DC motor controller System on ELT II board

January 2010, Ver. 1.1

Objective

To control the speed of the DC motor connected to the Stackable Stepper Motor Controller (SSMC) Snap-On Board using Entry Level Tool II (ELT II) board.

Introduction

Following section gives you brief introduction to the Stackable Stepper Motor controller system and guides you to run the project on ELT II board.

In this document you will learn:

- Overview of the Stackable Stepper Motor Controller System
- Tools used
- Hardware set up
- Running the system

SSMC System Overview

The stackable stepper motor controller system is developed for the SLS Stackable Stepper Motor Controller board.

In this system is running the DC motor speed and its rotation is controlled using program and switches on the board. Using switch SW1 on ELT II board we can move the DC motor in the forward direction and using switch SW2 we can rotate the motor in the reverse direction. In the program we have taken one 4 Bit counter for controlling the speed of the motor. When the counter has lower value the motor rotates with the highest speed. And when the counter has higher value, the motor rotates with the lower speed. This is done by controlling the ON-OFF period of the counter.

Refer the ***WormGear.v*** file for System code and **ELTII_WormGear_Control** folder for Quartus II project.

The frequency is selected by making the jumper connection on ELT II board. For 225 Hz frequency jumpers are connected at J6.19 and J6.20, J4.2 and J4.3, J5.2 and J5.3.

Tools Used

The application note uses following tools in order to create, the stepper motor controller system on ELT II board.

- SLS Stepper Motor Controller Board

  The SLS Stepper Motor Controller is that is developed specifically for providing the stepper motor interface to the development board using Santa Cruz header.

Figure 1. shows the SLS Stepper Motor Controller Board.

Figure 1. The SLS Stackable Stepper Motor Controller Board

- ELT II Board

  The ELT II provides a hardware platform for designing and developing simple and low-end systems based on Altera MAX II (CPLD) devices. Figure 2. shows the ELT II Education cum development board.

Figure 2. The SLS ELT II Board

- DC Motor

  The DC motor has voltage capacity upto 10V dc and the sink current is around 300mA. The above are the specification of the DC motor.

  A DC motor is known as an electric generator. An electrical Generator is a machine which converts mechanical energy (or power) into electrical energy (or power).

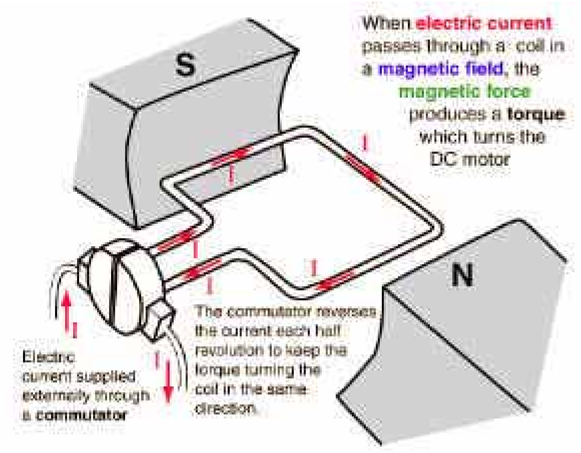
<u>Principle:</u>

It is based on the principle of production of dynamically (or motionally) include e.m.f. (Electromagnetic Force). Whenever a conductor cuts magnetic flux, dynamic included e.m.f. is produced in it according to **Faraday’s Laws of Electromagnetic Induction**. This e.m.f. causes a current to flow if the conductor circuit is closed.

Hence the basic essential parts of an electric generator are:

1. A magnetic Field
2. A conductor or conductors which can so move as to cut the flux

Figure 3. DC Motor Principle



When **electric current** passes through a coil in a **magnetic field**, the **magnetic force** produces a **torque** which turns the DC motor

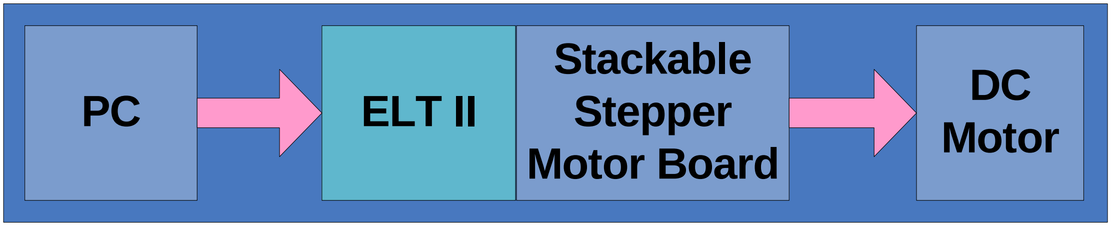
The commutator reverses the current each half revolution to keep the torque turning the coil in the same direction.

Electric current supplied externally through a **commutator**

Hardware Set up

We have used the ELT II board to control the function of DC Motor Controller system. We will connect our SSMC on the ELT II board at the expansion prototype connector and DC motor is connected at the spring connector of the SSMC board. The Figure 4. below shows the overview of the hardware set up.

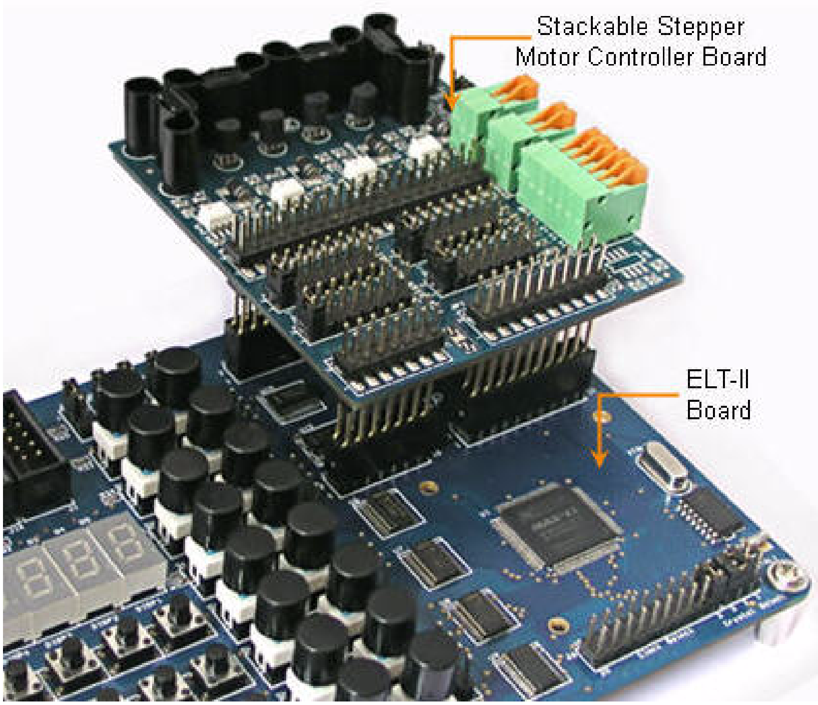
Figure 4. Hardware Set up Overview



Please follow the steps mentioned below to set up the hardware for controlling the function of DC motor by the Stackable Stepper Motor Controller System using ELT II.

3. Connect the stackable stepper motor controller board with the expansion headers on the ELT II board as shown in Figure 5.

Figure 5. Connection of Stackable Stepper Motor Controller Board with ELT II Board



4. Connect the DC motor wires with SSMC board's output as shown in Table 1 below.

Table 1. DC Motor Wire Connection with Stepper Motor Controller Board

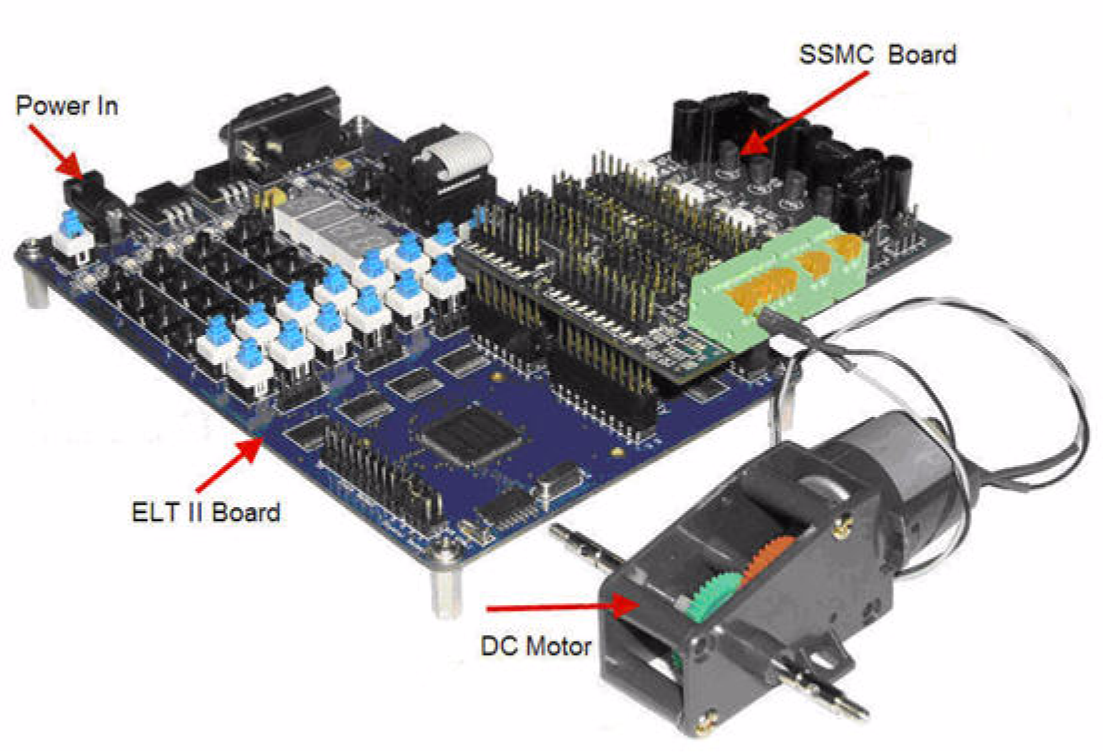
Wire Color	Driver Output
Red	Y1
Black	Y2

5. For controlling DC Motor, make the Stepper Motor Controller board's jumper settings as shown in Table 2.

Table 2. Jumper Settings for Stepper Motor1

Jumper Name	Jumper Settings
JP8	Short JP8.1 with JP8.2
JP9	Short JP9.1 with JP9.2

Figure 6. Connection of DC Motor with ELT II Board



Software Setup

For controlling the speed and the rotations of the DC motor rotation we have write down the code for it. The code is written in the verilog format. The program is as below:

```
module WormGear
(clk,reset_b,SwForward,SwReverse,PosTerm,NegTerm);
  input          clk;
  input          reset_b;
  input          SwForward;
  input          SwReverse;
  output         PosTerm;
  output         NegTerm;
  reg            PosTerm;
  reg            NegTerm;
```

The above part of the program is known as the entity definition. And rest of the lines are declaring the input and output of the program. Here we have take the four inputs and two output. In verilog code output is always define as the register to store the value.

Now the main part of the program to make the DC motor rotate in the particular direction. We have also written the code for the controlling the speed of the DC motor. For this we have take one counter to count the value and according that it will make the DC motor to ON.

```
reg   [3:0]    Count;
reg            Out;
always@(posedge clk)
  if (~reset_b)
    Count <= 0;
  else
    Count <= Count + 1;
always@(posedge clk)
  if (~reset_b || (Count ==4'b0000))
    Out <= 0;
  else
    case (Count)
    4'b0001  : Out <= 1;
     endcase
always@(posedge clk)
  if (~reset_b)
    begin
      PosTerm <= 0;
      NegTerm <= 0;
    end
  else
    begin
      case ({SwForward,SwReverse})
        2'b00:    begin
                    PosTerm <= 0;
                    NegTerm <= 0;
                  end
        2'b01:    begin
                    PosTerm <= Out;
                    NegTerm <= 0;
                  end
        2'b10:    begin
```

```
                          PosTerm <= 0;
                          NegTerm <= Out;
                        end
              2'b11:    begin
                          PosTerm <= 0;
                          NegTerm <= 0;
                        end
              default:  begin
                          PosTerm <= 0;
                          NegTerm <= 0;
                        end
            endcase
          end
    endmodule
```

As you can see from the above program that the motor is rotate in the forward direction when the SW1 bit is high and SWl bit is low then the DC motor stop. When the SW2 is ON, the motor rotates in the reverse direction. For moving the motor in particular direction we only need to energise the coil, so that we are only making output line high or low.

For controlling the speed of the motor we have used one 4 bit counter. We are incrementing counter at every clock pulses. So when it reaches to the particular value then it will start the motor to run according to the switch position. By increasing the number of the counter to make output bit high, we can rotate the motor more slowly.

Running the System

Please follow the steps mentioned below for programming the chip and running the application.

1. Open **Quartus II** software.
2. Make a new project called as ELTII_DC and select the design file type as the verilog.
3. Now add the verilog file the ***WormGear.v*** file for System code.
4. Select **Processing** > **Start** > **Start Analysis and Synthesis.**
5. Open the assignment editor by selecting from **Assignments** > **Assignment Editor** and give the pin name as shown in the table given below.
6. Select **Start Compilation.**
7. After compilation, open the **Tools** > **Programmer.**

Table 3. Pin Assignments

Pin Name	CPLD Pin Number
clk	PIN_14
PosTerm	PIN_99
NegTerm	PIN_97
reset	PIN_44
SwFroward	PIN_2
SwReverse	PIN_3

8. Select the Hardware setup as ByteBlaster II and mode as JTAG. Now click on the **Program/Configure**.
9. Click on **Start** button. The program will be downloaded into the chip.
10. Press SW1 into ON position and observe the output on the DC motor.
11. Press SW2 into ON position and observe the output on the DC motor.

Conclusion

Using Stackable Stepper Motor board, it's easy to drive the DC motor on ELT II board. We can also run the higher specification motor using the SSMC board.

Further Information

For more information about ELT II refer to http://www.slscorp.com/pages/entryleveltool.php

For information about Stackable Stepper Motor Controller Board, refer to http://www.slscorp.com/pages/steppermotorsls.php

Download the Quartus II project for the application note from http://www.slscorp.com/pages/download/appnotes/dcmotor/Ref_des_eltii.zip.

Revision History

Table below shows the revision history of the document.

Version	Date	Description
1.0	July 2008	Initial Release
1.1	January 2010	Add download link for application Quartus II project in Further information section

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