

VersaPlanetary Load Ratings

Introduction

The ratings in this guide are based on actual test data conducted by VEX Robotics on the final product versions of the VersaPlanetary gear box. All load ratings are based on a Safety Factor (SF) of 1.2 to accommodate manufacturing tolerance differences.

How to Use the Rating Tables

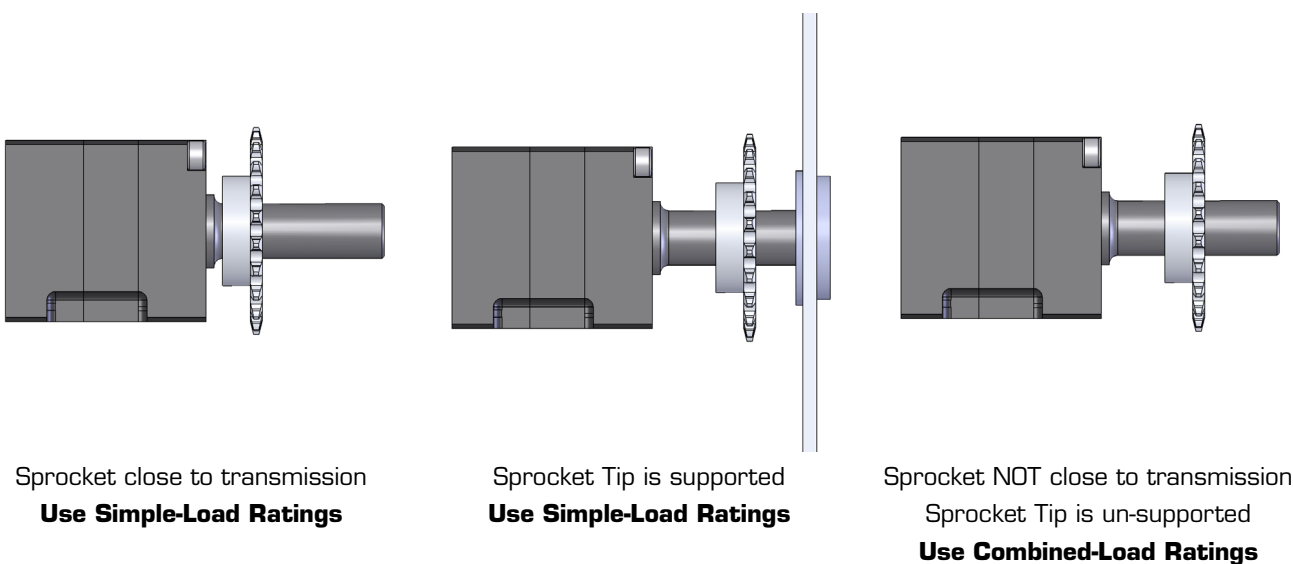
There are two types of rating tables in this guide:

- (1) Simple-Load Ratings
 - a. Conservative ratings based on a simplified loading case using just torsion.
- (2) Combined-Load Ratings
 - a. Load ratings that take bending loads into account as well as torsion.

Most users are recommended to mount their VersaPlanetary gearboxes in such a way that they can use the "Simple Load Ratings" table.

IMPORTANT NOTE:

The "Simple Loading Ratings" tables assume that the output of your shaft has minimal overhung loading (i.e. your sprocket is really close to the base of the shaft, or you support the tip of the shaft). See below examples.



The "Simple Load Ratings" tables use a red/green rating system. If the motor / gear ratio / output shaft combination you want to use is highlighted **green**, then it is within our maximum gear ratio recommendations. If the motor / gear ratio / output shaft combination is highlighted **red**, then the maximum motor torque will be capable of damaging the gearbox (with a significant enough load on the output shaft) and should be used with caution.

Example: User wants to use a RS-775 motor with a 2 stage gearbox with a 100:1 gear ratio and a 3/8" Hex Shaft. Is this combination recommended?

Using Table 3 (excerpt shown below), that combination is not recommended as indicated in red. However, all other gear ratio combinations are recommended for that motor.

Motor	Stage 1	Stage 2			
		3:1	4:1	5:1	10:1
AM-9015	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-550	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-775	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100

Simple Load Ratings Tables

Motor	Stage 1	Stage 2			
		3:1	4:1	5:1	10:1
AM-9015	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-550	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-775	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
FP-0673	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BAG Motor	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100

Table 1 - 2 Stage Max Gear Ratio w/ 1/2" Hex Output Shaft

Motor	Stage 1	Stage 2			
		3:1	4:1	5:1	10:1
AM-9015	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-550	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-775	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
FP-0673	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BAG Motor	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100

Table 2 - 2 Stage Max Gear Ratio w/ 1/2" Round Output Shaft

Motor	Stage 1	Stage 2			
		3:1	4:1	5:1	10:1
AM-9015	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-550	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-775	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
FP-0673	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BAG Motor	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100

Table 3 - 2 Stage Max Gear Ratio w/ 3/8" Hex Output Shaft

Motor	Stage 1	Stage 2			
		3:1	4:1	5:1	10:1
AM-9015	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-550	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BB RS-775	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
FP-0673	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100
BAG Motor	3:1	9	12	15	30
	4:1	12	16	20	40
	5:1	15	20	25	50
	10:1	30	40	50	100

Table 4 - 2 Stage Max Gear Ratio CIM Motor Output Shaft

Motor	Stage 1 & 2	Stage 3			
		3:1	4:1	5:1	10:1
AM-9015	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
BB RS-550	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
BB RS-775	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
FP-0673	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
BAG Motor	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000

Table 5 – 3 Stage Max Gear Ratio w/ 1/2" Hex Shaft

Ratio	Motor	Stage 1 & 2	Stage 3			
			3:1	4:1	5:1	10:1
9	AM-9015	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	BB RS-550	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	BB RS-775	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	FP-0673	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	BAG Motor	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000

Table 6 – 3 Stage Max Gear Ratio w/ 1/2" Round Shaft

Motor	Stage 1 & 2	Stage 3			
		3:1	4:1	5:1	10:1
AM-9015	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
BB RS-550	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
BB RS-775	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
FP-0673	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000
BAG Motor	9:1	27	36	45	90
	12:1	36	48	60	120
	15:1	45	60	75	150
	16:1	48	64	80	160
	20:1	60	80	100	200
	25:1	75	100	125	250
	30:1	90	120	150	300
	40:1	120	160	200	400
	50:1	150	200	250	500
	100:1	300	400	500	1000

Table 7 - 3 Stage Max Gear Ratio w/ 3/8" Hex Shaft

Ratio	Motor	Stage 1 & 2	Stage 3			
			3:1	4:1	5:1	10:1
9	AM-9015	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	BB RS-550	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	BB RS-775	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	FP-0673	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000
9	BAG Motor	9:1	27	36	45	90
12		12:1	36	48	60	120
15		15:1	45	60	75	150
16		16:1	48	64	80	160
20		20:1	60	80	100	200
25		25:1	75	100	125	250
30		30:1	90	120	150	300
40		40:1	120	160	200	400
50		50:1	150	200	250	500
100		100:1	300	400	500	1000

Table 8 - 3 Stage Max Gear Ratio w/ CIM Motor Shaft

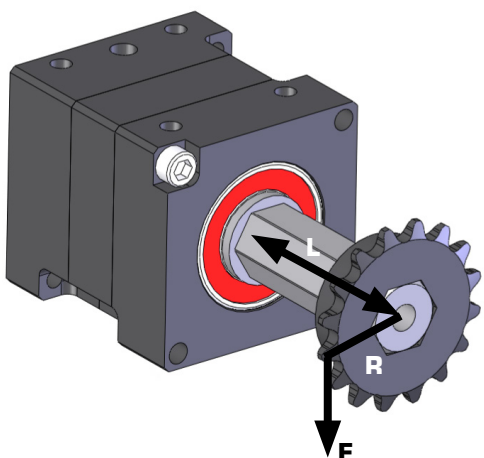
Combined Load Ratings Tables

The VersaPlanetary gearbox is designed to accommodate significant overhung loading with an unsupported shaft. However, as you will determine from this section, the torque carrying capability significantly increases if the gear, sprocket, or pulley is placed close to the mounting face or the end of the shaft is supported with another bearing.

The VersaPlanetary gearbox may fail in one of two different modes: (1) output shaft yield stress failure or (2) 10:1 carrier plate ultimate stress failure. However, improper lubrication combined with typical FRC practice robot driving time would also result in gear failure (eventually). Refer to the "VersaPlanetary User's Guide" for more information on proper maintenance.

Failure mode #2 (carrier plate failure) is not dependent upon the overhung loading and is solely determined by Table 9. However, all other failure modes listed in Table 9 are beam yield failures and that depend on both torsional failure and beam bending failure.

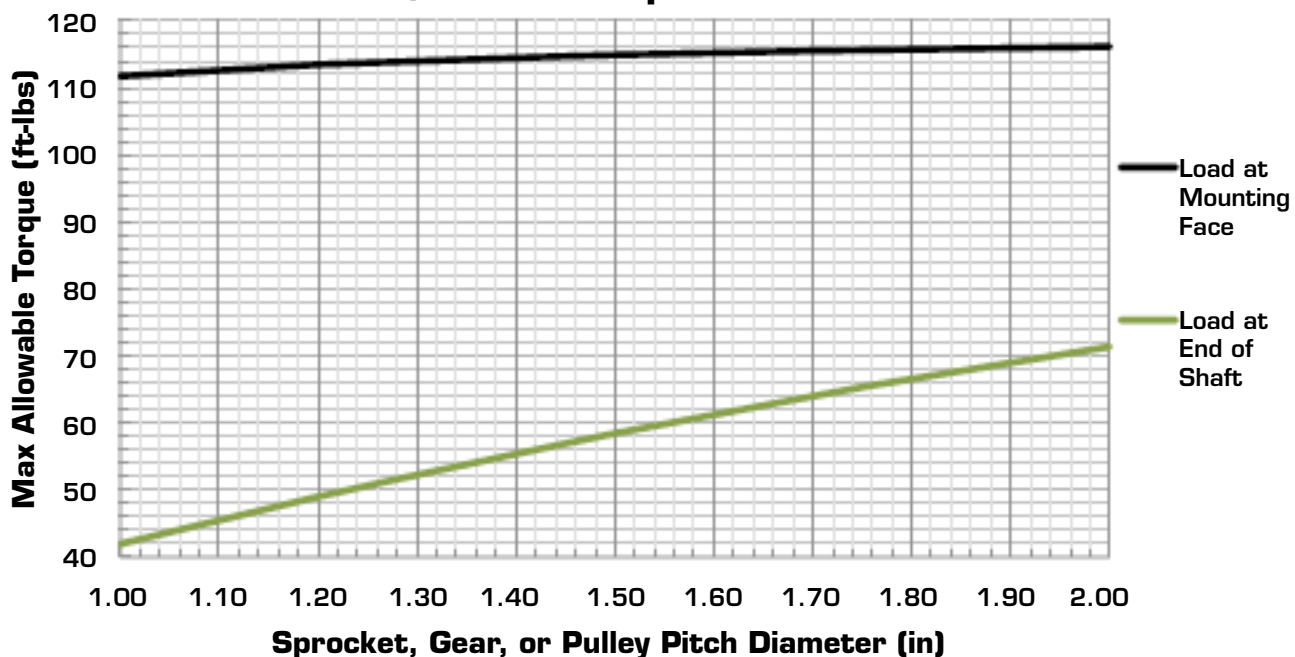
Failure mode #1 depends upon distance from the mounting face, gear / sprocket diameter, and torque load. Users should reference table 9 and the below charts to determine the maximum allowable loading for your design.



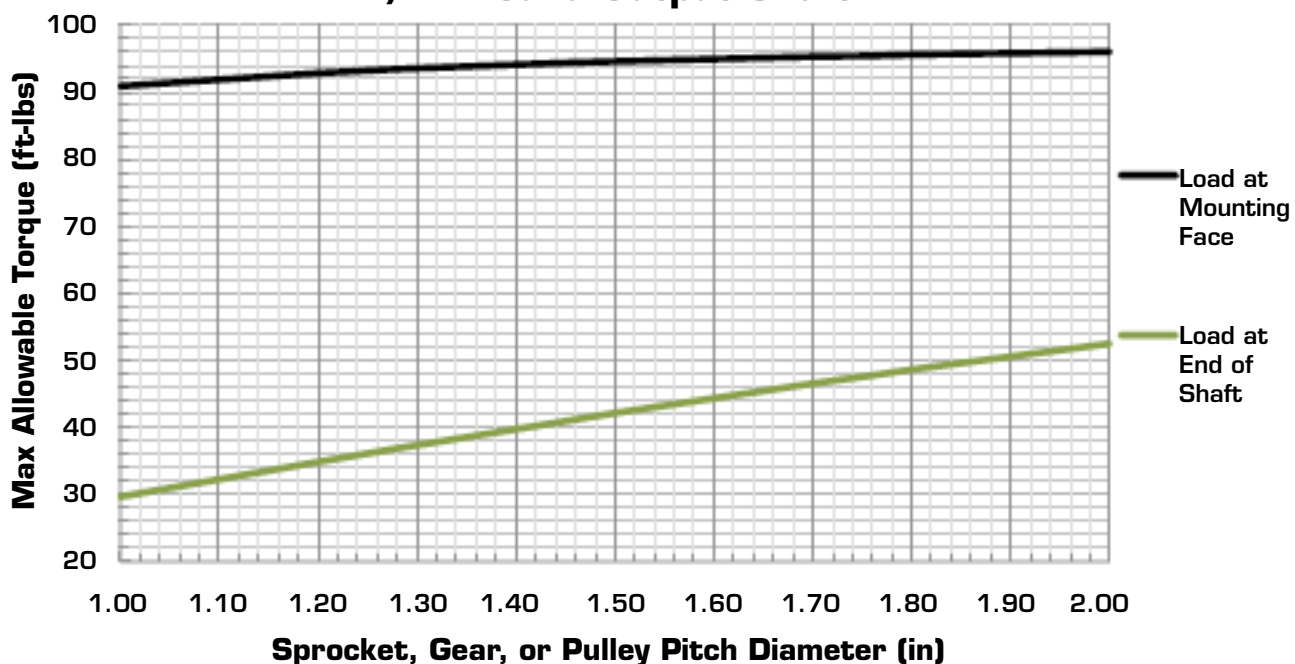
Failure Mode	Rated Load – Pure Torsion	
	N-m	ft-lbs
1/2" Hex Shaft Yield Stress	157	116
1/2" Round Shaft Yield Stress	130	96
3/8" Hex Shaft Yield Stress	57	42
CIM Motor Shaft Yield Stress	29	21
10:1 Carrier Plate Yield Stress	100	74

Table 9 – VersaPlanetary Output Torque Limits

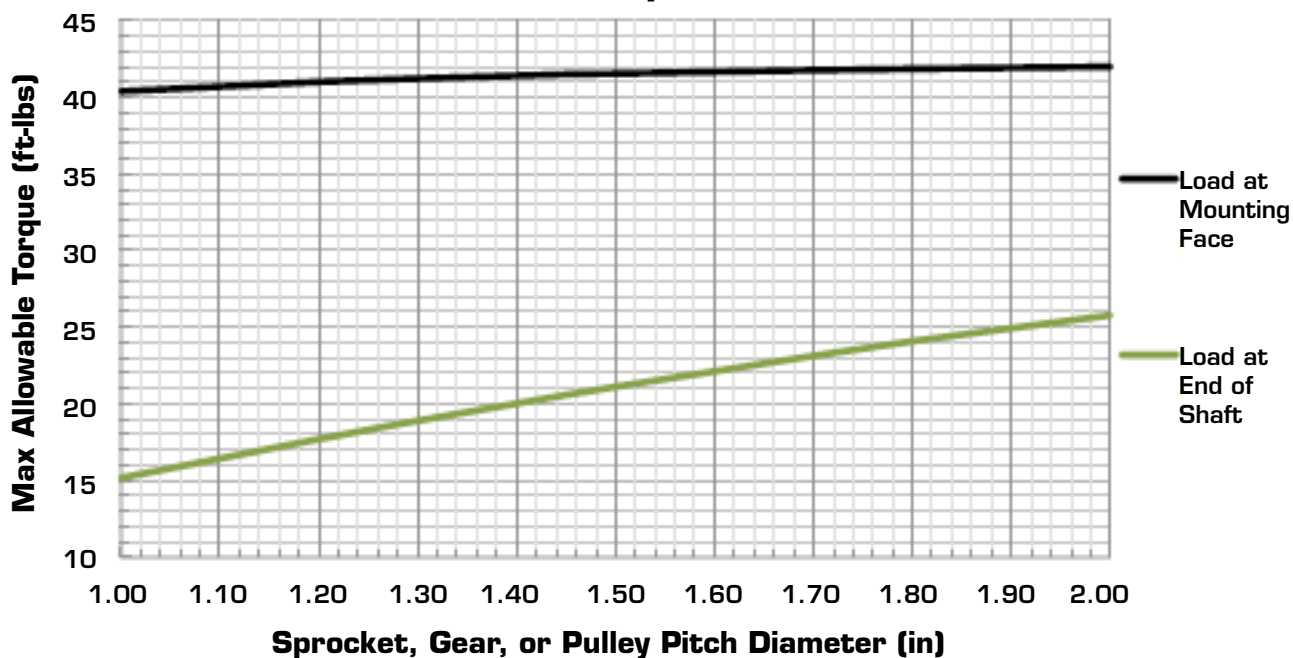
Max Output Torque vs. Pitch Diameter 1/2" Hex Output Shaft



Max Output Torque vs. Pitch Diameter 1/2" Round Output Shaft



Max Output Torque vs. Pitch Diameter 3/8" Hex Output Shaft



Max Output Torque vs. Pitch Diameter 8mm CIM Motor Output Shaft

