GDS Instruments

The GDS Triaxial Automated System (GDSTAS)

[This document aims to clarify the specification process for the GDS Triaxial Automated Testing System. There are many different system configurations available and many options within each configuration. The configurations presented here are by no means exhaustive and if none of them match requirements then please contact GDS for further information.]

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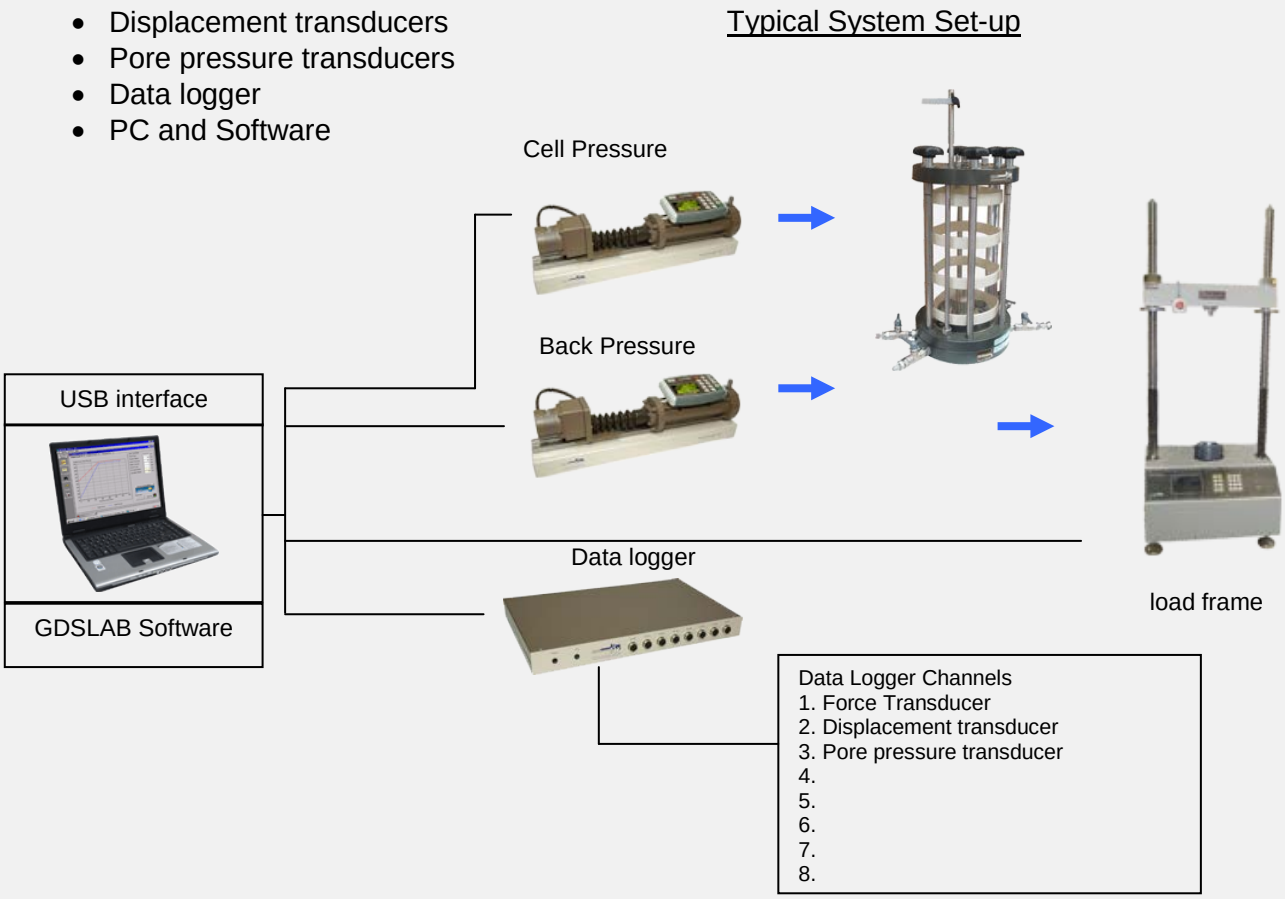
World Leaders in Computer Controlled Testing Systems for Geotechnical Engineers and Geologists

Overview GDS Automated Triaxial Testing System (GDSTAS)

Components of a Triaxial Testing System (GDSTAS):

- Loadframe
- Triaxial Cell
- Source of Cell pressure
- Source of Back pressure
- Force transducers
- Displacement transducers
- Pore pressure transducers
- Data logger
- PC and Software



Within the GDS range there are many options & variations to this basic system:

Different component substitution – Higher accuracy or reduced cost components, **Incorporation of existing OEM equipment into a new system** - pre-existing equipment can sometimes be utilised to reduce setup costs.
Multiple Cell Systems – these allow for multiple samples to be saturated and consolidated while another is being loaded / sheared in the load frame.
Multiple Station Configurations - these allow for multiple complete stations to be attached to one PC and may share some resources between stations.
Multiple Cell Type Configurations – An example would be the inclusion of a CRS type cell for consolidation testing.
Special Configuration Systems

- Low stress system
- Slurry consolidation system

Upgraded Functionality – various upgrades can be included to enhance performance

Substitution of Different Components

Various options are available within the GDS product range to change the performance of the overall system. Typical reasons for doing this may include; increasing accuracy, reducing system cost or simple user preference.

Pressure Controllers

Pressure controllers supply cell and back pressure during a test. GDS have four ranges of controller that are compatible with the GDSTAS apparatus:

Pneumatic – Cost effective and ideal for saturation and consolidation stations
Enterprise – Generally used for Commercial and teaching (Max pressure = 1MPa)
Standard – Widely applied for commercial and research testing (Max pressure = 4MPa)
Advanced - Highest accuracy and used generally for research testing (Pressure Range from 100kPa to 150MPa)

Triaxial Cells

Triaxial cells are typically chosen by the required sample size and the maximum operating pressure. To see a full list of our triaxial cells and their specifications, see our datasheet. http://www.gdsinstruments.com/datasheets/Triaxial%20Cell%20Datasheet.pdf

Loadframes

Loadframe choice is generally governed by the maximum load that the frame can apply. Occasionally other factors affect the choice of Loadframe such as the opening between the columns to fit a particular cell or the stiffness of the frame.

GDS offers two ranges of Loadframe: Standard or VIS (Virtual Infinite Stiffness). Standard frames tend to be cost effective and the VIS frames are designed to be very stiff. The increased stiffness of the VIS range is generally a requirement for rock mechanics testing or other high accuracy testing. The following frames are available from GDS:

Load Range (kN)	Product Range
50	Standard
100	Standard
250	Standard
100	VIS
250	VIS
400	VIS
500	VIS
1000	VIS

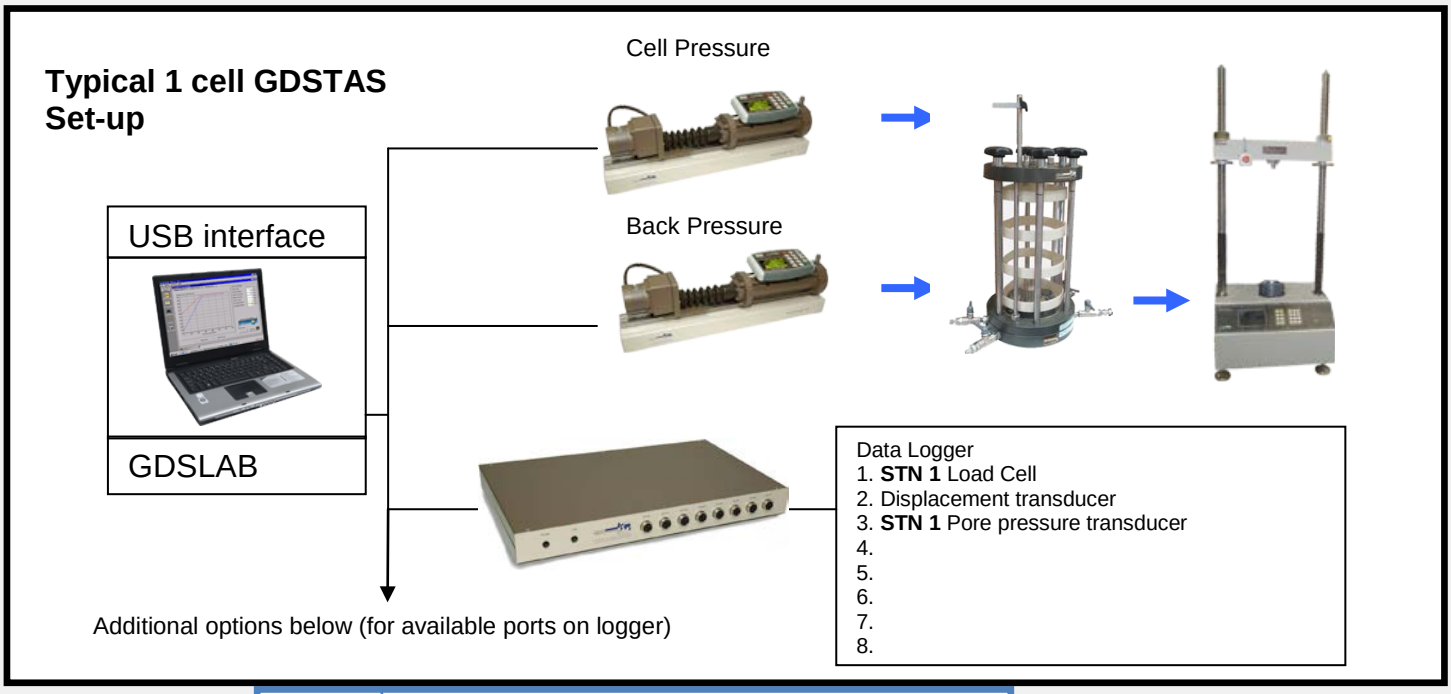
Incorporation of existing OEM equipment into a new system

Laboratories often have existing equipment that can be incorporated into a GDSTAS system. Generally components that have potential to be reused include:

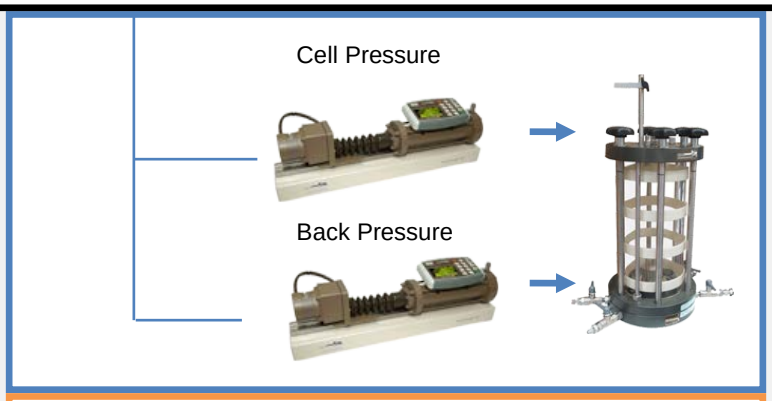
- Loadframes
- Triaxial Cells
- Data loggers

The list of compatible equipment is considerable so please contact us direct with any questions about specific products.

Multiple Cell Systems: The flexibility of the GDSTAS system allow for multiple cell configurations, providing an efficient way of increasing throughput for a triaxial testing lab. Typically systems are configured with either an extra one or two cells. Examples of this format are laid out below:

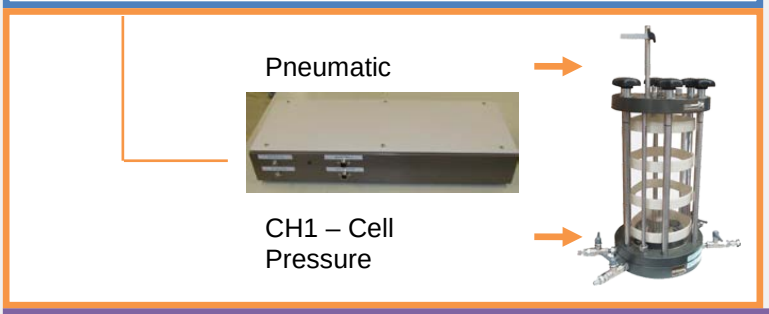


2 & 3 Cell GDSTAS Option



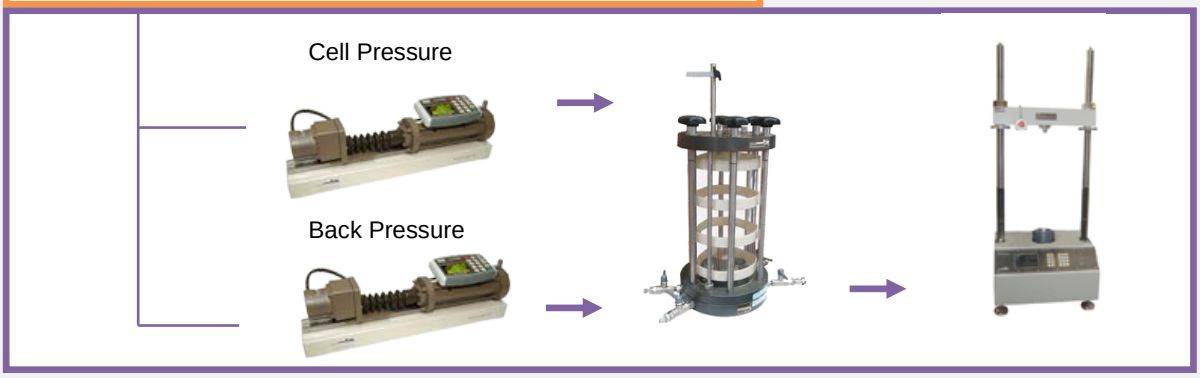
Note: There is enough ports to replicate this set-up, allowing 3 cells to be connected to the one system.

2 Cell GDSTAS Option



Note: The Dual Channel Pneumatic controller requires a source of clean, dry compressed air. It provides a cost effective source of cell and back pressure but must be used with an air / water interface for each channel. This can be a good solution where customers already have air/water interfaces and air driven manual regulator systems.

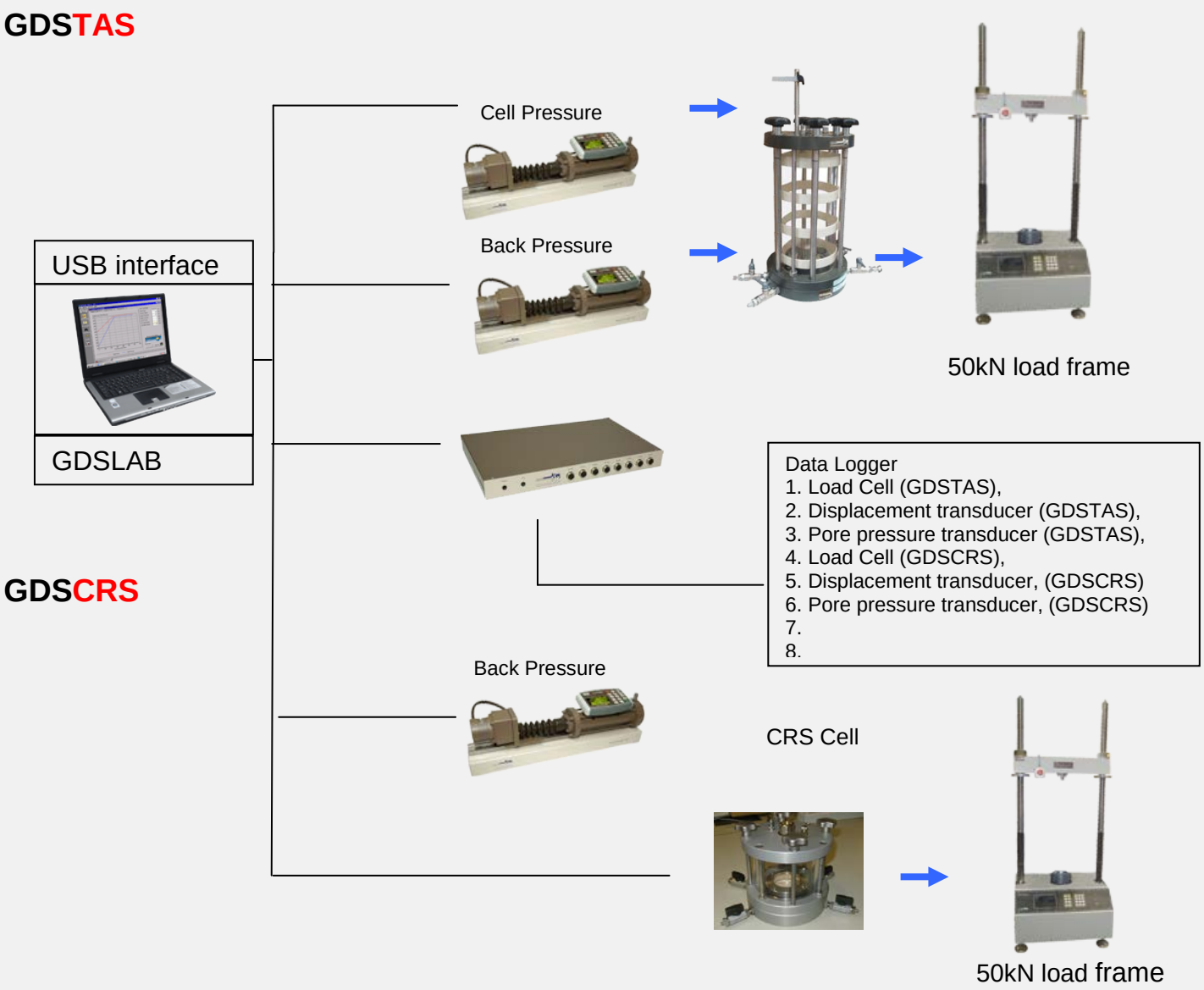
2 Cell & frame GDSTAS Option



Note: The above 2 & 3 cell options are example of possible extensions to an existing system. Other options are available, please contact us direct to discuss.

Multiple Cell Type Configurations

The GDSTAS can be configured to carry out two different types of testing. The most common example of this would be a triaxial and a consolidation (CRS) station, this is demonstrated below. Common equipment is shared between stations and one OR the other can be carried out at any given time.



Note: Additional software may be required when combining different systems.

Special Configuration Systems

Low Stress Setup: Where a GDSTAS system is being specified for use at very low stresses some modifications can be made to enhance the standard system to achieve the highest possible quality of results. This specification is laid out on the assumption that the system is also to be used at higher pressures and stresses at some time in the future.

The primary concern when defining a system for use in low stress testing is the accuracy and resolution of the transducers that are being used for control and measurement in the system. By way of example a “standard” GDSTAS system may be supplied with pressure controllers rated to work at up to 3MPa and as such the resolution on control and data logging would be 1kPa. If the maximum test pressure to be achieved is only for example 25kPa then the resolution is 4% of the target, while this may be acceptable it is slightly coarse. The ideal solution would be to use a lower range transducer so for example if a 200kPa transducer was used the resolution would be approximately 0.01kPa or in this example 0.04%. The result of such a change would yield much finer control of stresses in the system and an output data set of much higher quality.

However, to change the pressure transducer in a pressure controller is not an option when switching between higher stress tests and low stress tests, so another solution is offered. GDS pressure controllers have the possibility of adding a second, external, control transducer. The transducer is added via a Remote Feedback Module (or RFM for short). Once the RFM is added the controller can be simply switched via the keypad between the internal or external transducers.

A pressure controller is shown below with an RFM attached

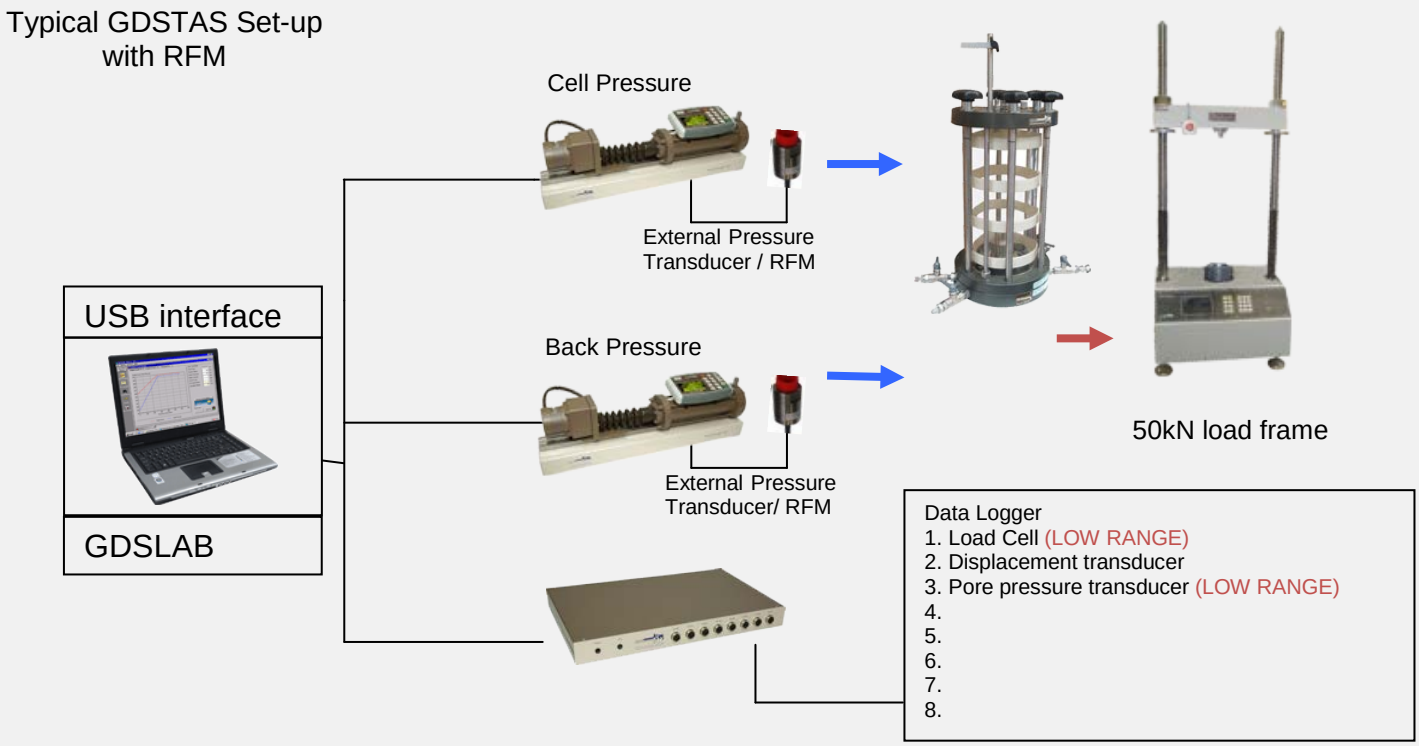
RFM Unit added on to controller

The RFM (on the end that cannot be seen above) has a single transducer input socket.

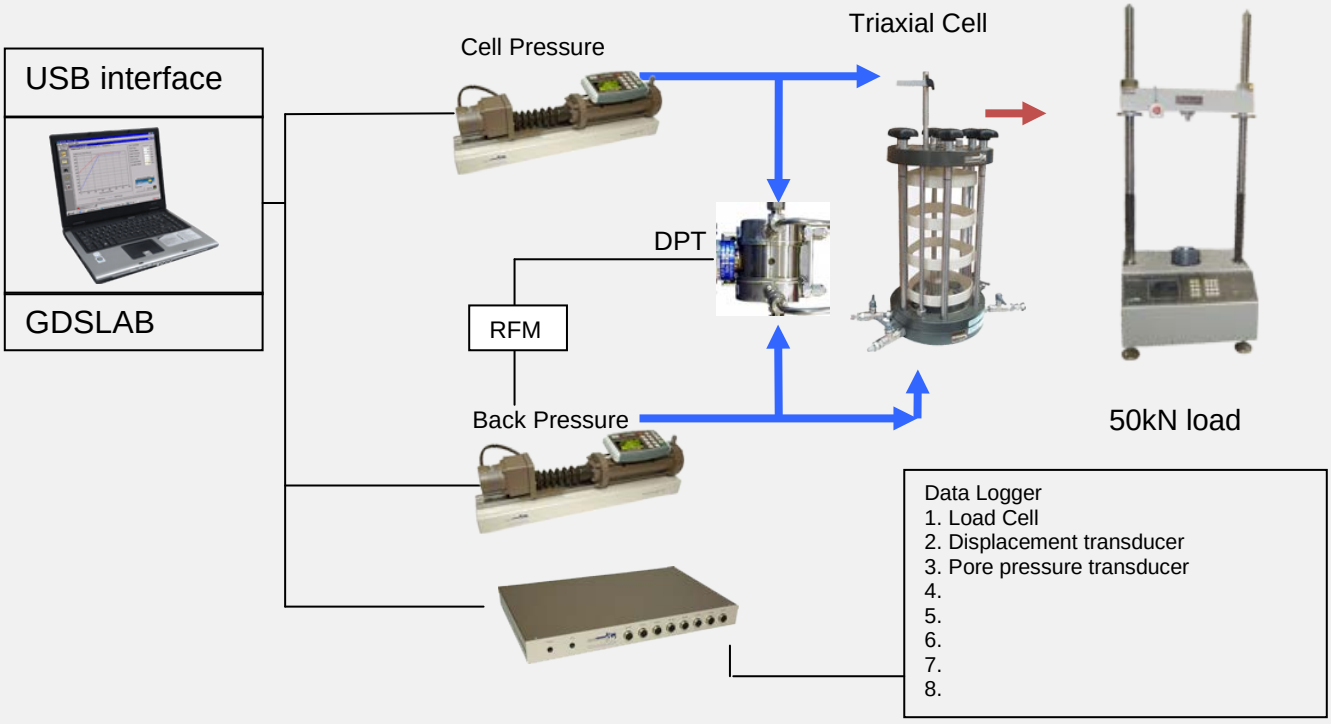
Below is a table that demonstrates the improvements to accuracy and resolution of pressure control and acquisition by using different range pressure transducers compared to the standard 3MPa internal transducer.

	Standard 3MPa	**RFM & 1MPa**	**RFM & 500kPa**	**RFM & 200kPa**
Resolution (kPa)	1kPa	0.03kPa	0.015kPa	0.01kPa
Accuracy (kPa)	7.5kPa	2.5kPa	1.25kPa	0.25kPa

In parallel a lower range loadcell should also be used to increase the accuracy and resolution of the load readings. The following low range loadcell ranges are available as standard from GDS: 0.2kN, 0.5kN, 1kN, 2kN, 4kN, 5kN, 8kN and 16kN.



Low Effective Stress System: The above low stress system give enhanced total stress control within a GDSTAS system. Another requirement has been to control very low effective stresses and to keep them constant. This can be better achieved by placing a differential pressure transducer between the cell pressure and back pressure lines. The use of a low range Differential Pressure Transducer (DPT) plugged into the back pressure controller allows the controller to accurately follow the cell pressure while maintain the effective stress very accurately.



For example if a 50kPa differential pressure transducer is used then the resolution of measurement for the effective stress would be 0.0015kPa.The difference between this system and the Low Stress system detail in the previous section is that this system can maintain accurate effective stresses even at higher overall total stresses.

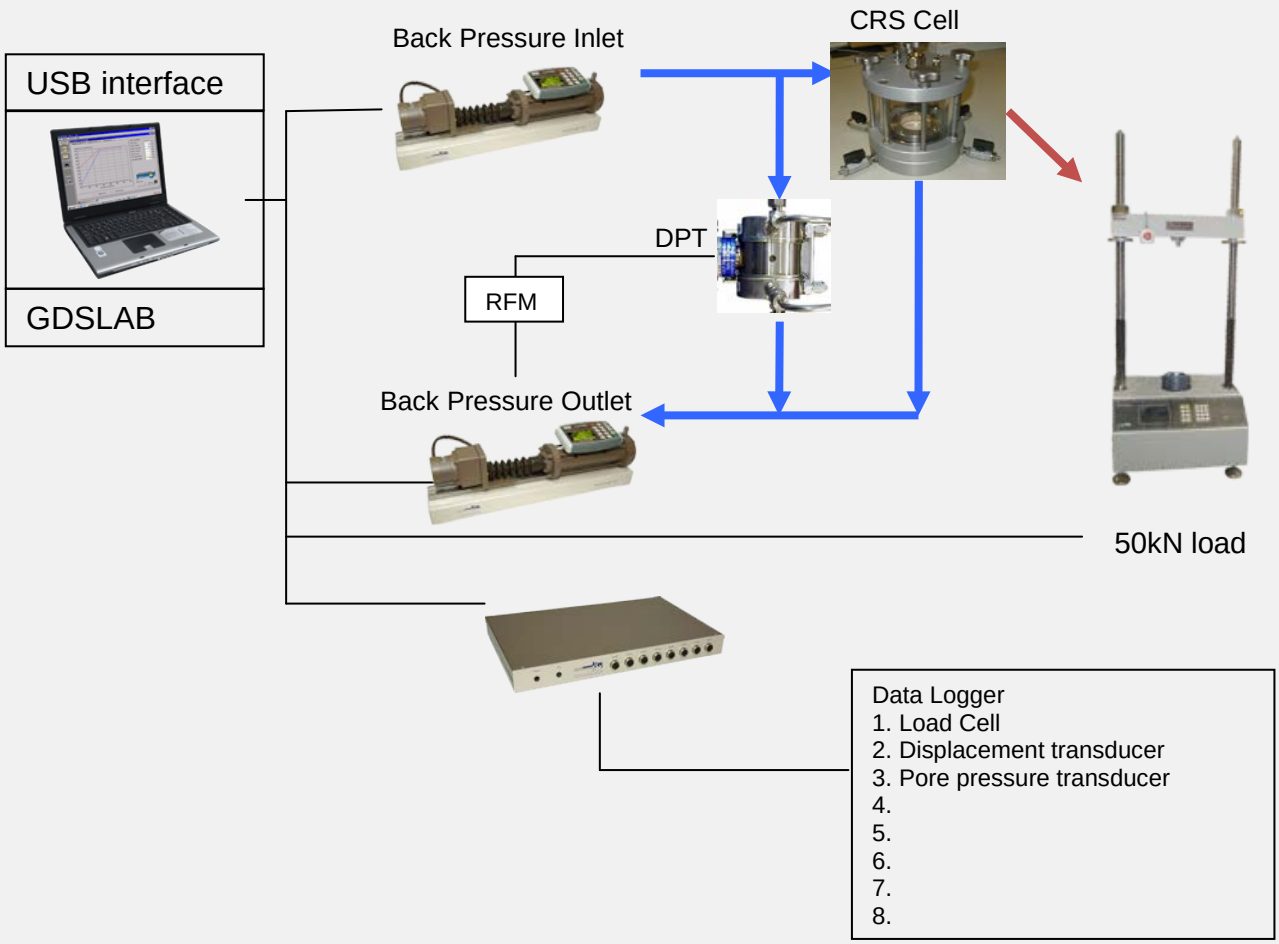
Slurry Consolidation System

The slurry consolidation system is generally used to test the consolidation properties of very soft, high water content materials such as mine tailings or paste back fill. Essentially the system is a modified CRS type system (described previously). The main modification is to the sample retaining setup, in that slurries are placed into the cell in very different ways to normal cohesive samples. The slurry can in effect be poured into the sample container without losses during the remainder of the cell setup procedure.

Optionally, other modifications can be made to the system to extend the usage of the cell further. These include making all metallic components of the cells from stainless steel for use with aggressive pore fluids that can be associated with mine tailings.

Another optional addition to the system can be to carry out low hydraulic gradient permeability tests. Traditionally these are difficult to control due to the very fine tolerances between the sample inlet pressure and outlet pressure of the permeability test. Using standard range components it would be difficult to implement a hydraulic gradient and control it well enough. Again, the GDS solution is to use an external transducer to control the pressure controller, with the feedback directly into the controller itself via an RFM. In this case a low range Differential Pressure Transducer (DPT) can be connected between the inlet and outlet pressure ports of the cell. The differential pressure transducer is then plugged in to control the outlet pressure controller to maintain a specified deferential.

The slurry consolidation system with Low Hydraulic Gradient Permeability



Upgraded Functionality

Many different upgrades can be applied to the GDSTAS triaxial testing system to extend the functionality of the system. Some of the more common upgrades are listed below:

Local Strain Equipment – This equipment allows sample strains to be measured directly. This results in improved accuracy in testing results and the ability to work at "small strains". Note: a full set of local strain equipment will require the system to have three spare data logger channels. More information can be obtained: http://www.gdsinstruments.com/transducers.htm
Generally two different types of local strain transducers are available: LVDTs and Hall Effects. As a general guide the Hall Effects are slightly less accurate but are very light so they tend to be best suited where soft samples are to be tested.

Bender Element Testing – These are transducers that can be mounted in the topcap and base pedestal as well as laterally through the membrane of the sample. Bender Elements directly measure the stiffness of the sample at small strains. More information can be found here: http://www.gdsinstruments.com/products/gdsbes.htm

Unsaturated Testing – This technique allows partially saturated triaxial samples to be tested while still measuring the sample volume change. More information is available here: http://www.gdsinstruments.com/products/unsaturated_triaxial_testing.htm

Software

The functionality of a given system is determined by the software modules that are purchased. Each general test type is defined in a different module. GDSLAB Kernel – Provides data acquisition and data presentation.

Test Modules are sold on a site license basis. This means that even if a lab is running multiple copies of GDSLAB on different PCs the test module only needs to be purchased once and it can be used on all systems.

Available triaxial modules for use with the GDSTAS system are as follows:

- Triaxial Modules
- Saturation and Isotropic Consolidation
- Standard Triaxial – UU, CU and CD tests including MULTISTAGE
- Stress Path – In terms of p &q or s and t
- K0 – Constant sample diameter testing
- Advanced Loading – Allows individual control of axial, cell and back pressure. Most commonly used for anisotropic consolidation. Including MULTISTAGE
- Consolidation Modules are also available for CRS type testing.

Please note: Due to the continued development specifications or products may change without notice.