University of Southern Queensland

Faculty of Engineering and Surveying

Design and Development of a Conveyor System for Semiconductor Industry

A dissertation submitted by

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In fulfilment of the requirements of

Courses ENG4111 and 4112 Research Project

towards the degree of

Bachelor of Engineering (MECHANICAL)

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Abstract

Conveyor system is an essential part in a Semiconductor Industry. It is used to transfer leadframes from one work station to another. As leadframe is a very delicate item and care must be taken not to damage them as any scratch marks or dents found on it will lead to it being scraped. Therefore, the design of the conveyor system is important. A good conveyor system will help to save up in the production process, time and most importantly cost.

Nowadays, companies with high end products have suddenly swamp into Singapore. This is due to it's attractive location, extensive telecommunications connectivity, superior logistics and supply chain infrastructure. Companies like Matsushita Electric and Chartered Semiconductor has invested hundreds of million dollar into it. These show that the semiconductor market is in the midst of a strong growth in equipment and materials, and all indications are that this trend will continue for a long time. Therefore a good process line is required for the manufacturing of the products in order to keep pace with the ever increasing demand. This is when a good conveyor system comes in handy.

The main objectives of this research project are to:

- Design and develop a custom made conveyor system to help in transferring the leadframe from the press machine to the stacker, whereby the leadframe will be nicely stack up after being cut, without damage.
- Separate the four strands of leadframes that is been cut out from a coil by the press machine, to aid in the stacking process.
- Save production process, time and cost.

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Limitations of Use

Certification

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Student Number : 0031135732

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Signature

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Date

Acknowledgements

I would like to express my sincere thanks to both my supervisors, Dr. Harry Ku and Dr. Yen Wenyi, for their endless help and guidance in making this project possible and successful.

In addition, I would also like to thank my subordinates and staff of SMMAP for their understanding and assistance in helping me towards completing the project.

Lastly I would like to thank my family and girlfriend for their fully support.

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Symbol	Description
Si	Silicon
Al	Aluminium
Au	Gold
Ag	Silver
Cu	Copper
C.G.	Centre of Gravity

Chapter 1

Introduction

Nowadays modern manufacturing methods dictate the use of material handling systems. Material handling is an integral part of many continuous processes. There are two basic methods used for moving materials: nonpowered material handling systems and powered material handling systems.

Nonpowered systems use gravity as the motive force and include devices such as chutes and slides, which are the simplest and least expensive methods available. However they require the starting point to be at a certain minimum elevation higher than the end point. In most material handling situations, this is rarely the case.

For moving material horizontally, vertically, over extended distances, or in a controlled fashion, powered material handling systems are required.

1.1 Importance of a Conveyor System

Conveyors, a type of materials handling system, are an essential part of large-scale production and continuous processes. They are used in such diverse fields as agriculture, food processing, plastics manufacturing, mining industries, and most important of all, semiconductor industries. Some conveyors can provide minor processing functions such as heating and cooling, but this is supplementary to the primary materials handling function.

Conveyor system is an essential part in a Semiconductor Industry. It is needed during the work process to transfer leadframe from one work station to another. Leadframe is a very delicate item and care must be taken not to damage them as any scratch marks or dents found on it will lead to it being scraped. Therefore, the design of the conveyor system is important. The materials, speed and belt used play an important part in the designing process. A good conveyor system will help to save up in the production process, time and most importantly cost.

1.2 Definition of Conveyor System

The following gives the definition of a conveyor:

A conveyor includes all fixed and portable equipment capable of moving material in a continuous or intermittent fashion, between two or more points, along a fixed path. While the material may be delivered intermittently, the drive operates continuously. The movement of material can be horizontal, vertical, inclined, or any combination of the three.

In order for a person to select a conveyor system, one is to have an understanding and familiarity of the specific process to which the equipment is to be applied. This knowledge is invaluable and may make the difference between a successful application and a failure. It is the small neglected detail in the process or the conveyed material that can lead to a system plagued with problems and unexpected downtime.

1.3 Types of Conveyor System

There are so many kinds of conveyor in the market. Which one of them is most suitable to be used in this project has to depend on its functionality. Let us look at some of the common types of conveyor.

1.3.1 Powered Rollers

Powered rollers conveyors, straight or curved, are extensively used for heavy and arduous applications such as rolling mills and foundries. They are also an ideal medium in package handling for systems where it is necessary to stop, meter, or manipulate articles without stopping the conveyor. It is also an economical way of moving heavy loads in limited space.

1.3.2 Chain

Chain conveyors have been designed to cover many varied applications in industry and employ several distinct patterns including twin chain, multiple chain, in-floor, on-floor and heavy duty overhead. They are particularly useful where high temperatures are involved, and special designs with expansion joints and automatic spray lubrication are available.

1.3.3 Belt

Belt Conveyors are probably the most widely used of all the various types of conveying equipment. They are extremely versatile and there are many variations. The range varies from very small conveyors used in packaging machinery through to heavy duty conveyors used for bulk materials. They usually consist of moving single or multiple endless bands of material upon which the product sits and is conveyed. The belts can take a straight path or can be twisted through more complex paths.

1.3.4 Slat

Slat conveyors are most suitable for use when the unit loads are beyond the capacity of belt conveyors, or where heat or other adverse conditions render the use of the latter impracticable. They are frequently fitted with chains having oversized rollers. The larger the roller diameter, by reducing the number of revolutions per roller, increases chain life and also allows the use of heavier chain sprockets. Slat conveyors are extremely versatile, not only because their design and construction is simple but also because maintenance and tracking problems are minimal. They are also excellent for heavy loads and rough treatment.

Chapter 2

Background

Nowadays, companies with high end products have suddenly swamp into Singapore. This is due to its attractive location, extensive telecommunications connectivity, superior logistics and supply chain infrastructure. These show that there is a high demand for the semiconductor products.

2.1 Overview of Semiconductor Industry

According to Stanley T. Myers, President and CEO, SEMI, these companys continue to see Singapore as an attractive location because of its business-friendly environment, respect for intellectual property, extensive telecommunications connectivity, skilled workforce, and superior logistics and supply chain infrastructure.

Evidence of this is the continued investments in the IC manufacturing sector that have reinforced Singapore’s role as a regional center for semiconductor production.

STMICROELECTRONICS NV, Europe's largest semiconductor maker, will invest another $2 billion over the next two years in Singapore, a move that will bring its total investment here to $6.7 billion by the end of 2006.

STMicroelectronics, which accounted for about 19 per cent of Singapore's semiconductor production last year, will invest the funds to increase its capacity. Last year, its manufacturing output in Singapore was $3.9 billion, compared with overall industry production in the nation of $21 billion, according to Trade Minister Lim Hng Kiang.

STMicroelectronics, based in Geneva, said that it made chips in Singapore for products such as cell phones equipped with digital cameras. According to a company press release, STMicroelectronics is the only semiconductor company in Singapore with a fully-integrated manufacturing value-chain employing about 7400 staff.

Several other device makers have increased their resources in Singapore recently. They include Matsushita Electric Industrial, which selected Singapore as the site for a new S$150 million assembly and test facility for charged coupled device (CCD) image sensors. Last year Infineon Technologies announced plans to increase its R&D headcount here to more than 350 and to make Singapore its global logic IC testing hub. In February, Xilinx said it would establish its Asia Pacific headquarters in Singapore, employing about 200 people. Then a month later foundry Chartered Semiconductor Manufacturing revealed plans to start outfitting its 300mm fab shell.

For SMMAP, the sponsor of this project, it has been constantly upgrading its working processes and machine performances to cope with the ever increasing high demands and standards of semiconductor products.

In addiction to device makers, equipment and materials suppliers view Singapore as a favourable location for key manufacturing and logistics operations. Over the past few years, several equipment suppliers have boosted their presence here, by tapping into the excellent infrastructure for the manufacture of subsystems and components.

All these companies have invested millions of dollars for the new technologies and facilities. These show that the semiconductor market is in the midst of a strong growth in equipment and materials, and all indications are that this trend will continue for a long time.

According to a source from SICAS, in a market where the 2004 August year-to-date world growth rate is 35 %, Asia-Pacific is growing at a rate of 50% and the three other regions are growing by roughly half of that. The Asia-Pacific share of the world market has grown to 42 %. Semiconductors are made to be assembled into end electronic equipment, which is what Asia-Pacific has grown increasingly adept at doing well and at the right price. Figure 2.1 shows the regional market trends for Semiconductors.

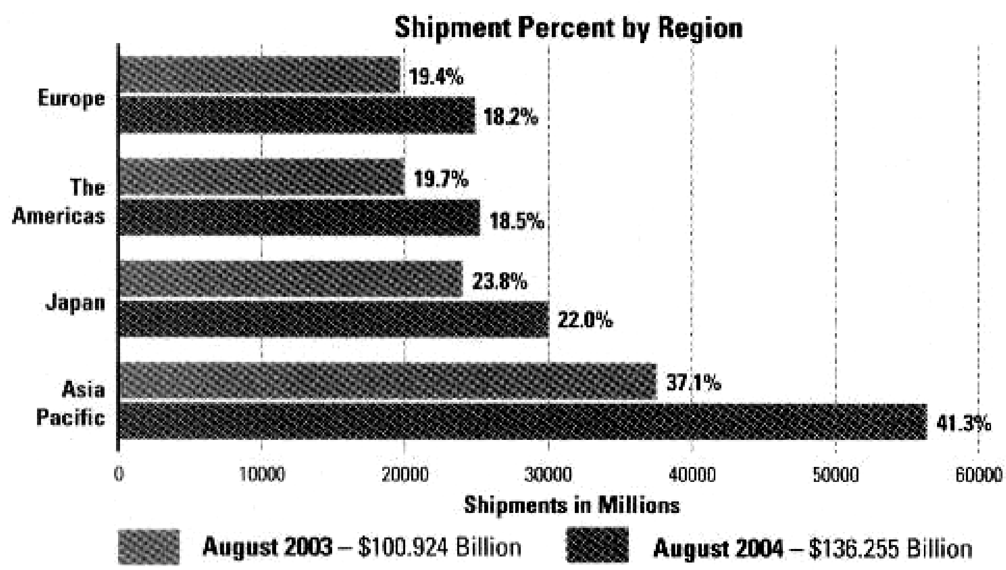


Figure 2.1 Regional Market Trends for Semiconductors

These show that there is a high demand for the semiconductor products. Therefore a good process line is required for the manufacturing of the products in order to keep pace with the ever increasing demand. This is when a good conveyor system comes in handy.

2.2 Definition of Leadframe

Other than common items like IC Chips, transistor, LED & wafers, leadframes are also one of the products from semiconductor industry. Over SMMAP, surface plating of lead frame is been processed and the end products are mainly in both coil form or strip form. It is the processing of leadframe that SMMAP is dealing with. Figure 2.2 shows the different types of leadframes.

Figure 2.2 Different Types of Leadframes

Leadframe is the skeleton of the IC package, providing mechanical support to the die during its assembly into a finished product. It consists of a die paddle, to which the die is attached, and lead fingers, which serve as the means for external electrical connection to the outside world. The die is connected to the lead fingers by wires through wirebonding or by tape automated bonds. Figure 2.3 shows the features of a leadframe. Leadframes are used in almost all semiconductor packages.

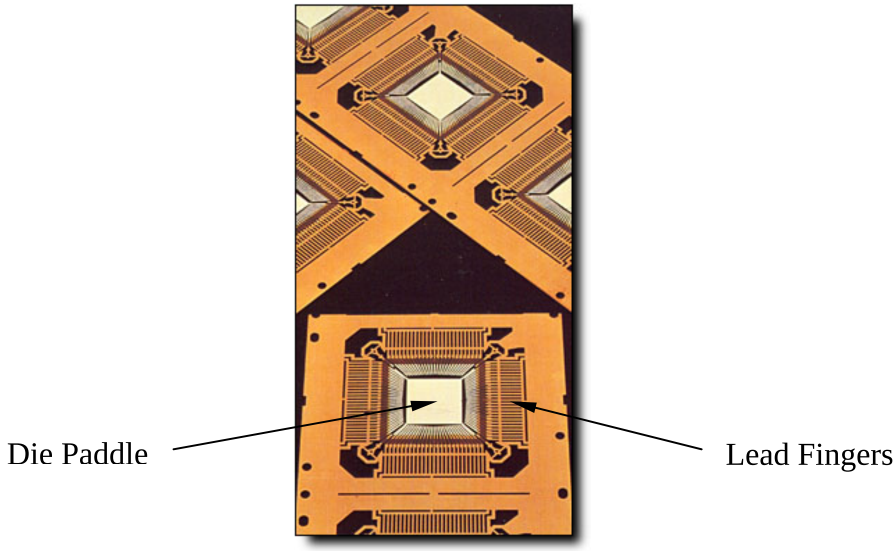


Figure 2.3 Features of Leadframe

Plastic package leadframes are made of alloys that meet the following critical properties: good adherence to the molding compound, a coefficient of thermal expansion as close as possible to those of the die and the molding compound, high strength, good formability, and high electrical and thermal conductivities. Alloy 42 is an example of such an alloy. However most of the leadframes are made of Cu.

2.3 Most Common Basic Elements

2.3.1 Silicon

Si is the most commonly used basic building block of integrated circuits. Si is a semiconductor, which means that its electrical behavior is between that of a conductor and an insulator at room temperature.

Aside from being used as semiconductor substrate, Si is also widely used as dielectric in integrated circuits, usually in the form of silicon dioxide. Dielectric layers are used to isolate conductive lines and the individual components in the circuit from each other.

Si is also widely used in semiconductor packaging, being the main ingredient of plastic encapsulants for integrated circuits. It is also used in die overcoats.

Property	Value	Property	Value
Atomic Number	14	Melting Point	1410 deg C
Atomic Group	14 or IVA	Boiling Temp	2355 deg C
Atomic Weight	28.086	Specific Gravity	2.33

Table 2.1 Silicon's Basic Properties

2.3.2 Aluminium

Al is a lightweight metal with silvery appearance. It is the most abundant metallic element on earth. It is used in many aspects of semiconductor manufacturing. On the integrated circuit, Al metal lines are commonly used as the main conductor between components, mainly because of its low resistivity (2.7 mohm-cm). As a thin film, it also has good adherence to silicon dioxide.

Al is also the metallization used for the bonding and probing pads on the die. When used for IC metallization, Al is usually very lightly doped with other elements such as Si and/or Cu to improve its characteristics and reliability.

In semiconductor assembly, ceramic packages are composed mainly of alumina. Al is also used for wirebonding integrated circuits in ceramic packages.

Property	Value	Property	Value
Atomic Number	13	Melting Point	660 deg C
Atomic Group	13 or IIIA	Boiling Temp	2467 deg C
Atomic Weight	26.9815	Specific Gravity	2.7

Table 2.2 Aluminium's Basic Properties

2.3.3 Gold

Au is a soft metallic element that is bright yellowish in color. A good conductor of heat and electricity, it is also the most malleable and ductile of all metals.

Au is used in many aspects of semiconductor manufacturing, particularly in the assembly or packaging processes. Its most widespread use is in wirebonding. Because of its excellent conductivity and ductility, it is extensively used in making wires for the connection of the integrated circuit to the leads of the package. Aside from manufacturability, the ductility of Au wires offers one more advantage when used in plastic-encapsulated devices, i.e., it makes the wires resistant to wire breaking during the encapsulation process.

Au is also used as die attach material for the eutectic die attach process, which is commonly used in old hermetic assembly processes. It is also used to cover the die cavity and bonding posts of ceramic packages to protect these from chemical degradation.

Property	Value	Property	Value
Atomic Number	79	Melting Point	1064 deg C
Atomic Group	Transition Elements	Boiling Temp	2808 deg C
Atomic Weight	196.97	Specific Gravity	19.3

Table 2.3 Gold's Basic Properties

2.3.4 Silver

Ag is a shiny metallic element used for ornamental and coinage purposes since the ancient times. It is next only to gold in terms of malleability and ductility, and is also a good conductor of heat and electricity. In fact, silver is the best conductor of electricity, better even than copper and gold.

Ag, like Au, is used in many facets of semiconductor manufacturing, again more particularly in the assembly or packaging processes. Most epoxy die attach materials contain silver fillers for increased thermal and electrical conductivity. Ag is also used to cover the surfaces of the die pad and bonding fingers of the leadframes of plastic packages to prevent chemical degradation of these areas, which may lead to die attach and bonding problems.

Property	Value	Property	Value
Atomic Number	47	Melting Point	962 deg C
Atomic Group	Transition Elements	Boiling Temp	2212 deg C
Atomic Weight	107.868	Specific Gravity	10.5

Table 2.4 Silver's Basic Properties

2.3.5 Copper

Cu is one of the most widely used metals in the history of mankind, mainly because of its many desirable properties. It is the second best conductor of electricity, next only to silver but better even than gold. It is also very malleable and ductile, and is also a good conductor of heat.

Cu is also widely used in semiconductor assembly. For instance, most leadframes for plastic packages are composed of copper. The leadframe is the skeletal support of a plastic package.

Cu, being an excellent conductor, would have been a very good candidate for use in metal lines in an integrated circuit, but difficulties in the manufacturing of IC's using Cu for metallization resulted in Al being the metal of choice for this purpose. Recent technological advancements though have already allowed the use of Cu as metal lines in semiconductor devices.

Property	Value	Property	Value
Atomic Number	29	Melting Point	1083 deg C
Atomic Group	Transition Elements	Boiling Temp	2567 deg C
Atomic Weight	63.546	Specific Gravity	8.9

Table 2.5 Copper's Basic Properties

2.4 Types of Processes

The processes of a leadframe can be categorized into two types: the wet process and the dry process.

2.4.1 The Wet Process

In wet process, chemical solutions and water is used throughout the etching, plating and cleaning processes. Etching consists of selectively covering the sheet metal with photoresist in accordance with the pattern of the leadframe. The sheet metal is then exposed to chemical etchants that remove areas not covered by photoresist.

Silver plating is done on the bonding fingers and die-pad to improve wirebond and die attach quality. After that the whole strip is cleaned with distilled water to remove all the chemical solution before passing through a blower to dry up. The end product is then coil up again for the subsequent dry process.

2.4.2 The Dry Process

For dry process, no chemical or water is needed. During this stage, taping, down-setting and cutting is done.

Taping consists of putting a lead lock tape over the leads to prevent lead deformation, while downsetting consists of pushing the die paddle down relative to the bonding fingers in compliance with standard industry requirements.

In Cutting, the required length of the leadframe is cut out from the long strip of coil using a stamping machine. From here the leadframe is then sent to a machine called ‘Stacker’ to stack up the strips of leadframe. For this to be able to carry out, a conveyor system is necessary.

Whereas only occasional rollers along the work station are used to support the leadframe for the rest of the process. Since the leadframe is in a long strip and moving of the leadframe from one process to the other is done by a driver. So it does not need a conveyor system. Figure 2.4 shows a flow chart of the various types of work process for leadframe.

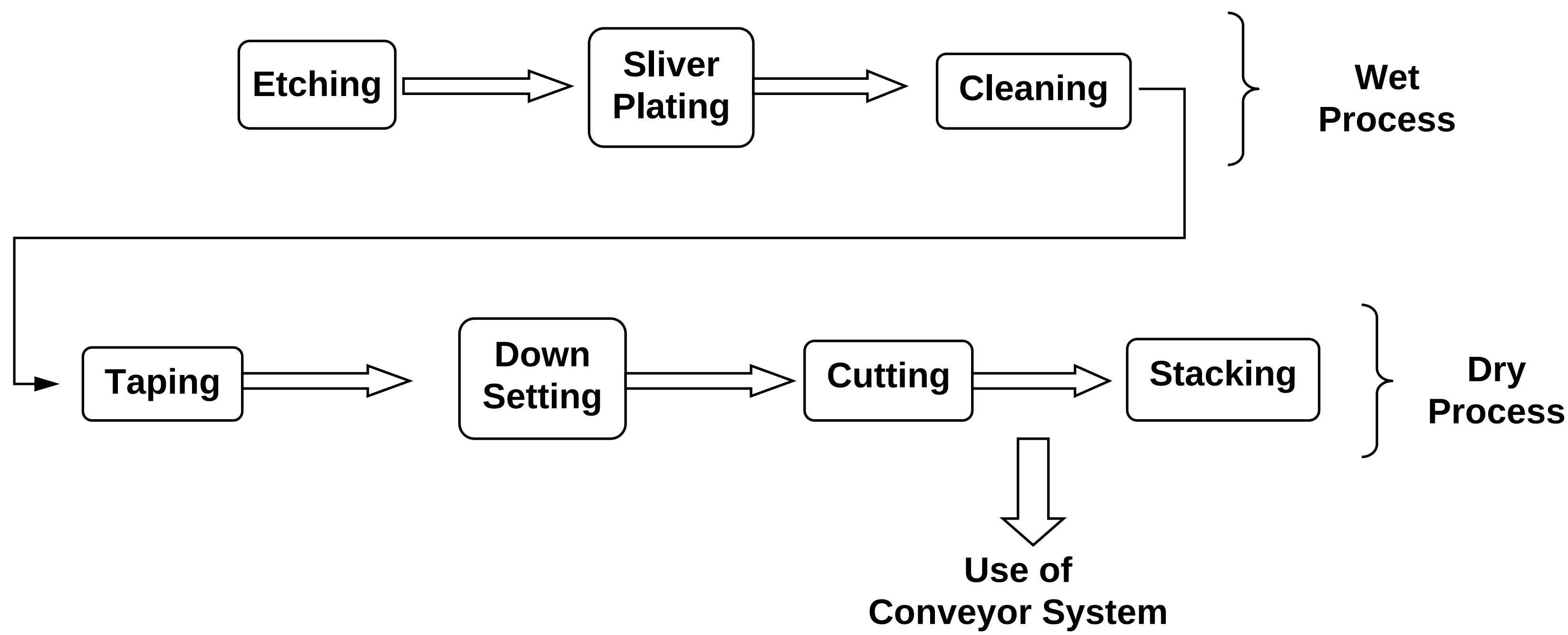


Figure 2.4 Work Process of Leadframes

Chapter 3

Objectives of the Project

The objectives of this project is to develop a custom made conveyor system to help in transferring the leadframe from the press machine to the stacker, whereby the leadframe will be nicely stacked up after being cut, without damage. It must link up well with the press and stacker machine. In addition, it must be able to separate the many strand of leadframes cut out by the press machine at a time to aid in the stacking process. This ultimate system will help to save a lot in the production process, time and cost.

The purpose of the project is also to conduct research studies on the various types of conveyors regarding its capabilities, materials used and work performances. Develop a custom made conveyor that is able to perform up to the highest standard and on top of that it must suit the kind of work processes required by semiconductor industry. It will generally help in the various aspects of the engineering productions.

Chapter 4

Methodology

Before starting on the project, a detail specification had to be prepared for the conveyor to be based on. So a meeting with the people involve is a must so that the project group can have a better understanding of the require system. Typically, the specification will contain information regarding the size, capacity, and layout of the conveyor system.

The peoples involve in the meeting include the customers, project managers, engineers, supervisors, technicians and even the operators from the related field.

4.1 Gathering of Information

Information regarding the project can be gathered through discussions and meetings. It is at this stage that a lot of matters have to be discussed. It is important that any issues regarding the project to be voiced out and discuss in order to have a clearer overview of what should be done. Below are the main areas.

4.1.1 Problems Encountered

Currently the present conveyor systems have a lot of problems. After checking, it was found that the systems cannot meet the new requirement and some of problems are due to wear. Below are the problems faced by the operators during production:

- Speed of the present conveyor is too slow and it cannot catch up with the outputs from the new press machine.
- It can only handle one piece of leadframe at a time.
- Conveyor belt gets loose easily. It does not have a proper tension.
- Black residue can be found around the bearings. It may due to wear.
- Conveyor belt tends to run and it is not in the center during operation.

4.1.2 Project Specifications

Specification of system is base on the customer requirement, so the system built must either meet the specification or exceeds the expectation. Below are some of the important areas:

- The different sizes of the leadframe which is to be run in the production.
- The speed range that the press machine has to be operated during production.
- The specific type of material that must be used for the system.
- The overall size of the whole system.
- The power rating for the electrical supply.
- The project schedule to let people.

4.1.3 Allocating of Task

Task allocating is important as it gives the people involved a clearer view of their responsibilities and their job scope. The type of task include:

- Overall in-charge of the project.

- The new concept design for the new stacker machine with the conveyor system.
- Mechanical installation for the whole unit.
- Electrical wiring and test run of the unit.

After the meeting with the persons involved, all the specifications and information is consolidated. Any changes to all these from the customer have to be discussed again and updated to everyone involved quickly. That is often why there are a few meetings to a project. The specifications and schedule for the project is tabulated and compiled in Appendix B and Appendix B respectively.

However customer must decide on their final requirements as soon as possible and a time limit to the changing of project specifications must be specified. If the specifications are to keep changing, designers will have a hard time in carrying out their design work. Because the designers have to change their designs according to the specifications. These make work difficult for them and are very time consuming. It will delay their work and as a result, it will affect the whole project schedule.

As this project is shared among a few people therefore communication and cooperation is important. Understanding of the peers' work is vital especially when there is a linkage between each other designs. It is not uncommon to find that the design of one component hit the other part of the design if there is a communication breakdown between the project team members. Therefore teamwork is very important.

4.2 Development of Ideas

Design of the conveyor system takes time and it often involves a lot of research and experiments. Ideas can come from different sources.

Brainstorming is the best way but this requires a group of staffs, and the more the better. Often in this situation what you cannot think of, others can. So there are a lot of ideas generate from here. Consulting professional and experienced personnel can help too as they can give valuable advices. This can save us lots of trouble during the design stage. If not, studying the various existing conveyors and combine their best feature together into a design is also another way. However not every features can be implemented into a design as it depends on the limitations and their relevance to the work process.

After hearing advices from peers and supervisor and through observation of the existing conveyor in the production floor. I had decided to design the conveyor system base on belt conveyor type. Belt conveyor is the most suitable design as compare to the rest of the conveyor since the load is very light and it suits the application.

Figure 4.1 and Figure 4.2 show two top views of the preliminary designs.

Figure 4.1 uses four conveyors to transfer each of the leadframe to their destination. This is a very simple and direct design. However after studying, it is noticed that it is impossible to put the conveyor side by side as the width of the conveyor must be very small. It is very difficult to fabricate a small conveyor.

Moreover the different sizes of the conveyors have to be used when different sizes of the leadframe is been worked on. Time and cost is an important factor in production and we cannot waste time in changing the conveyors and it is ridiculous to have so many different sizes of conveyor. After the long strip of leadframe is been cut out, the four small pieces of leadframes are separated from each other by about 3-5 mm apart. As the gap between the leadframes is small, there may be a tendency that the leadframes will jam at the entrance of the conveyor prior to entering. So this design is not workable.

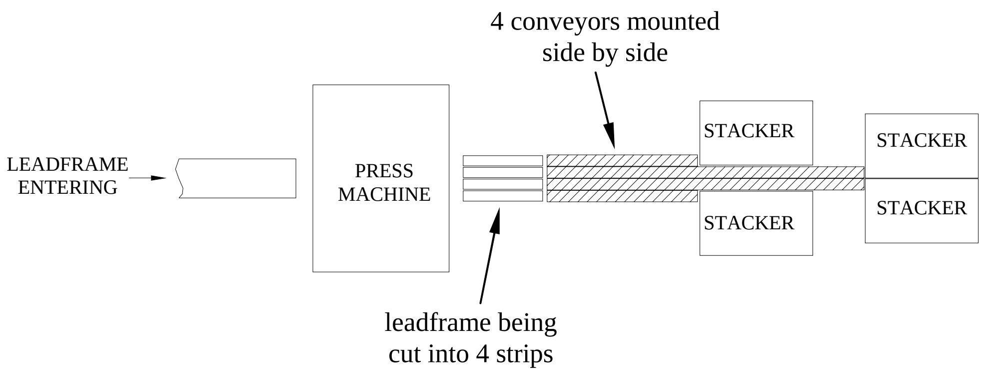


Figure 4.1. Top View of 1st Design

Let us now study Figure 4.2, the next design. A main conveyor is used to transfer the leadframes to their respective small conveyor with the aid of two separators. The separators are use to separate the leadframes further apart and they also prevent leadframes from jamming at the entrance of the small conveyors. The four small conveyors are not placed side by side; instead they are located further from each other. In this way, they can be of bigger size to cater for all the different sizes of leadframe. For this design, the small conveyor does not have to change to run all the defferent sizes of leadframe. As such, there is no need to have so many sizes of conveyors. So this design is very much preferred.

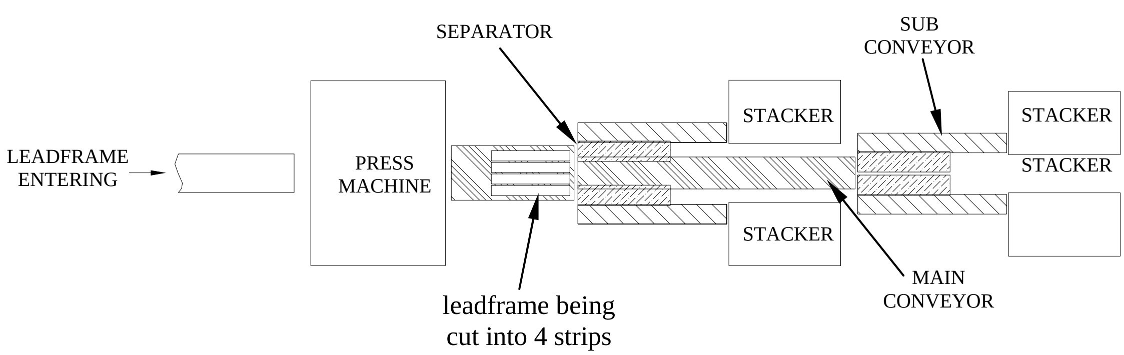


Figure 4.2 Top View of 2nd Design

4.3 Finalisation of Design

After much simulation using the drawing software, AutoCAD, it was realised that the 1st design is definitely not workable. Since the gap between each leadframe is only 3-4 mm, it is impossible to have a side plate of the conveyor to be 2 mm if they are to be placed side by side. As mentioned earlier, the 2nd design is workable and the final design will base on this concept. This design is made up of one main conveyor, four sub-conveyors and two separators. This design actually incorporates both the powered material handling system and the nonpowered material handling system. The former being the conveyors and the latter refers to the separators. See Figure 4.3 for the final design.

4.3.1 Working Principle

There are basically two processes to the operation: The 1st stage and the 2nd stage.

<u>1st Stage</u>

After the long strip of leadframe is being cut out into four leadfames of smaller length and width, they are being transferred out of the press machine by the main conveyor to the 1st separator. Due to the offset of the centre of gravity, the two outermost leadframes will tilt to one side of the separator. Eventually the leadframes slide down the separator due to their own weight. When the leadframes reach the end of the separator, they will drop to the sub-conveyor and then transferred to the stacker unit to stack up. Refer to Figure 4.4 and Figure 4.5.

As for the two centre leadframes, they will start to slide down the plate to the bottom main conveyor when they, together with the two outermost leadframes, reached the end of the top main conveyor. They continue to travel along the main conveyor until they reach the 2nd separators. Refer to Figure 4.4 and Figure 4.6.

In short, 1st stage of the operation is to separate the two outermost leadframes from the four pieces of leadframes.

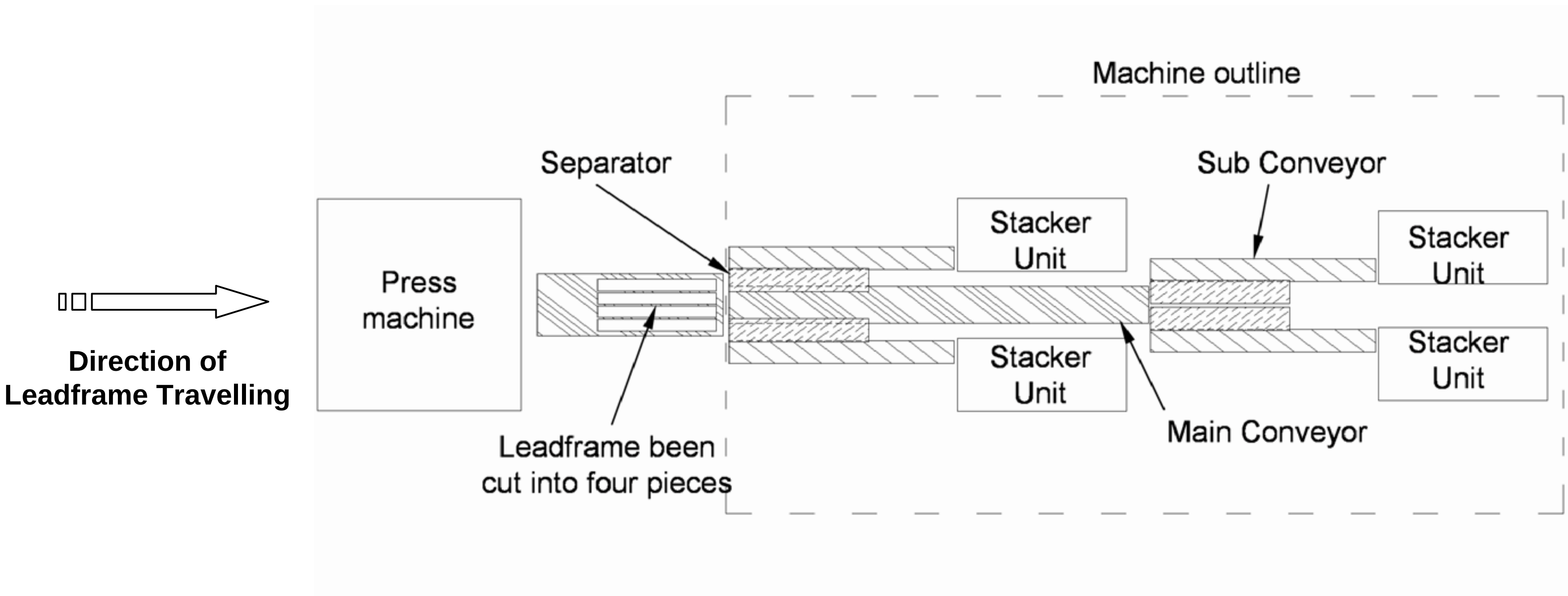
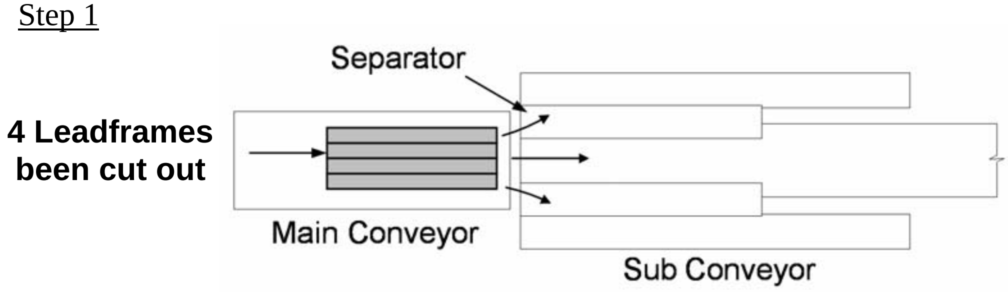


Figure 4.3 Plan View of Design

Step 1



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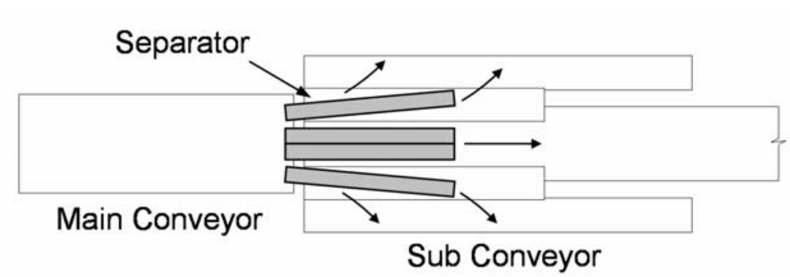

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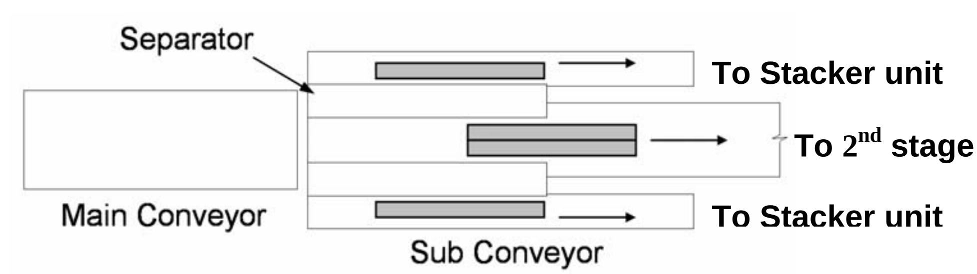


Figure 4.4 Top View Showing How Outermost Leadframe are Separated (1st Stage)

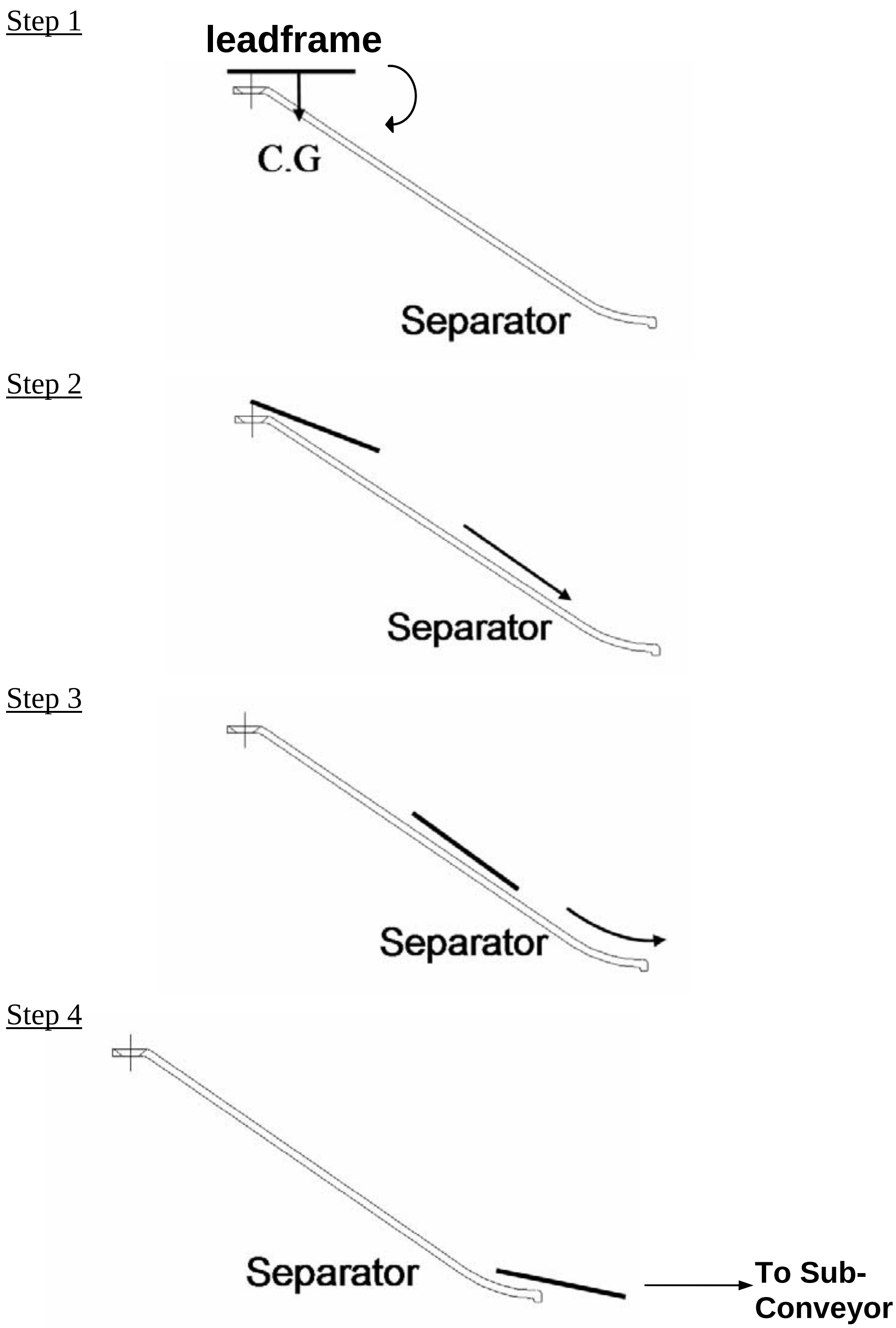
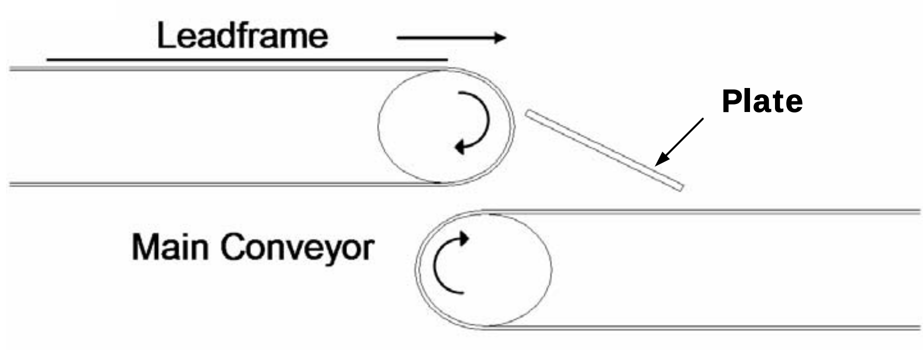


Figure 4.5. Side View Showing Outer Leadframe Sliding Down the Separator

Step 1



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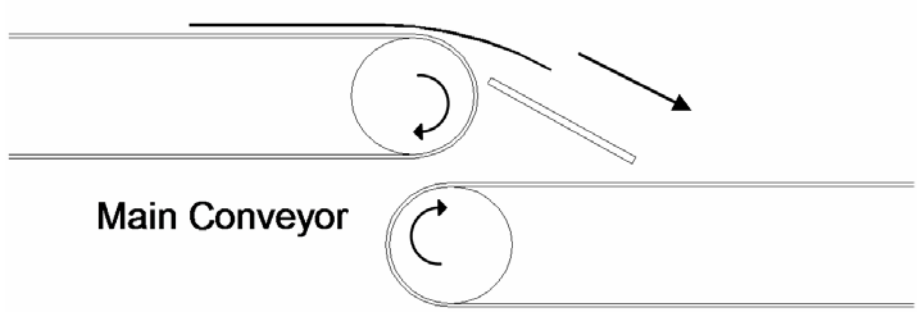

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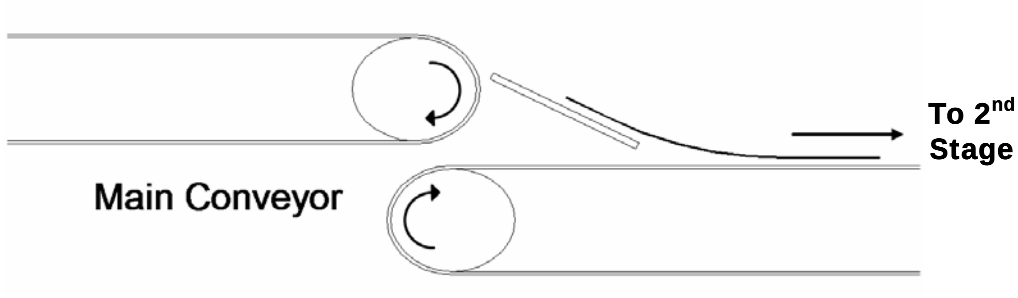


Figure 4.6 Front View Showing Inner Leadframe Moving Along the Main Conveyor

2nd Stage

When the two central leadframes reach the second separator, their centre of gravity is being offset. So they slide down to the other two sub-conveyors due to gravity. They are then transferred to the allocated stacker respectively for stacking up via the other two sub-conveyors. Refer to Figure 4.7 and Figure 4.8.

In short, the 2nd stage of the process is to separate the final two central leadframes.

4.4 General Approach

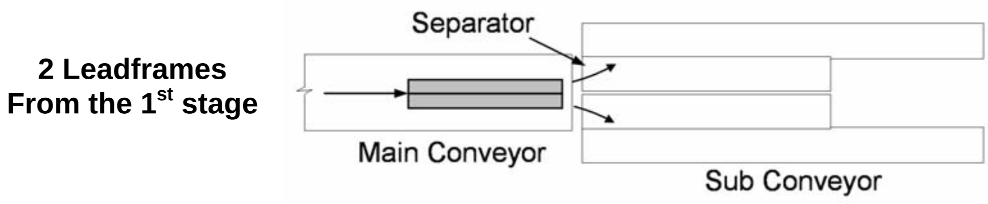
After the concept of the design is out, it is then possible to choose the component parts. The selection for the component parts is discussed in Chapter 5.

With the size of all the component parts determined, a detailed assembly of all the parts is drawn out with the aid of AutoCAD software. At this stage, careful attention is needed or else one will encounter a lot of problems during the assembly of the parts. Designers must have a clear mind and be able to visualize any obstruction in fixing up the conveyor system.

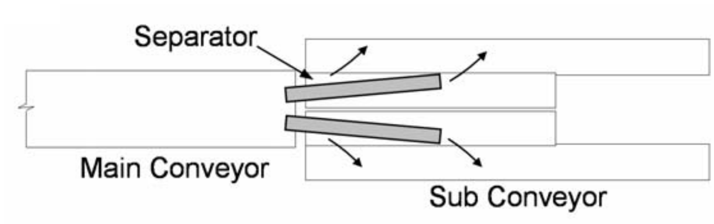
After sizing is done and the parts drawing drawn, I need to source for the vendors and get a few quotations for all the parts needed. It is good to find as many vendors as possible during sourcing so that the prices and the lead time for the parts can be compared. Only then can I gauge which one is the most desirable.

If time is limited, I can distribute some parts out to different vendors to fabricate. But one thing I need to take note of is that for those parts to be fitted together, eg. bush and shaft, have them fabricated by the same vendor. So that they can control the tolerances of the parts and the situations whereby the parts unable to fit or too loose will not happen. Some of the general information for designing work can be found in Appendix D.1.

Step 1



Step 2



Step 3

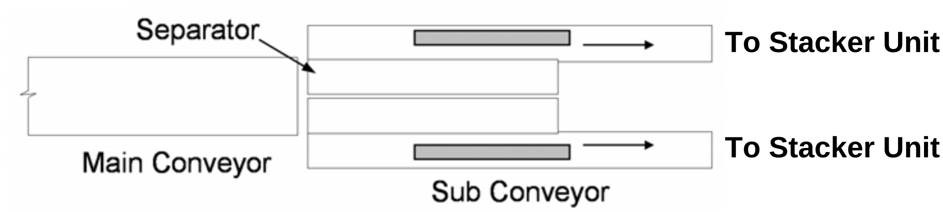
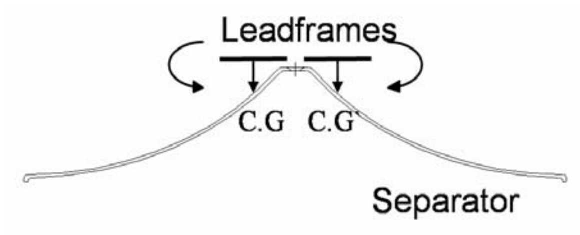
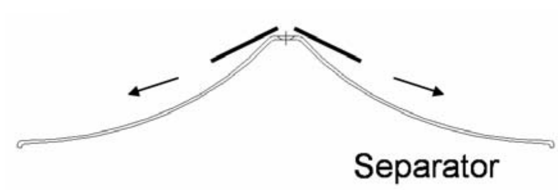


Figure 4.7 Top View Showing How Inner Leadframes are Separated (2nd Stage)

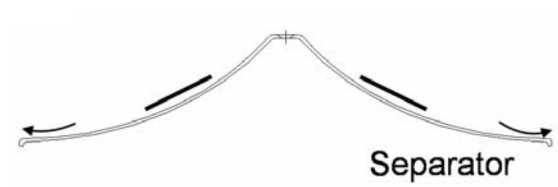
Step 1



Step 2



Step 3



Step 4

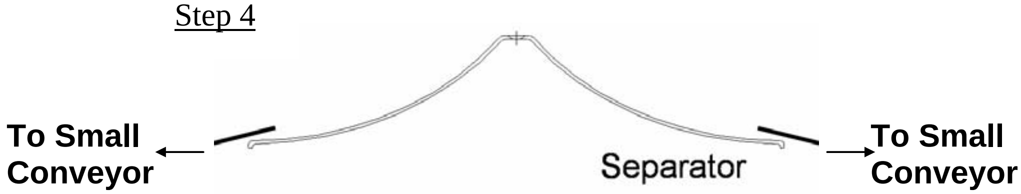


Figure 4.8 Side View Showing How Inner Leadframes are Separated

The following factors should be observed during the design stage of a component or assembly to reduce corrosion to a minimum:

- The design should avoid crevices and corners where moisture may become trapped, and adequate ventilation should be provided.

- The design should allow for easy washing down and cleaning.

- Joints which are not continuously welded should be sealed, for example by the use of mastic compounds or impregnated tapes.

- Where dissimilar metals have to be joined, high strength epoxy adhesives should be considered since they insulate the metals from each other and prevent galvanic corrosion.

- Materials which are inherently corrosion resistant should be chosen or, if this is not possible, an anti-corrosive treatment should be specified.

Chapter 5

Selection of Components

A conveyor system is made up of several components. Each of these components plays an important part in the work performances of the conveyor system. Therefore special care should be given when selecting the components.

5.1 Conveyor Belts

The belt is the primary component of a belt conveyor system. It usually represents a substantial part of the initial cost of the system. Since it is such a large investment, proper selection is important to ensure long life. All other systems of a belt conveyor should be designed and built with the purpose of obtaining the longest possible belt life.

5.1.1 Components of a Conveyor Belt

A belt is composed of four main components. See Figure 5.1.

5.1.1.1 Carcass

The carcass performs all of the primary functions of the belt. It provides the tensile strength necessary to move the loaded belt and absorbs the impact forces of material being loaded onto the belt. It also provides lateral stiffness necessary to support the load between idlers and gives adequate strength for mechanical fasteners to hold on to. It is formed by bonding the piles of fabric together with a rubber or polymer skim coat.

5.1.1.2 Breaker

A breaker is a special fabric found on top of the fabric piles. It is used to increase the adhesion between the carcass and the top cover. It can also be designed to increase the impact, heating, and ripping resistance of a belt. Breaker can also increase lateral support.

5.1.1.3 Top Cover

The top cover protects carcass from the material being conveyed. It must absorb abrasive wear at loading and protect the carcass from any adverse property of the material being conveyed. The top cover must also be capable of withstanding any environmental condition it is exposed to.

5.1.1.4 Bottom Cover

The bottom cover is the lining on the bottom of the belt. Its purpose is to protect the carcass from possible wear from idlers and pulleys. It is usually thinner than the top cover.

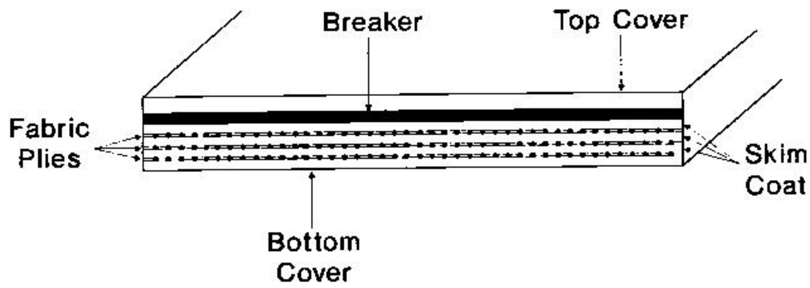


Figure 5.1 The Various Components of a Conveyor Belt

In order to confirm the correct type of belt is being considered, it is necessary to have the following information:

- Types of items to be carried.
- Width of belt.
- Speed of conveyor.
- Total load on belt.
- Size and weight of the largest article.
- Adverse conditions such as the presence of oil, water, dirt and dust, and temperature variations.

5.1.2 Belt Material

Conveyor belt is constructed from a variety of natural and synthetic materials. The trend for the last fifty years has been moving away from natural fibres to the more dependable synthetic fibres. Below are some of the fibres used.

5.1.2.1 Nylon

Nylon is the first man-made fibre to be used in conveyor belts. It is constructed from polyamide fibres. It has high strength, high elongation, good resistance to abrasion, and excellent fatigue and impact resistance. Unfortunately it will absorb water. This gives it poor dimensional stability. However it is highly resistance to mildew.

5.1.2.2 Polyester

Polyester has high strength and exceptionally good abrasion and fatigue resistance. Unlike nylon, it has low moisture absorption, which gives it good dimensional stability. It is also not affected by mildew.

5.1.2.3 Polyurethane

Polyurethane is a unique material that offers the elasticity of rubber combined with the toughness and durability of metal. Polyurethane can reduce plant maintenance cost. Urethanes have better abrasion and tear resistance than rubbers, while offering higher load bearing capacity. Compared to plastics, urethanes offer superior impact resistance, while offering excellent wear properties and elastic memory.

5.1.3 Belt Splice Techniques

Conveyor belt is usually made endless onsite, by either vulcanizing or mechanical fasteners. Of the two techniques, vulcanizing provides the stronger splice. Back when natural fibres and nylon made up the majority of belt carcasses sold, vulcanizing sealed the carcass away from moisture and mildew, prolonging belt life. Mechanical fasteners leave edges exposed. The mechanical splice has gained popularity due to its low cost and ease of installation.

Vulcanizing is still the preferred choice of splice for initial installations and repairs on high-tension belts. For onsite repairs of low-tension belts, mechanical fasteners are more popular.

5.1.3.1 Vulcanized Splice

Vulcanizing can be done by either hot and cold method. In hot vulcanizing, the belt is cured and set in a vulcanizing press. This produces the strongest splice possible but requires trained personnel and large specialized equipment to be brought onsite. Cold splicing produces a fairly strong bond and is done using a liquid cement and hardener. This can be done by moderately trained personnel. See Figure 5.2.

Step Splice

This technique is normally used with conventional plied carcass construction. It is easily performed with moderately trained personnel using the cold vulcanizing technique.

Skived Splice

This technique must be used on the more complex straight warp or solid woven carcass. It is popular with PVC belting.

Finger Splice

This technique is also used on straight warp and solid woven carcasses. The fingers provide increased bonding area for a stronger splice.

5.1.3.2 Mechanical Splice

Although mechanical splices are not as strong as vulcanized splices, they are still very popular. They are commonly used in low-tension applications on short to mid length size conveyors. Mechanical splices do not have sufficient strength to hold high tension belts together but they are many times less expensive than vulcanized splices. They can be applied with simple tools in minutes, rather than hours, as with a vulcanized splice. Personnel installing mechanical splices do not require special skills. Belt does not have to be precleaned as compared to vulcanized splice, making them ideal for onsite installation. Below are the two main types of mechanical splice.

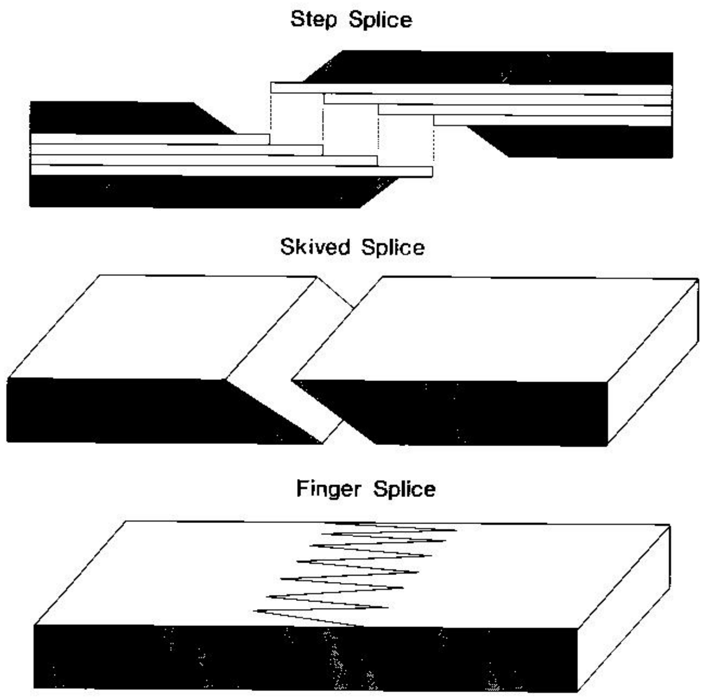


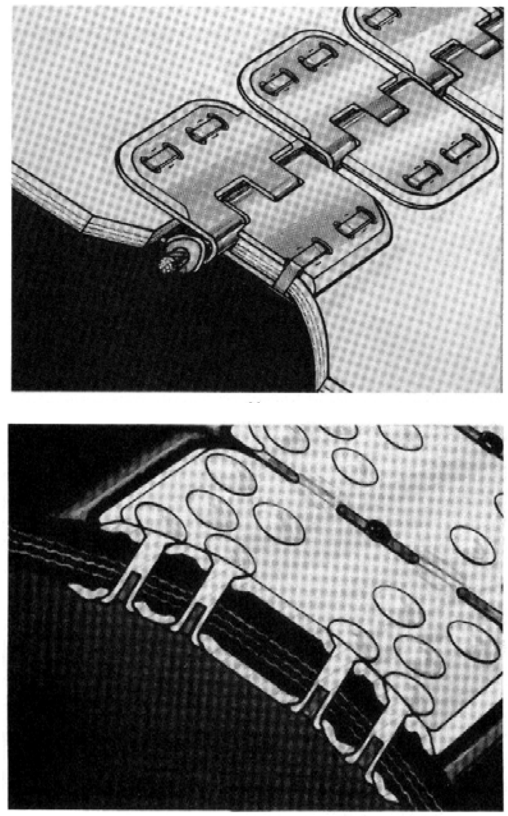
Figure 5.2 Types of Vulcanised Belt Splice Techniques

Hinged

Hinged splice can be installed in a shop and quickly joined onsite with the insertion of a hinge rod. The hinge rod can be removed, and one of the sides can be cut and reset. Hinged fasteners also offer the option of attaching a different thickness of belt to one another by hinging different size fasteners together. Hinged fasteners leave small openings that may allow fines to leak through the belt. This type of fastener is popular in mining as splices can be quickly separated or detached when extending the length of a conveyor. See Figure 5.3(a).

Solid plate

A solid plate fastener can handle higher tensions than its hinged counterpart. Since it has no moving parts, a longer service life can also be expected. This type of fastener also contains fine better. See Figure 5.3(b).



(a)

(b)

Figure 5.3 Types of Mechanical Belt Splice Techniques

Mechanical fasteners can be attached by staple, bolt, or rivet. Rivets are recommended because they damage the belt material the least.

5.1.4 Belt Training

Training or tracking a belt is the process of adjusting various components of a belt system so the belt consistently runs centrally.

Initial setup and maintenance should ensure that all idlers are in line, square, and level transversely. All pulleys should be concentric with the pulley shafts. The pulley shafts should be perpendicular to the centre line of the belt.

If the pulleys are not properly aligned, the belt will run off-centre, so damaging its edges on the structure. Other factors which can cause a belt to wander are: belt not cut perfectly straight, conveyor structure out of line, pulleys not adequately crowned. Some or all of these possibilities make it essential to provide fine adjustment of the pulleys. The bearings or dead-eyes on each side of the pulley must be independently adjustable and should be securely locked in position after adjustment. Various methods are used to adjust roller mountings but the easiest is simply to slot all fixing holes.

For this project, polyurethance belt with finger splice is used. Additional properties like green colour is specified and the belt must be antistatic. The length of the belt is determined by using the AutoCAD software. The specification of the belt can be found in Appendix D.2.

5.2 Bearings

Bearings provide support for rotating shafts and allow smooth, low friction motion between two surfaces. Load is applied to these bearings in either a radial or axial direction, or in a combination of these. Radial loads act at right angles to the shaft axis of rotation. Sometimes this radial load is the result of a side load caused by a chain, belt, or gear, and sometimes it is due to gravity alone. Axial (or thrust) load is load applied along the axis of the shaft. If a load is supported by a vertical shaft, then the bearing will experience a thrust load.

Lubricant creates a low friction barrier between the rotating and stationary members, thus minimizing friction. Lubricant in the bearing isolates the shaft and sleeve, preventing metal-to-metal contact.

5.2.1 Parts of Bearing

Bearing usually consists of an outer ring, inner ring, rolling elements (balls or rollers), and a cage which positions the rolling elements at fixed intervals between the ring raceways. See Figure 5.4.

The outer ring, inner ring, and rolling elements of bearing are made with extremely tight tolerances, even to millionths of an inch, to assure good performance and long life. These elements are made from hardened steel and are ground and lapped to the design dimensions. Case-hardened steels are often used, with surfaces hardened to various depths. The cages and separators are usually made of brass or low-carbon steel and are usually formed by stamping. Many bearing failures are due to cage failures resulting from improper lubrication and overheating.

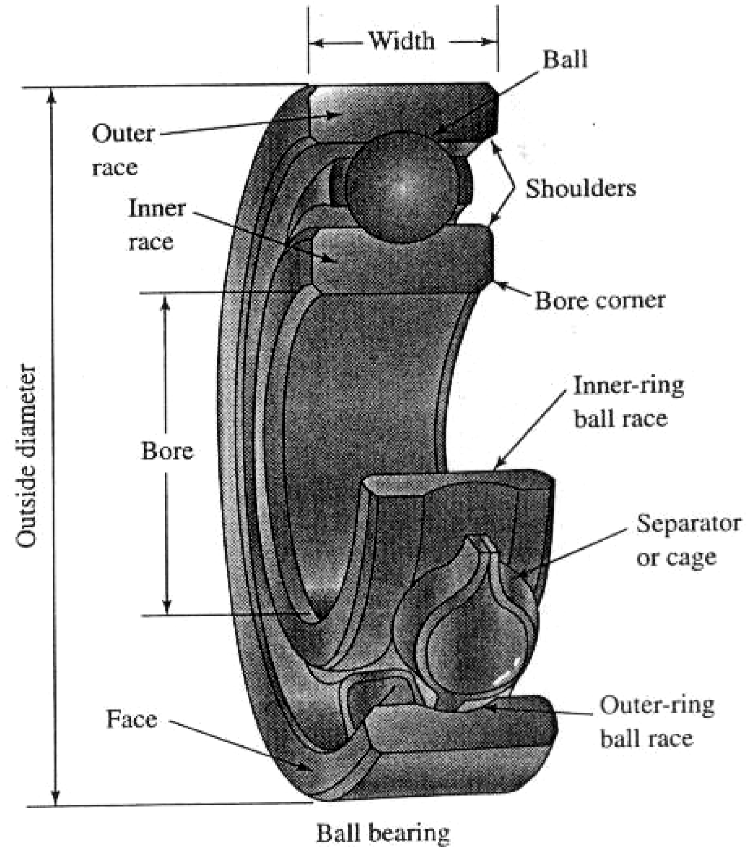


Figure 5.4 Parts of a Bearing

Rolling element bearings require sufficient lubrication to wet the rolling surfaces. Grease is used for most low speed applications. Seals and shields are often used to prevent loss of lubricant and to prevent dirt from getting into the bearing. Sealed bearings have lubrication included at assembly and are not relubricated. Less expensive unground bearings with much greater tolerances can be used for less demanding applications.

5.2.2 Types of Bearing

There are many different types of bearing available. Which is suitable will depends on their applications. Refer to Figure 5.5.

5.2.2.1 Ball Bearing

Ball bearing is the most popular of all the ball bearing types because it is available in a wide variety of seal, shield and snap-ring arrangements. It can sustain radial, axial, or composite loads and because of simple design, this bearing type can be produced to provide both high-running accuracy and high-speed operation.

5.2.2.2 Roller Bearing

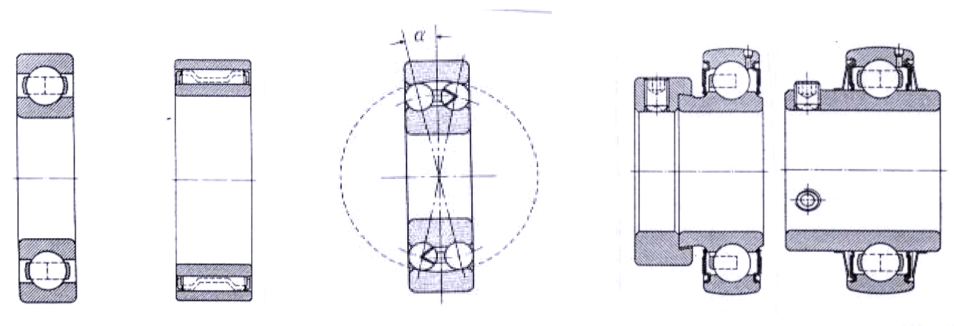
Roller bearing is often used in high-speed applications. Because the inner ring, outer ring, and rollers are in line contact, this bearing type has a large radial load capacity. Since it supports axial loads as sliding action between the end of the rollers and flange faces axial loading is limited.

5.2.2.3 Self-Aligning Bearing

Self-aligning ball bearing is suitable for long shafts where accurate positioning of housing bores is difficult. Due to its special construction, it will tolerate a small angular misalignment from deflection or mounting error.

5.2.2.4 S-Bearing Unit

S-bearing unit is actually deep groove ball bearing with extended inner rings. It is manufactured in a number of designs. At one end of the inner ring the bearing is clamped to the shaft with an eccentric locking ring or with two setscrews. The outer diameter of the outer ring is as a rule ground spherically, so that the ring can align itself in a suitably designed housing if the bearing locations are misaligned.



Ball Bearing | Roller Bearing | Self-Aligning Bearing | S- Bearing Unit

Figure 5.5 Types of Bearing

After some thought, a flange bearing is used for the project. It is actually a combination of the ball bearing and the S-bearing unit. Just that it has a flange to it. Flange mounted bearings are used when a shaft axis is perpendicular to the bearing mounting surface. They are available in 2, 3, or 4-hole configurations. The one with 2-hole configuration will be used in this case. Refer to Appendix D.3 for its specification.

5.3 Motor and Gearhead

The two primary components of a drive unit are the motor and the gear head. A variety of ancillary equipment may also be required. These devices may provide such functions as speed control, soft starting capability, and overload protection.
After having determined the type of conveyor, the next step is to select a drive system. Selection of the drive system is based on the following factors :

- Economics
- Space limitations
- Starting characteristics
- Ambient atmospheric conditions
- Single or variable speed requirements
- Type and voltage of power service available

When selecting a drive train, there is often a multitude of equipment choices and approaches. The difficulty lies in selecting the most appropriate system. Usually, economics is the deciding factor. But in some cases, special requirements or conditions will be the deciding factor.

5.3.1 Types of Motors

There are many types of motors in the market. Below are basically the few types.

5.3.1.1 Basic Motor

Continuous Operation (Induction Motor)

The speed of an induction motor varies with the load. It is used in applications where speed control is not required and within continuous uni-directional operation. This means that the direction of motor rotation can be changed just after bringing the motor to a stop.

Bi-directional Operation (Reversible Motor)

Reversible motors are capacitor-run induction motor and designed for applications where instantaneous reversal is required. By simple switching, the direction of motor rotation can be reversed frequently between CW and CCW rotation.

5.3.1.2 Brake Motor

If the applications require the motor to stop faster than the above mentioned, brake motor is recommended. With induction motor, it generally takes 30-40 revolution (at the motor shaft) before the motor comes to a complete stop after the switch is turned off. With reversible motor, it takes about 5-6 revolutions. But with brake motor, it is capable to reduce the overrun to just 1-1.5 revolutions. Some can even hold the load in position when the motor is stopped.

5.3.1.3 Speed Control Motor

The speed of the speed control motors can be easily set and adjust by the use of a potentiometer. The control system consists of a speed-feedback system, a motor, a control pack (or a driver) and a potentiometer. This motor is controlled by a closed-loop speed control system.

5.3.1.4 Linear Head Motor

Linear motion can be obtained by combining a rack-and pinion unit with motor. Linear head motor is designed especially for use with the AC standard motor coupled directly to the linear head, various type of movements are possible.

5.3.2 Selection Procedure

During the selection of a motor, there are fundamental criteria involved in the procedure. Below are the steps when selecting small size, standard AC motors such as induction motors and reversible motors:

- Determine the required specifications.
  First determine the basic required specification of mechanism and applications such as operating speed, load torque, power supply voltage and frequency.

- Calculate the operating speed and select gearhead.
  Induction and reversible motor speeds cannot be adjusted. Motor speed must be reduced with gearheads to match the required machine speed. It is therefore necessary to determine the correct gear reduction ratio.

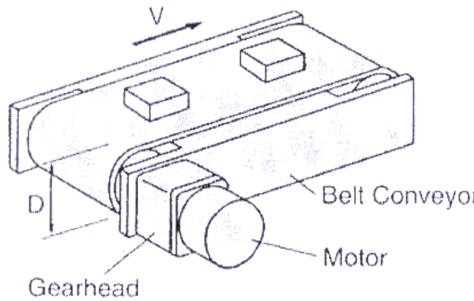
- Calculate the required torque.
  Calculate the required torque and confirm the torque needed for the gearhead.

- Select a motor.
  Use the required torque and speed to select a motor and gearhead from the catalogue.

- Check with the starting torque of the motor/ Speed confirmation
  At the same time, confirm the starting torque of the motor and the maximum permissible torque of the gearhead. In a single-phase induction motor, starting torque is always lower than the rated torque. Therefore, to drive a frictional load, select the speed on the basic of starting torque. Check if speed meets up to actual requirements.

5.3.3 Sizing of Motor

Motor need to be carefully selected in order not to oversize or undersize it. Following the selection procedure as mentioned before, calculation of the correct size of motor and gearhead for the main conveyor and the sub conveyor is given as below.



5.3.3.1 Main Conveyor

According to the specification in Appendix , the output for the press machine is 25 to 55 leadframes/min. From this we can find the minimum and maximum belt speed required.

Belt speed is given as below.

$$V = \text{(Machine Output x Leadframe Length) / 60} \quad \text{cm/sec}$$

$$\therefore \text{Maximum belt speed, } V_1 = 55 \times 25 / 60$$
$$= 22.9 \text{ cm/sec}$$

$$\therefore \text{Minimum belt speed, } V_2 = 25 \times 25 / 60$$
$$= 10.4 \text{ cm/sec}$$

Main conveyor specifications:

Total weight, W = 3 kg

Friction coefficient of sliding surface, μ = 0.3

Drum diameter, D = 3.2 cm

Roller Efficiency, η = 0.9

Angle of Inclination, α = $0°$

Belt speed, V_1 = 22.9 cm/sec

V_2 = 10.4 cm/sec

Input voltage = 200 V/ 50 Hz

Direction = uni-direction

a) Calculation of speed at gear shaft.

$$N_{G1} = V_1 \times 60 / (\pi \times D)$$
$$= 22.9 \times 60 / (\pi \times 3.2)$$
$$= 136.8 \text{ rpm}$$

$$N_{G2} = V_1 \times 60 / (\pi \times D)$$
$$= 14.6 \times 60 / (\pi \times 3.2)$$
$$= 62.1 \text{ rpm}$$

b) Determination of gear ratio.

With 50Hz power supply, torque of speed control motor is greatest at 1300rpm.

$$i_1 = 1300 / N_{G1}$$
$$= 1300 / 136.8$$
$$= 9.5$$

$$i_2 = 1300 / N_{G2}$$
$$= 1300 / 62.1$$
$$= 20.9$$

So to achieve both speed, smaller gear ratio must be taken.

Therefore gear ratio, i, of 9 is chosen.

$$
\begin{aligned}
N_{M1} &= N_{G1} \times i \\
&= 136.8 \times 9 \\
&= 1231.2 \text{ rpm} \\
N_{M2} &= N_{G2} \times i \\
&= 87.1 \times 6 \\
&= 558.9 \text{ rpm}
\end{aligned}
$$

c) Calculation of required torque.

$$
\begin{aligned}
F &= F_a + W(\sin\alpha + \mu\cos\alpha) \\
&= \cancelto{0}{F_a} + 3(\sin 0 + 0.3\cos 0) \\
&= 3(0.3) \\
&= 0.9 \text{ kg}
\end{aligned}
$$

Load torque at the gearhead shaft,

$$
\begin{aligned}
T_L &= (F \times D) / (2\eta) \\
&= 0.9 \times 3.2 / (2 \times 0.9) \\
&= 1.6 \text{ kgfcm}
\end{aligned}
$$

Load torque at the motor shaft,

$$
\begin{aligned}
T_m &= T_L / (i \times \eta_G) \\
&= 1.6 / (9 \times 0.73) \\
&= 0.24 \text{ kgfcm}
\end{aligned}
$$

Considering the fluctuation of power supply, 200% tolerance in the calculation is given as below.

$$
\begin{aligned}
T_m &= 0.24 \times 2 \\
&= 0.48 \text{ kgfcm}
\end{aligned}
$$

This required torque is applied to the motor constantly at any speed. Therefore the motor must have a greater torque than 0.48 kgfcm at low and high speed.

Based on the specification from Appendix D.4, speed control motor **US560-502E** is the best choice. Since the reduction ratio is 9, gearhead **5GU9KB** is selected.

Then using both the minimum speed and the maximum speed of the speed control unit to determine whether the product selected meets the required specification.

$$V_1 = (N_{max} \times \pi \times D) / (60 \times i)$$
$$= (1400 \times \pi \times 3.2) / (60 \times 9)$$
$$= 26.1 \text{ cm/sec}$$

$$V_2 = (N_{min} \times \pi \times D) / (60 \times i)$$
$$= (90 \times \pi \times 3.2) / (60 \times 9)$$
$$= 1.7 \text{ cm/sec}$$

The selected motor can operate at a higher speed and a lower speed as compared to the required specification. Therefore the motor meets the requirement.

5.3.3.2 Sub Conveyor

Since the speed of the sub conveyor has to be faster than that of the main conveyor so a higher speed need to be assigned to it. Taking that the small conveyor needs to handle 35 to 80 leadframes/min. From this we can find the minimum and maximum belt speed required.

Belt speed is given as below.

$$V = (\text{Machine Output} \times \text{Leadframe Length}) / 60 \quad \text{cm/sec}$$

$$\therefore \text{Maximum belt speed, } V_1 = 80 \times 25 / 60$$
$$= 33.3 \text{ cm/sec}$$

$\therefore$ Minimum belt speed, V_2 = 35 x 25 / 60

= 14.6 cm/sec

Small Conveyor specifications:

Total weight, W = 0.85 kg

Friction coefficient of sliding surface, μ = 0.3

Drum diameter, D = 3.2 cm

Roller Efficiency, η = 0.9

Angle of Inclination, α = $0°$

Belt speed, V_1 = 33.3 cm/sec

V_2 = 14.6 cm/sec

Input voltage = 200 V/ 50 Hz

Direction = uni-direction

d) Calculation of speed at gear shaft.

$$N_{G1} = V_1 \times 60 / (\pi \times D)$$
$$= 33.3 \times 60 / (\pi \times 3.2)$$
$$= 198.7 \text{ rpm}$$

$$N_{G2} = V_1 \times 60 / (\pi \times D)$$
$$= 14.6 \times 60 / (\pi \times 3.2)$$
$$= 87.1 \text{ rpm}$$

e) Determination of gear ratio.

With 50Hz power supply, torque of speed control motor is greatest at 1300rpm.

$$i_1 = 1300 / N_{G1}$$
$$= 1300 / 198.7$$
$$= 6.5$$

$$i_2 = 1300 / N_{G2}$$
$$= 1300 / 87.1$$
$$= 14.9$$

So to achieve both speeds, smaller gear ratio must be taken.

Therefore gear ratio, i, of 6 is chosen.

$$\begin{aligned} N_{M1} &= N_{G1} \text{ x } i \\ &= 198.7 \text{ x } 6 \\ &= 1192.2 \text{ rpm} \end{aligned}$$

$$\begin{aligned} N_{M2} &= N_{G2} \text{ x } i \\ &= 87.1 \text{ x } 6 \\ &= 522.6 \text{ rpm} \end{aligned}$$

f) Calculation of required torque.

$$\begin{aligned} F &= F_a + W(\sin\alpha + \mu\cos\alpha) \\ &= \cancelto{0}{F_a} + 0.85(\sin 0 + 0.3\cos 0) \\ &= 0.85(0.3) \\ &= 0.26 \text{ kg} \end{aligned}$$

Load torque at the gearhead shaft,

$$\begin{aligned} T_L &= (F \text{ x } D) / (2\eta) \\ &= 0.26 \text{ x } 3.2 / (2 \text{ x } 0.9) \\ &= 0.46 \text{ kgfcm} \end{aligned}$$

Load torque at the motor shaft,

$$\begin{aligned} T_m &= T_L / (i \text{ x } \eta_G) \\ &= 0.46 / (6 \text{ x } 0.73) \\ &= 0.11 \text{ kgfcm} \end{aligned}$$

Considering the fluctuation of power supply, 200% tolerance in the calculation is given as below.

$$\begin{aligned} T_m &= 0.11 \text{ x } 2 \\ &= 0.22 \text{ kgfcm} \end{aligned}$$

This required torque is applied to the motor constantly at any speed. Therefore the motor must have a greater torque than 0.22 kgfcm at low and high speed. Based on the specification from Appendix D.4, speed control motor **US425-402E** is the best choice. Since the reduction ratio is 6, gearhead **4GN6K** is selected.

Then using both the minimum speed and the maximum speed of the speed control unit to determine whether the product selected meets the required specification.

$$
\begin{aligned}
V_1 &= (N_{max} \times \pi \times D) / (60 \times i) \\
&= (1400 \times \pi \times 3.2) / (60 \times 6) \\
&= 39.1 \text{ cm/sec}
\end{aligned}
$$

$$
\begin{aligned}
V_2 &= (N_{min} \times \pi \times D) / (60 \times i) \\
&= (90 \times \pi \times 3.2) / (60 \times 6) \\
&= 2.5 \text{ cm/sec}
\end{aligned}
$$

The selected motor can operate at a higher speed and a lower speed as compared to the required specification. Therefore the motor meets the requirement.

5.4 Belt and Pulley

Belt drives provide an inexpensive means of transferring energy and motion from one rotating shaft to another. Belts are used when large distances between shafts make gears impractical or when the drive speed is too high for chain drives. Belt-drive systems include two shaft-mounted grooved pulleys, one on each shaft, and a belt loop.

Pulleys are used to transmit rotational energy to the various types of belts and they are generally made from steel or aluminium. Pulley width should be approximately 10% wider than the belt. Minimum pulley diameter should be at least 30 times the belt thickness. The shape of the pulley will often take the shape of the belt. This will minimize the slippage between the belt and the pulley.

Belt systems often include an idler pulley positioned to provide tension on the belt. Each pulley must be locked to its shaft. The drive pulley is mounted on the drive shaft, usually of an electric motor. The driven pulley is usually larger and has a lower rotational velocity. Figure 5.6 shows the assembly of a belt and pulley.

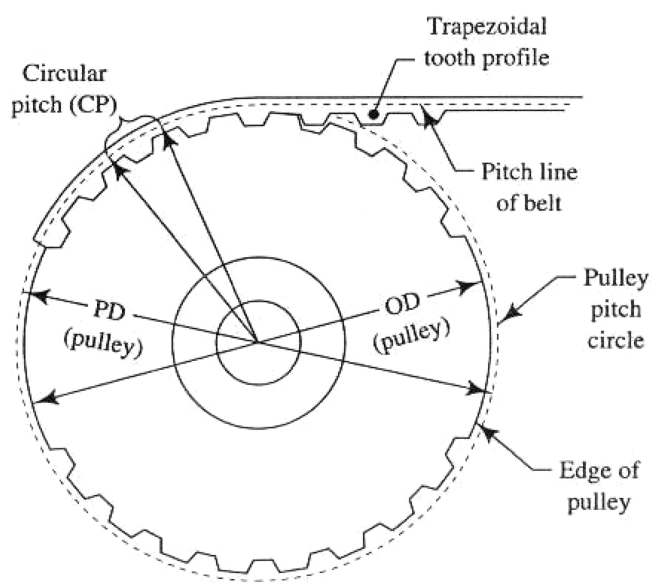


Figure 5.6 Assembly of Belt and Pulley

All belts except timing belts rely on friction between the pulley and the belt to transmit the force from the pulley to the belt. The force is exerted at the driven pulley to cause rotation, thereby transferring the force from one shaft to another. The distance the belt moves in a period of time, the belt velocity, multiplied by the force transferred produces the power supplied and received. Any differences in these quantities represent the inefficiency of the system.

5.4.1 Advantages and Disadvantages

The advantages of belt drives are that they do not require lubrication, they are low maintenance, they dampen and smooth out shock loads, and they provide quiet, smooth operation. Also pulleys are generally less expensive than drive sprockets.

The disadvantages of belt drives include load transfer limitations related to friction, a tendency for the belt to stretch, a tendency for the belt to jump from the pulley during shock loading, and inefficiency related to slippage.

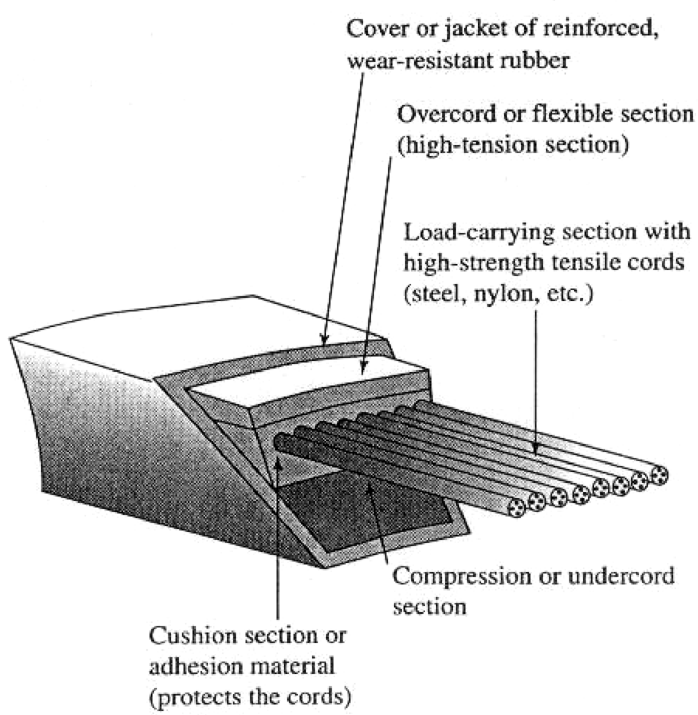


Figure 5.7 Features of Belt

5.4.2 Problems with Belt

Problems which often related with belts include slip, stretch, and creep. Slip is caused by a loss of friction between the belt and pulley and is minimized by sufficient belt warp or arc of contact. If slip is prevalent, excessive belt temperature results. Stretch is minimized by internal reinforcement such as with polyester cord. Creep is the tendency of a belt to relax or stretch over time as it moves around the pulley while under load. Figure 5.7 shows the features of a belt.

5.4.3 Types of Belt

The many types of belt include flat, round, V-belt, and Timing belt. Refer to Figure 5.8.

5.4.3.1 Flat Belt

Flat belt was the original type of belt used to transfer power from line shafts operating above the factory floor to individual machines. Flat belts have the capability to provide torque transmission around a corner. This permits connection of nonparallel shafting. To provide necessary friction, flat belts require higher tension belts. Often a slight crown is applied to the pulleys to increase the tension on the belt. This crown also helps the belt stay centered on the pulley. But flat belts are not practical for timing applications where the angular orientation of one shaft relative to another is critical.

5.4.3.2 Round Belt

Endless round belt is specialized belts that can provide high speed but have limited force-transmitting capability. It often has 90° twists or a serpentine path. A round belt is simply a large O-ring.

5.4.3.2 V-Belt

V-belt is used in many industrial applications. Multiple V-belts with parallel belt strands are comparable to chain drives in carrying power. The name *V-belt* comes from its driving action, which occurs at the tapered sides of the belt rather than across the flat bottom. They generally contain polyester cords to add strength and retard stretching. The tension section carries the load while the compressed section wedges against the pulley groove.

5.4.3.2 Timing Belt

Timing belt is made with teeth molded into the rubber that mesh with teeth in the driving and driven pulleys, producing a positive no-slip drive system permitting timed operation. Steel reinforcement is used in the belt construction to eliminate belt stretch. Tooth shape is usually trapezoidal and many automobile engines use timing belts to synchronize the timing between the crank and the cam shafts of the engine. The primary disadvantage of this type of belt is that it is expensive.

If open-ended belts are used, the ends must be carefully spliced to assure that the belt stays together under load.

5.4.4 Speed Ratio

Speed ratio in belt systems is determined by the ratio of the effective diameters of each driven pulley to the drive pulley. Related to the speed of the belt system is the centrifugal force associated with the belt as it approaches the pulley. If the speed is sufficient, the belt will rise off the pulley, introducing substantial slip and perhaps disconnecting from the pulley. To counteract this effect, tension must be increased with the idler or by slightly increasing the distance between pulley centers.

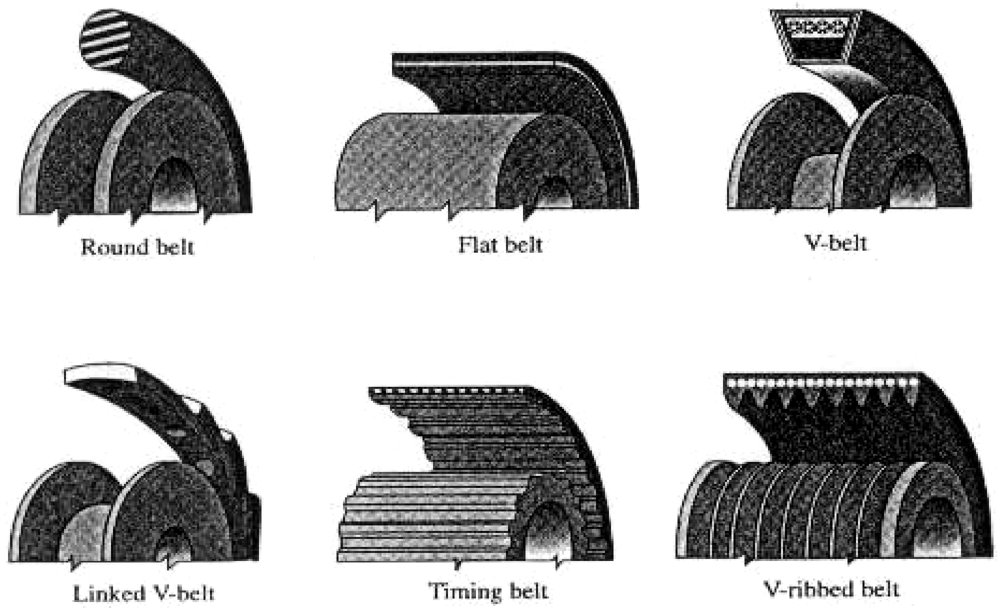


Fig 5.8 Types of Pulley Belt

Polyurethane timing belt and aluminium pulley are used in this project to transmit the power from the motor to the conveyor belt. The materials are choosen due to their better qualities than the others. The length of the belt is determined from the AutoCAD software. All the specification can be found in Appendix D.5 and Appendix D.6 respectively.

5.5 Conveyor Structure

A conveyor is seldom a precision tool and its construction should be robust, and easy to install and maintain. Pressed steel sections are ideal for light duty but frames of standard rolled steel members are more suitable for heavy-duty work.

It is a common practice to mount the shaft in self-aligning ball bearings to allow for the tracking adjustments that must be provided.

5.5.1 Materials

Materials that are often use for building the structure for the conveyors are mild steel rectangular bar or aluminium profile. Conveyor frames should not be designed in a way that requires welding in two directions, i.e. along and across the conveyor.

In this project, aluminium profile is used for making the structure. The reasons are aluminium is light and it is flexible in terms of fixing up. Because of the grooves available on the profile, parts fixing on it can be adjusted freely. This gives it more flexibility in mounting. See Appendix D.7 for more details.

5.5.2 Importance of Flatness

Due to site level variations, uneven floors, inaccuracies in manufacture, it is almost inevitable that the person doing the installation work will want to adjust the structure on site. Person in charge needs to take note to vendor that there should not be any splatter or uneven surface. Especially those surfaces that come in contact with the conveyor unit, flatness of the surface is also a critical part that must take care of. For surface protection of the bar, undercoat and epoxy paint can be use.

Mounting of cell to structure, the mounting of the cell is done usually by using a plate that is joined to the base of the cell and screw tightly to the structure. Having a flange on the base usually does the tank mounting, as mounting holes are located at the flange.

It is necessary to ensure that the edges of side members at joints are well radiused. If lining materials are used, these too must have radiused or chamfered edges, and all fixing bolts must be well countersunk.

On the whole, we should practice standardizing. Standardizing is the practices of using only one make of equipment and maybe only one or two sizes of that make. This is not always possible in every situation, particularly when custom-made equipment is required. A standard model is chosen based on past successes of certain makes, or the more deliberate approach of experimenting with different manufacturers' products.

There are numerous advantages to standardizing. For one, spare parts stocking are simplified. The plant need only stock a few spare parts for all the conveyors of the specific make. There is also an advantage in terms of maintenance. The plant personnel become familiar with repair routines, replacement, and lubrication schedules.

Standardizing should be approached cautiously and it should never be implemented at the expense of adequate equipment performance. Bear in mind no one conveyor can be applied to every situation. That is why there are so many different types.

Chapter 6

Safety Aspects

Safety measures are very important during the installation and operation of the conveyor system. They must be strongly adhere to in the prevention of incidents.

6.1 Areas to Take Note

Below are some of the areas which I had take note prior to design the conveyor system.

6.1.1 Electricity

Voltage supplies to motor in order for the conveyor to operate.

Problems : - Possibilities of people getting electrocuted if wires not connected properly.

Actions : - Check that wire connections are not exposed.

- Make sure the wire is well insulated.
- Cover up the speed controller so that the places near the joints of the connection wires are not accessible.
- Stick warning signs for high voltage supply at places near the speed controller.

6.1.2 Belt and Pulley

Using of pulleys and belts to transmit power from the motor to conveyors.

Problems : - Hands get caught by the pulleys and belts when motor is running. May cause serious fracture.

Actions : - Attached safety covers to the exposed belts and pulleys.
- Stick warning signs to warn operators of the moving parts.

6.1.3 Motor

Prolong usage of conveyors, especially during 24 hrs shift work.

Problems : - Motors get very hot. Hands will get burnt when they are accidentally touched.

Actions : - Attached safety covers with holes for ventilation purpose.
- Stick warning signs to warn operators of the moving parts.
- Arrange to run production in an air-conditioned room to cool down the motors faster.
- Stick warning signs to warn operators of the hot parts.

6.1.4 Structure

Prolong usage of conveyors, especially during 24 hrs shift work.

Problems : - Sharp edges and corners of the metal parts can cut people if they are not careful.

Actions : - State in drawing that all sharp edges and corners to be chamfered or rounded.
- Stick warning signs to warn operators of the moving parts.
- Minimize small angles at the corners or edges of the conveyors parts during design stage, as they are sharp.

6.2 General Guidelines

The person in charge must have a thorough knowledge of the following precautions and shall aim for zero incident operations.

In the precaution, the term "Person in charge" refers not only to the person who operates or supervises this system but also engaging directly in production activities; it includes people who maintain and inspect the equipment and all people engaged in work relating to the equipment.

6.2.1 Safety Acts for Assembly and Installation

- Be sure to put on safety equipment like safety shoe and etc.

- When performing assembly and installation, be sure that the parts are clean without any oil stain as it may dirty the products.

- Before performing any works, signboard "Work In Progress" should be put up at the most prominent area where every person can see.

- Before performing any works, secure all doors on the control panel or operating panel.

- Before performing any works, set the main switch to "OFF" position and lock the key, or place a sign saying " DO NOT SWITCH ON " on the main panel.

- If changing of system wiring is necessary, be sure to shut off the power supply. Performing wiring work with the power supply turned on, is danger of electrical shock.

- Electrician should take extra care when performing electrical wiring connection and disconnection on the primary power supply.

- Assembly and installation, either on electrical or mechanical work, must be done by skilled worker with electrical or mechanical equipment assembly and installation knowledge.

- Inspect the work area surrounding. All unsafe points must take extra measure to ensure safety. In particular, if there are places where footing is inadequate, there is a risk of human injury due to falling.

- Never use gloves if there is a danger of being wound into the rotating parts etc.

- Distinguish component storage location and passageway; do not place things in passageways. There is a risk of injury if people trip over them.

6.2.2 Safety Precaution for Operation Procedures

6.2.2.1 Before Operation

- Check that there are no people go near the rotating mechanism or high temperature parts.

- Never touch any electrical switches with wet hands.

- Cooperative work is required, be sure to signal your partner when starting any operation system

- Do not operate the system with the equipment safety cover removed.

- Carefully check the position and function of switches, buttons and keys before operating any system operation.

- Check power supply's cable and wire insulation. If damage, risk of fire and electrical shock is high.

- Keep the floor around the equipment organized and clean.

- Do not place any foreign objects on any of the movable mechanism.

- Secured all control or operating panel doors.

- When performing adjustment work, check for one or two completed revolution on all rotating mechanism by hands, to ensure they are not jammed either by foreign metal or driving mechanism itself.

- Remove obstruction around the system

- Check all fasteners are properly tightened.

6.2.2.2 During Operation

- First signal anyone around, before starting the operation.

- Always be alert of any abnormal vibration and noise. Stopped the operation immediately and remedy the fault.

- Do not touch the rotating mechanism when it is running.

6.2.2.3 After Operation

- Do not touch any equipment even when power shut off, some internal parts may still remain charged or temperature may be high. Work only when discharging and equipment temperature is low.

6.2.3 Emergency Act

- Press the emergency stop switch on touch screen panel.

- Follow the checklist stated in general precaution before operation.

- Never operate the system again before any fault is found and remedied.

- If the problems cannot be determined, seek specialist for assistance.

Chapter 7

Project Performance

After the conveyor system is installed on the stacker machine, several testing is done on the machine itself. Different sizes of leadframe are used for the testing purposes. The samples include the smallest and the largest leadframe that is to be processed during any time of the production and some of the sizes in between the range. The speed of the conveyor is adjusted according to the speed of the stamping machine. For the test run, the speed of the press machine is being put to the low side before the speed is being gradually increase. This is to prevent any serious damage to the machine if the punching tools are not aligned properly.

To start of with the test run, the coil of leadframe need to be prepared and set up in the machine. Every aspect of the machine must be adjusted and set to the required width of the leadframe. A number of things have to be adjusted before the transferring process is smooth. The separator has to be adjusted to cater for the width of the leadframe. By loosen the screws, the top part of the separator holder can be moved to either widen the gap or to narrow it. See Figure 7.1.

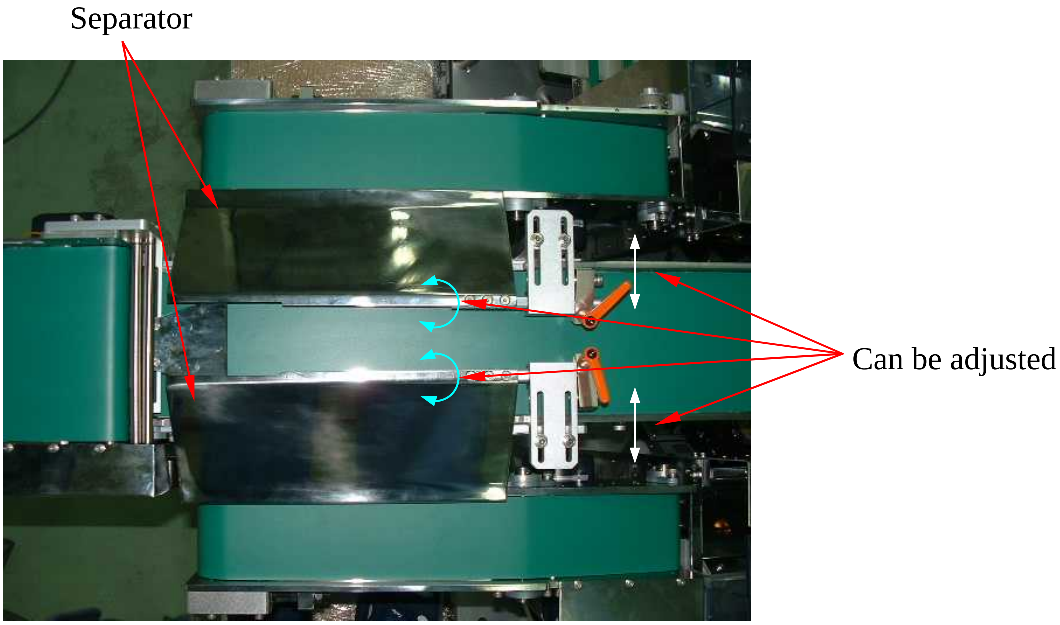
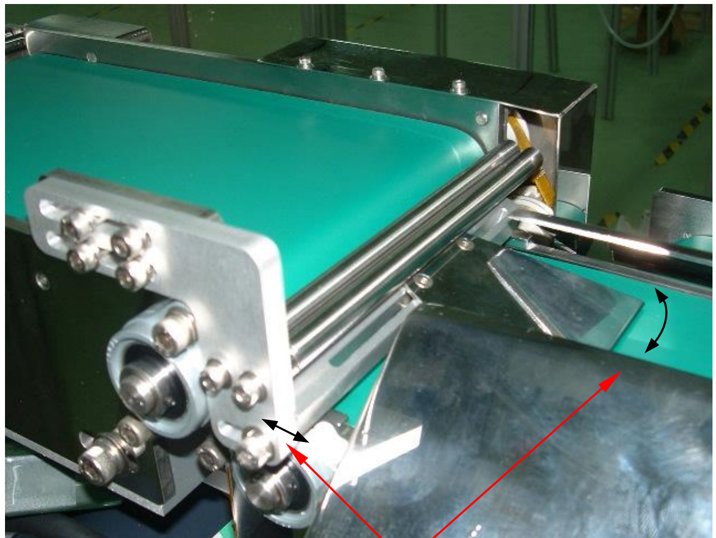


Figure 7.1 Adjustment of the Separator

As for the sliding of the two outer most leadframe, the orientation of the separator can be adjusted to give the best sliding action. It will prevent the leadframe from sliding too fast and damage the edges. It can also prevent leadframe from not sliding down due to not enough tilting angle.

For the 2 middle leadframe, the plate is used as a platform for them to slide to the bottom main conveyor. The position and tilting angle of the plate can be adjusted to aid the sliding action. See Figure 7.2.

Tapping and downsetting process is carried out before the leadframe is passed to the press machine for cutting. After cutting, the leadframe is then transferred out of the press machine by the conveyor system. It was found that the speed of the conveyor has to be faster than that of the press machine if not the conveyor will not be able to catch up with the press.



Can be adjusted

Figure 7.2 Adjustment of the Plate

7.1 Test Result

A speed of the minimum and the maximun is being tested and leadframes of various width were used for the testing. The testing was conductor for more than six hours. During this period, all the models of the leadframe that is to be run were tested. From the test run, it can be said that the machine is working fine. The test result for all the models tested is tabulated in Table 7.1.

From the result, we can see that the conveyor system is able to accommodate the various kind of leadframe models. It is able to achieve the cycle time without fail. However, it seems like the wider the width of the leadframe and the faster the conveyor runs, the likelihood that defects will occur. This is because as the conveyor runs fast, the momentum of the leadframe will be more and causes the leadframe to slide down the separator even faster. Since the force is too great, it slides down and hit the side of the conveyor and get dented.

No.	Model	Testing Time (min)	Cycle Time (sheet/min)	Compatibility	No. of Defects
1	1A	30	25	Yes	0
		30	40	Yes	0
		30	55	Yes	0
2	2B	30	25	Yes	0
		30	40	Yes	0
		30	55	Yes	0
3	3C	30	25	Yes	0
		30	40	Yes	1
		30	55	Yes	0
4	4D	30	25	Yes	0
		30	40	Yes	0
		30	55	Yes	1

Table 7.1 Test Result for the Conveyor System

To solve the problem, the tilting angle of the separator is changed to reduce the sliding force. Another way is to place a rubber padding at the side of the conveyor. This will act as a cushion for the leadframe.

7.1 Comparison Test

To further outline the advantages of this new conveyor system, an experiment on two production lines are conducted. The difference of the lines is that one of it uses the new conveyor system while the other uses manpower to collect the products. This experiment was continued for four months. The outcomes of both results were plotted in graphs shown in Figure 7.1 and Figure 7.2.

From Figure 7.1, we can see that the number of defective parts for manual collecting is far greater than that of the conveyor system. So it shows that the conveyor system is more reliable and it gives lower production cost.

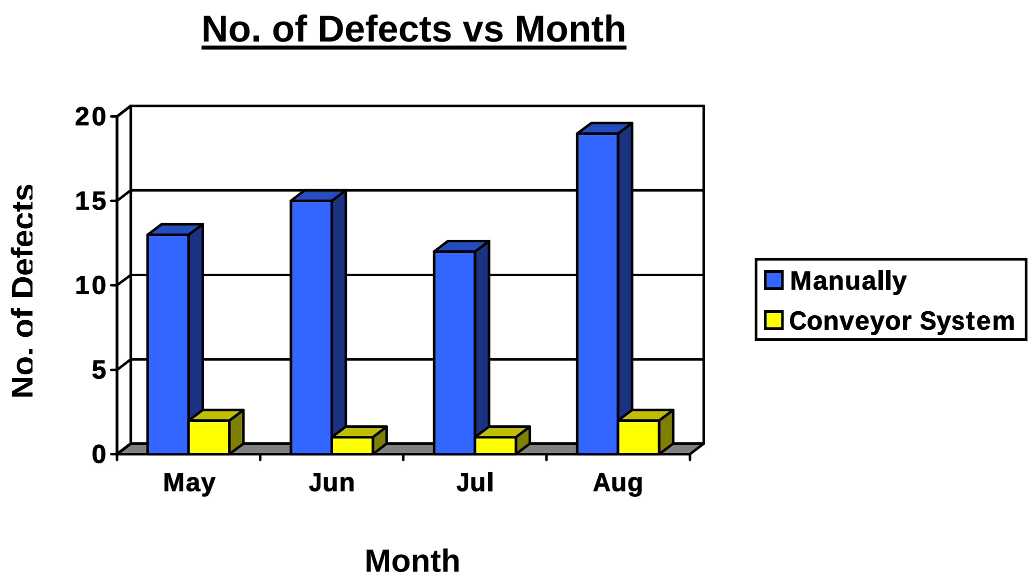


Figure 7.1 Test Result for the Conveyor System

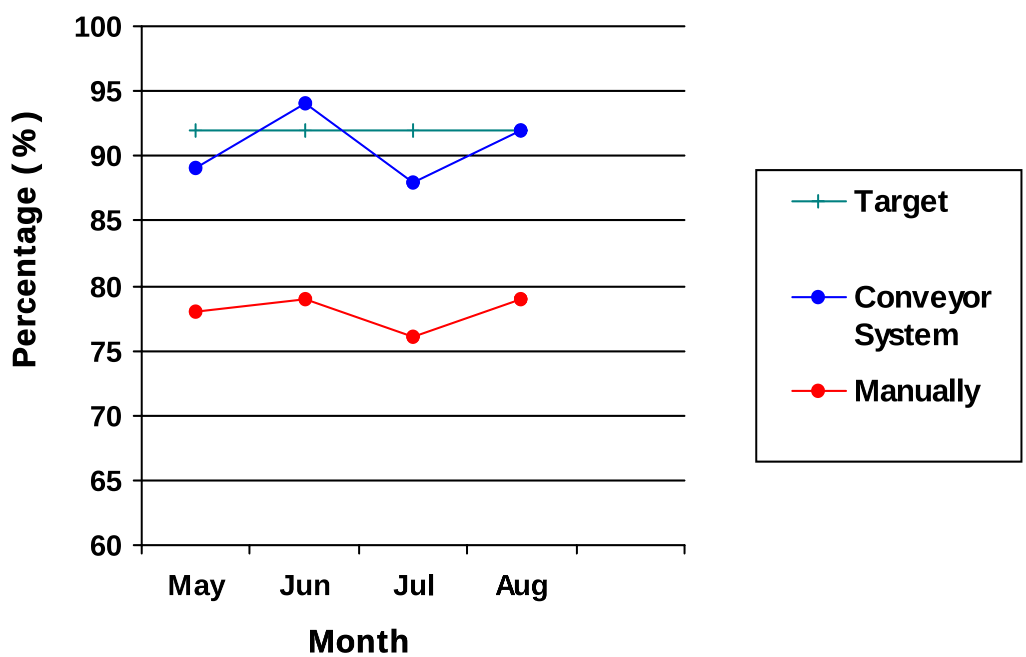


Figure 7.2 Monthly Yield Results

In Figure 7.2, due to the reliability of the conveyor system, the yield is much higher than that of manual operation. As the conveyor system is able to operate at high speed, therefore the output is also greater.

7.3 Aspect of Sustainability

For the case of my project, the resources that I use are commonly found in the market. Even if the parts are to be replaced due to wear and tear, they can still be recycled. These contribute a lot in reducing waste production and therefore act as a measure towards protection of the environment.

What I feel that is needed to accommodate in my design in the aspect of environmental protection are: minimization in air, noise and waste pollution. It must be environmental friendly. Currently the earth is under lots of destructive damages and the situation is alarming. It is necessary for us to save it and bring back the pleasant habitat it used to be.

Regarding the impact of my project work in global scale, I can foresee that for those companies who are my competitors, they will find this conveyor system attractive. They will like to acquire one if they do not have any. But in the future it is not unusual if people are trying to improve my design to make it a better system. They may feel that the one I make will not be good enough for future use. Since technology keeps advancing so the system has to constantly upgrade to meet the demand.

However, I think most people will still feel comfortable with my work. Since it is easy to operate and environmental friendly. As such, there are no environmental or pollution cost incur during production. This will help to save the production cost.

This project is mainly for improvement purpose. It is consider successful since the performance level had increased a few notch. In this case, operators do not need to attend to the machine so often and they can have more time for other works like inspection of work quality. There is even a possibility that one worker attending to 2 machines simultaneously instead of just one. As workforce is abundant, the management will have to retrench some workers to save labour cost. So indirectly this will cost some of the operators their rice bowls. This is indeed a sad situation.

Well, it is really an honour if my work is been recognized by other people in the world, especially in those developed countries. It will reflect that my work is of some standard. What I am certain is that this conveyor system is very user friendly as most people will be able to handle it without fail. It does not require an expert to operate. I am sure people from undeveloped countries are able to operate the systems too.

7.4 Ethical Responsibility

I personally feel that this system is quite safe and it will not bring any harm to the people if it is not misuse. Other than the lost of the operators' job, the rest are benefits to the users. Maybe people will comment that usage of the motor is very dangerous because of the voltage supply, people can get electrocuted if the connection of the wire is not done properly. Or people can get hurt if their hands get caught in the pulley and belt. But if the safety measures are done properly and rules are strictly follow, I do not think that anyone will get hurt so easily.

Chapter 8

Conclusion

In the semiconductor industry, manufacturers deal with changes every year: shorter device product lifecycles, rapid technology changes, and market demand volatility. There are no hard and fast rules for predicting effective lifecycles for semiconductor equipment. Manufacturers must have the flexibility to react quickly and effectively to market and technology changes.

In an age of market skepticism and consolidation, bringing a new idea or product is increasingly difficult. An innovation must demonstrate that it solves an existing or future problem, can be cost effective and can meet ever-increasing requirements of production. In the future, new technologies and roadmap milestones promise to present even greater challenges.

The rewards for overcoming these barriers and having an innovation incorporated into a production process can be substantial for a product that meets a critical need.

8.1 Achievement of Project Objectives

In view of the performance, the conveyor system has achieved its objectives that are stated in Chapter 3.

It links up well with the press machine and the stacker unit. It is able to separate the four strand of leadframes and transfer them to their respective stacker unit which the present conveyor system is not able to. The new design allows for greater production output since it is able to operate at a higher speed. The number of defects is very low as compared to manual operation. It is cost saving, efficient and has greatly improved the operation process.

From these, I conclude that this project is a success. Though it may need some improvement, it can still perform up to the required expectations.

8.2 Further Work

Usually the initial design is not the final one as it needs improvement in order to make the whole system runs better.

Although the idea of adjusting the sliding plate to various angles and different height is good, there are some problems in the adjusting. The workers have difficulty aligning the plates due to its weight and it is hard to get it straight. So time is often wasted in getting the sliding plates to its correct position.

So to solve the problems, grooves can be implemented in the adjusting plates so that movement of the plate is restricted to only one axis at a time. The operators can now adjust the sliding plates at ease.

Another area to improve on is the mounting blocks for the flange bearing. The fabrication cost can be reduced further by simplifying the design. A flat plate with mounting holes is good enough.

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Appendix A

Project Specification

University of Southern Queensland
Faculty of Engineering and surveying

ENG 4111/2 Research Project
Project Specification

FOR: **Lim Doou Gie**
TOPIC: Design & Development of Conveyor System for Semiconductor Industry
SUPERVISOR: Dr. Harry Ku
ASSOCIATE SUPERVISOR: Dr. Yan Wenyi
LOCAL SUPERVISOR: Mr. Tan Say Keong

SPONSORSHIP: **SUMITOMO METAL MINING ASIA PACIFIC PTE LTD**

PROJECT AIM: The aim of the project is to conduct research studies on the various types of conveyors regarding its capabilities, materials used and work performances. Develop a customer made conveyor that is able to perform the same criteria as those types of conveyor and on top of that it must suit the kind of work processes required by semiconductor industry. It will generally help in the various aspects of the engineering productions.

PROGRAMME: **Issue A, 15th March 2004**

1. Research background information on different processes in a semiconductor industry. (By mid April)
2. Study on the conveyors used and other types of conveyor available in the market. (By end March)
3. Analyse on the problems faced in the present conveyor
4. Study on the requirements of a good conveyor system. (By end April)
5. Design & development of the conveyor system. (By end April)
6. Detailed drawing of conveyor system using AutoCAD software. (By end May)
7. Liaise with vendors on the fabrication of the conveyor system. (By end June)
8. Assembly of the conveyor system by the company set-up team. (By end July)
9. Testing on the work performance of the conveyor system. (By end July)
10. Comparison of the new conveyor system with the old system. (By end July)
11. Conclusion on the conveyor system. (By end August)
12. Discussion with the supervisor on the project writes out. (By end August)
13. Initial drafting of the project and show to the supervisor. (By end September)
14. Final drafting of the project which includes modifications suggested by supervisor. (By end September)
15. Complete of the report. (By end October)

If time permits:

16. Implement new improvements to the conveyor system. (By end October)

Agreed by Student: Lim Doou Gie Date: 02 / 04 / 04

Agreed by Supervisors: ______________ Date: ___ / ___ / ___

Agreed by Associate Supervisors: ___________ Date: ___/ ___ / ___

Appendix B

Project Information

B.1 Parts Specifications

Leadframe & Standard Parts Specifications

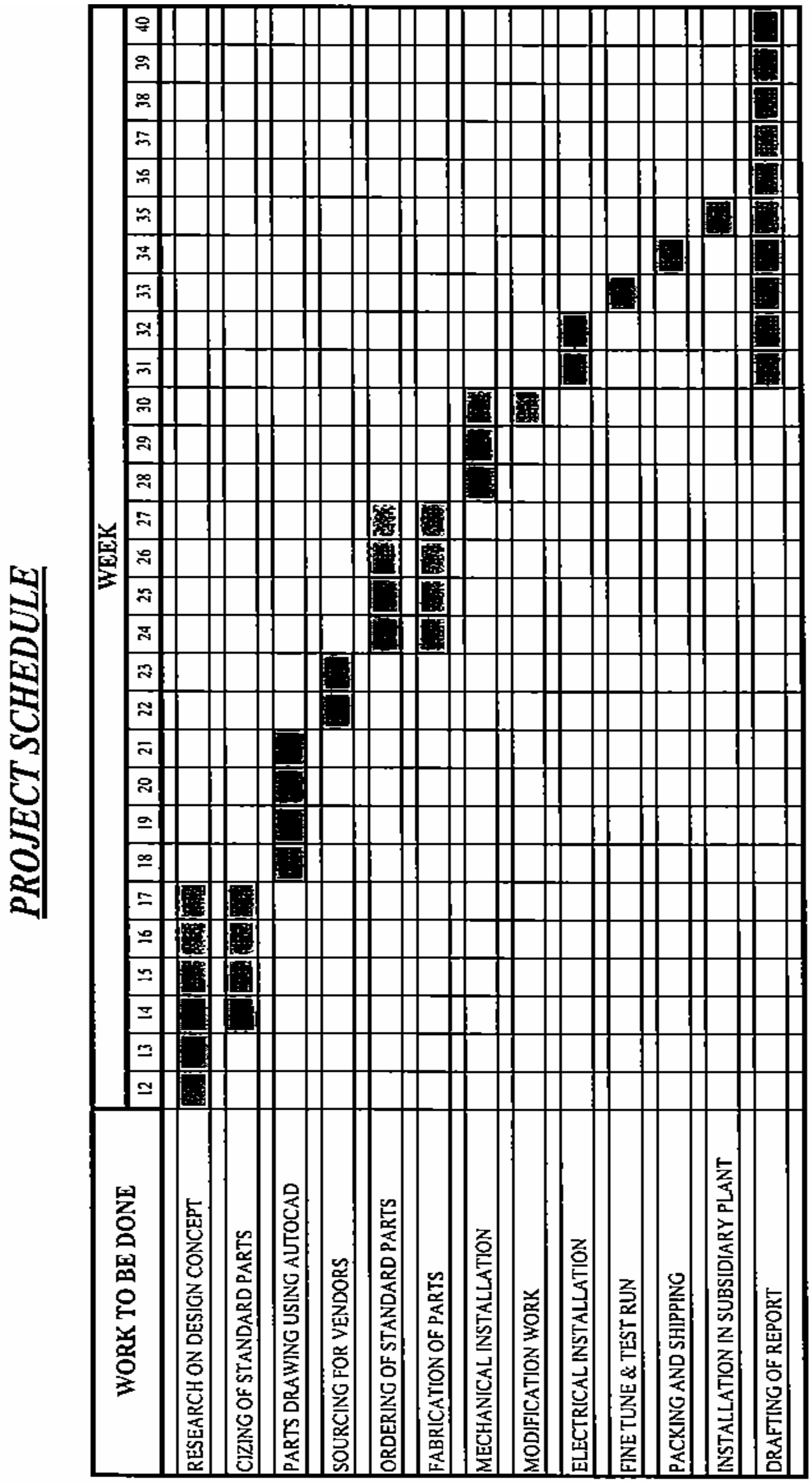
S/no	Items	Descriptions
1	Single, Dual or 4 Strand	4 Strand Stacker units kyoshin press (20 ton)
2	Interleaf	No
3	Output: min & max	25 ~ 55 leadframes/minute
4	Material of leadframe	A42 / Cu Alloy etched & stamped
5	Thickness of leadframe	0.100 mm to 0.254 mm
6	Leadframe Width : min & max	25 ~ 30 mm
7	Leadframe Length : min & max	150 ~ 250 mm
8	Stacking height	Depend on leadframe thickness (70 mm max.)
9	Number of stack on conveyor	3 ~ 5 stack (Base on leadframe width)
10	Type of belt of track conveyor & colour	Anti-static green belt
11	Type of belt of stack conveyor & colour	Anti-static green belt
12	Type of cushion of leadframe datum	Steel with cusion behind
13	Hopper pusher material	Nylon

General Machine Specification

S/no	Items	Descriptions
1	Machine direction	Right to Left
2	Machine size : L x W x H	2200 x 1750 x 1900
3	Power condition	200V 3 phase
4	Compress air	3 ~ 5 bar
5	Air consumption	300 L/min
6	Environment	18 ~ 25 deg C
7	Machine noise level during operation	< 80 dB
8	Conversion time allow	< 30 mins
9	Machine colour	Ivory (2.5Y9/1.5 or 3)
10	Machine structure	Aluminium profile with panel enclosures
11	Machine top enclosures	Aluminium profile with anti-static perspex
12	Control panel type	Touch screen (Proface)
13	PLC	YOKOGAWA
14	Emergency start / stop button	As standard
15	Pneumatic system	SMC or Koganei
16	All belts / transmission with safety cover	As standard
17	Facility failure detector for no air	As standard

Person-in-charge	: Tan Say Keong
Mechanical design	: Edmund Poon/ Roy Lim
Electrical design	: Edmund Koh
Mechanical installation	: Teo Tian Lai/ Jason Zhao
Electrical wiring	: Azli

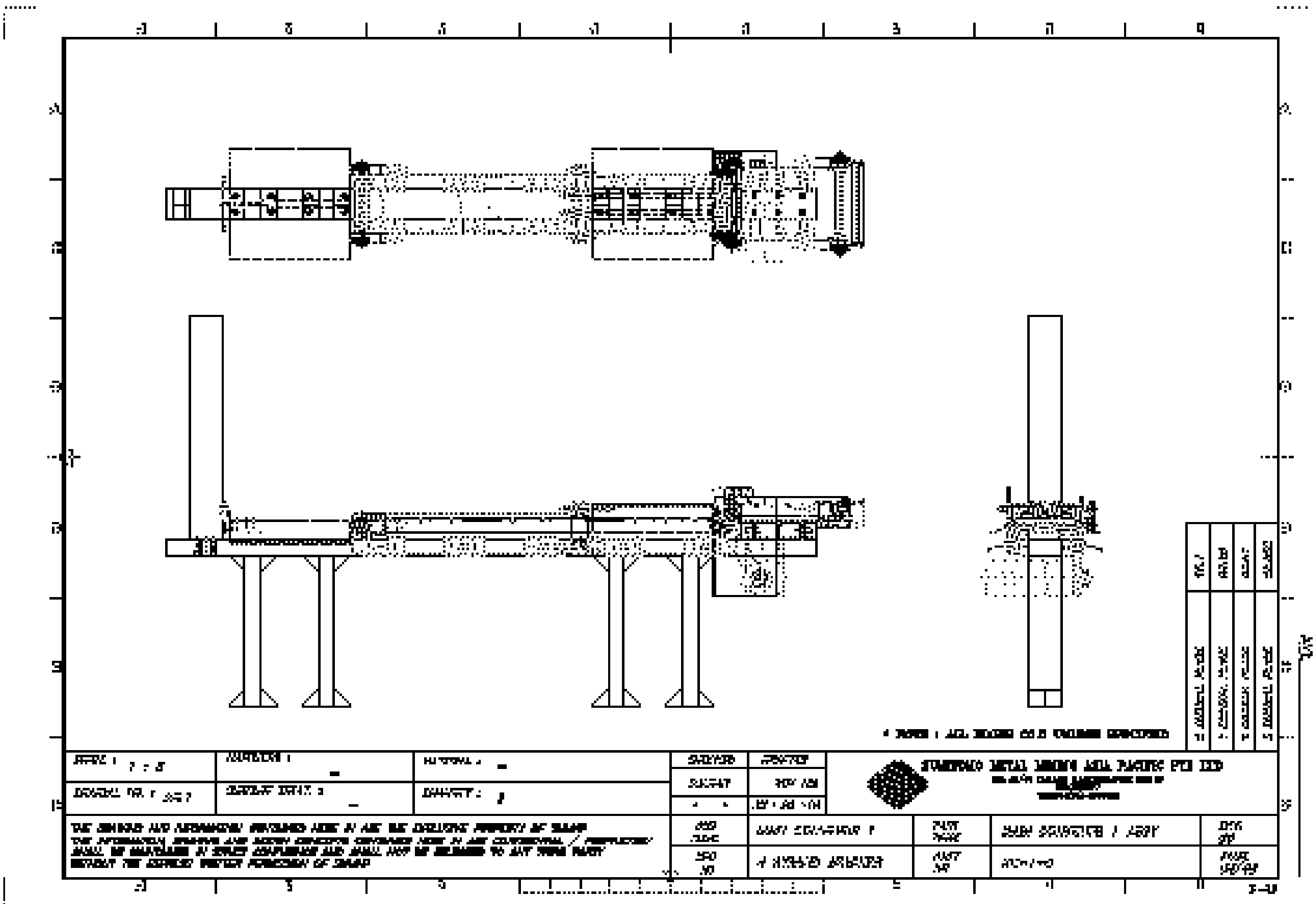
B.2 Schedule


PROJECT SCHEDULE
WORK TO BE DONE
WEEK
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
RESEARCH ON DESIGN CONCEPT
CIZING OF STANDARD PARTS
PARTS DRAWING USING AUTOCAD
SOURCING FOR VENDORS
ORDERING OF STANDARD PARTS
FABRICATION OF PARTS
MECHANICAL INSTALLATION
MODIFICATION WORK
ELECTRICAL INSTALLATION
FINE TUNE & TEST RUN
PACKING AND SHIPPING
INSTALLATION IN SUBSIDIARY PLANT
DRAFTING OF REPORT

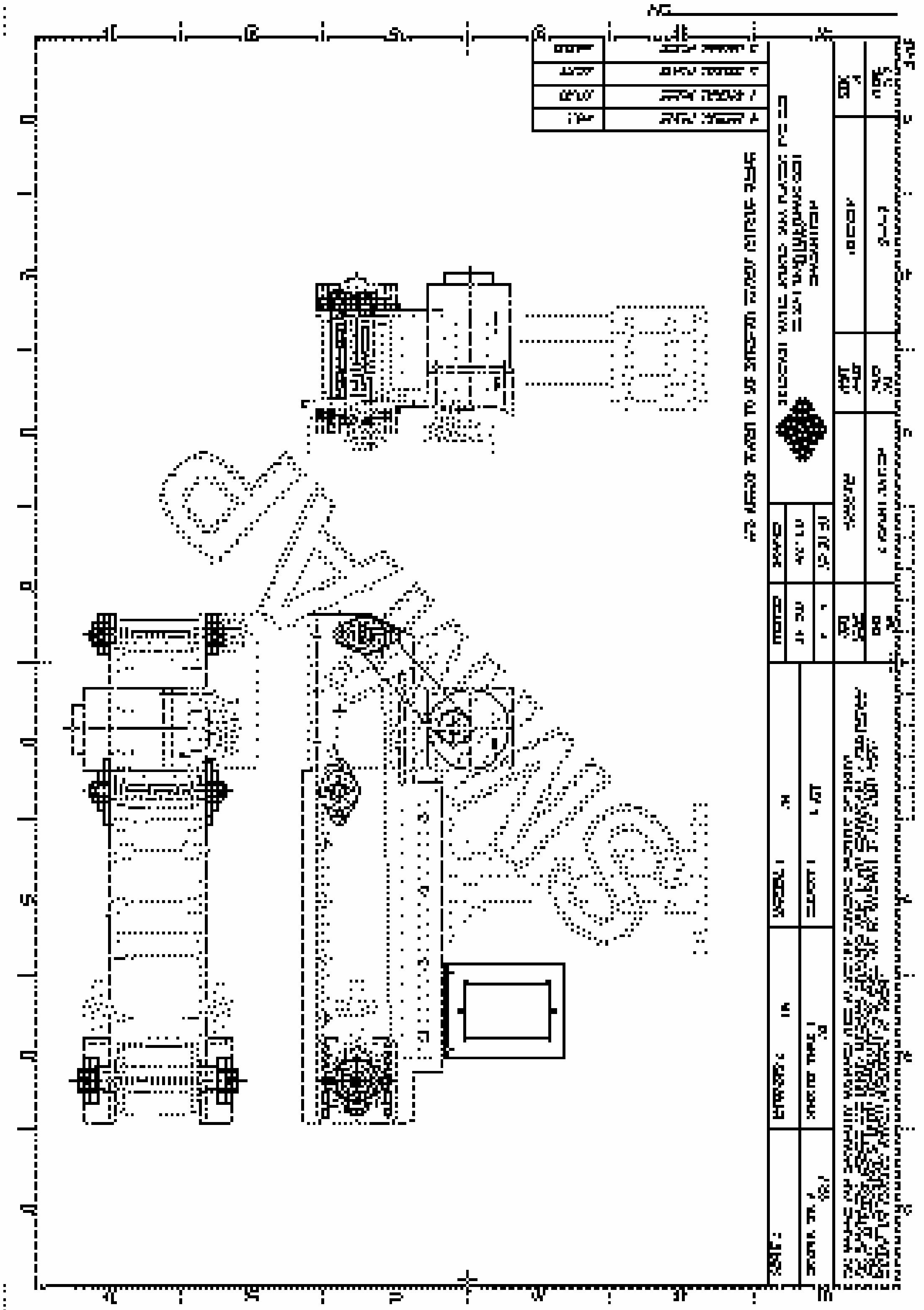
Appendix C

Assembly Drawings

C1 Main Conveyor



C.2 Sub Conveyor



C.3 Pictures

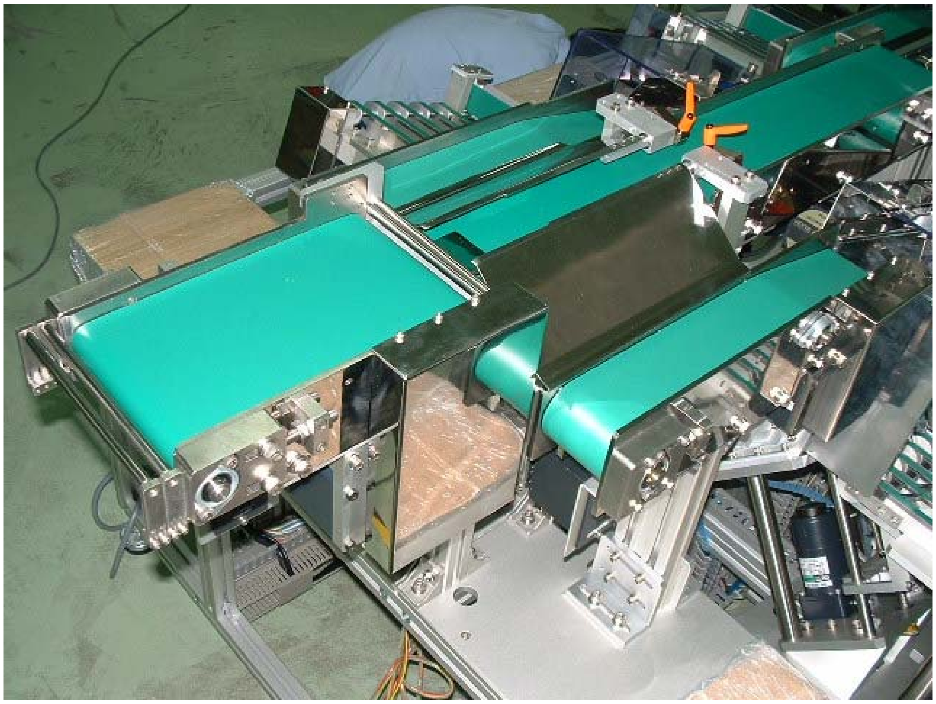


Figure C.1 Top View of Conveyor System

Figure C.2 Isometric View of Conveyor System

Figure C.3 Front View of Conveyor System

Figure C.4 Setting Up of Conveyor System in Production Floor

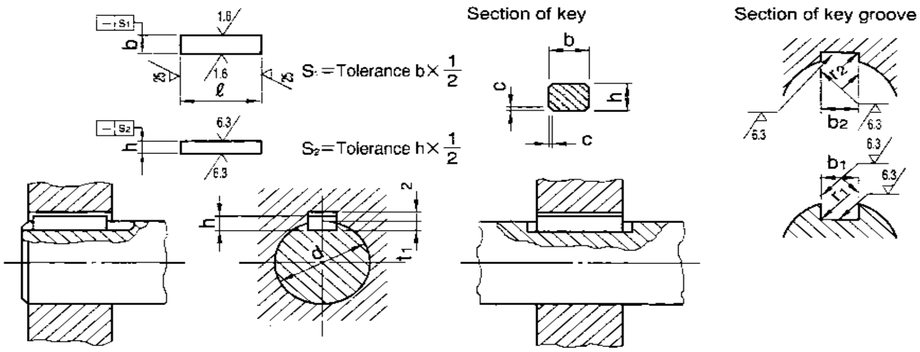
Appendix D

Data Sheets

D.1 General

(Technical Data) Sunk Keys and Key Groove

1.Shape and Dimension of Parallel Key and Key Groove



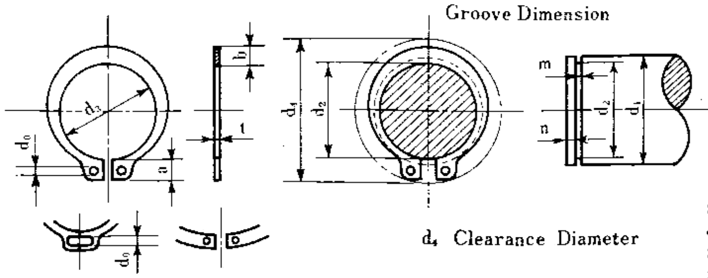
Unit : mm

Nominal Size of Key b×h	Dimension of Key Groove										Reference
	Basic Dimension of $b_1 \cdot b_2$	(Sliding Type) b_1 Tolerance (H9)	(Sliding Type) b_2 Tolerance (D10)	Regular Class b_1 Tolerance (N9)	Regular Class b_2 Tolerance (Js9)	Precision b_1 and b_2 Tolerance (P9)	r_1 and r_2	Basic Dimension of t_1	Basic Dimension of t_2	Tolerance of $t_1 \cdot t_2$	Applicable (¹) Shaft Dia. d
2×2	2	+0.025 0	+0.060 +0.020	−0.004 −0.029	±0.0125	−0.006 −0.031	0.08~0.16	1.2	1.0	+0.1 0	6~8
3×3	3							1.8	1.4		8~10
4×4	4	+0.030 0	+0.078 +0.030	0 −0.030	±0.0150	−0.012 −0.042		2.5	1.8		10~12
5×5	5						0.16~0.25	3.0	2.3		12~17
6×6	6							3.5	2.8		17~22
(7×7)	7	+0.036 0	+0.098 +0.040	0 −0.036	±0.0180	−0.015 −0.051		4.0	3.0	+0.2 0	20~25
8×7	8							4.0	3.3		22~30
10×8	10						0.25~0.40	5.0	3.3		30~38
12×8	12	+0.043 0	+0.120 +0.050	0 −0.043	±0.0215	−0.018 −0.061		5.0	3.3		38~44
14×9	14							5.5	3.8		44~50
(15×10)	15							5.0	5.0		50~55
16×10	16							6.0	4.3		50~58
18×11	18							7.0	4.4		58~65
20×12	20	+0.052 0	+0.149 +0.065	0 −0.052	±0.0260	−0.022 −0.074	0.40~0.60	7.5	4.9		65~75
22×14	22							9.0	5.4		75~85
(24×16)	24							8.0	8.0		80~90
25×14	25							9.0	5.4		85~95
28×16	28							10.0	6.4		95~110
32×18	32	+0.062 0	+0.180 +0.080	0 −0.062	±0.0310	−0.026 −0.088		11.0	7.4		110~130
(35×22)	35						0.70~1.00	11.0	11.0	+0.3 0	125~140
36×20	36							12.0	8.4		130~150
(38×24)	38							12.0	12.0		140~160
40×22	40							13.0	9.4		150~170
(42×26)	42							13.0	13.0		160~180
45×25	45							15.0	10.4		170~200
50×28	50							17.0	11.4		200~230
56×32	56	+0.074 0	+0.220 +0.100	0 −0.074	±0.0370	−0.032 −0.106	1.20~1.60	20.0	12.4		230~260
63×32	63							20.0	12.4		260~290
70×36	70							22.0	14.4		290~330
80×40	80						2.00~2.50	25.0	15.4		330~380
90×45	90	+0.087 0	+0.260 +0.120	0 −0.087	±0.0435	−0.037 −0.124		28.0	17.4		380~440
100×50	100							31.0	19.5		440~500

Note(¹) Applicable shaft diameters should be derived from the torque that corresponds to the key strength. Shown here, therefore, are reference for general usage.
When the key size is appropriate for the transmission torque, a shaft larger than the applicable shaft diameter may be used. In that case, it is recommended to adjust t_1 and t_2 so that the key side uniformly contacts the shaft and hub. This does not apply to shafts smaller than the applicable shaft diameter.

Reference Size codes in ( ) are not stipulated in the corresponding international standards and should not be used in new designs.

Retaining Rings (External) JIS B 2804



d₄ Clearance Diameter

Under Size No.9 Above Size No.170

S-PACK

STW-rings can be supplied in tape wrapped or banded.
Size No. 10 through 48 tape wrapped.
Size No. 50 through 125 tape wrapped or banded.

Unit. mm

Size-No.	Ring dimension d_3 Basic	d_3 Tol.	t Basic	t Tol.	b Approx.	a Approx.	d_0 Min.	Ref. d_4	Groove dimension d_1	d_2 Basic	d_2 Tol.	m Basic	m Tol.	Ref. n Min.
STW- ※ 3	2.7		0.25	+0.025	0.5	1.7	0.7	7	3	2.85		0.35		
※ 4	3.7	−0.04 / −0.15	0.4	−0.03	0.9	2.2	0.8	9	4	3.8	0 / −0.04	0.5		0.3
※ 5	4.7		0.6		1.1	2.4		10.5	5	4.8		0.7	+0.1 / 0	
※ 6	5.6		0.7		1.3	2.8		12	6	5.7		0.8		0.5
※ 7	6.5	+0.1 / −0.2	0.8		1.4	3	1	14	7	6.7		0.9		
※ 8	7.4				1.6	3		15	8	7.6	0 / −0.06			0.6
※ 9	8.4				1.8	3.2		16	9	8.6				
※ 10	9.3	±0.15			1.8	3	1.5	17	10	9.6	0 / −0.09			
※ 11	10.2			−0.04	2	3.1		18	11	10.5				
※ 12	11.1				2.1	3.2		19	12	11.5				
※ 13	12		1		2.1	3.3		20	13	12.4		1.15		
※ 14	12.9				2.2	3.4		22	14	13.4				
※ 15	13.8	±0.18			2.2	3.5	1.7	23	15	14.3	0 / −0.11			
16	14.7				2.2	3.6		24	16	15.2				
17	15.7				2.2	3.7		25	17	16.2				
18	16.5				2.6	3.8		26	18	17				
19	17.5				2.7	3.8		27	19	18				
20	18.5				2.7	3.9		28	20	19				
21	19.5				2.7	4		30	21	20				
22	20.5		1.2		2.7	4.1		31	22	21		1.35		1.5
※ 23	21.4				2.9	4.5		32.5	23	22				
24	22.2				3.1	4.2	2	33	24	22.9				
25	23.2	±0.2		±0.05	3.1	4.3		34	25	23.9	0 / −0.21			
26	24.2				3.1	4.4		35	26	24.9			+0.14 / 0	
※ 27	25				3.3	4.5		36	27	25.8				
28	25.9				3.1	4.6		38	28	26.6				
29	26.9				3.5	4.7		39	29	27.6				
30	27.9		1.5		3.5	4.8		40	30	28.6		1.65		
[illegible]	[illegible]				[illegible]	[illegible]		[illegible]	[illegible]					
34	31.5				4	5.3		45	34	32.3				
35	32.2	±0.25			4	5.4		46	35	33				
36	33.2				4	5.4		47	36	34				
38	35.2				4.5	5.6		50	38	36				
40	37				4.5	5.8		53	40	38	0 / −0.25			
42	38.5		1.75		4.5	6.2	2.5	55	42	39.5		1.9		
45	41.5				4.8	6.3		58	45	42.5				
※ 47	43.4	±0.4		±0.06	5	6.6		61	47	44.5				2
48	44.5				4.8	6.5		62	48	45.5				
50	45.8				5	6.7		64	50	47				
52	47.8		2		5	6.8		66	52	49		2.2		
55	50.8	±0.45			5	7		70	55	52	0 / −0.3			
[illegible]	[illegible]				5	7		71	56	53				

DESCRIPTION OF PREFERRED FIT

TOLERANCE SYSTEM - HOLE BASIS		
	H6	**EXTRA FINE HOLE**
EXTRA FINE TOLERANCE FIT	g5	Close running fit
	h5	Slide fit
	j5	Push fit
	k5	Light keying fit
	m5	Medium drive fit
	n5	Heavy drive fit
	p5	Force fit
	H7	**FINE HOLE**
FINE TOLERANCE FIT	e8	Slack running fit
	f7	Normal running fit
	g6	Close running fit
	h6	Slide fit
	j6	Push fit
	k6	Light keying fit
	m6	Medium keying fit
	n6	Heavy keying fit
	p6	Force fit
	H8	**MEDIUM HOLE**
MEDIUM TOLERANCE FIT	d9	Extra slack running fit
	e9	Slack running fit
	f8	Normal running fit
	h7	Slide fit
	H9	**COARSE HOLE**
COARSE TOLERANCE FIT	c9	Extra slack running fit
	d8	Loose running fit
	e8	Slack running fit
	h8	Slide fit

HOLE BASIS	SHAFT BASIS	DESCRIPTION
		CLEARANCE FITS
H11 / c11	C11 / h11	Loose running fit for wide commercial tolerances or allowances on external members.
H9 / d9	D9 / h9	Free running fit not for use where accuracy is essential, but good for large temperature variations, high running speeds, or heavy journal pressures
H8 / f7	F8 / h7	Close running fit for running on accurate machines and for accurate location at moderate speeds and journal pressures.
H7 / g6	G7 / h6	Sliding fit not intended to run freely, but to move and turn freely and locate accurately.
H7 / h6	H7 / h6	Locational clearance fit provides snug fit for locating stationary parts; but can be freely assembled and disassembled.
		TRANSITION FITS
H7 / k6	K7 / h6	Locational transition fit for accurate location, a compromise between clearance and interference.
H7 / n6	N7 / h6	Locational transition fit for more accurate location where greater interference is permissible
		INTERFERENCE FIT
H7 / p6*	P7 / h6	Locational interference fit for parts requiring rigidity and alignment with prime accuracy of location but without special bore pressure requirements. * Transition fit for basic sizes in range from 0 through 3mm.
H7 / s6	S7 / h6	Medium drive fit for ordinary steel parts or ahrink fits on light sections, the tightest fit usable with cast iron.
H7 / u6	U7 / h6	Force fit suitable for parts which can be highly stressed or shrink fits where the heavy pressing forces required are impractical.

MORE CLEARANCE

MORE INTERFERENCE

TOLERANCES OF COMMONLY USED HOLE FITS

Excerpt from JIS B 0401 (1986)

Deviations of holes to be used in commonly used fits

0·001 mm

Tolerance zone class of hole — Unit : μm

Basic size step (mm) Over	Or less	B10	C9	C10	D8	D9	D10	E7	E8	E9	F6	F7	F8	G6	G7
–	3	+180 +140	+85 +60	+100 +60	+34 +20	+45 +20	+60 +20	+24 +14	+28 +14	+39 +14	+12 +6	+16 +6	+20 +6	+8 +2	+12 +2
3	6	+188 +140	+100 +70	+118 +70	+48 +30	+60 +30	+78 +30	+32 +20	+38 +20	+50 +20	+18 +10	+22 +10	+28 +10	+12 +4	+16 +4
6	10	+208 +150	+116 +80	+138 +80	+62 +40	+76 +40	+98 +40	+40 +25	+47 +25	+61 +25	+22 +13	+28 +13	+35 +13	+14 +5	+20 +5
10	14	+220 +150	+138 +95	+165 +95	+77 +50	+93 +50	+120 +50	+50 +32	+59 +32	+75 +32	+27 +16	+34 +16	+43 +16	+17 +6	+24 +6
14	18														
18	24	+244 +160	+162 +110	+194 +110	+98 +65	+117 +65	+149 +65	+61 +40	+73 +40	+92 +40	+33 +20	+41 +20	+53 +20	+20 +7	+28 +7
24	30														
30	40	+270 +170	+182 +120	+220 +120	+119 +80	+142 +80	+180 +80	+75 +50	+89 +50	+112 +50	+41 +25	+50 +25	+64 +25	+25 +9	+34 +9
40	50	+280 +180	+192 +130	+230 +130											
50	65	+310 +190	+214 +140	+260 +140	+146 +100	+174 +100	+220 +100	+90 +60	+106 +60	+134 +60	+49 +30	+60 +30	+76 +30	+29 +10	+40 +10
65	80	+320 +200	+224 +150	+270 +150											
80	100	+360 +220	+257 +170	+310 +170	+174 +120	+207 +120	+260 +120	+107 +72	+126 +72	+159 +72	+58 +36	+71 +36	+90 +36	+34 +12	+47 +12
100	120	+380 +240	+267 +180	+320 +180											
120	140	+420 +260	+300 +200	+360 +200	+208 +145	+245 +145	+305 +145	+125 +85	+148 +85	+185 +85	+68 +43	+83 +43	+106 +43	+39 +14	+54 +14
140	160	+440 +280	+310 +210	+370 +210											
160	180	+470 +310	+330 +230	+390 +230											
180	200	+525 +340	+355 +240	+425 +240	+242 +170	+285 +170	+355 +170	+146 +100	+172 +100	+215 +100	+79 +50	+96 +50	+122 +50	+44 +15	+61 +15
200	225	+565 +380	+375 +260	+445 +260											
225	250	+605 +420	+395 +280	+465 +280											
250	280	+690 +480	+430 +300	+510 +300	+271 +190	+320 +190	+400 +190	+162 +110	+191 +110	+240 +110	+88 +56	+108 +56	+137 +56	+49 +17	+69 +17
280	315	+750 +540	+460 +330	+540 +330											
315	355	+830 +600	+500 +360	+590 +360	+299 +210	+350 +210	+440 +210	+182 +125	+214 +125	+265 +125	+98 +62	+119 +62	+151 +62	+54 +18	+75 +18
355	400	+910 +680	+540 +400	+630 +400											
400	450	+1010 +760	+595 +440	+690 +440	+327 +230	+385 +230	+480 +230	+198 +135	+232 +135	+290 +135	+108 +68	+131 +68	+165 +68	+60 +20	+83 +20
450	500	+1090 +840	+635 +480	+730 +480											

Basic size step (mm) Over	Or less	H6	H7	H8	H9	H10	JS6	JS7	K6	K7	M6	M7	N6	N7	P6	P7
–	3	+6 0	+10 0	+14 0	+25 0	+40 0	±3	±5	0 −6	0 −10	−2 −8	−2 −12	−4 −10	−4 −14	−6 −12	−6 −16
3	6	+8 0	+12 0	+18 0	+30 0	+48 0	±4	±6	+2 −6	+3 −9	−1 −9	0 −12	−5 −13	−4 −16	−9 −17	−8 −20
6	10	+9 0	+15 0	+22 0	+36 0	+58 0	±4.5	±7	+2 −7	+5 −10	−3 −12	0 −15	−7 −16	−4 −19	−12 −21	−9 −24
10	14	+11 0	+18 0	+27 0	+43 0	+70 0	±5.5	±9	+2 −9	+6 −12	−4 −15	0 −18	−9 −20	−5 −23	−15 −26	−11 −29
14	18															
18	24	+13 0	+21 0	+33 0	+52 0	+84 0	±6.5	±10	+2 −11	+6 −15	−4 −17	0 −21	−11 −24	−7 −28	−18 −31	−14 −35
24	30															
30	40	+16 0	+25 0	+39 0	+62 0	+100 0	±8	±12	+3 −13	+7 −18	−4 −20	0 −25	−12 −28	−8 −33	−21 −37	−17 −42
40	50															
50	65	+19 0	+30 0	+46 0	+74 0	+120 0	±9.5	±15	+4 −15	+9 −21	−5 −24	0 −30	−14 −33	−9 −39	−26 −45	−21 −51
65	80															
80	100	+22 0	+35 0	+54 0	+87 0	+140 0	±11	±17	+4 −18	+10 −25	−6 −28	0 −35	−16 −38	−10 −45	−30 −52	−24 −59
100	120															
120	140	+25 0	+40 0	+63 0	+100 0	+160 0	±12.5	±20	+4 −21	+12 −28	−8 −33	0 −40	−20 −45	−12 −52	−36 −61	−28 −68
140	160															
160	180															
180	200	+29 0	+46 0	+72 0	+115 0	+185 0	±14.5	±23	+5 −24	+13 −33	−8 −37	0 −46	−22 −51	−14 −60	−41 −70	−33 −79
200	225															
225	250															
250	280	+32 0	+52 0	+81 0	+130 0	+210 0	±16	±26	+5 −27	+16 −36	−9 −41	0 −52	−25 −57	−14 −66	−47 −79	−36 −88
280	315															
315	355	+36 0	+57 0	+89 0	+140 0	+230 0	±18	±28	+7 −29	+17 −40	−10 −46	0 −57	−26 −62	−16 −73	−51 −87	−41 −98
355	400															
400	450	+40 0	+63 0	+97 0	+155 0	+250 0	±20	±31	+8 −32	+18 −45	−10 −50	0 −63	−27 −67	−17 −80	−55 −95	−45 −108
450	500															

Basic size step (mm) Over	Or less	R7	S7	T7	U7	X7
–	3	−10 −20	−14 −24	–	−18 −28	−20 −30
3	6	−11 −23	−15 −27	–	−19 −31	−24 −36
6	10	−13 −28	−17 −32	–	−22 −37	−28 −43
10	14	−16 −34	−21 −39	–	−26 −44	−33 −51
14	18					−38 −56
18	24	−20 −41	−27 −48	–	−33 −54	−46 −67
24	30			−33 −54	−40 −61	−56 −77
30	40	−25 −50	−34 −59	−39 −64	−51 −76	–
40	50			−45 −70	−61 −86	
50	65	−30 −60	−42 −72	−55 −85	−76 −106	–
65	80	−32 −62	−48 −78	−64 −94	−91 −121	
80	100	−38 −73	−58 −93	−78 −113	−111 −146	–
100	120	−41 −76	−66 −101	−91 −126	−131 −166	
120	140	−48 −88	−77 −117	−107 −147		
140	160	−50 −90	−85 −125	−119 −159		
160	180	−53 −93	−93 −133	−131 −171		
180	200	−60 −106	−105 −151	–	–	
200	225	−63 −109	−113 −159			
225	250	−67 −113	−123 −169			
250	280	−74 −126	–	–	–	
280	315	−78 −130				
315	355	−87 −144	–	–	–	
355	400	−93 −150				
400	450	−103 −166	–	–		
450	500	−109 −172				

Note : This table shows that the upper figures are the upper deviation and the lower figures are the lower deviation.

TOLERANCES OF COMMONLY USED SHAFT FITS

Excerpt from JIS B 0401 (1986)

ns of shafts to be used in commonly used fits

0.001 mm

Tolerance zone class of shaft

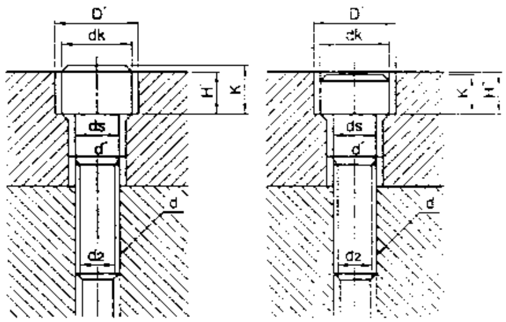
Unit : μm

b9	c9	d8	d9	e7	e8	e9	f6	f7	f8	g5	g6	h5	h6	h7	h8	h9	js5	js6	js7	k5	k6	m5	m6	n5 *	n6	p6	r6	s6	t6	u6	x6
-140	-60	-20	-20	-14	-14	-14	-6	-6	-6	-2	-2	0	0	0	0	0	±2	±3	±5	+4	+6	+6	+8	+8	+10	+12	+16	+20		+24	+26
-165	-85	-34	-45	-24	-28	-39	-12	-16	-20	-6	-8	-4	-6	-10	-14	-25				0	0	+2	+2	+4	+4	+6	+10	+14		+18	+20
-140	-70	-30	-30	-20	-20	-20	-10	-10	-10	-4	-4	0	0	0	0	0	±2.5	±4	±6	+6	+9	+9	+12	+13	+16	+20	+23	+27	—	+31	+36
-170	-100	-48	-60	-32	-38	-50	-18	-22	-28	-9	-12	-5	-8	-12	-18	-30				+1	+1	+4	+4	+8	+8	+12	+15	+19		+23	+28
-150	-80	-40	-40	-25	-25	-25	-13	-13	-13	-5	-5	0	0	0	0	0	±3	±4.5	±7	+7	+10	+12	+15	+16	+19	+24	+28	+32	—	+37	+43
-186	-116	-62	-76	-40	-47	-61	-22	-28	-35	-11	-14	-6	-9	-15	-22	-36				+1	+1	+6	+6	+10	+10	+15	+19	+23		+28	+34
																															+51
-150	-95	-50	-50	-32	-32	-32	-16	-16	-16	-6	-6	0	0	0	0	0	±4	±5.5	±9	+9	+12	+15	+18	+20	+23	+29	+34	+39		+44	+40
-193	-138	-77	-93	-50	-59	-75	-27	-34	-43	-14	-17	-8	-11	-18	-27	-43				+1	+1	+7	+7	+12	+12	+18	+23	+28		+33	+56
																															+45
																														+54	+67
-160	-110	-65	-65	-40	-40	-40	-20	-20	-20	-7	-7	0	0	0	0	0	±4.5	±6.5	±10	+11	+15	+17	+21	+24	+28	+35	+41	+48		+41	+54
-212	-162	-98	-117	-61	-73	-92	-33	-41	-53	-16	-20	-9	-13	-21	-33	-52				+2	+2	+8	+8	+15	+15	+22	+28	+35	+54	+61	+77
																													+41	+48	+64
-170	-120																												+64	+76	
-232	-182	-80	-80	-50	-50	-50	-25	-25	-25	-9	-9	0	0	0	0	0	±5.5	±8	±12	+13	+18	+20	+25	+28	+33	+42	+50	+59	+48	+60	
-180	-130	-119	-142	-75	-89	-112	-41	-50	-64	-20	-25	-11	-16	-25	-39	-62				+2	+2	+9	+9	+17	+17	+26	+34	+43	+70	+86	
-242	-192																												+54	+70	
-190	-140																										+60	+72	+85	+106	
-264	-214	-100	-100	-60	-60	-60	-30	-30	-30	-10	-10	0	0	0	0	0	±6.5	±9.5	±15	+15	+21	+24	+30	+33	+39	+51	+41	+53	+66	+87	—
-200	-150	-146	-174	-90	-106	-134	-49	-60	-76	-23	-29	-13	-19	-30	-46	-74				+2	+2	+11	+11	+20	+20	+32	+62	+78	+94	+121	
-274	-224																										+43	+59	+75	+102	
-220	-170																										+73	+93	+113	+146	
-307	-257	-120	-120	-72	-72	-72	-36	-36	-36	-12	-12	0	0	0	0	0	±7.5	±11	±17	+18	+25	+28	+35	+38	+45	+59	+51	+71	+91	+124	
-240	-180	-174	-207	-107	-126	-159	-58	-71	-90	-27	-34	-15	-22	-35	-54	-87				+3	+3	+13	+13	+23	+23	+37	+76	+101	+126	+166	—
-327	-267																										+54	+79	+104	+144	
-260	-200																										+88	+117	+147		
-360	-300																										+63	+92	+122		
-280	-210	-145	-145	-85	-85	-85	-43	-43	-43	-14	-14	0	0	0	0	0	±9	±12.5	±20	+21	+28	+33	+40	—	+52	+68	+90	+125	+159		
-380	-310	-208	-245	-125	-148	-185	-68	-83	-106	-32	-39	-18	-25	-40	-63	-100				+3	+3	+15	+15		+27	+43	+65	+100	+134		
-310	-230																										+93	+133	+171		
-410	-330																										+68	+108	+146		
-340	-240																										+106	+151			
-455	-355																										+77	+122			
-380	-260	-170	-170	-100	-100	-100	-50	-50	-50	-15	-15	0	0	0	0	0	±10	±14.5	±23	+24	+33	+37	+46		+60	+79	+109	+159			
-495	-375	-242	-285	-146	-172	-215	-79	-96	-122	-35	-44	-20	-29	-46	-72	-115				+4	+4	+17	+17		+31	+50	+80	+130			
-420	-280																										+113	+169			
-535	-395																										+84	+140			
-480	-300																										+126				
-610	-430	-190	-190	-110	-110	-110	-56	-56	-56	-17	-17	0	0	0	0	0	±11.5	±16	±26	+27	+36	+43	+52		+66	+88	+94				
-540	-330	-271	-320	-162	-191	-240	-88	-108	-137	-40	-49	-23	-32	-52	-81	-130				+4	+4	+20	+20		+34	+56	+130				
-670	-460																										+98				
-600	-360																										+144				
-740	-500	-210	-210	-125	-125	-125	-62	-62	-62	-18	-18	0	0	0	0	0	±12.5	±18	±28	+29	+40	+46	+57		+73	+98	+108	—	—	—	—
-680	-400	-299	-350	-182	-214	-265	-98	-119	-151	-43	-54	-25	-36	-57	-89	-140				+4	+4	+21	+21		+37	+62	+150				
-820	-540																										+114				
-760	-440																										+166				
-915	-595	-230	-230	-135	-135	-135	-68	-68	-68	-20	-20	0	0	0	0	0	±13.5	±20	±31	+32	+45	+50	+63	…	+80	+108	+126				
-840	-480	-327	-385	-198	-232	-290	-108	-131	-165	-47	-60	-27	-40	-63	-97	-155				+5	+5	+23	+23		+40	+68	+172				
-995	-635																										+132				

Table shows that the upper figures are the upper deviation and the lower figures are the lower deviation

DIMENSIONS OF HOLES FOR THE SOCKET HEAD CAP SCREWS (REFERENCE)

1. Dimensions of counterboring and bolt hole for the socket head cap screws



Unit : mm

Nominal of screws (d)	M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
d_s	3	4	5	6	8	10	12	14	16	18	20	22	24	27	30
d'	3.4	4.5	5.5	6.6	9	11	14	16	18	20	22	24	26	30	33
d_k	5.5	7	8.5	10	13	16	18	21	24	27	30	33	36	40	45
D'	6.5	8	9.5	11	14	17.5	20	23	26	29	32	35	39	43	48
K	3	4	5	6	8	10	12	14	16	18	20	22	24	27	30
H'	2.7	3.6	4.6	5.5	7.4	9.2	11	12.8	14.5	16.5	18.5	20.5	22.5	25	28
H''	3.3	4.4	5.4	6.5	8.6	10.8	13	15.2	17.5	19.5	21.5	23.5	25.5	29	32
d_2	2.6	3.4	4.3	5.1	6.9	8.6	10.4	12.2	14.2	15.7	17.7	19.7	21.2	24.2	26.7

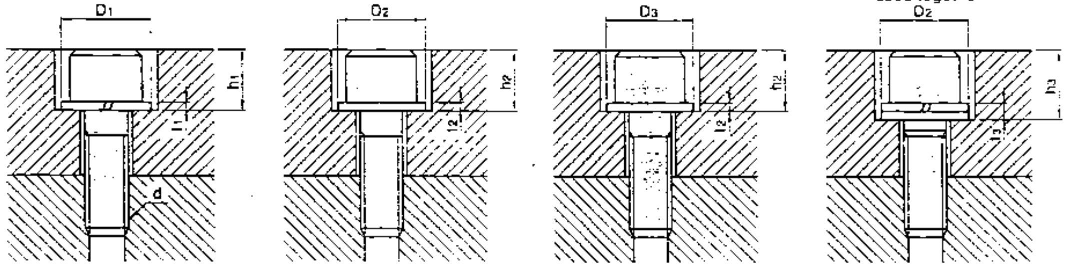
2. Dimensions of counterboring and bolt hole with spring washers or flat washers

Spring washer — D_1

Flat washer (normal round, fine round) — D_2

Flat washer (small round) — D_3

Spring washer and flat washer being used together — D_2



Unit : mm

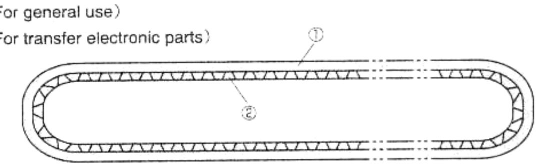
Nominal of screws (d)	M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
D_1	5.9	7.6	9.2	12.2	15.4	18.4	21.5	24.5	28	31	33.8	37.7	40.3	45.3	49.9
h_1	3.7	5	6.3	7.5	10	12.5	15	17.5	20	22.6	25.1	27.6	29.9	33.8	37.5
t_1	0.7	1	1.3	1.5	2	2.5	3	3.5	4	4.6	5.1	5.6	5.9	6.8	7.5
D_2	7	9	10	12.5	17	21	24	28	30	34	37	39	44	50	56
h_2	3.5	4.8	6	7.6	9.6	12	14.5	16.5	19	21	23	25	28	31	34
t_2	0.5	0.8	1	1.6	1.6	2	2.5	2.5	3	3	3	3	4	4	4
D_3	6	8	10	11.5	15.5	18	21	24	28	30	34	37	39	44	50
h_3	4.2	5.8	7.3	9.1	11.6	14.5	17.5	20	23	25.6	28.1	30.6	33.9	37.8	41.5
t_3	1.2	1.8	2.3	3.1	3.6	4.5	5.5	6	7	7.6	8.1	8.6	9.9	10.8	11.5

D.2 Conveyor Belt

Flat Belts
–For general use／Transfer electronic parts–

CAD Data Folder Name : Timing_Pulley

HBLT (For general use)
DHBLT (For transfer electronic parts)



Type	① Cover (Front)	② Main Body (Back)
	M	
HBLT	Polyurethane	Polyester
DHBLT	Electro conductive polyethylene	

Catalog No. Type	Belt Width	L(m) 0.1m Increments	Unit Price ／m	Endless Machining fee
HBLT	10	0.5~20	720	1,630
	15			
	20			
	25	0.8~20		
	30			
	35			
	40			
	50			
	60		960	2,640
	75			
	80		1,440	2,720
	90		1,490	
	100		1,650	
	125		1,980	3,000
	150		2,310	
	200		3,250	3,680
DHBLT	5	0.5~ 3	760	1,630
	10	0.5~20	640	
	15		720	
	20			

Example of Price Calculation
DHBLT15－14.5
(Specified length m) × (Unit price/m) + (Endless machining fee) = Total price
14.5 × 720yen + 1,630yen = 12,070yen

Order Example

Catalog No.		L
Type	Belt Width	
DHBLT	15	14.5

Production Time: 5 Days | Express B | 300 yen/piece P.64

A flat charge of 810 Yen for 3 pieces or more of the same size

Price

■Volume Discount Rate

Quantity	1	2~4	5~19	20~49	50~
Rate	–	5%	10%	15%	To be quoted

■Features of DHBLT

Item		Unit	DHBLT
Electric resistance of surface		Ω	10^4~10^5
Voltage of the traveling belt	* Testing conditions A	V	10~20
	* Testing conditions B		5~10

*Testing conditions
A : Belt speed 220 m/min, Temperature 21±0.5℃, Humidity 70±1%
B : Belt speed 20m/min, Temperature 18±0.5℃, Humidity 50±1%
Stated values here are for measurement example, and they are not guaranteed.

Safety Precautions

■Note for Storage
- Keep away from direct sunlight.
- Store in a place where rain water will not splash.
- Store in a place with a relative humidity of 80% or lower and with a temperature of 0~40℃.
- Do not store with large volumes stacked up and conditions of strong folding or bending.
- Do not put it directly on the ground.
- Do not contact the belt to oils or chemicals.

Type	Belt Characteristics: Driving Pulley Dia. mm	Min. Pulley Dia. mm	Friction Coefficient Against Cold-finished Steel	Weight kg／m²	Allowable Stress kg／cm	Belt Construction: Cover Thickness (mm) Front／Back	Surface Type Front	Surface Type Back	Thickness (mm)	Main Body Quantity	Appropriate Range: Continuous Usable Heating Temperature (Belt Surface Temperature)	Travel Surface Category Roller	Table
HBLT	50 or more	25 Knife edge 5R	Front surface 0.2	1.0	4.0	0.2／0	Smooth	Impregrated	0.9	1	−10~80℃	Good	Excellent
DHBLT		25 Knife edge 3R	Back surface 0.1	0.7	3.0	0.1／0		Cloth surface	0.6				

■Criteria for Endurance of HBLT against Chemicals and Other Substances

<Not damaged by>

Linseed oil, Alcohols, Ammonia (Gas), 〃 (Liquid), 〃 (Aqueous solution), Sulfur, Isopropyl alcohol, Isooctane, Ethyl alcohol (ethanol), Aluminum chloride, Ammonium chloride, Zinc chloride, Potassium chloride, Calcium chloride, Mercuric chloride, Stannic chloride, Ferric chloride, Cupric chloride, Nickel chloride, Barium chloride, Magnesium chloride, Hydrochloric acid (Under 5%), Potassium chlorate, Ozone, Oleic acid, Gasoline (Petroleum), Sodium perborate, Potassium permanganate, Volatile oils, Citric acid, Glycol

Glycerol, Diesel Fuel, Succinic acid, Phosphorous pentaoxide, Zinc acetate, Aluminum acetate, Calcium acetate, Acetate, Nickel acetate, Salicylic acid, Soda hypochlorite (800 PPM), Copper cyanide, Sodium cyanide, Fatty acid, Weak alkali, Weak acid, Aluminum bromide, Oxalic acid, Calcium bisulfite, Sodium bicarbonate, Crude oil, Sodium bisulfate, Aluminum nitrate, Potassium nitrate, Calcium nitrate, Silver nitrate, Ferric nitrate, Sodium nitrate, Nitrate, Mercury, Ammonium hydroxide

Potassium hydroxide, Calcium hydroxide, Barium hydroxide, Magnesium hydroxide, Stearic acid, Potassium cyanide, Petroleum, Soap, Tar oil, Ammonium carbonate, Carbon dioxide, Sodium carbonate, Tannic acid, Sodium thiosulfate, Nitrogen, Diesel oil, Turpentine oil, Natural gas, Urea, Lactic acid, Paraffin oil, Palmitic acid, Pitch, Butane, Butyl alcohol, Aluminum fluoride, Fluorosilicate, Fluoborate, Boric acid, Formalin aqueous solution, Maleic acid

Methyl alcohol (Methanol), Potassium iodide, Wool grease, Zinc sulfide, Calcium sulfide, Hydrogen sulfide, Sodium sulfide, Barium monosulfide, Aluminum sulfate, Aluminum sulfate, Potassium sulfate, Fe2 (SO4) 3, Cupric sulfate, Sodium sulfate, Nickel sulfate, Barium sulfate, Magnesium sulfate, Phosphoric acid, Ammonium phosphate, Sodium phosphate, Malic acid, Yeast cell, Tea leaves, Olive oil, Fruits, Cream, Whale oil, Spice, Cereals, Cocoa, Coffee beans

Flour, Rice, Fishes, Sugar, Salt · Table salt, Salt water, Fat, Tartaric acid, Food oil, Syrup, Soy sauce, Vinegar, Sauce, Cheese, Beet liquid, Theriac, Meat, Butter, Bread, Peanut oil, Beer, Grape sugar, Margarine, Mayonnaise, Water, Vegetables, Coconut oil, Lard

<Somewhat damaged by>

Ester, Sulfur chloride, Perchloric acid, Hydrogen peroxide (10%), Caustic soda (Sodium hydroxide), Caustic soda liquid (50%), Strong alkali, Ketone, Acetic acid water solution, Butyl acetate, Calcium hypochlorite, Soda hypochlorite (Undiluted solution), Hydrobromic acid, Cutting oil, Toluene (toluole), Naphthalene, Sulfur dioxide, Arsenic acid, Phenol, Benzine, Benzene, Aluminum boric acid, Rust-preventing oil, Machine oil, Mono-chloroacetic acid, 10% Sulfuric acid, 50% Sulfuric acid

<Damaged by>

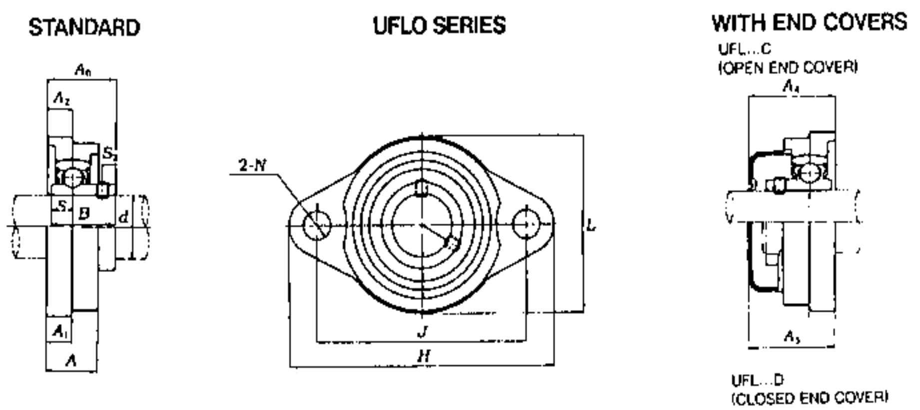
Acetone, Aniline, Aniline dye, Amyl alcohol, Aluminum naphthalene, Sulfurous acid, Sulfurous acid gas, Ether, Ethylbenzene, Hydrochloric acid (Gas), 〃 (5~36%), Chlorine (gas), 〃 (Liquid), Carbon tetrachloride, Dichloroethane, Trichloroethylene, Aqua regia, Sodium peroxide, Ammonium persulfate, Formic acid, Formic acid water solution, Xylene, Strong acid, Cresol, Chromic acid, Chlorosulfonic acid, Chloroform

Acetic acid, Ethyl acetate, Cyclohexane, Dimethylformamide, Bromine, 5% Nitric acid, 10% 〃, 50% 〃, Ammonium nitrate, Nitrobenzene, Carbon disulfide, Glacial acetic acid, Maleic anhydride, Methyl-ethyl ketone (MEK), 70% Sulfuric acid, 98% 〃, Cashew nut

D.3 Bearing

FYH

FLANGE UNITS



UNIT NO.	DIMENSIONS (mm) d	H	J	A_2	A_1	A	N	L	A_0	B	S	S_1	A_4 A_5	BOLT SIZE	BEARING NO.	LOAD RATING C(kgf)	LOAD RATING Co(kgf)	O.D	HOUSING NO. (1)	WEIGHT (gf)
UFL000 UFL000C UFL000D	10	60	45	6	6	12	7	36	16	15	5	3	20.5	M 6	SU000	465	200	26	FL000 FL000E1	65 70 70
UFL001 UFL001C UFL001D	12	63	48	6	6	12	7	38	16	15	5	3	20.5	M 6	SU001	520	245	28	FL001 FL001E1	70 75 75
UFL002 UFL002C UFL002D	15	67	53	6.5	6 5	13	7	42	17.5	16.5	5.5	3.3	22	M 6	SU002	570	290	32	FL002 FL002E1	90 100 100
UFL003 UFL003C UFL003D	17	71	56	7	7	14	7	46	18.5	17.5	6	3.3	23.5	M 6	SU003	610	335	35	FL003 FL003E1	115 125 125
UFL004 UFL004C UFL004D	20	90	71	8	8	16	10	55	22	21	7	4	27	M 8	SU004	955	515	42	FL004 FL004E1	190 205 205
UFL005 UFL005C UFL005D	25	95	75	8	8	16	10	60	23	22	7	4.5	28	M 8	SU005	1,030	595	47	FL005 FL005E1	220 235 235
UFL006 UFL006C UFL006D	30	112	85	9	9	18	13	70	26	24.5	7.5	5 5	31	M10	SU006	1,350	840	55	FL006 FL006E1	340 360 360

(1) code:E1 (with the cover)

UNIT NO.	DIMENSIONS (mm) d	H	J	A_2	A_1	A	N	L	A_0	B	S	BOLT SIZE	BEARING NO.	LOAD RATING C(kgf)	LOAD RATING Co(kgf)	HOUSING NO.	WEIGHT (gf)
UFL08	8	48	37	4	4	8.5	4.8	27	12.5	12	3.5	M 4	SU08	335	140	FL08	30

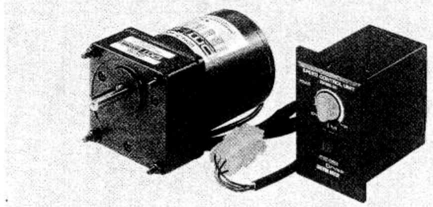
D.4 Motor and Gearhead

Standard AC Motors
Speed Control Motors

Unit Type
Speed Control Motor and Control Unit Package

US Series

The **US** series combines a separate-type control unit and a speed control motor. Connection between motor and control unit is simplified by a one-touch connector. The series is optimal for applications where remote control is required (Instantaneous stop function is not equipped).


The gearhead shown in the photograph is sold separately.

Features

Easy Connection

The operation is possible just by connecting the control unit into the power supply after connecting the motor and control unit through one-touch connector.

Easy Operation

The speed can be set easily with a potentiometer on the front panel of the control unit.

Approved by Safety Standards

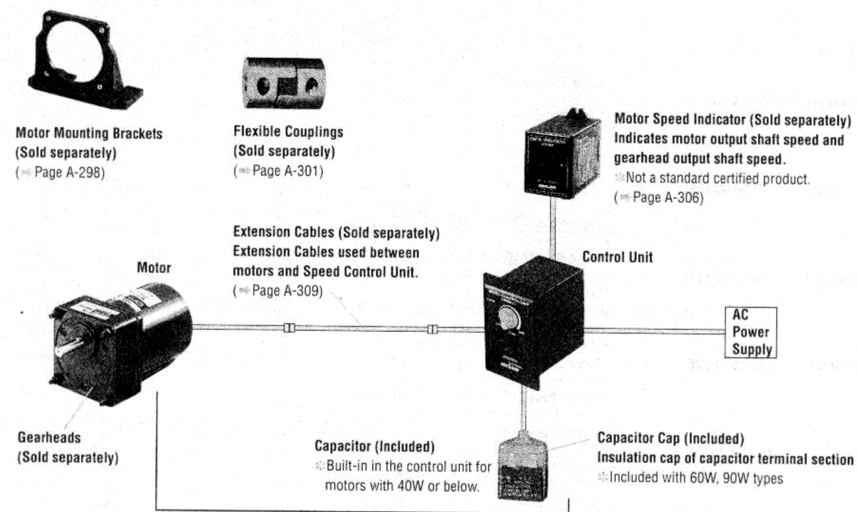
The **US** series is recognized by UL/CSA standards and conforms to EN standard (EN certifications are scheduled). CE marking is used in accordance with low voltage directive.

Safety Standards and CE Marking

Standards		Certification Body	Standards File No.	CE Marking
Motor	UL1004 UL2111	UL	E64199 (6W type) E64197 (15W~90W type)	Low Voltage Directives
	CSA C22.2 No.100 CSA C22.2 No.77			
	EN60950	VDE	114919ÜG (6W type) 6751ÜG (15W~90W type)	
	EN60034-1 EN60034-5	Conform to EN/IEC Standards (EN/IEC certifications are scheduled)		
	IEC60034-11 (15W~90W type)			
Control Unit	UL508	UL	E91291	
	CSA C22.2 No.14			
	EN60950 EN50178	Conform to EN/IEC Standards (EN/IEC certifications are scheduled)		

- Recognized name and certified name of each safety standards are motor model name and control unit name.
  List of Motor and Control Unit Combinations ➠ Page A-173
- For installations for EN/IEC standards ➠ Page F-2

System Configuration



●**Example of System Configuration**

US Series

(Body)

Unit (Pinion Shaft)
US560-501U

◎ : Required under this system.

○ : Selectable according to necessity. Oriental Motor provides.

(Sold separately) +

Gearhead	Extension Cable (1m)	Motor Mounting Bracket	Flexible Coupling	Motor Speed Indicator
5GU25KB	**CC01SS052**	**SOL5M6**	**MCL401515**	**SDM496**
◎	○	○	○	○

The system configuration shown above is an example. Other combinations are available. Right-angle gearhead (25W~90W) and decimal gearhead are also available.

Product Number Code

US 5 60 - 5 0 1U

Series
US: US Series

Motor Frame Size
2: 60mm
3: 70mm
4: 80mm
5: 90mm

Output Power (W)
(Example) 60: 60W

Motor Shaft Type
0: Round Shaft
4: Pinion Shaft (for use with **GN**-type gearhead)
5: Pinion Shaft (for use with **GU**-type gearhead)

Motor Type
0: Induction Motor

Power Supply Voltage
1U: Single-Phase 110V/115V
2E: Single-Phase 220V/230V

Product Number Code of the Gearheads ⇒ Page A-18

For the model names, refer to the specifications on the next page.

Specifications

ZP : The product are impedance protected.

TP : The product contains a built-in thermal protector. When a motor overheats for any reason, the thermal protector is opened and the motor stops. When the motor temperature drops, the thermal protector closes and the motor restarts. Be sure to turn off the power before inspecting.

Model: Pinion Shaft Type	Model: Round Shaft Type	Maximum Output Power W	Voltage V	Frequency Hz	Variable Speed Range r/min	Permissible Torque 1200r/min mN•m gfcm	Permissible Torque 90r/min mN•m gfcm	Starting Torque mN•m gfcm	Current A	Power Consumption W
ZP US206-401U	US206-001U	6	Single-Phase 110	60	90～1600	50 500	30 300	35 350	0.24	25
			Single-Phase 115						0.25	28
ZP US206-402E	US206-002E	6	Single-Phase 220	60	90～1600	50 500	29 290	27 270	0.13	27
			Single-Phase 230	50	90～1400			29 290		28
			Single-Phase 230	60	90～1600			29 290		28
TP US315-401U	US315-001U	15	Single-Phase 110	60	90～1600	125 1250	45 450	55 550	0.47	44
			Single-Phase 115						0.50	
TP US315-402E	US315-002E	15	Single-Phase 220	60	90～1600	85 850	35 350	52 520	0.18	39
			Single-Phase 230	50	90～1400	125 1250		54 540	0.21	43
			Single-Phase 230	60	90～1600	105 1050		55 550	0.22	47
TP US425-401U	US425-001U	25	Single-Phase 110	60	90～1600	200 2000	50 500	105 1050	0.74	70
			Single-Phase 115							73
TP US425-402E	US425-002E	25	Single-Phase 220	60	90～1600	130 1300	43 430	80 800	0.31	59
			Single-Phase 230	50	90～1400	190 1900	47 470	87 870	0.35	62
			Single-Phase 230	60	90～1600	130 1300	43 430	87 870	0.31	60
TP US540-401U	US540-001U	40	Single-Phase 110	60	90～1600	260 2600	70 700	180 1800	1.1	102
			Single-Phase 115							105
TP US540-402E	US540-002E	40	Single-Phase 220	60	90～1600	230 2300	63 630	125 1250	0.55	98
			Single-Phase 230	50	90～1400	300 3000		140 1400	0.53	90
			Single-Phase 230	60	90～1600	230 2300		140 1400	0.55	100
TP US560-501U	US560-001U	60	Single-Phase 110	60	90～1600	490 4900	200 2000	285 2850	2.0	178
			Single-Phase 115						2.1	186
TP US560-502E	US560-002E	60	Single-Phase 220	60	90～1600	450 4500	160 1600	210 2100	0.86	159
			Single-Phase 230	50	90～1400	490 4900	140 1400	240 2400	0.89	154
			Single-Phase 230	60	90～1600	450 4500	160 1600	240 2400	0.88	165
TP US590-501U	US590-001U	90	Single-Phase 110	60	90～1600	730 7300	200 2000	405 4050	2.6	230
			Single-Phase 115							246
TP US590-502E	US590-002E	90	Single-Phase 220	60	90～1600	730 7300	260 2600	360 3600	1.2	221
			Single-Phase 230	50	90～1400		230 2300	400 4000		201
			Single-Phase 230	60	90～1600		260 2600	400 4000		227

The variable speed ranges shown are under no load condition.

Single-Phase 220V/230V

Unit = Upper Values : N•m / Lower Values : kgfcm

Model Motor/Gearhead	Gear Ratio / Motor Speed r/min		3	3.6	5	6	7.5	9	12.5	15	18	25	30	36	50	60	75	90	100	120	150	180
US206-402E /2GN□K	1200		0.12	0.15	0.20	0.24	0.30	0.36	0.51	0.61	0.73	0.91	1.1	1.3	1.7	2.0	2.5	3	3	3	3	3
			1.2	1.5	2.0	2.4	3.0	3.6	5.1	6.1	7.3	9.1	11	13	17	20	25	30	30	30	30	30
	90		0.070	0.085	0.12	0.14	0.18	0.21	0.29	0.35	0.42	0.53	0.64	0.76	0.96	1.1	1.4	1.7	1.9	2.3	2.9	3
			0.70	0.85	1.2	1.4	1.8	2.1	2.9	3.5	4.2	5.3	6.4	7.6	9.6	11	14	17	19	23	29	30
US315-402E /3GN□K	1200	220V 60Hz	0.21	0.25	0.34	0.41	0.52	0.62	0.86	1.0	1.2	1.6	1.9	2.2	2.8	3.4	4.2	5	5	5	5	5
			2.1	2.5	3.4	4.1	5.2	6.2	8.6	10	12	16	19	22	28	34	42	50	50	50	50	50
		230V 50Hz	0.30	0.36	0.51	0.61	0.76	0.91	1.3	1.5	1.8	2.3	2.7	3.3	4.1	5	5	5	5	5	5	5
			3.0	3.6	5.1	6.1	7.6	9.1	13	15	18	23	27	33	41	50	50	50	50	50	50	50
		230V 60Hz	0.26	0.31	0.43	0.51	0.64	0.77	1.1	1.3	1.5	1.9	2.3	2.8	3.5	4.2	5	5	5	5	5	5
			2.6	3.1	4.3	5.1	6.4	7.7	11	13	15	19	23	28	35	42	50	50	50	50	50	50
	90		0.085	0.10	0.14	0.17	0.21	0.26	0.35	0.43	0.51	0.64	0.77	0.92	1.2	1.4	1.7	2.1	2.3	2.8	3.5	4.2
			0.85	1.0	1.4	1.7	2.1	2.6	3.5	4.3	5.1	6.4	7.7	9.2	12	14	17	21	23	28	35	42
US425-402E /4GN□K	1200	220V/230V 60Hz	0.32	0.38	0.53	0.63	0.79	0.95	1.3	1.6	1.9	2.4	2.8	3.4	4.3	5.1	6.4	7.7	8	8	8	8
			3.2	3.8	5.3	6.3	7.9	9.5	13	16	19	24	28	34	43	51	64	77	80	80	80	80
		230V 50Hz	0.46	0.55	0.77	0.92	1.2	1.4	1.9	2.3	2.8	3.5	4.2	5.0	6.3	7.5	8	8	8	8	8	8
			4.6	5.5	7.7	9.2	12	14	19	23	28	35	42	50	63	75	80	80	80	80	80	80
	90	220V/230V 60Hz	0.10	0.13	0.17	0.21	0.26	0.31	0.44	0.52	0.63	0.78	0.94	1.1	1.4	1.7	2.1	2.6	2.8	3.4	4.3	5.1
			1.0	1.3	1.7	2.1	2.6	3.1	4.4	5.2	6.3	7.8	9.4	11	14	17	21	26	28	34	43	51
		230V 50Hz	0.11	0.14	0.19	0.23	0.29	0.34	0.48	0.57	0.69	0.86	1.0	1.2	1.6	1.9	2.3	2.8	3.1	3.7	4.7	5.6
			1.1	1.4	1.9	2.3	2.9	3.4	4.8	5.7	6.9	8.6	10	12	16	19	23	28	31	37	47	56
US540-402E /5GN□K	1200	220V/230V 60Hz	0.56	0.67	0.93	1.1	1.4	1.7	2.3	2.8	3.4	4.2	5.0	6.0	7.6	9.1	10	10	10	10	10	10
			5.6	6.7	9.3	11	14	17	23	28	34	42	50	60	76	91	100	100	100	100	100	100
		230V 50Hz	0.73	0.87	1.2	1.5	1.8	2.2	3.0	3.6	4.4	5.5	6.6	7.9	9.9	10	10	10	10	10	10	10
			7.3	8.7	12	15	18	22	30	36	44	55	66	79	99	100	100	100	100	100	100	100
	90		0.15	0.18	0.26	0.31	0.38	0.46	0.64	0.77	0.92	1.1	1.4	1.7	2.1	2.5	3.1	3.7	4.2	5.0	6.2	7.5
			1.5	1.8	2.6	3.1	3.8	4.6	6.4	7.7	9.2	11	14	17	21	25	31	37	42	50	62	75
US560-502E /5GU□KB	1200	220V/230V 60Hz	1.1	1.3	1.8	2.2	2.7	3.3	4.1	4.9	5.9	7.4	8.9	10.7	14.9	17.8	19.9	20	20	20	20	20
			11	13	18	22	27	33	41	49	59	74	89	107	149	178	199	200	200	200	200	200
		230V 50Hz	1.2	1.4	2.0	2.4	3.0	3.6	4.5	5.4	6.4	8.1	9.7	11.6	16.2	19.4	20	20	20	20	20	20
			12	14	20	24	30	36	45	54	64	81	97	116	162	194	200	200	200	200	200	200
	90	220V/230V 60Hz	0.39	0.47	0.65	0.78	0.97	1.2	1.5	1.8	2.1	2.6	3.2	3.8	5.3	6.3	7.1	8.5	9.4	11.3	14.2	17
			3.9	4.7	6.5	7.8	9.7	12	15	18	21	26	32	38	53	63	71	85	94	113	142	170
		230V 50Hz	0.34	0.41	0.57	0.68	0.85	1.0	1.3	1.5	1.8	2.3	2.8	3.3	4.6	5.5	6.2	7.4	8.3	9.9	12.4	14.9
			3.4	4.1	5.7	6.8	8.5	10	13	15	18	23	28	33	46	55	62	74	83	99	124	149
US590-502E /5GU□KB	1200		1.8	2.1	3.0	3.5	4.4	5.3	6.7	8.0	9.6	12.0	14.5	17.3	20	20	20	20	20	20	20	20
			18	21	30	35	44	53	67	80	96	120	145	173	200	200	200	200	200	200	200	200
	90	220V/230V 60Hz	0.63	0.76	1.1	1.3	1.6	1.9	2.4	2.8	3.4	4.3	5.1	6.2	8.6	10.3	11.5	13.8	15.3	18.4	20	20
			6.3	7.6	11	13	16	19	24	28	34	43	51	62	86	103	115	138	153	184	200	200
		230V 50Hz	0.56	0.67	0.93	1.1	1.4	1.7	2.1	2.5	3.0	3.8	4.6	5.5	7.6	9.1	10.2	12.2	13.6	16.3	20	20
			5.6	6.7	9.3	11	14	17	21	25	30	38	46	55	76	91	102	122	136	163	200	200
US590-502E /5GU□KBH	1200		—	—	—	—	—	—	—	—	—	—	—	—	24.1	28.9	30	30	30	30	30	30
															241	289	300	300	300	300	300	300
	90	220V/230V 60Hz	—	—	—	—	—	—	—	—	—	—	—	—	8.6	10.3	11.5	13.8	15.3	18.4	23	27.6
															86	103	115	138	153	184	230	276
		230V 50Hz	—	—	—	—	—	—	—	—	—	—	—	—	7.6	9.1	10.2	12.2	13.6	16.3	20.4	24.4
															76	91	102	122	136	163	204	244

- Gearheads and decimal gearheads are sold separately.
- Enter the gear ratio in the box (□) within the model number.
- A colored background indicates gear shaft rotation in the same direction as the motor shaft; a white background indicates rotation in the opposite direction.

Gearmotor–Torque Table when Right-Angle Gearhead is Attached

A right-angle gearhead can be attached to **US425, US540, US560** and **US590** type.

➡ Page A-263

Permissible Overhung Load and Permissible Thrust Load

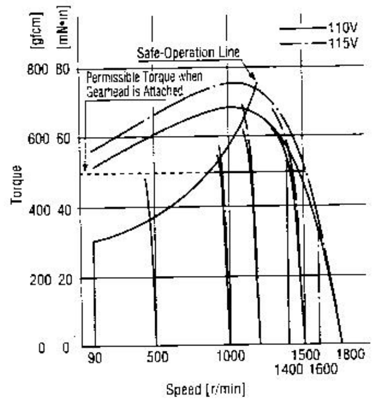
Motor (Round Shaft Type) ➡ Page A-14
Gearhead ➡ Page A-14

Permissible Load Inertia J (GD^2) for Gearhead

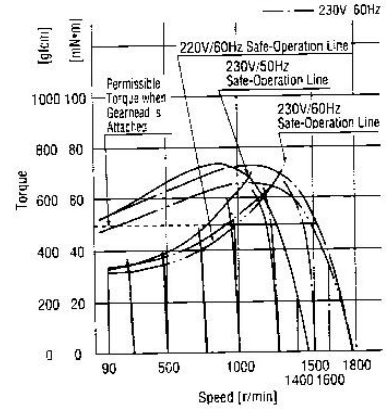
➡ Page A-15

Speed-Torque Characteristics

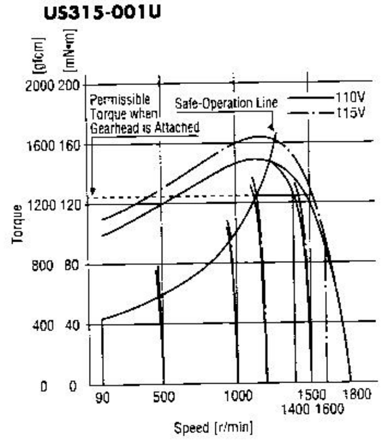
US206-401U
US206-001U



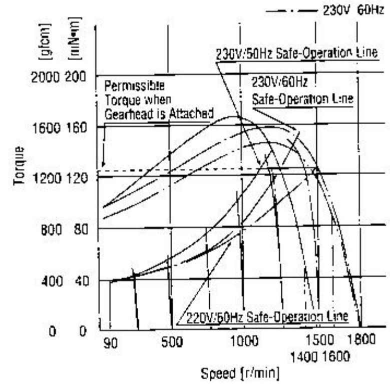
US206-402E
US206-002E



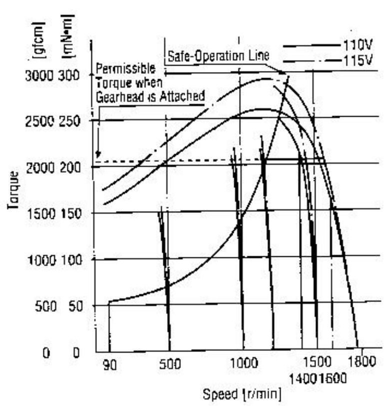
US315-401U
US315-001U



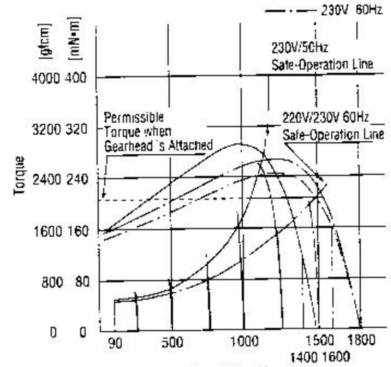
US315-402E
US315-002E



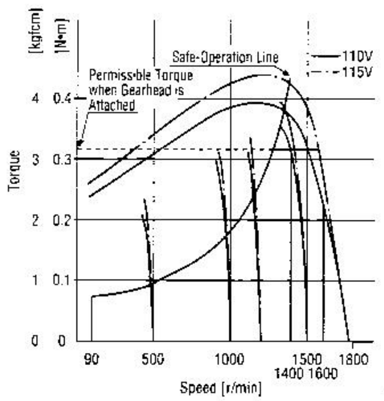
US425-401U
US425-001U



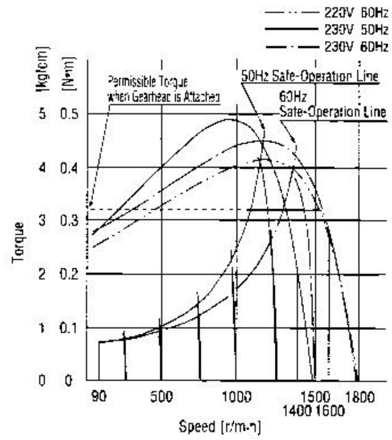
US425-402E
US425-002E



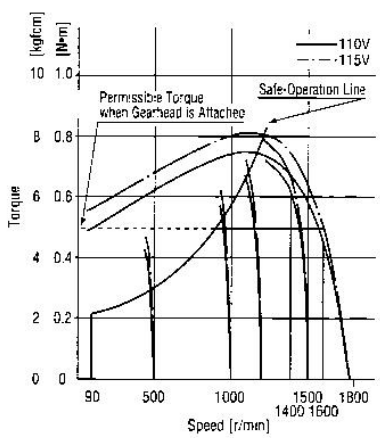
US540-401U
US540-001U



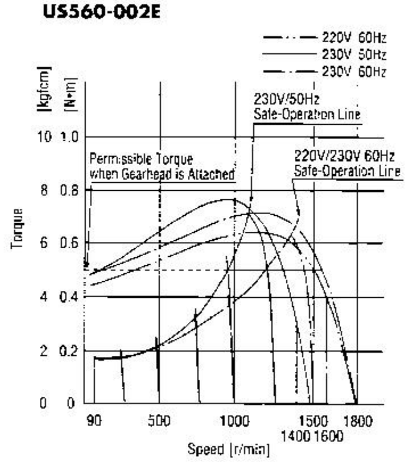
US540-402E
US540-002E



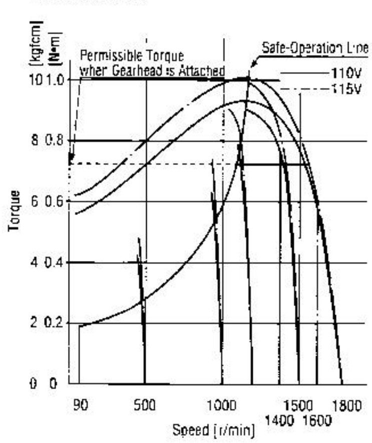
US560-501U
US560-001U



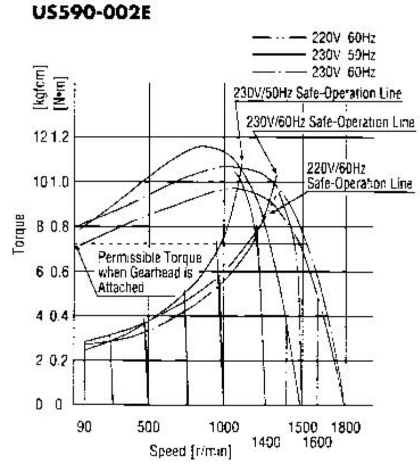
US560-502E
US560-002E



US590-501U
US590-001U

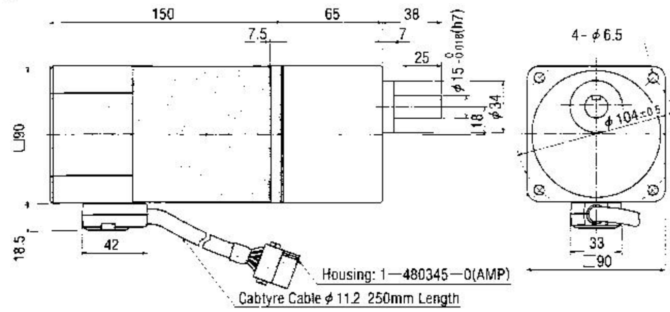


US590-502E
US590-002E



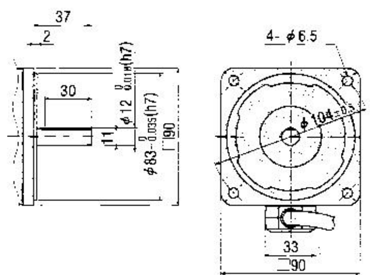
Motor/Gearhead

US560-501U, US560-502E (Pinion Shaft Type)
Motor: USM560-501W, USM560-502W
Mass: 2.8kg
Gearhead: **5GU□KB**
Mass: 1.5kg

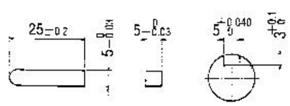


Shaft Section of Round Shaft Type

US560-001U, US560-002E (Round Shaft Type)
Motor: USM560-001W, USM560-002W
Mass: 2.8kg

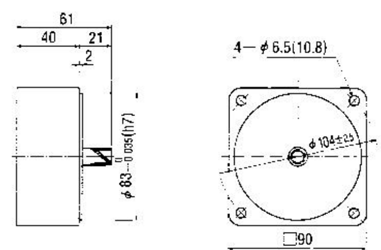


Key and Key Slot (Included with the gearheads, common to 5GU□KB and 5GU□K)



Decimal Gearhead

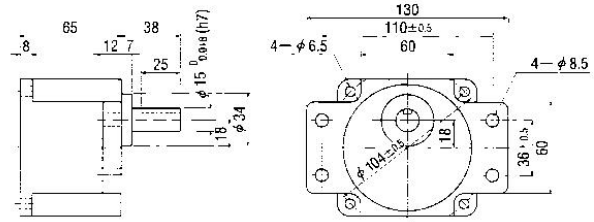
(Can be connected to **GU** pinion shaft type)
5GU10XKB (For **5GU□KB**), **5GU10XK** (For **5GU□K**)
Mass: 0.6kg



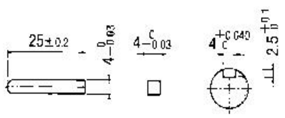
The figure in parenthesis indicates the dimension of **5GU10XKB**

Flange Mounting Type Gearheads

(Can be connected to **GU** pinion shaft type)
5GU□K
Mass: 1.5kg

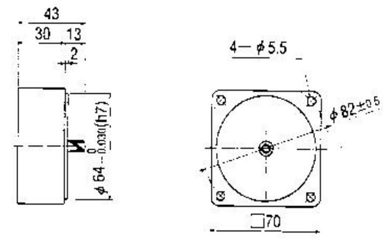


Key and Key Slot (Included with the gearheads)



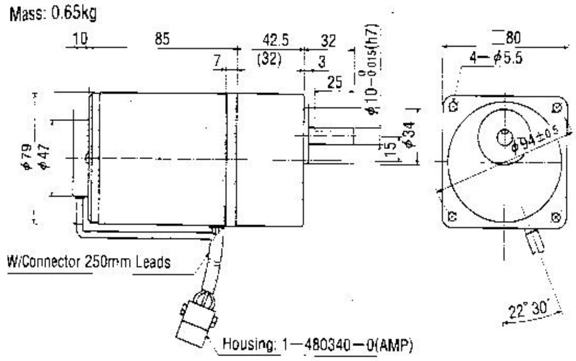
Decimal Gearhead

(Can be connected to **GN** pinion shaft type)
3GN10XK
Mass: 0.3kg



Motor/Gearhead

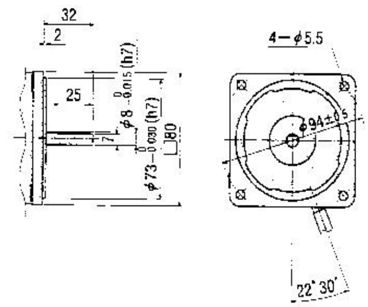
US425-401U, US425-402E (Pinion Shaft Type)
Motor: USM425-401W, USM425-402W
Mass: 1.6kg
Gearhead: **4GN□K**
Mass: 0.65kg



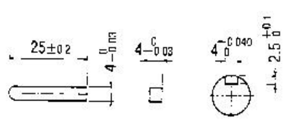
Asterisk ( ) indicates dimensions of **4GN25K~180K**
The figure in parenthesis indicates dimensions of **4GN3K~18K**

Shaft Section of Round Shaft Type

US425-001U, US425-002E (Round Shaft Type)
Motor: USM425-001W, USM425-002W
Mass: 1.6kg

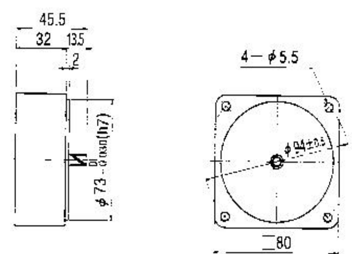


Key and Key Slot (Included with the gearheads)



Decimal Gearhead

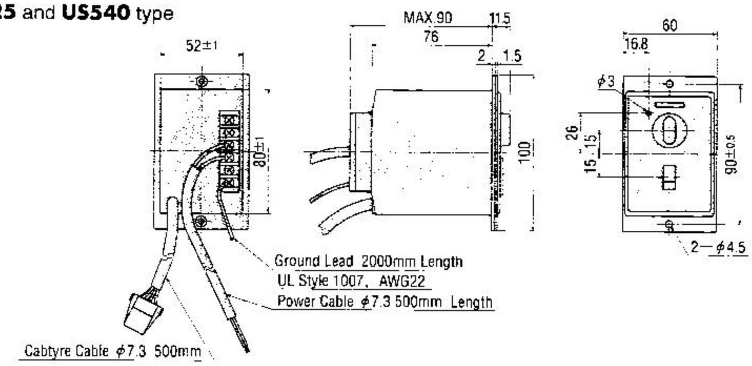
(Can be connected to **GN** pinion shaft type)
4GN10XK
Mass: 0.4kg



Control Unit

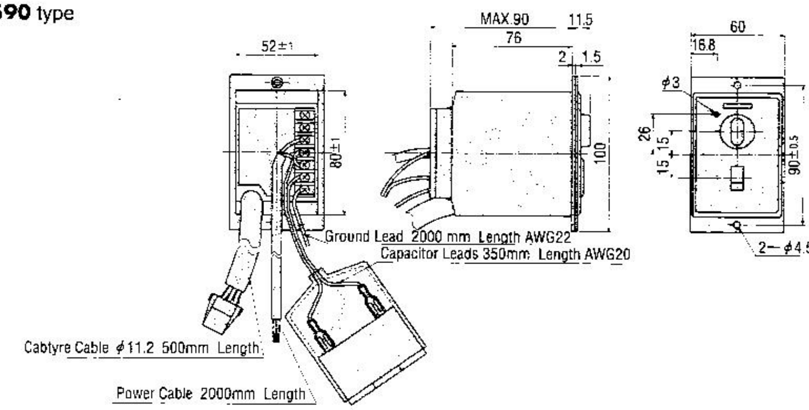
Common to **US206, US315, US425** and **US540** type

USP206-1U/USP206-2E
USP315-1U/USP315-2E
USP425-1U/USP425-2E
USP540-1U/USP540-2E
Mass: 0.45kg



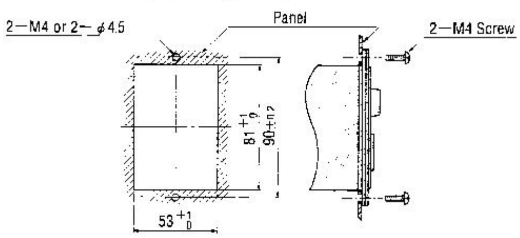
Common to **US560** and **US590** type

USP560-1U/USP560-2E
USP590-1U/USP590-2E
Mass: 0.5kg

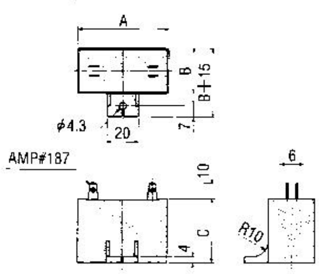


Panel Cut-Out for Control Unit

Installation Method by Opening a Square Hole



Capacitor (Included with the motor)



Capacitor Dimensions (mm)

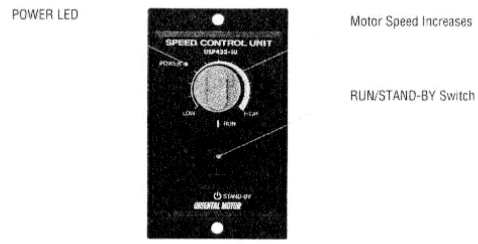
Model		Capacitor Model	A	B	C	Mass (g)
Pinion Shaft Type	Round Shaft Type					
US560-501U	**US560-001U**	CH180CFAUL	58	23.5	37	70
US560-502E	**US560-002E**	CH40BFAUL	58	23.5	37	65
US590-501U	**US590-001U**	CH200CFAUL	58	29	41	95
US590-502E	**US590-002E**	CH60BFAUL	58	29	41	85

- Capacitor cap is provided with the capacitor.

Connection and Operation

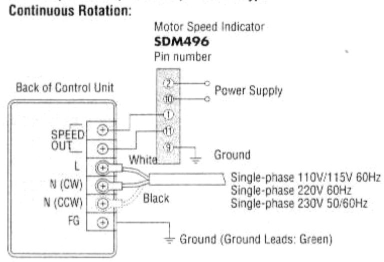
Names and Functions of Control Unit Parts

Front of Control Unit

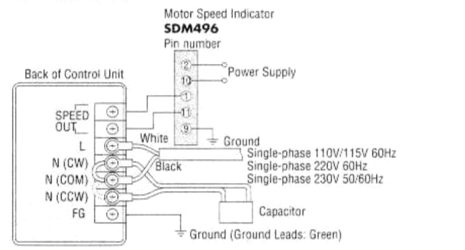


Wiring Diagrams

US206, US315, US425, US540 type
Continuous Rotation:

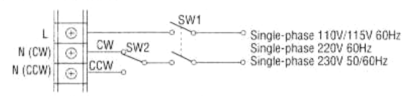


US560, US590 type
Continuous Rotation:



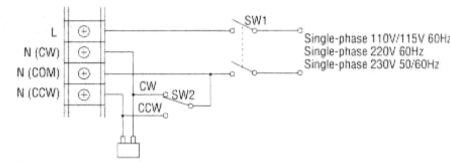
In the diagram above, the motor shaft rotates in the clockwise direction. When changed to the dotted line position, the motor shaft rotates in the counterclockwise direction.

Bi-directional Rotation:



Specifications : AC250V Induction Load 5A minimum

Bi-directional Rotation:

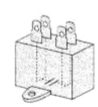


Specifications : AC250V Induction Load 5A minimum

- An extension between the motor and control unit is required, an extension cable can be used (sold separately). Using the longest cord, the distance can be extended up to 4.75m. Extension Cables ⇒ Page A-309

Inner Wiring Diagram for 4-Terminal Capacitor

Terminals of the capacitor are connected as shown in the figure. For lead wire connection, use one lead wire for each individual terminal.



Operation Method

There is a difference in operation method between **US206, US315, US425, US540** type and **US560, US590** type.

◇Rotation

· US206, US315, US425 and US540 types

Connect the motor lead wire connectors to the control unit. Then connect the AC power cord to the AC power supply. When the RUN/STAND-BY switch of the control unit is flipped to RUN, the motor rotates in the clockwise direction as seen from the motor shaft. (Control units are set for clockwise rotation at shipment. The direction of rotation for the gearhead output shaft may be the reverse of the direction of the motor shaft depending on the gear ratio.)

· US560 and US590 types

Connect the motor connector to the control unit. Then connect the AC power cord to the AC power supply. When the RUN/STAND-BY switch of the control unit is flipped to RUN, the motor rotates in the clockwise direction as seen from the motor shaft. (Control units are set for clockwise rotation at shipment. The direction of rotation for the gearhead output shaft may be the reverse of the direction of the motor shaft depending on the gear ratio.)

◇**Changing Speed**

When the potentiometer located on the front surface of the control unit is turned in the clockwise direction, motor speed increases; when turned in the opposite direction, motor speed decreases.

Motor speed can be set and adjusted over a range of 90r/min~1400r/min at 50Hz, 90r/min~1600r/min at 60Hz.

◇**Stopping**

When the RUN/STAND-BY switch on the control unit is set to STAND-BY, the motor stops. This switch is not a power ON/OFF switch. When the motor is to be stopped for a long time, a separate power ON/OFF switch should be installed.

◇**Changing the Direction of Rotation**

· US206, US315, US425 and US540 types (Capacitor is attached to the control unit.)

Continuous Rotation:

When the direction of motor rotation needs to be reversed for reasons relating to transmission mechanisms such as gearheads, change the terminal used for attaching the power cord, located at the back of control unit, from terminal N (CW) to terminal N (CCW).

The power cord connections are located at terminals L and N (CW) when shipping.

(This should always be done with the power OFF.)

Bi-directional Rotation:

Install an additional power switch and CW/CCW switch as shown in the diagram to the left, and use these switches to change the direction of rotation.

(Motor cannot be reversed instantaneously. Turn SW1 off and wait until the motor has come to a complete stop before switching SW2.)

Connecting the Speed Indicator:

Connect the terminals ① and ⑪ of the **SDM496** (a speed indicator) to the SPEED OUT terminals of control unit.

· US560, US590 types 〈Connection of capacitor is necessary.〉

Uni-directional Rotation:

After turning the power off, change the lead wire used for attaching the power cord located at the back of the control unit, from N(CW)-N(COM) to N(COM)-N(CCW). (The lead wire is set at N(CW)-N(COM) when shipping.)

Bi-directional Rotation:

Install an additional power switch and CW/CCW switch as shown in the diagram on page A-172, and use these switches to change the direction of rotation. (Motor cannot be reversed instantaneously. Turn SW1 off and wait until the motor has come to a complete stop before switching SW2.

Connecting the Speed Indicator:

Connect the terminals ① and ⑪ of the **SDM496** (a speed indicator) to the SPEED OUT terminals of control unit.

List of Motor and Control Unit Combinations

Model numbers for motor/control unit combinations are shown below.

Single-Phase 110V/115V

Output Power	Model	Motor Model	Control Unit Model
6W	**US206-401U**	USM206-401W	USP206-1U
	US206-001U	USM206-001W	
15W	**US315-401U**	USM315-401W	USP315-1U
	US315-001U	USM315-001W	
25W	**US425-401U**	USM425-401W	USP425-1U
	US425-001U	USM425-001W	
40W	**US540-401U**	USM540-401W	USP540-1U
	US540-001U	USM540-001W	
60W	**US560-501U**	USM560-501W	USP560-1U
	US560-001U	USM560-001W	
90W	**US590-501U**	USM590-501W	USP590-1U
	US590-001U	USM590-001W	

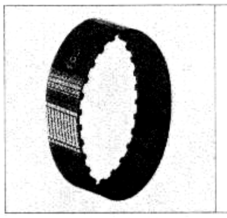
Single-Phase 220V/230V

Output Power	Model	Motor Model	Control Unit Model
6W	**US206-402E**	USM206-402W	USP206-2E
	US206-002E	USM206-002W	
15W	**US315-402E**	USM315-402W	USP315-2E
	US315-002E	USM315-002W	
25W	**US425-402E**	USM425-402W	USP425-2E
	US425-002E	USM425-002W	
40W	**US540-402E**	USM540-402W	USP540-2E
	US540-002E	USM540-002W	
60W	**US560-502E**	USM560-502W	USP560-2E
	US560-002E	USM560-002W	
90W	**US590-502E**	USM590-502W	USP590-2E
	US590-002E	USM590-002W	

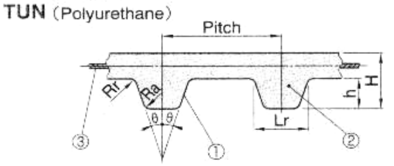
D.5 Timing Belt

Spec. Printed in Red

Synchronous Belts



TBN (Rubber)
TUN (Polyurethane)



Merit · Point of notice (P.989)

Type		M
TBN	①Teeth cover	Nylon cloth
	②Tooth rubber	Neoprene rubber
	③Core wire	Glass fiber cord, S/Z twist alternative series
TUN	①②Main body	Polyurethane
	③Core wire	Steel cord

Class	Pitch	2θ	Lr	h	H	Rr	Ra
MXL (T80,Polyurethane)	2.032	60°	—	0.46	1.22	—	—
MXL (Rubber)	2.032	40°	1.14	0.51	1.11	0.13	0.13
XL	5.08	50°	2.57	1.27	2.27	0.38	0.38
L	9.525	40°	4.65	1.91	3.61	0.51	0.51
H	12.7	40°	6.12	2.29	4.59	1.00	1.00

Note that the number of Belt No. is different meanings depending on their type.

※Belt No. is represented by the number of belt teeth for MXL and the belt peripheral length for XL, L, and H.

Order Example

Catalog No.		
Type	Belt No.	Belt Nominal Width
TBN	210MXL	025
TBN	210L	050

Production Time

•TBN (MXL · XL · L) — 3 Days — Express A 500 yen/piece P.64

•TBN (H), TUN — A flat charge of 1,350 Yen for 3 pieces or more of the same size

5 Days — Express B 300 yen/piece P.64

A flat charge of 810 Yen for 3 pieces or more of the same size

Price

■Volume Discount Rate

Quantity	1	2~4	5~19	20~49	50~
Rate	—	5%	10%	15%	To be quoted

■Type MXL(T80) (Pitch : 2.032mm)

Type	Belt No.	Belt Nominal Width	No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width 025	Unit Price Belt Width 037
TUN (Polyurethane)	77MXL	025 (6.4mm) / 037 (9.5mm)	77	156.46	330	430
	78MXL		78	158.50		
	80MXL		80	162.56		
	82MXL		82	166.62		
	83MXL		83	168.66		
	85MXL		85	172.72		
	87MXL		87	176.78		
	88MXL		88	178.82		
	89MXL		89	180.85		
	90MXL		90	182.88		
	91MXL		91	184.91	360	460
	94MXL		94	191.01		
	95MXL		95	193.04		
	98MXL		98	199.14		
	100MXL		100	203.20		
	102MXL		102	207.26		
	103MXL		103	209.30		
	104MXL		104	211.33		
	105MXL		105	213.36		
	106MXL		106	215.39		
	110MXL		110	223.52		
	112MXL		112	227.58		
	114MXL		114	231.65		
	115MXL		115	233.68		
	118MXL		118	239.78		
	120MXL		120	243.84		
	122MXL		122	247.90		
	123MXL		123	249.94		
	124MXL		124	251.97		
	125MXL		125	254.00	380	510
	126MXL		126	256.03		
	130MXL		130	264.16		
	132MXL		132	268.22		
	140MXL		140	284.48		
	142MXL		142	288.54		
	144MXL		144	292.61		
	145MXL		145	294.64		
	150MXL		150	304.80		
	155MXL		155	314.96	410	540
	160MXL		160	325.12		
	165MXL		165	335.28		
	170MXL		170	345.44		
	175MXL		175	355.60		
	180MXL		180	365.76		
	184MXL		184	373.89		
	190MXL		190	386.08	440	590
	195MXL		195	396.24		
	200MXL		200	406.40		
	210MXL		210	426.72		
	212MXL		212	430.78		
	221MXL		221	449.07		
	224MXL		224	455.17		
	228MXL		228	463.30	470	620
	235MXL		235	477.52		
	236MXL		236	479.55		
	239MXL		239	485.65		
	240MXL		240	487.68		
	248MXL		248	503.94		
	249MXL		249	505.97		
	250MXL		250	508.00		
	256MXL		256	520.19		
	260MXL		260	528.32		
	265MXL		265	538.48		
	277MXL		277	562.86	480	630
	280MXL		280	568.96	500	650
	290MXL		290	589.28		
	296MXL		296	601.47		
	300MXL		300	609.60	510	660

■Type MXL (Pitch : 2.032mm)

Type	Belt No.	Belt Nominal Width	No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width 025	Unit Price Belt Width 037
TBN (Rubber)	45MXL	025 (6.4mm) / 037 (9.5mm)	45	91.44	280	370
	48MXL		48	97.54		
	50MXL		50	101.60		
	52MXL		52	105.66		
	53MXL		53	107.70		
	54MXL		54	109.73		
	56MXL		56	113.79		
	59MXL		59	119.89		
	60MXL		60	121.92	300	400
	61MXL		61	123.95		
	63MXL		63	128.02		
	65MXL		65	132.08		
	67MXL		67	136.14		
	68MXL		68	138.18		
	70MXL		70	142.24		
	71MXL		71	144.27		
	72MXL		72	146.30		
	73MXL		73	148.34		
	75MXL		75	152.40		
	76MXL		76	154.43		
	77MXL		77	156.46		
	78MXL		78	158.50		
	79MXL		79	160.53		
	80MXL		80	162.56		
	82MXL		82	166.62		
	83MXL		83	168.66		
	85MXL		85	172.72		
	87MXL		87	176.78		
	88MXL		88	178.82		
	90MXL		90	182.88	320	420
	91MXL		91	184.91		
	92MXL		92	186.94		
	94MXL		94	191.01		
	95MXL		95	193.04		
	97MXL		97	197.10		
	100MXL		100	203.20		
	101MXL		101	205.23		
	102MXL		102	207.26		
	103MXL		103	209.30		
	105MXL		105	213.36		
	106MXL		106	215.39		
	110MXL		110	223.52		
	112MXL		112	227.58		
	114MXL		114	231.65		
	115MXL		115	233.68		
	118MXL		118	239.78		
	120MXL		120	243.84		
	122MXL		122	247.90		
	123MXL		123	249.94	340	470
	125MXL		125	254.00		
	126MXL		126	256.03		
	127MXL		127	258.06		
	128MXL		128	260.10		
	129MXL		129	262.13		
	130MXL		130	264.16		
	131MXL		131	266.19		
	132MXL		132	268.22		
	134MXL		134	272.29		
	140MXL		140	284.48		
	142MXL		142	288.54		
	144MXL		144	292.61		
	146MXL		146	296.67		
	150MXL		150	304.80		

Type	Belt No.	Belt Nominal Width	No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width 025	Unit Price Belt Width 037
TBN (Rubber)	155MXL	025 (6.4mm) / 037 (9.5mm)	155	314.96	380	500
	160MXL		160	325.12		
	162MXL		162	329.18		
	165MXL		165	335.28		
	170MXL		170	345.44		
	175MXL		175	355.60		
	180MXL		180	365.76		
	184MXL		184	373.89		
	190MXL		190	386.08	400	540
	192MXL		192	390.14		
	195MXL		195	396.24		
	200MXL		200	406.40		
	210MXL		210	426.72		
	212MXL		212	430.78		
	221MXL		221	449.07		
	222MXL		222	451.10		
	224MXL		224	455.17		
	226MXL		226	459.23	420	570
	228MXL		228	463.30		
	232MXL		232	471.42		
	236MXL		236	479.55		
	239MXL		239	485.65		
	240MXL		240	487.68		
	248MXL		248	503.94		
	250MXL		250	508.00		
	256MXL		256	520.19		
	260MXL		260	528.32		
	265MXL		265	538.48		
	273MXL		273	554.74	440	590
	280MXL		280	568.96	460	
	281MXL		281	570.99		
	290MXL		290	589.28		
	295MXL		295	599.44		
	300MXL		300	609.60	470	600
	305MXL		305	619.76		610
	310MXL		310	629.92		
	312MXL		312	633.98		
	315MXL		315	640.08		
	318MXL		318	646.18		
	320MXL		320	650.24		
	330MXL		330	670.56		
	332MXL		332	674.62		
	336MXL		336	682.75		
	337MXL		337	684.78		
	347MXL		347	705.10	480	620
	350MXL		350	711.20		
	355MXL		355	721.36	490	630
	359MXL		359	729.49		
	364MXL		364	739.65		
	365MXL		365	741.68		
	372MXL		372	755.90		
	380MXL		380	772.16		
	397MXL		397	806.70	500	640
	400MXL		400	812.80		
	435MXL		435	883.92	510	650
	448MXL		448	910.34		
	453MXL		453	920.50		
	487MXL		487	989.58		
	498MXL		498	1011.94		
	516MXL		516	1048.51	560	710
	525MXL		525	1066.80		
	550MXL		550	1117.60		

¥ Price

Volume Discount Rate

Quantity	1	2~4	5~19	20~49	50~
Rate	—	5%	10%	15%	To be quoted

Type XL (Pitch : 5.08mm)

Catalog No.			No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width		
Type	Belt No.	Belt Nominal Width			025	037	050
	60XL		30	152.40	320	410	550
	70XL		35	177.80		420	560
	76XL		38	193.04			
	78XL		39	198.12	330	450	590
	80XL		40	203.20			
	84XL		42	213.36	340	460	600
	90XL		45	228.60			
	92XL		46	233.68			
	94XL		47	238.76			
	96XL		48	243.84			
	98XL		49	248.92			
	100XL		50	254.00	350	470	630
	102XL		51	259.08			
	104XL		52	264.16			
	108XL		54	274.32			
	110XL		55	279.40			
	114XL	025	57	289.56			
	118XL	(6.4mm)	59	299.72	370	490	670
	120XL		60	304.80			
	122XL	037	61	309.88			
TBN	126XL	(9.5mm)	63	320.04	380	500	680
(Rubber)	128XL		64	325.12			
	130XL		65	330.20			
	136XL	050	68	345.44			
	138XL	(12.7mm)	69	350.52	390	510	700
	140XL		70	355.60			
	146XL		73	370.84	400	520	710
	150XL		75	381.00			
	152XL		76	386.08			
	154XL		77	391.16			
	156XL		78	396.24	430		
	158XL		79	401.32			
	160XL		80	406.40		590	770
	162XL		81	411.48			
	164XL		82	416.56	440		
	166XL		83	421.64			
	170XL		85	431.80			
	172XL		86	436.88			
	174XL		87	441.96	450	600	780
	176XL		88	447.04			
	180XL		90	457.20			

Catalog No.			No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width		
Type	Belt No.	Belt Nominal Width			025	037	050
	182XL		91	462.28			
	184XL		92	467.36	450	620	800
	188XL		94	477.52			
	190XL		95	482.60			
	194XL		97	492.76			
	196XL		98	497.84	470	630	810
	198XL		99	502.92			
	200XL		100	508.00			
	206XL		103	523.24	480	640	820
	210XL		105	533.40			
	212XL		106	538.48	490	670	830
	220XL		110	558.80			
	228XL		114	579.12			
	230XL		115	584.20	500	680	850
	234XL		117	594.36			
	240XL	025	120	609.60			
	250XL	(6.4mm)	125	635.00	510	690	860
	260XL		130	660.40	520	710	
	270XL		135	685.80			
TBN	276XL	037	138	701.04			
(Rubber)	280XL	(9.5mm)	140	711.20	540	720	880
	282XL		141	716.28			
	290XL		145	736.60	550	750	910
	300XL	050	150	762.00			
	310XL	(12.7mm)	155	787.40	570	770	940
	320XL		160	812.80			
	330XL		165	838.20	590	800	950
	340XL		170	863.60			
	348XL		174	883.92			
	352XL		176	894.08	600	820	970
	360XL		180	914.40			
	376XL		188	955.04			
	384XL		192	975.36			
	390XL		195	990.60			
	396XL		198	1005.84	630	850	1,010
	424XL		212	1076.96			
	460XL		230	1168.40			
	490XL		245	1244.60			
	630XL		315	1600.20	810	1,040	1,330
	860XL		430	2184.40	1,120	1,430	1,910

Type L (Pitch : 9.525mm)

Catalog No.			No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width		
Type	Belt No.	Belt Nominal Width			050	075	100
	109L		29	276.23	850	1,180	1,510
	124L		33	314.33			
	135L		36	342.90	880	1,220	1,620
	150L		40	381.00			
	165L		44	419.10	970	1,350	1,800
	187L	050	50	476.25			
	210L	(12.7mm)	56	533.40	1,050	1,480	1,960
	225L		60	571.50			
	240L		64	609.60	1,140	1,590	2,120
TBN	255L	075	68	647.70	1,160	1,670	2,200
(Rubber)	270L	(19.1mm)	72	685.80	1,220	1,720	2,300
	277L		74	704.85	1,250	1,760	2,370
	285L	100	76	723.90			
	300L	(25.4mm)	80	762.00	1,310	1,850	2,480
	320L		85	809.63	1,400	2,060	2,670
	322L		86	819.15			
	334L		89	847.73			
	337L		90	857.25	1,480	2,140	2,800
	345L		92	876.30			
	360L		96	914.40	1,520	2,220	2,910

Catalog No.			No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width		
Type	Belt No.	Belt Nominal Width			050	075	100
	367L		98	933.45	1,520	2,220	2,910
	375L		100	952.50			
	382L		102	971.55	1,600	2,370	3,080
	390L		104	990.60			
	394L		105	1000.13			
	420L	050	112	1066.80	1,680	2,490	3,270
	427L	(12.7mm)	114	1085.85	1,780	2,630	3,440
	450L		120	1143.00			
	480L		128	1219.20	1,860	2,750	3,600
TBN	510L	075	136	1295.40	1,930	2,850	3,740
(Rubber)	525L	(19.1mm)	140	1333.50	2,050	3,020	3,960
	540L		144	1371.60			
	548L	100	146	1390.65			
	581L	(25.4mm)	155	1476.38	2,230	3,270	4,290
	600L		160	1524.00			
	630L		168	1600.20	2,650	3,770	4,920
	653L		174	1657.35	2,690	3,800	4,960
	660L		176	1676.40	2,730	3,890	5,100
	697L		186	1771.65	3,000	4,250	5,610
	731L		195	1857.38			

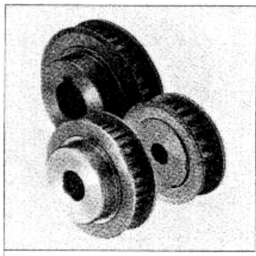
Type H (Pitch : 12.700mm)

Catalog No.			No. of Teeth	Belt Circum. Length (mm)	Unit Price Belt Width		
Type	Belt No.	Belt Nominal Width			100	150	200
	225H		45	571.50			
	230H		46	584.20	2,320	3,380	4,430
	240H		48	609.50			
	245H		49	622.30	2,510	3,650	4,730
	270H		54	685.80			
	280H		56	711.20	2,560	3,740	4,820
	300H		60	762.00	2,690	3,930	5,180
	310H		62	787.40			
	315H		63	800.10	2,880	4,210	5,540
	320H		64	812.80			
	330H		66	838.20			
	340H		68	863.60			
	350H		70	889.00	3,080	4,480	5,920
	360H		72	914.40			
	370H		74	939.80	3,190	4,630	6,090
	375H		75	952.50	3,240	4,760	6,260
	390H		78	990.60			
	400H		80	1016.00			
	410H		82	1041.40	3,440	5,040	6,640
	420H		84	1066.80			
	430H		86	1092.20	3,630	5,350	7,040
	450H		90	1143.00			
	465H		93	1181.10	3,830	5,600	7,360
	480H	100	96	1219.20			
	490H	(25.4mm)	98	1244.60	3,930	5,760	7,640
	510H		102	1295.40			
	530H		106	1346.20	4,210	6,200	8,150
TBN	540H	150	108	1371.60			
(Rubber)	560H	(38.1mm)	112	1422.40	4,320	6,370	8,420
	570H		114	1447.80			
	600H		120	1524.00	4,570	6,710	8,920
	605H	200	121	1536.70	4,710	6,920	9,140
	630H	(50.8mm)	126	1600.20			
	640H		128	1625.60			
	650H		130	1651.00	4,960	7,310	9,640
	660H		132	1676.40			
	680H		136	1727.20	5,200	7,640	10,130
	700H		140	1778.00			
	750H		150	1905.00	5,450	8,030	10,640
	770H		154	1955.80	5,810	8,590	11,360
	800H		160	2032.00			
	810H		162	2057.40			
	840H		168	2133.60	6,040	8,970	11,850
	850H		170	2159.00			
	860H		172	2184.40			
	880H		176	2235.20	6,430	9,520	12,570
	900H		180	2286.00			
	950H		190	2413.00	7,040	10,470	13,840
	1000H		200	2540.00			
	1100H		220	2794.00	7,700	11,360	15,070
	1130H		226	2870.20	8,590	12,740	16,890
	1250H		250	3175.00			
	1325H		265	3365.50			
	1350H		270	3429.00	9,520	14,120	18,770
	1400H		280	3556.00			
	1700H		340	4318.00	11,360	16,890	22,430

D.6 Pulley

Add. Spec. Printed in Red

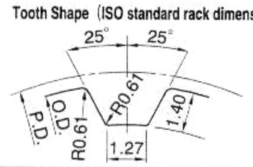
Synchronous Belt Pulleys—XL type—



ATP□□XL025 / XL037 / XL050 (Pitch 5.08mm) MTP□□XL025 / XL037 / XL050 (Pitch 5.08mm) STP□□XL025 / XL037 / XL050 (Pitch 5.08mm)

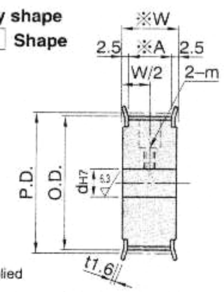
Type		M	S
ATP	Pulley	A2017	Clear Alumite (Anodized)
	Flange	A5052	
MTP	Pulley	S45C	—
	Flange	SPCC	
STP	Pulley	SUS304	—
	Flange	SUS304	

Tooth Shape (ISO standard rack dimension)



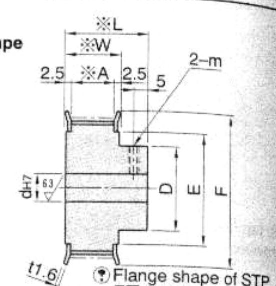
Pulley shape

A Shape



※Caulked flange,
Set screws are supplied

B Shape



Flange shape of STP P.939

Type	No. of Teeth	Type and Width Code	Pulley Shape	Shaft Hole Spec.	Shaft hole dH7 (select from Table 1) H·P·N·C Hole A Shape	H·P·N·C Hole B Shape	V Hole A Shape	V Hole B Shape	Shaft Hole V only (1mm Increments) Z A Shape	Z B Shape	J	P.D.	O.D.	D	F	E
	10				—	5・6	—	—	—	—	—	16.17	15.66	10	24	12
	11					5・6						17.79	17.28			
	12					5・6						19.40	18.90	12	25	15
	14					6~8						22.64	22.13	15	28	18
	15					6~10						24.26	23.75	17	32	20
	16※				6~13	6~10	6~7	6	9~10	9		25.87	25.36			
	18※				6~15	6~12	6~10	6~9	9~14	9~12		29.11	28.60	21	36	24
	19	XL025			6~15	6~12	6~10	6~9	9~14	9~12		30.72	30.22			
	20※	※A : 7.5			8~16	8~13	8~13	8~10	11~17	11~14		32.34	31.83	24	40	27
	21	※W:12.5		H	8~18	8~13	8~13	8~10	11~17	11~14		33.96	33.45			
	22※	※L :21			8~20	8~15	8~16	8~13	11~20	11~16		35.57	35.07	26	45	30
ATP	24※	XL037		P	8~22	8~15	8~16	8~13	11~20	11~16		38.81	38.30			
	25※	※A :11	A		8~22	8~18	8~20	8~16	11~25	11~20		40.43	39.92	30	48	35
MTP	26	※W:16		N	8~23	8~18	8~20	8~16	11~25	11~20		42.04	41.53			
	28※	※L :25	B		8~25	8~20	8~24	8~20	11~30	11~25	(When Shape is A) 2≦J≦W−2	45.28	44.77	35	55	40
STP	30※			C	10~30	10~20	10~24	10~20	13~30	13~25		48.51	48.00			
	32※	XL050			10~30	10~25	10~28	10~24	13~32	13~30		51.74	51.24	40	61	45
	34	※A :14		V	10~38	10~25	10~28	10~24	13~32	13~30	(When Shape is B) 2≦J≦L−2	54.98	54.47			
	36※	※W:19			10~38	10~25	10~30	10~24	13~35	13~30		58.21	57.70		67	50
	38	※L :28			10~43	10~25	10~30	10~24	13~35	13~30		61.45	60.94			
	40※				10~47	10~25	10~30	10~24	13~46	13~30		64.68	64.17		74	58
	42				10~50	10~25	10~30	10~24	13~46	13~30		67.91	67.41			
	44				10~50	10~25	10~30	10~24	13~46	13~30		71.15	70.64		80	60
	46				10~55	10~25	10~30	10~24	13~50	13~30		74.38	73.87			
	48				10~55	10~25	10~30	10~24	13~50	13~30		77.62	77.11		87	67
	50				10~55	10~25	10~30	10~24	13~50	13~30		80.85	80.34			
	60				10~55	10~25	10~30	10~24	13~55	13~30		97.02	96.51		104	84
	72				10~55	10~25	10~30	10~24	13~55	13~30		116.43	115.92		123	102

STP is only for sizes that have the ※ sign. When shaft hole specifications is V, then Z−d≧2

For applicable synchronous belt drive belts, refer to P.983.

Table 1 : Selection Table for Shaft Hole Dia. and Spec.

dH7 Shaft Hole I.D.	H Round hole	P Round hole	N New JIS	C Old JIS	V With Step hole	2-m (Coarse Thread)	Set Screw
5	○	○	—	—	—	M4	M4X3
6	○	○			○		
6.35	—	○			—		
7	○	○			○		
8	○	○	○		○		
10	○	○	○	○	○		
11	○	○	○	—	○		
12	○	○	○	○	○		
13	○	○	○	—	○	M5	M5X4
14	○	○	○		○		
15	○	○	○	○	○		
16	○	○	○	○	○		
17	○	○	○	—	○		
18	○	○	○	○	○	M6	M6X5
19	○	○	○	○	○		
20	○	○	○	○	○		
21	○	○	○	—	○		
22	○	○	○		○		
23	○	○	○		—		
24	○	○	○		○		
25	○	○	○		○		
26	○	○	○		○		
28	○	○	○		○		
29	○	○	○		—		
30	○	○	○		○		
31	○	—	—	—	—	—	—
32	○						
33	○						
34	○						
35	○						
37	○						
38	○						
40	○						
42	○						
43	○						
44	○						
46	○						
47	○						
48	○						
50	○						
52	○						
55	○						

Order Example

Catalog No.		Pulley Shape		Shaft Hole Spec. I.D.		Z		J
ATP24XL037	—	B	—	N10				
MTP40XL050	—	B	—	V15	—	Z29	—	J18

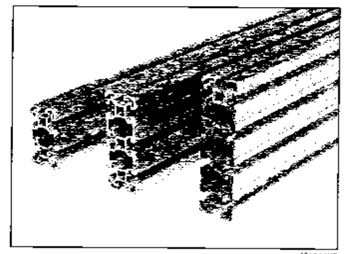
Production Time 3 Days Express A 800 yen/piece P.64

A flat charge of 2,160 Yen for 3 pieces or more of the same size.

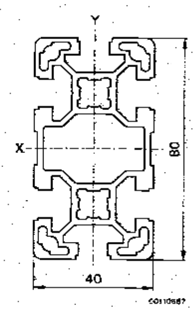
D.7 Structure

Profile / Profiles / Profilés

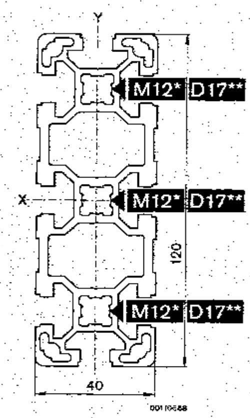
40x80L
40x120L
40x160L



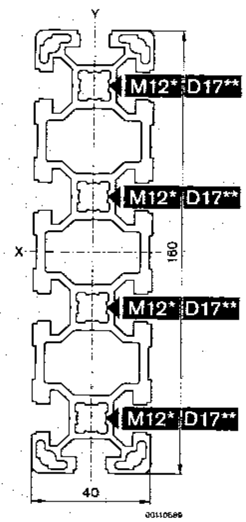
40x80L NEW 2002



40x120L NEW 2002



40x160L NEW 2002



	LE 1 x L = ... mm
	3 842 993 130
M12	3 842 993 131
M12 M12	3 842 993 132
D17 D17	3 842 993 135
D17 D17V	3 842 993 136
D17V	3 842 993 137
D17V D17V	3 842 993 138
	30 mm ≤ L ≤ 6000 mm

	LE 12 x L = 6070 mm
	3 842 529 341

	LE 1 x L = ... mm
	3 842 993 139
M12	3 842 993 140
M12 M12	3 842 993 141
D17 D17	3 842 993 142
D17V D17V	3 842 993 225
	30 mm ≤ L ≤ 6000 mm

	LE 12 x L = 6070 mm
	3 842 529 343

	LE 1 x L = ... mm
	3 842 993 143
M12	3 842 993 144
M12 M12	3 842 993 145
D17 D17	3 842 993 146
	30 mm ≤ L ≤ 6000 mm

	LE 6 x L = 6070 mm
	3 842 529 345

* Endenbearbeitung M12 an gekennzeichneter Zentralbohrung.
* End finishing M12 at marked central bore.
* Usinage des extrémités M12 dans la cannelure centrale marquée à cet effet.

** Endenbearbeitung D17 an gekennzeichneter Nut.
** End finishing D17 at marked groove.
** Usinage des extrémités D17 dans la rainure marquée à cet effet.

i 2-9, 2-63 | 2-26 | 2-26 | 2-54 | 2-62