



## Wheatstone bridge transducers

### Scope

Strain gauges are widely used in engineering to measure strains induced by the loads applied to structures. They also form the basic sensing element in a wide range of transducer such as load cells and pressure transducers.

When used in sensors they are typically in a Wheatstone bridge configuration. This is also known as a full bridge sensor.

All *DT80* range *dataTaker* data loggers support

- Gauge resistance to 5000 Ohms
- Voltage excitation.
- Current excitation.
- 4 wire full bridges.
- 6 wire full bridges.

The mathematical capability of the *DT80* range *dataTaker* data loggers allows simple conversion from raw sensor readings into engineering units

### Prerequisite

This worked example assumes basic knowledge of;

1. *dEX*, *DeTransfer* or *WEB UI*.
2. *dataTaker* programming language.

### Equipment

Hardware;

1. *DT80* range *dataTaker* data logger. Version 8.06.0001 firmware or later.
2. A Full bridge strain gauge based sensor.

Software;

1. *dEX*
2. *DeTransfer*.

Manuals;

1. *DT80* User manual Version UM-0085-B1 or later
2. Sensor specification, User manual or installation guide.



## Quick start

### Current excitation bridges

The preferred method of excitation for 4 wire full bridge sensors is to use current excitation.

#### Wiring

- Power + to \* terminal
- Power – to # terminal
- Output + to + terminal
- Output - to – terminal

**Note: Cable shielding is to be connected to either the Digital Ground or the ground screw terminal.**

1. When using *dEX* web based configuration interface
  - a. Open your web browser and enter the TCP/IP address of your *DT80* series data logger.

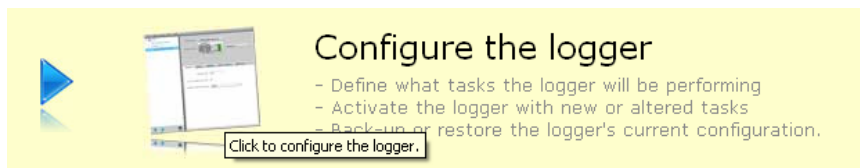


Figure 1 Accessing *dEX* configuration builder

- b. In the Menu tree select Schedule\_1 then click on “Add” in the menu bar

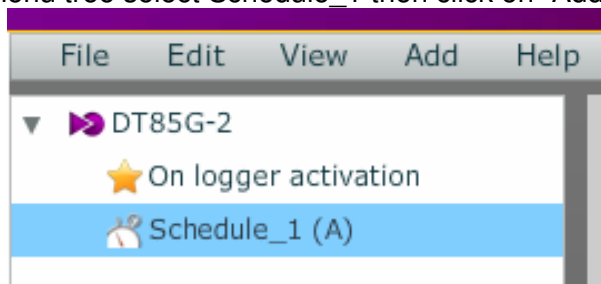


Figure 2 Adding a measurement



c. Expand out the add menu following the path Measurement -> Bridge -> Current bridge and click on Current bridge menu option.

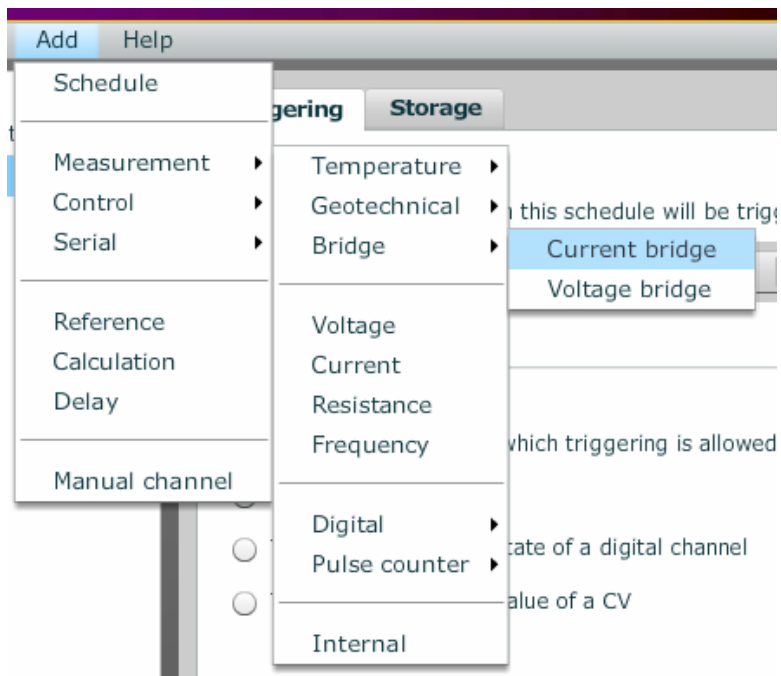


Figure 3 Adding a current excitation bridge channel type

d. In the tree view give the channel a unique and meaningful name. To accept the name click on the tick. Note: This name will be referred to in later calculations.

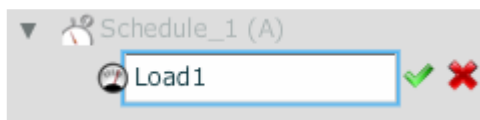


Figure 4 Naming the channel



e. In the view pane, click on “Select wiring” and select the first wiring option (4 Wire full bridge).

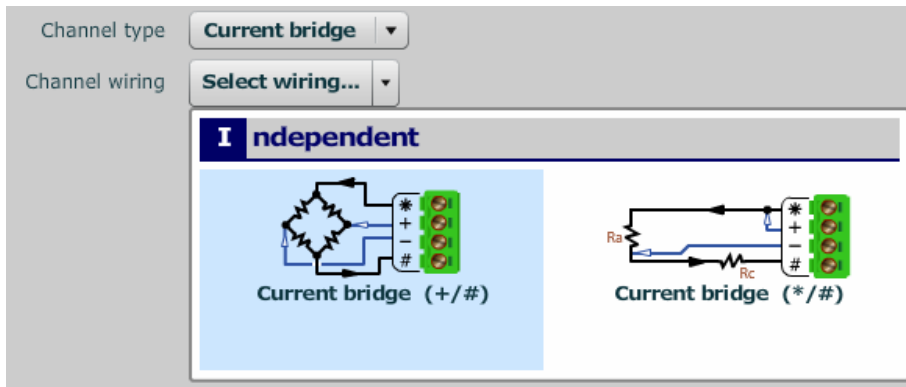


Figure 5 Selecting wiring type

f. In the view pane, click on the channel selector and select the analog channel number the vibrating wire sensor is physically connected to.

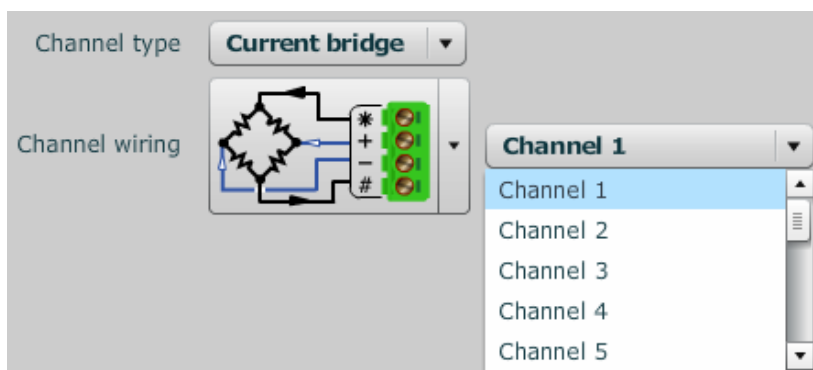


Figure 6 Selecting analog channel number

g. To send the configuration to the logger, on the menu bar, Click on “File” -> “Save to logger”

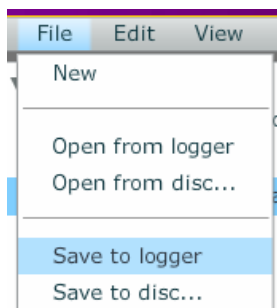


Figure 7 Sending configuration to logger



- 2. When using the *dEX* command window or *DeTransfer*.
  - a. Connect to the *DT80 series 2* data logger.
  - b. In the send window type the command *nBGI(4W)*. Where *n* is the analog channel number the load cell is connected to. This will cause the *DT80* to take a single reading from the load cell.
  - c. Sample result will be returned to the receive window.

**Voltage excitation bridges**

- a. Expand out the add menu following the path Measurement -> Bridge -> Voltage bridge and click on Voltage bridge menu option.

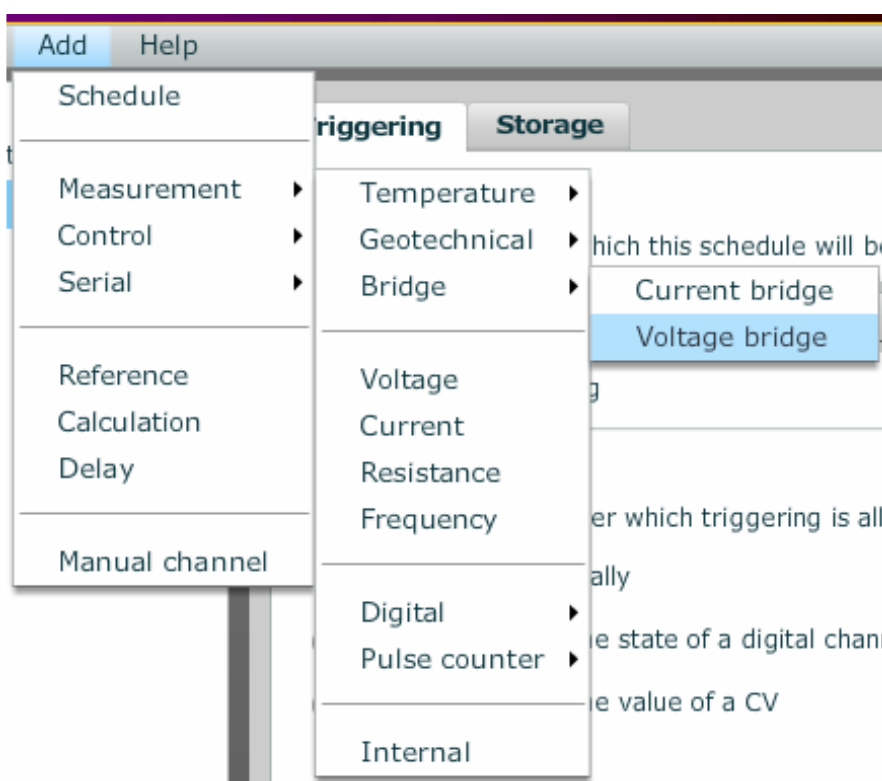


Figure 8 Adding a Voltage excitation bridge channel type

- b. In the tree view give the channel a unique and meaningful name. To accept the name click on the tick. Note: This name will be referred to in later calculations.

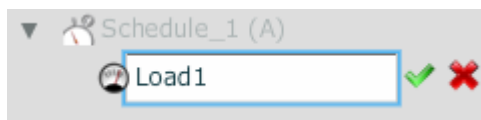


Figure 9 Naming the channel



c. In the view pane, click on “Select wiring” and select the wiring diagram that suit your bridge configuration

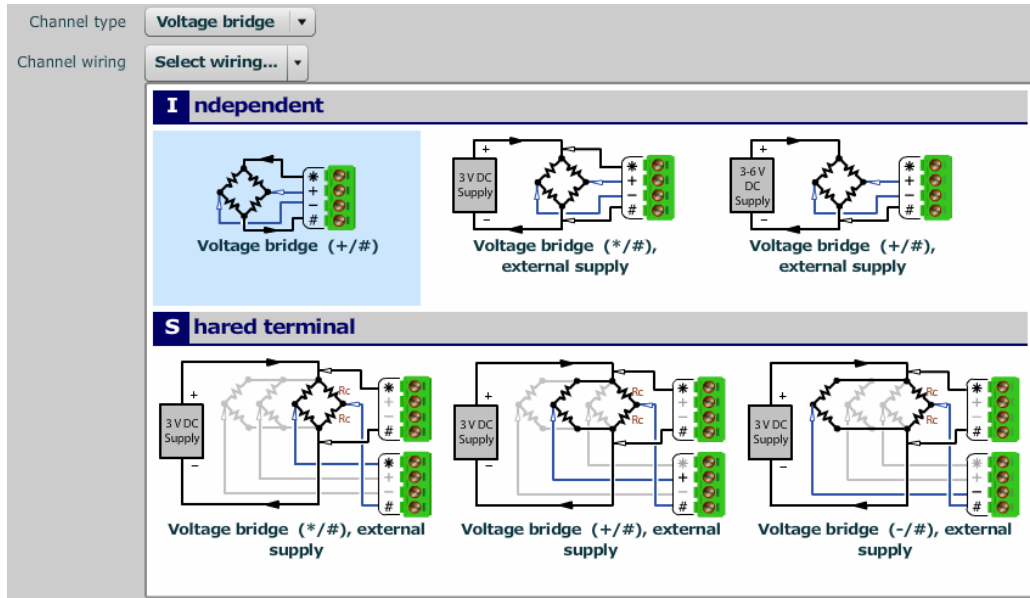


Figure 10 Selecting wiring type

d. In the view pane, click on the channel selector and select the analog channel number the vibrating wire sensor is physically connected to.

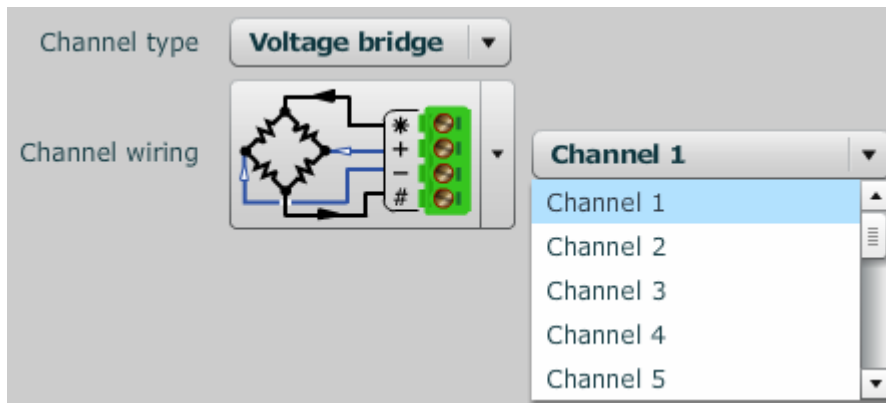


Figure 11 Selecting analog channel number



- e. To send the configuration to the logger, on the menu bar, Click on “File” -> “Save to logger”

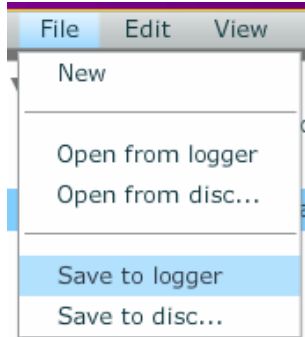


Figure 12 Sending configuration to logger

- 3. When using the *dEX* command window or *DeTransfer*.
  - a. Connect to the *DT80 series 2* data logger.
  - b. In the send window type the command *nBGV* for a 4 wire connection. Where *n* is the analog channel number the load cell is connected to. This will cause the *DT80* to take a single reading from the load cell.
  - c. Sample result will be returned to the receive window.



### Wheatstone bridge Support in detail

Because of its sensitivity, the Wheatstone bridge circuit is commonly used for the measurement of small changes in electrical resistance. Applications include load cells, pressure sensors and strain gauges.

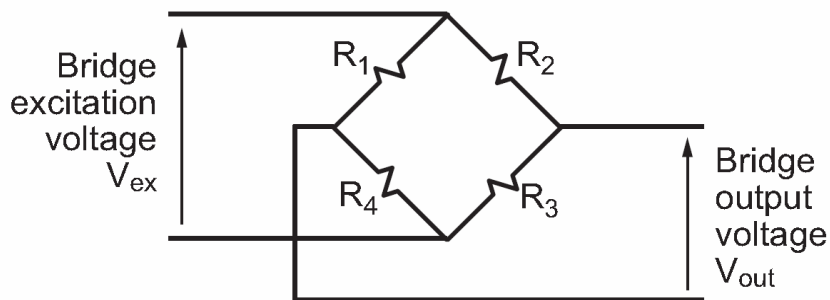


Figure 13 Wheatstone bridge

Bridges are designed such that when balanced the ratios  $R_1/R_4$  and  $R_2/R_3$  are equal, resulting in a zero output voltage ( $V_{out}$ ).

A small change to one or more of the resistances will then cause a corresponding change to  $V_{out}$ , which can then be measured accurately using the *DT80*'s sensitive 30mV input range.

When all four resistors in a bridge are active (sensitive to the quantity being measured with  $R_1$  and  $R_3$  experiencing resistance changes in the opposite magnitude to  $R_2$  and  $R_4$ ) the circuit is called a full bridge.

Wheatstone bridges are ratiometric, that is, the output ( $V_{out}$ ) is proportional to the excitation Voltage ( $V_{ex}$ ). The *DT80* returns all bridge measurements in a ratiometric form with units of parts per million (ppm)

$$ppm = \frac{V_{out}}{V_{ex}} \cdot 10^6$$

Figure 14 Calculation of ppm

### Conversion to engineering units

Sensors will be supplied with calibration certificates from the manufacturer. These often state the calibration in the format of milli Volts per Volt of excitation (mV/V). By definition mV/V are parts per thousand so to convert to ppm simply multiply by 1000. e.g If your calibration sheet has a calibration of 2.051 mV/V at full scale then the *DT80* will read 2051 ppm at full scale.

Conversion to engineering units can be done by using either a span or be using a calculation channel.





Load zero readings can be taken adding the channel to another schedule and polling this schedule at the point where the loads need to be zeroed then using a calculation channel to remove the zero readings in the reporting schedule.

**Grounding of cable shielding**

A shielded signal cable is recommended. Shielded wiring will reduce the potential risk of electrical noise. The preferred shield connection point is either one of the *DT80* digital ground (D GND) terminals, a case ground terminal strip or the ground point on either end of the *DT80* range end plates (Refer Fig 15.)



Figure 15 *DT80* range dataTaker showing grounding point (Silver screw)



## Programming the *DT80* data logger

### DeTransfer / *WEB UI* example

Enter the following *dataTaker* code into the send window of *DeTransfer* or the data logger WEB UI command send pane and send to the data logger.

Code example 1:

Current excitation with engineering units

```
BEGIN"Current"  
'Sample current excited bridge.  
S1=0,100,0,2051"kN"  
1BGI("Load 1 ppm",LM,=1CV,W)  
  
RA"Schedule_1"("b:",ALARMS:OV:100KB:W60,DATA:OV:1MB)5S  
LOGONA  
1BGI("Load 1 ppm",LM)  
CALC("Load 1~kN",LM)=S1("Load 1 ppm"-1CV)  
END
```