Machinery Fault Simulator Lite

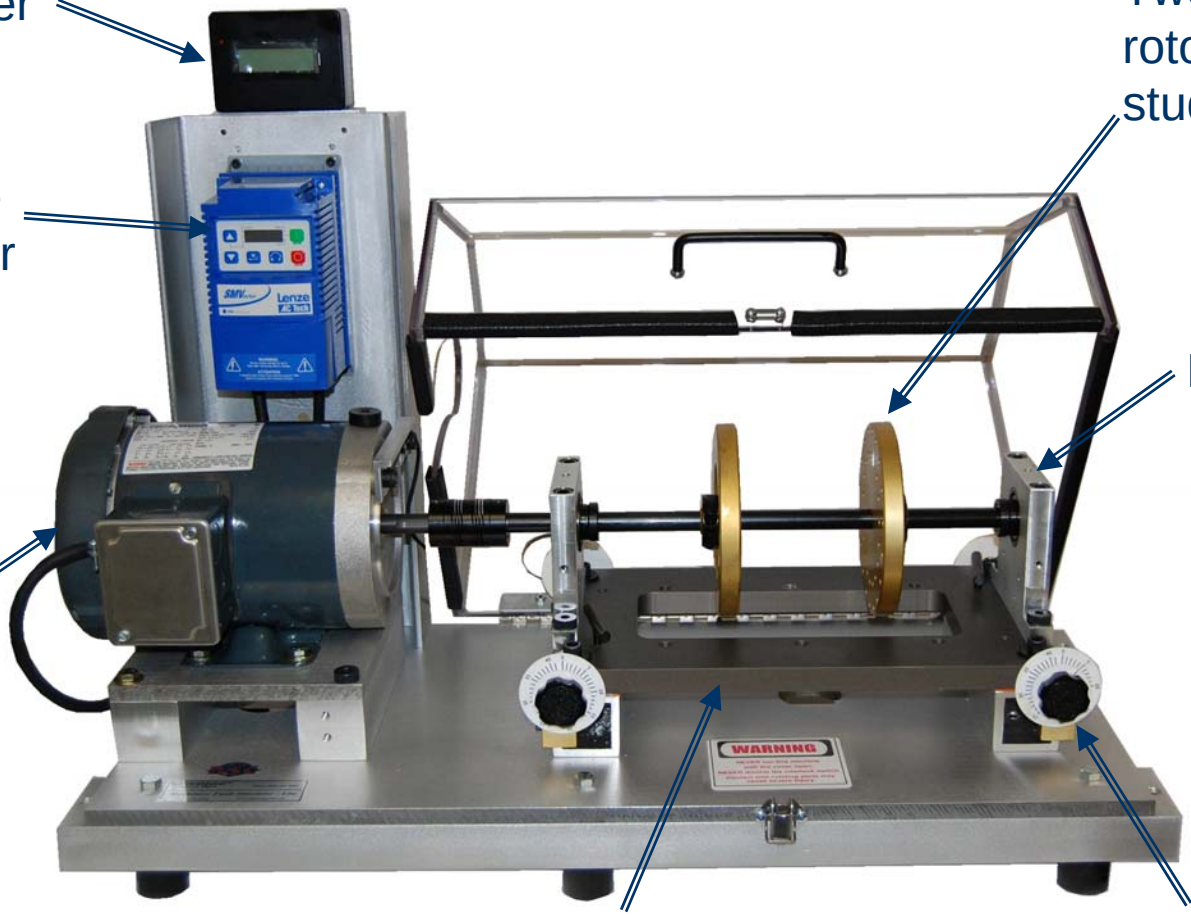
A Valuable Tool for Learning Machinery Diagnosis

SpectraQuest, Inc.
8201 Hermitage Road, Richmond, VA 23228 U.S.A.
TEL +1-804-261-3300/FAX +1-804-261-3303
www.spectraquest.com

Machinery Fault Simulator

- Innovative tool to study the signatures of common machinery faults without compromising production schedule or profits.
- Components is machined to high tolerances so it can be operated without conflicting vibration.
- Various faults can be introduced either individually or jointly in a totally controlled environment, making the MFS the best tool available for learning machinery diagnosis.
- Gain an in-depth understanding of different vibration signatures, controlled experiments on a device that emulates real world machinery are needed.

MFS-LT


Tachometer
1/2 HP variable speed controller
1/2 HP motor
Two 6” aluminum rotors for balance studies
Rolling bearing
15” rotor deck
Shaft alignment jack bolts
WARNING

MFS-LT Features

- Simple methods for introducing controlled and calibrated faults.
- Study the vibration spectra of common faults, learn fault signatures and validate rules provided in training courses.
- Bench top machine for hands-on training and skill sharpening.
- Learn machine condition monitoring and predictive maintenance.
- Manual with exercises for individually paced study.
- Learn resonance and variable speed diagnostics.
- Learn to determine vibration transmission path and perform root-cause analysis.
- Validate balancing procedures above and below the first critical resonance.

Applications

- Balance training
- Shaft alignment training
- Alignment system assessment
- Coupling studies
- Bearing faults and load effects
- “Cocked” rotor
- Eccentric rotor
- Resonance studies
- Sleeve bearing studies
- Mechanical rub
- Foundation studies
- Signal processing techniques
- Bent shaft
- Variable speed/load effects
- Rotor dynamics
- Operating deflection shape and modal analysis
- Vibration training
- Analyst certification

Basic MFS-LT

- 1/2 HP variable frequency AC drive with multi-featured front panel programmable controller
- 3 Phase, 1/2 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
- Split bracket bearing housings with five mounting positions for shaft span reconfiguration
- Two rolling element ball bearings with squeeze lock type
- Vibration isolators mounts and base stiffener
- Two balance rotors with two rows of holes
- Alignment system with calibrated reference dials and jack bolts
- One 5/8" TGP straight steel shaft
- Impact resistant clear safety cover with safety interlock

Option Kits

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

Training curriculum manual	SQI-TRCM
Eccentric rotor	M-ER-5/8
Cocked rotor	M-CR-5/8
Coupling type set	M-CK-5/8
Centrally bent rotor shaft for balance studies	ML-BRS-5/8
Coupling-end bent rotor shaft for alignment studies	ML-CBRS-5/8
Rolling bearing resonance/critical study kit	ML-RSK-1/2
Sleeve bearing resonance study kit (Requires M-RSK-1/2)	M-SBK-1/2

5/8" shaft bearing fault kit	M-BFK-5/8
5/8" shaft bearing loader	M-BL-5/8
1" shaft bearing study kit	ML-BSK-1
1" shaft bearing fault kit (Requires M-BSK-1)	M-BFK-1
1" shaft bearing loader (Requires M-BSK-1)	M-BL-1
Cocked bearing housing	M-CBM-5/8
5/8" shaft sleeve bearing (grease lubricated) kit	M-SBK-5/8
Mechanical rub kit	M-MRK
Damped bearing housing kit (Requires M-RSK-1/2)	M-DBHK-1/2
Crack shaft study kit	M-CSRK-5/8
Fan vibration kit	M-FVK-5/8
PC motor control kit	M-PCK
Shaft alignment kit	M-ATK
Vertical and horizontal bearing force transducer for 1/2" to 1" shafts	M-FTVH

Training Curriculum Manual (SQI-TRCM)

- Begins with textbook and basic classroom training in the fundamentals of classic machinery vibration, transducers, monitoring, signal processing, analysis, etc; from beginner to upper intermediate levels. It is both hands-on and mathematically oriented, being appropriate for both technicians and engineers.

- The training curriculum manual begins with textbook and basic classroom training in the fundamentals of classic machinery vibration, transducers, monitoring, signal processing, analysis, etc; from beginner to upper intermediate levels. It is both hands-on and mathematically oriented, being appropriate for both technicians and engineers.
- A wide array of laboratory exercises to be conducted on the MFS to provide a truly experiential learning environment.
- Use as a basis for accelerated course preparation and the development of vibration training program.

Eccentric Rotor (M-ER-5/8)

- Learn the effects of rotor eccentricity on vibration spectra.
- Determine relationships between eccentricity and unbalance.
- Develop techniques to locate and correct the effects of eccentricity.
- Learn the effect of varying the mass moment of inertia on vibration amplitude.
- The kit consists of one aluminum rotor with an asymmetrically located center and one clamp collar.

Cocked Rotor (M-CR-5/8)

- Learn the effects of a sheave that has not been fitted to the shaft properly.
- Learn vibration signature of a cocked rotor.
- Develop methods to correct cocked rotor problems.
- Learn the effect of varying the mass moment of inertia on vibration amplitude.
- The kit consists of a cocked aluminum rotor (0.5 degree off-axis) and one clamp collar

Coupling Type Set (M-CK-5/8)

- Learn the effects of coupling stiffness on rotor dynamics and vibration signature.
- Clarify the complexities of machinery shaft misalignment problems (spectral pattern for shaft misalignment is a strong function of coupling stiffness).
- The kit consists of one gear, one LoveJoy, one rubber, and one rigid steel coupling.

Centrally Bent Rotor Shaft (ML-BRS-5/8)

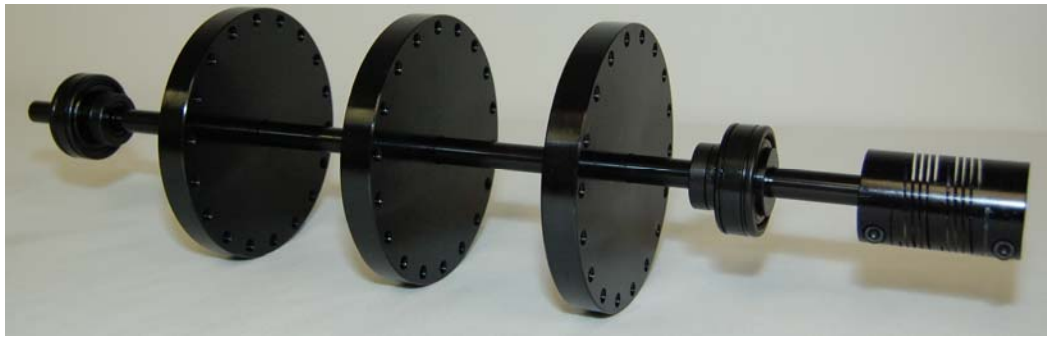
- Demonstrate the signature of a bent shaft.
- Observe the difficulty associated with attempting to balance a rotor mounted on a bent shaft.
- Learn to cope with the alignment issues due to a bent shaft.
- The kit consists of one 5/8” shaft centrally bent ~0.020”

Coupling-End Bent Rotor Shaft (ML-CBRS-5/8)

- Investigate complicated vibration signature due to gyroscopic effects.
- Observe the difficulty associated with attempting to balance an overhung rotor on a bent shaft.
- Learn to cope with the alignment issues due to a bent shaft.
- The kit consists of one 5/8” shaft coupling-end bent ~0.010”

Rolling Bearing Resonance/Critical Study Kit (ML-RSK-1/2)

- Study resonance and critical speed phenomena, at speeds below 2000 RPM to simulate real world operating conditions while improving safety. The standard ¾” shaft has a high resonance frequency, 7000 RPM or more depending on rotor positions.
- Study damaging effects of resonance and develop control methods.
- Relocate rotors and supports to study the effects of mass and stiffness on resonance frequencies and mode shapes.
- Study beating due to closely spaced modes.
- Study non-linear dynamics for chaos modeling.
- The kit consists of one ½” shaft, three rotors, two rolling element bearings, and one coupling.



Sleeve Bearing Resonance Study Kit (M-SBK-1/2)

- Study resonance and critical speed phenomena in sleeve bearings.
- The kit consists of two customized grease-lubricated, babbitt lined sleeve bearings, two bearing pedestals, and various thickness plastic shims

5/8" Shaft Sleeve Bearing Kit (M-SBK-5/8)

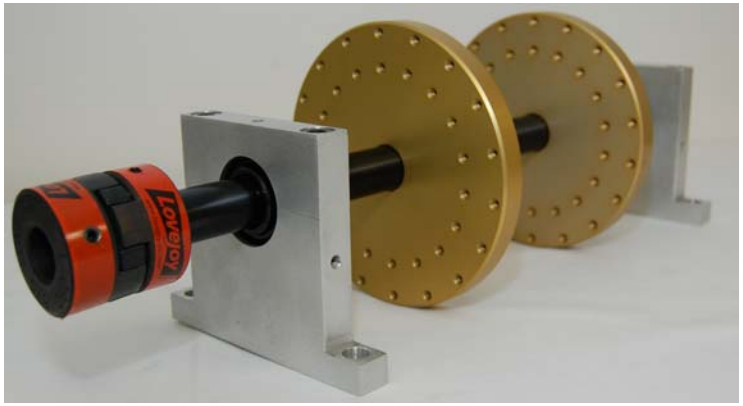
- Investigate waveform and spectral recognition of worn or loose fitting bearings.
- Modify the clearance of the split bearings with plastic shims.
- Perform shaft orbital analysis.
- The kit consists of two customized grease-lubricated, babbitt lined sleeve bearings, two bearing pedestals, and various thickness plastic shims

Cocked Bearing Housing (M-CBM-5/8)

- Recognize the signature of a cocked bearing due to improper seating or due to inconsistent installation.
- The kit consists of one cocked bearing housing

1" Shaft Bearing Study Kit (M-BSK-1)

- Study bearing fault frequencies away from multiples rotational speed. The standard 5/8” shaft exhibit fault frequencies close to multiples rotational speed, requiring ultra high resolution spectra to clearly identify bearing fault frequencies.
- Identify bearing fault frequencies in the presence of defects at multiples of shaft speed without using high-resolution spectra.
- Understand the signal processing issues such as averaging, spectral resolution, and leakage phenomena.
- The kit consists of two split bearing housings, two 1” inside diameter bearings, one 1” diameter shaft, and one coupling



5/8” and 1” Bearing Loader (M-BL-5/8 & M-BL-1)

- Investigate bearing radial loading effects.
- Enhance the spectral amplitude of system.
- The kit consists of one 5/8” or 1” bore loader weighting 11lb (5kg) and two clamp collars

5/8” and 1” Bearing Fault Kit (M-BFK-5/8 & M-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

Fan Vibration Kit (M-FVK-5/8)

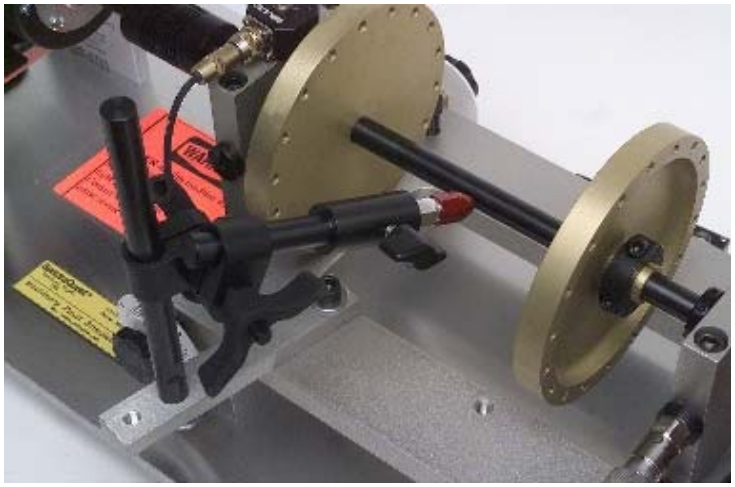
- Learn the sound and vibration signatures of fans.
- Study the effects of volumetric flow rate on pressure rise and fan vibration.
- Develop the noise and vibration control methods on fans.
- The kit consists of one six-blade paddle fan, one ten-blade paddle fan, one 12-blade axial fan, and one axial fan obstruction

Crack Shaft Study Kit (M-CSRK-5/8)

- Study the effects of crack on the natural frequencies and vibration behavior.
- Develop diagnostic technique to detect crack at early stage.
- Study crack propagation and breathing.
- Apply advanced signal processing techniques, such as wavelet, joint time-frequency analysis, time series analysis, to study the vibration caused by crack.
- The kit consists of one shaft with a 4 ½'' 4-bolt flange connection to simulate crack, one shaft with slit crack and filler, and one shaft with a deep V-notch crack.

Mechanical Rub Kit (M-MRK)

- Evaluate typical rub phenomena associated with a variety of materials under different angle, loading, and lubricant conditions.
- Experiment rubs on shaft or rotor.
- The kit consists of an adjustable spring-loader rub material holder and four different rub materials

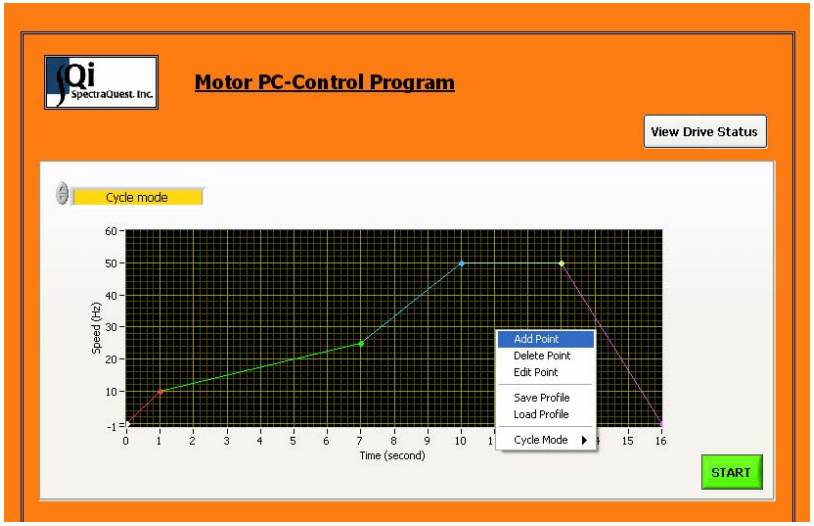


Damped Bearing Housing Kit (M-DBHK-1/2)

- Study bearing housing with a higher damping factor than the standard housing. Typical rolling element bearing systems are an all-metal structure with virtually no damping.
- Add damping to a standard rolling element bearing housing.
- Demonstrate the reduction in rotor resonance amplitude due to the installation of damping.
- The kit consists of two bearing housings and two ½" bearings fitted with isolators.

PC Motor Control Kit (M-PCK)

- Operate MFS 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.



Shaft Alignment Kit (M-ATK)

- Align shafts precisely with convenient and simple Windows alignment software.
- Accommodates ½” to 1 ¼” diameter shafts.
- The kit consists of two precision dial indicators, two mounting brackets/bars, one mirror, one set of feeler gauges, and instructions packaged in a rugged plastic case.

Vertical and Horizontal Bearing Force Transducer for 1/2" to 1" Shafts (M-FTVH)

- Measure forces exerted on bearings due to coupling misalignment, rotor unbalance, belt misalignment, and belt tension.
- Establish quantitative tensions for drive belt studies.
- Learn to relate the vibration signature to forces associated with common malfunctions such as resonance and bearing faults. Learn phase relationship between force and vibration spectrum.
- Learn nature of rotor dynamic forces due to common defects.
- Witness 180 degree phase shift between heavy and high spots when rotor goes through a critical speed. Demonstrate how mass unbalance force quadruples when the speed is doubled, but vibration amplitude does not follow the same trend.
- Verify and refine your rotor dynamic models and enhance modeling skills.
- The kit consists of one transducer simultaneously measuring vertical and horizontal force and one matching signal conditioner.

Value Packages

- The MFS-LT is also available in 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 machinery fault topics:

	Alignment	Balancing	Resonance	Bearing defects	Mechanical rub	Shaft crack	Damping	Fan	PC operation	Shaft alignment	Bearing force transducer
PKG 1	x	x	x								
PKG 2	x	x	x	x							
PKG 3	x	x	x	x	x	x	x	x			
PKG 4	x	x	x	x	x	x	x	x	x	x	x

	SQI-TRCM	M-ER-5/8	M-CR-5/8	M-CK-5/8	M-BRS-5/8	M-CBRS-5/8	M-RSK-1/2	M-SBK-1/2	M-BFK-5/8	M-BL-5/8	M-BSK-1	M-BFK-1	M-BL-1	M-CBM-5/8	M-SBK-5/8	M-MRK	M-DBHK-1/2	M-CSRK-5/8	M-FVK-5/8	M-PCK	M-ATK	M-FTVH
PKG 1	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							
PKG 3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
PKG 4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x(2)

Specifications

Electrical	
Motor	3 Phase, 1/2 HP motor, pre-wired self-aligning mounting system for easy installation/removal
Drive	1/2 HP variable frequency AC drive with multi-featured front panel programmable controller
RPM range	0 to 6000 rpm (short duration) variable speed
Current Measurement	Power leads accessible for current measurements
Tachometer	Built-in tachometer with LCD display and one pulse per revolution analog TTL output for DAQ purposes
Voltage	115/230 VAC, Single phase, 60/50 Hz
Mechanical	
Shaft Diameter	5/8” diameter; Turned, Ground, & Polished (TGP) steel
Bearing	Two sealed rolling element in aluminum horizontally split bracket housing for easy changes, tapped for transducer mount. Bearing mounts can be mounted in five different position for variable rotor span
Rotor Base	15” long, completely movable using jack bolts for easy horizontal misalignment and standard shims for vertical misalignment. Pinned for easy realignment.
Rotors	Two 6” aluminum with 36 threaded holes at 10 degree intervals for introducing unbalance
Safety Cover	Lockable clear, impact resistant hinged plastic cover with motor interlock switch to shut down motor when cover is raised
Foundation	1/2” (12.7 mm) die cast aluminum base, base stiffener and six rubber isolators
Physical	
Weight	Approximately 100lb (45kg)
Dimensions	L=32” (80cm), W=14” (36cm) , H=22” (55cm)