PCB Cutting Machine

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Abstract:- The goal of this paper is about to assemble a printed circuit board-cutting machine. The contemporary evolution in digital technology particularly embedded systems have now enabled us to make designing and implementing an automatic printed circuit board-cutting machine. This machine takes Printed Circuit Board from one side and cut it into two separate pieces, in essential size and shape. This paper presents a simple way that will reduce human work and improves accuracy of cutting the printed circuit board. System will minimize PCB damage chances by blades using the fabrication and covering. Cutting is separation of physical object, into two or more portions, through the application of an acutely directed force. However, any sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cutting, when it applied with sufficient force. Even liquids use to cut things when applied with sufficient force.

Keywords:- *Printed Circuit Board, motor, force, Volume.*

I. INTRODUCTION

A. Introduction

Cutting is separating a physics object into two or more parts by applying a sharply directed force. Common tools for amputation are knives and saws, or in science and medicine, microtome and scalpels. Nevertheless, a piece that is sharp enough must be sufficiently harder than the piece to be cutting and cutting with sufficient force. Even liquids cut with force. Cutting is a pressure-shear occurrence and can just occur when total stress created by cutting tool exceeds the ultimate strength of the material of the object cutting. The simplest equation is stress = force/area. The stress generated by the cutting tool is directly proportional to force applied by the cutting tool and inversely proportional to contact area. Therefore, the smaller the area (i.e. the sharper the cutting tool), the less force is required to cut something. In general, the cutting edge is thin for soft materials and thick for hard materials.

From cleavers to axes, this evolution balances the simplest cutting-action of thin blades with the power and margin longevity of broad blades. Machining has-been at the core of constructing all around history. Many methods used for hardware and can be assemble according to the physical occurrence used.

- Copper Clad Cutting
- Chip Forming - Drilling, Turning, Sawing, Milling, Etc.
- Shearing - Stamping, Scissoring, Punching.
- Abrading – Lapping, Polishing, Grinding; Water-Jet.
- Heat - Plasma Cutting, Laser Cutting, Flame Cuts.
- Electrochemical - Electrical Discharge Machining (EDM), Etching .

Each technique has its drawbacks in cost, effect on material, and accuracy. For e.g., laser cutting is less suitable for large amount of reflective material such as aluminum it may damage the quality of heat-treated alloys. Laser cutting sheet metal produces engraves parts and flat parts from difficult or easiest designs. It used over other cutting options for its specially made capacities and fast operation.

II. LITERATURE REVIEW

In view of proposed dissertation work concerned, following few of the researchers have done their experimental study and investigated results which have been review as follows

- J.S. Dureja & R. Singh- Taguchi L9 foursquare array has carried out for exploratory plan. S/N ratio and ANNOVA evaluation accomplished on D3 steel to become aware of giant parameters influencing device put on and floor roughness. Results represent the slicing pace to be the maximum giant thing, influencing flank put on.[1]

- Dr. C.J. Rao et al- result of cutting framework on cutting force and surface finish during turning. The authors used a working thing made of steel 1050 (484.00 HV hardness) and a ceramic tool with an Al203 + Tic matrix (KY1615).[2]

- R. R. & K venketesan- Taguchi's L9 array is use to perform Evaluation of dry turning of Inconel718 with carbide inserts. Feed rate found to be the most important parameter of surface roughness.[3]

- A Mahamani- the Taguchi method was use to get the machining equations. The effects of parameters on cutting force and surface roughness when turning AA2219-TiB2/ZrB2 in situ metal matrix composites investigated. An orthogonal L27 layout was use for the experiments. Response plots and variance analysis show that feed rate has the greatest effect on roughness force and surface cutting.[4]

- S. K. Nayak ET. Al. -creation of machining equations while dry turning of austenitic stainless steel IASI 304 performed. Three impact properties surface roughness, cutting force and MRR measured.[5]

- L. Beraneka & K. Kolarikb –an implementation of design of experiments performed to get turning parameters such as cutting-speed, cutting-depth and feed for duplex-steel. Duplex-steels generally tend to harden mechanically during machining. Feed and cutting speed have statistically significant effects on the surface hardness equations Ra, Rz. A larger factor increases the surface hardness, but the feed-rate is adjust to the level of 0.1 mm/rev. The effect of the cutting speed factor is small.[6]

- S Thamizhmanii, S. Hasan- the CBN inserts (cutting inserts) are used, cryogenically followed at -196 degrees Celsius. The cutting parameter is the cutting speed due to the feed rate. Cryogenically treated CBN inserts wear minimum titanium than AISI 440 carbon steel. Flank wear formation for titanium alloys was less than AISI 440 CD design of system[7]

III. DESIGN OF SYSTEM

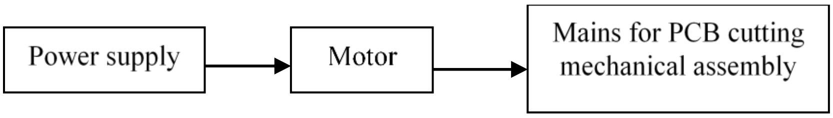

Fig 1:- Block diagram of the system

- *Power Supply:*

It is an electronic circuit, which consists of a 230V and will turn the motors on for PCB cutting.

- *Printed Circuit Board:*

Initially, circuit boards implemented manually by making a photomask on a clear Mylar-sheet, normally two or four times the actual size. Beginning with a schematic, we placed the component pin pads on Mylar and routed traces to connect the pads. Increased efficiency through dry transfer of common component footprints. Traces made with adhesive tape. A non-reproducible grid pre-printed on Mylar aided in the layout. To create the panel, the completed photomask photolithographically reproduced onto a photoresist coating on a bare copper-clad panel. Modern PCBs typically designed using specialized layout software that follows these steps:

Schematic capture using EDA tools. Board dimensions and stencils are determined based on the circuit required and his PCB package. Components and heating positions are determined. The number of layers on a printed circuit board Specified from one layer to several tens of layers depending on the complexity. Determine ground and power planes. The power plane is the counterpart to the ground plane and acts like an AC signal ground, delivering DC power to circuits mounted on the PCB. Signal connections traced at signal level. Signal planes placed on both outer and inner layers. High frequency signals routed on internal layers between ground and power or for optimal EMI performance.

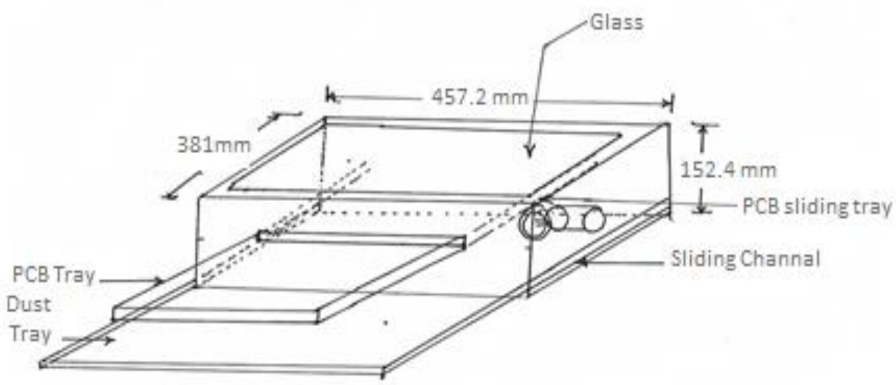

Fig 2:- Setup diagram

Line impedance is resolve by dielectric layer thickness, trace thickness, and trace width. Differential signaling also considers wire separation. Signal routing can be microstrip, stripline, or dual stripline. Placed component. Thermal refection and geometry taken into account. Vias and lands are marked. Wired signal line. Electronic design automation tools typically create spaces and connections for power and ground planes automatically. Gerber files generated for manufacturing.

A. Calculations:

Rpm = 8600
Voltage = 200 / 230 v
Current = 0.32 Amp

➢ Motor pulley Diameter

1. Motor pulley diameter = 30mm
2. IP_Shaft pulley diameter = 45mm
3. Reduction ratio = 45/30 = 1.5
4. IP_Shaft speed = 45/1.5 = 30rpm
5. Torque at IP Rear shaft = 1.5 x T

= Nm

$$P = \frac{2\pi NT}{60} = \frac{2 \times \pi \times}{60}$$

➢ Design Belt Drive

1. Length = 50
2. Motor pulley Diameter d =
3. IP_Shaft pulley diameter D =
4. Belt Thickness = 5.30

➢ Bear Types Model = 6202

1. Inner Diameter = 15mm
2. Outer diameter = 35mm

➢ Teeth Blades dimensions

1. Circulator disc blade Teeth = 100
2. Slider length = 457.2 mm
3. Inner width = 2.35

➢ Layer for protection from dust or cleaning purpose acrylic coating 16” x 16”

➢ Design of belt Drive:

1. Motor pulley diameter (d) = 30.00mm
2. IP_Shaft pulley diameter (D) = 45.00mm
3. Coefficient of friction = 0.230
4. Diameter of belt = 5.300 mm
5. Mass of belt per unit length is given by
6. P = density of belt material = 950.00 kg/m^3

Velocity of belt given by,

$$V = \frac{\pi dn}{60 \times 1000}$$

$$= \frac{\pi \times 5.3 \times 45}{60 \times 1000}$$

= 0.01248 m/s
= 12.480mm/s

Center distance between two pullies C = 180mm

1. Inner diameter = 15mm
2. Outer diameter = 35mm
3. Shaft diameter = 7.85 mm

To find Tension in belt,

$$P = \frac{(F1-F2)V}{1000}$$

$$50 \times 10^{-3} = \frac{(F1-F2) \times 0.01248}{1000}$$

F1 – F2 = 4006.41 N----- (1)
Center distance between two pullies of motor and pullies output C = 200mm.

$$\alpha = \sin^{-1} \frac{D-d}{2C}$$

$$\alpha = \sin^{-1} \frac{(45-30)}{2 \times 180}$$

$\alpha = 2.388^0$ (In Degrees)
$\alpha = 2.388 \times (\pi/180)$
$\alpha = 0.0416^o$ (In radians)

θ = angle of lap of belt
$\theta = \pi - 2\alpha$
$= \pi - [2 \times 0.041] = 3.14 - (0.082)$
$\theta = 3.058^0$(In Radians)
$\theta = 0.0416^o$ (In Degrees)

Coefficient of Friction = 0.23

$$\frac{F1}{F2} = e^\wedge \frac{\mu\theta}{\sin\beta}$$

$$\frac{F1}{F2} = e^\wedge \frac{(0.23 \times 3.05)}{\sin\beta}$$

Bearing selection:
P = 50 watt
Inner diameter = 12mm
Outer diameter = 44.45 mm
C = 180mm
L = 160mm
Slider length (sided double) = 457.2 mm

- *Shaft*

A shaft; rotating mechanical element is normally circular in cross section, which used to transmit power from one part to another or from a power-producing machine to a power-absorbing machine. Various elements such as pulleys and gears attached.

- *Shaft Design:*

To find the shaft diameter according to ASME code Actual Shear Stress of Commercial Steel Shaft
sτact = 55N/ mm2
$T = \pi/16 \times \tau act \times d^3$
$0.4774 = \pi/16 \times 55 \times d^3$
d=8.3736

ISSN No:-2456-2165

They classified into two types:

1. A transmission shaft used to transmit power between a power source and a driven machine. Like countershafts and vertical shafts.
2. A machine shaft is an integral part of the machine itself, such as the crakshaft.

- *Materials*

The material used for normal shafts is mild steel. Alloy steels such as nickel, nickel-chromium, and chromium-vanadium steels used when high strength is required.

Shafts are generally formed by hot rolling and finished size by cold drawing or turning and grinding.

Standard sizes

- *Machine shafts*
- Up to 25.00 mm steps of 0.50 mm
- *Transmission shafts*
- 25.00 mm to 60.00 mm with 5.00 mm steps
- 60 mm to 110 mm with 10 mm steps
- 110 mm to 140 mm with 15 mm steps
- 140 mm to 500 mm with 20 mm steps
- The standard lengths of the shafts are 5 m, 6 m and 7 m.

- *Stresses*

The next voltage induced in the wave is:

- Shear stress due to torque transfer (due to torsional loads).
- Bending stresses (tension or compression) due to forces acting on mechanical elements such as gears and belt pulleys, as well as the weight of the shaft itself.
- Stresses due to a combination of torsional and bending stresses.

- *Design stresses*

Major allowable design stress in bending (tension or compression) applied as follows:

- 112 N/mm2 for keyed shaft.
- 84 N/mm2 for non-keyed shafts.

The maximum allowable (design) shear stress applied as follows.

- 56 N/mm2 for keyed shafts.
- 42 N/mm2 for non-keyed shafts.

IV. IMPLEMENTATION OF SYSTEM

A. Cutter Tool

In the circumstance of constructing, a cutting tool is any tool used to remove material from a work piece by shear deformation, cutting with a single-point or multi-point tool. A single-edged tool is use to remove material with a single cutting edge in operations such as turning, forming, and planning. Milling and drilling tools are often multi-point tools. Grinding tools are also multi-point tools. Each grit acts as a fine single-point cutting edge (even with large negative rake angles) to cut off fine chips. The material cut is harder than the material cut and the tool must withstand the heat generated during the cutting process. In addition, the tool should have a specific geometry and clearance angle designed so that the cutting edge contacts the work piece without the rest of the tool grinding the surface of the work piece. I have. Rake angle is as important as flute width, number of flutes or teeth, and cutting size. Additionally, tool speed and feed is optimize for long tool life.

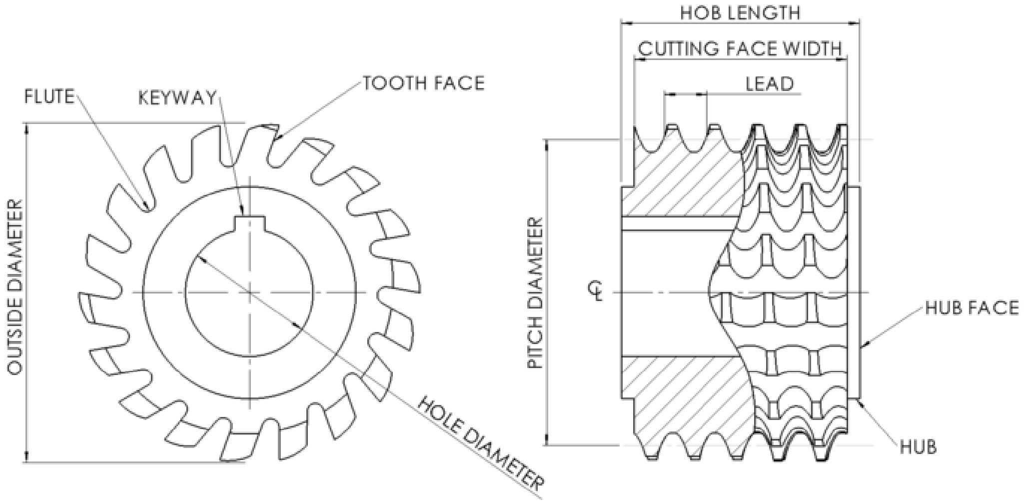

Fig 3:- Cutter Tool

Specification:
No of Teeth: - 100
Diameter:-101.6 mm
Pitch =8mm
Gauge thickness =22

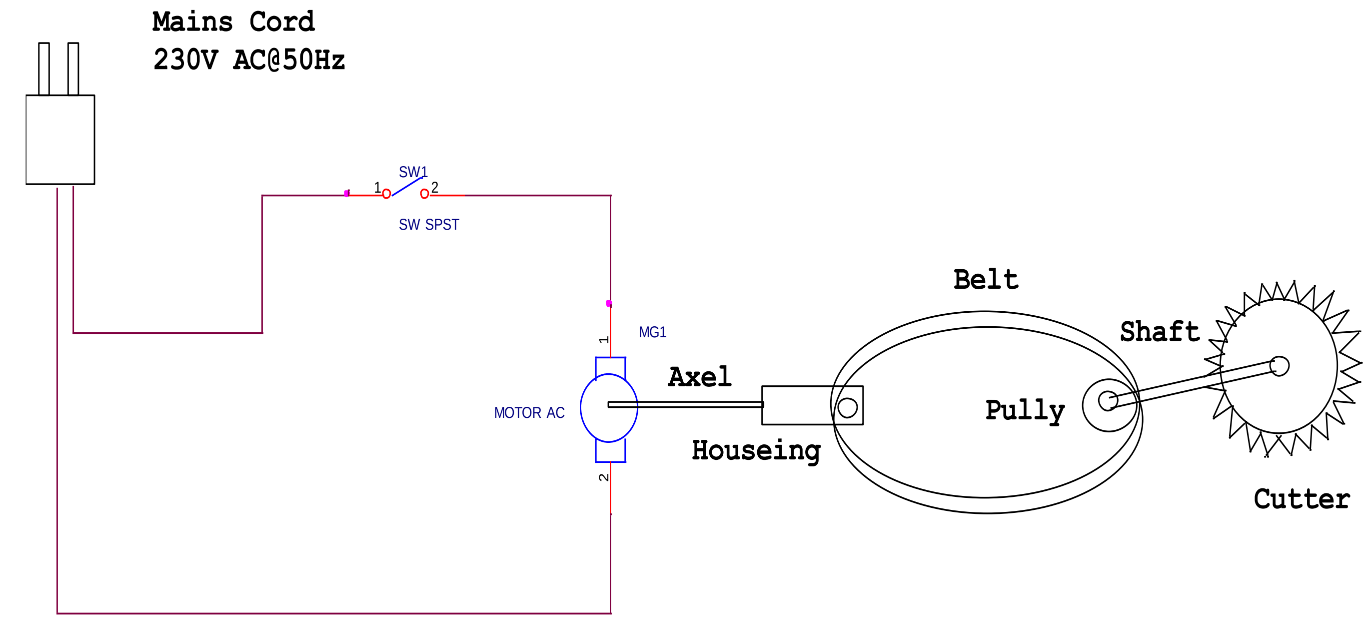

Fig 4:- Design of the system

B. Joints And Links:

The joints of industrial robots are similar to those of the human body. Provides relative motion between two body parts. Each joint gives the robot a so-called degree of freedom. They often classified by total number of degrees of freedom they possess, our project is to design six degrees of freedom. Two links attached to each joint, one of which is input link and the other is the output link. A limb considered a rigid component of a robot. The purpose of joints is to control the relative motion between input and output links. Almost all industrial robots have mechanical joints that divided into one of three types. The joints types are:-

- Linear joint: The relative motion between the input link and the output link is linear sliding motion. When the axes of the two links are parallel, which is call a type "L" joint.
- Orthogonal joints: a linear sliding motion, but the input and output links are perpendicular to each other during the motion. O type joint.
- Revolute Joint: This type provides relative rotational motion of the joint with the axis of rotation perpendicular to the axes of the input and output links. This is an "R" joint. Every joint types has a range of motion. A typical range for linear joints is from a few inches to a few feet. The movable range of the three types of joints with rotational motion is about 3600.

V. CONCLUSION

In our paper, we have designed the simplest and easiest model of printed circuit board (PCB) cutting machine and manufactured it in the most efficient manner and cost required for our project is lower than other printed circuit board cutting machines available in the market. During this PCB cutting machine, we will cut the PCB plate into two pieces according to required size with minimum time interval. The main advantage of clamping is that it significantly reduces the load and unload times compared to conventional manual clamping. The machine can work continuously therefore it increase the assembly rate. It reduces or eliminates the efforts of marking, measuring and setting of labor piece on a machine and maintains the accuracy of performance.

ACKNOWLEDGMENT

I am thankful to my parents and friends who helped me a lot in this research within limited time.

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