Bearing Prognostics Simulator (BPS)

Innovative Platform for Bearing Prognostics Research

SpectraQuest, Inc.
8201 Hermitage Road, Richn
TEL +1-804-261-3300/FAX +
www.spectraquest.com

Bearing Prognostics Simulator

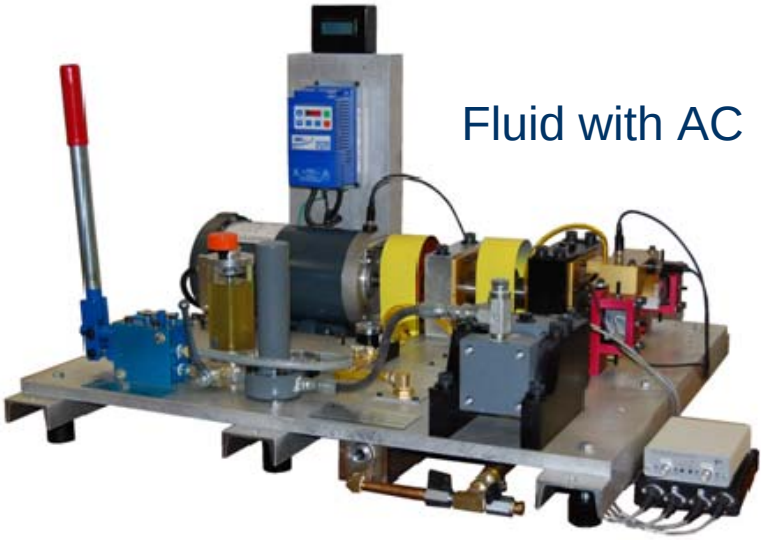
- Conduct fundamental research in bearing wear evolution.
- Characterize bearing failure mechanisms for developing a prognostics model.
- Study frictional force between the bearing rotating and stationary components.
- Model remaining bearing life based on routine condition monitoring measurement.

Bearing Prognostics Simulator Configurations

- Bearing Type
  - Rolling
  - Fluid
  - Grease lubricated

Rolling with Stepper

- Drive Type
  - Variable speed induction AC motor
  - Stepper motor of oscillatory motion



Fluid with AC

BPS Benefits

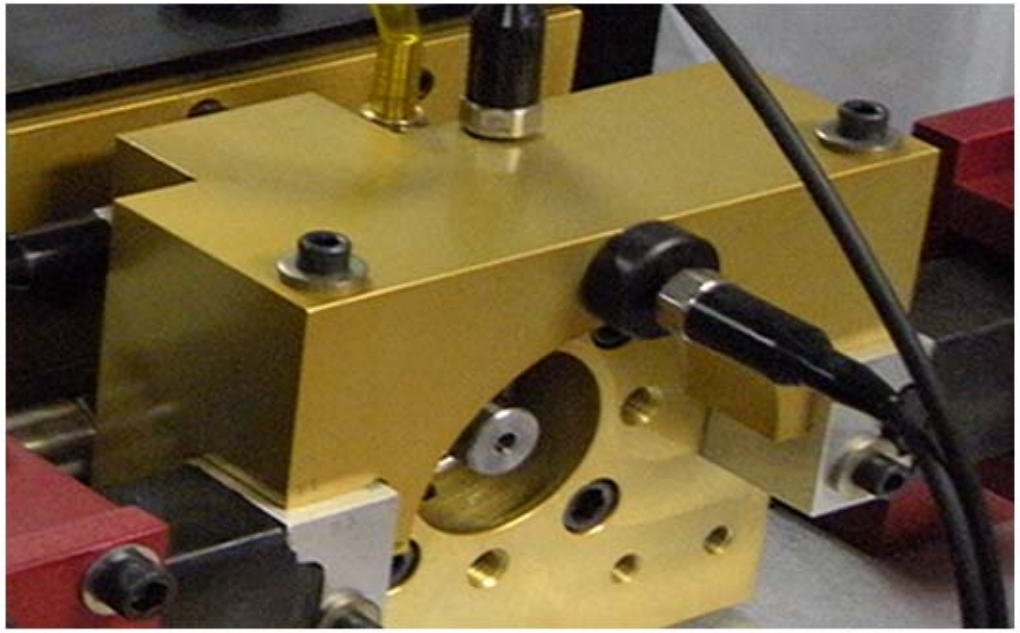
- Develop model for damage propagation mechanisms of rolling element bearings, pressurized fluid film bearings, and the grease lubricated bearings
- Understand bearing failure mechanisms as a function of load, rotational speed, and the oscillatory motion of the bearing
- Develop predictive models of the bearing remaining life based on damage evolution, operating speed, amplitude and type of the loading
- Research signal processing techniques and sensor types for condition monitoring of bearings for prognostics
- Study correlation among vibration, motor current, load, friction and noise spectra.
- Verify model-based diagnostics/prognostics algorithms

BPS Features

- Modular, robust and versatile bench top device for conducting bearing prognostics research
- Simultaneous measurement of radial or axial bearing load and friction torque
- Smart friction torque transducer designed for measuring small friction load in presence of heavy applied force
- Fully programmable motor input parameters for constant speed and for oscillatory motion with and without rotational speed
- Configurable to test rolling element bearing, grease lubricated bearing, and fluid film bearing in one unit
- Interchangeable variable speed AC motor and servo stepper motor for applying different types of loadings
- Instrumented easy to operate hydraulic bearing loading system
- Easy installation and removal of test bearing

Test Bearing Setup

- Configured overhung and are supported on two rows of heavy duty rolling element bearings.
- A fluid film support bearing system can be provided.
- Designed for easy test bearing access.

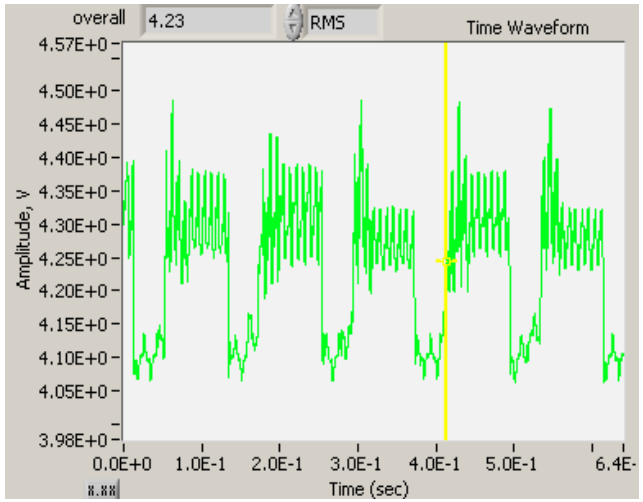


- The overhung configuration is selected for ease of loading the bearings and the measurement of the frictional torque generated during the test.

Force Transducer

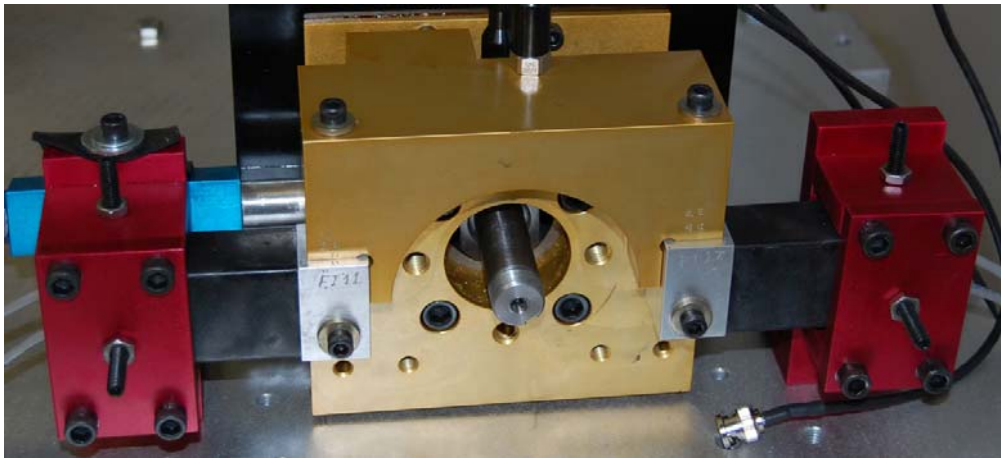
- Measure the transverse and/or axial load applied to the test bearing.
- Investigate force load fluctuation through the rotating cycle caused by worn bearings.
- Determine force response to oscillating torsional loading.
- Perform signature analysis as a function of wear damage growth.
- Up to 6000lb transverse load.

Measured force with oscillating load

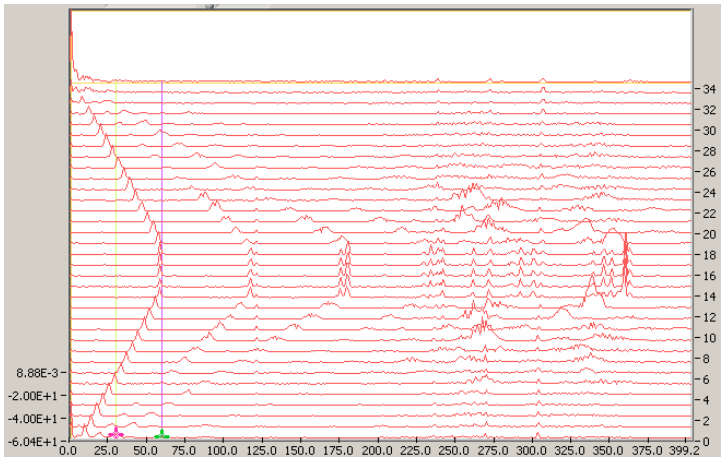


Friction Torque Transducer

- Study characteristics of the frictional force between rotating and the stationary components.
- Research friction bearing wear evolution.
- Cancels the torque associated with the bending forces and minimize the effects of supporting structure.
- Measure bearing frictional torque information as a function of damage growth.

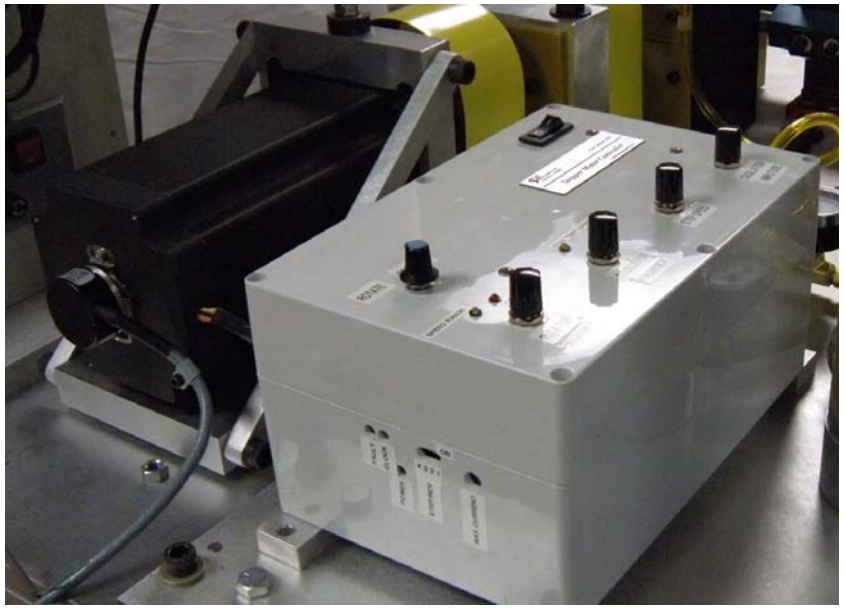


Measured friction during motor rampup and rampdown



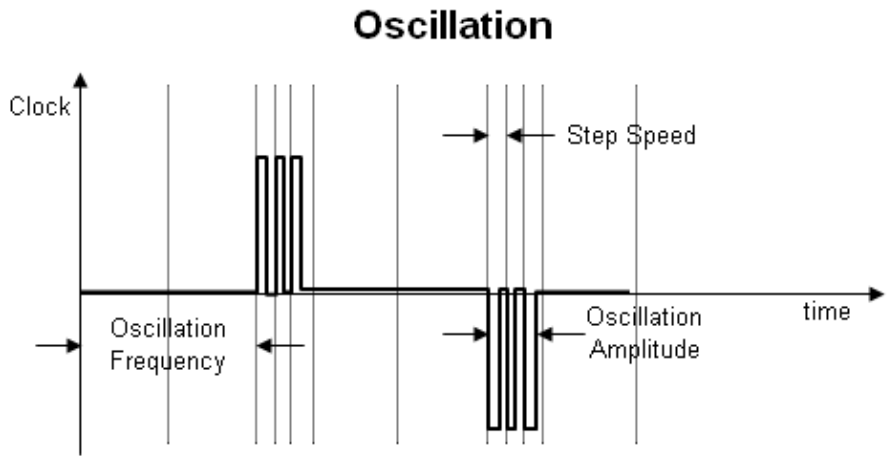
Stepper Motor Drive

- Study bearing wear patterns under oscillatory loading.
- Investigate bearing response to fluctuating loading.
- Three operation modes:
  - constant rotational speed,
  - oscillatory motion,
  - oscillatory excitation superimposed on rotation.

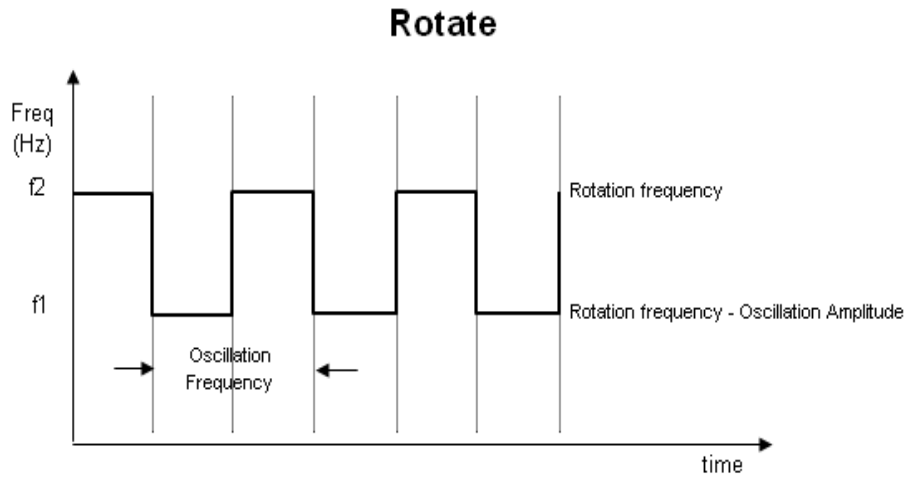


Stepper Motor Drive

- Oscillation
  - 0.225 to 360 degrees
  - Controllable oscillation frequency, amplitude, and step speed



- Rotation + Oscillation
  - Changes rotation speed at a given period
  - 0-180rpm (with no load)
  - Controllable oscillation and rotation frequency



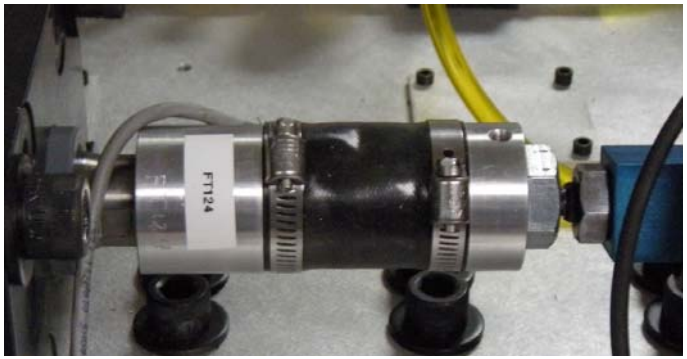
Option Kits

- SpectraQuest offers a complete array of option kits enabling detailed investigations of particular and more advance vibration phenomena or machinery faults.

Transverse force transducer	BP-TFT
Friction torque transducer	BP-FTT
Stepper motor	BP-STEP
Grease lubricated bearing	BP-GR
Axial force loader	BP-AXL
Axial force transducer	BP-AFT
Oil-lubricated support bearings	BP-OIL
Impact resistant clear safety cover	BP-COV

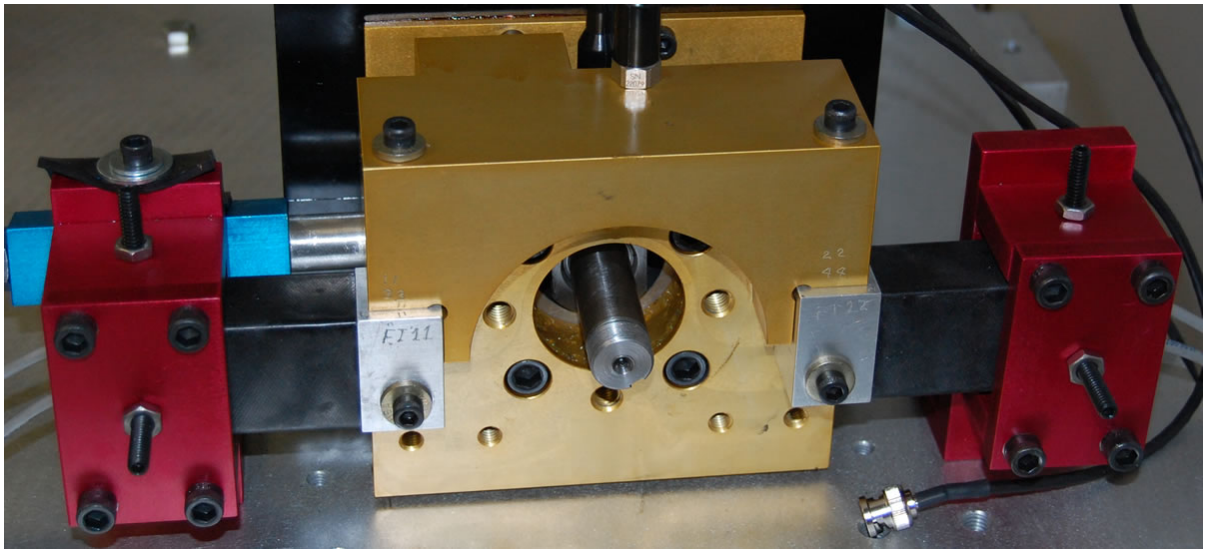
Transverse Force Transducer (BP-TFT)

- Measure the transverse load applied to the test bearing.
- Investigate transverse force load fluctuation through the rotating cycle caused by worn bearings.
- Determine transverse force response to oscillating torsional loading.
- Perform signature analysis as a function of wear damage growth.
- The kit consists of one axial force transducer and one signal conditioner



Friction Torque Transducer (BP-FTT)

- Study characteristics of the frictional force between rotating and the stationary components.
- Research friction bearing wear evolution.
- The kit consists of friction torque transducer, a torque bridge, and a signal conditioner



Grease Lubricated Bearing (BP-GR)

- Conduct fundamental research in grease lubricated bearing wear evolution.
- Develop model for damage propagation mechanisms.
- Verify model-based diagnostics/prognostics algorithms.
- The kit consists of grease lubricated bearing, hub, and mounting hardware.

Stepper Motor (BP-STEP)

- Study bearing wear patterns under oscillatory loading.
- Investigate bearing response to fluctuating loading.
- The kit consists of stepper motor, a controller, and an encoder

Axial Force Loader (BP-AXL)

- Study and model bearing wear under axial loading.
- The kit consists of one axial loader and mounting hardware

Axial Force Transducer (BP-AFT)

- Measure the axial load on the main shaft under dynamic excitation.
- Learn phase relationship between force and vibration spectrum.
- Study axial force response to rotating speed and transverse loading.
- Verify and refine your rotor dynamic models and enhance modeling skills.
- The kit consists of one axial force transducer and one signal conditioner.

Oil-Lubricated Support Bearings (BP-OIL)

- Reduce vibration signature from the BPS support bearings to improve signal clarity of the test bearing.
- The kit consists of fluid-film support bearings, mounting hardware, and oil distribution system with pump, pressure gage, stainless steel oil tank, back flow safety switch, and pressure interlock gauge.

Impact Resistant Clear Safety Cover (BP-COV)

- For increased safety, lockable clear, impact resistant hinged plastic cover with motor interlock switch to shut down motor when cover is raised.
- The kit consists of one lexan safety cover

Specifications

AC Motor	
Drive	3 HP, 3 Phase Variable Speed AC
RPM range	0 to 3600 variable speed
Voltage	115/230 VAC, Single phase, 60/50 Hz
Stepper Motor	
Drive	10lb.ft (14N.m) with controller
RPM range	0-180rpm (with no load)
Voltage	115/230 VAC, Single phase, 60/50 Hz
Mechanical	
Support shaft	Diameter: 2”, (50.8 mm)
Test bearing	Rolling Element Bearing: 1” (25.4 mm)
Dimensions	Fluid Film Bearing: 0.75 ” (19.08 mm)
Hydraulic Loading	Manually adjustable, up to 6000 lb (~27 KN)
Foundation	1/2” (12.7 mm) die cast aluminum base with removable stiffeners and six rubber isolators
Physical	
Weight	Approximately 250 lb
Dimension	L= 40” (102cm), W= 24” (61cm) , H= 30” (76cm)