Fluid

To insure maximum motor performance and life, use premium grade hydraulic oils. Fluids with a minimum of .125% zinc anti-wear additives should be used. API 10W40 SF or CD motor oils are recommended. Seals in **Torqlink™** Series motors are Nitrile, compatible with most mineral based and engine oils. If using synthetic fluids consult the factory for alternative seal materials.

- Minimum fluid viscosity is 50 SSU
- Fluid operating temperature is -28° C to 93° C (-20°F to 200° F)
- Filtration level is 20-50 micron nominal

Pressure

Operating the motor in its intermittent pressure range will shorten the life of the motor and should generally be restricted to 10% or less per minute. The reduced life resulting from continuous operation in the intermittent range may be acceptable in some applications. Consult the factory for details.

Shaft Loading

Use of one inch and 25mm shafts are not recommended when torque loads exceed 3500 lb. in. For the Corrosion Resistant Shaft "N" option limit torque to 1300 lb. in. For 7/8 inch splined shafts limit torque to 1250 lb. in. Maximum thrust load on the shaft should not exceed 1000 pounds inward of outward.

Performance Data

Performance data shown in this catalog is the result of testing performed using 10W40 oil at 54° C (130° F), 200 SUS. Actual performance will vary with fluid conditions. Lower viscosity will produce lower performance.

Inlet Conditions

Positive pressure *must* be available at the motor inlet while it is rotating. If an overrunning load causes the motor to rotate faster than the pump can fill it, cavitation will occur. Consult the factory for inlet pressure requirements and speed limitations.

Other Operating Conditions

Consult factory before operating at conditions exceeding any ratings or recommendations in this catalog.

Installation Recommendations

- To avoid contamination do not remove plastic port plugs until fittings are to be installed.
- Use SAE Grade 8 bolts and nuts. Torque on non-plated, lightly oiled mounting hardware should be 105 lb ft.
- Motor mounting flange must make full contact with equipment mount; do not use the mounting bolts to force the motor pilot into the pilot hole to align the motor.
- Pulleys, sprockets, wheels, or couplings should be properly aligned on the shaft to avoid excessive radial or thrust loads.
- To avoid damaging the thrust system, do not hammer on the motor or shaft to install or remove couplings, pulleys, sprockets, etc.

Castle Nut

All motors ordered with Tapered shafts are equipped with patch locking nuts. If desired, a castle nut may be specified.

Paint

Unless specified otherwise, motors are shipped unpainted and coated with a rust inhibitor. Paint options are:

- Single coat of black paint
- Double coat of black paint for increased corrosion resistance

Vespel™ Commutator Seal

Under conditions of high temperature or low lubricity, it is possible for the standard commutator seal to extrude. A Vespel seal should be specified.

Reverse Timed Manifold

All **Torqlink™** Series motors are bi-directional. The port that must be pressurized to obtain a desired direction of rotation is shown on the catalog page for that motor. To change that port specify a Reverse Timed Manifold.

Hydraulic Formulas

$$HP_{in} = \frac{QP}{1714}$$

$$HP_{out} = \frac{NT}{63025}$$

$$T = \frac{D\,\Delta\,Pe_m}{2\,\pi}$$

$$Q = \frac{DN}{231\,e_v}$$

Where

HP	=	Horsepower
Q	=	Flow, GPM
P	=	Pressure, PSI
Δ P	=	Pressure differential across the motor
T	=	Torque, lb in
D	=	Motor displacement, cubic inches per revolution
N	=	Shaft Speed, RPM
e_m	=	Mechanical efficiency
e_v	=	Volumetric efficiency

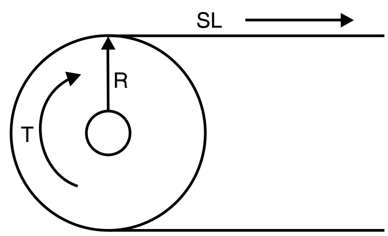
To Convert →	Into →	Multiply By
Into ←	**To Convert ←**	**Divide By**
bars	pounds/sq.in.	14.5
BTU/min	horsepower	.02356
BTU/min	kilowatts	.01757
centigrade	fahrenheit	(C°x9/5)+32
centimeters	inches	.3937
cu. cms.	cu. inches	.06102
cu. cms.	liters	.001
cu. inches	cu.cms.	16.39
cu. inches	liters	.01639
feet	meters	.3048
gallons	cu. inches	231
gallons	liters	3.785
horsepower	kilowatts	.7457
inches	millimeters	25.4
kilograms	pounds	2.205
pounds	newtons	4.448
pound-inches	newton-meters	.113
pound-inches	daNM	.0113
radians	degrees	57.3
square inches	sq. cms.	6.452

Side Load

Side loads are imposed upon the shaft of a motor by:

- Driving the load through a pulley or gear
- Supporting the weight of a vehicle or other load on the shaft

Or both



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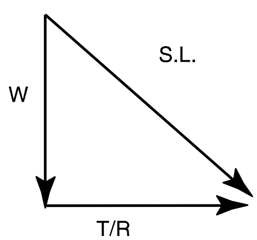
If the load above requires torque T pound-inches and is driven with a pulley on the motor shaft a with a radius of R inches, the side load imposed on the motor shaft is T/R pounds. If the motor shaft is connected to a sprocket for a chain drive, R is one half the pitch diameter of the sprocket. If an external load with a weight of W pounds is also being supported by the motor shaft above, the total side load on the shaft is:



$$(SL)^2 = W^2 + (T/R)^2$$

$$\text{Side Load(lb)} = \sqrt{W^2 + (T/R)^2}$$

Warning
This Catalog is not a Controlled Document. All Dimensions listed herein are for reference only. Consult a Sales engineer for detailed information.

Vehicle Propulsion Systems

Hydraulic motors are often used to drive off-highway vehicles, either directly or through gear reducers. The power required to propel the vehicle, called "Tractive Effort," is supplied by the hydraulic motor(s). It is normally expressed in pounds and is the sum of the forces below:

TE = (RR+GR+F+DP) x 1.1 Where:

RR = Rolling Resistance
GR = Grade Resistance
F = Acceleration Force
DP = Drawbar Pull

Definitions

• Tractive Effort (TE)

Tractive effort is the total linear force that a vehicle can exert on the ground. Sometimes called "rim pull," it is the axle torque divided by the distance from the axle to the surface it is traversing.

• Rolling Resistance (RR)

Rolling resistance is the force in pounds required to propel a vehicle at constant speed over level terrain. It varies with the weight of the vehicle and the type of surface it is traversing. Soft sand, for example, offers more resistance to movement than concrete

RR = GVW x R where:

RR = Rolling Resistance (lbs.)
GVW = Gross Vehicle Weight (lbs.)
R = Rolling Resistance Factor dependent upon type and condition of surface. Typical "R" values are shown in the accompanying table.

Surface Type	Surface Condition	R Value
Concrete	Excellent	0.010 lb.
Concrete	Good	0.015 lb.
Concrete	Poor	0.020 lb.
Asphalt	Good	0.012 lb.
Asphalt	Fair	0.017 lb.
Asphalt	Poor	0.022 lb.
Macadam	Good	0.015 lb.
Macadam	Fair	0.022 lb.
Macadam	Poor	0.037 lb.
Cobbles	Ordinary	0.055 lb.
Cobbles	Poor	0.085 lb.
Grass		0.025 lb.
Snow	2 In.	0.025 lb.
Snow	4 In.	0.037 lb.
Dirt	Smooth	0.025 lb.
Dirt	Sandy	0.037 lb.
Mud		0.037 to 0.150 lb.
Sand	Level/Soft	0.060 to 0.150 lb.
Sand	Dune	0.150 to 0.300 lb.

• Grade Resistance (GR)

Grade resistance is the additional force required to move a vehicle up an incline. The grade of a slope is normally expressed as a percentage, and represents the number of feet of rise in 100 feet of length. A slope that rises 10 feet in 100 feet has a grade of 10%. The gradeability of a vehicle is defined as the maximum grade the vehicle can climb.

$GR = 0.01 \times GVW \times G$ where:

GR = Grade Resistance (lbs.)
GVW = Gross Vehicle Weight (lbs.)
G = Grade (%)

The following table gives the approximate relationship between grade in percent and slope in degrees.

Grade (Percent)	Slope (Degrees)
1%	0° 35'
2%	1° 9'
5%	2° 51'
6%	3° 26'
8%	4° 35'
10%	5° 43'
12%	6° 54'
15%	8° 31'
20%	11° 19'
25%	14° 3'
32%	18°
60%	31°

• Acceleration Force (F)

The force required to accelerate a vehicle from an initial speed V_1 (in feet/second) to speed V_2 in T seconds is the accelerating force in pounds. If the acceleration is from rest, V_1 is zero.

$$F = \frac{V \times GVW}{T \times 32.16}$$ where

V = Change in Velocity (ft. per Second) (Final Velocity - Initial Velocity)
GVW = Gross Vehicle Weight (lbs.)
T = Time for Velocity Change (Seconds)

Note - To obtain velocity in feet per second when MPH is known, Multiply MPH by 1.467.

• Drawbar Pull (DP)

Drawbar Pull is the force a vehicle can exert on a load in addition to the force required to propel itself.

Actual force to tow or push a load can be calculated based upon Rolling Resistance, Accelerating Force and Grade Resistance of towed or pushed load.

• Motor Torque

The total Tractive effort required to propel a vehicle is the sum of the forces due to Rolling Resistance, Grade Resistance, Acceleration and Drawbar Pull plus 10% for friction and other variables:

$$TE = (RR + GR + F + DP) \times 1.1$$

When Tractive Effort has been calculated, hydraulic motor torque can be estimated by:

$$T = \frac{TE \times r}{G \times N}$$ where:

T = Hydraulic Motor Torque (lbs. in.)
TE = Tractive Effort
r = Rolling Radius of Driven Tires (inches)
G = Gear Reduction Ratio Between Hydraulic Motors and Driven Wheels (if none, use a value of 1)
N = Number of Driving Motors

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• Slip Torque

Slip torque is the torque at the motor shaft that will cause the wheels or tracks to break traction and skid. It is affected by the weight of the vehicle and the coefficient of friction between the wheels or tracks and the surface.

$$ST = \frac{VW \times u \times r}{G \times N} \quad \text{where:}$$

ST	=	Hydraulic Motor Slip Torque (lb in)
VW	=	Maximum Weight on Driven Wheel (lb) Including: Allowable Vehicle Overload Dynamic Weight Shift.
u	=	Coefficient of Friction Between Tire and Ground. (A value of 0.6 is used for "normal" tires and an average road surface)
r	=	Rolling Radius of Driven Tires (inches)
G	=	Gear Reduction Ratio Between Hydraulic Motors and Driven Wheel.
N	=	Number of Driving Motors

• Rolling Radius

The rolling radius should be based on actual application factors such as Plyrating, Rated Load and inflation pressure can result in different values.

• Hydraulic Motor Speed

$$S = \frac{168 \times V \times G}{r} \quad \text{where:}$$

S	=	Required Hydraulic Motor Speed (RPM)
V	=	Desired Vehicle Velocity (MPH)
G	=	Gear Reduction Ratio Between Hydraulic Motors and Driven Wheels (if none, use a value of 1)
r	=	Rolling Radius of driven Tires (inches)

The chart below will estimate the wheel RPM -vs- vehicle velocity for various rolling radii.

MPH -vs- RPM
for different Rolling Radii