MACHINERY DIAGNOSIS

GUNT is innovative

We are continuously monitoring trends in technological development in both the scientific and industrial fields. Our aim is to translate key topics and developments into teaching and training systems that provide schools, colleges and universities and their trainees and students with access to the latest state-of-the-art technologies.

There is frequent scientific co-operation between GUNT and academic institutions in specific fields. A prime example of this is the training systems covering the subject of plant and machinery condition monitoring.

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PT 500 – MACHINERY DIAGNOSTIC SYSTEM

Industrial plant

Vibrational analyser

Evaluation of vibrational signals

The purpose of modern-day machinery diagnosis is to carry out needs-based maintenance or repair and to minimise the repair and other servicing downtimes of a machine. The aim is to detect damage as it occurs.

The condition of a machine or of machine components can be accurately diagnosed from the nature and extent of its vibration. Accordingly, vibrations are measured, recorded and evaluated using sensors and recording equipment.

Correct interpretation of the measurement signals requires a thorough understanding of the mechanisms at work and a degree of experience.

The GUNT PT 500 machinery fault trainer is a modular system which deals with this complex and highly topical issue in technical tuition, developing it through experimentation.

A thorough treatment of the subject requires an engineer's know-how. However, skilled tradesmen and maintenance fitters can use the training system to familiarise themselves with this field of technology at a more practice-oriented level.

The PT 500 machinery fault trainer can be used to selectively simulate, measure and evaluate vibration signals generated by typical malfunctions and damage, thus allowing thorough interpretation of the measurement signals to be carried out.

The computerised vibration analyser supports effective learning notably.

BASE UNIT

A range of training exercises relating to machinery diagnosis and monitoring can be carried out using just the PT 500 base unit together with the computerized vibration analyser PT 500.04.

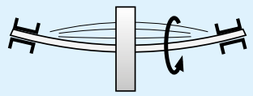
As well as the exercises in the measurement of the vibration (amplitude, velocity and acceleration in the time or frequency domains), field balancing of rigid rotors and alignment of shafting can also be practised.

The base unit includes a vibration-damped workholder plate, a speed-controlled drive motor with a tachometer, a shaft with two mass discs and two bearing units, a coupling and balancing weights.

A wide range of accessories enables almost any subject area relating to machinery diagnosis to be covered.

ACCESSORY SETS OPTIONALLY COUPLED TO THE BASE UNIT

PT 500.10 *Elastic Shaft*



Unbalanced mass vibration of a flexurally elastic shaft; resonance, critical rotation speed, balancing

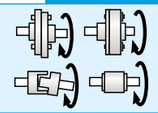
PT 500.11 *Crack Detection in Rotating Shaft*

Vibration behaviour of a cracked shaft, identification of the crack from the vibration signal

PT 500.12 *Roller Bearing Faults*

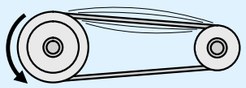
Identification of bearing damage from running noise.
Various pre-damaged roller bearings

PT 500.13 *Couplings*



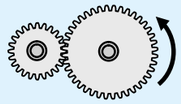
Properties of different coupling types, influence of eccentricity, wobble and pitch fault on vibration behaviour

PT 500.14 *Belt Drive*



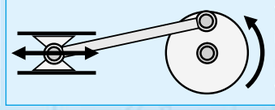
Vibration in belt drives, resonance and critical rotation speeds, influence of belt tension, eccentricity and misalignment

PT 500.15 *Damages to Gears*



Identification of gear damage from the vibration signal, influence of toothing type and lubrication

PT 500.16 *Crank Mechanism*



Vibration in crank drives, free inertia forces, bumps and jolts resulting from bearing play and wear

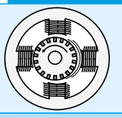
PT 500.17 *Cavitation in Pumps*

Noise and damage resulting from cavitation, conditions for cavitation inception

PT 500.18 *Vibrations in Fans*

Vibration in fans, demonstration of vibration excitation by blade passage, influence of centrifugal force

PT 500.19 *Electromechanical Vibrations*



Interaction of electromagnetic/ mechanical elements of system, influence of load, gap geometry and electrical asymmetry

PT 500 *Machinery Diagnostic System, Base Unit*

The illustration shows the base system PT 500 ready for conducting experiments, together with the trolley PT 500.01.

*** Base unit for setting up wide ranging experiments in machinery diagnostics using modular accessory sets**

*** Aluminium base plate with slots for quick, flexible assembly of different experimental setups**

*** Speed controlled drive motor with frequency converter; control unit with digital power and speed display**

*** Modern and well-structured instructional material**

Technical Description

The machinery diagnostic system can be used to simulate certain types of damage and investigate its effects on the vibration spectrum.

The PT 500 base unit permits vibration measurement exercises (measurement of vibration displacement, velocity and acceleration in the time/frequency range). Field balancing of rigid rotors and alignment of shafts can also be practiced.

The key components of the base unit are the mechanical elements (clutch, bearing blocks and shaft with rotors), the drive motor with variable speed via frequency converter and tachogenerator, and the display and control unit with digital displays for power output and speed.

The motor base plate is mounted on a carriage, enabling the motor to be aligned. The large aluminium base plate with locating slots allows quick, flexible and precise assembly of the system components. A transparent protective cover provides the necessary safety during operation, and enables clear system viewing during experiments.

All parts are clearly laid out and well protected in a storage box.

To measure and evaluate all experiments, the computerised vibration analyser PT 500.04 is required. The accessory sets PT 500.10 - PT 500.19 enable repeatable simulation of the different types of damage.

Use of the trolley PT 500.01 is recommended for flexible deployment of the training system.

Learning Objectives / Experiments

- introduction to vibration measurement methods on rotating machinery systems
  - * fundamentals of measurement of shaft and bearing vibrations
  - * basic variables and parameters
  - * sensors and measuring devices
  - * influences of speed and shaft layout
  - * influence of transducer positioning
- field balancing of rigid shafts
- influence of alignment between motor and coupling
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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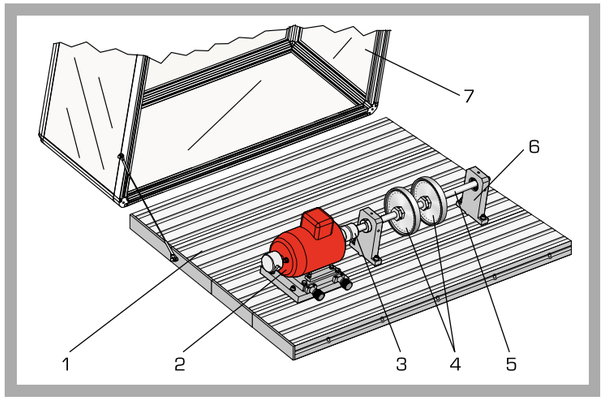
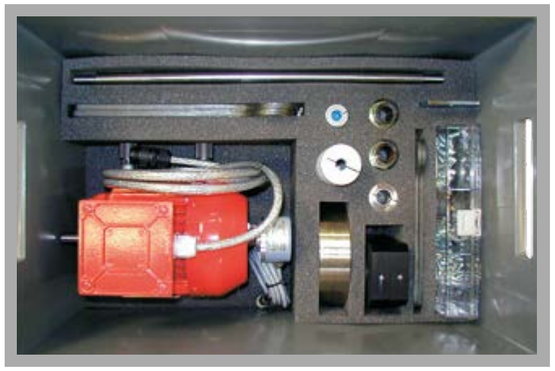
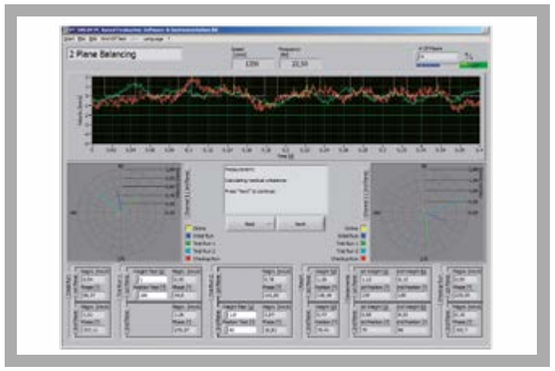
PT 500 *Machinery Diagnostic System, Base Unit*



1 base plate, 2 drive motor with adjustable carriage, 3 coupling, 4 bearing unit, 5 shaft, 6 unbalanced flywheel, 7 transparent hood



The illustration shows the components in the storage box.



Screenshot of evaluation software: field balancing in two planes.

Specification

[1] base unit for machinery diagnostic training system
[2] rigid base plate with workpiece holder slots
[3] drive motor with variable speed via frequency converter
[4] digital speed and power display
[5] 2 shafts: 1x short, 1x long
[6] 2 unbalanced flywheels with interchangeable balance weights
[7] bearing blocks, roller bearings, interchangeable
[8] fixing holes for vibration measurement transducer
[9] flexible claw coupling and Controlflex^{R} coupling
[10] motor can be aligned obliquely and transversally
[11] transparent protective hood
[12] stackable box for components

Technical Data

Asynchronous motor with frequency converter
- drive power output: 0,37kW
- nominal speed: 2800min^{-1}
Speed range via frequency converter
- 100...6000min^{-1}
Display and control unit with digital power and speed display

2 shafts: D=20mm, length 300mm, 500mm
2 unbalanced flywheels
- D=150mm, each 1675g, with interchangeable balance weights (bolts)
2 bearing blocks with roller bearings 6004 (can be exchanged)
Controlflex^{R} coupling: nominal torque: 15Nm

Dimensions and Weight

LxWxH: 1100x800x500mm (base plate + hood)
LxWxH: 475x415x195mm (control unit)
LxWxH: 600x390x325mm (storage box)
Weight: approx. 95kg (complete system)

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz, 1 phase

Scope of Delivery

1 base plate with protective hood
1 display and control unit
1 asynchronous motor with frequency converter
2 shafts, 2 unbalanced flywheels, 2 clutches
2 bearing units
1 holder plate, 2 clamp sets
1 set of tools
1 storage box with foam inlay
1 set of instructional material

Order Details

052.50000	PT 500	Machinery Diagnostic System, Base Unit

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PT 500 - Classification: Experimentation kits and required/optional components

Experiments \ Components	PT 500.05 Brake & Load Unit	PT 500.10 Elastic Shaft Kit	PT 500.12 Roller Bearing Faults Kit	PT 500.14 Belt Drive Kit	PT 500.15 Damages to Gears Kit	PT 500.01 Laboratory Trolley	PT 500.04 Computerised Vibration Analyser	PT 500 Machinery Diagnostic System, Base Unit
PT 500.10 Elastic Shaft Kit						optional	required*	required
PT 500.11 Crack Detection in Rotating Shaft Kit		required		required		optional	required	required
PT 500.12 Roller Bearing Faults Kit				required		optional	required	required
PT 500.13 Couplings Kit	optional					optional	required	required
PT 500.14 Belt Drive Kit	required					optional	required	required
PT 500.15 Damages to Gears Kit	required					optional	required	required
PT 500.16 Crank Mechanism Kit				optional	optional	optional	required	required
PT 500.17 Cavitation in Pumps Kit				optional		optional	required	required
PT 500.18 Vibrations in Fans Kit				optional		optional	required	required
PT 500.19 Electromechanical Vibrations Kit	required					optional	required	required

* PT 500.41 Two Displacement Sensors additionally required

PT 500.01 *Laboratory Trolley*

The illustration shows PT 500.01 together with the base plate with protective hood from the base unit PT 500.

*** Trolley for base unit**

*** 4 castors guarantee mobility**

Specification

[1] trolley for the modular machinery diagnostic training system
[2] blocan section, aluminium
[3] 4 castors, with brake

Technical Data

Top area, LxW: 1100x770mm

Dimensions and Weight

LxWxH: 1100x770x820mm
Weight: approx. 39kg

Scope of Delivery

1 trolley, complete

Technical Description

This laboratory trolley together with the PT 500 base unit permits the construction of a mobile experimental unit. The trolley features two shelves on which measuring equipment and other accessories can be placed. The sturdy trolley structure is manufactured from anodised aluminium section. The shelves are made from anodised aluminium sheet.

Order Details

052.50001 PT 500.01 Laboratory Trolley

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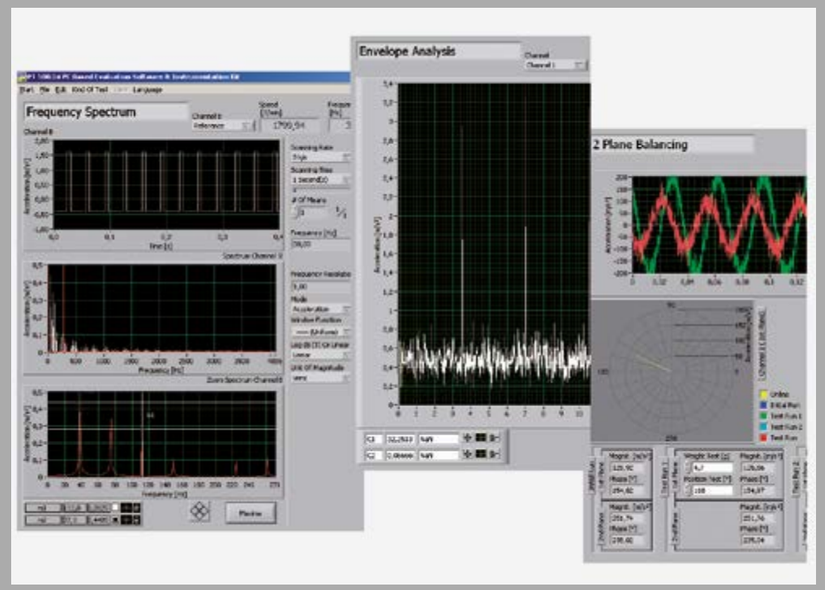
PT 500.04 *Computerised Vibration Analyser*



*** Versatile, powerful software for vibration analysis**

*** Supports all machinery diagnosis experiments of the PT 500 series**

*** Suitable for field balancing of rotors in 1 and 2 planes**

Technical Description

The computerised vibration analyser was developed specially to support analysis of machinery diagnosis experiments of the PT 500 series. The analyser can also be used in many other vibration experiments (such as TM 150).

The system comprises two acceleration sensors, a measuring amplifier with adjustable gain, a USB box and the analysis software.

The analysis software offers the following features: Two-channel oscilloscope for investigations in the time range; two-channel spectrum analyser for investigations in the frequency range; vibration measuring device; envelope analysis for bump effects and roller bearing damage; travelling filter to record run-up curves; orbit display; and a balancing module for field balancing of rigid rotors in 1 and 2 planes.

The software permits various analytical methods to be applied to a vibration signal and compared in terms of their efficacy. This enables the advantages and disadvantages of the various techniques to be effectively discovered. The balancing process is presented step-by-step.

The software features an intuitive user interface, and is highly user-friendly. An online help function provides guidance on the various functions. Measurement results can be printed out.

Cables, brackets and fixings are supplied.

Learning Objectives / Experiments

Within the context of the experiments in the complete PT 500 series, the following learning can be covered:

- familiarisation with vibration signals
- correct application of FFT analysis
- measurement of rotation speed, vibration displacement, vibration velocity and acceleration
- assessment of the vibration state of a machine
- damage analysis of roller bearings and gears by means of envelope spectra
- detection of cracks in shafts by means of run-up curves and order analysis
- measurement of imbalance vibrations and field balancing of rigid rotors in 1 and 2 planes

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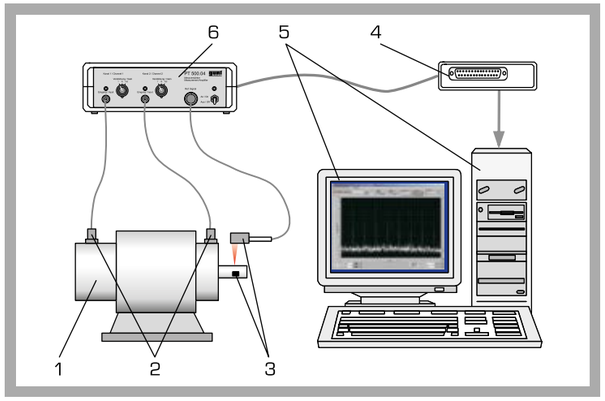
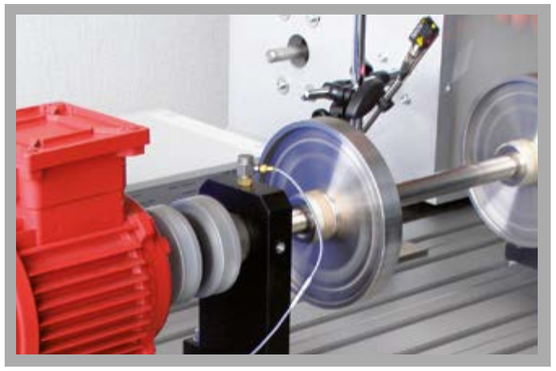
PT 500.04 *Computerised Vibration Analyser*



1 vibrating machinery, 2 acceleration transducers, 3 shaft with reference sensor, 4 USB box, 5 PC (PC not included), 6 amplifier / filter



Application of the sensors: acceleration sensor on the black bearing support, speed sensor with holder

Screenshot of the software working as oscilloscope

Specification

[1] computerised vibration analyser for representation and evaluation of experiments with the PT 500 "Machinery diagnosis" series
[2] 2 acceleration sensors to record vibration displacement, vibration velocity and acceleration
[3] optical sensor to record rotation speed
[4] 2-channel measuring amplifier with adjustable gain
[5] analysis software programmed in LabVIEW
[6] software features: 2-channel oscilloscope; 2-channel FFT analyser; envelope analysis; run-up curve and order analysis; 2-plane field balancing
[7] 2 displacement sensors PT 500.41 can be connected
[8] suitable for general vibration measurement tasks
[9] connection to PC via USB
[10] stackable storage system to house the components

Technical Data

Acceleration sensor
- frequency range: 1...10000Hz
- sensitivity: 100mV/g
- resonance frequency: 32kHz

Optical speed sensor
- sampling width: 3...150mm
- laser class II, 675nm

Measuring amplifier
- adjustable gain: x1, x10, x100
- powered by 12VDC power supply unit
- LxWxH: 230x220x80mm

USB box
- 16x analogue in, 2x analogue out
- each 4x digital in/out

System requirements: Windows Vista or Windows 7

Dimensions and Weight

LxWxH: 600x400x220mm (storage system)
Weight: approx. 6kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz/CSA, 1 phase

Scope of Delivery

2 acceleration sensors, 1 speed sensor with holder, 1 amplifier, 1 CD with evaluation software, 1 USB box + data cable, 1 combination wrench, AF 13, 1 storage system with foam inlay, 1 manual

Order Details

052.50004	PT 500.04	Computerised Vibration Analyser

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PT 500.05 Brake & Load Unit

*** Generation of a loading torque**

*** Two speed and torque ranges**

*** Vented magnetic particle brake with display and control unit**

Technical Description

Many vibration phenomena can only be achieved when the system is under load. The brake and load unit is used to generate vibration as a function of torque, e.g. in toothed gearing mechanisms or electric motors.

It consists of a magnetic particle brake and an electric display and control unit. The braking torque can be finely adjusted on the display and control unit. The exciter current is applied as a measure of the braking torque and is indicated digitally on a display.

An integrated belt drive, with a free shaft, provides the brake with two torque and speed ranges. The energy is converted by the brake into heat and discharged to the ambient air by a fan.

The brake can be quickly and precisely mounted on the slotted plate of the PT 500 base unit.

PT 500.05 is used with the following kits:
PT 500.13 Couplings
PT 500.14 Belt drive
PT 500.15 Damage to gears
PT 500.19 Electromechanical vibrations

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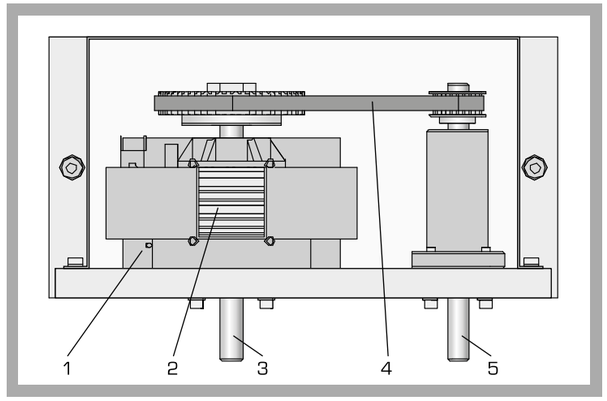
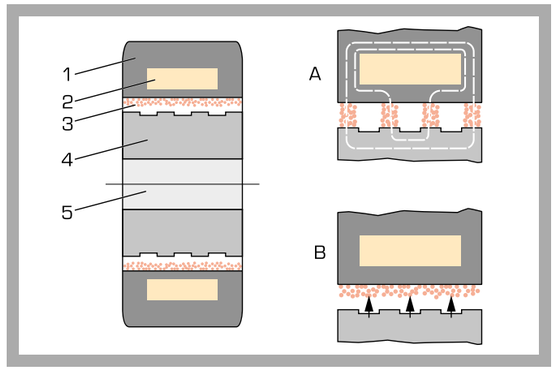
PT 500.05 Brake & Load Unit



1 magnetic particle brake, 2 fan, 3 shaft for direct connection of brake, 4 belt drive, 5 shaft for connection of brake via belt drive



Section through a magnetic particle brake: 1 stator, 2 exciter coil, 3 gap with magnetic particles, 4 rotor, 5 shaft; A current flows, B current flow is interrupted

The illustration shows PT 500.05 together with PT 500, PT 500.01, PT 500.15 and PT 500.04.

Specification

[1] brake and load unit for the machinery diagnostic training system
[2] magnetic particle brake
[3] display and control unit with exciter current display
[4] potentiometer to adjust braking torque
[5] integrated belt drive for second speed and torque range
[6] temperature protection and fan overheating protection
[7] stackable storage system to house the components

Technical Data

Continuous braking power: approx. 450W/3000min^{-1}

Transmission ratio between brake shafts: i=3

Direct brake operation
- speed range: 200...2000min^{-1}
- braking torque: 1...10Nm

Operation via belt drive
- speed range: 600...6000min^{-1}
- braking torque: 0,3...3,3Nm

Dimensions and Weight

LxWxH: 460x410x200mm (display and control unit)
LxWxH: 600x400x320mm (storage system)
Weight: approx. 30kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz, 1 phase

Scope of Delivery

1 magnetic particle brake
1 display and control unit
1 storage system with foam inlay
1 manual

Order Details

052.50005 PT 500.05 Brake & Load Unit

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PT 500.10 Elastic Shaft Kit

*** Flexural vibration of the elastic shaft**

*** Resonance and critical speed**

Technical Description

This accessory setup enables the response of an elastic rotor to unbalanced excitation to be studied. The subcritical, supercritical and resonance running states can be demonstrated. A comparison of the orbits (path curves) in the subcritical and supercritical range is of particular interest.

The field balancing of elastic rotors is another area which can be investigated. The supplied pendulum ball bearings ensure full mobility of the shaft. The retainer bearing limits the amplitudes to harmless values at speeds close to resonance.

The accessory setup is mounted on the base plate of the machinery diagnostic PT 500 base system.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 and two displacement sensors PT 500.41 are required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- familiarisation with the terms 'critical speed' and 'resonance'
- influence of unbalanced excitation
- balancing the elastic rotor
- influence of alignment errors
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

together with two displacement sensors PT 500.41

- study of the orbit in the subcritical and supercritical range

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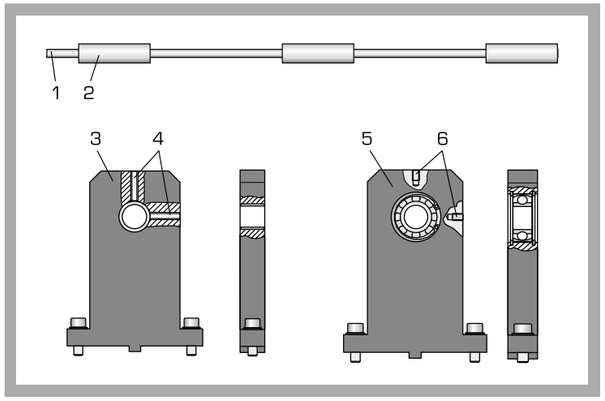
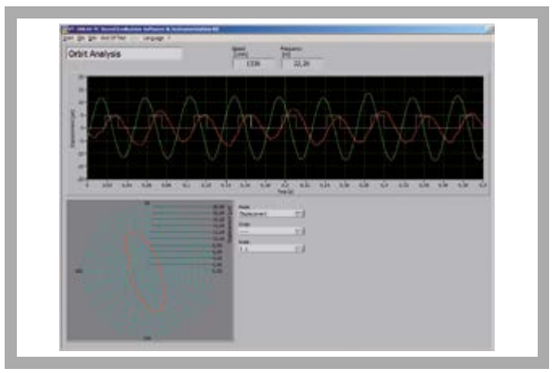
PT 500.10 Elastic Shaft Kit



1 elastic shaft, 2 bearing, 3 retainer bearing, 4 bores for position sensors, 5 bearing block with pendulum ball bearing, 6 bores for acceleration sensors

The illustration shows PT 500.10 together with PT 500, PT 500.01 and PT 500.04.



Screenshot of evaluation software
above: vibration signals as a function of time
below: orbit view for vibration on two planes

Specification

[1] investigation of flexural vibration of an elastic shaft
[2] stainless steel elastic shaft
[3] 2 bearing blocks with pendulum ball bearing
[4] 1 retainer bearing
[5] bearing blocks and retainer bearing with bores for sensor mounting
[6] accessory set for PT 500 machinery diagnostic training system
[7] stackable storage system to house the components

Technical Data

Elastic shaft
- min. diameter: D=10mm
- diameter at bearings: D=20mm
- length: 530mm
- nominal length between bearings: 450mm

Dimensions and Weight

LxWxH: 600x400x120mm (storage system)
Weight: approx. 6kg

Scope of Delivery

1 elastic shaft
2 bearing blocks
1 retainer bearing
1 storage system with foam inlay
1 manual

Order Details

052.50010 PT 500.10 Elastic Shaft Kit

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PT 500.11 Crack Detection in Rotating Shaft Kit

*** Vibration behaviour of shaft with radial crack**
*** Identification of damage**

Technical Description

Cracks due to material fatigue are very dangerous for rotating machines. Early detection of any crack is therefore essential before permanent rupture and often fatal consequences can occur. The crack influences the vibration behaviour of the shaft by changing its rigidity. Using suitable analysis software, this change can be registered and inspection of the machine organised in good time.

In the experiment, the crack is simulated by an asymmetric flange joint. Variable tightening of the flange bolts produces a temporary gaping of the butt joint, which closely approximates to the behaviour of a crack.

The accessory setup includes two shafts of different lengths: one short and one long. The short shaft simulates a protruding shaft end, and is loaded with the PT 500.14 belt drive. The long shaft is used in conjunction with a retainer bearing from PT 500.10 and an inertia disk from the base unit to investigate the effects of a crack in a shaft on the elastic rotor.

The accessory setup is mounted on the base plate of the machinery diagnostic base system PT 500.

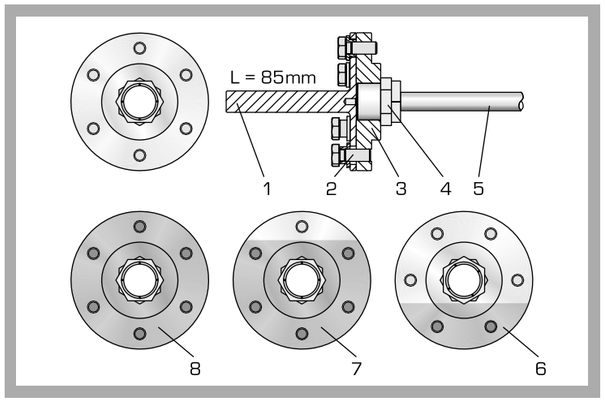
To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- change in characteristic vibration behaviour (natural frequency, resonance speed, amplitude and phase of vibrations) due to a crack
- crack identification from the change in vibration spectrum
- detection of cracks in rotating shafts at the protruding shaft end
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

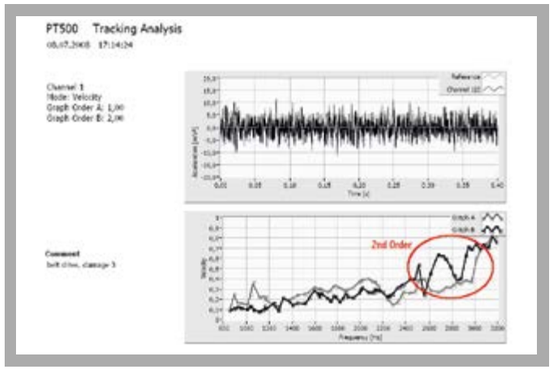
in conjunction with a retainer bearing (e.g. from PT 500.10 - elastic shaft accessory setup)
- detection of cracks in rotating shafts (the elastic rotor)

PT 500.11 Crack Detection in Rotating Shaft Kit



1 flange with short shaft (loaded by belt drive), 2 bolt, 3 pick-up disk, 4 clamp set, 5 driving shaft, 6 shaft with maximum crack (flange joint with 2 load-bearing bolts), 7 shaft with small crack (flange joint with 5 load-bearing bolts), 8 shaft with no crack (flange joint with 6 load-bearing bolts)

The illustration shows PT 500.11 together with PT 500, PT 500.01, PT 500.14 and PT 500.04.



Tracking analysis of a rotor with crack: significant rise in amplitude in 2nd order (marked red)

Specification

[1] investigation of the vibration behaviour of a cracked shaft
[2] crack adapter in flange form
[3] simulation of the crack by opening bolt joints
[4] 4 different sized cracks can be simulated
[5] short shaft to simulate a protruding shaft end
[6] long shaft to simulate an elastic rotor
[7] PT 500.14 (belt drive) generates required bending torque
[8] accessory setup for PT 500 machinery diagnostic training system
[9] stackable storage system to house the components

Technical Data

Flange diameter: D=90mm
6 hexagon flange bolts M8x20
Shafts
- diameter: D=20mm
- short shaft: L=85mm
- long shaft: L=200mm
- max. permissible bending torques
  short shaft for belt pulley: 15,9Nm
  long shaft for mass disk: 3,9Nm

Dimensions and Weight

LxWxH: 600x400x120mm (storage system)
Weight: approx. 3kg

Scope of Delivery

1 pick-up disk
1 long shaft
1 short shaft
1 centering arbor for alignment of shafts in experimental setup
6 bolts
1 clamp set
1 storage system with foam inlay
1 manual

Order Details

052.50011 PT 500.11 Crack Detection in Rotating Shaft Kit

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PT 500.12 *Roller Bearing Faults Kit*

Technical Description

Vibration analysis is a key tool in estimating the condition of a roller bearing. The slow change in the vibration spectrum provides indications of the remaining life of a bearing and can be used as a criterion for its replacement. The spectral distribution can deliver accurate information on the type and location of the damage.

This accessory setup contains six roller bearings on which different faults can be detected and explained. The radial load on the bearing can be set within broad limits using the belt drive accessory set PT 500.14 (setting of belt tension; fixed load).

The accessory setup is mounted on the base plate of the machinery diagnosis base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- vibrational spectrum of the running noise of roller bearings
- familiarisation with the envelope analysis
- influence of damage to outer race, inner race or roller body, on the spectrum
- estimating service lives of roller bearings
- influence of the lubricant on the vibration spectrum
- detection of faulty roller bearings
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

*** Assessment of bearing condition by vibration analysis**

*** Comparison of bearings with different faults**

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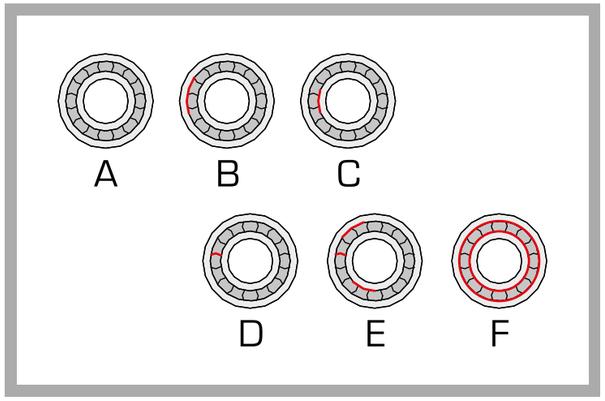
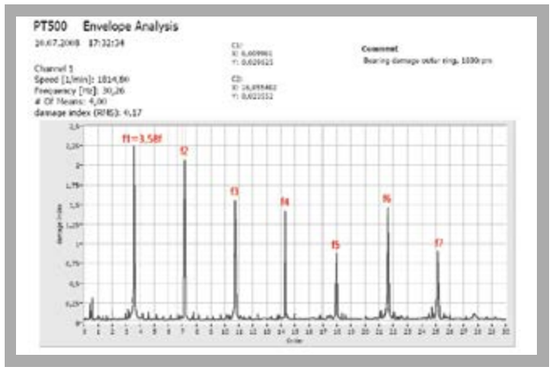
PT 500.12 *Roller Bearing Faults Kit*



A) undamaged bearing, B) bearing with damage to outer race, C) bearing with damage to inner race, D) bearing with damage to a roller body, E) bearing with damage to roller body, outer and inner race, F) heavily worn bearing

The illustration shows PT 500.12 together with PT 500, PT 500.01, PT 500.14 and PT 500.04.



Envelope analysis of the bearing with damage on outer ring (B) at f=1.800min^{-1}, damage frequency f_1=3,58f, harmonic wave f_2 to f_7

Specification

[1] investigation of the vibrations of roller bearings
[2] roller bearings with damaged outer race
[3] roller bearings with faulty inner race
[4] roller bearings with damaged rolling element
[5] roller bearings with combined damage
[6] long-running roller bearings
[7] new and undamaged roller bearings
[8] radial loading of bearings with PT 500.14 (belt drive)
[9] accessory set for PT 500 machinery diagnostic training system
[10] stackable storage system to house the components

Technical Data

Pendulum ball bearing of type NU204-E-TVP2
- inside diameter: d=20mm
- outside diameter: D=47mm
- width: 14mm
- number of rollers: 12

Dimensions and Weight

LxWxH: 600x400x120mm (storage system)
Weight: approx. 4kg

Scope of Delivery

6 roller bearings
1 bearing block
2 circlips
1 circlip pliers
1 storage system with foam inlay
1 manual

Order Details

052.50012 PT 500.12 Roller Bearing Faults Kit

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PT 500.13 Couplings Kit

The illustration shows PT 500.13 together with the claw coupling of PT 500.

*** Vibration analysis of couplings**

*** Eccentricity, wobble and pitch fault**

*** Properties of different coupling types: pin coupling, curved teeth coupling, flange coupling, claw coupling**

Technical Description

Rotating machine elements are interconnected by way of couplings. A coupling exhibiting production or assembly faults generates machine vibrations which can be analysed to give an indication of specific faults or damage.

The PT 500.13 accessory set can be used to simulate various faults and investigate their effects on vibration behaviour. The properties of various coupling types can also be compared. The curved teeth, pin, flange and claw coupling types are investigated. The couplings are installed between the motor and the shaft. The PT 500.05 load unit will also be required to investigate the behaviour of the couplings under load.

The accessory setup is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- effects of alignment errors on different coupling types
  * pin coupling with offset
  * claw coupling with offset
- effects of production faults such as eccentricity, wobble and pitch fault, on the running of the machine
  * flange coupling with no fault
  * flange coupling with eccentricity
  * flange coupling with wobble
  * pin coupling with no fault
  * pin coupling with pitch fault
- identification of coupling faults from the vibration signal
- load dependency of running behaviour
- influence of gear rim hardness on claw couplings
- comparison of curved teeth, pin, flange and claw couplings
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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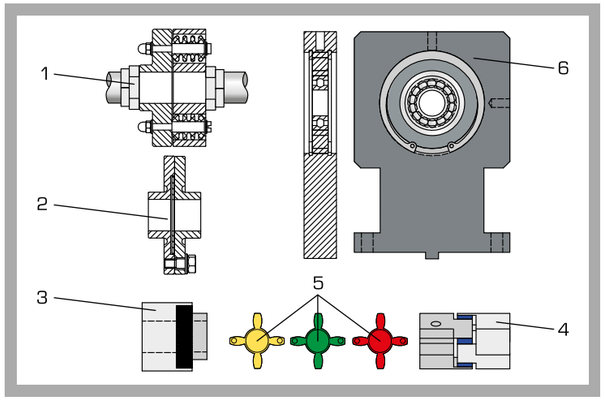
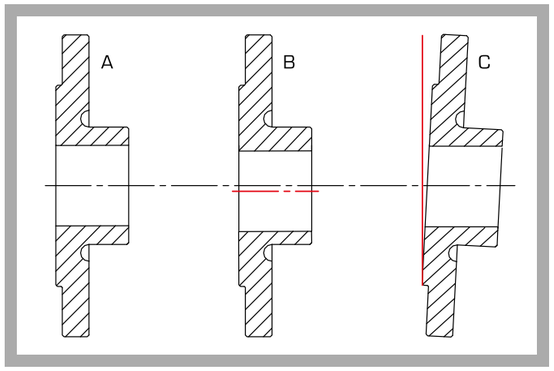
PT 500.13 Couplings Kit



1 pin coupling, 2 flange coupling, 3 curved teeth coupling, 4 claw coupling with coupling star (both from PT 500), 5 coupling stars, 6 bearing block with elastic bearing



Flange coupling halves: A without fault, B eccentricity, C wobble

The illustration shows PT 500.13 together with PT 500, PT 500.01, PT 500.05 and PT 500.04.

Specification

[1] investigation of the vibration behaviour of various coupling types with and without faults
[2] curved teeth coupling
[3] 3 different coupling stars for the elastic claw coupling of the base unit PT 500
[4] flange coupling with no fault
[5] flange coupling with eccentricity
[6] flange coupling with wobble
[7] pin coupling with and without pitch fault
[8] experimental setup can be used with brake and load unit PT 500.05
[9] accessory set for PT 500 machinery diagnosis training system
[10] stackable storage system to house the components

Technical Data

Pin coupling
- 1x centric pin
- 1x eccentric pin
  eccentricity of pin: 1mm
- max. pitch fault: 180° +/-1,909°

Coupling stars for claw coupling
- 98 Shore A (red)
- 92 Shore A (yellow)
- 64 Shore D (green)
- 80 Shore A (blue, included in PT 500)

Flange coupling
- eccentricity (centre offset): 0,2mm
- wobble: 0,4 +/-0,1mm

Dimensions and Weight

LxWxH: 400x300x170mm (storage system)
Weight: approx. 6kg

Scope of Delivery

1 curved teeth coupling
1 flange coupling with no fault
1 flange coupling with eccentricity
1 flange coupling with wobble
1 pin coupling with adjustable pitch fault
3 coupling stars
1 bearing block
1 set of tools
1 storage system with foam inlay
1 manual

Order Details

052.50013 PT 500.13 Couplings Kit

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PT 500.14 Belt Drive Kit

*** Vibrations in belt drives**

*** Resonance and critical speed**

Technical Description

When properly designed, manufactured, and correctly set; belt drives are low-maintenance, low-noise, long-life drive units. It is important that the belt should not vibrate and/or slip.

The PT 500.14 accessory setup can be used to investigate conditions that cause vibration or slip. The effect of disparate elongation on multiple belt drives can be demonstrated by means of individually-adjustable tensioning rollers. The belt drive is a dual belt drive with a belt tensioner. It can, however, also be operated with only one belt. An eccentrically-bored small belt pulley and a damaged V-belt enhance the range of possible experiments.

The brake and PT 500.05 load unit is required to conduct the experiment. The accessory set PT 500.14 can also be used to apply transverse loads in other experiments.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- influence of belt tension on vibration behaviour
- influence of speed on vibration behaviour
- influence of pulleys running untrue, and off-track running
- power split across multiple belt drive
- influence of slip on vibration running spectrum
- comparison between fault-free and damaged belts
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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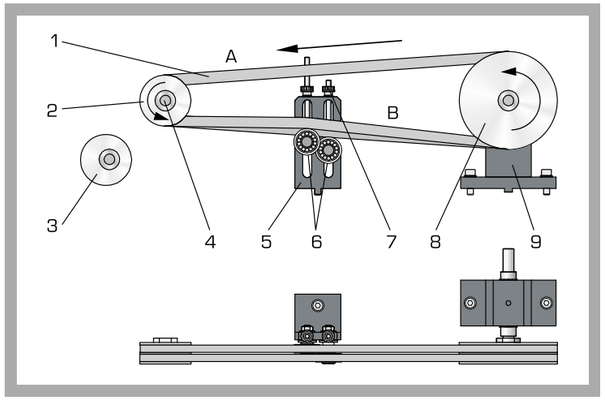
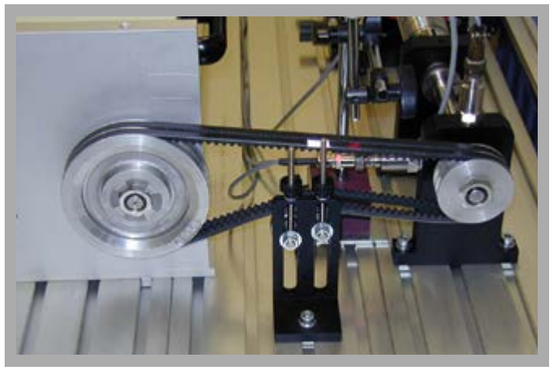
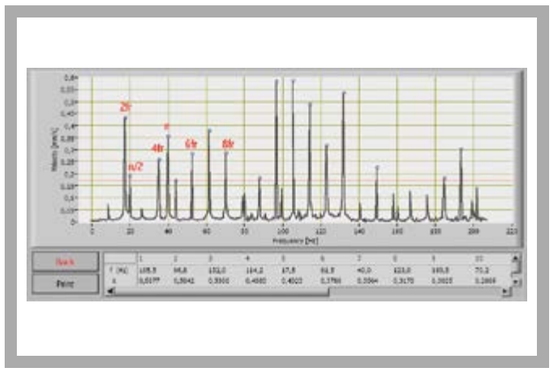
PT 500.14 Belt Drive Kit



1 belt, 2 small belt pulley (driving), 3 small eccentric V-belt pulley, 4 clamp set, 5 belt tensioner, 6 tensioning rollers, 7 adjustment of V-belt tension, 8 large V-belt pulley, 9 bearing block



The illustration shows PT 500.14 together with PT 500.05.



Frequency spectrum on the belt drive
belt frequency f_r with harmonic waves $2f_r$, $4f_r$, $6f_r$. drive speed n, n/2

Specification

[1] investigation of the vibrations of belt drives
[2] dual belt drive with V-belt
[3] belt drive can be operated with one belt
[4] individually-adjustable tensioning rollers
[5] belt drive with eccentricity
[6] damaged V-belt
[7] belt pre-tension measuring device 0...150N
[8] suitable for applying transverse loads on other systems within the accessory sets of the PT 500 series
[9] brake and load unit PT 500.05 required for experiments on the belt drive
[10] accessory set for PT 500 machinery diagnostic training system
[11] stackable storage system to house the components

Technical Data

V-belt pulleys
- large: D=125mm
- small: D=63mm
- small, eccentric: D=63mm

Axle centres: 300mm
V-belt
- SPZ, approx. 10mm wide
- belt length: 912mm

Dimensions and Weight

LxWxH: 600x400x170mm (storage system)
Weight: approx. 6kg

Scope of Delivery

3 V-belts
3 belt pulleys
1 tensioning roller set
1 belt pre-tension measuring device
1 storage system with foam inlay
1 manual

Order Details

052.50014 PT 500.14 Belt Drive Kit

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PT 500.15 Damage to Gears Kit

*** Vibration analysis of gearing damage**

*** Fault localisation on gears**

Technical Description

The PT 500.15 accessory setup is used to simulate typical damage to gears and study its effects on vibration behaviour. Various gear sets with tooth damage are supplied for this purpose. Undamaged gear sets are provided for comparative purposes. The difference between spur toothed and helical gearing can also be demonstrated. The influence of the centre distance and backlash can be studied using adjustable bearing plates. The type of lubrication has a significant influence on the vibration signal, so grease or gear oil can be used for lubrication.

The housing, with holes to accommodate sensors, is used for vibration experiments. The transparent housing cover allows the gear to be observed in operation without taking vibration measurements.

The PT 500.05 brake and load unit will be required to subject the gear unit to load.

The accessory setup is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- identification of gear damage from vibration behaviour
- influence of gearing type
  * spur toothed
  * helical
- localisation of damage
- influence of lubrication
- influence of centre distance and of backlash
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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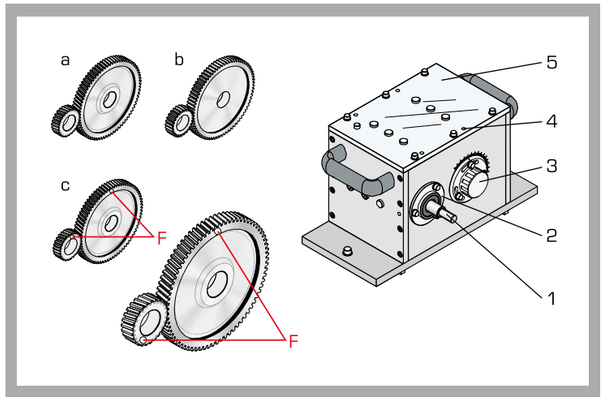
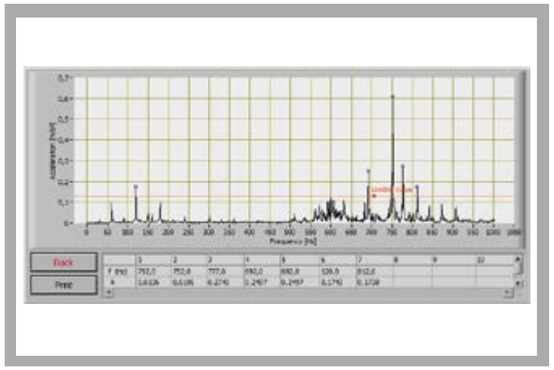
PT 500.15 Damage to Gears Kit



1 shaft end, 2 bearing cover with shaft gland, 3 bearing cover with centre distance adjustment facility, 4 tapped hole for vibration sensor, 5 transparent gear unit cover; a helical gear set, b spur toothed gear set, 4 damaged gear sets, F fault

The illustration shows PT 500.15 together with PT 500, PT 500.01, PT 500.05 and PT 500.04.



Spectrum of a spur toothed gear at 1800min^{-1}: tooth gearing frequency 752Hz

Specification

[1] investigation of the vibration behaviour of gears
[2] two-shaft gear unit
[3] 2 damaged and 2 undamaged gear sets
[4] spur toothed and helical gearing
[5] housing with sensor holes
[6] transparent housing cover
[7] gear can be lubricated with grease or oil
[8] loading of experimental setup with brake and load unit PT 500.05
[9] accessory set for PT 500 machinery diagnostic training system
[10] stackable storage system to house the components

Technical Data

Transmission ratio i: 1:3
Centre distance adjustable
Reference profile to DIN 867
Spur toothed gear sets
- gear wheel: 75 teeth on each, m=2mm
- pinion: 25 teeth on each, m=2mm

Helical gear sets
- gear wheel: 75 teeth on each, m=2mm
- pinion: 25 teeth on each, m=2mm
- helix angle: 10°

Dimensions and Weight

LxWxH: 600x400x320mm (storage system)
Weight: approx. 25kg

Scope of Delivery

1 gearbox
1 transparent housing cover
1 housing cover with sensor holes
4 gear wheels
4 pinions
1.5L motor oil SAE 10W 40
1 storage system with foam inlay
1 manual

Order Details

052.50015 PT 500.15 Damage to Gears Kit

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PT 500.16 Crank Mechanism Kit

*** Vibrations of crank drives**

*** Bearing clearance or slack in oscillating machine components**

Technical Description

Crank drives are frequently used in compressors and pumps. They cause vibration due to the oscillating masses and forces. Under the alternating stress in the drive mechanism, bearing clearance, for example, can generate shock impacts with high-frequency exciter spectra. In addition, free mass forces generate harmonic vibrations due to their non-linear kinematics.

The PT 500.16 accessory set enables the stroke, mass balance and bearing clearance on the crosshead to be adjusted. The speed is adjusted using the base unit PT 500. Gas pressure forces such as occur in compressors or combustion engines can be simulated using springs. Experiments with gas pressure forces require higher torques which are attained by reducing the speed of the drive motor from the base unit PT 500. This reduction is achieved either with the PT 500.14 belt drive or the PT 500.15 gear unit.

The transmission of alternating torque in toothed gearing mechanisms can be investigated together with accessory set PT 500.15 (for investigating damage to gears).

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- experimental modal analysis of mechanical systems
- familiarisation with the envelope analysis
- influence of bearing clearance and shock impact
- inconsistent torque characteristic
- wear measurement on piston rods
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

in conjunction with PT 500.15
- transmission of alternating torque in toothed gearing mechanisms

in conjunction with PT 500.14 or PT 500.15
- influence of gas pressure forces on the vibration spectrum

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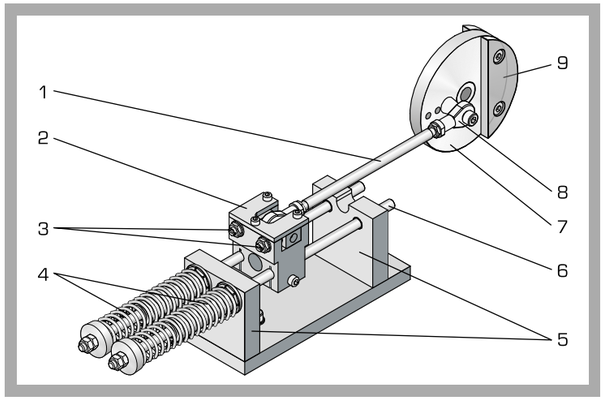
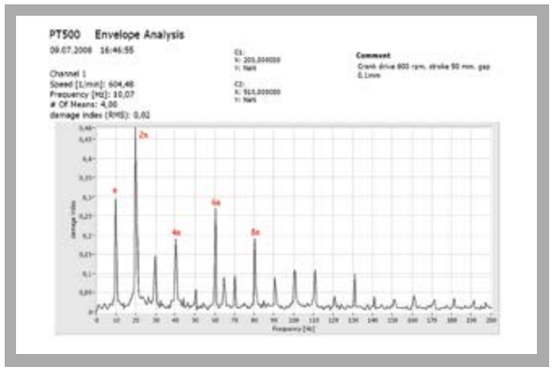
PT 500.16 Crank Mechanism Kit



1 connecting rod, 2 crosshead, 3 adjustment of bearing clearance, 4 pressure spring, 5 bearing block with journal bearing, 6 piston rod, 7 crank disk, 8 articulated head, 9 balance mass

The illustration shows PT 500.16 together with PT 500, PT 500.01 and PT 500.04.



Envelope analysis on crank drive with clearance at 600min^{-1}.
Dominant is the 2nd order 2n with harmonic waves 4n, 6n, 8n usw.

Specification

[1] investigation of the vibrations of crank drives
[2] crank drive with adjustable stroke
[3] interchangeable bearing bushes permit simulation of bearing clearance
[4] springs simulate gas pressure forces
[5] can be used together with gear damage accessory set PT 500.15
[6] belt drive PT 500.14 or gear unit PT 500.15 required for experiment with gas pressure forces
[7] accessory set for PT 500 machinery diagnostic training system
[8] stackable storage system to house the components

Technical Data

Stroke: 50 - 75 - 100mm
Balance mass total
- 490g, rated for operation with 50mm stroke

Bearing clearance: 0...1mm

Pressure spring
- relaxed length: 170mm
- spring stiffness: R=0,55N/mm

Dimensions and Weight

LxWxH: 600x400x170mm (storage system)
Weight: approx. 8kg

Scope of Delivery

1 crank drive
2 springs
2 balance masses
1 set of tools
1 storage system with foam inlay
1 manual

Order Details

052.50016 PT 500.16 Crank Mechanism Kit

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PT 500.17 Cavitation in Pumps Kit

*** Observation and measurement of cavitation**

*** Understanding conditions for cavitation**

Technical Description

Cavitation can play a major role in the vibration of pumps during operation.

With the PT 500.17 accessory set, cavitation can be experimentally induced and its influence on the vibration spectrum investigated.

The principal elements of the accessory set are a single-stage centrifugal pump and a storage tank. The pump and tank are interconnected by hoses. Valves and manometers in the delivery and intake lines allow various operating conditions to be set. The transparent plastic pump housing provides a view into the interior of the pump during operation. This enables the formation of cavitation bubbles to be observed. Stroboscopic analysis is specially recommended (stroboscope not supplied).

The pump can be driven directly through a flexible coupling on the base system PT 500 or by the PT 500.14 belt drive.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- observing and understanding cavitation in a centrifugal pump
  - * visually
  - * stroboscopically (stroboscope available as accessory)
  - * by vibration analysis
- investigation of the operating vibrations of a centrifugal pump
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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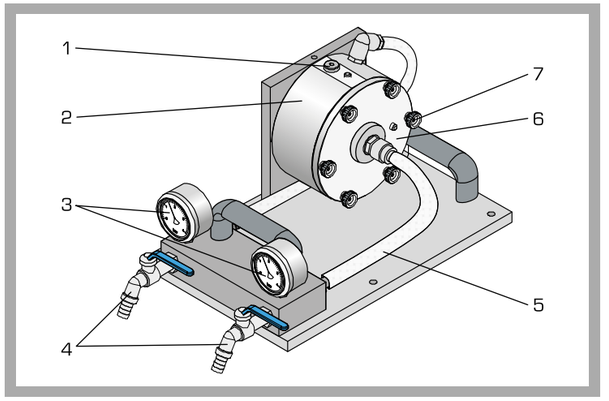
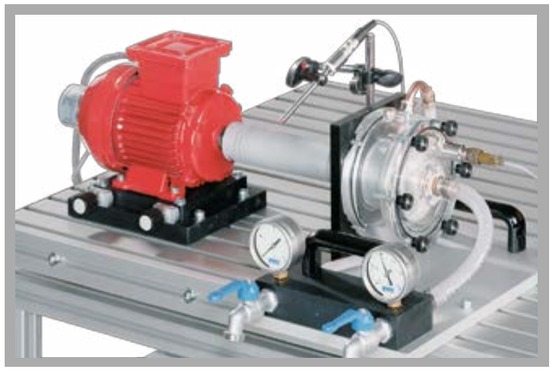
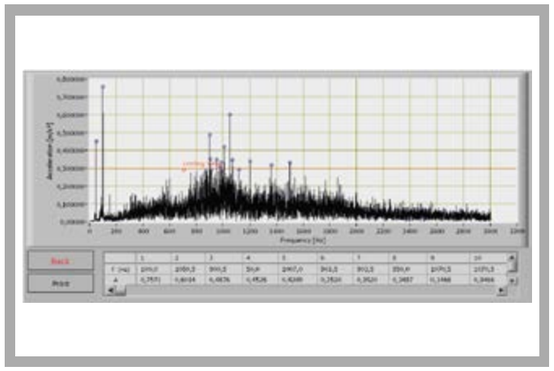
PT 500.17 Cavitation in Pumps Kit



1 pump housing vent screw, 2 pump housing, 3 manometer, 4 valve, 5 intake side hose, 6 housing cover, 7 thumb screw to open the housing cover



The illustration shows PT 500.17 together with PT 500 and PT 500.01.



Frequency spectrum in cavitation, measurement location: axial on pump cover
f_D rotational frequency, f_K frequency of cavitation, f_S blade passing frequency

Specification

[1] investigation of the conditions for cavitation in pumps
[2] single-stage centrifugal pump
[3] flow control valves permit the inception of cavitation
[4] manometers on intake and delivery side
[5] transparent housing
[6] pump driven via coupling (PT 500) or with belt drive PT 500.14
[7] accessory set for PT 500 machinery diagnostic training system
[8] stackable storage system to house the components

Technical Data

Centrifugal pump
- max. flow rate at 3.300min^{-1}: 17L/min
- max. head at 3.300min^{-1}: 12m
- impeller with 3 blades
- min. speed for cavitation: approx. 2.240min^{-1} (with restriction on intake side)

Tank
- material: HDPE
- capacity: 20L

Manometer
- delivery side: 0...4bar
- intake side: -1...1,5bar

Dimensions and Weight

LxWxH: 600x400x320mm (storage system)
Weight: approx. 16kg

Scope of Delivery

1 pump
1 tank
1 set of hoses
1 storage system with rubber mat
1 manual

Order Details

052.50017 PT 500.17 Cavitation in Pumps Kit

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web http://www.gunt.de
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PT 500.18 *Vibrations in Fans Kit*

*** Vibration measurements on fans**

*** Simulation of blade-induced vibrations**

Technical Description

Vibration measurements on fans and blowers play a major role in field monitoring operations. In addition to the usual signals caused by bearings and imbalance, the vibrations induced by the fan blades can be measured. The vibrations are induced by inhomogeneous flow fields.

The PT 500.18 accessory set induces the vibrations magnetically. Three fan rotors with differing numbers of blades can be investigated. A guard plate covers the rotating fans. An obliquely-mounted inertia disk is used to investigate the gyroscopic effect. Just as in actual practice, the fan model can also be driven directly via a flexible coupling or by the belt drive PT 500.14.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT 500.

To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

- vibration measurement on fans
- measurement of blade pass frequency
- identification of the vibration induced by the blades from the vibration spectrum
- effect of dynamic imbalance on the fan
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

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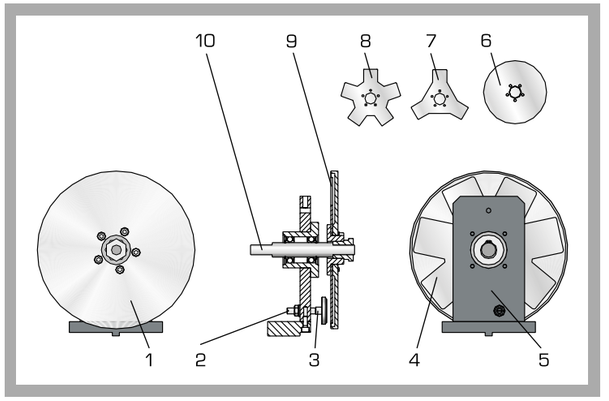
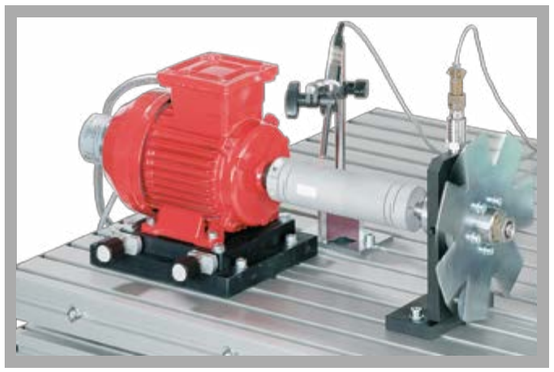
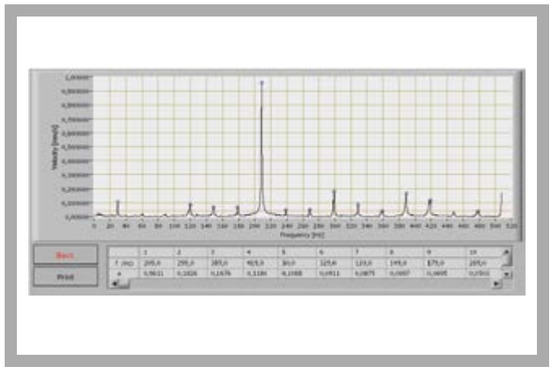
PT 500.18 *Vibrations in Fans Kit*



1 guard disk, 2 adjuster screw for gap between magnet and blades, 3 permanent magnet, 4 fan rotor with 7 blades, 5 bearing block, 6 mass disk to simulate axial forces, 7 fan rotor with 3 blades, 8 fan rotor with 5 blades, 9 fan blade, 10 fan shaft



The illustration shows PT 500.18 together with PT 500 and PT 500.01.



Frequency spectrum of a fan rotor with 7 blades: clear blade passing frequency at 210Hz

Specification

[1] investigation of the vibrations of fans
[2] model of an axial fan with blades
[3] magnetic induction of blade forces
[4] obliquely-mounted inertia disk to investigate gyroscopic effects
[5] 3 fan rotors with different numbers of blades
[6] guard disk for fan rotors
[7] gap between magnet and blades adjustable
[8] can be used with belt drive PT 500.14
[9] accessory set for PT 500 machinery diagnosis training system
[10] stackable storage system to house the components

Technical Data

Sheet-steel fan rotor
- 3 blades
- 5 blades
- 7 blades
- diameter: 204mm
- max. speed: 3.000min^{-1}

Protective disk, made of aluminium
- D=220mm

Dimensions and Weight

LxWxH: 400x300x320mm (storage system)
Weight: approx. 6kg

Scope of Delivery

3 fan rotors
1 mass disk
1 holder
1 guard disk
1 storage system with foam inlay
1 manual

Order Details

052.50018 PT 500.18 Vibrations in Fans Kit

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web http://www.gunt.de
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PT 500.19 *Electromechanical Vibrations Kit*

*** Interaction of electromagnetic and mechanical elements of the system**

*** Adjustable asymmetric gap between stator and rotor**

*** Electromagnetic asymmetry with winding that can be switched off**

Technical Description

Asynchronous motors are in widespread use as drive mechanisms. These motors can generate machine vibrations. If there is an asymmetric gap, the circulating magnetic forces induce rotational and bending vibrations. The same applies to partial failure of the electrical windings. In this case, the asymmetrical magnetic field also induces mechanical vibrations.

The PT 500.19 accessory set features an adjustable centering device to adjust an asymmetrical gap. A winding that can be switched off generates an electromagnetic asymmetry. The display and control unit of the PT 500 base system powers the asynchronous motor and permits the speed to be adjusted. The motor is subjected to load by the PT 500.05 brake and load unit.

The accessory set is mounted on the base plate of the machinery diagnostic base system PT500.

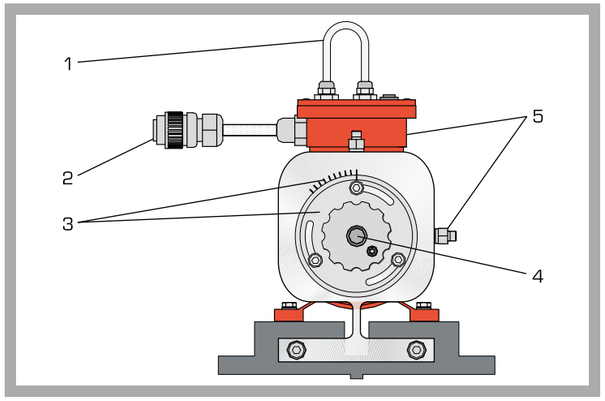
To measure and evaluate the experiment, the computerised vibration analyser PT 500.04 is required. It includes all the necessary sensors, a measuring amplifier and analysis software to record the vibration phenomena.

Learning Objectives / Experiments

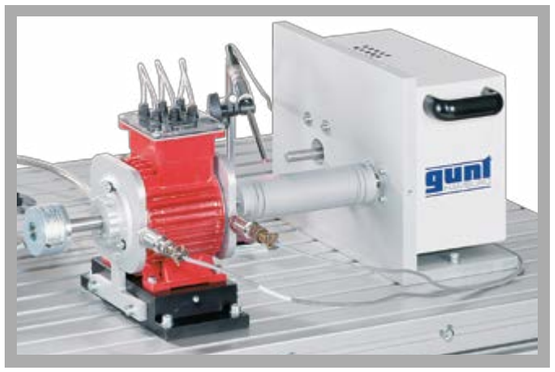
- influence of the gap on vibration behaviour
- influence of electromagnetic asymmetry on vibration behaviour
- influence of the load on the level of vibration
- influence of the gap on electromagnetic losses and efficiency
- influence of speed on vibration behaviour
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser

in conjunction with a current measuring probe
- measurement of current consumption per phase

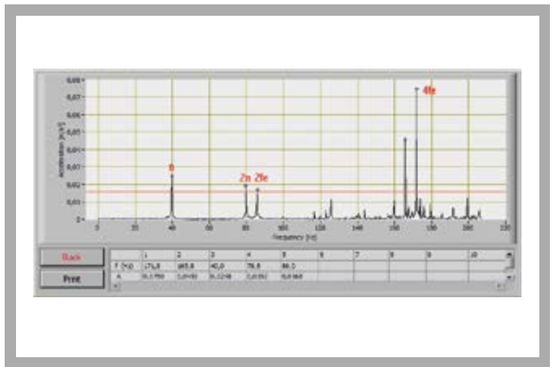
PT 500.19 *Electromechanical Vibrations Kit*



1 current measuring probe tap for the 3 phases, 2 connection to the display and control unit of PT 500, 3 bearing cover with adjustable centering and scale, to adjust gap, 4 motor shaft, 5 adapter for acceleration sensors



The illustration shows PT 500.19 together with PT 500, PT 500.01 and PT 500.05.



Typical spectrum of an electric motor
rotary frequent vibration with n, 2n because of balance error
power frequent vibration with 2fe, 4fe because of magnetic forces

Specification

[1] investigation of vibration behaviour of an electric motor
[2] asynchronous motor with adjustable gap
[3] asymmetric magnetic field by winding with shut-off facility
[4] variable speed via frequency converter of base unit
[5] speed display on display and control unit of base unit PT 500
[6] power display on display and control unit of base unit PT 500
[7] accessory set for PT 500 machinery diagnostic training system
[8] stackable storage system to house the components

Technical Data

Asynchronous motor with variable speed
- speed range: 100...6000min^{-1}
- nominal power output: 370W

Eccentricity of armature: 0...0,2mm

Dimensions and Weight

LxWxH: 400x300x320mm (storage system)
Weight: approx. 11kg

Scope of Delivery

1 electric motor with terminal box
1 storage system with foam inlay
1 manual

Order Details

052.50019 PT 500.19 Electromechanical Vibrations Kit

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WE TAKE QUALITY SERIOUSLY


Certificate DE04/52774

The management system of

G.U.N.T. Gerätebau GmbH
Hanskampring 15 - 17
D-22885 Barsbüttel
Germany

has been assessed and certified as meeting the requirements of

ISO 9001:2008

For the following activities

Developing, Manufacturing and Supply of Equipment with Emphasis on Equipment and Systems for Engineering Education

Further clarifications regarding the scope of this certificate and the applicability of ISO 9001:2008 requirements may be obtained by consulting the organization

This certificate is valid from 30/11/2013 until 29/11/2016
Issue 7. Certified since 17/07/1998

Mark Pinkerell
Managing Director

Christian Rathje
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Rödingsmarkt 16 D-20459 Hamburg (Germany)
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TGA-ZM-17-93-00

Page 1 of 1

Our quality management system has been certified since 1998.

DIN EN ISO 9001 – SGS-ICS ZERTIFIZIERTES QUALITÄTSMANAGEMENTSYSTEM – SGS

PT 500 MACHINERY DIAGNOSTIC SYSTEM

Training in machine condition monitoring:
Generating, measuring and evaluating mechanical vibrations

- *Up to date*
- *Practical*
- *Modular*
- *Compact*

THE SYSTEM FOR AN EASY INTRODUCTION TO A DEMANDING TOPIC