

ISSN 1726-5749

SENSORS & TRANSDUCERS

7^{vol. 81}
/07



Sensor Networks and Wireless Sensor Networks

International Frequency Sensor Association Publishing





Sensors & Transducers

Volume 81
Issue 7
July 2007

www.sensorsportal.com

ISSN 1726-5479

Editor-in-Chief: professor Sergey Y. Yurish, phone: +34 696067716, fax: +34 93 4011989,
e-mail: editor@sensorsportal.com

Editors for Western Europe

Meijer, Gerard C.M., Delft University of Technology, The Netherlands
Ferrari, Vittorio, Università di Brescia, Italy

Editors for North America

Datskos, Panos G., Oak Ridge National Laboratory, USA
Fabien, J. Josse, Marquette University, USA
Katz, Evgeny, Clarkson University, USA

Editor South America

Costa-Felix, Rodrigo, Inmetro, Brazil

Editor for Eastern Europe

Sachenko, Anatoly, Ternopil State Economic University, Ukraine

Editor for Asia

Ohyama, Shinji, Tokyo Institute of Technology, Japan

Editorial Advisory Board

- Abdul Rahim, Ruzairi**, Universiti Teknologi, Malaysia
Ahmad, Mohd Noor, Nothern University of Engineering, Malaysia
Annamalai, Karthigeyan, National Institute of Advanced Industrial Science and Technology, Japan
Arcega, Francisco, University of Zaragoza, Spain
Arguel, Philippe, CNRS, France
Ahn, Jae-Pyoung, Korea Institute of Science and Technology, Korea
Arndt, Michael, Robert Bosch GmbH, Germany
Ascoli, Giorgio, George Mason University, USA
Atalay, Selcuk, Inonu University, Turkey
Atghiaee, Ahmad, University of Tehran, Iran
Augutis, Vygantas, Kaunas University of Technology, Lithuania
Avachit, Patil Lalchand, North Maharashtra University, India
Ayesh, Aladdin, De Montfort University, UK
Bahreyni, Behraad, University of Manitoba, Canada
Baoxian, Ye, Zhengzhou University, China
Barford, Lee, Agilent Laboratories, USA
Barlingay, Ravindra, Priyadarshini College of Engineering and Architecture, India
Basu, Sukumar, Jadavpur University, India
Beck, Stephen, University of Sheffield, UK
Ben Bouzid, Sihem, Institut National de Recherche Scientifique, Tunisia
Binnie, T. David, Napier University, UK
Bischoff, Gerlinde, Inst. Analytical Chemistry, Germany
Bodas, Dhananjay, IMTEK, Germany
Borges Carval, Nuno, Universidade de Aveiro, Portugal
Bousbia-Salah, Mounir, University of Annaba, Algeria
Bouvet, Marcel, CNRS – UPMC, France
Brudzewski, Kazimierz, Warsaw University of Technology, Poland
Cai, Chenxin, Nanjing Normal University, China
Cai, Qingyun, Hunan University, China
Campanella, Luigi, University La Sapienza, Italy
Carvalho, Vitor, Minho University, Portugal
Cecelja, Franjo, Brunel University, London, UK
Cerda Belmonte, Judith, Imperial College London, UK
Chakrabarty, Chandan Kumar, Universiti Tenaga Nasional, Malaysia
Chakravorty, Dipankar, Association for the Cultivation of Science, India
Changhai, Ru, Harbin Engineering University, China
Chaudhari, Gajanan, Shri Shivaji Science College, India
Chen, Rongshun, National Tsing Hua University, Taiwan
Cheng, Kuo-Sheng, National Cheng Kung University, Taiwan
Chiriac, Horia, National Institute of Research and Development, Romania
Chowdhuri, Arijit, University of Delhi, India
Chung, Wen-Yaw, Chung Yuan Christian University, Taiwan
Corres, Jesus, Universidad Publica de Navarra, Spain
Cortes, Camilo A., Universidad de La Salle, Colombia
Courtois, Christian, Universite de Valenciennes, France
Cusano, Andrea, University of Sannio, Italy
D'Amico, Arnaldo, Università di Tor Vergata, Italy
De Stefano, Luca, Institute for Microelectronics and Microsystem, Italy
Deshmukh, Kiran, Shri Shivaji Mahavidyalaya, Barshi, India
Kang, Moonho, Sunmoon University, Korea South
Kaniusas, Eugenijus, Vienna University of Technology, Austria
Katake, Anup, Texas A&M University, USA
Dickert, Franz L., Vienna University, Austria
Dieguez, Angel, University of Barcelona, Spain
Dimitropoulos, Panos, University of Thessaly, Greece
Ding Jian, Ning, Jiangsu University, China
Djordjevic, Alexandar, City University of Hong Kong, Hong Kong
Donato, Nicola, University of Messina, Italy
Donato, Patricio, Universidad de Mar del Plata, Argentina
Dong, Feng, Tianjin University, China
Drljaca, Predrag, Instersema Sensoric SA, Switzerland
Dubey, Venketesh, Bournemouth University, UK
Enderle, Stefan, University of Ulm and KTB mechatronics GmbH, Germany
Erdem, Gursan K. Arzum, Ege University, Turkey
Erkmen, Aydan M., Middle East Technical University, Turkey
Estelle, Patrice, Insa Rennes, France
Estrada, Horacio, University of North Carolina, USA
Faiz, Adil, INSA Lyon, France
Fericean, Sorin, Balluff GmbH, Germany
Fernandes, Joana M., University of Porto, Portugal
Francioso, Luca, CNR-IMM Institute for Microelectronics and Microsystems, Italy
Fu, Weiling, South-Western Hospital, Chongqing, China
Gaura, Elena, Coventry University, UK
Geng, Yanfeng, China University of Petroleum, China
Gole, James, Georgia Institute of Technology, USA
Gong, Hao, National University of Singapore, Singapore
Gonzalez de la Ros, Juan Jose, University of Cadiz, Spain
Granell, Annette, Goteborg University, Sweden
Graff, Mason, The University of Texas at Arlington, USA
Guan, Shan, Eastman Kodak, USA
Guillet, Bruno, University of Caen, France
Guo, Zhen, New Jersey Institute of Technology, USA
Gupta, Narendra Kumar, Napier University, UK
Hadjiloucas, Sillas, The University of Reading, UK
Hashsham, Syed, Michigan State University, USA
Hernandez, Alvaro, University of Alcalá, Spain
Hernandez, Wilmar, Universidad Politecnica de Madrid, Spain
Homentcovschi, Dorel, SUNY Binghamton, USA
Horstman, Tom, U.S. Automation Group, LLC, USA
Hsiai, Tzung (John), University of Southern California, USA
Huang, Jeng-Sheng, Chung Yuan Christian University, Taiwan
Huang, Star, National Tsing Hua University, Taiwan
Huang, Wei, PSG Design Center, USA
Hui, David, University of New Orleans, USA
Jaffrezic-Renault, Nicole, Ecole Centrale de Lyon, France
Jaime Calvo-Galleg, Jaime, Universidad de Salamanca, Spain
James, Daniel, Griffith University, Australia
Janting, Jakob, DELTA Danish Electronics, Denmark
Jiang, Liudi, University of Southampton, UK
Jiao, Zheng, Shanghai University, China
John, Joachim, IMEC, Belgium
Kalach, Andrew, Voronezh Institute of Ministry of Interior, Russia
Rodriguez, Angel, Universidad Politecnica de Cataluna, Spain
Rothberg, Steve, Loughborough University, UK

Kausel, Wilfried, University of Music, Vienna, Austria
Kavasoglu, Nese, Mugla University, Turkey
Ke, Cathy, Tyndall National Institute, Ireland
Khan, Asif, Aligarh Muslim University, Aligarh, India
Kim, Min Young, Koh Young Technology, Inc., Korea South
Ko, Sang Choon, Electronics and Telecommunications Research Institute, Korea South
Kockar, Hakan, Balikesir University, Turkey
Kotulska, Malgorzata, Wroclaw University of Technology, Poland
Kratz, Henrik, Uppsala University, Sweden
Kumar, Arun, University of South Florida, USA
Kumar, Subodh, National Physical Laboratory, India
Kung, Chih-Hsien, Chang-Jung Christian University, Taiwan
Lacnjevac, Caslav, University of Belgrade, Serbia
Laurent, Francis, IMEC, Belgium
Lay-Ekuakille, Aime, University of Lecce, Italy
Lee, Jang Myung, Pusan National University, Korea South
Lee, Jun Su, Amkor Technology, Inc. South Korea
Li, Genxi, Nanjing University, China
Li, Hui, Shanghai Jiaotong University, China
Li, Xian-Fang, Central South University, China
Liang, Yuanchang, University of Washington, USA
Liawruangrath, Saisunee, Chiang Mai University, Thailand
Liew, Kim Meow, City University of Hong Kong, Hong Kong
Lin, Hermann, National Kaohsiung University, Taiwan
Lin, Paul, Cleveland State University, USA
Linderholm, Pontus, EPFL - Microsystems Laboratory, Switzerland
Liu, Aihua, Michigan State University, USA
Liu Changgeng, Louisiana State University, USA
Liu, Cheng-Hsien, National Tsing Hua University, Taiwan
Liu, Songqin, Southeast University, China
Lodeiro, Carlos, Universidade NOVA de Lisboa, Portugal
Lorenzo, Maria Encarnacio, Universidad Autonoma de Madrid, Spain
Lukaszewicz, Jerzy Pawel, Nicholas Copernicus University, Poland
Ma, Zhanfang, Northeast Normal University, China
Majstorovic, Vidosav, University of Belgrade, Serbia
Marquez, Alfredo, Centro de Investigacion en Materiales Avanzados, Mexico
Matay, Ladislav, Slovak Academy of Sciences, Slovakia
Mathur, Prafull, National Physical Laboratory, India
Maurya, D.K., Institute of Materials Research and Engineering, Singapore
Mekid, Samir, University of Manchester, UK
Mendes, Paulo, University of Minho, Portugal
Mennell, Julie, Northumbria University, UK
Mi, Bin, Boston Scientific Corporation, USA
Minas, Graca, University of Minho, Portugal
Moghavvemi, Mahmoud, University of Malaya, Malaysia
Mohammadi, Mohammad-Reza, University of Cambridge, UK
Molina Flores, Esteban, Benemirita Universidad Autonoma de Puebla, Mexico
Moradi, Majid, University of Kerman, Iran
Morello, Rosario, DIMET, University "Mediterranea" of Reggio Calabria, Italy
Mounir, Ben Ali, University of Sousse, Tunisia
Mukhopadhyay, Subhas, Massey University, New Zealand
Neelamegam, Periasamy, Sastra Deemed University, India
Neshkova, Milka, Bulgarian Academy of Sciences, Bulgaria
Oberhammer, Joachim, Royal Institute of Technology, Sweden
Ould Lahoucine, University of Guelma, Algeria
Pamidighanta, Sayanu, Bharat Electronics Limited (BEL), India
Pan, Jisheng, Institute of Materials Research & Engineering, Singapore
Park, Joon-Shik, Korea Electronics Technology Institute, Korea South
Pereira, Jose Miguel, Instituto Politecnico de Setebal, Portugal
Petsev, Dimitter, University of New Mexico, USA
Pogacnik, Lea, University of Ljubljana, Slovenia
Post, Michael, National Research Council, Canada
Prance, Robert, University of Sussex, UK
Prasad, Ambika, Gulbarga University, India
Prateepasen, Asa, Kingmoungut's University of Technology, Thailand
Pullini, Daniele, Centro Ricerche FIAT, Italy
Pumera, Martin, National Institute for Materials Science, Japan
Radhakrishnan, S. National Chemical Laboratory, Pune, India
Rajanna, K., Indian Institute of Science, India
Ramadan, Qasem, Institute of Microelectronics, Singapore
Rao, Basuthkar, Tata Inst. of Fundamental Research, India
Reig, Candid, University of Valencia, Spain
Restivo, Maria Teresa, University of Porto, Portugal
Rezazadeh, Ghader, Urmia University, Iran
Robert, Michel, University Henri Poincare, France
Royo, Santiago, Universitat Politecnica de Catalunya, Spain
Sadana, Ajit, University of Mississippi, USA
Sandacci, Serghei, Sensor Technology Ltd., UK
Sapozhnikova, Ksenia, D.I.Mendeleyev Institute for Metrology, Russia
Saxena, Vibha, Bhabha Atomic Research Centre, Mumbai, India
Schneider, John K., Ultra-Scan Corporation, USA
Seif, Selemeni, Alabama A & M University, USA
Seifter, Achim, Los Alamos National Laboratory, USA
Sengupta, Deepak, Advance Bio-Photonics, India
Shearwood, Christopher, Nanyang Technological University, Singapore
Shin, Kyuho, Samsung Advanced Institute of Technology, Korea
Shmaliy, Yuriy, Kharkiv National University of Radio Electronics, Ukraine
Silva Girao, Pedro, Technical University of Lisbon Portugal
Slomovitz, Daniel, UTE, Uruguay
Smith, Martin, Open University, UK
Soleymanpour, Ahmad, Damghan Basic Science University, Iran
Somani, Prakash R., Centre for Materials for Electronics Technology, India
Srinivas, Talabattula, Indian Institute of Science, Bangalore, India
Srivastava, Arvind K., Northwestern University
Stefan-van Staden, Raluca-Ioana, University of Pretoria, South Africa
Sumriddetchka, Sarun, National Electronics and Computer Technology Center, Thailand
Sun, Chengliang, Polytechnic University, Hong-Kong
Sun, Dongming, Jilin University, China
Sun, Junhua, Beijing University of Aeronautics and Astronautics, China
Sun, Zhiqiang, Central South University, China
Suri, C. Raman, Institute of Microbial Technology, India
Sysoev, Victor, Saratov State Technical University, Russia
Szewczyk, Roman, Industrial Research Institute for Automation and Measurement, Poland
Tan, Ooi Kiang, Nanyang Technological University, Singapore.
Tang, Dianping, Southwest University, China
Tang, Jaw-Luen, National Chung Cheng University, Taiwan
Thumbavanam Pad, Kartik, Carnegie Mellon University, USA
Tsiantos, Vassilios, Technological Educational Institute of Kaval, Greece
Tsigara, Anna, National Hellenic Research Foundation, Greece
Twomey, Karen, University College Cork, Ireland
Valente, Antonio, University, Vila Real, - U.T.A.D., Portugal
Vaseashta, Ashok, Marshall University, USA
Vazques, Carmen, Carlos III University in Madrid, Spain
Vieira, Manuela, Instituto Superior de Engenharia de Lisboa, Portugal
Vigna, Benedetto, STMicroelectronics, Italy
Vrba, Radimir, Brno University of Technology, Czech Republic
Wandelt, Barbara, Technical University of Lodz, Poland
Wang, Jiangping, Xi'an Shiyou University, China
Wang, Kedong, Beihang University, China
Wang, Liang, Advanced Micro Devices, USA
Wang, Mi, University of Leeds, UK
Wang, Shinn-Fwu, Ching Yun University, Taiwan
Wang, Wei-Chih, University of Washington, USA
Wang, Wensheng, University of Pennsylvania, USA
Watson, Steven, Center for NanoSpace Technologies Inc., USA
Weiping, Yan, Dalian University of Technology, China
Wells, Stephen, Southern Company Services, USA
Wolkenberg, Andrzej, Institute of Electron Technology, Poland
Woods, R. Clive, Louisiana State University, USA
Wu, DerHo, National Pingtung University of Science and Technology, Taiwan
Wu, Zhaoyang, Hunan University, China
Xiu Tao, Ge, Chuzhou University, China
Xu, Tao, University of California, Irvine, USA
Yang, Dongfang, National Research Council, Canada
Yang, Wuqiang, The University of Manchester, UK
Ymeti, Aurel, University of Twente, Netherland
Yu, Haihu, Wuhan University of Technology, China
Yufera Garcia, Alberto, Seville University, Spain
Zagnoni, Michele, University of Southampton, UK
Zeni, Luigi, Second University of Naples, Italy
Zhong, Haoxiang, Henan Normal University, China
Zhang, Minglong, Shanghai University, China
Zhang, Qintao, University of California at Berkeley, USA
Zhang, Weiping, Shanghai Jiao Tong University, China
Zhang, Wenming, Shanghai Jiao Tong University, China
Zhou, Zhi-Gang, Tsinghua University, China
Zorzano, Luis, Universidad de La Rioja, Spain
Zourob, Mohammed, University of Cambridge, UK

Contents

Volume 81
Issue 7
July 2007

www.sensorsportal.com

ISSN 1726-5479

Editorial

SENSOR+TEST 2007: Exhibition and Conference Report

Sergey Y. Yurish |

Research Articles

Dynamic Sensor Networks

Simone GABRIELE and Paolo DI GIAMBERARDINO 1302

Simple and Low-cost Wireless Distributed Measurement System

Alessandra Flammini, Daniele Marioli, Emiliano Sisinni, Andrea Taroni 1315

Impact of Different Air Protocols on the Use of the Radio Spectrum by Radio Frequency Identification (RFID) Devices in the 860 to 960 MHz Bands

Mike Marsh 1322

Initial Results on Low Cost Microprocessor and Ethernet Controller based Data Acquisition System in Optical Tomography System

Ruzairi Abdul Rahim, Goh Chiew Loon, Mohd. Hafiz Fazalul Rahiman, Chan Kok San, Pang Jon Fea, Leong Lai Chan 1333

PC Based Linear Variable Differential Displacement Measurement Uses Optical Technique

Tapan Kumar MAITI, Prasenjit PAUL, Indrajit DAS and Soumen SAHA 1341

Resistance Based Humidity Sensing Properties of TiO₂

B. C. Yadav, Amit K. Srivastava and Preeti Sharma 1348

Al₂O₃-modified ZnO Based Thick Film Resistors for H₂-gas Sensing

D. R. Patil, L. A. Patil 1354

Effect of Residual Stress on Divergence Instability of Rectangular Microplate Subjected to Nonlinear Electrostatic Pressure

Ghader Rezazadeh, Yashar Alizadeh, Hadi Yagubizade 1364

Control of Pressure Process Using Infineon Microcontroller

A. Siddique, M. R. Jayashree, O. Muthukumar, R. Maheswari and N. Sivakumaran 1373

Authors are encouraged to submit article in MS Word (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com
Please visit journal's webpage with preparation instructions: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm>

Control of Pressure Process Using Infineon Microcontroller

A. Siddique, M. R. Jayashree, O. Muthukumar, R. Maheswari and
N. Sivakumaran*

Embedded Systems Laboratory,
Department of Instrumentation and Control Engineering
National Institute of Technology, Trichy-620015, Tamil Nadu, India
E-mail: *nsk@nitt.edu

Received: 14 July 2007 / Accepted: 16 July 2007 / Published: 23 July 2007

Abstract: The main objective of this paper is to design a cost effective controller for real time implementation of pressure process using Infineon micro controller (SAB 80C517A). Model Identification is performed and it is found to be First Order Plus Dead Time Process (FOPDT). The performance measure is tabulated for different parameter and it is found that Proportional (P) controller is suitable for controlling the process. *Copyright © 2007 IFSA.*

Keywords: Real time, Pressure process, Microcontroller, Model Identification and Controller

1. Introduction

There are several methods for measurement and control of pressure process. The function of a feedback control system is to ensure that the closed loop system has desirable dynamic and steady state response characteristics. In typical control applications, it is not possible to achieve all of these goals simultaneously because they involve inherent conflicts and tradeoffs. The tradeoffs must balance two important objectives performance and robustness. Starting with these requirements, it is seen that the plant being a simple one, a sophisticated control system is not necessary for our purpose. Hence, conventional controllers are chosen. The PID controller is a very simple controller, but the major drawback is that there is no analytical way of finding the optimal set of parameters (K_p , τ_i , τ_d). But, empirical methods such as Ziegler-Nichols tuning and Cohen-Coons method can be used for the tuning. Since, it is required to build an embedded control system, discrete forms of P, PI, PD and PID controllers are required.

Sundaresan and Krishnaswamy (1978) have discussed the method obtaining first plus dead time model for a process using the reaction curve for a unit step change give to the process in open loop. From the response curve of the process to various step changes at different operating points and discuss the limitation of PI controller in this process. Somani et al. (1992) have proposed an analytical tuning formula for PI controller for a FOPDT process in open loop. Chidambaram and Padma Sree (2003) have proposed a simple method PI, PD and PID controller settings for an integrating plus dead-time transfer function model. The method is based on matching the coefficients of corresponding powers of s in the numerator and that in the denominator of the closed-loop transfer function for a servo problem. Skogestad (2003) has present an analytic rules for PID controller tuning that are simple and still result in good closed-loop behavior. A two-step procedure is proposed for deriving PID settings for typical process control applications. Any higher model is approximated to first order plus dead time model using half rule. Then PID controller is designed for the first order model using SIMC method. Koivo and Reijonen (2004) have suggested an optimization tuning of PID controllers for time varying, including state-dependent delays is discussed. The approach used in the paper is simulation and optimization. The plant can be nonlinear, but the results are easier to compare with classical results for constant delay case, when the dynamics is linear and of first order. In fact, iterative feedback tuning could he applied for real systems instead of simulation.

In this study, a cost effective real time implementation of pressure process using Infineon micro controller is performed and tested.

2. Design of PID Controller

A Proportional-Integral-Derivative controller (PID controller) is a common feedback loop component in industrial control systems. The controller takes a measured value from a process or other apparatus and compares it with a reference set point value. The difference (or “error” signal) is then used to adjust some input to the process in order to bring the process-measured value back to its desired set point. Unlike simpler controllers, the PID can adjust process outputs based on the history and rate of change of the error signal, which gives more accurate and stable control. The schematic of the traditional PID controller is shown in Fig.1.

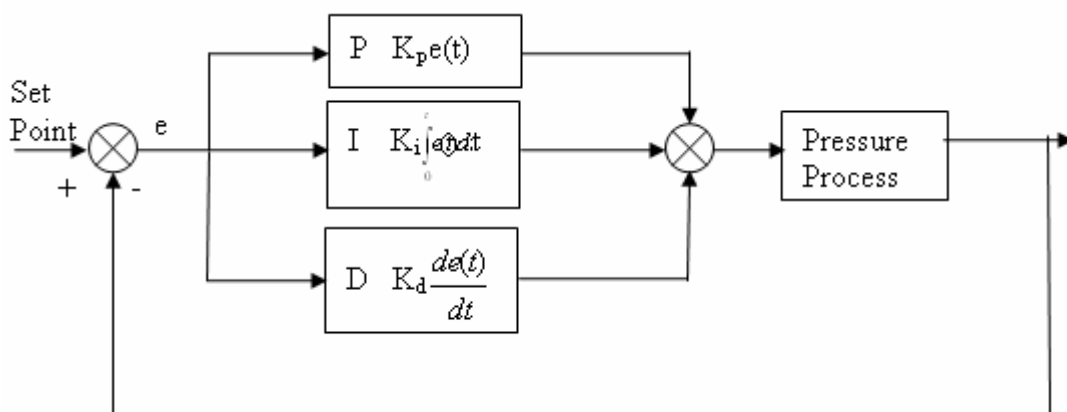


Fig. 1. Block diagram of a traditional PID controller.

The control output given by the PID controller is realized as

$$u(t) = K_c \left[e(t) + \frac{1}{\tau_i} \int_0^t e(t) dt + \tau_d \frac{d(e(t))}{dt} \right] + u_0 \quad (1)$$

For its implementation in a microcontroller, the discrete form of PID controller is used.

$$u[t] = u[t - 1] + K_c \left[e[t] - e[t - 1] + \frac{1}{\tau_i} e[t] + \tau_d (e[t] - 2e[t - 1] + e[t - 2]) \right]. \quad (2)$$

This has advantages like reduced computation time, lesser memory usage and also, it does not depend on the initial conditions of the system.

3. Process Description

For controlling the pressure of the tank, which is a closed loop process, the interfacing circuit is connected as shown in Fig.2. The output from DAC is in the range 0-5 V. This is converted to current range 4-20 mA and given as input to the I-P converter, whose output is the control signal for the control valve. A C program for acquiring the pressure value every 0.625s and calculating the appropriate control signal depending on the set point is calculated and fed back to the system through a DAC followed by an V-I converter. Simultaneously, the value of pressure and the control signal generated and fed back are stored for further analysis. The same procedure is repeated and values stored by controlling the pressure of the tank using P, PI, PD and PID controllers. The open loop response of the system is performed for simulation and experimental study and it validated with actual model is shown in Fig.3. The comparison of steady state error for simulation and experimental study is $\pm 2\%$.



Fig. 2. Plant overview.

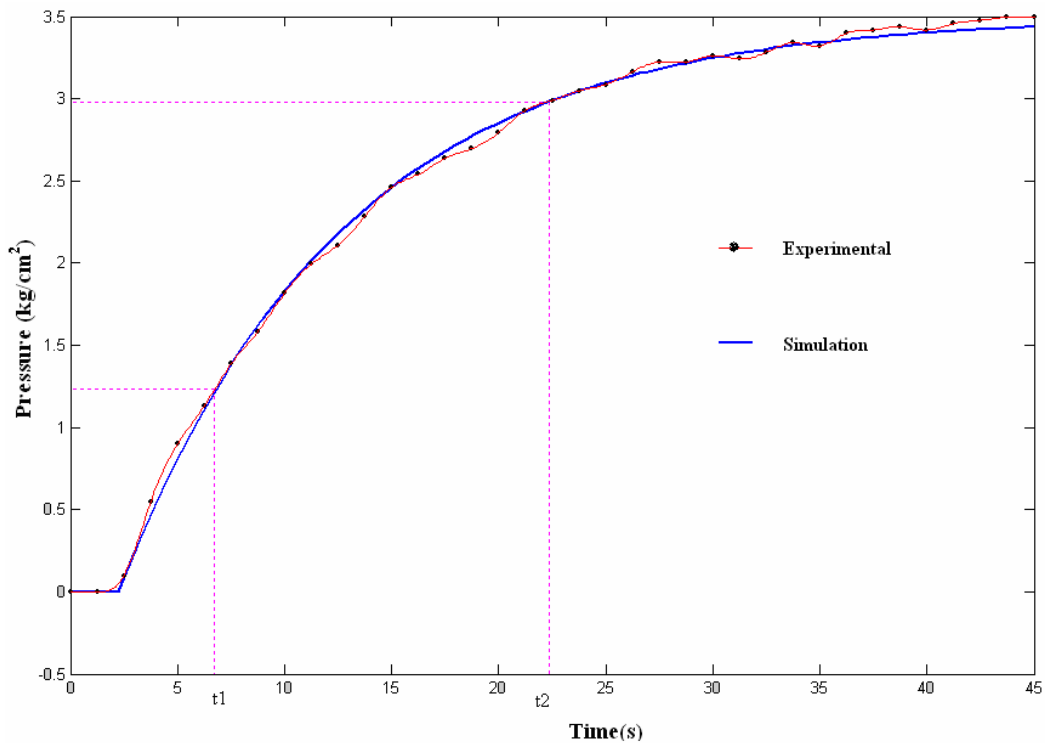


Fig. 3. Plot of transfer function obtained along with step response of the system.

4. Real Time Implementation

Design of Microcontroller Using Infineon 80C517A

The SAB 80C517A is a high-end microcontroller in the Siemens ACMOS technology and based on SAB 8051 8-bit microcontroller family. ACMOS is a technology, which combines high-speed, and density characteristics with low-power consumption and dissipation. It is a superset of the high-end microcontroller SAB 80C517. While maintaining all architectural and operational characteristics of the SAB 80C517 the SAB 80C517A incorporates more on-chip RAM as well as some enhancements in the compare capture unit. Also the operating frequency is higher than that of the SAB 80C517. It is based on the well-known industry standard 8051 architecture; a great number of enhancements and new peripheral features extended capabilities to meet the extensive requirements of new applications.

Sundaresan and Krishnaswamy (S and K) method is used to model the system as a first order system with time delay as given in equation 3. This method avoids use of the point of inflection construction entirely to estimate the time delay. It is proposed that two times, t_1 and t_2 , can be estimated from a step response curve, corresponding to the 35.3% and 85.3% response times, respectively. The time delay and time constant are then estimated from the following equations:

$$G(s) = \frac{5.37e^{-2.248s}}{10.45s + 1} \quad (3)$$

$$\theta = 1.3t_1 - 0.29t_2$$

$$\tau = 0.67(t_2 - t_1)$$

These values of q and t approximately minimize the difference between the measured response and the model, based on a correlation for many data sets.

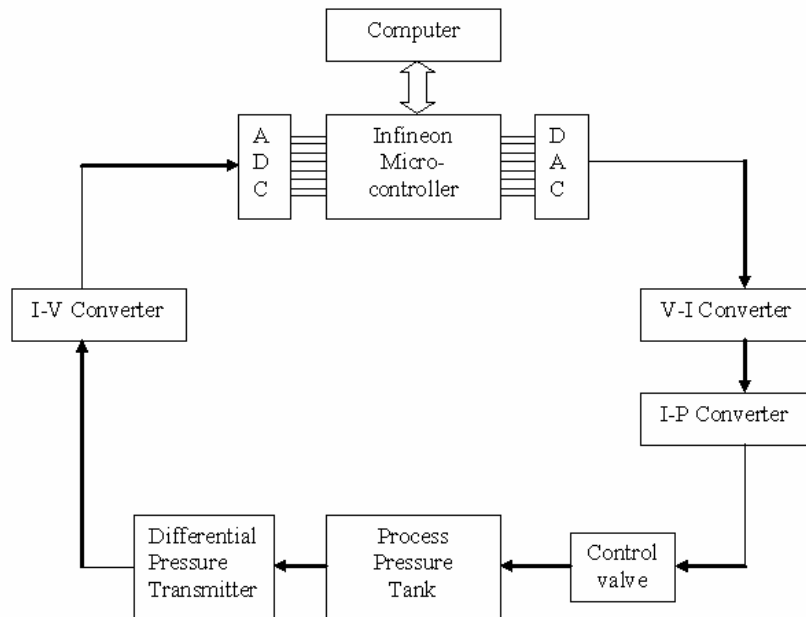


Fig. 4. Interfacing circuit for controlling the pressure set-up.

The real time interfacing circuit is shown in Fig.4. Here, the C code for acquiring the input parameters i.e. DP, VP and temperature and sending to the Infineon Microcontroller AT89C51 using PC is written using Keil Cross-Compiler which gives the corresponding Hex code. The Hex code is directly downloaded to SAB 80C517A microcontroller using serial port of the PC. In the target the C code is developed for receiving the multiple data sent by the PC and processing them using Model and PI control algorithm to calculate the Air Flow Rate (m^3/hour) and its control. The input parameters are converted into the standard (0 to 5V) range using appropriate Signal Conditioning units. The signals of standard value are given as time-multiplexed inputs to the ADC that converts each of its analog input into the corresponding digital output. Normalizing the system inputs in the range (0 to 5V) and the output (air flow rate) in the range (0 to 5V). The acquired input data is substituted in the Model which gives air flow rate in (m^3/hr) Error is calculated based on measured flow rate and desired flow rate, and the controller output is attained by PI algorithm. The controller output from the Microcontroller is fed to DAC, the corresponding signal is given to V to I converter, which in turns operate the control valve position by employing the I to P converter. A C program for acquiring the pressure value every 0.625s and calculating the appropriate control signal depending on the set point is calculated and fed back to the system through a DAC followed by an V-I converter. Simultaneously, the value of pressure and the control signal generated and fed back are stored for further analysis.

5. Results and Discussions

The value of pressure of the tank is calculated and plotted for analysis. The time domain parameters such as rise time, steady state error are calculated and are shown in Table 1. The control system study on pressure process is studied and the model is identified to be FOPDT.

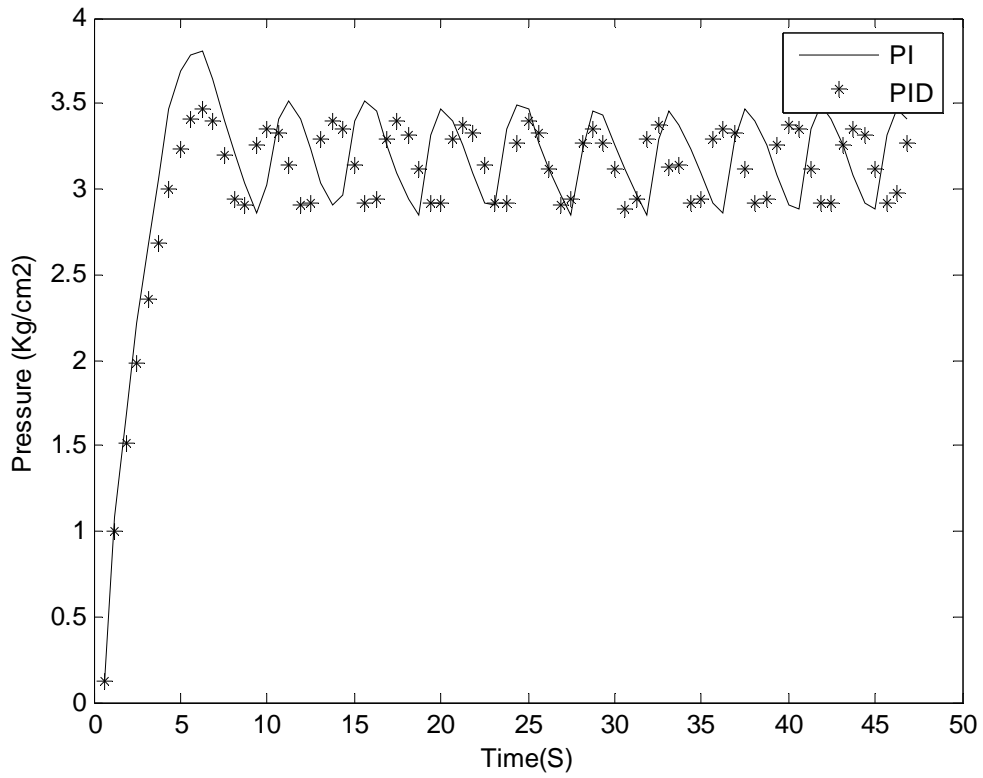


Fig. 5. Response of system controlled with PI and PID controller.

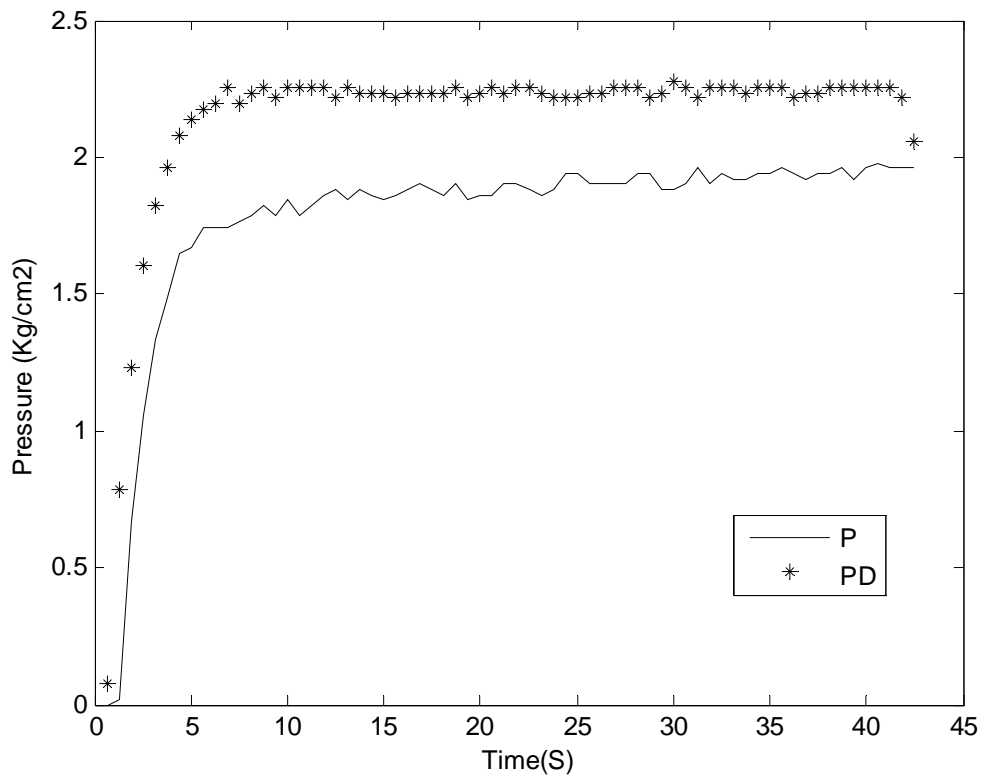
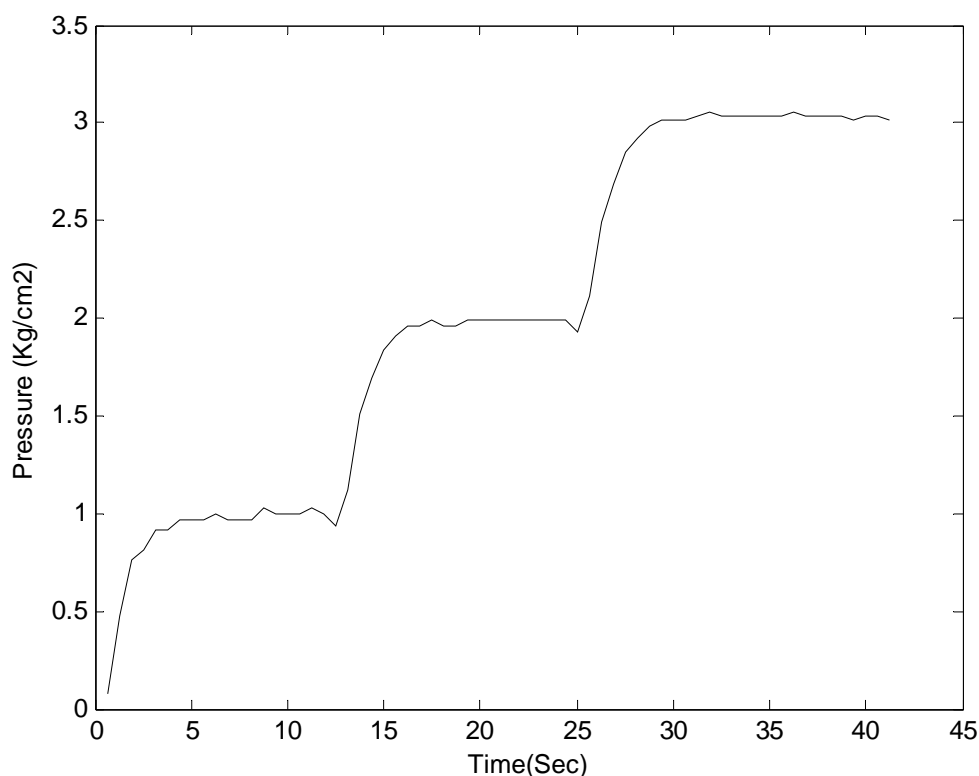


Fig. 6. Response of system controlled with P controller.

Table 1. Time domain parameters calculated for the experimental results.

Controller	Peak overshoot (%)	Peak time(s)	Rise time(s)	Settling time(s)	Steady state error (%)
P	No peaks	-	∞	38.75	2.43
PI	26.8	6.25	3.75	∞	0
PD	No peaks	-	∞	∞	25.44
PID	13.07	6.875	4.375	∞	0

The controller parameters are estimated and calculated for P, PI, PD, PID. The controller design using PI and PID tends to exhibit more peak overshoot and the settling time is not reached which is shown in Fig.5. Hence for a better controller design error and settling time decides effectiveness in the design. Hence, a P and PD controllers are compared and is shown in Fig.6. For a multiple changes in set point, the P controller tracks the set point effectively, Whereas PD exhibits offset without overshoot. To check the effectiveness of the P controller, the system is perturbed with multiple changes in set point and it is found that the system tracks the set point effectively with no overshoot and better settling time as shown in Fig.7. The P controller design is a suitable control of pressure using cost effective microcontroller.

**Fig. 7.** Response of system controlled with P controller for multiple-step inputs.

References

- [1]. H. N. Koivo, A. Reijonen, Tuning of PID Controllers for Varying Time-Delay Systems, *IEEE Proc. Conference on Mechatronics, ICM '04*, 2004, pp. 446-451.

- [2]. S. Skogestad, Simple analytic rules for model reduction and PID controller tuning, *Journal of Process Control*, 13, 2003, pp. 291–309.
- [3]. M. Chidambaram and R. Padma Sree, A simple method of tuning PID controllers for integrating/dead-time processes, *Computers & Chemical Eng.*, 27, 2003, pp. 211-215.
- [4]. M. K. Somani, M. V. Kothari, M. Chidambaram, Design formula for PI controller, *Hung. J. Ind. Chem.*, 20, 1992, pp. 205-211.
- [5]. K. R. Sundaresan, P. R. Krishnaswamy, Estimation of time delay ,time constant parameters in time frequency and Laplace domains, *Can.J.Chem.Eng.*, 56, 1978, pp. 257-262.
- [6]. K. J. Astrom and T. Hagglund, *PID Controllers: Theory, Design and Tuning*, 2nd ed., ISA Publications, North Carolina 1995.

2007 Copyright ©, International Frequency Sensor Association (IFSA). All rights reserved.
(<http://www.sensorsportal.com>)

Call for Papers

3rd International Conference

smart

materials structures systems

June 8-13, 2008 Acireale, Sicily, Italy

smart materials & micro/nano-systems

smart textiles

smart optics

intelligent structures
mechatronics & robotics

biomedical applications
of smart materials
nanotechnology and
micro/nano engineering

bio-inspired materials
& bionic systems

www.cimtecongress.org

 CIMTEC
2008

Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726- 5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because it is an open access, peer review international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per annual by International Frequency Association (IFSA). In addition, some special sponsored and conference issues published annually.

Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

Submission of papers

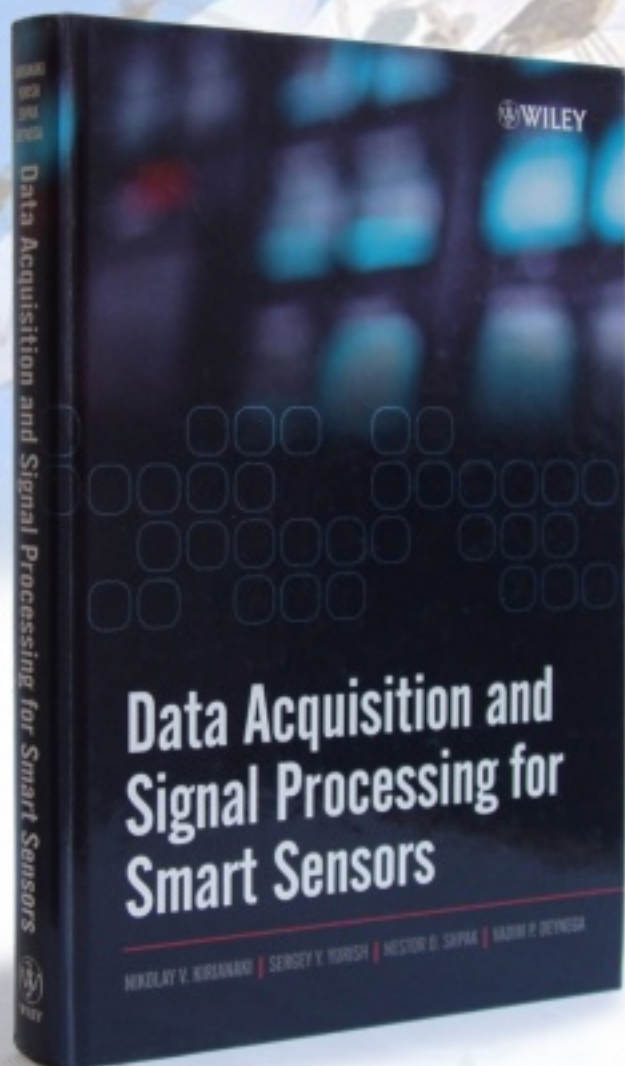
Articles should be written in English. Authors are invited to submit by e-mail editor@sensorsportal.com 4-12 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm> Authors must follow the instructions strictly when submitting their manuscripts.

Advertising Information

Advertising orders and enquires may be sent to sales@sensorsportal.com Please download also our media kit: http://www.sensorsportal.com/DOWNLOADS/Media_Kit_2007.PDF



KNOWLEDGE FOR GENERATIONS



'This book provides a good basis for anyone entering or studying the field of smart sensors not only for the inexperienced but also very useful to those with some experience'

(from IEEE Instrumentation & Measurement Magazine review)



Order online:

http://www.sensorsportal.com/HTML/BOOKSTORE/DAQ_SP.htm

www.sensorsportal.com