Digital-to-Analog Conversion

Acknowledgements: Developed by Ui Luu and Manny Griego, Faculty of Glendale Community College, Glendale, Arizona.

Time Required: 1 hour

Equipment & Tools

- Internet connection
- Standard browsing (web surfing) capabilities

Team or Individual: This is an individual activity.

Learning Objectives

1. Complete a table of specifications for a digital-to-analog converter.
2. Calculate digital values to achieved target output voltages of a digital-to-analog converter.
3. Determine the required digital input to a DAC to achieve a target speed of a DC fan.

Performance and Task Procedures

- Review the information presented in the Introduction below.
- Obtain a digital-to-analog converter data sheet from the Internet or other source.
- Use the formula to calculate digital values to achieve a desired fan speed with a given voltage to speed calibration table.

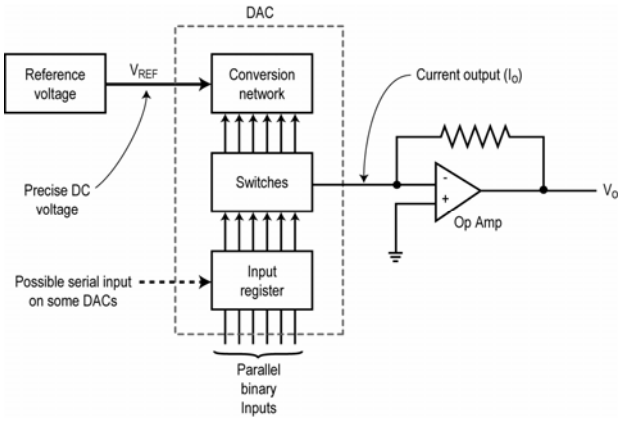
Deliverables

- Completed table for converter specifications
- Completed table for digital values, output voltages and fan speed

Scoring or Grading Criteria: The decision to grade students on their deliverables is left to the instructor.

Introduction

Digital-to-analog to conversion is the process of converting a binary input number into a proportional analog voltage by using a digital-to-analog converter (DAC). If the input to the DAC is a sequence of binary numbers, the DAC will produce an analog output level for each binary number. Some DACs have a parallel binary input of N bits while others have a serial input. Most DACs have a current output and use an op amp to convert that current into a voltage.

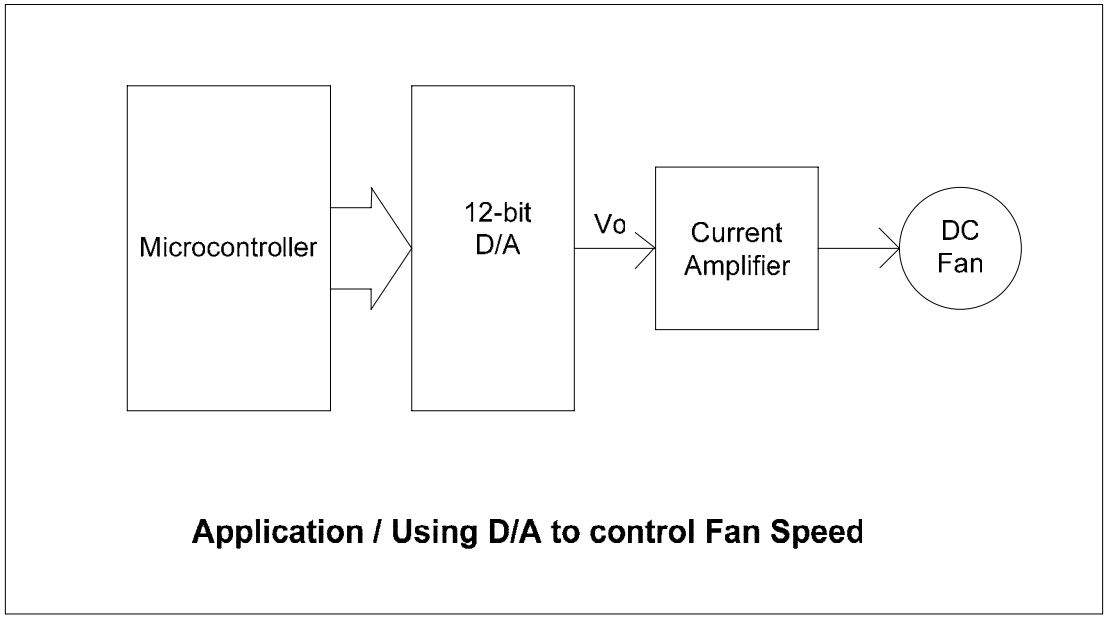


The reference voltage feeds the conversion network that performs the division of the reference into increments. The reference voltage source and the output op amp may be separate in some devices or may be included on the chip in others.

The specifications of digital-to-analog converters discussed in the narrative include:

- Number of DACs per chip
- DC power supply
- Resolution or number of bits (N)
- Input format.
- Input voltage levels
- Serial interface
- Reference voltage
- Current output level
- Type of input code
- Settling time
- Monotonicity
- Differential non-linearity (DNL)
- Conversion time

Digital converters have many applications in industry and manufacturing today. The DAC in this drill down is applied to control a DC fan speed as illustrated by the system block diagram. The system is based on a 12-bit D/A with full scale output of 12 V.



Application / Using D/A to control Fan Speed

To control a speed of a DC fan, a digital value is applied to the digital-to-analog converter to generate an output voltage that corresponds to a desired speed. For example, to achieve 3000 RPM, a digital value of 3071(base 10) is applied to the digital-to-analog converter to generate an output voltage of 9 V.

Drill Down Procedure

1. Use the formulas provided and calculate the digital values to achieve a desired fan speed for a 12 bit DAC with a 12 volt reference voltage. The fan speed is calibrated for a maximum of 4000 rpm with a 12 volt output. Record your answers in the table below.

   The formula for finding the digital value is: Digital Value = (Analog Value/V_{Ref}) x 4095

Voltage (V)	Digital Value	Fan Speed (RPM)
6		2000
7		2333
8		2667
9		3000
10		3333
11		3667
12		4000

2. Use a search engine such as Google or Yahoo or other technical magazines or books to locate a data sheet for a 12 bit digital-to-analog converter. The Web References section under Research and Resources lists some manufacturer's web sites as a starting point.
3. Copy or print out the data sheet to bring to class and share with other class members.
4. List the specifications for the DAC in the table on the next page.

Digital-to-Analog Converter Specifications

Manufacturer	
Web Site	
Part Number	
Number of DACs Per Chip	
DC Power Supply	
Input Format	
Input Voltage Levels	
Interface	
Reference Voltage	
Current Output Level	
Type of Input Code	
Settling Time	
Monotonicity	
Differential Non-Linearity (DNL)	
Conversion Time	
Cost	
Application	