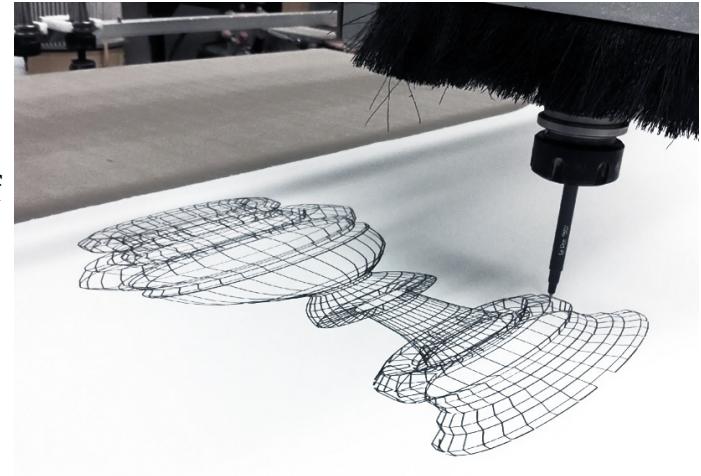


CNC Drawing Machining

The process of creating a “drawing” using a numerically controlled Sharpie is documented in a short video.

Vector graphics are converted into a tool path and then a machine language which controls a 3-axis CNC machine retrofitted with a special fixture that holds a marker and mimics hand pressure during the act of drawing.

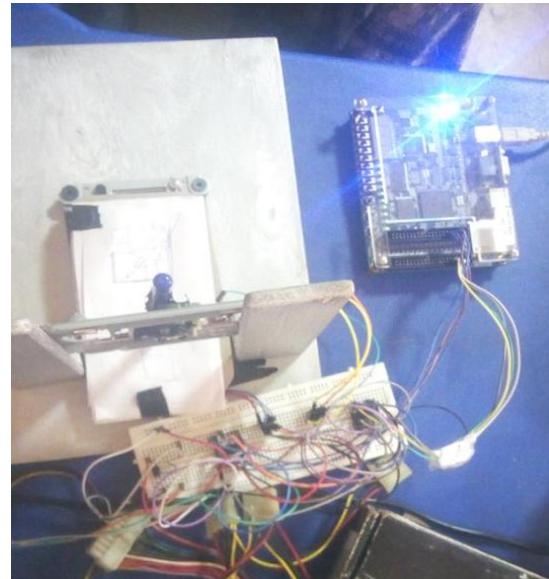
Our cnc drawing machine



Step 1: What You Will Need

- FPGA (field-programmable gate array)
- Breadboard
- 2x L293D ICs Motor driver
- Micro Servo Motor
- 2x DVD/CD Drives
- Resistors
- power supply

**USB to Serial adapter will allow the circuit to communicate with the computer through the USB cable, just like FPGA does.



Tools (only for 'pro' part list):

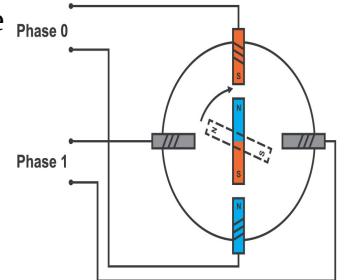
- Screwdriver
- Soldering iron
- Solder
- Cutting tool (e.g. Dremel)
- Glue

Stepper Motor

A **stepper motor** or **step motor** or **stepping motor** is a brushless DC motor that divides a full rotation into a number of equal steps

It mean that:

- 1) They have no brushes or commutator (the parts of a DC motor that reverse the electrical current and keep the rotor—the rotating part of a motor—constantly turning in the same direction)



- 2) In a basic DC motor, there is an outer permanent magnet that stays static and an inner coil of wire that rotates inside it.

In a brushless hub-motor, the coils of wire are static in the center and the permanent magnets spin around them on the outside.

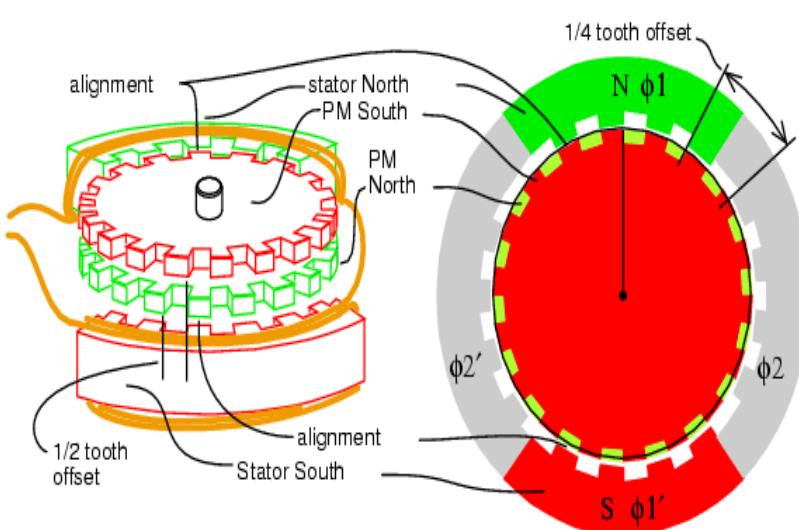
A stepper motor is different again. This time, the permanent magnets are on the inside and rotate (making up the rotor),

while the coils are on the outside and stay static (making up the stator).

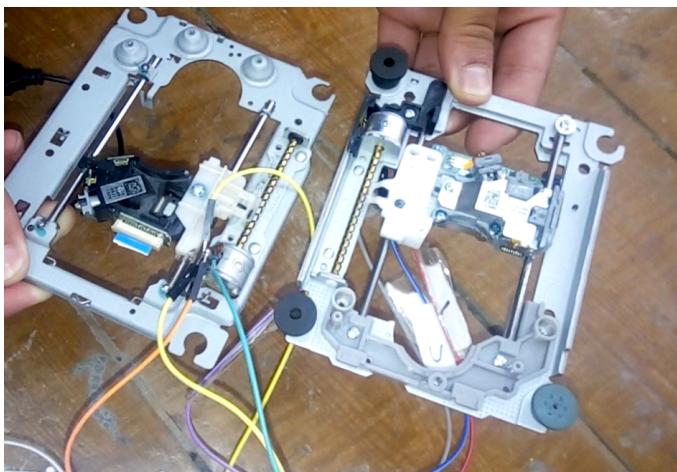
- 3) In the design of the stator and the rotor.

Instead of one large magnet on the outside (the stator) and one large coil rotating inside it (the rotor),

a stepper motor has an inner magnet effectively divided up into many separate sections, which look like teeth on a Gear wheel .



The outer coils have corresponding teeth that provide magnetic impulses, attracting, repelling, and making the teeth of the inner wheel rotate by small steps.



Our motor is 2Phase/ 4Inputs.

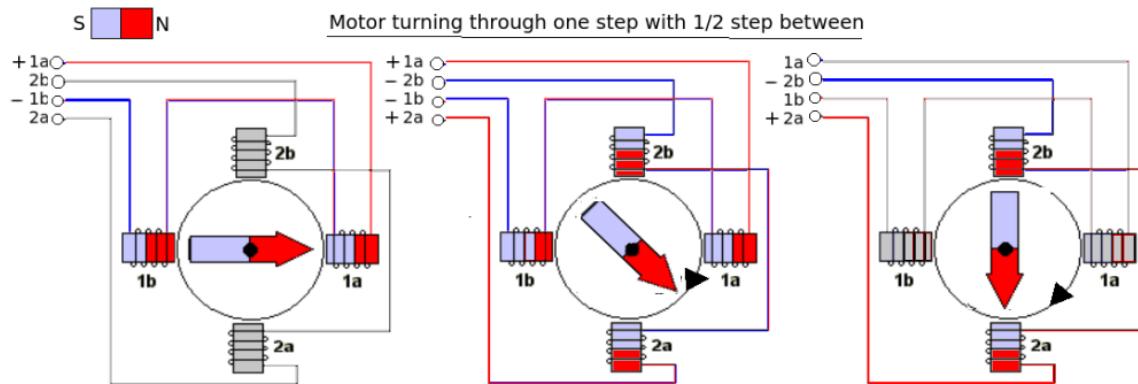
```

CASE count IS
WHEN 0 => cout2 <= "1010";
WHEN 1 => cout2 <= "1001";
WHEN 2 => cout2 <= "0101";
WHEN 3 => cout2 <= "0110";
WHEN 4 => cout2 <= "1010";
WHEN 5 => cout2 <= "1001";
WHEN 6 => cout2 <= "0101";
WHEN 7 => cout2 <= "0110";
end case;

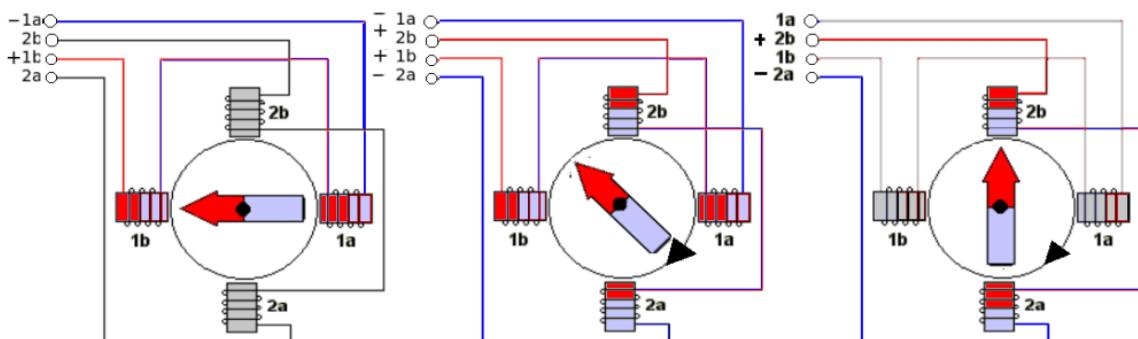
```

by using these states we will control its steppes , the variable count1 , count2 ,for each motor ,they increment to change the output vector(3 downto 0) - 4bit for 4wires - .

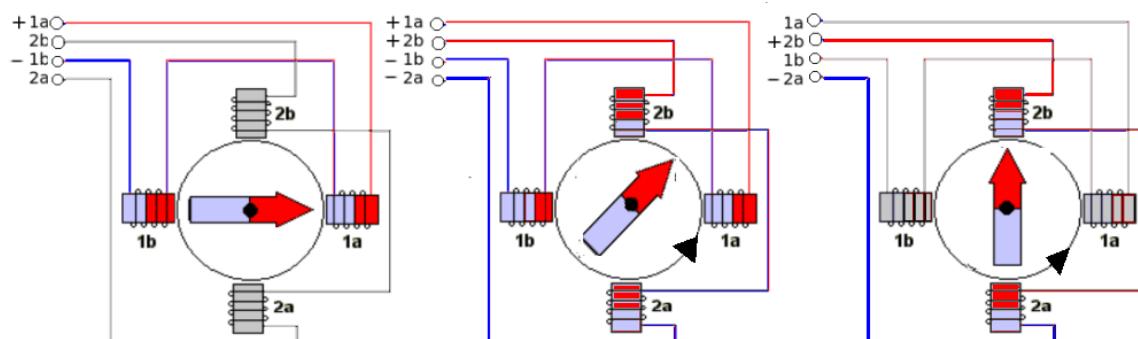
To complete the full rotating it need 7 states.



current in 'forward' direction producing a clockwise rotation



Reversing current in both coils does not change the direction of rotation



Reversing current in one pair of coils reverses direction

L293D

(The Driver / H-BRIDGE)

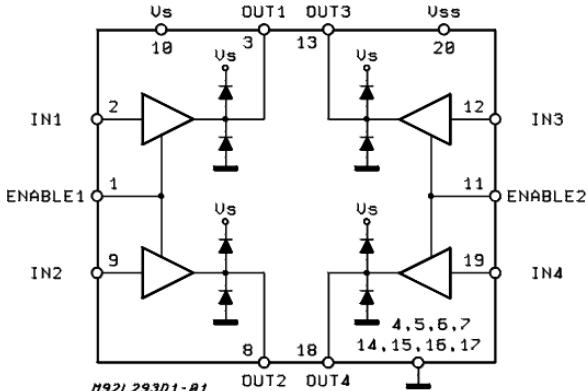
Run four solenoids, two DC motors or one bi-polar or uni-polar stepper with up to 600mA per channel using the L293D.

It drive the motor and supply its volt as the microcontroller cant do that.



*L293X data-sheet

BLOCK DIAGRAM



1 Features

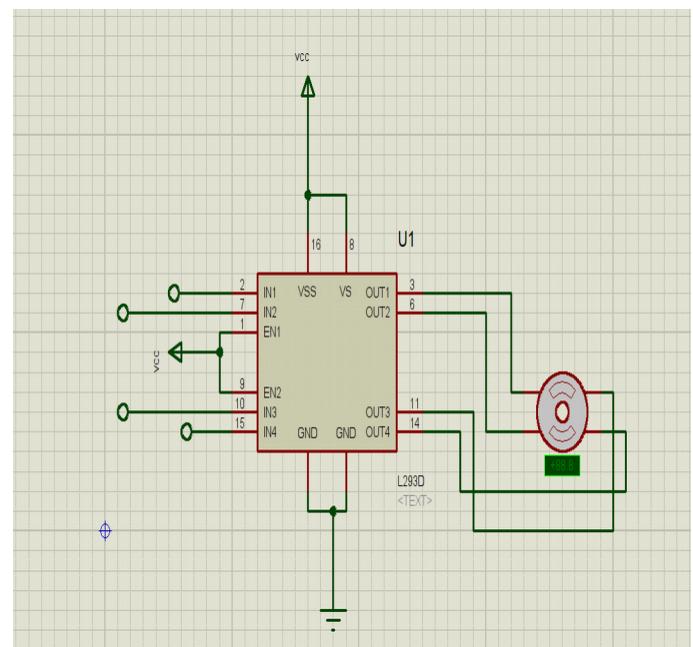
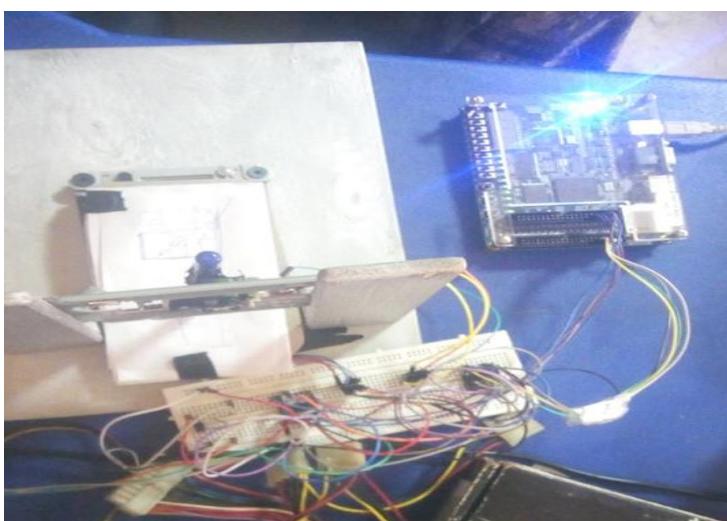
- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- High-Noise-Immunity Inputs
- Output Current 1 A Per Channel (600 mA for L293D)
- Peak Output Current 2 A Per Channel (1.2 A for L293D)
- Output Clamp Diodes for Inductive Transient Suppression (L293D)

2 Applications

- Stepper Motor Drivers
- DC Motor Drivers
- Latching Relay Drivers

Interfacing L293D with the stepper motor on protues

*pins (2 7 10 15) : are input from the fpga .
*Pins (3 6 11 14) : are the output to the stepper.



The truth table of the ic for Each 2solenoids.

1A (PIN 2 OF L293D)	2A (PIN 7 OF L293D)	M1
1	1	-
1	0	CLOCKWISE
0	1	ANTICLOCKWISE
0	0	-

the truth table of the ic for the stepper motor.

Note :

this 4 steps dont enough to make the stepper complete its full cycle , so we accurately write this code ^-^ .

Bipolar Stepper Motor				
Steps	RB3	RB2	RB1	RB0
1.	1	0	0	0
2.	0	0	1	0
3.	0	1	0	0
4.	0	0	0	1

All these 7 stepps which we mention previously need to complete just one cycle , so we need more for our project . This drive us to use the pulses .

we use constant n of a wide range to repeat the cycle .

And use it inside the clock as "K"

to enter the loop then increment "K" till the constant < " number_of_bit" else "K=0" , it will exist .

```
PACKAGE const IS
CONSTANT number_of_bits :INTEGER:=1000000;
CONSTANT n : INTEGER :=number_of_bits -1 ;
END const;
USE work.const.all;
```

```
22  VARIABLE count :INTEGER RANGE 0 TO 7;
23
24  VARIABLE k    :INTEGER RANGE 0 TO n;
25  BEGIN
26  IF (step'EVENT AND step = '1') THEN
27    IF k < (n+1) THEN
28      k := k + 1;
29    ELSE
30      k :=0;
31    IF M1 = "10" THEN count := count + 1;
```

Servo motor

Servo motors are small in size but pack a big punch and are very energy-efficient.

These features allow them to be used to operate remote-controlled or radio-controlled toy cars, robots and airplanes.

Servo motors are also used in industrial applications, robotics, in-line manufacturing, pharmaceuticals and food services.

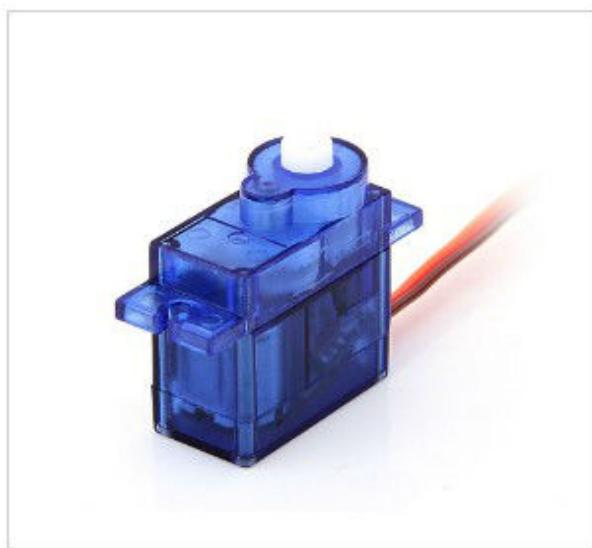


We use the micro servo motor : it has 3 colored wires

The Yellow one is the signal

The Red is (+)

The Brown is(-)



Micro 0.12sec/60degree 1.3kg.cm

Analog Servo FS90

Date: Mar 8, 2013

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SKU:	FS90
Dimensions:	23.2 × 12.5 × 22 mm
Weight:	9 g
Operating Speed :	0.12sec/60degree (4.8V) 0.10sec/60degree (6V)
Stall Torque :	1.3kg.cm/18.09oz.in(4.8V)
Operating Voltage :	4.8V~6V
Control System :	Analog
Direction :	CCW
Operating Angle :	120degree
Required Pulse :	900us-2100us
Bearing Type :	None
Gear Type :	Plastic
Motor Type :	Metal
Connector Wire Length :	20 cm

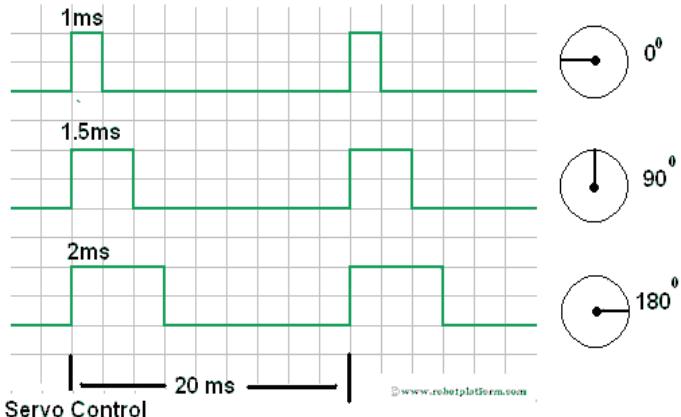
Servos are controlled by sending a **pulse width modulation** (PWM), through the control wire.

The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position.

The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns.

For example :

a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it in the counter clockwise direction toward the 0° position, and any longer than 1.5ms will turn the servo in a clockwise direction toward the 180° position



Optocoupler

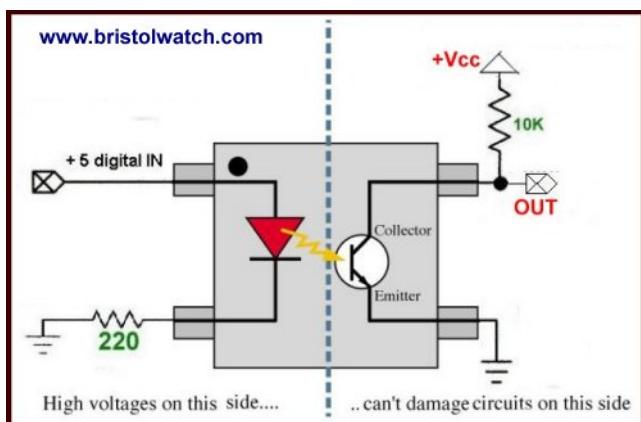
Optocoupler also called a **photocoupler**, optical isolator is a small chip that transfers signals between two isolated circuits using light.

A basic optocoupler uses a led and a phototransistor, the brighter the led the more current is allowed to pass through the phototransistor.



www.f-alpha.net

We use it to prevent servo load on the fpga , as it can damage this pin or burn the fpga .



Optocoupler data-sheet

ABSOLUTE MAXIMUM RATING

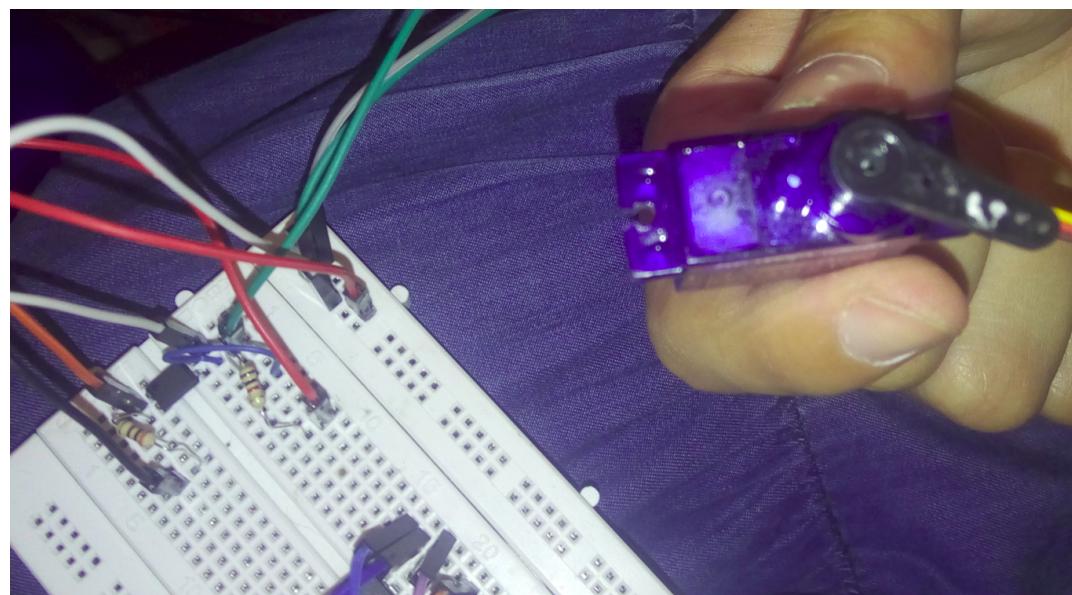
(Ta = 25°C)

PARAMETER		SYMBOL	RATING	UNIT
INPUT	Forward Current	I _F	50	mA
	Reverse Voltage	V _R	6	V
	Power Dissipation	P	70	mW
OUTPUT	Collector - Emitter Voltage	V _{CEO}	35	V
	Emitter - Collector Voltage	V _{ECO}	6	V
	Collector Current	I _C	50	mA
	Collector Power Dissipation	P _C	150	mW
Total Power Dissipation		P _{tot}	200	mW
*1 Isolation Voltage ○		V _{iso}	5,000	Vrms
Operating Temperature (LTV- 827 / 847)		T _{opr}	-30 ~ +110	°C
Operating Temperature (LTV-817)		T _{opr}	-30 ~ +110	°C
Storage Temperature		T _{stg}	-55 ~ +125	°C
*2 Soldering Temperature		T _{sol}	260	°C

FEATURES

- * Current transfer ratio
(CTR : MIN. 50% at I_F = 5mA, V_{CE} = 5V)
- * High input-output isolation voltage
(V_{iso} = 5,000Vrms)
- * Response time
(tr : TYP. 4μs at V_{CE} = 2V, I_C = 2mA, R_L = 100Ω)

Optocoupler
with the servo



Our Budget

NO. PICE	typ	price LE
2	Micro Servo Motor (1.3kg.cm)	60.00
3	L293D DUAL Motor Driver With Thermal Shutdown	15.00
2	Female Pin Headers (2 mm-40 pin)	5.00
2	Male Pin Headers (Standard 2.54 mm-40 pin)	2.00
1	Solder Wire RAM High Quality 100gm Sn70/Pb30 - 0.6mm [SOLDER.WIRE.RAM.100GM]	38.00

Total : 217 EL.

The fpga kit : 1000 EL.

Our Team

* Yara Mohsen
* Yasmine Mohamed
*Nourhan Ashref
*Marina Gad
* Mahmoud Eltayeb

* Esraa Metwally
* Hala Abdlerazek
* Nedaa Ahmed
* Mona Attia