Variable Direction Dynamic Cyclic Simple Shear (VDDCSS)

Overview: The VDDCSS is a Bi-directional Direct Simple Shear device which, allows direct simple shear to be performed in two directions, rather than the standard single direction. This is achieved by having a secondary shear actuator that acts at 90 degrees to the primary shear actuator.

When used as a variable direction machine, the secondary shear axis can be used independently of the other shear axis or in conjunction with it, therefore direct simple shear may be performed in any horizontal direction. Tests can be carried out with constantly rotating shear vectors.

Key Features:	Benefits to the User:
Active height control:	Constant volume conditions are enforced i.e simple shear. No manual intervention is required between stages. Little or no effects of vertical compliance due to the extremely stiff system design, critical for high quality DSS testing.
GDS Shear Loadcell:	Designed so that shear force is measured in front of the linear guides, as such the shear force measurement does not include frictional errors.
Low friction retaining rings:	A cylindrical soil specimen is laterally confined by coated low friction retaining rings ensuring a constant cross sectional area (K-zero condition). The ring substrate is Aluminium Bronze which is a hard, bearing grade material, providing less strain, less potential to deform and scratch than aluminium. The nickel based coating has high concentrations of sub-micron sized PTFE particles to provide excellent low friction and break out force performance even after years of use.
Electro-mechanical actuators that give superior performance, reduce space and provide cost savings:	Electro-mechanical actuators can carry out tests up to 1mm at 1Hz, with greater accuracies than comparable pneumatic actuators. Mains powered means no external noisy power pack is required and as opposed to pneumatic/hydraulic systems, electro-mechanical systems draw only the power that is required.
Axial & Shear linear guidance provided by super-stiff crossed-roller bearings:	200mm bearing length not only provides stability while ensuring minimal rotation of the topcap during shearing, allowing testing to be simple shear rather than rotational motion (an important aspect for testing to international standards), but also provides high load capacity with low friction with accurate linear guidance.

System Uses: The VDDCSS provides a system for testing soils which ,may undergo loadings that change direction over time. This includes a variety of offshore foundations for structures such as wind farms and oil rigs. The VDDCSS can also model situations which, bias in one direction and load in the other. An example of this is near-field seismic motions.

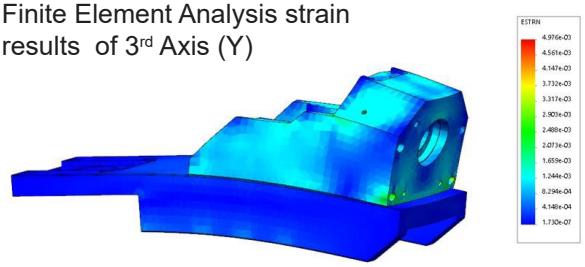
Upgrade Options: Bender Elements.

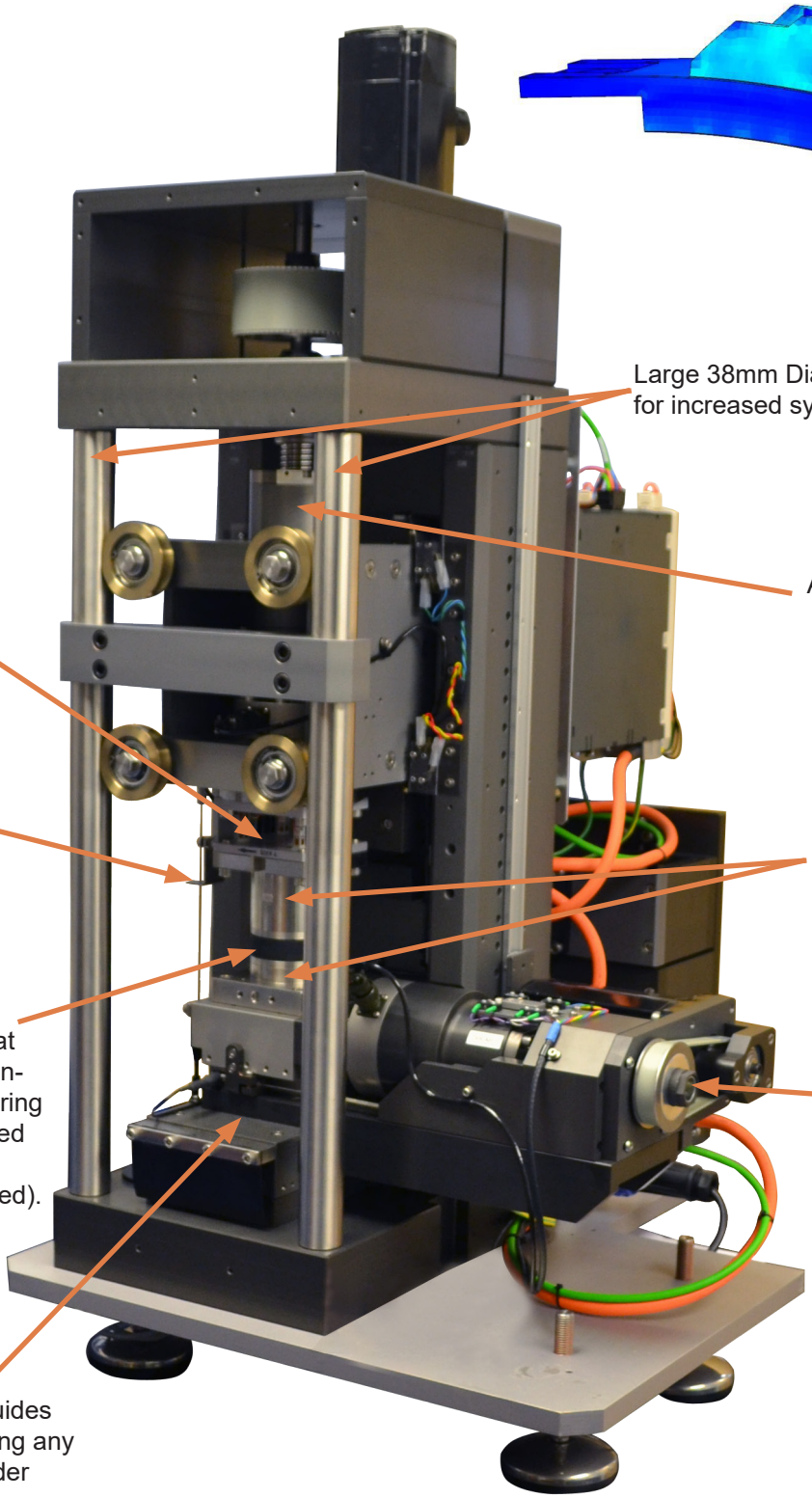
Technical Specification:

Dimensions (mm):	1200 (H) x 800 (L) X 610 (W)
Displacement Range:	Shear axis +/- 10mm (+/-30% shear strain) Normal axis +/- 25mm (+80% consolidation strain)
Displacement Resolution:	0.3µm
Load Range (kN):	5 normal force, 2 on each shear measurement (y and z)
Operating Frequency (Hz):	0 to 1
Sample Size (mm):	50 or 70 diameter, 20 to 30 height (other sizes on request)
Power:	240V or 110V 50/60Hz 1 ph
Weight (kg):	180

Key System Features

Finite Element Analysis strain results of 3rd Axis (Y)





Large 38mm Diameter 38mm Columns for increased system stiffness.

Shear Load Cell measures both X & Y shear, positioned such that friction is not measured.

Axial Load Cell.

Axial LVDT Armature for small strain Axial measurement.

Pedestal and Topcap include built-in drainage ports to provide water to the sample.

Bearing-grade material with a harder-wearing PTFE based plating that displays superior friction-reduction and load bearing characteristics compared to plain Teflon coated aluminium (as often used).

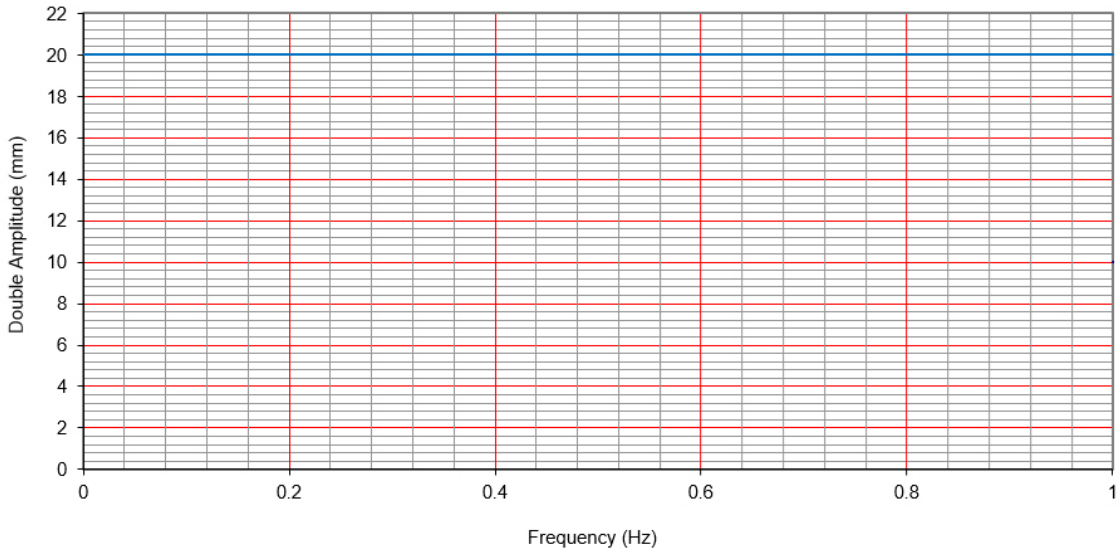
3rd axis, as shown in FEA strength test above (Y).

Low-friction linear guides assist rigidity, reducing any movement when under load.

The VDDCSS does not require any additional pressure controllers, hydraulic power packs or control boxes. The desktop apparatus just links to a PC running GDS Software via a single USB cable.

Typical system performance, showing frequency and amplitude (shear axis)

Frequency (Hz)	with zero kN force datum	
	Amplitude*	Double Amplitude*
0	10	20
1	10	20



How does it work?

A cylindrical soil specimen is laterally confined by Teflon coated low friction retaining rings, ensuring a constant cross sectional area. Vertical displacement is kept constant by using dynamic active height control, whilst shear force loading is applied, therefore constant volume conditions are enforced.

The VDDCSS apparatus allows for a smooth and continuous rotation through 90 degrees of the principal stress directions. The ability to simulate principle stress rotation is common to many geotechnical problems, including earthquake loading. The simple shear device allows direct investigation of the shear stress v. shear strain in drained and undrained situations (see graph Fig. 1). The simple shear test is used for routine work for undersea structures, landslips and earthquake performance studies. In addition, the dynamic cyclic capability allows investigation of damping ratio and liquefaction, also under the conditions of simple shear.

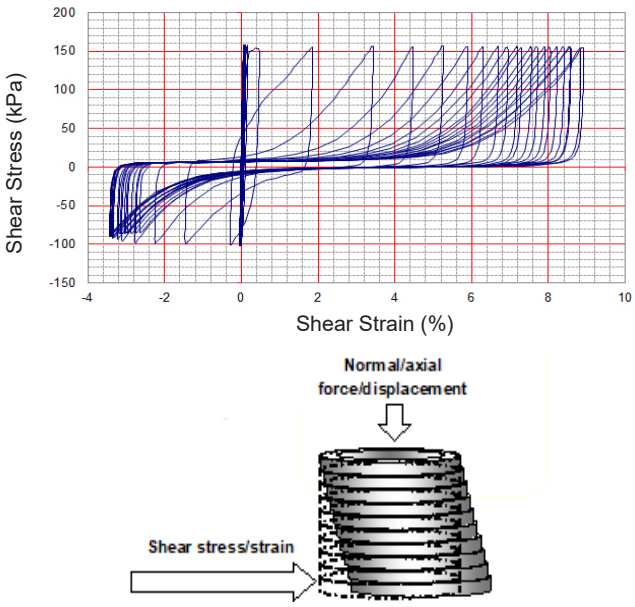
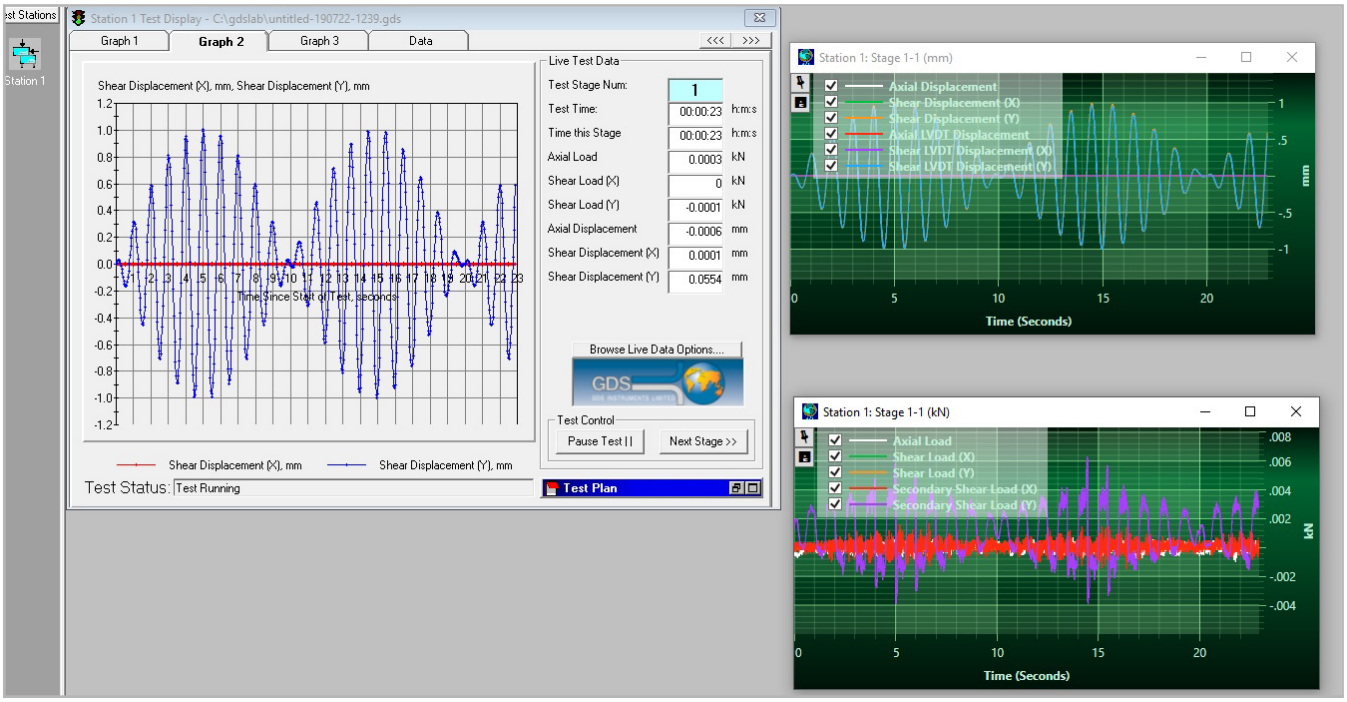


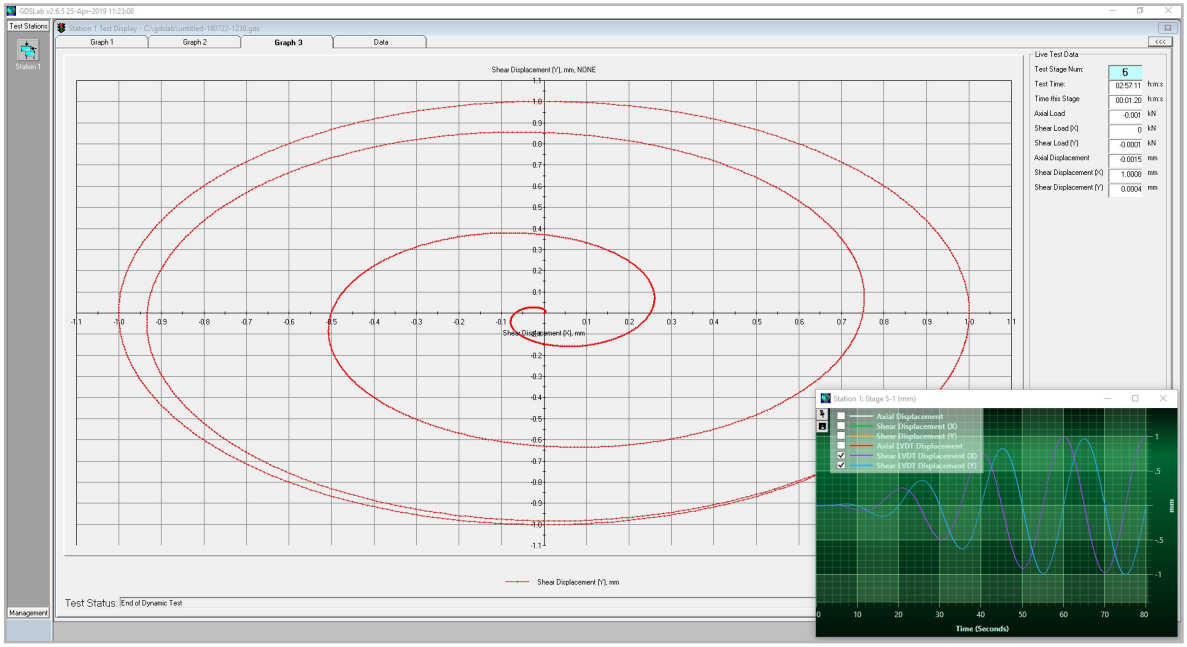
Fig. 1 Typical Graph shear stress (kPa) v shear strain (%) and sample schematic during sample shear

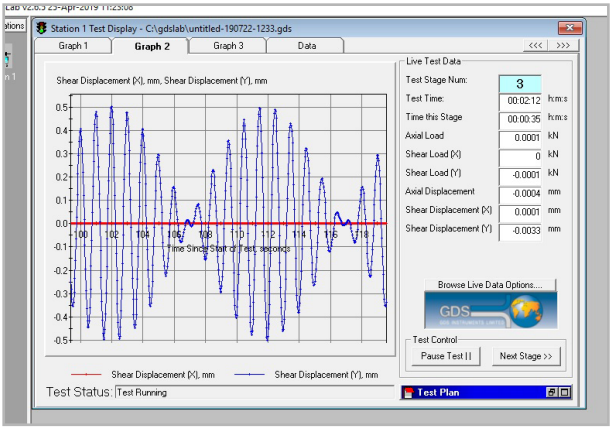
Control Software: Field upgradable firmware & Software provides easy updates and bug fixes (Screen shots of the software are shown below).

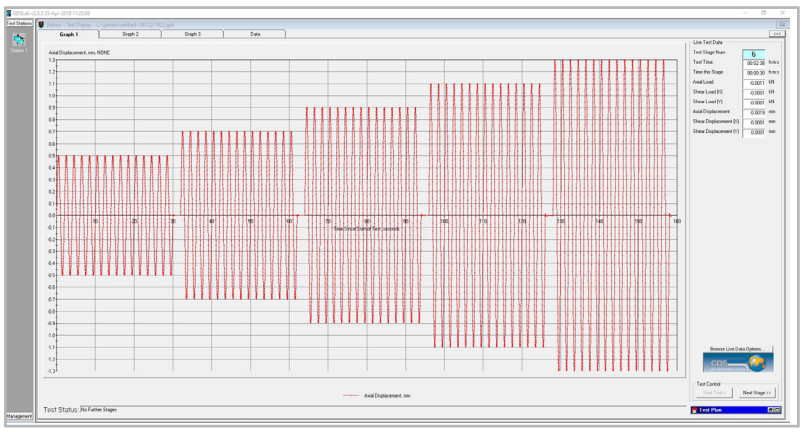


Operating System: Windows XP SP3 or higher (We recommend that whichever version of Windows you are running, that it is up to date with the latest Service Pack). PC Spec Hardware: 1GHz (minimum) / 1GB Ram (minimum): CD Rom.

Data can be exported to CSV.

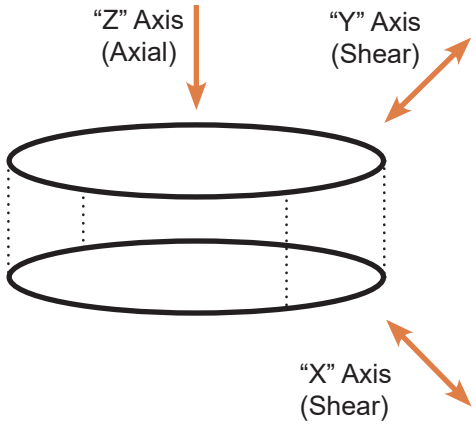






X, Y & Z Axis:

The VDDCSS is a fully dynamic system with all three axes utilising AC servo motors via a local closed loop synchronised control and acquisition unit. Using dynamic actuators for all three axes allows for active height (volume) control to be maintained during cyclic shear loading or even dynamic vertical load application. Cyclic loading of sinusoidal or user defined waveforms are available to run on each axis with wave types, frequencies, amplitudes, phase etc set per axis. Long duration cyclic loading patterns with different load patterns on each axis can be streamed to the system with optional software upgrade.



System Uses:

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Confined Pressure Testing:

An alternative system to the VDDCSS is the Confined Variable Direction Dynamic Cyclic Simple Shear VDDCSS-CON. The VDDCSS-CON allows the application of a confining pressure to the sample whilst performing variable direction testing.

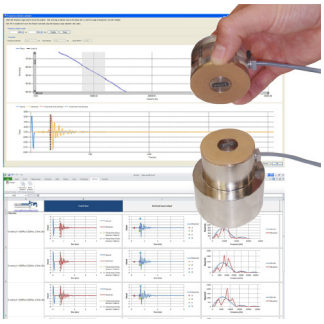
The VDDCSS-CON can apply up to 1 MPa confining pressure using a GDS Pneumatic Controller (GDSPPC), with specimens up to 100 mm diameter available for testing.

Please note existing VDDCSS systems cannot be upgraded to the VDDCSS-CON.

Upgrade to Bender Element Testing:

The VDDCSS can be upgraded to perform P and S wave bender element testing with the addition of the following items:

- Bender element pedestal with bender element insert.
- Bender element top-cap with bender element insert.
- High-speed data acquisition card.
- Signal conditioning unit which includes amplification of source and received signals (P and S wave) with user controlled gain levels (via software).
- GDS Bender Element Analysis Tool GDSBEAT (optional).



Screenshots of GDSBEAT software.

ADVDCS v2 Acquisition Pad Used with VDDCSS

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

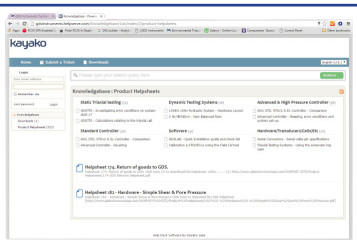
Extended Warranties:

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.

2 YEA EXTEND WARRAN
1 YEAR EXTENDED WARRANTY
3 YEAR EXTENDED WARRANTY

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.