

Diesel Engine Fuel-Injection Measurement System

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Category:

Automotive-Power Train

Products Used:

LabVIEW™
PCI-MIO-16E-4
5B modules

The Challenge:

To design a modern and flexible computer base system for test of various diesel engine fuel-injection subsystem (FIS). Pressure distribution in fuel injection pipe during injection cycle has to be measured. Support for different pressure sensors and various test bench equipment is needed as well as multilanguage support.

The Solution:

PC-based system with DAQ board, 5B signal condition modules controlled by custom program written with LabVIEW. Advanced graphical user interface represents image of fuel-injection cycle in different points of fuel-injection subsystem (FIS). Power and flexibility of LabVIEW allow computing many important injection parameters, saving and printing results in convenient forms.

Introduction

Our customer develops fuel-injection systems for new diesel engines. The fuel-injection subsystem (FIS) is a very important part of entire diesel engine because engine's power and fuel consumption is strongly depended from this FIS perfection. It's very important to know how fuel pressures distribute in injection system for working cycle of injection pump. Particular machine was created in purpose to real diesel engine simulation where FIS are placed. Fuel is bleeding through testing system under pressure generated by real diesel pump and come in injector. Then fuel is sprayed through injector in combustion chamber. For different engine working conditions (rotation per minute of engine shaft) fuel flows in different speeds and pressures. Injection cycle repeats one working cycle of injection pump. Complete information about pressure distribution may be receiving during this cycle.

Measuring equipment

Previous measuring equipment consisted of pressure sensors, special amplifiers and analogue oscilloscope. Many pump cycles was recording on perforated tape for documentation and later "manual" processing. New PC-based measurement system saves, prints and calculates all pressure flow parameters automatically. DAQ board provides signals measurements and versatile synchronization. Different types of pressure sensors could be connected via off-the-shelf signal conditioning devices.

System configuration

Full-bridge or half-bridge resistive custom sensors or standard piezoelectric ones could be installed on fuel-injection subsystem pipe. Up to six pressure sensors may be connected through 5B signal conditioning devices to DAQ board. All signal conditioning components as well as synchronization circuits are installed in durable metal housing with connectors for sensors and for DAQ board. Pressure sensor signals and fuel-injection pump speed of rotation sensor signal are measured by PCI-MIO-16E-4 board. DAQ board from National Instruments was chosen because it's flexible synchronization functionality: by signal level and by digital trigger for external impulses, it has timers for pulses width measurement, programmable gain factor on every channel for accurate measurement and more.

Synchronization

It is very important to monitor pressure flow in cycle per cycle basis as well as shift of maximum pressure point from cycle start point and average maximum pressure per several cycles as well as other parameters. Data flow is synchronized to injection cycle by pressure level or by rotation. Because of customer requirement to see pressure distribution by injection cycle, measurement system must detect start point of injection cycles and rotation speed. First attempt was to use analog trigger and DAQ-STC timer for frequency measurement of fuel-injection cycles but due to nonsinusoidal nature of real signal additional start point sensor was chosen. DAQ-

STC measured generated impulse period. The same impulse started data acquisition process. The program also has possibility to detect frequency of fuel injection with help of power LabVIEW mathematics function for signal spectrum analysis without this additional sensor. Thanks to the frequency information and digital and analog triggers program acquire and represent data synchronously with rotation.

PumpTEST program GUI

PumpTEST program is the core of fuel-injection measurement system. LabVIEW helped us to produce easy to us graphical user interface (GUI) regardless of program internal sophistication. For all time of program development we actively interact with customer for satisfy needs in handy graphical user interface and functionality for "machinery" guys.

Due to LabVIEW user interface scaling functionality user interface window use full screen, resized automatically according current display resolution.

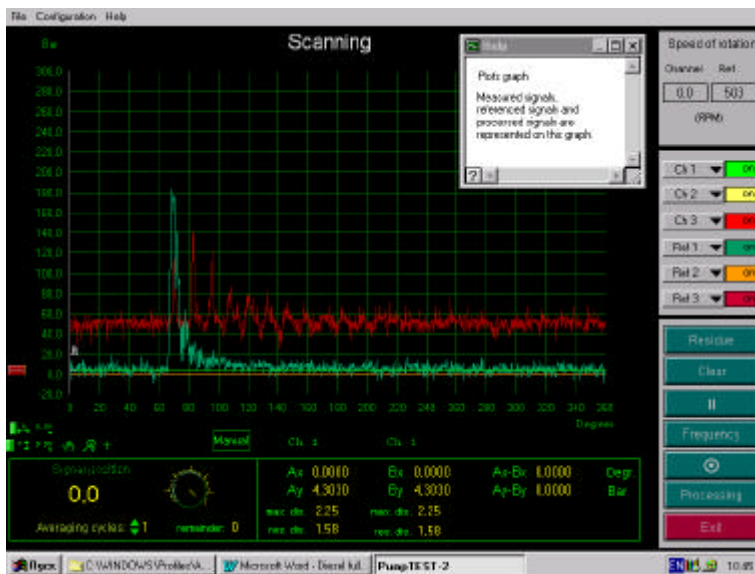


Figure. 1 PumpTEST main window

Main window graph displays pressure signals and processed parameters. We used standard LabVIEW capability for zooming plots, cursors and graph grids as well as special tricks for vertical signal distribution and multiple scale support, such as: relative injection, cycle injection, speed of injection.

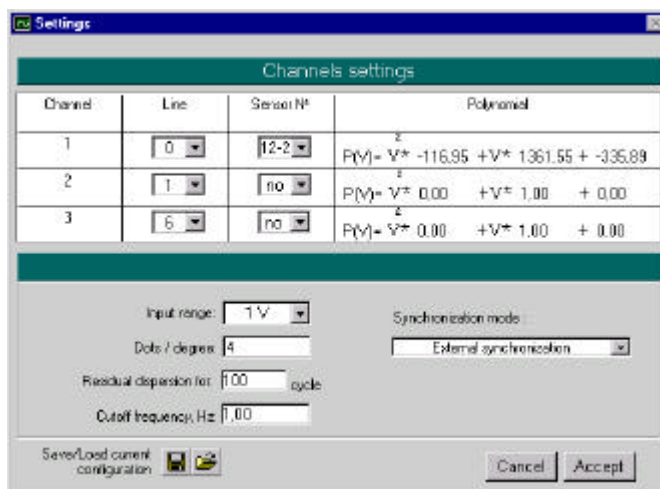


Figure. 2 Settings window provide flexible system configuration

Build in LabVIEW ActiveX technology MS Excel communication is supported. PumpTest program saves data to disk in ASCII file, sends data to the MS Excel and prints reports. Operator controls several measurement and presentation parameters. There are possibilities to choose best synchronization method. With analog trigger user can see signals relatively particular pressure level. With digital trigger user can see signals relatively revolution

of fuel pump. In additional pump speed of rotation irregularity could be reviewed and analysed. There are useful subroutines for custom transducer calibrating.

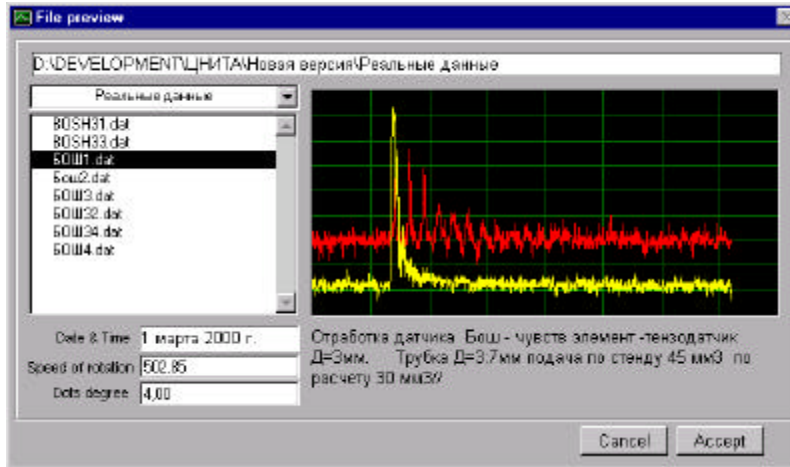


Figure. 3 File preview allow to select appropriate data file for signals comparison

Conclusion

Two full functional releases of PumpTest software were produced during one year. Computer based fuel-injection measurement system is based on open technologies and consists of standard components so may be ease modernized and expanded. LabVIEW and DAQ products line ensures that we can quickly configure the solution and optimize it for any customer needs.