Asian Journal of Applied Sciences (ISSN: 2321 – 0893)
Volume 04 – Issue 02, April 2016

The Design of High-End Pressure Control Valve (PCV) Control System with DeviceNet Interface in Semiconductor Wafer Foundry

Wei-Cheng Lin[a,*], Te-Hsun Liu[b]

[a]EE-Department of I-Shou University, No. 1, Sec. 1, Syuecheng Rd.
Dashu District, Kaohsiung City, Taiwan

[b]Fred Automation Co., LTD, No.18, Aly. 40, Ln. 13, Jinfu St.
Zhudong Township, Hsinchu County 310, Taiwan

[*]*Corresponding author's email: Byron [AT] isu.edu.tw*

ABSTRACT---- ***This paper presents a novel design of control system with features of DeviceNet interface and remotely accessible database via Internet for high precision pressure control valve (PCV). This PCV control system is particularly suitable for pressure/flow process control within vacuum chamber in the fully automated manufacturing machines for semiconductor industry ranging from wafer foundry, LCD/LED panel plant to photoelectric plant. In 2015, Taiwan-based Fred Automation Corporation has been successfully implemented this PCV control system for field testing in the evaluation of performance and benefits.***

Keyword---- Pressure Control Valve (PCV), DeviceNet, Semiconductor Industry

---

1. INTRODUCTION

Pressure control valve (PCV) belongs to a class of high-end instruments which has been widely applied in semiconductor industry. The processing of thin film within vacuum chamber in wafer manufacturing processes, such as physical/chemical vapor deposition (PVD/CVD) and dry/wet/vapor etching and diffusion, is strongly depended on the operation of PCV in the pressure/flow control system. This paper presents the development of a novel PCV control system with DeviceNet interface for the advanced semiconductor wafer foundry. The proposed PCV control system is particularly suitable for pressure/flow process control within vacuum chamber in the fully automated manufacturing machines for semiconductor industry ranging from wafer foundry, LCD/LED panel plant to photoelectric plant. Three tasks have been done to complete the system design, firstly the integration of DSP-based embedded system, DeviceNet communication and peripherals of analog/digital Baratron transducers to form the host controller of PCV control system. Secondly, the firmware coding of PCV process control scheme helps to manipulate the PCV operation via DeviceNet. Lastly, the functional evaluation and performance optimization of PCV control system on an emulated field testing system.

2. THE DESIGN OF PCV CONTROL SYSTEM

Fig. 1 shows the framework of PCV control system and field testing system, the PCV control system consists of a host controller with DeviceNet interface to communicate with valve controller and Baratron manometers, a CAN-to-Ethernet signal converter and a remote console with web-based database over Internet. The PCV field testing system is composed of vacuum chamber with analog/digital Baratron capacitance manometers, throttle/butterfly valve and its controller, and the pump. The details of hardware/software structure of PCV control system are depicted in Fig. 2 and Fig.3 respectively. The graphic user interface (GUI) of remote console is shown in Fig.4.

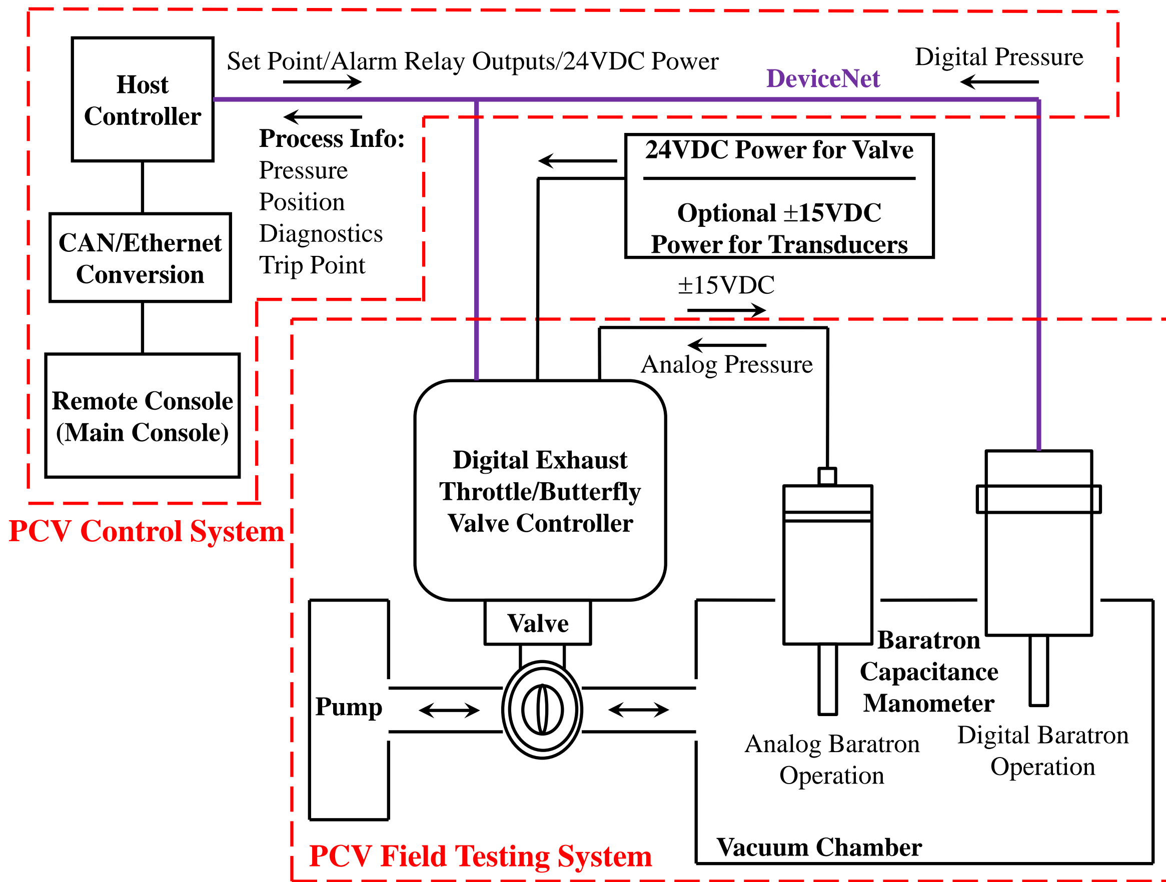

Fig. 1: The framework of PCV control system and field testing system

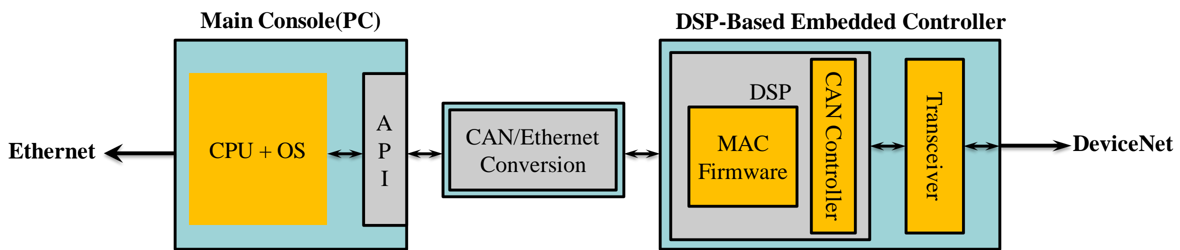

Fig. 2: The hardware structure of PCV control system

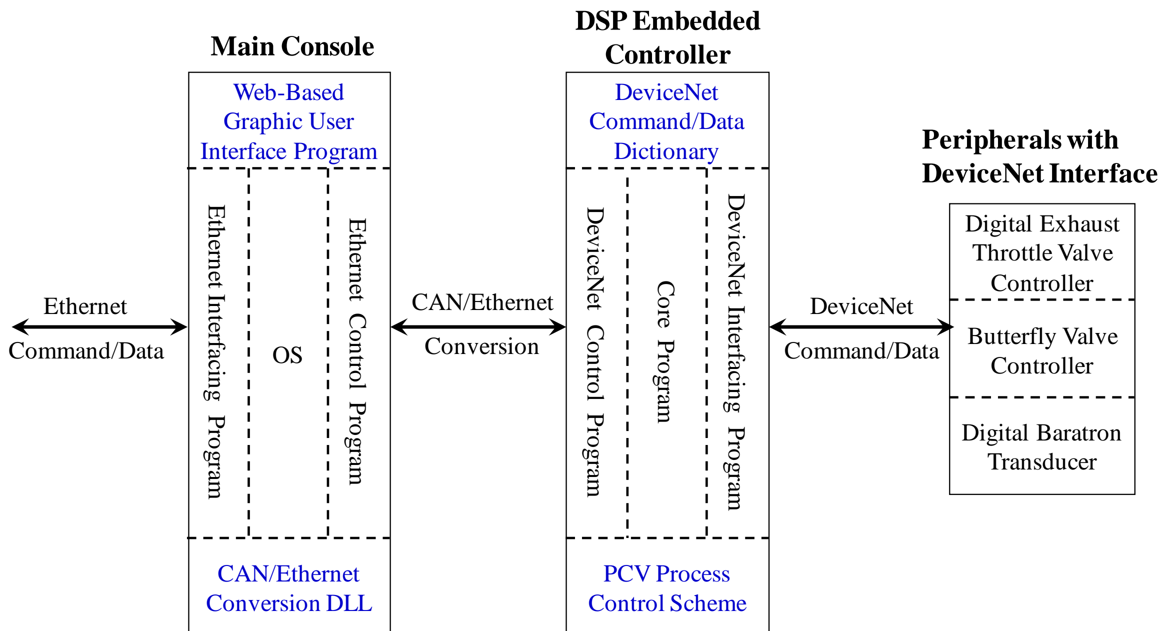

Fig. 3: The software structure of PCV control system

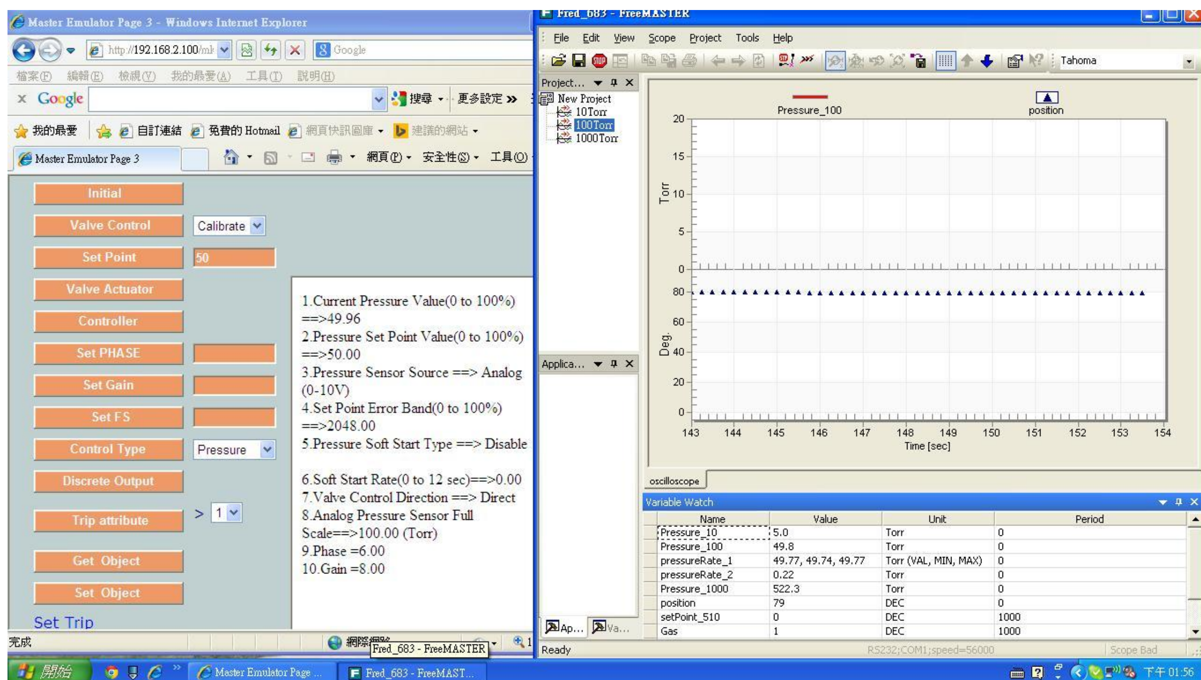

Fig. 4: The GUI of remote console

3. THE PERFORMANCE EVALUATION OF PCV CONTROL SYSTEM

In 2015, Taiwan-based Fred Automation Corporation has been successfully implemented the proposed PCV control system and conducted functional tests on an emulated field testing system where two most wildly used valve controllers, the MKS683 and T3B by MKS INSTRUMENTS, are adopted to emulate the real manufacturing environments in semiconductor wafer foundry. In order to prove the effectiveness of the implemented PCV control system, the following three operational scenarios, the valve opening control in sequence of 0° →45° →90° , the fixed pressure control at 20Torr and the varied pressure control from 20Torr to 10Torr are simulated and the results are shown in Fig.5~7, respectively.

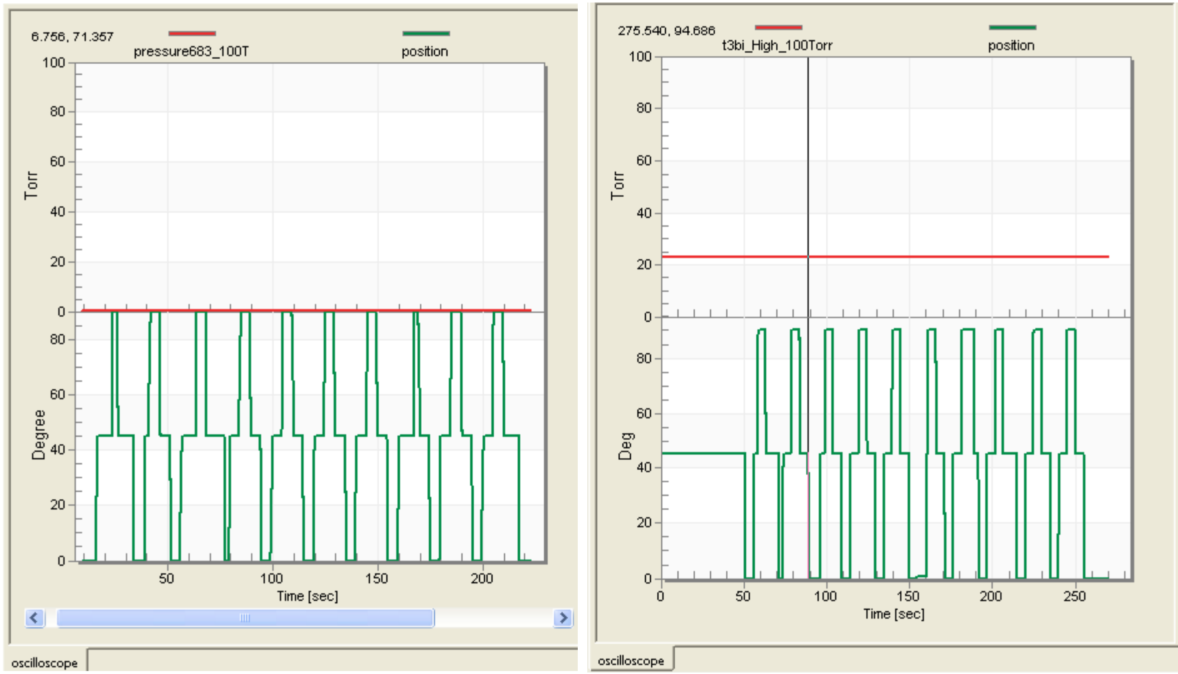

Fig. 5: The valve opening control in sequence of 0° →45° →90° for MKS683(left) and T3B(right)

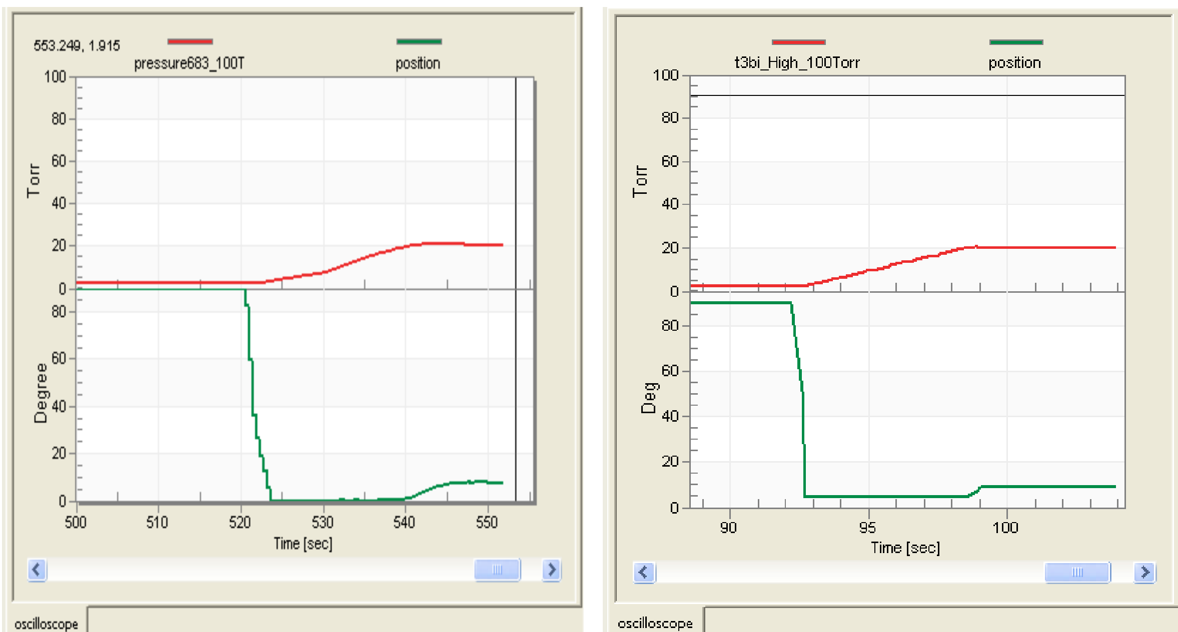

Fig. 6: The fixed pressure control at 20Torr for MKS683(left) and T3B(right)

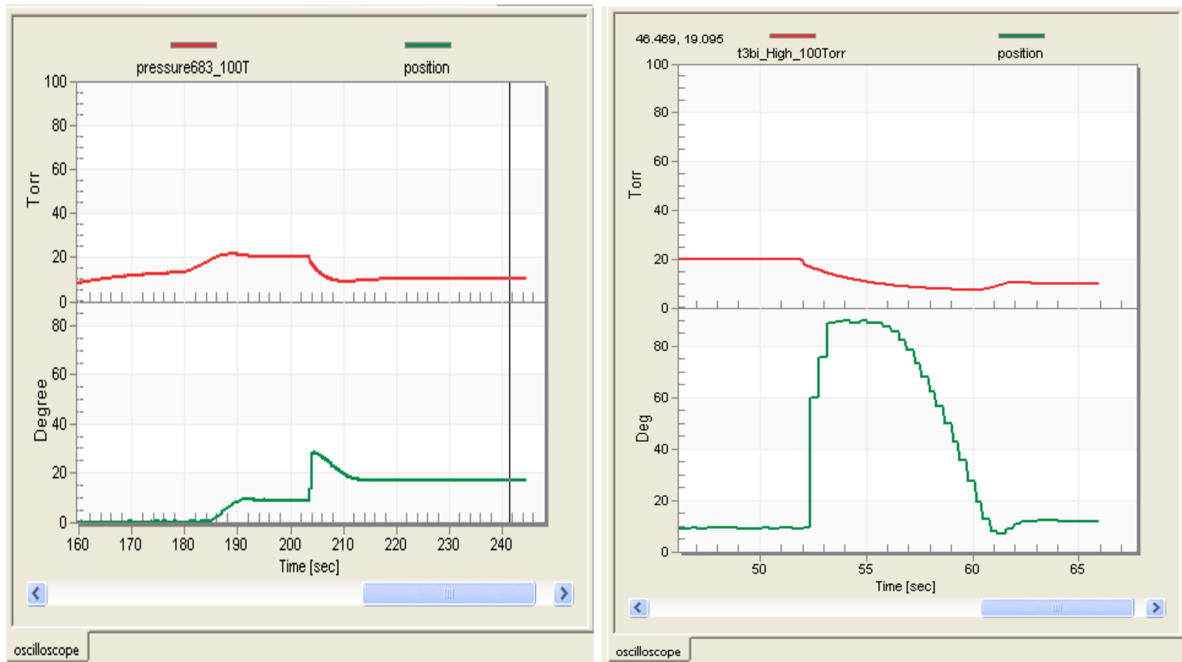

Fig. 7: The varied pressure control from 20Torr to 10Torr for MKS683(left) and T3B(right)

4. CONCLUSION

This paper presents the development of a novel PCV control system with DeviceNet interface for the advanced semiconductor wafer foundry. This PCV control system is particularly suitable for pressure/flow process control within vacuum chamber in the fully automated manufacturing machines for semiconductor industry ranging from wafer foundry, LCD/LED panel plant to photoelectric plant. In 2015, Taiwan-based Fred Automation Corporation has been successfully implemented the PCV control system and proved its effectiveness through field testing.

5. ACKNOWLEDGMENTS

This research work is supported by Ministry of Science and Technology, Taiwan and I-Shou University under contracts No. MOST103-2622-E-214-008-CC2 and ISU104-01-04A.

6. REFERENCES

- Open DeviceNet Vendor Association (ODVA), Inc. (2001). *DeviceNet Technical Overview*, ODVA Inc., http://www.odva.org/
- Controller Area Network (CAN) (2003~2013), ISO11898-1~6.
- MKS INSTRUMENTS, Inc. http://www.mksinst.com/index.aspx
- Fieldbus (2008), IEC 61158.
- TPSS (Taiwan Patent Search System), Intellectual Property Office, Ministry of Economic Affairs, Taiwan.