List of Terms and Symbols for Power Transmission Belts

Design (transmission power, transmission capacity, correction factor)-related			Belt/pulley dimension-related		
Term	Symbol	Meaning of term	Term	Symbol	Meaning of term
Transmission power	Pt	Belt power to be transmitted from driving shaft to driven shaft	Pitch length	Lp	Length along the belt's pitch line
Design power	Pd	Power for belt selection obtained by correcting driven power with various transmission correction factors	Effective length	Le	Length calculated with the pulley's effective diameter when a belt is attached to two identical pulleys to a fixed tension
Driven power	Pn	Power consumed by the driven shaft	Outside length	Lo	Length along the back face or outer face of a belt
Overload factor	Ks	Correction factor for transmission power due to load characteristics or other operating conditions (Ks=Ko+Ki+Ke)	Inside length	Li	Length along the bottom face or inner face of a belt
Load correction factor	Ko	Transmission correction factor used in relation to load variation and operation frequency of the driving machine or machinery used	Pulley outside diameter	do	Maximum diameter of the periphery of a pulley body
Idler correction factor	Ki	Transmission correction factor used when an idler is used	Large pulley	D	The pulley with a larger diameter of a pair of pulleys connected by a belt
Environmental correction factor	Ke	Transmission correction factor used depending on the environmental conditions (temperature, humidity, etc.) in which a belt is used	Pinion	d	The pulley with a smaller diameter of a pair of pulleys connected by a belt
Speed ratio correction factor	Kr	Transmission correction factor used in relation to the speed ratio at the time of acceleration or deceleration	Pitch diameter	dp	Diameter of a pitch line of a belt wound around a pulley
Transmission capacity	Pe	Value obtained by adding an additional transmission capacity by the rotation ratio to the basic power rating (Pe = Pr + Pa)	Effective diameter	de	Diameter with the effective width of a V-pulley
Basic power rating	Pr	Power that can be transmitted for a certain time with the standard condition of a belt with reference dimensions	Center distance	C	Distance between the centers of two shafts to which pulleys are attached
Corrected power rating	Pc	Transmission capacity obtained by correcting the basic power rating with various belt correction factors	Temporary center distance	C′	Pre-planned rough center distance
Transmission capacity added depending on the speed ratio	Pa	Transmission capacity added to the basic power rating depending on the speed ratio	Adjustment range	Cs Ci	Amount of adjustment of the center distance for attaching or tensioning a belt
Length correction factor	Kl	Belt correction factor used when the effective length is other than the reference length	Standard effective length	L	Effective length of a belt of a standard size
Width correction factor	Kb	Belt correction factor used when the belt width is other than the reference width	Rough effective length of a belt	L′	Rough effective length of a belt calculated from a temporary center distance and a pulley diameter
Mesh correction factor	Km	Belt correction factor used when the number of meshed teeth in synchronous belt power transmission is five or less			
Contact angle correction factor	Kθ	Belt correction factor used when the angle of contact is less than 180°			

Belt-tensioning method-related			Others		
Term	Symbol	Meaning of term	Term	Symbol	Meaning of term
Initial tension	To	Theoretical tension that should be given to the belt for power transmission	Friction factor	μ	Dynamic frictional factor that occurs between the belt and the pulley
Installation tension	Ti	Tension applied when a belt is attached or re-tensioned taking changes in tension into consideration	Apparent frictional factor	μ'	Dynamic frictional factor corrected by the wedge effect of a V-belt
Static tension	Tp	Tension at a halt after the belt finished operating	Number of meshed teeth	Zm	Number of meshed teeth between a synchronous belt and a synchronous pulley
Effective tension	Te	Tension for rotating pulleys and a difference between tight side tension and slack side tension	Angle of contact	θ	Central angle to an arch in contact with a belt and a pulley
Centrifugal tension	Tc	Tension that is generated by centrifugal force on the belt on a rotating pulley	Belt speed	v	Speed (m/sec) in the length direction when a belt is running
Tight side tension	Tt	Tension that occurs on the tight side of a belt	Belt unit mass	m	Mass (kg/m) per unit width or length of a belt
Slack side tension	Ts	Tension that occurs on the slack side of a belt	Pinion revolution	n_1	Revolution of the shaft to which a pinion is attached
Maximum drive tension	Tmax	Maximum tension among the tensions that occur on a belt	Revolution of large pulley	n_2	Revolution of the shaft to which a large pulley is attached
Allowable tension	Ta	Maximum drive tension allowed under given conditions	Ride out	ro	Height of projection of a V-belt over the peripheral surface of a V-pulley
Shaft load	F	Load applied by belt tension on a shaft	PLD	a	Radial distance between the pitch diameter and the addendum circle diameter of a synchronous pulley
Static shaft load	Fr	Load applied on a shaft to which the respective pulley is attached when the belt is stationary	Adjacent pitch error	ak	Difference between two adjacent pitches on a pitch circle of a synchronous pulley
Dynamic shaft load	Fc	Load applied on a shaft to which each pulley is attached when the belt is operating	Cumulative pitch error	Ek	Difference between the sum of actual pitches and measured values on a pitch circle between two arbitrarily chosen teeth of a synchronous pulley
Deflection load	Fδ	Load with which a belt is pressed when the belt tension is measured by deflection	Backlash	Lc	Play between mating flanks when a synchronous belt is meshed with a synchronous pulley
Deflection	δ	Position of displacement in the load direction when a deflection load is applied	Pressure angle	β	Angle formed by the center line of a tooth and the line of a mating flank of a synchronous belt
Span length	Ls	Distance between contact points of a common tangent of two pulleys			

List of Formulas

Item	Formula	Remarks
Design power	$Pd = Pt \times (Ko + Ki + Kr + Ke)$	Pd : Design power (kW) Ki: Idler correction factor Pt: Transmission power (kW) Kr: Speed ratio correction factor Ko : Load correction factor Ke: Environmental correction factor
Transmission power	$Pt = \frac{Tr \times n}{9550}$	Pt : Transmission power (kW) Tr : Load torque (N•m) n : Revolution (rpm)
Torque (at the time of sudden stop or sudden acceleration)	$Trq = \frac{\Sigma GD^2 \times (n_1 - n_2)}{38.2 \times t}$ (synchronous belt)	Trq : Load torque at the time of a sudden stop or sudden acceleration (N•m) GD^2 : Flywheel effect (kgf•m^2) $n_1 - n_2$: Difference in revolution (rpm) t : Time (s) to change from n_1 to n_2
Design power (at the time of sudden stop or sudden acceleration)	$Pdq = \frac{Trq \cdot n}{9550} \times Kq$ (synchronous belt)	Pdq : Design power at the time of a sudden stop or sudden acceleration (kW) n : Revolution (rpm) Kq : Correction factor by rotation at the time of a sudden stop or sudden acceleration
Speed ratio	$Speed\ ratio = \frac{n_1}{n_2}$	n_1 : Pinion revolution (rpm) n_2 : Large pulley revolution (rpm)
Pulley dia.	$dp = pt \cdot Z / \pi$ $do = pt \cdot Z / \pi - 2a$ (synchronous belt)	dp : Pitch diameter (mm) Z : Number of teeth of pulley do : Pulley outside diameter (mm) π : 3.1416 Pt : Pulley tooth pitch (mm) a : PLD (mm)
Belt speed	$v = \frac{dp \cdot n}{19100}$	v : Belt speed (m/s) dp : Pulley pitch diameter (mm) n : Pulley revolution (rpm)
Pitch length	$Lp = 2C + 1.57(Dp + dp) + \frac{(Dp - dp)^2}{4C}$	Lp : Pitch length (mm) dp: Pinion pitch diameter (mm) C : Center distance (mm) Dp : Large pulley pitch diameter (mm)
Center distance	$C = \frac{B + \sqrt{B^2 - 2(Dp - dp)^2}}{4}$	C : Center distance (mm) Dp: Large pulley pitch diameter (mm) B = Lp - 1.57(Dp + dp) dp: Pinion pitch diameter (mm) Lp : Pitch length (mm)
Number of meshed teeth	$Zm = Z_1 \times \frac{\theta_1}{360}$ (synchronous belt)	Zm : Number of meshed teeth of pinion Z_1 : Number of teeth of pinion θ_1 : Angle (°) of contact of pinion
Angle of contact of pinion	$\Theta_{11} = 180 - \frac{57.3(Dp - dp)}{C}$	θ_1 : Angle (°) of contact of pinion Dp : Large pulley pitch diameter (mm) dp : Pinion pitch diameter (mm)
Width correction factor	$Kb = \frac{Pd}{Pr \cdot km}$ (synchronous belt)	Kb : Width correction factor Km: Mesh correction factor Pb : Design power (kW) Pr : Basic power rating (kW)
Effective tension	$Te = \frac{1000Pt}{v}$	Te : Effective tension (N) v : Belt speed (m/s) Pt : Transmission power (kW)
Design tension	$TD = Te(Ko + Ki \times N)$ (synchronous belt)	TD : Design tension (N) Te: Effective tension (N) Ko : Load correction factor N: Number of idlers Ki : Idler correction factor
Tight side tension	$Tt = \frac{1000 \cdot Pd}{v} + mv^2$ (synchronous belt)	Tt : Tight side tension (N) m: Belt unit mass (kg/m) v : Belt speed (m/s) Pd : Design power (kW)
Tight side tension	$Tt = 1.25 \times \frac{1000 \cdot Pd}{K\theta \cdot v} + Nmv^2$ (V-belt)	Tt : Tight side tension (N) Pd: Design power (kW) v : Belt speed (m/s) N: Number of belts $K\theta$: Contact angle correction factor m: Belt unit mass (kg/m)

List of Formulas

Item	Formula	Remarks
Slack side tension	$Ts = Tc = mv^2$ (synchronous belt)	Ts : Slack side tension (N) v: Belt speed (m/s) Tc : Centrifugal tension (N) m : Belt unit mass (kg/m)
Slack side tension	$Ts = \frac{1.25 - K\theta}{K\theta} \times \frac{1000Pd}{v} + Nmv^2$ (V-belt)	Ts : Slack side tension (N) v: Belt speed (m/s) $K\theta$: Contact angle correction factor N: Number of belts Pd : Design power (kW) m: Belt unit mass (kg/m)
Initial tension	$To = 0.9 \times \frac{Tt + Ts}{2}$ (V-belt)	To : Initial tension (N) Tt : Tight side tension (N) Ts : Slack side tension (N)
Static shaft load (Max.)	$Fr = 1.5 \times (2 \cdot To \cdot \sin\frac{\theta_1}{2})$ (V-belt)	Fr : Static shaft load (N) To : Initial tension (N) θ_1 : Angle (°) of contact of pinion
Dynamic shaft load	$Fc = \frac{2.5 - K\theta}{K\theta} \times \frac{1000Pd}{v} \sin\frac{\theta_1}{2}$ (V-belt)	Fc : Dynamic shaft load (N) $K\theta$: Contact angle correction factor Pd : Design power (kW) θ_1: Pinion contact angle (°) v : Belt speed (m/s)
Static shaft load	$Fr = 2To \sin\frac{\theta_1}{2}$ (synchronous belt)	Fr : Static shaft load (N) To : Initial tension (N) θ_1 : Angle (°) of contact of pinion
Dynamic shaft load	$Fc = \frac{1000Pd}{v}$ (synchronous belt)	Fc : Dynamic shaft load (N) Pd : Design power (kW) v : Belt speed (m/s)
Span length	$Ls = \sqrt{C^2 - \frac{(Dp - dp)^2}{4}}$	Ls : Span length (mm) dp: Pinion pitch diameter (mm) C : Center distance (mm) Dp : Large pulley pitch diameter (mm)

List of SI Units

SI (abbreviation for International System of Units) units were defined to internationally unify previous unit systems. From a worldwide point of view, some countries have already switched to SI units entirely. Japan also switched from the previous unit systems, including standards such as JIS, and standardized the SI units in 1994.

This section summarizes how to convert previous unit systems into SI when needed for belt design. See below.

Quantity unit	Symbol of previous unit	Basic SI unit	Converted value
Mass	kg	kg	Same as before
Force / Weight	kgf	N (Newton)	1kgf=9.80665N 1000kgf=9.81kN
Moment of force	kgf•m	N•m	1 kgf•m = 9.80665 N•m
Power	ps,W	W	1ps=0.7355 kW
Acceleration	G	m/s^2	1G=9.80665 m/s^2
Length	m	m	Same as before
Angle	(°)	rad	1° = (π / 180) rad
Area	m^2	m^2	Same as before
Speed	m/s	m/s	Same as before
Revolution	rpm	S^{-1}	1 rpm = 1.667 × 10^{-2}S^{-1}
Pressure	kgf/cm^2	Pa (Pascal)	1 kgf/cm^2 = 9.80665 × 10^{-5} GPa

Precautions for Safe Use of Synchronous Belts and Frictional Power Transmission Belts

Before using our products, please read the catalog, design data, and other necessary documents carefully, pay close attention to the following items, and handle the products properly. The degree of impact of each item on safety is classified as follows.

Symbols and terms	Description
⚠ Danger	When the product is mishandled, it is expected to cause an imminent danger of death or serious injury to the user.
⚠ Warning	When the product is mishandled, it is expected that it may cause death or serious injury to the user.
⚠ Caution	When the product is mishandled, it is expected to cause a danger that causes injury to the user or an occurrence of property damage only.

Application/Purpose of Use

⚠ Danger	When a cut belt is expected to cause the device to run idle, run on its own, or stop and lead to a personal accident or serious accident, be sure to separately provide a safety device.
⚠ Danger	Do not use a belt as a hoisting tool or a towing tool.
⚠ Warning	When static electricity generated by a belt power transmission device is expected to cause a fire or a malfunction of control equipment, use an anti-static belt and provide a static elimination mechanism on the device side.
⚠ Caution	Do not use a belt as an insulator. The insulation characteristics vary depending on the belt type; please contact us.
⚠ Caution	When a belt comes into direct contact with food stuffs, use a belt that conforms to the Food Sanitation Law.
⚠ Caution	Do not additionally process belts. It may affect the quality or performance of the belt.

Functions and Performance

⚠ Caution	Do not use belts for other applications or outside the allowable ranges described in the catalog, design data, etc. of the respective belt. It may cause early breakage.
⚠ Caution	Adhesion of water, oil, chemicals, paints, or dust particles on a belt or pulley causes a reduced transmission force or early breakage.
⚠ Caution	Synchronous belts may emit large noise in high-speed operation. In that case, install a sound-proofing cover.

Storage and Transport

⚠ Caution	A heavy belt should be stored using an appropriate fixture or stopper to prevent it from collapsing or rolling.
⚠ Caution	When you transport or handle a heavy belt or pulley, use a transporting apparatus or device suitable for the weight. Lifting up with hands may hurt your lower back etc.
⚠ Caution	Do not bend belts with unreasonable force or place a heavy object on belts when transporting or storing them. The belts may remain bent or become damaged, leading to early breakage.
⚠ Caution	Store belts in a low-humidity location at temperatures of -10°C to 40°C. In addition, do not expose stored belts to direct sunlight.

Installation and Operation

⚠ Danger	Install safety covers for all rotating sections, including belts and pulleys. Hair, gloves, or clothing may be entangled with a belt or pulley. When a belt or a pulley broke, a projecting piece may cause injury.
⚠ Danger	When you maintain, inspect, or replace belts, follow the items below. (1) Be sure to turn off the switch and wait until the belts and pulleys completely stop before performing the work. (2) When removal of a belt may cause the machinery to start operating, fasten the machinery before performing the work. (3) Take measures to prevent the switch from being turned on unintentionally during the work.
⚠ Caution	When replacing a belt or a pulley, use an equivalent part type to the one that had been used. A different part type leads to early breakage.
⚠ Caution	A misaligned pulley causes early breakage of the belt or falling off of a flange. Perform adjustment.
⚠ Caution	Do not cut a tense belt with a knife or scissors. The belt may whip and cause injury.
⚠ Caution	When multiple belts are used, be sure to replace all belts on the same occasion. It causes early breakage.
⚠ Caution	Check if the belt sits on the pulley groove properly before using them.
⚠ Caution	The belts and pulleys may be at very high temperature immediately after they stop rotating. Do not touch them until they cool down.
⚠ Caution	When you install a belt, never ply it in with unreasonable force. Forcing a belt to climb over a flange or the peripheral section of a V-groove or plying the belt in using a screwdriver or the like causes early breakage. When you install a belt, use a motor slide, tension pulley, a dedicated tugging machine, etc.
⚠ Caution	Use an installation tension and elongation percentage of the belt that are appropriate tensions based on the catalog, design data, etc. An inappropriate tension causes early belt breakage or shaft breakage.
⚠ Caution	When you additionally machine a pulley before use: (1) Remove burrs and sharp edges of machined sections. (2) Ensure the dimensional accuracy after machining. (3) Ensure the pulley strength after machining.
⚠ Caution	When you install a flange on a pulley, check for no foreign substances in the joint between the pulley body and the flange and secure them by crimping etc. so that the flange has no looseness. Inappropriate securing causes the flange to come off.
⚠ Caution	When you replaced a flat belt, be sure to perform trial operation and adjust the running.

Endless Machining

⚠ Warning	Never use flame in the work site. It may cause a fire.
⚠ Warning	When you use a solvent or an adhesive, perform sufficient ventilation. It may harm health.
⚠ Warning	Perform installation and endless machining with the materials, method, and procedure specified by us.
⚠ Warning	Follow the instruction manual when you use a solvent or an adhesive.

Handling of Used products

⚠ Danger	Do not burn belts. They generate toxic gases.