Bando Power Transmission Belts Product Design Manual

List of Power Transmission Belt Products

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Required Quality Communication Form for Power Transmission Belt (Information Necessary for Belt Design)

When you need calculation for power transmission belt design, please check the following listed items and contact us.

Machinery name		Section where the belt is to be used	
Driving machine characteristics	1. Standard motor (AC motor (normal torque / squirrel-cage type / synchronous transmission) DC motor (shunt-wound)) Engine with two or more cylinders 2. Special motor (AC motor (high torque / single-phase / series-wound) DC motor (series-wound / shunt-wound)) Single-cylinder engine / line shaft / clutch		
Driven power (If unclear, enter driving power)	Normal _____ (kW, W, kgf•m, kgf•cm PS, N•m, N•cm) Maximum _____		
Driving pulley dia.	Outside diameter _____ ± _____ mm Pitch dia. No. of teeth of pulley _____		
Driving pulley revolution	_____ rpm		
Driven pulley dia.	Outside diameter _____ ± _____ mm Pitch dia. No. of teeth of pulley _____		
Driven pulley revolution	_____ rpm ± _____ rpm		
Allowable pulley width	_____ mm		
Center distance	_____ mm ± _____ mm		
Operating time	1. Intermittent use (3 to 5 hours/day) 2. Normal use (8 to 10 hours/day) 3. Continuous use (16 to 24 hours/day)	Use of idler pulley	Use / Not use (inside / outside) (slack side / tight side)
Requirement characteristics	Vertical shaft power transmission / Fixed pulley diameter / Static electricity prevention / Electrical insulation / Water resistance Humidity resistance / Oil resistance (mist form / liquid form) / Dust particle resistance / Low noise Low speed / For positioning / With reciprocating motions / For food conveyance / For conveyance For high load / Multi-axis power transmission / With idler pulley / Fixed center distance Long span (power transmission / conveyance) / Special profile (back face processing etc.) Others		
Sudden stop and sudden acceleration	1. Sudden stop ····· Braking on the (driving / driven side) Sum total of GD^2 _____ kgf•m^2 (opposite side to the brake) Deceleration from revolution n_1 to n_2 _____ Time to change from n_1 to n_2 _____ s Frequency of sudden stop ___ times/day		
	1. Sudden acceleration Sum total of GD^2 _____ kgf・m^2 Acceleration from revolution n_1 to n_2 _____ Time to change from n_1 to n_2 _____ s Frequency of sudden acceleration times/day		
Other requirements			

Functional Selection Table

	Belt type \ Characteristics	Load (kW) 0.75 or less	Load (kW) 0.75 ~ 7.5	Load (kW) 7.5 ~ 75	Load (kW) 75 or more	Belt speed (m/s) 20 or less	Belt speed (m/s) 20 ~ 30	Belt speed (m/s) 30 or more	Driving machine characteristics *1 Standard driving machine	Driving machine characteristics *2 Special driving machine	Permanent elongation (%)	Center distance (m) 0.5 or less	Center distance (m) 0.5 ~ 2	Center distance (m) 2 or more	Speed ratio 1:5 or less	Speed ratio 1:5 ~ 1:10
Synchronous Belts	KPSII (King Power Synchronous Belt)			[S8M]	[S14M]		30				0.1 or less					1:10
Synchronous Belts	Ceptor-X Ceptor-VI HP-STS (High-Performance Super-Torque Synchronous Belt) STS (Super-Torque Synchronous Belt) Double-Sided STS HP-HTS (High-Performance High-Torque Synchronous Belt)	[S1.5M] [S2M]	[S3M] [S4.5M] [S5M]	[S8M] [8M]	[S14M]			33			0.15 or less					1:10
Synchronous Belts	Synchronous Belt Double-Sided Synchronous Belt	[MXL] [XL]	[L]	[H] [XH]	[XXH]			30			0.15 or less					1:10
Synchronous Belts	Bancollan Synchronous Belt Bancollan Double-Sided Synchronous Belt	[XL] [T5] [TN15]	[L] [T10]			20					0.25 or less					1:10
Synchronous Belts	Bancollan STS	[S2M]	[S3M]			20					0.25 or less					1:10
Synchronous Belts	Long Synchronous Belt					10					0.15 or less					1:10
Synchronous Belts	Bancollan Long Synchronous Belt					10					0.25 or less					1:10
Frictional Transmission Belts	V-belt: Red Scrum	[M]	[A]	[B,C]	[D,E]	[M]15	[A ~ E] 30				1.5 ~ 2		[M]	[A ~ E]		
Frictional Transmission Belts	V-belt: Standard		[A]	[B,C]	[D,E]		[A ~ E] 30				1.5 ~ 2			[A ~ E]		
Frictional Transmission Belts	V-belt: Red S II		[SA]	[SB,SC]			30				1.5 ~ 2					
Frictional Transmission Belts	Power Ace Scrum Power Ace Aramid Combo			[3V]	[5V,8V] [5VK, 8VK]			40			1.0 or less		[3V]	[5V,8V] [5VK, 8VK]		1:10
Frictional Transmission Belts	Power Ace Cog			[3VX]	[5VX]			40			1.0 or less		[3VX] [5VX]			1:10
Frictional Transmission Belts	Sunrope (open-ended)	[M]	[A,B,C]			[M]15 [A ~ C] 20					2 ~ 3					
Frictional Transmission Belts	Double-Sided V-Belt		[AA]	[BB] [CC]			30				1.5 ~ 2		[AA]	[BB] [CC]		
Frictional Transmission Belts	Banflescrum		[5MS]	[7MS]	[11MS]			60			0.8 or less					1:10
Frictional Transmission Belts	Bancollan V-Belt	[J]				10					1.5 ~ 2					
Frictional Transmission Belts	Rib Ace 2 (for general industry)	[PJ]	[PK] [PL]					50			1~1.5					
Frictional Transmission Belts	Bancollan Polybanrope	[H]	[J]				20				2~2.5					
Frictional Transmission Belts	Bancollan Round Belt	Φ2 ~ Φ5				10					0.5 ~ 1					
Frictional Transmission Belts	Bancord round belt	Φ1.5 ~ Φ12				10					3 ~ 5					
Frictional Transmission Belts	PS Belt	[A Series] [B Series] [C Series] [E Series]				[C Series] 20	[B Series] 30	[A Series] 60			2.0 or less		[A Series] [B Series] [C Series] [E Series]			1:10
Frictional Transmission Belts	Flat belt (cotton)			San Special San Atlas		20					2 ~ 3					
Frictional Transmission Belts	Banbelt		[Light]	[Medium] [Heavy]			30				1.5 ~ 2					

Values in the table indicate general allowable values of belt characteristics.

However, the permanent elongation indicates a normal range.

The brackets [ ] indicate belt type.

Color-coded indication: Can be used sufficiently. / Can be used conditionally. / Avoid use.

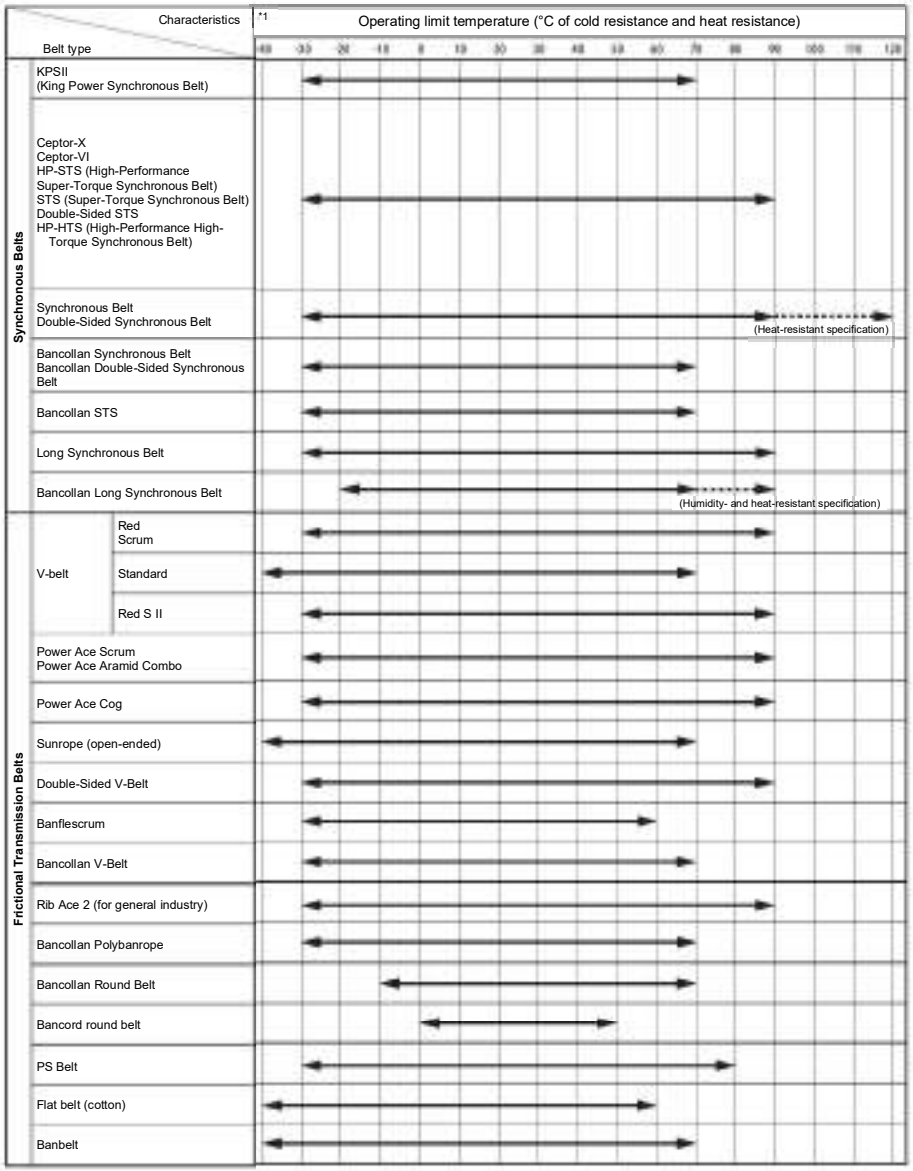
	Belt type \ Characteristics	Minimum pulley diameter (mm) 50 or less	50 ~ 100	100 ~ 200	200 or more	*3 Back face tension Pulley dia.	Low initial tension	Miniaturized	Sudden stop	Vertical-shaft power transmission	Cross application	Back face tension	Back face drive
Synchronous Belts	KPSII (King Power Synchronous Belt)	[S8M] 18 teeth	[S14M] 22 teeth										
Synchronous Belts	Ceptor-X Ceptor-VI HP-STS (High-Performance Super-Torque Synchronous Belt) STS (Super-Torque Synchronous Belt) Double-Sided STS HP-HTS (High-Performance High-Torque Synchronous Belt)	[S1.5M] 16 teeth [S2M] 14 teeth [S3M] 14 teeth [S4.5M] 12 teeth [S5M] 14 teeth [S8M] 22 teeth [8M] 22 teeth		HP-STS S14M 28 teeth STS S14M 34 teeth		1.2x							
Synchronous Belts	Synchronous Belt Double-Sided Synchronous Belt	[MXL] 12 teeth [XL] 10 teeth [L] 12 teeth	[H] 14 teeth	[XH] 22 teeth [XXH] 22 teeth		1.2x							
Synchronous Belts	Bancollan Synchronous Belt Bancollan Double-Sided Synchronous Belt	[TN15] 20 teeth [XL, L, T5] 10 teeth [T10] 12 teeth				1.2x							
Synchronous Belts	Bancollan STS	[S2M] 14 teeth [S3M] 14 teeth				1.4x							
Synchronous Belts	Long Synchronous Belt	MXL,XL,L S5M	S8M H	XH S14M	XXH	1.2x							
Synchronous Belts	Bancollan Long Synchronous Belt	S2M,S3M XL,L T5,T10	S8M H			1.4x							
Frictional Transmission Belts	V-belt: Red Scrum	[M] 40	[A] 67	[B] 118 [C] 180	[D] 300 [E] 450	1.3x							
Frictional Transmission Belts	V-belt: Standard		[A] 67	[B] 118 [C] 180	[D] 300 [E] 450	1.3x							
Frictional Transmission Belts	V-belt: Red S II		[SA] 60 [SB] 80	[SC] 100		[SA] 35 [SB] 45 [SC] 60							
Frictional Transmission Belts	Power Ace Scrum Power Ace Aramid Combo		[3V] 67	[5V] 150 [5VK] 150	[8V] 300 [8VK] 300	1.3x							
Frictional Transmission Belts	Power Ace Cog		[3VX] 56	[5VX] 112		1.3x							
Frictional Transmission Belts	Sunrope (open-ended)		[M80]	[A] 100 [B] 150	[C] 250								
Frictional Transmission Belts	Double-Sided V-Belt			[AA] 100 [BB] 180	[CC] 260	-							
Frictional Transmission Belts	Banflescrum	[5MS] 26 [7MS] 40	[11MS] 63										
Frictional Transmission Belts	Bancollan V-Belt	16				1.3x							
Frictional Transmission Belts	Rib Ace 2 (for general industry)	[PJ] 20	[PK] 50 [PL] 70			1.5x							
Frictional Transmission Belts	Bancollan Polybanrope	[H] 14 [J] 24											
Frictional Transmission Belts	Bancollan Round Belt	[3∅] 18 [5∅] 30				-							
Frictional Transmission Belts	Bancord round belt	[3∅] 23	[10Φ] 80			-							
Frictional Transmission Belts	PS Belt	[A] 5 [B] 11 [C] 5											
Frictional Transmission Belts	Flat belt (cotton)		[3P] 80	[4P] 130 [5P] 180		-							
Frictional Transmission Belts	Banbelt			[Spinning] 150	[Light] 225 [Medium] 375 [Heavy] 500	-							

*1 Standard driving machines refer to AC motors (normal torque, squirrel-cage type, synchronous power transmission), DC motors (shunt-wound), and engines with two or more cylinders.

*2 Special driving machines refer to AC motors (high torque, single-phase series-wound), DC motors (series-wound, compound-wound), single-cylinder engines, line shafts, and clutches.

*3 Back face tension pulley diameters are expressed by multiples of minimum pulley diameters.

Characteristics Selection Table (Reference)



* The effect on belt service life deterioration increases as the operating temperature is closer to the operating limit temperature.
Please check the applicability to the operating temperature with the actual machine.

Belt type	Characteristics	*2 Oil resistance	Acid resistance	Alkali resistance	Weather resistance	Water resistance Humidity resistance	Flame resistance	Noise	Vibration
Synchronous Belts	KPSII (King Power Synchronous Belt)								
	Ceptor-X Ceptor-VI HP-STS (High-Performance Super-Torque Synchronous Belt) STS (Super-Torque Synchronous Belt) Double-Sided STS HP-HTS (High-Performance High-Torque Synchronous Belt)								
	Synchronous Belt Double-Sided Synchronous Belt	*3	*4			*4		*5	
	Bancollan Synchronous Belt Bancollan Double-Sided Synchronous Belt								
	Bancollan STS								
	Long Synchronous Belt								
	Bancollan Long Synchronous Belt								
Frictional Transmission Belts	V-belt Red Scrum								
	V-belt Standard								
	V-belt Red S II								
	Power Ace Scrum Power Ace Aramid Combo								
	Power Ace Cog								
	Sunrope (open-ended)								
	Double-Sided V-Belt								
	Banflescrum								
	Bancollan V-Belt								
	Rib Ace 2 (for general industry)								
	Bancollan Polybanrope								
	Bancollan Round Belt								
	Bancord round belt								
	PS Belt								
	Flat belt (cotton)								
	Banbelt								

Color-coded indication
- Very high
- High
- Slightly problematic
- Better not to use

*1 The operating limit temperature indicates ambient temperature.
*2 For material quality, oil resistance evaluation takes belt slip into consideration.
*3 Very high with oil-resistant specification products.
*4 Low-noise specification products should not be used.
*5 High with low-noise specification products.

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 lengths	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 Factors	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	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) Pt : Transmission power (kW) Ko : Load correction factor Ki : Idler Correction Factors Kr : Speed ratio 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•m²) $n_1 - n_2$: 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 diameter	$dp = pt \cdot Z / \pi$ $do = pt \cdot Z / \pi - 2a$ (synchronous belt)	dp : Pitch diameter (mm) do : Pulley outside diameter (mm) Pt : Pulley tooth pitch (mm) Z : No. of teeth of pulley π : 3.1416 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) B =Lp-1.57(Dp+dp) Lp : Pitch length (mm) Dp : Large-pulley pitch diameter (mm) dp : Pinion pitch diameter (mm)
Number of meshed teeth	$Zm = Z_1 \times \frac{\theta_1}{360}$ (synchronous belt)	Zm : Number of meshed teeth of pinion Z_1 : No. of teeth of pinion θ_1 : Angle of contact of pinion (°)
Angle of contact of pinion	$\theta_1 = 180 - \frac{57.3(Dp - dp)}{C}$	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 Pb : Design power (kW) Pr : Basic power rating (kW) Km : Mesh correction factor
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) Ko : Load correction factor Ki : Idler Correction Factors Te : Effective tension (N) N : Number of idlers
Tight side tension	$Tt = \frac{1000 \cdot Pd}{v} + mv^2$ (synchronous belt)	Tt : Tight side tension (N) v : Belt speed (m/s) Pd : Design power (kW) m : Belt unit mass (kg/m)
Tight side tension	$Tt = 1.25 \times \frac{1000 \cdot Pd}{K\theta \cdot v} + Nmv^2$ (V-belt)	Tt : Tight side tension (N) v : Belt speed (m/s) Kθ : Contact angle correction factor Pd : Design power (kW) N : Number of belts 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) Tc : Centrifugal tension (N) M : Belt unit mass (kg/m) v : Belt speed (m/s)
Slack side tension	$Ts = \frac{1.25 - K\theta}{K\theta} \times \frac{1000Pd}{v} + Nmv^2$ (V-belt)	Ts : Slack side tension (N) Kθ : Contact angle correction factor Pd : Design power (kW) v : Belt speed (m/s) N : Number of belts m : Belt unit mass (kg/m)
Initial tension	$To = 0.9 \times \frac{Tt + Ts}{2}$ (V-belt)	To : Initial tension (N) T : Tight side tension (N) Ts : Slack side tension (N)
Static shaft load (maximum)	$Fr = 1.5 \times (2 \cdot To \cdot \sin\frac{\theta_1}{2})$ (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) Pd : Design power (kW) v : Belt speed (m/s) Kθ : Contact angle correction factor θ_1 : Angle of contact of pinion (°)
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 (°)
Static 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) C : Center distance (mm) Dp: Large pulley pitch diameter (mm) dp : Pinion 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	1kgf · m = 9.80665N · m
Power	ps,W	W	1ps = 0.735kW
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}	$1rpm = 1.667 \times 10^{-2} s^{-1}$
Pressure	kgf/cm^2	Pa (Pascal)	$1kgf/cm^2 = 9.80665 \times 10^{-5} GPa$

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 rust-inhibiting oil is applied to the pulley, install the belt after degreasing the belt running surface of the pulley.
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.

Flat Belt Drive System (Hyper Flat Drive System™)

Eco Drive System with Top Energy-Saving Level!

The HFD (Hyper Flat Drive) is a high-efficiency power transmission system that meets the needs of the entire Earth environment, such as energy-saving and reduced CO_2 emissions.

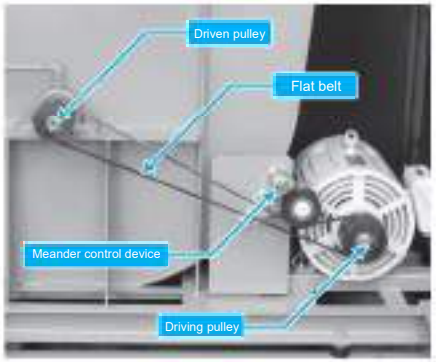
Product Concept

We have developed a high-efficiency belt power transmission system (HFD) using an anti-meander device and a newly designed flat belt that aim at energy-saving and reduced CO_2 emissions and that were developed as items that can smoothly transmit power with a flat belt at high efficiency.

Product Features

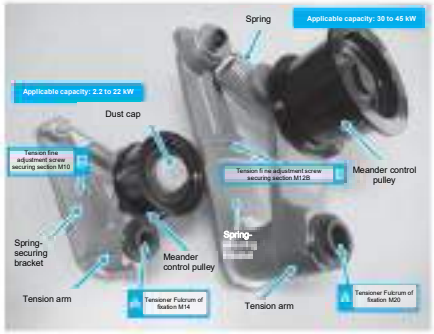
- Transmission efficiency improvement and operation at an optimum tension allow you to expect a significant energy-saving effect and reduced CO_2 emissions.
- The longer service life and tensioning by the tensioner eliminate the need for maintenance.
- The thin belt and the resulting lower effect of distortion due to bending enable smaller pulleys and miniaturization.

Mounting Example



Principles and structure of flat belt drive system (HFD)

Device Structure



* The applicable capacities are guidelines.
* When you consider the use outside the range of the applicable capacity, please consult us.

This is a high-power-transmission and high-efficiency flat belt specification using the rubber and cord design techniques that were accumulated over many years in the automobile field.
By installing a pulley that controls the meander of the flat belt, the belt and the pulleys can autonomously control themselves, and by stably maintaining tensioning using the spring, a long service life and the elimination of the need for maintenance have become possible.
The system can be easily installed by securing the sections A and B on the bracket as designed. By so doing, the system is designed to provide an appropriate tension.

Flat belt Structure

Adoption Track Record

Air-conditioning machines, blowers, compressors, robotics field, etc.

Range of Manufacturable Sizes

■ Flat belt

● List of belt standard lengths (Unit: mm)

1000	1060	1120	1180	1250	1320
1400	1500	1600	1700	1800	1900
2000	2120	2240	2360	2500	2650
2800	3000	4000	4250	4400	4600
4750	5000	5200			

- The standard belt widths are 10 mm, 15 mm, 20 mm, 25 mm, 30 mm, 35 mm, 40 mm, and 45 mm, totaling eight types.
- The standard belt thickness is 2.6 mm (belt standard lengths: 1000 to 3000 mm) and 3.0 mm (belt standard lengths: 4000 to 5200 mm), totaling two types.

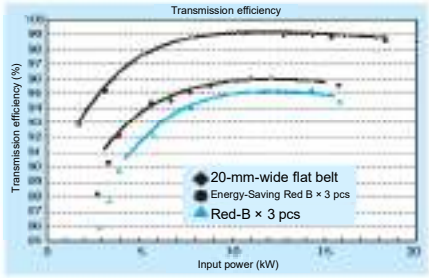
■ Meander control pulley
The standard pulley widths are 30 mm, 40 mm, and 75 mm, totaling three types.

■ Flat pulley
Driving and driven pulleys for the HFD system require flat pulleys.
* Flat pulleys are available from us; please consult us.

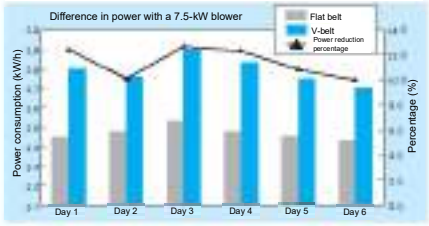
■ Flat belt system design
The current setting range is aimed at 2.2 to 45 kW (75 kW). For a capacity of 45 kW or more or outside the range of the applicable capacity, please consult us.
We will consult with you on energy-saving, pulley miniaturization, and size reduction in accordance with the operating conditions and layout drawings.

Verification Result for Flat Belt Drive System

■ Power transmission efficiency verification result

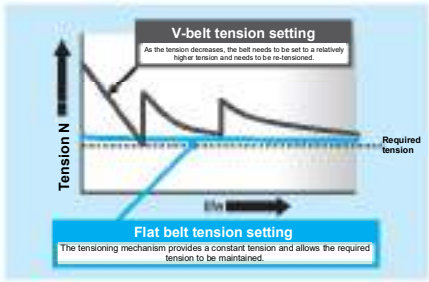


■ Power consumption verification result



■ Energy-saving and CO_2 emissions reduction effects
The Type-A three V-belts Red of the 7.5-kW blower were replaced with a single 10-mm flat belt!
(Calculated with an operating rate of 10 h/day and 300 days of operation annually)
<Energy-saving effect> With approx. 0.3 kW/h and an electricity cost of 12 yen/kWh,
Effect in value = 12 yen × 0.3 kW/h × 10 h/day × 300 days/year
≈ 10,800-yen/year reduction in cost
<Amount of CO_2 emissions reduced> CO_2 conversion factor =0.378 kg CO_2/kWh
Amount reduced: 0.378 × 0.3 kW/h × 10 h/day × 300 days/year
≈ 340-kg/year reduction in CO_2 emissions
Note: The CO_2 conversion factor used the average value for general electric utilities by the "Calculation method of greenhouse gas emissions from utilities (draft proposal)" by the Global Environmental Bureau of the Ministry of Environment in July 2003.

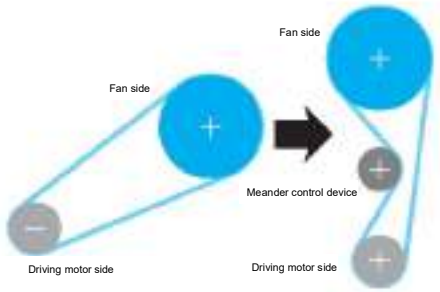
■ Elimination of the need for maintenance
(Compared to V-belts: about 2.5-fold service life)
The longer service life and tensioning by the tensioner have eliminated the need for maintenance.



As the flat belt is thin, it is less affected by bending distortion when it is wrapped around a pulley. Therefore, even if it is affected by reverse bend, its service life is as long as approximately 2.5 times that of V-belts. The tensioning mechanism eliminates the reduction in tension that used to occur with V-belts and allows a tension close to the required tension to be maintained at all times; making the belt maintenance-free and achieving a longer service life.

■ Compact design possible
(Compared to V-belts: about 40% reduction)
The thinness and the little effect of distortion by bend eliminate the effect on durability even when reverse bend is applied, allowing compact designs.

		Previous system	Flat Belt Drive System
Belt specification		V-Belt Red	Flat belt
(Experiment example at 11 kW)		Type B × 3 belts (50.1 mm)	20-mm width
Pulley diameter	Driving motor side Pulley diameter	Φ133 mm/1750 rpm	Φ115 mm/1750 rpm
	Fan side Pulley diameter	Φ710 mm	Φ612 mm
Center distance		1220 mm	500 mm
Pitch length		3810 mm (150 inches)	2542 mm



Precautions for Use

- Applicable model: For driving blowers and compressors (For applications, please consult us.)
- Applicable capacity: 2.2 to 45 kW (75 kW) (For outside this range, please consult us.)
- Operating temperature range: -10°C to 60°C
- For HFD installation layout, we will provide a recommend design based on design layout drawings and operating conditions.
- Other environmental conditions that should be avoided
  - ① Operation in a condensing condition
  - ② Use in a dusty environment
  - ③ Use with 6P motors other than inverters
  - ④ Use with insufficient frame strength
  - ⑤ Use in an environment that may be directly exposed to rainwater
    - * In particular, never let rainwater or the like into the sliding section of the fulcrum of the tensioner.
  - ⑥ For use in an environment in which water or oil may adhere and in environments described in ② and ⑤, provide protection by covers or the like.
  - ⑦ For HFD installation, we will provide guidance separately, including settings such as misalignment.

Next-Generation Tension Gauge [Natural Vibration Measuring Instrument]

TENSION MASTER

Tension Master (Natural vibration measuring instrument) Capable of measuring natural vibration

Smartphone Download the dedicated app

Tension gauge Capable of measurement on the highest level in the industry

Features

① As vibrations can be measured directly with the acceleration sensor, measurement can be performed even under a noisy environment.
(A sonic-type tension gauge senses noise simultaneously with the microphone, making it likely to result in a measurement error.)
② Accurate measurement is possible even with a layout or belt type that emits low-frequency sound, which is difficult to measure with the sonic type.
③ Measurement accuracy on the highest level in the industry.
④ The calculation function software can be used with a smartphone (tablets can also be used).
⑤ It can also be used as a measuring instrument for natural frequency of equipment, machinery, or buildings.

Flip with a finger etc. to vibrate it.

Measurement accuracy

- Measurement range of natural frequency: 10 to 1000 Hz
- Measurement accuracy of natural frequency: 10 to 100 Hz… ±0.8 Hz, 100 to 1000 Hz… ±1 Hz
- Sampling frequency: 3.2 kHz
- Operating ambient temperature: -10°C to 60°C

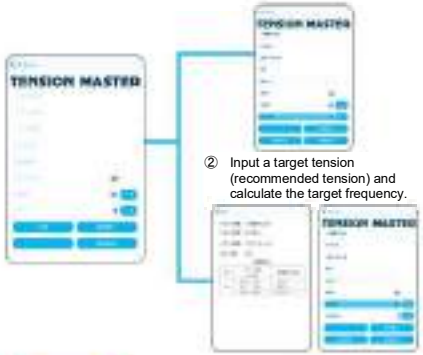
How to use

Download the app into your smartphone.

* The app is available on Google Play and App Store. Calculation on the website is also possible.

Pattern 1 Tension calculation by selecting a belt

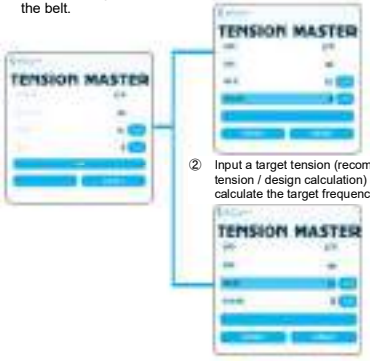
① Input operating conditions.
② Measure the frequency with the Tension Master. → Input the frequency and calculate the tension.



② Input a target tension (recommended tension) and calculate the target frequency.

Pattern 2 Tension calculation from the unit weight

① Input a unit weight and span length of the belt.
② Measure the frequency with the Tension Master. → Input the frequency and calculate the tension.



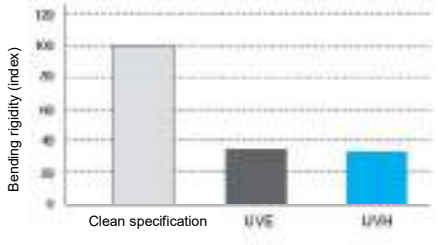
② Input a target tension (recommended tension / design calculation) and calculate the target frequency.

Synchronous Belts for Bill/Card Conveyance with UVH Specification

Synchronous belts with improved oil resistance to fatty oils adhering to polymeric bills and cards as a new additional function for applications to convey bills and cards in financial equipment

Belt rigidity

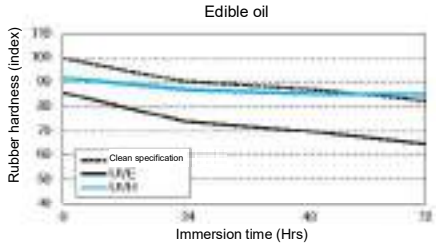
This specification has enhanced belt flexibility while controlling its bending rigidity in order to reduce the starting torque required for conveyance of bills.



* The initial bending rigidity was measured

Oil resistance

The newly developed rubber improves the oil resistance by 10% compared to the previous clean specification, and by 20% compared to the UVE specification, thereby suppressing the swelling of the belt caused by oil, etc.

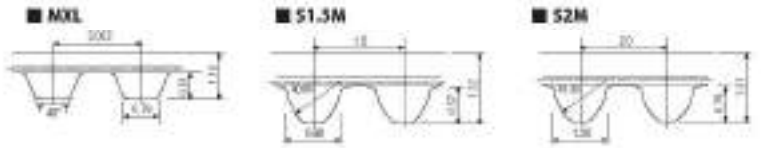


* The belt (S2M) was immersed in each soaking material for 72 hours in a constant temperature and humidity bath at 35°C temperature/80% humidity

Belt characteristics table

Item	Clean specification	UVE	UVH
Heat resistance	○	◎	◎
Cold resistance	○	◎	○
Oil resistance	○	×	○
Ozone resistance	○	◎	○(inferior to UVE)
Transmission capacity	○	△	△
Rubber dropping property	◎	○	○
Belt rigidity	○	◎	◎
Fastening force	○	◎	◎

Lineup <tooth profile>



* Please contact us for size.