Journal Bearing Description

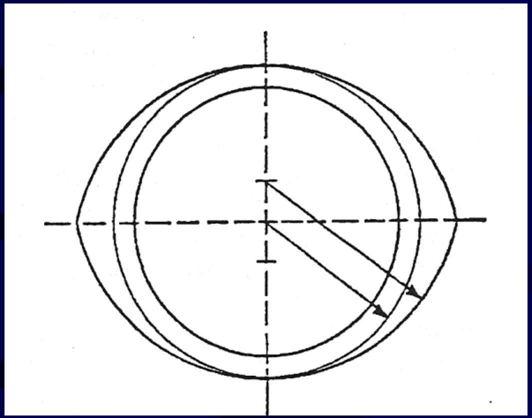
- Most rotor support bearings are either antifriction or journal type
  - Antifriction – ball or roller type bearings
  - Journal – oil lubricated hydrodynamic type

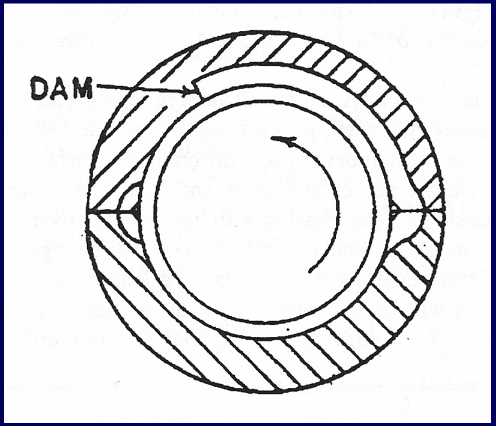
Ray Kelm, PE
President/Chief Engineer
Kelm Engineering, LLC

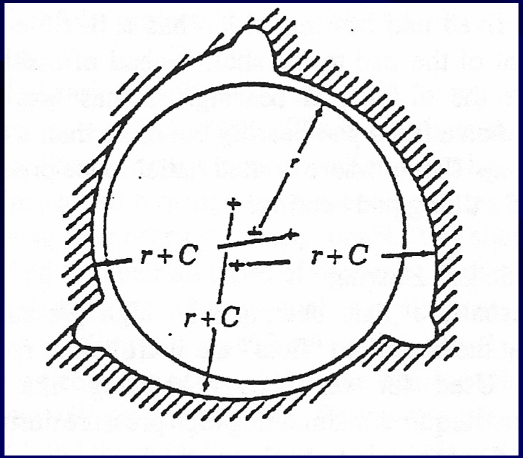
Common Uses for Journal Bearings

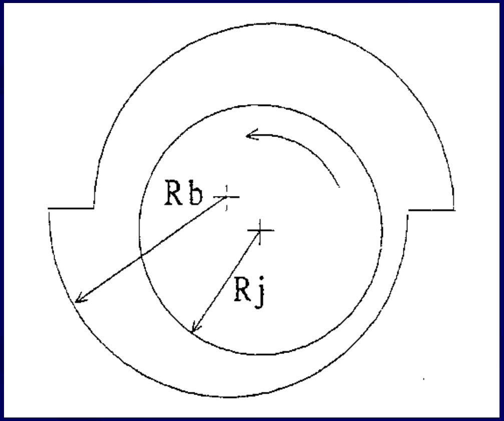
- Larger or higher speed machines
- Machines that must operate above a critical speed

Different Bearing Profiles

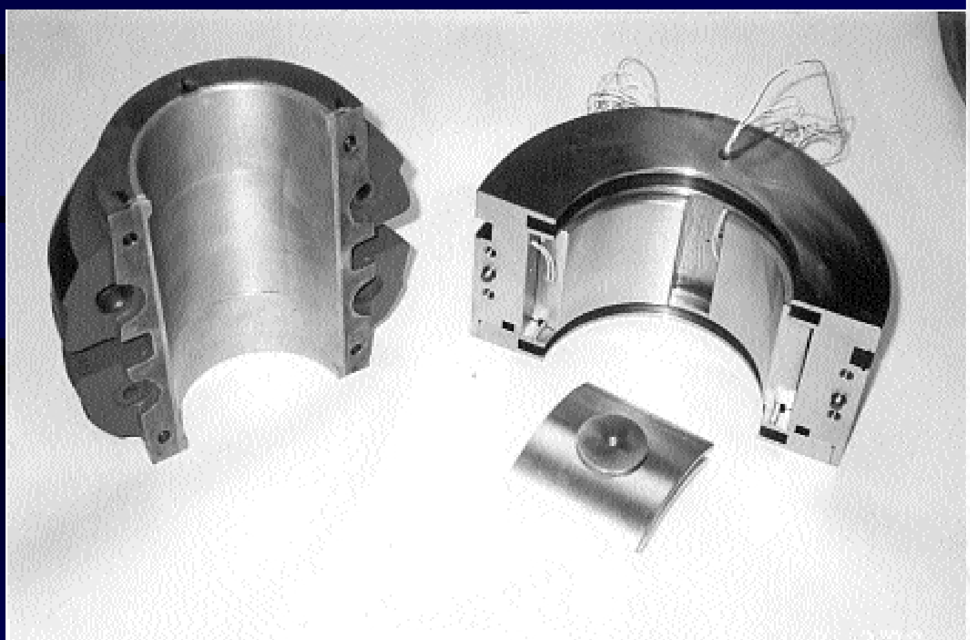


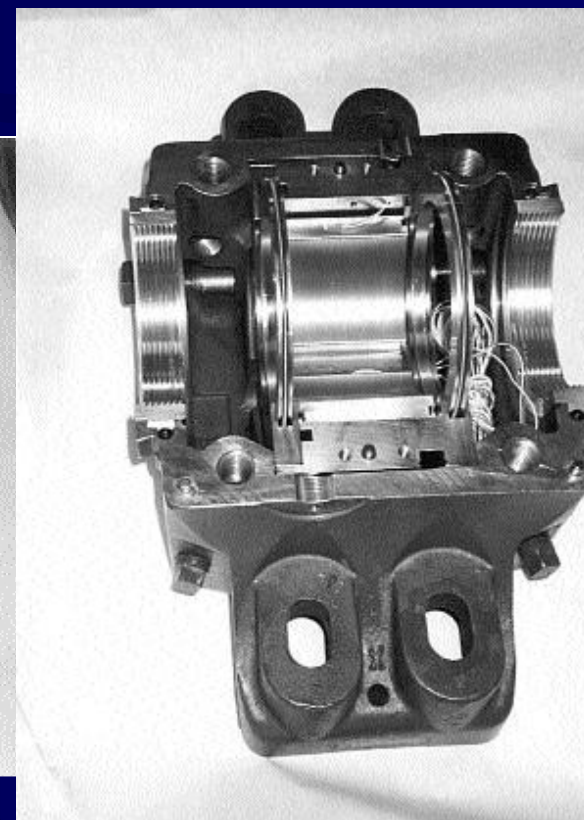




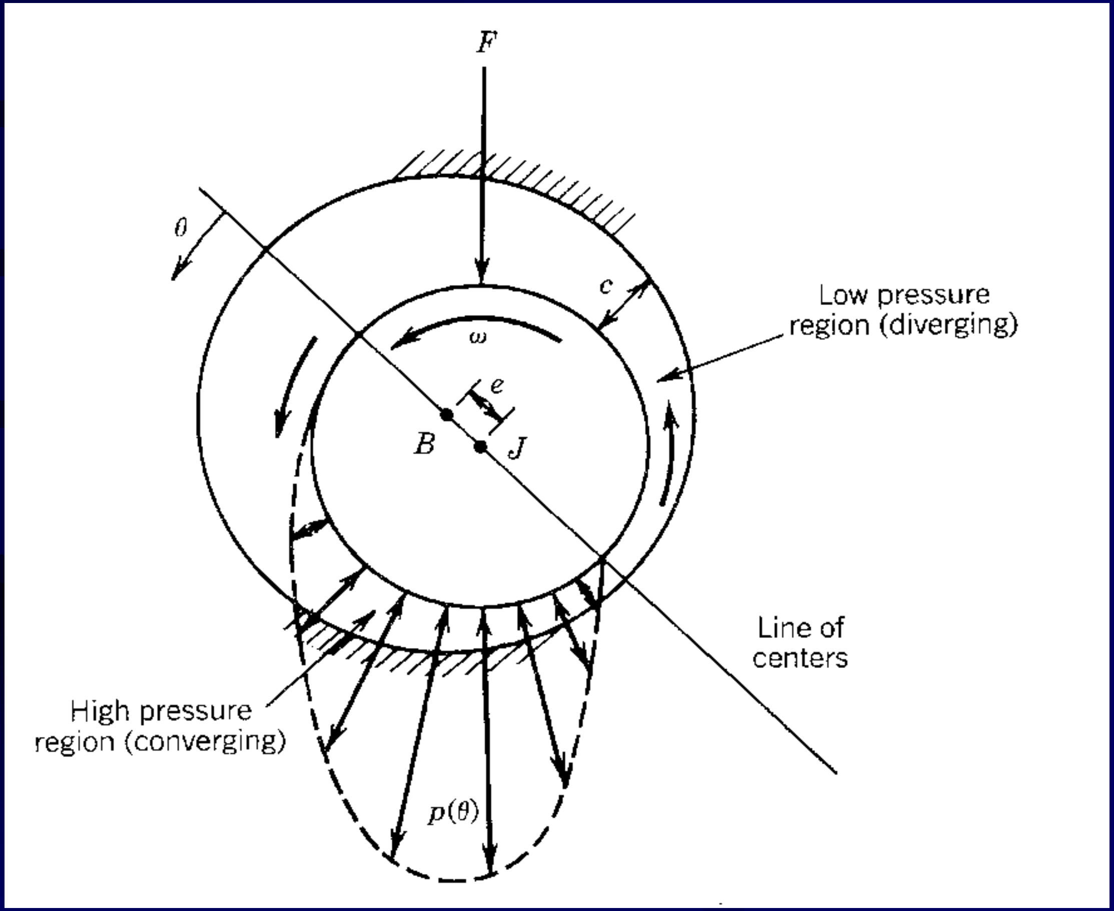


Examples of Journal Bearings

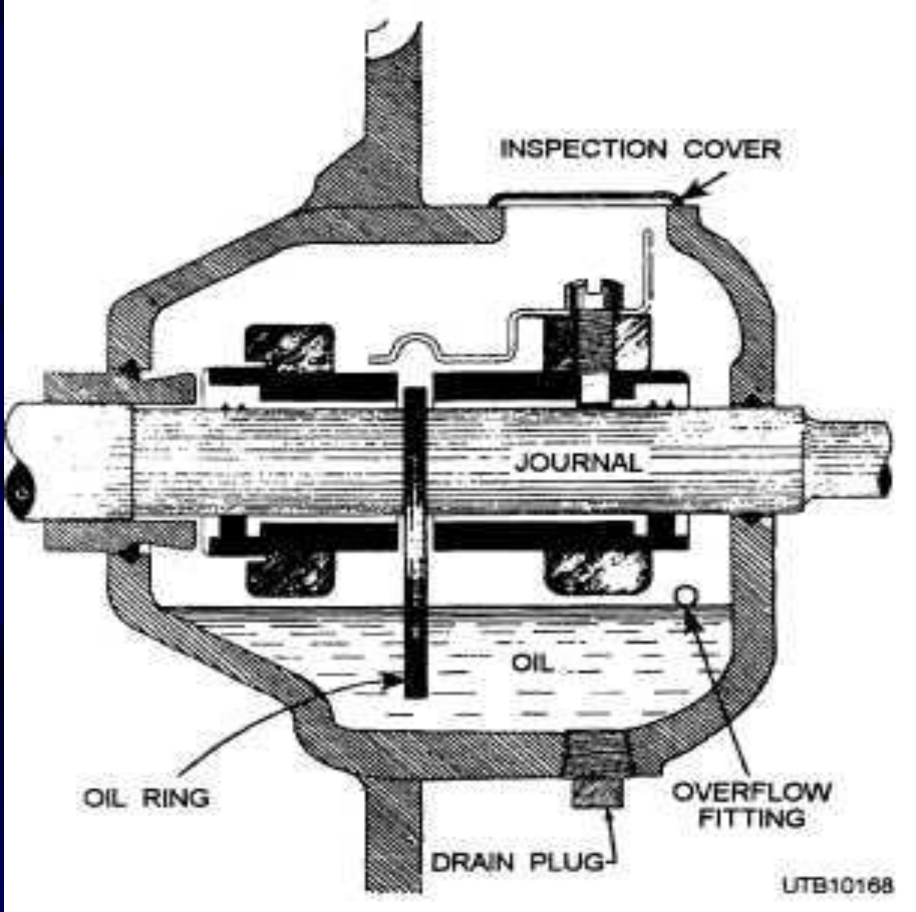




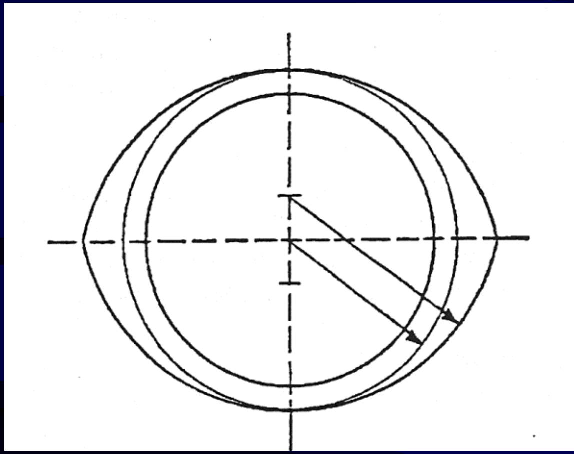
How a Journal Bearing Works

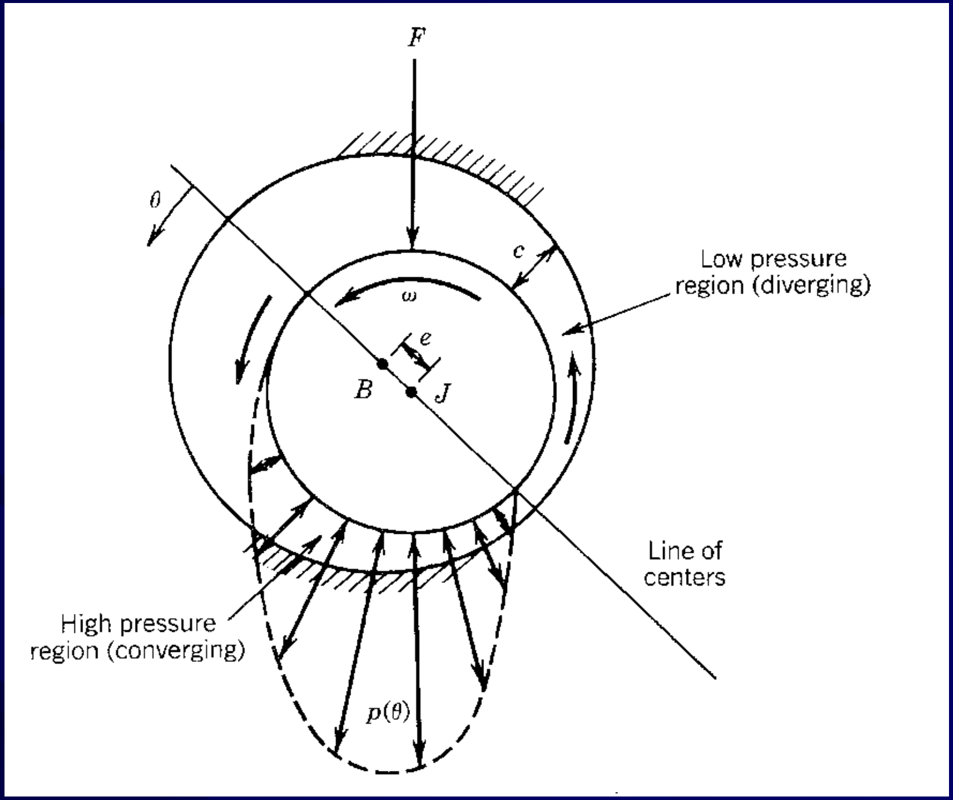


Oil Ring Lubrication

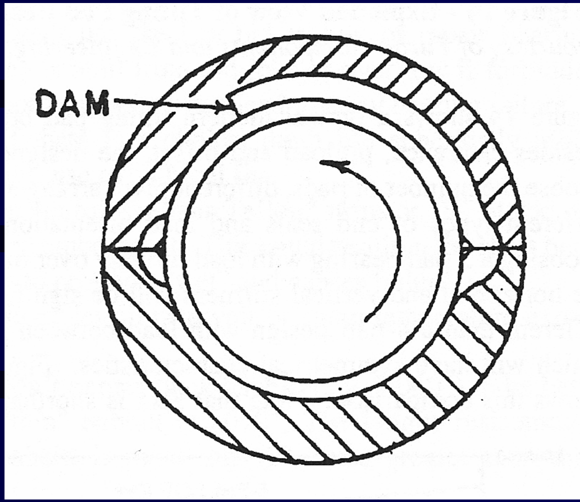


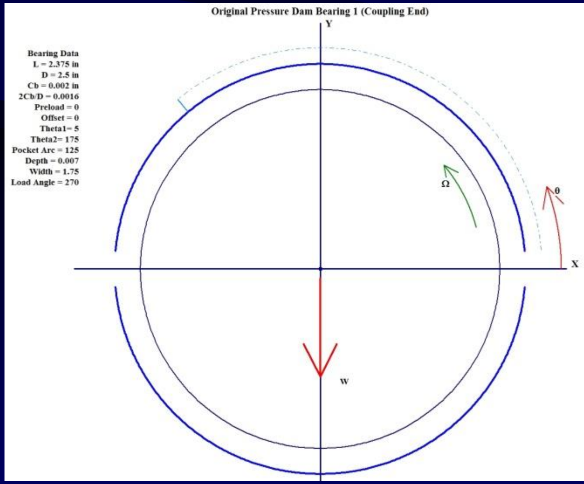
Plain Sleeve/Lemon Bore Type

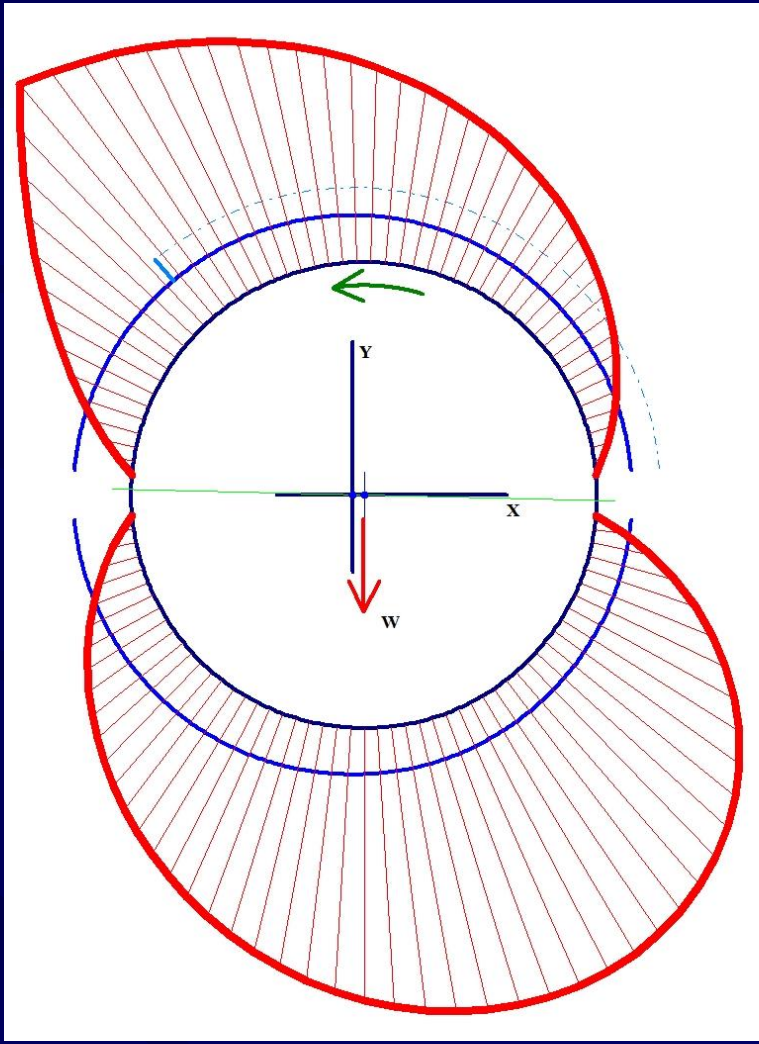




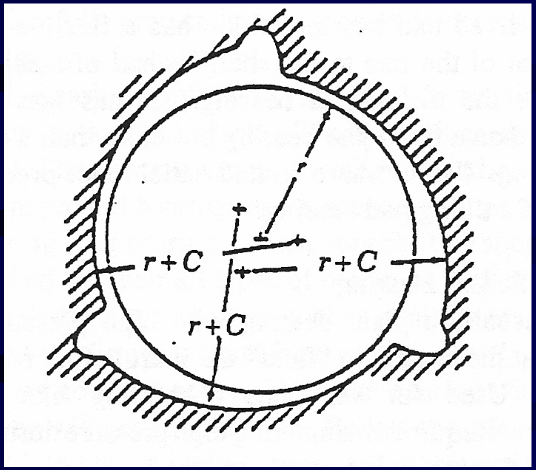
Pressure Dam Type

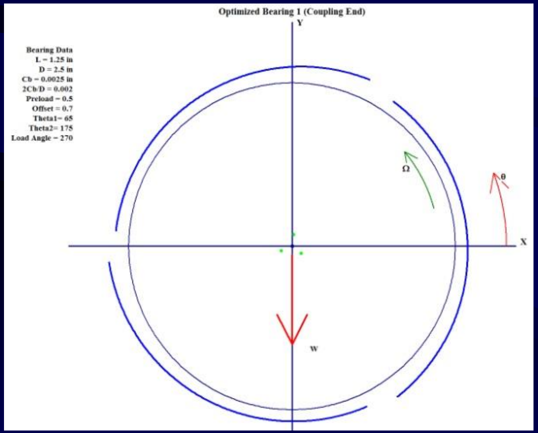


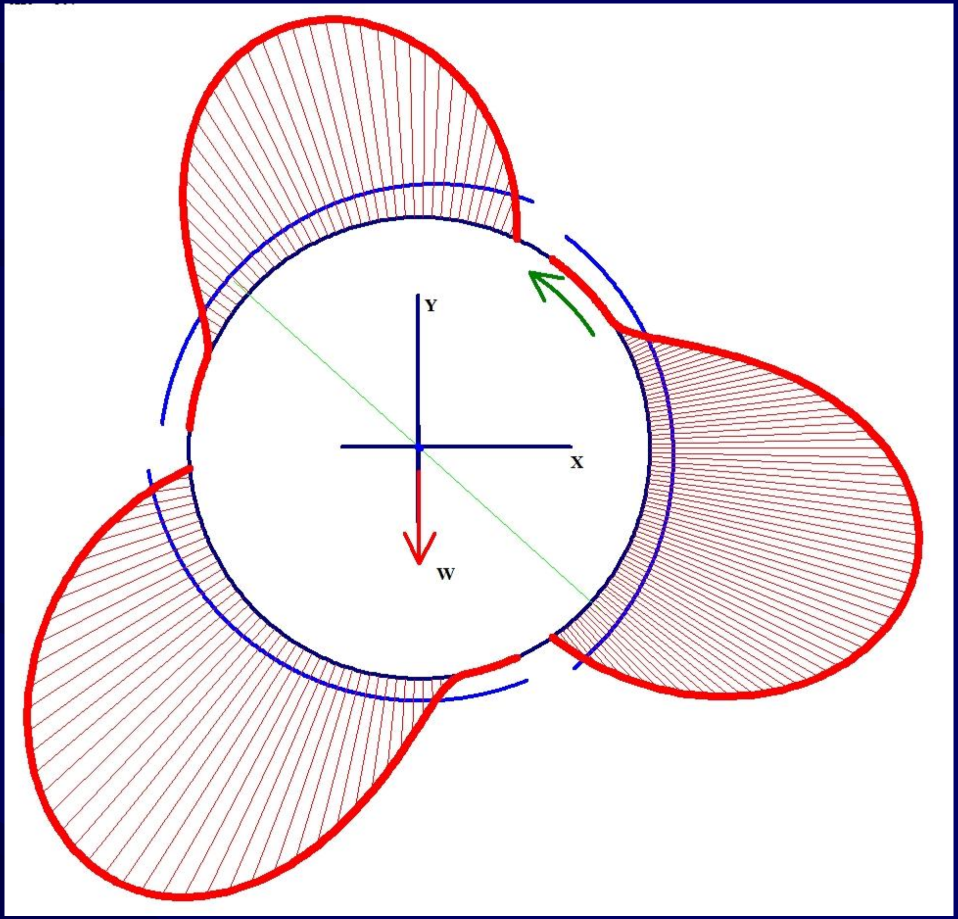




Fixed Lobe Type

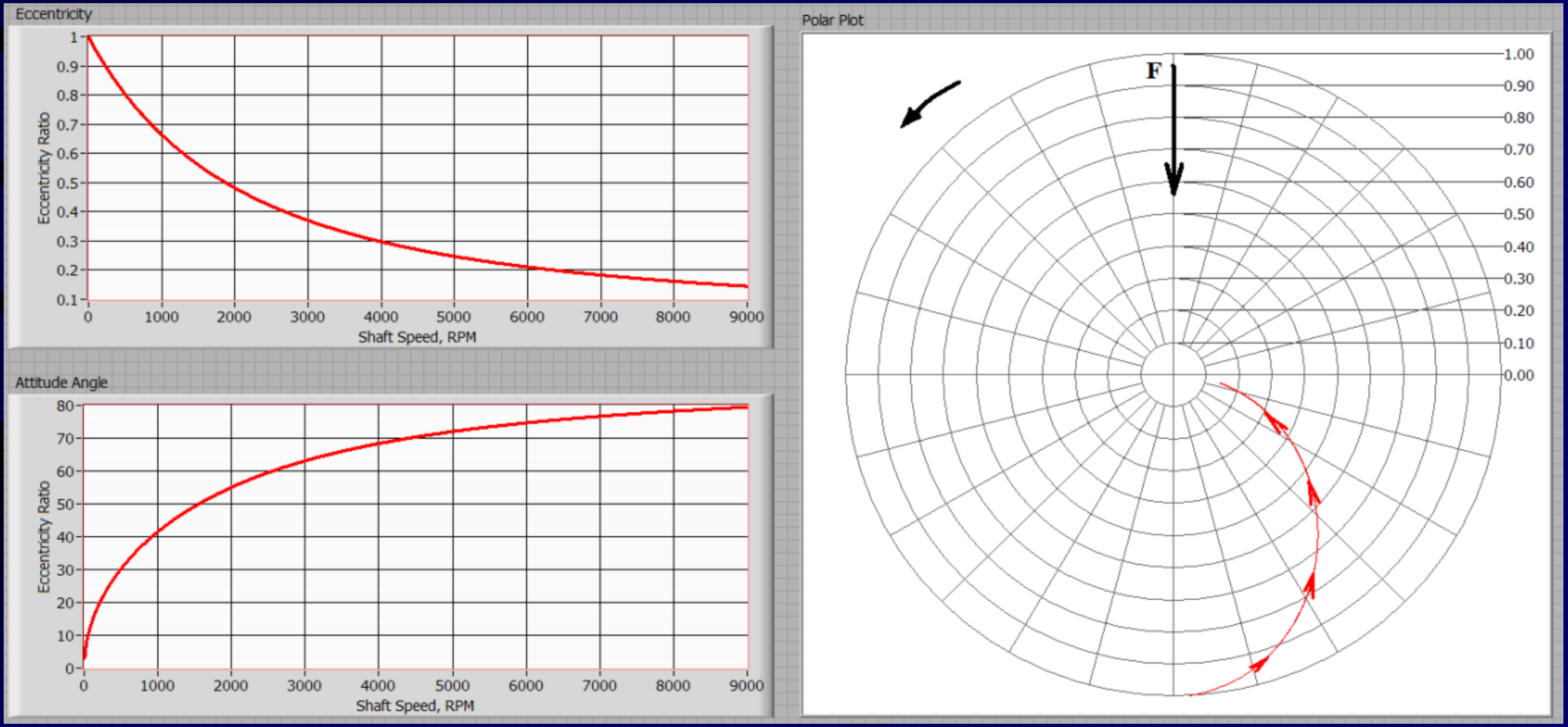




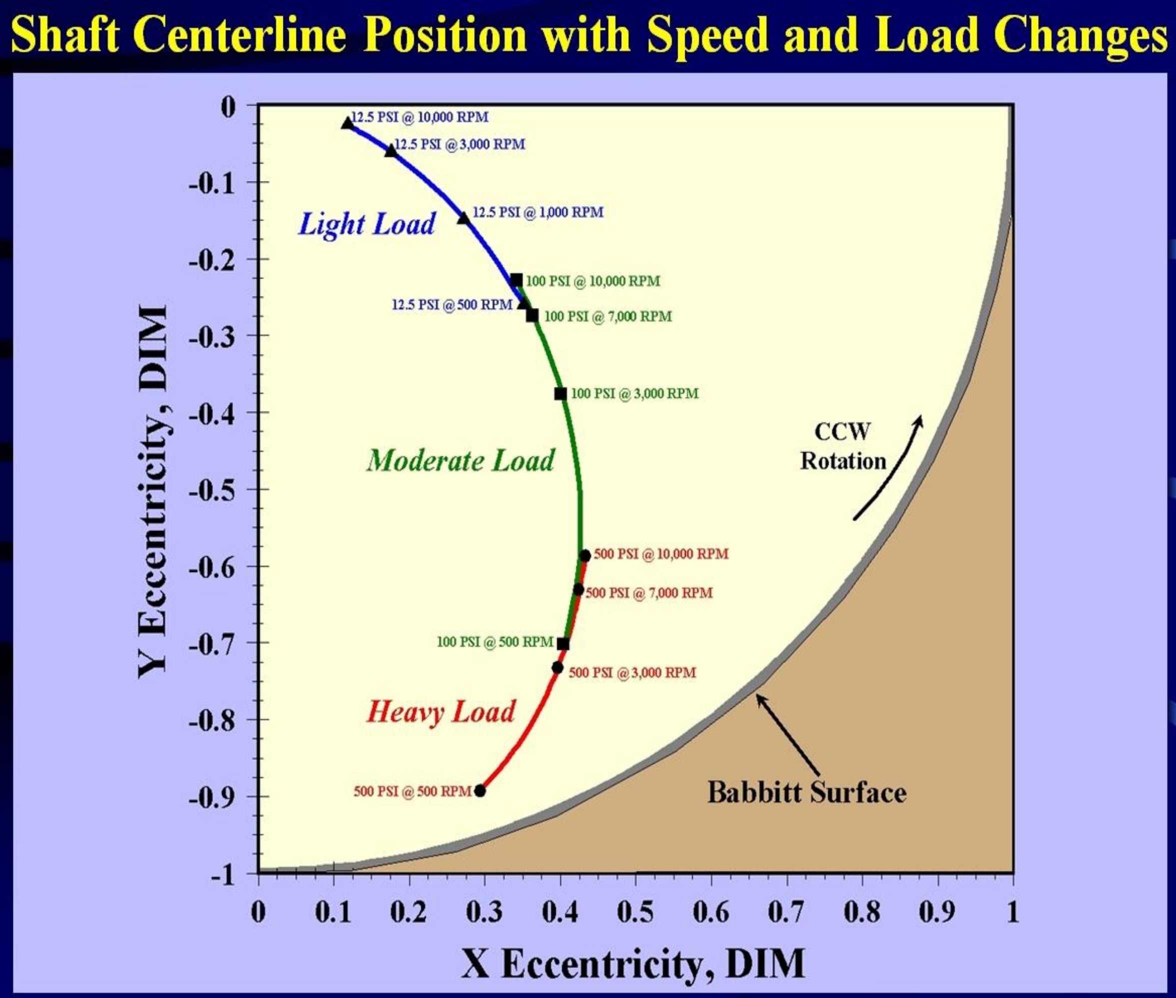


3-Lobe Bearings

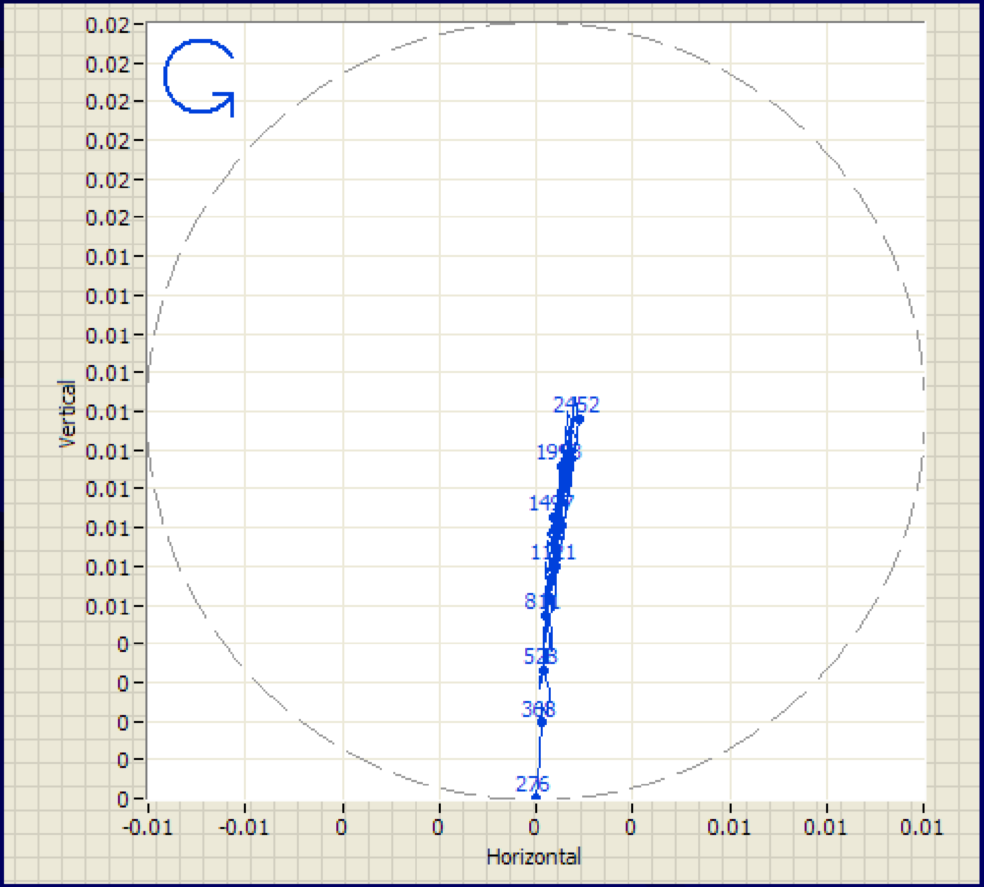
Sleeve Bearing Static Position



Sleeve Bearing Static Position



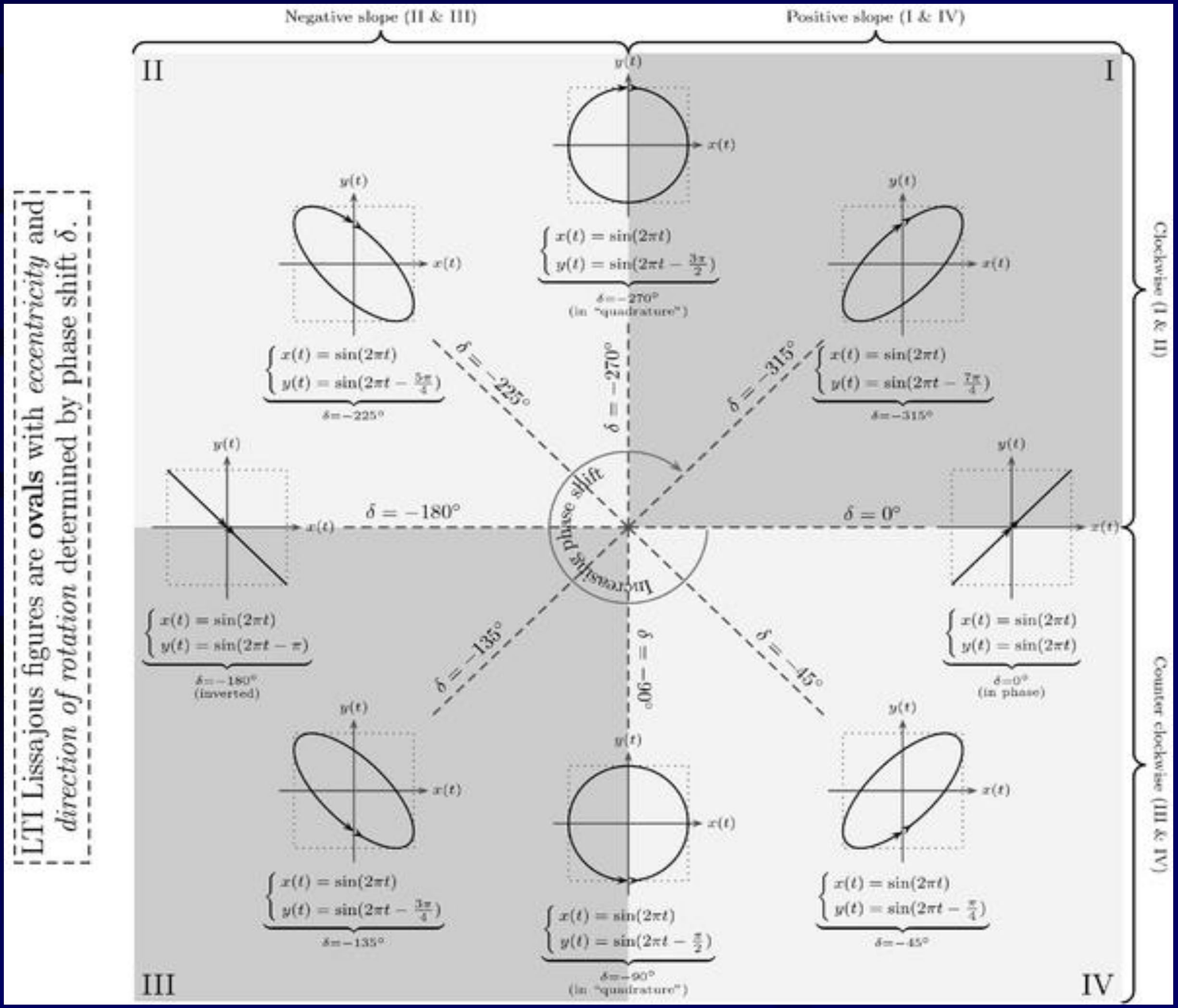
Symmetric Tilting Pad Static Position vs. Speed



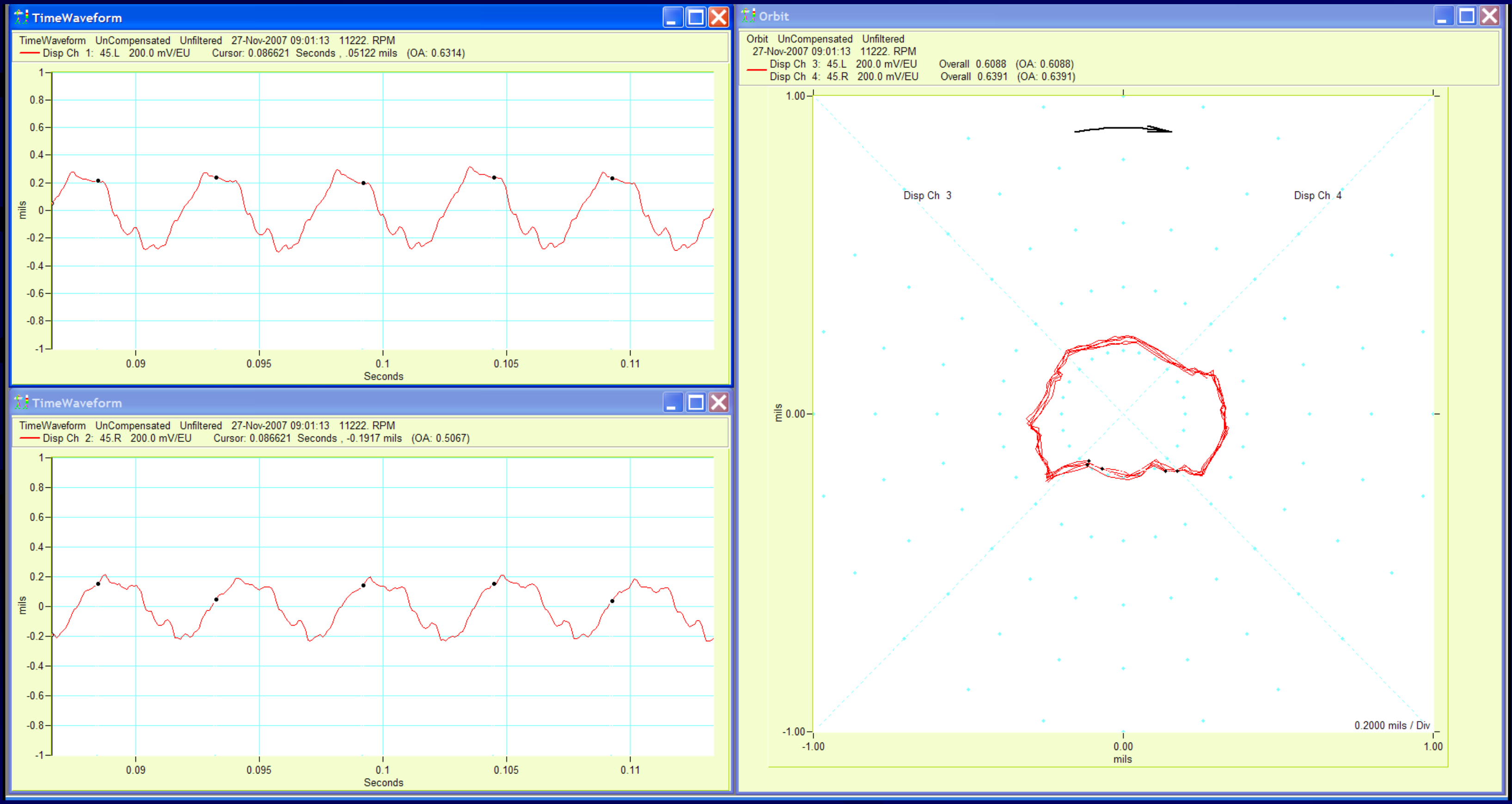
Vibration Detection on Sleeve Bearing Equipment

Machine Description	**Probe Type**	**Comments**
Centrifugal compressor	Proximity	Normally casing is very heavy and well supported and rotors are very light
Steam turbines	Proximity	Normally casing is very heavy and well supported and rotors are very light
Motors/generators	Proximity/seismic	Rotors are generally light compared to casing, but vibration related to the casing (120 Hz) is generally better measured with seismic sensors
FD/ID Fans	Seismic	Rotors are heavy and supports/pedestals are flexible. Proximity is good but insensitive for some cases.
Gas turbines	Proximity/seismic	Casing is rather flexible for even large industrial gas turbines. Often need to use both sensor types.
Centrifugal pumps	Proximity/seismic	Bearings are better monitored with proximity probes, but general pump issues may be better monitored with seismic.
Anti-friction bearing machines	Seismic	NEVER use proximity probes with anti-friction bearing applications

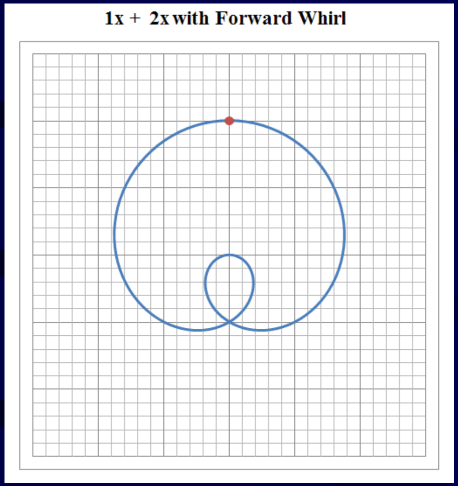
Orbit Analysis

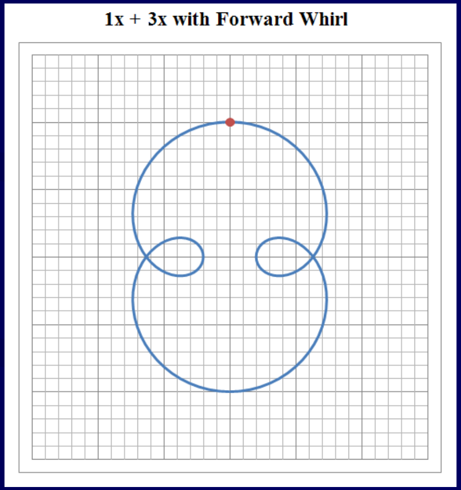


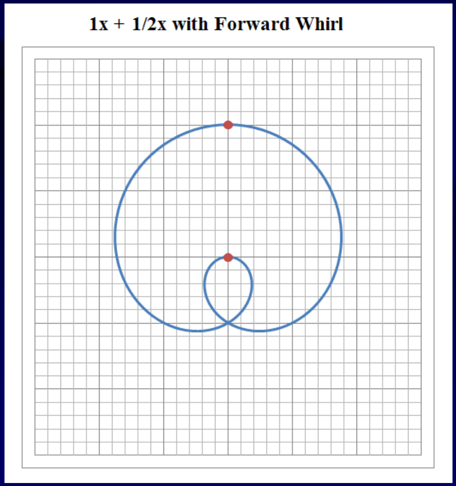
“Normal” Orbit Plot

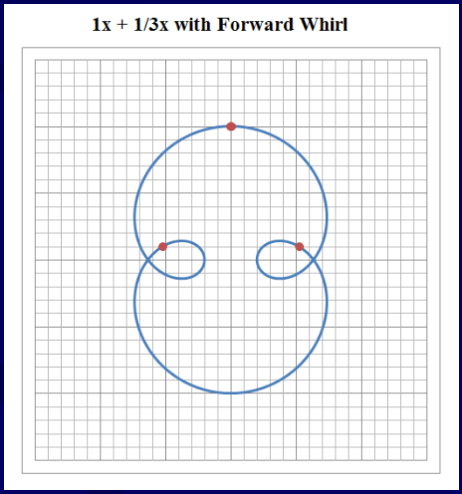


Different Orbit Characteristics – Forward Whirl

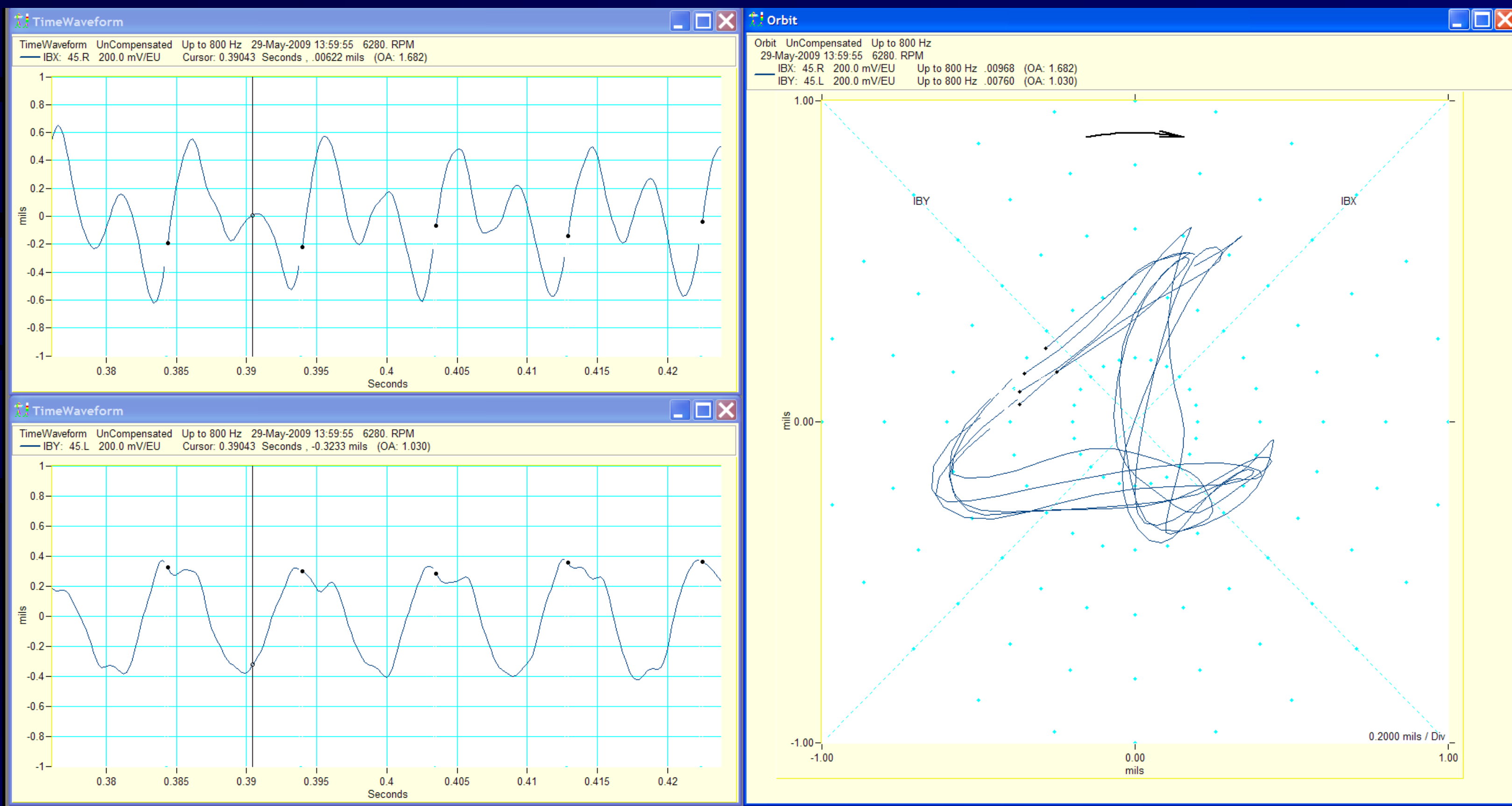




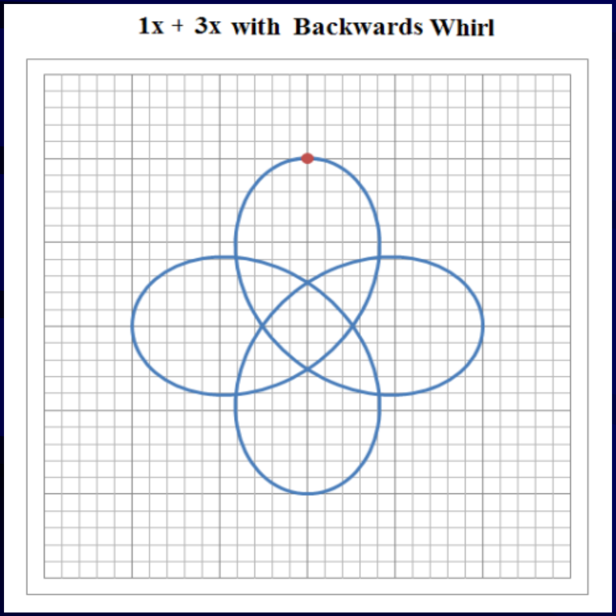


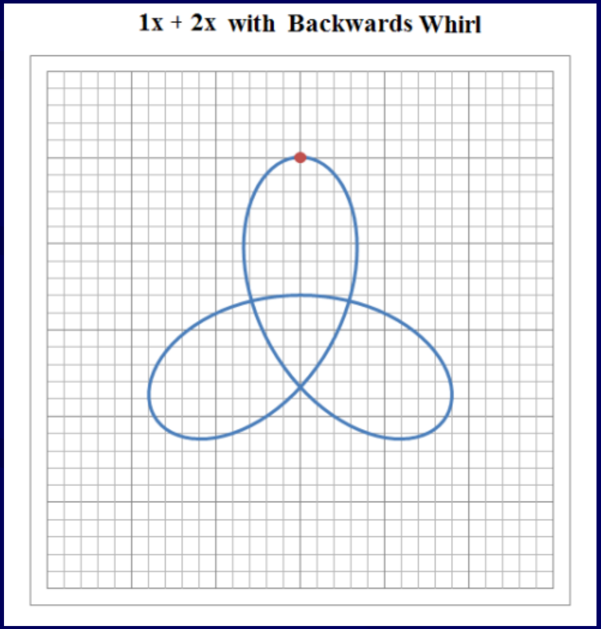


Actual Obit with 1x and 2xRPM

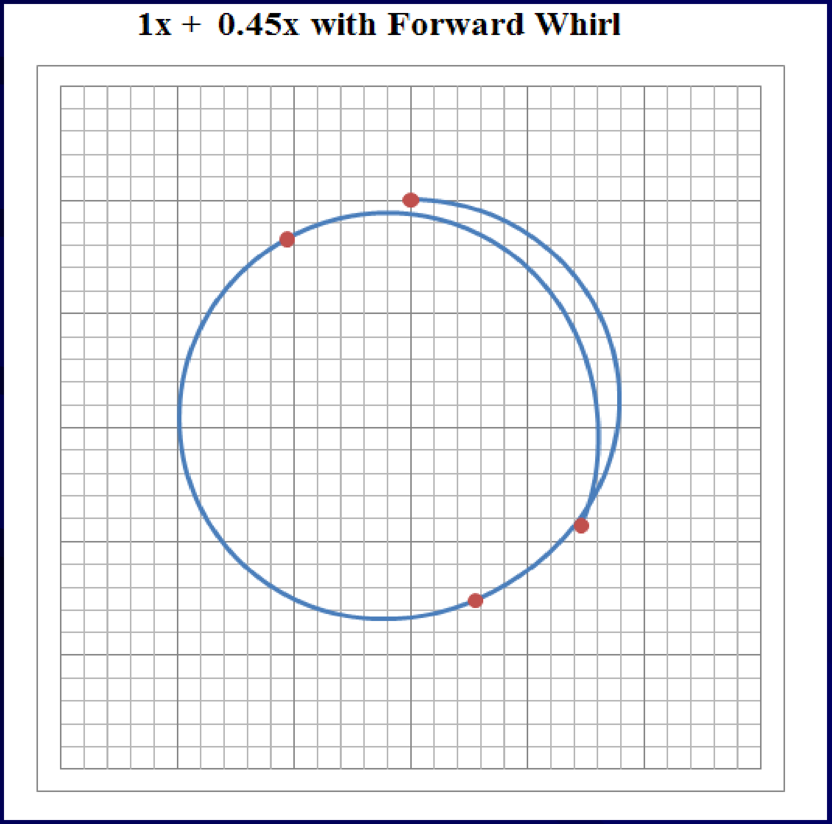


Orbit Examples Backward Whirl

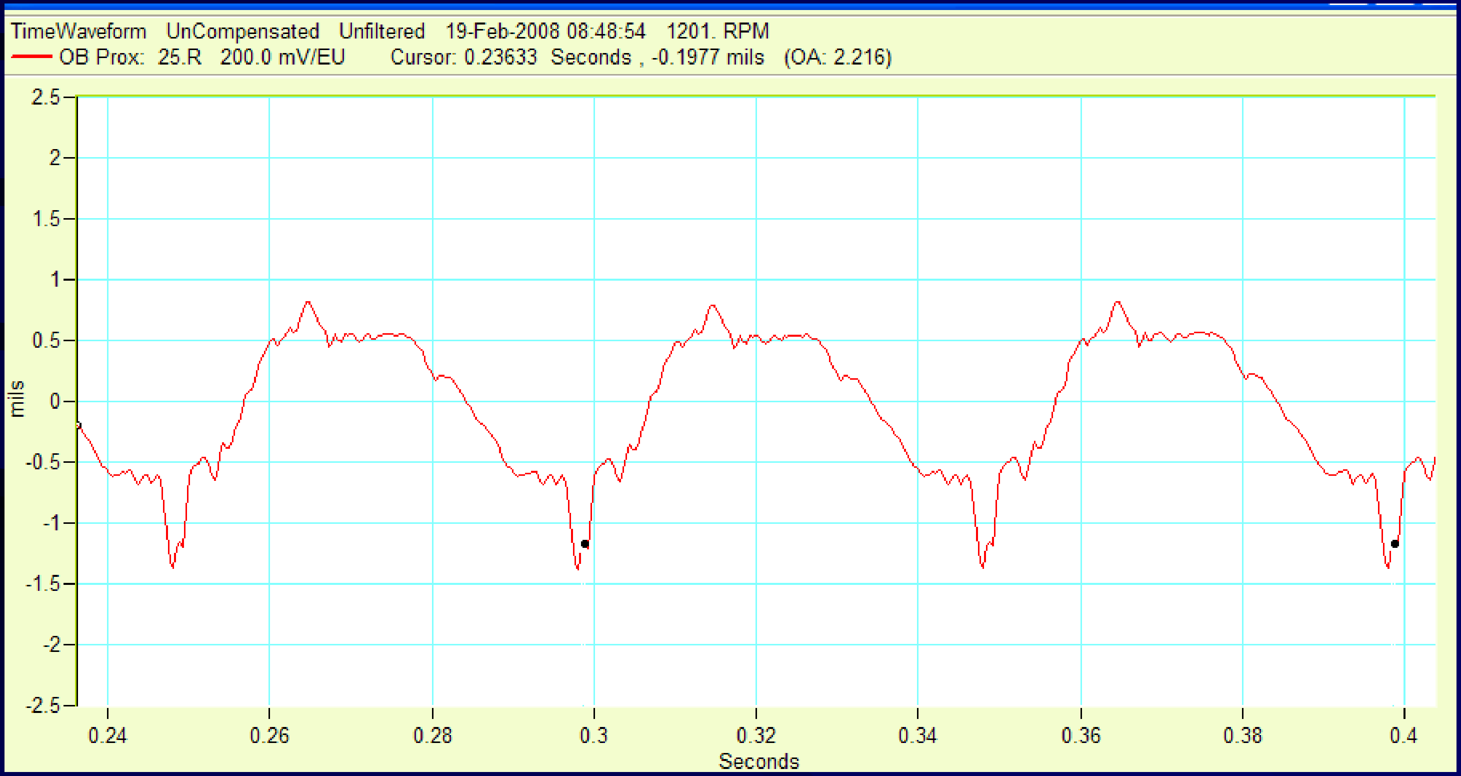




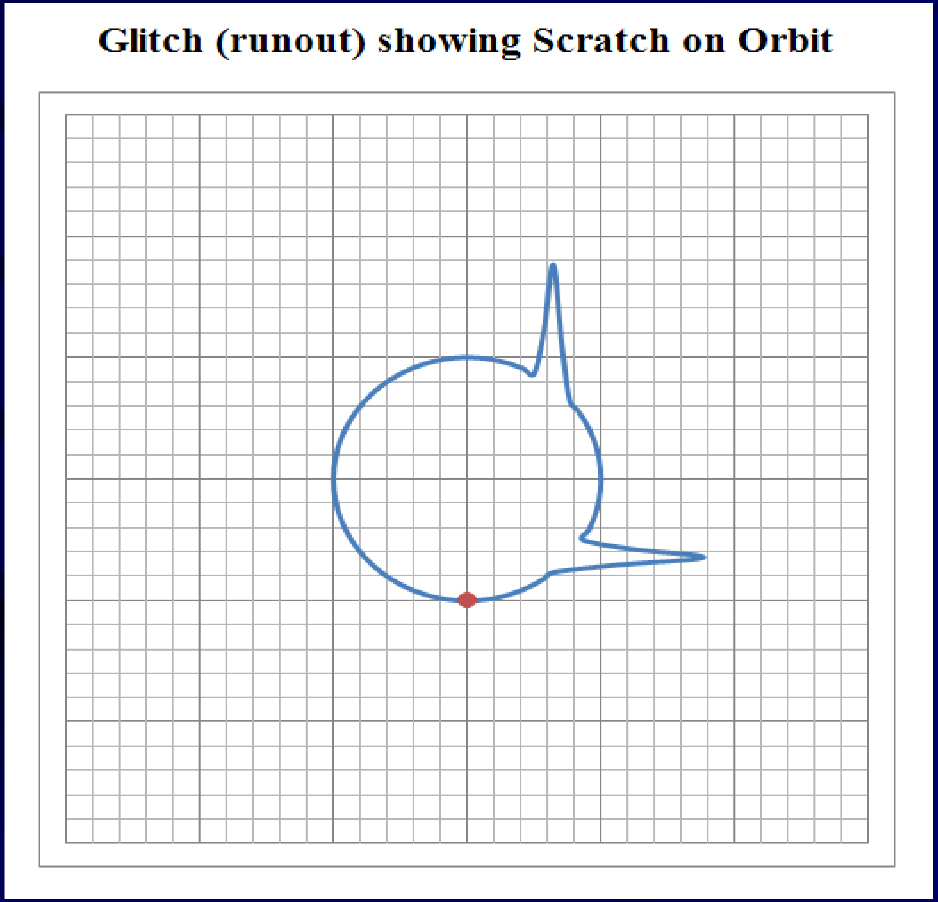
Orbit Example with Oil Whirl



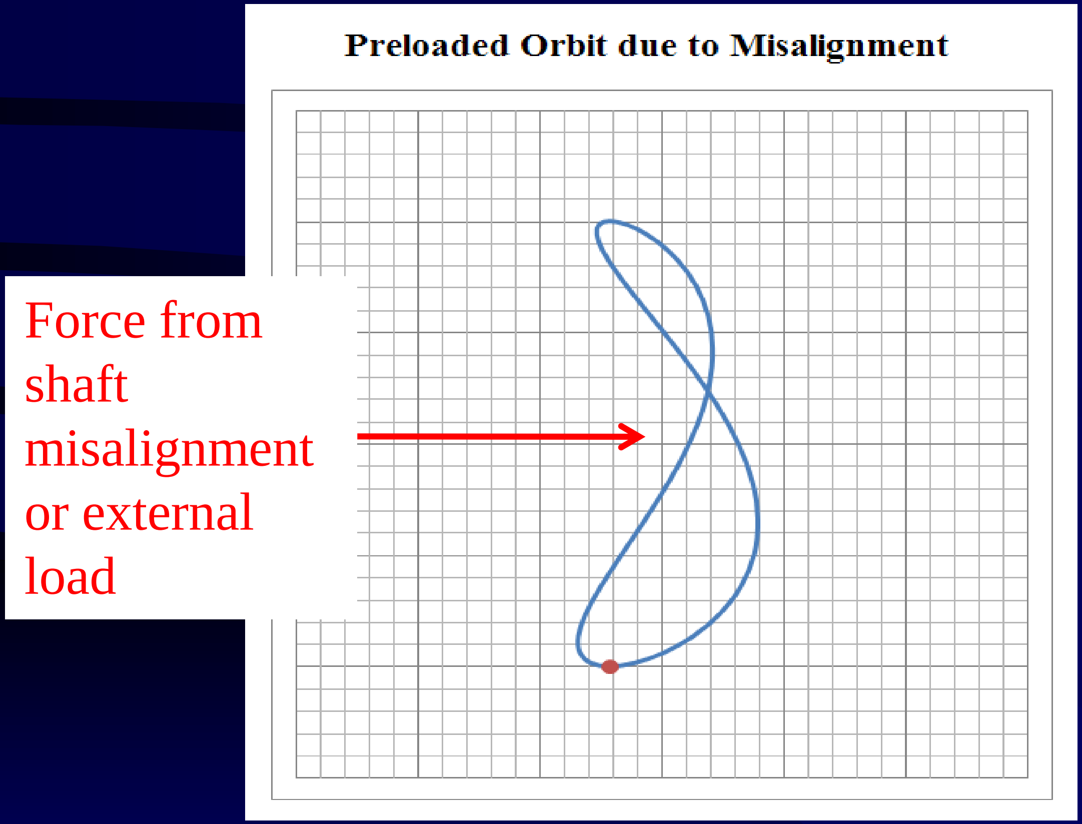
Glitch Example From Motor



Runout or Glitch



Common Preloaded Orbit



Summary, cont.

- Analysis is commonly done with two proximity probes (displacement) located 90° apart on the bearing
  - This allows review of orbit plots and shaft centerlines in addition to normal spectrums and waveforms
  - Much of the analysis is done using orbit plots

Summary, cont.

- Orbits should show fairly circular orbits for normal operation.
- Various characteristics of orbits indicate specific faults
  - Glitch/runout
  - Preload
  - Loops
  - Erratic phase reference

Summary, cont.

- Shaft centerline plots normally show semicircular path for plain sleeve and vertical path for tilting pad as speed increases
- Typical operation is at eccentricities greater than 0.4 and attitude angles less than 50° from bottom dead center

Summary, cont.

- Orbit loop rules:
  - Inner loops imply forward whirl
    - Ratio of frequencies is loops + 1
  - Outer loops imply backward whirl
    - Ratio of frequencies is loops – 1
  - For all loops use the number of timing marks to determine actual frequencies
  - Unsteady orbit implies non-synchronous vibration