# Automated Test Stand for Otto- and Diesel Engine Waterpumps

by
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**Category:**
Automotive-Power Train

**Products Used:**
LabVIEW™ 5.1.1
Data Aquisition Driver Software (NI-DAQ™ 6.6)
Multifunction- I/O- card (AT-MIO-16XE-50)
Signal Conditioning eXtension for Instrumentation (SCXI™)
SCXI 4-Slot-Chassis (SCXI-1000)
32-Channel Analog Input Module (SCXI-1100)
16-Channel General-Purpose Switch/Relay Module (SCXI-1160)
32-Channel Optically Isolated Digital Input Module (SCXI-1162HV)

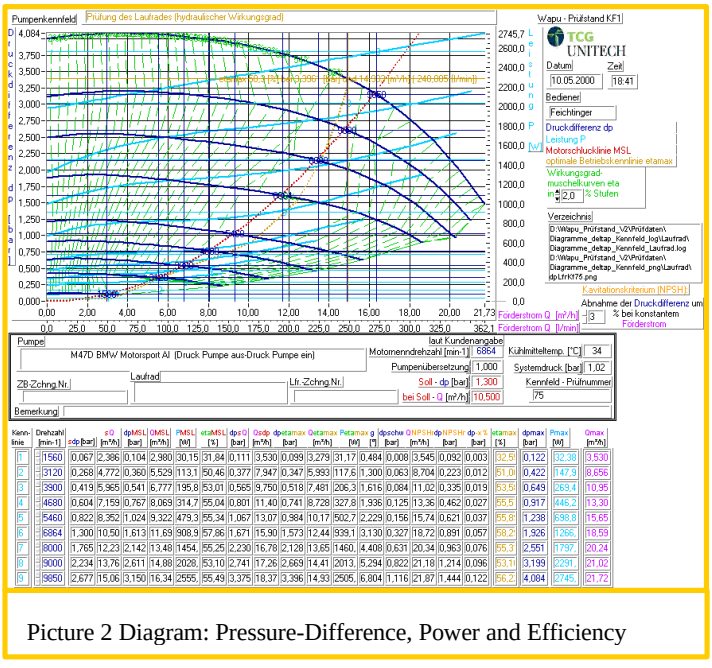
**The Challenge:**
Setting up an automated test stand to test the operating characteristics of Otto- and Diesel Engine waterpumps (picture 1). Determining diagrams to draw conclusions for the developement of the waterpumps, for design verification and documentation for the customer.

**The Solution:**
Automating the previously set up test stand with manual control with SCXI, a multifunction- I/O- card, LabVIEW and a PC to decouple the operator from the monotonous testing process, avoiding input failures, shortening of testing time and lowering the personnel-costs for testing.

**Introduction**
TCG Unitech Plc works in the area of industrial engineering and is system deliverer for BMW. It has been developing and producing camshaft shift facilities and waterpumps. To be able to test the operating characteristics of waterpumps in the company we decided to set up a waterpump test stand. With the help of the test stand diagrams are determined for transport height / pressure-difference, power and efficiency (picture 2) which are functions of the volume flow as also for pump-drive-loss and pressure-drop.

**Technical Background**
Further reduction of fuel consumption and emissions of Otto- and Diesel engines requieres optimized auxiliary aggregates. Our target is to design waterpumps with highest efficiency and lowest power input.

Picture 1 Automated Test Stand for Otto- and Diesel Engine Waterpumps




Picture 2 Diagram: Pressure-Difference, Power and Efficiency

To optimize waterpumps you need an easy to use test stand. To lower the personnel-costs for testing you have to automate it. Only the determination of the raw data for the diagram transport height / pressure-difference, power and efficiency (picture 2) with the test stand in manual control would take 4 to 8 hours (depending on the pump size).

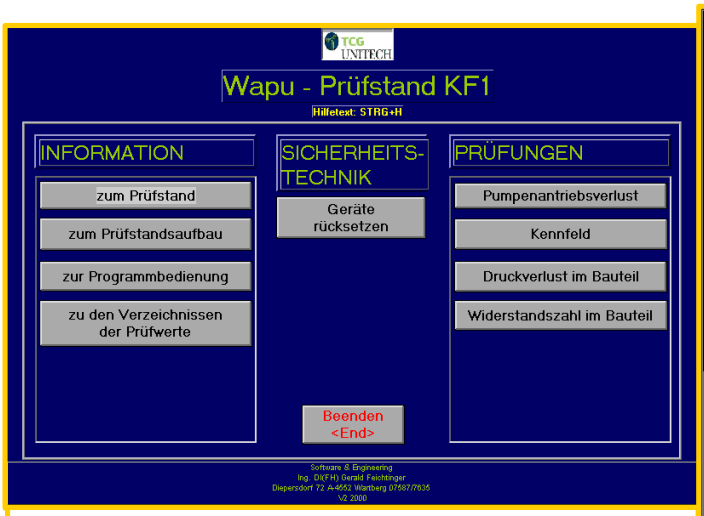
**Automated Test: Pressure Loss**
Determination of the pressure losses of the cooling circuit components (engine block, cylinder head, radiator, thermostat, tubes,...) to determine the required pressure-difference at the desired volume flow of the waterpump. At this test the cooling circuit component is flowed by a frequency-converter controlled auxiliary-pump at increasing volume flow steps. At each step the pressure is measured before and after the component. After the measurement the pressure losses and the pressure loss at the desired volume flow of the waterpump are calculated and a diagram is prepared.

**Automated Test: Pump-Drive Loss**
Determination of the losses of waterpump bearing and glide-ring-sealing. At this test the pump-drive on the test stand with mounted waterpump without impeller is driven by a current-converter controlled D.C. motor. The pump speed is increased in steps and the pump-drive torque is measured to the rated speed of the Otto- or Diesel engine. The measurement is needed to calculate the hydraulic efficiency of the waterpump. To calculate the total efficiency of the waterpump the test is repeated without mounted waterpump.

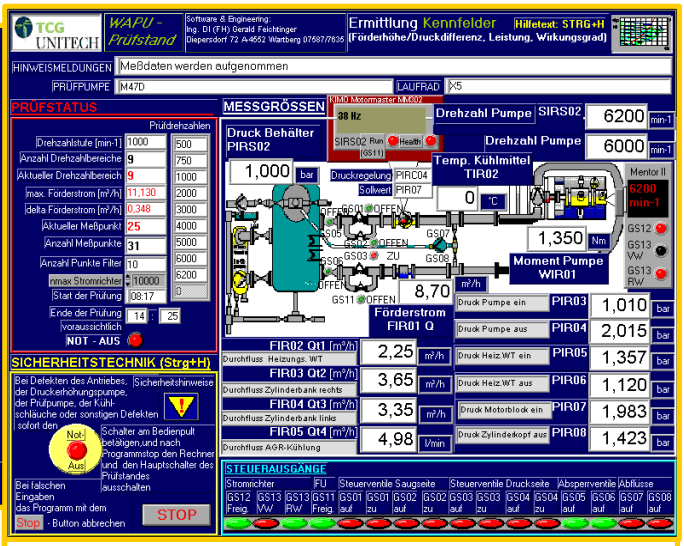
**Automated Test: Pump Performance (picture 2)**
Determination of transport height / pressure-difference, power and efficiency of the waterpump at pump speeds to the rated speed of the Otto- or Diesel engine. At this test the waterpump is driven at constant speeds by the current-converter controlled D.C. motor. The volume flow of the pump is adjusted trough throttle-valves from zero to maximum flow in small steps while the inlet pressure of the pump is controlled at 1 bar by the auxiliary-pump . At each step the pressure before and after the pump, the volume flow and the pump-drive torque is measured. After the measurement the pressure differences, power inputs and efficiencies of the waterpump are calculated and diagrams are prepared.

**Test Stand Control and Data Aquisition**
The test stand can be operated in manual and automated mode. In automated mode the test stand is controlled by the help of a LabVIEW program which handles all following steps:

- user interface for the selection of the tests and information concerning the test stand and test stand operation (picture 3)
- user interfaces for the input of the organizational and technical data
- controlling the test sequences, drives and data aquisition
- HMI to display and monitor the actual characteristical pump phenomenas (pressure, volume flow, pump-drive-torque, pump speed, temperature and density of the coolant) and the actual condition of the test stand (picture 4)
- calculations
- preparing, printing and saving the several diagrams
- preparing, printing and saving the test report
- preparing and saving continuously lists of the several tests with the most important organizational and technical data




Picture 3 Waterpump Test Stand Main Menu




Picture 4 Waterpump Test Stand HMI

**System Considerations, Experiences**

We choosed the SCXI-system to ensure the proper measurement accuracy in the noisy environment the test stand is located in. The use of the Measurement & Automation Explorer made the hardware-configuration very simple. With LabVIEW´s graphical programming language and it´s built in Vi´s the test stand programm could be prepared in a short time. A revision of the test stand programm using the new capabilities of LabVIEW 5.1.1 (ActiveX, Multithreading,...) improved the functionality, flexibility and documentation automation of the test stand further.

**Conclusion**

Within 2 years the test stand was in use for 250 pump performance, 80 pressure loss and 60 pump-drive-loss tests. This wouldn´t have been possible without the automation of the test stand with National hard- and software which is saving us time and money.