



# ROCK BROCHURE

EDITION 2018

## FULLY AUTOMATIC TEMPERATURE CONTROLLED PERMEABILITY TESTING FOR ROCKS

The permeability of rocks in core holders or different sample jigs is a crucial parameter in geothermal reservoir engineering. Due to possible errors in transient temperature condition measurements such as changes of viscosity, salt contents, or thermal expansion can occur. For an accurate permeability or porosity measurement most testing systems require temperature-controlled conditions. This device measures permeabilities under continuous flow or steady/non-steady conditions.

### Applications

- Geothermal soil and rock testing
- Mining projects
- CO<sub>2</sub> injection
- Hydraulic fracture test
- Gas and oil reservoirs
- Gas hydrates

### Features

- Automatic electromechanic corrosion resistant volume /pressure-controller for constant volume flow or constant pressure (ramps)
- Applicable for various testing fluids (such as water, corrosive fluids and gases)
- Different control interfaces are available depending on customer's requirements
- Different specimen sizes, test jigs and permeability cells



Temperature controlled permeability testing system

### Available Specifications

Pressure range	1 to 150 MPa
Temperature	up to 300 °C

## HIGH PRESSURE TRIAXIAL AND PERMEABILITY SYSTEM FOR CORROSIVE FLUIDS AND BRINES

High pressure and high temperature test systems for investigation of temperature controlled behaviour of gas/fluid/soil or other solid matter compounds.

### Features

- Standard and stress path triaxial tests
- Consolidation tests
- High precision strain, stress and position control
- User defined test procedures with the flexible GEOsys software
- Several upgrade options:
  - ▶ Unsaturated soil testing
  - ▶ Wave velocity measurement
  - ▶ Acoustic emission tests

### Technical Specifications

Static axial load	up to 1000 kN
Confining pressure	up to 70 MPa
Temperature range	up to 200 °C
Specimen diameter	up to 150 mm

Or customized on request



High pressure/high temperature controlled triaxial and permeability testing system

## ADVANCED UNIAXIAL AND TRIAXIAL TESTING SYSTEMS

These advanced rock testing plants enable our customers to meet all test requirements in rock research testing. The systems are able to test a range of materials from soft rock (e.g. sandstone) to hard rock and building materials with high-strength.

The modular systems can be configured with various types of hydraulic actuators with different load ranges, a variety of test jigs, triaxial cells with different specimen diameter and pressure ranges, pressure controllers, as well as different sensors with the necessary attachments.

Advanced software packages and further accessories can also be arranged to suit your specific testing needs.

A variety of jigs and attachments to perform uniaxial compressive strength, triaxial strength, post failure, bending, indirect tensile, direct tensile, fracture toughness, creep, flexural and cyclic loading tests are available.



Uniaxial and triaxial testing system

### Features

- Uniaxial compression test (e.g. e-modulus)
- Creep tests of cylindrical specimens in uniaxial compression
- Direct tension tests
- Indirect tension tests (Brazilian Test)
- Fracture toughness tests
- Triaxial test configuration



High pressure/high temperature triaxial test system

### Technical Specifications

Load type	servo-hydraulic or electromechanic
Axial load	up to 5,000 KN
Confining and pore pressure	up to 300 MPa
Working temperature	up to 200 °C
Frame stiffness	up to 10.000 kN/mm, >10 X 10 <sup>9</sup> N/m
Sample diameter	Ø 25 - 100 mm

*Or customized on request*



High pressure / high temperature triaxial cell with sample adapter (internal view)

## TEST SYSTEMS FOR GAS HYDRATE

This gas hydrate-testing system is designed to produce and test gas hydrate sediments under uniaxial and triaxial conditions, at low temperatures and high pressures.

The cell can be pressurized up to 40 MPa with a constant temperature between  $-40^{\circ}\text{C}$  to  $40^{\circ}\text{C}$  (or any specific temperature).

This modular testing system consists of different components, e.g. a loading frame, pressure controller, etc.

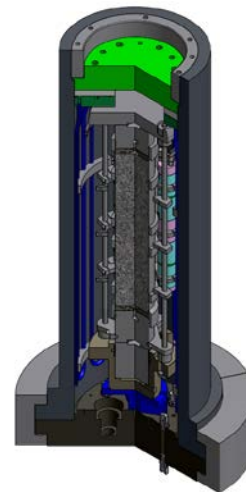
The system can be equipped with various sensors and components to monitor experiment progress (e.g.  $\text{CO}_2$  trapping).



Gas hydrate triaxial test systems

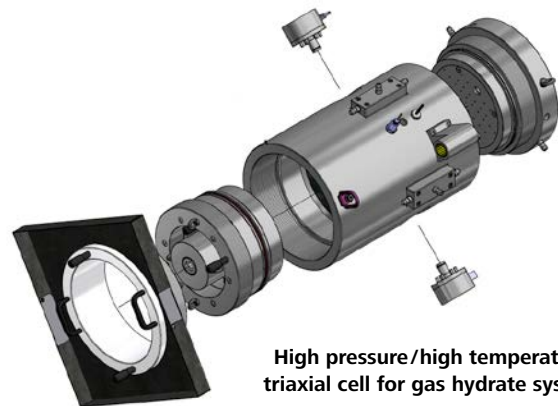
### Main Features

- Special piston pumps to apply back or pore pressure using various gaseous media for example, methane, carbon dioxide, nitrogen or etc.
- Different types and ranges of in-vessel transducers (on sample), for example, load cells, axial displacement, circumferential transducers, wave velocity, acoustic emission and electrical impedance
- Expandable real time high resolution data acquisition and closed-loop control systems
- Controlling software for flexible test procedures of all uniaxial, triaxial or polyaxial test applications with pore pressure and permeability
- Freely programmable test stages with interactive, calculated parameters and procedures via GEOsys software



### Different upgrading features

- ▶ Radial injection of sub-/supercritical  $\text{CO}_2$
- ▶ Discharge and quantification of sediment
- ▶ Sample volume change determination
- ▶ Ultrasonic measurements (P, S1, S2),
- ▶ Electrical resistivity/impedance tomography (ERT)
- ▶ Accessories for permeability tests



High pressure/high temperature triaxial cell for gas hydrate system

## SINGLE OR COMBINED ROCK DIRECT SHEAR / TRIAXIAL TEST SYSTEM

The combined modular Direct Shear and Triaxial Test System is designed to determine the shear strength of intact or joint rock or concrete samples. Different sample sizes can be tested by the system, no matter if they are cylindrical, prismatic, cubical or irregularly shaped.

The high stiffness system with different accessories and options offers the possibility to perform a variety of tests with one single device.

GEOsys software, with several testing modules/applications for triaxial, uniaxial and direct shear tests, in-line with ASTM, ISRM or national standards. Additionally the system can work fully automated system and provides an easy way to create custom test modules.



Static and cyclic direct shear test device

### Main Features

- Suitable for precise direct shear and triaxial tests on rocks, sliding surfaces and building materials
- The shear boxes consist of a tilting free lower and upper shear frame, which is guided by linear bearings, a fixed upper shear frame and a guided load piston.
- Expandable real-time high resolution data acquisition and closed-loop control system (20 bit)
- Transparent test area guard with front security door
- High-speed, closed-loop control of load, displacement, position and volume or flow
- The system is capable of applying different stress paths or strain rates
- Load independent shear rates (shear stress optionally) via micro-processor controlled high quality servo-valve
- Real-time graphics software with zoom and freeze functions for printer output at any time (after and during the test)



Combined dynamic shear/triaxial test system

### Technical Specifications

Load type	servo-hydraulic
Axial force	up to 5000 kN
Shear force	100 - 1000 kN
Specimen Size	25 - 300 mm
Cyclic Load	on request

*Or customized on request*



Modular static and cyclic shear testing system

## ADVANCED ROCK POLYAXIAL TESTING SYSTEM

This unique experimental testing system is a customized solution used to study the behaviour of rock under various dimensional and compressive stress regimes ( $\sigma_1 \neq \sigma_2 \neq \sigma_3$ ). This fits to the research goals of geothermal energy researchers, hydrologists, petroleum reservoir engineers and researchers in the mining section, geophysics and geotechnical sectors.

The system is capable of testing a wide range of materials from granite to mudstones and also for post-failure regime of high-strength brittle rocks.

Polyaxial rock testing systems are designed to induce stress on cubic samples via three independent controlled principal axes ( $\sigma_1 \neq \sigma_2 \neq \sigma_3$ ) up to 600 MPa (depending on sample size).

The sample chamber can house cubic samples up to 300x300x300 mm and has the option to be equipped with a temperature control up to 200 °C as well as a pore pressure device up to 210 MPa and the ability to have ultrasonic, acoustic emission and permeability testing.

The complete system is fully automated and controlled by our flexible and programmable GEOsys Software. Various sensors, transducers, testing and experiment options are available.

### Options

- Hydraulic fracturing test
- Directional permeability test
- Pore or hydrostatic pressure
- System for measuring P- and S-wave in combination with acoustic emissions
- Temperature controlling up to 200 °C

### Technical Specifications

Load type	servo-hydraulic or electromechanic, 6 actuators (or 3 independent stresses)
Max. stress	up to 600 MPa (depending on sample size)
Specimen size	up to 300*300*300 mm
Permeability test	steady state or transient

*Or customized on request*



Polyaxial testing system



Sample installation



Test specimen preparation

## NEW "PATERSON APPARATUS" ULTRA HIGH PRESSURE - HIGH TEMPERATURE GAS TRIAXIAL CELL

In the 1960s-80s, Prof. Mervyn Paterson at the Australia National University (ANU) developed a unique gas-media deformation apparatus.

In 2018 APS-Wille Geotechnik® now presents a new modified and upgraded generation of these sophisticated high pressure high temperature internally heated pressure vessel system aiming to perform complex rock triaxial experiments at elevated P-T conditions. This triaxial system axial stresses down to approximately 13 km, using gas as pressurizing medium. With features for measuring pore size distribution and analysis or the determination of e.g. fluid/gas permeability in rocks.

### Main Features

- Cell made of special, non-corrosive steel
- Pressure-compensated internal and external load cell
- Different high pressure feed-throughs
- Multi-zone furnace with a number of integrated thermocouples for direct temperature measurement and control
- Gas and fluid permeability tests

### Technical Specifications

Max. cell pressure	400 (600) MPa
Max. temperature	650 °C up to 1200 °C (optional)
Sample sizes	Ø 24 mm / Height 50 mm
Axial stresses	1-2 GPa (depending on sample size)
Pore pressure	300 MPa (optional higher)
Options	Torque actuator Ultrasonic System (P&S)

*Or customized on request*



High pressure/high temperature triaxial deformation apparatus

## “SYNCHRO CT” MATERIAL TESTING SYSTEM

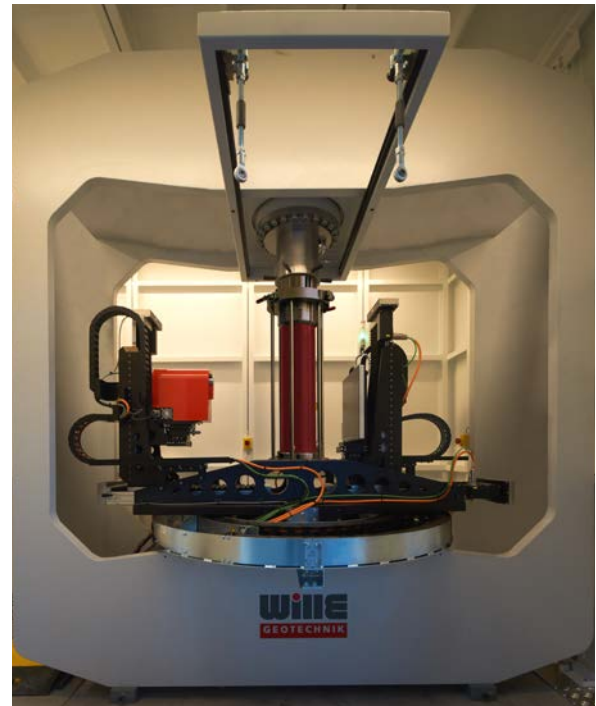
### Simultaneous CT Uni- and Triaxial Test System

The unique development includes a special frame design and integrated X-ray CT system, which opens a new world of possibilities for dynamic and static uniaxial or triaxial test procedures in geotechnics and material testing under environmental conditions. Sample's porosity, crystallization and dissolution, exchange of pore fluids, pre- and post-failure geometry or even crack propagation can be now monitored in-situ during testing, also in time resolved manner.

The system is suitable for a wide range of analysis between pore size, fluid and material like soils, gas hydrate bearing sediments, rocks, concrete, asphalt and synthetic construction materials.

### Main Features

- Simultaneous real-time CT triaxial test system
- CT-ready load frame design with different test spaces for small to large sizes from 5 to 500 mm diameter and 1500 height
- Max. vertical load from 100 up to 5000 kN
- High potential for upgrades (visualization systems e.g.  $\mu$ -CT, AE, ERT, custom made test jigs and environmental chambers etc.)
- Low noise hydraulic system
- Triaxial conditions with confining pressures from 0.1 to 100 MPa (or on request)
- Environmental temperature control between -20 and 200 °C as an option
- Pore pressure control system suitable for experiments with different standard or aggressive fluids
- Ultrasound investigations between end-caps
- State of the art close loop control and data acquisition system
- CT resolution > 5  $\mu$ m



Simultaneous CT uniaxial and triaxial test system



CT test system including x-ray chamber



## HIGH PRESSURE CONSOLIDATION SYSTEM FOR BOREHOLE SIMULATION

The High-Pressure Consolidation System for Borehole Simulation is a high-end apparatus designed for conducting experiments on cemented soil samples to perform a soil grouting procedure under in-situ geological stresses and simulate petroleum recovery processes at conventional production flow rates.

The device enables conducting consolidation, cementation, saturation, ultrasonic measurement, sample perforation and sand production experimental stages.

The capability of the system operating with special cementing agents (e.g. "CIPS"), reutilization of discharged liquids, extrusion of samples, etc. makes it unique within soil testing devices.

### Technical Specifications

- Servohydraulic compression load frame in combination with a hydraulic power pack and digital high-speed controller for axial loading up to 5 MN under stress or position control
- Corrosion protected consolidation cell with inner space  $\varnothing$  300 x 250 mm can be equipped axially and radially with radial stress, ultrasonic transmission sensors, cell and pore pressure sensors, etc.
- Servo-pneumatic pressure regulator (APC) in combination with medium separator for injection of highly corrosive liquids or gases up to 10 bar under pressure control
- Hydraulic pressure actuator (piston pump) for all-around fluid injection into the cell up to 70 bar under flow and pressure control in combination with 1 m<sup>3</sup> liquid reservoirs (e.g. for water, oil)
- Digital mass flow meter for a direct measurement of a single and multiphase mass flow (oil, water, gas) in a range 0.1 – 5.5 l/min under up to 70 bar pressures, suitable for high-viscous oils up to 600 cP
- Ultrasonic sensor system for acoustic wave generation (max. 1 MHz) and measurement of travel-time through the sample for determination of sample's stiffness properties.
- Automatic multi-channel control and data acquisition software GEOsys for stress, strain, position, pressure or flow-controlled test procedure



High pressure consolidation test system for borehole simulations

## HIGH PRESSURE TRIAXIAL CELLS

Advanced high-pressure triaxial cell with up to 300 MPa for different specimen diameter with cell lifting (as optional item) is designed for testing the physical parameters (e.g. shear and creep characteristics) of rock core samples or solid materials (e.g. granites, evaporates, cemented tills or clays) under triaxial stress conditions.

### Features

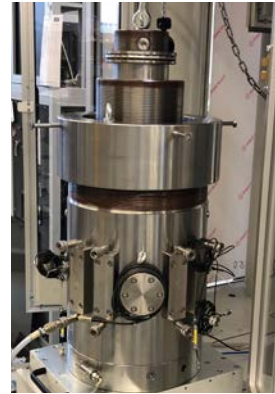
- Applicable for Triaxial shear tests optionally expandable for:
  - ▶ In-vessel load cell
  - ▶ In-vessel deformation measuring devices
  - ▶ permeability test equipment
  - ▶ Ultrasonic material testing equipment
  - ▶ Acoustic emission testing equipment
- Cell made of annealed special steel or corrosion resistant steel, depending from the test application
- Cell is comprising exchangeable end caps for different applications and load pistons for different sample diameter
- Including of High-pressure electrical feed-through ports for all internal transducers covered up to 200 MPa
- Permeability end caps for corrosive pore fluids with standard fluid distribution grooves

### Technical Specifications

Material	Stainless steel
Confining pressure rating	up to 300 MPa
Pore pressure rating	up to 300 MPa
Max. sample diameter	up to 102 mm
Max. sample height	up to 250 mm
Operation temperature	up to 250 °C

*Custom sample sizes on request*

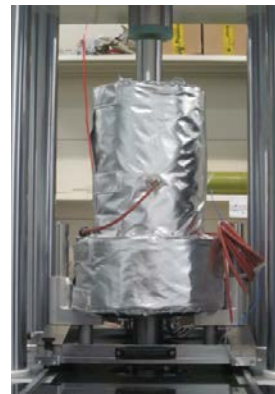
**Note:** Above technical specifications can be optimized upon request.



High pressure consolidation cell



High pressure/ high temperature triaxial cell with external cooling system



High pressure/ high temperature cell with thermal insulation



High pressure triaxial cell

## SENSORS

We offer a wide range of sensors and transducers for high-precision measurements for static or dynamic application.

- Radial deformation
- Axial deformation
- Circumferential deformation
- Pore pressure
- Force
- Submersible load
- Ultrasonic wave
- Acoustic emission
- Electrical conductivity

## CIRCUMFERENTIAL AND AXIAL EXTENSOMETER

The transducer-test kit consists of a circumferential deformation-measuring device using a specially manufactured sensitive roller-chain, a high-quality LVDT displacement transducer (extensometer) and a high-pressure cable with a quick connector to adapt to high-pressure cable ports.

A sample attachment kit can be used to help the extensometers work with a variety of sample diameters. Axial extensometers can be mounted simultaneously with circumferential extensometers.

The axial extensometer is placed between two clamps which are mounted on the rock sample to be tested – this is done using coil springs to avoid platen interference.

This series of extensometers is ideal for a variety of test types, such as:

- Uniaxial compression-tension testing under temperature controlled conditions
- High-pressure high-temperature triaxial tests
- Hydrostatic compression
- Asphalt, concrete or rock samples

### Technical Specifications

Operating pressure	up to 210 MPa
Operating temperature	various options up to 180°C
Measuring range	+/- 2.5; +/- 5; +/- 10 mm
Sample diameters	various versions from 28 mm to 150 mm
Linearity	0.1% FS
Accuracy class	0.5
Output signal	+/- 10 VDC
Signal conditioning	0-10 V

*Or customized on request*



Acoustic emission test system



Axial deformation measuring device



Circumferential deformation measuring device

The transducer-set has different configurations, which can consist of single or dual axial deformation transducers (triple is optional between compression platens). The dual transducer can be located 180° apart on the sample and has dual outputs, which can be recorded separately or averaged.

## HIGH PRECISION SYRINGE PUMPS

High precision piston pumps are digital microprocessor servo-controlled hydraulic actuators.

They are considered to provide continuous flow rates or constant pressures.

The syringe pumps are available in different models, like table top, stand floor oder modular version for higher flexibility at customers site (e.g. build-in system for temperature control, etc.).

High accuracy mass flow and pressure control of fluids and gases for applications, e.g. rock core analyzing, reservoir engineering, oil and gas production enhancement studies and reactor feed/chemical synthesis in chemical process.

### Main Features

- Mass flow and pressure control of fluids and gases
- Modular and expendable system
- Compact and space saving design
- Stainless steel and corrosion resistant pressure chamber
- Integrated limit switches and pressure overload limits (safety stop)
- Operation via touch panel or computer controlled
- Different communication protocols available, e.g. LabView, ASCII
- Calibration of the sensors via operator panel



High pressure syringe pump (stand floor)

High pressure syringe pump (table top)

### Technical Specifications

Pressure ranges	from 10 MPa up to 200 MPa (optional up to 400 MPa)
Pressure resolution	0.01 MPa
Accuracy (standard)	0.2 (0.1 or 0.05 %)
Accuracy (optional)	< 0.05 % F.S. (temperature compensated)
Operating temperature	Standard +5 to +40 °C
Volume	From 75 ml up to 1150 ml (depending on pressure range)
Flow range	0.00001 ml/min up to 300/150/150/80/50/40/20 ml/min
Flow accuracy	0.01 %
Plumbing ports	Customised / Swagelok
Output ports	Ethernet and serial port / analogue output
Working Temperature range (option)	Customized from -20 or +100 °C, or external solution
Wetted parts	High corrosion resistant stainless steel (optional: Hastelloy C-276)

*Or customized on request*

**Note:** Flow rates (max. and min.) always depend on the technical configuration of the pump (pressure, volume etc.).

Please contact us for detailed information about how we can help with your testing demands.



Dual pumping system provides two independent channels for controlling of pressure and volume with one controller.

## CERCHAR ROCK ABRASIVENESS TESTER

**Standard: acc. Cerchar (1986)**

The cerchar rock abrasiveness tester is used to determine the CERCHAR Abrasivity Index (CAI) value in accordance with the ASTM D7625-10 standards.

An accurate stainless steel weight is used for axial test loads of 70 N in combination with a cross-table.

The cross-table allows for the highly precise movement of samples in a clamping device.

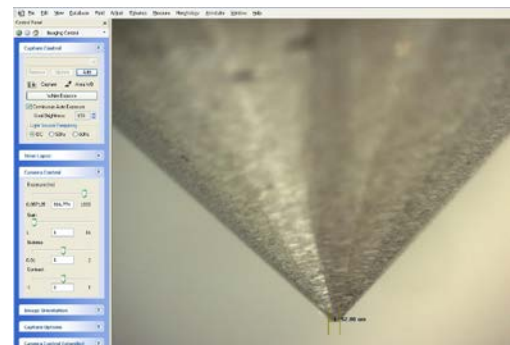


Cerchar rock abrasiveness tester

### Technical Specifications

Axial load	70 N
Maximum sample height	200 mm
Maximum ample diameter	Ø 80 mm

*Or customized on request*



Evaluation software for test pins

## ABRASIVE TEST MACHINE (LCPC)

**Normalised according to AFNOR P18-579**

The abrasive nature of rock is an important factor when designing appropriate testing machinery. The impact on tool wear much depends on the machinery used for excavation. This includes all devices and tools that come into contact with the material being excavated. The most technical way to determine rock abrasivity is to use an index laboratory test as well as LCPC.

### Technical Specifications

Rotational speed	4500 rpm, adjusted electronically
Dimensions (approx.)	500 x 600 x 1900 mm
Power supply	3 x 400 VAC, 50 Hz, 16 A plug IEE
Power consumption	app. 1,5 kVA
Miniature fuse	PKZM motor protection 2-5 A adjustable lifting drive LS C 3A

*Or customized on request*



Abrasive test machine (LCPC)

## CORE DRILLING MACHINE

This core drilling machine is used in laboratories to cut cores from uniform and non-uniform hard samples, such as rock, natural stone and concrete. The 3 kW electric motor is equipped with a 4-speed mechanical gearbox to provide high torque drilling capability throughout the drilling speed range. This enables the drill bit to maintain speed under loading to produce a uniform core sample.

### Technical Specifications

Motor power	3 kW
Coring speed	240/580/1160/2220 rpm
Coring range	AX to NX from 8 to 150 mm diameter
Level of acoustic power emitted by the LWA device	98 dB (A)
Dimensions (approx.)	900 × 900 × 2200 mm
Weight (approx.)	350 kg

*Or customized on request*



Core drilling machine

## CORE TRIMMER AND CUTTING MACHINE

The cutting machine is used to cut rock samples of irregular shapes, rock cores, as well as surfacing and machining the ends of the cylindrical or cubical samples.

### Main Features

- Stainless steel cutting bed
- Compact, powerful, easy and quick operation
- Maximum safety standards with electronic brake and interlocking safety device
- Includes cooling fluid inlet for cutting blade
- Transparent sample holder chamber
- it can works with big samples by placing them upside down in the device
- Special clamping devices for non-uniform samples can be provided upon request

### Technical Specifications

Wheel speed	2800 rpm
Operation	manual
Wheel Diameter	Ø 250 mm / Ø 350 mm
Cutting Capacity	Ø 90 mm / Ø 115 mm
Cutting Capacity	50 x 165 mm / 50 x 195 mm
T-Slot table dimension	255 x 250 mm

*Or customized on request*



Core trimmer and cutting machine

## GRINDING MACHINE

This grinding machine has two electronic motors and is used for the vertical grinding of rock samples on two parallel sides. It can be used for working with natural stones, concrete, as well as ceramic and other materials.

The grinding distance can be adjusted in micrometres for various sample lengths from 50 to 320 mm via a hand wheel.

Cube or cylinder samples are easily locked in place on the grinding table. Grinding is carried out automatically by moving the sample from one side to the other side through the grinding wheels.

The machine is equipped for grinding cubic samples from 50 mm to 200 mm in size, as well as cylindrical samples with diameters from 50 to 150 mm.

### Technical Specifications

Dimensions (approx.)	1800×1500×1700 mm
Weight (approx.)	350 kg
Electrical connection	400 V, 50 Hz
Sensitivity	0.1 mm
Cooling unit capacity (available on request)	50 l/h

*Or customized on request*



Grinding machine

## PORTABLE POINT LOAD TEST APPARATUS

The portable point load tester provides an index for the strength classification of hard rocks and allows for a quick, non-expensive on-site evaluation of hard rock strength.

The rock sample is mounted between two hardened cones to apply the point load. The peak-applied load is recorded and used to calculate the point load index.

The standard test-set consisting of:

- Hydraulic cylinder with conical pistons
- Hydraulic pump
- Digital-manometer with pressure and load display
- Base plate
- Operator protection set



Point load test apparatus

### Ordering Information:

- Version with digital precision pressure gauge Cl. 0.1% with maximum memory, IP 65, resolution 0.1 kN
- Version with analogue pressure gauge, pressure range: 0 – 100 kN and 0 – 25 kN, accuracy: 1.0 kN resp. 0.5 kN
- Digital measuring device for axial strain
- Splinter protection
- Test set for uniaxial test includes lower and upper platens Ø 110 mm
- Test set for indirect tensile test (Brazilian test) for Ø 50/60 mm or Ø 80/90 mm includes hardened moulds and ball adapter

## ULTRASONIC WAVE VELOCITY TEST SYSTEM

The ultrasonic velocity measurement system is a non-destructive method of measuring compression and shear waves through rock samples or stiff materials as a function of temperature, confining and pore pressures.

This is a complete system and is comprised of all required electrical and mechanical hardware e.g. signal conditioner and pulse generator, data acquisition controller, ultrasonic platens including combined P and S (S1 & S2) transducers as well as the required software.

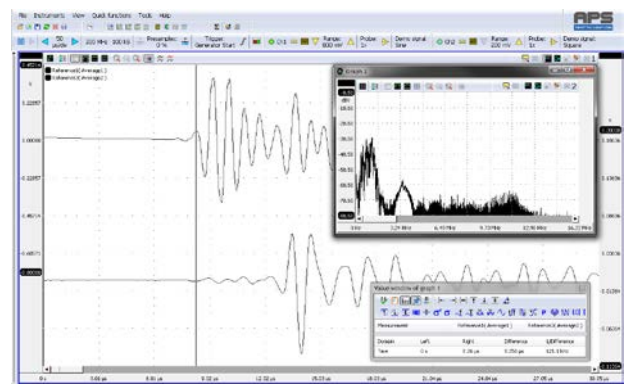
Based on the length of the sample and travel-time from transmitter to receiver, ultrasonic wave velocities ( $V_p$  &  $V_s$ ) are calculated and can be used with uniaxial, triaxial or polyaxial test system. This simultaneously measures and calculates the static and dynamic properties of rock e.g. shear modulus (G), poisson's ratio ( $\nu$ ), bulk modulus (K) and young's modulus (E), as well as other parameters.

### Main Features

- Complete system for generating, receiving, converting and monitoring ultrasonic waves
- Combined P and S (S1 & S2) transducers
- Optional with pore pressure ports
- Low noise preamplifier to amplify ultrasonic signals
- Multiplexer up to 36 channels for conditioning and pulse generation, high speed data acquisition, and computer interface
- Available for vertical and/or horizontal methods
- Real-time graphics software with zoom and freeze functions for printer output at any given time
- All functions operated via mouse-click



Ultrasonic wave velocity test system



Data acquisition software for ultrasonic test system

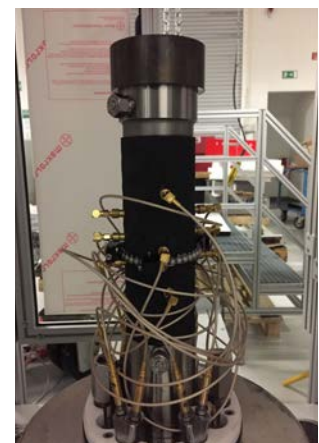


Electronic controller for ultrasonic test system

### Technical Specifications

Sampling rate of data acquisition board	Dual channel 200 MS/s (14 bit) Single channel 500 MS/s (14 bit) (16 bit interpolated)
Record length per channel	32.000.000 sampling points
Analog amplification	Max. 60 dB
Onboard trigger system	P- and S-Wave, Switching Frequency max. 100 Hz
Ultrasonic platens	38 mm to 150 mm
Working pressure	up to 210 MPa
Working temperature	up to 180 °C

*Or customized on request*



Acoustic emission test system



## HYDRAULIC FRACTURING TESTING SYSTEMS

Hydraulic fracturing is performed to determine the magnitude and direction of the in-situ stress in the process of fluid pumping with an injection rate into a cavity hole that subsequently leads to an increase in pressure and formation of tensile fracturing in the cylinder wall. Breakdown pressure is defined as the wellbore pressure when inducing hydraulic fracturing.

### Applications:

- Study of hydraulic fracture initiation and propagation
- Testing with a variety of fluids and additives (water, brine and oil)

### Technical Specifications

Confining pressure	up to 300 MPa
Pore pressure rate	1 up to 300 MPa
Flow rates from	0.001 $\mu$ l up to 1000 ml/min
Core diameter	25 mm to 102 mm

*Custom sample sizes on request*



High pressure syringe pump



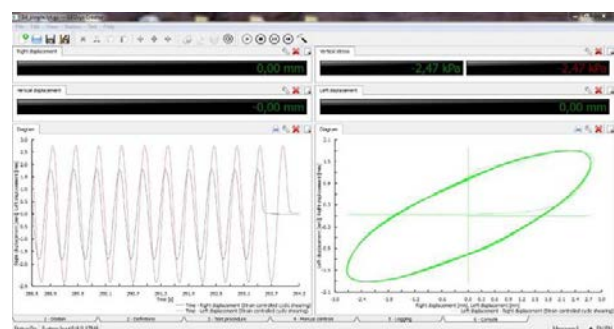
Example of a fractured rock sample

## DIGITAL CONTROLLER SYSTEM

Different digital real-time multi-channel control systems (20 bit) with closed-loop control for static and dynamic applications.

### Features

- High performance real-time multi-channel controller system
- Expandable up to any number of controller with master/slave function
- High speed high resolution closed-loop control (up to 24 bit)
- The controller is a real digital controller. That means, all adjustments like PID parameters will be done by the software.
- This offers a smooth bumpless transfer between load-, position- and strain control.
- Almost all kinds of analog or digital transducers can be connected via plug-in cards.
- Communication using Ethernet and serial ports



Controlling and data acquisition software GEOsys

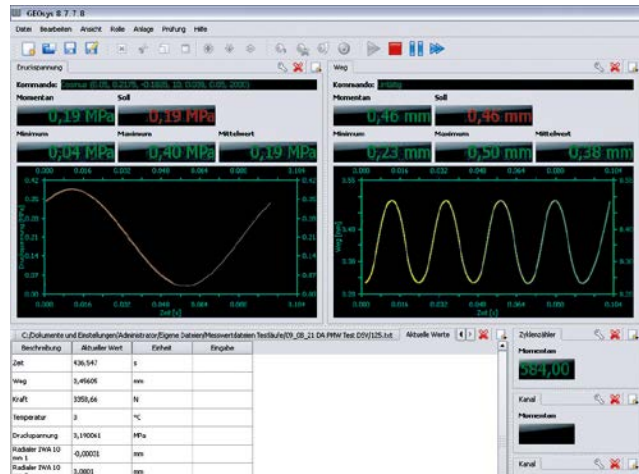
## GEOsys Professional

GEOsys is a multi-functional and modular controlling and data acquisition software in Windows. It allows for the simple programming of complex user defined test sequences via structured Windows instructions on a graphic user interface.

GEOsys utilizes a flexible, programmable system that controls test appliances that coordinate various test operations. The flexible operating panel provides tools to configure the appliance, editors to carry out load procedures, and functions for analysis, presentations and logs.

The software is designed to support a modular structure for the test environment so as to enable a flexible configuration and thus fulfil the specific requirements of the company.

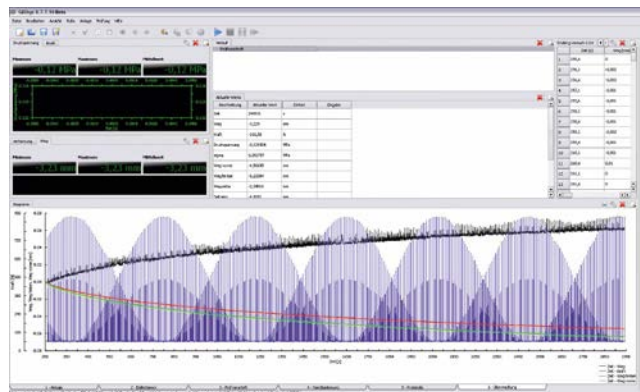
The important key feature of this software is the ability to allow users to simply and freely program standard or complex test sequences with structured Windows operations via a graphic user interface.



Thanks to the wide range of abilities Geosys offers, it is not only compatible with our products, but it can also be used with hardware from other manufacturers, providing data acquisition and test controlling for hardware of a similar or more advanced standard.

### Main Features

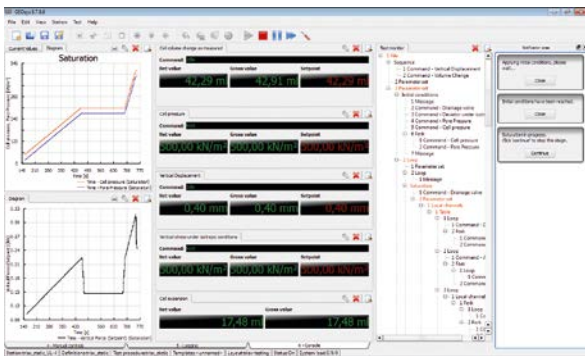
- Unique platform to address all testing needs, be it soil, asphalt, rock or construction related, both dynamically and statically
- Controlling and data acquisition software
- Simultaneous loops for all connected actuators
- Free programmable Test Sequence Control and Formula Editor
- Complete real-time data-acquisition and closed-loop control for each channel using real parallel configured channels
- Flexible and user-friendly
- Supporting functions of similar manufacturer
- Options concerning data conversion in ASCII
- Digital setting of PID Parameters (parameter optimizing or tuning depending on the material) even during operation
- User roles (administrator, service, developer, lab assistant) for easy handling – decreasing the likelihood of errors
- OS platform independent software (e.g. available for WINDOWS, LINUX or MAC OS X)
- Ability to allow users to simply and freely program standard or complex test sequences with structured Windows operations via a graphic user interface.
- Suitable for up to any number of simultaneous and independent real-time, closed-loop controlled channels, machines, or test devices, such as axial load, confining pressure, pore water pressure, as pore air-pressure
- Management of hardware components
- User supplied, calculated measurements
- Languages: English, German, Russian, Chinese



The advantage of the new software is in its application. Even inexperienced users are able to program complex checking processes within a short space of time.

The software opens up the possibility of optimizing the machine regulation during operation. The effects of the automatic controller adjustments become immediately visible in the diagram.

PID control data is storable as a file, so different test programs with the automatic controller adjustments optimized particularly for it can be carried out.



## More Features

- Simultaneous loops for all connected actuators
- Peak-control of cyclic and dynamic set-parameters
- Complete real-time data-acquisition and closed-loop control for each channel using real parallel configured channels
- It Includes of transducer library, wave-shape and test library
- Analogue and status display, as well as real-time graphics with zoom and freeze functions for printer output at any time, after and/or during the test
- Individually modifiable data acquisition
- Each channel can be controlled by any transducer or parameter (load, displacement, pressure) using the digital calibration and PID-parameter setting software windows
- Individually configurable data acquisition, such as collecting rate, parameter setting, recording type (e.g. ASCII)
- Interactive change of test parameters for all channels or test devices
- Various platforms for operators and different users for system parameter settings, for example, configuration, PID- Parameters, transducer configuration, and range plausibility
- Integrated simulation. For instance, functionality can be checked without installing a sample

## Rock test modules

GEOsys is designed for closed-loop controlled static & dynamic tests for all test applications in material testing, such as stress-controlled, strain-controlled, all stress paths, loops, any kind of waveforms like sine, rectangle, triangle, and predefined waves.

GEOsys is controlling and data acquisition software and also has different modules to run tests according to ASTM or ISRM methods.

Depends on the requirement of the customer one or several modules would be delivered with main software.

- Uniaxial compression tests
- Uniaxial creep tests
- Indirect tension tests on Rock specimens
- Direct Tension tests on rock specimen
- Fracture toughness according to the recommendations of ISRM
- Strength of rock tests
- Angle of internal friction
- Poisson's ratio
- K ratio
- Adhesive force (Cohesion)
- Ultimate and breaking strength
- ASTM, Triaxial compression strength test
- ASTM, Rock core creep test software in Triaxial Compression
- ISRM Rock Triaxial compression test software
- Static Rock Shear testing
- Cyclic Rock Shear Tests
- Rock Permeability tests
- Temperature control tests
- Rock Polyaxial tests
- Data Acquisition

*made in germany*



### About us

APS Antriebs- Prüf- und Steuertechnik GmbH (drive test and control technology company) is a highly regarded German enterprise due to its soil, rock, asphalt and material testing machines, which are marketed under the brand name "Wille Geotechnik".

The initial activities of the company began in the 1990s in cooperation with universities and the implementation of research activities and development of scientific equipment.

The contact and collaboration with such institutes remains strong to this day, and has developed over the past years with the APS GmbH having now over 40 employees.

### Make it in Germany

With many years of experience we are able to tailor our products and services to your aims and needs. Our customized solutions can help you achieve unique and specific requirements.

We approach each project individually and openly, and would be proud to support you in achieving the desired laboratory testing system.

We have the knowledge and experience to help with a variety of testing systems, for example:

- Exploration and production of fossil fuels
- Gas hydrate
- Mining and construction
- Tunneling
- Geothermal energy development
- Rock mechanics research
- Earthquake mechanics

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