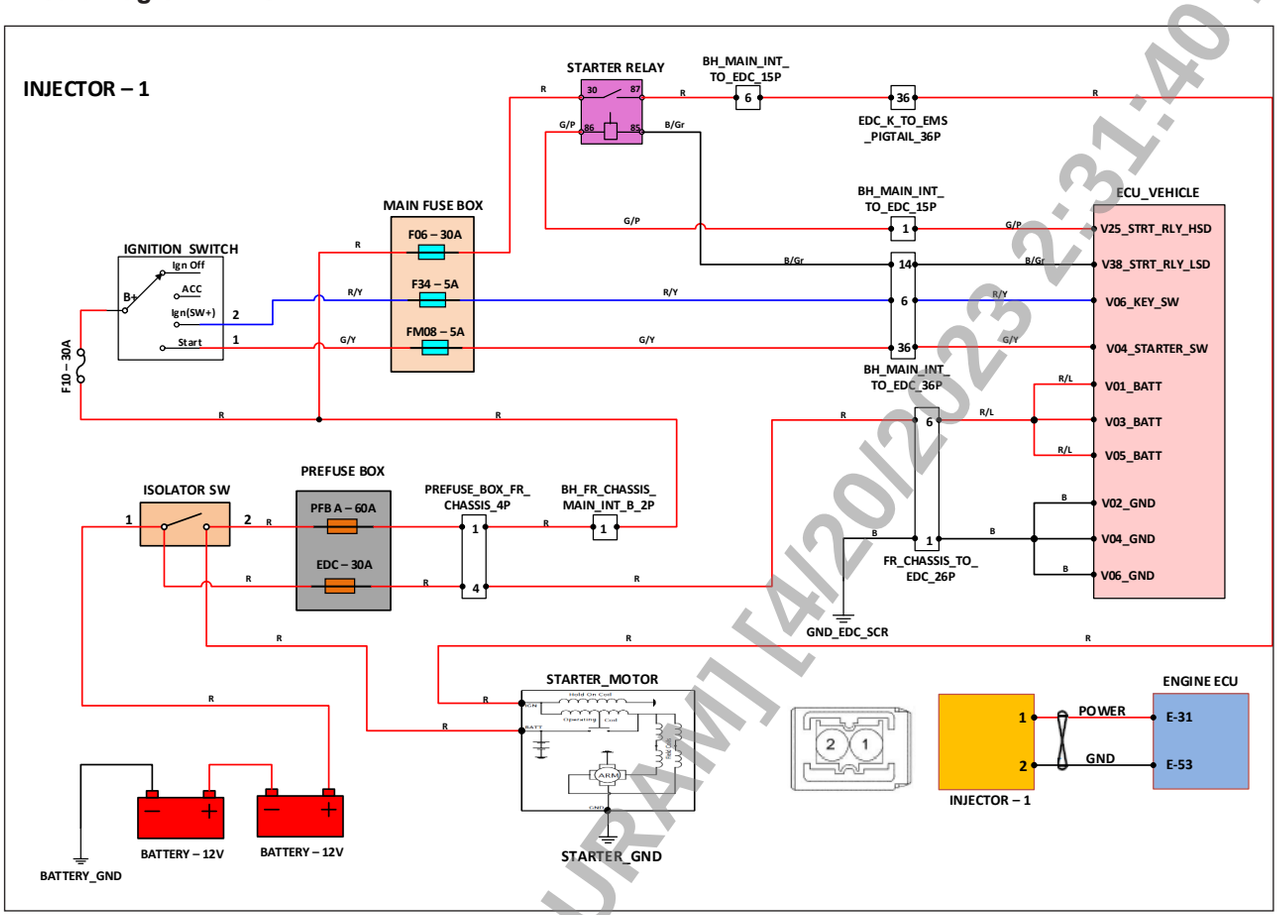
Fault Path - 4 CYLINDER

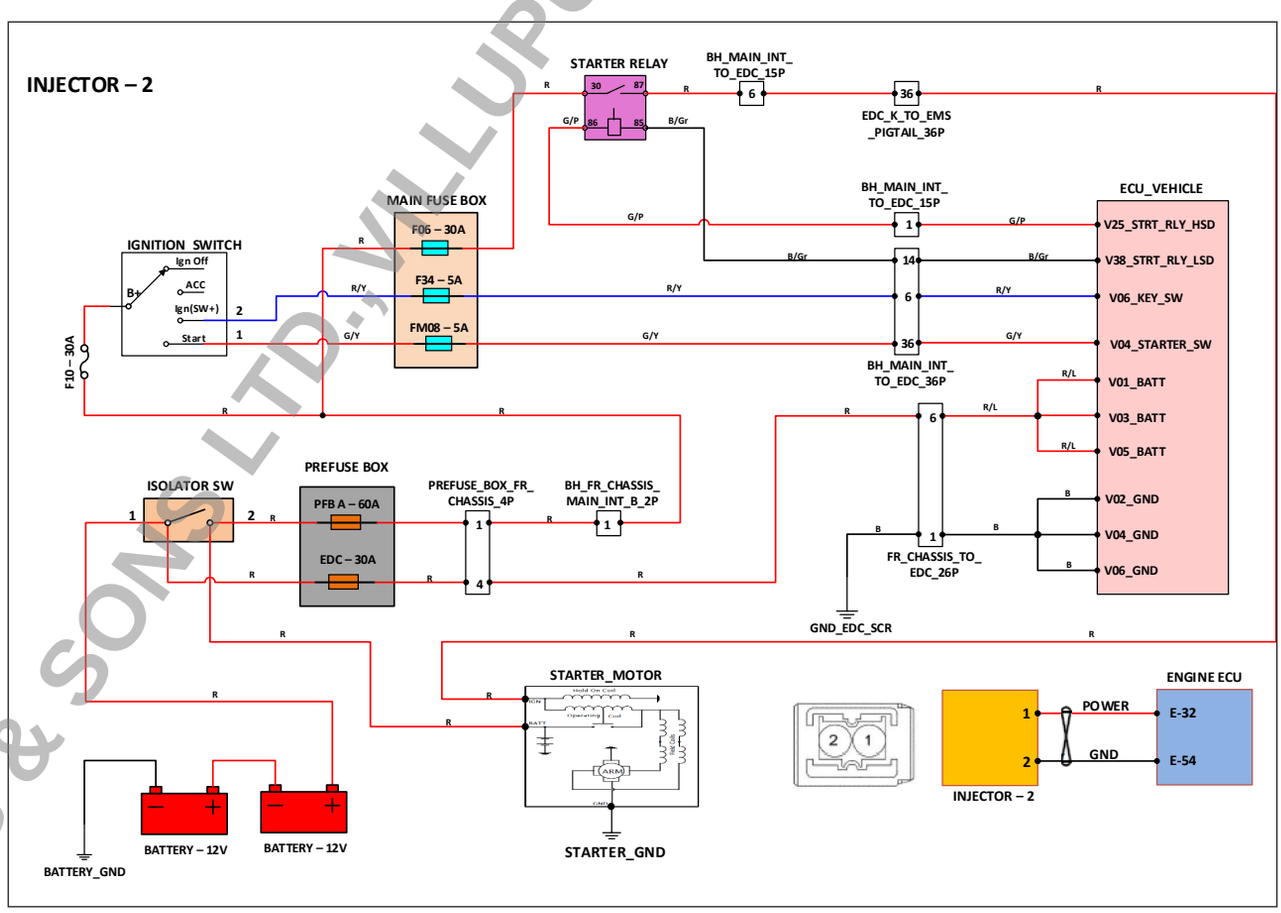
Error Code (Hand held diagnostic tool)	Description	Reactions
P2148	Injector Bank 1 short circuit	Engine rpm limitation at 1750
P2151	Injector Bank 2 short circuit	
P2147	Injector Bank 1 open load	
P0201	Injector 1 open load	Engine rpm limitation at 1750
P0202	Injector 2 open load	
P2150	Injector Bank 2 open load	
P0203	Injector 3 open load	
P0204	Injector 4 open load	
P0262	Injector 1 general short circuit	
P2625	Injector 2 general short circuit	
P0268	Injector 3 general short circuit	
P0271	Injector 4 general short circuit	
P0263	FBC correction quantities at limitation 1	No Reaction
P0266	FBC correction quantities at limitation 2	
P0269	FBC correction quantities at limitation 3	
P0272	FBC correction quantities at limitation 4	
P2696	Injector code not available in ECU	

Service Recommendation

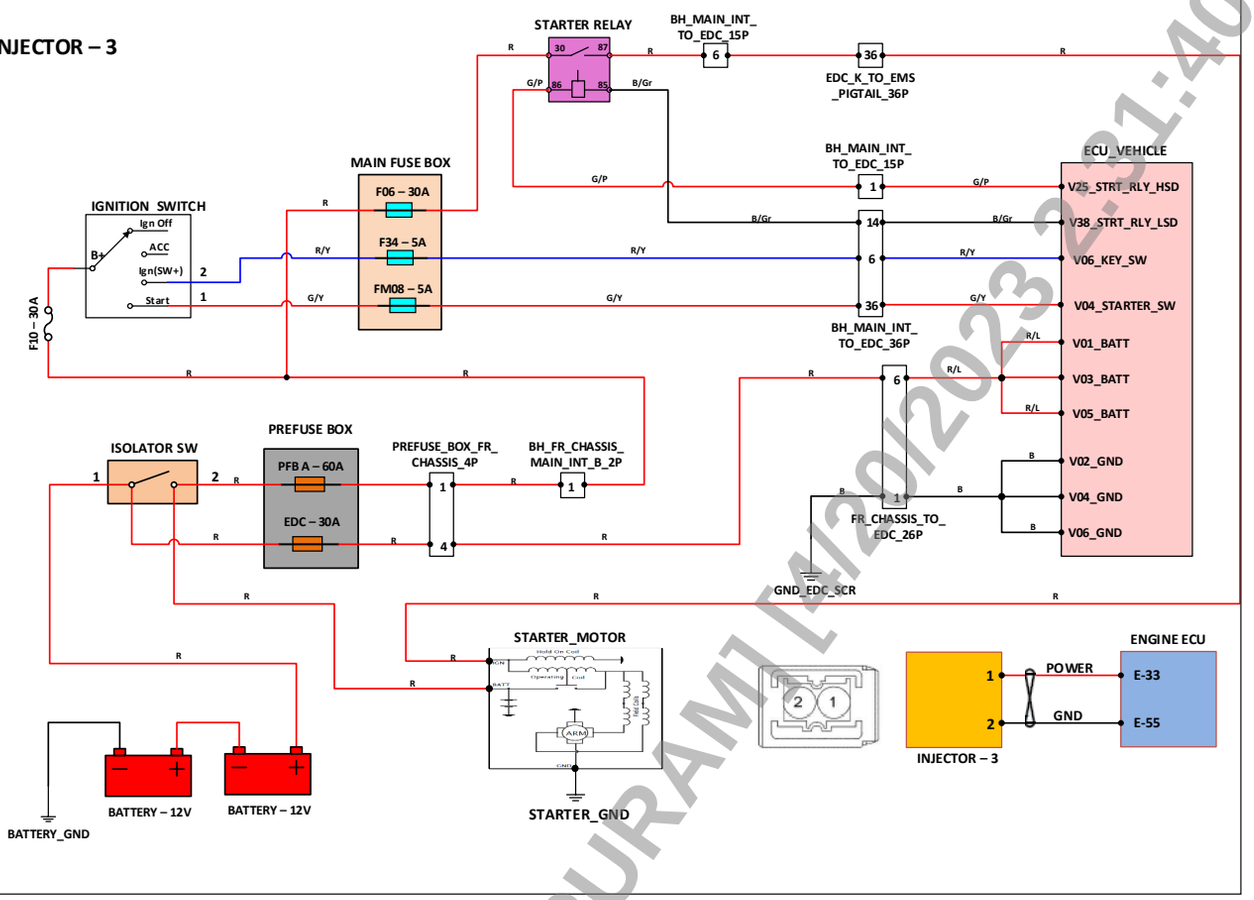
- Physically check for any loose connection of the Injector terminal.
- Check for physical contact of injector terminal or wiring harness short with each other.
- Check for continuity of the injector terminal with ECU side connector as per terminal Diagram
- The injector should be preserved in a dry,non salty and clean environment and it should be protected against whether (rain snow and sunshine) and impact

Circuit Diagram - TRUCK

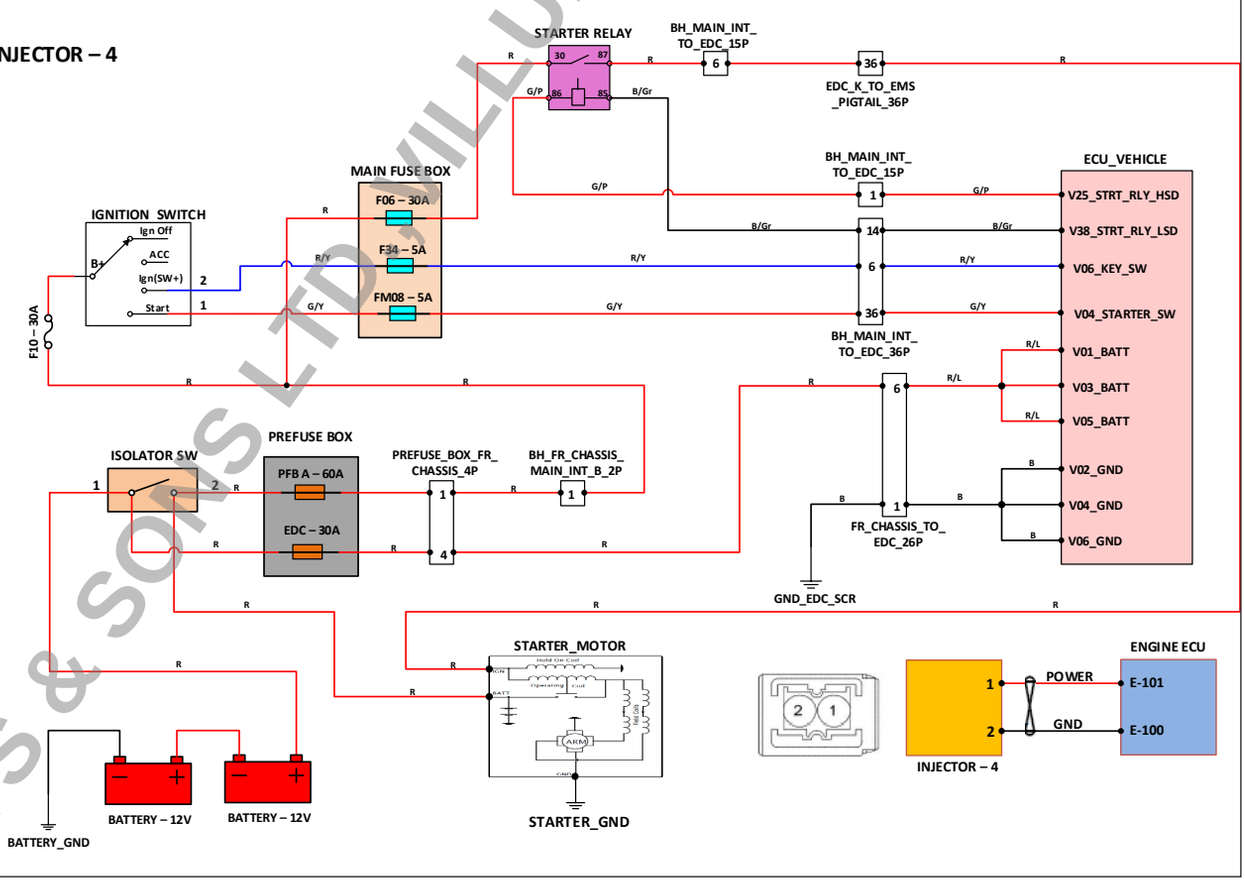




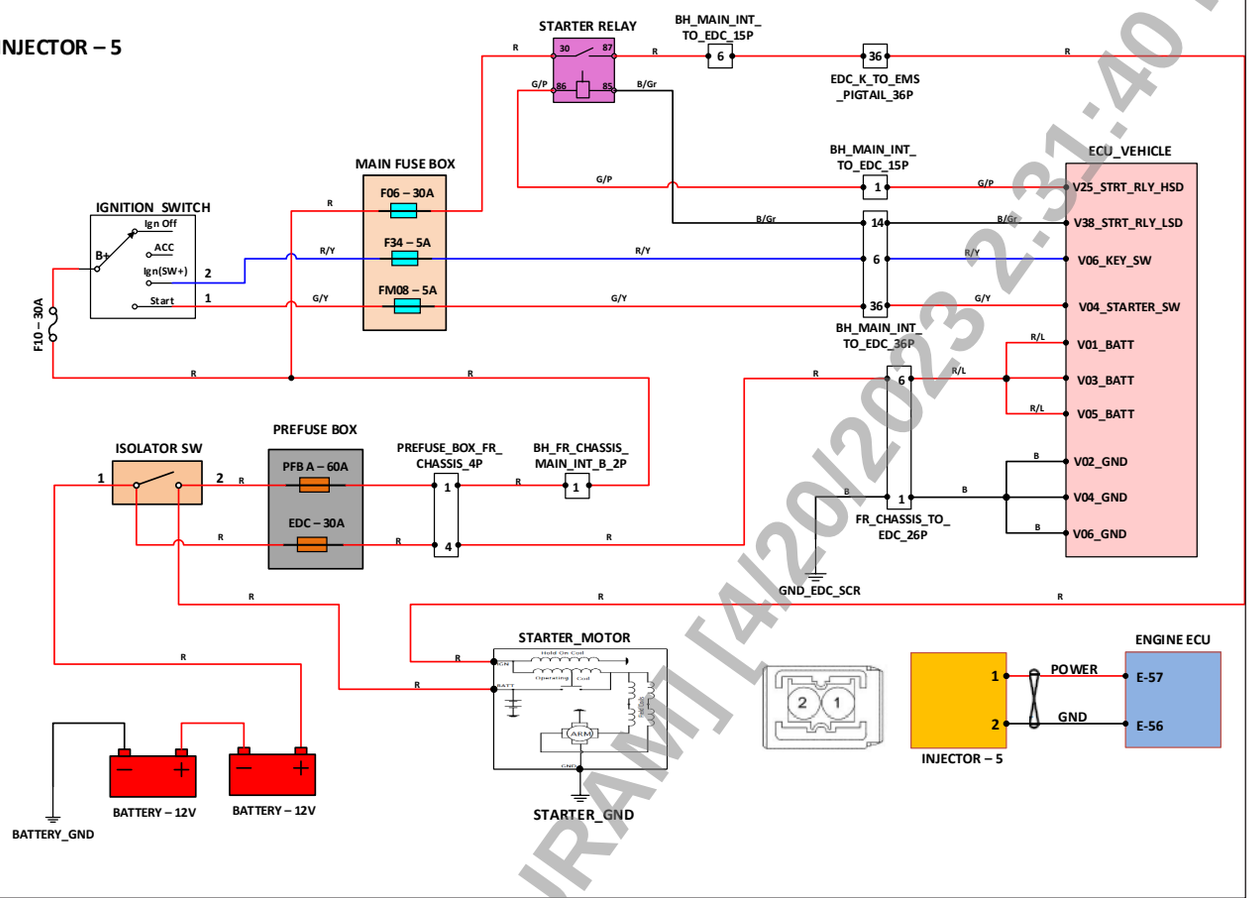
INJECTOR – 3



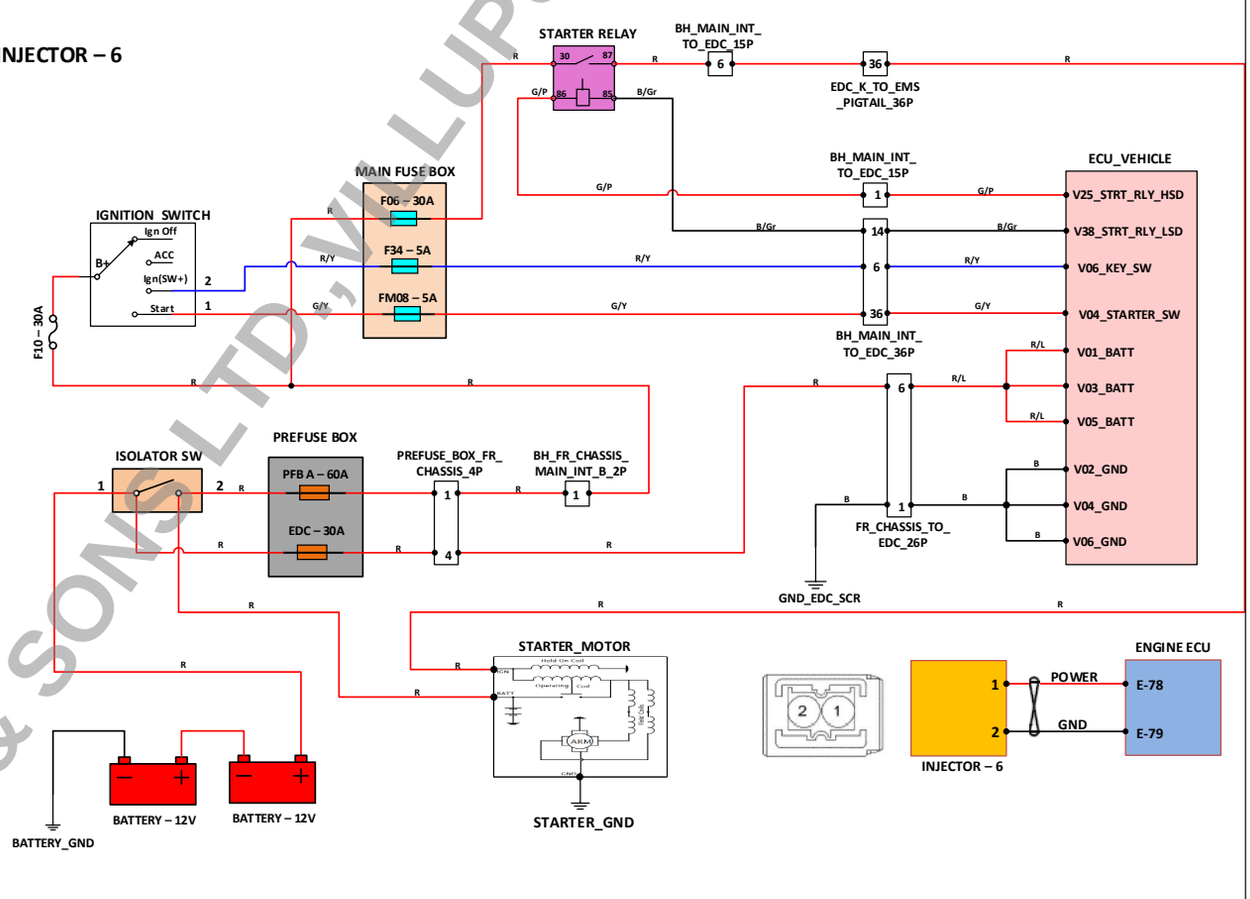
INJECTOR – 4



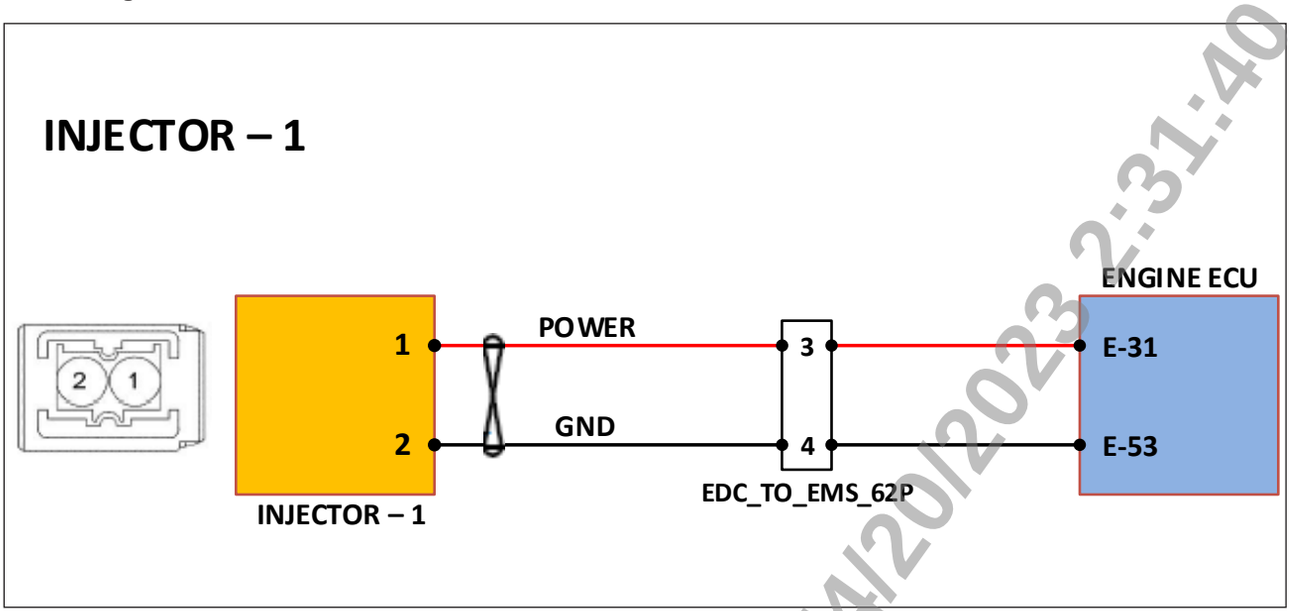
INJECTOR – 5

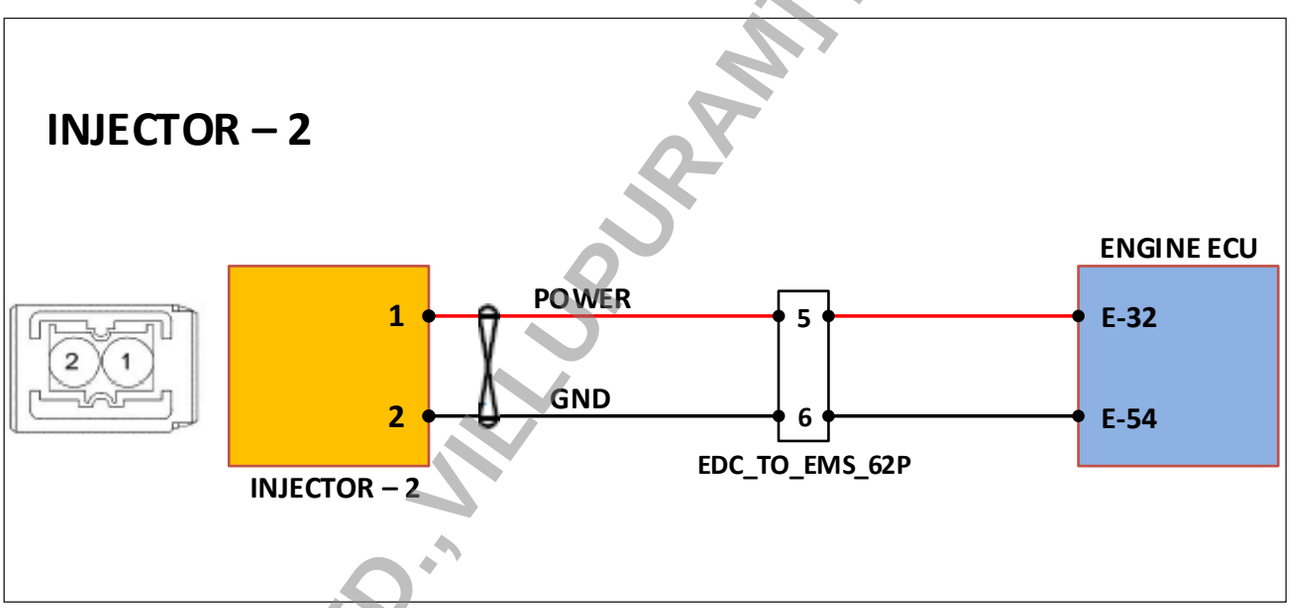


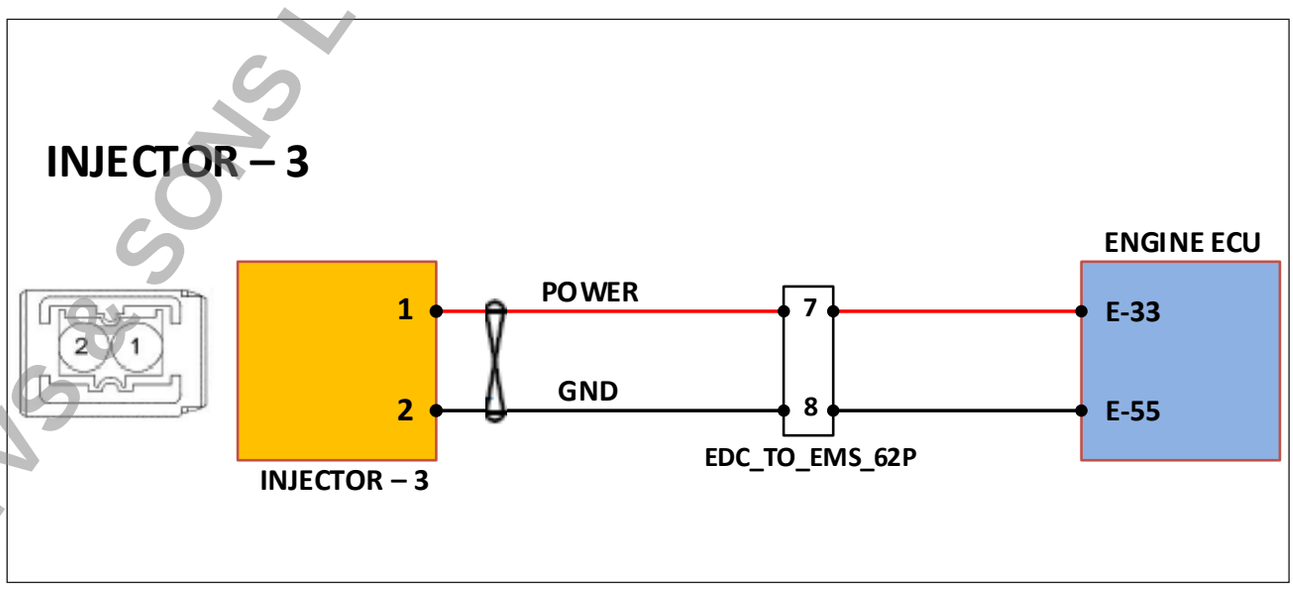
INJECTOR – 6



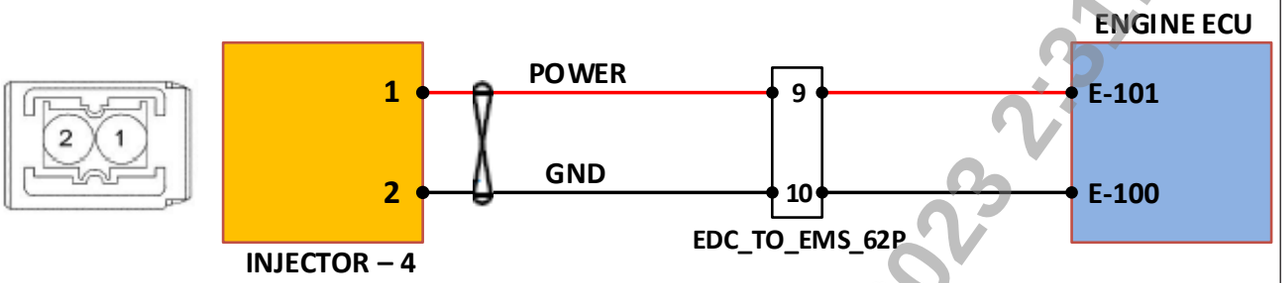
Circuit Diagram - BUS



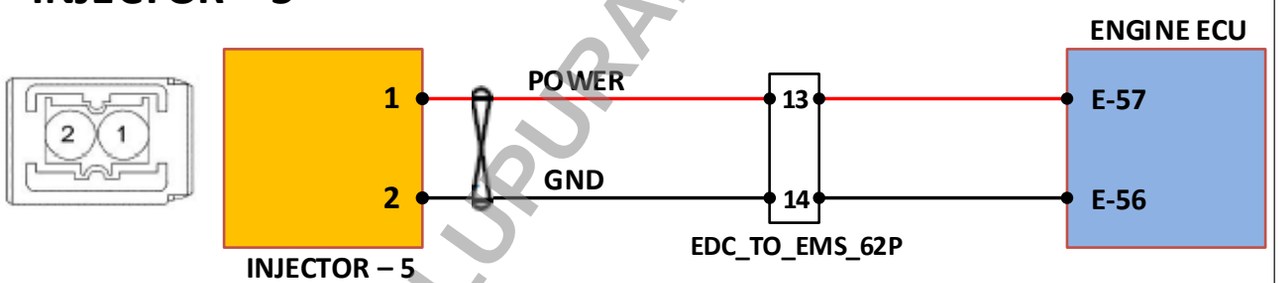




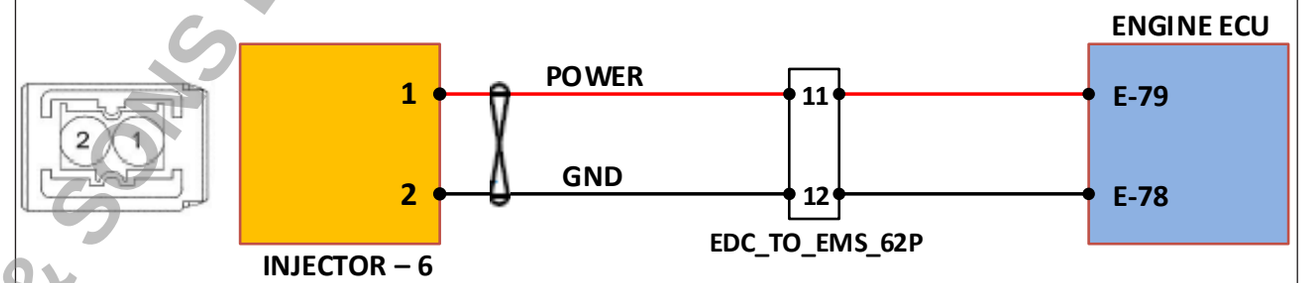
INJECTOR – 4



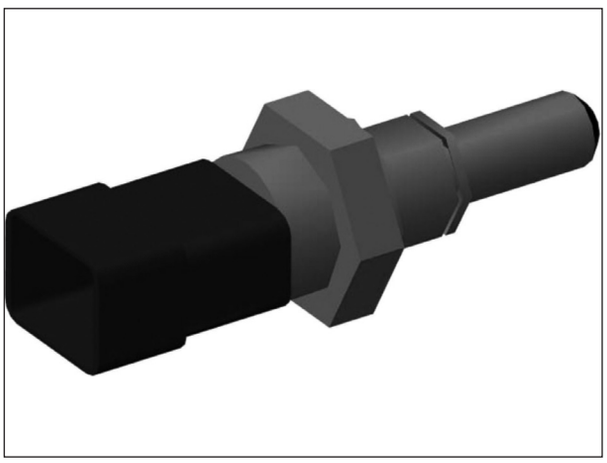
INJECTOR – 5



INJECTOR – 6



12.2.7 Coolant Temperature Sensor



Working principle:

It's based on NTC (NTC = Negative Temperature Coefficient) principle which when exposed to external heat, resistance drops drastically and provided the supply voltage remains constant, their input current climbs rapidly. This property is utilized for temperature measurement

Use:

To sense the engine operating temperature

Function:

NTC - Gives voltage inversely proportional to Temperature

Need: To measure engine coolant temperature

Location: On thermostat housing

No of pins: 2

Tightening torque : 20 - 25 Nm

Specifications

Resistance: At 40°C - 1.118 to 1.231 Kilo Ohms

Temperature range : - 40 to 130°C

Rated voltage : Operation by pull up resistance of 2.056k Ω (1.940k Ω to 2.173kΩ) at 25˚C.Fault Path

Error Code (Hand held diagnostic tool)	Description	Reactions
P0118	Coolant temperature sensor signal voltage above upper limit	40% Torque Limitation
P0117	Coolant temperature sensor signal voltage Below lower limit	
P0116	Coolant temperature sensor plausibility	
P0217	Engine Coolant Over Temperature Condition	Torque reduction - System protection

Service instruction

Check the resistance btw pin.no. 2 & 1 of coolant pressure sensor it should be in between

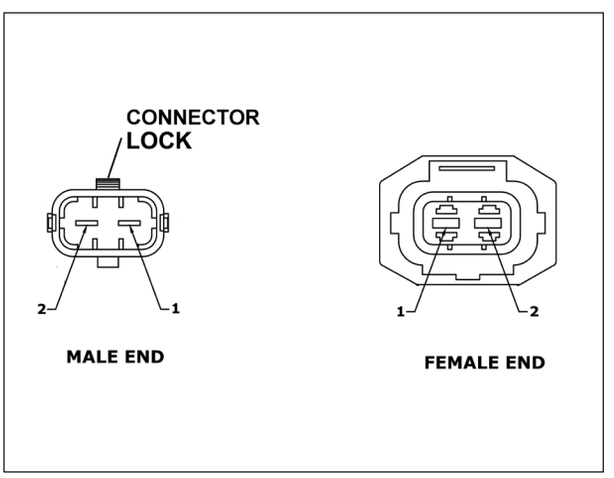
1. 1940 ohms to 2173 ohms at (25' c)

2. 1118 ohms to 1231 ohms at (40' c)

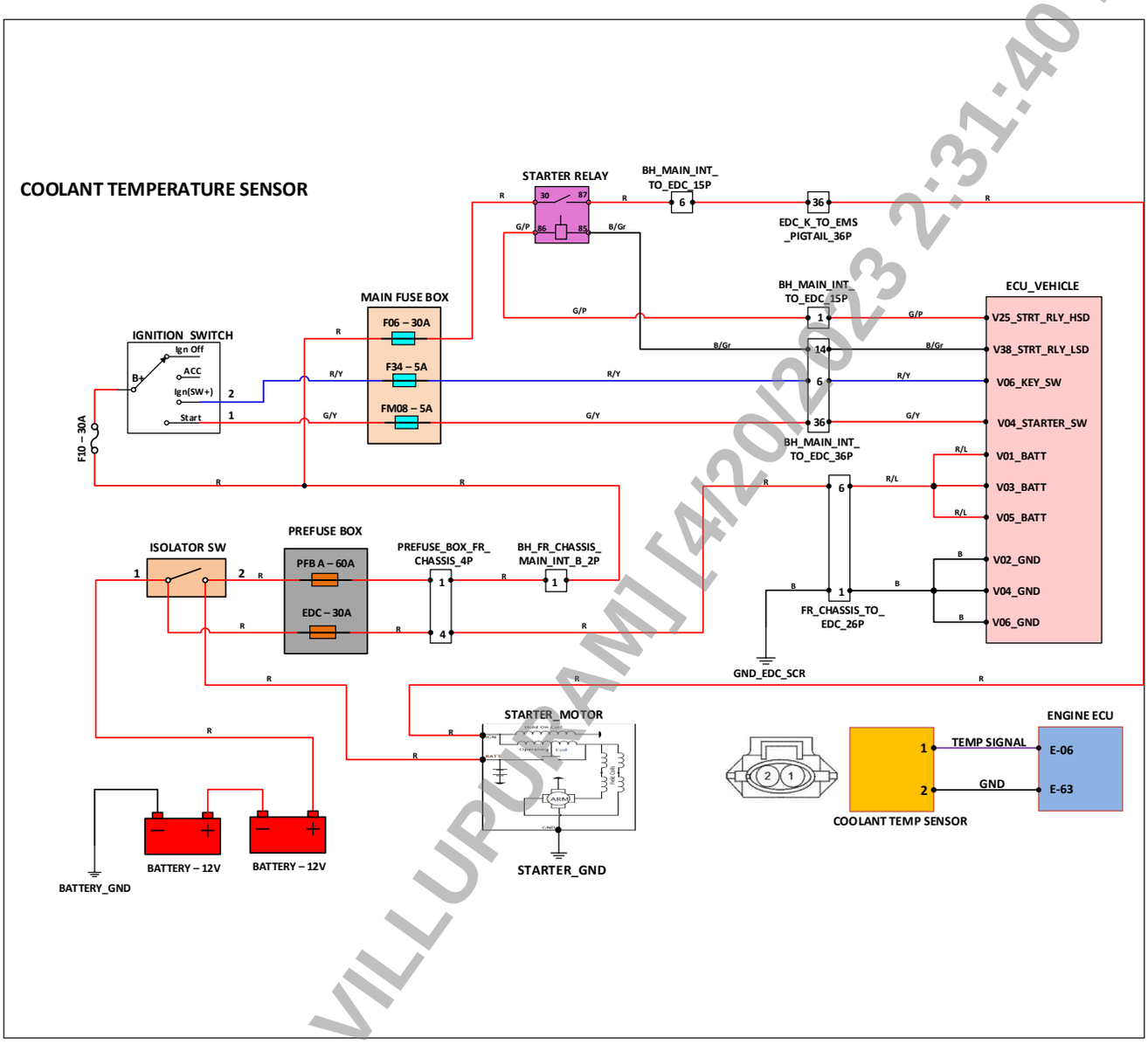
3. 573 ohms to 618 ohms at (60' c)

4. 313 ohms to 332 ohms at (80' c)

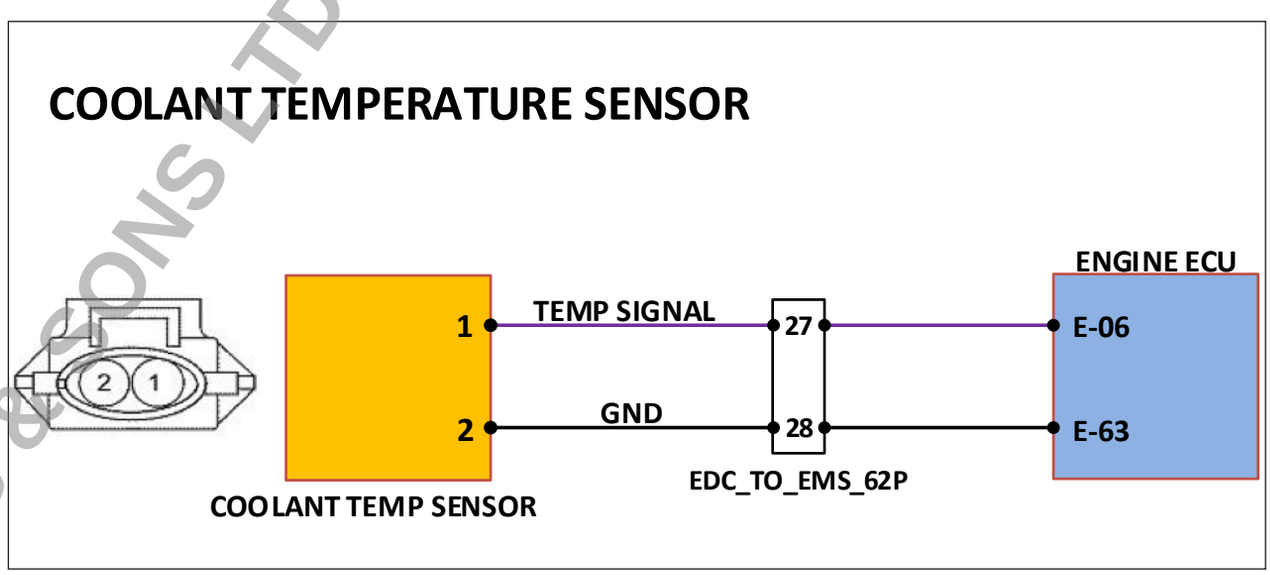
Pin configuration & connection details



Circuit Diagram - TRUCK

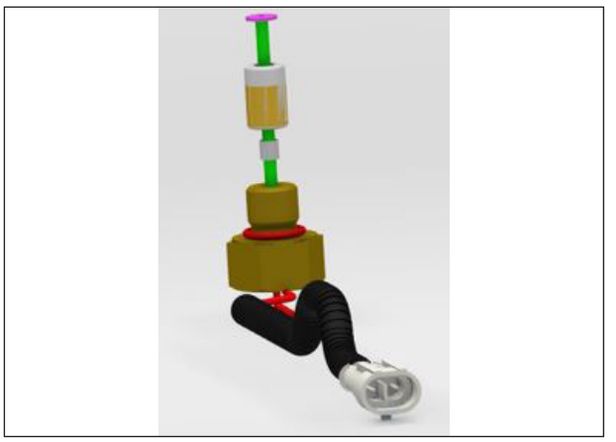


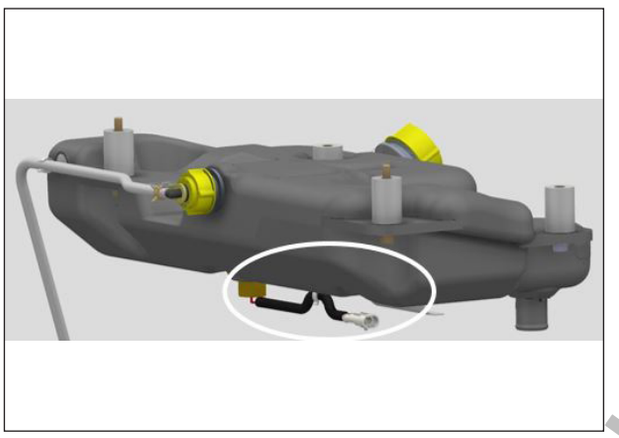
Circuit Diagram - BUS



Connect a multimeter across the two terminals and measure the resistance across it. It should show a resistance beyond the limit of 2.056k Ω (1.940k Ω to 2.173k Ω)at 25˚C.

12.2.8 Coolant level switch





Function: When coolant level changes, magnet in the float activates the Reed switch (Sending a voltage signal)

Need: To know the level of coolant.

Working principle: Reed switch type

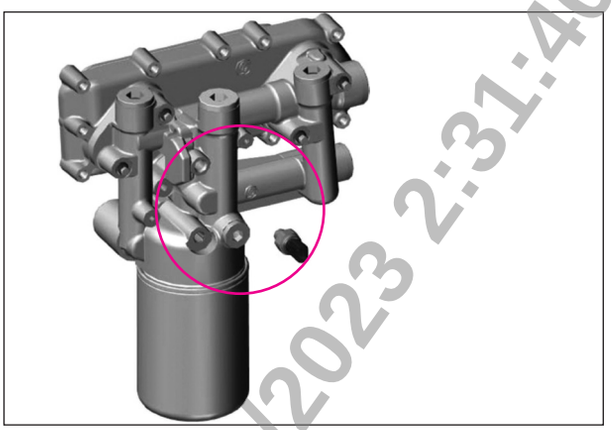
Location: Bottom of deaeration tank.

Initial contact resistance: 150 m Ohm

No of pins: 2

Operating temperature: - 35 to 120 deg C

12.2.9 Oil Pressure & Temperature Sensor



Technology used: Temperature sensing by thermistor, Pressure sensing by piezo-resistive element in MEMS (Micro-Electro Mechanical Systems) technology. [Active sensor]

Function: Measures the temperature and pressure of the lubrication oil in the engine, and notifies the ECU at very high oil temperature and low oil pressure conditions.

Location: On Oil Cooler Module (OCM)

Working Principle:

Sensing element is a Piezo-resistive strain gauge in a wheat stone bridge arrangement. When the element is subjected to pressure it flexes due to which the resistance of the it changes, consequently generating a voltage due to imbalance in the wheat stone bridge circuit. This voltage gives the change in resistance which in turn can be calibrated with that of the pressure that caused the deflection.

The temperature sensing element is a Negative Temperature Coefficient (NTC) type of thermistor When temperature of air increases the resistance of the sensing element decreases.

Installation:

Smear grease on the O ring of Oil temp and pressure sensor. Place the sensor on the mounting hole provided on the Oil cooler alumimum housing.

Tightening torque : 11.5 Nm

Specifications:

Pressure sensor:

Pressure range: 50 – 600 kPa

Supply voltage: 5 V

Nominal Output Transfer Function of Pressure Sensor

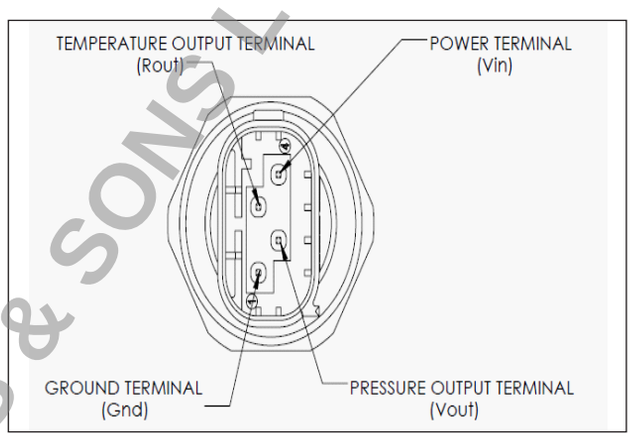
Temperature sensor:

Temperature range: -40 – 140 ºC

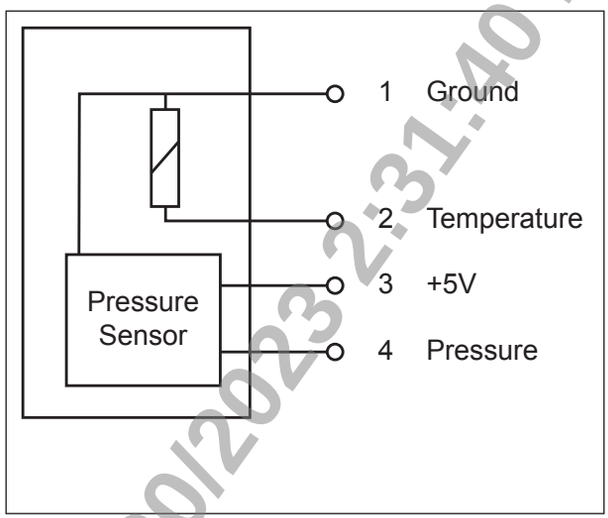
Characteristic of Temperature Sensor

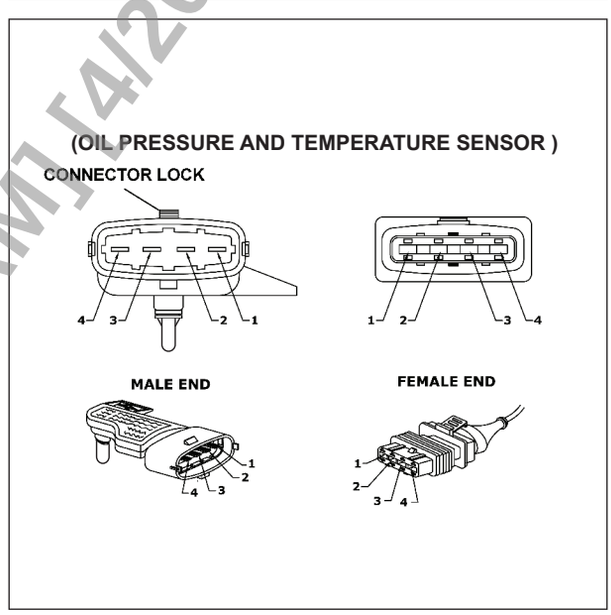
Fault Path:

DTC code (Hand Held diag-nostic tool)	Description	FAULT REACTION
P0198	Oil Temperature sensor signal voltage above upper limit	No Reaction
P0197	Oil Temperature sensor signal voltage below lower limit	
P0523	Oil pressure sensor signal voltage above upper limit	Engine rpm limitation at 1750
P0522	Oil pressure sensor signal voltage below lower limit	
P0524	Low oil pressure error	80% Torque Limitaion
P0298	Oil temperature too high plausibility error	Engine protection torque limitation



Pin Configuration and connection details





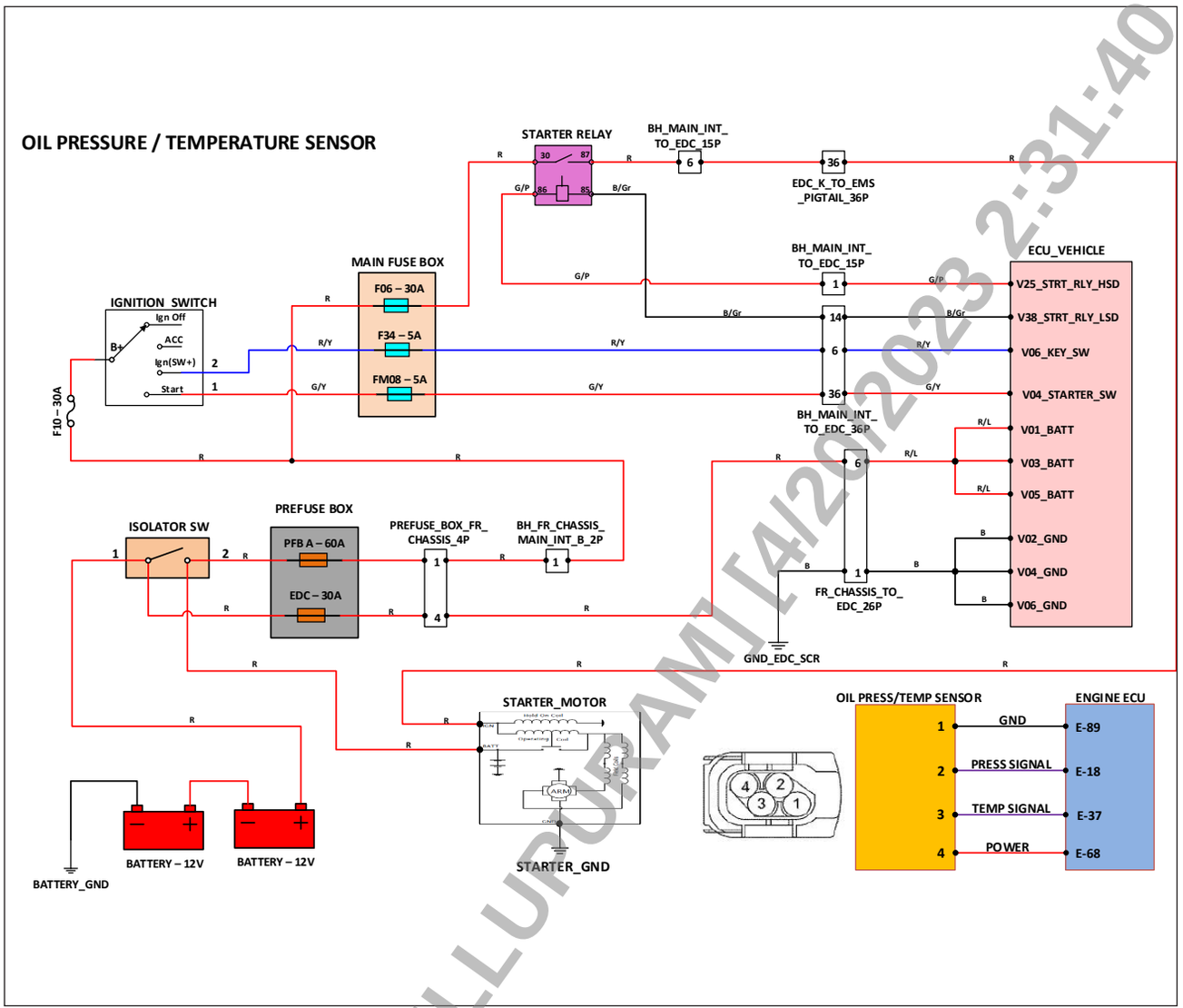
Continuity check for Temperature Sensor:

Pressure sensor: Nil

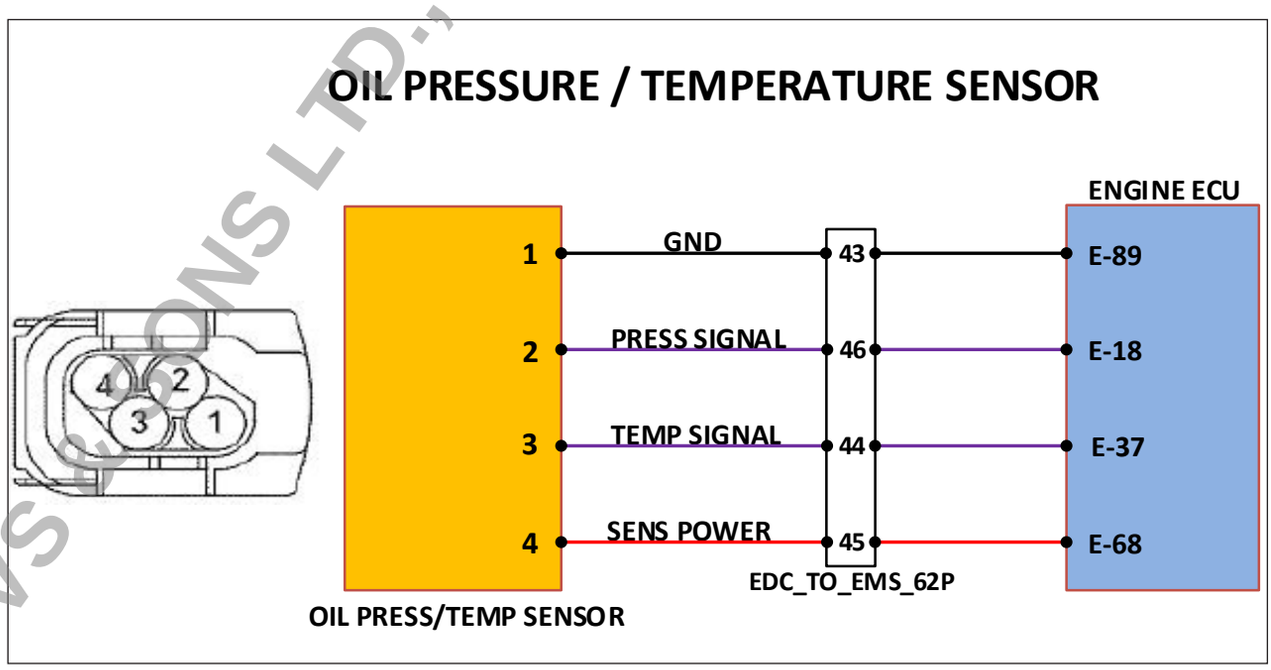
Temperature sensor: The resistance between ground and temperature output pins must be

~1.581 - 1.697 kOhm @30 ºC

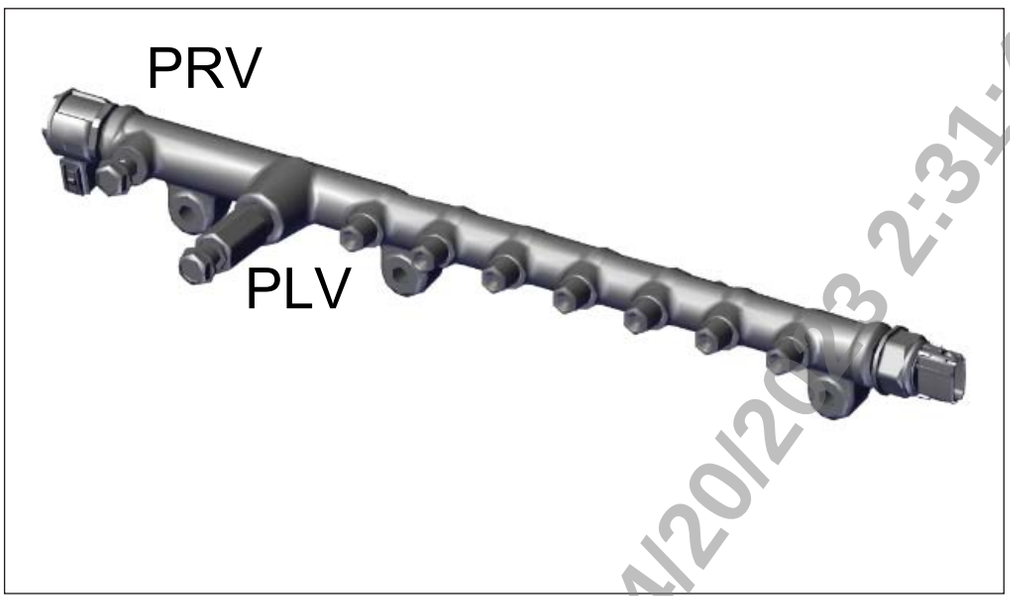
Circuit Diagram - TRUCK



Circuit Diagram - BUS



12.2.10 Rail Pressure Sensor



Function & working principle:

Rail pressure sensor is integrated with common rail used to measure and maintain the required fuel pressure inside the common rail.

- Electrical circuit with analog output
- Piezo resistor type pressure sensor
- Range up to 2000 bar abs

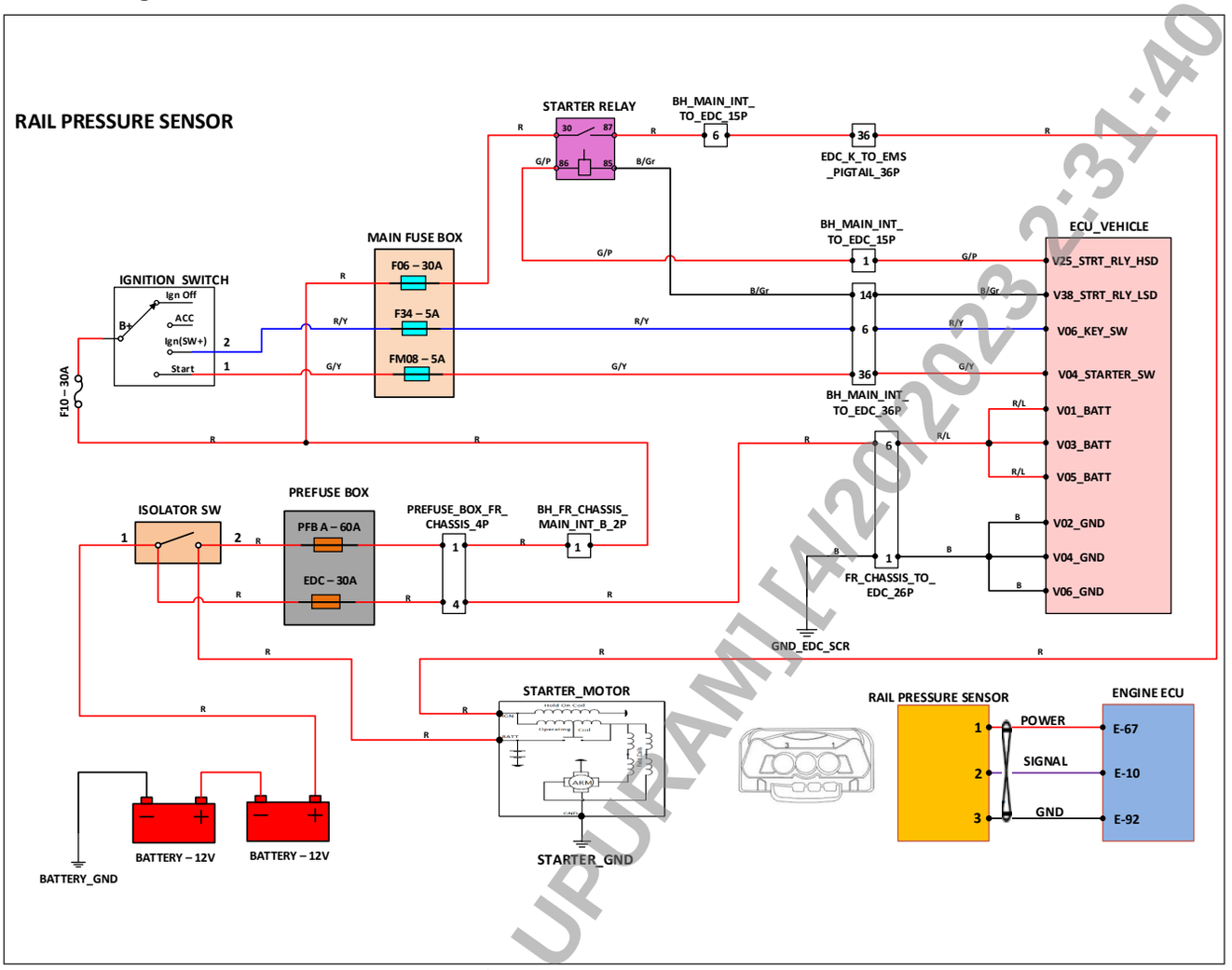
Fault Path

Dtc Code (Hand Held Diagnostic Tool	Description	Reactions
P0193	Rail Pressure Sensor signal voltage above upper limit	40% Torque Limitation & EGR Shut Down
P0192	Rail Pressure Sensor signal voltage below lower limit	
P0191	Rail pressure sensor drift (pos and neg drift)	25% Torque Limitation

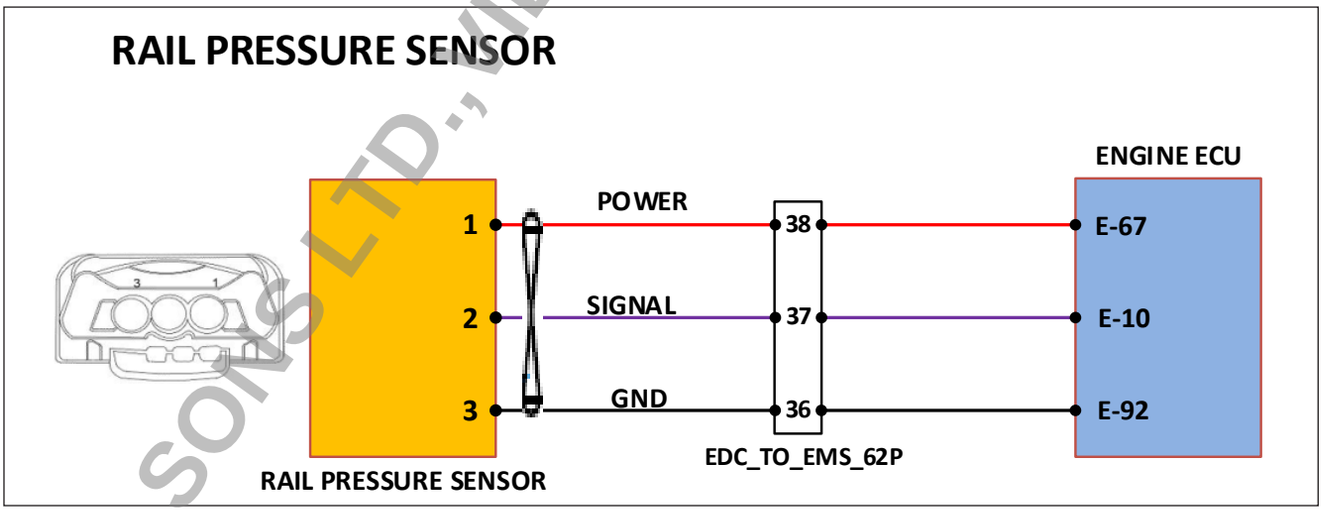
Recommendation:

Refer Chapter: Trouble shooting using error code

Circuit Diagram - TRUCK



Circuit Diagram - BUS



SENSOR CHECK :

1. Check wiring harness continuity and short circuit
2. Check the sensor signal voltage through tester.
3. Voltage should be 500+or- 40mv

Replace sensor - if the voltage is out of specified limit

12.2.11 Vehicle Speed Sensor

WORKING PRINCIPLE : vehicle speed sensor generates a magnetic pulse in the form of a wave proportional to the speed of the vehicle

LOCATION : Vehicle speed sensor mounted on gearbox (output flange)

FUNCTION : To determine the speed of the vehicle and distanced travel vehicle

Installation:

Vehicle speed sensor is mounted on the gearbox at speedo drive output shaft for Manual transmission.

Note: In Automated Manual Transmission (AMT), Vehicle speed signal will be sent to Engine ECU through CAN by AMT ECU.

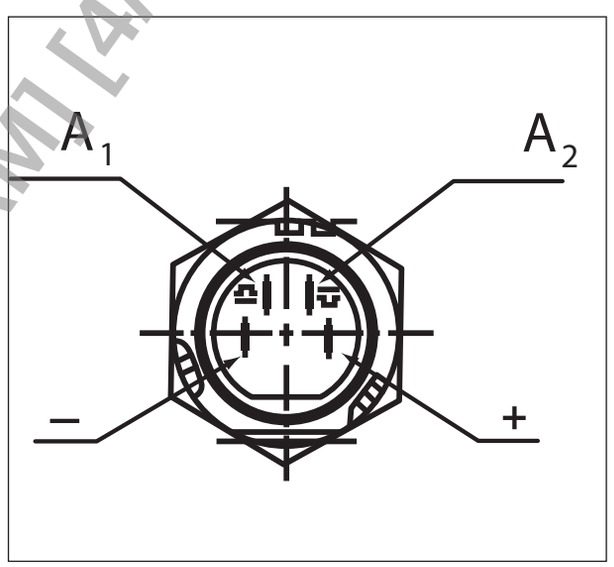
Specifications:

Operating Voltage	:	9 to 32 V
Supply Current	:	18mA max
Output Signal	:	V Bat - 1.5 V

FAULT PATH

Error Code (Hand held diagnostic tool)	Description	Reactions
P0503	Maximum threshold error for Vehicle speed sensor	No Reaction
P0501	Plausibility defect for vehicle speed	Engine Speed limitation w.r.to drive line configuration

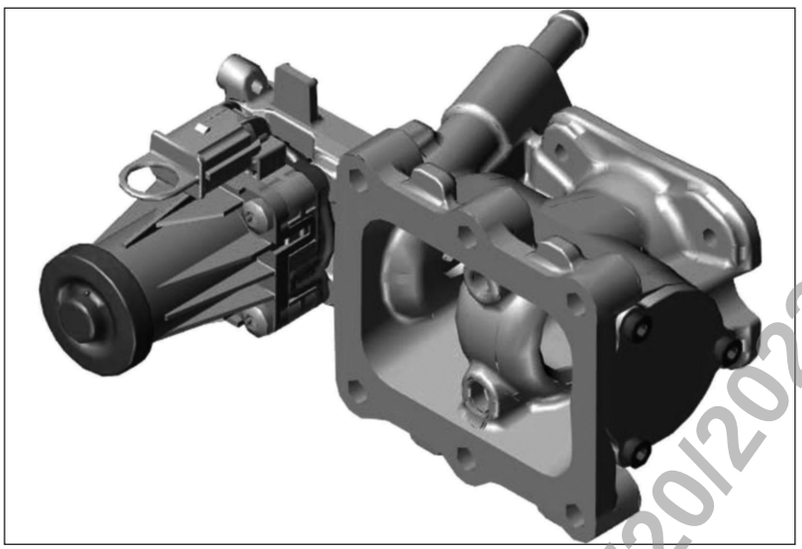
Pin Configuration & Connection details :



SENSOR CHECK :

1. Check vehicle speed in vehicle static condition, through scan tool live data.
2. It should be zero. if not zero replace the vehicle. speed sensor

12.2.12 EXHAUST GAS RECIRCULATION



Technology used: DC motor driven valve.

Function: Controls the amount of exhaust gases to be re-circulated to the intake manifold.

Location: mounted on EGR mixer pipe (Intake manifold side)

Working Principle:

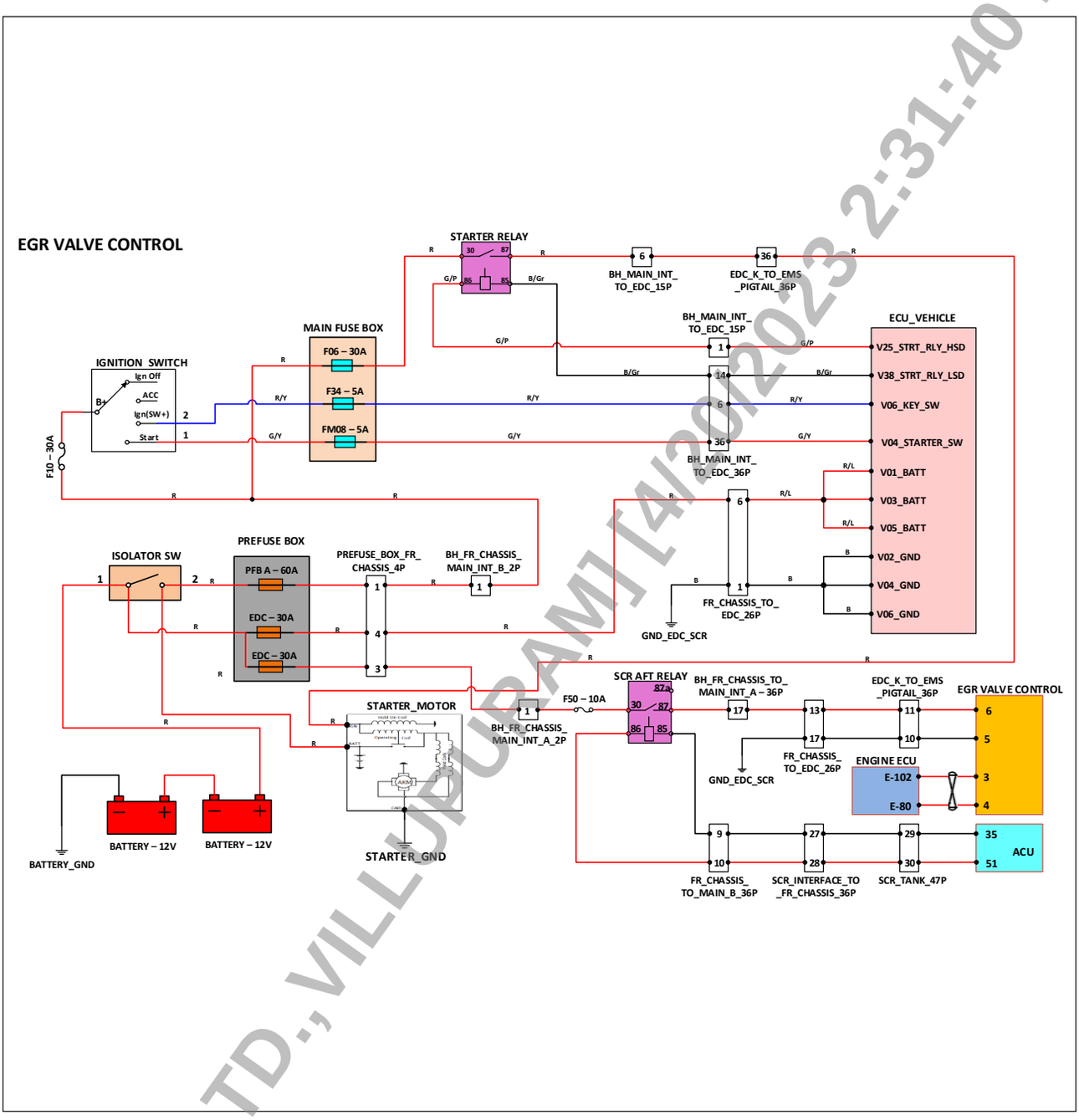
The EGR valve controls the flow rate of exhaust gases to the intake manifold.

The brushless DC motor drives the EGR valve to the position as per the input from control unit.

Fault Path

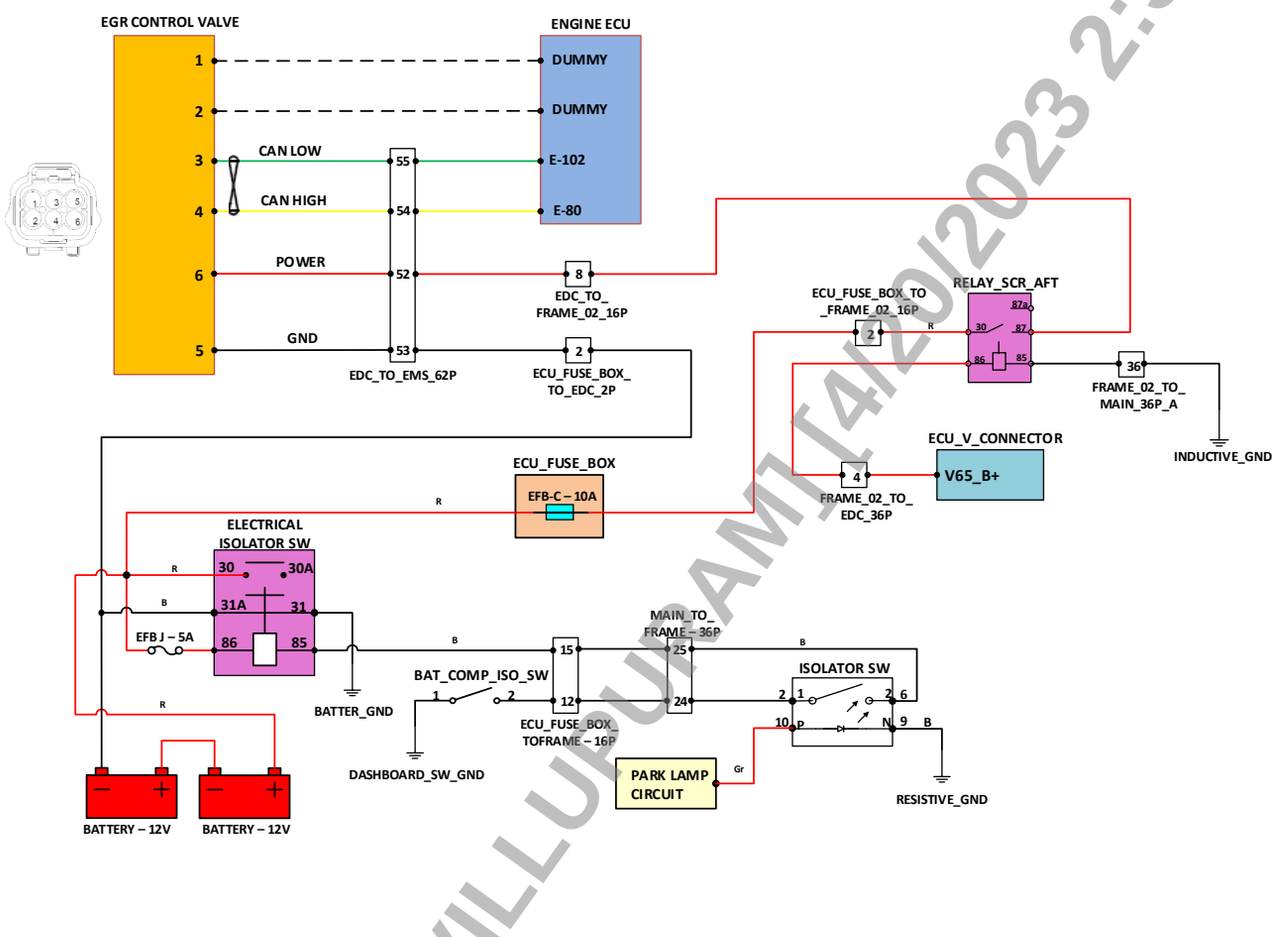
Error Code (Hand Held Diagnostic tool)	Description	Reactions
P0405	EGR Valve position sensor signal voltage below lower limit	low level inducement (25% trq limitation) if >100 hrs severe inducement (20 kmph) & EGR Shut down
P0487	EGR Valve Open load error - H bridge	
P0406	EGR Valve position sensor signal voltage above upper limit	
P213A	EGR valve Short circuit to battery/ground at Out1 / out2	
P042E	EGR valve jammed at closed position	low level inducement (25% trq limitation) if >100 hrs severe inducement (20 kmph)
P2457	Low EGR Cooler Efficiency	No Reaction
P0402	EGR High flow	
P0401	EGR Low flow	
P1201	EGR DC motor thermal protection	No Reaction but EGR duty limited for 30 mins

Circuit Diagram - TRUCK

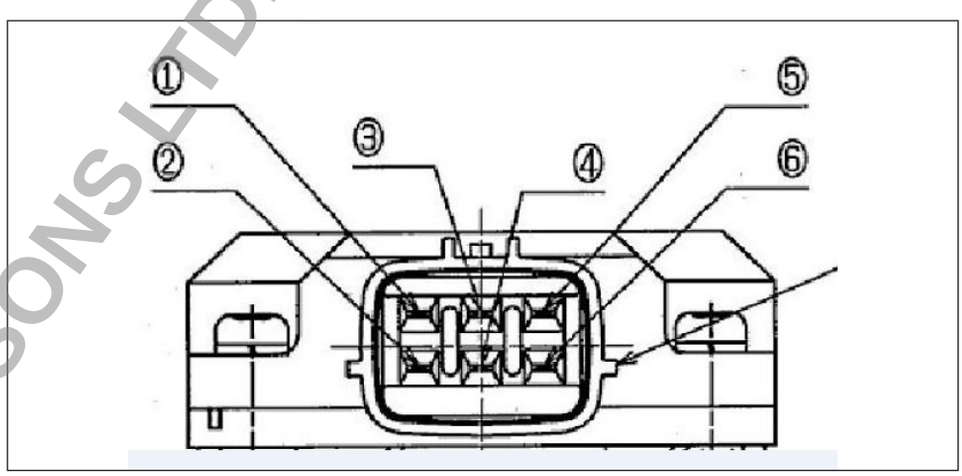


Circuit Diagram - BUS

EGR CONTROL VALVE



Pin Configuration and Connector details



NOTE

There will be an electrostatic discharge which tends to damage the sensor inside the EGR DC motor.

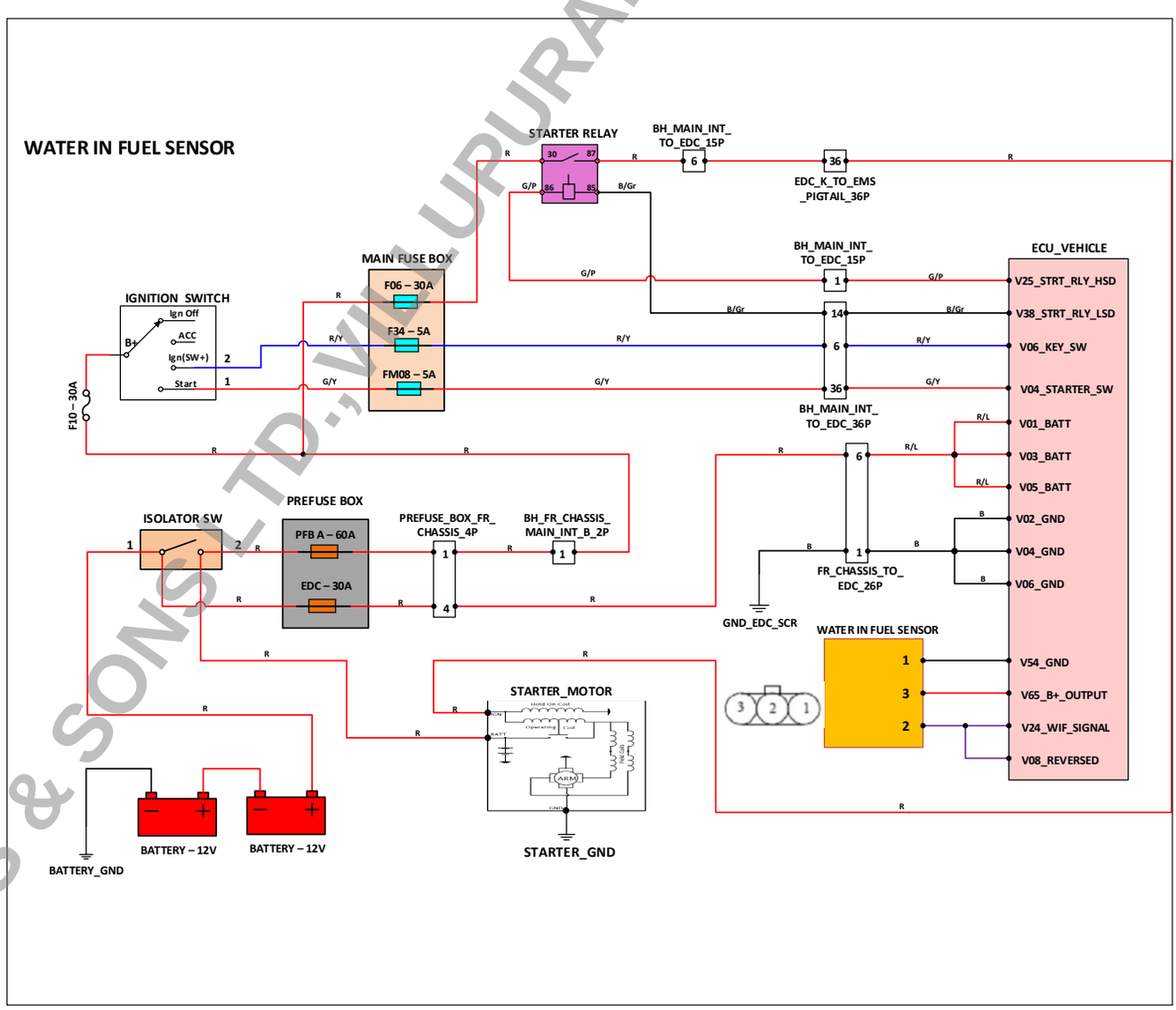
12.2.13 Water-in-Fuel sensor

Working principle:

The purpose of the sensor is to detect the presence of water in diesel fuel. The sensor is mounted on water filter assembly inside of the fuel filter and has two main output signal stages, low level and high level, which identify the presence and absence of water. The output signal level is changed when water reaches a defined water level in the fuel filter.

Operating temperature range: -40°C to +135°C

Circuit Diagram - TRUCK

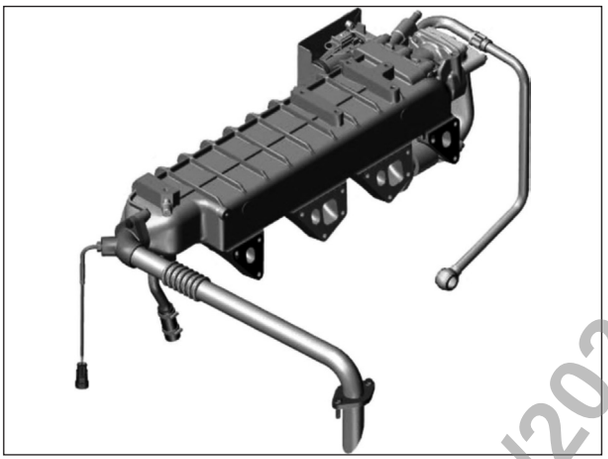


Use:

To indicate the driver that water level has exceeded and needs immediate attention (draining the water)

Error Code (Hand held diagnostic tool)	Description	Reactions
P2267	Water in Fuel Sensor Defective error	No reaction
P2269	Water in Fuel Detection	40% Torque Limitation

12.2.14 EGR Temperature Sensor :



Technology used: Resistance Temperature Detector PT-500 (Positive Temperature Coefficient-PTC)

Function: Measures the temperature of the exhaust gas recirculated into engine.

Location: Downstream EGR, Downstream Intercooler

Working Principle: When temperature of the EGR gas increases the resistance of the sensing element also increases.

Pin Confirguration: White wire: Ground

Grey wire: Sensor signal

Functionality check:

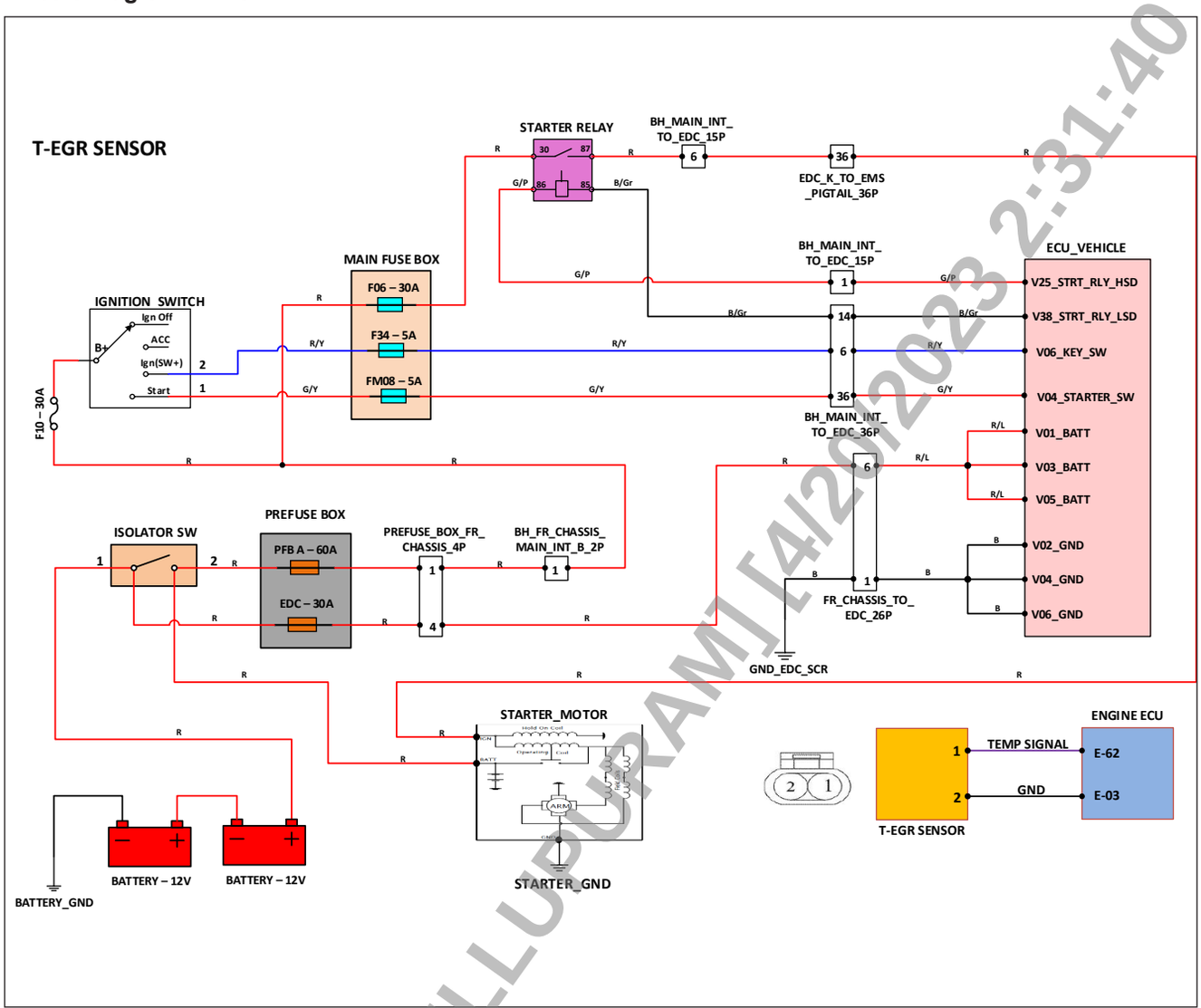
The resistance between pins 1 and 2 must be ~550 Ohm @30 ºC

Specification:

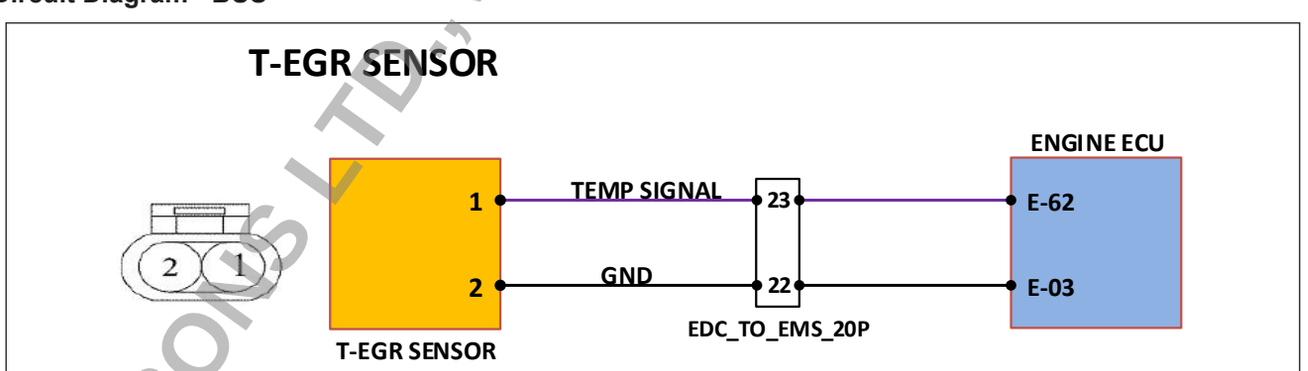
Temperature range: -40 – 500 ºC

Error Code (Hand held diagnostic tool)	Description	Reactions
P040D	SRC High for EGR Cooler downstream temp sensor	No reaction
P040C	SRC low for EGR Cooler downstream temp sensor	

Circuit Diagram - TRUCK



Circuit Diagram - BUS



Temperature Vs Voltage/ Resistance output:

T	Rs	UO	RSmin	RSmax
°C	W	V	W	W
50	597.99	1.871	593.17	602.8
200	880.28	2.341	875.68	884.87
500	1405.89	2.922	1398.39	1413.38

12.2.15 INTAKE THROTTLE VALVE

Technology used: DC motor driven throttle body (flap type), Sensor – Hall effect type position sensor

Function: Throttle body controls the amount of air flowing into the engine. Sensor provides actual position of throttle body blade.

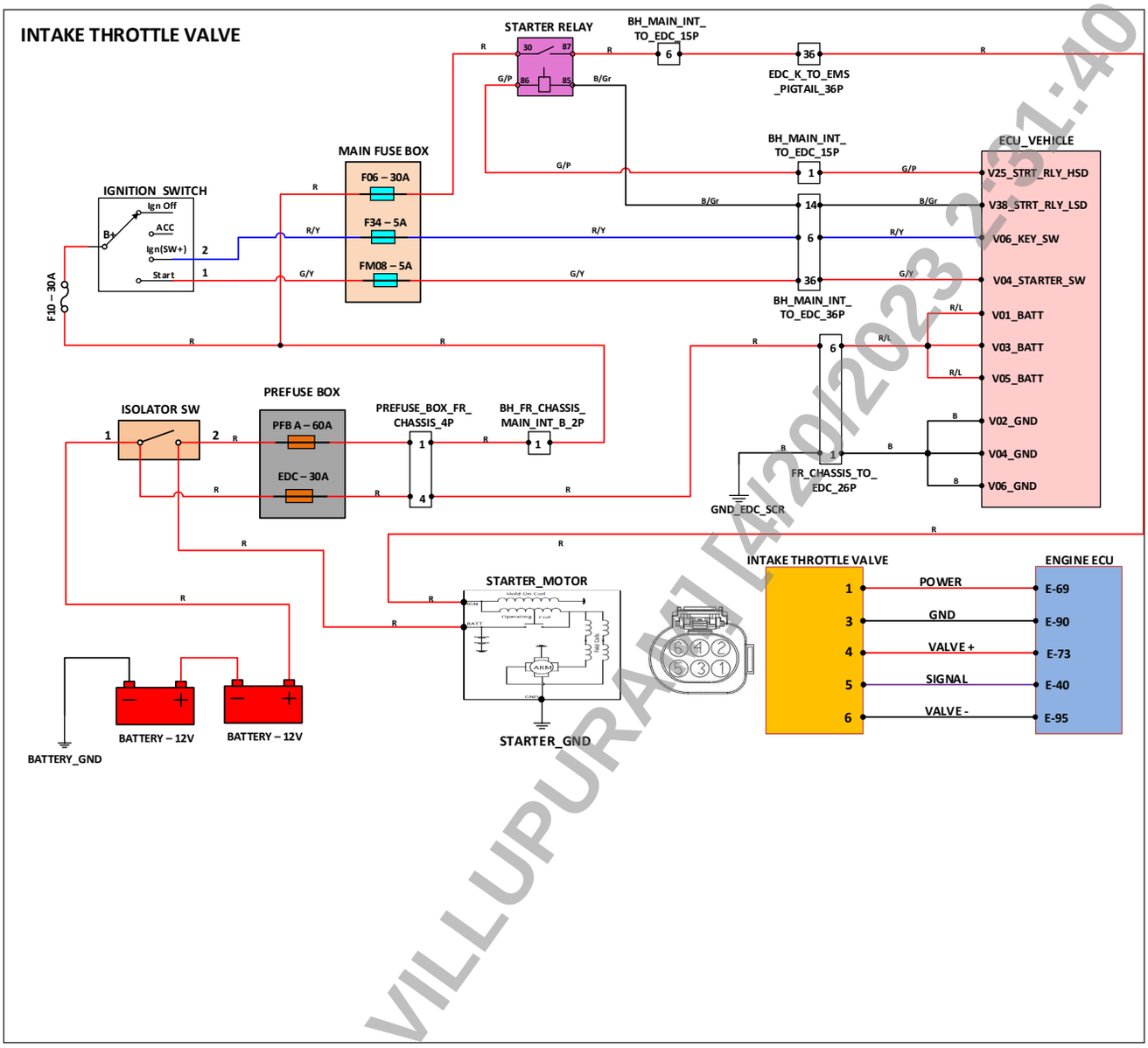
Location: Downstream intercooler before air intake manifold

Working Principle: The throttle body throttle the inlet-air and creates vacuum downstream

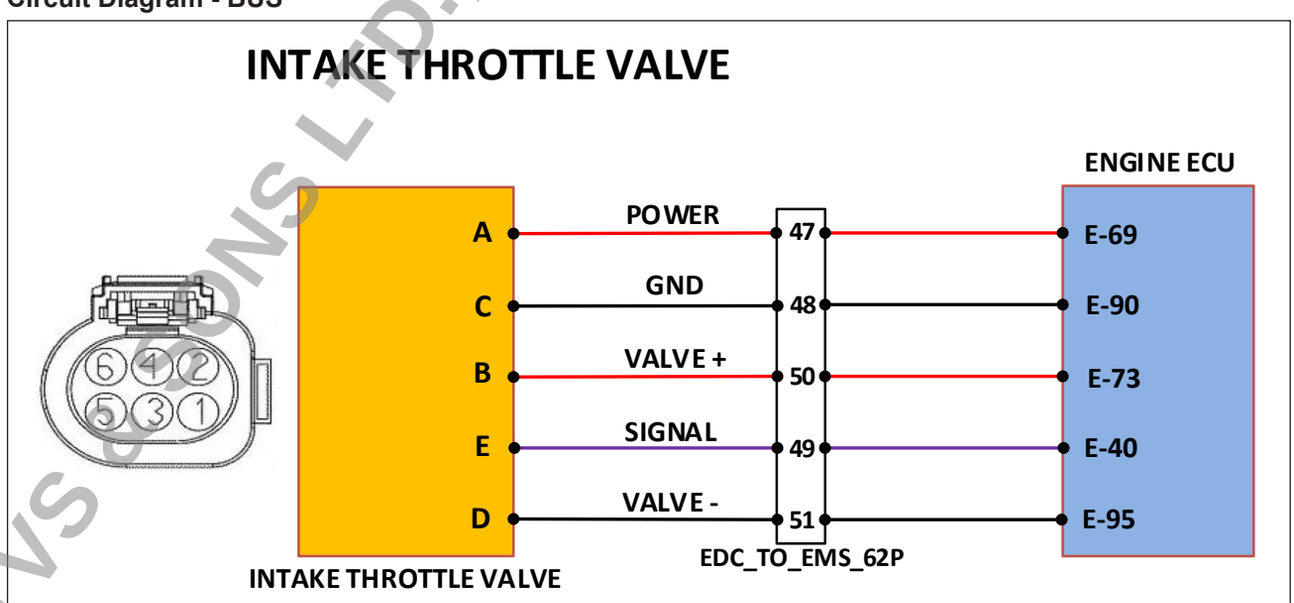
The electric drive positions the throttle blade. The electric drive consists of DC motor, 2 stage gear train and the position sensor

Error Code (Hand Held Diagnostic tool)	Description	Reactions
P2622	Throttle Valve SRC Max for Position feedback sensor	40% Torque Limitation & EGR Shut Down
P2621	Throttle Valve SRC Min for Position feedback sensor	
P2108	Intake Throttle Valve Governor Deviation	
P2100	Intake Throttle Valve H-bridge Open load	
P2103	INTAKE THROTTLE VALVE H-BRIDGE SHORT CIRCUIT ERROR	

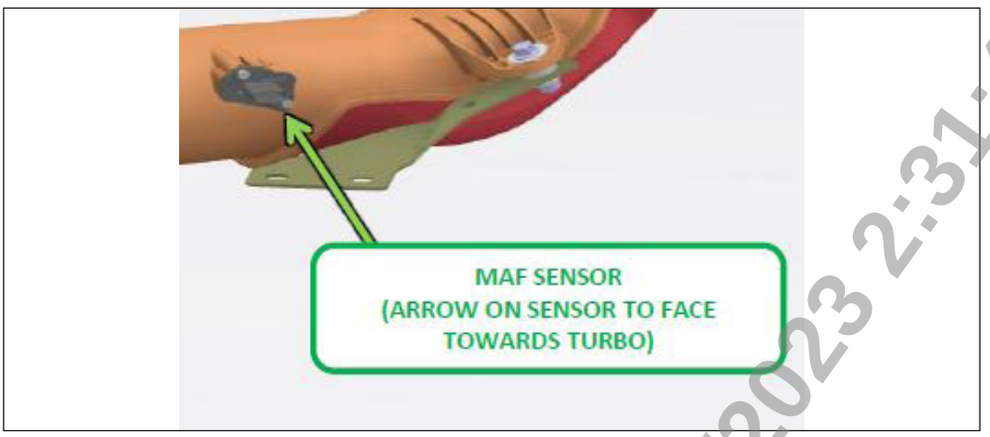
Circuit Diagram - TRUCK



Circuit Diagram - BUS



12.2.16 HFM Sensor

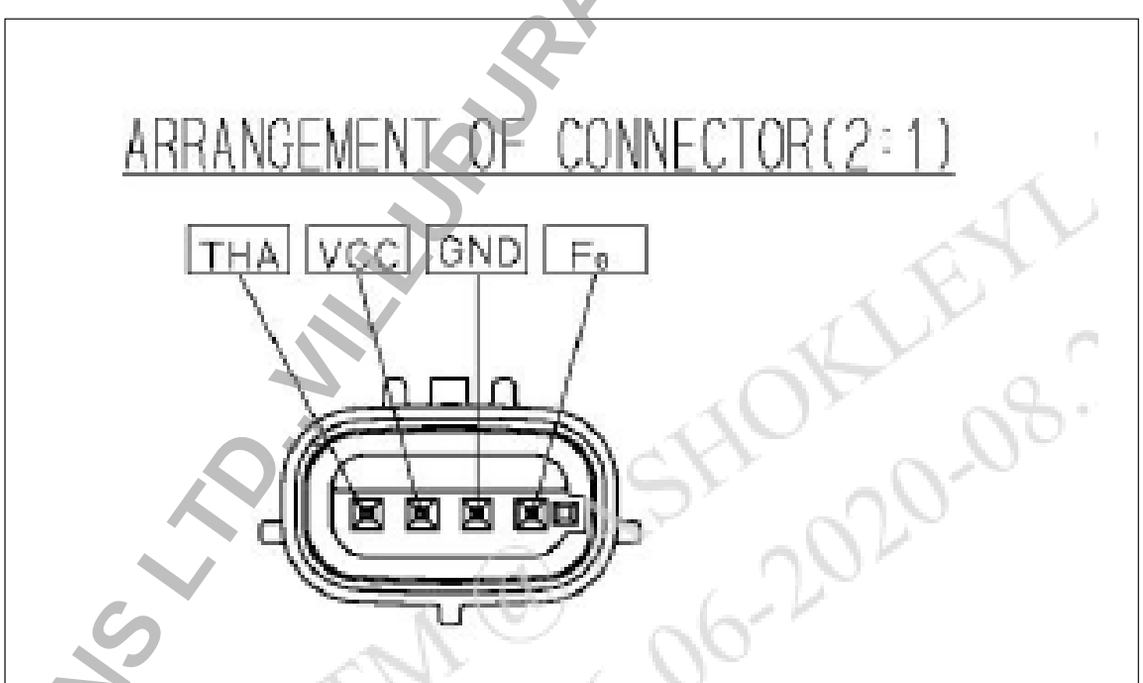


Technology used: Micro Electro Mechanical System(MEMS) Technology for mass flow, Thermistor for temperature measurement(NTC)

Function: Measures the mass flow of filtered fresh air entering the engine through the air intake system and measures the temperature of the fresh air in the Air Intake system

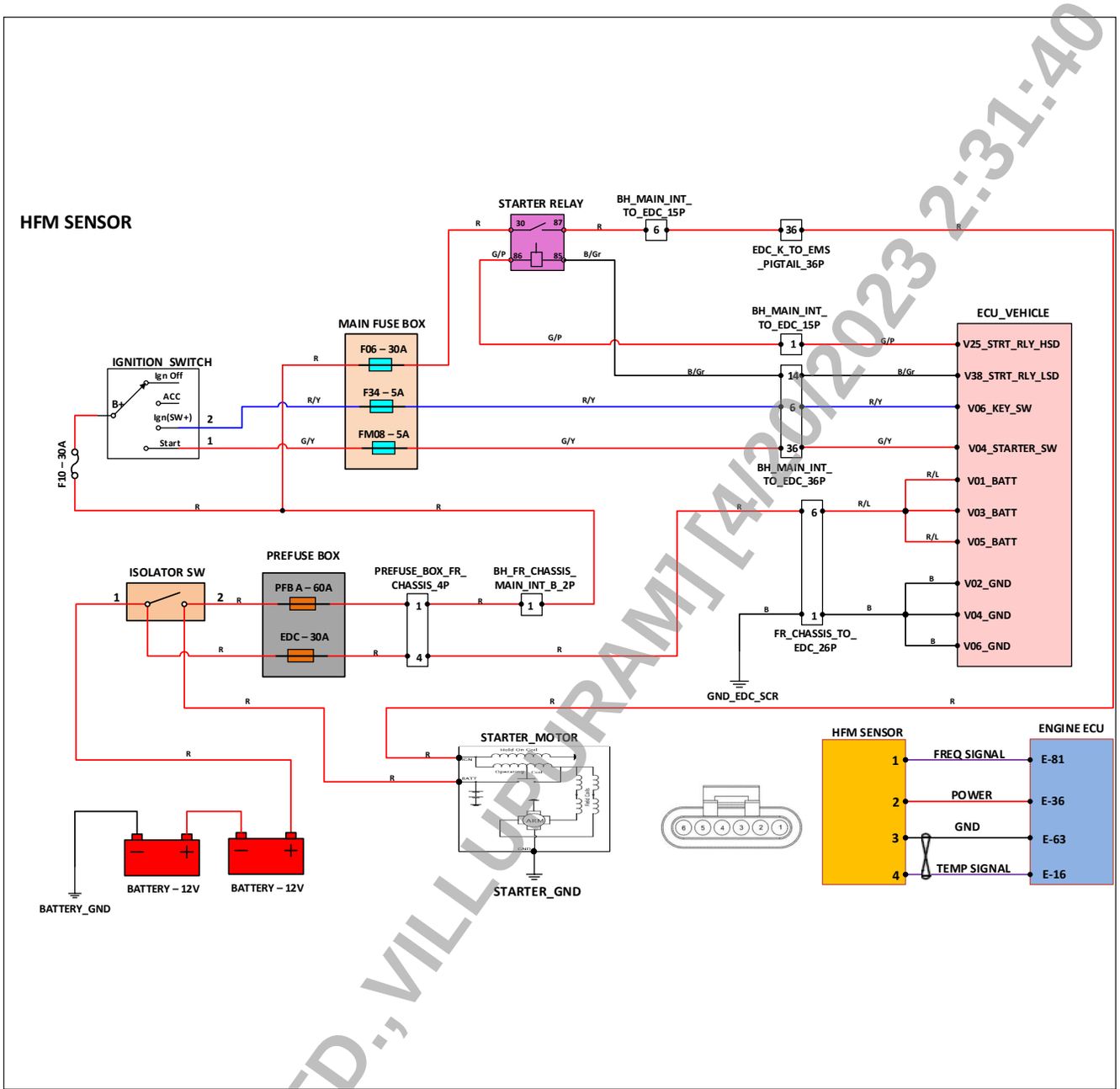
Location: In the clean side of the air intake system (upstream turbo compressor)

Working Principle: Sensing element is a Piezo-resistive strain gauge in a wheat stone bridge arrangement. When the element is subjected to pressure it flexes, due to which the resistance of the it changes, consequently generating a voltage due to imbalance in the wheat stone bridge circuit. This voltage gives the change in resistance which in turn can be calibrated with that of the pressure that caused the deflection.

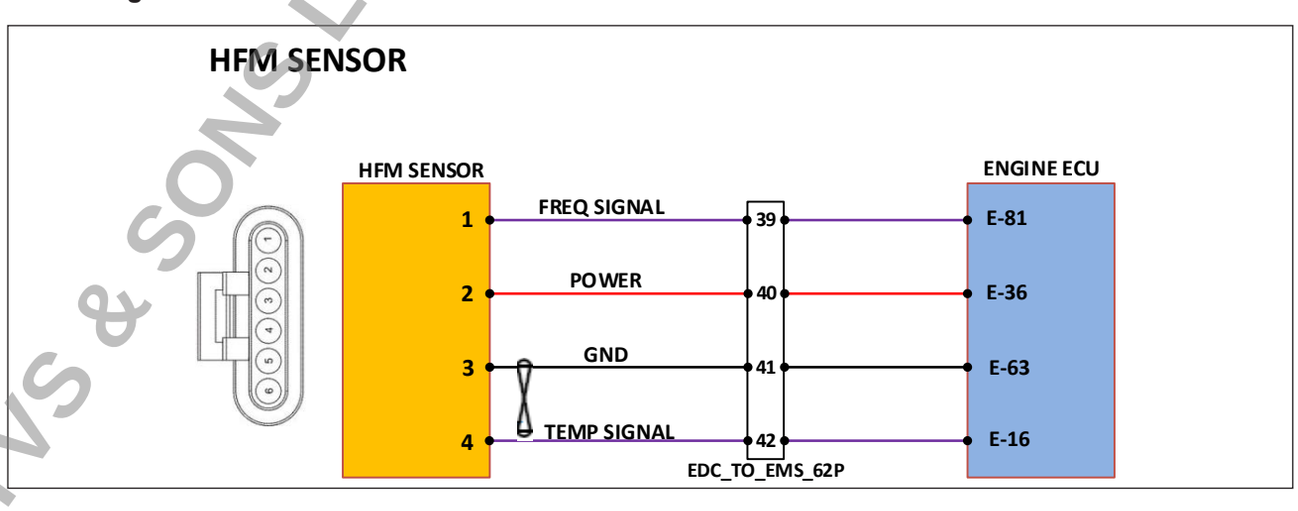


Error Code (Hand Held Diagnostic tool)	Description	Reactions
P0103	MAF Sensor (pulse type) signal too high	40% Torque Limitation & EGR Shut down
P0102	MAF Sensor (pulse type) signal too low	
P0101	MAF Sensor plausibility error	

Circuit Diagram - TRUCK



Circuit Diagram - BUS

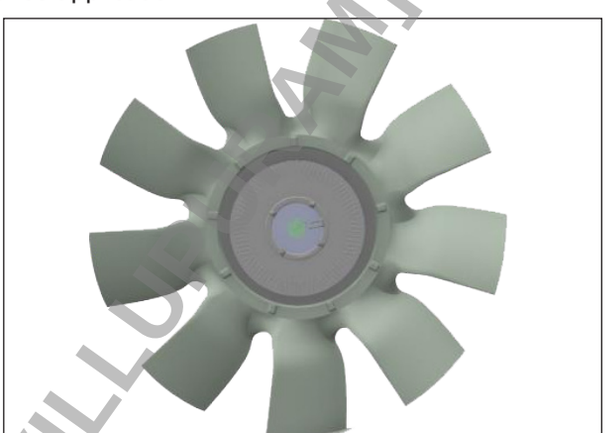


12.2.18 E - VISCOUS FAN

The E-Viscous clutch is controlled electronically based on coolant/boost temperature to improve fuel efficiency, performance and system integration by faster response and low idling speed.

Clutch is with fail safe mechanism which means, if there is any power supply cut to the fan clutch, it will get fully engage.

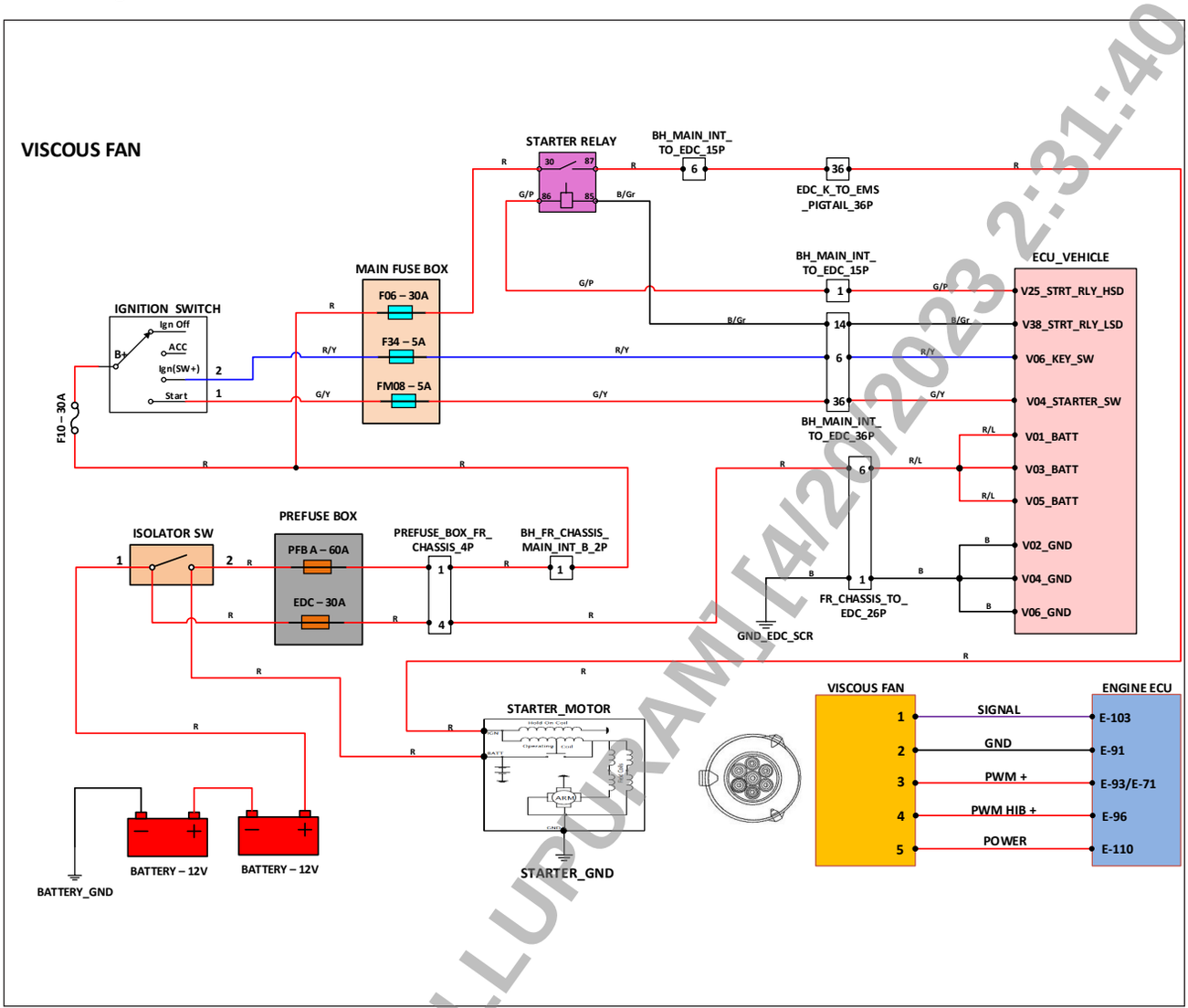
Data set is different between fan makes. Appropriate engine data set to be flashed corresponding to Fan make/ blade series/diameter/clutch series/application



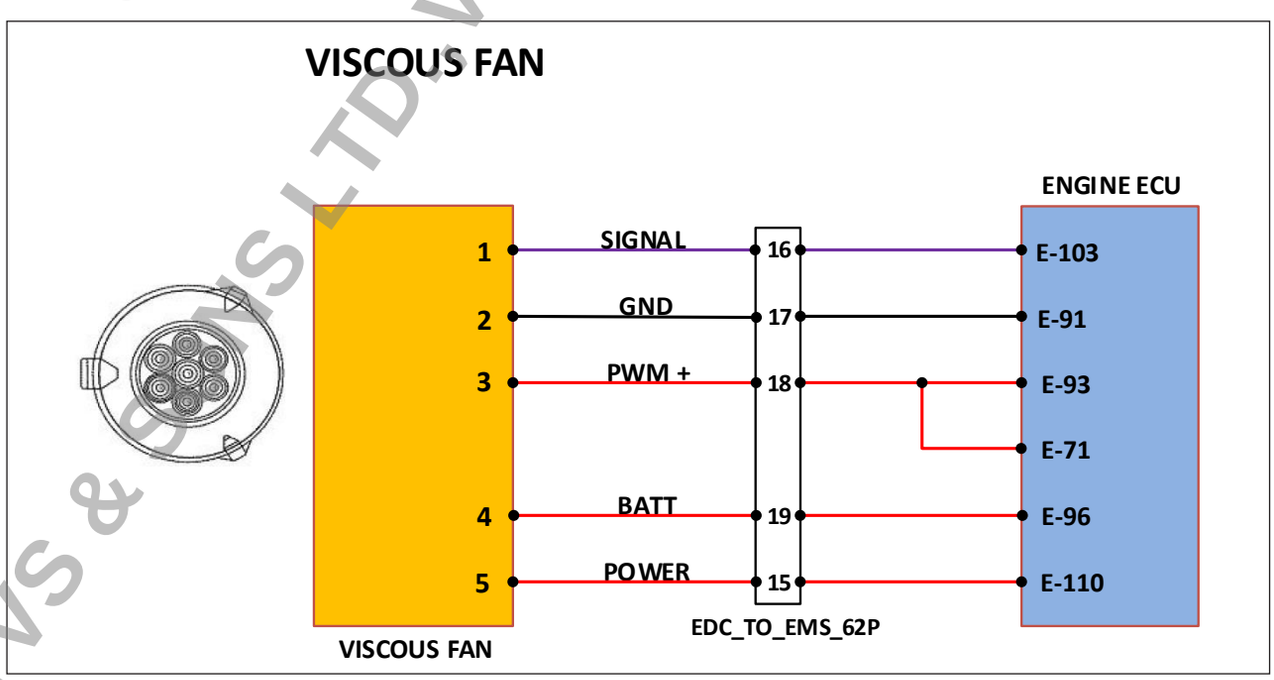
Viscous fan clutch engages when the bi-metal coil [in front of the clutch] senses 75±3 degC [air temperature]

Error code	Error Description	Reactions
P0692	Fan PWM Coil Short Circuit to Battery error	Fan will get fully engaged
P0693	Fan PWM Coil Short Circuit to Ground error	
P0495	Fan Speed Feedback Sensor signal range above upper limit	
P0494	Fan Speed Feedback Sensor signal range below lower limit	
P0691	Fan PWM Coil Open Load Error	

Circuit Diagram - TRUCK



Circuit Diagram - BUS



FUEL PRESSURE SENSOR

TECHNOLOGY USED: Piezo-resistive strain gauge

FUNCTION: Measures the pressure of fuel in the HC dozing circuit

LOCATION: In the HC dosing circuit

WORKING PRINCIPLE:

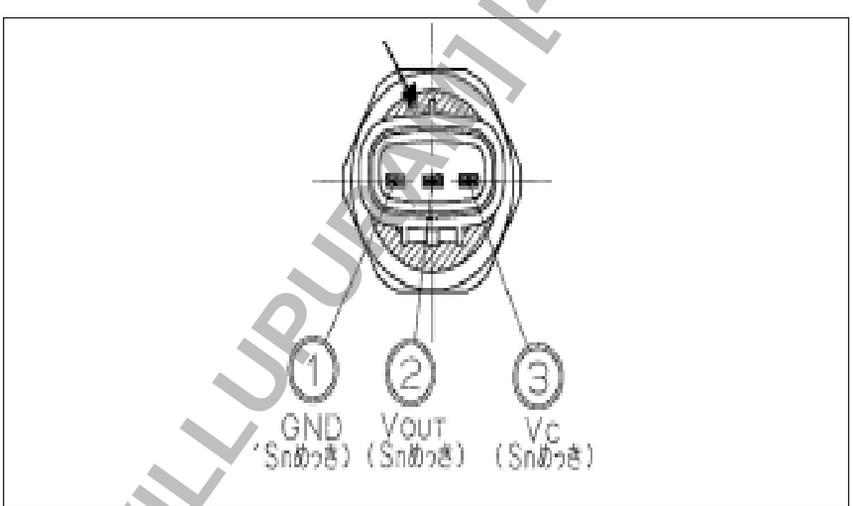
Sensing element is a Piezo-resistive strain gauge in a wheat stone bridge arrangement. When the element is subjected to pressure it flexes, due to which the resistance of the it changes, consequently generating a voltage due to imbalance in the wheat stone bridge circuit. This voltage gives the change in resistance which in turn can be calibrated with that of the pressure that caused the deflection.

PIN CONFIRGURATION:

GROUND

SENSOR SIGNAL

SENSOR SUPPLY

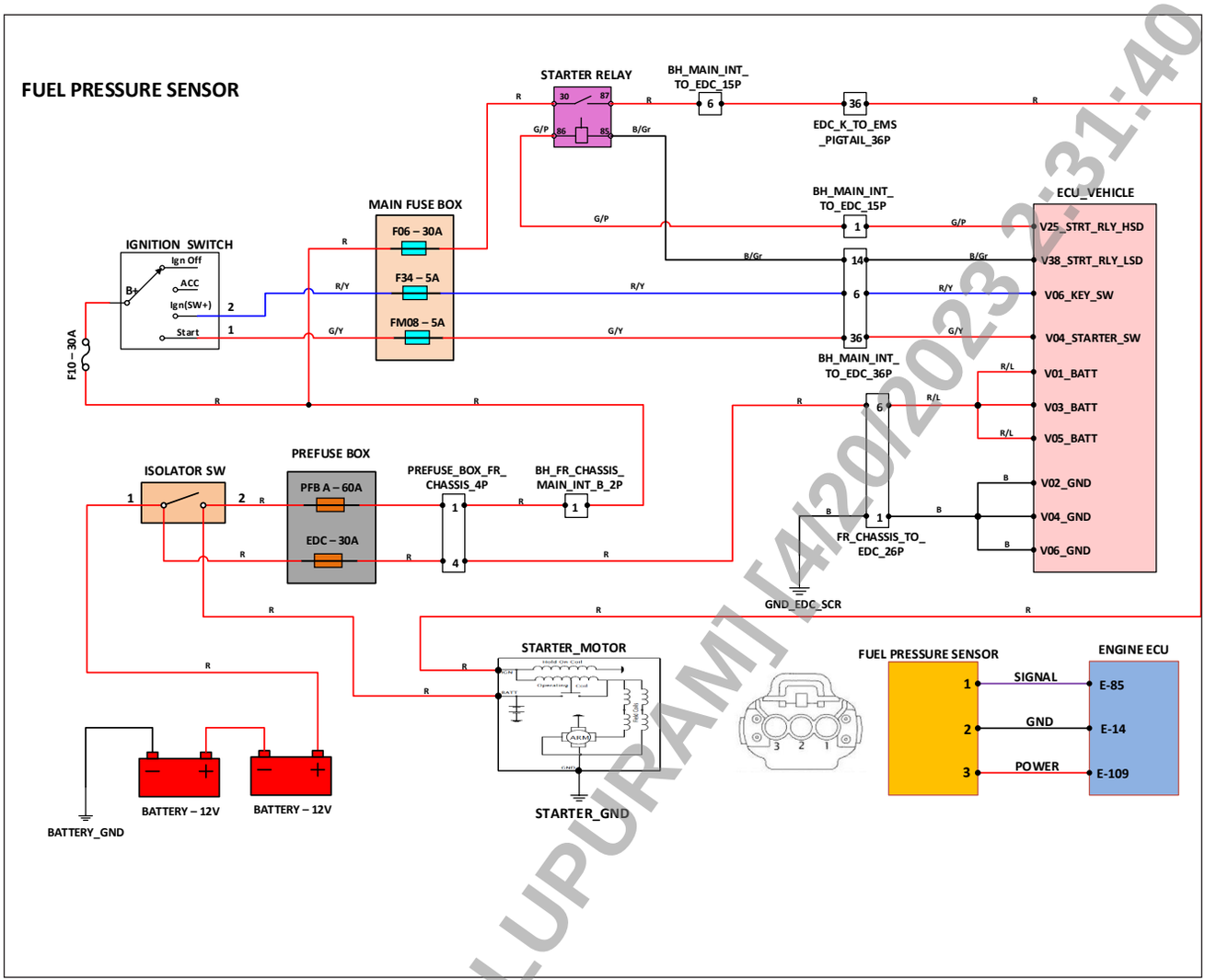


FUNCTIONALITY CHECK: NIL

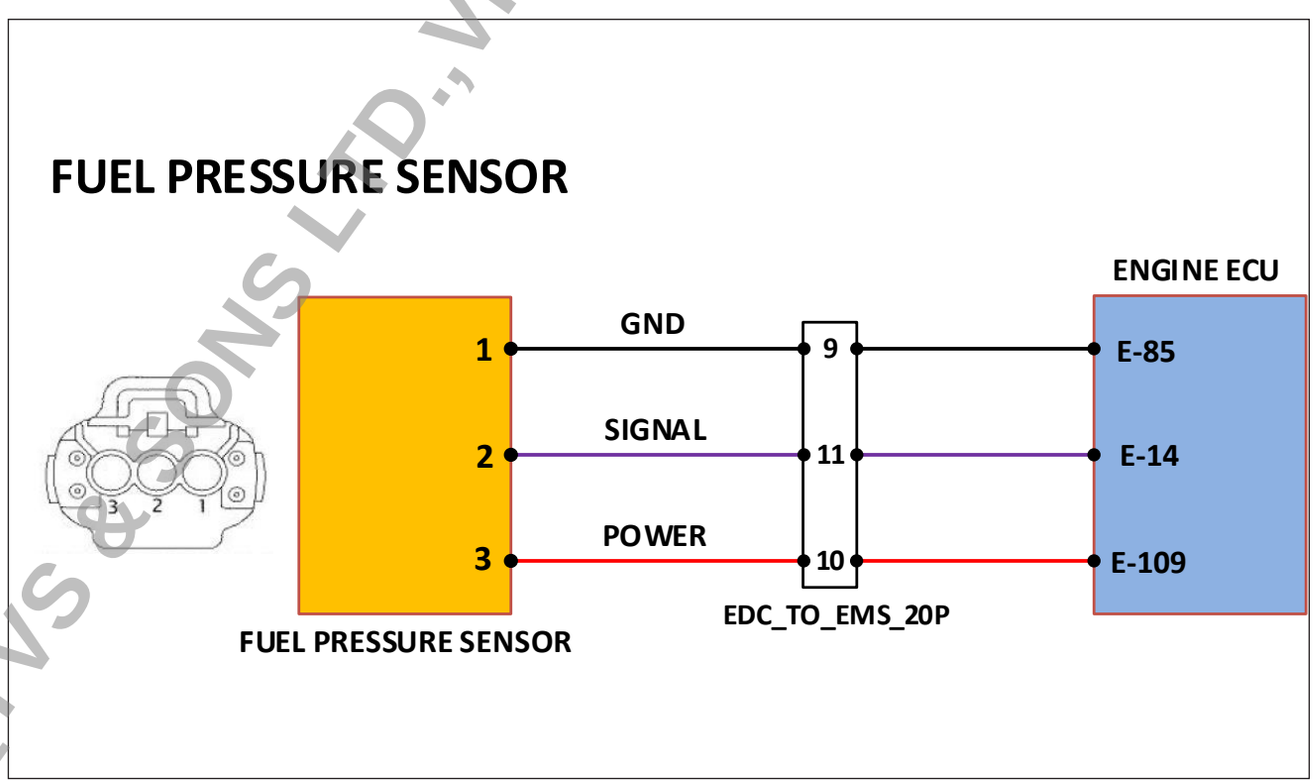
SPECIFICATION

USE CONDITION	VALUE
Pressure	0 -2 Mpa
Voltage	5 ± 0.25 V
Temperature	-30- 120 Deg C
Pressure Medium	Diesel Oil

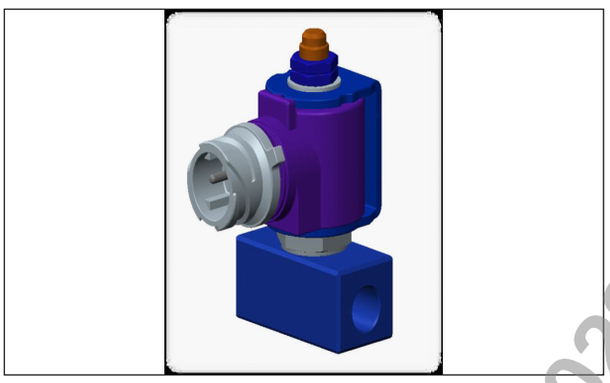
Circuit Diagram - TRUCK



Circuit Diagram - BUS



FUEL CUT-OFF VALVE



TECHNOLOGY USED: normally closed 2/2 solenoid valve

FUNCTION: Fuel cut-off valve stops the fuel supply to the cylinder enabling the engine to stop.

LOCATION: mounted on fuel accumulator

WORKING PRINCIPLE:

Valve is designed as Normally closed so that it can restrict the fuel flow in Idle Condition.

In the energized state of the Solenoid, plunger will move upward & will allow the fuel flow from inlet to Outlet Port.

PIN CONFIRGURATION:

PIN NAME	PIN NO
Fuel Cut- off supply	1
Fuel Cut off GND	2

FUNCTIONALITY CHECK: NIL

FUEL CUT-OFF VALVE CHARACTERISTICS

Solenoid Type : 2/2 NC Solenoid Valve

Working Medium : Air

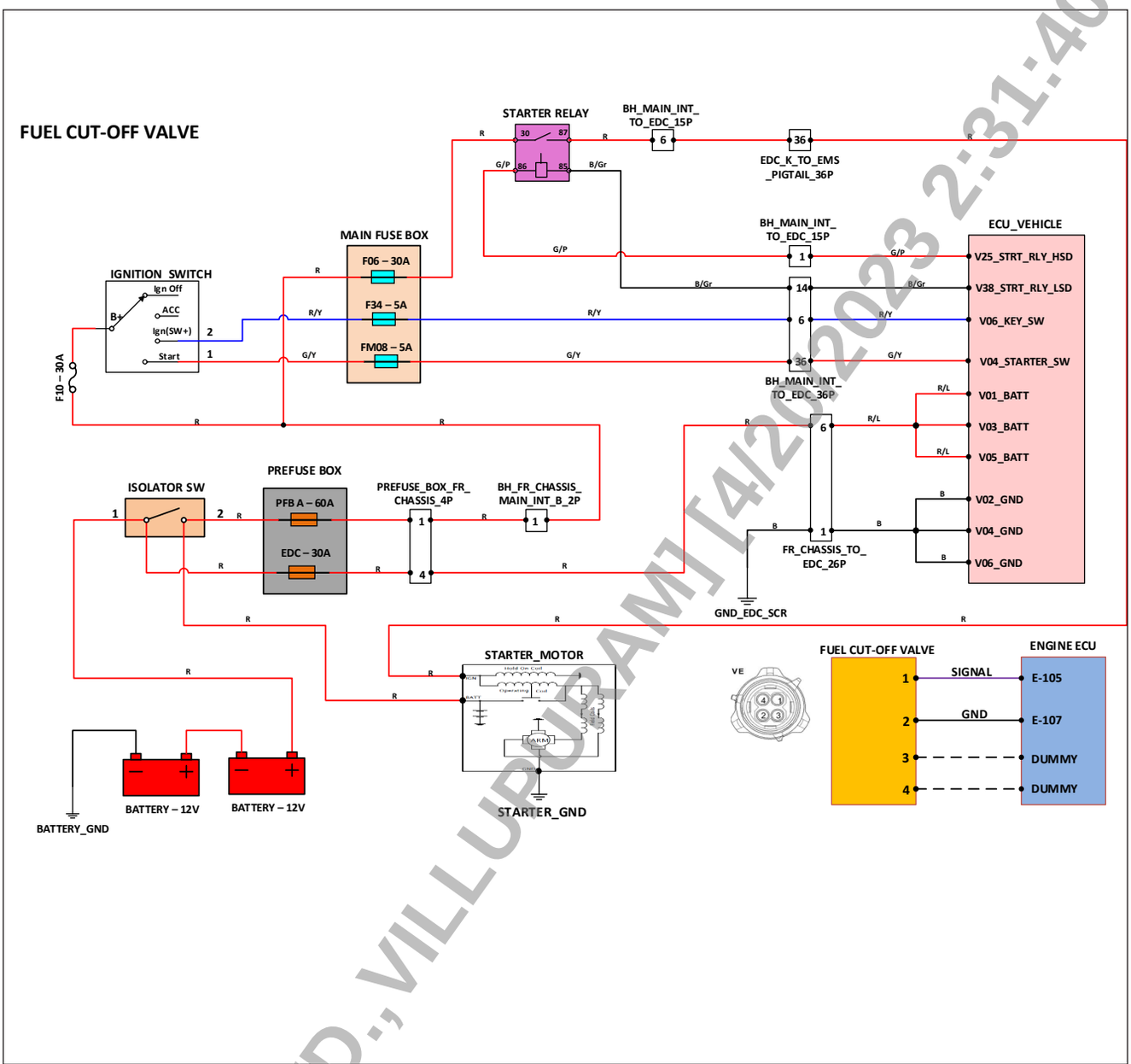
Resistance @ RT : 48±2.5 Ω

Nominal Voltage : 24 V

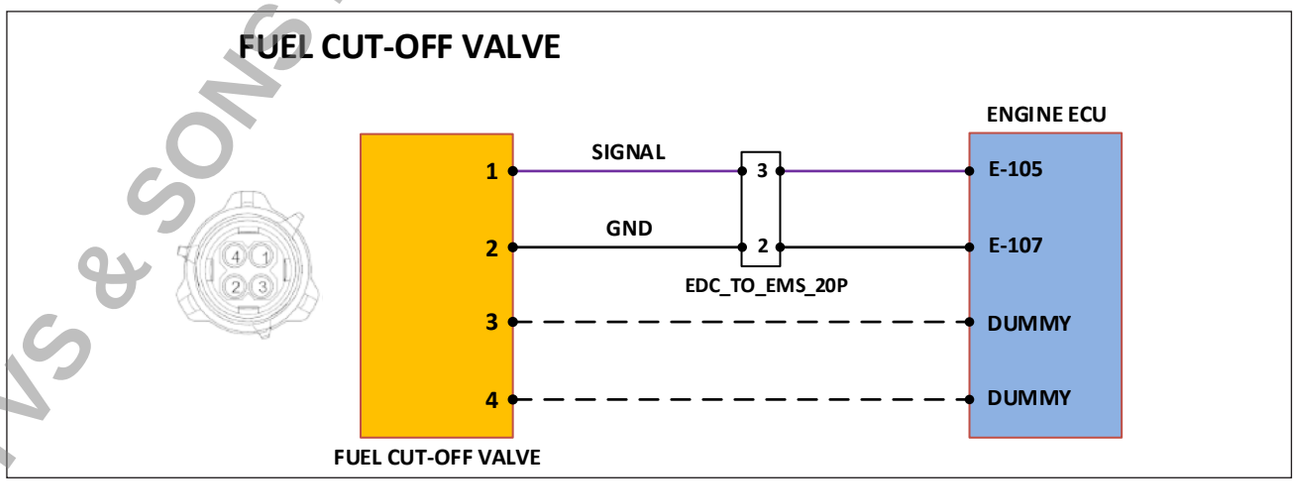
Actuating Voltage : ≤ 16 V

Release Voltage : ≥ 2.0 V

Circuit Diagram - TRUCK



Circuit Diagram - BUS



EXHAUST GAS TEMPERATURE SENSOR (EGT)

Technology used: Resistance Temperature Detector PT-200 (Positive Temperature Coefficient-PTC)

Function: Measures the temperature of the exhaust gas in the exhaust system

Working Principle:

When temperature of the exhaust gas increases the resistance of the sensing element also increases..

Pin Confirguration:

Grey wire: Sensor signal

White wire: Ground

Functionality check:

The resistance between the 2 pins must be ~220Ohm @25 ºC (refer table in next slide)

Specification:

Temperature range: -40 – 850 ºC

Location of the 4 EGTs in the EATS system

1. Diesel Oxidation Catalyst (DOC) IN
2. Diesel Oxidation Catalyst (DOC) OUT / Diesel Particulate Filter (DPF) IN
3. Diesel Particulate Filter (DPF) OUT / Hydrolysis pipe IN
4. Hydrolysis pipe OUT / SCR IN

Temperature vs Voltage / Resistance output

T(°C)	RS (Ω)	UO (V)
-40	169.7	0.725
25	219.6	0.900
100	275.9	1.081
400	488.1	1.640

NOX SENSORS

TECHNOLOGY USED: YSZ electrochemical sensors of the amperometric type

FUNCTION: To measure NOx PPM in the exhaust gas at inlet/outlet location of aftertreatment system and send the data to ECM/ACM using CAN lines

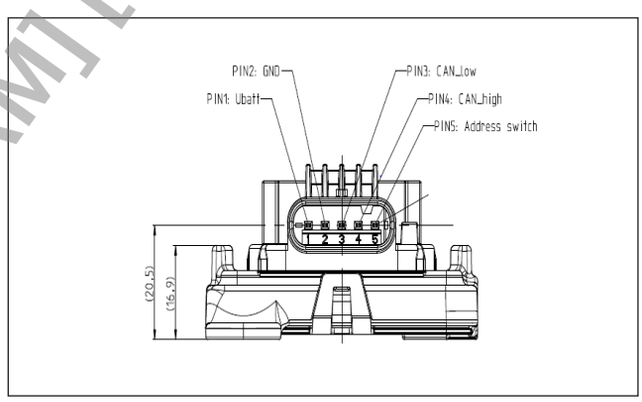
LOCATION:

UPSTREAM SENSOR: Hydrolysis pipe IN

DOWNSTREAM SENSOR: SCR OUT

WORKING PRINCIPLE: YSZ electrochemical sensors of the amperometric type Conductivity of the oxygen ions is used for measurement of oxygen concentration in heated electrochemical YSZ sensors when heated upto minimum of 800 °C (conductivity of oxygen is maximum at this temperature).

PIN CONFIRGURATION:



FUNCTIONALITY CHECK: NIL.

1. UNIVOLT SENSOR – OPERABLE WITH BOTH 12 AND 24 V INPUT.
2. **BAUD RATE – 250/500 KBPS**
3. Output signals of NOx sensor on CAN bus:
   - **NOX SIGNAL (PPM)**
   - **O2 SIGNAL (%)**
   - **STATUS BYTE**
   - **ERROR BYTE**
4. Flat 5 pin connector – 5th pin is address switch which enables us to use same sensor for both upstream and downstream sensor

5TH PIN	GND	UPSTREAM LOCATION
5TH PIN	Float	DOWNSTREAM LOCATION

There are two part numbers because of the cable length being different for the upstream and downstream sensors to account for packaging.

Upstream sensor – XCA00500 (515 mm cable)

Downstream sensor – XCA00400 (715 mm cable)

DIFFERENTIAL PRESSURE SENSOR (DPS)

TECHNOLOGY USED: Strain-sensitive piezo-resistors are implanted in silicon substrate

FUNCTION: To measure the pressure difference across the Diesel Particulate Filter (DPF). Differential pressure provide the pressure output across the diesel particulate filter

LOCATION: Across the Diesel Particulate Filter (DPF)

WORKING PRINCIPLE:

Pressure across diaphragm results in tensile stress in centre, compressive stress at edge

Strain-sensitive piezo-resistors are implanted in silicon substrate and connected in a full bridge configuration

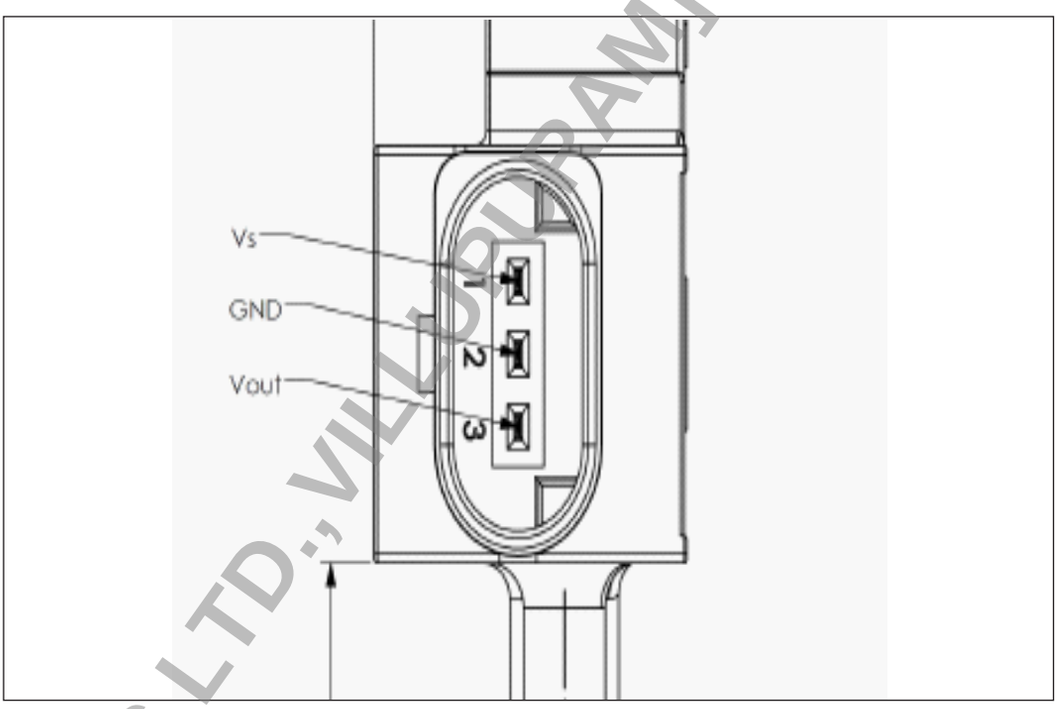
Applied pressure results in a bridge imbalance that is amplified and compensated in signal conditioning electronics

PIN CONFIRGURATION:

1. +5 V SUPPLY

2. GND

3. DP SIGNAL



FUNCTIONALITY CHECK: NIL

SPECIFICATION:

Input pressure range: 0 – 100 kPaD

Differential proof pressure: 200 kPa @RT

Differential burst pressure: 300 kPa @RT

12.3 SWITCHES

12.3.0 Brake Signal Switch

FUNCTION:

1. This switch gives input to the ECU about the brake pedal status. (Pressed/ not pressed).

2. This switch is also an one of the inputs for exhaust brake system.

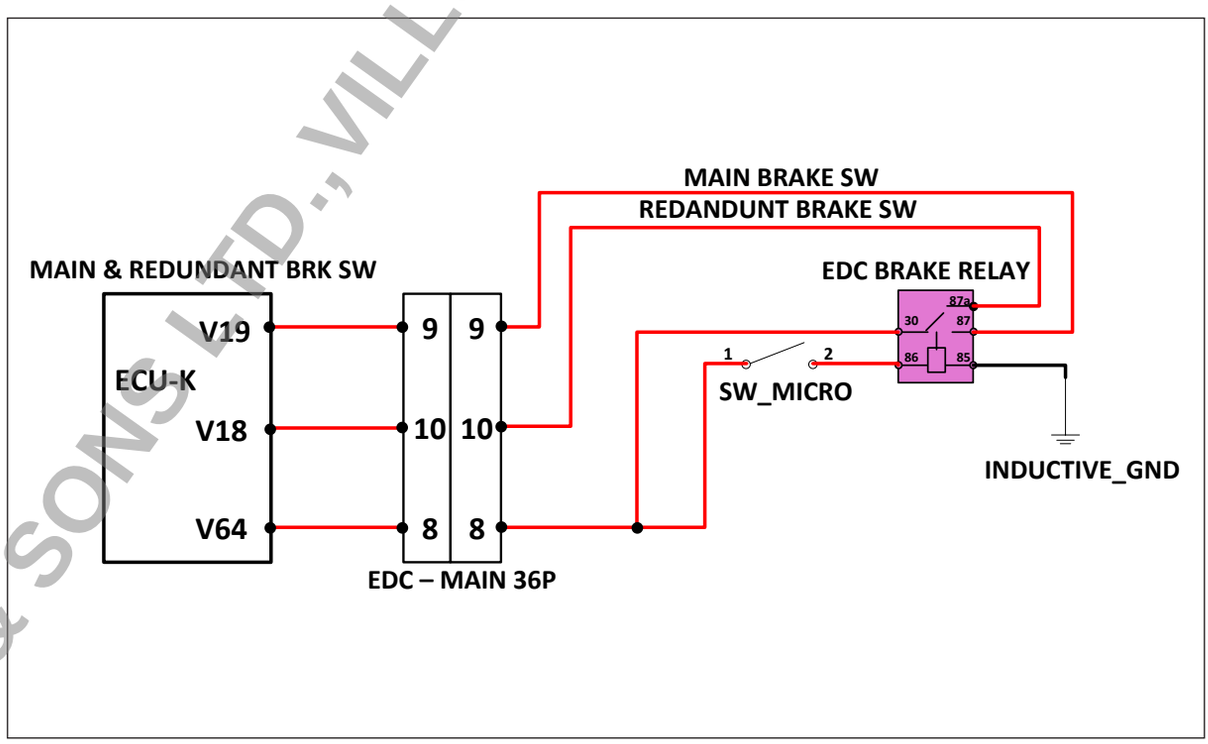
WORKING PRINCIPLE:

When switch input is available, exhaust brake will be activated based on engine speed and acc pedal conditions.

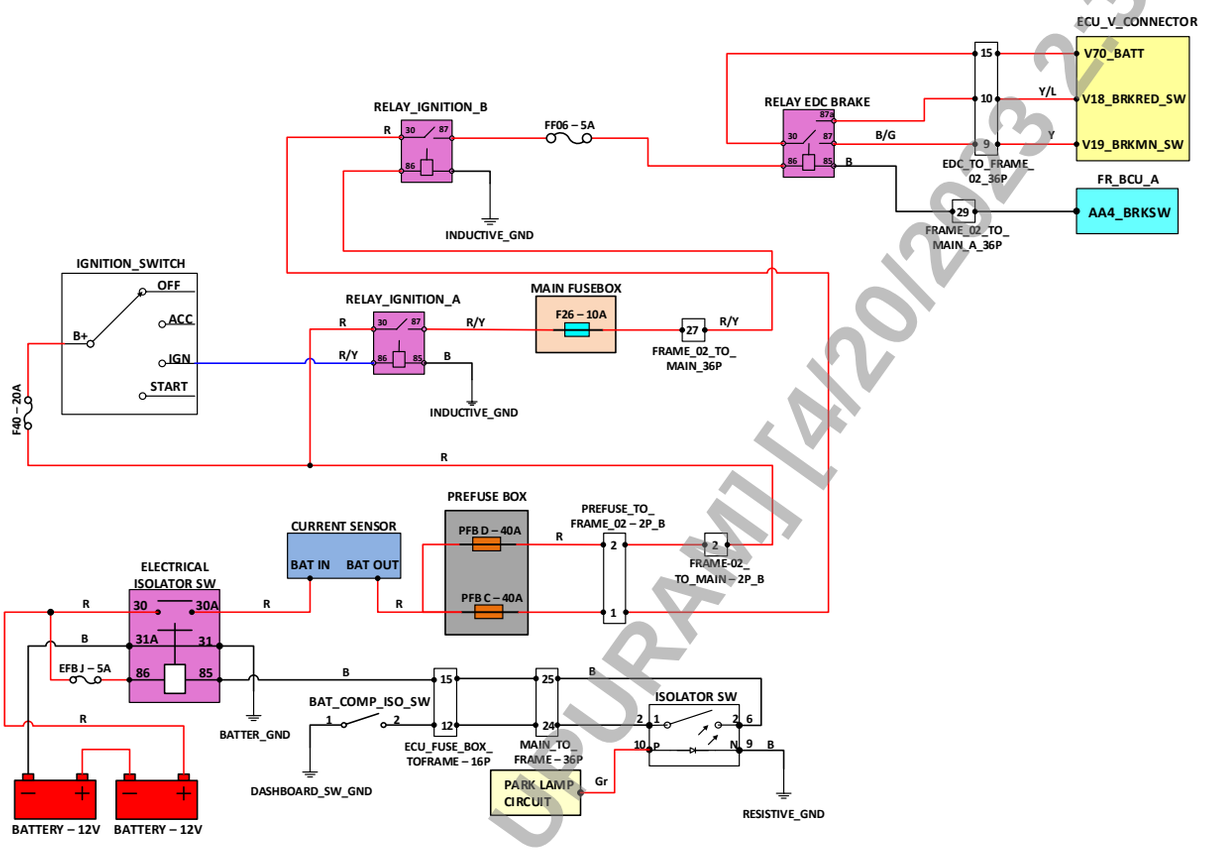
FAULT PATH :

Error Code (Hand Held Diagnostic tool)	Description	Reactions
P0504	Plausibility check for Brake	No reaction
P1B01	Exhaust flap signal open load error	
P1B02	Exhaust flap signal short circuit with battery	

Circuit Diagram - TRUCK



Circuit Diagram - BUS

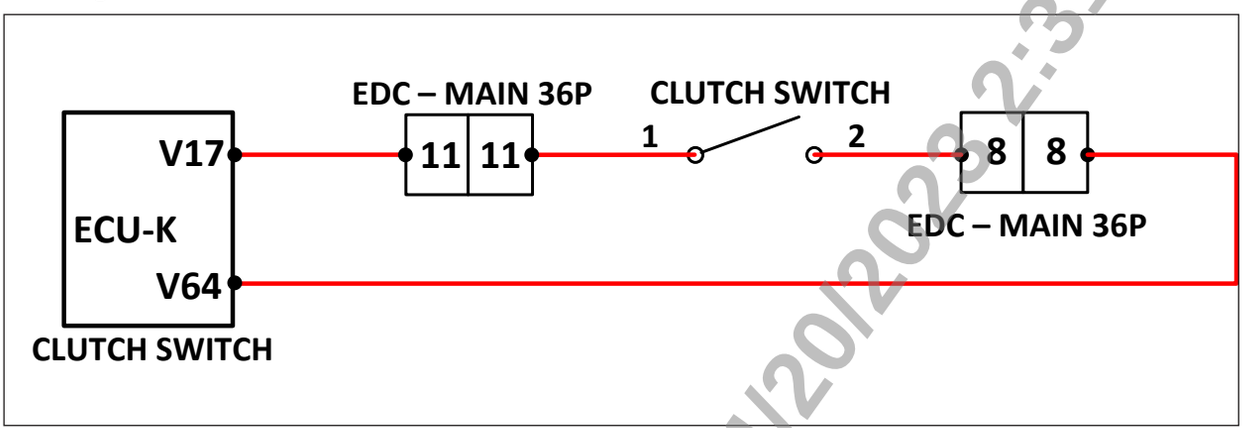


12.3.1 Clutch Signal Switch

This switch gives input to the ECU about the clutch pedal status. (Pressed/ not pressed).

Function: To provide input when clutch pedal is pressed

Circuit Diagram - Truck

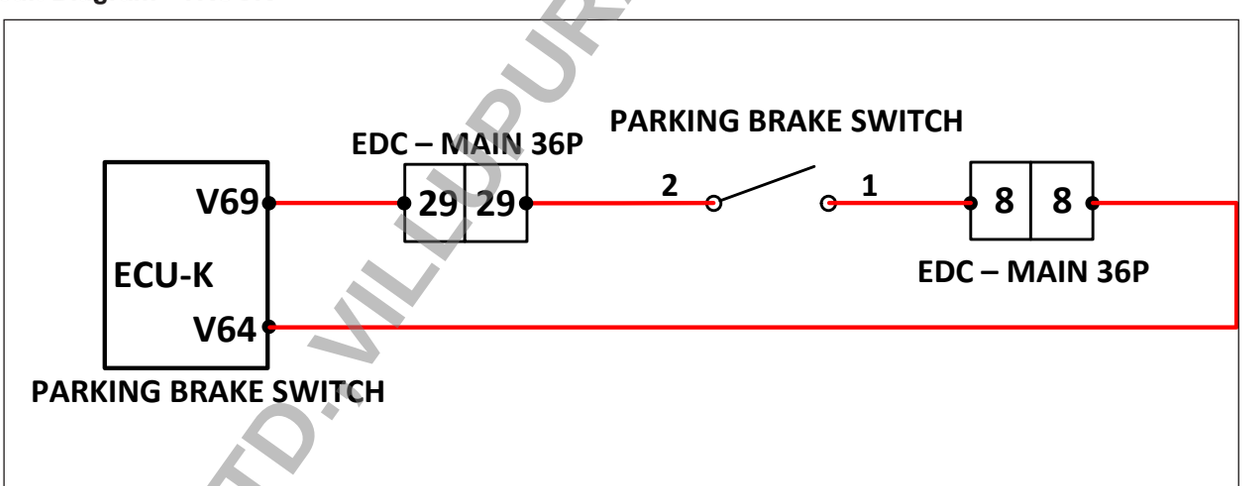


12.3.2 PARKING BRAKE SWITCH

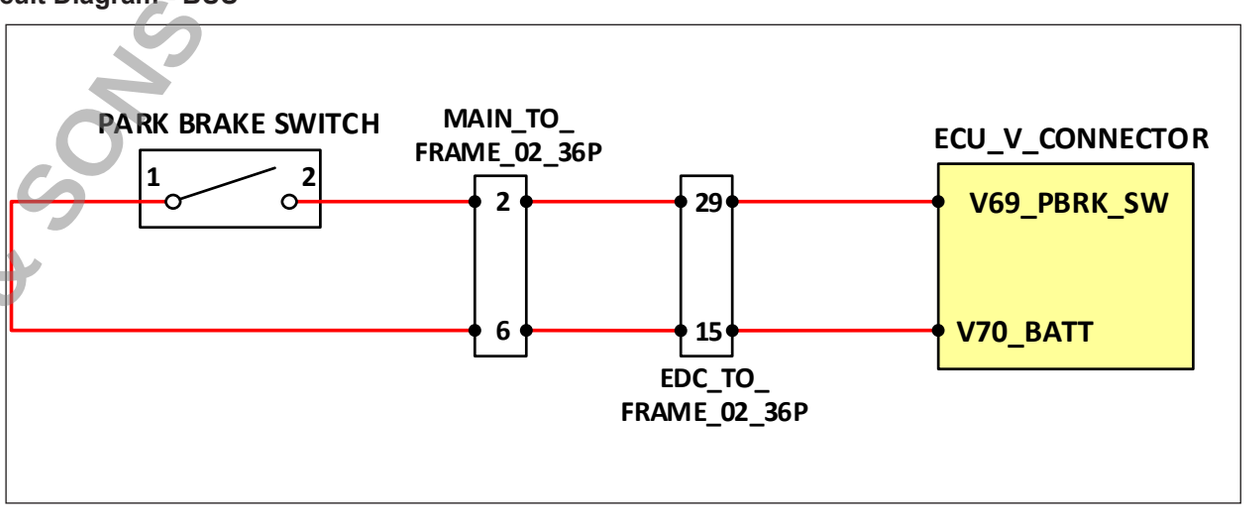
This switch gives input to the ECU about the parking brake/ hand brake status. (Engaged / not engaged).

Function: To provide input when parking brake is ON and OFF.

Circuit Diagram - TRUCK



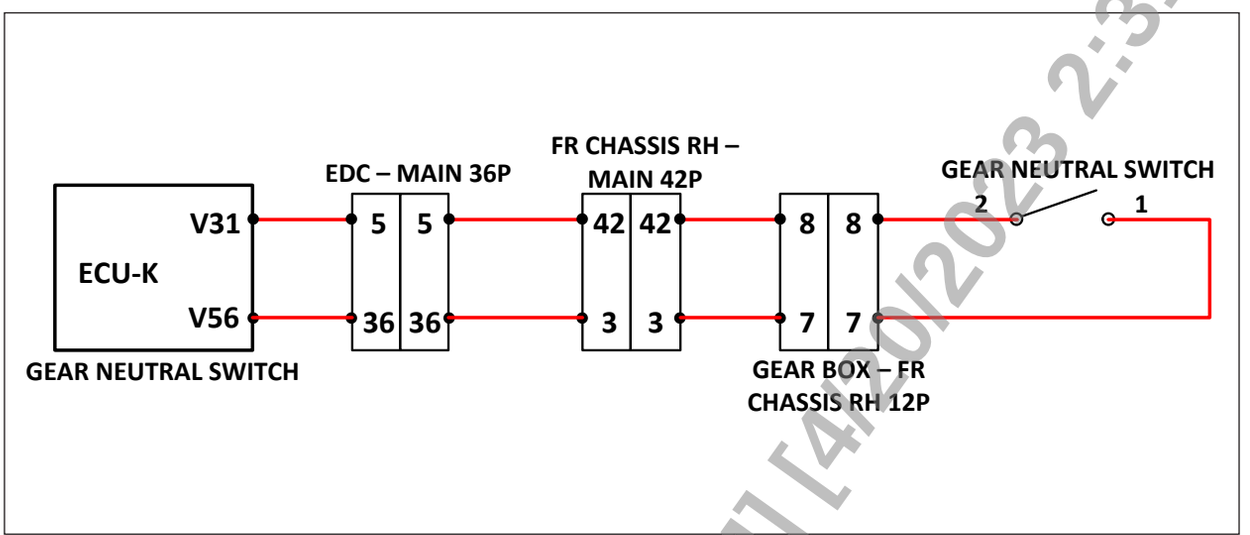
Circuit Diagram - BUS



12.3.3 GEAR NEUTRAL SWITCH

Function: To provide input when vehicle is in neutral gear condition.

Circuit Diagram - TRUCK



Error Code (Hand Held Diagnostic tool)	Description	Reactions
P0930	Range Shift Inhibitor solenoid short to ground / open load	No reaction
P1B01	Range Shift Inhibitor solenoid short to ground / open load	
P1B02	Gear High Range Switch Plausibility error	

12.3.4 Diagnostic lamp

Function and Working

Diagnostic lamp is provided on the dashboard. In event of any errors reported by the ECU in course of operation of the vehicle, the diagnostic lamp glows, indicating that there are errors reported in the system and recorded by the ECU. Only selected errors (which can have a direct effect on the engine / vehicle performance) are reported to the diagnostic lamp.

Depending on the criticality of the error reported, the ECU could either switch off the engine or change to limp home mode. Details of the errors can be viewed with the help of the diagnostic tool.

NOTE

Diagnostic lamp is only an indicator of any error reported.

12.3.5 Water in Fuel Sensor and Lamp

Water in Fuel Sensor

Water-in-Fuel sensor is a part of the Fuel Pre-filter and has a water collecting bowl in which the sensor is mounted. As the water gets separated and collected in the bowl, level of water in the fuel is used for identifying the change in conductivity in turn gives a voltage output. This is sensed by the ECU and water level threshold is identified with the voltage threshold range as per specification and finalized after trials (partial, slow fill, gradient etc)

When the water level exceeds the threshold following are the actions performed

- Indicate the driver that a critical error has occurred which needs an immediate attention
  - Torque reduction by 40%
  - A Dedicated Tell-Tale lamp is made to “BLINK”
- Error is assigned as high priority to store in ECU memory for longer duration to be read by the tester

The following counters can be read through diagnostic tester:

1. **Water Detection counter:** No of times Vehicle switched off and restarted without water in bowl emptied
2. **Water Detection Duration:** Duration in seconds for which the vehicle runs and Sensor detects water

These counters should be reset (through diagnostic tester) after draining the water from the water separator bowl.

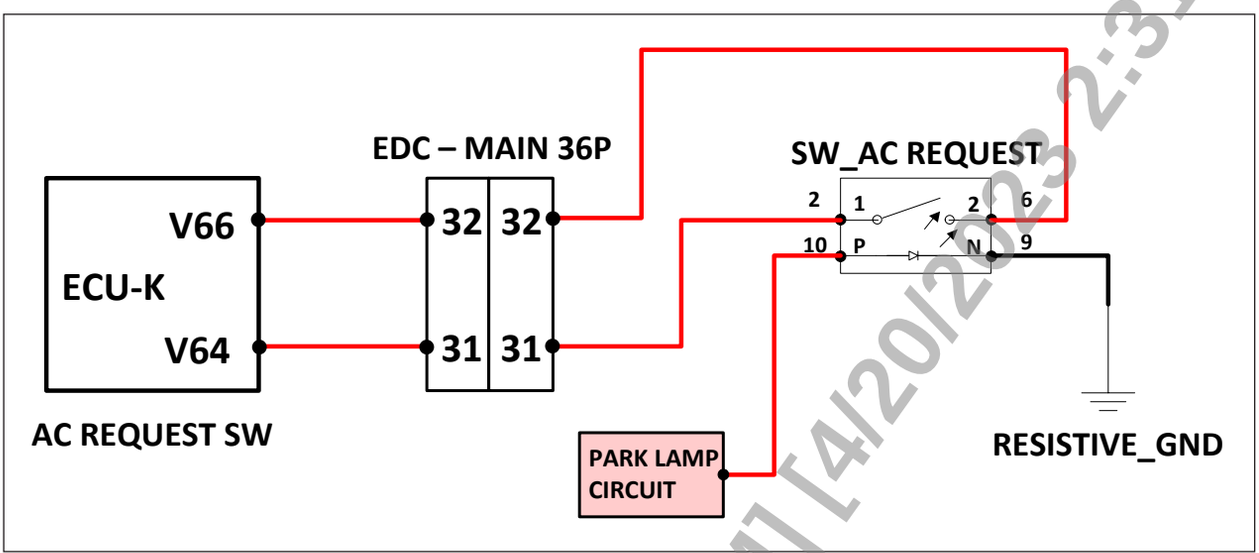
Water in Fuel Lamp

Water in fuel lamp is provided on the instrument cluster Water in fuel sensor is a part of pre-filter which senses the water level in diesel. When the predefined threshold exceeds, the Water in fuel lamp starts blinking indicating the excess amount of water in diesel and brings a need for draining the water in pre-filter. Excess water in the fuel system could damage precision fuel injection equipment and engine.

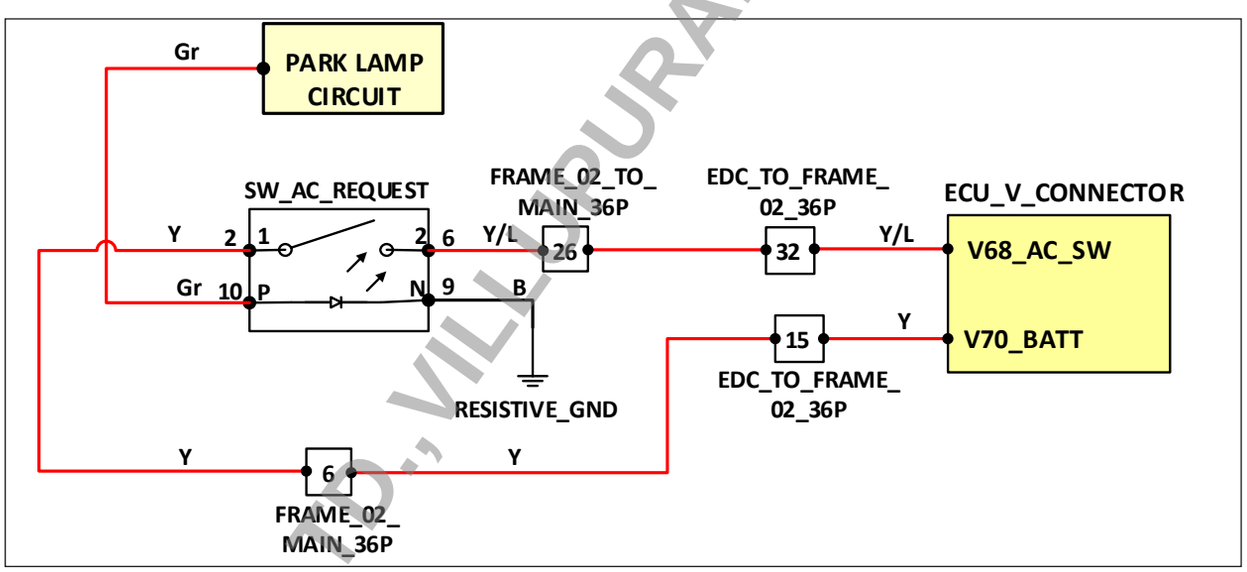
12.3.6 AC switch signal

AC switch status read from AC request SW relay (R06) and the output of the relay is given to engine ECU for RPM shifting. Engine rpm will be shifted from idling rpm (w/o AC request) to 800rpm if AC switch is on.

Circuit Diagram - TRUCK



Circuit Diagram - BUS



Specification:

AC request SW relay and AC switch are 24V type.

The starter motor is controlled by Engine ECU. The ECU control starting feature is for protection against re-cranking, over cranking and inching. Hence the starter motor life will be increased.

Crank position output from the ignition switch is given to ECU. The ECU will energize the starter relay and start the engine when the driver starts the engine.

Specification:

Starter relay is 24V type.

Note: The starter motor could not start without starter relay.

12.4 CAN BACKBONE

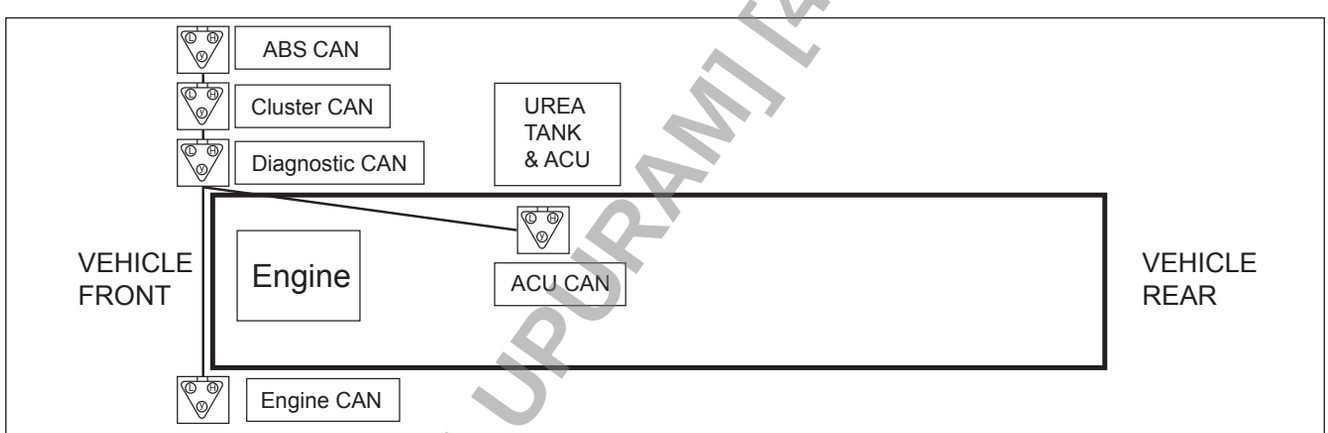
CAN – Controller Area Network is used for communication between the Electronic Control Units (ECUs) in the vehicle. The advantages of CAN are,

1. Same sensor input can be used by different ECUs
2. One ECU can give control message to another in case of safety/emergency conditions

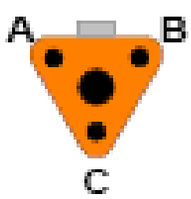
CAN backbone wire harness is used for this CAN communication. CAN backbone wiring is connected between EDC wiring and Main wiring for communication of Engine ECU, AMT ECU, SCR ACU and Diagnostic tester, Cluster /Display.

Error Code (Hand Held Diagnostic tool)	Description	Reactions
U0113	ECU - ACU CAN Time out error	Engine rpm limitation at 1750 & 40% torque limitation & EGR Shut down Vehicle speed limitation to 20 kmph after 100 hrs

CAN connection layout given below.



Specific 3 way triangular connectors (Deutsch make) have been used in the CAN backbone wire harness.



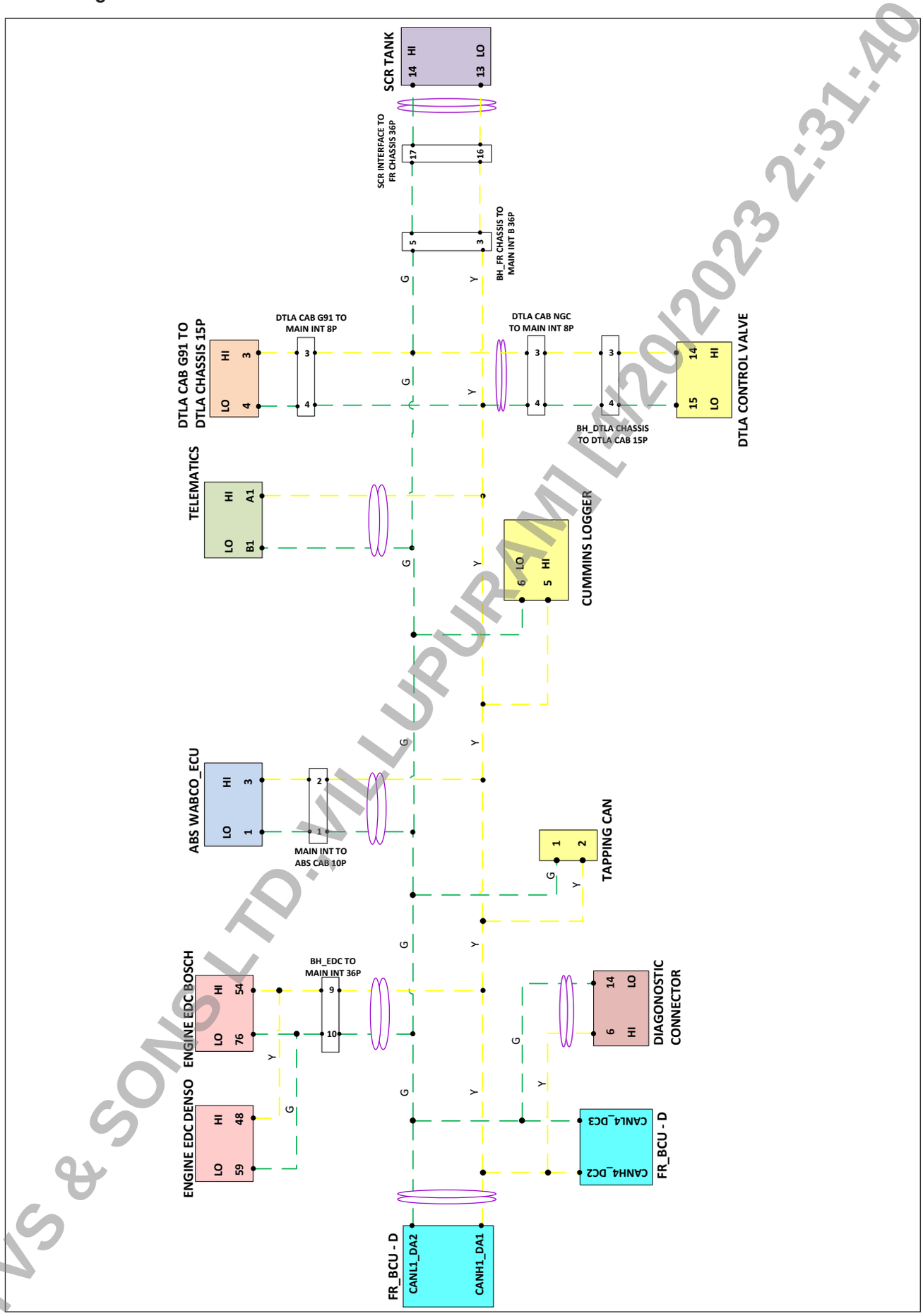
Pin A – CAN high

Pin B – CAN low

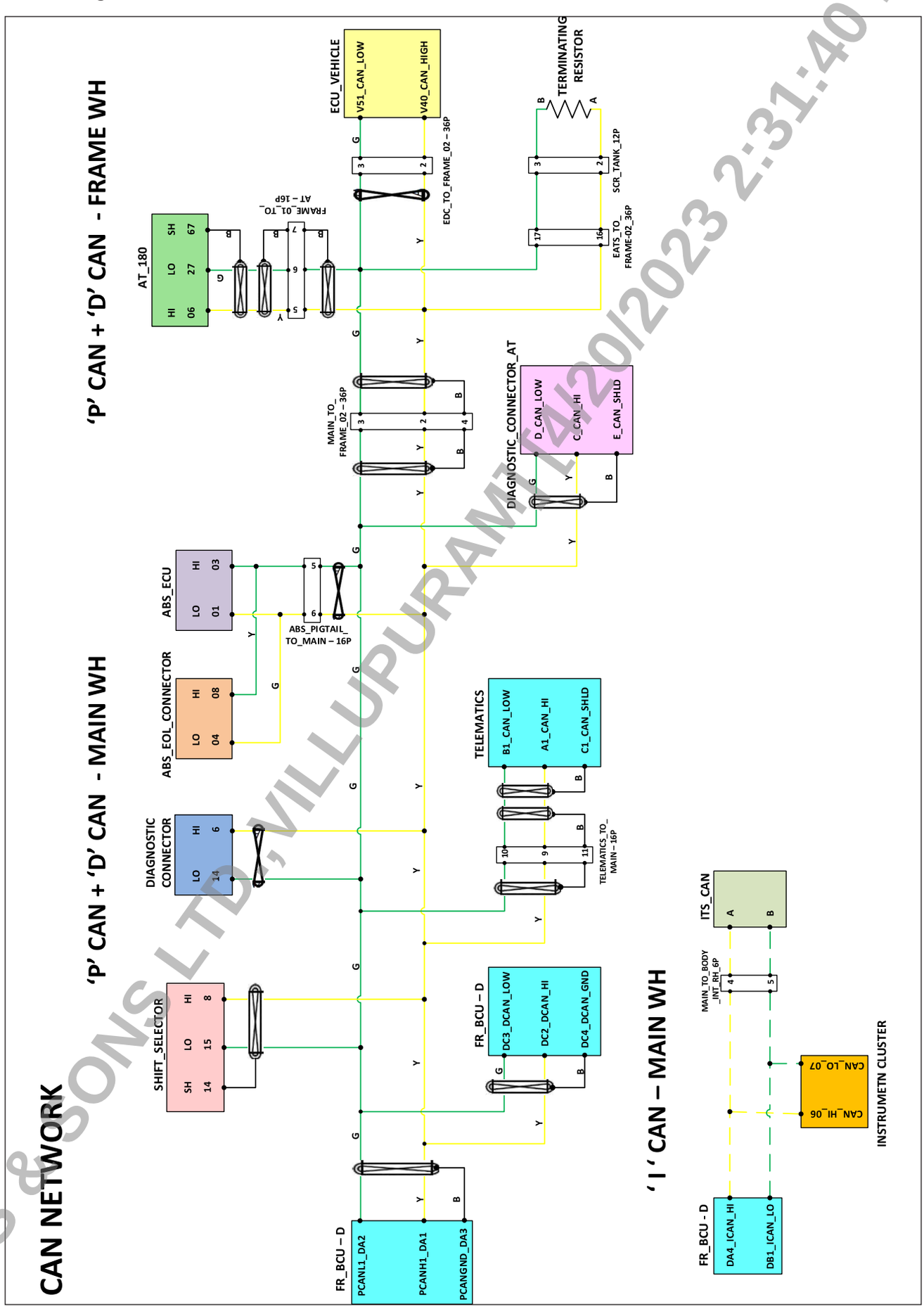
Pin C – CAN shield

Terminating resistor 120 ohms has been used in the CAN backbone to ensure proper communication.

Circuit Diagram - TRUCK



Circuit Diagram - BUS



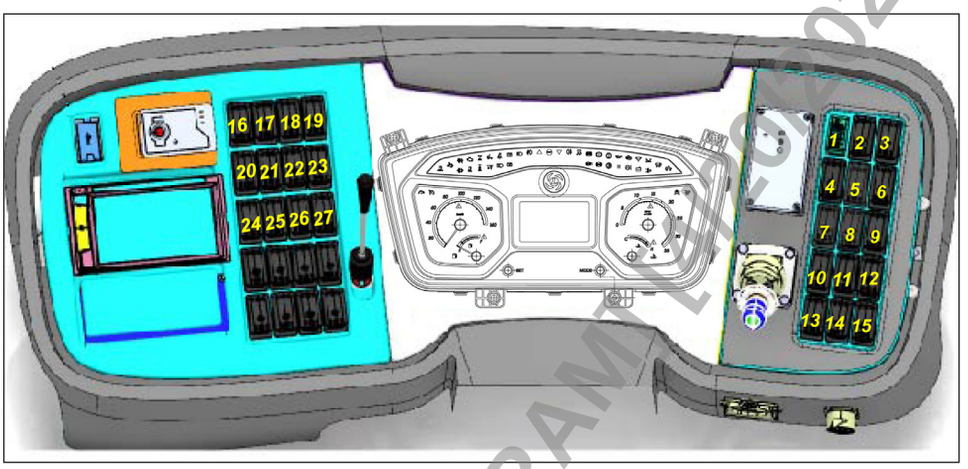
12.5 DIAGNOSTICS

ECU integrated diagnostics belong to the basic scope of electronic engine -management systems. During normal vehicle monitoring algorithms checks operation, input and output signals and the overall system is checked for malfunctions and faults. If faults are discovered in the process, these are stored in the ECU memory. When the vehicle is checked in the workshop, this stored information is retrieved only by a diagnostic tool through a serial interface and provides the basis for rapid and efficient trouble shooting and to attend repair.

12.5.0 Diagnostic Concept

1. Using Diagnostic Tester

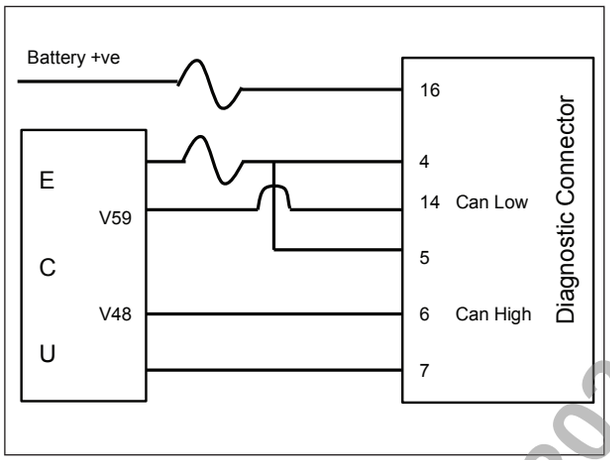
12.5.1 Diagnostic Tester for MDV bus



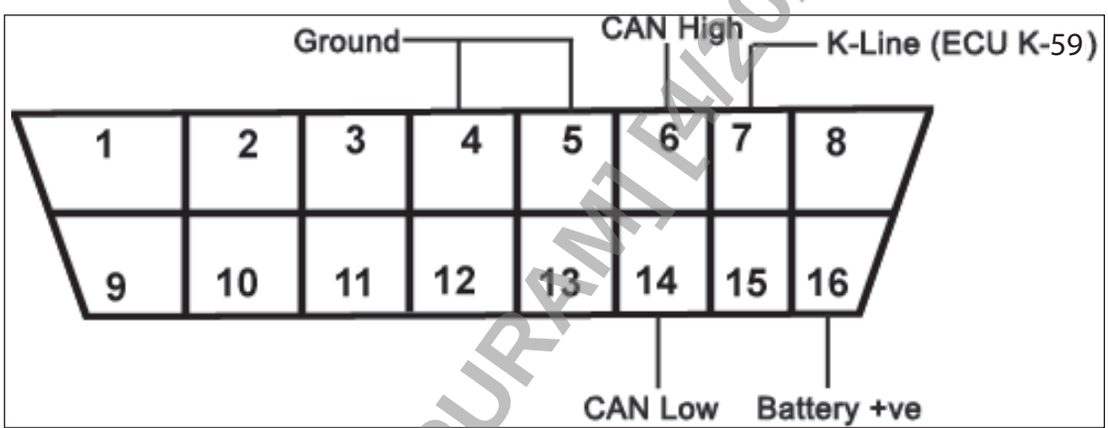
Use diagnostic equipment tool for reading the Error recorded in the ECU. The diagnostic socket is provided beneath dashboard.

Diagnostic Tester for MBP truck

Diagnostic Connector and Circuit Diagram



Diagnostic connector Female (Wiring Harness side)



This is a 16 pin D type connector provided with cap for On Board Diagnostics (OBD). Diagnostics tool / tester with the mating connector to be plugged in to this 16 pin connector for trouble shooting, current data monitoring and erasing the fault codes stored in the ECU memory.

CAUTION

Always ensure that the diagnostic connector is covered with cap when not in use.

In case of no power supply to the diagnostic tester check the following

- Condition of 5 amp fuse on fuse and relay box
- Continuity of the wires between ECU and the diagnostic connector.

Once the defective circuit is identified with the help of the diagnostic tool, please refer the service instruction pertaining to that sensor / actuator circuit.

LIVE DATA PARAMETERS		
SL.NO	**DESCRIPTION**	**UNIT**
1	Calculated Load	%
2	Engine speed	rpm
3	Coolant temperature	degC
4	Ambient Pressure	kPa
5	Inner Torque	Nm
6	Friction torque	%
7	Injection Quantity	mm3/st
8	Cumulative Fuel Consumption	L
10	Accelerator Pedal Position	%
11	Inner Torque	Nm
12	Injection Quantity	mm3/st
13	Rail Pressure Setpoint	MPa
14	Actual Rail Pressure	MPa
15	Boost Pressure	kPa
16	Boost Temperature	degC
17	Coolant Temperature	degC
18	Throttle Position - Actual	%
19	EGR Position - Actual	%
20	Battery Voltage	V
21	Vehicle Speed	km/h
22	Gear Position	-
23	EGR Position - Actual	%
24	EGR Position - Desired	%
25	EGR valve Full Close Learning Value	%
26	EGR valve Full Open Learning Value	%
27	Accelerator Pedal Position	%
29	Inner Torque	Nm
30	Offset Angle	CA
31	Engine Overspeed Count	-
32	Maximum Engine Speed	rpm
33	Engine Overspeed total duration	hr
34	Maximum Overheated Coolant Temperature	degC
35	Overheated Coolant Temperature duration	msec
36	Final Injection Timing	CA
37	Injection Quantity	mm3/st
38	Metering Unit Actual Current	mA
39	Metering Unit Setpoint Current	mA
40	Metering Unit Duty Cycle Output	usec
41	Final Pump Duty ratio	%
42	Pump Learning Value	mA
43	Pump Difference Learning Value Current Value	mA
44	Rail Pressure Setpoint	MPa
45	Actual Rail Pressure	MPa
46	ITV Position - Actual	%
47	ITV Position - Desired	%
48	ITV Full Open Learning Value	%
49	ITV Full Open Actual Learning Value	%
50	ITV Full Close Learning Value	%
51	ITV Full Close Actual Learning Value	%
52	Boost Pressure	kPa

LIVE DATA PARAMETERS		
SL.NO	**DESCRIPTION**	**UNIT**
53	Ambient pressure	kPa
54	Oil Pressure	kPa
55	Actual Rail Pressure	MPa
56	Pressure Limiter Valve Open Count	-
57	Pressure Limiter Valve Open Accumulated Time	msec
58	Engine Operation Status	-
59	Pump Learning Status	-
60	T15 Status	-
61	T50 Status	-
62	Clutch switch status	-
63	Gear neautral switch status	-
64	AC switch status	-
65	Exhaust Brake switch status	-
66	Main Brake switch status	-
67	Redundant Brake switch status	-
68	Cruise main switch status	-
69	PTO switch status	-
70	Coolant level switch status	-
71	Hand brake status	-
72	EDC lamp status	-
73	MIL lamp status	-
74	Exhaust Brake relay activation status	-
75	AC Relay activation status	-
76	Starter Relay activation status	-
77	Grid Heater Relay activation status	-
78	Boost Temperature	degC
79	Coolant Temperature	degC
80	Oil Temperature	degC
81	Battery Voltage	V
82	Vehicle Speed	km/h
83	Actual Fan speed	rpm
84	Target Fan speed	rpm
85	PWM Fan control Duty	%
86	Gear Position	-
87	Total Distance Since First Start	km
88	Engine hours	hr
89	Total Fuel Consumption	L
90	Inner Torque	Nm
91	Water-in-Fuel Detection timer	msec
92	Boost Temperature - Raw Voltage	V
93	Coolant Temperature - Raw Voltage	V
94	EGR Feedback - Raw Voltage	V
95	Oil Pressure - Raw Voltage	V
96	Oil Temperature - Raw Voltage	V
97	Accelerator Pedal Position 1 - Raw Voltage	V
98	Accelerator Pedal Position 2 - Raw Voltage	V
99	Boost pressure - Raw Voltage	V
100	Rail Pressure - Raw Voltage	V
101	Water-in-Fuel sensor - Raw voltage	V
102	Throttle Feedback - Raw Voltage	V

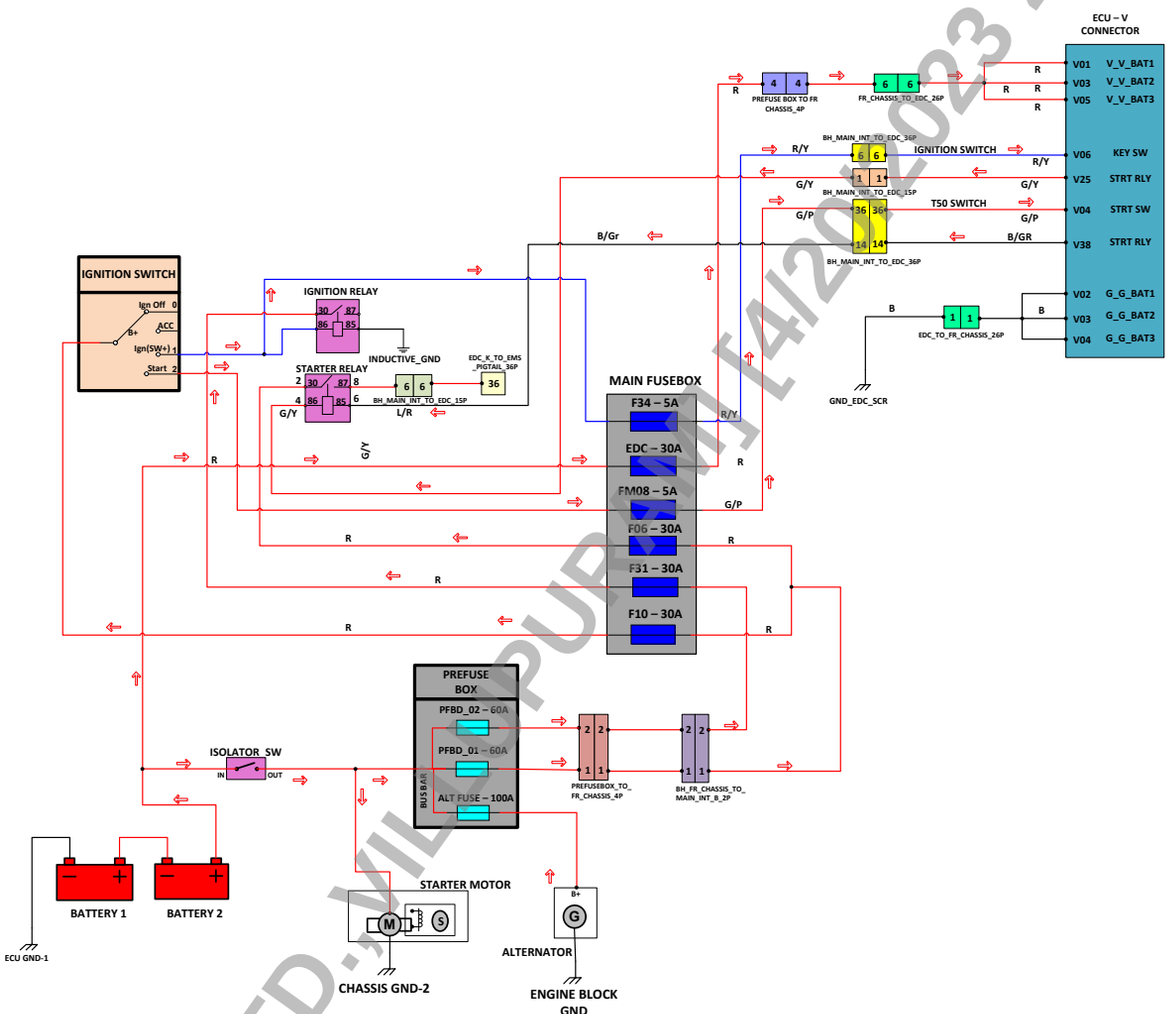
LIVE DATA PARAMETERS		
SL.NO	**DESCRIPTION**	**UNIT**
103	Battery Voltage Sensor - Raw Voltage	V
104	Air Mass Flow Sensor - Raw Frequency	usec
105	EGR Temperature - Raw Voltage	V
106	HFM air temperature - Raw Voltage	V
107	EGR Temperature after Cooler	degC
108	Modelled Exhaust Gas Temperature	degC
109	Ambient Temperature	degC
110	ITV Duty Cycle	%
111	EGR Duty Cycle	%
112	Air Mass Flow	kg/hr
113	Limitation Injection Quantity	mm3/st
114	Smoke Limitation Quantity	mm3/st
115	Request torque / limit torque	%

12.6 LIMP HOME AND EDC FAILURE REACTION FUNCTIONS

The table shown indicates the details of sensor failure and its effect on the vehicle. This function enables the vehicle to reach the nearest dealership point for service attention, in case of any sensor failure / malfunctioning.

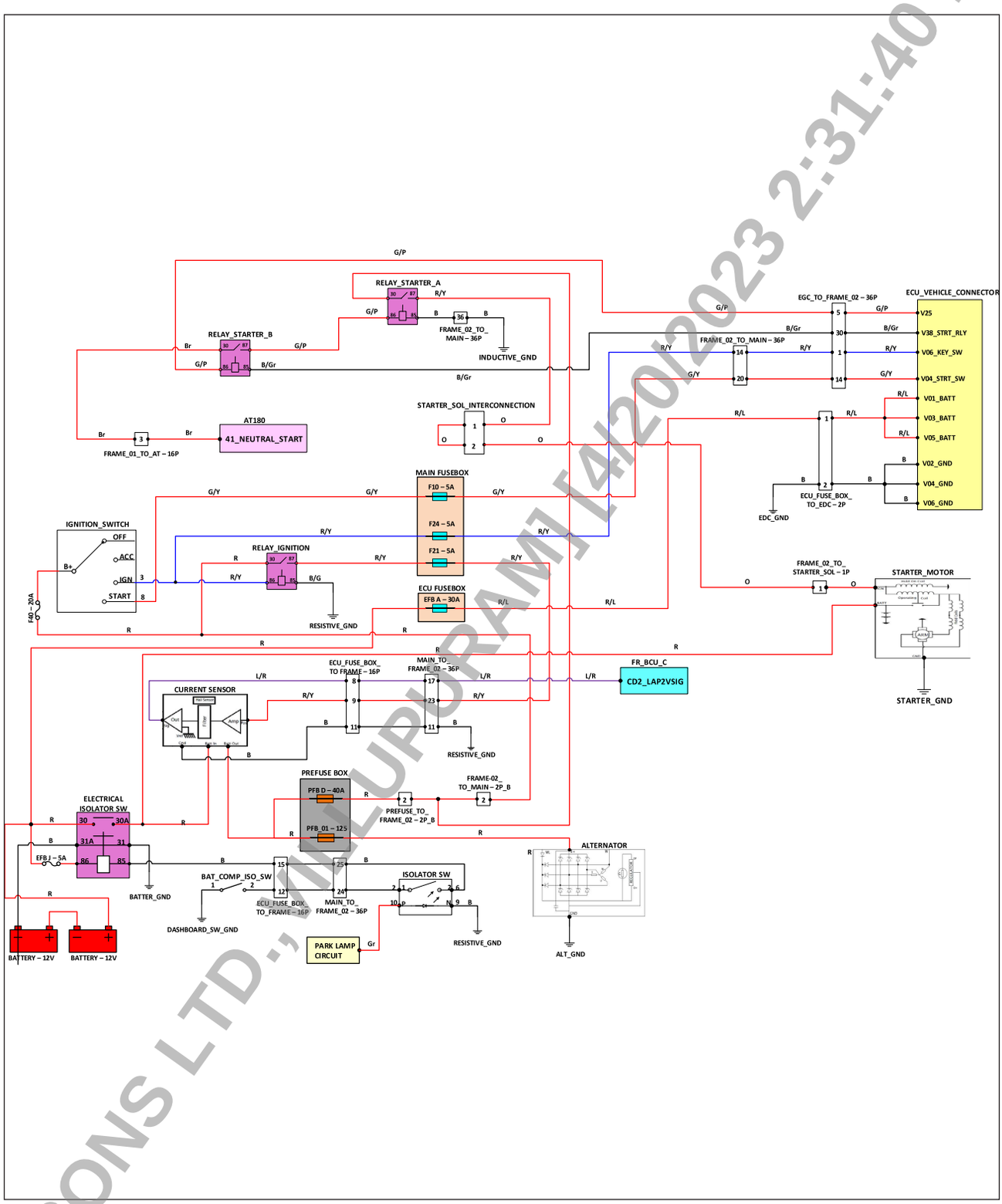
Sl. No.	Description	Vehicle Behaviour in case of Failures
Limp home functions		
1	Accelerator Pedal sensor failure	Limp home - Engine speed limited to 1350 rpm and accelerator pedal no response
Torque reduction and engine stop		
2	Crank or Cam Speed sensor	Engine RPM limited to 1750 rpm + 25% torque reduction
3	One Injector failure or Open load and short circuit between injectors	Engine speed limited to 1750 rpm and drop in pick-up.
4	Rail Pressure sensor or Metering Unit failure	40% Torque reduction and Pressure Relief Valve (PRV) open
5	Oil pressure sensor failure or water in fuel sensor detects water in fuel	40% Torque reduction and engine speed limited to 1750 rpm
6	Low oil Pressure in system or Both coolant and oil temperature sensor failure	80% Torque reduction
7	Engine coolant sensor failure	40% torque reduction and engine over heat
8	ECU failure or Rail pressure exceeds 1890 bar	Engine shutoff
9	Both crank and cam sensor failure	Engine will not start
10	Improper connectivity or malfunction of starter relay	Engine will not start (ECU controlled start function)
Other malfunctions		
11	Vehicle speed sensor	Engine speed limited to specific rpm (as per legislation)
12	Brake switch or Clutch switch or Dashboard lamps or switches failure	Vehicle performance will not be affected
OBD II related malfunctions (Applicable only for BS IV vehicles)		
13	Identified faults that causes NOx above OBD limit 1	MIL ON
14	Identified faults that causes NOx above OBD limit 2	40% Torque Limitation + MIL ON

CIRCUIT DIAGRAM - STARTING & CHARGING CIRCUIT- TRUCK



Sl. No.	NAME	DEVICE TYPE	CURRENT RATING
1	F1	FUSE	30A
2	F2	FUSE	5A
3	F3	FUSE	5A
4	F4	FUSE	5A
5	F5	FUSE	30A
FUSE F (S.NO.1) WILL BE AN INLINE FUSE IN THE BATTERY POSITIVE CABLE FOR EDC SYSTEM			

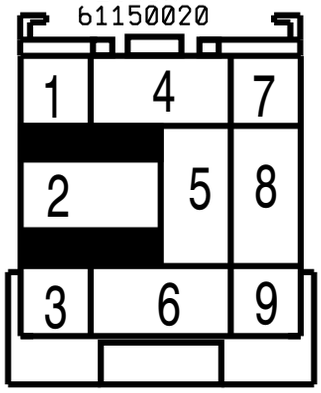
CIRCUIT DIAGRAM - STARTING & CHARGING CIRCUIT- BUS



Sl. No.	NAME	DEVICE TYPE	CURRENT RATING
1	EFB-A-1	FUSE	30A
2	F10	FUSE	5A
3	F24	FUSE	5A
4	F21	FUSE	5A
FUSE F (S.NO.1) WILL BE AN INLINE FUSE IN THE BATTERY POSITIVE CABLE FOR EDC SYSTEM			

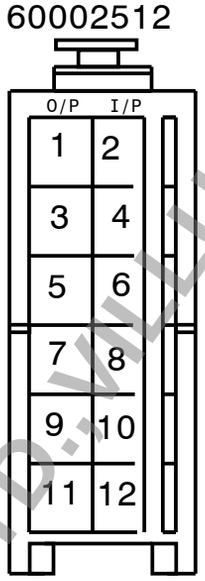
R-1
RELAY

RELAY BASE 9 PIN(5+4) B
Black
61150020



Fuse Base 6 Way
60002512

F-1
Fuse Base

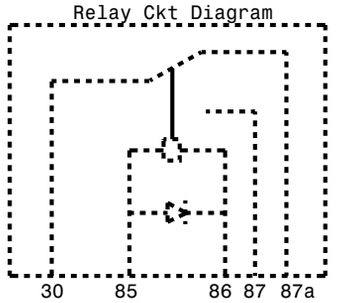


No	Description	Ratings
F1	Battery Fuse	30A
F2	Diagnostic Fuse	5A
F3	Vehicle Speed Sensor	5A
F4	EDC Supply Fuse	30A
F5	Starter – ve	30A

60000608
Cross referance for Relay Base & Relay

Dwg View	Relay Base	Relay Pin
2	E	87
4	A	86
8	B	30
6	C	85

Relay Ckt Diagram

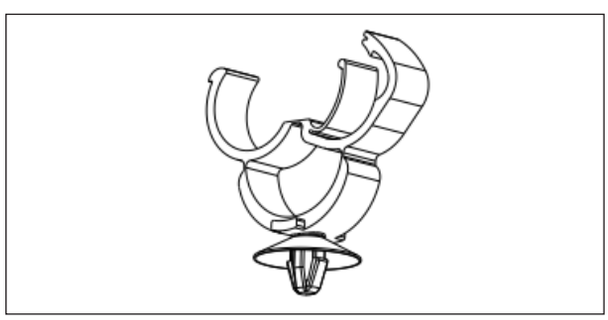
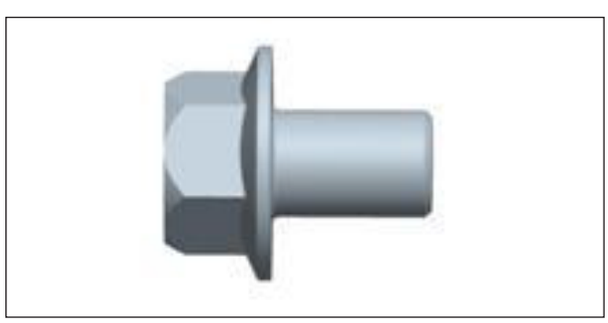


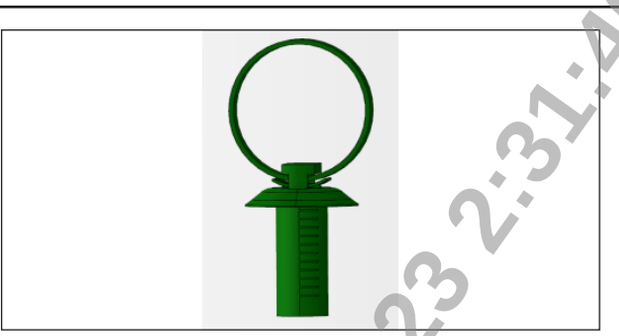
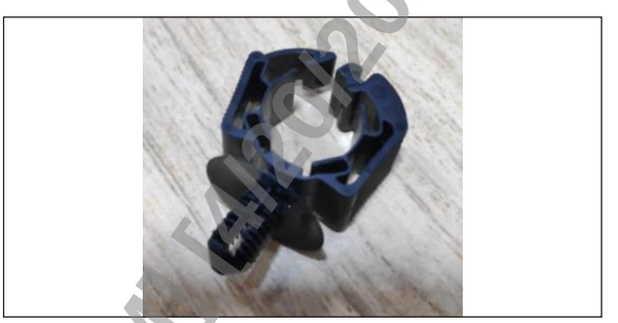
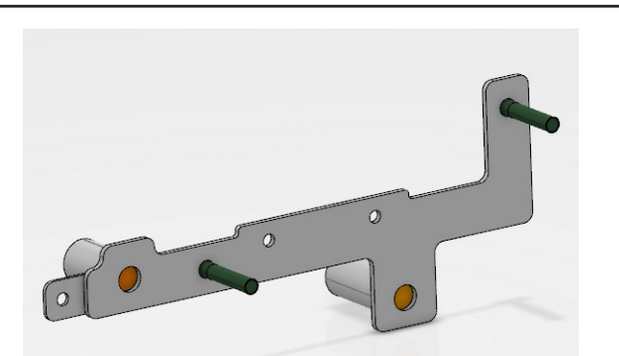
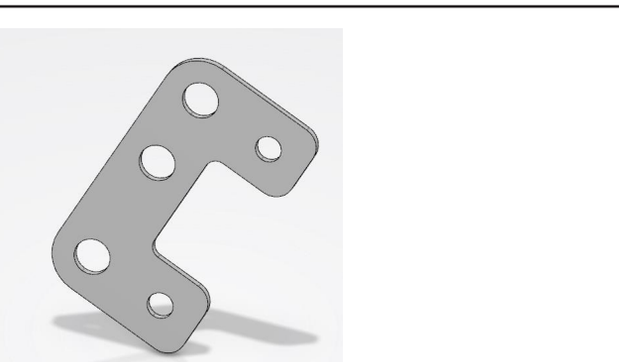
Error Code (Hand Held Diagnostic tool)	Description	Reactions
P0563	SRC high for battery voltage sensor	No reaction
P0562	SRC low for battery voltage sensor	
P0641	Error Sensor power supply 1	
P0651	Error Sensor power supply 2	
P2670	Acuator relay 2 Short circuit to ground error	
P0658	Acuator relay 0 Short circuit to ground error	
P0659	Acuator relay 1 Short circuit to ground error	
P2535	Defective T50 switch	
P0615	Starter relay open load error	
P081B	Starter relay high side short to Battery	
P081A	Starter relay high side short to Ground	
P0617	Starter relay low side short to Battery	
P0616	Starter relay low side short to Ground	
P060C	ECU internal Error	Reactions based on ECU internal HW componenets (40% Torque Limitation based on ECU internal HW componenets)

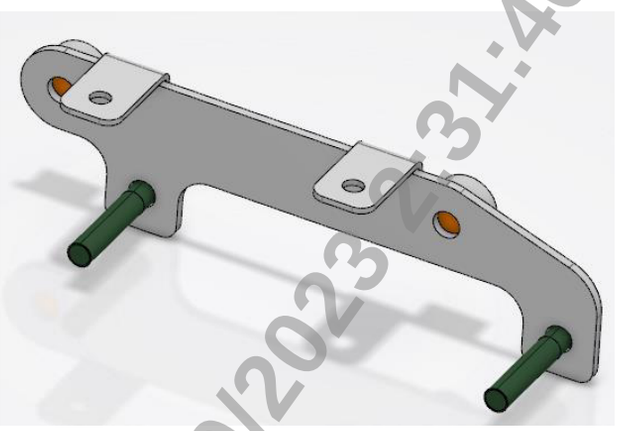
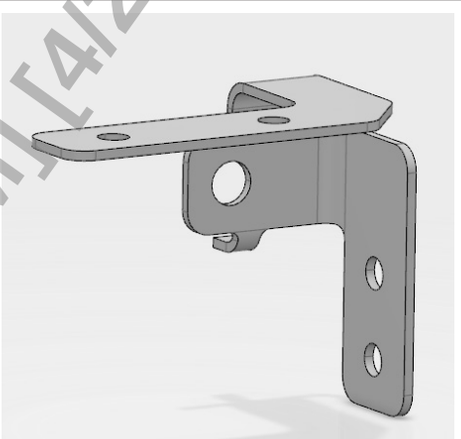
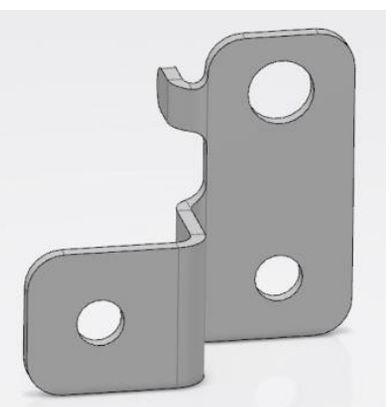
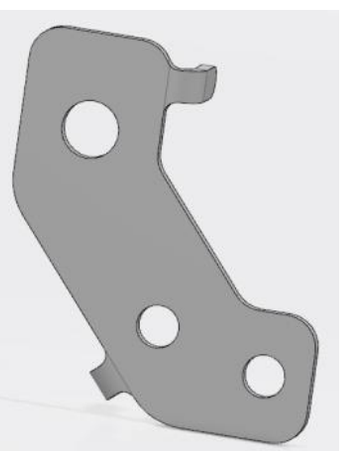
12.7 H6 4V BSVI ENGINE HAS FOLLOWING ELECTRONIC COMPONENTS/CONNECTIONS

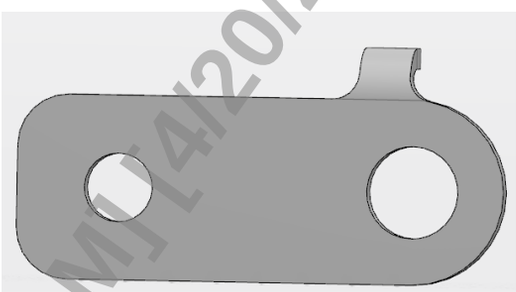
- Crankshaft Speed sensor (CRS –DG6) – Mounted on flywheel housing.
- EGR Controller (EGR) – Mounted on flywheel housing.
- Camshaft Speed Sensor – Mounted on FIP flange
- Rail Pressure sensor – Integrated with Common Rail
- Coolant temperature sensor (CTS) – Mounted on Thermostat housing
- Boost pressure / temperature sensor (LDFT6) – Mounted on intake manifold
- Fuel Metering Unit – Integrated with FIP
- Injector solenoid connection – On fuel injectors
- Oil pressure Sensor – Mounted On Oil Pump
- E Viscous Fan Sensor – On Fan Assembly
- Alternator Signal Sensor – On Alternator
- Compressor Sensor – On AC Compressor
- Fuel Pressure Sensor – On Fuel Controller
- Fuel Cutoff Valve – On Fuel Controller
- Fuel Temperature Sensor – On Fuel Controller
- Air Intercooler Temperature Sensor – Tied Back
- Pressure Relief Valve – On Pressure Relief Assembly
- WIF Sensor – On Water filter Assembly
- Starter Solenoid Sensor – On Starter Motor
- HFM + Air Restricted Sensor – Air intake filter Assembly
- Temp-EGR sensor – Mounted on EGR heat Exchanger
- Intake Throttle Valve – Mounted on intake Throttle Pipe
- HC Dozer Unit Connector – On HC Dozer Housing
- EDC ECU Connector – On ECU
- 36 Pole inline Connector – On EDC Chassis 36 pole interconnect

- Above components on the engine are coupled with the connectors in Engine Wiring Harness which terminates at EDC ECU (E) connector. This is connected to ECU.
- The fuel injection system is electronically controlled by the ECU. It receives signal from the sensors on engine/ vehicle and actuates the Metering Unit and Injectors for optimum fuel injection to achieve desired performance.
- For satisfactory and safe operation of Electronic Diesel Control system, proper connection of sensors, actuators and wiring harness is necessary.

CLAMPS AND FASTENERS USED	
Fir Tree Clip	
Arrow Head Clip	
Hose Clip.	
Arrow Head Clip	
Flange Bolt M8 X 12 X 1.25 (L9010812)	

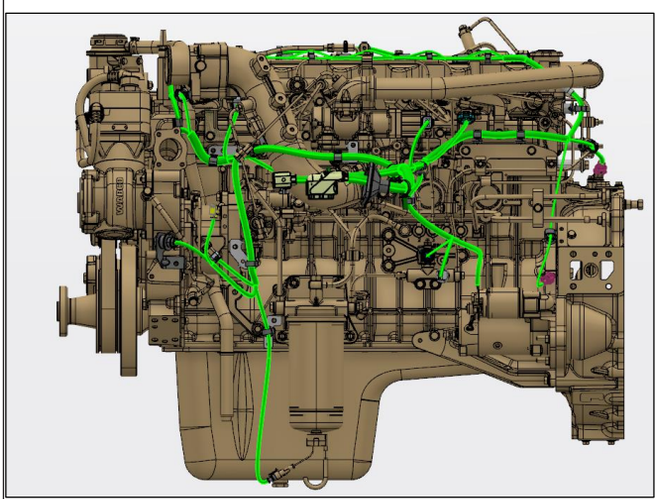
CLAMPS AND FASTENERS USED	
Fir Tree Clip	
Fir Tree Clip	
XBY00813	
BHZ00507	
XBY00613	

CLAMPS AND FASTENERS USED	
BHZ00506	
XBY00513	
XBY01413	
XBY01313	

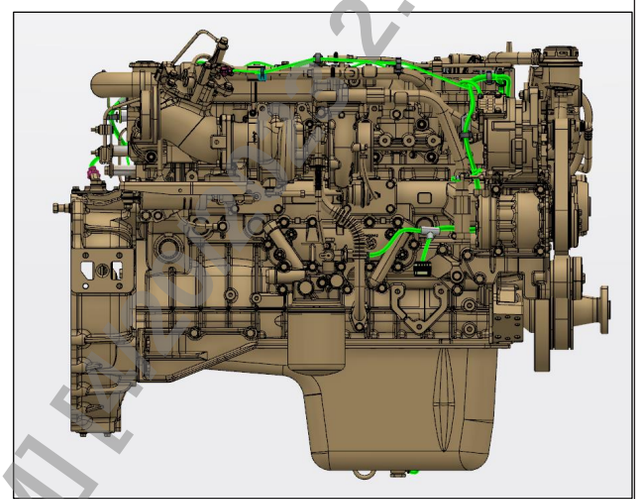
CLAMPS AND FASTENERS USED	
XBY01213	
XBY00713	
F8M09113	

12.8 ENGINE WIRING HARNESS ROUTING ON ENGINE:

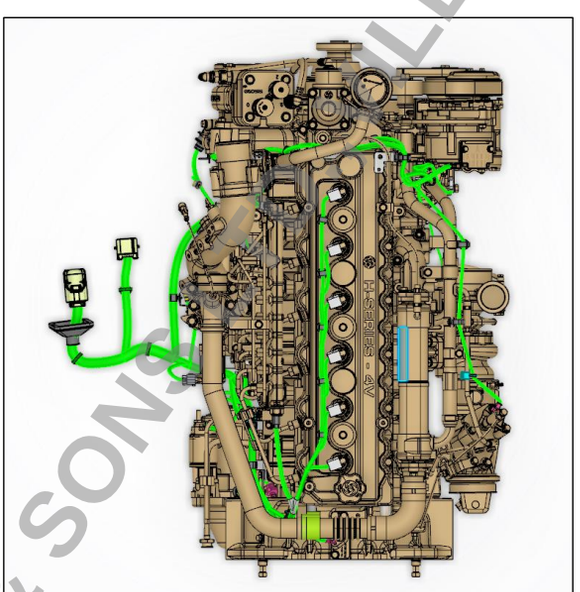
ASSEMBLY OF H6 4V -ENGINE WIRING HARNESS



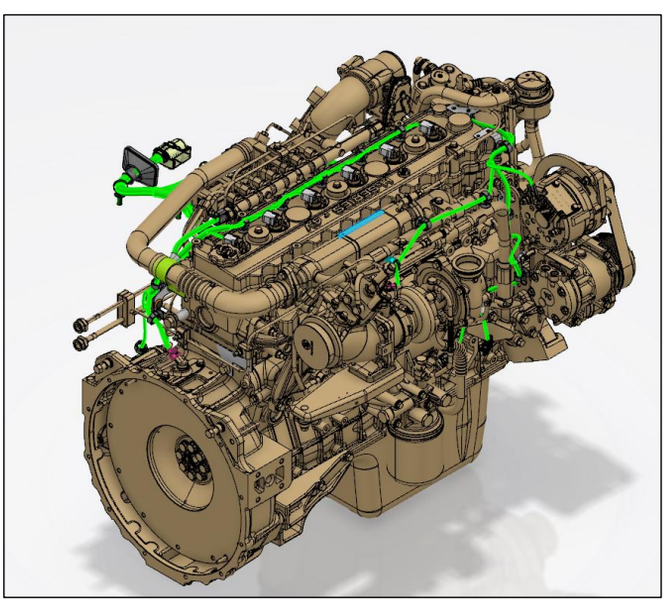
Right Side view



Left Side view

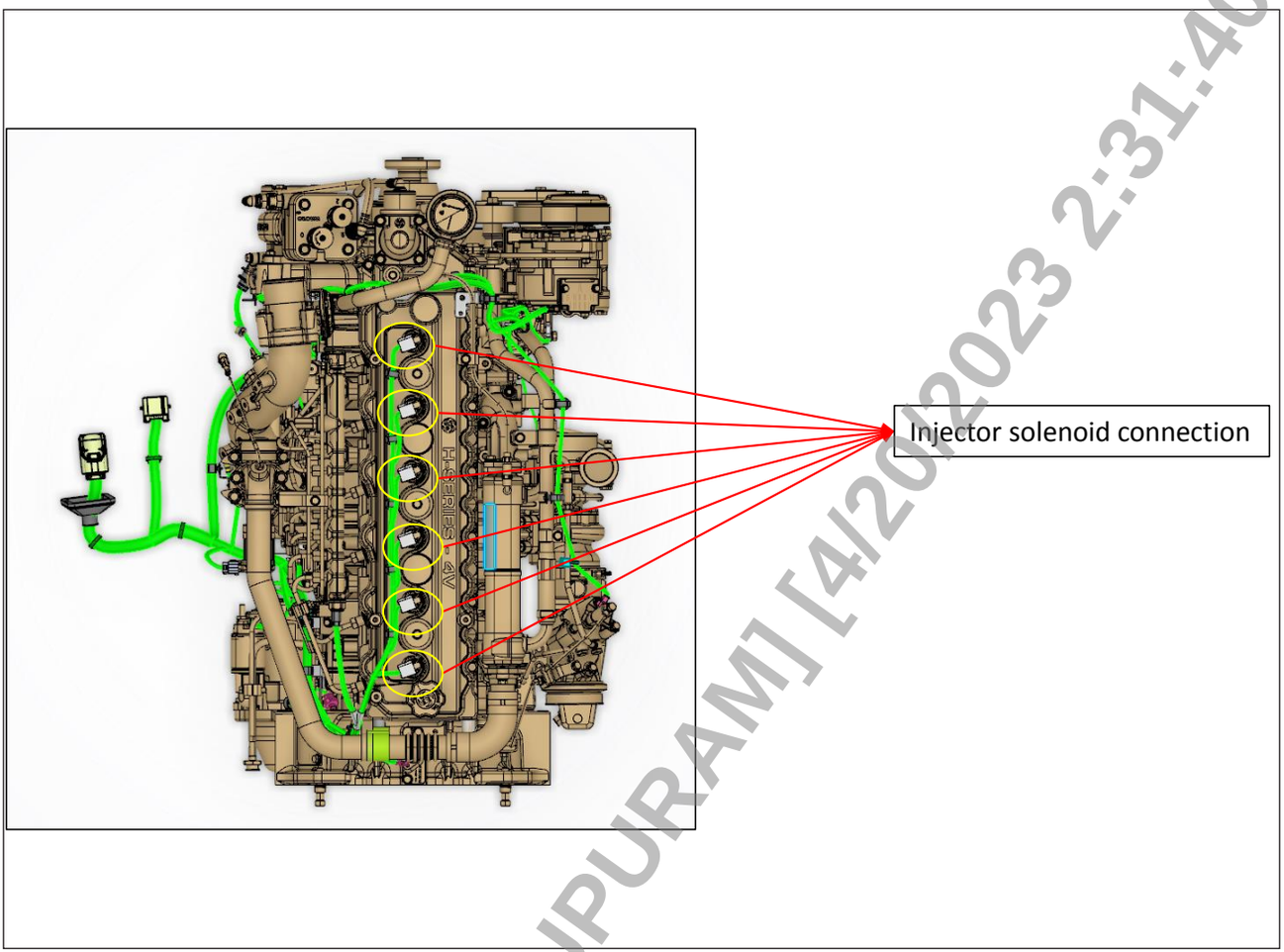


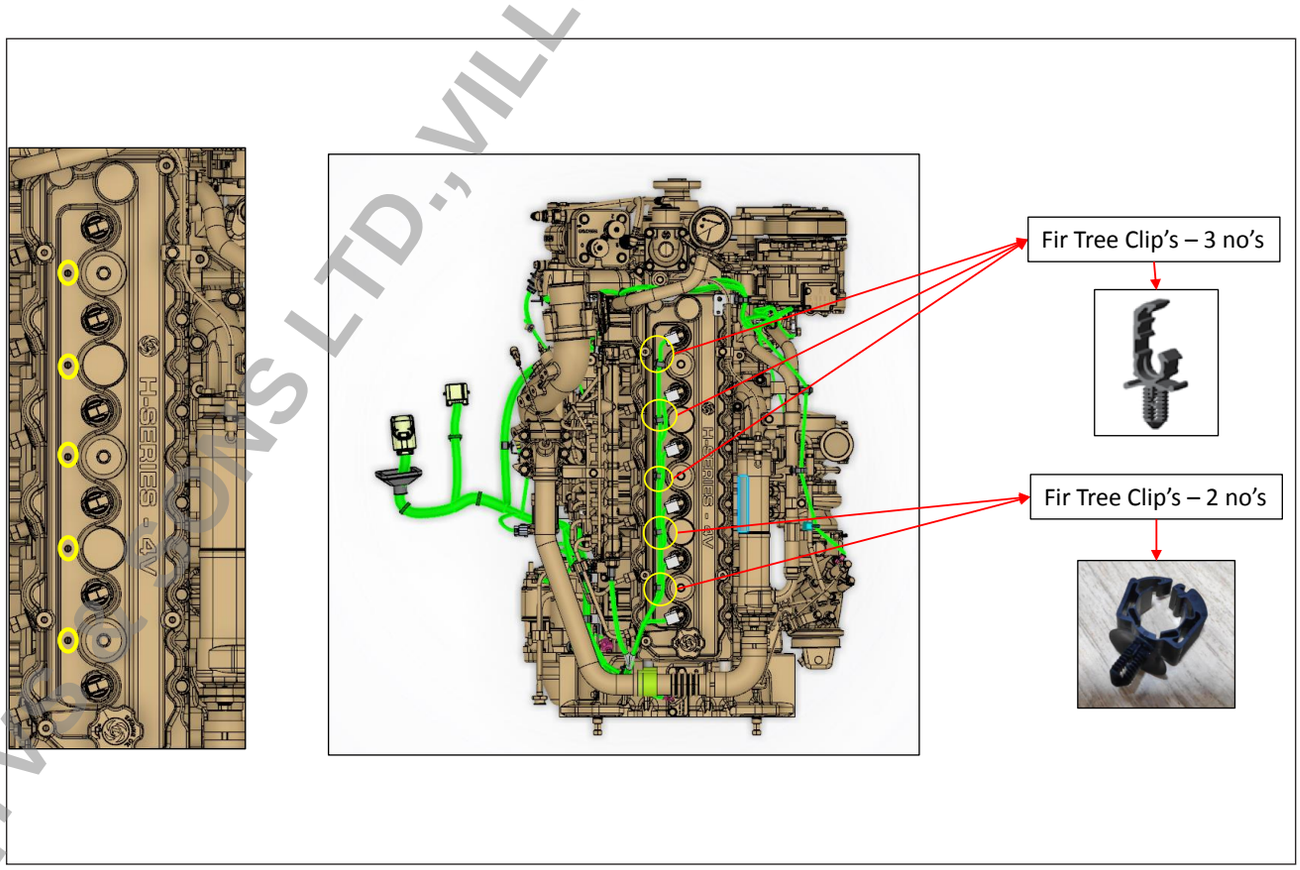
Top View



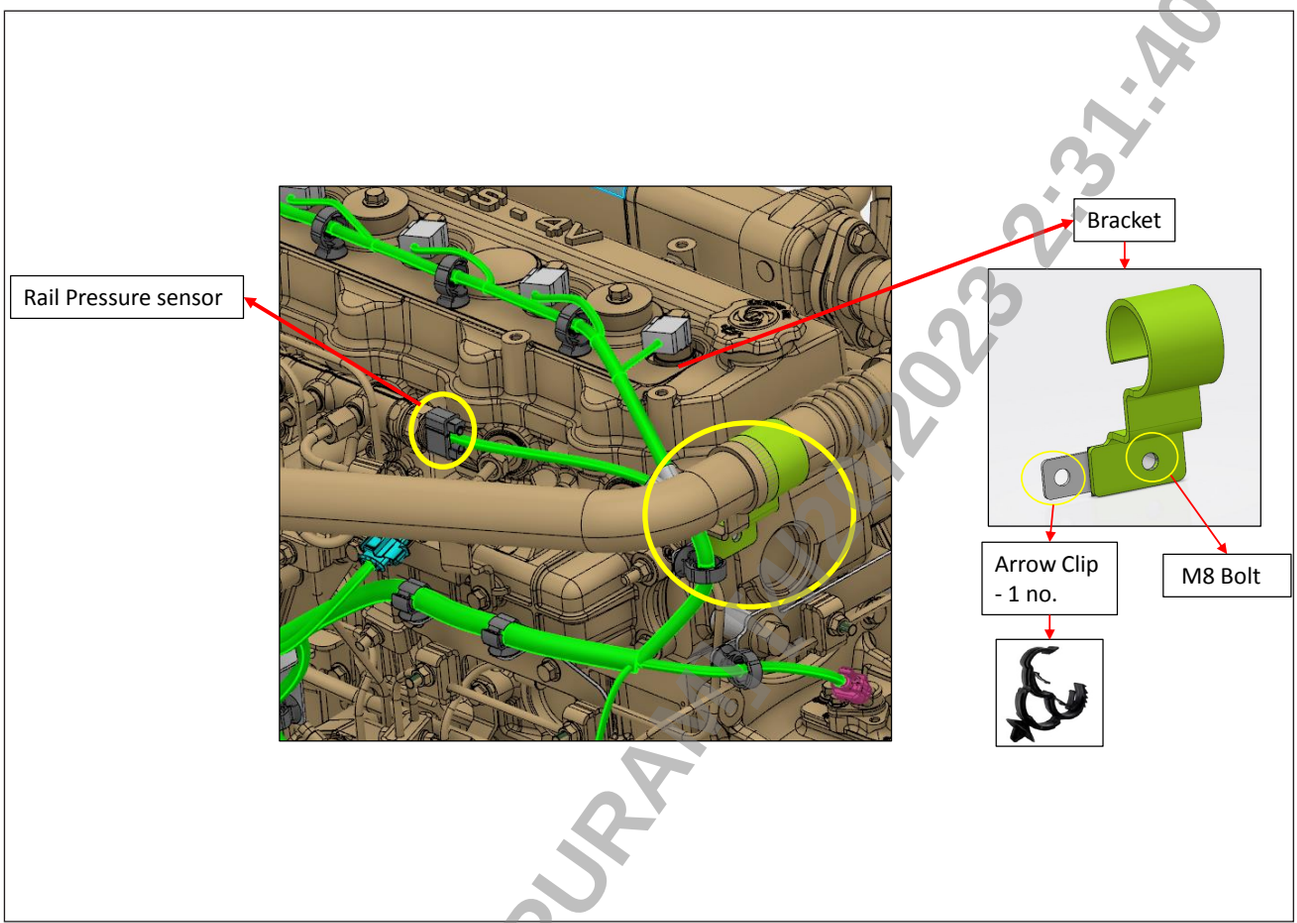
Isometric View

STEP 1 : Assemble Injectors Branch ‘s with the help of Fir tree clip with respective to bracket as shown

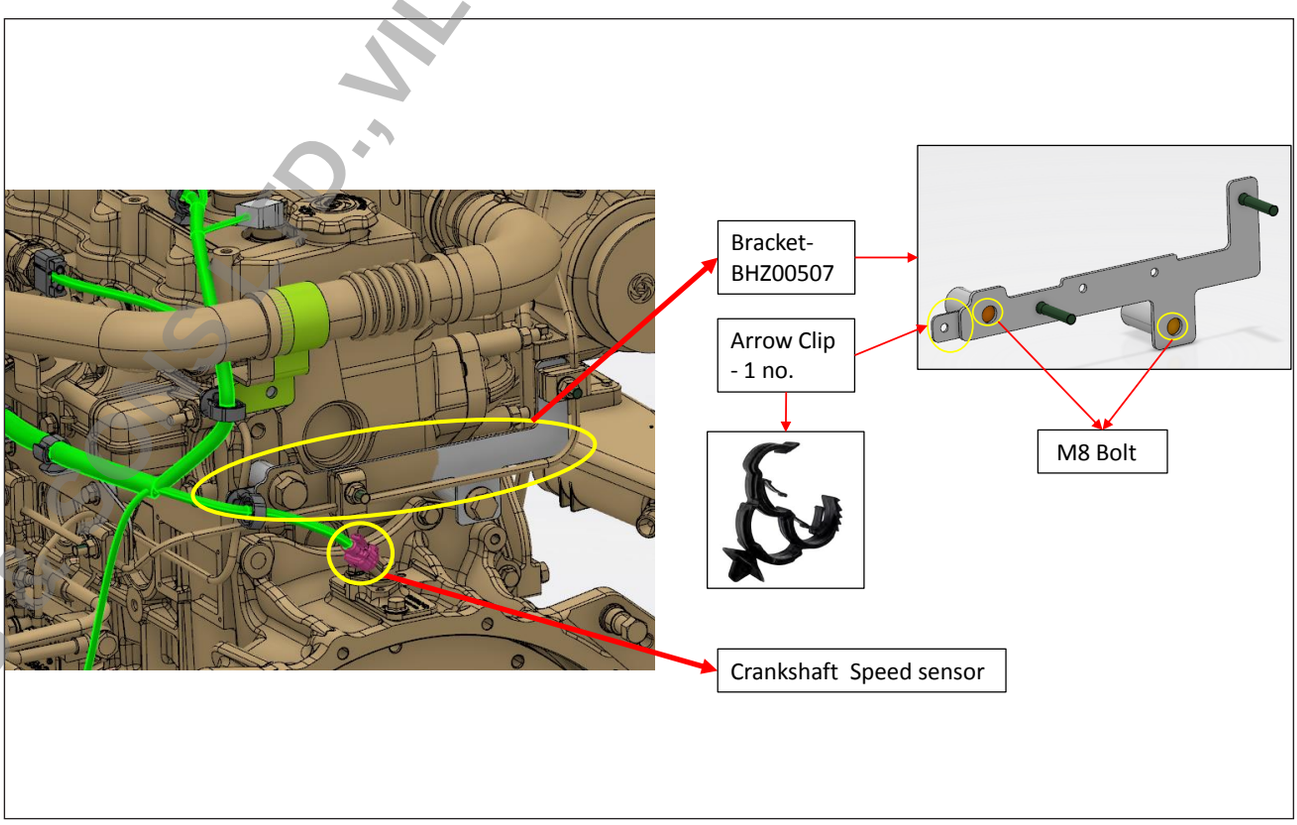




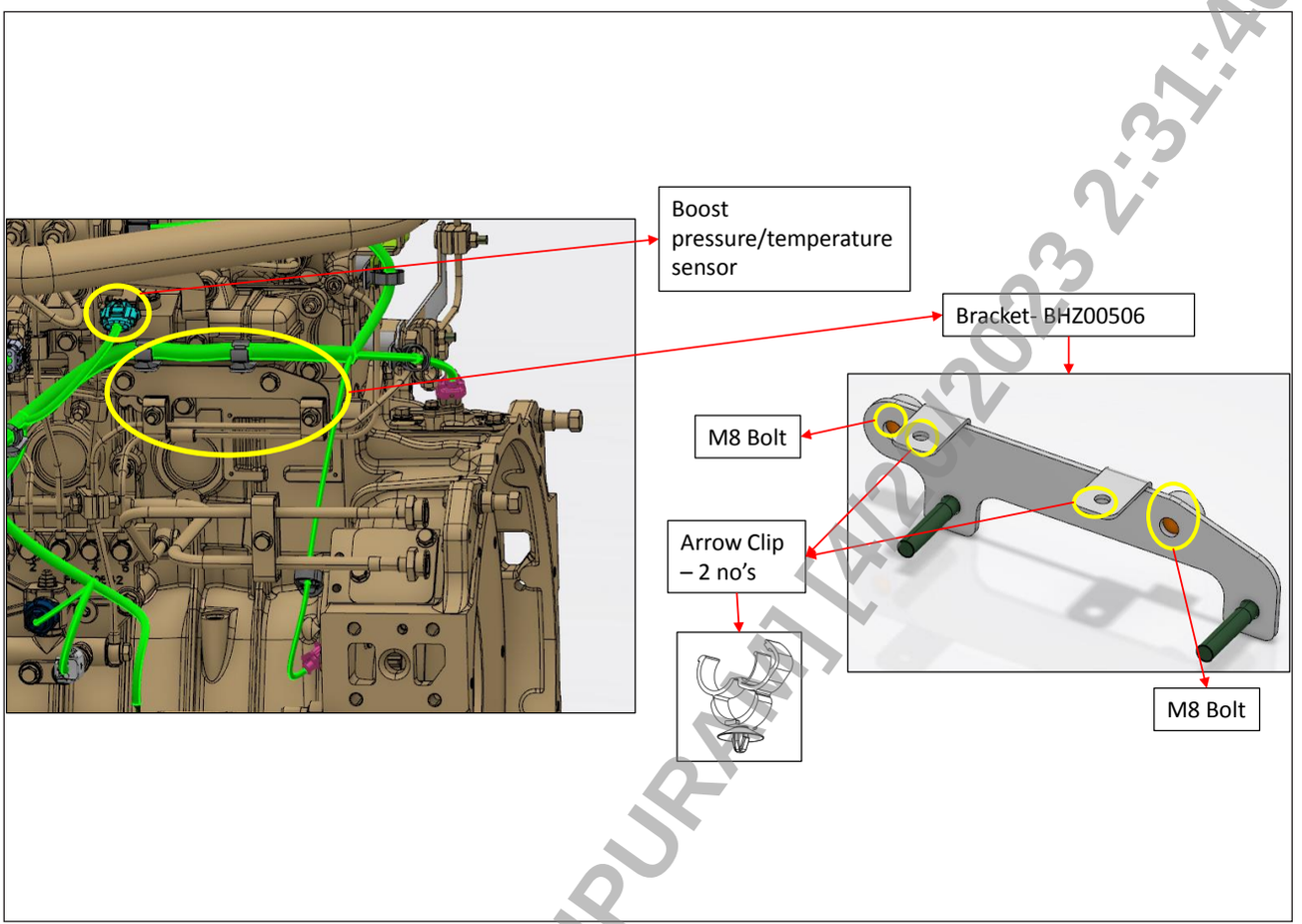
STEP 2 : Assemble the Rail pressure sensor branch as shown below



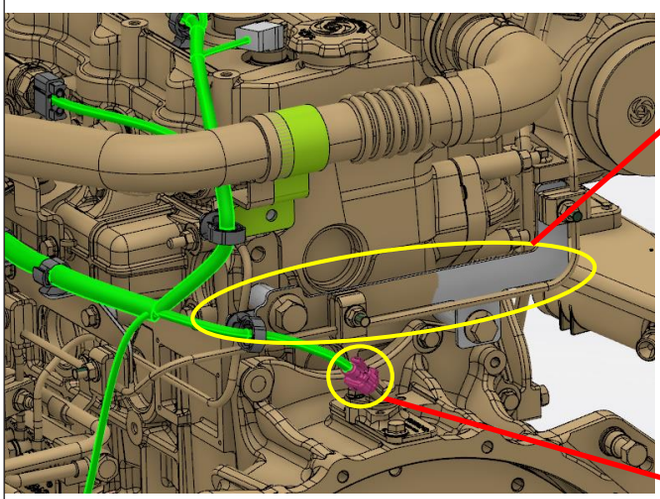
STEP 3 : Assemble the crank sensor branch with the help of Arrow clip with rexpective to bracket as shown below

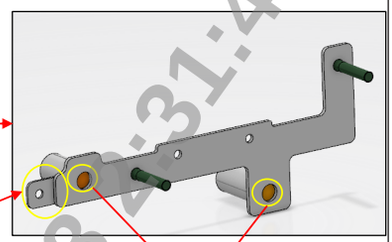


STEP 4 : Assemble the Boost pressure / temperature branch with the help of arrow clip with respective to bracket as shown below



STEP 5 : Assemble EGR branch with the help of arrow clip as shown below





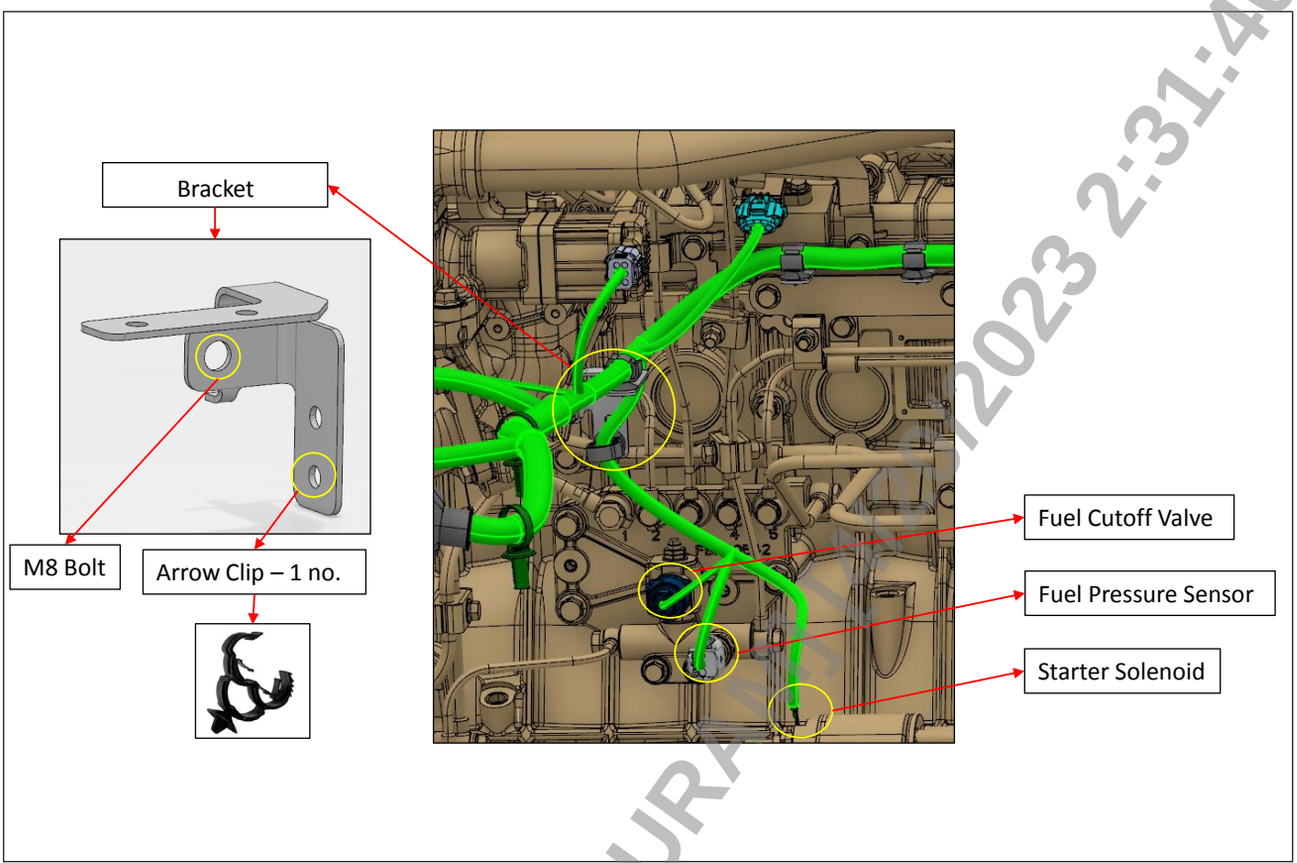
Bracket-
BHZ00507

Arrow Clip
- 1 no.

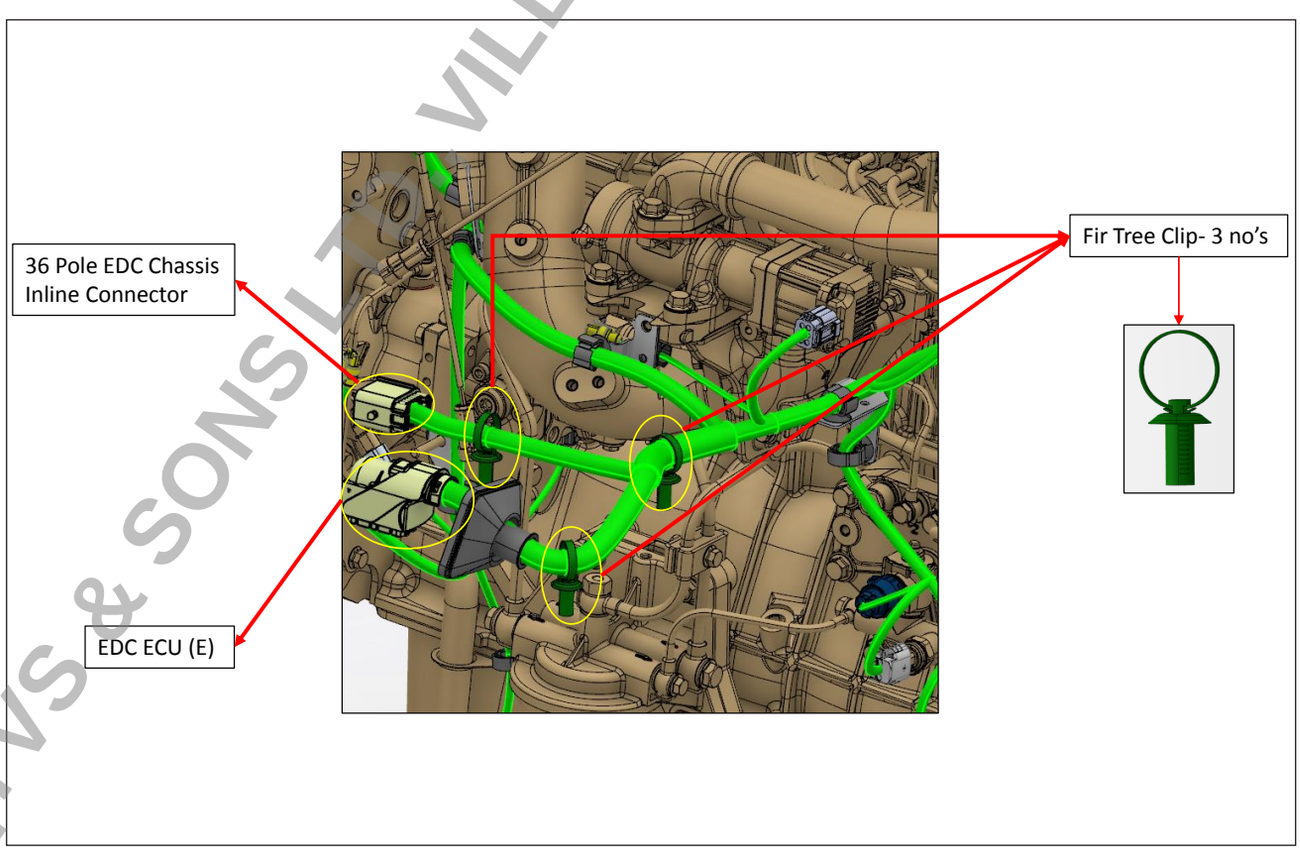
M8 Bolt

Crankshaft Speed sensor

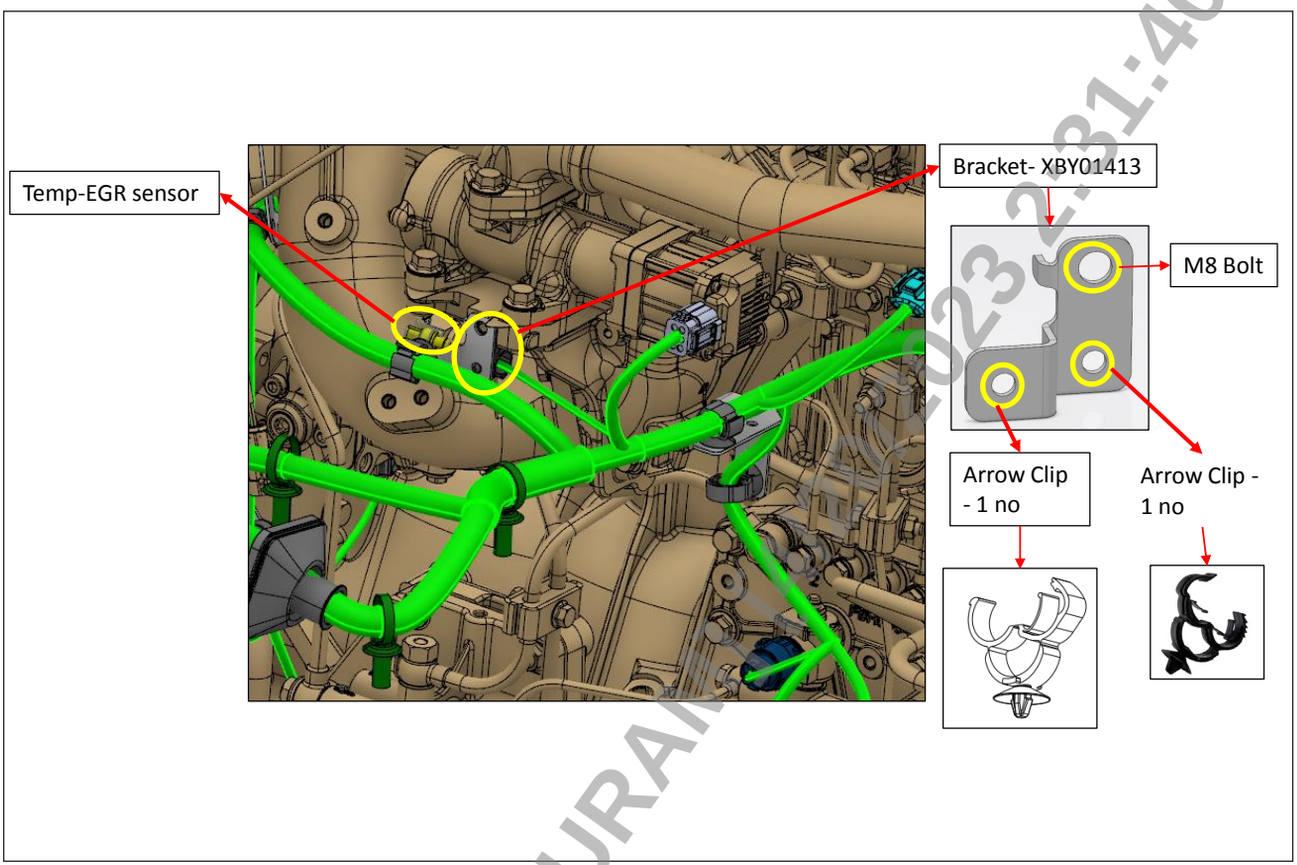
STEP 6 : AssembleFuel cutoff valve , Fuel pressure sensor and Starter Solenoid branch's respectively with the help of arrow clip with respective to bracket as shown below

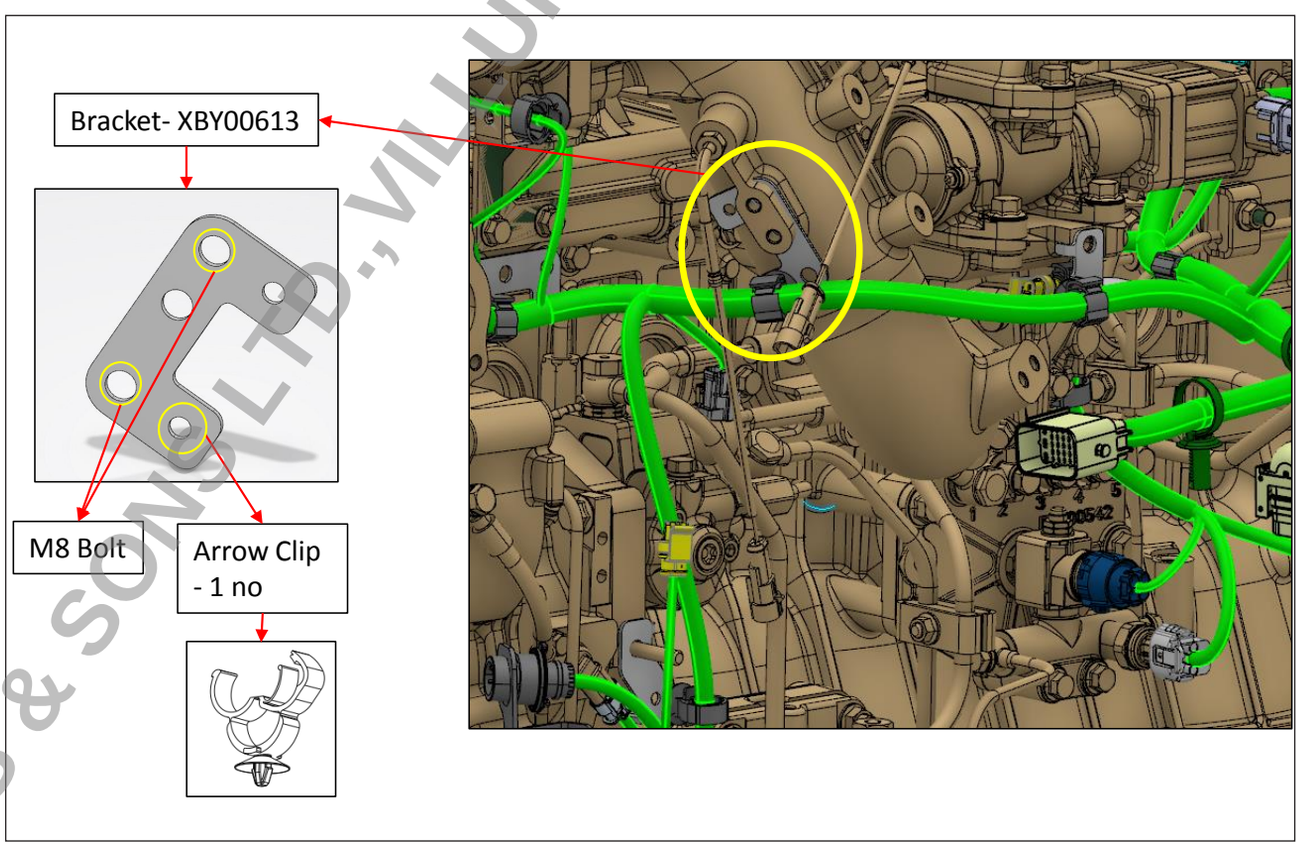


STEP 7 : Assemble the 36 pole EDC Chassis inline and EDC ECU (E) branch's respectively as shown below. Fir Tree clips will be connected in vehicle side.

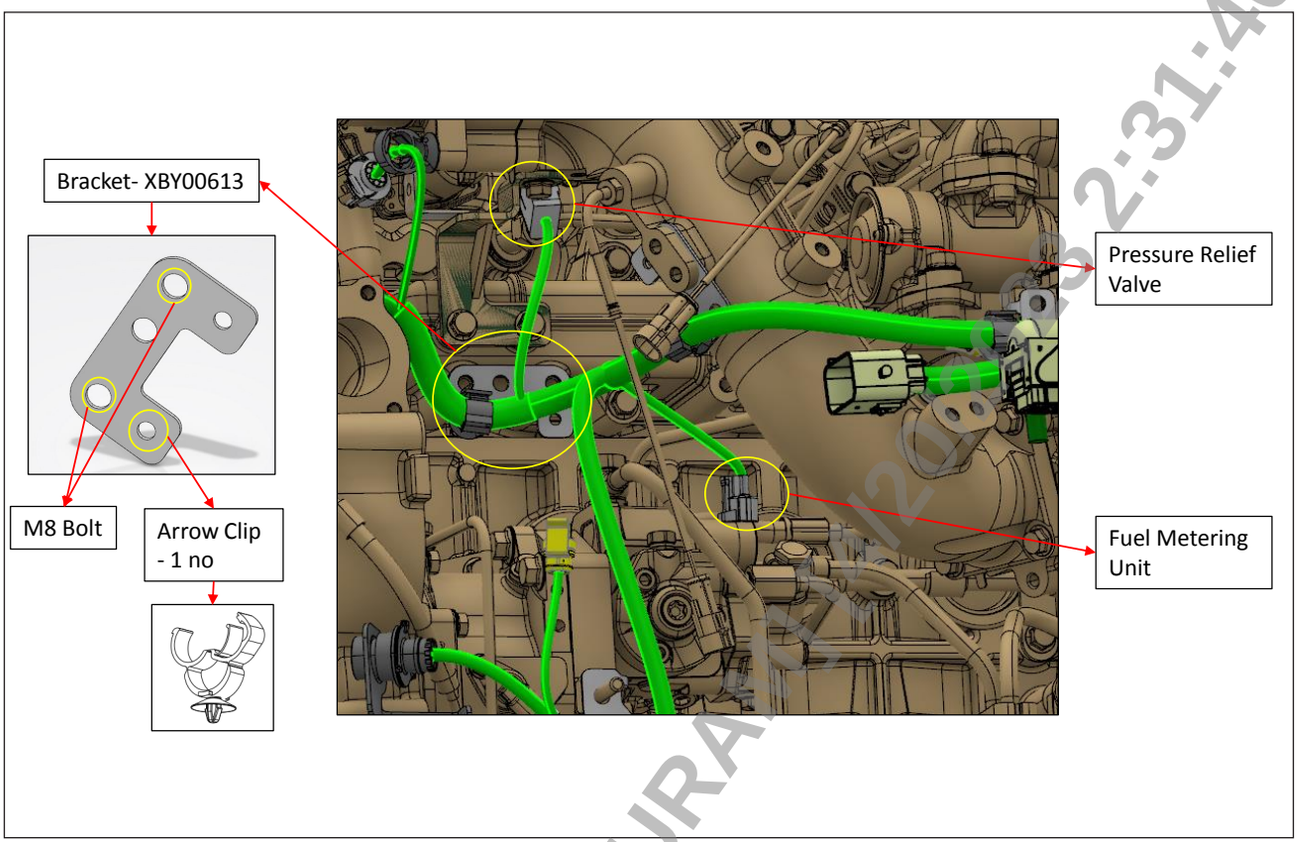


STEP 8 : Assemble Temp - EGR Sensor branch respectively with the help of arrow clip with respective to bracket as shown below

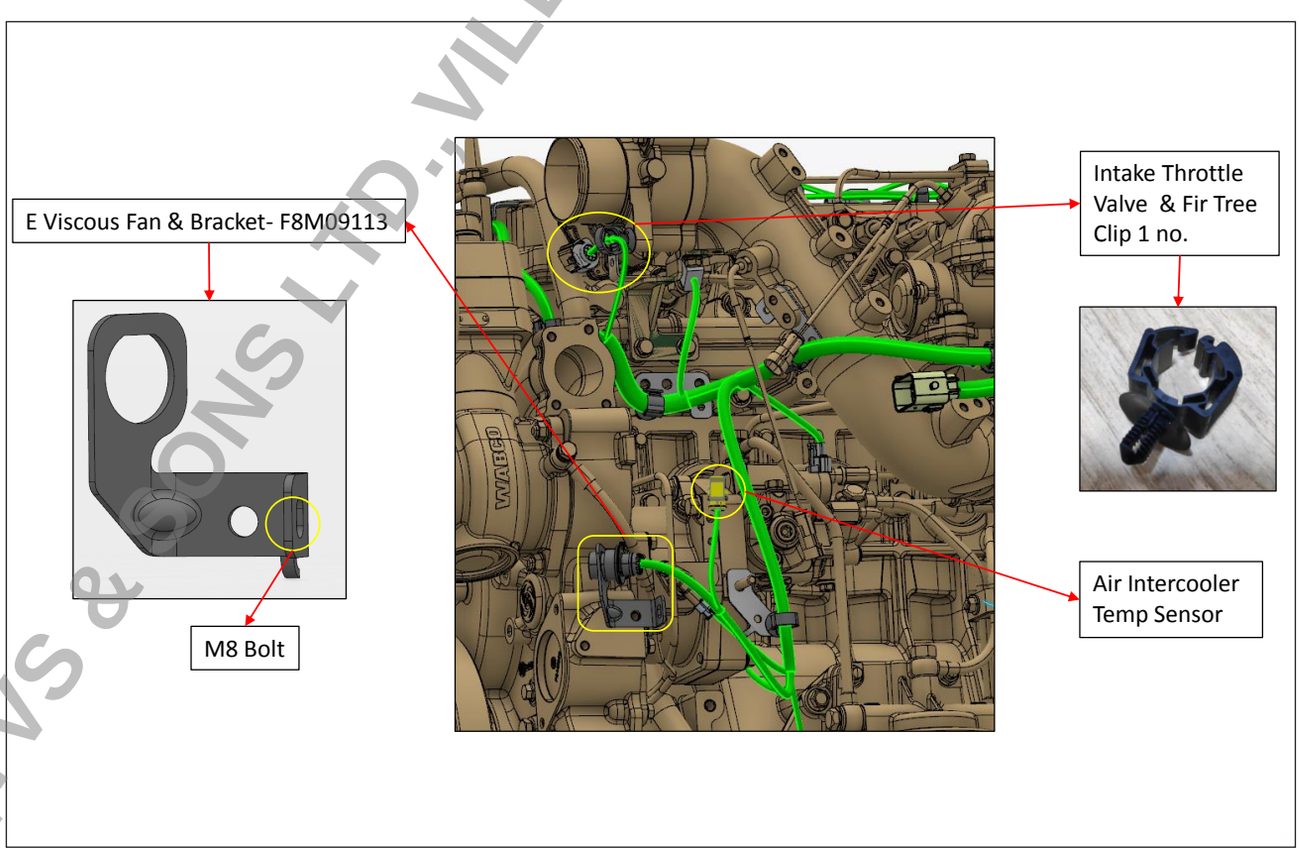




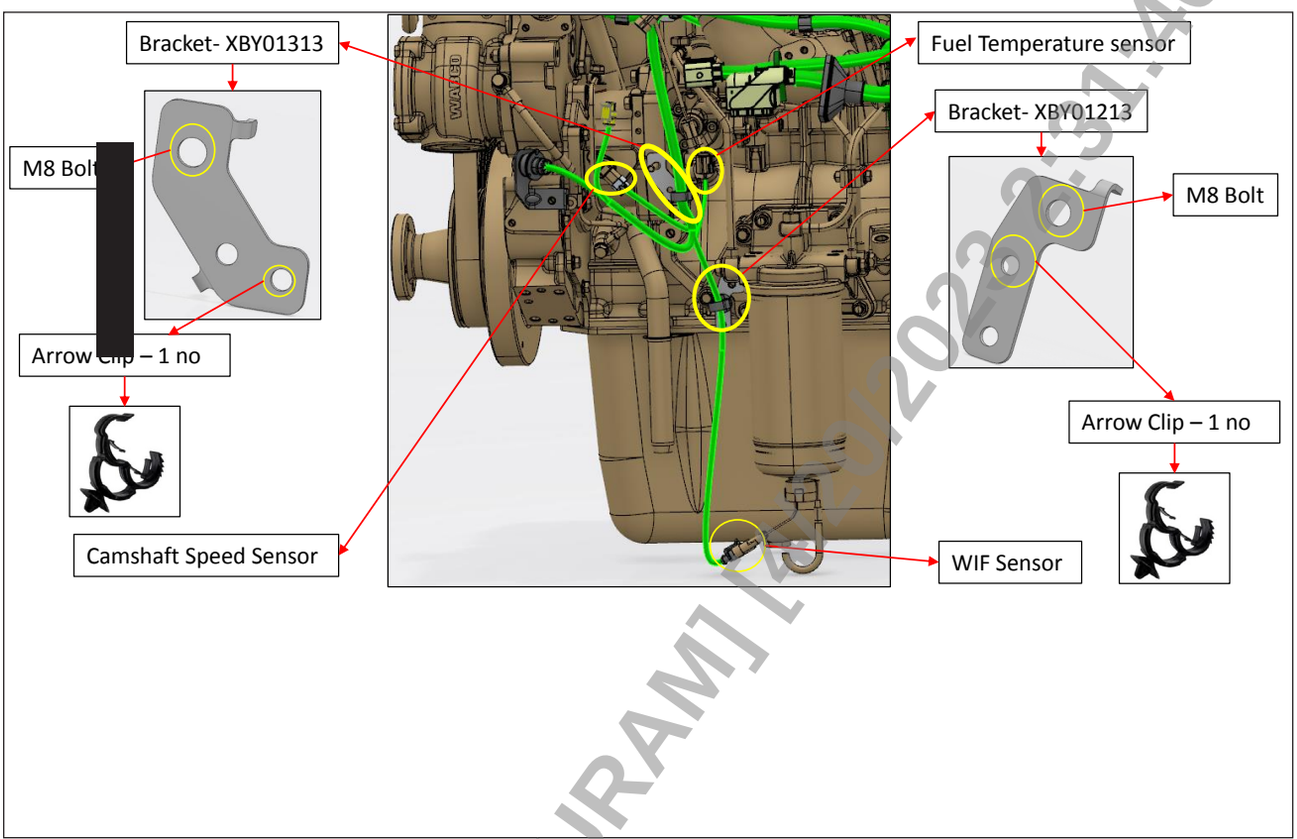
STEP 9 : Assemble Fuel metering and pressure valve branch and arrow clip with respective to bracket as shown.

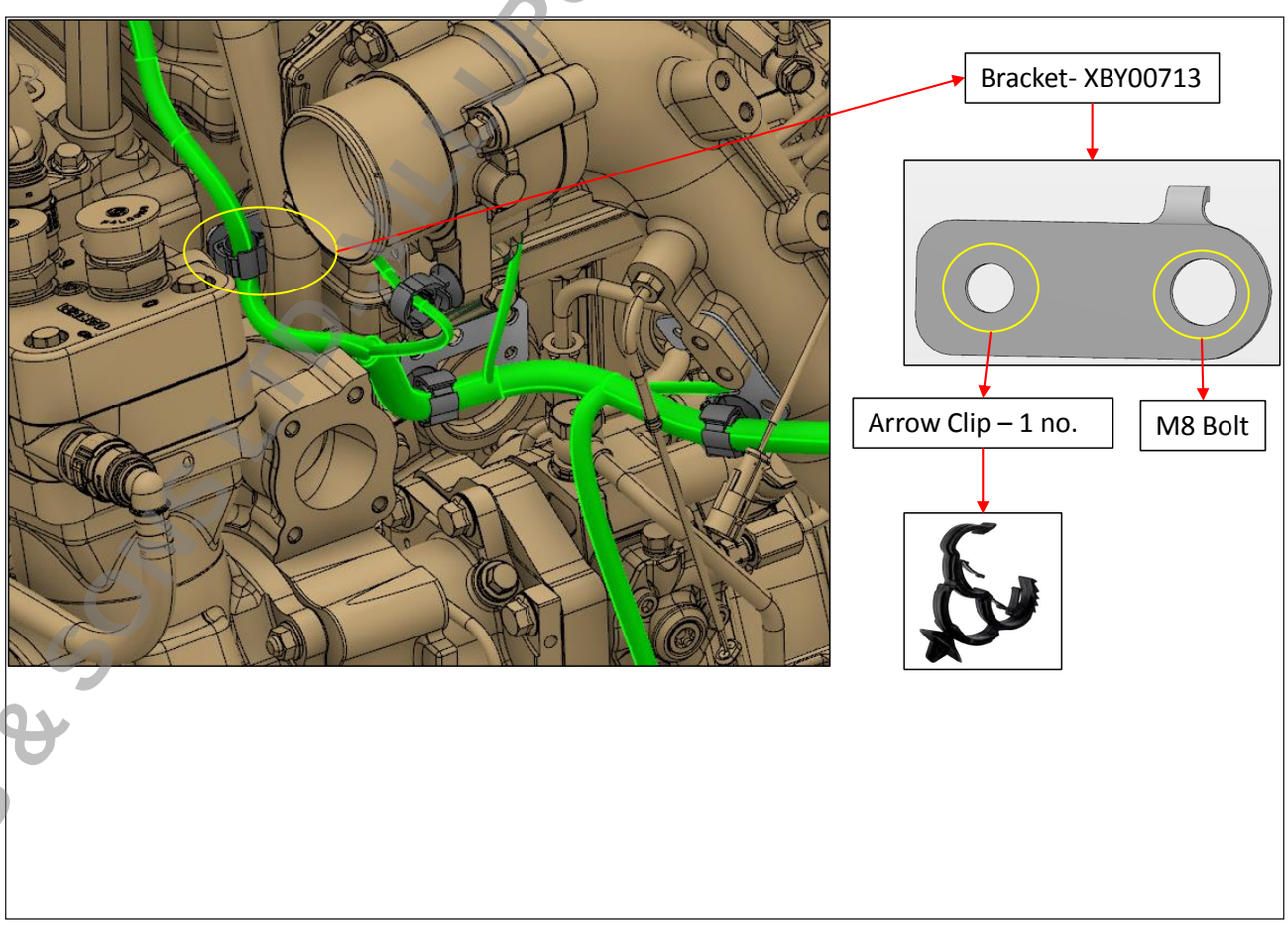


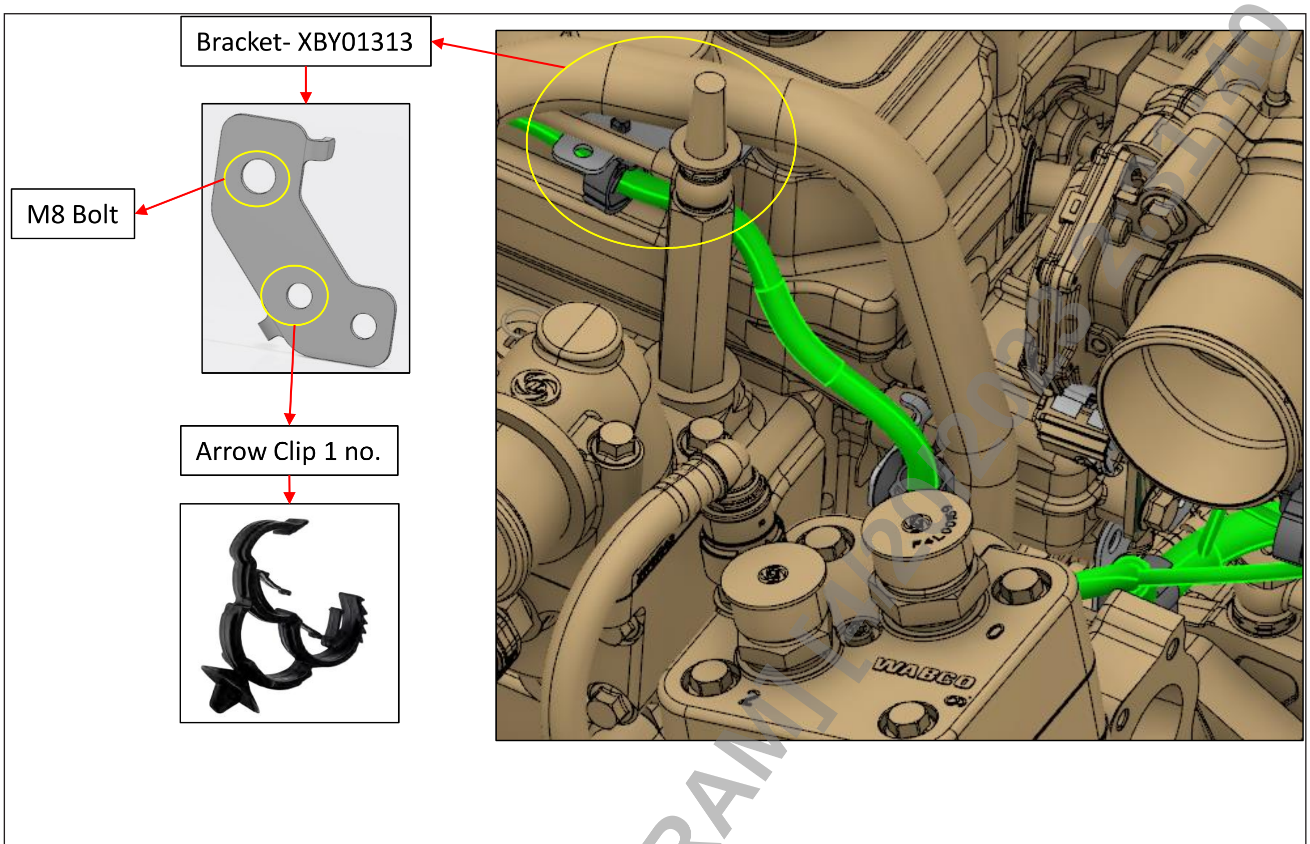
STEP 10 : Assemble intake throttle valve , air intercooler temperature sensor and viscous fan branch with the help of arrow and fir tree clip and fix fan connector using fixing ring with respective to bracket as shown.



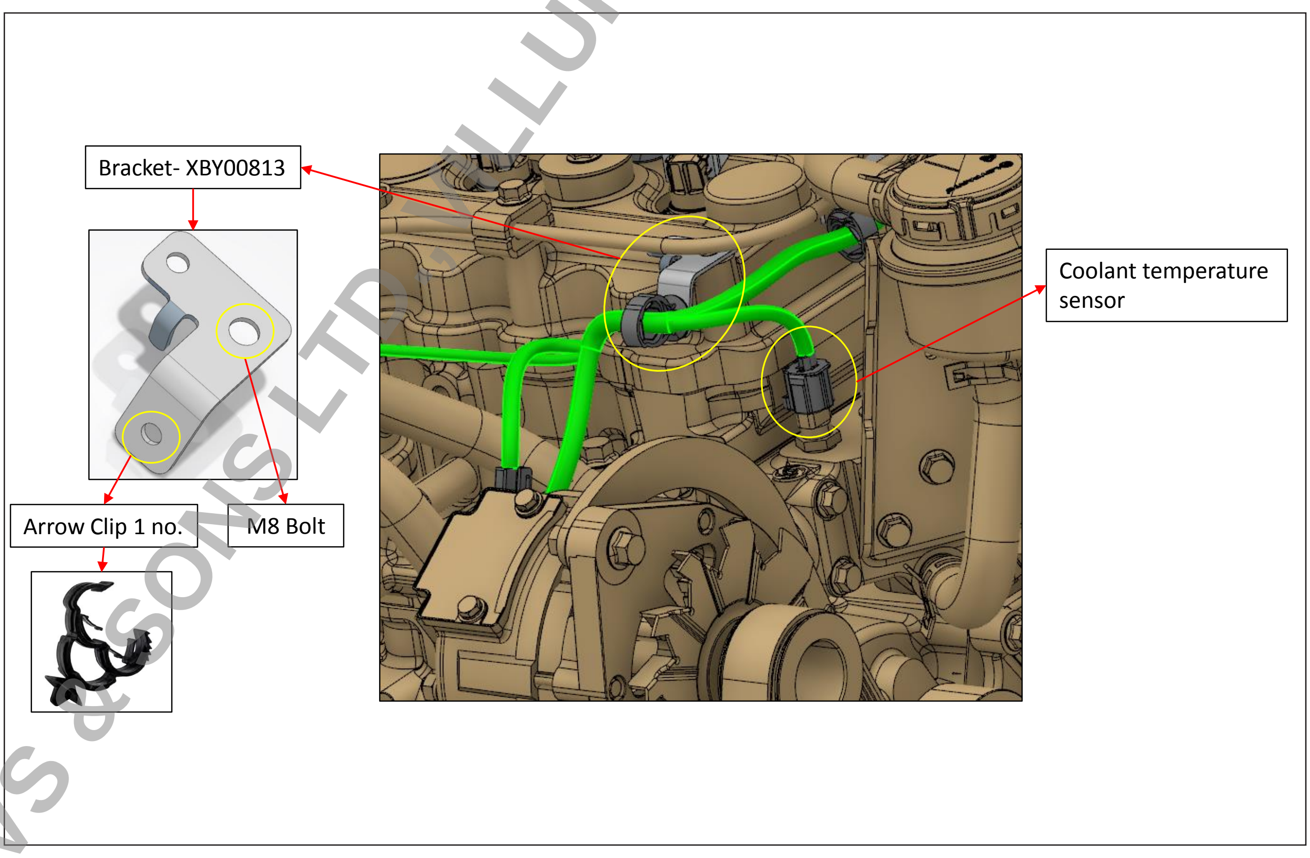
STEP 11 : Assemble Fuel Temperature camshaft speed sensor and WIF sensor branch respectively with the help of arrow clip with respective to bracket as shown.



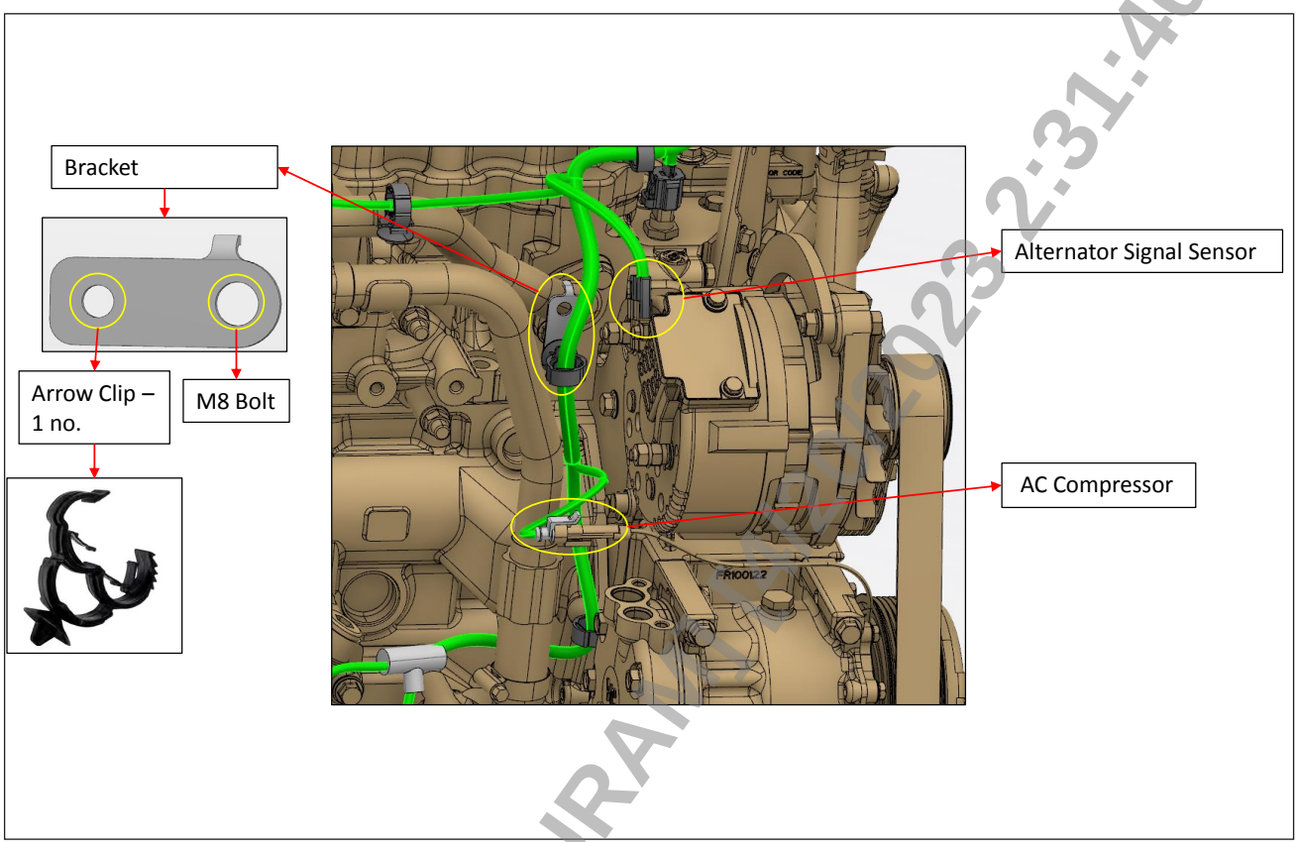




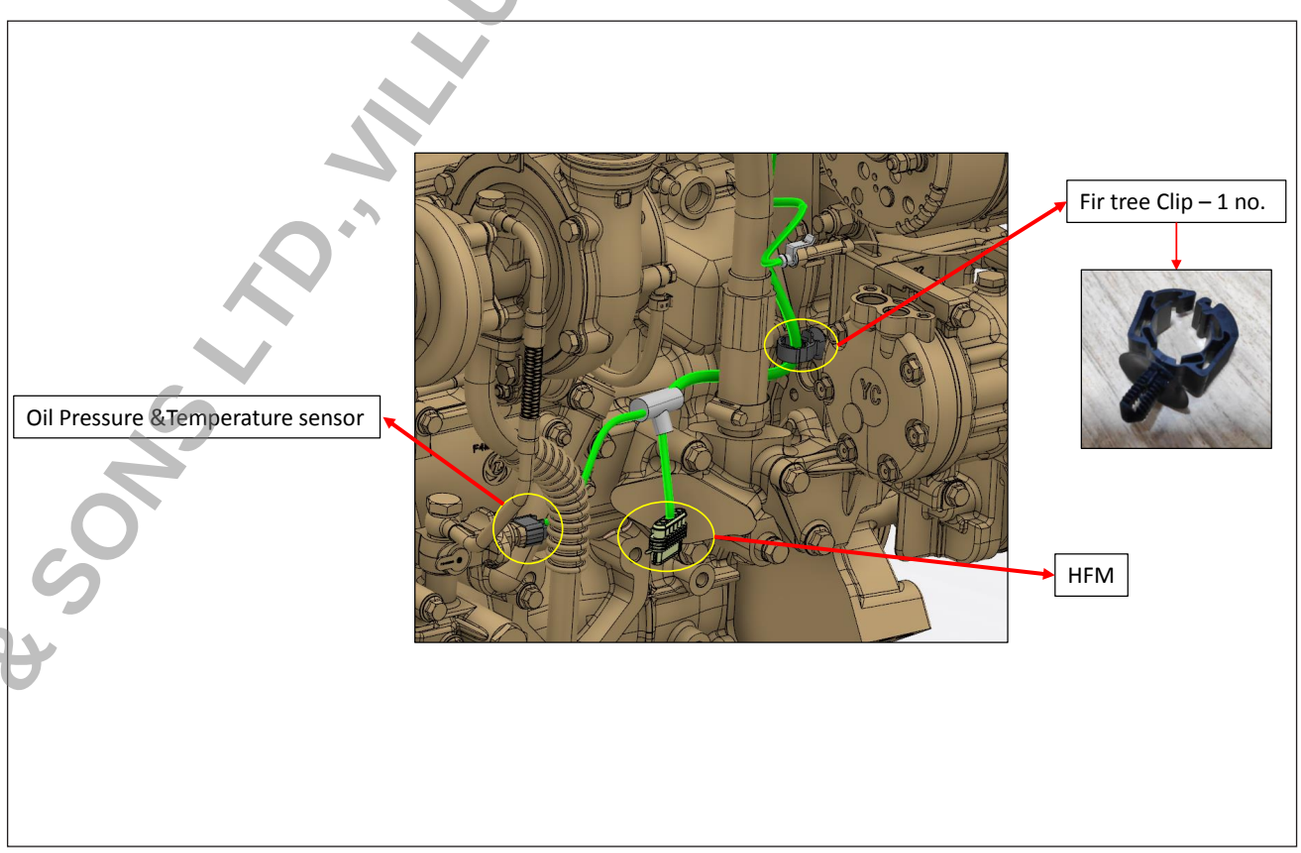
Step 12. Assemble the coolant temp sensor branch as shown below



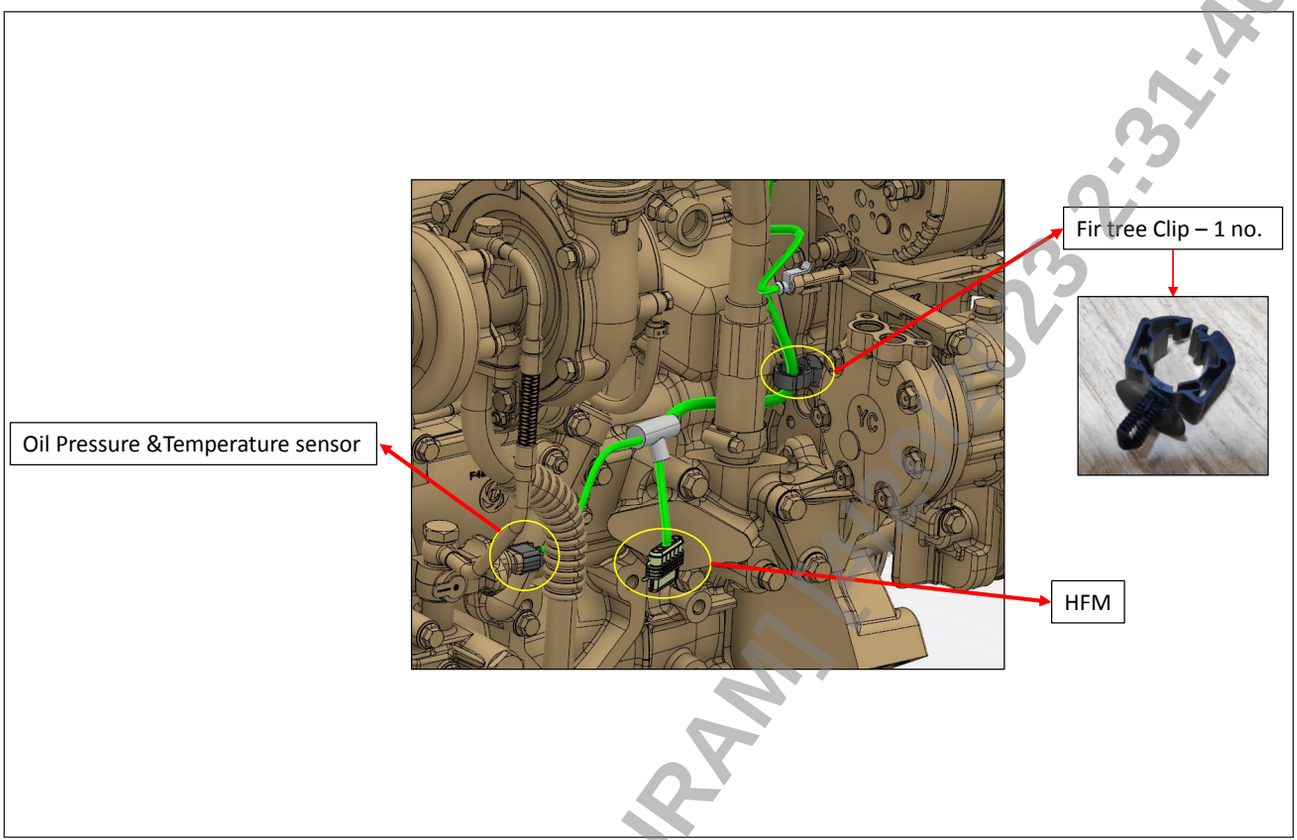
Step 13 Assemble the alternator signal sensor & Ac compressor connector branches respectively and arrow clip with respective to bracket as shown



Stpe 14 . Assemble the HFM and Oil pressure sensor branches respectively with Fir tree clip with respective to bracket as shown make sure HFM connection is connected to mating harness and is properly tied back to support bracket.



Step 15 Assemble the Dozer Injector branch , Hose clip and corrugated Holder clip with respective to bracket as shown.



12.9 GUIDELINES FOR CHECKING SENSORS AND COMPONENT

1. Checking Voltage / Resistance at Component or ECU End - Allowed with proper instrument & care.

2. Few test to be carried out with Ignition ‘OFF”/’ON’ and Engine running mode condition to confirm the fault and after erasing the error.

3. Avoid Checking at ECU End. In case of utmost requirement ensure ECU body is always connected to Starter Negative.

4. Measure resistance of the sensor at the Connector end and on the connector at the ECU end after connecting the respective sensor. Given resistance values are as measurable at the sensor end. While measuring resistance at the ECU connector end with sensors connected, the resistance of the wire will get accounted.

5. Care to be taken not to short the supply voltage / Sensor Output with earth / Negative.

12.10 PRECAUTIONS FOR ELECTRONIC DIESEL CONTROL SYSTEM (EDC) DURING BODY BUILDING

Extreme care to be taken while assembling the body on the chassis with respect to the ECU.

General

1. The ECU should be disconnected from the harness and a dummy cap/cover with plastic bags should be put on the ECU connector. There should be no ingress of water through the wiring harness on the ECU.
2. The ECU as such should be covered in a box so that if any washing is done, the ECU will be protected.
3. Maximum cleanliness in the work area and the tools should be employed . Check to see if the ECU has become dirty during the body building phase especially at the connector end and pins. Use a soft clean & dry paint brush to remove the dust.

Ashok Leyland specific:

Ensure that the intermediate connector (supply +ve and -ve for ECU) between the DC to DC converter and wiring harness is properly locked and intact.

EDC System

Have a clear space in front of the EDC panel cover for easy removal and fitment of electrical/electronic parts of EDC panel.

Instructions

1. Before and during welding

- Disconnect battery terminals (Positive and Negative terminals of 24V supply).
- Disconnect Two connectors of the ECU and have the panel cover refitted.
- Avoid falling of hot weld spatters on wiring harness, sensors and Accelerator Pedal Module.
- Do not use Accelerator Pedal as a support during body building.
- Avoid falling of any sharp/Heavy objects on the accelerator pedal module and its connecting wire.
- Do not disturb the clamps of EDC system wiring harness unless it is very essential, but ensure it is replaced/refitted properly.

2. Do not disturb/remove the connected DC negative connection of EDC system. DC negative is connected at two places
   a) Chassis
   b) Starter Motor Negative to Engine Block
3. Do not remove or cut wires of the EDC system wiring harness. No unprescribed extension or intermediate joints are permitted.
4. Ensure fuse and connectors of the EDC system power cable (closer to the battery cable terminal ends) are kept inside the battery box.
5. To power ECU and the ECU system minimum 18 Volts at battery is required.
6. Push start is possible when starter motor is not functioning properly and battery output is 18 Volts is minimum.
7. Before connecting the engine wiring harness, the battery terminals (Both positive and negative terminals) are to be disconnected.
8. Make sure that the lock of the connectors are fitted properly.
9. Clip/clamp the wiring harness every 500 mm.

Do's and Don'ts for Body builders, Field service

Do's

1. Reverse polarity protection: Care needs to be taken while removing the battery connection during body building and reconnect the terminals in correct polarity.
2. Check the battery condition regularly and keep the batteries in healthy condition.
3. Ensure proper connectivity of ECU/Sensor connectors with wiring harness.
4. Keep the ignition "Switch Off" while removing/ reconnecting the battery connections in the vehicle.
5. Correct tightening torques should be used for mounting the ECU and other electrical/electronic parts on EDC panel. 8 ± 2 Nm torque (M6 - 8.8 Gr).
6. Connectors of the ECU must be connected or disconnected only when the power is switched off/ ignition switch is in off position.
7. Carryout trouble shooting of EDC system with diagnostic tool.
8. Continuity check on the wiring harness with opened connector ends (No power supply to ECU can be done, if it is found extremely essential and unavoidable. Care must be taken not to damage the terminals, pins and seals.
9. Attempt verification/checking of EDC system parts including wiring harness after confirming and clearing identified mechanical troubles as there might be a wrong lead of EDC malfunction due to effect of mechanical troubles.
10. Advice drivers on Limp home functions, Speed IImitations and Torque reduction functions.
11. Ensure diagnostic connector cap is present always to avoid dust / water entry and shorting. Protect diagnostic connector from tampering / damage.
12. Run EDC system engine always with batteries connected.
13. Ensure paint removal on the surface / clean surface before connecting the negative connection of EDC system and the high current negative of vehicle electrical connection.
14. Check if all the connectors are positioned properly and well connected. Positive locking to be ensured.
15. Check if the relays and fuses are properly inserted in the relay and fuse module respectively.
16. Ensure proper fitment of 15A fuse of the battery positive cable. The spare fuses (30A - 1 no. and 5A - 2 nos.) is available in the relay and fuse module.
17. Ensure that the ignition switch and battery isolator switch is off when the vehicle is in parked condition.

Dont's

1. Electrical tapping (EDC 24V/5V) not allowed from EDC wiring. Tapping should NOT be taken as this can severely affect the performance of the ECU and sensor (Discourage use of 24V by centre tapping method from batteries for additional loads)
2. Care should be taken while washing the vehicle. Do not direct jet of water on to the ECU, accelerator pedal sensors and other electrical components.
3. Diagnostic connector should not be left hanging loose and should be handled with care.
4. Do not allow / provide intermittent connections / junction in the EDC wiring harness. Maintain routing and clamping of wiring as provided by AL.
5. Do not change mounting position of the ECU/EDC panel.
6. No undue pressure to be applied on the ECU during the service.
7. Do not touch the pins of the ECU to avoid damage due to electrostatic discharge.
8. Never attempt to connect negative battery cable to positive terminal of battery and positive battery cable to negative terminal of battery. This will damage the EDC system electronic / electrical units.
9. Do not test (continuity check) ECU pins with multimeter.
10. Developed independent wiring harness for EDC system is provided with prewired connectors to avoid any disturbances and disconnection unless it is induced.
11. Do not use spanners / other heavy tools to remove the sensor and ECU connectors.
12. While coiling or bending of cables / wires avoid sharp bends or folding.
13. Do not lift the wiring harness bunch by the end connectors.
14. Do not jump start the vehicle (by connecting external batteries - master / slave method). This will cause series damage to the ECU.

12.11 MAINTENANCE PROGRAMME - MDV TRUCK

S No	Maintenance activity	PDI	Customer Check			Workshop Check	Remarks
			Daily	Weekly	Monthly	Every km x 1000	
	Electronic diesel control						
1	Check tightness of engine speed sensors and clean the sensor tip for any dirt/ dust deposits					40	