Engineering Info

MASTERDRIVE
POWER TRANSMISSION PRODUCTS

To Find	Given	Formula	
1. Basic Geometry			
Circumference of a circle	Diameter	Circumference =	3.1416 x diameter
Diameter of a circle	Circumference	Diameter =	Circumference / 3.1416
2. Motion			
Ratio	High Speed & Low Speed	Ratio =	$\frac{\text{RPM High}}{\text{RPM Low}}$
RPM	Feet per Minute of Belt and Pulley Diameter	RPM =	$\frac{\text{FPM}}{.262 \text{ x diameter in inches}}$
Belt Speed Feet per Minute	RPM & Pulley Diameter	FPM =	.262 x RPM x diameter in inches
Ratio	Teeth of Pinion & Teeth of Gear	Ratio =	$\frac{\text{Teeth of Gear}}{\text{Teeth of Pinion}}$
Ratio	Two Sprockets or Pulley Diameters	Ratio =	$\frac{\text{Diameter Driven}}{\text{Diameter Driver}}$
3. Force - Work - Torque			
Force (F)	Torque & Diameter	F =	$\frac{\text{Torque x 2}}{\text{Diameter}}$
Torque (T)	Force & Diameter	T =	(F x Diameter) / 2
Diameter (Dia.)	Torque & Force	Diameter =	(2 x T) / F
Work	Force & Distance	Work =	Force x Distance
Chain Pull	Torque & Diameter	Pull =	(T x 2) / Diameter
4. Power			
Chain Pull	Horsepower & Speed (FPM)	Pull =	(33,000 x HP)/ Speed
Horsepower	Force & Speed (FPM)	HP =	(Force x Speed) / 33,000
Horsepower	RPM & Torque (#in.)	HP =	(Torque x RPM) / 63025
Horsepower	RPM & Torque (#ft.)	HP =	(Torque x RPM) / 5250
Torque	HP & RPM	T #in. =	(63025 x HP) / RPM
Torque	HP & RPM	T #ft. =	(5250 x HP) / RPM
5. Inertia			
Accelerating Torque (#ft.)	WK^2, RMP, Time	T =	$\frac{WK^2 \text{ x RPM}}{308 \text{ x Time}}$
Accelerating Time (Sec.)	Torque, WK^2, RPM	t =	$\frac{WK^2 \text{ x RPM}}{308 \text{ x Torque}}$
WK^2 at motor	WK^2 at Load, Ratio	WK^2 Motor =	$\frac{WK^2}{Ratio^2}$
6. Gearing			
Gearset Centers	Pd Gear & Pd Pinion	Centers =	$(Pd_G + Pd_P) / 2$
Pitch Diameter	No. of Teeth & Diametral Pitch	Pd =	Teeth / DP
Pitch Diameter	No. of Teeth & Module	Pd =	(Teeth x Module) / 25.4
Diametral Pitch	Pd & No. of Teeth	DP =	Teeth / Pd
Module	Pd & No. of Teeth	Module =	(Pd x 25.4) / Teeth
Circular Pitch	Pd & No. of Teeth	CP =	(3.1416 x Pd) / Teeth
Circular Pitch	Diametral Pitch	CP =	3.1416 / DP
Number of Teeth	Pd & DP	Teeth =	Pd x DP
Number of Teeth	Pd & Module	Teeth =	(Pd x 25.4) / Module
Tooth Depth	Diametral Pitch	TD =	2.35 / DP
Tooth Depth	Module	TD =	(2.35 x Module) / 25.4

To Find	*Given*		*Formula*
7. Belting			
Effective Tension	T_1 and T_2	Te =	$T_1 - T_2$
Effective Tension	HP, RPM, Pulley Radius	Te =	63025 x HP / RPM x R
Effective Tension	Torque, Pulley Radius	Te =	Torque / R
Effective Tension	Horsepower, Belt Velocity (FPM)	Te =	(HP x 33000) / FPM
Total Load	T_1 & T_2	TL =	$T_1 + T_2$
8. Overhung Load			
Overhung Load	Torque, Diameter	OHL =	(T x 2) / Diameter
Overhung Load	Effective Tension, Belt Factor f = 1.50 V-Belts f = 2.50 flat belts	OHL =	Te x f
Overhung Load	Horsepower, Speed (RPM) Diameter, factor f = 1.0 chain f = 1.25 gear drives f = 1.50 V-belts f = 2.50 flat belts	OHL =	126000 x f x HP / Diameter x RPM
Overhung Load	Weight	OHL =	Weight
9. Electricity			
Motor Speed (RPM)	Number of Poles	RPM =	120 x HZ / No. of Poles
Horsepower Single Phase or Direct Current Motor	Volts, Amps, Power factor Efficiency	HP =	Volts x Amps x Pf x Eff. / 746
Horsepower 3 Phase Motor	Volts, Amps, Power factor Efficiency	HP =	Volts x Amps x 1.73 x Pf x Eff. / 746
Horsepower	Watts	HP =	Watts / 746
Horsepower	Kilowatts	HP =	KW / .746
Motor Power (Watts), Single Phase	Volts, Amps, Pf, Eff.	Watts =	V x Amps x Pf x Eff.
Motor Power (Watts), 3 Phase	Volts, Amps, Pf, Eff.	Watts =	1.73 x V x Amps x Pf x Eff.
10. Temperature			
Degrees Fahrenheit	Degrees Centigrade	°F =	(1.8 x ° C) + 32
Degrees Centigrade	Degrees Fahrenheit	°C =	5/9 (°F - 32)

11. Metric Conversions

Inches x 25.4 = Millimeters	Millimeter x .0394 = inches
Pounds x .455 = Kilograms	Kilogram x 2.2 = pounds
U.S. Gallons x 3.785 = Liters	Liter x .264 = U.S. Gallon
Pounds (Force) x 4.448 = Newtons	Newtons x .2246 = Pounds (Force)
Pounds inches x .113 = Newton Meters	Newton Meters x 8.85 = Pound-ins.
Horsepower x .746 = Kilowatts	Kilowatts x 1.34 = Horsepower
Pounds/in^2 (psi) x .0069 = Newtons/mm^2	Newton /mm^2 x 145 = Pounds/in^2
BTU x .00029 = Kilowatt Hours	Kilowatt Hours x 3415 = BTU's

MASTERDRIVE POWER TRANSMISSION PRODUCTS

Engineering Calculations Quick Reference Guide

Torque

$$\text{Horsepower} = \frac{(\text{Torque, Pound-inches})(\text{RPM})}{63{,}025}$$

$$\text{Horsepower} = \frac{(\text{Torque, Pound-feet})(\text{RPM})}{5{,}252}$$

Flywheel Effect, WR^2

$$WR^2 = \frac{0.17773F\,(D_o^4 - D_1^4)}{1000} - \frac{NY\,(D_o - Z)^3}{1000}\ \text{lb.-ft}^2$$

for gray iron. Multiply by 1.08 for steel.

Where:
- D_0 = Outside diameter of rim, inches.
- D_1 = Inside diameter of rim, inches.
- F = Face width of rim, inches
- N = Number of grooves
- Y = Groove constant from table
- Z = Groove constant from table

Torque Required to Accelerate or Decelerate a Flywheel

The torque required to uniformly accelerate or decelerate a sheave, pulley or flywheel can be calculated as follows:

$$\text{Torque (in. lbs.)} = \frac{.03908 \times N \times W \times R^2}{t} \qquad \text{Torque (ft. lbs.)} = \frac{.003257 \times N \times W \times R^2}{t}$$

N = Difference between initial and final RPM.
W = Weight of rim in pounds.
R = Mean Radius of Sheave Rim, Pulley or Flywheel in feet.
t = Time required to effect speed change, in seconds.

Data for WR^2 Calculations

Groove	Pitch Diameter	Add to PD to find D_o	Outside Diameter (in)	Outside Diameter (D_0) Minus Inside Diameter (D_1) for Standard Sheaves	Y	Z
3V	-	-	up to 10.6	1.2	.113	.30
	-	-	10.7 to 25.0	1.3	.113	.30
	-	-	25.1 to 35.5	1.5	.113	.30
5V	-	-	up to 21.2	1.9	.320	.50
	-	-	21.2 to 31.5	2.0	.320	.50
	-	-	37.5 to 50.00	2.2	.320	.50
8V	-	-	up to 22.4	2.7	.885	.80
	-	-	22.5 to 53.0	2.9	.885	.80
	-	-	53.1 & up	3.0	.885	.80
A Multi-Duty	All	.75	-	1.6	.377	.50
B Multi-Duty	All	.35	-	1.6	.377	.50
A	All	.25	-	1.5	.238	.40
B	All	.35	-	1.7	.384	.50
C	Up to 18.0	.40	-	2.1	.696	.65
C	20.1 to 50.0	.40	-	2.2	.696	.68
D	Up to 20.0	.60	-	2.9	1.280	.90
D	20.0 to 58.0	.60	-	3.0	1.280	.90
E (Special)		.80	-		2.050	1.14

V-Belt Drive Factors

Arc of Contact Correction Factors G and R

$\frac{D-d}{C}$	Small Sheave Arc of Contact	Factor G	Factor R	$\frac{D-d}{C}$	Small Sheave Arc of Contact	Factor G	Factor R
.00	180^{0}	1.00	1.000	.80	133^{0}	.87	.917
.10	174^{0}	.99	.999	.90	127^{0}	.85	.893
.20	169^{0}	.97	.995	1.00	120^{0}	.82	.866
.30	163^{0}	.96	.989	1.10	113^{0}	.80	.835
.40	157^{0}	.94	.980	1.20	106^{0}	.77	.800
.50	151^{0}	.93	.968	1.30	99^{0}	.73	.760
.60	145^{0}	.91	.954	1.40	91^{0}	.70	.714
.70	139^{0}	.89	.937	1.50	83^{0}	.65	.661

D = Diam. of large sheave
C= Center distance
d = Diam. of small sheave

Allowable Sheave Rim Speed

Sheave Material	Rim Speed in Feet per Minute
Cast Iron	6,500
Ductile Iron	8,000
Steel	10,000

NOTE: Above rim speed values are maximum for normal considerations. In some cases, these values may be exceeded. *Consult factory and include complete details of proposed application.*

Bearing Load Calculations

To find actual loads, it is necessary to know machine component weights and values of all other forces contributing to the load. Sometimes it becomes desirable to know the bearing load imposed by the V-belt drive alone. This can be done if you know bearing spacing with respect to the sheave center and shaft load and apply it to the formula:

Short Cut Ways to Figure Pump Drives

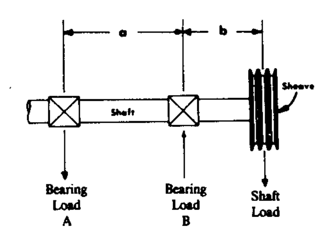
*D = Diameter of pump sheave
*d = Diameter of engine sheave
SPM = Strokes Per Minute
RPM = Engine Speed in Revolutions Per Minute
R = Gear box ratio
*C = Shaft center distance
**Required values to determine belt length*

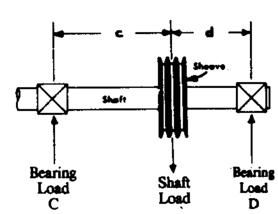
$$\text{Belt length} = 2C + 1.57\,(D+d) + \frac{(D-d)^2}{4C}$$

$$D = \frac{RPM \times d}{SPM \times R} \qquad RPM = \frac{SPM \times R \times D}{d}$$

$$d = \frac{SPM \times R \times D}{RPM} \qquad R = \frac{RPM \times d}{SPM \times D}$$

$$SPM = \frac{RPM \times d}{R \times D}$$





Overhung Sheave

$$\text{Load at B, lbs} = \frac{\text{Shaft Load} \times (a+b)}{a}$$

$$\text{Load at A, lbs} = \frac{\text{Shaft load} \times b}{a}$$

Where: a and b = spacing, inches

Sheave Between Bearings

$$\text{Load at D, lbs} = \frac{\text{Shaft Load} \times c}{c + d}$$

$$\text{Load at C, lbs} = \frac{\text{Shaft Load} \times d}{c + d}$$

Where: spacing, inches

V-Belt Tension

Belt Effective Pull

$$T_1 - T_2 = 33{,}000 \left(\frac{HP}{V}\right)$$

Where: T_1 = Tight Side Tension, pounds
T_2 = Slack Side Tension, pounds
HP= Design Horsepower
V = Belt Speed, feet per minute

Total Belt Pull

$$T_1 + T_2 = 33{,}000\ (2.5 - G) \left(\frac{HP}{GV}\right)$$

Where: T_1 = Tight Side Tension, pounds
T_2 = Slack Side Tension, pounds
HP= Design Horsepower
V = Belt Speed, feet per minute
G = Arc of Contact Correction Factor

Arc Correction Factor

$$G = 1.25\left(1 - \frac{1}{e^{5123}\theta}\right)$$

Where: θ = arc of contact in radians

Belt Speed

$$V = \frac{(PD)\ (RPM)}{3.82} = (PD)\ (RPM)\ (.262)$$

Where: V = Belt Speed, feet per minute
PD = Pitch Diameter of sheave or pulley
RPM = Revolutions Per Minute of the same sheave or pulley

Tight Side Tension

$$T_1 = 41{,}250 \left(\frac{HP}{GV}\right)$$

Where: T_1 = Tight Side Tension, pounds
HP = Design Horsepower
V = Belt Speed, feet per minute
G = Arc of Contact Correction Factor

Slack Side Tension

$$T_2 = 33{,}000\ (1.25 - G) \left(\frac{HP}{GV}\right)$$

Where: T_2 = Slack Side Tension, pounds
HP = Design Horsepower
V = Belt Speed, feet per minute
G = Arc of Contact Correction Factor

Belt Length

$$\text{Belt Length} = 2C + 1.57\ (D+d) + \frac{(D-d)^2}{4C}$$

Belt Length = Belt outside diameter
D = O.D. of large sheave
d = O.D. of small sheave
C = center distance between shafts