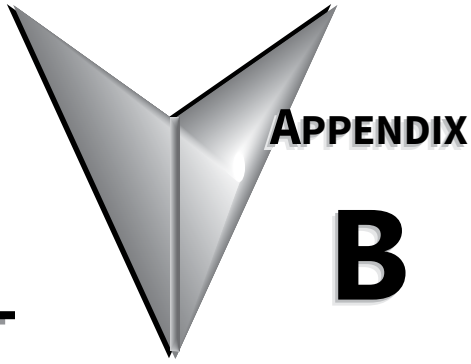
Gearbox Selection



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Gearbox Selection Steps

1) Determine the torque and speed required for the load.
2) Determine the overall speed ratio of motor speed to load speed.
3) Determine the gearbox ratio as well as any reduction outside the gearbox (pulleys, gears, etc.).
4) Determine the applicable service factor and overhung load K factor.
5) Determine the gearbox real output torque required, and select a gearbox with a higher Maximum Thermal output Torque rating (for WG cast-iron gearboxes; not applicable for WGA aluminum gearboxes).
6) Determine the gearbox design output torque required (torque with service factor applied), and select a gearbox with a higher Maximum Mechanical Output Torque rating. (Gearbox must also meet requirement #5.)
7) Determine the required sizes of pulleys, gears, etc., and determine the overhung load force. Select a gearbox with a higher Overhung Load rating. (Gearbox must also meet requirements #5 & #6.)
8) Confirm that the selected gearbox meets the applicable system requirements.
9) Select a compatible motor.

Gearbox Selection Example

(Refer to the specifications tables for gearbox specifications, service factors, and K factors.)

A conveyor will run 10 hours/day with moderate shock loading. The conveyor will be driven by a V-belt and needs to be driven at approximately 20 rpm. The motor to be used will have a nominal speed of 1800 rpm (1725 rpm actual speed). The conveyor will require 2700 in·lb of torque.

1) Required **torque** = 2700 in·lb; required **speed** = 20 rpm.
2) Determine the **overall speed ratio** of motor speed to load speed:
   Overall speed ratio = motor speed / load speed = 1725 / 20 = 86.25 [about 86:1]
3) Determine pulley ratios at available gearbox ratios:
   Gearbox ratio = (overall speed ratio) / (pulley ratio)
   Pulley ratio = (overall speed ratio) / (gearbox ratio)
   = (conveyor pulley diameter) / (gearbox pulley diameter)
   For ~~5:1 gearbox~~: pulley ratio = 86.25 / 5 = ~~17.25~~ [17.25" pulley ratio is prohibitively large]
   For 10:1 gearbox: pulley ratio = 86.25 / 10 = 8.63
   For 15:1 gearbox: pulley ratio = 86.25 / 15 = 5.75
   For 20:1 gearbox: pulley ratio = 86.25 / 20 = 4.31
   For 30:1 gearbox: pulley ratio = 86.25 / 30 = 2.88
   For 40:1 gearbox: pulley ratio = 86.25 / 40 = 2.16
   For 60:1 gearbox: pulley ratio = 86.25 / 60 = 1.44
   For 80:1 gearbox: pulley ratio = 86.25 / 80 = 1.08
4) Determine **service factor (SF)** and **overhung load factor (K)** from applicable tables:
   SF = 1.25 due to moderate shock loading and 3-10 hours/day operation
   K = 1.5 due to V-belt

5) Use specifications table to select gearbox with
Max Thermal* Torque rating > required real torque:
Gearbox required real torque = (final torque) / (pulley ratio)

For 10:1 gearbox:	(2700 in·lb) / 8.63 = 312.86 in·lb;	use WG-175-x or larger
For 15:1 gearbox:	(2700 in·lb) / 5.75 = 469.57 in·lb;	use WG-175-x or larger
For 20:1 gearbox:	(2700 in·lb) / 4.31 = 626.45 in·lb;	use WG-206-x or larger
For 30:1 gearbox:	(2700 in·lb) / 2.88 = 937.50 in·lb;	use WG-325-x or WGA-63M*
For 40:1 gearbox:	(2700 in·lb) / 2.16 = 1250.0 in·lb;	use WG-325-x
For 60:1 gearbox:	(2700 in·lb) / 1.44 = 1875.0 in·lb;	use WG-325-x

* *Aluminum gearboxes do not have thermal ratings; use mechanical ratings.*

6) Use specifications table to select gearbox with Max Mechanical Torque rating > required design torque:
Gearbox required design torque = (real gearbox torque)(service factor)

For 10:1 gearbox:	(312.86 in·lb)(1.25) = 391.08 in·lb;	use WG-175-x or larger
For 15:1 gearbox:	(469.57 in·lb)(1.25) = 586.96 in·lb;	use WG-206-x or larger
For 20:1 gearbox:	(646.45 in·lb)(1.25) = 808.06 in·lb;	use WG-206-x or larger
For 30:1 gearbox:	(937.50 in·lb)(1.25) = 1178.88 in·lb;	use WG-325-x or WGA-63M
For 40:1 gearbox:	(1250.0 in·lb)(1.25) = 1562.50 in·lb;	use WG-325-x
For 60:1 gearbox:	(1875.0 in·lb)(1.25) = 2343.75 in·lb;	use WG-325-x

7) Use the gearbox overhung load ratings from the specifications table to determine the minimum allowable pulley diameters. Select gearbox with **Overhung Load rating > overhung load force**:
Gearbox required OHL rating = (gearbox real torque)(K)(SF)/(gearbox pulley diameter / 2)
Minimum gearbox pulley diameter = (T)(K)(SF)(2)/(OHL rating)
Conveyor pulley diameter = (gearbox pulley diameter)(pulley ratio)

For 10:1, WG-175-010-x gearbox:
Minimum gearbox pulley diameter = (312.86 in·lb)(1.5)(1.25)(2)/(650 lb) = 1.8" [use 2"]
Conveyor pulley diameter = (2")(8.63) = ~~17.26"~~ [17.26" pulley size is prohibitively large]
Determine pulley sizes and OHL for next larger gearbox ratio.

For 15:1, WG-206-015-x gearbox:
Minimum gearbox pulley diameter = (469.57 in·lb)(1.5)(1.25)(2)/(700 lb) = 2.5" [use 2.5"]
Conveyor pulley diameter = (2.5")(5.75) = 14.38" [use 14.4"]
Select **WG-206-015-x gearbox, 2.5" gearbox pulley, and 14.4" conveyor pulley.**

For 20:1, WG-206-020-x gearbox:
N/A – All gearboxes of the same frame size are the same price, yet the smaller ratio gearboxes offer higher efficiency and power characteristics than higher ratio gearboxes. Therefore, the WG-206-015-x gearbox is preferable over the WG-206-020-x gearbox for this application.

For 30:1, WGA-63M-030-H1 gearbox:
Minimum gearbox pulley diameter = (937.50 in·lb)(1.5)(1.25)(2)/(736 lb) = 4.78" [use 5"]
Conveyor pulley diameter = (5")(2.88) = 14.40" [use 14.4"]
N/A – WGA-63M & WG-325-x gearboxes cost more than WG-206

For 40:1, WG-325-040-x gearbox:
N/A – WG-325-xxx gearboxes cost more than WG-206 at any ratio

For 60:1, WG-325-060-x gearbox:
N/A – WG-325-xxx gearboxes cost more than WG-206 at any ratio

8) **Check results** against original speed and torque requirements:
   a) Conveyor speed = (motor speed) / (gearbox ratio)(pulley ratio)
      = (1725 rpm) / (15)(14.4”/2.5”) = 20 rpm
   b) Maximum real torque available at conveyor = (gearbox thermal torque)(pulley ratio)
      = (673 in·lb)(14.4”/2.5”) = 3876 in·lb
   c) Maximum design torque available at conveyor
      = (gearbox mechanical torque)(pulley ratio) / (service factor)
      = (1002 in·lb)(14.4”/2.5”) / 1.25 = 4617 in·lb

The speed is correct as required, and both maximum torque values are greater than the 2700 in·lb required by the load.

9) **Select** a **motor** and check torque transmitted to the load:
From the gearbox spec tables, WG-206-015-x efficiency = 85%.
maximum thermal input power = 1.40 hp
maximum mechanical input power @ 1.0 SF = 2.09 hp
maximum mechanical input power @ 1.25 SF
= (rated max mechanical input power) / (SF) = 2.09 hp / 1.25 = 1.67 hp
maximum allowable motor power = 1.40 hp; select nominal 1hp motor

Select **1hp motor**, and check for adequate torque at the load:

Torque = Power / Speed *[conversion factor: (1hp) = (63,025 in·lb·rpm)]*

Torque $_{load}$ = (63,025 in·lb·rpm/hp)(gearbox input hp)(gearbox efficiency) / (motor rpm / (gearbox ratio)(pulley ratio))
= (63,025)(1)(0.85) / (1725 / (15/1)(14.4/2.5)) = ~~2683 in·lb~~ [insufficient torque at load]
This torque value is less than the 2700 in·lb required by the load.
So, select and check the next larger nominal motor size, which is 1-1/2 hp.
Since the 206 frame size, 15-ratio gearbox does not meet the required 1-1/2 hp thermal rating, choose the WG-237-015-x gearbox.

Select **1-1/2 hp motor** and **WG-237-015-x gearbox**, and check for adequate torque:
WG-237-015-x gearbox efficiency = 84%
maximum thermal input power = 1.55 hp
maximum mechanical input power @ 1.25 SF = 2.64 hp / 1.25 = 2.11 hp
maximum allowable motor power = 1.55 hp; nominal 1-1/2 hp motor
gearbox ratio is still 15:1, and OHL rating is increased to 900 lb,
so the previous pulley calculations [step 7] remain sufficient
[smaller pulleys can be calculated and selected for this gearbox, if desired]
Torque = Power / Speed *[conversion factor: (1hp) = (63,025 in·lb·rpm)]*
T_{load} = (63,025 in·lb·rpm/hp)(1.5hp)(84%) / (1725 rpm / (15/1)(14.4/2.5))
= 3977 in·lb > 2700 in·lb; **sufficient torque at load**

Final gearbox and motor selection: 1-1/2 hp motor WG-237-015-x gearbox