BELT DRIVE SELECTION PROCEDURE

Before designing a synchronous belt drive, you need to determine and tabulate the following drive requirements:

1. Power requirement and type of driveN machine
2. The rpm of the driveR machine
3. The rpm of the driveN machine
4. The approximate centre distance for the drive
5. Hours per day operation.

To select a Gates PowerGrip® GT3, PowerGrip® HTD® or PowerGrip® belt drive, you need to complete the following steps:

STEP 1

DETERMINE THE SERVICE FACTOR

Service life of a belt drive depends on the specific use and function. By selecting the appropriate service life for a drive and designing it accordingly, you will obtain the most economical drive for your specific application. If the drive conditions are unknown, then the following classification guide will assist in the selection of the appropriate service factor.
For an idler, add 0.2 to the basic service factor. For intermittent or seasonal operation, deduct 0.2 from the basic service factor.
For speed-up drives, add to the basic service factor an additional factor as given in the table.

Speed-up ratio range	Additional factor
1 to 1.24	none
1.25 to 1.74	0.1
1.75 to 2.49	0.2
2.50 to 3.49	0.3
3.50 and over	0.4

Additional service factors are required for unusual conditions such as load reversal, heavy shock, plugged motor stop, electric brake. These should be determined by a Gates transmission specialist.
Any change in the service factor affects the entire calculation. For the majority of drive applications, the service factors here are adequate. It must be recognised, however, that these factors are not a substitute for judgement. You may find it practical to adjust the service factor to conform with your knowledge of the drive conditions and their severity.

STEP 2

CALCULATE THE DESIGN POWER

Design power = service factor x power requirement

A. To calculate the design power it is necessary to determine the service factor for the drive. Using the service factor chart on page 22, determine the type of driveR machine.

B. Using the service factor chart, determine the service factor for the driveN machine and the type of operational service.

C. Multiply the power requirement of the drive by the service factor you have selected. This gives you the design power for use in designing the drive.

BELT DRIVE SELECTION PROCEDURE

2

SERVICE FACTOR CHART

DRIVE N MACHINE	DRIVE R					
The driveN machines listed below are representative samples only. Select a driveN machine whose load characteristics most closely approximate those of the machine being considered.	AC motors: normal torque, squirrel cage, synchronous, split phase, inverter controlled. DC motors: shunt wound, stepper motors. Engines: multiple cylinder internal combustion.			AC motors: high torque, high slip, repulsion induction, single phase, series wound, slip ring. DC motors: series wound, compound wound, servo motors. Engines: single cylinder internal combustion. Line shafts. Clutches.		
	Intermittent service	**Normal service**	**Continuous service**	**Intermittent service**	**Normal service**	**Continuous service**
	3-8 hours daily or seasonal	**8-16 hours daily**	**16-24 hours daily**	**3-8 hours daily or seasonal**	**8-16 hours daily**	**16-24 hours daily**
Display equipment. Dispensing equipment. Instrumentation. Measuring equipment. Medical equipment. Office equipment. Projection equipment.	**1.0**	**1.2**	**1.4**	**1.2**	**1.4**	**1.6**
Appliances. Sweepers. Sewing machines. Screens: oven, drum, conical. Woodworking equipment (light): band saws, drills, lathes.	**1.1**	**1.3**	**1.5**	**1.3**	**1.5**	**1.7**
Agitators for liquids. Conveyors: belt, light package. Drill presses. Lathes. Saws. Laundry machinery. Woodworking equipment (heavy): circular saws, jointers, planers.	**1.2**	**1.4**	**1.6**	**1.6**	**1.8**	**2.0**
Agitators for semi-liquids. Centrifugal compressors. Conveyor belt: ore, coal, sand. Dough mixers. Line shafts. Machine tools: grinders, shapers, boring mills, milling machines. Paper machinery (except pulpers): presses, punches, shears. Printing machinery. Pumps: centrifugal, gear. Screens: revolving, vibratory.	**1.3**	**1.5**	**1.7**	**1.6**	**1.8**	**2.0**
Brick machinery (except pug mills). Conveyors: apron, pan, bucket, elevator. Extractors. Washers. Fans. Centrifugal blowers. Generators and exciters. Hoists. Rubber calender. Mills. Extruders.	**1.4**	**1.6**	**1.8**	**1.8**	**2.0**	**2.2**
Centrifuges. Screw conveyors. Hammer mills. Paper pulpers. Textile machinery.	**1.5**	**1.7**	**1.9**	**1.9**	**2.1**	**2.3**
Blowers: positive displacement. Mine fans. Pulverisers.	**1.6**	**1.8**	**2.0**	**2.0**	**2.2**	**2.4**
Reciprocating compressors. Crushers: gyratory, jaw, roll. Mills: ball, rod, pebble, etc. Pumps: reciprocating. Saw mill equipment.	**1.7**	**1.9**	**2.1**	**2.1**	**2.3**	**2.5**

These service factors are adequate for most belt drive applications. Note that service factors cannot be substituted for good engineering judgement. Service factors may be adjusted based upon an understanding of the severity of actual drive operating conditions.

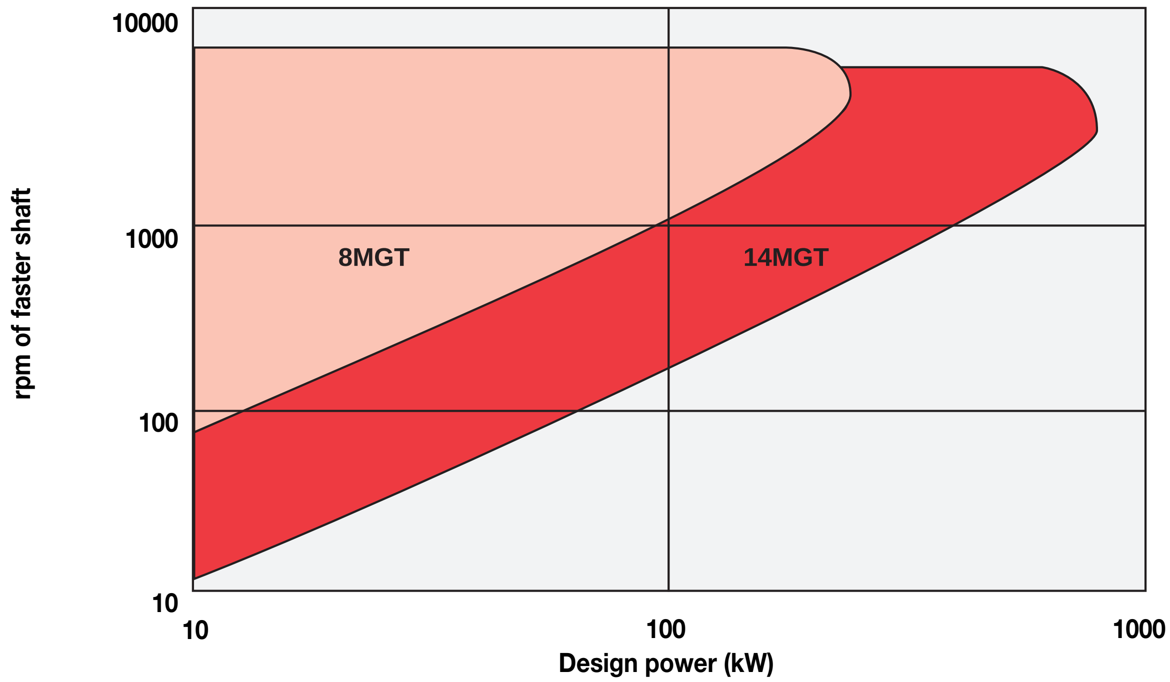
STEP 3

DETERMINE THE BELT PITCH

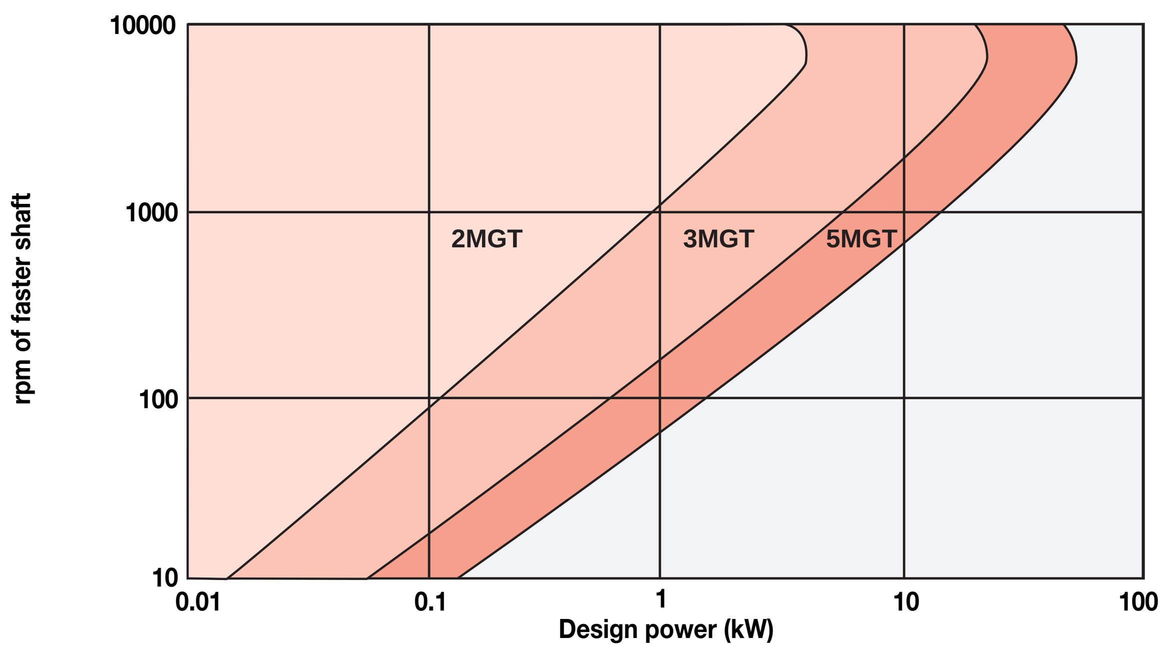
A. Go to the belt pitch selection guides below or on the following page. Locate the design power along the bottom of one of the belt pitch selection guides. Read up to the rpm of the faster shaft (smaller pulley). The belt pitch indicated in the area surrounding the point of intersection is the one you should use for your design. If the point of intersection falls outside of the area, contact your local Gates representative. If the point falls very near the line between adjacent pitches a good drive can likely be designed using either belt pitch.

B. Design the drives using both belt pitches and select the drive best meeting your size requirements or the most economical drive.

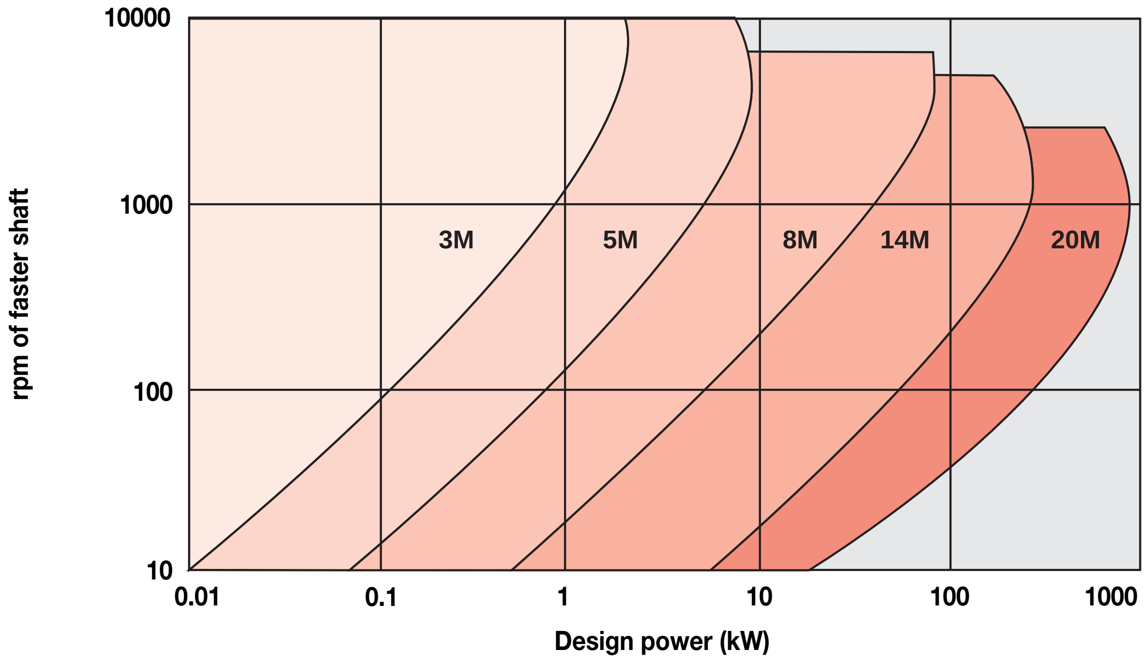
POWERGRIP® GT3 8MGT & 14MGT BELT PITCH SELECTION GUIDE



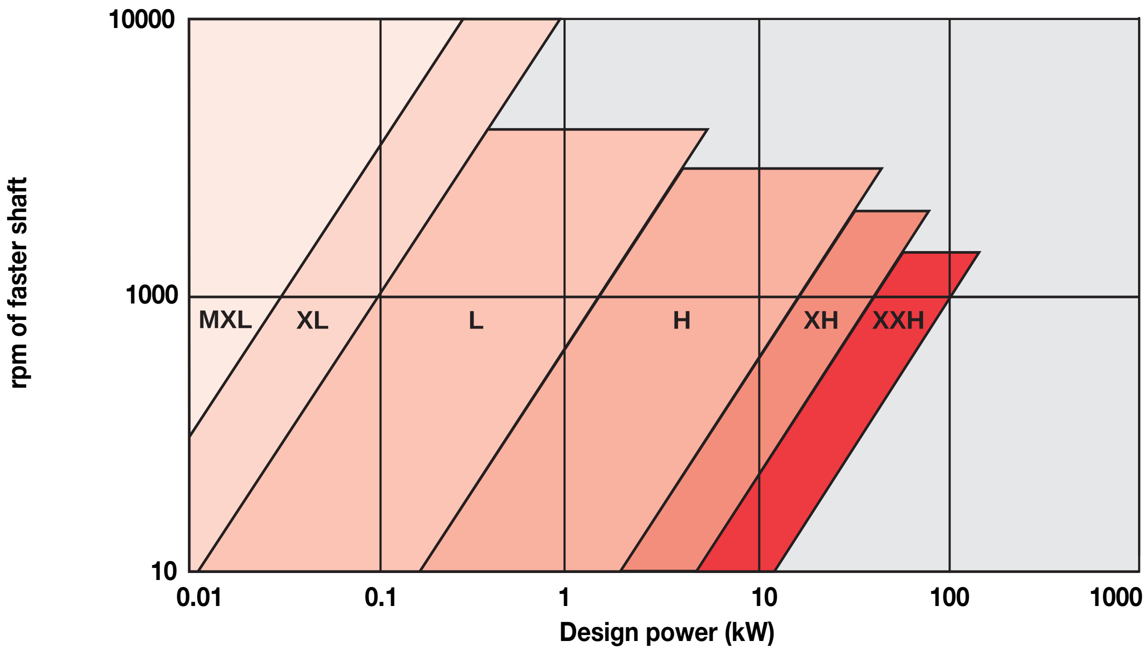
POWERGRIP® GT3 2MGT, 3MGT & 5MGT BELT PITCH SELECTION GUIDE



POWERGRIP® HTD® BELT PITCH SELECTION GUIDE



POWERGRIP® CLASSICAL TIMING BELT PITCH SELECTION GUIDE



STEP 4

SELECT THE PULLEY COMBINATION, BELT LENGTH AND CENTRE DISTANCE

Locate the correct centre distance table for the belt you selected (pages 28-127).

For standard and non-standard motor speeds:

A. Calculate the speed ratio by dividing the rpm of the faster shaft by the rpm of the slower shaft. In the centre distance tables, refer to the column headed speed ratio. Locate the speed ratio nearest to your requirements.

B. For the speed ratio selected, note the number of grooves and the pitch diameter of each pulley. If there are several combinations close to your requirements, you may want to consider more than one combination in your drive selection.

C. Reading further to the right on the same line, locate and record the centre distance nearest to your requirements. The belt length code is given at the top of that column in mm. Note these values.

Alternative method to establish the belt length/centre distance

The nomograph on page 26 provides a quick, effective method for determining the nominal centre distance and belt length of a drive and converting these nominal values into design values. The values of belt length and centre distance obtained using this nomograph are approximate and only intended for use in applications where reasonable centre distance adjustment is possible.
The nomograph is based on the number of pitches rather than on actual diameters and lengths.

Hence:

Pulley size

N = number of grooves in large pulley
n = number of grooves in small pulley

Belt length

$$Nb = \frac{\text{belt length}}{\text{pitch}} \text{ (number of pitches)}$$

Centre distance

$$Nc = \frac{\text{centre distance}}{\text{pitch}} \text{ (number of pitches)}$$

To establish required belt length

a. Calculate the values N + n and Nc.
b. Place a straight edge across the nomograph connecting these two points.
c. Read off the Nb value and multiply it by the pitch to give the nominal belt length in mm.
d. Select the nearest suitable belt length using the size listings on pages 13-20 .
e. Convert this belt length to pitches and re-apply this value to the nomograph to obtain the actual centre distance (Nc).

This method will give sufficient accuracy for drives having a speed ratio of 3:1 or less. If the ratio is greater than 3:1 then a correction will be necessary.

$$\text{Corrected centre distance} = Nc - \frac{N - n}{1.114 \times Nc}$$

If there is limited room for centre distance adjustment

Establish the belt length in millimetres as previously outlined. Calculate the centre distance using the following formula:

Pulley centre distance

$$C = \frac{K + \sqrt{K^2 - 32\,(D - d)^2}}{16}$$

Where K = 4L - 6.28 (D + d)
D = pitch circle diameter large pulley (mm)
d = pitch circle diameter small pulley (mm)
L = belt length (mm)

Fixed centre applications

For applications where no centre distance adjustment is possible, contact Gates' application engineers.

Exact values may be calculated from the following:

1. Belt length (L)

$$L = 2C \sin\frac{\beta}{2} + \frac{\pi}{2}\left[(D + d) + \left(1 - \frac{\beta}{180}\right)(D - d)\right]$$

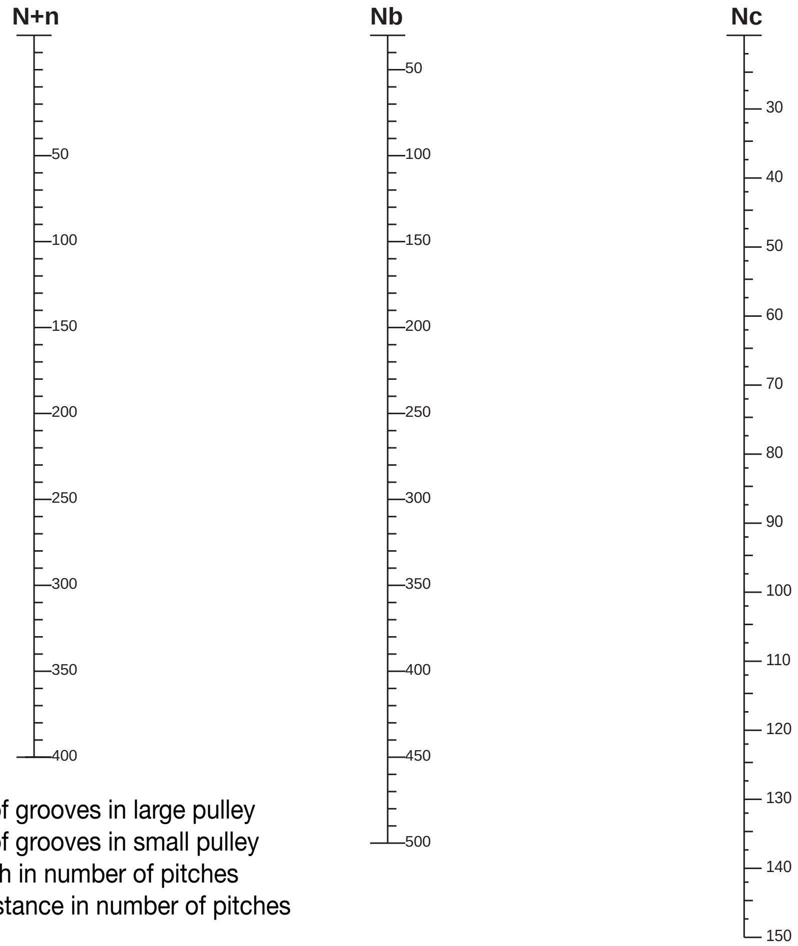
$$\text{Where } \beta = 2 \cos^{-1}\left(\frac{D - d}{2C}\right)$$

2. Centre distance (C)

$$C = \frac{1}{2 \sin\left(\frac{\beta}{2}\right)}\left\{L - \frac{\pi}{2}\left[(D - d) + \left(1 - \frac{\beta}{180}\right)(D - d)\right]\right\}$$

BELT DRIVE SELECTION PROCEDURE

DESIGN NOMOGRAPH



Where N = number of grooves in large pulley
n = number of grooves in small pulley
Nb = belt length in number of pitches
Nc = centre distance in number of pitches

STEP 5

SELECT THE BELT WIDTH

A. The tables on pages 128-147 show the power ratings for each belt which, when combined with the width factors, will give the rating for each belt width. The left hand column lists the rpm of the smaller pulley. The stock pulleys are listed across the top of the columns and are designated by the number of grooves and the pitch diameter. By reading down the first column to the speed of your faster shaft and across the line to the column headed by your smaller pulley, the power rating can be determined for any stock belt width.

IMPORTANT
The tables on pages 128-147 provide power ratings that are based on a minimum of six teeth in mesh. If less than six teeth are in mesh the power rating should be multiplied by the approximate teeth in mesh factor from the following table.

Use the following formula to establish the number of teeth in mesh:

$$\text{Teeth in mesh (T.I.M.)} = n\left[0.5 - \frac{(N - n)}{18.85 \times Nc}\right]$$

Teeth in mesh factor

Teeth in mesh	≥6	5	4	3	2
Factor	1	0.8	0.6	0.4	0.2

B. Select a stock belt width and determine the power rating as outlined in Step 5A. If the power rating is equal to or exceeds the design power found in Step 2, that belt width can be used. If not, move on to the next stock belt width and repeat this step. If the widest stock belt width for the pitch selected is still not acceptable, you may want to consider larger pulley diameters or a larger pitch belt if possible.

C. Where there are several pulley combinations which meet your drive requirements, the following rules of thumb may influence your choice.

a. The larger the pulley diameter, the narrower the belt.
b. Larger diameter pulleys typically reduce bearing and shaft loads.

BELT DRIVE SELECTION EXAMPLE

A centrifugal blower is to be driven by an AC Motor.
Drive requirements and characteristics are as follows:

Driver machine
Type: AC motor- normal torque
Power: 740 Watts
Speed: 2850 rpm
Shaft diameter: 19 mm

Driven machine
Type: Centrifugal blower
Power: 600 Watts (absorbed)
Speed: 6800 rpm
Shaft diameter: 12 mm

Drive conditions
Smooth uniform load
Operating 8 hrs/day, 5 days/week

Drive design limitation
Maximum driving pulley diameter = 75 mm
Shaft centres = 70 mm ± 5 mm
Idler: not requested

STEP 1

DETERMINE THE SERVICE FACTOR

From the service factor chart select the service factors which are applicable to the drive.
Basic service factor = 1.5
In this case additional factors must be added:
Speed up factor:
it is a speed increasing drive ratio: $\frac{6800}{2850}$

Additional factor = 0.2
Resultant service factor = 1.5 + 0.2
= 1.7

STEP 2

CALCULATE THE DESIGN POWER

a) Determine speed ratio
Driver speed = 2850 rpm
Driven speed = 6800 rpm
Speed ratio = 2.39 (speed increase)

b) Design power
Multiply the drive absorbed power by the service factor:
600W x 1.7 = 1020W

STEP 3

DETERMINE THE BELT PITCH

Refer to the belt pitch selection guides on pages 23-24. Use the design power of 1020W and the small pulley speed of 6800 rpm. The chart will show that these conditions give an intercept inside the 3MGT power envelope. Therefore a 3MGT drive is required.

STEP 4

SELECT THE PULLEY COMBINATION, BELT LENGTH AND CENTRE DISTANCE

a) Select pulleys
Check size limitation (see page 148).
Driven pulley max. dia. = 75 mm hence max.
Stock pulley = 3MR - 72S

Driven pulley shaft dia. = 12 mm hence min.
Driven pulley = 3MR - 30S

Bearing these limitations in mind, the stock pulley combination to give the speed ratio of 2.4 : 1 is 3MR - 72S : 3MR - 30S

b) Select belt length
Required centres = 70 ± 5 mm
Referring to centre distance table page 48, the most suitable will be the belt 300 - 3MGT which will give centres of 70.63 mm when combined with the above pulley selection.

Hence the pulley/belt combinations required will be:
pulleys: 3MR - 72S, 3MR - 30S
belt: 300 - 3MGT

STEP 5

SELECT BELT WIDTH

Selection is always based on the smallest pulley, i.e. 3MR - 30S running at 6840 rpm.

Refer to the 3MGT power ratings table on page 129 and note the ratings for the 30 groove pulley for 6000 and 8000 rpm.

Interpolate these ratings for a speed of 6840 rpm (i.e. 1920W).

This value is for a width of 6 mm.
Multiply by the width factor:

Width	Factor	Watts
6 mm	0.62	1190
9 mm	1	1920
15 mm	1.89	3629

Teeth in mesh factor
See page 26. Calculated value is 14 teeth in mesh. As this figure is greater than 5, the factor is 1. Hence the power rating is not changed.

Our design power requirement is 1020W, hence a belt width of 6 mm will be required.

The selected drive will therefore be:

Driver pulley: **3MR - 72S - 6**
Driven pulley: **3MR - 30S - 6**
Belt: **300 - 3MGT - 6**