LET'S TALK WINCHES

The theory behind them, how they should be installed and the way this affects the loading and performance of the winch.

Winch Loadings

Below are our definitions of winch loadings

MWL: Max Working Load (the load the winch can pull under our no-stop endurance design validation test)

BL: Break Load (the load the winch can take statically before damaging permanently a component)

BL, as defined above, can be affected by a number of factors:

- The load history of the winch,
- The deck mounting fasteners stiffness and strength,
- The deck stiffness,
- The load entry angle and height

All Harken winches have a BL exceeding 150% of their MWL as per our definition of BL above if a component failure happens between 150% and 200% MWL, that failure is not structural. So structural failures have a minimum safety factor of 200% the winch MWL

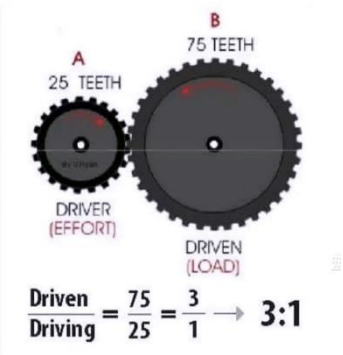
Smaller winches normally have the deck bolts fixings as their first failing component and their BL can exceed 300% of their MWL.
Going bigger in winch size, the first component to fail moves from being the fixings on the deck to be the final pinion, or its bearing set. These component failures will stop the winch from working but in a safe way, much like a fuse.

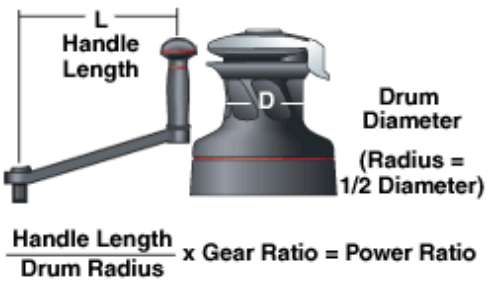
Power Ratio

Power ratio is the term we use to describe the ability of winches to pull a load. Harken uses a winch's power ratio as the winch name. For example, a 48 has a power ratio of 48:1 in the final gear. This means a kilo of handle input, generates 48 kilos of power.

Calculating Power Ratio (PR)

PR is calculated as follows: (Handle Length / Drum Diameter) x Gear Ratio = PR





Speed and Power Inversely Related

In winches, as in any simple machine, speed and power are inversely related. If you want fast trimming, you will have lower power. If you want high power, you will have slow trimming. This is the reason that all moderate and large winches are offered with two or three speeds. For light loads, you can use a fast speed that doesn't offer much power, and as the load increases, shift to a higher power and trim the last few feet at lower speed.

- Low Power = Fast Trim (Light Loads)
- High Power = Slow Trim (High Loads)

Winch Speed

When we talk about speed in a winch, it refers to the amount of line that is pulled for each revolution of the handle. The primary considerations in determining winch speed are the gear ratio and the drum circumference. Since the line is wrapped on the drum, each revolution of the winch will pull in an amount of line equal to the circumference of the drum (Circumference = pi x diameter).

When you are looking for a "fast" winch, you will use a wide body winch with a large diameter drum. Unfortunately, since the drum diameter is also a function of the power ratio, the wide body winch will offer less power for the same gear ratio. The average racing boat that uses wide body winches compensates for this loss of power by a pedestal system that increase the amount of human input available.

- Wide Drum Diameter = High line speed; low power
- Short Winch Handle = High line speed; low power

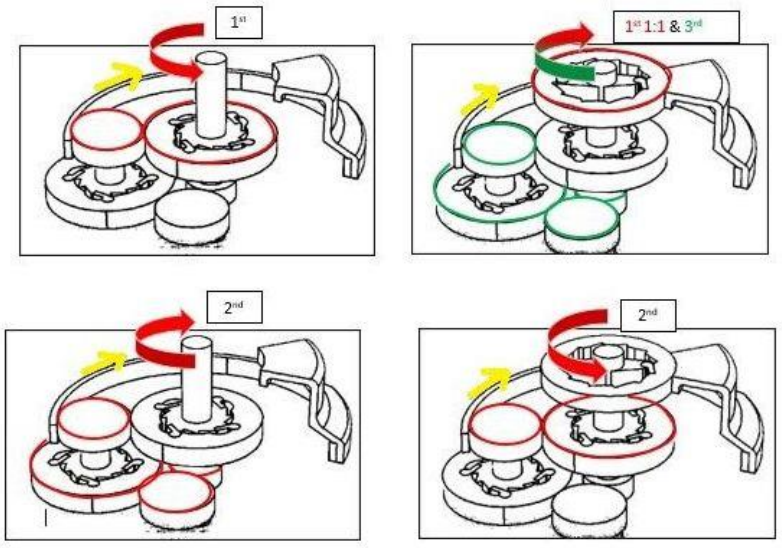
Faster Speeds

Faster winch speeds can also be achieved with three- and four-speed winches. A typical smaller three-speed winch, like the 65.3ST offers direct drive in first speed. The drum turns one revolution for each revolution of the handle, so under low loads, sheets can be trimmed very fast. While this speed is not geared, there is a slight mechanical advantage obtained from the relationship between the lever (handle) and the drum diameter. Larger three-speed winches, from the 990.3 up, are typically being specified with a reduced 1st Speed, this adds additional mechanical advantage and also increase the working load of the winch in 1st Speed.

For example, in light air upwind, or for most spinnaker trimming, you might well choose a direct drive for very fast trimming, while for hoisting a wet spinnaker in a breeze a reduced 1st speed would be an advantage.

An example of how 2 and 3 speed winches operate is below, the Yellow arrow indicates the drum direction,

2 Speed Winch | **3 Speed Winch**

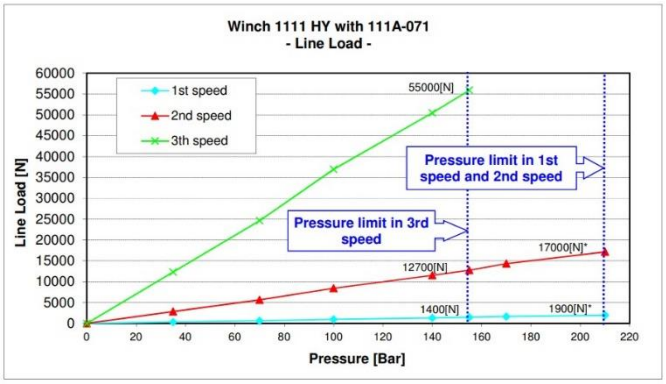


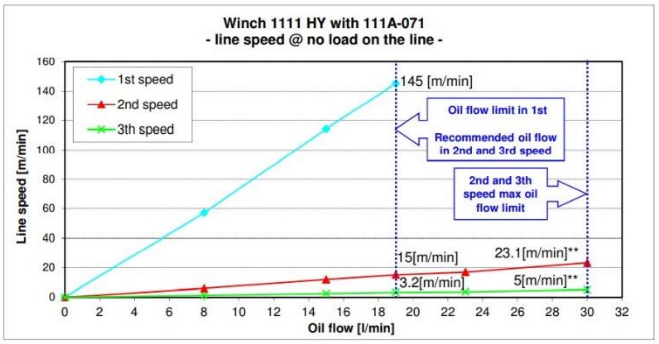
Handle Length

Another way to increase the speed of a winch is to use a shorter handle, typically an 8" (203 mm) handle. The 8" handle is faster because it swings in a smaller arc and a crew can rotate the handle faster. The same power problem is experienced, though, as handle length is a part of the power ratio calculation and decreasing the handle length 20% reduces power by 20%. Still, the 8" handle is a very effective and inexpensive means of increasing winch speed in light and moderate conditions.

Flow and Pressure

With a Hydraulic system the flows and pressures can be tunes to give maximum performance. It must be noted however that if a winch is run at or near to its limits a full proactive service program must be used. An example of the Pressure and Flow diagrams are below, these re used to tune the winches performance.





Alignment

Line entry at final drive gear location = decreased load on gear housing and drum bearings

Ls = Sheet load
Lgh = Gearing housing load
Ldp = Drive pinion load

Let's look at two examples: One with the load aligned properly and one with the opposite situation. In case A, with the proper alignment, the load on the gear housing is minimized since Ls and Ldp are in opposite directions. In case B, where the load is improperly aligned, the load on the drive gear is maximized — Lgh + L1 + Ldp — but this time the loads are in the same direction and adding up.