30 GDS Helpsheet

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

Software

GDS Triaxial Testing System

GDSTTS Ver.6.0 Release Notes Digital Transducer Interface

1. Introduction

This release of GDSTTS has two major changes. The first is the incorporation into the GDSTTS system of the Digital Transducer Interface (DTI). The second major change saves data directly to disk as the test proceeds.

The DTI allows an additional eight transducers to be used with the standard GDS Triaxial Testing System hardware. These additional transducers are:

- A submersible load cell
- Three Hall Effect local strain transducers
- Two additional pore pressure transducers
- Two external displacement transducers (GDS Digital Indicators)

When you start the GDSTTS system you will be shown the list of IEEE addresses for the attached controllers. This list will now include the DTI. If the DTI is present (IEEE address not equal to 99) then you will be shown the configuration parameters for the DTI. For each channel you will be shown:

- the name of the channel,
- the engineering units it makes measurements in,
- its sensitivity in these units per millivolt,
- its maximum output value in engineering units,
- its minimum output value in engineering units,
- whether or not this transducer is present.

You will then be given the option to amend any of these parameters. After you have made the desired amendments (if any) then you can accept the changes or ask to make further ones.

When you choose the option to run tests you will be asked if you wish to set the zero offsets of the transducers which are connected to the DTI. If you select this option then the current readings of the transducers will be taken and these values will be saved as the zero reference for the transducer. You do not need to set the zero reference for the transducers before every test. Most modern transducers will be stable over very long periods. Many transducers, however, especially pressure transducers, are sensitive to changes in temperature. If you set the zeroes at say 18 degrees C and then later carry out a test at 24 degrees C it would be advisable to reset the zero offsets.

The transducer details for a fully configured DTI may be displayed as follows:-

DTI TRANSDUCER DETAILS

CHANNEL NAME	UNITS	SENSITIVITY UNITS/mV	MAX UNITS	MIN UNITS	PRESENT
LOAD CELL	kN	+0.00050	+5.00000	-5.00000	YES
HALL AX 1	MICROMETRES	+2.50000	+2500.00000	-2500.00000	YES
HALL AX 2	MICROMETRES	+2.50000	+2500.00000	-2500.00000	YES
HALL RAD 1	MICROMETRES	+2.50000	+2500.00000	-2500.00000	YES
PORE 1	kPa	+0.20000	+2000.00000	-100.00000	YES
PORE 2	kPa	+0.20000	+2000.00000	-100.00000	YES
D.I. 1	MICROMETRES	+0.00000	+12500.00000	-12500.00000	YES
D.I. 2	MICROMETRES	+0.00000	+12500.00000	-12500.00000	YES

You will then be asked

DO YOU WISH TO CHANGE THE DTI TRANSDUCER DETAILS (Y or N) ?

If you do want to change the details then you will be asked a series of questions for each transducer in a similar manner to the following example for the load cell:-

DO YOU WISH TO CHANGE THE DETAILS FOR THE LOAD CELL

Y

IS THE LOAD CELL PRESENT

Y

ENTER SENSITIVITY IN kN PER MILLIVOLT

0.0005

ENTER MAXIMUM VALUE IN kN

5

ENTER MINIMUM VALUE IN kN

-5

When you have entered the details for each transducer you will be shown the details for the complete DTI and asked once more if you wish to change them. If you say N (no) then the system will continue.

You will then be asked if you wish to zero the transducer outputs. Normally you will do this at the beginning of each test set-up. Before setting up the test specimen, you will fill the cell with water so that the pore pressure transducers (PORE1 and PORE2) communicate with the cell fluid. Designate your cell pressure controller as the master controller and set zero pressure. This will then be the zero for your pore pressure transducers. Your Hall Effect transducers will not have their magnets near them at this time i.e. they will give a zero Gauss output. The load cell will be unloaded at this time. Make sure the system has been powered on for a minimum of 24 hours and the cell water has been in the cell for 24 hours. All transducers and measuring systems will then have come into thermal equilibrium. You can then reply "Y" (yes) to the question "DO YOU WANT TO ZERO THE TRANSDUCER OUTPUTS?'. ***If you reply "Y" when there are arbitrary loads, pressures and displacements on the DTI transducers then these arbitrary values will become the new zeros and all subsequent values will be measured from these arbitrary zeros as datums. Keep the cell water for refilling the cell after you have set up the test specimen. This makes sure the cell water is still at room temperature.***

2. Calculation of Sensitivities

You need to be careful with the calculation of sensitivity. Each channel has a different gain so that the input to the A/D converter is standardised to the range +/- 10V. For example a load cell will have an output of 20mV for 5kN say. The preconditioning on the load cell channel has a gain of 500 so that the input to the A/D converter becomes 20mV * 500 = 10000 mV or 10V. The sensitivity is therefore 5kN/10000 mV = 0.0005 kN/mV.

You need to divide the sensitivity of the transducer as specified by the manufacturer (in terms of engineering units per millivolt) by the gain range of the channel that the transducer is connected to in order to calculate the sensitivity for the DTI. As another example a pore pressure transducer with a full range output of 2000 kPa at 95mV (this gives a manufacturers sensitivity specified as 21.053 kPa/mV) is connected to one of the pore pressure channels with a gain of 100. The sensitivity for the DTI is therefore calculated as (2000kPa/95mV)/100 = 0.21053 kPa/mV.

The channels have the following gains:-

Channel		Gain	FRO mV
8	=Load cell	500	20
9	=Hall ax. 1	1	10,000
10	=Hall ax. 2	1	10,000
11	=Hall rad. 1	1	10,000
12	=Pore 1	100	100
13	=Pore 2	100	100

The Digital Indicators do not have a gain associated with them because they are not read with the A/D converter. Their output is digital and is read by a special multiplexer which is an integral part of the DTI.

3. What Does the Display of Transducer Readings Mean

From the table above you can see that the gains are fixed to give each channel a Full Range Output (FRO) that corresponds to typical FROs for load cells (20mV), pressure transducers (100mV) and Hall Effect transducers (4V).

The display of transducer readings are given in full precision or "counts". The DTI carries out analogue to digital conversion (A/D) using a 16 bit A/D. This means that the continuous analogue output (mV) of the transducers is converted into a "staircase" having 2 to the power of 16 steps i.e. 64,536. This is spread over the plus and minus ranges of the transducer and so in the positive range there are 32,768 counts (actually 32,768-1= 32,767).

Interpreting the display will now be illustrated by the following examples.

Examples

Imagine you are wanting to check the consistency of calibration throughout your GDS Triaxial Testing System. You can do this by putting a stainless steel cylinder test specimen in the triaxial cell, filling the cell with water, and setting pressure zeros and set pressures in the usual way. Let us say that you apply a cell pressure of 500kPa and a lower chamber pressure of 1000kPa. The back pressure controller is on FUNCTION i.e. it is reading pressure only (to make sure it is reading the cell pressure you can slacken off the connection to the base pedestal inside the cell).

Now select channel 8. The display is the output of the load cell in counts. At zero load this was -240 and at the set pressures it is +22600. The sensitivity of the 3kN load cell is given by the manufacturer as 2.858mV/Volt. The DTI energises the transducer with 10.000V. This means the FRO of the load cell is 28.58mV at 3,000N.

The display is therefore interpreted as:

The proportion of FRO counts is C= (22600+240)/32767.

The load cell outputs 28.58mV at 3,000N. For this channel which is set up for 20mV, the FRO corresponds to a load of L=(20/28.58) x 3000N.

The display therefore corresponds to a force of L x C =1463N.

Now the area of the Bellofram Rolling Diaphragm is 2931 sq.mm. Using Bishop & Wesley's equations gives the relationship between net lower chamber pressure (i.e. less the cell pressure) p, and axial force L of p=0.3412L. We have p=(1000-500)=500 in this example and so L=500/0.3412= 1465N (c.f. 1463N as measured by the load cell above).

Now select channel 12. This indicates the output of the pore pressure transducer connected to the base pedestal. At zero pressure this was -307 and at 500kPa this was +9205. The sensitivity of the 500psi pressure transducer is given by the manufacturer as having an FRO of 200.22mV at10.000V.

The proportion of FRO counts is C= (9205+307)/32767.

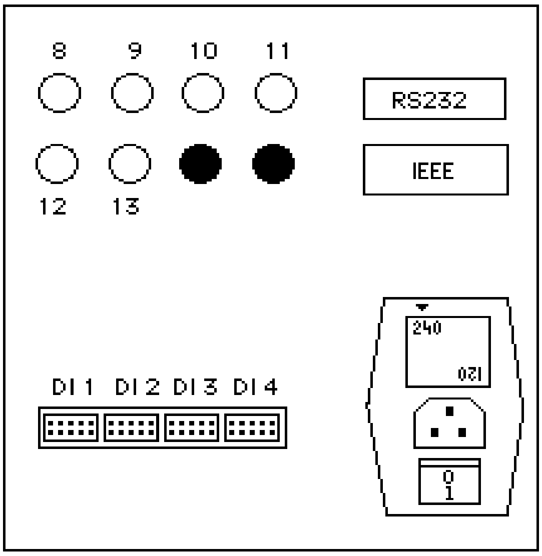
Noting that 1psi=6.895kPa, the output of the transducer at 2000kPa is therefore (2000/(500psi x 6.895)) x 200.22mV= 116.15mV. For this channel which is set up for 100mV, the FRO corresponds to a pressure of P=(100/116.15) x 2000kPa.

The display therefore corresponds to a pressure of P x C =499.86kPa (cf 500kPa set by the cell pressure controller).

For the Hall Effect transducers the arithmetic is similar. Generally for the Hall Effect transducers the sensitivity is 4µm/mV. The Hall Effect channels on the DTI are set for 10V (10,000mV) i.e. the FRO is 40,000µm. Imagine an original reading in counts was -8157 and that the final reading in counts was -6312. The displacement is then (-8157- -6312)/32677 x 40,000 = 2552µm movement in the positive (compression) direction.

All of these conversions from counts into engineering units are automatically carried out by the computer when you run GDS software

LAYOUT OF DIGITAL TRANSDUCER INTERFACE BACK PANEL



ALLOCATION OF CHANNELS FOR GDSTTS v 6

8 = LOAD CELL GAIN = 500
9 = HALL AX 1 GAIN = 1
10 = HALL AX 2 GAIN = 1
11 = HALL RAD 1 GAIN = 1
12 = PORE 1 GAIN = 100
13 = PORE 2 GAIN = 100

DI 1 = EXTERNAL AX 1
DI 2 = EXTERNAL AX 2

Layout of Digital Transducer Interface back panel