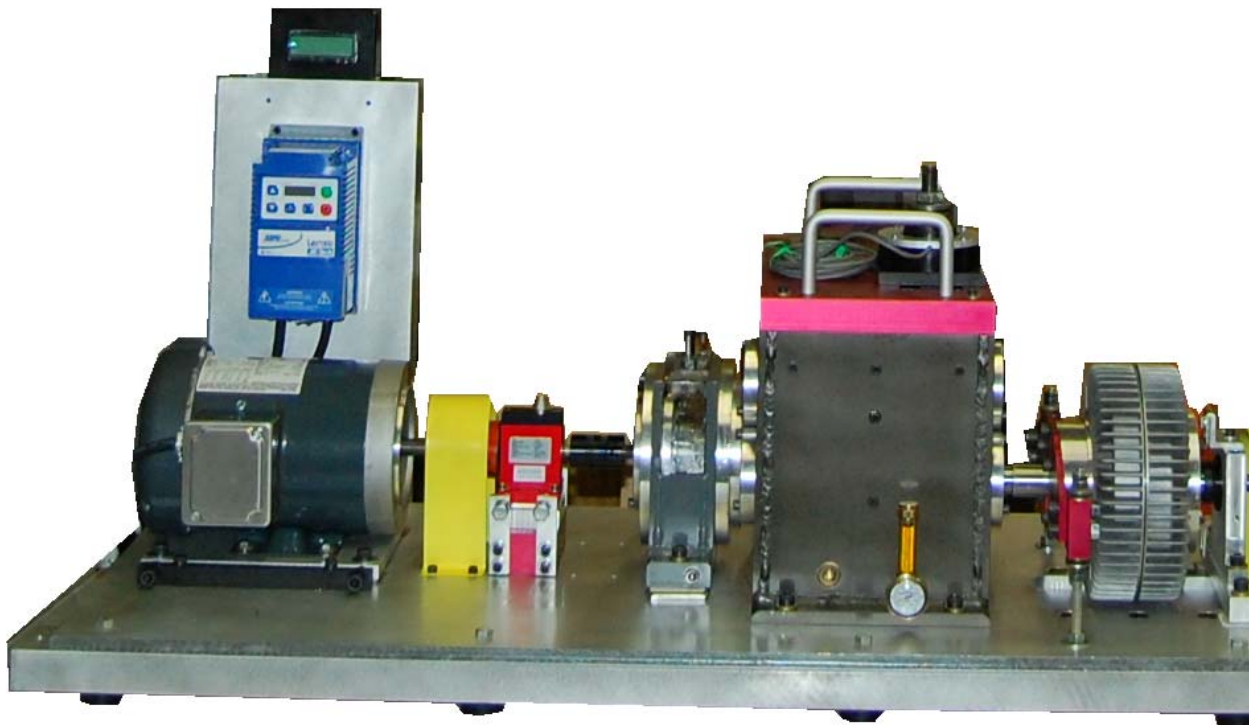# Drivetrain Diagnostics Simulator

DDS

The Perfect Tool for Gearbox and Bearing Diagnostics and Dynamics Studies

www.haopute.com
email:info@haopute.com
phone:02884625157
mobile:18982185717

Drivetrain Diagnostics Simulator (DDS)

An Ideal Apparatus For Drivetrain Reliability Studies

SpectraQuest's Drivetrain Diagnostics Simulator (DDS) has been specifically designed to simulate industrial drivetrains for experimental and educational purposes. The 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. All elements of the DDS have been 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. It is robust enough to handle heady loads and spacious enough for easy gear placement, setup, and installation of monitoring devices. The two-stage parallel shaft gearbox can be configured as to reduce or increase the gear ratio. The planetary gear train, sun, planet and ring gears, the carrier, and bearings are all easily accessible.
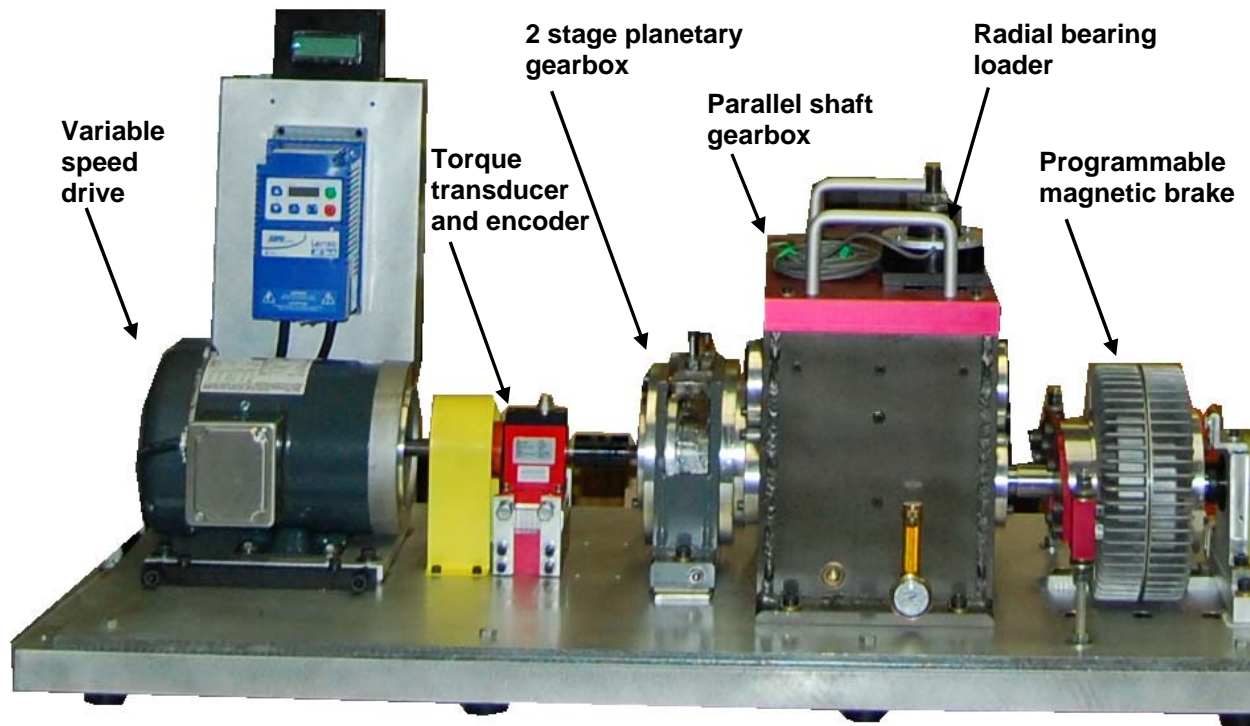
Flexible Drivetrain Fault Diagnostics

The effect 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. Drivetrain misalignment can also be introduced intentionally in the DDS. 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: the torsional load is applied via a 3 HP variable frequency AC drive with a programmable, user-defined speed profiles; and the 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.

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.
- ❖ Choice of rolling element bearing or sleeve bearings.
- ❖ Alterable backlash by replacing bearing mounting hubs to provide the desired clearance.
- ❖ 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.
- ❖ Additional devices may be mounted instead of the brake.

Drivetrain Diagnostics Simulator (DDS)

Variable speed drive

Torque transducer and encoder

2 stage planetary gearbox

Parallel shaft gearbox

**Radial bearing loader**

Programmable magnetic brake

The DDS is Heavy-Duty and Easily Configurable

The DDS design enables changing gearbox and bearing components quickly and easily. The unit is adaptable to install either rolling element bearings or oil-impregnated sleeve bearings with either spur or helical gears. The modular design makes the introduction of faulted bearing and/or faulted gears an easy task. Multiple mounting locations are provided for installation of transducers. The motor, gearboxes, brake are mounted on a half inch aluminum plate with stiffeners and vibration isolators to minimize environmental vibration.

Transducers and DAQ

The drivetrain is 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. A torque meter enables precise load measurement. The 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 per customers' request. Data acquisition hardware and software are also available from Spectra Quest and ready to do time domain and frequency domain signal analysis.
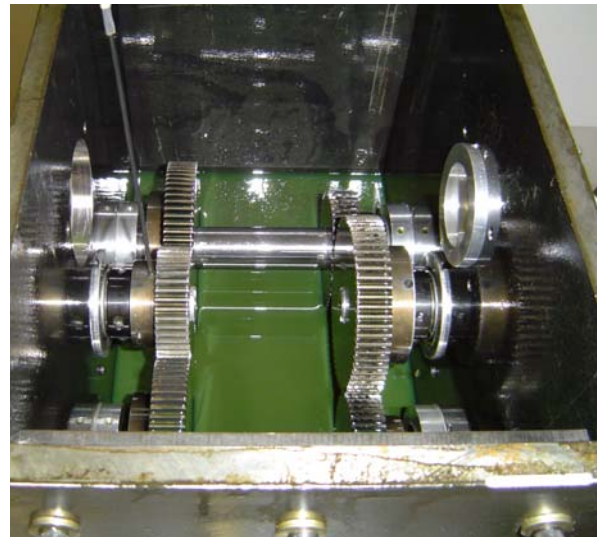
Drivetrain Diagnostics Simulator (DDS)

Basic DDS Configuration and Option Kits

The DDS provides a basic setup for performing drivetrain experiments and for learning vibration signatures of gearbox and bearing malfunctions. However, a detailed investigation of particular and more advance vibration phenomena will require additional attachments and fixtures which are available through optional kits.

Basic DDS Configuration (DDS2010)

- ❖ 3 HP Variable frequency AC drive with multi-featured front panel programmable controller, 220 VAC 1 phase supply
- ❖ 3 Phase 3 HP motor, pre-wired self-aligning mounting system for easy installation/removal
- ❖ Built-in tachometer with LCD display and one pulse per revolution analog TTL output for DAQ purposes
- ❖ 2 stage parallel shaft gearbox with three in-line parallel shafts configurable as single or two stage reduction/increaser
- ❖ 2 stage planetary gearbox with 27:1 gear ratio planetary gear with 4 planet stage1 and 3 planet stage 2
- ❖ Four Spur Gears to obtain two gear mesh frequencies in parallel gearbox and three shaft speeds
- ❖ Six rolling element bearings in parallel gearbox
- ❖ Programmable Heavy duty magnetic brake (780lb-in) with power supply for gearbox loading
- ❖ Precision machined bearing housings at both ends of the gearbox with mountings for direct measurements of bearing vibration
- ❖ Parallel gearbox oil level gauge
- ❖ 1/2" die cast aluminum base, base stiffener and eight rubber isolators
- ❖ Comprehensive operations manual

Parallel Gearbox Bearing Fault Kit (G-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 (G-BFK-P)

- ❖ Study bearing faults in planetary gearbox
- ❖ **The kit consists of two different levels of inner race fault and two different levels of needle fault**

Parallel Gearbox Oil-impregnated Sleeve Bearing (G-SBH)

- ❖ Compare vibration signature between rolling element and sleeve bearings.
- ❖ Investigate waveform and spectral recognition of worn or loose fitting bearings.
- ❖ **The kit consists of six 1" oil-impregnated bronze sleeve bearings**

Radial Bearing Loader (G-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**

Drivetrain Diagnostics Simulator (DDS)

Defective spur gears (G-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 crack gear, and one surface wear gear**

Defective planetary gears (G-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**

Eccentric spur gear (G-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 (G-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 (G-HDG)

- ❖ Study the effect of damaged helical gears.
- ❖ Apply phase demodulation signal analysis to detect gear damage.
- ❖ **The kit consists of one missing tooth gear, one chipped tooth gear & one surface wear gear**
  - ❖ Requires G-HG

Torque transducer with built encoder on input shaft (G-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 (G-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**

PC Motor Control Kit (G-PCMK)

- ❖ 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.**
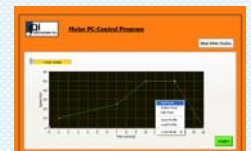
PC Load Control Kit (G-PCLK)

- ❖ 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.**

Drivetrain Diagnostics Simulator (DDS)

Radial Bearing Loader Force Transducer (G-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.**
- ❖ Requires G-RBL

3 HP AC Motor With Built-In Rotor Unbalance (G-UBM-3)

- ❖ Study the effects of unbalanced rotor on vibration and/or current signature.
- ❖ Study the effect of unbalance rotor on power quality and consumption.
- ❖ Study the effect of temperature rise on non-linear characteristics of induction motors.
- ❖ **The kit consists of one unbalanced 3 HP AC motor**
- ❖ Study the effects of unbalanced rotor on vibration and/or current signature.

3 HP AC Motor With Built-In Bowed Rotor (G-BRM-3)

- ❖ Study the effects of rotor bow on vibration and/or current signature.
- ❖ Study the effect of bowed rotor on power quality and consumption.
- ❖ **The kit consists of one 3 HP AC motor with centrally bent rotor**

3 HP AC Motor With Built-In Faulted Bearings (G-FBM-3)

- ❖ Study the effects of bearing faults on vibration and/or current signature.
- ❖ Study the effect of bearing faults on power quality and consumption.
- ❖ **The kit consists of one 3 HP AC motor fitted with one inner race faulted bearing and one with outer race faulted bearing. User can specify the types of bearing faults.**

3 HP AC Motor With Built-In Rotor Misalignment System (G-MAM-3)

- ❖ Study the effect of variable air gap on vibration and/or current signature.
- ❖ Study the effect of amount/type of misalignment and rotor speed on vibration/current spectra.
- ❖ Determine the effect of misalignment on power quality and consumption.
- ❖ Study the effect of temperature rise on non-linear characteristics of induction motors.
- ❖ **The kit consists of one 3 HP AC motor with custom machined end bells, which allows for easy introduction of known misalignment at either end of the motor.**

3 HP AC Motor With Built-In Broken Rotor Bars (G-BRBM-3)

- ❖ Study the effect of broken rotor bars on motor vibration and/or current signature as a function of speed and load.
- ❖ Study the effect of broken rotor bars on power quality and consumption.
- ❖ Study the effect of temperature rise on non-linear characteristics of induction motors.
- ❖ **The kit consists of one 3 HP AC motor with broken rotor bars**

3 HP AC Motor With Stator Winding Faults (G-SSTM-3)

- ❖ Study the effects of turn-to-turn short in stator windings on vibration and/or current signature.
- ❖ Study the effect of turn-to-turn short in stator windings on power quality and consumption.
- ❖ Study the effect of temperature rise on non-linear characteristics of induction motors.
- ❖ **The kit consists of one 3 HP AC motor with shorted stator winding turns, and one control box to vary short conditions**

3 HP AC Motor With Voltage Unbalance & Single Phasing (G-VUSM-3)

- ❖ Study the effects of voltage unbalance and one phase loss on motor current/vibration signatures.
- ❖ Study the effect of voltage unbalance and one phase loss on power quality and consumption.
- ❖ Study the effect of temperature rise on non-linear characteristics of induction motors.
- ❖ **The kit consists of one 3 HP AC motor and one control box to vary voltage balance and to disconnect one**

Drivetrain Diagnostics Simulator (DDS)

High Value Combination Packages

The DDS is also available in various high value combination packages. From basic to comprehensive, each package is designed to provide you with all the tools needed to study a variety of drivetrain fault topics.

Package No. 1: Basic DDS+ Kits for in-depth studies of diagnostics concepts
Package No. 2: Basic DDS+ Kits in-depth studies of drivetrain diagnostics with instrumentation
Package No. 3: Basic DDS+ Kits in-depth studies of drivetrain diagnostics with instrumentation plus torque transducer and encoders
Package No. 4: Basic DDS+ Kits in-depth studies of drivetrain diagnostics and motor diagnostics with instrumentation

Option kit		PKG 1	PKG 2	PKG 3	PKG 4
Parallel gearbox bearing fault kit	G-BFK-1	X	X	X	X
Planetary gearbox bearing fault kit	G-BFK-P	X	X	X	X
Defective spur gears	G-SDG	X	X	X	X
Eccentric spur gear	G-ESG	X	X	X	X
Helical gears set	G-HG	X	X	X	X
Defective helical gears	G-HDG	X	X	X	X
Defective planatary gears	G-PDG	X	X	X	X
Parallel gearbox oil-impregnated sleeve bearing	G-SBH		X	X	X
PC motor control kit	G-PCMK		X	X	X
PC Load control kit	G-PCLK		X	X	X
Radial bearing loader	G-RBL		X	X	X
Radial bearing loader force transducer (Requires G-RBL)	G-RBFT		X	X	X
Torque transducer with built encoder on input shaft	G-TOR			X	X
Shaft encoder	G-ENC			X	X
3 HP AC motor with built-in rotor unbalance	G-UBM-3				X
3 HP AC motor with built-in rotor misalignment system	G-MAM-3				X
3 HP AC motor with built-in bowed rotor	G-BRM-3				X
3 HP AC motor with built-in faulted bearings	G-FBM-3				X
3 HP AC motor with built-in broken rotor bars	G-BRBM-3				X
3 HP AC motor with stator winding faults	G-SSTM-3				X
3 HP AC motor with voltage unbalance & single phasing	G-VUSM-3				X

The DDS was designed to simulate industrial drivetrains for experimental and educational purposes

Drivetrain Diagnostics Simulator (DDS)

SpectraQuest: A Valuable Resource for Keeping Companies Productive

SpectraQuest offers a wide range of optional tool kits for productivity enhancement. We also continue to develop new applications and improvements for the DDS so that the investment you make in this important training tool will continue to provide value for many years to come. To learn more about the DDS and how it can help you to keep your plant operating profitably, please call or e-mail us.

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
Foundation	1/2" (12.7 mm) die cast aluminum base, base stiffener and eight rubber isolators
Physical	
Weight	Approximately 200 lb
Dimensions	L=45" (114cm), W=20" (50cm), H=24" (60cm)