Exhaust Gas Temperature (EGT)

This topic is discussed on many forums in great lengths. This short report will attempt to answer some of the questions about EGT and showing how I build my own EGT monitor. I could not have done it without all the help from fellow LROC members and info from other sources on the Internet. I would like to thank Johann Hugo specifically for his valuable input and patience to get everything working.

What is EGT?

EGT represents the exact temperature of the fuel mixture after it "combusted" in the cylinder. This should be measured as close to the outlet valves as possible.

Why is it necessary to monitor the EGT?

It is common believe that EGT on Diesel (especially Turbo Diesel) engines that exceed 720 degrees Celsius, may cause permanent engine component damage. This may vary slightly as different engines are made from different alloys that have varying heat properties. The rule of thumb is to keep EGT below the 720deg C mark. Under normal driving conditions the EGT may vary between 250 to 680 degrees C. It will increase when driving up-hill and may even pass the "safe-point 720 deg C" if you really push the motor hard.

What happens if the temperature goes much higher than 720deg C?

Although there is no immediate explosion or melting of the engine visible, to your disappointment maybe, it shortens the life of the motor. Again, this is all relative to the periods that the engine is exposed to extreme temperatures. Keeping your foot down while the EGT is climbing past the 750 mark may result in smoke escaping somewhere that will send you of to the bank manager soon. EGT is a direct indication of how hard the engine is working, so when you release the accelerator pedal the temperature decrease immediately.

Building an EGT monitor

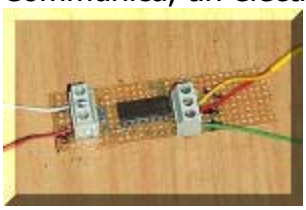
EGT monitors could be installed by automotive tuning shops such as DASTEK, SAC and others. This section however describes how to build your own EGT monitor.

The EGT monitor consists of the following components:

- A **probe** that will measure the exhaust gas temperature in the exhaust manifold. You may go wild and install a probe for each cylinder, but I decided to measure a sample of the combined exhaust gas in the manifold.
- An **electronic chip** that will receive the input from the probe and translate it into a low voltage output, typically translating 10 milli-volts per 1 deg Celsius.
- A 4 digit **LCD display**. This is simply a voltage meter where the decimal point is omitted – 6.23 volt displays 623.
- A **5 volt DC** Power Supply Unit (PSU) is needed for the LCD display. This is then all connected to the truck's electrical system either permanently-on or via the ignition switch to only show the EGT when switched on via the ignition key. If you would like the LCD backlight to be linked to your other instrument lights, you will need a second 5 volt PSU for that circuit.

Temperature probe.
Johann Hugo went through some trouble to design/spec the probe that is used. The probe is supplied by a local SA company, Temp Control. I used the 20cm K-type stainless steel tube probe with the sensor surface-mounted on the inside of the tube. The probe is ordered with a 2 meter cable but it can be ordered with a longer cable. It is not wise to extend the cable with non-thermocouple cable. In temperature measuring the K-type thermocouples can measure temperatures from -50 to +1200 degrees C. The probe is supplied with a copper compression-gland nut.

Electronic chip (or integrated circuit – IC) AD595A
I sourced the IC from AVNET. It is specifically designed to translate the K-type thermocouple input into 10 milli-volts per 1 deg Celsius format that could be displayed on the LCD display. The IC looks like a 14-legged spider and will not work on its own. You need to solder some resistors, the thermocouple wires, power and output wires to it. I used a small piece of Vero-board (strip board) to position and solder the components together. These components were sourced from Communica, an electronics retailer.

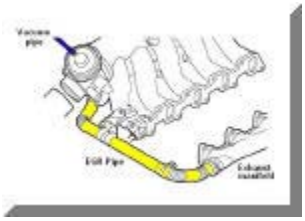


LCD Display

At first I used a cheap (ZAR 99.00) LCD display (also called a DPM – Digital Panel Meter), bought from another electronics retailer that proved to be faulty. After speaking to Johann, I decided to buy the more expensive (ZAR 352.00) Falcon DPM952 from Communica. This DPM can display icons for Deg C, F, Volt, Amps etc. too apart from the 4 digits. This works great as I permanently connected the pins for the degree Celsius to be displayed.

Installing the probe – Part 1: Removing EGR (Exhaust Gas Regulation) system (Td5)
You need a good place for the probe to go. On pre-2002MY model Td5 Land Rovers this result in an additional "upgrade" by removing the existing EGR system. On the Td5 the exhaust manifold has an outlet for the EGR pipe. All pre-2002MY models are fitted with the EGR system but the later models only have a 6mm steel blanking plate fitted on the exhaust manifold. This means that the pre-2002MY models recycle exhaust gas through the engine via the inlet manifold. This is not needed in South Africa (seems unnecessary in the rest of the world as it was omitted on later

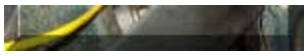
models) so this filthy system has been discarded. To remove the EGR the following have to be done:



- Remove the noise cover.
- Remove the 2 EGR pipe bolts on the exhaust manifold and **discard**
- Remove the EGR pipe clamp on the cylinder head (under the noise damp cover)
- Loosen the EGR pipe clamp on the Inlet manifold and remove the EGR pipe completely.
- Block the rubber vacuum pipe on the EGR valve at the manifold side with a ball bearing that fits tight into the vacuum pipe.
- Seal the EGR intake hole where the EGR pipe entered the inlet manifold. I sealed the mounting piece of the original EGR pipe (cut off) and fitted it to the valve opening using the same clamp.
- Use the EGR pipe exhaust mounting as a mask to cut a 6mm blanking plate.
- Although the *Manifold Absolute Pressure (MAP) / Inlet Air Temperature (IAT)* sensor on the inlet manifold still send info to the ECU to regulate the opening of the EGR valve, this will have no effect on the engine performance. This setting can be disabled by a Land Rover dealer, using the TestBook, but it is not essential.

Installing the probe – Part 2: Fitting the probe to the EGR blanking plate (Td5)

- Drill a hole in the centre of the blanking plate, large enough to take the probe's mounting nut and fasten the probe to the blanking plate.
- I used silicon gasket maker to secure a proper fit and tightened the blanking plate with **2 new bolts** to the manifold, ensuring that the probe does not touch the inner side of the manifold. The probe body may be bent slightly. Lesson learnt – a used bolt broke off which set me back at least 2 hours to remove it.
- Route the probe wires neatly through the engine bay and pull it through to the monitor location.
- Replace the noise cover.



In the first picture the probe is secured to the blanking plate and fitted to manifold with new bolts. The second picture shows the same probe just from another angle after protective housing is installed and the dirty part is almost complete.

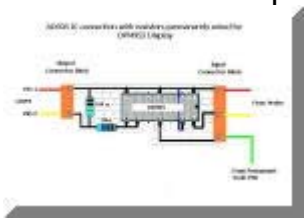
So far I have installed the EGT only on three Td5 Land Rovers but I understand that the probe installation could be done in a similar way on other TDi models. I have read that in some installations a hole had to be drilled in the exhaust manifold. This was done without removing the manifold, but care was taken to ensure that no drillings entered the exhaust manifold. This could be achieved by drilling while the engine was running as the drillings would be blown out by the exhaust pressure. A reputable engineering shop or service centre should also be capable of installing the probe.

These are Pictures of Johann's 300Tdi probe installation through the EGR blanking plate:

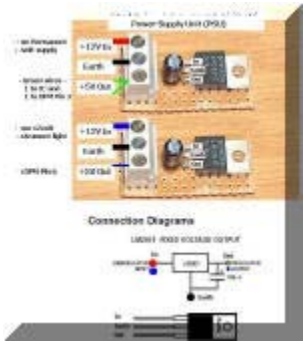



Soldering the Electronics together.

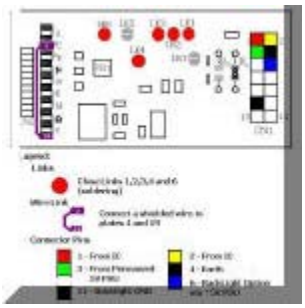
This is the part where a picture could better explain the job. You can also download a comprehensive document that explains other uses for the AD595A IC from Analog Devices.
LCD displays (DPM) are designed to measure up to 200 mv. The output of the IC could be up to 12000mv or 12v, as the K-type thermocouple can measure up to 1200 deg C. Two resistors are added to the IC output to provide the correct voltage to the DPM.



The DPM is setup to use a 5v DC power supply and these components are also soldered to a separate Vero-board (strip board). We used the LM2931T 5.0volt 3-pod regulator. It is specifically designed for use in vehicle applications, it is robust and is built to last longer than *most* modern vehicles.



It is much easier to solder the thin connecting wires for the DPM straight onto the DPM pins. This also ensures a better connection.



All the electronic components need to be isolated. I used insulation tape to do this, but Johan seals it permanently with silicon sealer in a small plastic box with only the connecting wires hanging out.

Where to put the monitor display

I've seen it being mounted in many different places, these pictures show some of the owners ideas. Basically it should be in a place where you are able to see it easily without taking your eyes off the road.

Connecting it all up

This is the easy part.

- Connect the Probe wires (Thin Yellow Pin 2 and Thin Red Pin 1) to the input connector block of the IC.
- Connect the DPM wires (Yellow and Red) to the output connector block of the IC.
- Connect the earth wire (**Black**) from the two 5 volt PSUs and DPM Pins 4 & 11 to a proper earth on the truck.
- Connect the 5 volt PSU's 12v supply wire (**Thick Red**) to a fused 12v circuit in the truck, either as permanently on or to a circuit that is only live when the ignition switch is on.
- Connect the regulated 5 volt supply wires (Thin Green) to the IC input connector block and DPM Pin 3
- Connect the 12v Backlight wire (**Thick blue**) from an existing positive instrument backlight wire, to the backlight 5 volt PSU.
- Connect the regulated +5 volt backlight supply wire (Thin Blue) to the DPM-Pin 6 (Backlight - to Pin 11).

Your LCD display should now show you the temperature inside your exhaust manifold. Start the engine and see how fast the monitor reacts.

Other links and valuable input used

AutoSpeed - Installing an EGT monitor
Analog Data Products - a division of Avnet Kopp (Pty) Ltd
Avnet Kopp (Pty) Ltd
Pete's Automotive Electronics Notebook
Temperature Controls
The 12volt Side of Life Part 2
Temperature probes

Enhancements to the monitor

I am currently testing an audible alarm that can be set to go off at a preset temperature.
Johann used a 390ohm resistor in series with the backlight 12V power feed to DPM pin 6 that basically eliminates the second 5V PSU.
Johann also uses the DPM to display battery voltage. This is made possible by manually switching between circuits. See his photo.