

DB101 Two-Channel Ethernet Thermocouple Data Logger Manual

Prepared by



WWW.DATABADGER.CO.UK

1 Contents

1	Contents.....	2
1.	Introduction	4
2.	Device Overview	5
1.1	Device Description	5
1.2	Device Specification	5
1.3	Package Contents.....	5
1.4	Operating Environment	6
1.5	Warranty	6
1.6	Support.....	6
1.7	Product Tailoring Service	6
3.	Getting Started.....	7
1.8	Requirements.....	7
1.9	Setup	7
4.	Device Configuration.....	10
1.10	DB101 Device Settings	10
4.1.	Data Refresh Rate.....	11
4.2.	Device Label	11
4.3.	Device Model	11
4.4.	MAC Address	11
4.5.	DHCP Enabled	11
4.6.	Device Status	12
4.7.	Reset to Factory Settings.....	12
4.8.	Reboot Device	12
5.	Data Configuration.....	13
5.1.	Calibration Points	13
5.2.	Calibration Mode	13
5.3.	Mains Frequency Filter	14
5.4.	Thermocouple Type	14
5.5.	Sample Averaging	14
5.6.	Channel Status	14
5.7.	Clear Calibration.....	15
6.	Data Calibration	16



1.11	No Calibration	16
1.12	One Point Calibration.....	16
1.13	Two Point Calibration.....	17
2	Support.....	18



1. Introduction

The DataBadger Thermocouple Data Logger is designed to allow easy access to accurate, high resolution temperature data from anywhere via either local network or the internet. Using the DataBadger BadgerView application simple measurement and data logging tasks can be performed without detailed knowledge of networking.

For those developing their own systems, DataBadger devices form an ideal sub-system, allowing the rapid development of distributed control systems and industrial automation. DataBadger devices do not require specialised interfaces or device drivers and so there is a minimal learning curve involved with system integration.

This manual provides a complete overview of the DataBadger Thermocouple Data Logger device along with some simple examples using the BadgerView application. A complete explanation of BadgerView can be found in the software manual.

2. Device Overview

2.1. Device Description

The DB101 two-channel thermocouple data logger allows high-resolution and accurate measurements of two thermocouples to be taken at the same time. The DB101 samples thermocouple data immediately from application of power and allows the latest measurements to be accessed via Ethernet. With some configuration, temperature information may be gathered remotely from anywhere.

Data logging may be performed using the DataBadger BadgerView application, which is free of charge for single device measurement. BadgerView allows the user to locate DataBadger devices on the local area network and sample data periodically. This data is displayed to the user and can be logged to a CSV file for later analysis. With a user license, BadgerView can log data from multiple devices simultaneously.

With a growing range of measurement and control devices, DataBadger aims to simplify the process of acquiring quality data and controlling systems for both industrial and scientific applications.

2.2. Device Specification

Table 1: DB101 device specification

Hardware	
Data channels per unit	2 thermocouple + 2 cold junction
Temperature accuracy	±0.15%
Temperature resolution	0.01 °C
Mains filter frequency	50 Hz or 60 Hz (selectable)
Thermocouples supported (1 type per unit)	K, J, N, S,E, T, R, and B
Internal sampling rate	10 Hz (all channels)
Operating ambient temperature	-20 °C to +80 °C
Operating relative humidity	5 % to 80 % non-condensing
Measurement temperature range	-250 °C to +1600 °C
Device Dimensions (LxWxH)	94.5 mm x 77.3 mm x 32.0 mm
Device weight	0.1 kg
Ingress protection	IP40
Connectors	2 x mini thermocouple 1 x 10/100 Ethernet 1 x 2.1 mm DC jack
Software	BadgerView is available free for use with a single device. See: www.databadger.co.uk/software

2.3. Package Contents

The shipping package of the DB101 should contain the following;



- DB101 two-channel thermocouple Ethernet data logger
- 5V DC power supply

2.4. Operating Environment

For best device performance it is advised that the DB101 device case be kept in a position of stable (or slow changing) temperature and away from rapid air movement. This allows the cold-junction to reach a constant temperature, which maximises the accuracy of the cold-junction compensation system and thus the data obtained.

2.5. Warranty

DataBadger provides a 12-month warranty from delivery of goods, unless otherwise stated. Goods provided by DataBadger shall be free from defects in materials or workmanship for this period under expected working and storage conditions.

DataBadger shall accept no responsibility for defects occurring as a result of misuse, negligence, deliberate actions, improper environmental conditions, contamination, reasonable wear & tear, and tampering.

DataBadger devices do not contain user serviceable parts and any attempt to repair, alter, or otherwise interfere with the device shall be considered tampering, unless done so at the request of DataBadger.

2.6. Support

DataBadger is continually adding to and improving the available range of hardware and software. We therefore suggest that the user visit our website's software section periodically to check for updates to the BadgerView application.

Technical support is available by contacting admin@atabadger.co.uk or via one of the contact forms on our website. DataBadger customer support is, and will always be free of charge for the lifetime of the device. We are committed to helping you get the best from our products.

2.7. Product Tailoring Service

Should you require features or systems which are not available in our current range of software or hardware, please contact us at admin@atabadger.co.uk. We offer a product tailoring and consulting service and can help you with your requirements. Common examples are devices with extra data channels, devices with mix type data channels, and bespoke measurement systems.

DataBadger product tailoring and consulting services are quoted on a per project basis.

3. Getting Started

This section will cover the most basic steps required to get the Thermocouple Data Logger running and log data to a file for later analysis. An exhaustive description of the BadgerView application can be found in the software manual. This manual will assume the reader has some familiarity with the application.

3.1. Requirements

In order to set up the DB101 for the first time, the user will require the following;

- DB101 logger unit
- 5V DC power supply shipped with the unit
- Ethernet cable
- Router configured for DHCP
- PC running Microsoft Windows with BadgerView installed

3.2. Setup



Figure 1: Thermocouple connector views

Figure 1 shows the back and front of Thermocouple Logger, showing two miniature thermocouple input connectors; in this case these are K-type inputs. The device is available with inputs configured for all the main types of thermocouple devices commonly available. Using the correct connector for the thermocouple type in use ensures best measurement accuracy by correctly matching thermocouple materials right to the cold junction.

The rear of the device features a 2.5 mm pin DC power jack for power supply connection, an Ethernet port, and a power LED. The Ethernet port has a green connection LED and an orange data LED.



In order to quickly get started with the device;

1. Connect an Ethernet cable to the 10/100 Ethernet port on the rear of the logger. Ethernet cable should also be connected to a network router configured with DHCP.
2. Connect the device power supply.
3. Connect a suitable thermocouple to one or both connectors on the front of the device.
4. After a few moments the red power LED and green Ethernet LED will illuminate.
5. Start the BadgerView application.

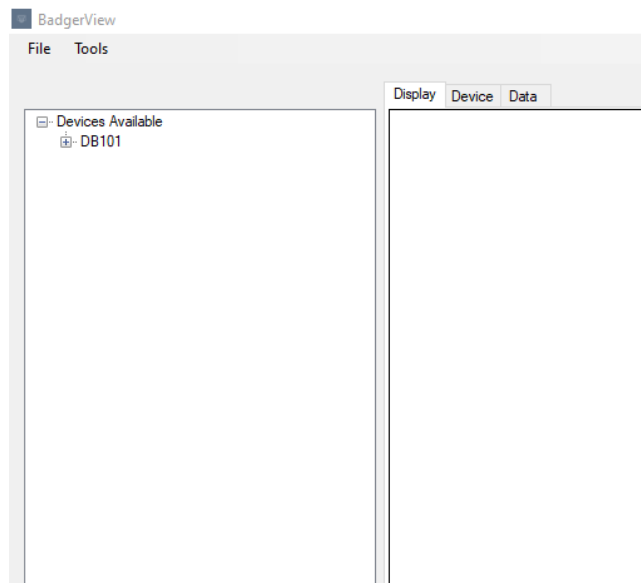


Figure 2: BadgerView device listing

6. On startup, BadgerView will scan the local network and populate devices identified into the list on the right. Figure 2 shows a thermocouple data logger (model number DB101) has been located. Devices also can be searched for manually by selecting Tool->Find Devices on the top bar.

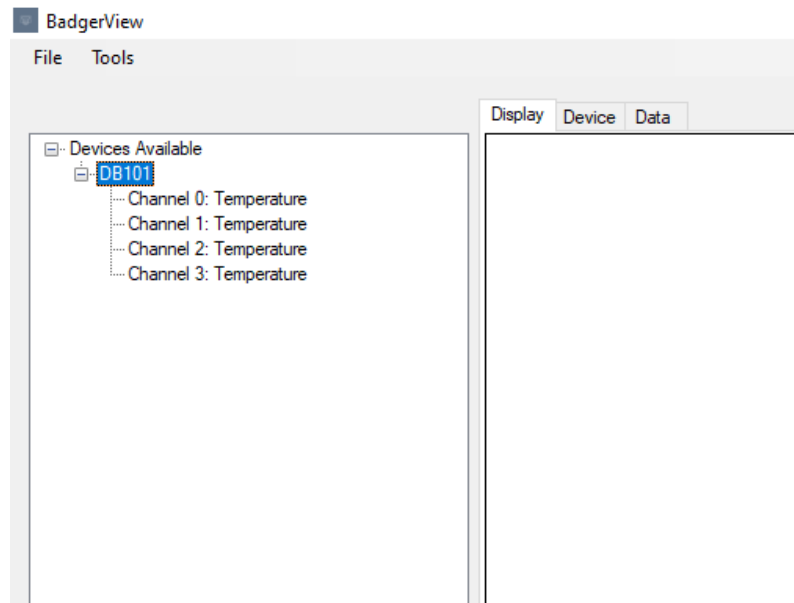


Figure 3: Data channels available

7. Left click the + symbol to the left of the device name to show the data channels associated with the device. Figure 3 shows that the DB101 device has four temperature measurement channels available. Channels 0 and 1 are thermocouple measurement channels and channels 2 and 3 are the device cold junction temperature for each thermocouple channel.
8. To view the data associated with any of the channel listed, right click the required channel and left click *Add*. The data will be displayed on the graph in the main panel, as shown in Figure 4. Repeat this step for each channel of data required.

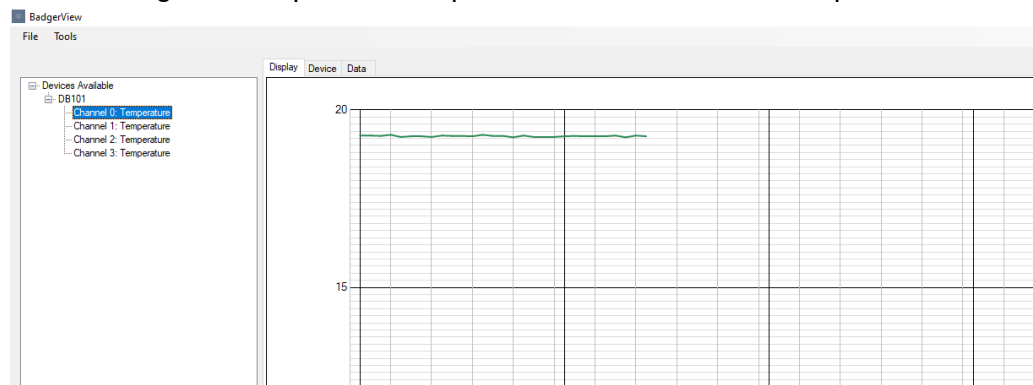


Figure 4: Displaying channel data

9. With the desired data displayed on the graph, the data may be logged to file via the toolbar menu. File->Log to file. A dialog menu will be displayed to allow the user to specify the directory/file in which to save the data. Please ensure that the user has the required privileges to write data to the location selected. The data is time stamped and saved into a CSV file, allowing easy data import to applications such as Microsoft Excel.

4. Device Configuration

Many users require configurations other than the default simple configurations provided by DataBadger logger devices. Therefore, a wide range of device settings are available through the device settings menu.

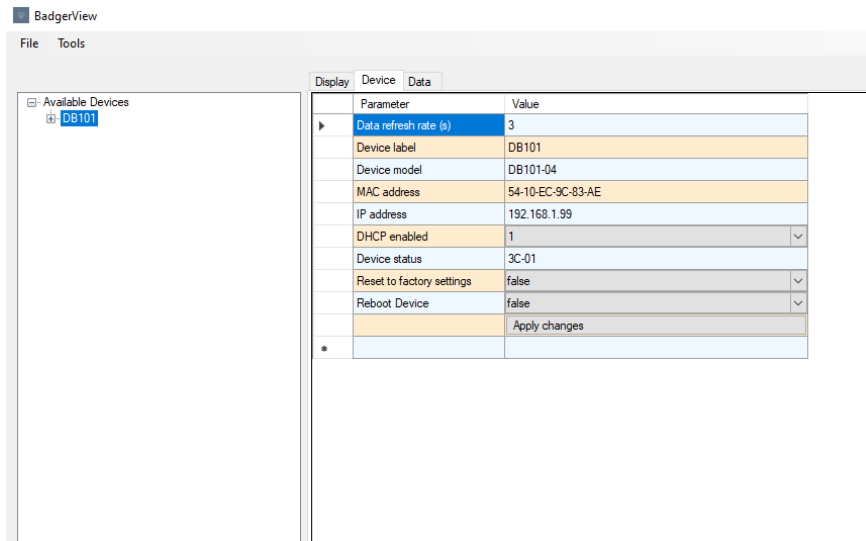


Figure 5: Device settings menu

To view the device settings, select the device in the tree view menu to the left of the BadgerView main GUI, as shown in Figure 5. Then select the device settings tab on the main panel. BadgerView will then query the selected device for the available settings and display them.

4.1. DB101 Device Settings

The device settings available to the DB101 thermocouple logger are given in Table 2 together with a summary of which may be modified by the user. Following any device reboot or power interruption, applied settings are retained by the device.

Table 2: DB101 device settings

Parameter	Default Value	Read/Write
Data refresh rate (ms)	N/A	R/W
Device label	DB101	R/W
Device model	DB101	R
MAC address	N/A	R
IP Address	Auto	R/W
DHCP enabled	1	R/W
Device status	N/A	R
Reset to factory settings	False	W
Reboot device	False	W

4.2. Data Refresh Rate

The data refresh rate is the period between each sample requested from the DataBadger devices added to the log. The specified refresh rate is a global value used in software for all devices and changing the value under one device will change it for all. The DB101 produces data internally far faster than is available via Ethernet. This data is used internally to feed items such as the mains filter and averaging systems. The maximum rate at which data can be acquired by a network system is likely to be <5 Hz but will depend upon network bandwidth available and contention as well as the number of devices and channels added to the log.

4.3. Device Label

When multiple devices of the same type are used on a network, it can become confusing which device is of interest to a user. Therefore, the device label can be modified to something meaningful to the user.

The device label can consist of up to 16 standard keyboard characters only. To modify this parameter, double-click the device label to enter editing mode. Modify the parameter as required and then click the *Apply changes* button at the bottom of the page. The parameter will be updated and the device page repopulated to confirm the new settings.

The device tree to the left of the main GUI will not be updated by applying changes on the device settings page.

4.4. Device Model

To aid in the identification of device function, the device model parameter displays the DataBadger logger model number and cannot be modified.

4.5. MAC Address

The device MAC address is a globally unique identifier used in networking to identify a particular device. The MAC address cannot be modified and is hardware specific.

4.6. DHCP Enabled

Dynamic Host Configuration Protocol (DHCP) is a network protocol whereby an IP address can be automatically assigned by a network router configured as a DHCP server. With DHCP enabled, the DataBadger logger will obtain IP addresses automatically from the network router.

In static mode, the device will use the IP address specified by the user. In order to use a static IP, double click the IP address entry and enter the desired IP address. Then select the 'DHCP enabled' drop down box and select 0. Left click *Apply changes* to confirm the new settings. The device will change settings and reboot with the new IP address.

To reset the device to use DHCP, simply change the *DHCP enabled* setting to 1.

In static mode the user must ensure that the device IP address is on the same subnet as other devices with which it is to communicate. Devices on different subnets are generally not visible to one another.

4.7. Device Status

The device status is debugging information which is used internally by DataBadger. In the event of any issues with the device, it is recommended that a record of the reported device status be made and reported to DataBadger.

4.8. Reset to Factory Settings

Requesting a reset to factory settings will revert the device settings to the default values given in Table 2.

To reset the device, change the reset to factory settings dropdown box to *true* and click *Apply changes*. The device will reboot with the device parameters reset.

The only parameters not to be reset by a factory reset are the data calibration settings. As data calibration is often a time consuming process, calibration should be preserved whenever possible. However, data calibration can be cleared via the data settings tab, should this be required.

4.9. Reboot Device

The reboot device performs a simple reset. No device settings are changed but the device will reset without the user having to physically reset the power. All device hardware will also be reinitialised.

To perform a device reboot, change the, 'Reboot device' dropdown box to *true* and click *Apply changes*.

5. Data Configuration

The data settings available to the DB101 thermocouple logger are given in Table 3. Any data configuration changes made to the device area retained between power cycles.

Table 3: DB101 data settings

Parameter	Default Value	Read/Write
Calibration point 1 (CH1)	0	R/W
Calibration point 2 (CH2)	0	R/W
Calibration point 1 (CH2)	0	R/W
Calibration point 2 (CH2)	0	R/W
Calibration mode	0	R/W
Mains frequency filter (Hz)	50	R/W
Thermocouple type	Module dependant	R
Sample averaging	8	R/W
Channel 1 status	00	R
Channel 2 status	00	R
Clear calibration	False	W

5.1. Calibration Points

Data calibration allows the removal of errors associated with the thermocouple in use. Although the DB101 uses thermocouple linearization, this process is based upon typical characteristics for the thermocouple type in use. Deviation from the corrected linear characteristic in gradient and offset can only be corrected using a two point calibration. The DB101 allows the user to enter up to two calibration points per channel, which are retained until the calibration is cleared manually.

Calibration point 1 for channel 1 & 2 should be of a lower temperature than calibration point 2. For maximum accuracy, it is advised that a new calibration is performed each time the thermocouple in use is changed. For most applications a single point or offset calibration should be sufficient.

Calibration is discussed further in chapter 6.

5.2. Calibration Mode

Calibration mode allows the user to select the calibration type to use. The options are;

0: No calibration is applied – cold-junction compensation and thermocouple linearization are always applied.

1: One-point or offset calibration is applied. This uses calibration point 1 for both channel 1 & 2 to compute an offset which is applied to all subsequent temperature readings.

2: Two-point calibration is applied. This uses calibration points 1 and 2 for channels 1 & 2 to compute gradient and offsets which are applied to all subsequent temperature readings.

5.3. Mains Frequency Filter

Though most power supplies provide filtering of the low voltage supply output, it is common to some residual mains frequency to remain in the DC voltage supplied to the measurement system. As the DB101 is a high resolution measurement device, any disturbance on the power supply voltage could propagate to the temperature reading. Therefore, the DB101 uses a high-performance notch filter to reject mains frequency. This filter is switchable between 50 Hz and 60Hz, allowing operation anywhere.

In order to set the filter, select the application mains frequency for the user location from the *Mains frequency filter* drop down box and left click *Apply settings*. The mains filter is immediately reinitialised to use the selected settings for all new measurements.

5.4. Thermocouple Type

The DB101 is pre-installed with the correct thermocouple connector which has conductor material matching that in the thermocouple in use. Correct matching of thermocouple materials prevents the creation of parasitic cold-junctions and thus maximises the accuracy of temperature data measured. As the user may have multiple DB101 units present on the network, the thermocouple type readout helps to positively identify which unit is being viewed.

5.5. Sample Averaging

As part of the noise reduction process, the DB101 is capable of performing internal measurement averaging on each channel. Increased sample averaging acts to produce smoother output data but slightly reduces the speed at which the unit can respond to temperature changes. The minimum resultant thermocouple response times for each averaging level are given in Table 4.

Table 4: Sample averaging level resultant response time

Averaging	50 Hz mains filter	60 Hz mains filter
1	98 ms	82 ms
2	118 ms	98.67 ms
4	158 ms	132.01 ms
8	238 ms	198.69 ms
16	398 ms	332.05 ms

The averaging level may be set by selecting the desired averaging level from the *Sample averaging* drop down box and left clicking the *Apply settings* button at the bottom of the page. The measurement system is immediately reinitialised with the new averaging level applied.

5.6. Channel Status

The channel status readouts provide diagnostic information about the state of the measurement system and allow the user to diagnose setup issues which will affect the temperature measurement data. The status readout is a hexadecimal representation of the bits given in Table 5. Some of the information is used internally by DataBadger to aid in error diagnosis.

Table 5: Channel status diagnostic information

Bit	Description
7	1: Cold-junction out of range 0: Cold-junction performance normal (default)
6	1: Thermocouple outside of operating range 0: Thermocouple performance normal (default)
5	N/A – Used for internal diagnostics only
4	N/A – Used for internal diagnostics only
3	N/A – Used for internal diagnostics only
2	N/A – Used for internal diagnostics only
1	1: Input voltage error 0: Input voltage normal (default)
0	1: Thermocouple is open circuit – Check connection and thermocouple wiring 0: Thermocouple normal (default)

5.7. Clear Calibration

In order to clear the current data calibration, select *true* in the, *Clear calibration* drop down box and left click *Apply changes* at the bottom of the page. All data calibration values and the calibration mode are reset to 0.

When resetting the device to factory settings, the calibration values are not cleared. This is because calibration is often a time consuming and expensive process and so calibration is retained unless the user explicitly clears this setting.

6. Data Calibration

As mentioned in Chapter 5, the DB101 allows the user to perform calibration to further improve system accuracy performance. This chapter will discuss thermocouple data calibration in more detail. The DB101 automatically performs thermocouple characteristic linearization and cold-junction compensation and so, in most applications, further calibration is not required.

When the best thermocouple accuracy is required, it is advised that calibration is performed. The DB101 offers three on-board calibration modes which will be discussed further.

6.1. No Calibration

With no calibration applied, the DB101 device outputs data following application of cold-junction compensation and thermocouple linearization. In this mode the system is expected to achieve an accuracy of $\pm 0.15\%$ in optimum conditions.

All calibrations discussed in this chapter rely on the use of a reference to accurately determine the temperature of the calibration medium. For maximum accuracy, calibration will need to be performed each time a thermocouple is changed as the calculated parameters relate only to a single thermocouple/device combination. Calibration should also be repeated periodically as thermocouple characteristics change as the device ages.

6.2. One Point Calibration

One point calibration uses a single calibration point (per channel) to compute an offset which is applied to subsequent measurement to correct of linear offsets in measurement data. Such offsets can occur due to thermocouple extension cables used, for example, to allow measurements to be taken within machinery. This extra resistance introduced by these cables can reduce the current following due to the thermoelectric effect, causing a perceived temperature offset. Applications reliant upon high accuracy temperature information (e.g. control of chemical reactions) may be adversely affected by this. Therefore, the DB101 allows the removal of such offsets through a one point calibration.

It is advised that a single point calibration is carried out within the temperature range at this measurement data is to be acquired.

To perform the one point calibration;

- 1.) Place the DB101 thermocouples and reference measurement sensor into a suitable measurement medium (E.g. water, or a thermal block). Try to keep all the temperature sensors as physically close together as possible to minimise error due to temperature variation in the medium.
- 2.) Heat/cool the medium to the desired working temperature and allow to fully stabilise. This is usually done by monitoring the DB101 channel until the graph shows the medium temperature to be stable.
- 3.) Take a reading from the reference device and enter this reading into the *Calibration point 1* entries for channels 1 & 2.

- 4.) Left click *Apply changes* at the bottom of the data settings page. This saves the calibration reading to the DB101 along with the current thermocouple readings. Offset values for channel 1 and channel 2 are computed and saved.
- 5.) To apply this calibration, click the calibration mode drop down box and select mode 1. Left click *Apply changes*. All new DB101 measurements will now include one point calibration correction.

6.3. Two Point Calibration

A two point calibration allows the user to correct both the offset and the gradient of the thermocouple characteristic. This provides the greatest accuracy possible with the DB101 measurement system and provides the best correction for aging thermocouples and those using long extension cables.

To perform a two point calibration;

- 1.) Place the DB101 thermocouples and reference measurement sensor into a suitable measurement medium (E.g. water, or a thermal block). Try to keep all the temperature sensors as physically close together as possible to minimise error due to temperature variation in the medium.
- 2.) Heat/cool the medium to the lowest temperature in the expected working range and allow to fully stabilise. This is usually done by monitoring the DB101 channel until the graph shows the medium temperature to be stable.
- 3.) Take a reading from the reference device and enter into the *Calibration point 1* entries for channels 1 & 2.
- 4.) Heat the measurement medium to the highest expected temperature in the working range and allow to stabilise.
- 5.) Take a reading from the reference device and enter into the *Calibration point 2* entries for channels 1 & 2.
- 6.) Left click *Apply changes* at the bottom of the data settings page. This saves the calibration readings to the DB101 along with the current thermocouple readings. Offset and gradient values are for channel 1 and channel 2 are computed and saved.
- 7.) To apply this calibration, click the calibration mode drop down box and select mode 2. Left click *Apply changes*. All new DB101 measurements will now include two point calibration correction.



2 Support

For any support or sales queries please contact admin@atabadger.co.uk