Selecting a Gearmotor in 4 Simple Steps

A Groschopp, Inc. White Paper
For design engineers in the process of selecting components for an application, the motor or gearmotor can be one of the more difficult components to source. There are so many types of motors and gearmotors all screaming for your attention and promising to be the “most efficient”, the “highest quality” or boasting about “high precision”. Groschopp uses 4 simple steps to lead designers to the best motor/gearmotor choice for a particular application. There are several key design parameters that should be considered when selecting a motor or gearmotor for a motion control application.

<table>
<thead>
<tr>
<th>Step</th>
<th>Purpose</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Determine application requirements</td>
<td>Use Application Checklist</td>
</tr>
<tr>
<td>2</td>
<td>Select motor type</td>
<td>Use Motor Quick Reference Guide</td>
</tr>
<tr>
<td>3</td>
<td>Select matching speed and torque output for gearmotor</td>
<td>Use vendor specifications and gearmotor curve</td>
</tr>
<tr>
<td>4</td>
<td>Ensure application yield strength and pull up torque match the application requirements</td>
<td></td>
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Table 1: Gearmotor Selection Process: steps to complete to ensure a gearmotor properly matches the application

As the motor or gearmotor selection process begins, the designer must gather the relevant technical and commercial requirements. This first step is often overlooked, but it is a critical component in the design process. The gathered design inputs information will then be used in the selection process and will dictate the ideal motor for the application. Failure to gather the proper inputs can lead the designer down an untended path. For this reason, it is helpful to use the Application Checklist (Table 2) when developing the motor specification. These parameters, along with some project specific requirements, will be helpful when navigating the selection process.

| Input Power Source | • Voltage  
|                   | • Frequency (measured in Hz)  
|                   | • Maximum Current (measured in amps)  
|                   | • Control Type (if applicable)  |
| Environment | • Ingress Protection (IP) Rating  
|             | • Ambient Temperature  
|             | • Application Temperature  |
| Gearmotor Specifications | • Size and Weight  
|                        | • Life Expectancy/Maintenance  
|                        | • Noise  |
| Gearmotor Performance | • Speed and Torque  
|                     | • Starting/Still Torque  
|                     | • Duty Cycle (“on” time and “off” time)  |
| General Requirements | • Mounting Orientation & Type (e.g. face)  
|                     | • Overhung and Side Loads  
|                     | • Envelope Size  
|                     | • Lubrication Selection (e.g. low-temperature grease or food-grade grease)  |

Table 2: Application Checklist - use this checklist to help formulate the specific requirements to ensure the gearmotor vendor has the critical information necessary to achieve the best match between the gearmotor and the application
Next, the designer must consider what type of motor technology best suits the intended application. Using the design inputs, the Motors Quick Reference Guide (Table 3) can be used as a selection matrix in the first step of the decision process. This reference guide details four common motor types and provides general information to consider when selecting each motor. Because each application has its own unique characteristics, it is important to determine which of the parameters (e.g. horsepower, efficiency, life, starting torque or noise ratings) are most important to the application under consideration. During the motor selection process, by looking at the required speed and torque of the application, it should become evident to the designer if the motor chosen requires a gearbox to meet the necessary requirements. If a gearmotor is necessary for the application, another level of complexity will be added and several additional criteria need to be evaluated.

Table 3: Motors Quick Reference Guide - provides a comparison of common parameters used during the motor selection process

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>UNIVERSAL</th>
<th>DC</th>
<th>AC</th>
<th>BRUSHLESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC, DC</td>
<td>8000-20000+</td>
<td>350-6000</td>
<td>1200-3400</td>
<td>2300-3800</td>
</tr>
<tr>
<td>SPEED (RPM)</td>
<td>UP TO 2.5 HP</td>
<td>0.01-0.52 HP</td>
<td>0.01-1.11 HP</td>
<td>0.08-0.43 HP</td>
</tr>
<tr>
<td>HORSEPOWER</td>
<td>55-70%</td>
<td>60-70%</td>
<td>40-80%</td>
<td>65-80%</td>
</tr>
<tr>
<td>EFFICIENCY</td>
<td>LOW</td>
<td>MEDIUM</td>
<td>VERY HIGH</td>
<td>VERY HIGH</td>
</tr>
<tr>
<td>LIFE</td>
<td>HIGH</td>
<td>MEDIUM</td>
<td>VERY LOW</td>
<td>VERY LOW</td>
</tr>
<tr>
<td>MAINTENANCE</td>
<td>NOISY</td>
<td>MEDIUM</td>
<td>QUIET</td>
<td>VERY QUIET</td>
</tr>
<tr>
<td>NOISE</td>
<td>POOR</td>
<td>FAIR</td>
<td>GOOD</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>SPEED REGULATION</td>
<td>VARIES</td>
<td>VERY HIGH</td>
<td>LOW-MEDIUM</td>
<td>VERY HIGH</td>
</tr>
<tr>
<td>STARTING TORQUE</td>
<td>VARIES</td>
<td>BRAND NEW</td>
<td>LOW-MEDIUM</td>
<td>BRAND NEW</td>
</tr>
</tbody>
</table>

Conceptually, motors and gearboxes can be mixed and matched as needed to best fit the application, but in the end, the complete gearmotor is the driving factor. There are a number of motors and gearbox types that can be combined; for example, the right angle worm, planetary and parallel shaft gearboxes can be combined with permanent magnet DC, AC induction, or brushless DC motors. Though there are a vast number of different motors and gearboxes combinations available, not just any one will work for the application. There will be certain combinations that will be more efficient and cost-effective than others. Knowing the application and having accurate ratings for the motor and gearbox is the foundation for successfully integrating the gearmotor into the system.

As the designer looks at selecting a gearmotor, there are two methods that can be used.

- Method 1: Select motor and gearbox separately and assemble
- Method 2: Select a pre-engineered gearmotor
While both methods 1 and 2 are effective means of finding the most compatible gearmotor, Method 2 reduces design time and project risk for the designer. When selecting a pre-engineered solution, the manufacturer has done much of the heavy lifting to ensure that the motor and gearbox combination will work properly together. Since performance calculations and testing have been performed by the manufacturer, gearmotor failures caused by miscalculations or improper component matching will be minimized. Due to the complexity of Method 1 this article focuses on Method 2.

Once again, looking back to the gearmotor performance data gathered from the Application Checklist (Table 2), the speed and torque required for the application is critical in selecting the gearmotor combination. Using the speed and torque measurements the designer can then select the manufacturer’s performance curves that match the application needs. The gearmotor curve (Figure 1) combines the performance of the motor and gearbox by displaying speed, torque and efficiency. If a complete gearmotor assembly is purchased from a manufacturer this curve is provided by the vendor.

Finally, after selecting a few performance curves that appear to meet the application needs, it is important to review the design limitations. Look for the following information in the manufacturer’s performance calculations and use it to determine if the chosen gearmotor will cause any issues within the application.

Thermal characteristics

- Full-load gearbox torque
- Gearbox input speed
- Gearbox yield strength
- Intermittent duty considerations

Figure 1: Gearmotor Performance Curves - the Speed / Torque and Efficiency / Torque curves for a PM gearmotor
Once the gearmotor has been chosen and installed in the application, it is critical to perform several test runs in sample environments that best reflect typical operating scenarios. If extreme motor heat, unnatural noises or obvious motor stress occurs repeat the motor selection process or contact the manufacturer. It’s important to take the time and put in the effort to properly select a motor because a hasty decision and lack of testing can cause a host of problems with the gearmotor and could possibly damage the application.

Though the gearmotor selection process can be arduous, a properly selected gearmotor can last for years and will optimize the application to its peak potential and efficiency. From a company perspective, an optimal gearmotor will also reduce operating costs and increase plant productivity. Chances are, we’ve got the one you need!

>> Need more motor selection help? Read our motor & gearmotor selection whitepaper, or read the rest in our series of motor selection blog posts. Or, submit your application specs and we’ll contact you to discuss your best solution.
POWERFUL ONLINE TOOLS AND RESOURCES
Available on our website: www.groschopp.com

MOTOR SEARCH TOOL
- Web based software
- Sophisticated algorithms to calculate and match various search parameters
- 8000 proven product platforms and over 154,000 possible product configurations
- Allows a specific range for searching speed, torque and power

STPe CALCULATOR: SPEED, TORQUE AND POWER
- Web based tool that is available for download
- Simplifies fractional horsepower motor and gearmotor selection for our engineers.
- Quickly calculates speed, torque and power
- Conversions are automatically and accurately generated

DATA SHEETS AND OUTLINE DRAWINGS
- Program developed by Groschopp engineers
- Provide a comprehensive overview of a motor or gearmotor’s specifications.
- Calculates speed-torque curves in reference to different temperatures, efficiency curves, and additional specification breakdowns.

ONLINE CUSTOMIZATIONS
- Match the motor to your application as closely as possible
- Working from a standard frame size is typically the most cost effective approach when customizing a motor
- Delivery times are quicker when basing off of a standard frame size

VIDEOS, WHITEPAPERS & BLOGS
- Resources to help you understand our company and what we do
- Helpful tips for motor care and preservation