Wind Turbine Drivetrain Diagnostics Simulator

The Perfect Tool for Wind Turbine Drivetrain Diagnostics and Dynamics Studies

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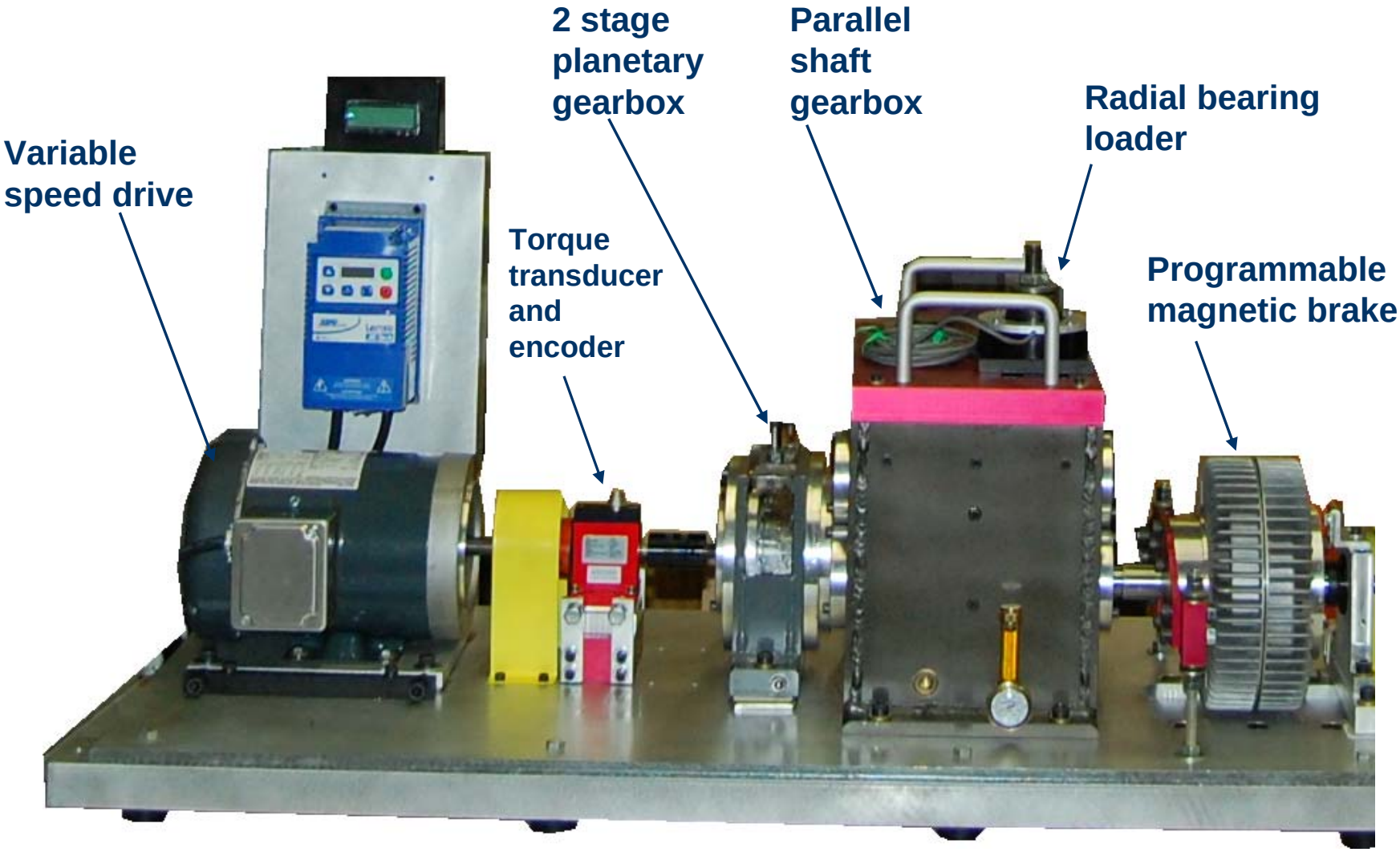
Wind Turbine Drivetrain Diagnostics Simulator

- Simulate wind turbine drivetrains for experimental and educational purposes.
- Drivetrain consists of a 2 stage planetary gearbox, a 2 stage parallel shaft gearbox with rolling or sleeve bearings, a bearing loader, and a programmable magnetic brake.
- Designed to maximize the number of drivetrain configurations to investigate gearbox dynamics and acoustic behavior, health monitoring, vibration based diagnostic techniques, lubricant conditioning or wear particle analysis.
- Robust enough to handle heavy loads and spacious enough for easy gear placement, setup, and installation of monitoring devices.
- Can be configured to reduce or increase the gear ratio.
- Planetary gear train, sun, planet and ring gears, the carrier, and bearings are all easily accessible.

Wind Turbine Drivetrain Diagnosis Simulator

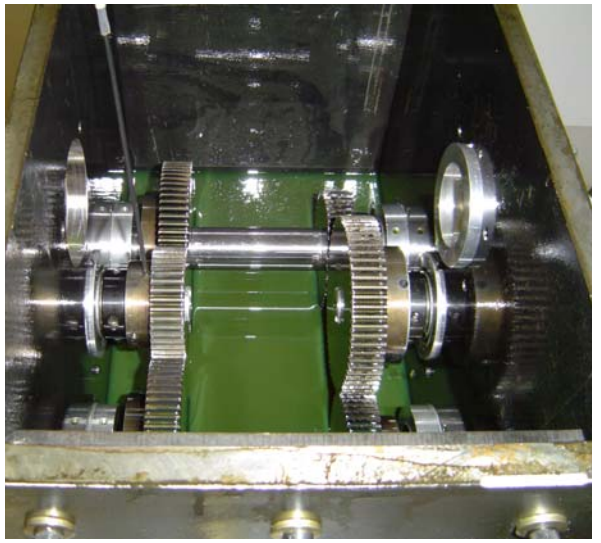


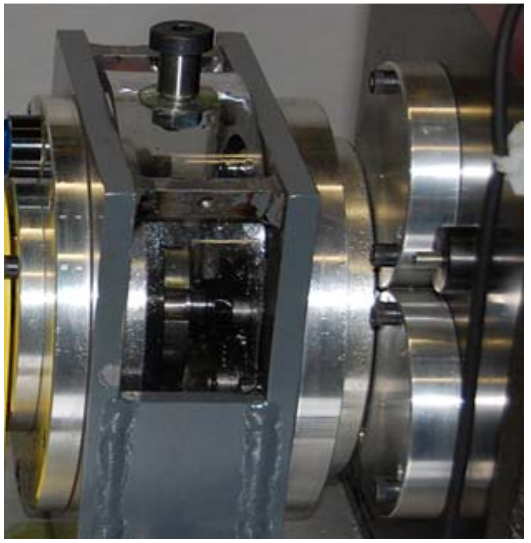
WTDS Benefits

- Faults like surface wear, crack tooth, chipped tooth and missing tooth can be demonstrated on either spur gears or helical gears.
- Rolling element bearing faults like inner race, outer race, ball damage can also be incorporated.
- Adjustable clearance to study backlash is possible: increasing the amount of backlash is without major consequence (other than increased noise and rotational play), and reducing backlash can result in binding and/or excessive operating temperatures.
- Misalignment can also be introduced intentionally
- Any of these faults can be added to the drivetrain one at a time, or simultaneously to study fault interactions.
- Both torsional and radial loadings can be applied to study damage signature or propagation in gears and/or bearings
  - Torsional load is applied via a 3 HP variable frequency AC drive with a programmable, user-defined speed profiles
  - Radial load is applied to a shaft in the parallel gearbox.
- With the programmable magnetic brake, rapid load fluctuation can be applied to simulate real life loading conditions experienced by wind turbines.

WTDS Features

- 2-stage planetary gearbox and 2-stage oil-lubricated parallel shaft gearbox
- Gears can slide along the shafts to alter system stiffness and make room for additional devices.
- Adaptable to spur or helical gears.
- Intentionally damaged or worn gearing can be fitted to study the effects on vibration signature.
- Alterable backlash by replacing bearing mounting hubs to provide the desired clearance.
- 2 stage, 27:1 gear ratio planetary gear with 4 planet stage1 and 3 planet stage 2





Versatility

- Modular design makes the introduction of faulted bearing and/or faulted gears an easy task.
- Multiple mounting locations provided for installation of various transducers.
- Develop diagnosis techniques and advanced signal processing methods.
- Torsional and radial variable speed loading
- PC controlled magnetic brake connected directly to output shaft to provide loading

Transducers and DAQ

- Designed to accommodate different types of sensors easily.
- Accelerometers can be installed on the gearboxes and on the bearing housing to measure the vibrations in all three directions.
- Torque meter enables precise load measurement.
- Input and output shafts can be fitted with encoder or tachometer to measure the transmission error or for time synchronize averaging.
- Other transducers can also be installed as per customer's request.
- Data acquisition hardware and software are also available from Spectra Quest and ready to do time domain and frequency domain signal analysis.

Basic WTDS

- 3 HP variable frequency AC drive with multi-featured front panel programmable controller
- 3 Phase 3 HP motor, pre-wired self-aligning mounting system for easy installation/removal
- Built-in Tachometer with LCD Display and analog output for DAQ purposes
- Three in-line parallel shafts configurable as single or two stage reducer/increaser
- 2 stage planetary gearbox
- Four spur gears to obtain two gear mesh frequencies
- Six rolling element bearings
- Magnetic break for gearbox loading
- Precision machined bearing housings at both ends of the gearbox with mountings for direct measurements of bearing vibrations
- Gearbox oil level gauge
- Vibration isolators mounts and base stiffener

Option Kits

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

Parallel gearbox bearing fault kit	W-BFK-1
Planetary gearbox bearing fault kit	W-BFK-P
Parallel gearbox oil-impregnated sleeve bearing	W-SBH
Radial bearing loader	W-RBL
Defective spur gears	W-SDG
Eccentric Spur Gear	W-ESG
Helical gears set	W-HG
Defective helical gears	W-HDG
Defective planatary gears	W-PDG
PC motor control kit	W-PCK
PC controlled brake	W-PCB
PC controlled blade pitch with sensors	W-BPC
Radial bearing loader force transducer (Requires W-RBL)	W-RBFT
Torque transducer with built encoder on input shaft	W-TOR
Shaft encoder	W-ENC

Parallel Gearbox Bearing Fault Kit (W-BFK-1)

- Learn waveform and spectra of classic bearing defects.
- Learn about signal processing issues such as averaging techniques, leakage, and spectral resolution on determining bearing faults.
- Perform experiments with increasing severity of defects.
- Determine why an ultra-high resolution spectrum is needed to diagnose a bearing fault when fault frequencies are located close to multiples rotational speed.
- Learn how a large signal can mask adjoining low amplitude signal due to spectra leakage.
- The kit consists of one inner race defect, one outer race defect, one with ball defect, and one combination of defects.

Planetary Gearbox Bearing Fault Kit (W-BFK-P)

- Study bearing faults in planetary gearbox
- The kit consists of one inner race defect, one outer race defect, one with ball defect, and one combination of defects.

Radial Bearing Loader (W-RBL)

- Investigate bearing radial loading effects.
- Understand bearing failure signature as a function of load and rotational speed.

- Compare vibration signature between loaded and unloaded bearings.
- Study outer race bearing fault signature as a function of load location.
- The kit consists of one mechanical bearing loader

Defective Spur Gears (W-SDG)

- Study the effect of damaged tooth in gearboxes.
- Apply phase demodulation signal analysis to detect gear damage.
- Investigate backlash between mating gears.
- The kit consists of one missing tooth gear, one chipped tooth gear, one root

Eccentric Spur Gear (W-ESG)

- Study the effects of eccentric spur gear.
- Measure the vibration signature of eccentric gears.
- The kit consists of one eccentric spur gear.

Helical Gears Set (W-HG)

- Study the helical gears parallel shaft gearbox.
- Compare vibration signature between spur and helical gears.
- The kit consists of four helical gears to replace standard spur gears in gearbox

Defective Helical Gears (W-HDG)

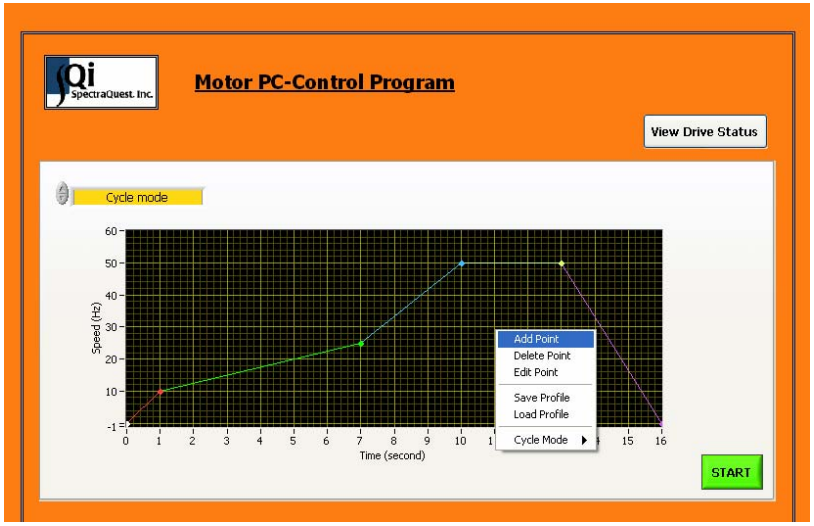
- Study the effect of damaged helical gears.
- Apply phase demodulation signal analysis to detect gear damage.
- The kit consists of one gear with chipped tooth and one gear with missing tooth

Defective Planetary Gears (W-PDG)

- Study the effect of damaged planetary gears.
- Apply phase demodulation signal analysis to detect gear damage.
- The kit consists of one missing tooth gear, one chipped tooth gear, one root crack gear, and one surface wear gear

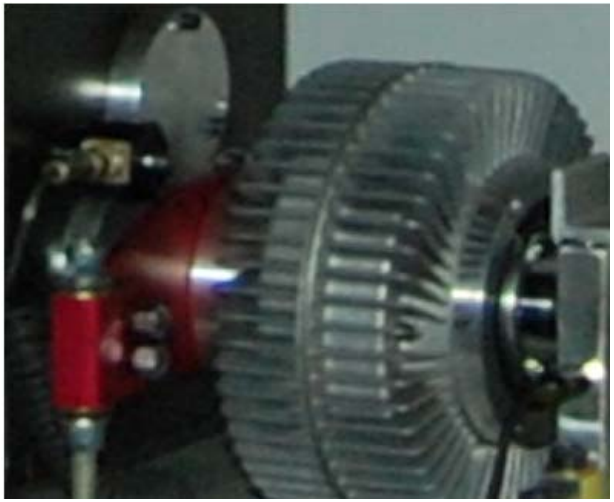
PC Motor Control Kit (W-PCK)

- Operate DDS from remote location.
- Pre-program speed acceleration, deceleration, and length of run to meet exact requirements.
- The kit consists of PC software, one interface module to motor drive and cables.



PC Controlled Brake (W-PCB)

- Operate magnetic brake from remote location.
- Pre-program load profiles of run to meet exact requirements.
- The kit consists of PC software, one interface module to magnetic brake and cables.



PC Controlled Blade Pitch with Sensors (W-BPC)

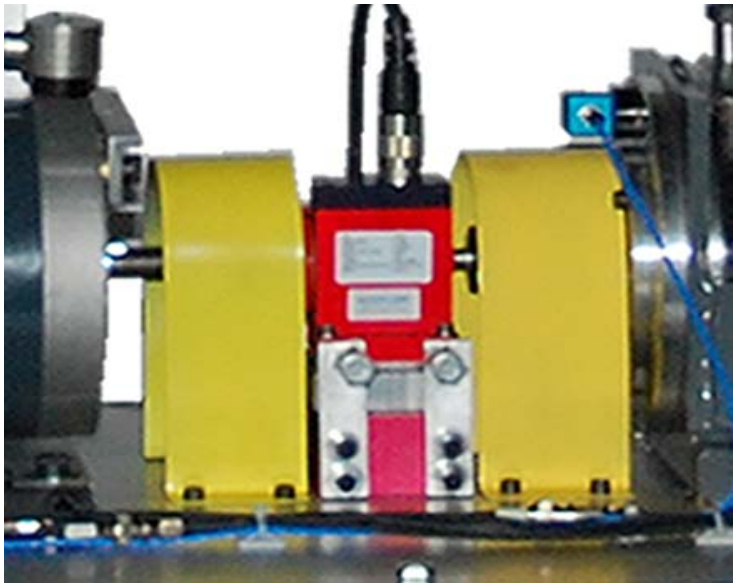
- Operate wind turbine blade pitch from remote location.
- Pre-program load profiles of run to meet exact requirements.
- The kit consists of PC software, one interface module, and cables.

Radial Bearing Loader Force Transducer (W-RBFT)

- Measure the radial load applied by the mechanically operated bearing loader.
- The kit consists of one transducer measuring radial force and one matching signal conditioner.

Torque Transducer with Built Encoder on Input Shaft (W-TOR)

- Measure the torque on the input shaft.
- Study torque variation through full rotation cycle.
- Track shaft position in signal analysis.
- The kit consists of one 20 N.m torque meter with built-in 360 pulse encoder



Shaft Encoder (W-ENC)

- Measure transmission error in the gearbox by comparing input and output rotation.
- The kit consists of one 360 pulse per revolution encoder and once per revolution index

Value Packages

- The WTDS is also available in high value combination packages

	Wind turbine drivetrain diagnostics	Instrumentation
PKG 1	X	
PKG 2	X	X

	W-BFK-1	W-BFK-P	W-SBH	W-RBL	W-SDG	W-ESG	W-HG	W-HDG	W-PDG	W-PCK	W-PCB	W-BPC	W-RBFT	W-TOR	W-ENC
PKG 1	X	X	X	X	X	X	X	X	X						
PKG 2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Specifications

Electrical	
Motor	3 Phase, 3 HP motor, pre-wired self-aligning mounting system for easy installation/removal
Drive	3 HP variable frequency AC drive with multi-featured front panel programmable controller
RPM range	0 to 5000 rpm variable speed
Tachometer	Built-in tachometer with LCD display and one pulse per revolution analog TTL output for DAQ purposes
Voltage	230 VAC, Single phase, 60/50 Hz
Mechanical	
Shaft Diameter	1” diameter; Turned, Ground, & Polished (TGP) steel
Planetary Gearbox	2 stage, 27:1 gear ratio planetary gear with 4 planet stage1 and 3 planet stage 2
Parallel Shaft Gearbox	2 stage, 2.5 maximum ratio per stage, spur or helical gears
Bearing	Deep groove ball bearing or oil-impregnated bronze sleeve bearing
Torque meter	Up to 20N.m with built-in 360 pulse encoder
Bearing Loader	3000lb capacity with available force transducer
Magnetic Brake	1.5 to 32 lb.ft capacity heavy duty magnetic particle brake
Wind Turbine	Belt driven 3 blade, 6 feet span
Foundation	1/2” (12.7 mm) die cast aluminum base, base stiffener and eight rubber isolators
Physical	
Weight	Approximately 250 lb
Dimensions	L=56” (142cm), W=76” (190cm), H=96” (220cm)