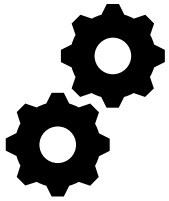
Gearbox

Gearboxes are a common transmission element, used either to step up the output torque and step down the speed, or to step down the output torque and step up the speed.

There are several different kinds of gearbox, each suited to different applications, and their designs can become quite complex. However, the simplest gearboxes are most common and use a single reduction stage, with spur or helical gears.



For equipment using a gearbox, the reduction ratio should be entered in the equipment information table under Transmission Element: Gearbox. The transmission ratio should be entered in the top row (as speed out / speed in). If the number of teeth of the driver is known, this too should be entered. This allows the P100 to calculate gear meshing frequency.

In some cases, *in a single stage gearbox*, the only information available is the number of teeth on the driver and driven gears. You should then input the transmission ratio according to the following formula:

$$T_{driver} / T_{driven}$$

Here T_driver and T_driven are the number of teeth on the driver and driven gears respectively. If the gearbox has *multiple reduction stages* then the total reduction ratio should be entered, found by multiplying together the reduction ratios of each stage. Alternatively, the total transmission ratio can be found in the gearbox manual.

If none of this information is available, then it is reasonable to estimate the transmission ratio by dividing an estimate of output speed (in RPM) by the motor rated speed (in RPM). Motor rated speed is given on the motor plate, and output speed can be either a good guess or can be estimated by counting revolutions over a minute. The P100 will attempt to match peaks in the frequency spectrum that approximately match the input transmission ratio (giving a higher confidence for a perfect match).

Cause

Gearbox problems can be caused by poor installation or adjustment (such as incorrect alignment), excessive loads (especially transient loads), and lubrication defects (insufficient, degraded, or dirty lubricant). These problems can lead to micropitting or fretting of the gear teeth, or axial cracks in the gear. Broken gear teeth will cause an uneven torque to be put on the driven equipment, and at this point the gearbox is in a very poor condition.

Effect

Gearbox problems can be expensive if they lead to failure; and a severe problem may cause the gearbox to jam and fail completely. However, early detection of faults allows simple and effective ‘proactive maintenance’ that can avoid failure and costly interventions. Typical tasks are precision alignment and improved lubrication.

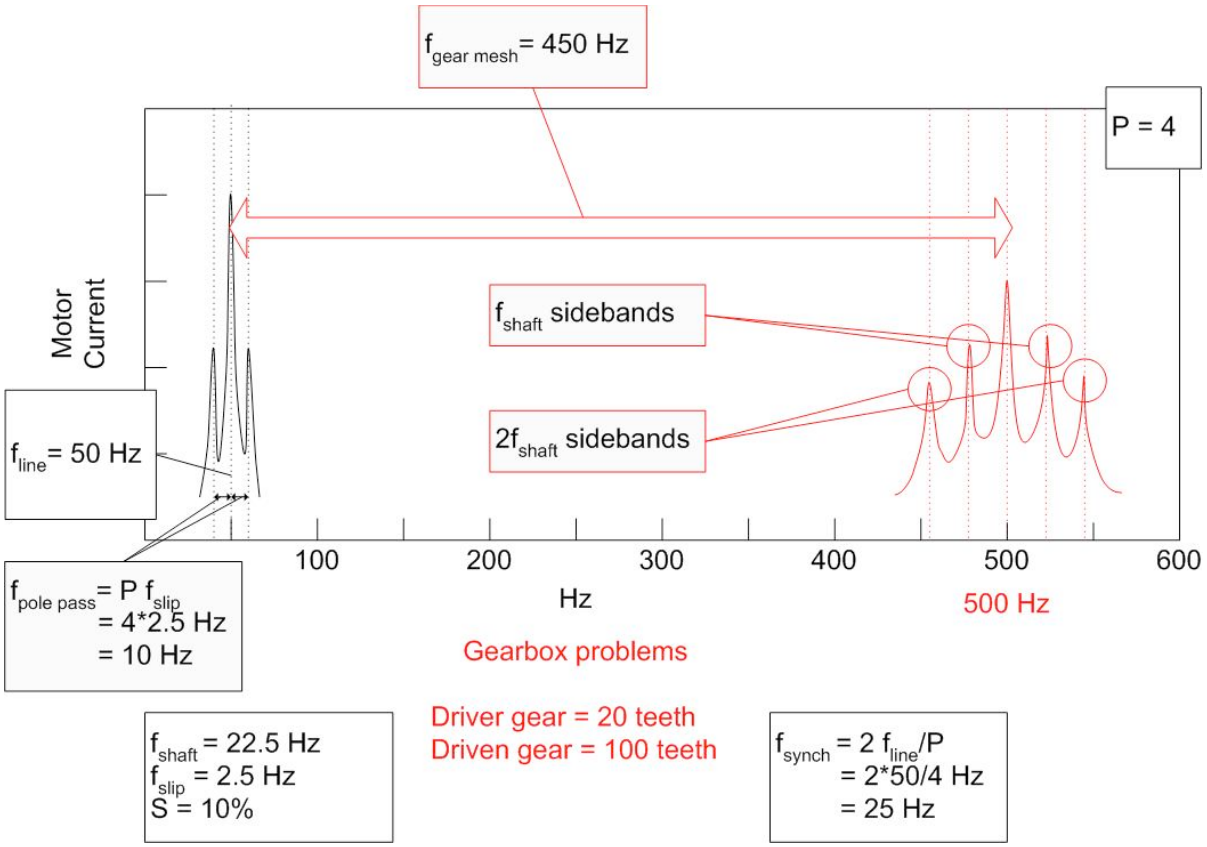
Furthermore, gearbox inefficiencies can vary hugely and losses of up to 10% are not unreasonable. Certain types or gear (worm gears) are fundamentally inefficient, and here an energy efficiency saving may not be a priority. However, gearboxes using bevel gears are likely to be 90% efficient (or higher) if well maintained, and so a 10% loss in efficiency would be noticeable.

Diagnosis

Diagnostic parameters - Belt/blade/trans element/driven equipment

In the PSD, gearbox problems show characteristic frequency peaks centred on the gear mesh frequency (driver speed times number of teeth on driver). Sidebands at multiples of shaft speed on this gear mesh frequency are strong indicators of tooth wear or damage. Physical parameters such as power factor and RMS current are also valuable to indicate whether power consumption has increased, as a result of greater losses in the gearbox.

The P100 trend value "Transmission Element" represents gearbox health – and the diagnostic algorithms will perform better if the gearbox information is entered in the Equipment Information table.



Action

Proactive maintenance tasks should be prioritised. These include laser alignment and proper lubrication. Oil analysis/ lube testing should be carried out if there appears to be a developing gearbox problem.