ITOH DENKI

TECHNOLOGY FOR TOMORROW

MDR Belt Design Guide

- FOR 2.5" DIAMETER ROLLERS -

Introduction

This design guide has been created to convey best practices for utilizing motorized rollers in belted applications. When applied properly, the motorized roller zone offers many benefits over a standard roller conveyor zone. After reviewing this belt guide, one should be able to:

- Select a belted zone configuration based on conveyor requirements
- Select a motorized roller for the belted zone
- Determine the viability of motorized roller selected for this application
- Determine the loads imparted to the motorized roller assembly
- Select the method of controls for the motorized roller zone

This guide is intended to be an outline for a manufacturer (OEM) to develop a proper belted zone conveyor. However, it is not intended to be a catch-all for details of the actual design. It is the responsibility of the conveyor OEM to make certain that all aspects of good design practices have been followed. This guide is not intended to be a supplement or outline for safety considerations for motorized roller belted zones. The OEM must ensure to follow CEMA and their own internal safety standards when designing and developing a product line.

There are many uses for belted zones in motorized roller applications. These include, but are not limited to the following:

- General handling of irregular and/or small packages which would otherwise be problematic to convey on traditional roller bed conveyor
- Handling of packages where more prompt and reliable stopping is required which may be problematic to convey on roller bed conveyor
- Incline and decline applications where it is desirable to start and stop conveyors to accumulate packages on the incline or decline section of the conveyor
- Check weigher or scale applications where a low cost motorized roller can be used in place of a standard drive to eliminate other drive-train components

The benefits of the belted zone are many, so long as the design has been properly executed. Belted zones offer the following over traditional roller zones:

- Higher friction levels between the product and the belt as compared to a roller zone
- Ability to accumulate products on an inclined or declined zoned conveyor
- A flat, continuous conveying surface free from valleys present on traditional roller zones
- Quick and very responsive acceleration and deceleration of packages
- Potentially lower inertia than a close center roller zone
- Potential lower cost than a close center roller zone
- Fewer piece part counts than a roller zone (where applicable)

The belted motorized roller zone is not without its set of limitations. It is essential to remember that the belted zone is driven by a low power motor. This traditionally means very efficient and safe conveyance. However, this can also present an issue for the belted zone. The crux of the issue with the motorized roller zone is the power consumption to move the belt. The power to move the belt is a function of its tension and the thickness and/or any fibers in the belt. Belt construction varies significantly between styles and manufacturers and it is imperative you engage a belting expert when you lay out the initial design. If a very thick and stiff belt is selected and this requires a significant amount of belt tension, this can create a very large problem for the motorized roller. A problem which manifests itself in terms of available power and expected life span of the roller. All emphasis should be on selecting the most flexible belt which keeps tension levels low and therefore keeps power levels low.

The goal with any motorized roller belted application should be to use the most cost effective roller to do the job. If an extremely heavy belt is selected which requires a lot of tension just to keep it drawn on the roller then you just may determine that the roller you wanted to use is no longer a viable option and you have to either move up in power, down on speed (up in torque), or into a larger sized roller which can handle the tension levels (i.e. higher area moment of inertia and larger bearings, etc.). There are no short cuts here and you must balance the following variables:

- Belt life (i.e. fatigue on bend radius, etc.)
- Belt tracking (tracking rib or no tracking rib, etc.)
- Belt tension (how much tension do you have to put into the assembly to achieve a flat belt that drives properly and tracks properly?)
- Power consumed to move the belt

The current draw of the roller is a direct indication of how hard the motor is working. Motorized roller technology is designed to be run in an "on-off-on-off…" arrangement. In other words, the motors are designed to be run and then shut off once product has passed that zone. This is true regardless of roller or belted zones.

The motorized roller will always pull in a higher current upon startup than it draws in a normal running operation, all other variables being held constant. This is intuitive in any mechanical system and applies here as well as it takes more force to accelerate the package than it does to keep it running at speed. At startup is where the motorized roller will draw its highest current levels. Itoh Denki rollers have been rated at a life span of 15,000-20,000 hours of accumulated "on" time at their rated current. All Itoh Denki motorized rollers can draw more than rated current up to their limiting startup current. It is intuitive that the harder the draw on the mechanical system the more current will need to be applied to accelerate and keep the roller running at the desired speed. One should look to achieve a running current for the belted zone which is near or below the rated current for that roller. This process includes calculations and experimentation to determine the final solution.

A good motorized roller belted zone design will result in:

- Low power consumption
- Long motor life
- Achievement of desired speeds
- Long belt life
- Ease of maintenance

Belted Zone Configuration Matrix

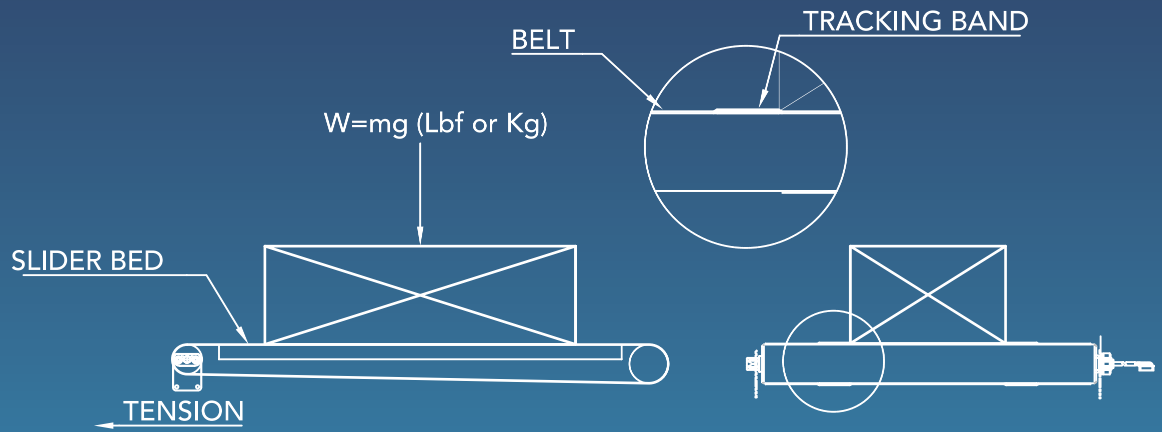
This guide contains 4 recommended belted zone layout configurations. An overview matrix of these configurations follows:

Belted Zone Configuration	Roller Diameter; In.	Roller Position	Bed Style	Belt Style	Belt Tracking	Jump Drive Style
1	2.5	Head	Slider	Elastic	Tracking Bands	N/A
2	2.5	-1	Slider	Endless-Thin Ply	Vulcanized Tracking Rib	Poly-V
3	3.0	Head	Roller	Endless-Thin Ply	Vulcanized Tracking Rib	N/A
4	3.0	Head	Slider	Endless-Thin Ply	Vulcanized Tracking Rib	N/A

These 4 configurations are to serve as a recommendation for effective layouts for belted zones when being powered with motorized rollers. Certainly, aspects from several of these layouts can be combined to come up with yet another configuration. The exact belted zone configuration should be determined by the OEM and should be properly tested and documented prior to manufacture.

The following diagrams depict options 1 through 4 in further detail and an explanation of each layout follows.

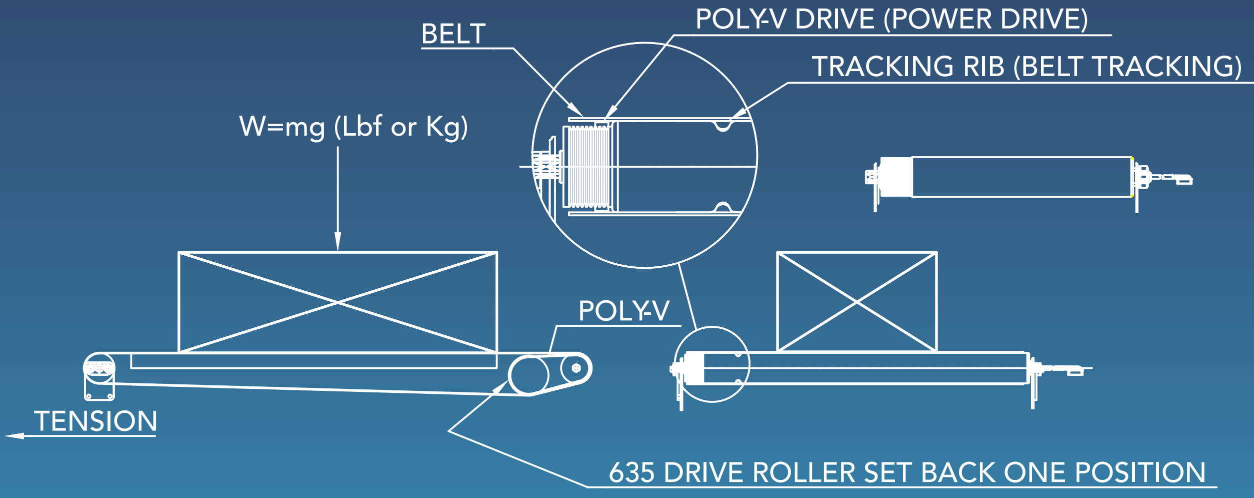
1 PM635 (2.5") BELT OVER SLIDER BED-ELASTIC BELT



MOTORIZED ROLLER: 635 FS OR 635KE
MOTORIZED ROLLER POSITION: HEAD
ELASTOMERIC BELT-FLAT CROSS SECTION, TRACKING TIRES LOCATED ON HEAD AND TAIL PULLEY (2X HEAD 1X TAIL)
TENSION REQUIRED: MODERATE-REQUIRES ADEQUATE TENSION FOR PROPER TRACKING
HIGHLIGHTS: EXCELLENT HEAVY DUTY MOTORIZED ROLLER BELT SETUP
635KE ROLLER ALLOWS FOR HIGH TORQUE APPLICATIONS-POSSIBLE TO DO LONGER RUN BELTS
ROLLER FIXATION: THREADED HEX -STANDARD 635 FIXATION
TENSION: TENSION IDLER ROLLER, THREADED JACK SCREW OR ECCENTRIC CAM PLATE
APPLICATIONS: LEVEL, INCLINE, DECLINE-LONGER RUNS AND STEEP INCLINES POSSIBLE

Layout 1 consists of a 2.5” PM635 series motorized roller in the head position of the belted zone. This configuration shows a stretchy belt with a tracking rind to draw and center the belt. The 635 rollers have the potential to take a lot higher tension load and as well can provide a lot of torque capacity, specifically when equipped with a 10-Amp motor (653KE). In this example the slider bed will create additional drag on the system, however if the belt material and slider bed material is properly selected this should not be a large concern, specifically considering the ability for the 635 to be able to provide substantial torque.

2 PM635 (2.5") BELT OVER SLIDER BED-JUMP DRIVE



MOTORIZED ROLLER: 635FS or 635KE WITH POLY-V ENDCAP

MOTORIZED ROLLER POSITION: 2ND BACK-ALLOWS 1.9" IDLER FOR MINIMIZED GAP

BELT STYLE: BELT WITH SERATED AND
VULCANIZED TRACKING RIB

TENSION REQUIRED: MINIMAL-TRACKING RIB HOLDS BELT TRACKED

HIGHLIGHTS: EXCELLENT HEAVY DUTY MOTORIZED ROLLER
BELT CONVEYOR SETUP WHERE BELT TENSION FORCES REQUIRE 1.9" THROUGH SHAFT IDLERS

LIMITATIONS: DRIVE AND BELT FORCES MUST BE CALCULATED BEFORE ROLLER IS SELECTED
SLIDER PAN MUST BE SPLIT DESIGN OR HAVE GROOVE FOR TRACKING RIB

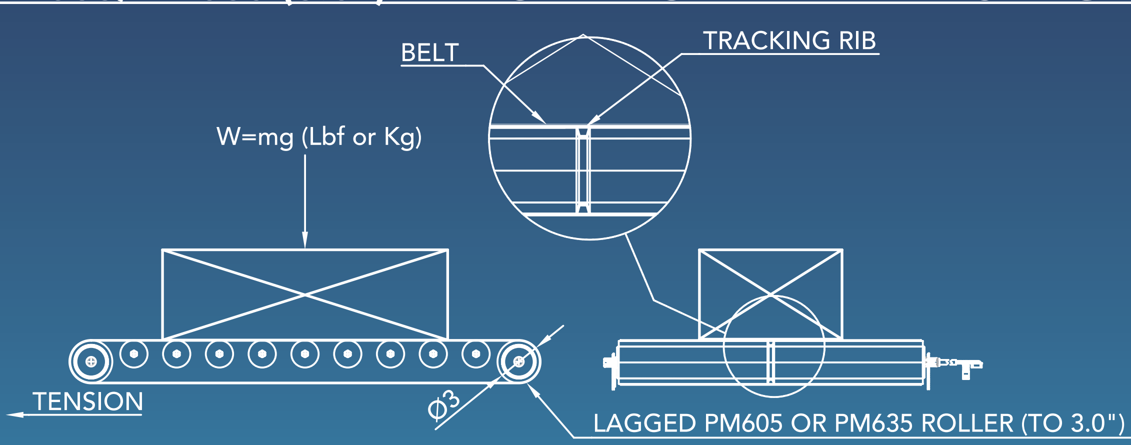
ROLLER FIXATION: STANDARD 635 THREADED FIXATION

TENSION: TENSION IDLER ROLLER, THREADED JACK SCREW OR ECCENTRIC CAM PLATE

APPLICATIONS: LEVEL, INCLINE, DECLINE-LONGER RUNS AND STEEP INCLINES POSSIBLE

Layout 2 consists of a 2.5" PM635 series motorized roller in the 2nd position back position of the belted zone. The belt in this example is a thin or medium thickness belt with a tracking rib vulcanized to the belt. This layout is not intended to take the motorized roller out of the head position because of tension limits, but rather to allow for a smaller 1.9" roller to make the transition between zones should the smaller gap be required between belted zones. The Poly-V drive can be setup with as many ribs as desired to transmit the required torque, so long as the head pulley can withstand this tension. In this example the slider bed will create additional drag on the system, however if the belt material and slider bed material is properly selected this should not be a large concern, specifically considering the ability for the 635 to be able to provide substantially more torque than the 486 roller series.

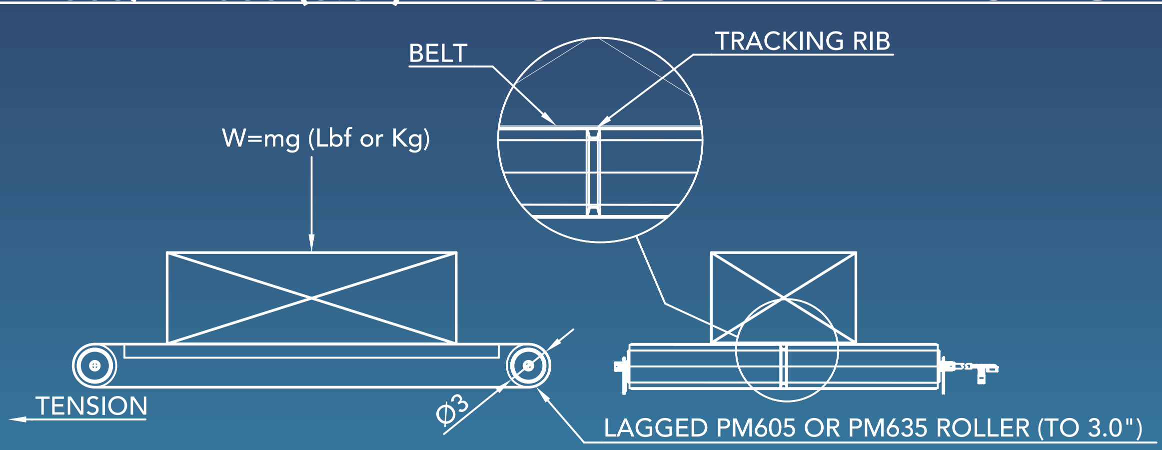
3 PM605/PM635 (3.0") BELT OVER ROLLER BED-TRACKING RIB



MOTORIZED ROLLER: PM605FE/PM635FS/PM635KE LAGGED TO 3.0"
MOTORIZED ROLLER POSITION: HEAD
BELT STYLE: BELT WITH TRACKING RIB
TENSION REQUIRED: MINIMAL-TRACKING RIB HOLDS BELT TRACKED-HIGH BELT TENSIONS POSSIBLE
HIGHLIGHTS: EXCELLENT LIGHT TO HEAVY DUTY MOTORIZED ROLLER BELT CONVEYOR
ROLLER FIXATION: MBB SERIES AXLE LOCKS 4X OR PM635 THREADED HEX FIXATION
TENSION: TENSION IDLER ROLLER, THREADED JACK SCREW OR ECCENTRIC CAM PLATE
APPLICATIONS: LEVEL, INCLINE, DECLINE-LONGER RUNS AND STEEP INCLINES POSSIBLE

Layout 3 consists of a PM605 or PM635 roller expanded to an effective 3" diameter by way of a lagging applied to the roller tube which has then been grooved to create a space for a vulcanized rib on the underside of the belting material. This is a highly engineered solution and can be used when high tensions and high torques are required. This is not a cost limited design and should be used when the maximum performance is desired but costs are not as sensitive. Consider longer zones can be created with this layout and a 635KE roller.

4 PM605/PM635 (3.0") BELT OVER SLIDER BED-TRACKING RIB



MOTORIZED ROLLER: PM605FE/PM635FS/PM635KE LAGGED TO 3.0"
MOTORIZED ROLLER POSITION: HEAD
BELT STYLE: BELT WITH TRACKING RIB
TENSION REQUIRED: MINIMAL-TRACKING RIB HOLDS BELT TRACKED
HIGHLIGHTS: EXCELLENT HEAVY DUTY MOTORIZED ROLLER
BELT CONVEYOR SETUP WHERE BELT TENSION FORCES REQUIRE 1.9" THROUGH SHAFT IDLERS
LIMITATIONS: DRIVE AND BELT FORCES MUST BE CALCULATED BEFORE ROLLER IS SELECTED
SLIDER PAN MUST BE SPLIT DESIGN OR HAVE GROOVE FOR TRACKING RIB
ROLLER FIXATION: MBB SERIES AXLE LOCKS 4X OR PM635 THREADED HEX FIXATION
TENSION: TENSION IDLER ROLLER, THREADED JACK SCREW OR ECCENTRIC CAM PLATE
APPLICATIONS: LEVEL, INCLINE, DECLINE-LONGER RUNS AND STEEP INCLINES POSSIBLE

Layout 4 consists of a PM605 or PM635 roller expanded to an effective 3" diameter by way of a lagging applied to the roller tube which has then been grooved to create a space for a vulcanized rib on the underside of the belting material. The slider bed in this example will create more drag against belt motion, but this is likely of little concern provided the correct roller is selected. This is a highly engineered solution and can be used when high tensions and high torques are required. This is not a cost limited design and should be used when the maximum performance is desired but costs are not as sensitive. Consider longer zones can be created with this layout and a 635KE roller.

Governing Equations

When selecting equation sets for use with belted zones, there are many factors involved and there seem to be as many equations available. Before jumping to equations, it is important to discuss the basis of the belting equation.

To start, any belt will require a certain amount of tension just to achieve the desired drive and as well to draw the belt around the end rollers to achieve the desired driven belt profile for that particular belt. A lot of mistakes get made here when selecting motorized rollers for belted zones, specifically if a very heavy belting material is selected. One can err so badly as to never achieve the desired speed on the conveyor because the motorized roller has such low power output. It is absolutely essential that the OEM perform the necessary testing on the rollers to make certain of the current consumed just to drive the belt, at that belt's required tension, is not excessive. Excessive in this case would mean consuming so much current just to drive the belt such that nothing remains to drive any products of nominal weight. Consider that compared to a traditional belt drive, the motorized roller zone will consume a proportionately larger amount of force just to drive the belt as compared to the traditional longer belt drive. Therefore, the torque required to move the belt at the desired speed must be measured and then plotted on the motor's torque-speed-current chart to make certain there are no issues.

Once the tension and belt drive requirements are required, a more standard set of equations can be utilized to determine the additional amount of force required out of the roller. Certainly these forces will depend largely upon:

- Roller or slider bed
- Flat or incline conveyor
- Weight of the package to be conveyed

Power is a rate of doing work and considering mechanically rotating devices, there are two constituents; torque and speed. Very simply power is calculated by multiplying torque by speed. Torque is a function of a force acting a distance from the center of rotation. It is here we find the constituent required to calculate the force required to pull the belt, or in terms of the Itoh Denki catalog data, the tangential force. Motors are selected based on tangential force and there are many considerations when looking at tangential force numbers in a catalog or chart which must be considered before making a final motor selection.

The following equation sets are meant to represent a guide for selection of a motorized roller for the intended application. Like the layouts, these are intended to be a guideline. You may find that you are combining several aspects of each equation set to arrive at a final equation set for your specific layout.

List of variables:

Ft=The force required by the roller to drive a belt at a given speed with a given load, Newtons or Lbf
ur=Coefficient of rolling friction, dimensionless (use 0.033)
us=Coeffienct of sliding friction, dimensionless (use 0.330)
g=gravitational acc. constant, 9.81m/s^2 or 32.2 ft/sec^2
mp=Mass of heaviest product to be moved, Newtons, or slugs
mb=Mass of belt used, Newtons or slugs
mr=Mass of rollers (total), Newtons or slugs
Fbf=Belt flexure force required just to drive the belt, Newtons, or Slugs
Fjj=Force required to jump drive to head roller, Newtons or Slugs
A=Angle of incline, degrees

The ultimate goal of the development exercise is to arrive at a motorized roller which can do the job at hand. The roller's jobs are many including, but not limited to;

- Achieving the proper speed while conveying the heaviest load
- Having ample torque to start the heaviest load while still able to achieve the desired cycle rate
- Running most of the time at or around the rated current for that roller
- Not burdening the project with so much cost as to become cost prohibitive

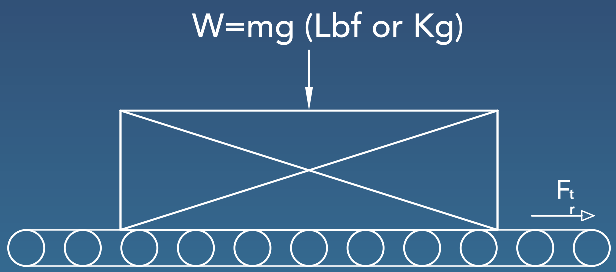
Clearly, judgment is necessary when selecting the proper motorized roller to do the job. Going larger all the time has cost implications. Going too small has implications for overheating the roller or running the roller at a significantly higher current draw than rated such that the motor's life is compromised significantly.

Secondary to this, the selection of the belt and method of belt drive also play a large role in the selection of the motorized roller. A stiffer belt will require more tension just to hold the belt on the roller and addition will require more power just to cycle over the roller. Typically thinner, more flexible belts are preferred because of the small power output of the motorized roller is not as heavily taxed. This leaves more tangential force for driving the product.

While the equations are expressed in terms of tangential force and can be used as such, it is likely more effective to combine some testing and some calculations to arrive at the final result. For example, it is necessary to test the belt flexure force to arrive at a number for the actual force. This will manifest itself as current draw in the motor and it is fully possible to measure this force simply by running the belt without any product and measuring the current. This current can be compared to the base current of the motorized roller just running by itself.

Some judgment is required when determining the allowable limits of your design and as well towards selecting a motorized roller to meet the needs of the application. Once you have done some testing, it is then possible to derive the constituents of the equation based on your empirical data. The equations are intended as a guideline.

1 ROLLER BED GOVERNING EQUATION-FLAT

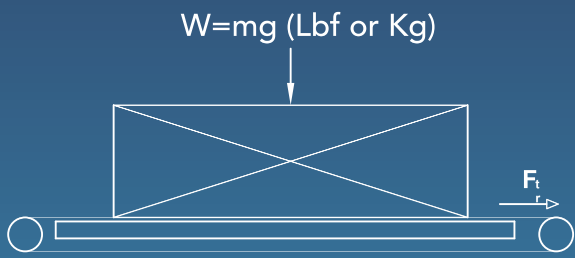


$$F_t = u_r \cdot g \cdot (m_{pb} + m_b + m_r) + F_{bf}$$

F_t=Tangential Force, lbf or kg
u_r=Rolling coefficent of friction-belt to roller
g=gravitational acceleration constant ($32.2\ ft/s^2$ or $9.81\ m/s^2$)
m_p=mass product, slugs or Newtons
m_b=mass belt, slugs or Newtons
m_r=mass rollers, slugs or Newtons
F_{bf}=Force belt flexure, lbf or kg

Equation 1 is used to calculate the simple flat belt over roller application. Very simply, this equation takes into consideration the weight of the product, rollers and belt and then applies a rolling coefficient of friction to these weights to then arrive at a belt pull. In addition to this, there is a facet of the equation which documents the force required to move the desired belt at speed. This force is also a function of the tension itself.

2 SLIDER BED GOVERNING EQUATION-FLAT

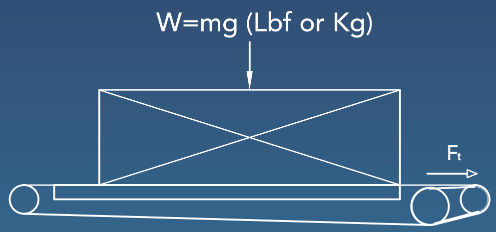


$$F_t = u_s \cdot g \cdot (m_p + m_b + m_r) + F_{bf}$$

F_t=Tangential Force, lbf or kg
u_s=Sliding coefficent of friction-belt to roller
g=gravitational acceleration constant (32.2 ft/s^2 or 9.81 m/s^2)
m_p=mass product, slugs or Newtons
m_b=mass belt, slugs or Newtons
m_r=mass rollers, slugs or Newtons
F_{bf}=Force belt flexure, lbf or kg

Equation 2 is used to calculate the simple flat belt over slider bed application. Very simply, this equation takes into consideration the weight of the product, rollers and belt and then applies a sliding coefficient of friction to these weights to then arrive at a belt pull. In addition to this, there is a facet of the equation which documents the force required to move the desired belt at speed. This force is also a function of the tension itself and how the bet interacts with the slider bed.

3 ROLLER BED GOVERNING EQUATION-FLAT W/JUMP DRIVE

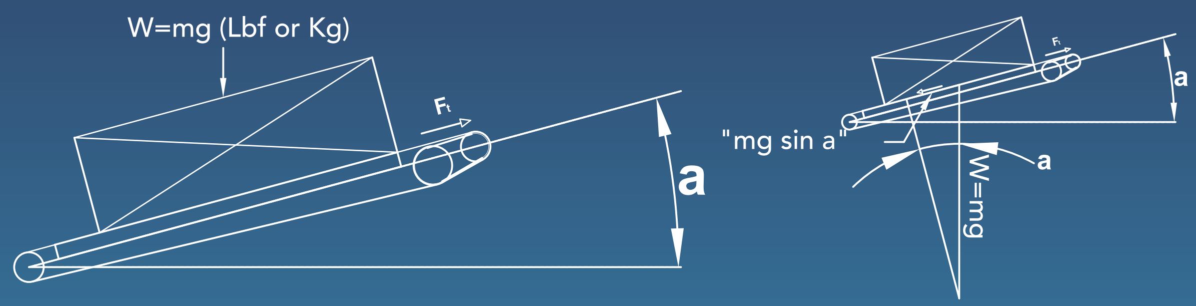


$$F_t = u_s \cdot g \cdot (m_{pb} + m_b + m_r) + F_{bf} + F_{jj}$$

F_t=Tangential Force, lbf or kg
u_s=Sliding coefficent of friction-belt to roller
g=gravitational acceleration constant (32.2 ft/s^2 or 9.81 m/s $)^2$
m_p=mass product, slugs or Newtons
m_b=mass belt, slugs or Newtons
m_r=mass rollers, slugs or Newtons
F_{bf}=Force belt flexure, lbf or kg
F_{jj} =Force jump drive, lbf or kg

Equation 3 is used to calculate the belt over slider bed application when used with a jump drive to a smaller nose pulley. Very simply, this equation takes into consideration the weight of the product, rollers and belt and then applies a sliding coefficient of friction to these weights to then arrive at a belt pull. In addition to this, there is a facet of the equation which documents the force required to move the desired belt at speed and one which documents the additional force required to drive the jump drive. In reality the two additional forces to drive the belt and the jump drive can both be measured at the same time through experimentation.

4 ROLLER BED GOVERNING EQ.-INCLINE W/JUMP DRIVE



$$F_t = u_s \cdot g \cdot (m_{pb} + m + m_r) + F_{bf} + F_{jj} + (g \cdot m_p \cdot \sin a)$$

F_t=Tangential Force, lbf or kg
u_s=Sliding coefficent of friction-belt to roller
g=gravitational acceleration constant (32.2 ft/s^2 or 9.81 m/s^2)
m_p=mass product, slugs or Newtons
m_b=mass belt, slugs or Newtons
m_r=mass rollers, slugs or Newtons
F_{bf}=Force belt flexure, lbf or kg
F_{jj} =Force jump drive, lbf or kg
a =Angle of incline, x°

Equation 4 is used to calculate the belt over slider bed application when used with a jump drive to a smaller nose pulley on an incline. Very simply, this equation takes into consideration the angle of incline, the weight of the product, rollers and belt and then applies a sliding coefficient of friction to these weights to then arrive at a belt pull. In addition to this, there is a facet of the equation which documents the force required to move the desired belt at speed and one which documents the additional force required to drive the jump drive. In reality the two additional forces to drive the belt and the jump drive can both be measured at the same time through experimentation.

Motorized Roller Selection

Selecting the proper motorized roller is critical to the success of the development effort. While a motor may look like the right choice initially, this will only be determined after extensive testing has been performed. There are many things to consider when selecting the motorized roller and while some are easily determined, others require a judgment call. The following list represents some things to consider when selecting the motorized roller for the application:

- Size of roller (2.5”)
- End-cap design (Standard, Poly-V, or other?)
- Groove requirements
- Drive roller position (head or positioned back)
- Lagging requirements
- Tangential force requirements
- Speed requirements (at a given tangential force)
- Cost

You must first make an effort to determine what type of drive you want to use before running testing to determine the roller you wish to use.

When the general size and style of roller is selected, it is necessary to then pick a gearbox to go with that motor. Tangential forces are offered up in the catalog. Realize the tangential forces at starting current and running current will vary greatly. Additionally please realize that while the motor for a given roller is basically of set power level, that power level can be split up to offer; higher speed and lower torque or lower speed and higher torque.

There is no free lunch here and you have to use discretion. The process looks something like this:

- Select roller size
- Select motorized roller family
- Calculate estimated tangential force for roller using governing equations
- Select gear ratio that yields the best torque-speed combination
- Determine amperage required to pull the belt at the given speed
- Determine the force being placed into the bearings of the roller
- Check that speed requirements can be met while holding torque levels
- Verify selection by plotting the operating condition on the motorized roller performance graph.

Considering the limited power output of a motorized roller, it is absolutely imperative you know how much of the capacity of the roller is being used to drive the belt. Every belt will be different in its needs in terms of power to flex the belt and additionally you must consider that the tension required to drive the belt is a function of the belt tension.

Some belts are not good candidates for motorized roller belted application. More specifically, this means selecting a very thick and stiff belt is an inherently bad idea. A thick and stiff belt is a bad idea for the following reasons:

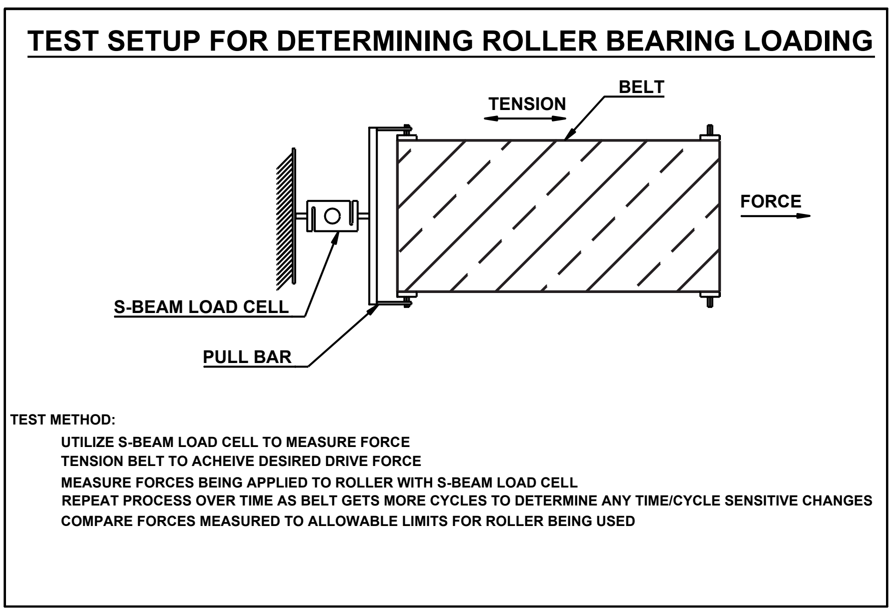
- It requires more tension to get the belt to wrap properly around a small roller
- It requires more power to drive the belt at speed because the belt is continually being flexed as it goes around the roller. Consider that the same belt that works really well on a 5HP 6” center drive pulley is likely not going to work well at all on a 2.5” roller of limited power output.

It is your responsibility to make certain that you know how much current is being consumed just to drive your selected belt at your desired speed. The process for determining this current draw is very simple and basically follows this sort of procedure:

- Select a belt which you believe meets your needs and is a good candidate for motorized roller zone application.
- Tension this belt by measuring the force required to keep the belt on the pulley, properly track the belt and to provide adequate drive force for the load you plan to move.
- Run the belt at steady state conditions without any product on the belt to determine the current required to run the belt at your desired speed. You can directly measure the current going into the motor control card by way of an amp clamp or by directly running the current through a meter (preferred over amp clamp).
- Repeat the current draw at a given speed for the roller with the belt un-attached to the assembly. The difference between the unloaded roller draw current and the loaded (with belt) current draw represents the current required to drive just your belt.
- You should repeat this process for various belt tensions. A good design will limit the amount of tension placed into the belt and it is a good idea for you to know the current draw at various tension levels, specifically when over-tensioning the adjustment in the field. The best designs will limit the belt tension!
- Consider that you must make certain that the tension you are placing into the roller assembly must not exceed the guidelines set forth in this document. Failure to follow the guidelines may result in premature bearing or end cap failure within the motorized roller.

Determining Roller Loading

Part of the process of setting up a good motorized roller belt zone is to make certain you are not over loading the motorized roller. Due to the design of the motorized roller, it is not possible to have a full length through shaft in the design. This limits the amount of force you can place into a roller assembly.



Inspection of the above diagrams shows a sample of how the belted zone can be setup and tested to assure the loading for the roller is not being surpassed.

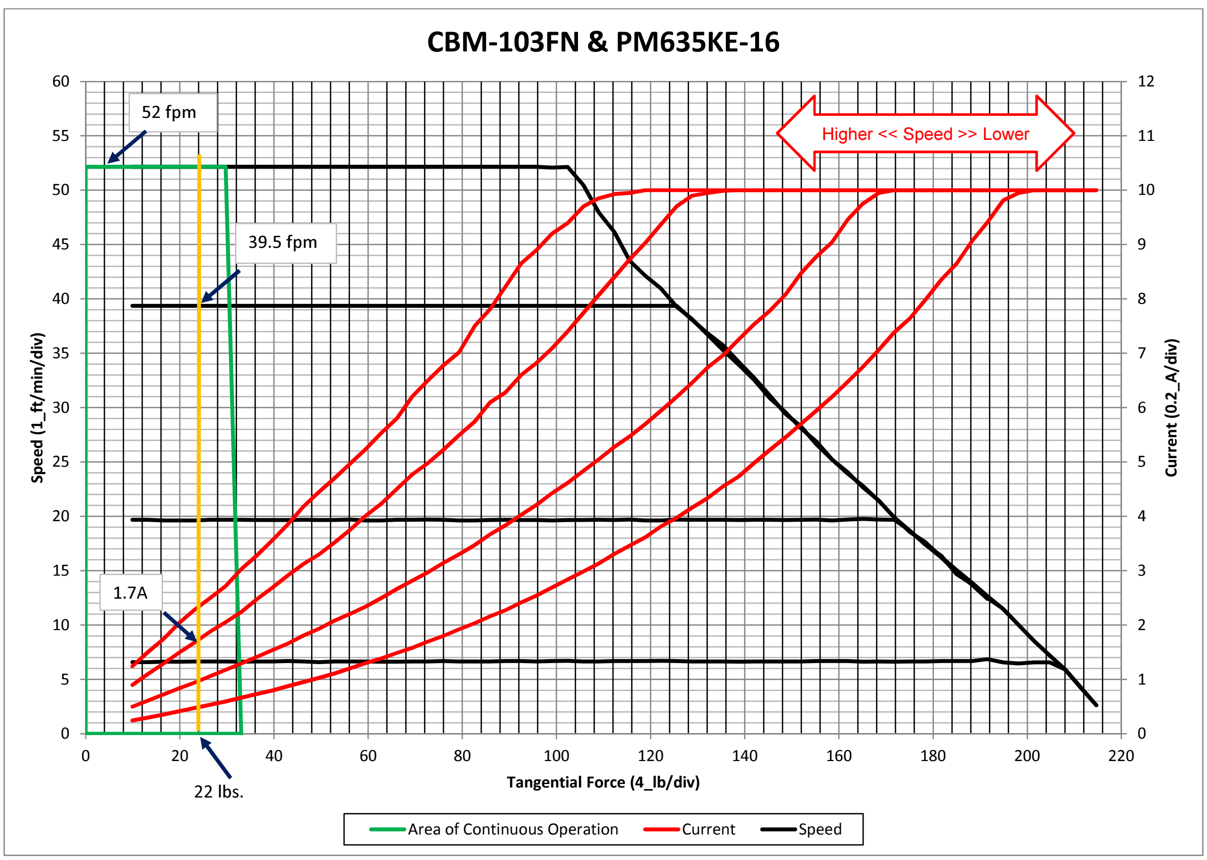
The limits presented below for each style of motorized roller are based on achieving a solid design that not only performs well initially, but also lasts an appropriate amount of time.

Motorized Roller Belt Tension Load Limits		
Belted Zone Configuration	Roller Diameter; In.	Loading Limits, lbf
PM635FS	2.5	75
PM635KE	2.5	75

Please make every effort to adhere to the limits presented in this guide to make certain you are arriving at a design which will perform and last.

All Itoh Denki rollers have been tested to determine their torque-speed characteristics. Having this data is vital to development of a successful belt zone design. Please keep in mind that when dealing with motorized rollers you are dealing with very low power levels. Selecting the correct roller yields a well performing, long lasting and cost effective solution. Selecting the wrong roller can yield exceptionally poor results, including; poor performance, overheating, damaged bearings and other issues beyond the scope of this document. It is the designer's responsibility to make certain that all foreseeable loads, misuse and the like are taken into consideration when designing the system.

Itoh Denki motorized rollers are designed to be used in a run on demand type setup. Run on demand means when no product is present, the motorized roller is turned off to; save energy, reduce wear, and reduce noise. While running the motor all the time is possible in many cases, please realize this goes against the grain of the true plan for the technology.



Very simply, this graph shows the interrelationship between torque, speed and current draw. There are 4 speed curves plotted on this graph in black. Starting at the upper left of the above chart we see the peak speed this roller can achieve, in this case 52 ft/min. Note that this speed corresponds with basically zero load, in other words you won't achieve this speed if you want to have any kind of tangential force. You can see that the lower the speeds plotted, the more likely you will have higher levels of tangential force available. This is intuitive. Corresponding to these 4 speed curves, there are 4 current curves plotted. Each current curve corresponds to a speed curve on the graph. Tangential force is plotted on the abscissa while speed and current are plotted on the ordinates. Areas to the left of the sloped black line represent areas free for use. Areas right of the line represent areas where this motorized roller cannot perform.

In this example, let's say we have need to create 22 lbs of tangential force at just under 40 ft/min (39.5 ft/min in this example). We see the roller is capable of doing this as this speed-torque combination lies to the left of the upper black line. So, therefore 40 or so ft/min can easily be achieved with 22 lbf of tangential force available. If we look to the current lines in red and look at the third line which corresponds to the 3rd speed line (our 40 ft/min line in this case), we can see that the motor will require roughly 3 amps of current to maintain this torque-speed relationship. More tangential force means more current. Less tangential speed means less current.

We can see that all current lines stop in this case at 10.0 amps, as this is the limit of this motor. Any card used with this motor will clamp the current at this limit to minimize the risk of over drawing current into the winding. The area in green on the graph represents the area of continuous operation. Simply put, the motorized roller can be operated in this area continuously without fear of overheating in reasonable ambient conditions.

In this example, we see that our roller running at 39.5 ft/min and supplying 22 lbf of tangential force is running at 1.7 amps. The rated current in the Itoh Denki catalog for this roller is 2.8 amps. Therefore at this loading, we are slightly above rated current and clearly also just stepping into an area where continuous operation is not endorsed.

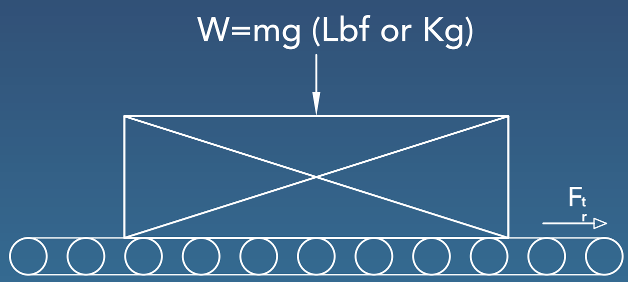
You must pay particular attention to where your specific application falls on these graphs as this is the best way to determine how properly you have done your matching to your application.

The PM635KE is an excellent motorized roller belt conveyor drive motor choice.

It represents a good basis for starting on a design, but does not represent all options. If you are considering a different motorized roller option, please contact your Itoh Denki representative for further assistance.

Please familiarize yourself with the torque-speed-current graphs as these are the key to understanding the operational characteristics of each motor. Once you have determined how to read this chart, interpreting the results between motors selected will become second nature.

1 ROLLER BED GOVERNING EQUATION-FLAT



$F_t = u_r \cdot g \cdot (m_{pb} + m_b + m_r) + F_{bf}$

F_t=Tangential Force, lbf or kg
u_r=Rolling coefficent of friction-belt to roller
g=gravitational acceleration constant (32.2 ft/s^2 or 9.81 m/s^2)
m_p=mass product, slugs or Newtons
m_b=mass belt, slugs or Newtons
m_r=mass rollers, slugs or Newtons
F_{bf}=Force belt flexure, lbf or kg

Example Problem

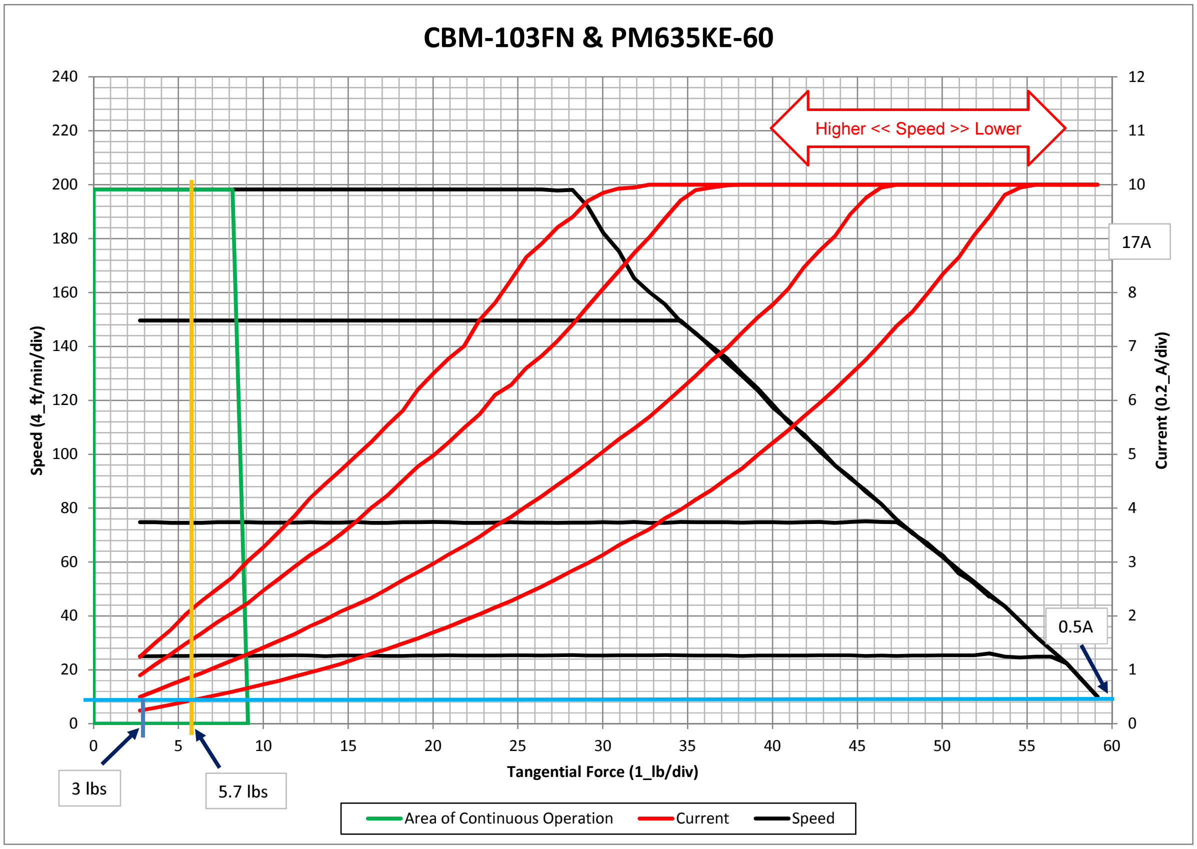
You have decided that you want to use layout style 1, belt over roller bed and need to move a 50 lb package at 75 ft/minute. Choose the best roller for the application:

Select layout 1 as the basis for the design. This requires you to use a thin belt with a tracking rib. Through test setup and experimentation you have determined the following:

- No load current draw: 0.25 amps
- Belted load current draw: 0.75 amps
- Load required to hold belt tracked and down: 21 lbs

From the above measured values, we can see that this application is a good candidate for the 2.5" rollers, most specifically based on the fact that the current draws look within reason for 10-amp roller and also the forces required to hold this belt in the proper position are below the stated limits.

From here, the additional loading can be determined by using equation 1 and entering in the variables:



Ur=0.033
Weight product=(mp*g)=50 lbs
Weight rollers=(mr*g)=30 lbs (measure)
Weight belt=(mb*g)=1 lbs (negligible)
Total weight=81 lbs

The tangential force required to move this load (rollers, belt, load) is then calculated:

Ft=81lbf*0.033=2.7 lbf

Fbf can be estimated by looking to see where the 0.5 amp draw correlates in terms of 75 ft/min on the PM635KE-60 chart to start out.

Plotting 0.5 amps back to just below the intersection of the 2nd red current curve is running (this corresponds to roughly 75 ft/min) and then plotting downward to the abscissa you can estimate this at about 3 lbs of tangential force.

Assume tangential force required to drive the belt is 3 lbf.

The total force required to drive this load and the belt is then 3 lbf+2.7 lbf=5.7 lbf. It would be wise to apply a factor or safety to this number so we could say very conservatively that we are below 7-10 lbf of tangential force.

In this case the force required to drive this belt at 75 ft/min is well within the green area of continuous operation for the PM635KE roller and thus the PM635KE roller would be a good candidate for this application.

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Revision Number	Change
2015-0421	Initial Document
2015-0528	Added Roller Bearing Loading Chart Added Belt Tension Load Limits
2015-0529	Removed all references to PM486 Revised Charts

Specifications subject to change without notice