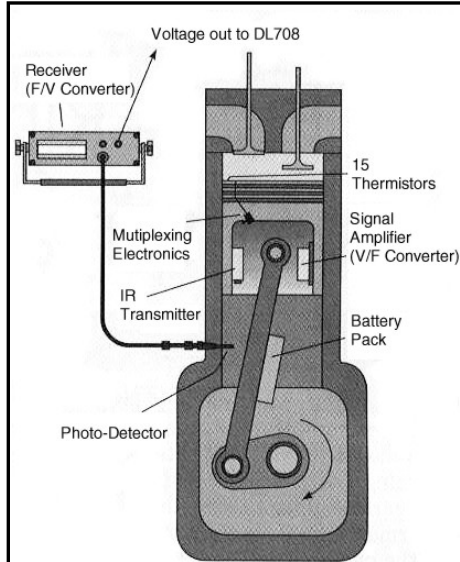


# Automobile: Piston Temperature Measurement using Telemetry

## [Overview of Application]

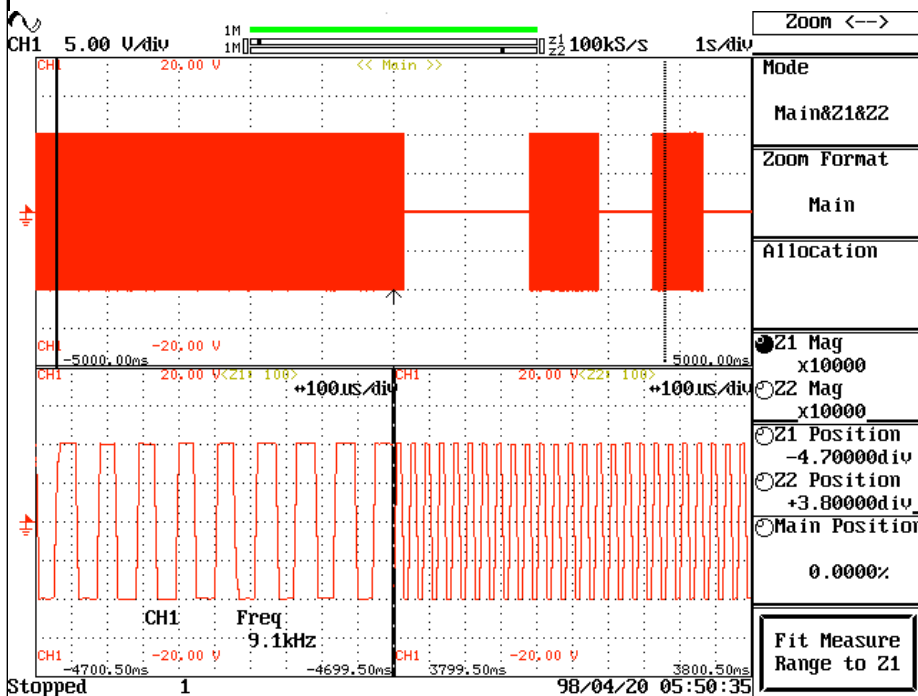
During engine development and testing, it is very important to measure the cooling capability of the prototype design. In addition to measuring many points around the engine head and block, the engineers like to get temperature data of the piston itself as well. This is an extremely difficult task, since the piston is moving inside the engine at high speeds. Several techniques have been used in the past, including temperature plugs and wired thermocouples, but these designs have limited effectiveness and relatively high cost. Using Infrared and Microwave Telemetry systems allows the engineer to get accurate temperature data over the full engine operating conditions.



The diagram to the left shows a cutaway view of a single engine cylinder. 15 Thermistors are mounted around the top of the piston, and are connected to a multiplexing circuit. The output of the multiplexer is converted to a frequency pulse by the V/F converter mounted on the inside wall of the piston. The IR Transmitter then sends this frequency pulse train down the the Photo-Detector mounted in the bottom of the cylinder. The IR signal in this example works on the same electrical principle as most household wireless remote controls.

The signal received by the Photo-Detector is then fed to a Receiver outside the engine. The Receiver converts the frequency pulses received at the Photo-Detector back into one voltage waveform which can then be analyzed. Each Thermistor temperature is represented by a pulse train of a certain frequency. The pulse trains are a fixed width (app. 500ms) for each channel and spaced sequentially in time. A very high frequency dummy signal is added as channel 16 so the operator can identify the channels in the output waveform. The total capture time required is then app. 8-10 seconds.

During a normal test, the engine is brought to steady state at a certain RPM, then the data is collected over a 10 second period. Then the engine is ramped up to another fixed RPM level and a second 10 seconds of data is collected. The process continues through many RPM values, usually until the max RPM is reached or the engine fails. At high RPM's, a substantial amount of oil is present in the cylinder, and causes breaks in the pulse train output. Enough data is still available to make the temperature calculations, but the computer DAS has difficulty in this situation. By using the DL708, the frequency of the channel can be calculated with only a few cycles of data, and the temperature can then be manually calculated.



While the test is running, it is very important to gather the data quickly, save it and move on to the next RPM level. At high RPM's, the need for getting the information quickly becomes critical, as the engine may overheat rapidly. Since high sample rates are required to correctly obtain the frequency pulses, a 1MW record length is required on a 1s/div time axis. The internal hard disk coupled with the fast file saving operation allow the entire test to be captured and saved in app. 20 seconds. This time is faster than the time required for the dyno operator to change to a new RPM for the next test.

## [Key Features of the DL708 ]

- \* Long memory length allows capture of all Frequency Information, allowing the temperature data to be calculated even if several pulses from the telemetry system are missed.
- \* Measurement functions used in combination with zooming allow the engineer to quickly determine the frequency of any temperature channel quickly.
- \* Internal HDD allows the engineer to save several steady state tests at different RPM's and then do the temperature analysis later.