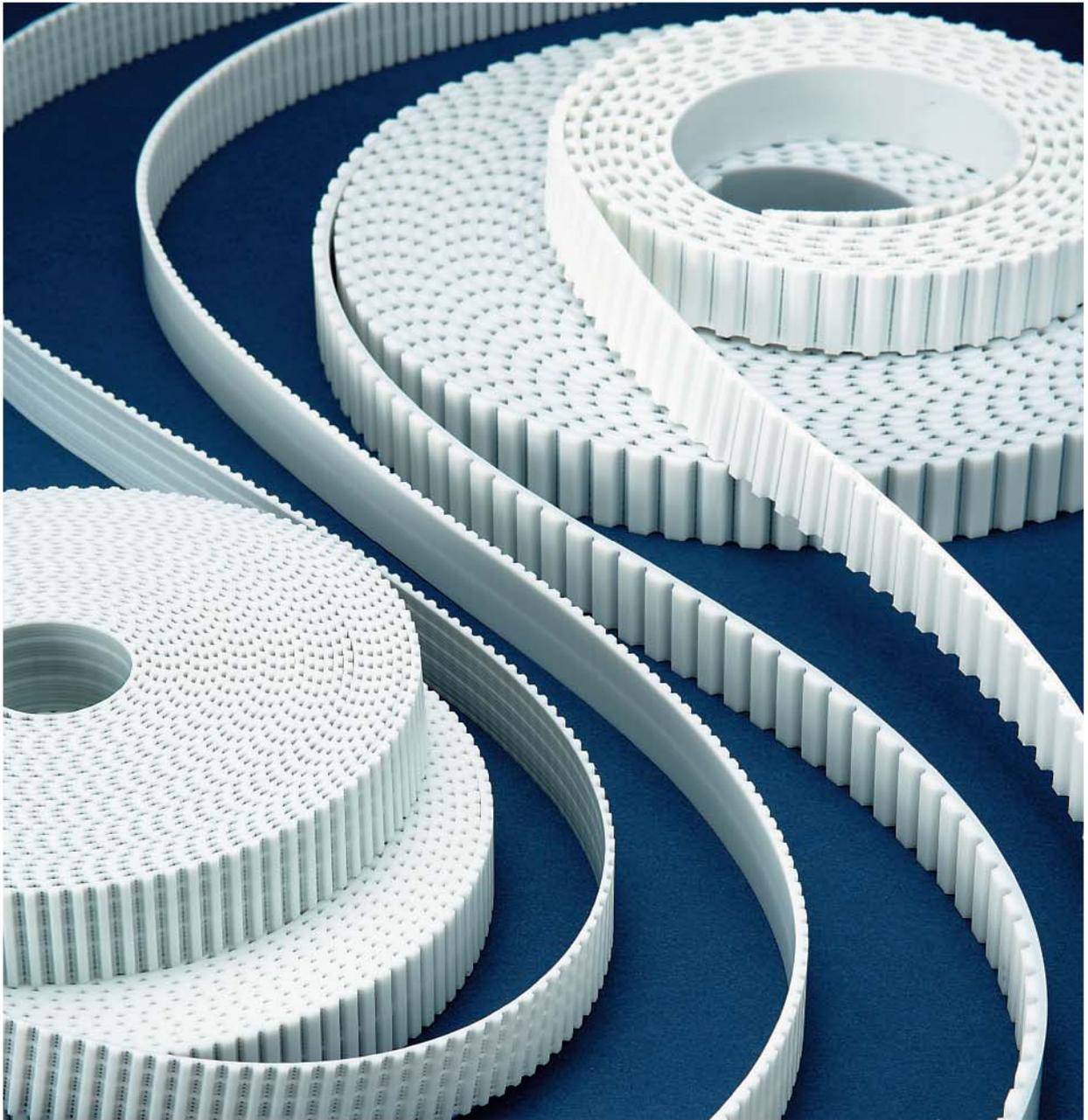




Polyurethane Timing Belt

# **FREESPAN™ Belt**



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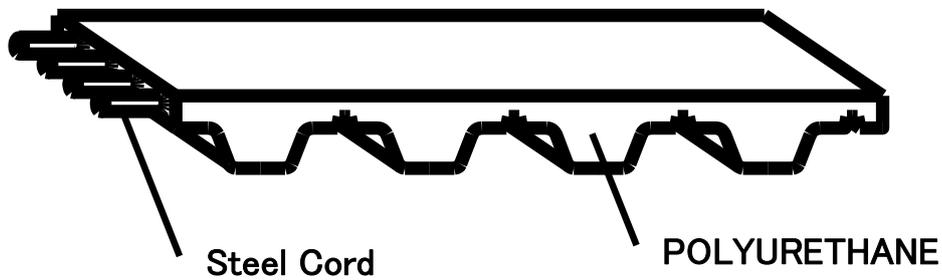
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# 1. Introduction

FREESPAN Belt is polyurethane timing belt made by MITSUBOSHI Belting Ltd. FREESPAN Belt consists of thermoplastic polyurethane and steel cords. This belt is suitable for synchronous transportation and power transmission requiring accurate positioning. The tension members are parallel to each other to ensure a suitable synchronous drive. Polyurethane also has good physical properties & good chemical resistance. Belt Temperature range is from -30°C to +80°C.

## Structure

Polyurethane : ShoreA 92 Thermoplastic Polyurethane  
 Tension member : Zinc coated steel cords



### \*Mechanical Properties

- High flexibility
- Length stability
- Low friction

### \*Chemical Properties

- Good Hydrolysis resistance
- Good oil and fuel resistance
- Good abrasion resistance
- Good weather resistance

### Chemical Resistance

- Good Resistance
- △ limited Resistance
- × Poor Resistance

Table-1

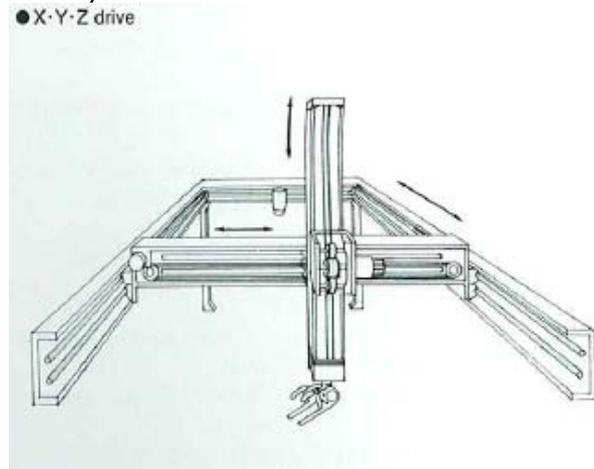
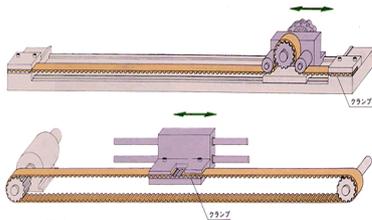
Chemicals		Resistance
Water	water	○
	salt water	○
Acid	acetic acid	△
	Hydrochloric acid 20%	△
	Sulfuric acid 25%	△
	nitric acid	×
Alkalis	Ammonia 10%	○
	sodium Hydroxide	△
Solvent	kerosene	○
	Acetone	△
	Ethanol	△
	Isopropanol	△
	methyl Ethyl Ketone	△
	Gasoline	△
	Methylene chloride	×
	Toluene	×
	diethyl formamide	×
Oil	Mineral oil	○
	Diesel oil	○
Grease	lubricating Grease	○



### 3 Applications

#### 3-1 Open End Applications

- Linear guide positioning system
- Robot for Material handling.
- Automatic door system (Elevators etc)
- Lifting machine
- Conveyers of Glass plates for Displays (TV).
- Embroidery machines
- Assembly line for the automotive industry.



#### Large Industrial Robot



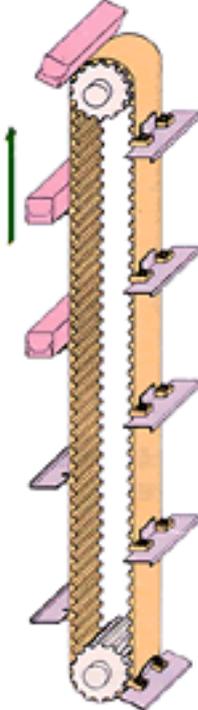
#### Embroidery machine



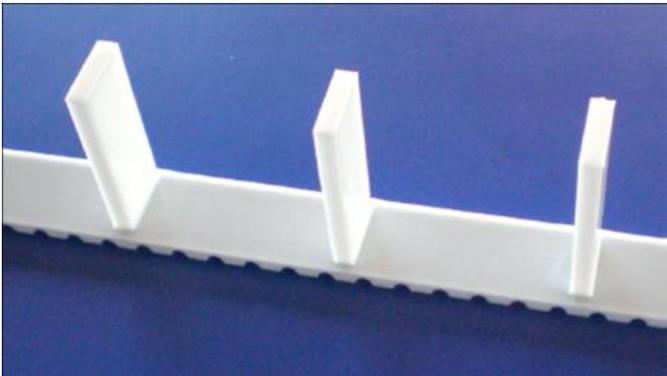
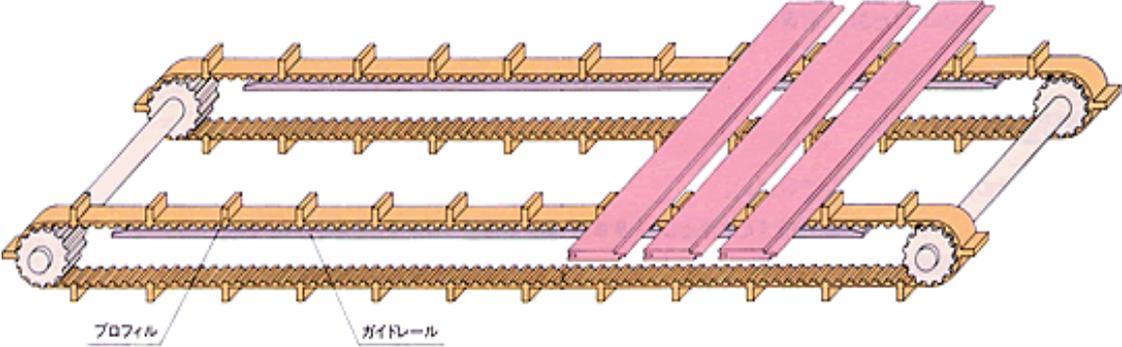
### 3-2 Cleats Belt Application

Packaging and Transfer System.

1) Vertical Conveyor



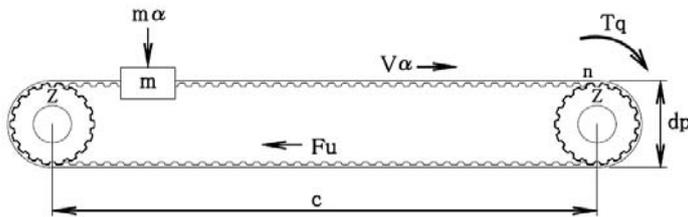
2) Level Conveyor Synchronous State



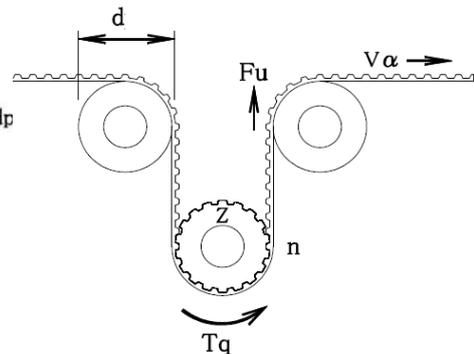
## 4. Design Manual

### 1) Design Conditions

#### Linear Motion Belt (2 Shafts)



#### Omega Linear Motion Belt



### Definition

Table-3

	Definition	Unit
$\alpha$	Acceleration	m/s <sup>2</sup>
Bw	Belt width	mm
Ks	Safety Factor	-
Zm	Meshing tooth Number	-
d	Idler pulley diameter	mm
dp	Pulley pitch diameter	mm
Fp	Pretension	N
Fu	Peripheral force	N
Fp spec	Tooth share strength	n/cm
ATL	Max Allowable tensile Load	N
BS	Belt breaking strength	N
C	Center distance	mm
g	Gravity	m/s <sup>2</sup>
$\mu$	Coefficient of friction	-
m	Carriage mass	kg
Tq	Drive torque	Nm
n	RPM of pulley	1/min
P	Drive power	kW
FR	Friction force	N
V	Belt speed	m/s
Zd	Pulley groove number	-

### Useful Formulas

$$V = \frac{\pi \times dp \times n}{1000 \times 60} = \frac{dp \times n}{19100}$$

$$n = \frac{V \times 19100}{dp}$$

$$dp = \frac{V \times 19100}{n}$$

$$Tq = \frac{Fu \times d}{2000}$$

$$P = \frac{Tq \times n}{9550}$$

$$Tq = \frac{9550 \times P}{n}$$

## 2) Design Procedures

### STEP 1

#### Choice of Belt tooth profile.

According to the Fig.-1, Select the tooth profile.

This figure is based on more than 12 tooth meshing.

### STEP 2

#### Calculation of the Peripheral force

In case of known Mass

Horizontal or Conveying

$$F_u = (m \times a) + (m \times g \times \mu)$$

Vertical

$$F_u = (m \times a) + (m \times g)$$

Note:  $\mu$  number is shown in Table-5

In case of known drive power

In case of known drive torque

$$F_u = 2000 Tq / dp$$

### STEP 3

#### Determination of the belt width

The belt width is calculated by following formula.

$$Bw = (F_u \times K_s \times 10) / (F_{spec} \times Z_m)$$

$F_u$

Use above calculation result.

$K_s$

Safety factor

$Z_m$

Number of tooth meshing in drive pulley.

$Z_m$

$Z_{arc}$  of contact /  $360^\circ$

$F_{spec}$

Tooth share strength (N/cm)

### STEP 4

#### Calculation of the Pre-Tension

Linear & Omega linear motion

$$F_p = 2F_u$$

Conveying

$$F_p = F_u$$

### STEP 5

#### Checking the allowable tension.

Ensure the maximum

$$\text{Maximum allowable tension of the chosen belt} > F_p / 2 + (F_u \times K_s)$$

### STEP 6

#### Pulley diameter and Idler pulley diameter check

Pulley & Idler pulleys are equal to or bigger than the minimum pulley diameter.

### STEP 7

#### Elongation

$$\Delta l = F_u / \text{Max allowable tension} \times (4 / 1000)$$

### 3) Linear Motion Design Procedure (Example)

#### Machine Condition

Center distance	1000mm
Pulley diameter	75mm
rpm	300rpm
Motor power	1.5kW
Fluctuating rate	Low → 1.4

#### STEP 1

##### Choice of Belt tooth profile.

According to the belt profile selection table, We can choose AT10  
Because Pulley diameter is 76mm, so  $Z=24$  (O.D=74.54)

#### STEP 2

##### Calculation of the Peripheral force

$$F_u = \frac{19.1 \times 1000000 \times P}{d_p \times n} = \frac{19.1 \times 1000000 \times 1.5}{300 \times 76.39} = 1,250 \text{ N}$$

#### STEP 3

##### Determination of the belt width

$$B_w = (F_u \times K_s \times 10) / (F_{spec} \times Z_m)$$

$$B_w = \frac{F_u \times K_s \times 10}{F_{spec} \times Z_m} = \frac{1250 \times 1.4 \times 10}{62 \times 12} = 23.5 \text{ mm}$$

$F_u$	Use above calculation result.
$K_s$	Safety factor
$Z_m$	Number of tooth meshing in drive pulley.
$Z_m$	$Z \times \text{arc of contact} / 360^\circ$
$F_{spec}$	Tooth share strength (N/cm)

So, the next closest width is 25mm → **25AT10 is selected.**

#### STEP 4

##### Calculation of the Pre-Tension

$$F_p = 2 \times F_u = 2 \times 1250 = 2500 \text{ N}$$

#### STEP 5

##### Checking the allowable tension.

25AT10 Maximum allowable tension is 3610N

$$\text{Maximum allowable tension} > F_p / 2 + (F_u \times K_s) = 1250 \text{ N} + 1250 \text{ N} \times 1.4 = 3000 \text{ N}$$

#### STEP 6

##### Pulley diameter and Idler pulley diameter check

Pulley & Idler pulleys are equal to, or bigger than the minimum pulley diameter.

$$Z_m = 24 > Z_{min} = 14$$

#### STEP 7

##### Elongation

$$\Delta l = F_u / \text{Max allowable tension} \times (4 / 1000) = 1250 \text{ N} / 3610 \text{ N} \times (4 / 1000) = 1.38 \text{ mm} / 1000 \text{ mm}$$

#### 4) CALCULATION PARAMETERS

##### a) Belt Tooth Profile Selection

Fig.-1

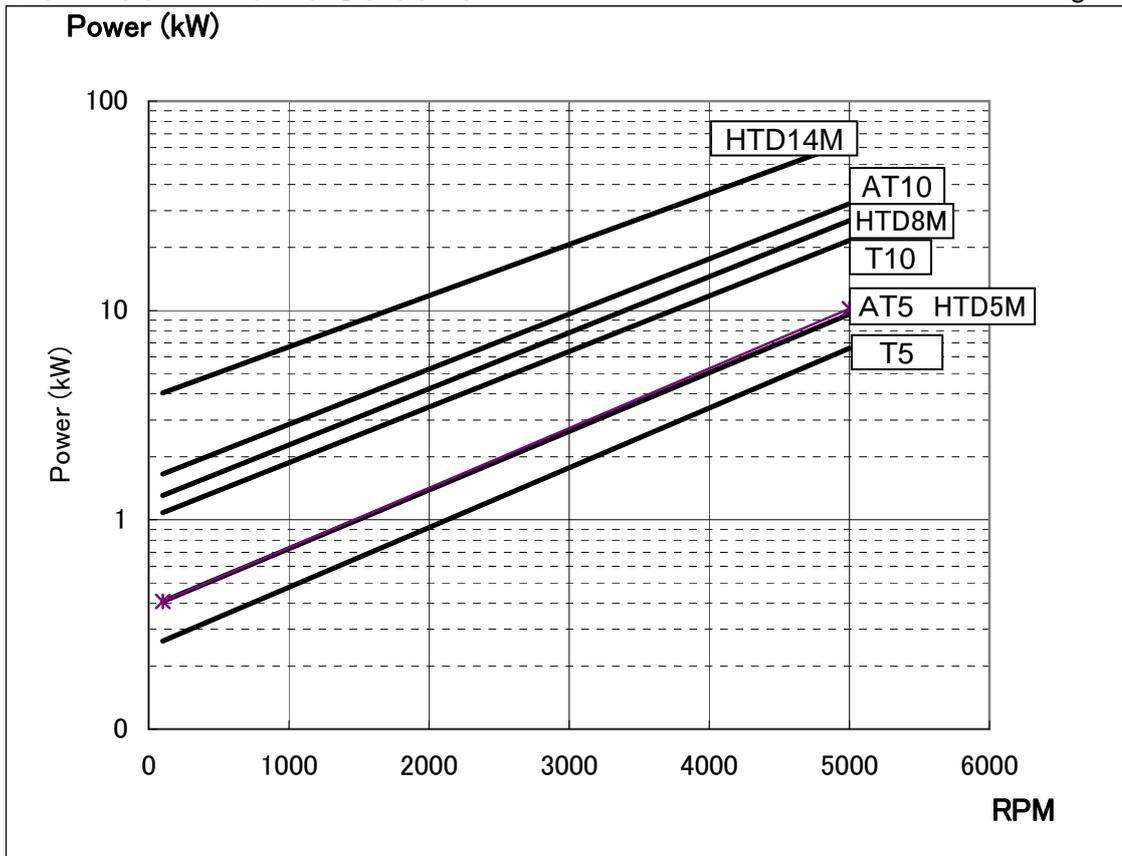
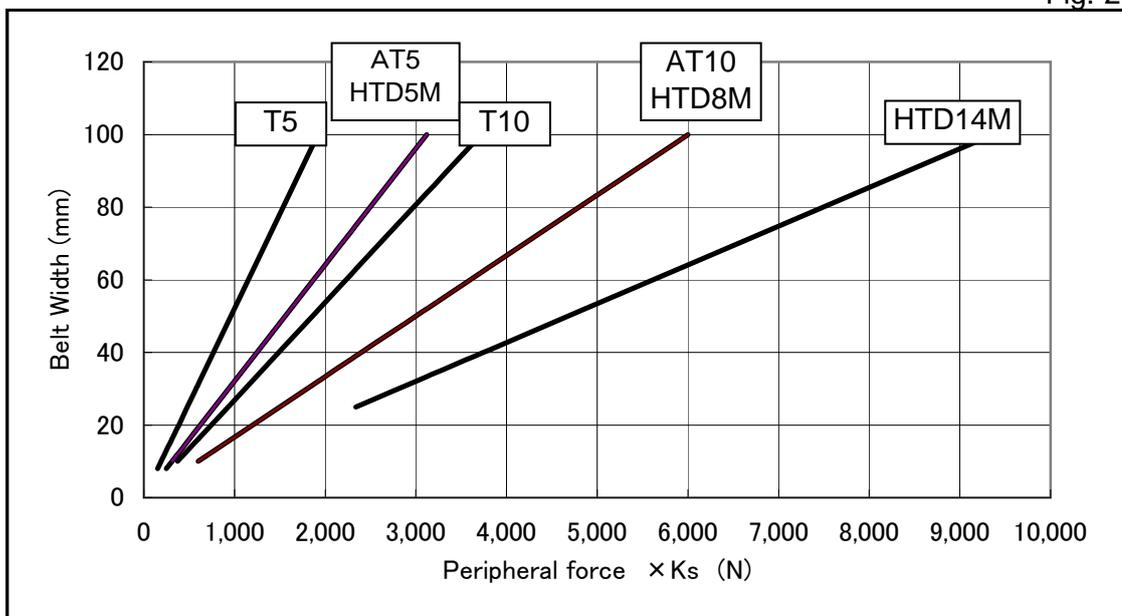


Fig.-2



This graph gives a indication of the belt width for each tooth profile. Please calculate the belt width followed by calculation procedure.

\*Graph condition is 1000rpm

**b) Safety Factor**

Safety factor depends on the operating conditions,  
Please use the following safety factor.

Table-4

Operating Condition		Safety Factor
Steady Load		1.0
Shock Load	Low	1.4
	Middle	1.7
	High	2.0

**c) Coefficient of Friction**

When the supporting table is used,  
Please use the following Coefficient of Friction.

Table-5

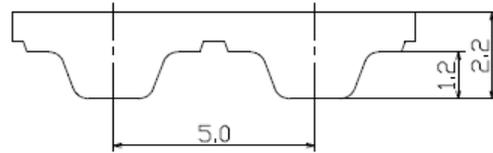
	Polyurethane
Steel	0.7
Stainless	0.7
Aluminium	0.4
UHMW	0.3
Teflon	0.2

# FREESPAN T5

# Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	2.2 mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Standard Width

Width (mm)	8	10	16	25	32	50	75	100	150
Weight (g/m)	18	22	35	55	70	110	165	220	330

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	750	1000	1500	2000	3000	4000	5000	8000
F <sub>spec</sub> (N/cm)	24	23	23	22	22	22	20	19	19	18	17	16	15	14	12	11	11	9

## Max Allowable Tension

Width(mm)	8	10	16	25	32	50	75	100	150
Max Allowable Tensile Load	278	324	556	834	1112	1667	2501	3335	5002
Breaking Strength	1170	1365	2340	3510	4680	7020	10530	14040	21060

## Pulley

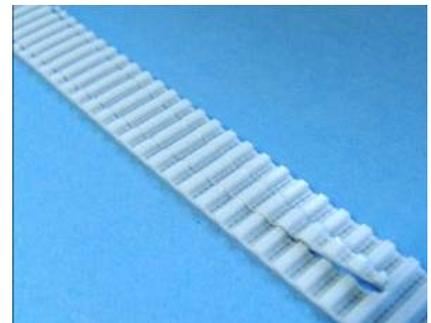
Minimum Pulley

	T5	
2 Shafts	φ18.27	12 Teeth
Ω Layout	φ27.82	18 Teeth
Inside Idler	φ30	—
Outside Idler	φ30	—

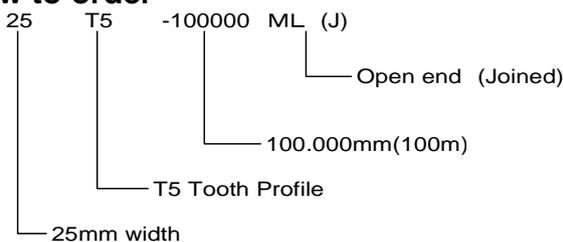
## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%  
Joined belt is suitable for transportation.



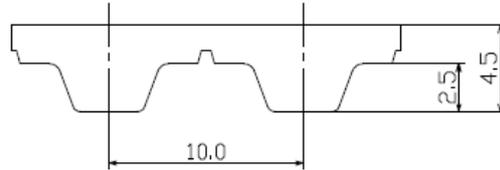
## How to order



# FREESPAN T10 Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	4.5mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Belt Standard Width and Weight

Width (mm)	10	16	25	32	50	75	100	150
Weight (g/m)	45	72	113	144	225	338	450	675

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	750	1000	1500	2000	3000	4000	5000	8000
Fpspec(N/cm)	51	49	48	47	46	45	41	39	37	36	33	31	28	25	22	20	18	14

## Max Allowable Tension

Width(mm)	10	16	25	32	50	75	100	150
Max Allowable Tensile Load	698	1097	1796	2195	3591	5387	7182	10773
Breaking Strength	2940	4620	7560	9240	15120	22680	30240	45360

## Pulley

Minimum Pulley

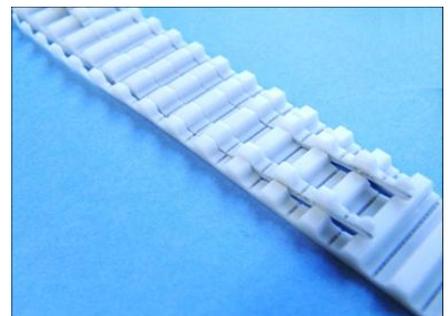
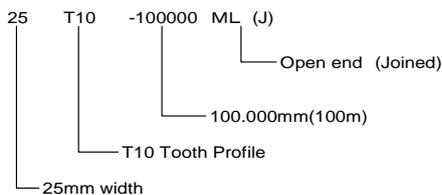
	T10	
2 Shafts	φ42.71	14 Teeth
Ω Layout	φ61.81	20 Teeth
Inside Idler	φ60	—
Outside Idler	φ60	—

## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%  
Joined belt is suitable for transportation.

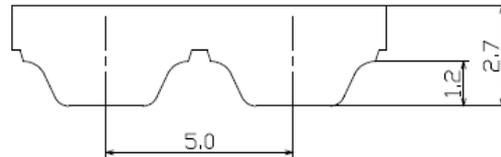
## How to order



# FREESPAN AT5 Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	2.7mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Belt Standard Width and Weight

Width (mm)	8	10	16	25	32	50	75	100	150
Weight (g/m)	26	33	53	83	106	165	248	330	495

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	750	1000	1500	2000	3000	4000	5000	8000
Fpspec(N/cm)	35	35	35	34	34	34	32	31	30	29	27	26	24	22	19	18	16	13

## Max Allowable Tension

Width(mm)	8	10	16	25	32	50	75	100	150
Max Allowable Tensile Load	542	677	1083	1692	2166	3384	5077	6769	10153
Breaking Strength	2280	2850	4560	7125	9120	14250	21375	28500	42750

## Pulley

Minimum Pulley

	AT5	
2 Shafts	φ22.64	15 Teeth
Ω Layout	φ38.56	25 Teeth
Inside Idler	φ30	—
Outside Idler	φ60	—

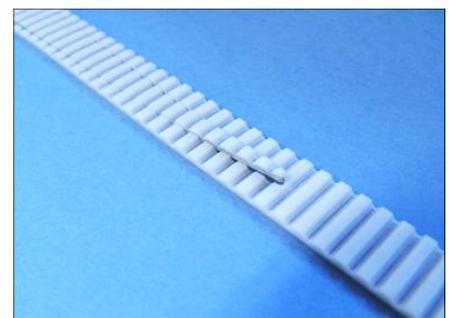
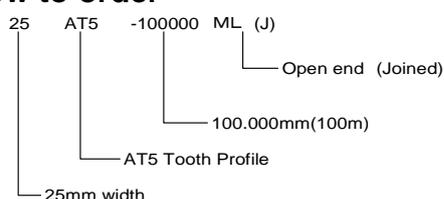
## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%

Joined belt is suitable for transportation.

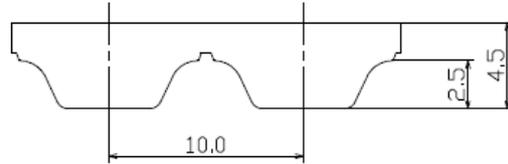
## How to order



# FREESPAN AT10 Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	4.5mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Belt Standard Width and Weight

Width (mm)	10	16	25	32	50	75	100	150
Weight (g/m)	60	96	150	192	300	450	600	900

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	750	1000	1500	2000	3000	4000	5000	8000
Fpspec(N/cm)	74	72	71	71	70	69	65	62	60	58	53	50	44	40	35	30	27	20

## Max Allowable Tension

Width(mm)	10	16	25	32	50	75	100	150
Max Allowable Tensile Load	1354	2256	3610	4513	7220	10830	14440	21660
Breaking Strength	5700	9500	15200	19000	30400	45600	60800	91200

## Pulley

### Minimum Pulley

	AT10	
2 Shafts	φ45.90	15 Teeth
Ω Layout	φ77.73	25 Teeth
Inside Idler	φ50	
Outside Idler	φ120	

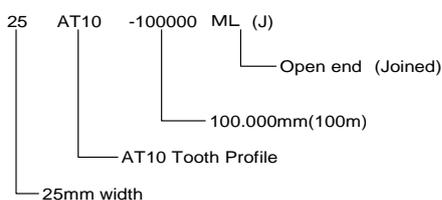
## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%

Joined belt is suitable for transportation.

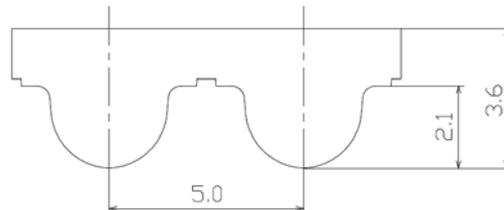
## How to order



# FREESPAN HTD 5M Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	3.6 mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Standard Width

Width (mm)	10	15	25	50	75	100	150
Weight (g/m)	41	62	103	205	308	410	615

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	1000	1500	2000	3000	4000	5000	8000
F <sub>pspec</sub> (N/cm)	37	36	36	35	35	34	33	31	30	29	26	24	22	19	17	16	12

## Max Allowable Tension

Width(mm)	10	15	25	50	75	100	150
Max Allowable Tensile Load	1031	1620	2651	5301	7952	10602	15903
Breaking Strength	4340	6820	11160	22320	33480	44640	66960

## Pulley

Minimum Pulley

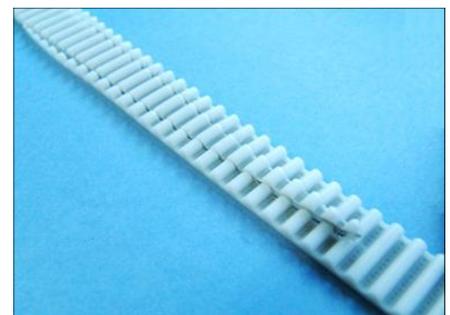
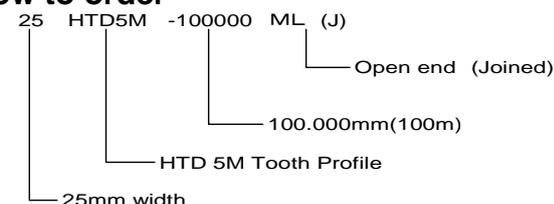
	H T D 5M	
2 Shafts	φ22.28	14 Teeth
Ω Layout	φ30.23	20 Teeth
Inside Idler	φ50	—
Outside Idler	φ50	—

## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%  
Joined belt is suitable for transportation.

## How to order

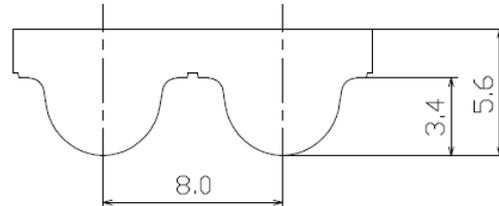


# FREESPAN HTD 8M

# Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	5.6mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Belt Standard Width and Weight

Width (mm)	10	15	20	30	50	85	100	150
Weight (g/m)	59	89	118	177	295	502	590	885

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	1000	1500	2000	3000	4000	5000
Fpspec(N/cm)	74	72	71	70	69	68	64	62	59	57	48	43	39	33	28	25

## Max Allowable Tension

Width(mm)	10	15	20	30	50	85	100	150
Max Allowable Tensile Load	1354	2256	2708	4513	7220	12184	14440	21660
Breaking Strength	5700	9500	11400	19000	30400	51300	60800	91200

## Pulley

Minimum Pulley

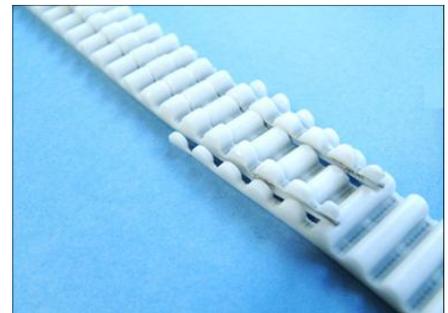
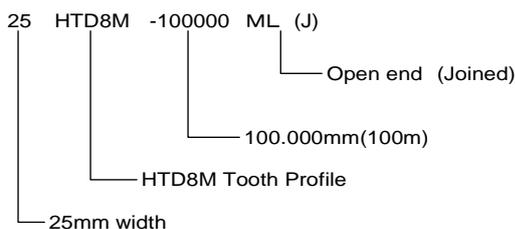
	H T D 8M	
2 Shafts	φ50.93	20 Teeth
Ω Layout	φ76.39	30 Teeth
Inside Idler	φ50	—
Outside Idler	φ120	—

## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%  
Joined belt is suitable for transportation.

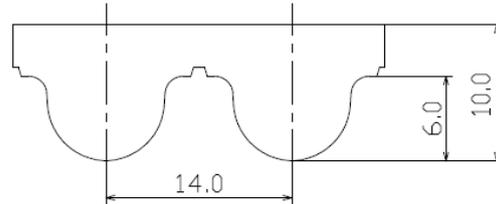
## How to order



# FREESPAN HTD 14M Open-end Belt Joined Belt

## Belt Characteristics

Standard Color	White
Polyurethane	Thermoplastic Polyurethane Shore A 92
Standard cords	S and Z zincked steel cords
Standard Thickness	10.0mm
Standard roll Length	100m
Belt options	
Joined Belt	
Cleats	



## Belt Standard Width and Weight

Width (mm)	25	40	55	85	100	115
Weight (g/m)	268	428	589	910	1,070	1,231

## Tooth Share Strength

rpm	0	20	40	60	80	100	200	300	400	500	1000	1500	2000	3000	4000
F <sub>pspec</sub> (N/cm)	130	128	126	123	122	120	110	104	99	95	78	67	59	47	38

## Max Allowable Tension

Width(mm)	25	40	55	85	100	115
Max Allowable Tensile Load	5752	9039	12326	18900	23009	26296
Breaking Strength	24220	38060	51900	79580	96880	110720

## Pulley

Minimum Pulley

	HTD 14M	
2 Shafts	φ124.77	28 Teeth
Ω Layout	φ124.77	28 Teeth
Inside Idler	φ120	—
Outside Idler	φ180	—

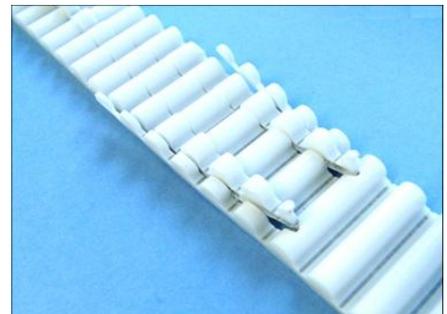
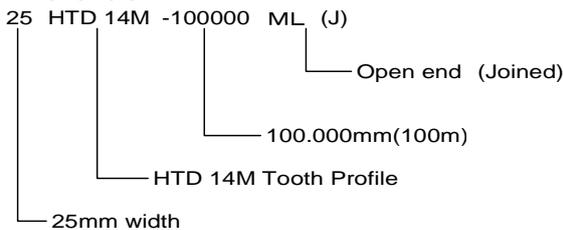
## Joined Belt

Minimum length: 1000mm

Tooth Share Strength and Max allowable Tension become 50%

Joined belt is suitable for transportation.

## How to order



## Profile (Cleats)

Freespan belt can be welded variously shaped Cleats on the Belt.

### Cleats Material

Thermoplastic Polyurethane Shore A 92

### Standard Rectangle Cleats

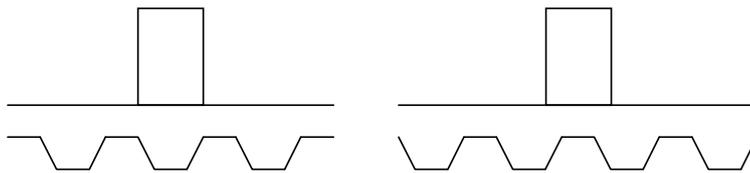
Thickness of cleats is available from 2mm to 10mm

Height of the cleats is available from 20mm to 50mm

### Position of the cleats.

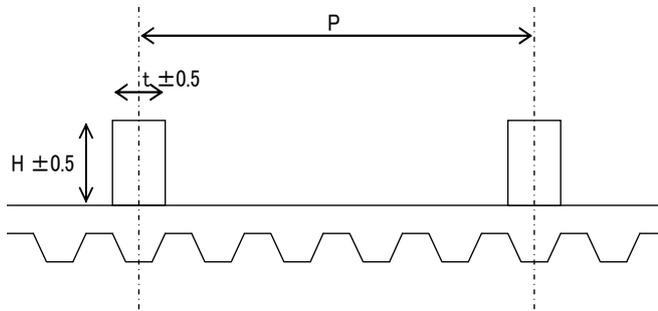
We recommend that Cleats should be mounted over the tooth position. This position gives the better flexibility.

Cleats over the tooth position      Cleats not over the tooth



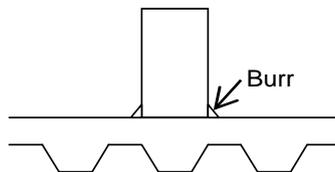
### Tolerance of the Cleats

Cleats thickness Tolerance		$\pm 0.5\text{mm}$
Cleats Height Tolerance		$\pm 0.5\text{mm}$
Tolerance of the position		$\pm 0.5\text{mm}$
P: Cleats Pitch Tolerance	$\leq 250\text{mm}$	$\pm 0.5\text{mm}$
	$250\text{mm} < \leq 500\text{mm}$	$\pm 1.0\text{mm}$
	$500\text{mm} <$	$\pm 2.0\text{mm}$



### Burr at welded Cleats

When the cleats are welded on the belt, The Burr tend to occurs at root of the Cleats. If this burr interfere the function, please request us to remove the burr.



## Molded Cleats

We can produce the special cleats as follows.  
If you need special cleats, please contact us.

