

Hollow Cylinder Apparatus (GDSHCA)



The GDS Hollow Cylinder Apparatus (GDSHCA) allows for rotational displacement and torque to be applied to a hollow cylindrical specimen of soil. Using this device it is possible to control the magnitude and direction of the three principal stresses. Studies can for example be made of the following:

- The anisotropy of soil samples.
- The effects of principal stress rotation.
- The effects of intermediate principal stress.

The GDSHCA has specifically been designed to be capable of testing at very small axial strains (down to 0.00004%). The GDSHCA can apply a uniquely wide range of stress paths on the test specimen. The loading systems are computer controlled and strains can be measured directly on the test specimen. Studies can therefore be made under the following test conditions:

- Plane strain.
- Simple shear.
- Very small shear strain both axially and in rotation.

Key Features:

Benefits to the User:

The system exhibits a high level of axial and torsional stiffness coupled with the minimum amount of backlash and friction:	Resulting in a machine being well suited for small strain testing right through to high load and high strain testing.
Flexibility in the capacity of the system:	Specimen size, load, pressures can be chosen to ensure the system is created specifically to suit the testing required and the budget.
Balanced ram:	Allows a static pressure controller to be used for cell pressures with no significant fluctuations of cell pressure during dynamic tests.
Submersible, interchangeable combined axial / torque loadcell:	Measures axial load/torque with no errors introduced due to friction on the loading ram.
Cell top lift frame:	For ease of use when lifting the cell top, comes as standard.
Can be used as a triaxial system:	By changing the pedestals, the system converts into a fully functioning dynamic triaxial testing system.

Technical Specification:

Operating Frequency:	5Hz	5Hz
Load Range:	10kN	20kN
Axial/Torque Force Range:	100Nm	200Nm
Pressure Range:	2MPa	2MPa
Sample Size:	100mm OD/60mm ID	100mm OD/60mm ID
Lifting Frame:	As standard	As standard

Optional Extras:

Unsaturated Testing	Available
Triaxial Sample Upgrade	50, 70mm

System Elements & Options

The fundamental system hardware elements are shown in Fig. 1 below. The actual hardware used may be chosen to suit your testing and budgetary requirements.

ADVDCS v2 Acquisition Pad

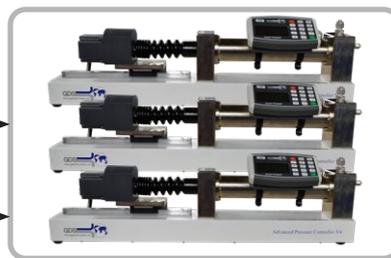
The ADVDCS v2 is based around a modern, high speed, 32 bit processing core and has eight simultaneous sampling 24 bit universal analogue input channels, enabling any transducer in the GDS range to be connected. High speed digital bus technology allows real-time streaming of transducer data making it ideal for high speed data acquisition. The ADVDCS v2 supports full digital control of servo motor and hydraulic actuators allowing accurate, precise and noise free control of actuators.

GDSLAB Software

The GDSLAB control and acquisition software is a highly developed, yet extremely flexible software platform. Starting with the Kernel module and the ability to perform data acquisition, additional modules are added for your testing requirements.



Note: Connection via USB interface to PC.



Pressure Volume / Controllers

- Enterprise Triaxial Automated System (ELTAS) which is based on 1MPa Enterprise Pressure / Volume Controller (ELDPC).
- Standard Triaxial Automated System (STDTAS) which is based on 3MPa Standard Pressure / Volume Controller (STDDPC).
- Advanced Triaxial Automated System (ADVTAS) which is based on 2MPa Advanced Pressure / Volume Controller (ADVDCPC).

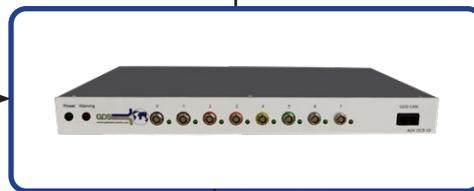
Hollow Cylinder System

Frequency Range (Hz) / Load (kN) / Torque Range (Nm)

- 5/10/100, 5/20/200

Specimen Sizes (mm)

- 100mm OD/ 60mm ID



Pore Pressure (kPa)
Rotation (degs)
Torque (Nm)
Axial Displacement (mm)
Axial Load (kN)

Load frame control

Cell pressure / volume

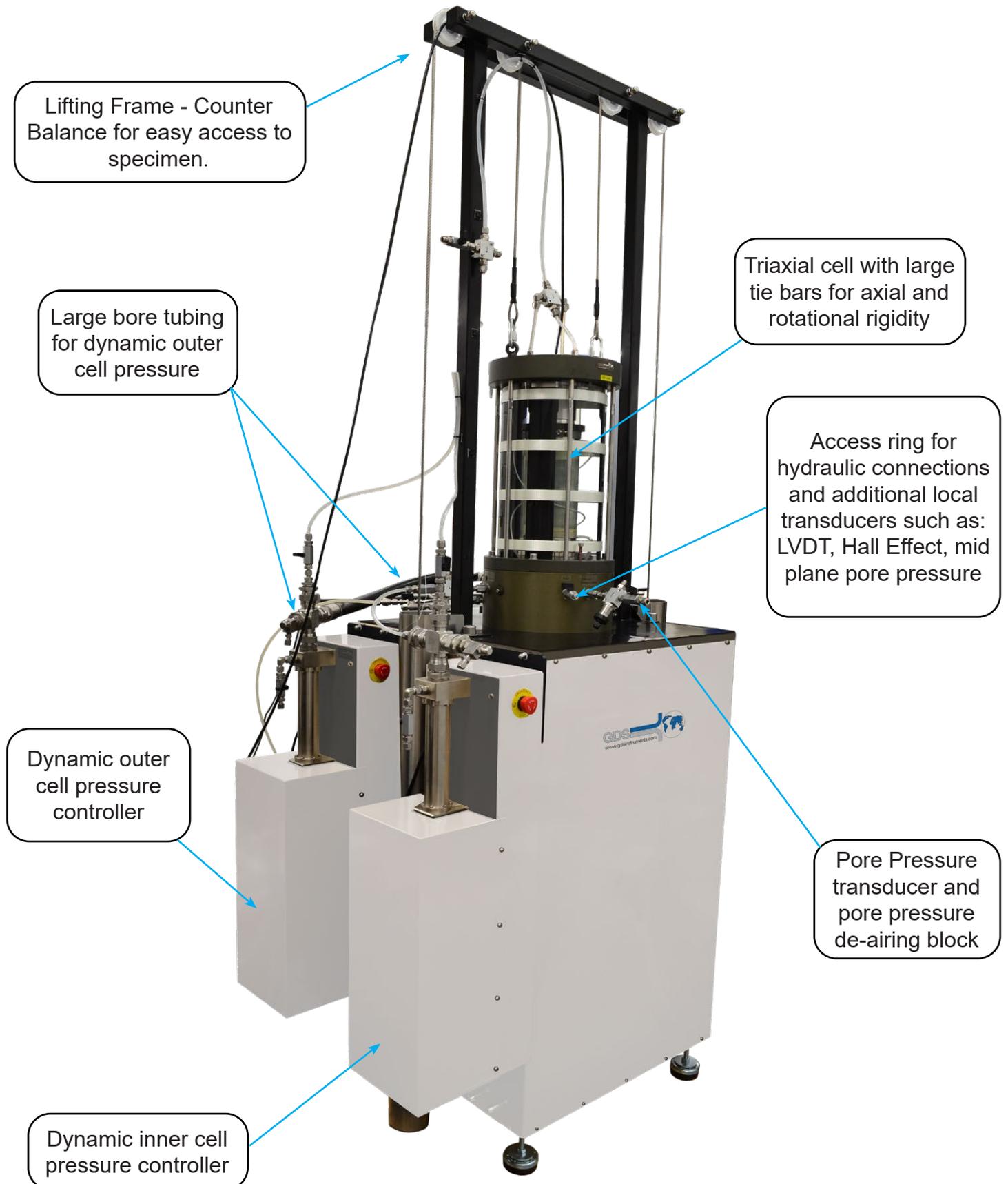
Back pressure

Inner cell pressure/volume

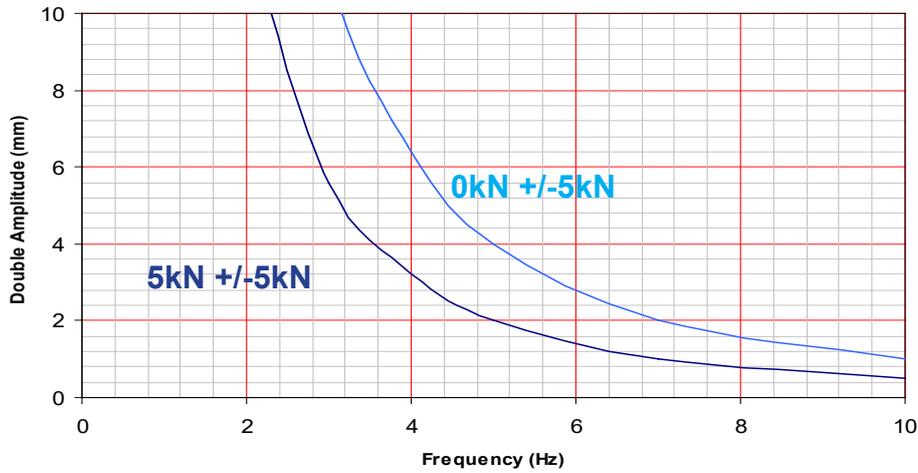


Fig. 1 Fundamental system hardware elements

Hollow Cylinder Apparatus with Inner and Outer Cyclic Cell Pressure Control



SS-HCA, Example dynamic system performance for axial axis based on a 5Hz machine.



with 5kN force datum

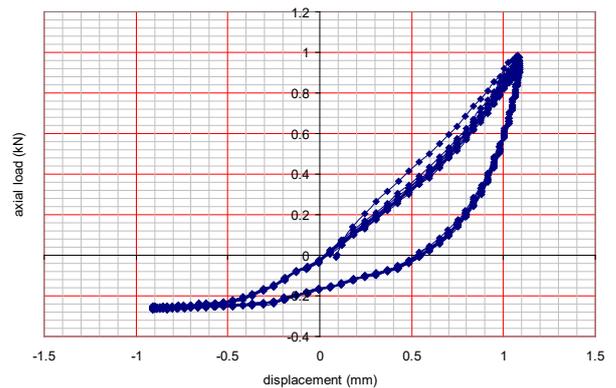
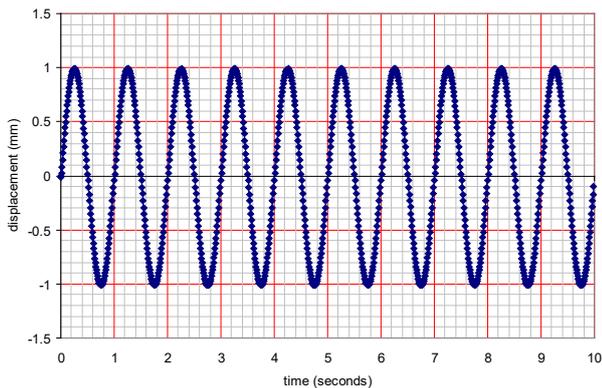
with zero kN force datum

Frequency (Hz)	Amplitude (mm)	Double amplitude (mm)	Amplitude (mm)	Double amplitude (mm)
0.1	50	100	50	100
0.2	50	100	50	100
0.5	26.5	53	26.5	53
1	13.3	26.6	13.3	26.6
2	6	12	6	12
3	2.8	5.6	4.4	8.8
4	1.6	3.2	3.2	6.4
5	1	2	2	4
7	0.5	1	1	2
10	0.25	0.5	0.5	1

Typical test results

Axial displacement feedback control

Frequency (Hz)	1.00
Peak to peak (mm)	2.000
Radial stress (kPa)	200.0



GDSLAB Control Software

The GDSLAB control and acquisition software is a highly developed, yet extremely flexible software platform. Starting with the Kernel module and the ability to perform data acquisition only, additional modules may be chosen for your testing requirements. Some currently available modules are as follows:

- SATCON (saturation and consolidation).
- Standard triaxial.
- Stress path testing (p, q and s, t).
- Advanced loading tests.
- Unsaturated testing.
- K0 consolidation.
- Permeability.

Modules specific to GDS HCA:

- Dynamic HCA test module.
- Static HCA test module.
- HCA stress path module.

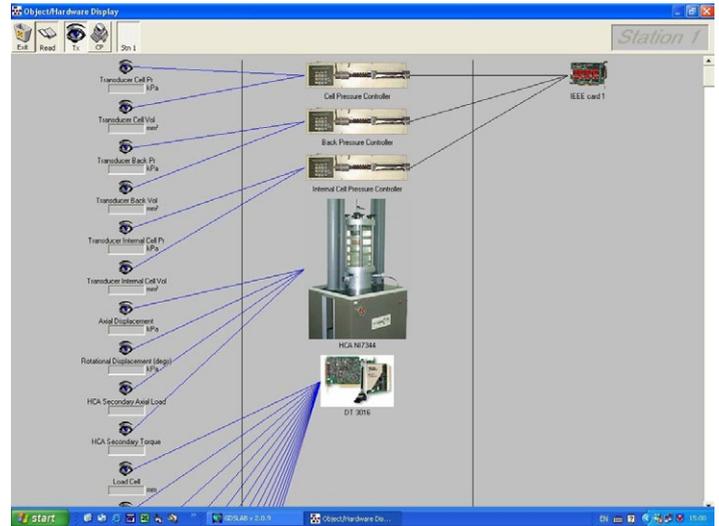


Fig. 2 GDSLAB hardware display window

GDSLAB has the ability to be configured to your hardware of choice, no matter how unique the arrangement. A text file (*.ini) or initialisation file is created that describes the hardware connectivity to the PC. The hardware layout is available in graphical format via the GDSLAB 'object display'. This makes setting up the devices and checking the connectivity extremely simple.

GDSLAB Dynamic HCA test module

- Dynamic cyclic loading tests at frequencies up to 5Hz (depending on the model).
- Provides sinusoidal cyclic control of axial displacement or axial force and rotational displacement/torque (see Fig. 3).
- A complete cycle of data can be saved every N cycles where the value of N is defined by the user.
- Controlled data displayed in real-time.
- Up to 1000 points saved per cycle.
- Built in standard waveforms: Sinusoidal, triangular, square, havesine.
- User defined waveforms using 1000 point ASCII file.
- Dynamic control of inner and/or outer cell pressure may be performed with the addition of optional dynamic pressure actuators.

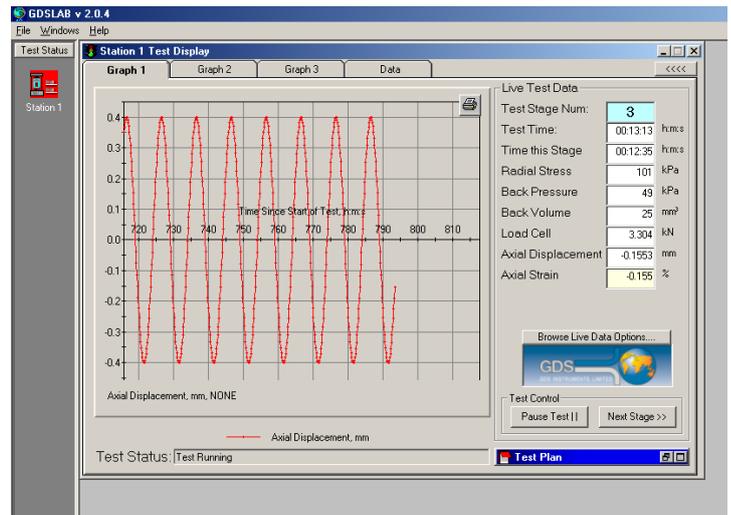


Fig. 3 GDSLAB dynamic test window

GDSLAB Static HCA Test Module

- Independent control of the 5 principal parameters, i.e. Axial, rotational, outer cell pressure, inner cell pressure and back pressure.
- Axial Control by: Axial Stress (kPa), Axial Displacement (mm), Axial Load (kN).
- Rotational Control by: Rotational Stress (kPa), Rotational Load (Nm), Rotational Displacement (degs).
- A phase shift offset angle may be introduced between axial and rotational axes when slow speed cyclic tests are being performed.

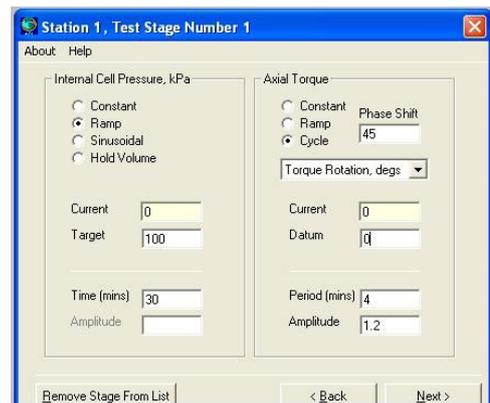
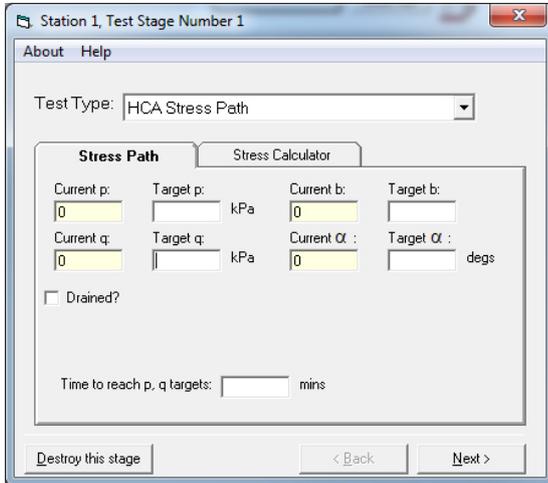


Fig. 4 GDSLAB HCA advanced loading test setup window

GDSLAB HCA Stress Path Module

The GDSLAB HCA Stress Path Module provides independent linear control of p, q, b and alpha under stress or strain control. This module provides the fundamental HCA stress path control functions that test specifications demand, with unlimited number of linked paths. Below HCA stress path setup screen.



GDSDCS - Digital Control System

The GDS dynamic systems are all based around the GDS DCS high speed digital control system with closed loop feedback of displacement and load.

With 16 bit data acquisition (A/D) and 16 bit control output (D/A), the GDSDCS runs at a control frequency of 10kHz per channel. This means that when running at 10Hz the system uses 1000 control points per cycle. When running at 1Hz, it uses 10000 control points per cycle

The advantage of GDSDCS system is that no matter which dynamic system is purchased, they all use the same high speed control system. This ensures that the system has the highest level of functionality and reliability because all of our dynamic systems, over our complete range, use the same high specification control system. A result of this is that the accuracy and resolution of the test is only a function of the actuator used, whether it be a low cost pneumatic actuator, high accuracy electro-mechanical actuator or high capacity hydraulic actuator.

Adaptive Control Firmware - As standard on Dynamic HCA - Adaptive Control is a cutting edge technology that significantly improves the dynamic load control performance of an apparatus, leading to increased testing precision.

The GDS Adaptive Control firmware algorithm automatically adjusts the control gain values based on the observed specimen stiffness, removing the need for the user to enter a specimen stiffness value prior to the test. This has the additional advantage of ensuring specimen stiffness changes during a test are also dealt with correctly. An example of this is observed during liquefaction testing, in which the specimen stiffness reduces considerably as the soil liquefies. When testing using an apparatus running GDS Adaptive Control, the firmware automatically optimises the control gains' values based on variations in soil stiffness as a cyclic test stage progresses, enabling a consistent loading amplitude to be applied to the test specimen.



HCA Top Cap and Base Pedestal

Sintered bronze porous disks with finned ridges. The top cap and base pedestal have large bore inner cell pressure ports, designed to clamp inner membrane in place

Sample Preparation:

The GDSHCA can be supplied with equipment for making toroidal samples in either cohesive (using the Cohesive Sample Preparation Kit, picture in Fig. 6) or non-cohesive materials (Non-Cohesive Sample Preparation Kit, pictured in Fig 7) using an internal, collapsible sample former.

The manual soil lathe is suitable for all available sample sizes up to 200/160/400 (OD, ID, height). The correct platens then needs to be fixed to the lathe in order to prepare the required sample size. Platens for specific sample sizes are purchased separately to the lathe.

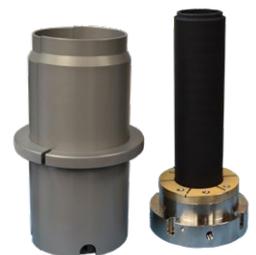


Fig. 6 Cohesive Sample Preparation Kit

Fig. 7. Non-Cohesive Sample Preparation Kit



ADVDCS v2 Acquisition Pad Used with GDSHCA

Overview: The ADVDCS v2 is a modern high speed digital control and acquisition system developed especially for geotechnical testing, and is the premier device in the GDS range, typically supplied with our most advanced dynamic test and control systems. The ADVDCS v2 has been fully

designed and developed by GDS' in-house engineering team.

The ADVDCS v2 is based around a modern, high speed, 32 bit processing core and has eight simultaneous sampling 24 bit universal analogue input channels, enabling any transducer in the GDS range to be connected. High speed digital bus technology allows real-time streaming of transducer data making it ideal for high speed data acquisition. The ADVDCS v2 supports full digital control of servo motor and hydraulic actuators allowing accurate, precise and noise free control of actuators.

The ADVDCS v2 is the direct result of GDS research into high accuracy dynamic control, and contains machine learning algorithms that adapt in real-time to dynamic changes in sample compliance thereby delivering excellent control over the full machine performance envelope.

Technical Specification:

Connection to PC:	USB
Acquisition Channels:	8 Analogue + 1 Quadrature Decoder
Control Channels:	2 (Analogue or digital)
Multi Box Capability:	x4
Max Number of Channels:	Up to 32 analogue + 4 quadrature channels with synchronised data acquisition
Sample Rate:	5kHz
Resolution:	24 bit, 16,777,216
Gain Ranges:	8 (User defined in software)
Description:	Advanced level solution for the highest performance of dynamic acquisition & control
Voltage Resolution:	~ 0.000001 mVolts (1 nanovolt)
Voltage Input Type:	Fully Differential, Balanced Precision Inputs with Integrated Signal Conditioning
Transducer Excitation Voltage:	Differential, Fixed Precision +/-5V, Independent (not Ganged), Ratiometric Excitation
Number of Input Ranges:	8 Independently Selectable Ranges Per Channel from (-10...+10mV) to (-10...+10V)
Excitation Current Sense:	Yes - can monitor transducer currents - alerts user of disconnected transducers
Excitation/Transducer Fault Detection:	Overvoltage, Overcurrent, Absent Transducer
Excitation Fault Tolerance:	Independent Per Channel, if any channel is shorted the other channels will continue to operate normally
Current Input Mode:	Yes - Via resistor fitted in cable termination (different ranges possible)
Differential Measurement Range:	-10mV...+10mV up to -10V...+10V for balanced differential signals
Transducer Calibration:	Linear, polynomial and custom transducer calibration
Virtual Transducers:	Up to 32 virtual transducers (e.g. strain, compliance, calculated values)
Data Acquisition Options:	Digital filtering for noise reduction
Digital Control:	1 kHz 32-bit floating point control loop
Analogue Control:	Control of both digital and analogue motor drives possible
Compliance Estimation:	Real time specimen compliance estimation
Adaptive Control:	Adaptive load and stress control
Custom Waveforms:	Custom waveform control with a maximum of 16000 points per waveform
Sample Docking:	Automatic sample docking
Display and Monitoring:	Data acquisition in GDSLab via USB interface, High resolution real time graphs
Software:	GDSLAB
System Characteristics:	200 MHz dual core ARM Cortex-M4 CPU, 32-bit architecture, On-board flash memory, 480 Mbit/s USB connection
Minimum System Requirements:	OS: Windows 7 or later, CPU: 1.5 GHz or higher, Memory: 2 GB, USB 2.0

Why Buy GDS?

GDS have supplied equipment to over 86% of the world's top 50 Universities:

GDS have supplied equipment to over 86% of the world's top 50 Universities who specialise in Civil & Structural Engineering, according to the "QS World University Ranking 2020" report.

GDS also work with many commercial laboratories including BGC Canada, Fugro, GEO, Geolabs, Geoteko, Golder Associates, Inpijn Blokpoel, Klohn Crippen, MEG Consulting, Multiconsult, Statens Vegvesen, NGI, Ramboll, Russell Geotechnical Innovations Ltd, SA Geolabs, SGS, Wiertsema and Partners to name a few.

**TOP
50**

Would you recommend GDS equipment to your colleague, friend or associate?

100% of our customers answered "YES"

Results from our post-delivery survey asked customers for feedback on their delivery, installation (if applicable), supporting documentation, apparatus and overall satisfaction with GDS. The survey ran for two years.



Made in the UK:

All GDS products are designed, manufactured and assembled in the UK at our offices in Hook. All products are quality assured before they are dispatched.

GDS are an ISO9001:2015 accredited company. The scope of this certificate applies to the approved quality administration systems relating to the "Manufacture of Laboratory and Field Testing Equipment".

**40 YEARS OF
BRITISH
INNOVATION**



Extended Warranties:

All GDS apparatus are covered by a 12 month manufacturers warranty. In addition to the standard warranty, GDS offer comprehensive extended warranties for 12, 24 and 36 months, for peace of mind against any repairs in the future. The extended warranties can be purchased at any time during the first 12 months of ownership.



GDS Training & Installation:

All installations & training are carried out by qualified engineers. A GDS engineer is assigned to each order throughout the sales process. They will quality assure the apparatus prior to shipping, if installation has been purchased, install the apparatus on the customers site & provide the training.



Technical Support:

GDS understand the need for ongoing after sales support, so much so that they have their own dedicated customer support centre. Alongside their support centre GDS use a variety of additional support methods including remote PC support, product helpsheets, video tutorials, email and telephone support.

