Embedded systems interfacing

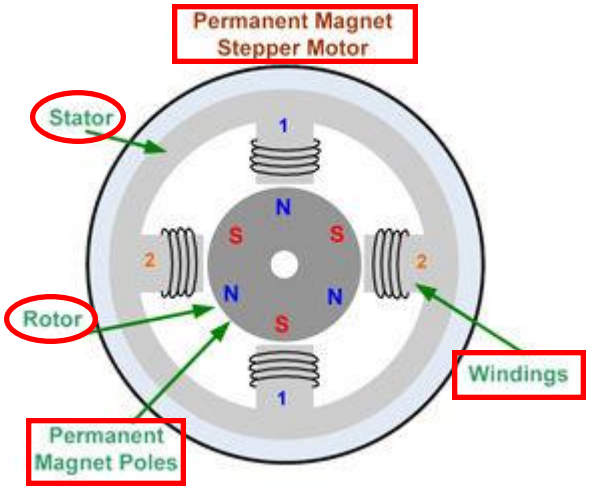
Lecture Five (Stepper Motor)

Stepper Motor

Stepper Motor

A stepper motor is a DC motor that divides a full rotation into a number of steps. It is mainly consists of a rotational part (Rotor) which a permanent magnet and a static part (Stator) which is a set of coils. These coils are called phases, by energizing each phase in sequence, the motor will rotate, one step at a time.

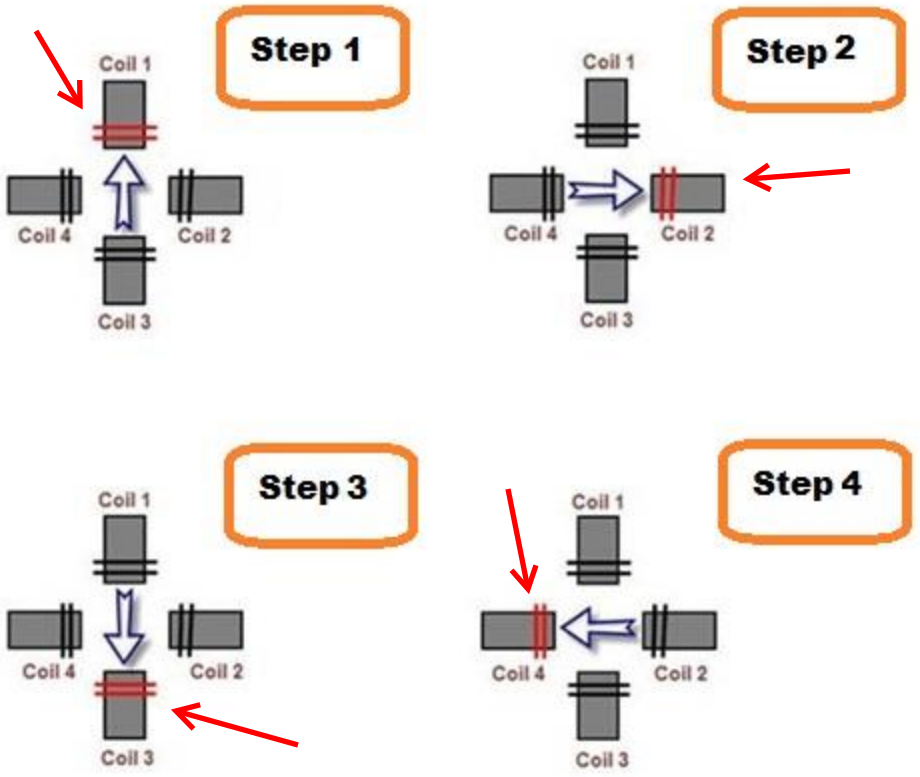
Using stepper motor, we can control the rotation direction and rotation speed simply without using and additional electrical components, such as an encoder within the other motors. For this reason, stepper motors are very robust and have high reliability with very few failures.



Basic Idea of Operation

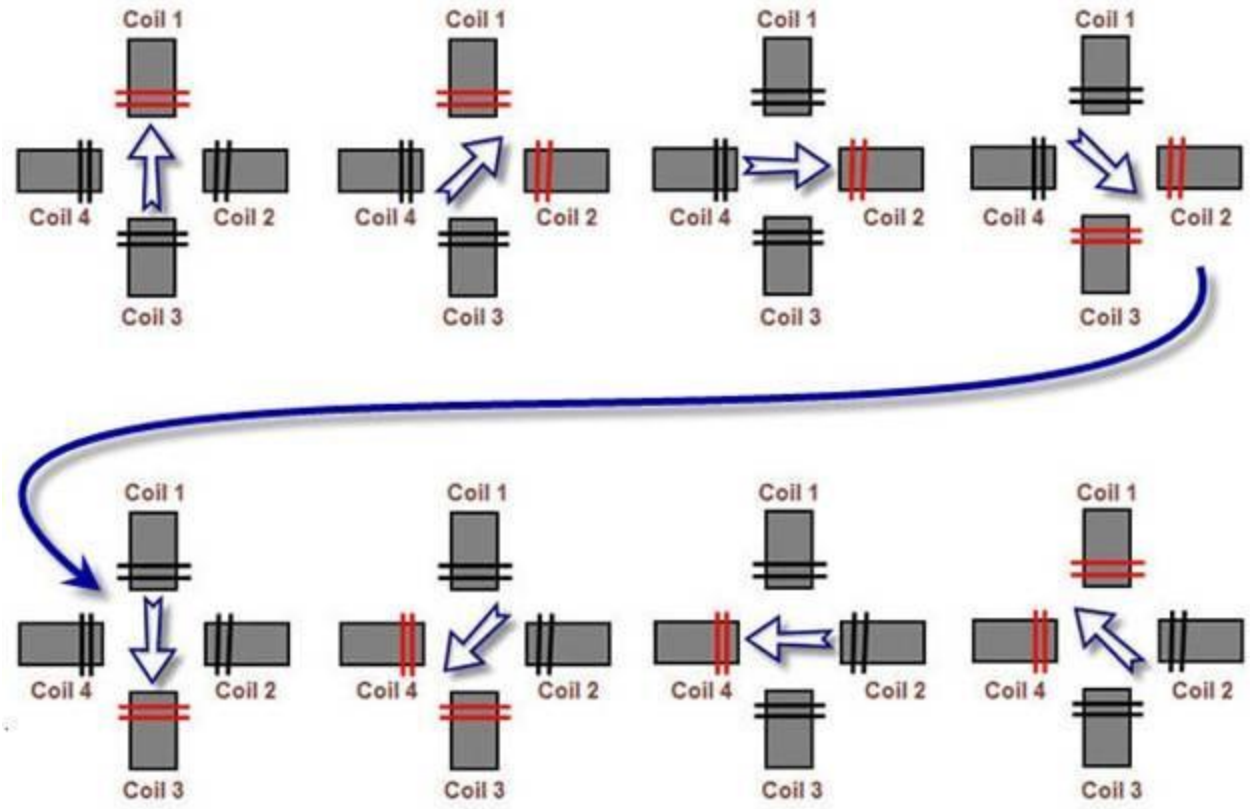
When current flows through coil “1" the magnet is attracted and moves one step forward. Then, coil “1" is turned off and coil “2" is turned on. Now, the magnet takes another step, and so on. For a stepper motor to move, these coils should be activated in a correct sequence.

In this simple orientation of coils, we assume that the step is 90 degree. For that the motor makes a full rotation in 4 steps only. But in reality, the motor may have more coils to achieve smaller step.



Full Step Operation

Half step rotation



This step is used to achieve higher precision by having the rotor moving half step at time

28byj48 Stepper

Speed and Direction

After applying any pattern to the motor to move it one step, and before applying the next pattern to move it another step, we have make some delay according to the motor maximum working frequency.

In our case, the motor 28byj48 the maximum frequency is 100 Hz, which means the time between any 2 steps shall not be lower than 10 mille seconds. and this is the maximum speed. Be increasing the time between the step and the next step, the motor speed decreases.

Controlling the direction is simply done by reversing the energizing order of the coils.

Rated voltage :	5VDC
Number of Phase	4
Stride Angle	5.625°/64
Frequency	100Hz

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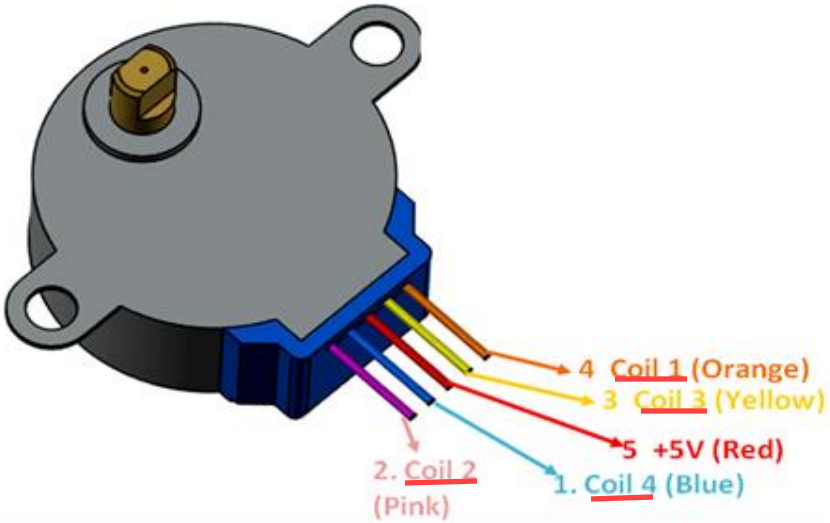
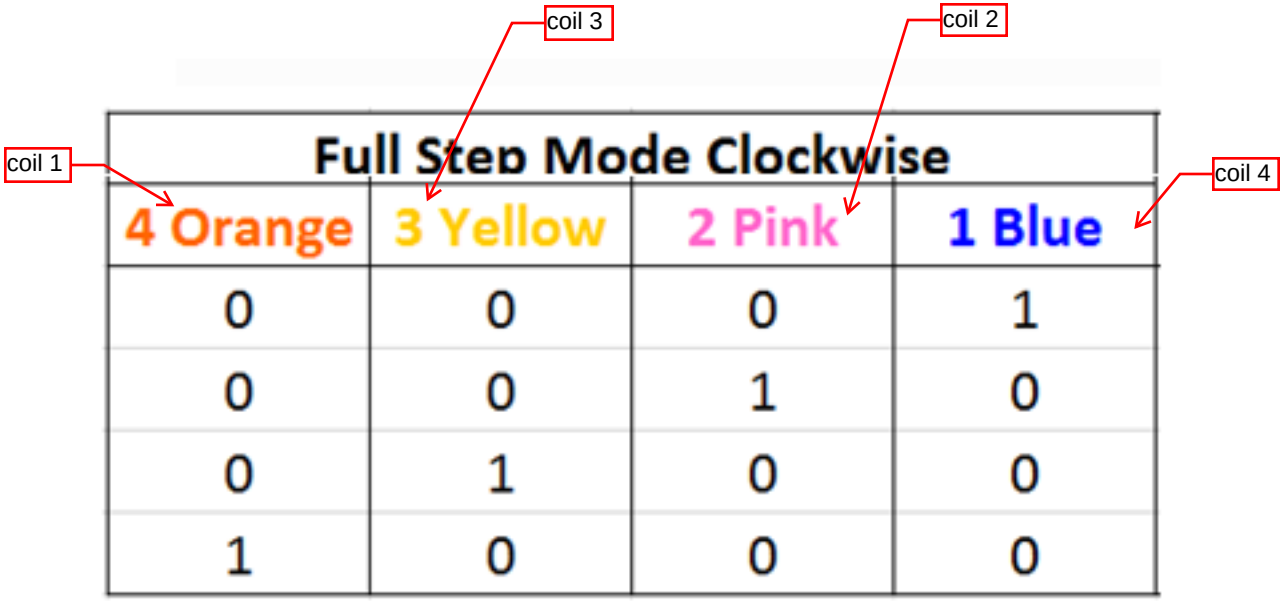
In-traction Torque	>34.3mN.m(120Hz)
Self-positioning Torque	>34.3mN.m
Friction torque	600-1200 gf.cm
Pull in torque	300 gf.cm



Full step Sequence



Full Step Mode Clockwise			
4 Orange	3 Yellow	2 Pink	1 Blue
0	0	0	1
0	0	1	0
0	1	0	0
1	0	0	0

Half step Sequence

Half Step Mode Clockwise			
4 Orange	3 Yellow	2 Pink	1 Blue
1	0	0	1
0	0	0	1
0	0	1	1
0	0	1	0
0	1	1	0
0	1	0	0
1	1	0	0
1	0	0	0

Speed and Direction

After applying any pattern to the motor to move it one step, and before applying the next pattern to move it another step, we have make some delay according to the motor maximum working frequency.

In our case, the motor 28byj48 the maximum frequency is 100 Hz, which means the time between any 2 steps shall not be lower than 10 mille seconds. and this is the maximum speed. Be increasing the time between the step and the next step, the motor speed decreases.

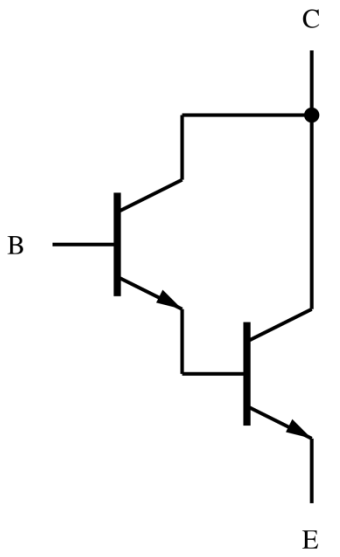
Controlling the direction is simply done by reversing the energizing order of the coils.

The Darlington Pair

The stepper motor needs high current to work, the current of a digital input output pin in the microcontroller can not drive it. So, we need an electronic switch to that we be controlled by the microcontroller and supply a current to the motor from the power supply.

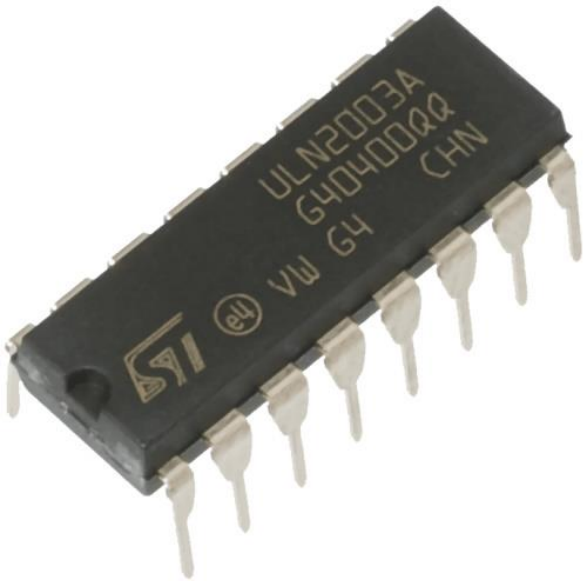
Transistor can do that as discussed in pervious lecture, but what if we have 2 serial transistors. This is called the Darlington pair.

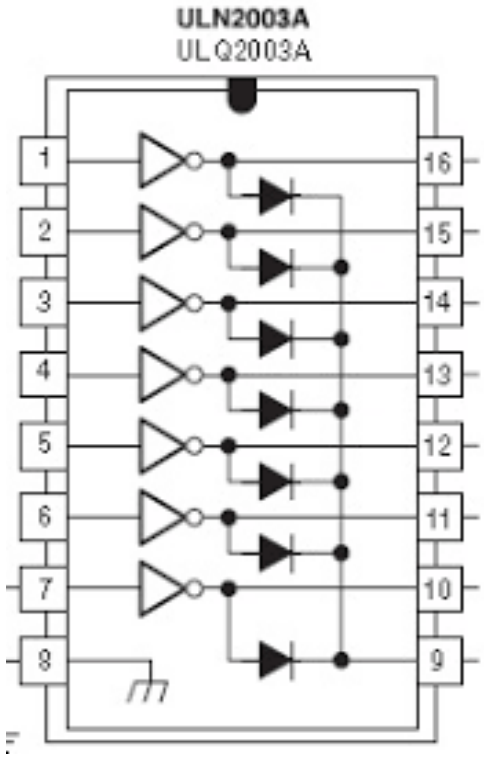
The Darlington transistor (commonly called a Darlington pair) is a compound structure of a particular design made by two bipolar transistors connected in such a way that the current amplified by the first transistor is amplified further by the second one.



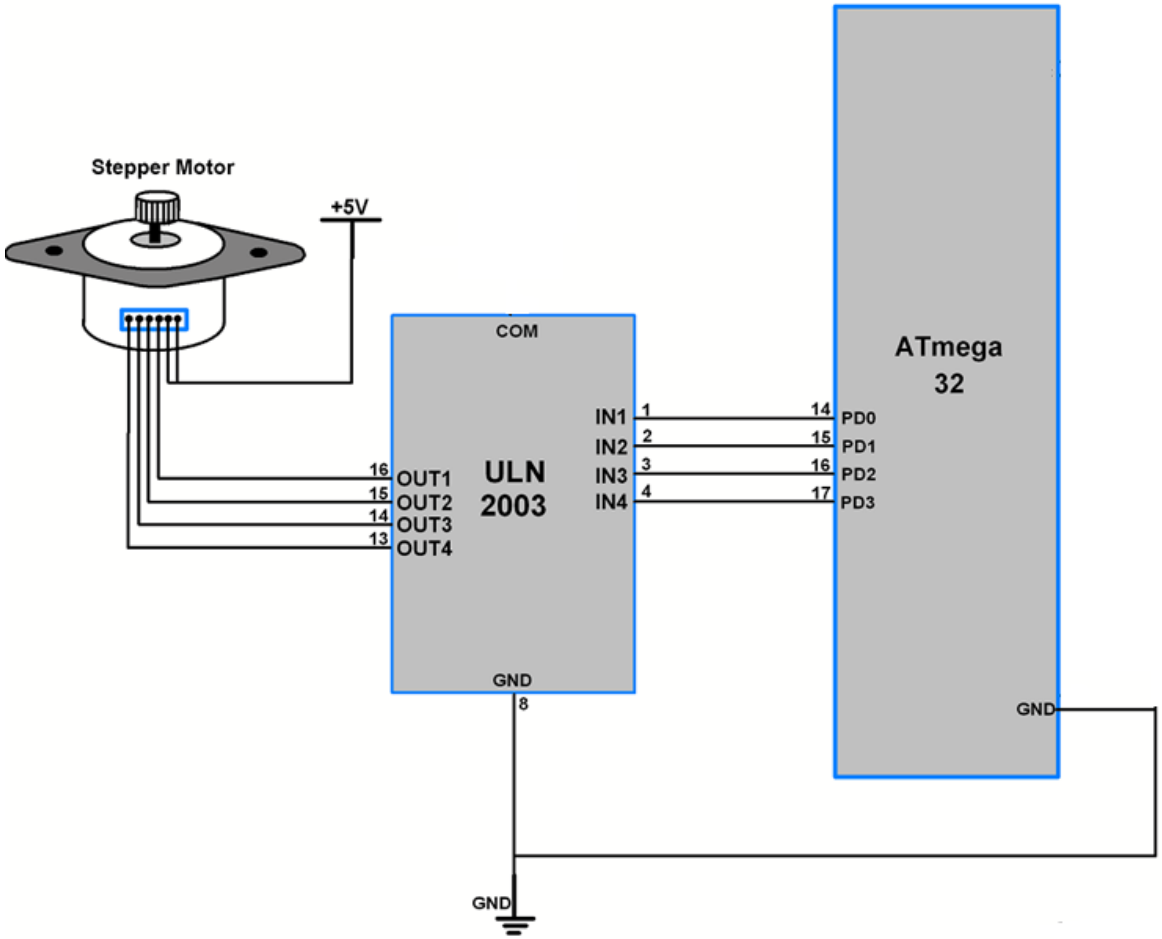
ULN2003 IC

This IC combines 7 Darlington pairs, each one has input for the base and output for its collector.
If the input is 0, the output is GND
if the input is 1, the output is floating pin





Stepper Motor Interfacing



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