Engine, Pump and Compressor Power Take-Off Clutches

Warner Electric
Altra Industrial Motion
Principles of Operation

An electric clutch operates on the basic principle of magnetic attraction. Closing a switch sends electric current to an electromagnet or "field", producing a strong magnetic attraction which concentrates around the magnetic poles of the field. The magnetic attraction jumps the small air gap between the field and the rotor, effectively making the rotor a spinning magnet. This "magnet" attracts the armature, grips it tightly and causes it to turn with the rotor. Opening the switch turns off the magnet, disengaging the clutch.

Magnetic Circuit

The heart of an electric clutch is its field assembly, with an electric coil to produce magnetism and iron magnet housing to direct that magnetism through the rotor to most effectively attract the armature. The illustration on the right shows how the rotor and armature surfaces of Warner Electric clutches are slotted and grooved. Magnetism, also called magnetic "flux", concentrates at the poles of the field housing and jumps to the outer rims of the rotor. The flux passes through areas where contact is most intimate between the armature and rotor faces. Concentrating the magnetic attraction at these poles rather than over the entire face creates a strong attraction between the armature and rotor. The result is a great deal of torque in a small clutch.

Coupling a clutch with a hydraulic pump mounted on a truck engine offers advantages in numerous other mobile applications, such as tire changing trucks, refuse disposal trucks, scissor lift airliner food delivery trucks and "cherry picker" type man lifts.
An engine mounted pump on this highway maintenance truck supplies hydraulic pressure for the sand spreader. Mounting an electric clutch on the pump will increase equipment life, improve machine efficiency, and allow the operator to engage and disengage the hydraulic system on demand.

Electric clutches provide for remote control of the feed and chopping mechanisms on straw choppers, insulation blowers, and salt spreaders.
The Right Clutch For Your Application

Several specifications must be determined to select the right Warner Electric clutch for a particular application. Compile these from the selection factors discussed on the next four pages and compare them to the clutch specifications found on pages 7 through 24 to find the correct clutch for your application.

Clutch Dimensions

Overall or envelope dimensions of a clutch being considered for an application must be noted to ensure that the clutch will fit into the space allotted.

Choosing the Correct Size Clutch

Torque and horsepower calculations are important in choosing the right clutch for your application.

Two important factors needed to determine the static torque required for an application are the driven machine’s horsepower and clutch operating speed. Locate horsepower and clutch RPM on their respective columns in the accompanying chart. Draw a straight line between the two points. The torque is the numerical value read from where this line intersects the TORQUE column. This number must be multiplied by a known service factor “K” from the data below to obtain the correct torque requirement for the clutch.

Service Factor “K”

The power pulses of a gasoline or diesel engine result in momentary torque output which is several times higher than the engine’s rated torque. Many electric motors can also deliver up to three times their rated output for a short period. A clutch coupled to these power systems must be able to transmit the required torque for these short periods without slipping. Using the chart at right, estimate the “K” service factor which is appropriate for your application.

<table>
<thead>
<tr>
<th>Type of Application</th>
<th>“K Range”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyor and augers where a static load must be started by the dynamic torque of the clutch.</td>
<td>K = 3 to 5</td>
</tr>
<tr>
<td>Hydraulic pumps where the clutch may have to work against pressure at time of engagement</td>
<td>K = 2.5 to 5</td>
</tr>
<tr>
<td>Gasoline or diesel engines where the clutch should be able to stall the engine.</td>
<td>K = 2 to 5</td>
</tr>
<tr>
<td>Air compressors</td>
<td>K = 2 to 4</td>
</tr>
<tr>
<td>Electric motors where the clutch should be able to stall the motor. Use the overload factor from the motor catalog or use.</td>
<td>K = 2 to 3</td>
</tr>
<tr>
<td>Light machines where the load is applied after the clutch is engaged, (e.g. a lathe)</td>
<td>K = 1.5 to 2.5</td>
</tr>
</tbody>
</table>
**Example**

A 10 horsepower pump driven by an electric motor operates at 1500 RPM. Using 3 as the value of the “K” factor, determine the required clutch torque capacity.

10 HP at 1500 RPM = 35 lb.ft. torque
“K” factor 3 x 40 lb.ft. = 105 lb.ft. torque.

This application will require a clutch with a static torque rating of 105 lb.ft.

Static torque can also be calculated by using the following formula:

\[
T = \frac{5250 \times HP \times K}{RPM}
\]

Where:
- \( T \) = Torque (lb. ft.)
- \( HP \) = Horsepower
- \( RPM \) = Speed of Clutch (revolutions per minute)
- \( K \) = Service factor (see chart on page 3)

**Example**

A truck mounted hydraulic pump requires 8 horsepower to operate at 2000 RPM. What is the required clutch torque rating?

Using a service factor of 5:

\[
T = \frac{5250 \times 8 \times 5}{2000}
\]

\[T = 105 \text{ lb.ft.}\]

A clutch with a static torque capacity of 105 lb.ft. is required for this application.

**Fluid Power Formula**

\[
T = \frac{5250 \times HP \times K}{RPM}
\]

\[
T = \frac{\text{CIR} \times \text{PSI}}{75.4}
\]

Where:
- \( T \) = Torque (lb. ft.)
- \( HP \) = Horsepower
- \( RPM \) = Speed of Clutch (revolutions per minute)
- \( \text{CIR} \) = Cubic inch per revolution (hydraulic pump)
- \( \text{PSI} \) = Pounds per square inch
- “K” = Service factor (see chart on page 3)

If HP is unknown:

\[
HP = \frac{\text{GPM} \times \text{PSI} \times .000583}{\text{Pump efficiency}}
\]

**Where:**
- \( \text{GPM} \) = Fluid flow in gallons per minute
- \( \text{PSI} \) = Pressure in pounds per square inch
- Pump efficiency = normally 85%

**Rule of Thumb:**

- 1 HP per gallon @ 1500psi
- .7 HP per gallon @ 1000psi

If PSI is unknown:

- 1 cubic inch per revolution equals 16 lb.in. of torque per 100 psi.
- 1 gallon equals 231 cubic inches.

**TYPICAL DYNAMIC TORQUE**

Dynamic Torque as Percent of Static Torque

\[
\text{FPM} = \frac{\text{RPM} \times 3.14}{12} \times \text{Diameter (of clutch)}
\]

---

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\]
Shafts

Warner Electric standard clutches are available to adapt to three different shaft configurations:

- **Straight bore** - for through shaft or end of shaft mounting.
- **Tapered bore (8:1)** - shaft tapers 1 1/2 inches per foot, for end of shaft mounting.
- **Tapered bore (4:1)** - shaft tapers three inches per foot, for end of shaft mounting.

Types of Drives

Warner Electric offers clutches which are compatible with the three basic types of drives.

- **Direct Drive**
  In direct drive arrangements, a drive shaft with a universal joint or other flexible coupling is attached to the engine crankshaft or transmission PTO on one end and the pump or compressor on the other. The clutch usually mounts on the pump or compressor. The “yoke drive” clutches in this section are equipped with flanges designed to bolt directly to a universal joint assembly. **Drive shaft alignment must be within 3°.**

- **Parallel Shaft**
  In parallel shaft applications, torque is transmitted from a drive or line shaft to the pump, compressor or other accessory which is mounted parallel to it. The straight bore clutches with bearing mounted fields are often used in this drive arrangement. Belt or chain drives are most frequently used in parallel shaft applications.

- **Belt Drive**
  The most common method of driving mobile accessories is through automotive or industrial belts. The driven accessory is parallel to and driven by a pulley mounted on the engine crankshaft. The relative diameters of the drive and driven pulleys, speed range of the engine, and required pump or compressor performance are all factors to be considered when selecting a belt driven clutch. Warner Electric clutches have AB grooved pulleys, which permit the use of either an A or B V-belt.
Electrical

Electrical Ratings
All current and resistance ratings are taken at ambient temperatures of 70°F (20°C).

Voltage Requirements
Warner Electric clutches are normally furnished with 12 VDC coils. Clutches can be designed to accommodate other voltages.

Current Draw
Current draw for each clutch model is listed in the product specifications section of this section.

Resistance/Heat Dissipation
Electrical resistance increases with coil temperature. Since the increase in electrical resistance reduces coil current, the torque transmitted by the clutch will be reduced. In applications where heat dissipation from the clutch is not adequate, air from an external source should be forced over the clutch to ensure proper operation. Most Warner Electric clutches shown in this section have been designed to operate in typical under hood temperatures.

Clutch Mounting
Warner Electric clutches are offered with flange or bearing mounts. Select the type best suited for your application based on the information below.

Bearing Mounted Clutches
Bearing mounted clutches are preassembled into a complete operating unit which is mounted directly to the shaft. In this design, the field is mounted on its own bearing as an internal part of the clutch and has an antirotation tang to prevent it from turning in operation. This antirotation tang is to be pinned LOOSELY to a member or held with a torque arm.

Flange Mounted Clutches
In a flange mount clutch application, the field is bolted directly to a fixed member on either the output (engine crankcase or electric motor) or the driven accessory (input). Mounting brackets and fixtures for a specific application must be designed in accordance with the clutch dimensions found in the specifications section to ensure proper perpendicularity and concentricity.

Clutch Location
Wherever possible, the clutch should be located on the higher speed shaft.

Clutch Rotation
Direction of drive can be a significant design consideration in applications with a peak load during clutch engagement. Warner Electric clutches incorporate leaf springs in the armature to transmit the load. When peak loads at start-up are possible, springs should be oriented so that they are placed in tension (stretch). Clutch rotation can be determined by observing the leaf spring direction on the armature.
Engine, Pump and Compressor Clutches- Dimensions

Tapered Bore Clutches
(Flange Mount, Single Row Bearing)

Field
(Common)

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<tr>
<th>A</th>
<th>Clutch Type</th>
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<th>X</th>
<th>Y</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Gage Line</th>
<th>Current(^1) Draw Amps</th>
<th>Resistance Ohms(^1)</th>
<th>Static Torque lb ft</th>
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\(^1\)Cold current draw  \(^2\)24V

Notes:
All dimensions are inches. All units 12V unless otherwise indicated.
Tapered Bore Clutches
(Flange or Yoke Direct Drive,
Double Row Bearing)

**Notes:**

All dimensions are inches.  
All units 12V unless otherwise indicated

Drive shaft alignment must be within 3° maximum.
(Clutch centerline must be within 3° of power source centerline)

<table>
<thead>
<tr>
<th>A</th>
<th>Clutch Type</th>
<th>Field Type</th>
<th>B</th>
<th>X</th>
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Cold current draw
Tapered Bore Clutches
(Flange Mount, Single Row Bearing)
Engine, Pump and Compressor Clutches- Dimensions

Tapered Bore Clutches
(Flange Mount, Double Row Bearing)

Fields

![Diagram of Tapered Bore Clutches]

Notes:
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All units 12V unless otherwise indicated

<table>
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<tr>
<th>A</th>
<th>Clutch Type</th>
<th>Field Type</th>
<th>B</th>
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¹Cold current draw  ²24V  ³Special terminal
Tapered Bore Clutches
(Flange Mount, Double Row Bearing)

Same Field as page 12

Notes:
All dimensions are inches.
All units 12V unless otherwise indicated

<table>
<thead>
<tr>
<th>A</th>
<th>Clutch Type</th>
<th>B</th>
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¹Cold current draw  ²24V
Tapered Bore Clutches
(Flange Mount, Double Row Bearing)

Notes:
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¹Cold current draw  ²24V
# Engine, Pump and Compressor Clutches- Dimensions

## Tapered Bore Clutches

(Flange Mount, Double Row Bearing)

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### Notes:

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<td>.841</td>
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<td>36°</td>
<td>.841</td>
<td>4.651</td>
<td>2.58</td>
<td>75</td>
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</table>

¹Cold current draw  "²24V  "³Special terminal
## Engine, Pump and Compressor Clutches - Dimensions

### Tapered Bore Clutches
(Flange Mount, Double Row Bearing)

![Diagram of Tapered Bore Clutches](image)

Same Field as page 12

![Diagram of Field](image)

**Field**
(1466-99 only)

<table>
<thead>
<tr>
<th>A</th>
<th>Clutch Type</th>
<th>B</th>
<th>Number of Grooves</th>
<th>X</th>
<th>Y</th>
<th>Groove Size</th>
<th>Gage Line</th>
<th>Current^1 Draw Amps</th>
<th>Resistance Ohms^2</th>
<th>Static Torque lb ft</th>
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<td>.841</td>
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<td>2.42</td>
<td>100</td>
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</tbody>
</table>

^1Cold current draw  ^224V  ^3A/B groove

**Notes:**
All dimensions are inches.
All units 12V unless otherwise indicated.
Engine, Pump and Compressor Clutches- Dimensions

Tapered Bore Clutches
(Special Construction, Flange Mount, Double Row Bearing)

Clutches on this page are specially constructed to withstand more severe operating environments. All dimensions are inches. All units 12V unless otherwise indicated.

<table>
<thead>
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<th>X</th>
<th>Y</th>
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<th>Resistance Ohms(^1)</th>
<th>Static Torque lb ft</th>
<th>Rotation</th>
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<td>Y</td>
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<td>.36°</td>
<td>.75</td>
<td>4.36</td>
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\(^1\)Cold current draw  \(^2\):8:1 Taper  \(^3\)A/B groove  \(^4\)24V
### Engine, Pump and Compressor Clutches - Dimensions

#### Straight Bore Clutches (Bearing Mount)

![Diagram of Straight Bore Clutches](image)

#### Armatures

- **A1**
  - 2x 328/.320 Dia. Holes
  - Equally spaced
  - 3.500 Dia. B.C.

- **A2**
  - 4x 1/4-20 UNC-2B
  - Equally spaced
  - 3.078 Dia. B.C.

#### Fields (Common)

- Typical antirotation tang to be pinned loosely to a member to prevent field rotation. Do not bolt rigidly.

---

#### Notes:

- All dimensions are inches.
- All units 12V unless otherwise indicated.

<table>
<thead>
<tr>
<th>Bore Size</th>
<th>Clutch Type</th>
<th>Armature Type</th>
<th>A</th>
<th>B</th>
<th>X</th>
<th>C</th>
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<th>Current (Amps)</th>
<th>Resistance (Ohms)</th>
<th>Rotation</th>
<th>Keyway</th>
<th>Model No.</th>
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1. Cold current draw
2. 90 Volts
Engine, Pump and Compressor Clutches - Dimensions

Straight Bore Clutches
(Bearing Mount)

1. [Diagram]
2. [Diagram]
3. [Diagram]
4. [Diagram]
5. [Diagram]
6. [Diagram]

A1
A2
A3

3.076 Dia. B.C.
4 x 1/4-20 UNC

3.50 Dia. B.C.
2 x .324

3.50 Dia. B.C.
4 x .284
Engine, Pump and Compressor Clutches - Dimensions

Straight Bore Clutches
(Bearing Mount)

Notes:
All dimensions are inches. All units 12V unless otherwise indicated.

<table>
<thead>
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<th>Clutch Type</th>
<th>Armature Type</th>
<th>Field Type</th>
<th>A Bore Size</th>
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<th>B Bore Size</th>
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<th>Y</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Static Torque</th>
<th>Current Draw</th>
<th>Resistance Ohms</th>
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1 Cold current draw
Engine, Pump and Compressor Clutches - Dimensions

Straight Bore Clutches
(Special Construction, Flange Mount)
(The clutches on this page include mounting hub)
Engine, Pump and Compressor Clutches - Dimensions

Mounting Hubs

**F1**

4x 5/16-24 UNF-2B

2x  M10X1.5-6H

ø4.173

ø2.300

ø1.160

**F2**

3.228

ø5.000

2x 3/8-16 UNF-2B

**F3**

2x M10X1.5-6H

Notes:

All dimensions are inches.
All units 12V unless otherwise indicated

F3 Mounting hub fits AA mount pumps

<table>
<thead>
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<th>Bore Size</th>
<th>Clutch Type</th>
<th>Mounting Hub Type</th>
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<th>B</th>
<th>X</th>
<th>Y</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Static Torque (lb ft)</th>
<th>Current Draw (Amps)</th>
<th>Resistance (Ohms)</th>
<th>Rotation</th>
<th>Keyway</th>
<th>Model No.</th>
</tr>
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</table>
Engine, Pump and Compressor Clutches - Dimensions

Straight Bore Clutches
(Special Constructions)

1

2

3

4

5

6
### Engine, Pump and Compressor Clutches - Dimensions

#### Fields

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<tr>
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<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
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<td><img src="image3.png" alt="Field F3 Diagram" /></td>
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<td><img src="image5.png" alt="Field F5 Diagram" /></td>
<td><img src="image6.png" alt="Field D1 Diagram" /></td>
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### Notes:

All dimensions are inches.  
All units 12V unless otherwise indicated.

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<th>Field Type</th>
<th>Drive Coupling</th>
<th>A</th>
<th>A Belt</th>
<th>B</th>
<th>B Belt</th>
<th>B X</th>
<th>Y</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Static Torque (lb ft)</th>
<th>Current Draw (Amps)</th>
<th>Resistance (Ohms)</th>
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<th>Model No.</th>
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1: Cold current draw  
2: 24V  
3: For Gresen pump only  
4: 13 tooth spline hub clutches must be installed on pumps with internal involute flat root side fit splines per ANSI-B92.1.  
Major diameter .901" max.
Engine, Pump and Compressor Clutches - Dimensions

Straight Bore Clutches
(Shaft Mount)
Engine, Pump and Compressor Clutches - Dimensions

Straight Bore Clutches
(Shaft Mount)

Fields

Notes:
All dimensions are inches.
All units 12V unless otherwise indicated

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<tr>
<th>Bore Size</th>
<th>Clutch Type</th>
<th>Field Type</th>
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<th>A Belt</th>
<th>B Belt</th>
<th>B</th>
<th>X</th>
<th>Y</th>
<th>C</th>
<th>D</th>
<th>Static Torque lb ft</th>
<th>Current Draw Amps</th>
<th>Resistance Ohms</th>
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1"Cold current draw  2Bracket mounting  24 Volt
For all models shown: E Nom. 1.18, F Max. .170, G Max. 1.20, H Max. 1.47.
Glossary

Acceleration Time, Engagement Time
The time required to change the speed of a system from the moment the clutch receives the appropriate electrical signal until the clutch is fully engaged and the system is moving at its maximum speed.

Bearing Mount
A clutch which is preassembled into a complete operating unit and is mounted directly to the shaft.

Brushholder
A clutch component which carries electrical current from the lead wires to the rotating magnet.

Build Up Time
The time in seconds required to build up to 90% of rated flux which corresponds to 80% rated torque.

Burnishing
The process of cycling or “wearing in” of clutch or brake friction surfaces. This process ensures rated torque during initial cycles, and decreases the cycles required from installation to full rated torque output.

Decay Time
The time in seconds required to decay to 10% of rated flux which corresponds to 1% of rated torque on de-energization of the unit.

Deceleration Time, Engagement Time
The time required to stop a system from the moment the brake receives the appropriate electrical signal until the brake is statically engaged and the system is at rest.

Field
A component part of Warner Electric clutches consisting of a steel shell and a coil. Also referred to as a magnet.

Flange Mount
A clutch which has the field bolted directly to a fixed member on the machine.

Flux
Magnetic attraction caused by an electrical current.

Gap
The distance between armature and rotor faces in clutches when the unit is in an inactive state (i.e. disengaged).

Integral Key
A key shaped directly into the bore of a clutch. This is sometimes used in place of a standard keyway and key.

K Factor
See service factor.

Poles
1. Refers to magnet poles: North/South poles.
2. The edges of a Warner Electric magnet or field shell through which the magnetic flux flows.

Pulley
A sheave that turns or is turned by a belt so as to transmit torque, rotation.

Rotor
The input member of a clutch/brake.

Service Factor
A figure by which torque is multiplied to ensure performance of the clutch under the worst case application conditions.

Tapered Bore (Shaft)
Many hydraulic pumps incorporate a taper on the output shaft, providing stronger clutch-to-shaft engagement than on straight shafts. Tapered shafts are most commonly in 4:1 and 8:1 taper ratios.

4:1 Taper: The shaft changes in diameter by one inch for each four inches of length.

8:1 Taper: The shaft changes in diameter by one inch for each eight inches of length.

Torque
Static: The torque which is developed when there is no relative motion or slippage between the mating friction surfaces. A clutch which is fully engaged and driving exhibits static torque. All standard units are rated on the basis of static torque after burnishing.

Dynamic: The torque developed when there is relative motion between the mating friction surface. The torque varies inversely with the amount of slip, so specific values must be taken from engineering data.

Residual Magnetism
The condition in magnets where low level magnetism remains after the electric current is removed.
Technical Considerations

Clutch Location
Wherever possible, the clutch should be located on the higher speed shaft.

Clutch Rotation
Direction of drive can be a significant design consideration in applications with a peak load during clutch engagement. Warner Electric clutches incorporate leaf springs in the armature to transmit the load. Where peak loads at start-up are possible, springs should be oriented so that they are placed in tension (or stretch).

Spring rotation can be determined by observing the leaf spring direction on the armature.

Electrical Ratings
All current and resistance ratings are taken at ambient temperatures of 70°F (20°C).

Fluid Power Formula
If you are sizing a clutch for a pump application, but do not know the HP required, the following formula will allow you to work back to the torque formula.

If HP is unknown:

\[
HP = \frac{GPM \times PSI \times 0.000583}{\text{Pump Efficiency}}
\]

Where:
- GPM = Fluid flow in gallons per minute
- PSI = Pressure in pounds per square inch
- Pump efficiency = normally 85%

Rule of Thumb:
- 1 HP per gallon @ 1500psi
- .7 HP per gallon @ 1000psi

If PSI is unknown:
- 1 cubic inch per revolution equals 16 lb.in. of torque per 100 psi
- 1 gallon equals 231 cubic inches

If GPM is unknown:

\[
GPM = \frac{\text{RPM} \times \text{DISP (IN^3)}}{231}
\]

Static Torque
The torque requirements for your particular application may be determined by using the following relationship:

\[
T = \frac{520 \times \text{HP}}{\text{RPM}}
\]

\[
T = \frac{\text{CIR} \times \text{PSI}}{75.4}
\]

Voltage Requirements
Most clutches and clutch/brakes require 12 VDC to operate at their maximum torque rating. Less than 12 VDC may cause clutch slippage and premature failure.

Abbreviations:
- T = Torque (lb. ft.)
- HP = Horsepower
- RPM = Speed of Clutch (revolutions per minute)
- CIR = Cubic inch per revolution
- PSI = Pounds per square inch
- “K” = Service factor
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Ogura (MA-7A)
Mobile Power Application Data Form

For Application Assistance, Phone 815-389-6369 or Fax 815-389-7648

Date _______________________________________________________________________________________________________

Company Name _____________________________________________________________________________________________

Address ____________________________________________________________________________________________________

City _______________________________________________________________________________________________________

Type of Application

_______________________________________________

_______________________________________________

_______________________________________________

Shaft Diameter (give limits)

☐ Straight ________________________________

☐ Taper _________________________________

Maximum Torque at Clutch

☐ Lb. Ft.

☐ HP at RPM’s _____________ _____________

☐ GPM at PSI _____________ _____________

Electrical System

☐ Regulated _________________________________

☐ Unregulated ______________________________

Clutch Duty Cycle

(Time On/Off)/Hr____________________________

Environment

Temp Range __________________ °F

Location___________________________________________

Quantity

Annual____________________________________________

Power Source (give HP and Mfg)

☐ Gas________________________________________

☐ Diesel_______________________________________

☐ Electric_______________________________________

☐ Other________________________________________

Driven Load (give parameters)

☐ Air Compressor_____________________________

☐ Pump_______________________________________

☐ Mower Deck_________________________________
The Power Of One, The Strength Of Many.

OTHER PRODUCT SOLUTIONS FROM
ALTRA INDUSTRIAL MOTION

Our comprehensive product offerings include various types of clutches and brakes, overrunning clutches, engineered bearing assemblies, gearing and gear motors along with linear products, belted drives, couplings and limit switches. With thousands of product solutions available, Altra provides true single source convenience while meeting specific customer requirements. Many major OEMs and end users prefer Altra products as their No. 1 choice for performance and reliability.
The Brands of Altra Industrial Motion

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  - www.ameridrives.com
- Bibby Turboflex
  - www.bibbyturboflex.com
- Guardian Couplings
  - www.guardiancouplings.com
- Huco
  - www.huco.com
- Lamiflex Couplings
  - www.lamiflexcouplings.com
- Stromag
  - www.stromag.com
- TB Wood’s
  - www.tbwoods.com

**Geared Cam Limit Switches**
- Stromag
  - www.stromag.com

**Electric Clutches & Brakes**
- Inertia Dynamics
  - www.idicb.com
- Matrix
  - www.matrix-international.com
- Stromag
  - www.stromag.com
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  - www.warnerelectric.com

**Linear Products**
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  - www.warnerlinear.com

**Engineered Bearing Assemblies**
- Kilian
  - www.kilianbearings.com

**Heavy Duty Clutches & Brakes**
- Industrial Clutch
  - www.indclutch.com
- Twiflex
  - www.twiflex.com
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**Belted Drives**
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**Gearing**
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- Delroyd Worm Gear
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- Nuttall Gear
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**Overrunning Clutches**
- Formsprag Clutch
  - www.formsprag.com
- Marland Clutch
  - www.marland.com
- Stieber
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