

8.3.3 Timing Belts

*This guide follows Mott

1. To start off, you will be given the following specifications:

- H_{nom} [hp], nominal horsepower
- n [rpm], Input speed
- VR, velocity ratio. Recall:

$$VR = \frac{V_{driving}}{V_{driven}} = \frac{D}{d} = \frac{n_{driving}}{n_{driven}}$$

- CD [in.], nominal center distance²⁰
- Other minor details, such as:
 - Maximum Sprocket diameter [in.]
 - Operation time [hr]
 - Shaft diameters [in.]

2. Next, determine the service factor (SF) from the figure in the next page and find the design power (H_d).

$$H_d = H_{nom} \times SF$$

²⁰The CD is usually given as a range with some \pm tolerance in these cases

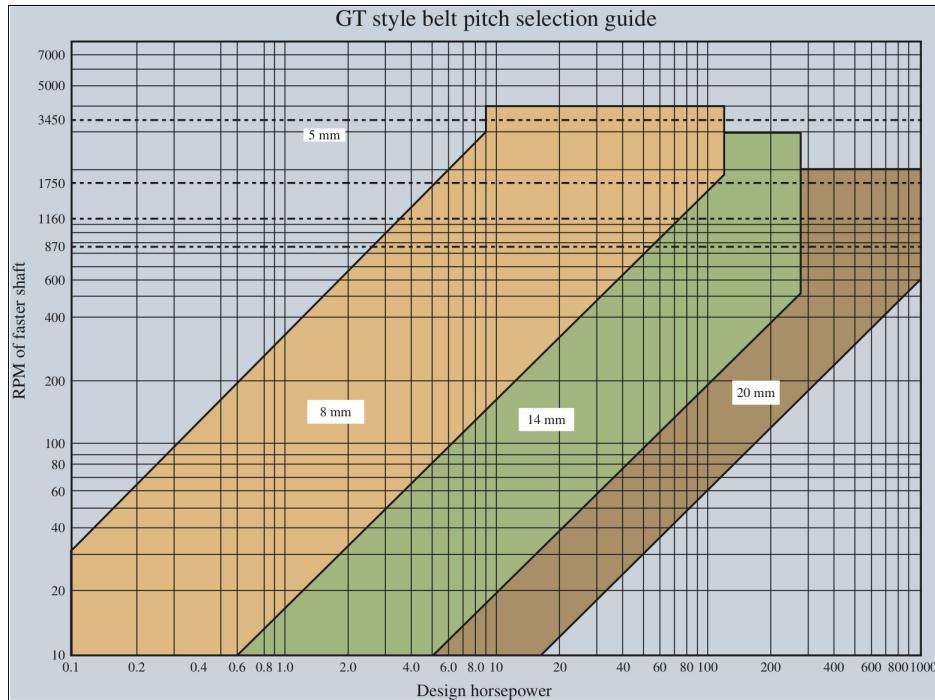
TABLE 7-8 Service Factor

DriveN machine				DriveR		
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 (Up to 8 Hours Daily or Seasonal)	Normal Service (8-16 Hours Daily)	Continuous Service (16-24 Hours Daily)	Intermittent Service (Up to 8 Hours Daily or Seasonal)	Normal Service (8-16 Hours Daily)	Continuous Service (16-24 Hours Daily)
Display, Dispensing Equipment Instrumentation Measuring Equipment Medical Equipment Office, Projection Equipment	1.0	1.2	1.4	1.2	1.4	1.6
Appliances, Sweepers, Sewing Machines Screens, Oven Screens, 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 Press, Lathes, Saws Laundry Machinery Wood Working Equipment (Heavy): Circular Saws, Jointers, Planers	1.2	1.4	1.6	1.6	1.8	2.0
Agitators for Semi-Liquids Compressor: Centrifugal Conveyor Belt: Ore, Coal, Sand Dough Mixers Line Shafts Machine Tools: Grinder, Shaper, Boring Mill, 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) Conveyor: Apron, Pan, Bucket, Elevator Extractors, Washers Fans, Centrifugal Blowers Generators & 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 Pulvertizers	1.6	1.8	2.0	2.0	2.2	2.4
Compressors: Reciprocating Crushers: Gyratory, Jaw, Rod 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 judgment. Service factors may be adjusted based upon an understanding of the severity of actual drive operating conditions.

3. Find the required pitch for the belt from your H_d and n values using the figure below.²¹

²¹I could bet my entire fortune that it will be 8 mm, but do check anyways



4. From your VR, use the figures in Appendix A to choose combinations of driver and driven sprocket teeth sizes (N_d and N_D) that work.²² Now check to see which combinations work (first three columns in table only for now!). To do this, check for all possible limitations, such as

- Check bushing style and maximum bore sizes in case you are given shaft information. Use the Tables (7-4 and 7-5) below and compare to your given diameter. Make sure

$$\text{Min. Bore Diameter} < \text{Shaft Diameter} < \text{Max. Bore Diameter}$$

- Check sprocket sizes using table 7-4 below. Make sure they pass whatever limitations are imposed by the question.

²²The figures took up too much space here, so I had to put them in an appendix. From now on, this will be the case for some figures as well

TABLE 7–4 Sprockets with 8 mm Belt Pitch

Dim's all widths			20-mm Wide belt		30-mm Wide belt		50-mm Wide belt		85-mm Wide belt	
No. of teeth	Pitch dia.	Flange dia.	Sprocket number	Bushing size						
22	2.206	2.559	P22-8MGT-20	1108	P22-8MGT-30	1108	N/A	N/A	N/A	N/A
24	2.406	2.756	P24-8MGT-20	1108	P24-8MGT-30	1108	N/A	N/A	N/A	N/A
26	2.607	2.953	P26-8MGT-20	1108	P26-8MGT-30	1108	N/A	N/A	N/A	N/A
28	2.807	3.15	P28-8MGT-20	1108	P28-8MGT-30	1108	P28-8MGT-50	MPB	N/A	N/A
30	3.008	3.346	P30-8MGT-20	1210	P30-8MGT-30	1210	P30-8MGT-50	1210	N/A	N/A
32	3.208	3.543	P32-8MGT-20	1210	P32-8MGT-30	1210	P32-8MGT-50	1210	N/A	N/A
34	3.409	3.819	P34-8MGT-20	1610	P34-8MGT-30	1610	P34-8MGT-50	1610	P34-8MGT-85	1615
36	3.609	3.937	P36-8MGT-20	1610	P36-8MGT-30	1610	P36-8MGT-50	1610	P36-8MGT-85	1615
38	3.810	4.134	P38-8MGT-20	1610	P38-8MGT-30	1610	P38-8MGT-50	1610	P38-8MGT-85	1610
40	4.010	4.331	P40-8MGT-20	1610	P40-8MGT-30	2012	P40-8MGT-50	2012	P40-8MGT-85	2012
44	4.411	4.764	P44-8MGT-20	2012	P44-8MGT-30	2012	P44-8MGT-50	2012	P44-8MGT-85	2012
48	4.812	5.157	P48-8MGT-20	2012	P48-8MGT-30	2012	P48-8MGT-50	2012	P48-8MGT-85	2012
56	5.614	5.945	P56-8MGT-20	2012	P56-8MGT-30	2012	P56-8MGT-50	2517	P56-8MGT-85	2517
64	6.416	6.772	P64-8MGT-20	2012	P64-8MGT-30	2517	P64-8MGT-50	2517	P64-8MGT-85	2517
72	7.218	7.598	P72-8MGT-20	2012	P72-8MGT-30	2517	P72-8MGT-50	2517	P72-8MGT-85	3020
80	8.020	8.386	P80-8MGT-20	2517	P80-8MGT-30	2517	P80-8MGT-50	2517	P80-8MGT-85	3020
90	9.023	N/A	P90-8MGT-20	2517	P90-8MGT-30	2517	P90-8MGT-50	3020	P90-8MGT-85	3020
112	11.229	N/A	N/A	N/A	P112-8MGT-30	2517	P112-8MGT-50	3020	P112-8MGT-85	3020
144	14.437	N/A	N/A	N/A	P144-8MGT-30	2517	P144-8MGT-50	3020	P144-8MGT-85	3535
192	19.249	N/A	N/A	N/A	N/A	N/A	P192-8MGT-50	3020	P192-8MGT-85	3535

TABLE 7–5 Taper-Lock Bushing

Bushing size	Min bore	Max bore
1008	0.500	0.875
1108	0.500	1.000
1210	0.500	1.250
1610	0.500	1.500
1615	0.500	1.500
2012	0.500	1.875
2517	0.500	2.250
3020	0.875	2.750
3525	1.188	3.250
3535	1.188	3.250
4030	1.438	3.625
4040	1.438	3.625
4535	1.938	4.250
4545	1.938	4.250
5040	2.438	4.500
6050	4.438	6.000
7060	4.938	7.000

Once you've determined the sprocket combination given your velocity ratio, go back to Appendix Table 7-4 above and determine the pitch diameters PD_d and PD_D [in.] for your sprockets.

5. After that, go back to Appendix A and choose a belt given your sprocket combination and your desired CD range
6. Now, you have to select the belt width²³. First, find the belt length correction factor (C_L) from the figure below.

TABLE 7-11 8M GT Style Belt Length Correction Factor

Pitch/Length designation	No. of teeth	Correction factor	Pitch/Length designation	No. of teeth	Correction factor	Pitch/Length designation	No. of teeth	Correction factor	Pitch/Length designation	No. of teeth	Correction factor
384-8MGT	48	0.70	920-8MGT	115	1.00	1440-8MGT	180	1.10	2600-8MGT	325	1.20
480-8MGT	60	0.80	960-8MGT	120	1.00	1512-8MGT	189	1.10	2800-8MGT	350	1.20
560-8MGT	70	0.80	1040-8MGT	130	1.00	1584-8MGT	198	1.10	3048-8MGT	381	1.20
600-8MGT	75	0.80	1064-8MGT	133	1.00	1600-8MGT	200	1.10	3280-8MGT	410	1.20
640-8MGT	80	0.90	1120-8MGT	140	1.00	1760-8MGT	220	1.10	3600-8MGT	450	1.20
720-8MGT	90	0.90	1160-8MGT	145	1.00	1800-8MGT	225	1.20	4400-8MGT	550	1.20
800-8MGT	100	0.90	1200-8MGT	150	1.00	2000-8MGT	250	1.20			
840-8MGT	105	0.90	1224-8MGT	153	1.00	2200-8MGT	275	1.20			
880-8MGT	110	0.90	1280-8MGT	160	1.10	2400-8MGT	300	1.20			

7. Next, use the two figures²⁴ in the next pages with your values of N_d and n to find the rated power of your belt. Then, get the adjusted power using

$$P_{adjusted} = P_{rated} \times C_L$$

Compare this value to your design horsepower and make sure it is well above it!²⁵

²³You basically have two choices here, 30 mm or 50 mm.

²⁴Again, try either or both to check. If you are given a weird n value, you need to interpolate

²⁵Tip: if 30 mm doesn't work, 50 mm will probably work, so starting off with 50 mm may be smart!

TABLE 7-9 8M GT Style Belt Power Rating Table—30-mm Belt Width

RPM of faster shaft	Base rated horsepower for small sprocket (Number of grooves and pitch diameter, inches)															
	22 2.206	24 2.406	26 2.607	28 2.807	30 3.008	32 3.208	34 3.409	36 3.609	38 3.810	40 4.010	44 4.411	48 4.812	56 5.614	64 6.416	72 7.218	80 8.020
10	0.10	0.12	0.13	0.15	0.16	0.17	0.19	0.20	0.22	0.23	0.26	0.29	0.34	0.40	0.45	0.51
20	0.20	0.22	0.25	0.28	0.31	0.33	0.36	0.39	0.42	0.44	0.50	0.55	0.66	0.76	0.87	0.98
40	0.37	0.43	0.48	0.53	0.59	0.64	0.69	0.75	0.80	0.85	0.96	1.06	1.27	1.47	1.68	1.88
60	0.54	0.62	0.70	0.78	0.86	0.94	1.01	1.09	1.17	1.25	1.40	1.55	1.86	2.16	2.46	2.76
100	0.87	1.00	1.12	1.25	1.38	1.51	1.63	1.76	1.89	2.01	2.26	2.51	3.00	3.49	3.98	4.47
200	1.64	1.89	2.13	2.38	2.63	2.87	3.12	3.36	3.60	3.84	4.33	4.80	5.76	6.70	7.64	8.58
300	2.37	2.74	3.10	3.46	3.82	4.18	4.54	4.90	5.25	5.61	6.32	7.02	8.42	9.80	11.2	12.5
400	3.08	3.56	4.04	4.51	4.99	5.46	5.93	6.40	6.87	7.33	8.26	9.18	11.0	12.8	14.6	16.4
500	3.77	4.36	4.95	5.54	6.13	6.71	7.29	7.87	8.45	9.02	10.2	11.3	13.6	15.8	18.0	20.2
600	4.45	5.15	5.85	6.55	7.25	7.94	8.63	9.31	10.0	10.7	12.0	13.4	16.1	18.7	21.4	24.0
700	5.11	5.93	6.74	7.54	8.35	9.15	9.95	10.7	11.5	12.3	13.9	15.5	18.6	21.6	24.7	27.7
800	5.77	6.69	7.61	8.52	9.44	10.3	11.2	12.1	13.0	13.9	15.7	17.5	21.0	24.5	27.9	31.4
870	6.22	7.22	8.22	9.20	10.2	11.2	12.2	13.1	14.1	15.1	17.0	18.9	22.7	26.5	30.2	33.9
1000	7.05	8.19	9.33	10.5	11.6	12.7	13.8	14.9	16.0	17.1	19.3	21.5	25.8	30.1	34.3	38.5
1160	8.06	9.37	10.7	12.0	13.3	14.5	15.8	17.1	18.4	19.6	22.2	24.7	29.6	34.5	39.4	44.2
1200	8.31	9.66	11.0	12.3	13.7	15.0	16.3	17.6	19.0	20.3	22.9	25.4	30.6	35.6	40.6	45.6
1400	9.54	11.1	12.7	14.2	15.7	17.3	18.8	20.3	21.8	23.3	26.3	29.3	35.2	41.0	46.8	52.4
1600	10.7	12.5	14.3	16.0	17.8	19.5	21.2	23.0	24.7	26.4	29.8	33.1	39.8	46.3	52.8	59.1
1750	11.6	13.6	15.5	17.4	19.3	21.2	23.0	24.9	26.8	28.6	32.3	36.0	43.2	50.3	57.2	64.1
2000	13.1	15.3	17.5	19.6	21.8	23.9	26.0	28.1	30.2	32.3	36.5	40.6	48.7	56.7	64.5	72.1
2400	15.4	18.0	20.5	23.1	25.6	28.1	30.7	33.1	35.6	38.1	43.0	47.8	57.3	66.6	75.6	84.4
2800	17.6	20.6	23.6	26.5	29.4	32.3	35.2	38.0	40.9	43.7	49.3	54.8	65.6	76.1	86.2	96.0
3200	19.8	23.2	26.5	29.8	33.1	36.4	39.6	42.8	46.0	49.2	55.4	61.6	73.6	85.2	96.2	
3450	21.1	24.7	28.3	31.9	35.4	38.9	42.3	45.8	49.2	52.5	59.2	65.7	78.4	90.6	102.2	
4000	24.0	28.1	32.2	36.2	40.3	44.2	48.1	52.0	55.9	59.7	67.1	74.5	88.5			
4500	26.6	31.1	35.6	40.1	44.5	48.9	53.2	57.5	61.7	65.9	74.0	82.0				
5000	29.0	34.0	39.0	43.8	48.7	53.4	58.1	62.8	67.3	71.8	80.6	89.1				
5500	31.4	36.8	42.2	47.5	52.7	57.8	62.9	67.8	72.7	77.5	86.8					

TABLE 7-10 8M GT Style Belt Power Rating Table—50-mm Belt Width

RPM of faster shaft	Base rated horsepower for small sprocket (Number of grooves and pitch diameter, inches)												
	28 2.807	30 3.008	32 3.208	34 3.409	36 3.609	38 3.810	40 4.010	44 4.411	48 4.812	56 5.614	64 6.416	72 7.218	80 8.020
10	0.25	0.28	0.30	0.33	0.35	0.38	0.40	0.45	0.50	0.59	0.69	0.78	0.88
20	0.49	0.53	0.58	0.63	0.68	0.72	0.77	0.86	0.96	1.14	1.33	1.51	1.70
40	0.93	1.02	1.11	1.21	1.30	1.39	1.48	1.66	1.84	2.20	2.56	2.92	3.27
60	1.35	1.49	1.63	1.76	1.90	2.03	2.17	2.43	2.70	3.23	3.75	4.28	4.80
100	2.18	2.40	2.62	2.84	3.06	3.28	3.50	3.93	4.36	5.22	6.08	6.92	7.77
200	4.14	4.57	4.99	5.42	5.84	6.26	6.68	7.52	8.35	10.0	11.7	13.3	14.9
300	6.02	6.65	7.27	7.90	8.52	9.14	9.75	11.0	12.2	14.6	17.0	19.4	21.8
400	7.85	8.67	9.49	10.3	11.1	11.9	12.7	14.4	16.0	19.2	22.3	25.5	28.6
500	9.63	10.7	11.7	12.7	13.7	14.7	15.7	17.7	19.7	23.6	27.5	31.4	35.2
600	11.4	12.6	13.8	15.0	16.2	17.4	18.6	20.9	23.3	28.0	32.6	37.2	41.7
700	13.1	14.5	15.9	17.3	18.7	20.1	21.4	24.2	26.9	32.3	37.6	42.9	48.2
800	14.8	16.4	18.0	19.6	21.1	22.7	24.2	27.3	30.4	36.5	42.6	48.6	54.5
870	16.0	17.7	19.4	21.1	22.8	24.5	26.2	29.5	32.9	39.5	46.0	52.5	58.9
1000	18.2	20.1	22.1	24.0	25.9	27.9	29.8	33.6	37.4	44.9	52.4	59.7	67.0
1160	20.8	23.1	25.3	27.5	29.7	32.0	34.1	38.5	42.9	51.5	60.0	68.5	76.8
1200	21.5	23.8	26.1	28.4	30.7	33.0	35.2	39.8	44.2	53.1	61.9	70.6	79.2
1400	24.7	27.4	30.0	32.7	35.3	38.0	40.6	45.8	51.0	61.2	71.3	81.3	91.2
1600	27.9	30.9	33.9	36.9	39.9	42.9	45.9	51.8	57.6	69.2	80.6	91.8	102.9
1750	30.2	33.5	36.8	40.1	43.3	46.6	49.8	56.2	62.5	75.0	87.4	99.5	111.4
2000	34.1	37.8	41.5	45.2	48.9	52.6	56.2	63.4	70.6	84.7	98.5	112.1	125.4
2400	40.2	44.6	48.9	53.3	57.6	62.0	66.2	74.7	83.1	99.7	115.8	131.5	146.8
2800	46.1	51.2	56.2	61.2	66.2	71.1	76.0	85.7	95.3	114.1	132.3	149.9	166.9
3200	51.9	57.6	63.2	68.9	74.5	80.0	85.5	96.4	107.1	128.0	148.1	167.4	
3450	55.4	61.5	67.6	73.6	79.6	85.5	91.3	102.9	114.3	136.4	157.5	177.7	
4000	63.0	70.0	76.9	83.7	90.4	97.1	103.7	116.8	129.5	154.0			
4500	69.7	77.4	85.0	92.6	100.0	107.3	114.5	128.7	142.5				
5000	76.2	84.7	92.9	101.1	109.1	117.1	124.9	140.1	154.9				
5500	82.5	91.6	100.5	109.3	117.9	126.4	134.7	150.9					

8. Finally, calculate the belt speed and make sure it is less than 6500 fpm:

$$V = \frac{\pi n P D_d}{12}$$

9. Now, display your results and make sure to specify the belt names and what not clearly!

You're done!

Timing belts are probably the easiest to size, and require even less calculations than V-belts. For that reason, I do not have a calculator made for them.