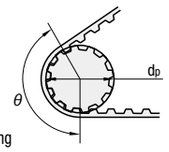
[Technical Data]
Selection of Iron Rubber® Synchronous Belt 1

Iron Rubber® is a registered trademark of NOK Corporation.

Iron Rubber® Belts (**P.1473**, **P.1475**) are selected based on applied Load Torque (Nm) or Transmission Capacity (kW).

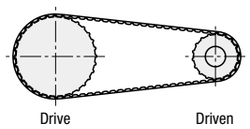
■ Selection Condition

Conditions Needed For Selecting
- · Pulley Pitch Diameter: d_p (mm)
- · Pulley Rotational Speed: n (rpm)
- · Pulley Wrap Angle: θ (°)
- · Load Torque: Md (Nm) or Transmission Capacity: P (kW)

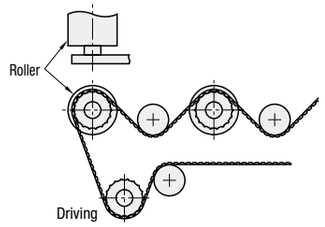


Fundamentally use the Drive side pulley for calculations. When the Driven side pulley is also transmitting torque, calculate for the Driven side also, and make the belt selection based on more severe side.

Ex. 1) When Drive Pulley Diameter > Driven Pulley Diameter, also calculate for the Driven side pulley.



Ex. 2) When the driven pulley is connected to a roller, also calculate for the Driven side.



■ Selection Method

[Step 1] Load Torque, Transmission Capacity Corrections

Back-side Idler Correction

• When a Transmission Capacity is given as a conditional parameter

$P = P_0 \times (1 + 0.1 \times f)$

P : Transmission Capacity Used for Selection (kW)
P_0 : Transmission Capacity Given as Conditional Parameter (kW)
f : Number of Back-side Idlers

• When a Load Torque is given as a conditional parameter

$Md = Md_0 \times (1 + 0.1 \times f)$

Md : Transmission Capacity Used for Selection (Nm)
Md_0 : Transmission Capacity Given as Conditional Parameter (Nm)
f : Number of Back-side Idlers

[Step 2] Selection of Belt Model

Select belt model using Simplified Selection Chart on **P.2279**.

• When a Transmission Capacity is given as a conditional parameter
Select belt model based on Transmission Capacity and Pulley Speed (See Table 6)

• When a Load Torque is given as a conditional parameter
Select belt model based on Load Torque and Number of Sm. Pulley Tooth (See Table 7)

[Step 3] Selection of Pulley Tooth Count Z

Note the Min. Pulley Tooth Count when selecting the number of tooth. (See Table 1)

Table 1: Min. Pulley Tooth Count

Rotational Speed (rpm)	MA3	MA5	MA8	AT5	AT10	T5	T10	MXL	XL	L	H
600 or Less	18	15	20	15	15	12	14	12	10	10	14
720 or Less										12	
900 or Less			22								
1200 or Less		16	24		18		16				16
1800 or Less	20	20	26	16	20	14	18	14	12	14	18
3000 or Less	22	24	28	18	22	16	20	16		16	20

[Step 4] Selection of Belt Tooth Count ZB

<When pulley ratio is not 1:1>
Obtain belt tooth count from belt length.
Select belt loop length from shaft distance (C), Lg. Pulley Dia., and Sm. Pulley Dia.

$$Lp = 2C + \frac{\pi(Dp+dp)}{2} + \frac{(Dp-dp)^2}{4C}$$

C : Shaft Center Distance
dp : Small Pulley Pitch Circle Diameter (mm)
Dp : Large Pulley Pitch Circle Diameter (mm)
Lp : Belt length (mm)

Calculate number of tooth from belt length.

$$Z_B = \frac{Lp}{t}$$

Z_B : Number of Belt Tooth
t : Belt Pitch (exT10 → t=10)

<When pulley ratio is 1:1>

$$Z_B = \frac{2C}{t} + Z$$

C : Shaft Center Distance
t : Belt Pitch
z: Number of Pulley Tooth

[Step 5] Calculating Tooth Mesh Count

<When pulley ratio is not 1:1>

$$Z_E = \frac{z_1}{180} \times \cos^{-1}\frac{t(z_2-z_1)}{2\pi C}$$

z_1 : Small Pulley Number of Tooth
z_2 : Large Pulley Number of Tooth

<When pulley ratio is 1:1>

$$Z_E = \frac{z}{2}$$

z : Number of Pulley Tooth

However, Max. Number of Effective Meshed Teeth on the right table will be the upper limit.

Table 2: Max. Number of Effective Meshed Teeth

Belt Type	Max. Number of Effective Meshed Teeth
Long Synchronous Belt	6
Open End Belt	12

[Step 6] Calculating Minimum Belt Width bc

Calculate the minimum belt width from Allowable Transmission Capacity and Allowable Transmission Torque on **P.2279**.

• When a Transmission Capacity is given as a conditional parameter
Allowable Transmission Capacity (Ps) in Table 8 (**P.2279**) is used.

$$bc = \frac{P \times 10^4}{Ps \times Z_E \times z} \times fw$$

bc: Belt Width (mm)
P: Transmission Capacity (kW)
Ps: Allowable Transmission Capacity
Z_E: Number of Meshing Tooth
fw: Width Factor (Long Synchronous Belt T10150 : 1.5, Others : 1)
Z: Number of Pulley Tooth

• When a Load Torque is given as a conditional parameter
Allowable Transmission Torque (Mds) in Table 9 (**P.2279**) is used.

$$bc = \frac{Md \times 10^3}{Mds \times Z_E \times z} \times fw$$

M_d: Load Torque (Nm)
Mds: Allowable Transmission Torque
Z_E : Number of Meshing Tooth
fw: Width Factor (Long Synchronous Belt T10150 : 1.5, Others : 1)
Z: Number of Pulley Tooth

Select standard belt widths larger than the calculated minimum width bc.

[Step 7] Confirming Min. Shaft Center Distance Adjustment Range

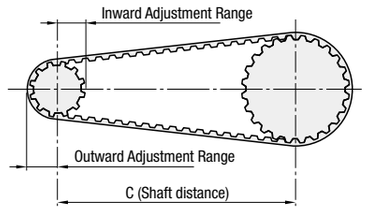
Refer to the table below for Min. Shaft Center Distance Adjustment Range by considering the mounting and adjustment range.

Table 3: Outside Adjustment Range

Outside Adjustment Range (mm)	Outside Adjustment Range (mm)
600 or Less	5
Over 600~1000 or Less	10
Over 1000~1500 or Less	15
Over 1500~2000 or Less	20
Over 2000~2500 or Less	25
Over 2500~3000 or Less	30
Over 3000	Shaft Center Distance × 0.01

Table 4: Inside Adjustment Range

Model	Inside Adjustment Range (mm)
MA3, T5, XL, MXL	5
MA5, AT5, L	10
MA8, AT10, T10, H	15

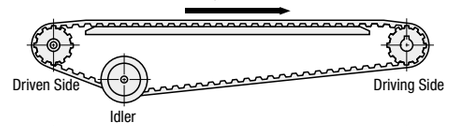


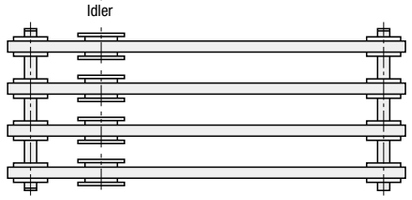
For flanged pulleys, allow ample adjustment margin by considering the flange dia .

■ Notes on Selection

• Load Torque and Transmission capability
Load torque and transmission capability should be calculated from absolute max. load values applicable to the belt for safety.

• For Multiple Belt Parallel Use
- · If each belt receives an equal load, calculate with a value of total load divided by the number of belts used. However, if the load on each belt may potentially become uneven, calculate with the max. load applicable on one belt.
- · The mechanism should be designed to facilitate individual belt tension adjustments.



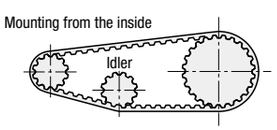


• When an Idler is used
- · If use of Idler is unavoidable, always use the Idler on the slack side.
- · Position the Idler on the inside if possible. When positioning an Idler on the inside, use one with more teeth than the smaller side pulley. For placing the Idler on the outside, use a flat pulley not crowned.

Table 5. Minimum Idler Diameter

Belt Type	Minimum Idler Diameter (mm)
MA3	30
MA5, AT5	40
MA8, AT10	80
T5	30
T10	70
MXL	15
XL	30
L	50
H	90

Mounting from the inside



Mounting from the outside

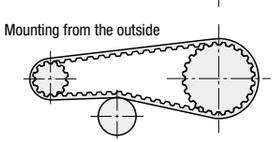


Table 6: Selection Guide Table 1 (Transmission Capacity)

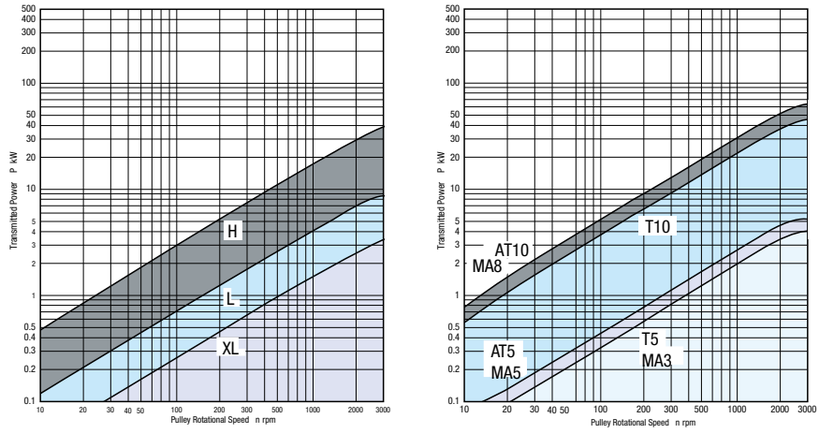
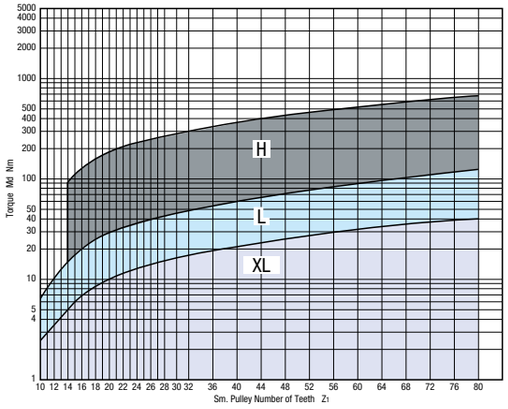


Table 7: Selection Guide Table 2 (Torque)



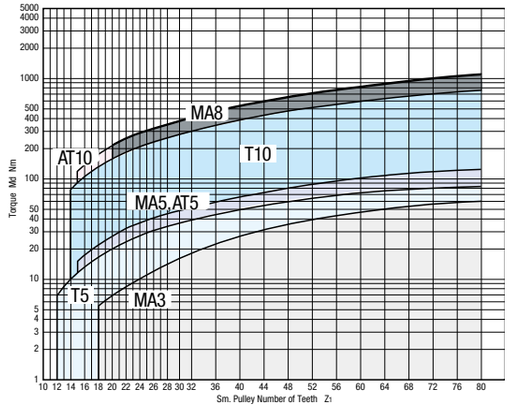


Table 8: Allowable Transmission Capacity (Ps)

Pulley Rotational Speed n (rpm)	MA3	MA5	MA8	AT5	AT10	T5	T10	MXL	XL	L	H
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.026	0.052	0.181	0.052	0.226	0.043	0.181	0.007	0.044	0.129	0.206
40	0.050	0.101	0.351	0.101	0.439	0.084	0.351	0.014	0.085	0.250	0.401
60	0.074	0.147	0.511	0.147	0.639	0.123	0.511	0.020	0.124	0.364	0.583
80	0.096	0.192	0.661	0.192	0.826	0.160	0.661	0.026	0.161	0.471	0.753
100	0.116	0.233	0.800	0.233	1.000	0.194	0.800	0.032	0.196	0.572	0.910
200	0.211	0.422	1.423	0.422	1.779	0.351	1.423	0.058	0.354	1.019	1.616
300	0.296	0.592	1.984	0.592	2.480	0.494	1.980	0.082	0.498	1.419	2.250
400	0.376	0.753	2.496	0.753	3.120	0.627	2.490	0.104	0.632	1.789	2.830
500	0.452	0.905	2.976	0.905	3.720	0.754	2.980	0.126	0.760	2.140	3.370
600	0.525	1.050	3.432	1.050	4.290	0.875	3.430	0.147	0.881	2.470	3.880
700	0.593	1.187	3.864	1.187	4.830	0.989	3.870	0.168	0.999	2.780	4.370
800	0.662	1.324	4.280	1.324	5.350	1.104	4.280	0.188	1.113	3.080	4.830
900	0.728	1.456	4.664	1.456	5.830	1.213	4.680	0.208	1.223	3.370	5.280
1000	0.791	1.538	5.064	1.538	6.330	1.319	5.070	0.227	1.330	3.650	5.720
1100	0.854	1.708	5.440	1.708	6.800	1.423	5.440	0.247	1.434	3.920	6.130
1200	0.914	1.829	5.800	1.829	7.250	1.524	5.800	0.266	1.536	4.190	6.540
1300	0.974	1.947	6.152	1.947	7.690	1.623	6.150	0.285	1.636	4.440	6.930
1400	1.031	2.060	6.496	2.060	8.120	1.719	6.490	0.303	1.733	4.690	7.310
1500	1.088	2.180	6.824	2.180	8.530	1.814	6.830	0.322	1.829	4.930	7.680
1600	1.144	2.290	7.152	2.290	8.940	1.907	7.150	0.340	1.923	5.170	8.040
1700	1.199	2.400	7.464	2.400	9.330	1.998	7.460	0.358	2.010	5.400	8.390
1800	1.254	2.510	7.776	2.510	9.720	2.090	7.770	0.378	2.110	5.620	8.730
1900	1.308	2.610	8.072	2.610	10.090	2.180	8.070	0.394	2.190	5.840	9.060
2000	1.356	2.720	8.368	2.720	10.460	2.260	8.370	0.413	2.280	6.060	9.390
2200	1.458	2.920	8.936	2.920	11.170	2.430	8.940	0.448	2.450	6.480	10.020
2400	1.560	3.120	9.480	3.120	11.850	2.600	9.480	0.485	2.620	6.880	10.630
2600	1.656	3.310	10.008	3.310	12.510	2.760	10.010	0.520	2.780	7.270	11.210
2800	1.746	3.490	10.512	3.490	13.140	2.910	10.510	0.556	2.940	7.640	11.760
3000	1.838	3.680	11.000	3.680	13.750	3.060	11.000	0.590	3.090	8.000	12.300

Table 9: Allowable Transmission Torque (Mds)

Pulley Rotational Speed n (rpm)	MA3	MA5	MA8	AT5	AT10	T5	T10	MXL	XL	L	H
0	1.260	2.520	8.888	2.520	11.110	2.100	8.890	0.344	2.130	6.310	10.150
20	1.230	2.460	8.640	2.460	10.800	2.050	8.640	0.339	2.080	6.140	9.860
40	1.200	2.400	8.392	2.400	10.490	2.000	8.390	0.328	2.030	5.970	9.560
60	1.173	2.350	8.136	2.350	10.170	1.955	8.140	0.319	1.976	5.800	9.270
80	1.144	2.290	7.888	2.290	9.860	1.906	7.890	0.311	1.923	5.630	8.980
100	1.114	2.230	7.640	2.230	9.550	1.857	7.640	0.303	1.871	5.460	8.690
200	1.006	2.010	6.800	2.010	8.500	1.677	6.800	0.276	1.690	4.860	7.720
300	0.943	1.887	6.304	1.887	7.880	1.572	6.300	0.260	1.584	4.520	7.150
400	0.898	1.797	5.952	1.797	7.440	1.497	5.950	0.249	1.509	4.270	6.740
500	0.864	1.728	5.680	1.728	7.100	1.440	5.680	0.241	1.451	4.080	6.430
600	0.836	1.671	5.456	1.671	6.820	1.393	5.460	0.234	1.403	3.920	6.180
700	0.811	1.623	5.272	1.623	6.590	1.352	5.270	0.229	1.363	3.790	5.960
800	0.791	1.581	5.112	1.581	6.390	1.318	5.110	0.225	1.328	3.680	5.770
900	0.772	1.545	4.968	1.545	6.210	1.287	4.970	0.221	1.298	3.580	5.610
1000	0.756	1.512	4.840	1.512	6.050	1.260	4.840	0.217	1.270	3.490	5.460
1100	0.741	1.482	4.720	1.482	5.900	1.235	4.720	0.214	1.245	3.410	5.320
1200	0.728	1.456	4.616	1.456	5.770	1.213	4.620	0.211	1.223	3.330	5.200
1300	0.715	1.430	4.520	1.430	5.650	1.192	4.520	0.209	1.202	3.260	5.090
1400	0.704	1.407	4.432	1.407	5.540	1.173	4.430	0.207	1.182	3.200	4.980
1500	0.693	1.386	4.344	1.386	5.430	1.155	4.350	0.205	1.164	3.140	4.890
1600	0.683	1.366	4.264	1.366	5.330	1.138	4.270	0.203	1.148	3.080	4.800
1700	0.673	1.347	4.192	1.347	5.240	1.122	4.190	0.201	1.132	3.030	4.710
1800	0.665	1.329	4.120	1.329	5.150	1.108	4.120	0.200	1.117	2.980	4.630
1900	0.656	1.312	4.056	1.312	5.070	1.094	4.060	0.198	1.103	2.940	4.560
2000	0.648	1.296	3.952	1.296	4.940	1.080	4.000	0.197	1.089	2.890	4.480
2200	0.634	1.267	3.880	1.267	4.850	1.056	3.880	0.195	1.065	2.810	4.350
2400	0.620	1.240	3.776	1.240	4.720	1.033	3.770	0.193	1.042	2.740	4.230
2600	0.607	1.215	3.672	1.215	4.590	1.012	3.680	0.191	1.021	2.670	4.120
2800	0.596	1.192	3.584	1.192	4.480	0.993	3.590	0.190	1.002	2.610	4.010
3000	0.585	1.170	3.504	1.170	4.380	0.975	3.500	0.188	0.984	2.550	3.910

■ Allowable Tension

Table 10: Joint Processed Belt (Iron Rubber®) Allowable Tension Unit: N

Type of Belt	Belt Width						
	025	037	050	075	100	150	200
XL	90	135	175	–	–	–	–
L	–	–	320	480	640	–	–
H	–	–	–	480	640	960	1280

Unit: N

Type of Belt	Belt Width					
	100	150	200	250	400	500
T5	150	200	270	350	–	–
T10	–	320	440	640	960	1280
AT5	210	350	–	–	–	–
AT10	–	890	890	1070	–	–

Table 11: Open End Belt (Iron Rubber®) Allowable Tension Unit: N

Type of Belt	Belt Width						
	025	037	050	075	100	150	200
XL	180	270	350	–	–	–	–
L	–	–	640	960	1280	–	–
H	–	–	–	960	1280	1920	2560

Unit: N

Type of Belt	Belt Width						
	070	100	150	200	250	400	500
MA3	200	300	400	–	–	–	–
MA5	–	470	740	960	–	–	–
MA8	–	–	1620	2160	2700	–	–
T5	200	300	400	550	700	–	–
T10	–	–	640	880	1280	1920	2560
AT5	–	470	740	–	–	–	–
AT10	–	–	1620	2160	2700	–	–

■ Initial Tension Setup

Determine the Initial Tension based on the maximum tension that occurs during operation.
Initial tension is equal throughout the entire belt loop during non-running or idling states.
There are Tension and Slack sides on belts during operation. The differential of the tension is called Effective Tension.
This differential via the pulleys generates torque or transmission capacity.
For toothed belt applications, apply initial tension not to cause belt sags on the Slack side.
When a sag is evident during the start-up, it indicates that the initial tension is insufficient.

$$U = \frac{2 \times 10^3 \times Md}{dp} \quad \text{Or} \quad U = \frac{19.1 \times 10^6 \times P}{n \times dp}$$

Elasticity Guideline $0.5U < Fv < 0.5F + 0.2F$

U: Effective Tension (N)
Md: Load Torque (Nm)
P: Transmission Capacity (kW)
dp: Pulley Diameter (mm)
n: Pulley Rotational Speed (rpm)
Fv: Initial Tension (N)
F: Allowable Tension (N)

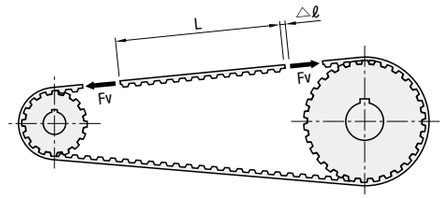
However, if the value resulting from the calculation, "0.5U + 0.2F," exceeds 0.5F, regard "0.5F" as the maximum value.

■ Method for Checking Initial Tension

• Method by Checking Belt Elongation

Belt elongation (guideline) at Allowable Tension F,

Joint Process	0.2% = 2mm/m
Open End	0.4% = 4mm/m



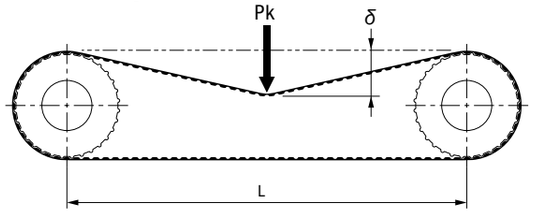
The relationship between force and elongation follows Hooke's Law (In proportional relationship), and the intermediate value can be obtained by calculations.

• Method Using Belt Vibrations

$Fv = 4 \times f^2 \times m \times \ell^2$

Fv: Belt Tension (N)
f: Vibration Frequency (Hz)
m: Belt Weight Per 1m (kg/m)
ℓ: Span Length (m)

• Method Using Deflection Force and Deflection Amount



Pk = Fv/16
Adjust in such a way that deflection meets the following criteria: [δ=L/64]

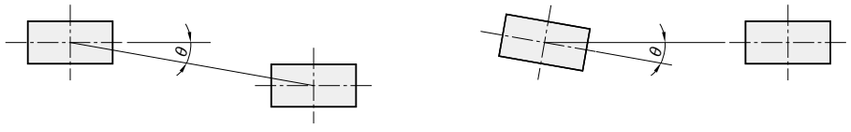
Pk: Deflection Force (N)
Fv: Desired Tension (N)
δ : Deflection Amount (mm)
L: Span Length (mm)

Early failures and countermeasures

Abnormal Phenomena	Cause	Measures
Abnormal Wear of Belt Side Faces	· Pulley misalignment · Pulley shafts misalignments · Bent pulley flanges	· Realign · Correct shaft misalignments · Correct bent pulley flanges
Tooth Contact Pressure Surface Abnormal Wear	· Overload · Belt tension too high, too low	· Redesign with a wide belt or use larger belt pitch · Adjust initial belt tension
Belt abnormal wear on pulley contacting area	· Pulley tooth shape incorrect · Belt tension too high	· Adjust initial belt tension · Try to recreate belt systems by taking note of tooth tip radius
Broken/missing tooth	· Pulley diameter too small · Small pulley meshing 6 teeth or less · Shock loading exists	· Redesign · Increase small pulley tooth mesh or redesign · Avoid shock loading on belt · Increase belt width
Severed Core Wire	· Overload · Core wire decreased elasticity or corrosion · Induction of foreign matter · Excessive temperature	· Redesign · Check belt storage and shipping history/condision · Avoid shocks · Provide a belt cover · Lower environment temperature
Cracks on Backing Rubber	· Usage in low temperature · Pulley diameter too small	· Raise environment temp. · Increase pulley diameter
Heat Degradation of Rubber	· Rubber degradation due to high enviroment temperature	· Lower environment temperature
Rubber Swelling	· Contact with oils · Contact with water	· Avoid oil from contacting · Avoid water from contacting
Abnormal Wear of Pulley Teeth	· Overload · Belt tension too high · Pulley material too soft	· Redesign · Adjust initial belt tension · Apply surface hardening treatment on pulley or change pulley material
Pulley Circumference Wear	· Pulley service life has been reached · Belt tension too high (core wire visible on belt back side)	· Replace with a new pulley · Replace with new pulley and belt, and use lower belt tension
Abnormal Sound	· Belt tension too high · Overload · Pulley diameter too small · Pulley tooth shape incorrect	· Realign · Adjust initial belt tension · Redesign · Correct pulley tooth geometry
Apparent Belt Stretch	· Shaft center distance too small · Loose machine base	· Adjust to correct shaft distance · Reinforce machine base

About Pulley Alignments

Misaligned pulleys may cause early belt failure and flange damages.
Align as show below



•MXL/XL/L/H/S_M/MTS_M/T Series

Belt width (mm)	10	20	30≤
tanθ	5/1000	3/1000	2/1000

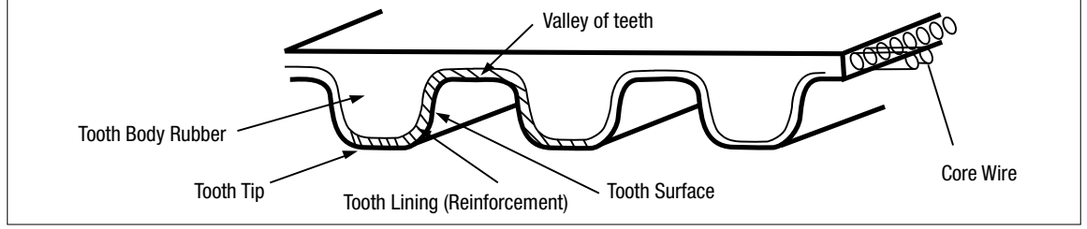
•P_M/UP_M

Belt width (mm)	≤30
tanθ	5/1000

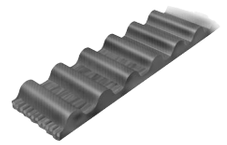
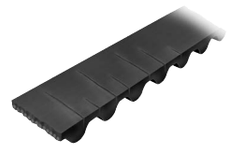
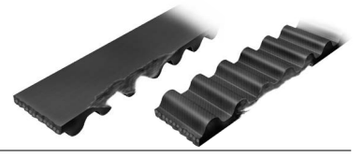
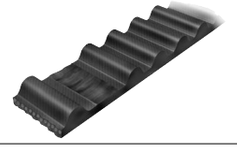
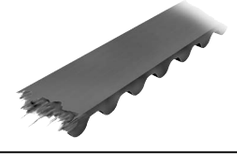
•_GT/EV5GT/EV8YU

Belt width (mm)	≤20	20<40
tanθ	6/1000	3/1000

Names of Belt Components



Examples of Belt Replacement Signs

Examples	Condition
1. When belt tooth reinforcement fabric is worn and rubber/core wire are exposed When tooth surface/grooves are worn and rubber/core wire are exposed	
2. When the backing rubber shows cracks due to hardening	
3. When cracks reaching the rubber are seen at tooth base	
4. Belt side faces are damaged due to wear	
5. When missing tooth can be seen	
6. When excessive wear can be seen on belt back side	
7. When belt or core wire are broken	

These are belt replacement timing guides. Early or periodical replacements are recommended even the signs shown above are not yet visible.