Design of Wedge Wood cutting Machine

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الإهداء

بسم الله الرحمن الرحيم

((قل إعملوا فسيرى الله عملكم ورسوله والمؤمنون))

صدق الله العظيم

الى من رعونا بنور قلوبهم وحمونا بحكمتهم وقدموا لنا حنانهم ومنحونا الحب والحنان، الى من فرشوا طريقنا بالورود ورافقونا في الصعود، إلى من فتحوا أمامنا أبواب التفوق والنهوض ، إلى بسمة الامل ونبع الحنان إلى من هم بلسم روحنا إلى ورود حياتنا

..اليكم والدينا..

إلى القلوب الطاهرة الرقيقة والنفوس البريئة إلى رياحين حياتنا

..إخوتنا..

الى شموع أحرقت نفسها لتضيء من هم حولها.. اليكم يا وردة فاح عبيها وطاب شذاها ..اليكم يا وردة زاد بريقها

..أساتذتنا الأفاضل..

ونخص بالذكر مشرفنا المهندس مكاوي حريز

الى الذين وقفوا بجانبنا في السراء والضراء

..أصدقائنا..

الى من يعصف قلوبنا.. الى من نحن فداه

..وطننا فلسطين..

الى من ضحى بحريتهم من اجل غيرهم

أسرانا البواسل

الى من هم اكرم منا جميعا

شهدائنا الأبطال

الى أمهات الشهداء والأسرى والجرحى

إلى كل من أحبنا واحببناه

Abstract:

Wedge wood its using to make a gap between the stones in the construction process, in the industrial and practical life, the technicians managed to find certain form for wedge wood to make build operation easy, these ideas came to the technicians to cut the wedge wood manually, the traditional way has many disadvantages in terms of, Effort and a long time in production, in addition making the human life in risk, the main goal of this project is to build a machine to cut the wedge wood in automatic way, the worker put the wood piece to the machine, and he start the machine from a safely distance , this project aimed to solving this problem by design and implementation of a wedge wood cutting machine, that producing the wedge wood in automatic way, The machine was desired to reduce the time and effort that need for production and to ensure the best shape of the product.

الملخص

إسفين الخشب يستخدام لإحداث فجوة بين الحجارة في عملية البناء، في الحياة الصناعية والعملية، تمكن الفنيين العثور على شكل معين لاسفين الخشب لجعل عملية البناء سهلة، وجاءت هذه الأفكار إلى الفنيين لقطع إسفين الخشب يدويا، والطريقة التقليدية لديها العديد من العيوب من حيث، جهد ووقت طويل في الإنتاج، بالإضافة إلى جعل الحياة البشرية في خطر، والهدف الرئيسي من هذا المشروع هو بناء آلة لقطع إسفين الخشب بطريقة اوتوماتيكية، يضع العامل قطعة الخشب إلى الجهاز، وتبدأ الالة العمل من مسافة بأمان، ويهدف هذا المشروع إلى حل هذه المشكلة من خلال تصميم وتنفيذ آلة قطع إسفين الخشب ، التي تنتج إسفين الخشب بطريقة اوتوماتيكية، الجهاز مطلوب للحد من الوقت والجهد التي تحتاجه إلى الإنتاج وضمان أفضل شكل للمنتج.

List of Contents

List of Figures

List of Tables

List of Appendix

1

Chapter One

Introduction

1.1 Introduction:

In our region Palestine and Jordan, spread stone and marble for building houses, institution and hospitals.

the stone used by The technicians to build the buildings, have specific measurements, usually it's have the same width, and variable length, there is a distance from 50mm to 100mm between the stone and the other, that's for some reasons:

1) To give a beautiful view , as shown in figure (1.1).

Figure (1.1):Stone Building.

2) If there is no distance between the stones, the rain well cause issues to the building, as shown in figure (1.2).

Figure (1.2): distance between the stones

3) In some cases, the distance between the stones not equals, as shown in figure (1.3).

Figure(1.3): Distance between the stones not equals.

To solve those issues, must found the distance between them, making this distance by putting some material like plastic, steel, or wood, steel high cost, the plastic has issues like slid the stones from each other and not workable, in the work field, the wood is the most solution workable cheap cost proves stone on each other.

Even the wood it can’t use all types for some reasons which faced shear technicians and builder.

In the industrial and practical life, the technicians managed to find certain form for wedge wood to make build operation easy, these ideas came to the technicians to shear the wedge manually. Thus came to us design a machine to shear the wedges automatically.

1.2 Problem statement:

This study will focus on studying the following problems and investigating the appropriate solutions:

1) The technicians can’t shear all the wedges in same size , as shown in figure (1.4).

Figure (1.4) : wedges wood .

2) The traditional technique of shearing the wedge make the humans life in risk, as shown in figure (1.5).

Figure (1.5) :human risk.

1.3 Goals and Objectives:

The main objective to this study make a design to shear the wedge wood and other reasons:

1- Protect human life when using the traditional technique to produce wedge.

2- Minimize or reduce the amount of damaged wood, and use them in wedges wood industry.

3- Achieve standard sizes of the wedges.

1.4 project scope

Project aims are to give a suggested design of Wedge Wood cutting Machine . Each machine contains many processes from input to output as illustrated in block diagrams in figure (1.6).

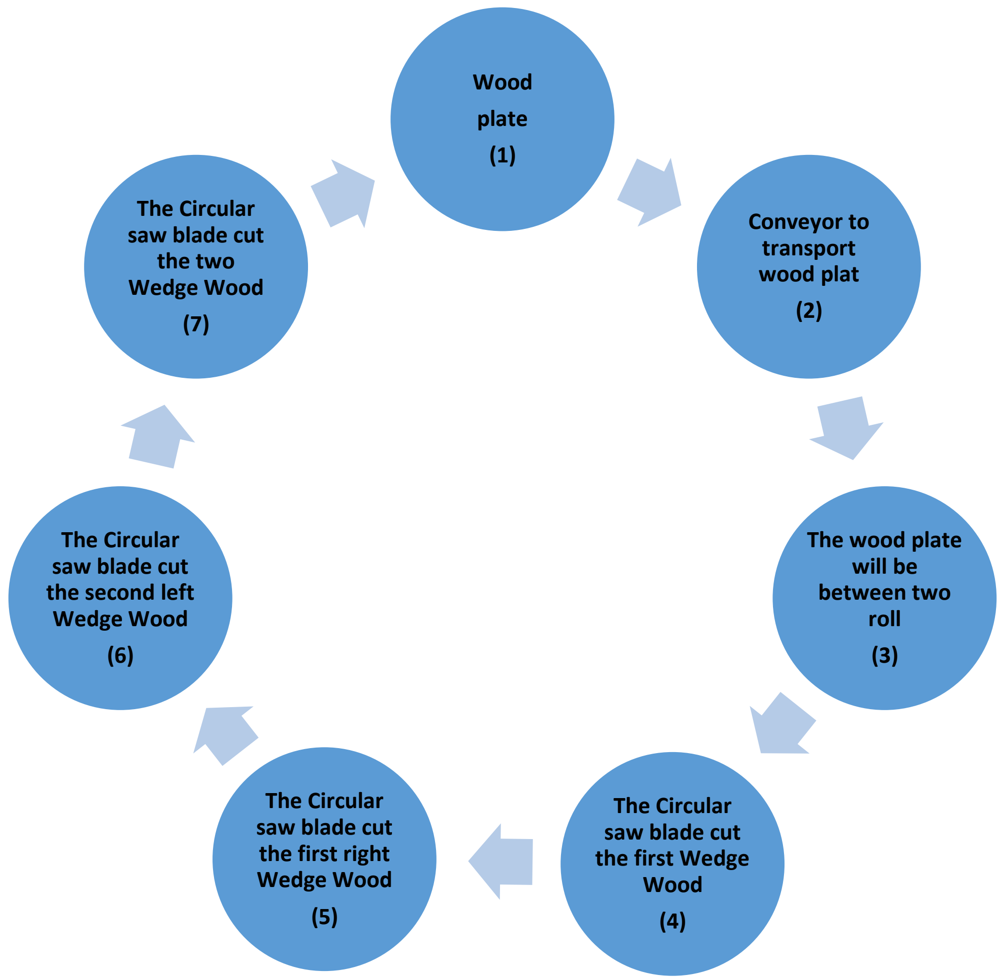


Figure (1.6): Block diagram of cutting wedge wood.

The process starts with enter wood plate to the conveyor. Second the wood plate enter between two roll .Third the motor circular saw works and the circular saw cutting the first right wedge wood. Fourthly the circular saw cutting left wedge wood. And finally the circular saw cut mid two wedge wood.

1.5 Flowchart of project .

The flowchart will explain the operation of the machine, as shown in figure (1.7).

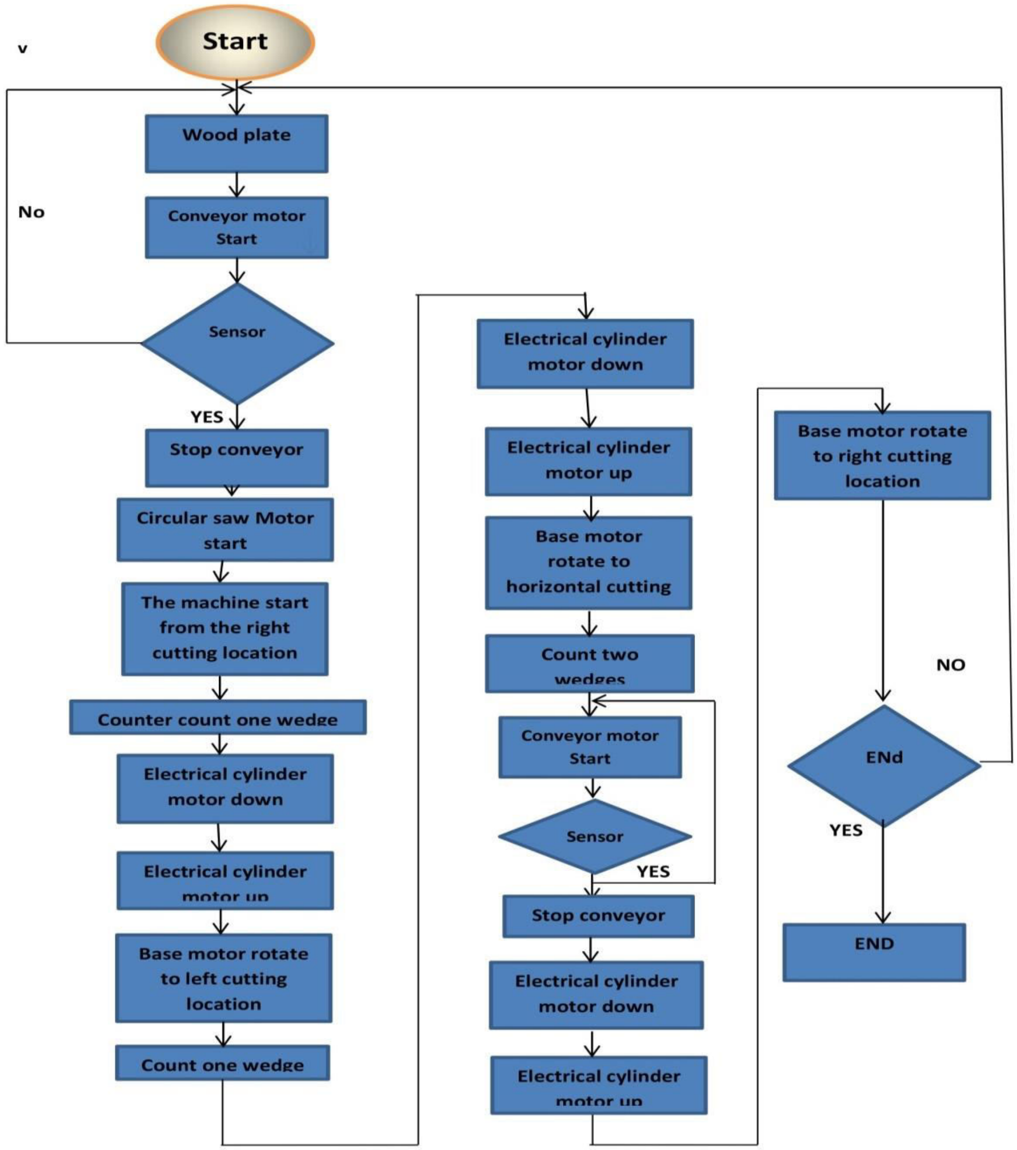


Figure (1.7): Flowchart of project.

1.6 Time Schedule for the Project .

As shown in Table 1.1 and Table 1.2 the time schedules for the project in steps. The time needed for the project is Thirty weeks., Table 1.1 and Table 1.2 lists the tasks of the project respectively, and the needed tasks for each in gray.

Table (1.1): Time schedule for introduction of the project

First semester															
No. of week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Identification of project idea	■	■	■												
Sites visit			■	■											
Introduction about the project operation				■	■	■	■								
Mechanical design								■	■	■	■				
Electrical design											■	■	■	■	■

Table (1.2): Time schedule for the project

Second semester															
No. of week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Determine Mistakes	■	■													
Generate Solutions			■	■											
Generate Alternative Designs				■	■	■	■	■	■	■	■	■	■		
Writing and Documentation							■	■	■	■	■	■	■	■	■
Results and Conclusion											■	■	■	■	■

1.6 Total Cost for the Project

The Table below shows the budget of the project and its distribution. The budget of the project is estimated to be around 4185 NIS, In Table 1.3 is listed the needed components for the project, the price of each component's single unit, the number of units needed of each component, and the total price for each component.

Table (1.3): The budget

	Component name	Quantity	Price (NIS)	Total price (NIS)
1	PLC	1	600	600
2	Ac motor	1	300	300
3	24v DC motor	1	100	100
4	24v DC cylinder	1	100	100
5	12v DC motor	1	100	100
6	Micro switch	2	50	100
7	rolls	2	250	500
8	Steel for Body	-	300	300
9	Emergency Switch	1	25	25
10	Limit switch	3	10	30
11	HMI	1	600	600
12	Over load	1	70	70
13	Relays	7	50	350
14	Photo sensor	2	50	100
15	Bearing	9	40	360
16	Circular saw blade	1	50	50
17	Gears	2	100	200
18	Electrical cabinet	1	200	200
19	Parts	-	100	100
			Total price	**4185 (NIS)**

2

Chapter Two

Production of wedge Wood

2.1 Introduction.

2.2 Types of wood.

2.3 Traditional method of cutting wedges.

2.4 Automated method of cutting wedges.

2.1 introduction.

There have been many developed methods for wedge wood production, some of them are considered traditional, while others are automated. Before we introduce our machine, we will talk about the disadvantages of common methods of wedge wood production.

2.2 Types of wood

There is two main type of wood:

1) Hardwood: this type of wood not compatible with this operation, because it's expensive and hard to cut.
2) Softwood: this type good for this operation, easy to cut and almost cheaper than hardwood.

Softwood have many type and not all of them can work, the types that work:

1) Spruce wood
2) White wood

Figure (2.1): white wood

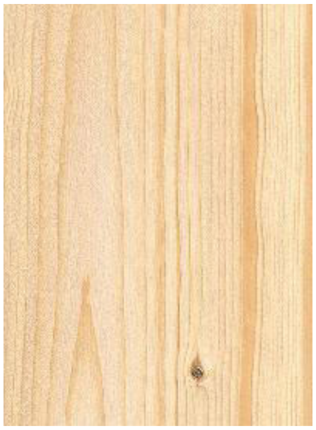


Figure (2.2): spruce wood

2.3 Traditional method of cutting wedges

The worker holds the wood piece and put it with wedge wood jig figure (2.4), and pass it through the circular saw blade, as shown in figure (2.3), then he flips the stock so that the front faces back and the top faces down, then he repeats this process, “cut, cut, flip… cut, cut, flip…”, If just “cut, cut, cut”, it will end up with a chunk.

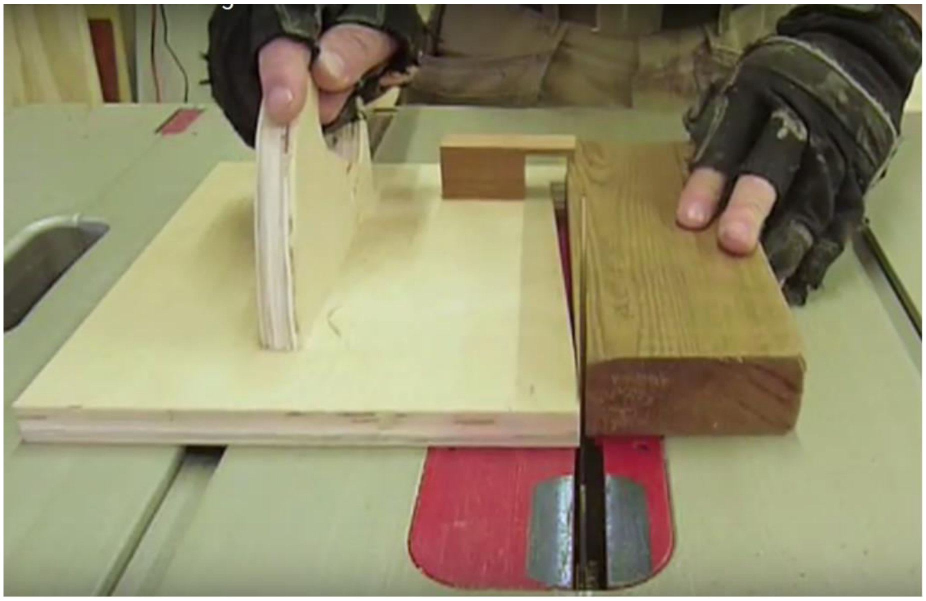


Figure (2.3): Traditional cutting of wedge wood.

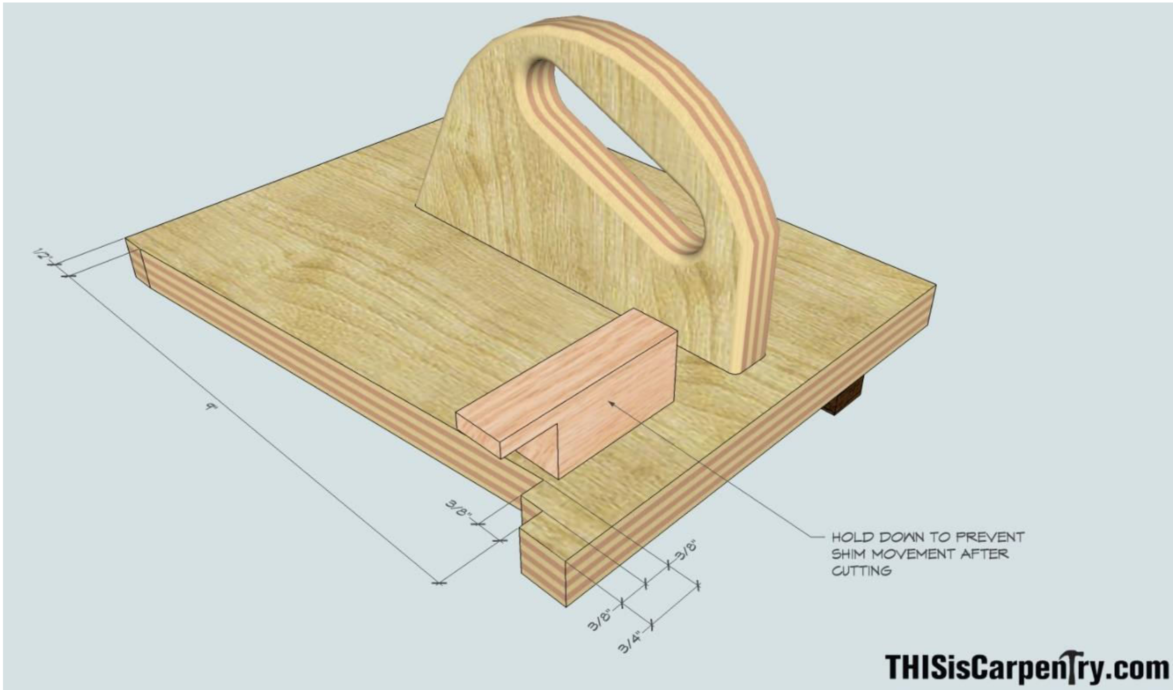


Figure (2.4): Wedge wood jig

Disadvantages of traditional method:

- Make human life in danger like it may be cut the finger of worker or grain of wood get into his eye.
- Its take much time of producing.

2.4 Automated method of cutting wedges.

In our project we will show the new technology of producing the wedge wood using a full automated machine programmed with a PLC, which will allow the user to control the operation of the machine by a pushbutton installed on the HMI, this method of production will ensure to save the time and the workers life, the proposed machine, is shown in the figure (2.5).

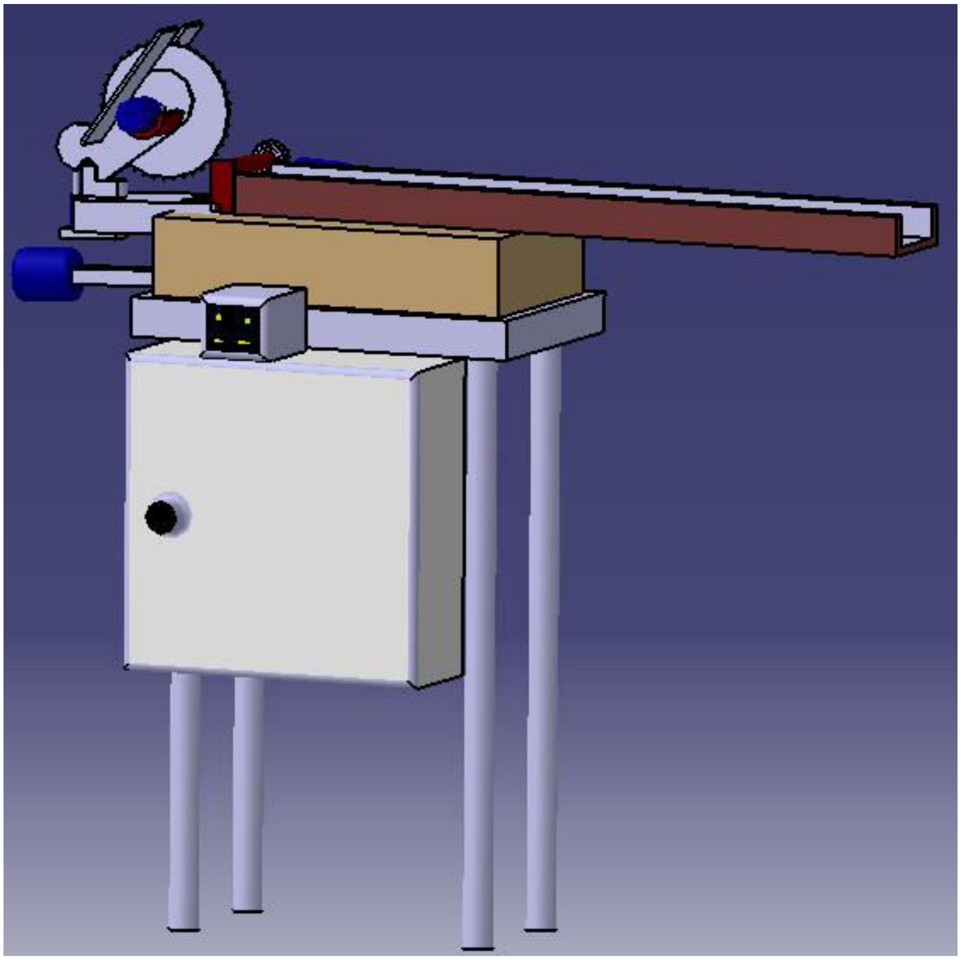


Figure (2.5): Proposed design of the machine

In order to take an image in our minds about how the machine works and the manufacturing stages passes through it to get the final product, we divided the stages of production into four stages.

1. Loading stage.
2. Right cutting stage.
3. Left cutting stage.
4. Horizontal cutting stage.

These four stages are integrated with each other in order to get the final product, in the coming sections each stage will be explained in full details.

2.4.1 Loading Stage:

The worker put the wood plate into the conveyor guide manually, then the conveyor transport the wood plate inside, as shown in figure (2.6).

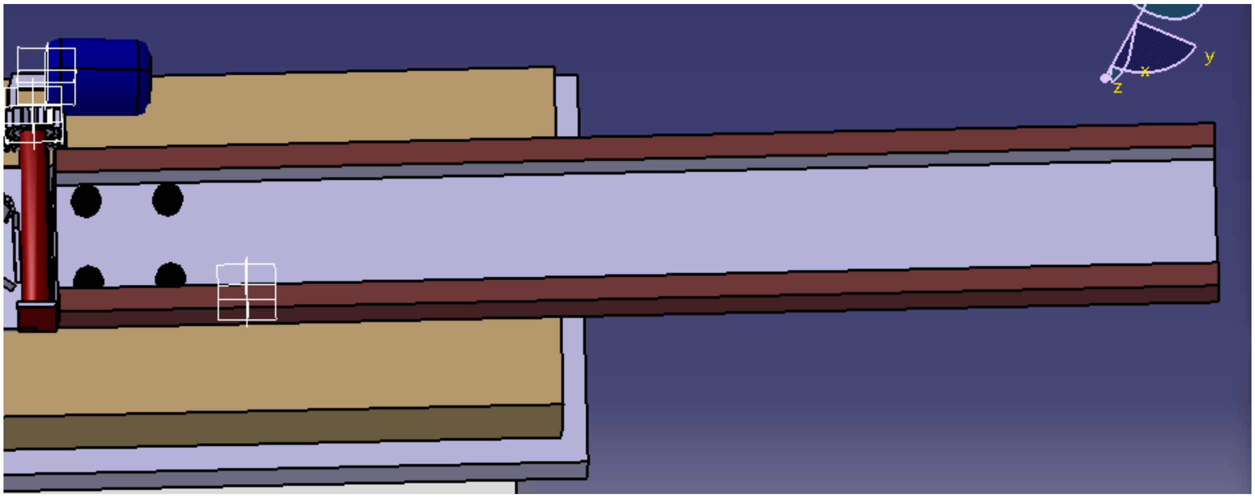


Figure (2.6): conveyor guide

2.4.2 Right cutting stage:

After the conveyor transport the wood plate the base motor rotate the circular saw motor to the right cutting location, then the electrical cylinder make the circular saw up and down, in order to know that the machine start cutting from the right cutting stage, as shown in figure (2.7).

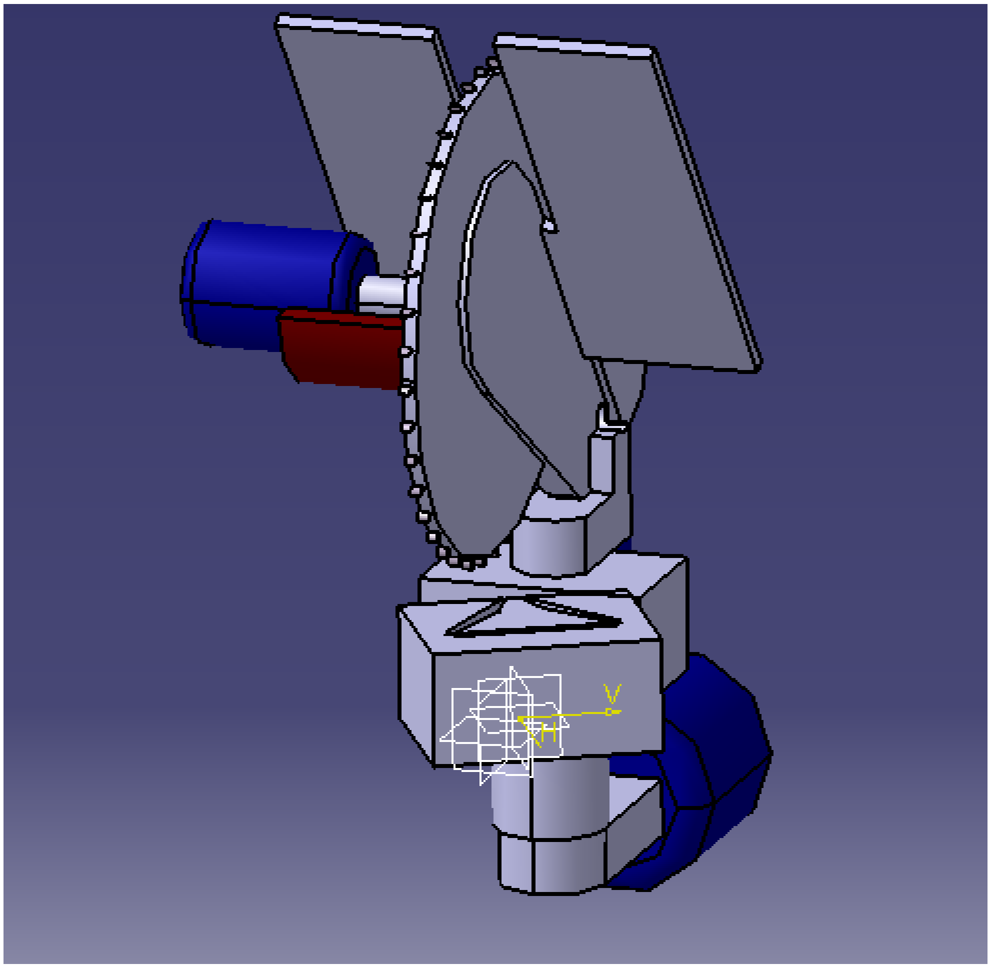


Figure (2.7): right cutting stage.

After the right cutting stage, the wood plate will show in figure (2.8).

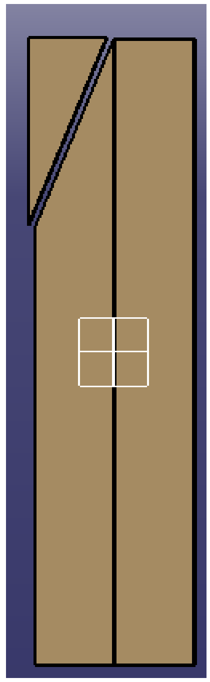


Figure (2.8): right cutting stage wedge

2.4.3 Left cutting stage:

The base motor rotates the circular saw motor to the left cutting location, as shown in figure (2.9), then the electrical cylinder make the circular saw up and down.

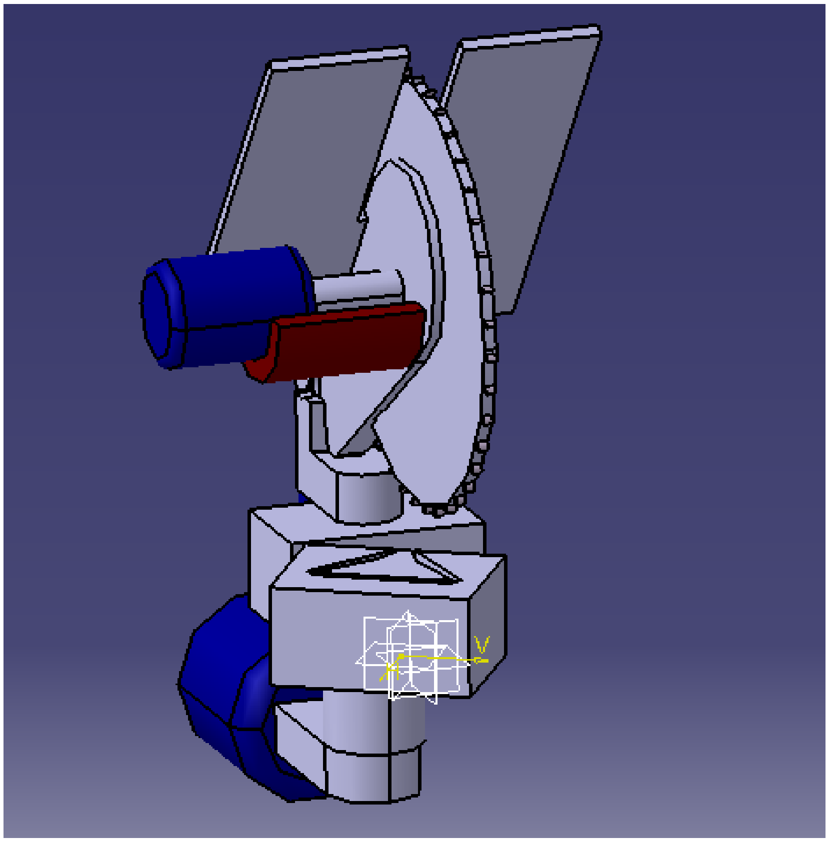


Figure (2.9): left cutting stage.

After the left cutting stage, the wood plate will show in figure (2.10).

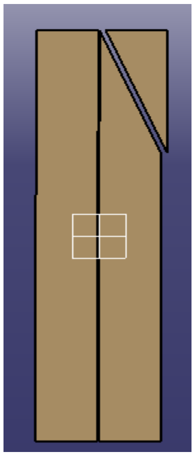


Figure (2.10): left cutting stage wedge

2.4.4 Horizontal cutting stage:

The base motor rotates the circular saw motor to the horizontal cutting location, as shown in figure (2.11), then the electrical cylinder make the circular saw up and down.

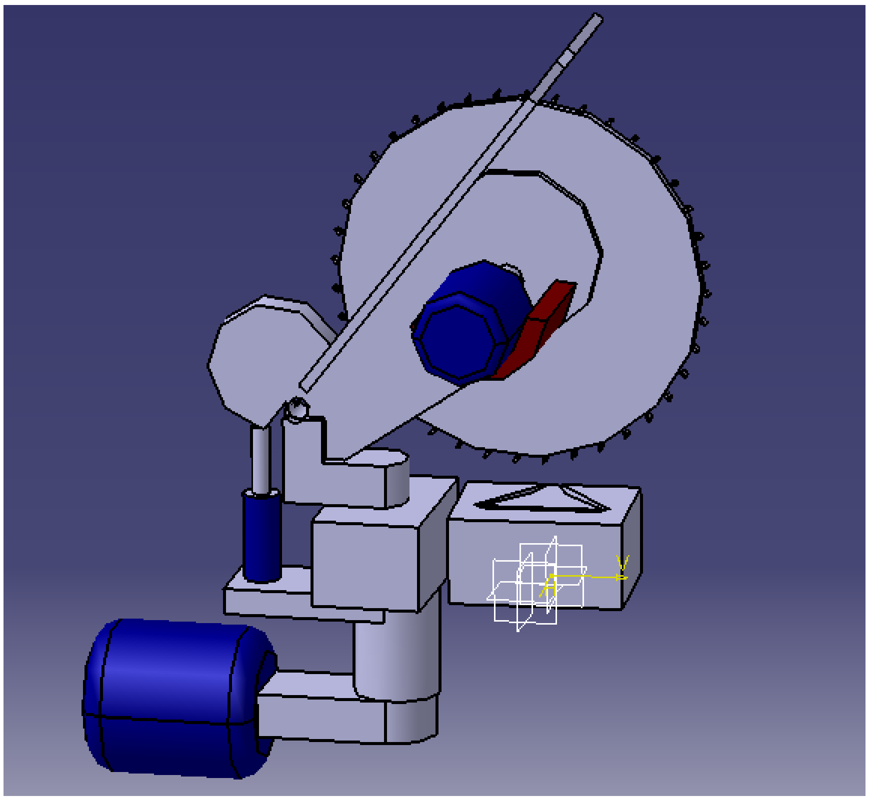


Figure (2.11): horizontal cutting stage.

After the left cutting stage, the wood plate will show in figure (2.12).

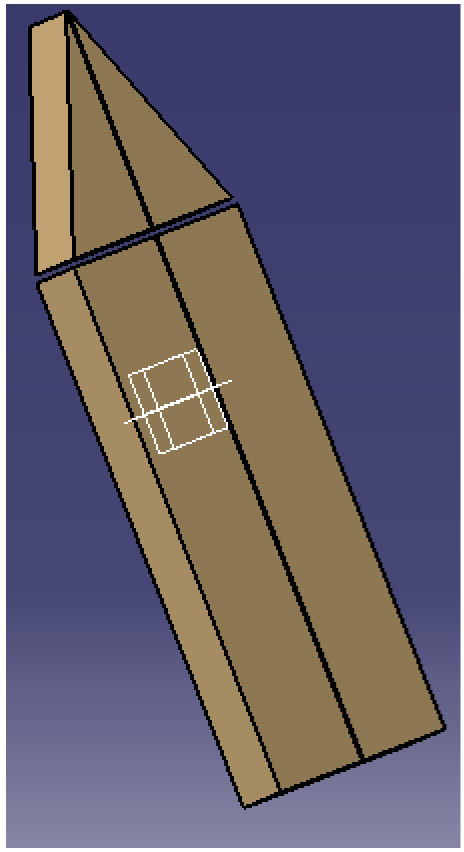


Figure (2.12): horizontal cutting stage wedges

3

Chapter Three

Mechanical Selection

3.1 Introduction

3.2 Mechanical Selection

3.1 Introduction.

It is desired to design and produce Wedge Wood cutting Machine fully automated and controlled. The process starts when the user puts the wood in the Conveyor guide and press the start button, The wood is prepared and loaded to the conveyor manually, but the process of pulling the wood automatically and the wood stops after reach the sensor and then begins the first cut-off operation that cuts the first wedge and after the first cut-off operation spins the engine to start with the process of the second cut and that cut the second wedge and then the traffic rotates at the angle of 180, which cut the third and fourth wedge together, thus bringing the number of wedges produced in each cut is equal to four wedges.

The machines divided into four subsystems:-

1. loading wood.

2. Right cutting stage

3. Left cutting stage

4. Horizontal cutting stage.

3.2 Mechanical Selection.

In this section each block will be explained in detail noting that, the used material for most parts in this machine is high strength steel.

3.2.1 Selection of Conveyor.

3.2.1.1 Selection Bearing of Conveyor.

In the design of conveyor bearing we consider that there is no thrust loading, and the loading is only radial.

Step 1: Compute F_x and F_y by applying static equilibrium equations to the shaft supported by the bearing.

$Sf= Si +Vt+ \frac{1}{2} a t^2$ (3.1)

s_f: The distance from the middle to the end of the conveyor.

s_i: The ini1tial distance, and equal zero.

v_i: Initial velocity of the belt.

a: Acceleration of the belt.

We want the wood plate to move from the start to the end of conveyor in 0.5 seconds (t=0.5 sec).

$0.08 = \frac{1}{2} a\, 0.5^2$

$a = 0.64\ m^2/s$

$F_x = \mu * N + m * a$ (3.2)

$N = \rho_w * v_t * g$ (3.3)

μ: The coefficient of friction between the belt and the roller, and equals 0.05.

N: The normal force affected on trunks.

ρ_w: The maximum density of stove wood, which is considered to be 440 Kg/m^3.

v_t: The maximum volume of the trunk, which equals the base area multiplied by the length.

a: Acceleration of the belt.

N = 440*0.05 *0.025 * 1* 9.81 = 5.39 N.

$F_x = 0.05 * 5.39 + 3 * 0.64 =$

$F_x = 0.26 + 1.9 = 2.18$ N

$F_y = m * g$ (3.4)

m: Maximum total mass of wood piece loaded on conveyor.

g: the acceleration of gravity, and equals 9.8 m/s^2.

$F_y = 3 * 9.81 = 29.43$ N

Figure 3.1 demonstrates the free body diagram of the ball bearing, where the forces are perpendicular to the axis of the bearing.

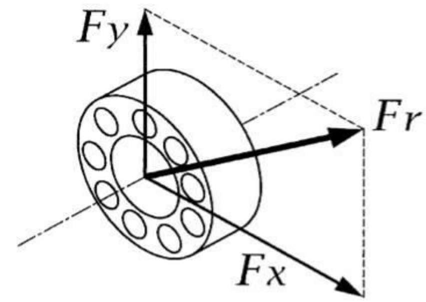


Figure (3.1): Free body diagram of ball bearing

Step 2: Now we find the resultant radial load (F_r):

$$F_r = \sqrt{{F_x}^2 + {F_y}^2} \quad (3.5)$$

$$= \sqrt{(2.18)^2 + (29.43)^2}$$

$F_r = 29.44$ N

Where:

Fr: force resultant.

Specifying FD.

The design load can be defined by:

$$F_D = a_f * V * F_r \quad (3.6)$$

F_D: Design radial load.

V: Rotation factor, and equals *1* (rotating inner ring).

F_r: Radial load on the bearing.

a_f: Application factor used because loads are often variable (non-steady) and may increase during operation, and equals 1.2(machinery with no impact).

$F_D = 1.2 * 1 * 9.8 = 35.28$ N

Step 3: Assuming the desired life (L_D) and Reliability (R_D), we find X_D.

$$X_D = \frac{L_{Dh}}{L_{10}} \quad (3.7)$$

$$L_{DH} = L_D * N * 60 \quad (3.8)$$

$$\ddot{\theta} = \frac{a}{r} \quad (3.9)$$

Where :

$\ddot{\theta}$: angular acceleration of the pully

r: radious of the pully

X_D :Life ratio.

L_{DH}: Design Life, , and equals 30000 (general industrial machinery).

L_{10}: Number of revolutions. and equals $1 * 10^6$(based on 90% reliability).

L_D: Desired life (revolutions).

N: speed motor

X rev = $\frac{0.08}{0.05}$ =1.6 rev/m

Y rev = $\frac{0.05}{0.01}$ =5 rev/m

Xrev * Yrev = 8 turn of motor per piece

$\ddot{\theta} = \frac{0.64}{.06}$ =10.6 m/s

N= $8 \frac{rev}{m} * \frac{0.08}{0.25} * \frac{60\ sec}{1\ min}$ = 153.6 rpm

$L_{Dh} = 30000 * 153.6 * 60 = 276.48 * 10^6$

$X_D = \frac{276.48*10^6}{1 * 10^6} = 276.48$ h

Step 4: Calculate the required catalog rating (C_{10}).

$$C_{10} = X_D^{1/a} * F_D \quad (3.10)$$

$C_{10} = 276.48^{1/3} * 35.28 = 586.6$ N

Figure 3.2 displays a single-row, deep groove ball bearing, with the balls and the groove appearing.

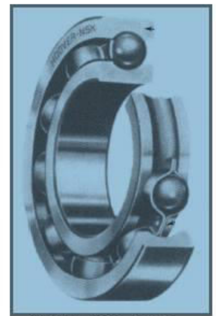


Figure (3.2): bearing

Step 5: Check the catalog and select a suitable bearing.

From Table 3.2.

C10=586.62 N, Bore=10mm, OD=30mm.

Step 6: Finally, we find the diameter the Bearing bore, using the law of factor of safety and the law shear stress.

$$n = \frac{S_y}{\tau} \qquad (3.11)$$

τ: Shear stress.

S_y: The yield strength and from Table A-20: S_y for high carbon hot rolled steel is 220 Mpa.

n: Factor of safety and we have chosen it to be 4. .

$$\tau = \frac{220*10^6}{4} = 55*10^6 \text{ Mpa}$$

$$\tau = \frac{F_r}{A} \qquad (3.12)$$

A: Area of bearing bore.

$$\tau = \frac{9.8\text{ N}}{\frac{\pi}{4}d^2} \qquad d^2 = \frac{4*F}{\pi*\tau} \rightarrow d = \sqrt{\frac{4*9.8}{\pi*55*10^6}}$$

d= $2.26*10^{-3}$ m

d=*2.26* mm.

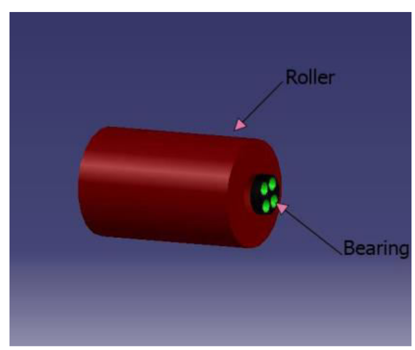


Figure (3.3): An image showing the roller and the bearing, where both are installed inside the belt.

Figure 3.3 shows the roller and the bearing. Both of them belt. in the conveyor belt.

3.2.1.2 Calculating the Torque of the Conveyor Gear

The free body diagram of the conveyor pulley is depicted in Figure (3.4).

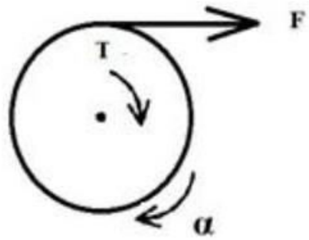


Figure (3.4): The free body diagram of the conveyor pulley

$\sum M = J\,\ddot{\theta}$ (3.13)

$T = J\ddot{\theta} + \ (\mu * N + m * a)\ r$

$m = 3\ kg$

$N = m * g = 29.4\ N$

$\mu * N = 0.05 * 29.4\ N = 1.47\ N$

$m_{pulley} = \rho * v$ (3.14)

$A = \pi(d_{out} - d_{in})^2$ (3.15)

$A = \pi\ (0.06 - 0.03)^2 = 0.0028\ m^2$

$V = A * L$ (3.16)

$V = 0.0028\ m^2 * 0.02\ m = 5.6\ * 10^{-5} m^3$

$m_{pulley} = 7850\ kg/m^3 * 5.6\ * 10^{-5}\ m^3 = 0.441\ kg$

$J = \frac{1}{2}\ m_{pulley}\ R^2$ (3.17)

$$J = \frac{1}{2}(0.44)(0.1)^2 = 0.0022\ kg.m^2$$

m_{pulley}: The mass of the pulley.

m: The maximum total mass of two trunks.

ρ: Density of high carbon steel and equals 7850 kg/m^3.

v: Volume of the pulley.

d_{out}: The outer diameter of the pulley.

d_{in}: The inner diameter of the pulley.

From equation 3.18:

T = $((0.0022 * 10.6) + (29.44) * (0.1)$

=2.92 N.M

3.2.1.3 Finding the Torque and the Power of Conveyor Gear

In this sub section we want to find the torque and the power of the conveyor motor, knowing the speed of the gear (n_{gear}) found from the previous calculations.

$w_{gear} = \frac{2\pi * n_{gear}}{60}$ (3.18)

w: Angular Velocity.

n: Desired speed.

$$w_{gear} = \frac{2\pi\ * 153.6}{60} = 16.06\ rad/sec$$

$$w_{motor} = \frac{w_{gear}}{1/10} \quad (3.19)$$

$$w_{motor} = 160.6 \text{ rad/sec}$$

$$n_{motor} = \frac{160.6 * 60}{2\pi}$$

$$= 1534 \text{ rpm} \approx 1500 \text{ rpm}$$

$$T_{motor} = \frac{T_{gear}}{10} \quad (3.20)$$

$$T_{motor} = = \frac{2.92 \text{ N.m}}{10} = 0.29 \text{ N.m}$$

$$P = T_{motor} * \omega \quad (3.21)$$

$$= .29 \text{ N.m} * 160.6 \text{ rad/sec}$$

$$P = 46.5 \text{ watt}$$

3.2.2 Circular saw blade.

Many saw blades are designed to provide their best results in a particular cutting operation. You can get specialized blades for ripping lumber, crosscutting lumber, cutting veneered plywood and panels, cutting laminates and plastics, cutting melamine and cutting non-ferrous metals. There also are general purpose and combination blades, which are designed to work well in two or more types of cuts. (Combination blades are designed to crosscut and rip. General-purpose blades are designed to make all types of cuts, including in plywood, laminated wood and melamine.

3.2.2.1 Number of Teeth:

In general, blades with more teeth yield a smoother cut, as shown in figure (3.5), and blades with fewer teeth remove material faster. A 10" blade designed for ripping lumber

A crosscut blade, is designed to produce a smooth cut across the grain of the wood, without splintering or tearing. This type of blade will usually have 60 to 80 teeth, and the higher tooth count means that each tooth has to remove less material. A crosscut blade makes many more individual cuts as it moves through the stock than a ripping blade and, as a result, requires a slower feed rate. The result is a cleaner cut on edges and a smoother cut surface. With a top-quality crosscut blade, the cut surface will appear polished.

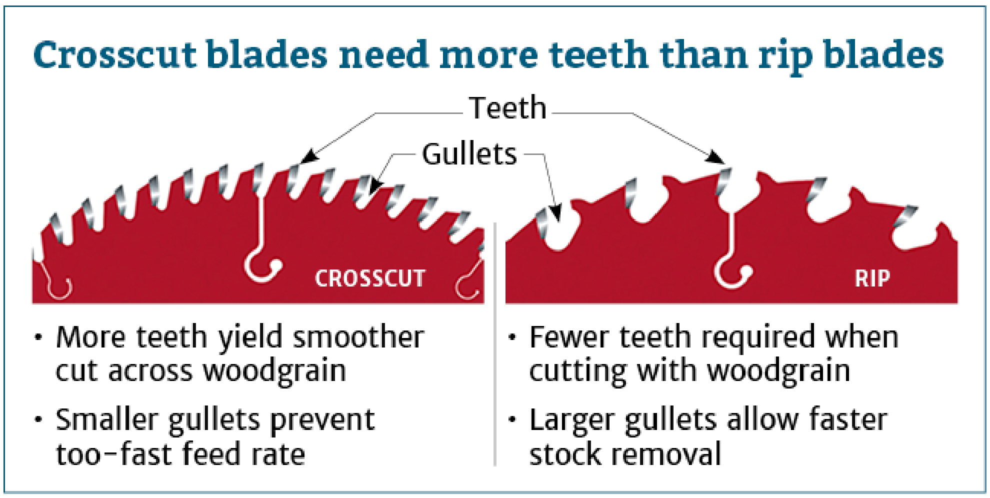


Figure (3.5): Teeth description.

3.2.2.2 Gullet.

The gullet is the space in front of each tooth to allow for chip removal. In a ripping operation, the feed rate is faster and the chip size is bigger, so the gullet needs to be deep enough for the large amount of material it has to handle. In a crosscutting blade, the chips are smaller and fewer per tooth, so the gullet is much smaller. The gullets on some crosscutting blades also are purposely sized small to inhibit a too-fast feed rate, which can be a problem especially on radial-arm and sliding miter saws. The gullets of a combination blade are designed to handle both ripping and crosscutting. The large gullets between the groups of teeth help clear out the larger amounts of material generated in ripping. The smaller gullets between the grouped teeth inhibit a too-fast feed rate in crosscutting.

3.2.2.3 Tooth Configuration.

The shape of the saw blade tooth and the way the teeth are grouped also affect the way the blade cuts. The configuration of the teeth on a saw blade has a lot to do with whether the blade will work best for ripping, crosscutting or laminates.

Flat-Top (FT): Flat-top teeth are used on blades for ripping hard and soft woods. Because wood is much less likely to chip and splinter when it is being cut with the grain, a rip blade is designed to quickly and efficiently remove material. The flat-top tooth is the most efficient design for cutting and raking material out of the cut, as shown in figure (3.6.1).

Alternate Top Bevel (ATB): This means that the blade teeth alternate between a right- and left-hand bevel. This configuration yields a smoother cut when crosscutting natural woods and veneered plywood. The alternating beveled teeth form a knife-like edge on either side of the blade and make a cleaner cut than flat-top teeth, as shown in figure (3.6.2).

Combination Tooth (Comb.): Combination blades are designed to do both crosscutting and ripping. The teeth are arranged in groups of five – four ATB teeth and one FT – with a large gullet between the groups, as shown in figure (3.6.3).

Triple Chip Grind (TCG): The TCG configuration excels at cutting hard materials such as laminates, MDF and plastics. Teeth alternate between a flat "raking" tooth and a higher "trapeze" tooth. The TCG configuration is also used for non-ferrous metal cutting blades, as shown in figure (3.6.4).

High Alternate Top Bevel (Hi-ATB): The Hi-ATB configuration is used for extra-fine crosscutting and to cut materials surfaced with melamine, which is prone to chipping. The high bevel angle increases the knife-like action at the edge of the blade, as shown in figure (3.6.5).

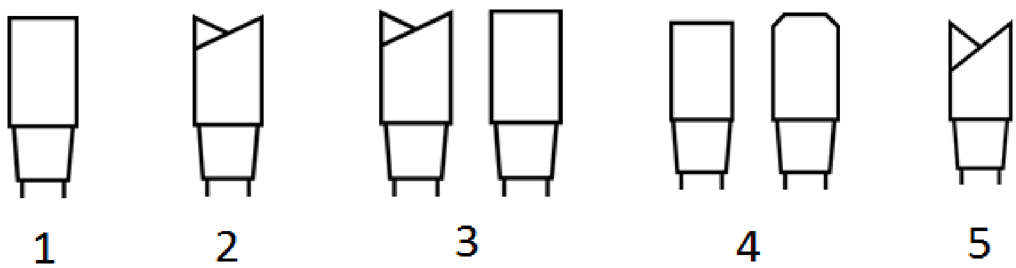


Figure (3.6): Tooth Configuration

3.2.2.4 Hook Angle.

On most saw blades, the faces of the teeth are tipped forward or backward, rather than being perfectly in line with the center of the blade. This is called "hook angle." On a blade with a positive hook angle, the teeth are tipped forward, toward the direction of the blade's rotation. A negative hook angle means that teeth tip away from the direction of rotation, and a 0° hook angle means that the teeth are in line with the center of the blade.

Hook angle has an important effect on blade operation. A blade with high positive hook angle (say, 20°) will yield a very aggressive cut and a fast feed rate. A low or negative hook angle will slow the feed rate and will also inhibit the blade's tendency to "climb" the material being cut. A blade for ripping lumber on a table saw will generally have a high hook angle, where an aggressive, fast cut is usually what you want. Radial-arm saws and sliding compound miter saws, on the other hand, require a blade with a very low or negative hook angle to inhibit overly fast feed rate, binding and the blade's tendency to "climb" the material, as shown in figure (3.7).

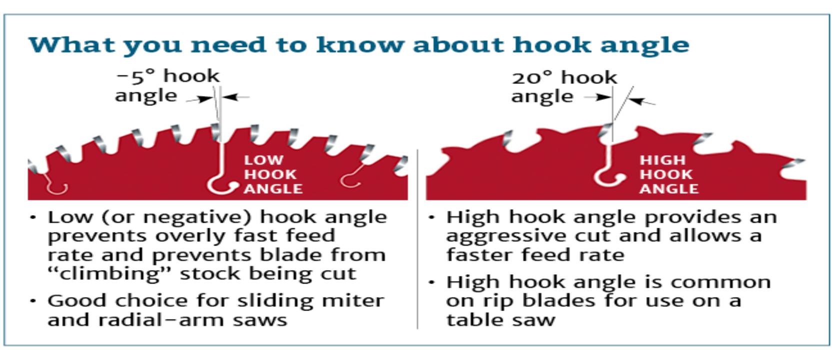


Figure (3.7): Hook angle

3.2.2.5 Kerf Width.

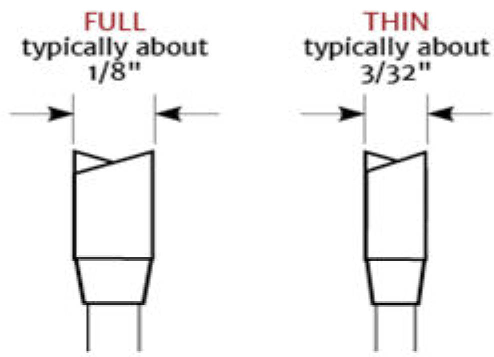


Figure (3.8): Kerf width

The width of the "kerf" – the slot the blade cuts in the material – is another important consideration. Many blade types are available in both full-kerf and thin-kerf varieties. Full-kerf blades typically cut a 1/8" slot and are intended for use on saws powered by 3 hp (or greater) motors.

Thin-kerf saw blades – blades with a kerf thickness of less than 1/8" – were developed for use on portable and contractor model table saws with motors of less than 3 hp. Because a thin-kerf blade has to remove less material than a full-kerf blade, it requires less power to operate and allows lower-powered saws to cut material at an appropriate feed rate without the risk of bogging down during the cut. (Bogging down causes excessive friction; as a result, the blade heats up and can become distorted or burn the cut surface.)

A potential trade-off for the thinner kerf is the fact that the blade plate is thinner and therefore might be expected to vibrate more than a thicker, more rigid plate. However, technological advances in blade design have generated thin-kerf blades that rival the best industrial-quality full-kerf saw blades. Vibration-dampening systems, like the one used with Freud thin-kerf blades, compensate for the slight loss of stability and make thin-kerf blades the optimum choice for lower-powered saws.

As described above, the type of wood should have these specifications:

- Number of teeth: (80) blades with more teeth yield a smoother cut.
- Gullet: the chips are smaller and fewer per tooth.
- Tooth configuration: Alternate Top Bevel (ATB).
- Hook angle: low hook angle (-5°).
- Kerf width: full kerf (1/8") for three phase.

Saw designer program designed circular saw blade.

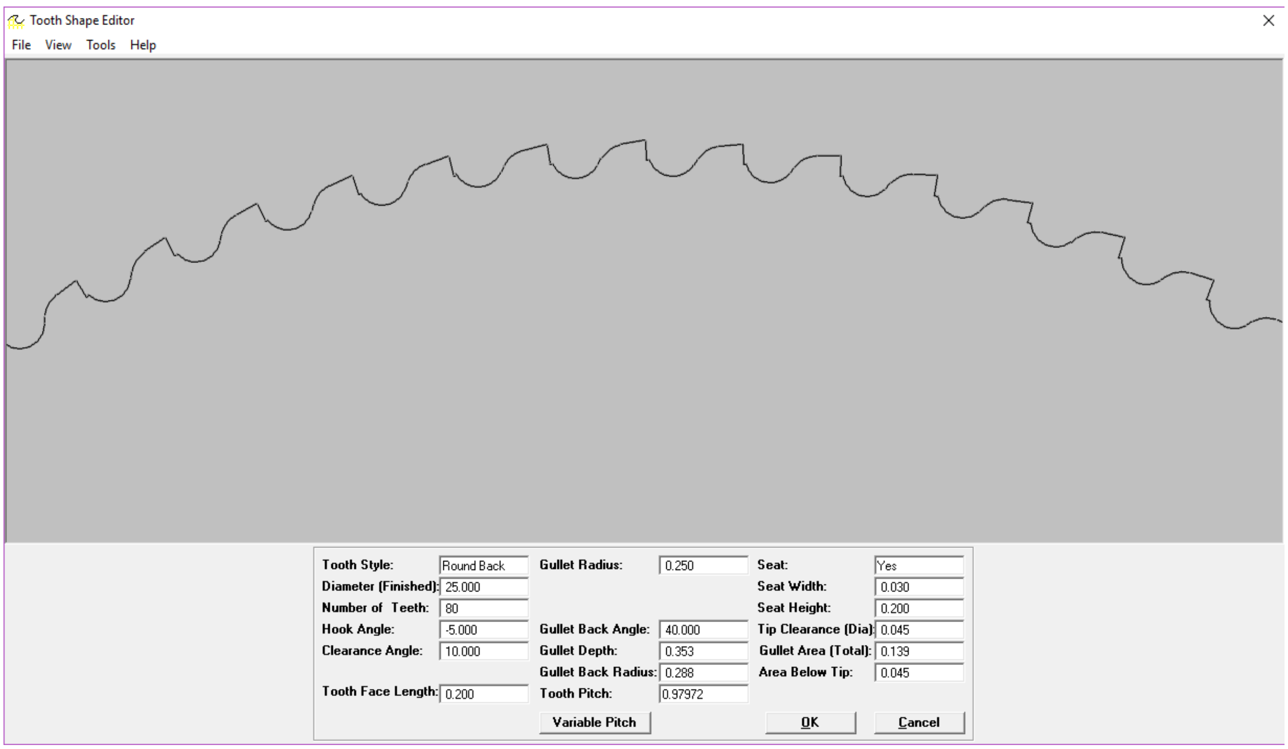


Figure (3.9.1): Tooth shape

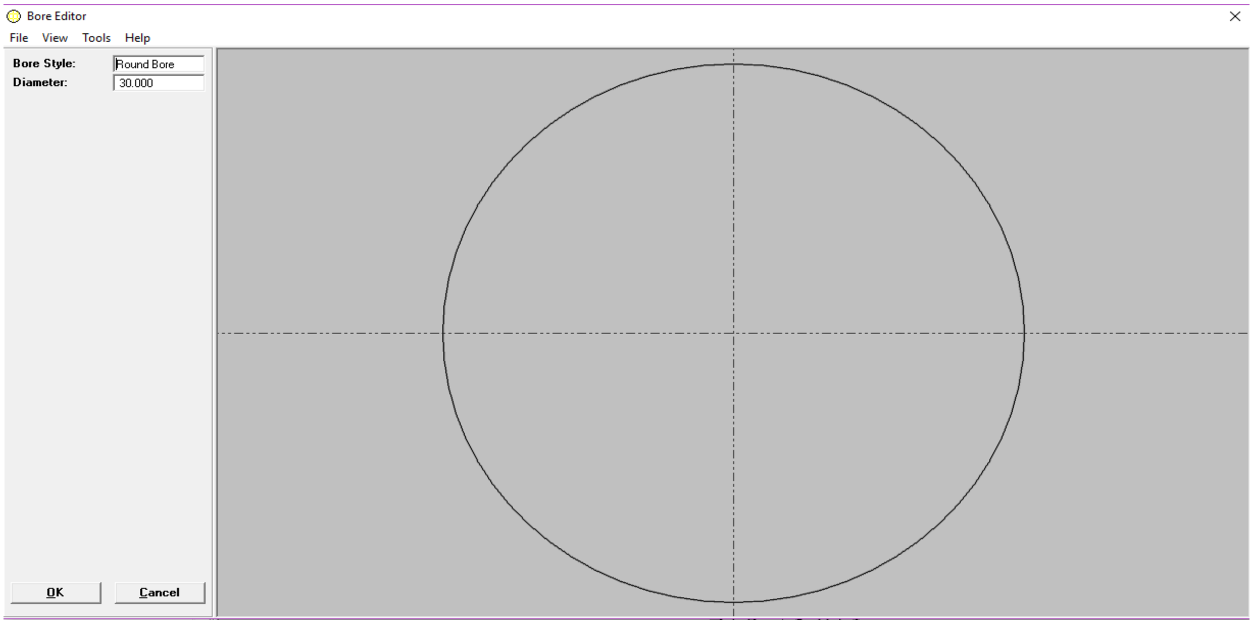


Figure (3.9.2): Bore (the center of blade)

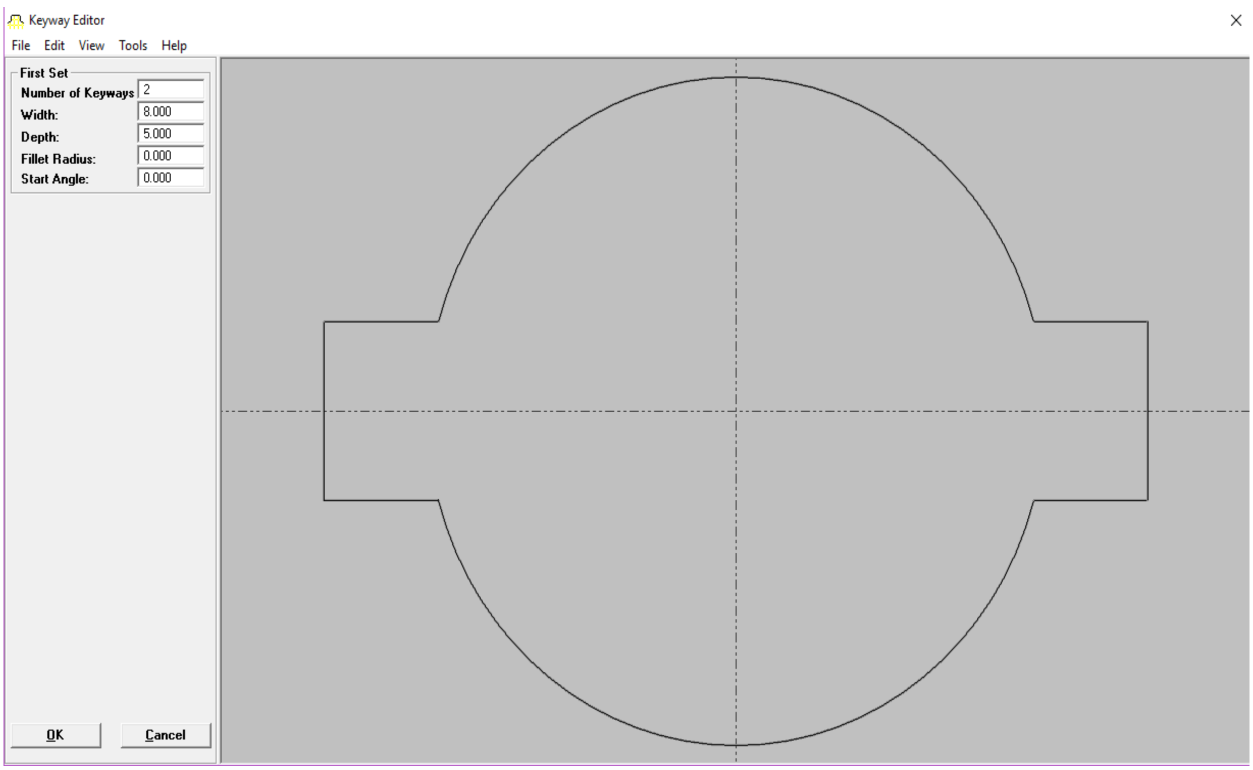


Figure (3.9.3): The keyway of blade

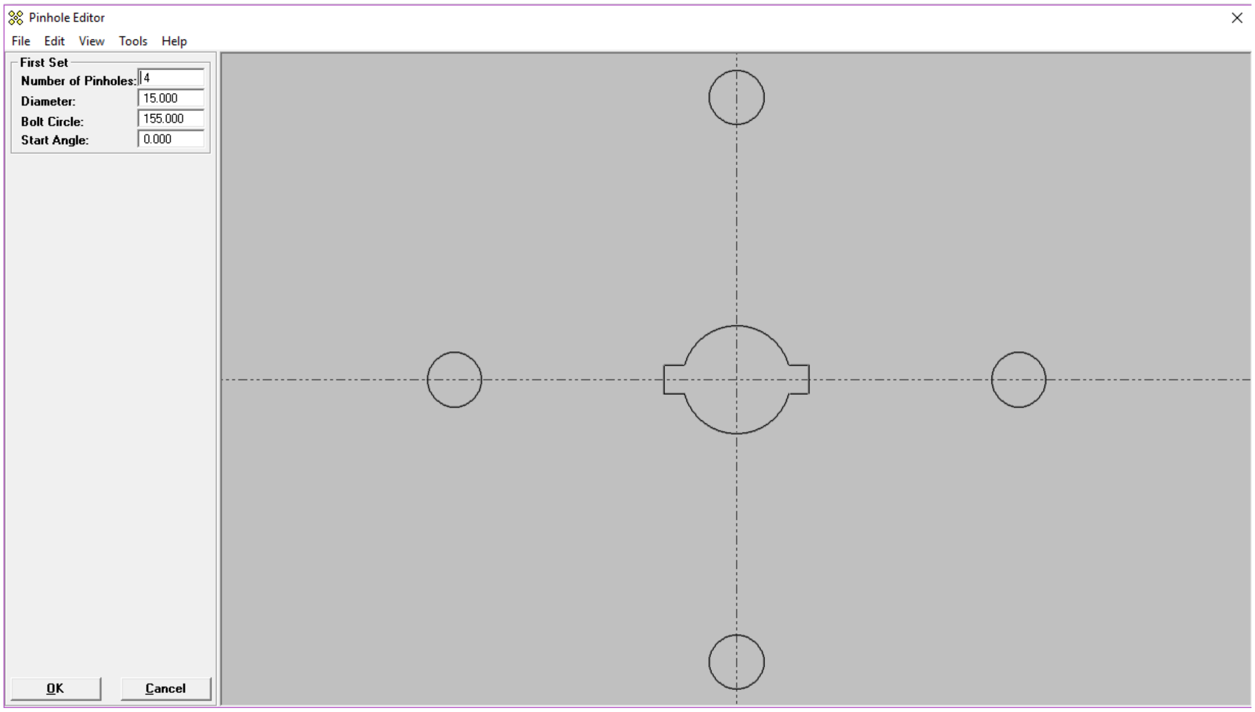


Figure (3.9.4): The pinhole of blade

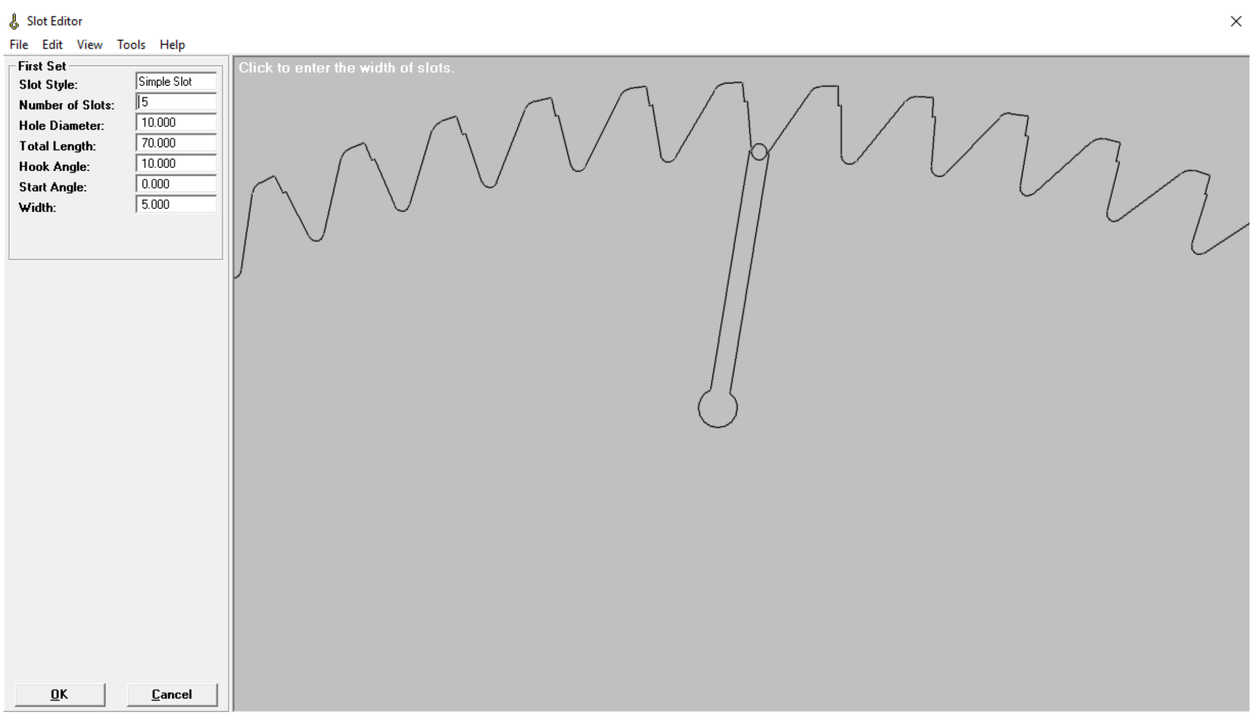


Figure (3.9.5): The slot of blade

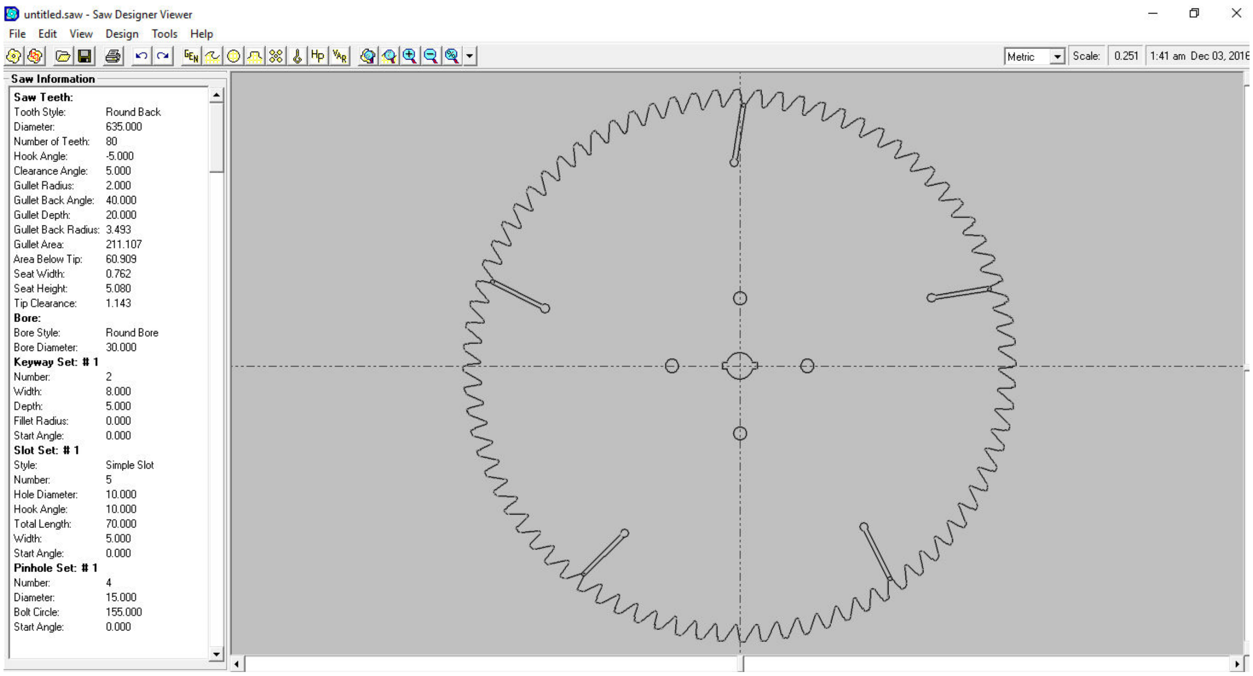


Figure (3.9.6): Circular saw blade design

3.2.2.6 Calculation of circular saw blade motor.

Step1: calculate tooth bite (F/T).

$$Tb = \frac{Fr*12}{Rpm*Nt} \qquad (3.22)$$

Tb: Tooth bite (F/T).

Fr: Feed rate (F/M).

Rpm: Shaft speed (RPM).

Nt: Number of teeth.

$$Tb = \frac{200 * 12}{1500 * 80} = 0.02$$

Step2: calculate gullet area required.

$$Gr = Tb * Dc \quad (3.23)$$

Gr: gullet area required (in^2).

Dc: Depth of cut (in).

$$Gr = 0.02 * 0.9842 = 0.0196$$

Step3: calculate bite factor.

$$Bf = 0.5 + (4 * Tb) \quad (3.24)$$

Bf: bite factor.

$$Bf = 0.05 + (4 * 0.02) = 0.58$$

Step4: calculate hardness factor.

$$Hf = Sg * 2.2$$

Sg: Specific gravity(Table3.2).

$$Hf = 0.35 * 2.2 = 0.77$$

Table (3.1): specific gravity

Type	Value
Softwood	0.35
Cedar-Western Red	0.31
Douglas Fir-Coast	0.45
Pine-Ponderosa	0.38
Spruce-White	0.37
Hardwood	0.65
Birch-Yellow	0.55
Maple	0.56
Oak-White	0.60

Step5: calculate horsepower.

$$Hp = Gr * Nt * Rbm * Bf * Hf * Kwf * Fwf * 0.003 \qquad (3.25)$$

Fwf: Face width factor (1.0).

Kwf: Kerf width factor (Table 3.3).

Table (3.2): Kerf width factor

Tip Kerf		Factor
0.125	1/8	0.36
0.15625	5/32	0.45
0.1875	3/16	0.55
0.21875	7/32	0.64
0.250	1/4	0.73
0.28125	9/32	0.82
0.3125	5/16	0.91
0.34375	11/32	1.00
0.375	3/8	1.09

$$Hp = 0.0196 * 80 * 1500 * 0.58 * 0.77 * 0.36 * 1 * 0.003 = 1.134\ Hp$$

4

Chapter Four

PLC & HMI Programming

4.1 Introduction.

As it has been mentioned before the wedge wood machine is fully automated and the process is performed sequentially, this can be performing by using PLC (programmable logic controller). This made adding automation capability and safety precautions possible, which is explained through this chapter.

4.2 PLC description.

Programmable Logic Controller (PLC) is a digital computer used for automation of electromechanical process, such as control of machinery on factory assembly lines, PLCs are used in many industries and machine. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. programs to control machine operation are typically stored in battery backed-up or non- volatile memory.

The PLC used in this machine is **PLC- DVP20EX00R2.**

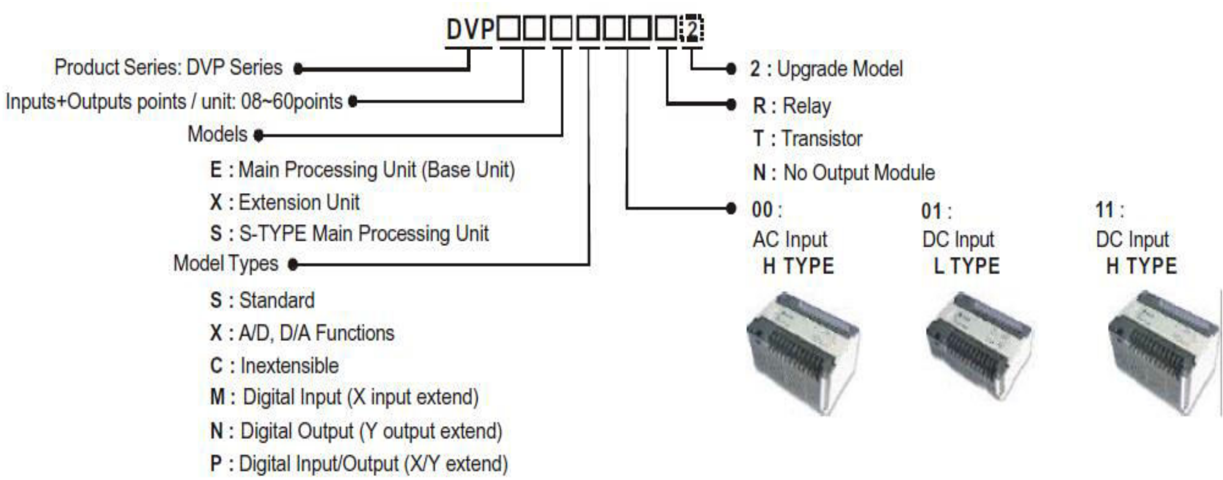


Figure (4.1): model explanation.

The software for **PLC- DVP20EX00R2** is the program WPLsoft, as shown in the figure (4.2).

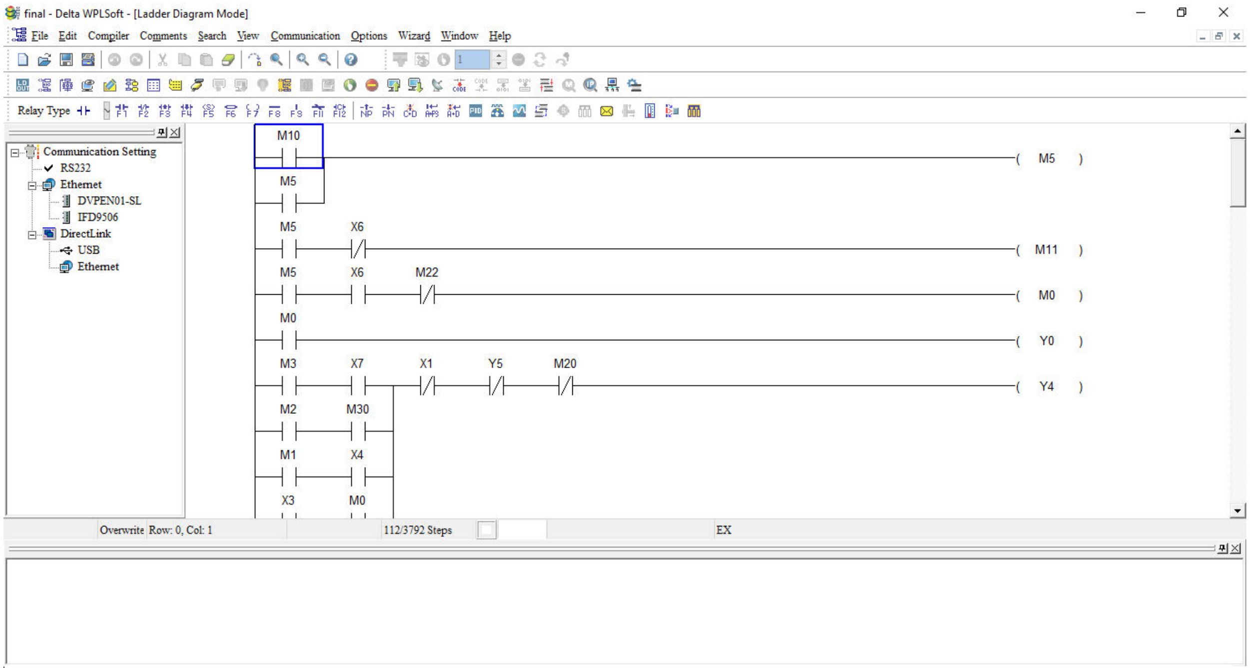


Figure (4.2): WPLsoft software.

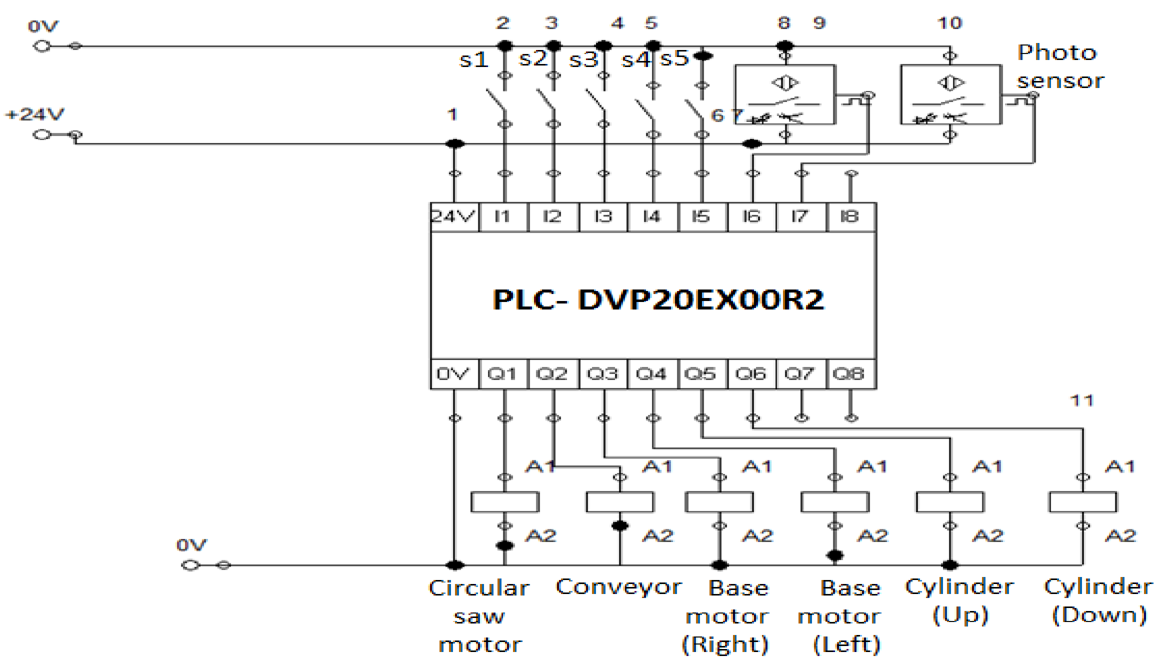


Figure (4.3): PLC connection.

In this machine we need 7 inputs, described in table (4.1), and 6 outputs, described in table (4.2)

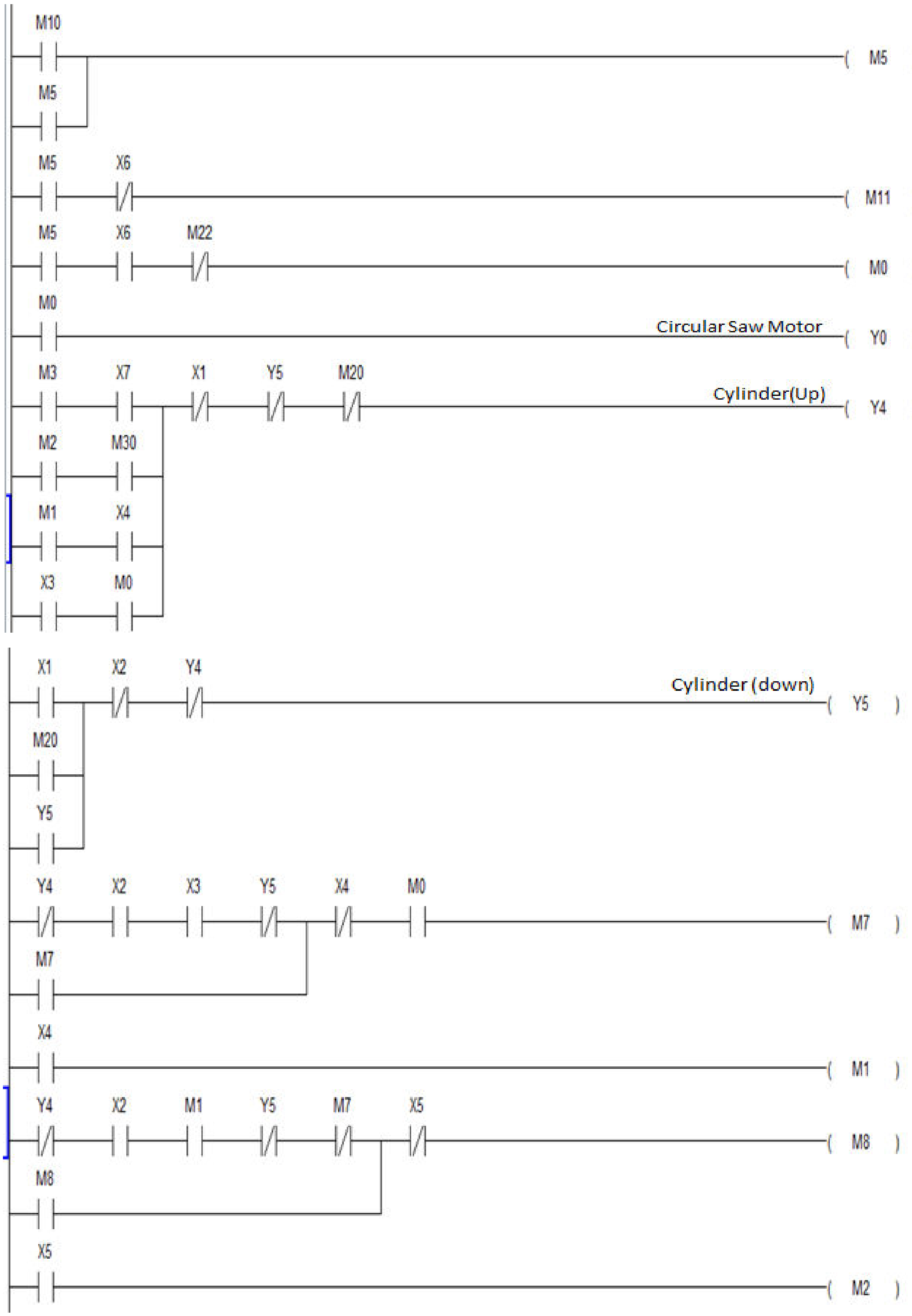
Table (4.1): PLC inputs.

Input	**Logic allocation**	**address**
S1	Limit switch (Cylinder Up)	X1
S2	Limit switch (Cylinder Down)	X2
S3	Micro switch (Base Right)	X3
S4	Micro switch (Base left)	X4
S5	Limit switch Base 180'	X5
S6	Photo transistor (first stage)	X6
S7	Photo transistor (first stage)	X7

Table (4.2): PLC outputs

Output	**Logic allocation**	**address**
Motor 1	Circular Saw Motor	Y0
Motor 2	Conveyor	Y1
Motor 3	Base Motor (Right)	Y2
Motor 4	Base Motor (Left)	Y3
Motor 5 UP	Cylinder(Up)	Y4
Motor 5 Down	Cylinder (down)	Y5

4.3 PLC Ladder program.



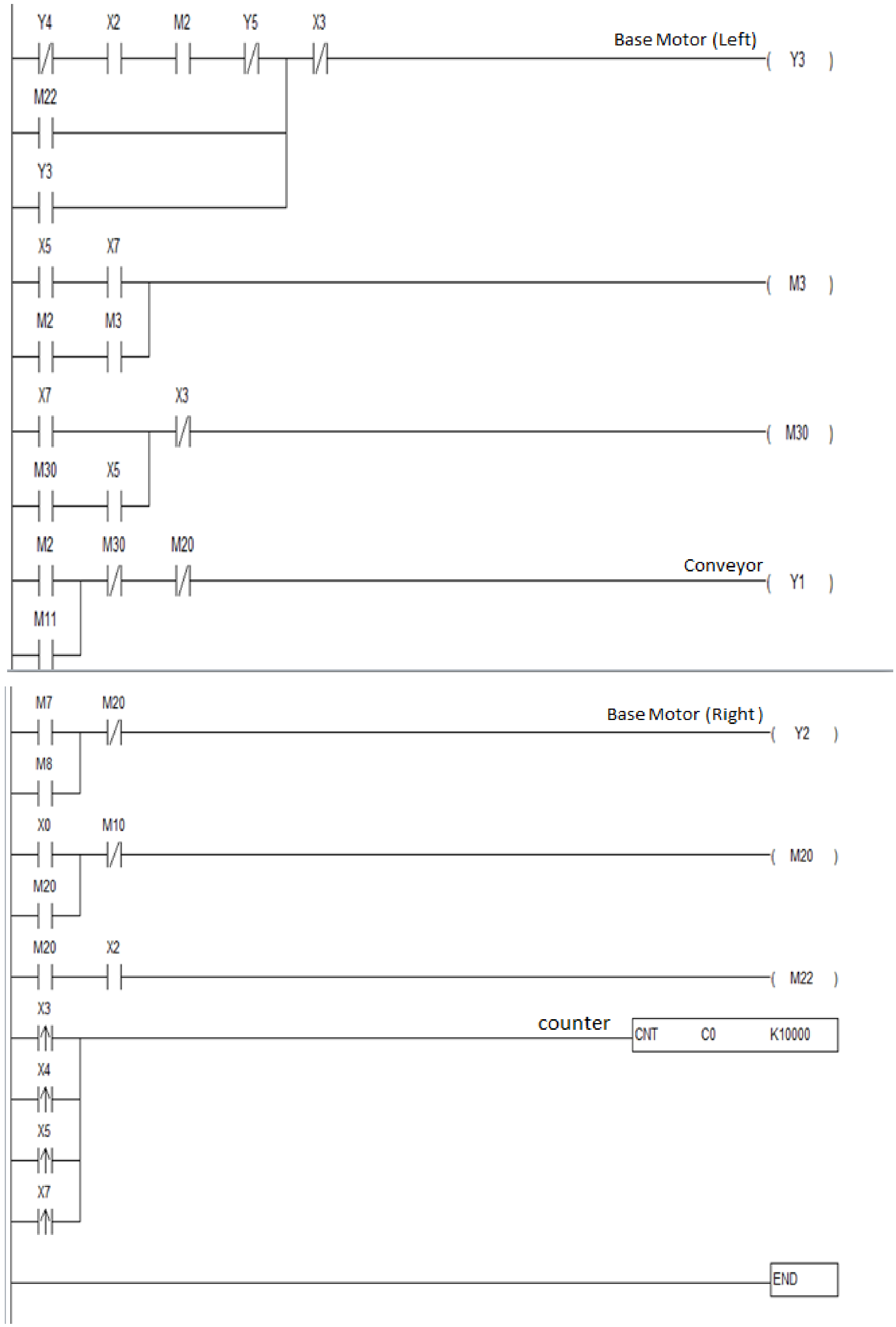


Figure (4.4): PLC Ladder program.

4.4 Human machine interface (HMI).

4.4.1 Introduction.

The Human Machine Interface (HMI) includes the electronics required to signal and control the state of industrial automation equipment. These interface products can range from a basic LED status indicator to a 20-inch TFT panel with touchscreen interface. HMI applications require mechanical robustness and resistance to water, dust, moisture, a wide range of temperatures, and, in some environments, secure communication. They should provide Ingress Protection (IP) ratings up to IP65, IP67, and IP68, it must first be working with a programmable logic controller (PLC). It is the PLC that takes the information from the sensors, and transforms it to Boolean algebra, so the HMI can decipher and make decisions.

The HMI that used in this project is delta HMI DOP-AS35THTD, as shown in figure (4.5).

Figure (4.5): HMI.

The software for DOP-AS35THTD is the program Screen editor, as shown in the figure (4.6).

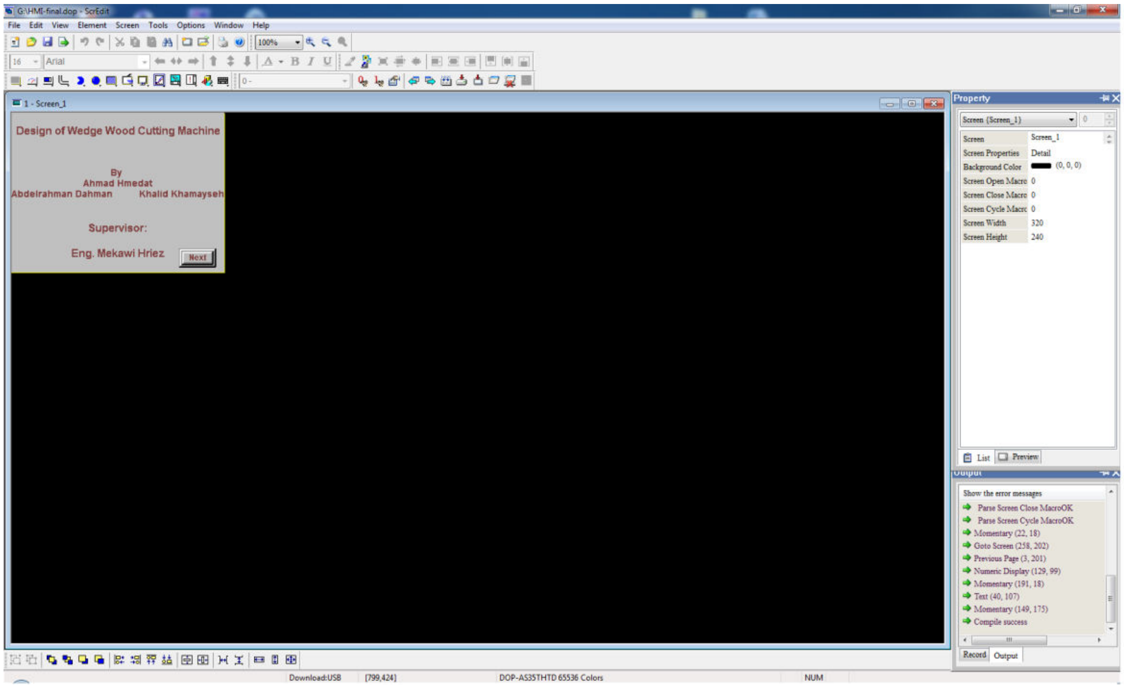


Figure (4.6): Screen Editor software.

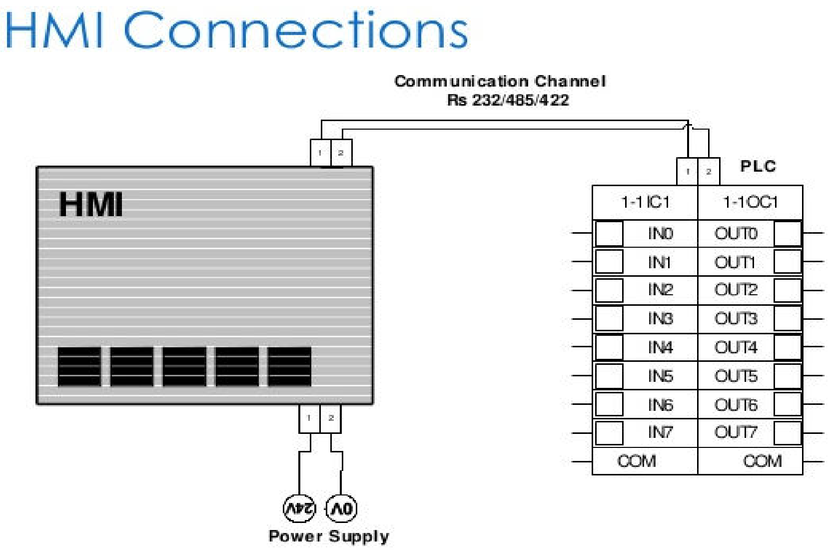


Figure (4.7): HMI to PLC communication.

4.4.2 HMI design.

The (start) pushbutton to start cutting the wedge wood, and the (stop) pushbutton to stop cutting, first of stopping order, make the electrical cylinder get up the cutting motor then turn off the cutting motor, then turn on the base motor to rotate the cutting motor to the right cutting location.

The counter to count how much the machine cut wedge wood from the start, and by push on (Reset) pushbutton the counter will reset to zero.

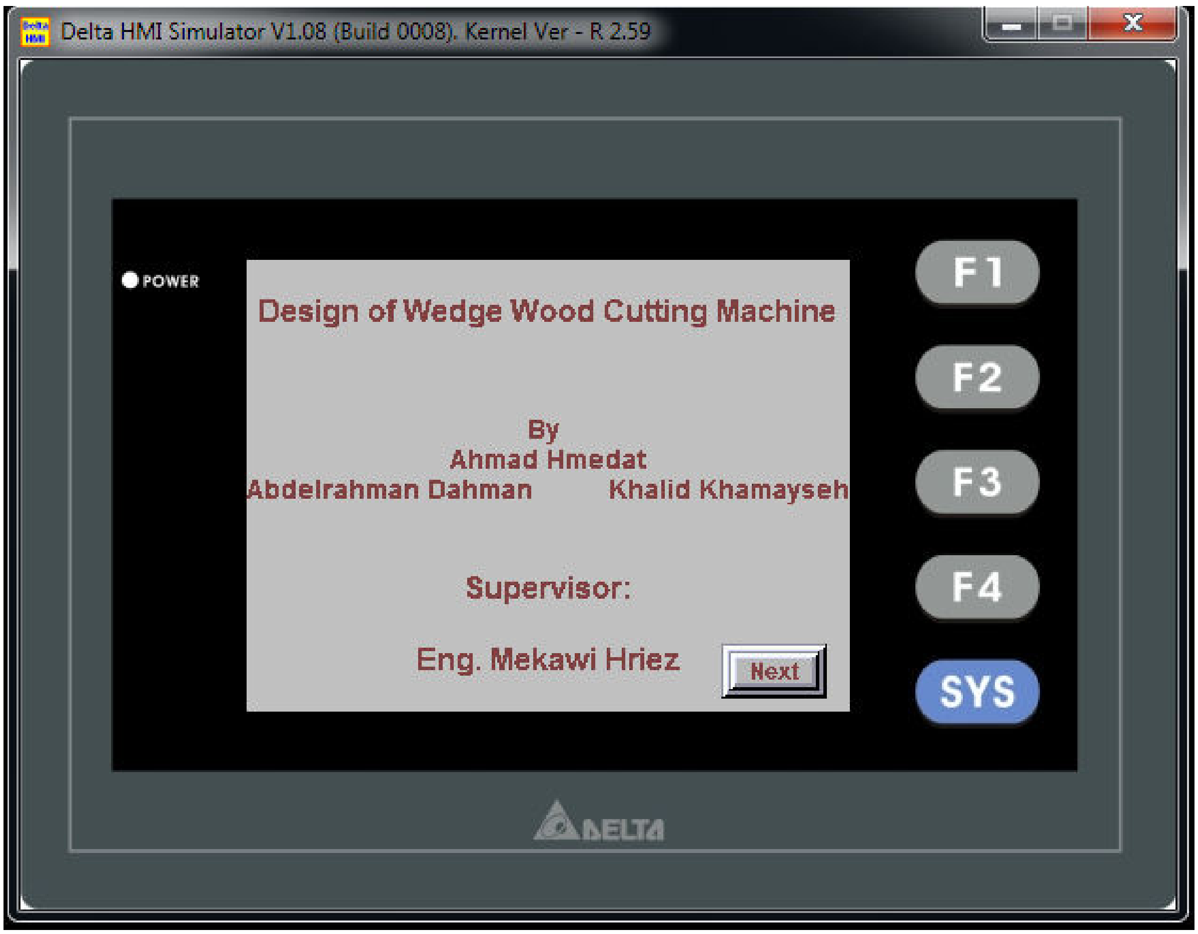


Figure (4.8): Screen 1

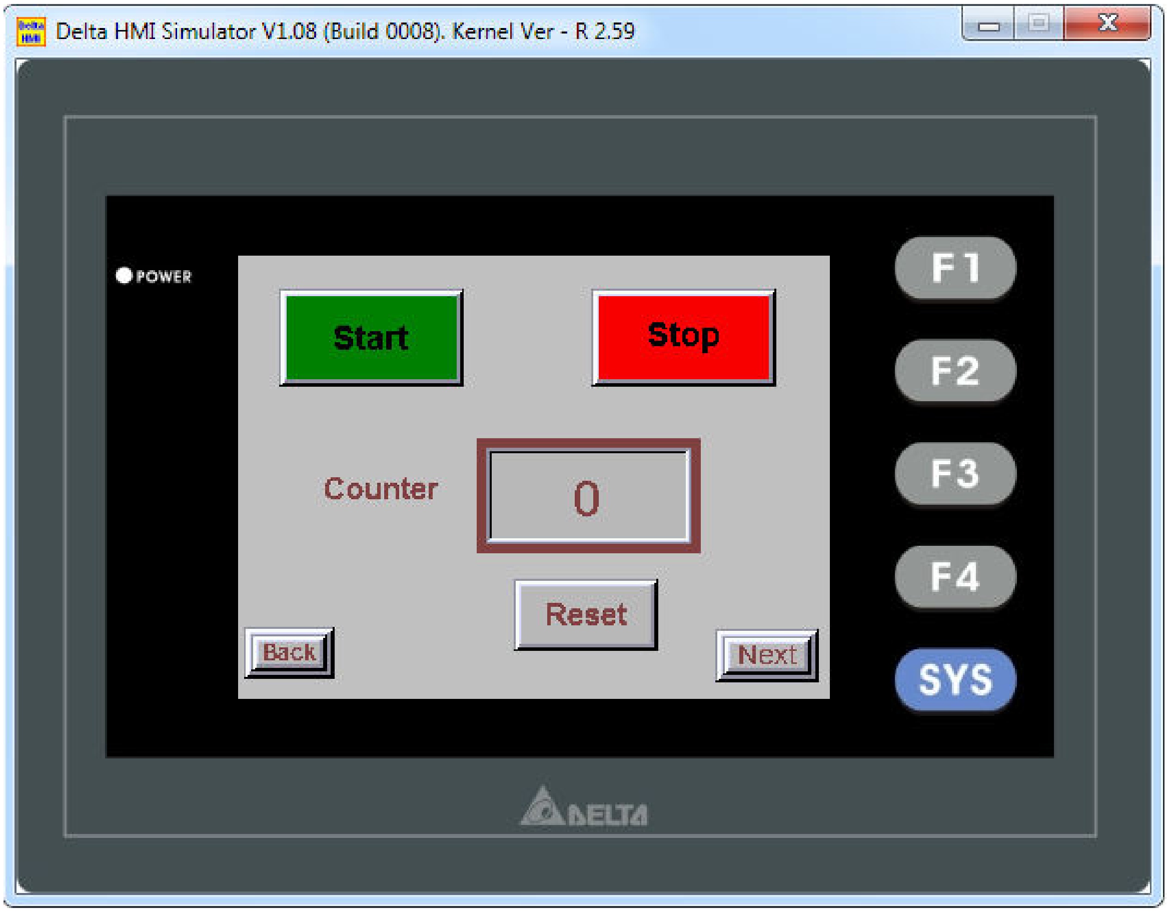


Figure (4.9): Screen 2

5

Chapter Five

Electrical Selection & Protection

5.1 Introduction.

5.2 Motors.

5.3 Components.

5.4 Power Circuit

5.1 Introduction.

This chapter contains the electrical component specifications (motor, switch, sensor, etc.).

5.2 Motors.

In this project there are one AC motor and three DC motors (electric linear actuator, Conveyer Motor, base motor).

5.2.1 Single phase induction motor

The induction motor is the motor most commonly used in agriculture. The speed of rotation of an induction motor is fairly constant, but it does vary somewhat with loading. As the motor is loaded, it slows down slightly.

Single-phase induction motors are not self-starting without an auxiliary stator winding driven by an out of phase current of near 90^o. Once started the auxiliary winding is optional. The auxiliary winding of a permanent-split capacitor motor has a capacitor in series with it during starting and running. A capacitor-start induction motor only has a capacitor in series with the auxiliary winding during starting. A capacitor-run motor typically has a large non-polarized electrolytic capacitor in series with the auxiliary winding for starting, then a smaller non-electrolytic capacitor during running. The auxiliary winding of a resistance split-phase motor develops a phase difference versus the main winding during starting by virtue of the difference in resistance, as shown figure (5.1).

Figure (5.1): single phase induction motor

In this project we used this one as single phase induction motor describe in table (5.1)

Table (5.1): single phase induction motor Specifications

Power (kw)	Current (A)	Voltage (V)	RPM	Eff (%)
0.25	3.5	220	3000	72

5.2.2 Electrical linear actuator.

A linear actuator moves a load, which can be an assembly, components, or a finished product, in a straight line. It converts energy into a motion or force and can be powered by pressurized fluid or air, as well as electricity.

An electric linear actuator converts electrical energy into torque. An electric motor mechanically connected turns a lead screw. A threaded lead or ball nut with corresponding threads that match those of the screw is prevented from rotating with the screw. When the screw rotates, the nut gets driven along the threads. The direction the nut moves depends on which direction the screw rotates and also returns the actuator to its original position, as shown figure (5.2).

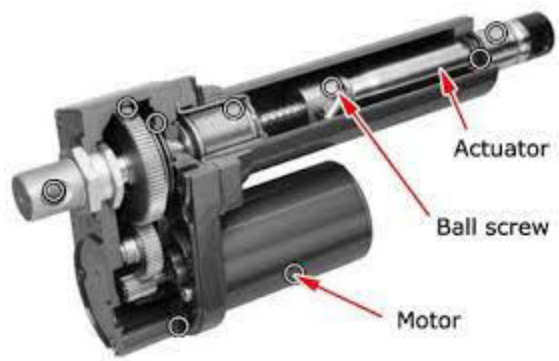


Figure (5.2): Electric linear actuator.

In this project we used this one electric linear actuator as describe in table (5.2).

Table (5.2): Electric linear actuator Specifications

SANXING FD24-A1-460 24 VOLT LINEAR ACTUATOR MOTOR	
INPUT VOLTAGE:	24V DC
SPEED:	4MM/S
DUTY CYCLE:	10% MAX: 2 DK/18 DK
MAX LOAD:	6000N/PUSH 4000N/PULL
STRONG:	33 CM
weight: weight :	2300 gr (bulk) 2500 gr (packing)

.

5.2.3 Dc series motor.

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

Series dc wiper motor that used in this project for conveyor motor, as describe in table (5.3).

Table (5.3): 24VDC series motor Specifications

Voltage	Current	Power	Torque	Speed
24V	5A	120W	35.8N.M	32RPM

The motor that used in this project dc series wiper motor for base motor, as describe in table (5.4)

Table (5.4): 12VDC motor Specifications

Voltage	Current	Power	Torque	Speed
12V	4A	45W	13.4N.M	32RPM

5.3 Components.

5.3.1 Limit switch.

Limit switch is a switch operated by the motion of a machine part or presence of an object. They are used for control of a machine. In this project there is 3 limit switches, the limit switches used in this project shown in figure (5.3)

Figure (5.3): Limit switch.

5.3.2 Clements.

Clements Used to connect wire to another wire, as shown in figure (5.4).

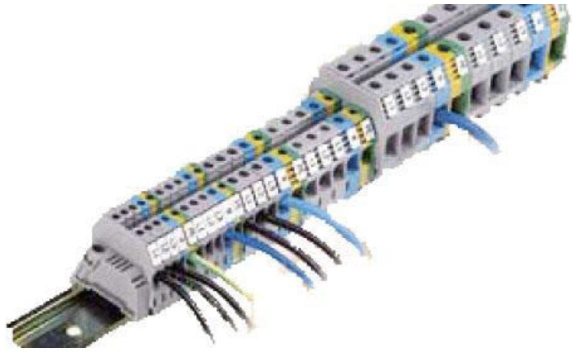


Figure (5.4): Clements.

5.3.3 Photoelectric sensor.

A self-contained photoelectric sensor contains the optics, along with the electronics. It requires only a power source. The sensor performs its own modulation, demodulation, amplification, and output switching. Some self-contained sensors provide such options as built-in control timers or counters. Because of technological progress, self-contained photoelectric sensors have become increasingly smaller.

Remote photoelectric sensors used for remote sensing contain only the optical components of a sensor. The circuitry for power input, amplification, and output switching are located elsewhere, typically in a control panel. This allows the sensor, itself, to be very small. Also, the controls for the sensor are more accessible, since they may be bigger.

Table (5.5): Photoelectric sensor Specifications

Model	Sensing Distrance	Operation voltage	Output		Response time	Sensing method
			Method	Mode		
G50-3A30NA	30cm 50cm	DC10-30V	NPN	NO	<2mS	Diffuse type
G50-3A30NB	30cm 50cm	DC10-30V	NPN	NC	<2mS	Diffuse type
G50-3A30NC	30cm 50cm	DC10-30V	NPN	NO+NC	<2mS	Diffuse type

Figure (5.5): Photoelectric sensor

5.3.4 Relay.

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts, as shown figure (5.6).

Figure (5.6): Relay

5.3.5 Overload

Overload relays are intended to protect motors, controllers and branch-circuit conductors against excessive heating due to prolonged motor over currents up to and including locked rotor currents. Protection of the motor and other branch-circuit components from higher currents, due to short circuits or grounds, is a function of branch-circuit fuses, circuit breakers or motor short circuits protectors. The system needs one overloads to protect the motors. See the figure 5.7

Figure (5.7): Overload

5.3.6 Emergency Stop Button.

Emergency Stop Button is shown in a figure 5.8 provides safety for humans and the machine; it offers a wide range of safety components for the protection of humans, machine and production goods in emergency situations.

It is the purpose of emergency-stop device to deflect or minimize the risk as quickly as possible and optimally in the event of an emergency arising

Figure (5.8): Emergency Stop Button

5.4 Power circuit.

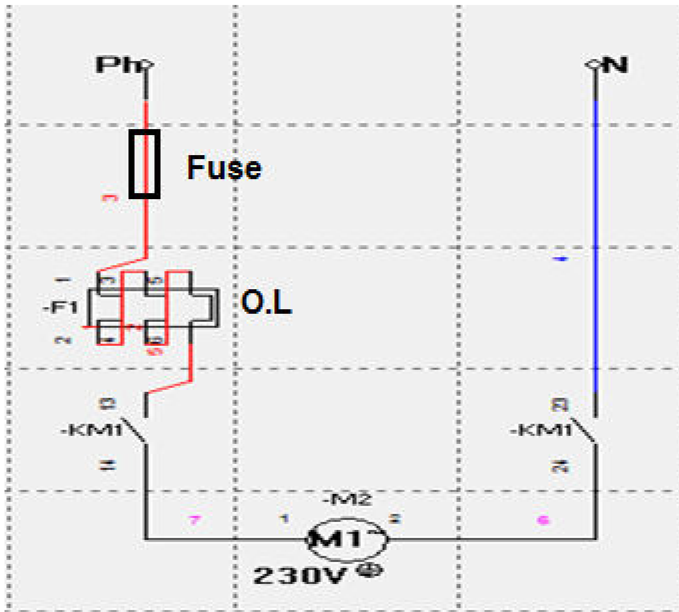


Figure (5.9): power circuit for cutting motor

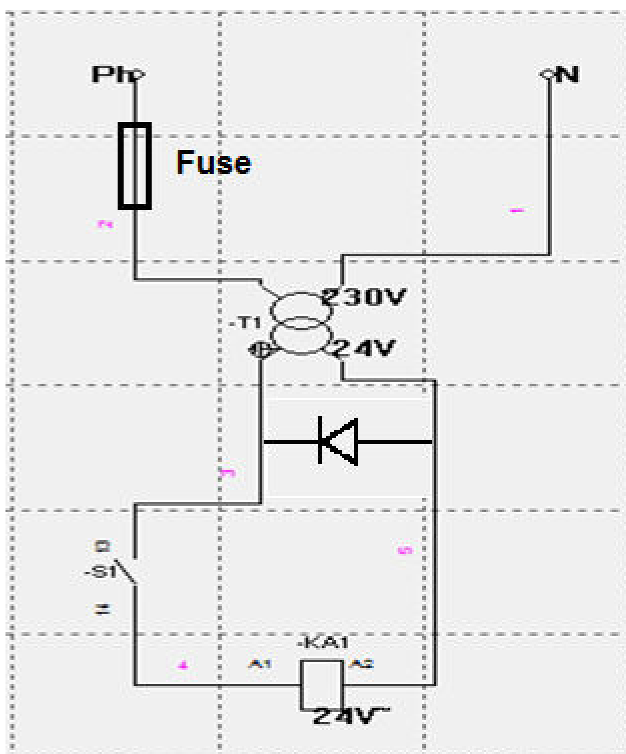


Figure (5.10): power circuit for conveyor motor

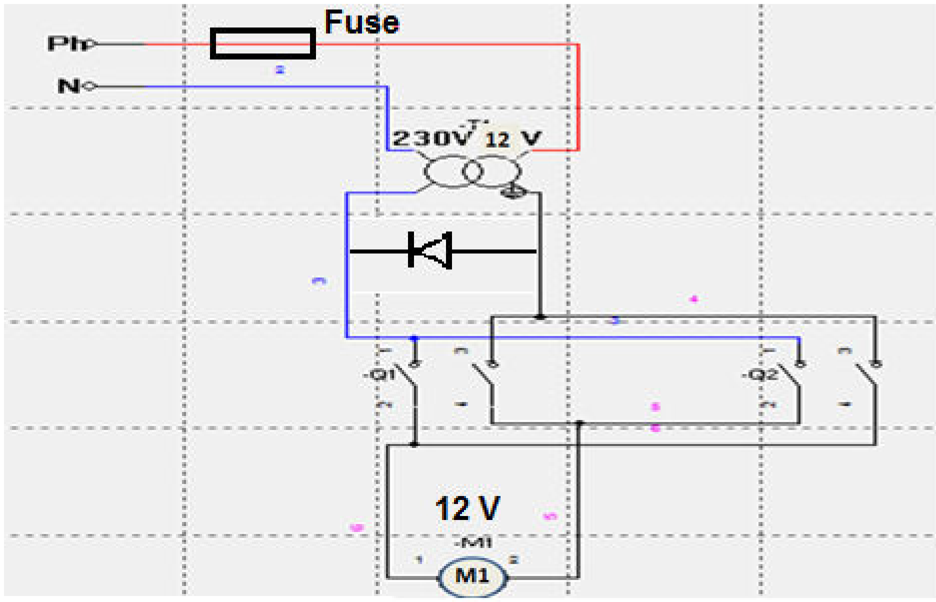


Figure (5.11)**:** power circuit for base motor

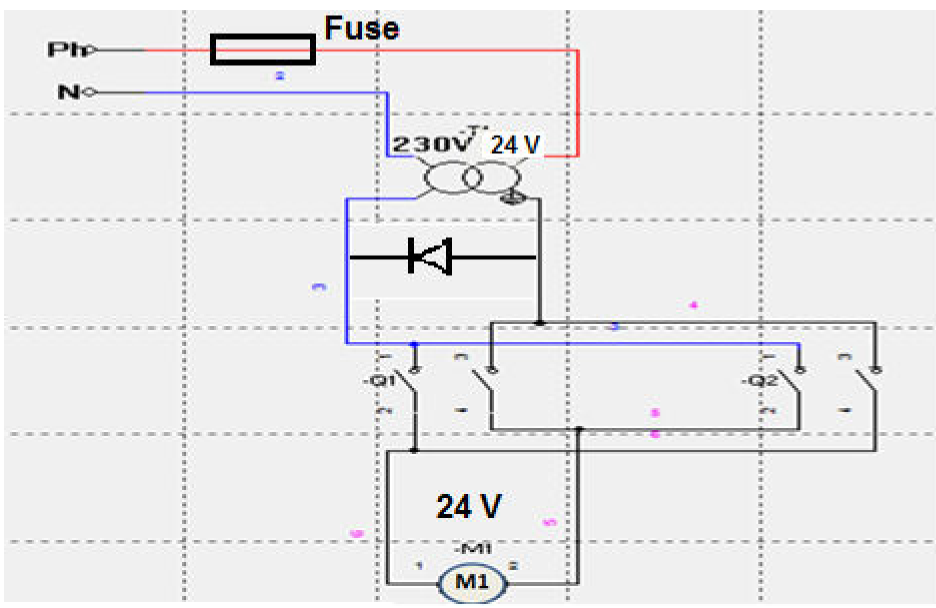


Figure (5.12)**:** power circuit for conveyor motor

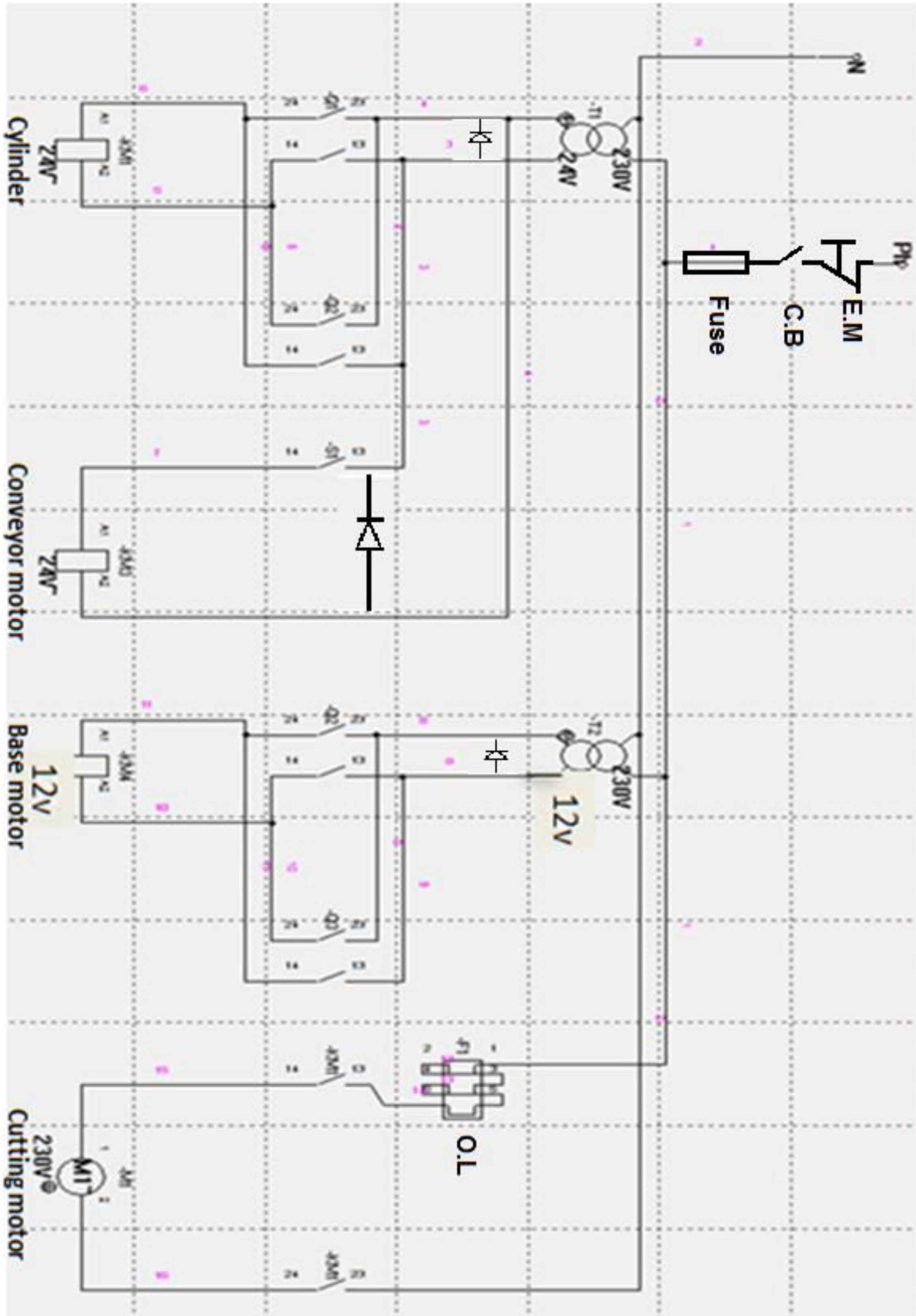


Figure (5.13): machine power circuit.

6

Chapter Six

Experimental Result & Future work

6.1 Introduction

6.2 Test Result

6.3 Recommendations

6.4 Future Work

6.5 Conclusion

6.1 Introduction

This chapter provides experimental result and some future work for this project. In this chapter we are listing some goals hope to be accomplished or at least under attention.

6.2 Test Result

1) Transporting system: Before obtaining wedges from the wood plate, we try to check the operation of the conveyor by sensing the presence of the wood plate.
2) The size of the machine suitable and small (50cm*150cm)
3) Get the wedge with all the precision and best shape it has, taking into consideration the direction of cutting the wood.
4) The periodic cycle of cutting four wedges is (70 second).
5) Linear actuator system: used to have slow speed and increase accuracy.
6) Make a sheet in cut directions in order to provide a path for cutting blade.

The experimental result of the machine, as shown in figure (6.1) have the best shape as the wedges wood must to be.

Figure (6.1): wedge wood Sizes.

The final machine, as shown in figure (6.2).

Figure (6.2): The final machine

6.3 Recommendations.

These recommendations are recorded to people who can create opportunities for student to make something new and useful, in order to make difference in our country Palestine:

1) Such projects should be handled among different departments according to the project nature (we had lots of mechanical problems that might solve without having enough previous knowledge).
2) Once the university administration financially supported graduation projects, this support must be provided at the beginning of the project work, to enable students to do their projects according to the time plan, and to test them at the proper time.
3) The university should provide the proper toolsets, which enable the student to assemble his project and to test it the university campus, so he could get benefit of experiences in the university.

6.4 Future Work.

The following tasks are suggested as future works:

1) Improving the machine to produce more wedge wood number in less time.
2) Setting a vacuum for the Carpentry.
3) Improving the rotation by using position control.
4) Covering the circular saw blade in terms of increasing the safety.
5) Improving the machine by increase the speed of cutting.

6.5 Conclusion.

1) The price of one kilo of wedge wood that produced in traditional method is 5 shekels, and its cost 2.5 shekels, after calculate the cost in the automatic method, its 2.5 shekels, by increasing the number of wedges per hour the profit will increase

2) The best shape of wedges that the automatic method produced make the construction process easier than the traditional method.

3) The automatic method saves the human life unlike the traditional method

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Appendix A

A.1 Dimensions of Bearing

A.2 Mechanical Properties of Steel 1080

A.3 Figure 19-1: Single-Strand Roller Chain Selection Chart

A.4 Dimensions of Chains-Single Strand Source

A.5 Service Factors, Ks

A.6 Horsepower Ratings of Single Strand Roller Chain, No. 40

A.7 Preferred Sizes and Reynard (R-Series) Numbers

A.8 Specifications for Steel Bolts

A.9 Bending Properties of Fillet Welds

A.1: Dimensions of Bearing

Table 11–2

Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm d_S	d_H	Load Ratings, kN Deep Groove C_{10}	C_0	Angular Contact C_{10}	C_0
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65
30	62	16	1.0	35	55	19.5	10.0	20.3	11.0
35	72	17	1.0	41	65	25.5	13.7	27.0	15.0
40	80	18	1.0	46	72	30.7	16.6	31.9	18.6
45	85	19	1.0	52	77	33.2	18.6	35.8	21.2
50	90	20	1.0	56	82	35.1	19.6	37.7	22.8
55	100	21	1.5	63	90	43.6	25.0	46.2	28.5
60	110	22	1.5	70	99	47.5	28.0	55.9	35.5
65	120	23	1.5	74	109	55.9	34.0	63.7	41.5
70	125	24	1.5	79	114	61.8	37.5	68.9	45.5
75	130	25	1.5	86	119	66.3	40.5	71.5	49.0
80	140	26	2.0	93	127	70.2	45.0	80.6	55.0
85	150	28	2.0	99	136	83.2	53.0	90.4	63.0
90	160	30	2.0	104	146	95.6	62.0	106	73.5
95	170	32	2.0	110	156	108	69.5	121	85.0

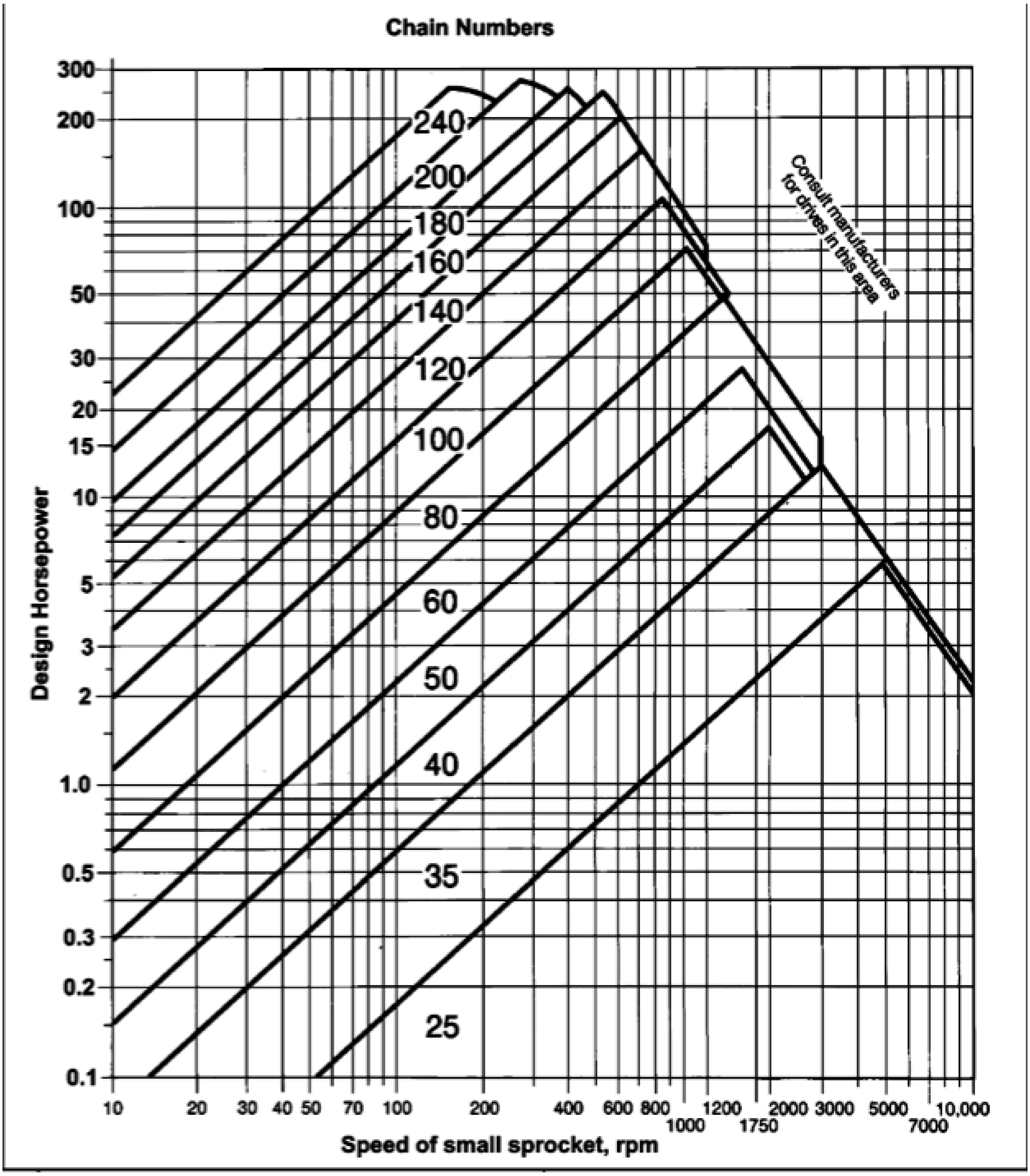
A.2: Mechanical Properties of Steel 1080, 1095 and 1018

Table A–20

Deterministic ASTM Minimum Tensile and Yield Strengths for Some Hot-Rolled (HR) and Cold-Drawn (CD) Steels [The strengths listed are estimated ASTM minimum values in the size range 18 to 32 mm ($\frac{3}{4}$ to $1\frac{1}{4}$ in). These strengths are suitable for use with the design factor defined in Sec. 1–10, provided the materials conform to ASTM A6 or A568 requirements or are required in the purchase specifications. Remember that a numbering system is not a specification.] *Source:* 1986 SAE Handbook, p. 2.15.

1	2	3	4	5	6	7	8
UNS No.	SAE and/or AISI No.	Process-ing	Tensile Strength, MPa (kpsi)	Yield Strength, MPa (kpsi)	Elongation in 2 in, %	Reduction in Area, %	Brinell Hardness
G10060	1006	HR	300 (43)	170 (24)	30	55	86
		CD	330 (48)	280 (41)	20	45	95
G10100	1010	HR	320 (47)	180 (26)	28	50	95
		CD	370 (53)	300 (44)	20	40	105
G10150	1015	HR	340 (50)	190 (27.5)	28	50	101
		CD	390 (56)	320 (47)	18	40	111
G10180	1018	HR	400 (58)	220 (32)	25	50	116
		CD	440 (64)	370 (54)	15	40	126
G10200	1020	HR	380 (55)	210 (30)	25	50	111
		CD	470 (68)	390 (57)	15	40	131
G10300	1030	HR	470 (68)	260 (37.5)	20	42	137
		CD	520 (76)	440 (64)	12	35	149
G10350	1035	HR	500 (72)	270 (39.5)	18	40	143
		CD	550 (80)	460 (67)	12	35	163
G10400	1040	HR	520 (76)	290 (42)	18	40	149
		CD	590 (85)	490 (71)	12	35	170
G10450	1045	HR	570 (82)	310 (45)	16	40	163
		CD	630 (91)	530 (77)	12	35	179
G10500	1050	HR	620 (90)	340 (49.5)	15	35	179
		CD	690 (100)	580 (84)	10	30	197
G10600	1060	HR	680 (98)	370 (54)	12	30	201
G10800	1080	HR	770 (112)	420 (61.5)	10	25	229
G10950	1095	HR	830 (120)	460 (66)	10	25	248

A.3: Figure 19-1: Single-Strand Roller Chain Selection Chart



A.4: Dimensions of American Standard Roller Chains-Single Strand

Source: Compiled from ANSI B29.1-1975

ANSI Chain Number	Pitch, in (mm)	Width, in (mm)	Minimum Tensile Strength, lbf (N)	Average Weight, lbf/ft (N/m)	Roller Diameter, in (mm)	Multiple-Strand Spacing, in (mm)
25	0.250 (6.35)	0.125 (3.18)	780 (3 470)	0.09 (1.31)	0.130 (3.30)	0.252 (6.40)
35	0.375 (9.52)	0.188 (4.76)	1 760 (7 830)	0.21 (3.06)	0.200 (5.08)	0.399 (10.13)
40	0.500 (12.70)	0.312 (7.94)	3 130 (13 920)	0.42 (6.13)	0.312 (7.92)	0.566 (14.38)
50	0.625 (15.88)	0.375 (9.52)	4 880 (21 700)	0.69 (10.1)	0.400 (10.16)	0.713 (18.11)
60	0.750 (19.05)	0.500 (12.7)	7 030 (31 300)	1.00 (14.6)	0.469 (11.91)	0.897 (22.78)
80	1.000 (25.40)	0.625 (15.88)	12 500 (55 600)	1.71 (25.0)	0.625 (15.87)	1.153 (29.29)
100	1.250 (31.75)	0.750 (19.05)	19 500 (86 700)	2.58 (37.7)	0.750 (19.05)	1.409 (35.76)
120	1.500 (38.10)	1.000 (25.40)	28 000 (124 500)	3.87 (56.5)	0.875 (22.22)	1.789 (45.44)
140	1.750 (44.45)	1.000 (25.40)	38 000 (169 000)	4.95 (72.2)	1.000 (25.40)	1.924 (48.87)
160	2.000 (50.80)	1.250 (31.75)	50 000 (222 000)	6.61 (96.5)	1.125 (28.57)	2.305 (58.55)
180	2.250 (57.15)	1.406 (35.71)	63 000 (280 000)	9.06 (132.2)	1.406 (35.71)	2.592 (65.84)
200	2.500 (63.50)	1.500 (38.10)	78 000 (347 000)	10.96 (159.9)	1.562 (39.67)	2.817 (71.55)
240	3.00 (76.70)	1.875 (47.63)	112 000 (498 000)	16.4 (239)	1.875 (47.62)	3.458 (87.83)

Table 19.1

A.5: Service Factors, Ks

15

Table 19-2: service factors, K_s

Load Type	Driven machine type	Types of driver: Soft starts (AC motors: Normal torque[a]; DC motors: Shunt-wound; Engines: Multiple-cylinder) <6 h per day	6–15 h per day	>15 h per day	Heavy starts (AC motors: High torque[b]; DC motors: Series-wound, compound-wound; Engines: 4-cylinder or less) <6 h per day	6–15 h per day	>15 h per day
Smooth	Agitators, blowers, fans, centrifugal pumps, light conveyors	1.0	1.1	1.2	1.1	1.2	1.3
Light Shock	Generators, machine tools, mixers, gravel conveyors	1.1	1.2	1.3	1.2	1.3	1.4
Medium Shock	Bucket elevators, textile machines, hammer mills, heavy conveyors	1.2	1.3	1.4	1.4	1.5	1.6
High Shock	Crushers, ball mills, hoists, rubber extruders	1.3	1.4	1.5	1.5	1.6	1.8
Heavy Shock	Any machine that can choke	2.0	2.0	2.0	2.0	2.0	2.0

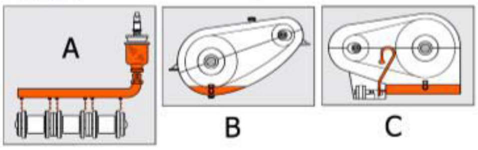
A.6 : Horsepower Ratings of Single Strand Roller Chain, No. 40:

Table 19-5(*c*): Horsepower ratings of single strand roller chain, No. 40

No. of Teeth	0.500 inch Pitch																								
	10	25	50	100	180	200	300	500	700	900	1000	1200	1400	1600	1800	2100	2500	3000	3500	4000	5000	6000	7000	8000	9000
11	0.06	0.14	0.27	0.52	0.91	1.00	1.48	2.42	3.34	4.25	4.70	5.60	6.49	5.57	4.66	3.70	2.85	2.17	1.72	1.41	1.01	0.77	0.61	0.50	0.00
12	0.06	0.15	0.29	0.56	0.99	1.09	1.61	2.64	3.64	4.64	5.13	6.11	7.09	6.34	5.31	4.22	3.25	2.47	1.96	1.60	1.15	0.87	0.69	0.57	0.00
13	0.07	0.16	0.31	0.61	1.07	1.19	1.75	2.86	3.95	5.02	5.56	6.62	7.68	7.15	5.99	4.76	3.66	2.79	2.21	1.81	1.29	0.98	0.78	0.00	
14	0.07	0.17	0.34	0.66	1.15	1.28	1.88	3.08	4.25	5.41	5.98	7.13	8.27	7.99	6.70	5.31	4.09	3.11	2.47	2.02	1.45	1.10	0.87	0.00	
15	0.08	0.19	0.36	0.70	1.24	1.37	2.02	3.30	4.55	5.80	6.41	7.64	8.86	8.86	7.43	5.89	4.54	3.45	2.74	2.24	1.60	1.22	0.97	0.00	
16	0.08	0.20	0.39	0.75	1.32	1.46	2.15	3.52	4.86	6.18	6.84	8.15	9.45	9.76	8.18	6.49	5.00	3.80	3.02	2.47	1.77	1.34	0.00		
17	0.09	0.21	0.41	0.80	1.40	1.55	2.29	3.74	5.16	6.57	7.27	8.66	10.04	10.69	8.96	7.11	5.48	4.17	3.31	2.71	1.94	1.47	0.00		
18	0.09	0.22	0.43	0.84	1.48	1.64	2.42	3.96	5.46	6.95	7.69	9.17	10.63	11.65	9.76	7.75	5.97	4.54	3.60	2.95	2.11	1.60	0.00		
19	0.10	0.24	0.46	0.89	1.57	1.73	2.56	4.18	5.77	7.34	8.12	9.68	11.22	12.64	10.59	8.40	6.47	4.92	3.91	3.20	2.29	0.09	0.00		
20	0.10	0.25	0.48	0.94	1.65	1.82	2.69	4.39	6.07	7.73	8.55	10.18	11.81	13.42	11.44	9.07	6.99	5.31	4.22	3.45	2.47	0.00			
21	0.11	0.26	0.51	0.98	1.73	1.91	2.83	4.61	6.37	8.11	8.98	10.69	12.40	14.10	12.30	9.76	7.52	5.72	4.54	3.71	2.66	0.00			
22	0.11	0.27	0.53	1.03	1.81	2.01	2.96	4.83	6.68	8.50	9.40	11.20	12.99	14.77	13.19	10.47	8.06	6.13	4.87	3.98	2.85	0.00			
23	0.12	0.28	0.55	1.08	1.90	2.10	3.10	5.05	6.98	8.89	9.83	11.71	13.58	15.44	14.10	11.19	8.62	6.55	5.20	4.26	3.05	0.00			
24	0.12	0.30	0.58	1.12	1.98	2.19	3.23	5.27	7.28	9.27	10.26	12.22	14.17	16.11	15.03	11.93	9.18	6.99	5.54	4.54	0.87	0.00			
25	0.13	0.31	0.60	1.17	2.06	2.28	3.36	5.49	7.59	9.66	10.69	12.73	14.76	16.78	15.98	12.68	9.76	7.43	5.89	4.82	0.00				
26	0.13	0.32	0.63	1.22	2.14	2.37	3.50	5.71	7.89	10.04	11.11	13.24	15.35	17.45	16.95	13.45	10.36	7.88	6.25	5.12	0.00				
28	0.14	0.35	0.67	1.31	2.31	2.55	3.77	6.15	8.50	10.82	11.97	14.26	16.53	18.79	18.94	15.03	11.57	8.80	6.99	5.72	0.00				
30	0.15	0.37	0.72	1.41	2.47	2.74	4.04	6.59	9.11	11.59	12.82	15.28	17.71	20.14	21.01	16.67	12.84	9.76	7.75	6.34	0.00				
32	0.16	0.40	0.77	1.50	2.64	2.92	4.31	7.03	9.71	12.36	13.68	16.30	18.89	21.48	23.14	18.37	14.14	10.76	8.54	1.41					
35	0.18	0.43	0.84	1.64	2.88	3.19	4.71	7.69	10.62	13.52	14.96	17.82	20.67	23.49	26.30	21.01	16.17	12.30	9.76	0.00					
40	0.21	0.50	0.96	1.87	3.30	3.65	5.38	8.79	12.14	15.45	17.10	20.37	23.62	26.85	30.06	25.67	19.76	15.03	0.00						
45	0.23	0.56	1.08	2.11	3.71	4.10	6.06	9.89	13.66	17.39	19.24	22.92	26.57	30.20	33.82	30.63	23.58	5.53	0.00						

Type A — Type B — Type C

Type A: Manual or Drip Lubrication
Type B: Bath or Disc Lubrication
Type C: Oil Stream Lubrication



A.7: Preferred Sizes and Renard (R-Series) Numbers

Table A–17

Preferred Sizes and Renard (R-Series) Numbers
(When a choice can be made, use one of these sizes; however, not all parts or items are available in all the sizes shown in the table.)

Fraction of Inches

$\frac{1}{64}$, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{9}{16}$, $\frac{5}{8}$, $\frac{11}{16}$, $\frac{3}{4}$, $\frac{7}{8}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2, $2\frac{1}{4}$, $2\frac{1}{2}$, $2\frac{3}{4}$, 3, $3\frac{1}{4}$, $3\frac{1}{2}$, $3\frac{3}{4}$, 4, $4\frac{1}{4}$, $4\frac{1}{2}$, $4\frac{3}{4}$, 5, $5\frac{1}{4}$, $5\frac{1}{2}$, $5\frac{3}{4}$, 6, $6\frac{1}{2}$, 7, $7\frac{1}{2}$, 8, $8\frac{1}{2}$, 9, $9\frac{1}{2}$, 10, $10\frac{1}{2}$, 11, $11\frac{1}{2}$, 12, $12\frac{1}{2}$, 13, $13\frac{1}{2}$, 14, $14\frac{1}{2}$, 15, $15\frac{1}{2}$, 16, $16\frac{1}{2}$, 17, $17\frac{1}{2}$, 18, $18\frac{1}{2}$, 19, $19\frac{1}{2}$, 20

Decimal Inches

0.010, 0.012, 0.016, 0.020, 0.025, 0.032, 0.040, 0.05, 0.06, 0.08, 0.10, 0.12, 0.16, 0.20, 0.24, 0.30, 0.40, 0.50, 0.60, 0.80, 1.00, 1.20, 1.40, 1.60, 1.80, 2.0, 2.4, 2.6, 2.8, 3.0, 3.2, 3.4, 3.6, 3.8, 4.0, 4.2, 4.4, 4.6, 4.8, 5.0, 5.2, 5.4, 5.6, 5.8, 6.0, 7.0, 7.5, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20

Millimeters

0.05, 0.06, 0.08, 0.10, 0.12, 0.16, 0.20, 0.25, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 1.0, 1.1, 1.2, 1.4, 1.5, 1.6, 1.8, 2.0, 2.2, 2.5, 2.8, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 8.0, 9.0, 10, 11, 12, 14, 16, 18, 20, 22, 25, 28, 30, 32, 35, 40, 45, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300

Renard Numbers*

1st choice, R5: 1, 1.6, 2.5, 4, 6.3, 10

2d choice, R10: 1.25, 2, 3.15, 5, 8

3d choice, R20: 1.12, 1.4, 1.8, 2.24, 2.8, 3.55, 4.5, 5.6, 7.1, 9

4th choice, R40: 1.06, 1.18, 1.32, 1.5, 1.7, 1.9, 2.12, 2.36, 2.65, 3, 3.35, 3.75, 4.25, 4.75, 5.3, 6, 6.7, 7.5, 8.5, 9.5

*May be multiplied or divided by powers of 10.

Appendix B

B.1: Model Explanation and Peripherals.

B.2: Terminal Wiring.

B.3: Product Profile and Outline.

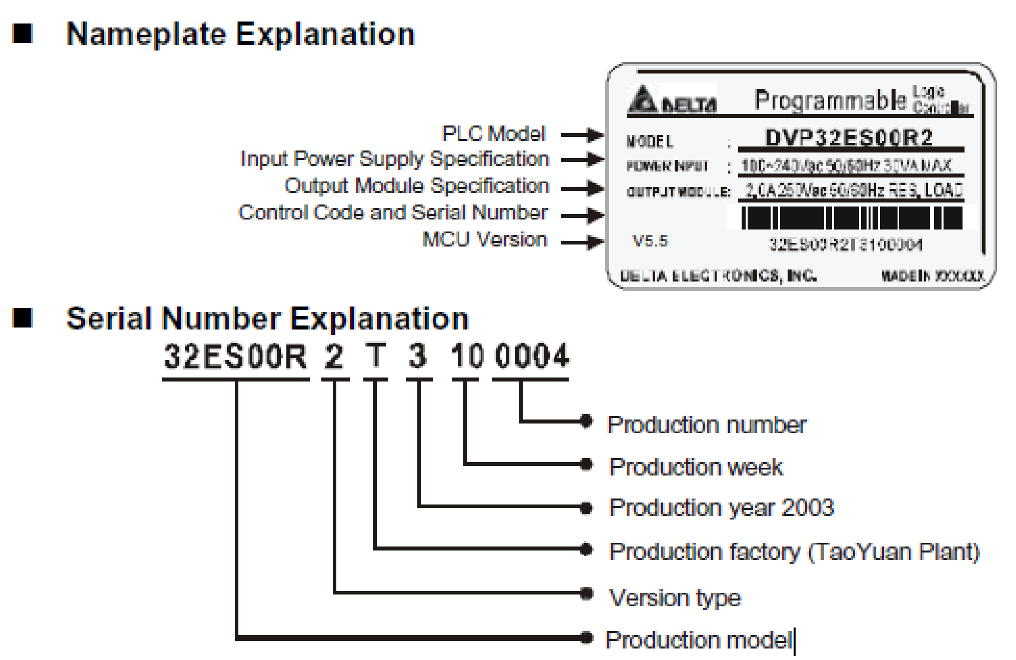
B.4: Power Input Wiring.

B.1: Model Explanation and Peripherals

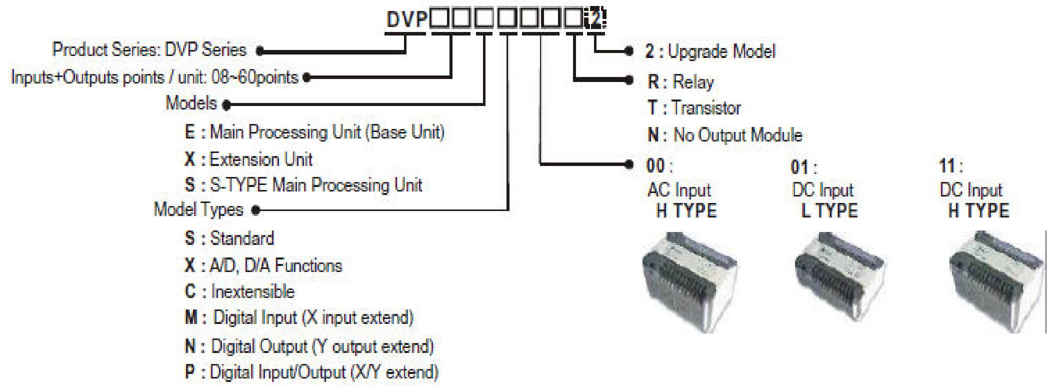
Thank you for choosing DELTA’ s PLC DVP Series. The DVP Series has main processing units and extension units. The main processing units offer 14-60 points and the extension units offer 8-32 points. The maximum input/output can be extended up to 128 points. It also can be used on applications according to INPUT/OUTPUT points, power sources, output modules, digital/analog exchanges (A/D & D/A converter). In addition, DVP SS Series has the special modules (AD/DA/PT/TC/XA) used for extending its functions and the maximum special modules can be extended up to 8 units. For more information on the DVP SS Series, refer to the DVP SS Series user manual.

DVP ES/EX/SS MPU is made from improving the functions and specifications of R/T model structure. The additional R2/T2 model has wide improvement in commands type and execution speed. Please refer to the detail information about

usable application commands and devices in this manual when using R2/T2 model. The specification in this manual is major for R2/T2 model so that there are some new commands and functions won’ t be provided for R/T model.



■ **Model Explanation**

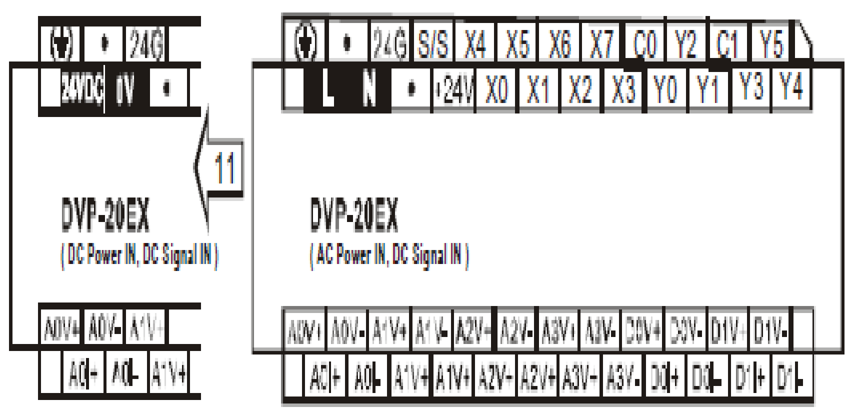


■ **Peripheral Equipment**

- ◎ DVPHPP: Handheld Programming Panel
- ◎ WPLSoft: Windows Ladder Logic Programming Software
- ◎ DPLSoft: DOS Ladder Logic Programming Software
- ◎ DVPACAB115: 1.5M Cable (HPP ⇔ PLC, DVPHPP has this cable attached)
- ◎ DVPACAB215: 1.5M Cable (PC (9 PIN & 25 PIN D-SUB) ⇔ PLC)
- ◎ DVPACAB230: 3M Cable (PC (9 PIN & 25 PIN D-SUB) ⇔ PLC)
- ◎ DVPACAB2A30: 3M Cable (PC (9 PIN D-SUB) ⇔ PLC)
- ◎ DVPACAB230: 3M Cable (PC ⇔ PLC)
- ◎ DVPACAB315: 1.5M Cable (HPP ⇔ PC)
- ◎ DVPACAB403: 30cm Cable (MPU-main processing unit⇔Extension Unit or Extension Unit⇔Extension Unit I/O signal extension cable)
- ◎ DVPAADP01: HPP Power Supply (DVPACAB315 is attached)

B.2: Terminal Wiring

- **Terminals Layouts of Special Function MPU**

DVP20EX	

B.3: Product Profile and Outline

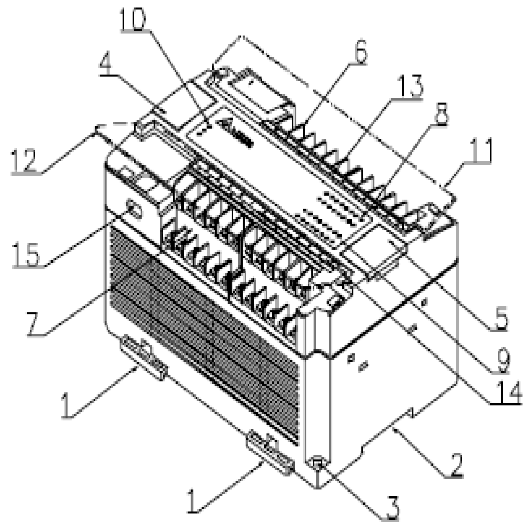


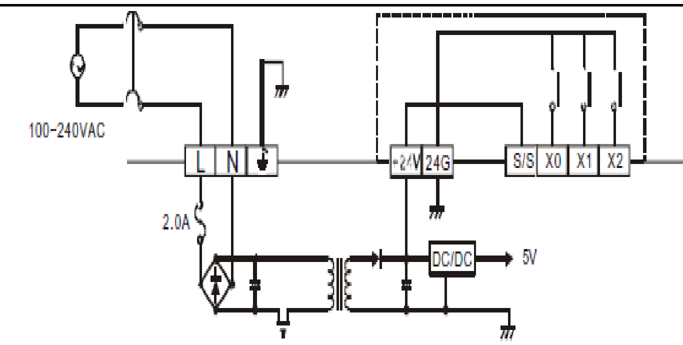
Fig. 1-1: Features of the DVP PLC

1	DIN rail clip	9	Output indicators
2	DIN rail (35mm)	10	Status indicators, POWER, RUN ERROR
3	Direct mounting holes	11	I/O terminal cover
4	Programming port cover (RS-232)	12	I/O terminal cover
5	Extension port	13	I/O terminal nameplate panel
6	I/O terminals	14	I/O terminal nameplate panel
7	I/O terminals	15	RS-485 Communication port
8	Input indicators		

B.4: Power Input Wiring

The following diagram shows various possible external power connections for DVP PLC. When wiring AC power, the 'Live' cable should be connected to the ' L' terminal and the ' Neutral' cable should be connected to the ' N' terminal. When wiring DC power, the 'positive' cable should be connected to the ' +' terminal and the negative should be connected to the '-' terminal. At no time should the power supply terminals be connected to any other terminal on the PLC.

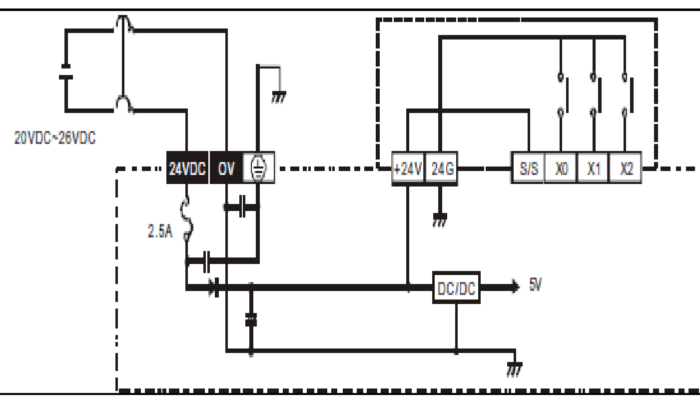
AC Input Type



- The +24V supply output is rated at 0.4 Amperes. DO NOT connect external power supply to this terminal.
- FUSE Protection: there are internal fuses on all DVP PLCs. However, the fuse does not guarantee the prevention of DVP PLC damage, but it will provide added protection.

When DC voltage is supplied to the PLC, make sure the power is at terminals 24VDC and 0V (power range is 20VDC~26VDC). When voltage is lower than 17.5VDC, PLC will stop operating, all outputs will turn OFF and the ERROR LED will flash Continuously.

DC Input Type



Appendix C

C.1 Circular Saw Blade Selection

C.1 Circular Saw Blade Selection:

Diagram for cutting speed

Circular saw blades

The scale shows the cutting speed in m/s, defined by RPM and tool diameter.
Due to the higher risk of kick-back and increased noise. 70 m/s may not be exceeded with MAN labelled tools.
The maximum RPM, labelled on all tools, must not be exceeded. Maximum RPM is not identical with optimum RPM.
The scale shows a guideline of cutting speeds for HW saw blades in relation to the processed material.
When defining the cutting speed range for composite materials the most
difficult material always has to be chosen for definition. On average chip removals of 0,075 should be chosen for larger cutting heights and 0,15 mm for smaller cutting heights.

Cutting speed - Formula

$$v_c = \frac{D \cdot \pi \cdot n}{60 \cdot 1000} \text{ (m/s)}$$

The maximally admissible rpms n up to....
given on the tools, may under no circumstances be exceeded! They mark the safety limit.
They are not identical with the rpm producing the best possible economic efficiency.

D mm \ Speed n (1/min)	1500	2000	2500	2850	3000	4000	4500	5000	5600	6000	8000	9000	10000	12000	18000
50	4	5	7	7,5	8	11	12	14	14,5	16	22	24	28	32	48
60	5	6	8	9	10	13	14	16	17,5	20	26	28	32	40	56
70	5,5	7	9	10,5	11	15	16,5	18	20,5	22	30	33	36	44	66
80	6,5	8,5	10,5	12	13	17	191	21	23,5	26	34	38	42	52	76
90	7	9,5	12	13,5	14	19	21	24	26,5	28	38	42	48	56	84
100	8	10,5	13	15	16	21	24	26	29	32	42	48	52	54	96
120	9,5	13	16	18	19	26	28	32	35	38	52	56	64	76	112
125	10	13,5	16,5	18,5	19,5	27	29	33	36,5	39	54	59	66	78	118
140	11	15	18	21	22	30	33	36	41	44	68	66	72	88	132
150	12	15,5	19,5	22,5	23,5	31,5	33,5	39	44	47	63	70,5	78,5	94,5	141,5
160	13	17	21	24	26	34	38	42	47	52	67	76	84	104	152
180	14	19	24	27	28	38	42,5	48	53	56	76	85	96	118	170
200	16	21	26	30	32	42	47	52	58,5	64	84	94	104	128	188
225	18	24	30	33,5	36	48	58	60	66	72	96	106	120	144	212
250	20	26	33	37	40	52	59	66	72,5	80	104	118	132	160	236
300	24	31,5	40	45	48	63	71	90	88	96	126	142	160	192	284
350	28	36,5	47	52	56	73	83	94	105	112	146	166	188	224	332
400	32	42	54	68	64	84	94	108	117	128	168	188	216	256	376
450	35,5	47	59	67,5	70,5	94,5	106	118	132	141,6	188	211	236	283	424
500	40	53	67	74,5	80	106	118	134	146,5	160	212	236	268	320	472

Mineral fibre plates

Non-ferrous metal
Wood-based material
Plastic material

Natural wood (hard)

Natural wood (soft)

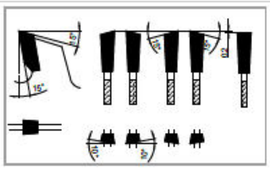
Safety limit

Universal Plus

The improved Universal circular saw blade for cross cuts and mitre cuts.

0515

APPLICATION:	Trimming of wood-based material in finish cut quality
MATERIAL:	Laminated wood-based material including material with very thick top layers, solid wood, plastic profiles, synthetically coated ledges
MACHINE:	Vertical panel sizing saw, trimming saw, CNC or machining centre, double mitre saw
DESIGN:	Reduced kerf; low noise due to specific laser ornaments
TOOTH:	Alternate top bevel tooth (with axial angle) – Alternate top bevel tooth (with axial angle) – Alternate top bevel tooth (with axial angle) – Alternate top bevel tooth (with axial angle) – flat tooth



	D mm	B mm	b mm	d mm	NL mm	Machine	Z	Order No.
NEW	180	3,00	2,20	30			60	051518030
NEW	200	3,00	2,20	30			65	051520030
NEW	220	3,00	2,20	30			70	051522030
	240	3,00	2,20	30	cs pinholes i.W. 8/5,5/52	Homag BAZ	75	051524030
	240	3,00	2,20	40	cs pinholes top clockwise 8/5,5/52	Homag BAZ Flex 5/5+, Weeke	75	051524040
	250	3,00	2,20	30	NLK		80	051525030
	255	3,00	2,20	30	NLK		80	051525530
	303	3,00	2,20	30	NLK	Striebig Altendorf	100	051530330
	355	3,00	2,20	30	NLK		100	051535530
	405	3,00	2,20	30	NLK		120	051540530
	450	3,60	2,80	30	NLK		130	051545030
	500	3,60	2,80	30	NLK		145	051550030

Your advantages with Universal Plus

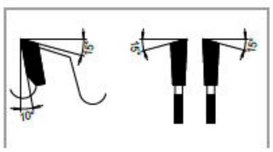
- Specific tooth geometry, aggressive cutting angle
- Very high number of teeth
- Low cutting pressure
- Optimized noise level due to special laser ornaments

Universal circular saw blade

Longitudinal and cross cut

APPLICATION:	Longitudinal cut, cross cut. For thin panel material
MATERIAL:	Solid wood, panel material, thermoplastic material, duroplastic material
MACHINE:	Sizing saw
DESIGN:	Saw blade with high number of teeth. ♪ Soundstar design: noise reduced
TOOTH:	Alternate top bevel tooth (W), HW

0015



	D mm	B mm	b mm	d mm	NL mm	KN mm	Z	Order No.
	150	3,20	2,20	30			48W	001515030
	180	3,20	2,20	30			54W	001518030
	200	3,20	2,20	30			60W	001520030
	220	3,20	2,20	30			64W	001522030
	230	3,20	2,20	30			64W	001523030
☺	250	3,20	2,20	30	NLK		80W	001525030
♪	250	3,20	2,20	30	NLK		80W	011525030
☺	300	3,20	2,20	30	NLK		96W	001530030
♪	300	3,20	2,20	30	NLK		96W	011530030
	350	3,20	2,20	30	NLK		108W	001535130
☺	350	3,50	2,40	30	NLK		108W	001535030
♪	350	3,50	2,40	30	NLK		108W	011535030
	370	3,50	2,40	30	NLK		108W	001537030
	400	3,50	2,40	30	NLK		120W	001540030
	400	3,50	2,40	35			120W	001540035
	450	4,00	2,80	30	NLK		138W	001545030
	450	4,80	3,50	30	NLK		138W	001545031
	500	4,80	3,50	70	6/8/220		96W	001550070
	500	4,00	2,80	30	2/10/80 NLK		144W	001550030
	500	4,80	3,50	30	2/10/80 NLK		144W	001550031

Appendix D

D.1: Power Line Installation

D.2: Basic Inspection

D.3: Pin Definition of Serial Communication

D.4: Specifications

D.1: Power Line Installation

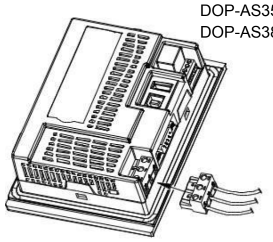
The specifications for power terminal wiring are shown in the table below:

Type	Wire Gauge (AWG)	Stripped length	Torque
Solid	28~12	7~8 mm	5 kg-cm (4.3 lb-in)
Stranded	28~12	7~8 mm	5 kg-cm (4.3 lb-in)

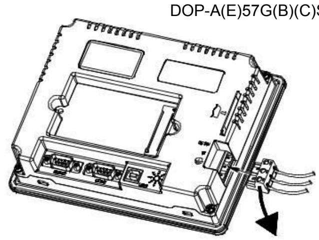
The specifications for communication terminal wiring are shown in the table below (AS Series only):

Type	Wire Gauge (AWG)	Stripped length	Torque
Solid	30 ~ 16	5 ~ 6 mm	2 kg-cm (1.7 lb-in)
Stranded	30 ~ 16	5 ~ 6 mm	2 kg-cm (1.7 lb-in)

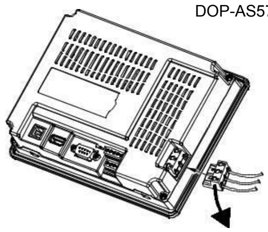
Be sure to plug power line into HMI according to following arrow direction.



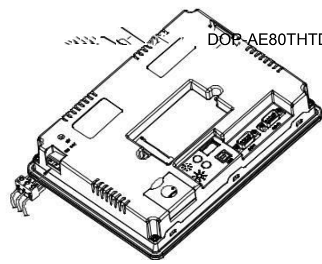
DOP-AS35THTD
DOP-AS38BSTD



DOP-A(E)57G(B)(C)STD



DOP-AS57BSTD



DOP-A80THTD1
DOP-AE80THTD

DOP-A(E)10THTD1

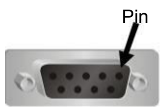
D.2: Basic Inspection

Item	Content
General Inspection	„ Periodically inspect the screws of the connection between the HMI and device. Tighten screws as necessary as they may loosen due to vibration and varying temperatures. „ Ensure that oil, water, metallic particles or any foreign objects do not fall inside the HMI, control panel or ventilation slots and holes. As these will cause damage. „ Ensure the correct installation and the control panel. It should be free from airborne dust, harmful gases or liquids.

Item	Content
Inspection before operation (power is not applied)	„ Ensure that all wiring terminals are correctly insulated. „ Ensure that all wiring is correct or damage and or malfunction may result. „ Visually check to ensure that there are not any unused screws, metal strips, any conductive or inflammable materials inside HMI. „ Ensure to lower electromagnetic interference when devices are influenced by it. „ Ensure that the external applied voltage to HMI is correct and matched to the controller.
Inspection before operation (power is applied)	„ Check if power LED lights. „ Check if the communication among devices is normal. „ Please contact our local distributors or Delta sales representative if there are any abnormal conditions.

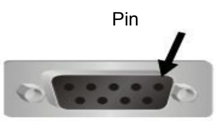
D.3: Pin Definition of Serial Communication

COM1 Port [A, AE and AS57BSTD Series]

COM Port	PIN	Contact
		RS-232
	1	
	2	RXD
	3	TXD
	4	
	5	GND
	6	
	7	RTS
	8	CTS
	9	

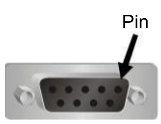
Note: Blank = No Connection.

COM2 Port [A Series]

COM Port	PIN	MODE1	MODE2	MODE3
		RS-232	RS-422	RS-485
	1		RXD-	D-
	2	RXD	RXD+	D+
	3	TXD	TXD+	D+
	4		TXD-	D-
	5		GND	
	6		RTS-	
	7	RTS	RTS+	
	8	CTS	CTS+	
	9		CTS-	

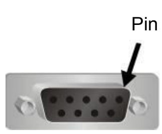
Note 1: Blank = No Connection.
Note 2: When selecting Mode3 (for RS-485), D+ indicates that PIN 2 and PIN 3 is connected, and D-indicates that PIN 1 and PIN 4 is connected.

COM2 and COM3 Port [AE, A80THTD1 and A10THTD1 Series]

COM Port		PIN	MODE1	MODE2	MODE3	MODE4	MODE5	MODE6
			RS-232	RS-422	RS-485	RS-232*2	RS-422*2	RS-485*2
	COM2	1		RXD-	D-		RXD1-	D1-
		2	RXD	RXD+	D+	RXD1	RXD1+	D1+
		3	TXD	TXD+	D+	TXD1	TXD1+	D1+
		4		TXD-	D-		TXD1-	D1-
		5	GND					
	COM3	6		RTS-			TXD2-	D2-
		7	RTS	RTS+		TXD2	TXD2+	D2+
		8	CTS	CTS+		RXD2	RXD2+	D2+
		9		CTS-			RXD2-	D2-

Note 1: Blank = No Connection.
Note 2: When selecting Mode3 (for RS-485), D+ indicates that PIN 2 and PIN 3 is connected, and D-indicates that PIN 1 and PIN 4 is connected.
When selecting Mode6 (for RS-485), D1+ indicates that PIN 2 and PIN 3 is connected, D1- indicates that PIN 1 and PIN 4 is connected, D2+ indicates that PIN 7 and PIN 8 is connected, and D2- indicates that PIN 6 and PIN 9 is connected.

COM1 and COM3 [AS38BSTD, AS35THTD Series]

COM Port		PIN	MODE1	MODE2
			RS-232	RS-232*2
	COM1	1		
		2	RXD	RXD1
		3	TXD	TXD1
		4		
		5	GND	
	COM3	6		
		7	RTS	TXD2
		8	CTS	RXD2
		9		

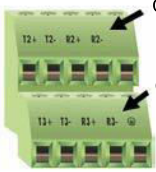
Note: Blank = No Connection.

COM2 Port [AS38BSTD, AS35THTD Series]

COM Port	PIN	MODE1 RS-422	MODE2 RS-485
R- 	R-	RXD-	D-
	R+	RXD+	D+
	T-	TXD-	D-
	T+	TXD+	D+
	G	GND	GND

Note 1: When selecting Mode2 (for RS-485), D+ indicates that R+ and T+ is connected, and D-indicates that R- and T- is connected.

COM2 and COM3 Port [AS57BSTD Series]

COM Port		PIN	MODE1 RS-485*2	MODE2 RS-422*2	MODE3 RS-422
COM2  COM3	COM2	R-	D-	RXD-	RXD-
	COM2	R+	D+	RXD+	RXD+
	COM2	T-		TXD-	TXD-
	COM2	T+		TXD+	TXD+
		G	GND	GND	GND
	COM3	R-	D-	RXD-	CTS-
	COM3	R+	D+	RXD+	CTS+
	COM3	T-		TXD-	RTS-
	COM3	T+		TXD+	RTS+

Note 1: Blank = No Connection.

Note 2: When using RS-422 flow control, please refer to the COM3 Port signals table above for pin assignments. At this time, COM2 and COM3 ports cannot be used individually.

Comparison of Flow Control Protocols

COM Port	DOP-AE Series	DOP-A Series	DOP-AS57 Series	DOP-AS35 / AS38 Series
COM1	RS-232 flow control supported	RS-232 flow control supported	RS-232 flow control supported	RS-232 flow control supported. But, when RS-232 flow control function is enabled, COM3 can not be used.
COM2	RS-422 flow control supported. But, when RS-422 flow control function is enabled, COM3 can not be used.	RS-422 flow control supported	RS-422 flow control supported. But, when RS-422 flow control function is enabled, COM3 can not be used.	RS-422 flow control is not supported.
COM3	RS-422 flow control supported. But, when RS-422 flow control function is enabled, COM3 can not be used.	N/A	RS-422 flow control supported. But, when RS-422 flow control function is enabled, COM3 can not be used.	RS-232 flow control supported. But, when RS-232 flow control function is enabled, COM3 can not be used.

D.4: Specifications

MODEL		AS35THTD	AS38BSTD	AS57B(C)STD	A(E)57BSTD	A(E)57GSTD
LCD MODULE	Display Type	3.5" TFT LCD (65536 colors)	3.8" STN LCD (8 shades of blue)	5.7" STN LCD (8 shades of blue)	5.7" STN LCD (8 shades of blue)	5.7" FSTN LCD (16 shades of gray)
LCD MODULE	Resolution	320 x 240 pixels	320 x 240 pixels	320 x 240 pixels	320 x 240 pixels	320 x 240 pixels
LCD MODULE	Back Light	LED Back Light 30,000 hours half-life at 25°C (Note 1)	LED Back Light 10,000 hours half-life at 25°C (Note 1)	CCFL Back Light (less than 50,000 hours half-life at 25°C) (Note 1)	CCFL Back Light (less than 50,000 hours half-life at 25°C) (Note 1)	CCFL Back Light (less than 50,000 hours half-life at 25°C) (Note 1)
LCD MODULE	Display Size	70.08 x 52.56mm	76.8 x 57.6mm	115.17 x 86.37mm	115.17 x 86.37mm	115.17 x 86.37mm
Operation System		Delta Real Time OS	Delta Real Time OS	Delta Real Time OS	Delta Real Time OS	Delta Real Time OS
MCU		32-bit RISC Micro-controller	32-bit RISC Micro-controller	32-bit RISC Micro-controller	32-bit RISC Micro-controller	32-bit RISC Micro-controller
Flash ROM		Flash ROM 2Mbytes	Flash ROM 1Mbytes	Flash ROM 1Mbytes	Flash ROM 2Mbytes	Flash ROM 2Mbytes
SDRAM		8Mbytes	4Mbytes	16Mbytes	16Mbytes	16Mbytes
Backup Memory (Bytes)		128K	128K	128K	A: 256K AE: 512K	A: 256K AE: 512K

EXT. Memory	SM Card				●	●
	USB Host (Ver 1.1)	●	●	●		
Extension Interface					● (AE)	● (AE)
USB Client		1 USB Client Ver 1.1				
Serial COM Port	COM1	RS-232				
	COM2	RS-422 / RS-485			RS-232 / RS-422 / RS-485	
	COM3	RS-232		RS-422 / RS-485	RS-232 / RS-422 / RS-485 (AE)	
Function Key		User defined key x 4 + System key x 1				
Operation Voltage		DC +24V (-10% ~ +15%) (Please use isolated power supply) (Note 2)				
Backup Battery		3V lithium battery CR2032 x 1 / battery life: 5 years				
Buzzer		85dB				
Perpetual Calendar (RTC)		Built-in				
Cooling Method		Natural air circulation				
Safety Approval (Waterproof for front panel)		IP65 / NEMA4 / CE, UL				
Operation Temp.		0°C ~ 50°C				

MODEL	AS35THTD	AS38BSTD	AS57B(C)STD	A(E)57BSTD	A(E)57GSTD
Storage Temp.	-20°C ~ +60°C				
Ambient Humidity	10% ~ 90% RH [0 ~ 40°C], 10% ~ 55% RH [41 ~ 50°C] Pollution Degree 2				
Vibration Resistance	IEC 61131-2 Compliant 5Hz≦f＜9Hz = Continuous: 1.75mm / Occasional: 3.5mm 9Hz≦f≦150Hz = Continuous: 0.5g / Occasional: 1.0g X, Y, Z directions for 10 times				
Dimensions (W) x (H) x (D) mm	140.8 x 104.8 x 44.8		184.1 x 144.1 x 47		
Panel Cutout (W) x (H) mm	118.8 x 92.8		172.4 x 132.4		
Weight	Approx. 315g	Approx. 310g	Approx. 760g		

1) The half-life of backlight is defined as original luminance being reduced by 50% when the maximum driving current is supplied to HMI. The life of LED backlight shown here is an estimated value under 25°C normal temperature and humidity conditions.
2) Users please use isolated power supply except DOP-A80THTD1, DOP-AE80THTD and DOP-A(E)10THTD1 these models.
3) Users can download the Screen Editor V1.05, the program editor of Delta HMI product and the user manual via the following link: http://www.delta.com.tw/industrialautomation/.
4) The content of this quick start may be revised without prior notice. Please consult our distributors or download the most updated version at http://www.delta.com.tw/industrialautomation/.

MODEL	A(E)57CSTD	A80THTD1	A(E)10THTD1

			AE80THTD	
LCD	Display Type	5.7" STN LCD (256 colors)	8" TFT LCD (65536 colors)	10.4" TFT LCD (65536 colors)
	Resolution	320 x 240 pixels	640 x 480 pixels	
	Back Light	CCFL Back Light (less than 50,000 hours half-life at 25°C) (Note 1)		CCFL Back Light (less than 30,000 hours half-life at 25°C) (Note 1)
	Display Size	115.17 x 86.37mm	162.2 x 121.7mm	211.2 x 158.4mm
Operation System		Delta Real Time OS		
MCU		32-bit RISC Micro-controller		
Flash ROM		Flash ROM 2Mbytes	Flash ROM 6Mbytes	
SDRAM		16Mbytes	32Mbytes	32Mbytes
Backup Memory (Bytes)		A: 256K AE: 512K	512K	512K
EXT. Memory	SM Card	●	● (AE)	
	USB Host (Ver 1.1)		●	●
Extension Interface		● (AE)	● (AE)	● (AE)
USB Client		1 USB Client Ver 1.1		
Serial COM Port	COM1	RS-232		
	COM2	RS-232 / RS-422 / RS-485		
	COM3	RS-232 / RS-422 / RS-485 (AE)	RS-232 / RS-422 / RS-485	
Function Key		User defined key x 4 + System key x 1	User defined key x 6 + System key x 1	User defined key x 7 + System key x 1
Operation Voltage		DC +24V (-10% ~ +15%) (Please use isolated power supply) (Note 2)		
Backup Battery		3V lithium battery CR2032 x 1 / battery life: 5 years		
Buzzer		85dB		
Perpetual Calendar (RTC)		Built-in		
Cooling Method		Natural air circulation		
Safety Approval (Waterproof for front panel)		IP65 / NEMA4 / CE, UL		
Operation Temp.		0°C ~ 50°C		
Storage Temp.		-20°C ~ +60°C		
Ambient Humidity		10% ~ 90% RH [0 ~ 40°C], 10% ~ 55% RH [41 ~ 50°C] Pollution Degree 2		