Innovative test bench for throttle bodies

The goals

Vici&C. needed **a new generation test bench** able to perform different types of tests on **throttle bodies** and especially to fulfill the strict requirements of machine parts makers and automotive businesses, as guaranteeing the **best performances**, **certain safeness** and **absolute reliability**.

Actually, guaranteeing high quality standards is a great challenge, and Vici wanted a test bench being on top of the situation.

The test bench is required to be an **easily adaptable solution** able to handle both **characterization tests** and very articulated **life tests** on different types of throttle bodies**.** The testing process is supposed to work better thanks to the **placement of different monitoring points** on the basis of which data can be stored and validated. As a remarkable feature, **these points have to be settable by users** according to position and absorbed electric current.

Fastness, reliability, precision and multitasking are fundamental requirements for such a solution: a test bench has to **test up to twenty bodies at the same time** and to record not only bodies data, but also environmental temperatures, shakers frequency, and acceleration.

As regards the system precision, in particular, it is fundamental for a test bench thought to be completely reliable to get **millisecond resolution of motion profiles** and **minimize** as much as possible **testing margins of error**. This is the reason why it has to **use a PID algorithm optimized for throttle bodies**, able to consider their mechanical and electrical properties**.**

In the matter of fastness, instead, it was required to develop **real time data acquisition**, since the bench has to learn **automatically** particular body properties as upper and lower mechanical stop (UMS and LMS), upper

Vici&C. is a leading company working for industrial automation businesses well known for its high performance designing and manufacturing solutions for mechanical, wood and ceramic industrial field.

About thirty years of remarkable experience, careful work and attention for customer's satisfaction allowed Vici&C. to guarantee customized practical solutions suitable for several applications.

Vici&C. is particularly committed in creating new products and more and more in improving them once created: manufacturing optical measuring machines, quality control machines with vision system and advanced robot-guide systems make up the range of technological solutions that Vici presents.

and lower electrical stop (UES and LES), limp home, etc., and must do it in the shortest time.

These were the basic points needed to get an appropriate and competitive solution, since it has in facts to deal with a particularly complex area. The test bench indeed is required to **use a PID algorithm** optimized for throttle bodies and works with **analog position sensors and digital position sensors with SENT protocol (Single Edge Nibble Transmission)**.

The solution

T4SM has found out the best solution, tradeoff among complexity, fastness and precision of the system.

Testing process building

The test bench elaborated by VICI is composed of a PC, used by operators to monitor the test process, connected to four CompactRIOs and a CompactDAQ. Each CompactRIO handles data of five throttle bodies at the same time. **This high performing work line allows to test up to 20 bodies simultaneously**.

The CompactDAQ handles signals coming from thermocouples, programmable power supplies, an environmental chamber and a shaker, **succeeding in simultaneously handling a huge amount of data**.

With this solution, test process precision and completeness are ensured, because each CompactRIO mounts:
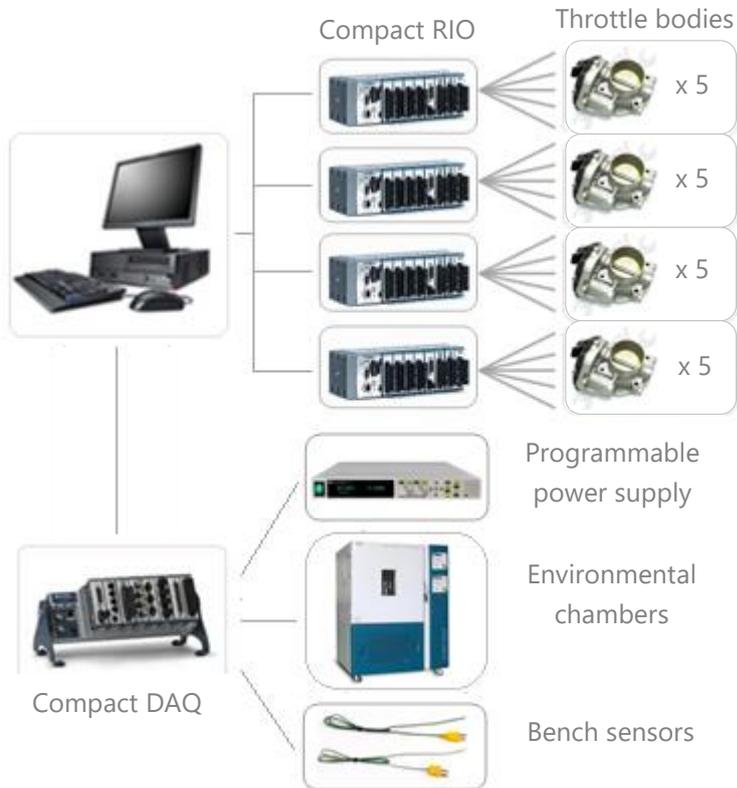
- **Five 9205 modules for handling throttle bodies H-bridges**;
- A module for acquiring TP1 and TP2 **analog signals**;
- A module for acquiring **fast digital signals**, used for real-time identification and decoding of bodies position with SENT sensors;
- An I/O digital module used to connect unit engines to the bench, in order to measure accurately the switch-off instant.

The following diagram shows the components of the

Resources

- LabVIEW
- LabVIEW Real-Time
- LabVIEW FPGA
- CompactRIO
- CompactDAQ
- SQL-Server
- Programmable power supply

bench, their interconnections and the connections with external devices:

Compact RIO   Throttle bodies

x 5

x 5

x 5

x 5

Programmable power supply

Environmental chambers

Compact DAQ

Bench sensors

Implementations and developments

Beside the remarkably performing hardware side developed by VICI, T4SM has worked out an equally careful code optimization to get the best results and to balance work load on all the available CPUs.

Advanced signals acquiring system

In order to allow complete monitoring, the test bench can generate and acquire various types of signals. It has been provided in facts with **a system of generation of PWM signals**, so that not only throttle bodies but also their engines can be supervised, and with **a system for acquiring and calibrating position signals**.
As a great innovation, this tool is now able to acquire also SENT signals, because T4SM has, for the first time

ever, **decodified SENT protocols** (usually belonging to the automotive industry) **on a CompactRIO's FPGA**, so

Implementations

- Generation of PWM signals.
- Decodification of SENT protocols on FPGA.
- Acquisition and calibration of position signals.
- Management of movement profiles.
- Management of profiles for turning angles recording.
- Developed graphic editors.
- Development of PIDs.
- Innovative data encoding.
- Specific functionalities for channels used to store data.
- Introduction of start-stop tests commands.
- Enhanced data exporting.
- Introduction of multilingual interface.

that **also digital data can be received and analyzed**.

Powerful interface

In addition to the completeness in signals acquiring, GUI was developed to make testing process handling easier.

Users are enabled to **manage both movement profiles and movement range of throttle bodies.** The application has **graphic editors** for control points setting, handling cycles development and thermic profiles definition, while **apposite PIDs** have been developed in order to allow complete control on engine movements.

Users can also **define settings regarding data storing channels** thanks to the implementation of specific functionalities (for example, all 1KHz recorded signals are saved in TDMS format).

This application has been even more customized by **making test sessions start or stop according to users commands or to determinate triggers** as environmental chamber temperature or elapsed time values.

It has been completed later by the introduction of functionalities for **exporting data** and a **multilingual interface.**

High performance data storage

Storage side has been improved through **the design of a bit packing protocol to minimize the size of motion profiles transmitted to FPGA limited memory**. It enables the system to handle control profiles both when throttle bodies are open, closed and with switched-off engine.

The test bench has been produced in various models and is used in several automotive research centers all around Europe.

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