dSPACE DS1103 Control Workstation Tutorial and DC Motor Speed Control

Functional Requirements List and Performance Specifications

By

Annemarie Thomas

Advisor: Dr. Winfred Anakwa

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Introduction

The dSPACE DS1102 was first used at Bradley University in the year 2000 when a user's manual and a workstation based on this board were developed. Since then, a newer dSPACE DS1103 board has been developed. With grant from the Bradley College of Engineering of $2,000 and additional funds of $12,200 provided by Dr. Larry Kendrick at the Caterpillar Technical Center, a dSPACE DS1103 board and additional parts needed have been purchased to set up a DS1103 workstation. Initial setup has been completed by Mr. Chris Mattus. The object of the *dSPACE DS1103 Control Workstation Tutorial and DC Motor Speed Control* project is to develop a tutorial for use of the new dSPACE DS1103 Workstation by implementing a DC motor speed control system. The tutorial will minimize the time required for future students to become proficient in using the workstation, therefore increasing the time they can spend designing and implementing more complex control systems.

Project

The goals for the *dSPACE DS1103 Control Workstation Tutorial and DC Motor Speed Control* project are the following:
- Determine and implement any additional setup that may be required for the dSPACE DS1103 control workstation.
- Write a tutorial for use of the workstation, paying particular attention to details related to the DS1103 board using a DC motor speed controller as the example application.
- Design a controller to control the speed of a DC motor.
- Implement the designed DC motor speed controller on the dSPACE DS1103 system using the Simulink and the dSPACE blocksets, the Matlab-to-DSP interface libraries, Real-Time Interface to Simulink, and Real-Time Workshop.

The ultimate goal of this project is to decrease the learning curve for future students who use the workstation for more complex projects. Past projects completed by Bradley University students using the dSPACE DS1102 board included OFDM transmission and magnetic suspension projects. The dSPACE DS1103 Control workstation could be used for similar projects and is well adapted for use in automobile [1], airplane, and many other control applications.
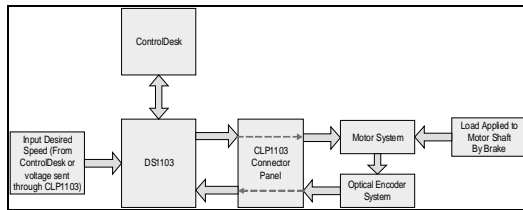
Overall System Requirements

Figure 1: Motor Speed Control System Block Diagram

Requirements and specifications for the overall system shown in figure 1 above are as follows:

- The operating range of the system shall be 0 to 40 degrees C.

- The system shall use a 30 VDC or smaller power supply.

- The motor used shall be a Pittman DC Motor Model Part # GM9236C534-R2.

- The values for the motor model to be used for design simulation in Simulink shall be determined from the datasheets and verified experimentally.

- A control panel shall be created in the "ControlDesk" application to monitor the inputs and the outputs of the system.

- The output from the "DS1103" to the "Motor System" shall be passed through a PWM output located on the "CLP1103 Connector Panel".

- The output from the "DS1103" to the "Motor System" shall be a 12 kHz PWM signal.

- The input to the "DS1103" from the "Optical Encoder System" shall be passed through an Incremental Encoder input located on the "CLP1103 Connector Panel".

- The input to the "DS1103" from the "Optical Encoder System" shall be converted to RPM for display purposes.

- The RPM measurement displayed using a control panel in "ControlDesk" shall be within ±10 RPM of the actual value.

- There shall be a method to input/control the desired speed of the motor.
  Note: The desired speed can be input as an RPM value using a control panel in "ControlDesk" or a voltage input through an Analog-to-Digital Converter input of the "CLP1103 Connector Panel".

- The desired maximum speed/velocity that shall be input is 834 RPM.

- Load Torque shall be applied to the motor shaft using a HB-420 Brake.

Note: The maximum load torque that can be applied should be limited to reasonable values.

- The controller design shall be downloaded onto the Texas Instruments' TM320F240 DSP [1] located on the "DS1103" board using "ControlDesk".

Controller Requirements

Requirements and specification applicable to the controller functionality are as follows:

- The DC motor speed controller shall be designed/simulated using Simulink and dSPACE blocksets, Matlab-to-DSP interface libraries, the Real-Time Interface to Simulink, and Real-Time Workshop.

- Overshoot shall be less than or equal to 5%.

- Rise time shall be less than or equal to 20 ms.

- Steady-state error shall be less than or equal to 5 RPM.

Other Requirements

Other requirements particular to this project are as follows:

- A tutorial shall be written on the use of the workstation using the DC motor speed controller as the example application.

References

[1] "DS1103 PPC Controller Board", Germany: dSPACE, July 2008.
[2] "Connector and LED Panels," Catalog 2008, Germany: dSPACE: 2008, p. 302.
[3] ControlDesk Experiment Guide For ControlDesk 3.2, Germany: dSPACE GmbH, 2008, Release 6.1.
[4] dSPACE System First Work Steps For DS1103, DS1104, DS1005, DS1006, and Micro Auto Box, Germany: dSPACE GmbH, 2007, Release 6.0.