DBK16   2-Channel Strain-Gage Card

Reference Notes:

- o Chapter 2 includes pinouts for P1, P2, P3, and P4. Refer to pinouts applicable to your system, as needed.

- o In regard to calculating system power requirements, refer to *DBK Basics* located near the front of this manual.

Overview

The DBK16 will condition signals from most types of bridge circuit configuration transducers that have a signal output of less than 50 mV. Strain gages and load cells are common types of these transducers. For half- and quarter-bridge strain gages, the DBK16 can accommodate user-supplied bridge completion resistors that complete the bridge circuit.

The bridge circuit must be complete for the DBK16 to operate correctly.

Each channel of the DBK16 offers a selectable 3-pole, low-pass filter with a user-set cut-off frequency. Up to 8 DBK16 boards can be connected to each of 16 analog LogBook or Daq device base channels for a maximum of 256 input signals. Remote-sense terminals are used with 6-wire Kelvin connections.

The DBK16 provides an amplifier gain range of ×100 to ×12,500 for use with strain gages having 0.4 to 10 mV/V sensitivities. Most strain gages are specified for a full-scale value of weight, force, tension, pressure, or deflection with an output of mV/V of excitation. For example, a strain gage with a full-scale rating of 1000 lb of tension might output 2 mV/V of excitation at full load. With an excitation of 10 VDC, 1000 pounds of load would produce an output of 20 mV.

The card's 0 to 5 VDC offset and output-scaling permit nulling of large quiescent (inactive or motionless) loads and expansion of the dynamic range for maximum resolution. Typically, the quiescent output is non-zero. Prior to a force being applied, a mounted strain gage can be in a state of partial deflection resulting in an output. In the case of a tension gage, this output may be due to the weight of a hook or empty container.

DBK16 Block Diagram
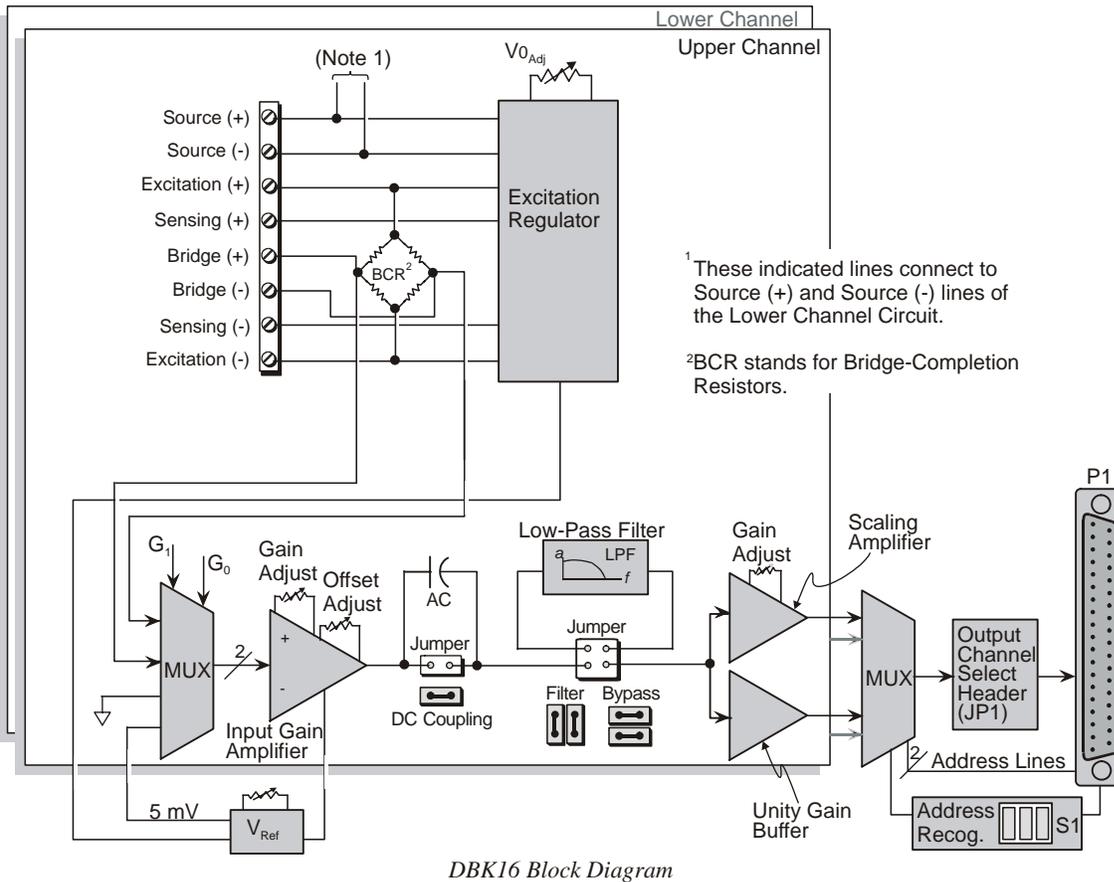
A wide-range excitation regulator is adjustable from 1.5 to 10.5 VDC with a current limit of 50 mA. The DBK16 requires a 12 to 15 VDC external excitation voltage that can be supplied from the DBK30A battery module or other user-supplied source.

Hardware Setup

| CAUTION |
|---|
| Each regulator has a maximum current of 50 mA. The maximum amount of excitation that can be provided by the DBK16 excitation regulator is represented by the following equation: $$V_{EXC[MAX]} = 0.05 \times R_{GAGE}$$ Where R_{GAGE} = the resistance of 1 element in the bridge circuit. **Exceeding the maximum allowed excitation can cause the DBK16 to fail.** |

Card Connection

For DBK16s, the strain gage is configured as a 4-element bridge. There are 4 legs in a bridge circuit; the *quarter, half* or *full* designation refers to how many elements in the bridge are strain-variable. A quarter bridge has 1 strain-variable element; a half bridge has 2; and a full bridge has 4. Each DBK16 channel has locations for bridge completion resistors. These resistors of fixed values are necessary to fill out the bridge configuration.

In the following diagram, a 4-element bridge-type strain gage is referenced to the upper and lower channel bridge completion resistor designations for the DBK16.

Bridge resistors are used in either the DBK16 or the strain gage, but not in both at the same time.

Locations of Bridge-Completion Resistors (Internal)
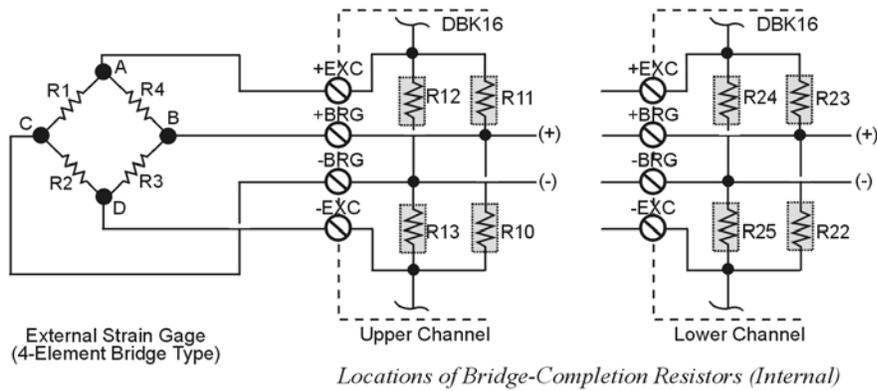
Connections are provided for Kelvin-type excitation. The excitation regulators stabilize the voltage at the points connected to the on-board sampling dividers. Unless you run separate sense leads to the excitation terminals of the strain gage, the voltage regulation is most accurate at the terminal blocks on the DBK16. In a Kelvin-type connection, six wires run to a 4-element strain gage, and the excitation regulation is optimized at the strain gage rather than at the terminal blocks. For high accuracy, this can be a worthwhile connection for as little as 10 feet of 22 gauge lead wire.

Kelvin Excitation Leads

Full Bridge, Resistor Configuration for DBK16
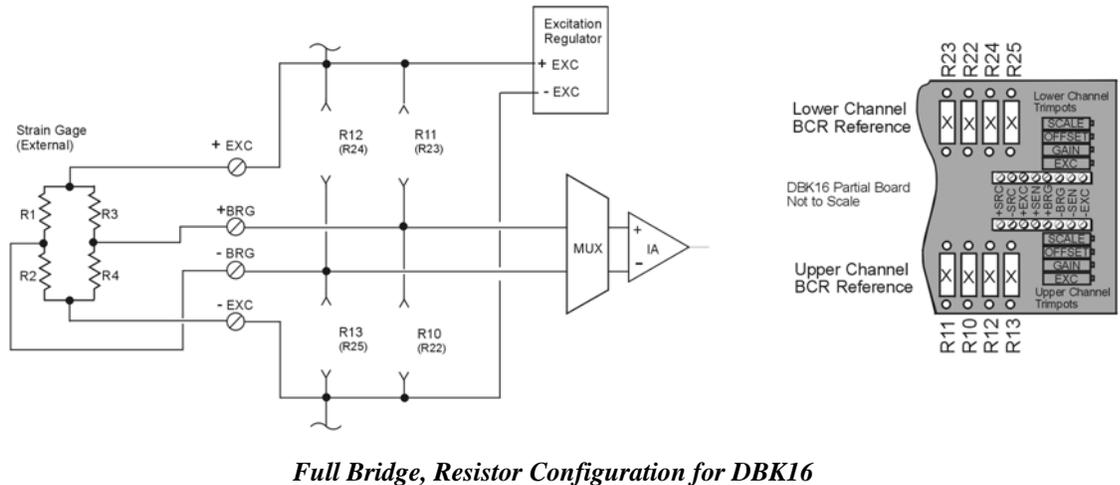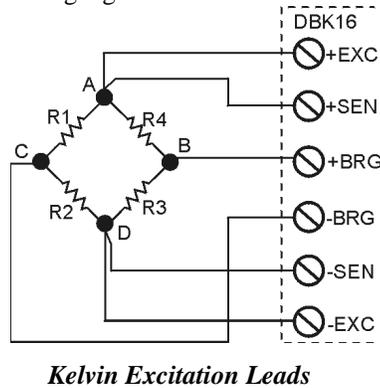
The full bridge configuration makes use of all four elements of the strain gage. When using a full bridge external strain gage (all four elements), the following applies to the DBK16 on board resistor configuration:

Upper Channel – R10, R11, R12, and R13 are not installed.

Lower Channel – R22, R23, R24, and R25 are not installed.
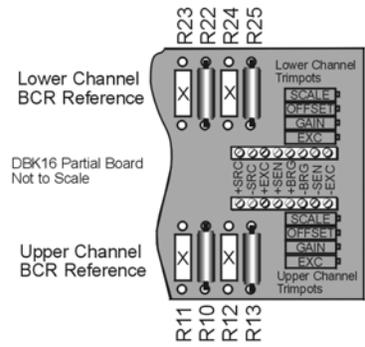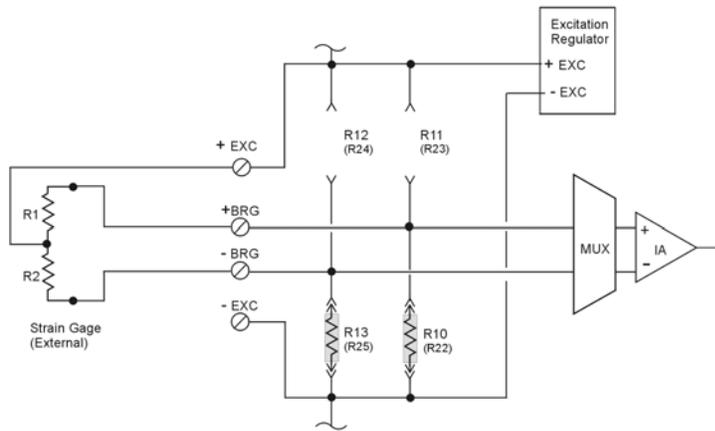
Half Bridge, **(** $\Delta R1\downarrow$ and $\Delta R2\uparrow$ **)** $\Rightarrow \Delta E_{OUT}\uparrow$ **)**
*Resistor Configuration for DBK16*

The half bridge configuration makes use of two elements of the strain gage. When using a half bridge external strain gage (two of four elements), the following applies to the DBK16 on board resistor configuration:

Upper Channel – R10 and R13 are to be installed.

Lower Channel – R22 and R25 are to be installed.

Note that other Half Bridge scenarios exist. The one illustrated applies to the equation:

$\Delta R1\downarrow$ and $\Delta R2\uparrow$ **)** $\Rightarrow \Delta E_{OUT}\uparrow$
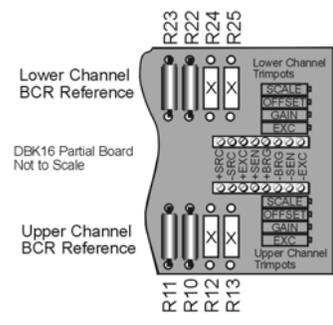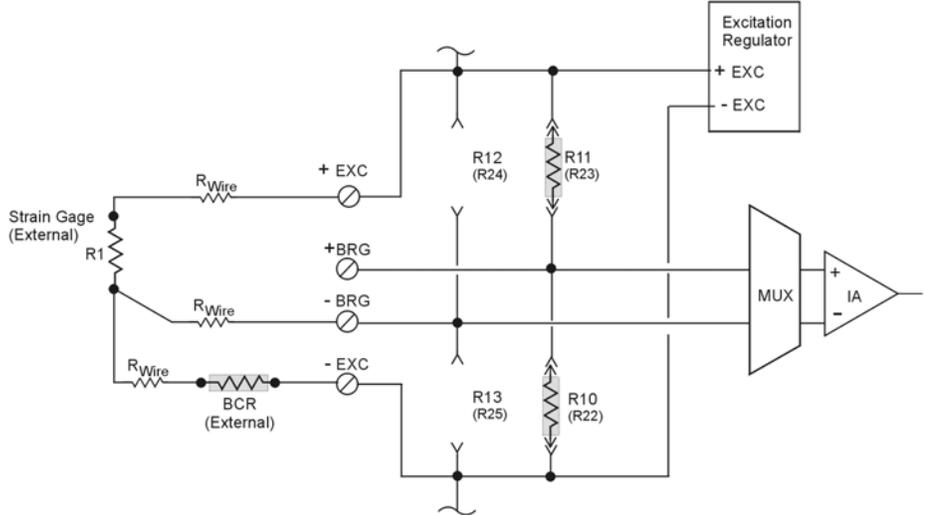
3-Wire, Quarter-Bridge, Negative ($\Delta R\uparrow \Rightarrow \Delta E_{OUT}\uparrow$ *) for DBK16*

The quarter-bridge configuration makes use of one element of the strain gage. The three-wire, quarter-bridge can be configured as "positive" or "negative." The above figure represents the negative (minus) configuration. In this setup, the magnitude of voltage out is directly proportional to the change in resistance ($\Delta R\uparrow \Rightarrow \Delta E_{OUT}\uparrow$). When using a quarter-bridge external strain gage in the "negative" configuration, the following applies:

Upper Channel – R10 and R11 are to be installed.
Lower Channel – R22 and R23 are to be installed.
An external BCR is to be placed in the –EXC to R1 line (see previous figure).
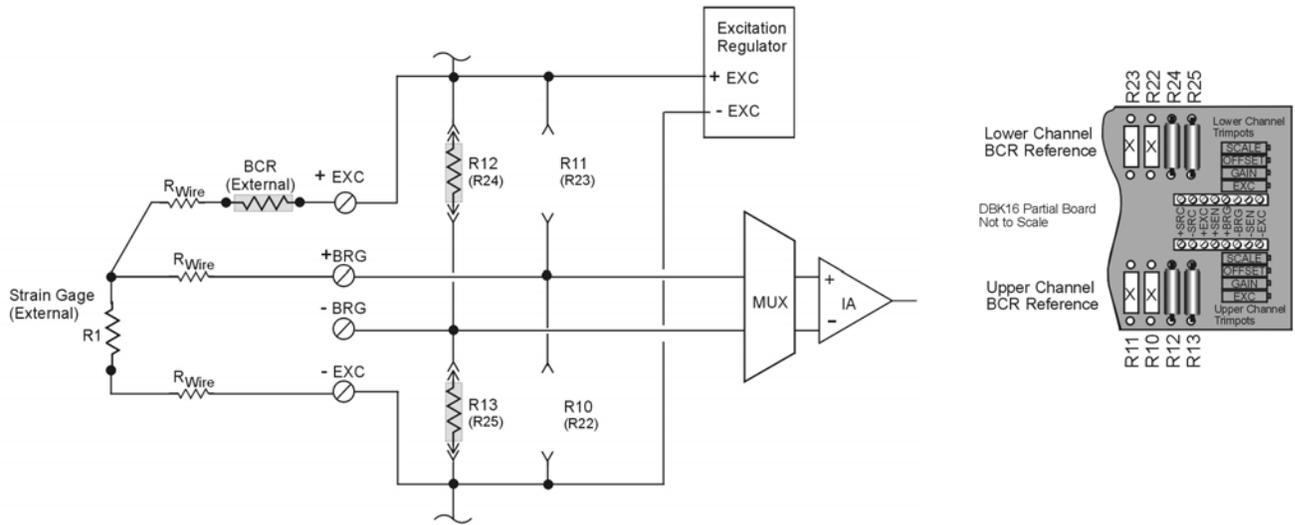
3-Wire, Quarter-Bridge, Positive ($\Delta R\downarrow \Rightarrow \Delta E_{OUT}\uparrow$) for DBK16

The quarter-bridge configuration makes use of one element of the strain gage. The three-wire, quarter-bridge can be configured as "positive" or "negative." The above figure represents the positive (plus) configuration. In this setup, the magnitude of voltage out is inversely proportional to the change in resistance ($\Delta R\downarrow \Rightarrow \Delta E_{OUT}\uparrow$). When using a quarter-bridge external strain gage in the "positive" configuration, the following applies:

Upper Channel – R12 and R13 are to be installed.
Lower Channel – R24 and R25 are to be installed.
An external BCR is to be placed in the +EXC to R1 line (see previous figure).

Excitation

To supply excitation voltage to a single DBK16:
Connect J1 (terminals SRC+ and SRC-) to a source of filtered (not necessarily regulated) DC between 12 and 15 V.

To supply excitation to multiple DBK16s:

1. Connect J1 (terminals SRC+ and SRC-) to a source of filtered (not necessarily regulated) DC between 12 and 15 V.

2. Connect J2 of the powered DBK16 to J1 of the next DBK16 (see figure). The excitation power terminals are wired in parallel to *daisy-chain* multiple DBK16s (in systems with more than 2 transducers).

Connecting Multiple DBK16s
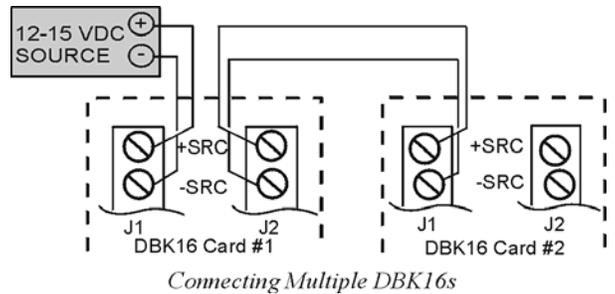
The user-supplied excitation source is attached to a voltage regulator in the DBK16 circuitry. This regulator provides the excitation to the actual transducer (there is a separate regulator for each transducer, hence two regulators per DBK16). Each regulator has a maximum current of 50 mA. The maximum amount of excitation that can be provided by the DBK16 excitation regulator is represented by the following equation:

$$\mathbf{V_{EXC[MAX]} = 0.05 \times R_{GAGE}}$$

Where R_{GAGE} = the resistance of 1 element in the bridge circuit.

The user-supplied excitation source should provide adequate current levels for all the DBK16s that are powered. The minimum current required for the user-supplied excitation source for each transducer (2 per DBK16) is:

$$I_{MIN} = \text{Excitation voltage}/R + 5\text{ mA}$$ (where R = the resistance of 1 element in the bridge circuit)

The user-supplied excitation source must be 12 to 15 VDC and connected with the proper polarity.

Enhanced DBK16 cards contain two additional jumpers (JP6 and JP7). Their configuration determines whether the channel excitation regulator's power source is *external* (default) or *internal*. Review the following **note** and **CAUTION** prior to selecting the *internal power source*.

- **JP6 – Selects the upper channel's source. Default is *external*.**
- **JP7 – Selects the lower channel's source. Default is *external*.**

> **It is possible to power excitation regulators from an internal +15 V on the LogBook's or Daq device's P1 if no other DBKs are being used. On enhanced DBK16 cards, two 3-pin headers (JP6 for upper channel and JP7 for lower channel) are set by default to use an *external* power source. Moving the jumpers to the *internal* position connects the excitation terminals to the +15 VDC rail from P1.**

CAUTION

Avoid overloading LogBook's , DaqBook's or DaqBoard's +15 VDC power supply. The power supply can be overloaded if DBK16 jumpers JP6 and/or JP7 are set to "Internal" and one or more of the following conditions exist:

- **Additional DBKs are being used.**
- **120 Ω bridge-completion resistors are being used in the strain gage configuration.**

Card Configuration

Factory Defaults:

- **Bridge configuration – Full**
- **Coupling – DC**
- **Excitation source – External**
- **Low pass filter – Disabled (by-passed)**
  The cutoff frequency, if enabled, has a default of 3.7 Hz. This is obtained using 100kΩ resistors for R17, R18, and R19 for the lower channel; and using 100kΩ resistors for R5, R6, and R7 for the upper channel. See the following board layout for resistor locations.

The next few sections of this document module explain the following aspects of configuring DBK16.

- AC Coupling and Low-Pass Filter Options
- Channel and Card Address Selection
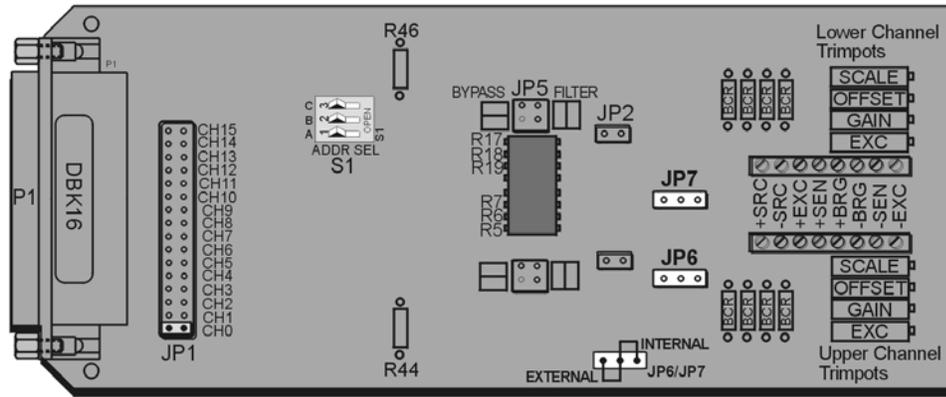
DBK16 Board Layout

AC Coupling, DC Coupling, and Low-Pass Filter Options

Headers on the board accommodate the coupling and low-pass filter options and the output channel selection (see above figure). Resistors can be removed to lower filter gain from ×2 to ×1. A filter frequency determining resistor network can be inserted into an IC socket.

The **AC or DC coupling** choice (on each channel) is set by the presence or absence of a **shunt jumper** on a two-pin header. If the shunt jumper is in place, the coupling is DC. If the shunt jumper is absent, the coupling is AC. **JP3** is used to configure the upper channel's coupling; **JP2** is used to configure the lower channel.

The choice of **using or bypassing the low-pass filter** (for each channel) is made by the orientation of shunt jumpers on a 2×2-pin header. When the shunt jumpers are oriented in the same way as the "bypass" symbol (horizontal, parallel with labels on card), the filter is bypassed. When the shunt jumpers are oriented in the same way as the "filter" symbol (vertical), the filter is in the signal path. **JP4** is used to configure the upper channel; **JP5** is used to configure the lower channel.

The **corner frequency of the low-pass filters** is determined by three resistor values in each filter circuit. Located in the center of the card, the *lower channel resistors* are **R17-R18-R19**; and the *upper channel resistors* are **R5-R6-R7**. These resistor locations are arranged to allow the use of an 8-position DIP network (as a convenient means of changing all 6 resistors at once). The machined-pin socket allows you to insert individual resistors (should the two filter sections have different corner frequencies). The table to the right lists common frequencies, nominal resistance values, and Bourns part numbers.

Frequency	Resistance (Ω)	Bourns Part Number
37Khz	10	4116R-001-100
19Khz	20	4116R-001-200
7Khz	50	4116R-001-500
3.7Khz	100	4116R-001-101
1.9Khz	200	4116R-001-201
700Hz	500	4116R-001-501
370Hz	1K	4116R-001-102
190Hz	2K	4116R-001-202
70Hz	5K	4116R-001-502
37Hz	10K	4116R-001-103
19Hz	20K	4116R-001-203
7Hz	50K	4116R-001-503
3.7Hz	100K	4116R-001-104

Note: Due to settling time, the filter should not be enabled during the DBK16 setup.

DBK16's *active* **low-pass filters have an inherent gain of ×2. You must factor this gain into your setup calculations. To change the gain to ×1, remove the following 10 KΩ resistors: R44 for the upper channel, R46 for the lower channel.**

Reference Note: Methods of calibrating DBK16 are discussed in the calibration section.

Channel and Card Address Selection

The lower and upper channels on the DBK16 are multiplexed into one of the channels (0 to 15). The base channel (that the DBK16 is multiplexed into) is set by the shunt jumper on the 16×2 header designated **JP1** (see previous figure, DBK16 Board Layout).

Each base channel can have up to 16 expansion channels multiplexed into it. Since the DBK16 represents two expansion channels, eight DBK16 cards can be multiplexed into each base channel. To distinguish channels, there is a card address bank of three switches on each DBK16. These switches are binary-weighted with eight possibilities (0-7).

Base Channel	First Expansion Channel Number (N)
0	16
1	32
2	48
3	64
4	80
5	96
6	112
7	128
8	144
9	160
10	176
11	192
12	208
13	224
14	240
15	256

DIP Switch Setting			Card Channels (n)	
C	B	A	Upper	Lower
Open	Open	Open	1	0
Open	Open	Closed	3	2
Open	Closed	Open	5	4
Open	Closed	Closed	7	6
Closed	Open	Open	9	8
Closed	Open	Closed	11	10
Closed	Closed	Open	13	12
Closed	Closed	Closed	15	14

The switch settings are: **open = 0, closed = 1 (enabled).** The weights (when closed) are: **A = 1, B = 2, C = 4**. The table above shows the switch settings. The table to the right lists card channels (n) with respect to the base channel.

Since the LogBook or the Daq device has sixteen base channels, up to 128 DBK16s can be used, providing a maximum of 256 channels. To keep track of all base and expansion channels, the base channels are designated 0 to 15 and the expansion channels are designated 16 to 271. Channel 16 is the first channel on the first expansion board (lower channel on card address 0 with JP1 set to CH0). Channel 271 is the last channel on the last expansion board (upper channel on card address 7 with JP1 set to CH15).

To calculate the actual input channel, use the above tables and add the applicable "N" and "n." The result is the expansion channel number. This number is needed when writing a program to read from that particular channel. For more information on multiplexing, refer to the *Signal Management* chapter.

Calibrating DBK16 for Daq Devices

Reference Note:
This section covers calibrating a DBK16 that is being used in a Daq device application.
LogBook users: refer to Calibrating DBK16 and DBK43A for LogBook, which begins on page 15.

Bridge circuit transducers are used for many different applications, and the DBK16 is flexible enough to support most of them. Each DBK16 channel circuit has an excitation regulator, a high gain (100-1250) input amplifier with offset adjustment, a low-pass filter, a scaling (1-10) amplifier, and a calibration multiplexer.

There are 4 trimpots to set up each channel circuit. The trimpots are labeled to represent the following adjustments:

> **EXC**   for adjusting the Excitation Voltage to the transducer
>
> **GAIN**   for setting the gain of the input amplifier
>
> **OFFSET** for adjusting the circuit offset for quiescent loads or bridge imbalance
>
> **SCALE**   for setting the gain of the scaling amplifier

Proper setup includes the use of software commands that control the calibration multiplexer in each circuit. The calibration multiplexer is used to switch the bridge circuit out and apply reference voltages to the input for use in the DBK16 setup. The calibration multiplexer also allows the Daq device to record the individual adjustments. The next table shows the setup commands, their binary codes, and a description of their function. These commands are accessible through DaqView and the Daq device driver as gain settings and through most third party software support as well as GageCal.

Setup Command	Code	Description
Dbk16ReadBridge	00	Reads bridge circuit with all gains and offsets included (normal operation)
Dbk16SetOffset	01	Applies a grounded input and allows the user to read the circuit offset voltage multiplied by the input amplifier and the low-pass filter gain.
Dbk16SetScalingGain	10	Applies 5 mV to the input and allows the user to read the voltage out of the circuit through the input gain amplifier, the low-pass filter* and the scaling gain amplifier.
Dbk16SetInputGain	11	Applies 5 mV to the input and allows the user to read the voltage out of the circuit through the input gain amplifier and low-pass filter only.

The following equations represent the voltage recorded by the Daq device when the calibration mux is set in 1 of 4 possible settings.

Code	Equation
00	Vout = (Scaling Gain)(Filter Gain*)[(InputGain)(bridge circuit voltage) - offset voltage]
01	Vout = (Filter Gain*)(Input Gain)(-offset voltage)
10	Vout = Filter Gain*(Scaling Gain[(Input Gain)(5 mV) - offset voltage])
11	Vout = (Filter Gain*)(Input Gain)(5 mV) - offset voltage
	Asterisk (*) implies the filter is enabled.

A typical setup procedure is as follows:

1. Disable the low-pass filters (JP4 and/or JP5) and set DC coupling (install JP2 and/or JP3) for all the channels that are being setup. If you plan on using the filter during your acquisition, take note of the gain in the filter stage (default ×2, or ×1 with resistor removed) and allow for it in your setup.

2. Determine what the excitation for the transducer will be from the transducer specifications and the current limitations of the DBK16 excitation regulator.

3. Determine what the maximum voltage will be from the transducer at maximum load or strain, and calculate what the DBK16 channel total gain should be based on a full-scale Daq device (-5 V to +5 V for DaqBook and DaqBoard [ISA type] in bipolar mode; 0 to +10 V for DaqBook [/100 & /200], DaqBoard [ISA type] and DaqBoard/2000 in unipolar mode; -10 to +10 V for DaqBoard/2000 in bipolar mode and Daq PC-Card). (See examples on page 12.)

4. Determine how the total gain will be distributed between input amplifier gain, filter gain and scaling amplifier gain. (See examples on page 12.)

5. Hook up the transducer to the terminal strips labeled Lower or Upper according to the figures in the *Card Connection* section. Install the appropriate bridge completion resistors if applicable.

6. Set the excitation voltage for the transducer by adjusting the trimpot labeled EXC and measuring the voltage with a voltmeter across the +EXC and -EXC terminals on the DBK16.

7. Send the DBK16SetOffset command (usually through a gain setting in the software support). Adjust the OFFSET trimpot for a reading of 0.00 volts. This removes all offset from the DBK16 channel circuit.

8. Send the DBK16SetInputGain command (usually through a gain setting in the software support). Adjust the GAIN trimpot for a voltage reading equal to (.005)(the desired input amplifier gain).

9. Send the DBK16SetScalingGain command (usually through a gain setting in the software). Adjust the SCALE trimpot for a voltage reading equal to (.005)(the desired input amplifier gain)(the desired scaling amplifier gain).

10. Send the DBK16 ReadBridge command (default). With the quiescent (normal or inactive) load or strain applied, adjust the OFFSET trimpot for a reading of 0.00 volts. This adds offset to the circuit to compensate for the quiescent load and allows maximum resolution for the measurement.

11. Enable the low-pass filter and/or AC coupling if required for your application.

12. From the transducer specifications and the total gain of the DBK16 channel, calculate the Daq device voltage/transducer units and apply it to your Daq device voltage readings through software.

13. Apply a known load or strain and verify the DBK16 and software settings.

Set-Up Notes:

- The offset adjustment is unipolar 0 to 5 V on the input amplifier output. If the offset can not be adjusted to 0.00 V at the end of the setup procedure, try swapping the +BRG and -BRG wire connections or dropping the input gain and increasing the scaling gain.

- For very high system gains, the Scaling Gain might have to be set first with the Input Gain low and then set the Input Gain (the Daq device can only measure up to 10 V).

DaqBook/100 Series & /200 Series and DaqBoard [ISA type] Configuration

Use of the DBK16 requires setting jumpers in DaqBooks/100 Series & /200 Series device and DaqBoards [ISA type].

1. If not using auxiliary power, place the JP1 jumper in the expanded analog mode.

Note: This default position is necessary to power the interface circuitry of the DBK16 via the internal ±15 VDC power supply. If using auxiliary power (e.g., a DBK32A or DBK33), you must remove both JP1 jumpers (refer to *Power Management* in the *DBK Basics* section and to the DBK32A or DBK33 sections as applicable.

2. For DaqBook/100, DaqBook /112 and DaqBook /120 *only*, place the JP4 jumper in *single-ended* mode.
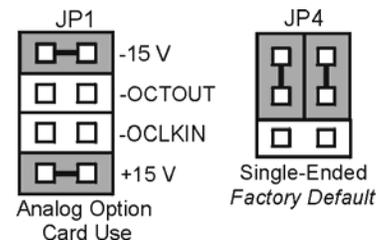
Configuration Jumpers

DaqBook/2000 and DaqBoard/2000 Series Configuration

No jumper configurations are required for these 2000 series devices.

Software Setup

Reference Notes:
- o **DaqView users** - Refer to chapter 3, *DBK Setup in DaqView*.
- o **LogView users** - Refer to chapter 4, *DBK Setup in LogView*.

GageCal Program

GageCal is not used for LogBook applications.

Note: GageCal is best suited for a load cell application

To install the GageCal program on your computer, close all other programs and run SETUP.EXE on Disk 1 (or CD-ROM, as applicable) from Windows 3.1, 3.11, or Windows 95/98/Me. Follow the installation instructions from the setup program.

Execute GAGECAL.EXE from a Windows environment to start the program. The first screen that appears will set up the Daq device interface. Input the correct Daq device interface information and click OK. If the program does not detect the Daq device, please check connections and try again or refer to the troubleshooting tips in the *Troubleshooting Tips* chapter.

Through GageCal, DBK16 channels can be configured and calibrated as needed. The typical procedure for using GageCal with a DBK16 is as follows:

1. Highlight the expansion channel number you want to configure and calibrate. Notice the channel numbers are listed 16 to 271 with respect to the Daq device (if necessary, see the section entitled, *Channel and Card Address Selection*).

2. Click on the CONFIGURE button. Setup and verify your hardware setting with the diagram on the screen. Please note that the coupling must be set to DC and the filter must be disabled to calibrate the DBK16. After the hardware is setup and verified, click on the ACCEPT button to configure the next channel or ACCEPT CONFIGURATION AND EXIT to return the main GageCal screen.

3. Highlight the first configured channel and click on the button labeled CALIBRATE. The Application Parameters screen appears. There are 2 types of calibration that the DBK16 can accommodate. **Nameplate calibration** allows you to enter specifications of your transducer and application;
Two-Point calibration allows you to enter two points of millivoltage out of the transducer vs pounds or other physical units. From the parameters you enter, GageCal instructs you how to set up the DBK16.

Note: All application parameters entered will be used in the DBK16 setup. Any inaccuracies will result in the DBK16 being configured incorrectly.

4. Click on the CONTINUE button, and follow the instructions from the GageCal program. GageCal has a help file that will explain any questions on the different screens or menus. If you have trouble in your setup, a DIAGNOSTIC window can show a DBK16 circuit to help you troubleshoot the problem.

5. After GageCal completion, go to DaqView and convert ±5 V to engineering units using mx+b.

Example

The following examples perform selected steps for a typical setup. There will be strain gage and load cell examples. Referring to the typical setup procedure, step 3 says to determine the maximum voltage from the transducer at maximum load or strain.

A **strain gage** example:

Most strain gages come with Gage Factors (GF) used to calculate the approximate output of the bridge circuit with a typical strain value. The formula is:

$$\frac{(\text{Excitation Voltage})(\text{Gage Factor})(\text{Strain in strain units})}{4} = \text{*Bridge circuit output voltage}$$

*linear estimate, some strain gages are not linear, refer to strain gage theory for more information.

If we have a 120 ohm strain gage with a gage factor of 2.1 and excitation voltage of 5 V (due to the current limitation of the excitation regulator on the DBK16, it must be less than 6 V) and we are measuring 4000 microstrain:

$$\text{Bridge output voltage for 4000 microstrain } = \frac{(5)(2.1)(4000 \times 10^{-6})}{4} = 10.5 \text{ mV}$$

A **load cell** example:

Load cells come with a mV/V specification which means for each volt of excitation at maximum load, the load cell will output a specific millivolt level.

Consider a 3000 pound load cell rated at 2.05 mV/V using 10 V of excitation (assume it is a 350 ohm load cell). When 3000 pounds are applied, the voltage out of the load cell is:

$$(10)(2.05 \times 10^{-3}) = 20.5 \text{ mV}$$

For 1000 pounds, it would be $(1000/3000)(10)(2.05 \times 10^{-3}) = 6.833$ mV

Now that we know what our full-scale voltage will be from our sensor, we can calculate what the voltage gain should be on the DBK16 so the full-scale sensor output will correspond to the full-scale Daq device input. Full-scale Daq device inputs are:

-5 to +5 V for DaqBook and DaqBoard [ISA type] in bipolar mode

0 to +10 V for DaqBook, DaqBoard [ISA type], and DaqBoard/2000 in unipolar mode

-10 to +10 V for DaqBoard/2000 in bipolar mode and Daq PC-Card

To calculate the needed DBK16 gains, use the maximum voltage you want to represent the full-scale of the sensor (usually full-scale Daq device input with a little space to prevent saturation) divided by the full-scale sensor output.

Example: The strain gage above at 4000 microstrain will output 10.5 mV. If using a DaqBook in bipolar mode, full-scale is +5 V. Also, we will allow 0.5 V space on the full-scale input. The DBK16 gain should be:

4.5 V/10.5 mV = 428.6

Now we must determine how to distribute the gain in the DBK16 (typical setup procedure step 4). There is the input amplifier that has a gain range of ×100 to ×1250, the filter gain (×1 or ×2) and the scaling amplifier that has a range of ×1 to ×10. If we round off our gain to ×420, any of these possible settings will work.

Input Gain	×420	×100	×240	×300
Filter Gain (enabled)	No	Yes (×2)	Yes (×1)	No
Scaling Gain	×1	×2.1	×1.75	×1.4
Total DBK16 Gain	×420	×420	×420	×420

After we determine how all our gains will be distributed, the sensor can be hooked up to the DBK16, the bridge completion resistors installed, and the excitation voltage set. Then we can proceed to set the gains. We will use DaqView for this.

Launch DaqView and set it up for the DBK16 at the correct Daq device input channel determined by the setting of JP1 and S1. On return to the DaqView main spreadsheet screen, notice the **type** column in the spreadsheet. All the DBK16 channels should say **bridge**. Changing the type will allow us to set the offset and gains in the DBK16. When setting up the DBK16 gains, enable only the channel you are setting up. Turn all the others off in DaqView. Also, set DC coupling and disable the on-board filter during the gain and offset settings.

First, we want to remove all the offset adjustment from the circuit. Set the type to **Offset Gain**. Enable the input reading column from the Acquire menu or the tool bar. While reading the spreadsheet, set the trimpot labeled OFFSET to read a value of 0.00. Disable the input reading column.

Next, set the type to **Input Gain.** This allows us to set the input amplifier gain. The DBK16 has a 5 mV signal on the input, so the reading that we want to set the trimpot labeled GAIN to is (.005)(Input Gain). Enable the input reading column and set the Input Gain. Disable the input reading column.

Typical Input Gain settings:

Gain	DaqView Reading	Gain	DaqView Reading
100	0.5 volts	200	1.0 volts
300	1.5 volts	400	2.0 volts
500	2.5 volts	600	3.0 volts
700	3.5 volts	750	3.75 volts
800	4.0 volts	900	4.5 volts
1000	5.0 volts	1200	6 volts *
* requires DaqBook/DaqBoard to be in unipolar mode.			

Next set the type to **Scaling Gain**. This allows us to set the scaling amplifier gain. When setting the scaling gain, the input gain is also present and must be considered when making the adjustment. The scaling gain reading you want to read is (.005)(input gain)(scaling gain). Enable the input reading column, and set the Scaling Gain. Disable the input reading column.

For an input gain of 200, typical scaling gains are:

Scaling Gain	DaqView reading
2	2.0 volts
4	4.0 volts
6	6.0 volts*
8	8.0 volts*
10	10.0 volts*
* requires DaqBook/DaqBoard to be in unipolar mode.	

Now all the gains are set correctly, and we have to adjust the offset for any bridge circuit imbalance or quiescent loads. Enable the on-board filter. Set the type to **Bridge.** Make sure the quiescent load is applied. Enable the input reading column and adjust the trimpot labeled OFFSET for a reading of 0.00. If you can not adjust it to 0.00, try dropping your input gain and compensate for the drop by raising your scaling gain. If it still does not adjust to 0.00, swap the +BRG and -BRG wires to reverse the polarity of the signal. The offset adjustment is unipolar and only affects the input gain. **After the final offset is made, the gain readings will be incorrect (if you want to go back and check them) unless the circuit offset is removed.** (Step 7 in typical setup procedure.)

Using the DBK16 with 3-Wire Strain Gages

Each single-element 3-wire strain gage has 1 wire connected to one side of the gage element and 2 wires connected to the other. Follow these steps for using the DBK16 with the 3-wire single-element strain gages.

1. Install bridge completion resistors R12 and R13 (R24 and R25 for lower channel).

2. Attach the 1-wire side of the gage element to the -EXC and -SEN terminals.

3. Attach one wire on the 2-wire side of the gage to +BRG terminal.

4. Attach one more bridge completion resistor to the end of the other wire on the 2-wire side of the gage element.

5. Attach the other side of the 3rd bridge completion resistor to the +EXC terminal.

Notes

Calibrating DBK16 and DBK43A for *LogBooks*

Reference Note:
This section covers calibrating a DBK16 that is being used in a LogBook application.
Daq users: Refer to *Calibrating DBK16 and DBK43A for Daq Devices,* which begins on page 9.

Overview

Calibrating a strain gage channel includes:

- One-time adjusting of the bridge excitation.
- One-time tuning of the electronic gains and offset via trimpots to maximize performance and dynamic range.
- Applying a transfer function to the voltage output to convert it to engineering units, e.g., pounds, kilograms.
- Executing a software scale and offset adjustment periodically to maintain accuracy.
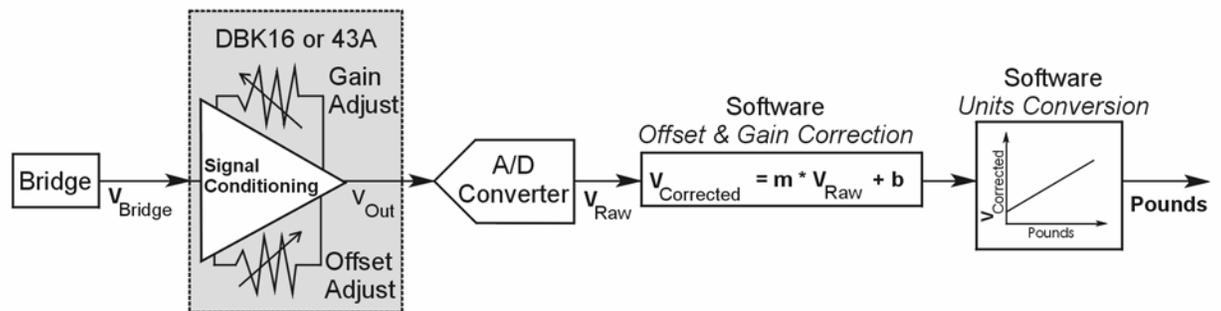
*Example of a Unit Conversion from Voltage to Pounds*

The trimpots provide course tuning so large quiescent offsets can be nulled and the bridge signal can be amplified to match the A/D input range. Once these adjustments are made, the operator can periodically fine-tune the calibration via software using LogView's 2-Point calibration feature. LogView's scale and offset features provide a simple means to apply a transfer function that converts the voltage to user units, for example, pounds, as in the above block diagram.

Bridge circuit transducers are used for many different applications, and the strain gage signal conditioning modules are flexible enough to support most of them. Each channel circuit has an excitation regulator, a high gain (x100 to x1250) input amplifier with offset adjustment, a low-pass filter, a scaling (x1 to x10) amplifier, and a calibration multiplexer.

By using software-controlled multiplexers, on-board reference voltages can be read by the data acquisition system so that precise gains and offsets can be set. LogView provides a means of easily controlling the calibration multiplexers so that the reference voltages can be displayed while the trimpots are being adjusted.

There are four trimpots to set up each channel circuit. The trimpots are labeled to represent the following adjustments:

- **EXC - for adjusting the excitation voltage to the transducer**

- **GAIN - for setting the gain of the input amplifier**

- **OFFSET - for adjusting the circuit offset for quiescent loads or bridge imbalance**

- **SCALE - for setting the gain of the scaling amplifier**
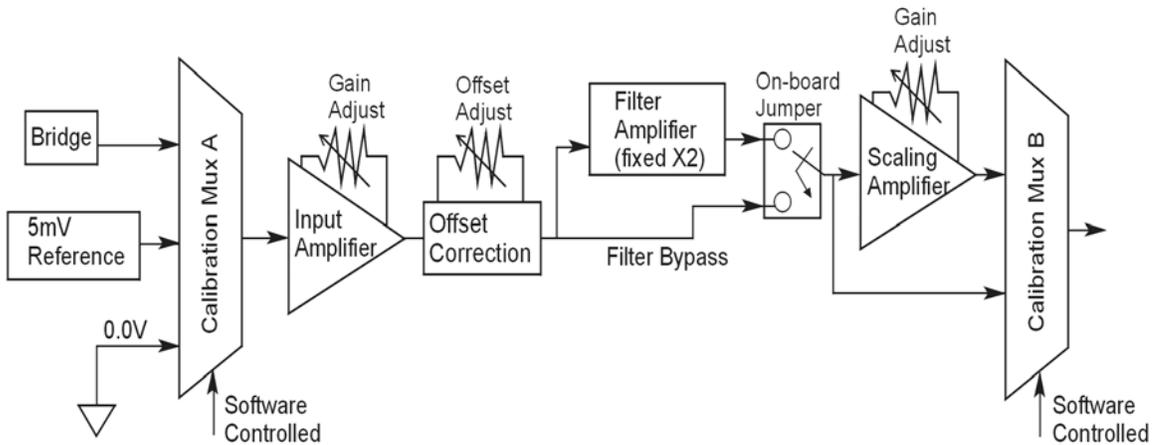
Signal-FlowRelationship of Software Controlled Multiplexers and On-Board Reference Voltages

> **This calibration procedure can only be executed while LogBook is attached to a PC that is running LogView.**

> **To adjust trimpots, use one of the following calibration methods, as appropriate: Nameplate, 2-Point, Shunt, or Manual.**

Calibration Methods

Several different calibration techniques are supported by strain gage signal conditioning modules. Calibration methods include; Nameplate, 2-Point, Shunt, and Manual. From the following discussion, select the calibration method that is best for your application.

Nameplate –uses the transducer's published specs.

Nameplate calibration is typically used with packaged load cells with millivolt-per-volt (mV/V) transfer functions. Using the mV/V spec of the load cell or a strain gage's Gage Factor (GF), the necessary system gain can be calculated and applied to a channel.

2-Point – uses 2 known loads, one of which might be "no load."

The 2-Point calibration method requires the operator to apply two known loads to the load cell or strain gage, one at a time, while the data acquisition system takes measurements. Typically, the first point is with no load applied and the second point is close to the maximum load capacity of the gage. While measuring the first point the offset is nulled, and while measuring the second point the gain is adjusted to span the majority of the input range of the A/D. No gain calculations are required to perform this calibration method.

Shunt *– applies a shunt resistor to the bridge to simulate a load.*

Shunt calibration is identical to 2-Point calibration except that the second point is simulated so that applying a load near the gage's maximum load is unnecessary. To simulate a bridge imbalance, a shunt resistor is placed across one leg of the bridge. Once the shunt resistor value has been calculated, it is applied to the bridge to provide the desired simulated load. No gain calculations are required to perform this calibration method.

Manual *– used to assign specific gains and offsets.*

If a particular gain and offset are already known, these values can be used to setup a strain gage channel.

Procedures Common to All Calibration Steps (Required)

Set the Selected Channel(s) to DC Coupling

Since the applied calibration-signals are DC, set DC coupling for all the channels that are being adjusted. *If your application requires AC coupling*, don't forget to remove the jumpers when the adjustment procedure has been completed.

Determine Channel Parameters

Before adjusting the trimpots, the excitation needs to be determined. Typically, the supplier of the gage of load cell will recommend a suitable value, but make sure that the maximum output current of the excitation regulator is not exceeded.

Initialize LogView

Launch LogView and use the *LogBook Hardware Configuration window* (hardware tree) to configure all of the DBK options that are to be used in the system. If needed, refer to the LogView chapter.
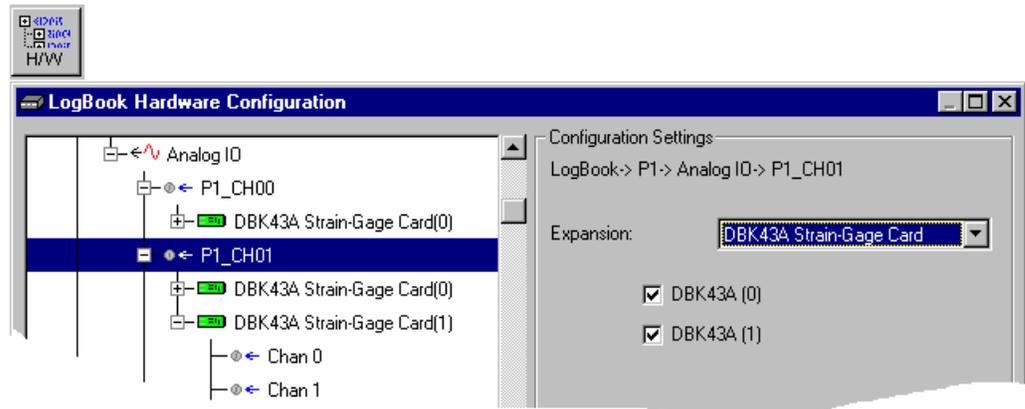
LogBook Hardware Configuration, Button and Screen

Open the *Analog Input Channel Configuration Window*. Click the User Scaling Tab and verify that all of the strain gage channels that are to be adjusted have scale and offset values of 1 and 0, respectively.
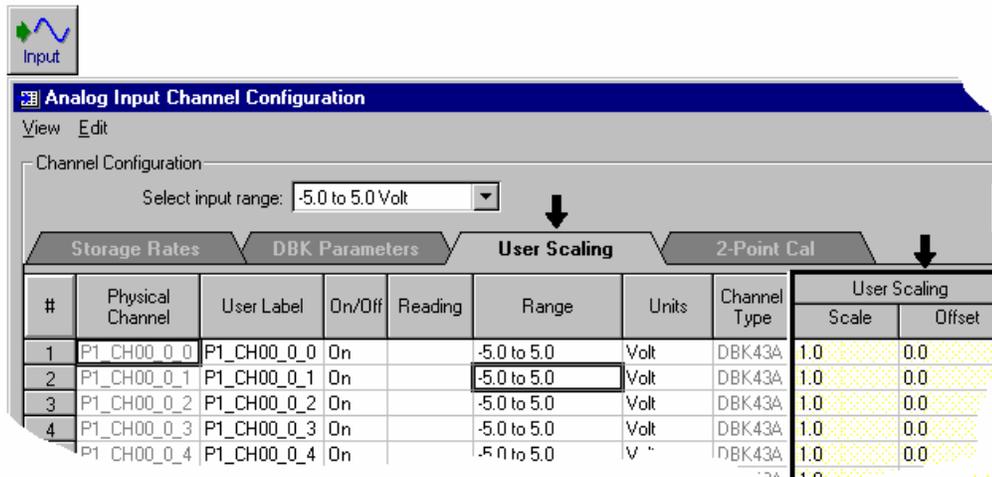
Analog Input Channel Configuration Window, Button and Screen … "User Scaling" Tab Selected

For all of the strain gage channels that are to be adjusted, set their ranges to $\pm 5V$.

Click the *DBK Parameters tab* to expose the strain gage signal conditioning programmable settings.

Click the Attach button to substantiate a connection between the PC and the LogBook.

Adjust the Excitation   -   *DBK16*

For DBK16, set the excitation voltage for the transducer by adjusting the trimpot labeled EXC and measuring the voltage with a voltmeter across the +EXC and -EXC on the bridge or at the terminals of the signal conditioning module.

## Adjust the Excitation   -   *DBK43A*

DBK43A is equipped with a switch that allows the excitation voltage to be read by the LogBook and displayed in LogView. For all DBK43A units to be adjusted, you must:

1. Reposition the DBK43A's "physical" calibration switch (located next to the Power LED) to the CAL position.

2. Select CAL in LogView. This is detailed in the following paragraph.
    Open the *LogBook Hardware Configuration window* and select DBK43A (see following figure). In the Configurations settings box, set the CAL/NORM Switch to CAL. If the DBK43A is not displayed click the + to the left of the base channel (to which it is attached), this action expands the hardware tree in the *LogBook Hardware Configuration window*. Repeat this process for all DBK43A units that are to be adjusted. Click OK to lock in the changes.
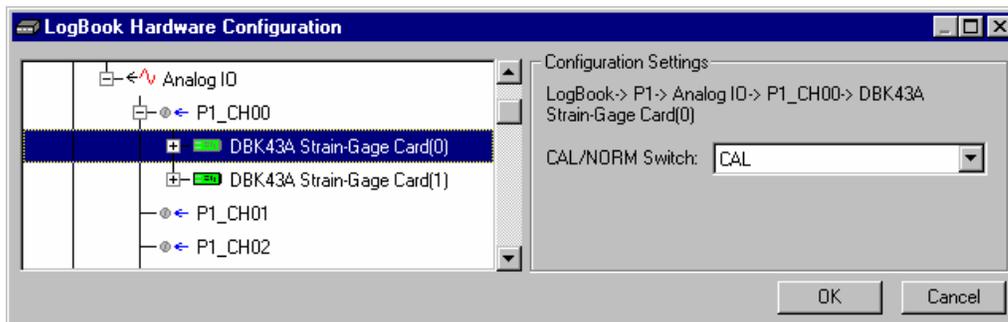

Setting a DBK43A Cal/Norm Switch to "CAL"

3. In the Param1 column (see next figure for location), select all of the DBK43A channels that are to be adjusted.

4. Set Mode equal to Excitation from the drop down list (located above the DBK Parameters tab).

5. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.
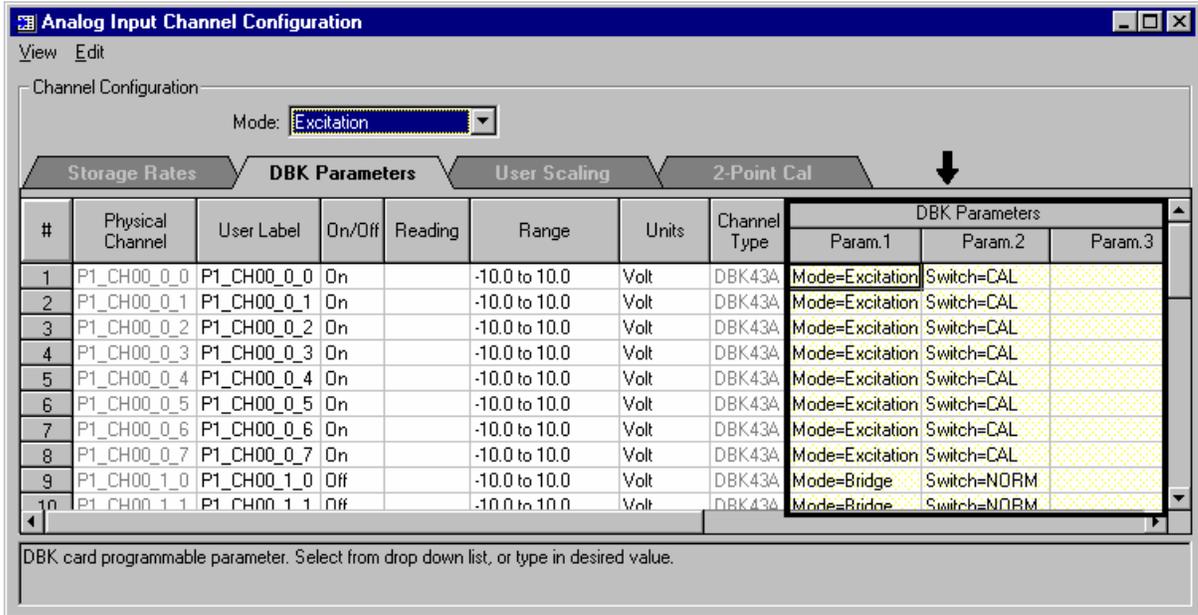
Selecting "Mode = Excitation" for DBK Parameter 1

6. Click the Download button to send the current configuration to the LogBook.

7. Select Indictors \ Enable Input Reading Column from the menu bar to display the excitation values for each channel.

Download Button
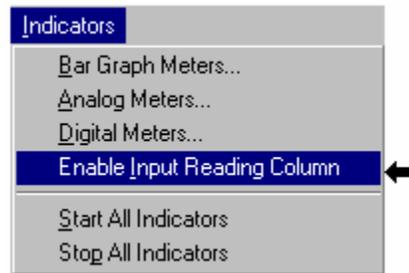
Selecting "Enable Input Reading Column"(from the Indicators Pull-Down Menu)

8. Set the excitation voltage for each transducer by adjusting the trimpot labeled EXC for the associated channel while reading their values in LogView.

9. Select Indictors \ Disable Input Reading Column from the menu bar.
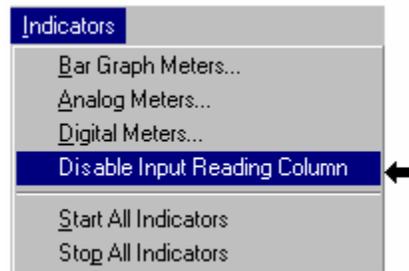
Selecting "Disable Input Reading Column"(from the Indicators Pull-Down Menu)

10. Return the physical calibration switches (of the applicable DBK43As) to the NORM position.

11. In LogView, open the *LogBook Hardware Configuration Window* (hardware tree) and select NORM for each DBK43A.

<div style="background-color: yellow; border: 1px solid black; text-align: center;">

This completes the section entitled: "Procedures Common to All Calibration Steps (Required)"

</div>

Nameplate Calibration and Manual Calibration

To properly calibrate a strain gage channel using the **Nameplate method**, the required gain must first be calculated. If the desired gain and offset are already know [as in the **Manual calibration** method] skip to the section, *Determining the Gain of Each Amplification Stage*.

The following examples outline the necessary steps for determining the required gain for **Nameplate calibration**. Both *strain gage* and *load cell* examples are provided.

Calculating the Required Gain

Determining a Strain Gage's Maximum Output Voltage

Most strain gages come with Gage Factors (GF) used to calculate the approximate output of the bridge circuit with a typical strain value. The formula is:

$$V_{BR} = (V_{EXC} * G * S * B) / 4 \qquad \text{[See following important notice]}$$

Where: V_{BR} = Bridge output voltage

V_{EXC} = Excitation Voltage

G = Gage Factor

S = Strain in user units (in uStrain)

B = Configuration factor (1 for ¼ bridge, 2 for ½ bridge, 4 for full bridge)

The equation, $V_{BR} = (V_{EXC} * G * S * B) / 4$ produces a linear estimate. If you are using a non-linear strain gage you should refer to strain gage theory for additional information as needed.

For a 120 ohm strain gage with a gage factor of 2.1 and excitation voltage of 5 V, applying 4000 microstrain would produce an bridge output of 10.5mV for a ¼ bridge configuration.

$$V_{BR} = (5 * 2.1 * 4000x10^{-6}) / 4 = 10.5mV$$

Determining a Load Cell's Maximum Output Voltage

Load cells come with a mV/V specification—for each volt of excitation at maximum load, the load cell will output a specific millivolt level.

$$V_{LC} = R * V_{EXC}$$

Where: V_{LC} = Load cell output voltage

R = Load cell spec (mv/V)

V_{EXC} = Excitation voltage

Consider a 3000 pound load cell rated at 2.05 mV/V using 10 V of excitation (assume a 350Ω load cell). When 3000 pounds is applied, the voltage out of the load cell is 20.5mV.

$$V_{LC} = (10 * 2.05 \times 10^{-3}) = 20.5 \text{ mV}$$

If 1000 pounds were applied, we would see 6.833 mV. This is arrived at as follows:

$$(1000/3000) * 10 * 2.05 \times 10^{-3} = 6.833 \text{ mV}$$

Using the Calculated Maximum Voltage to Determine the Necessary Gain

To maximize the resolution and dynamic performance of the system, the sensor's output should be amplified to correspond to the data acquisition system's input range.

Using the LogBook's $\pm 5V$ input range, the required gain is calculated by dividing 5V by the maximum output voltage of the sensor. Before performing the calculation, it is typically a good idea to pad the maximum sensor voltage by about 5% so that, once amplified, it won't bump into the limit of the 5V range.

$$G = V_{LB} / (V_{GO} + V_{GO} * 5\%)$$

Where: G = Gain

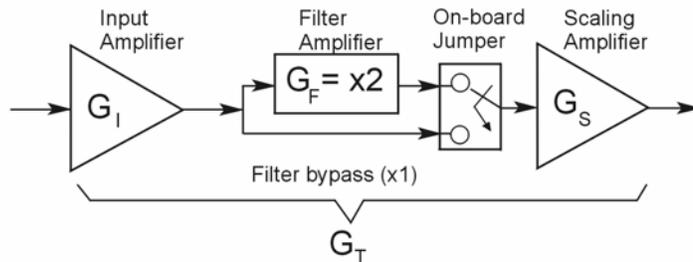V_{LB} = LogBook input range

V_{GO} = Maximum gage output

For the strain gage in the previous example with a maximum output of 10.5mV, the required gain is:

$$G = 5.0V / (0.0105V + 0.0105V * 0.05) = 453.5$$

For the above load cell with a maximum output of 20.5mV, the required gain is:

$$G = 5.0V / (0.0205V + 0.0205V * 0.05) = 232.3$$

Determining the Gain of Each Amplification Stage

The system's total gain is:

$$G_T = G_I * G_F * G_S$$

Where: G_T = Total gain

G_I = Input amplifier gain

G_F = Filter gain

G_S = Scaling amplifier gain

Note: Maximum gain calibration is x1000 for $\pm 5V$ range.

The majority of the gain should be assigned to the Input Amplifier, with the Scaling Amplifier used for fine-tuning. If the filter is enabled, a gain of x2 is automatically introduced.

The input amplifier has a gain range of ×100 to ×1250; the filter gain ×1 or ×2; and the scaling amplifier has a range of ×1 to ×10. For the strain gage example, if we round off our gain to ×420, any of these possible settings will work.

	Option A	Option B	Option C	Option D
Input Gain	×420	×100	×240	×300
Filter Gain (enabled)	No	Yes (×2)	Yes (×2) *See Note	No
Scaling Gain	×1	×2.1	×1.75	×1.4
Total Gain	×420	×420	×420	×420

For Option C, the LPF gain is typically x2.
For gains of x1 (if the filter is enabled), the following apply:

DBK16 - For a gain of x1 (if the filter is enabled),10KΩ resistors R44 and R46 must have been previously removed (for the low and high channels, respectively).

DBK43A - For a gain of x1 (if the channel filters are enabled), removal of the following 10 KΩ resistors applies: Ch0 – R144, Ch1 – R244, Ch3 – R444, Ch4 – R544, Ch5 – R644, Ch6 – R744, Ch7 – R844.

Channel Calibration Procedure

Adjust the Offset

The following steps are used to adjust the offset.

1. In the Param1 column (see page 19 for location), select all of the DBK43A channels that are to be adjusted.

2. **Select Mode = SetOffset** from the drop down list above the grid. This selection commands the calibration multiplexer to route the 0.0V reference through the entire analog path (see following figure).
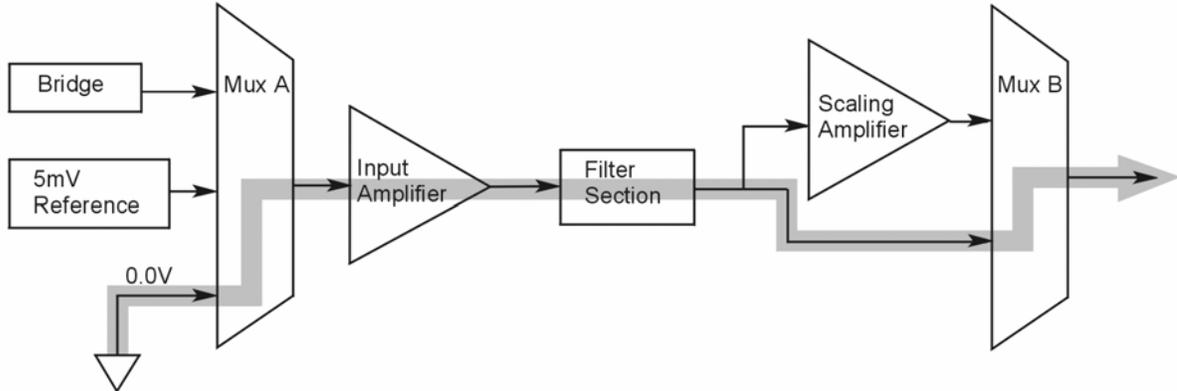
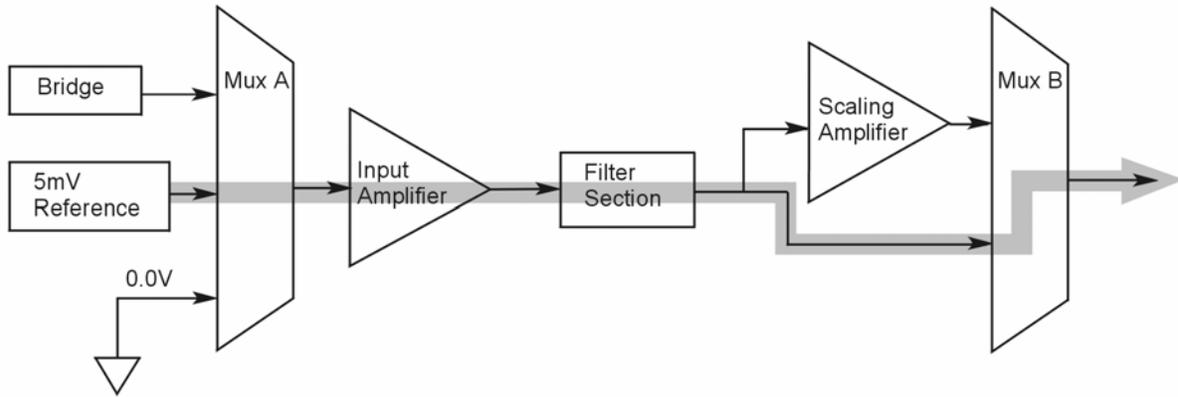*"Mode = Offset" 0.0 Volt Reference is Routed*

3. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.

4. Click the Download button. This sends the current configuration to the LogBook.

5. Select Indictors \ Enable Input Reading Column from the menu bar. This displays the offset values for the enabled channels.

6. Set the offset voltage to 0.0V for each transducer by adjusting the trimpot labeled OFFSET for the associated channel.

7. Select Indictors \ Disable Input Reading Column from the menu bar.

Adjust the Input Amplifier Gain

Perform the following steps to adjust the Input Amplifier Gain.

1. In the Param1 column (see page 17 for location), select all of the DBK43A channels that are to be adjusted.

2. Select **Mode = SetInputGain** from the drop down list above the grid. This selection commands the calibration multiplexer to route a 5mV reference through the Input Amplifier and bypass the Scaling amplifier (see following figure).

   Note: If the filter is enabled (not bypassed) accommodate an additional x2 gain stage.

"Mode = SetInputGain," 5 milli-Volt Reference Route

3. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.

4. Click the Download button to send the current configuration to the LogBook.

5. Select Indictors \ Enable Input Reading Column from the menu bar to display the values for each channel.

6. For the associated channel, set the voltage to [G_I * G_F * 0.005] for each transducer by adjusting the trimpot labeled GAIN. Use the Input Amplifier Gain (G_I) calculated earlier.

Note: If the filter is enabled, the filter gain (G_F) is 2; otherwise $G_F = 1$.

> *Example 1:* If $G_I = 250$ and the filter is *disabled;*
> the GAIN trimpot would be adjusted to obtain 1.25V.
> *Example 2:* If $G_I = 250$ and the filter is *enable;* the GAIN trimpot would
> be adjusted to obtain 2.50V.

7. Select Indictors \ Disable Input Reading Column from the menu bar.

Adjust the Scaling Amplifier Gain

Adjust the Scaling Amplifier Gain as follows:

1. In the Param1 column (see page 19 for location), select all of the DBK43A channels that are to be adjusted.

2. Select **Mode = SetScalingGain** from the drop down list above the grid. This selection commands the calibration multiplexer to route a 5mV reference through all of the amplification stages as shown below.
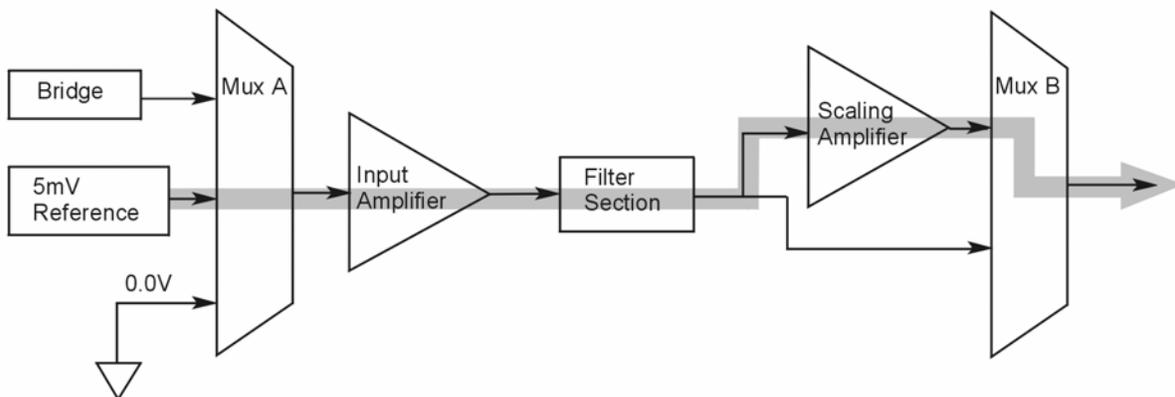
"Mode = ScalingGain," *5 milli-Volt Reference Route*

3. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.

4. Click the Download button to send the current configuration to the LogBook.

5. Select Indictors \ Enable Input Reading Column from the menu bar to display the values for each channel.

6. For the associated channel, set the voltage to [G_T * 0.005] for each transducer by adjusting the trimpot labeled SCALE. Use the total system gain (G_T) calculated earlier.

   *Example*: If G_T = 435.5, the SCALE trimpot would be adjusted to obtain 2.17 V.

7. Select Indictors \ Disable Input Reading Column from the menu bar.

Trimming Bridge Quiescent Load

Most bridges have some level of offset, even if no quiescent load is present. In quarter and half bridge situations, use of 1% bridge completion resistors can cause up to 1mV/V of offset. If the bridge has 4mV of offset and the Input Amplifier is set to x100, the Offset potentiometer would need to nullify 400mV.

DBK16 – For DBK16s, the Offset Potentiometer can adjust out 0 to +5V of offset amplified by the Input Amplifier.

DBK43A – For DBK43As, the Offset Potentiometer can adjust out -1.25 to +5V of offset amplified by the Input Amplifier.
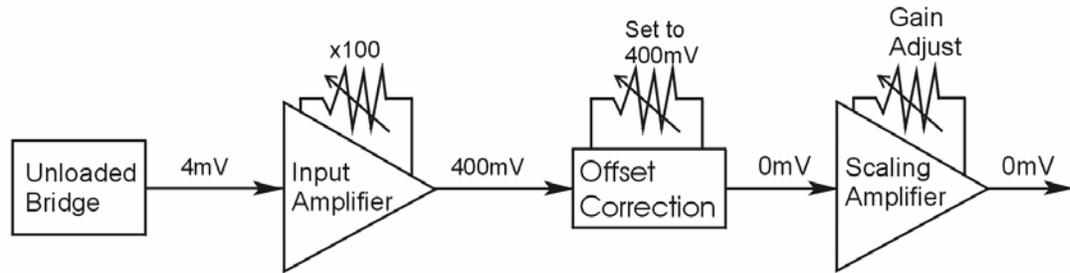

Trimming Bridge Quiescent Load

If a significant amount of quiescent offset is present and the Input Amplifier gain is set too high, the Offset Potentiometer will not have enough range to adequately nullify the offset. In this case, the gain of the Input Amplifier must be reduced while the gain of the Scaling Amplifier is increased proportionately.

Use the following steps to trim bridge quiescent load (unload the bridge).

1. In the Param1 column (see page 19 for location), select all of the DBK43A channels that are to be adjusted.

2. Select **Mode = Bridge** from the drop down list above the grid. This selection commands the calibration multiplexer to route the transducer output through the analog path as shown below.
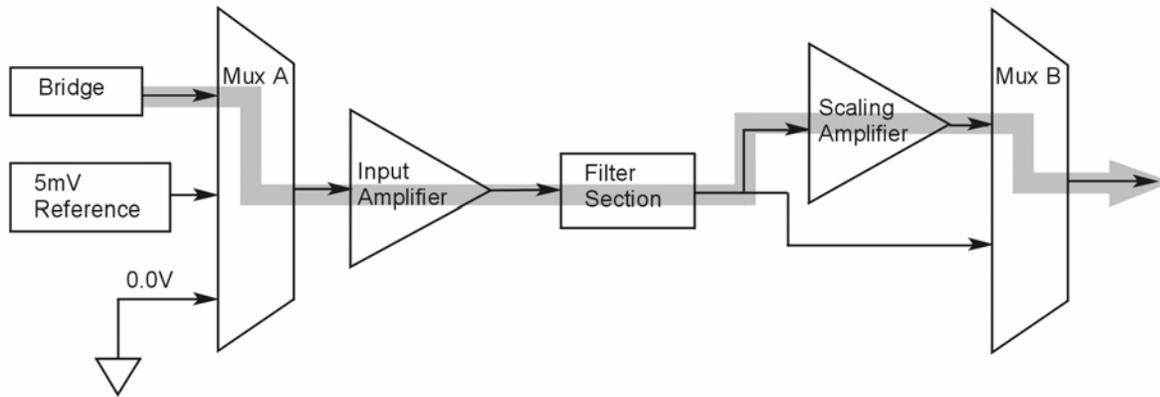
"Mode = Bridge," Reference Route

3. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.

4. Click the Download button to send the current configuration to the LogBook.

5. Select Indictors \ Enable Input Reading Column from the menu bar to display the offset values for each channel.

6. For the associated channel, set the offset voltage to 0.0V for each transducer by adjusting the trimpot labeled OFFSET.

Note: If you are unable to nullify the quiescent offset of the bridge, your Input Amplifier gain may be too high. Information regarding gain redistribution can be found in the section entitled, *Determining the Gain of Each Amplification Stage.*

7. Select Indictors \ Disable Input Reading Column from the menu bar.

2-Point Calibration

This 2-point calibration method makes use of trimpot adjustments. It should not be confused with the LogView software 2-Point Calibration (discussed in the LogView chapter in the LogBook User's Manual).

In the 2-Point calibration method, the user places two known loads on the gage, one at a time, then adjust the trimpots until the expected value is reached. Typically, the first of loads is "no load." In the case of a weight scale, the scale would first be unloaded to adjust the offset, then a known load (near maximum expected) would be applied to adjust the gain.

Shunt calibration (discussed immediately after this *2-Point Calibration* section) is the same as the 2-Point method, except the second load is applied in a simulated fashion by shunting 1 leg of the bridge with a shunt resistor. Shunt calibration is preferred in cases where applying a real load (near the maximum expected) is not practical.

Initialize the System

1. Download a single setup and continuously display data in LogView. The continuous display can remain throughout the procedure since the calibration multiplexers do not need reset between steps.

2. In the Param1 column (see page 19 for location), select all of the DBK43A channels that are to be adjusted.

3. Select **Mode = Bridge** from the drop down list above the grid. This selection commands the calibration multiplexer to route the transducer voltage through the analog path.

4. Turn off all the channels in the system, except for those DBK43A channels that are to be adjusted.

5. Click the Download button to send the current configuration to the LogBook.

6. Select Indictors \ Enable Input Reading Column from the menu bar to display the offset values for each channel.

Adjust the Offset

For the associated channel, apply the first calibrated load to each gage (typically no-load) and set the voltage to 0.0V for each transducer. This is accomplished by adjusting the trimpot labeled OFFSET. If the first point is actually a calibrated load, you will need to move the load to each gage, one at a time, to adjust its associated offset.

Adjust the Input and Scale Amplifier Gain

Complete the following steps to adjust the channel gain.

1. Apply the second load to each gage channel. The value of this load should approximate that of the maximum expected load. For the best results, a gain should be selected so that the bridge's maximum output equals 90% of the A/D's input range.

2. Calculate the desired voltage for the second point using the following equation:

$$V_D = (L_A/L_M) * V_I * 90\%$$

Where: V_D = Desired voltage for 2nd point of calibration

L_A = Applied load used in calibrating the 2nd point

L_M = Maximum load expected during usage

V_I = Input voltage range

Example: The load standard that will be applied to the gage as the 2nd point in the 2-Point calibration is 100lbs. The maximum expected load during usage is 150lbs. The programmable input range of the data acquisition system is set for $\pm5V$. The desired output voltage of the strain gage signal conditioning electronics is:

$$V_D = (100/150) * 5 * 0.90 = 3V$$

In this example, we should adjust the GAIN and SCALE trimpots until a value of 3V is measured.

If 150lbs is applied to the gage, a voltage of 4.5V will be measured.

$$V_D = (150/150) * 5 * 0.90 = 4.5V$$

3. Apply the second calibrated load to each gage and set the voltage to V_D, as derived in step 2. Do this for each transducer by adjusting the trimpots labeled GAIN and SCALE for the associated channel. Note that the GAIN trimpot provides most of the amplification (course adjustment), while the SCALE trimpot allows for fine-tuning.

Repeating the Process

Since adjusting the gain for the first time will have an affect on the offset, it is recommended that offset and gain adjustment be performed twice for each channel.

Shunt Calibration

Shunt calibration is virtually identical to the 2-Point method just discussed, except that the second point is simulated. The simulated load is achieved by shunting one leg of the bridge with a shunt resistor. Shunt calibration is the preferred calibration method when applying a real load (of a value approximating the maximum expected load) is not practical. To adjust the channel gain, the shunt must be applied to the bridge.

Calculate and install the necessary shunt resistor before continuing.

- **DBK43A** has direct support for shunt calibration, accommodating the resistor in its enclosure and allowing the software to apply it when requested.

- **DBK16** does not have direct support, so the shunt resistor must be applied externally and switched in manually.

Adjust the Offset

Adjust the offset as follows.

1. In the Param1 column, select all of the DBK43A channels that are to be adjusted.

2. Select **Mode = Bridge** from the drop down list above the grid. This selection commands the calibration multiplexer to route the transducer voltage through the analog path.

3. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.

4. Click the Download button to send the current configuration to the LogBook.

5. Select Indictors \ Enable Input Reading Column from the menu bar to display the offset values for each channel.

6. For the associated channel, apply the first calibrated load to each gage (typically no-load) and set the voltage to 0.0V for each transducer by adjusting the trimpot labeled OFFSET.

If the first point is an actual calibrated load, you must move the load to each gage, one at a time, to adjust its associated offset.

Adjust the Input and Scale Amplifier Gain

For the best results, a gain should be selected so that the bridge's maximum output equals 90% of the A/D's input range.

1. Use the following equation to calculate the desired shunt voltage (V_D).

$$V_D = (L_s/L_M) * V_I * 90\%$$

Where: V_D = Desired voltage from the after amplification when the shunt is applied

L_s = Simulated load produced by shunt

L_M = Maximum load expected during usage

V_I = Input voltage range

Example: The simulated load produced by the shunt 100lbs. The maximum expected load during usage is 150lbs. The programmable input range of the data acquisition system is set for $\pm$5V. The desired output voltage of the strain gage signal conditioning electronics is:

$$V_D = (100/150) * 5 * 0.90 = 3V$$

In this example, we would adjust the GAIN and SCALE trimpots until a value of 3V is measured.

If 150lbs is applied to the gage, a voltage of 4.5V will be measured.

$$V_D = (150/150) * 5 * 0.90 = 4.5V$$

For **DBK16,** *only* … Externally apply the shunt resistor and set the voltage to V_D, as derived above for each transducer. This is done by adjusting the trimpots labeled GAIN and SCALE for the associated channel. The GAIN trimpot is used for course adjustment; and the SCALE trimpot for fine-tuning.

For **DBK43A** *only* … DBK43 is equipped with a physical switch that allows the shunt to be applied when directed by the software. For each DBK43A to be adjusted, move this physical switch from NORM to CAL.

2. In LogView, open the *LogBook Hardware Configuration window* and select the DBK43A.
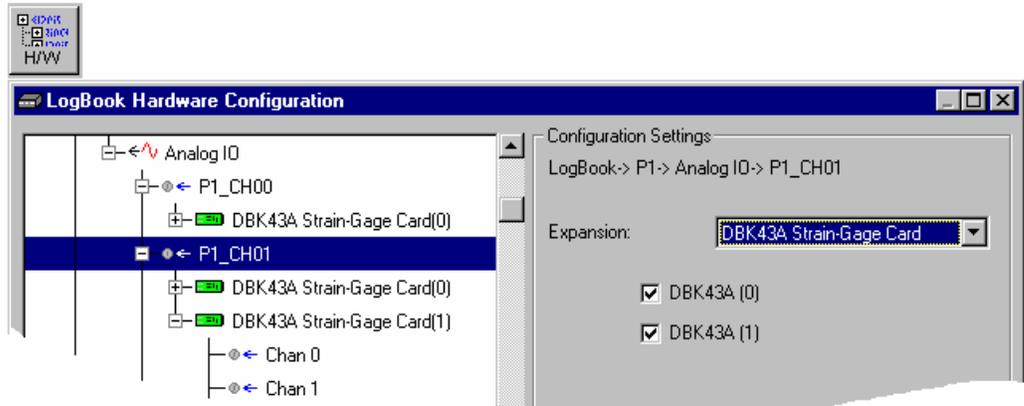
LogBook Hardware Configuration, Button and Screen

3. Select the DBK43A from the *LogBook Hardware Configuration window's* hardware tree.

4. Set the list box to the right to CAL. If the DBK43A is not displayed click the + to the left of the base channel to which it is attached to expand the hardware tree.
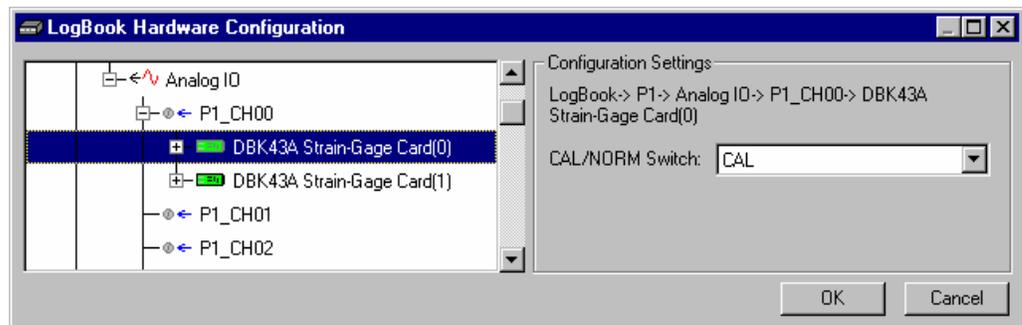
Setting a DBK43A Cal/Norm Switch to "CAL"

5. Repeat this process for each DBK43A that is to be adjusted.

6. Click OK to lock in the changes.

7. Open the Analog Input Channel Grid. In the Param1 column (see page 19 for location), select all of the DBK43A channels that are to be adjusted. Select **Mode = Shunt** from the drop down list above the grid. Turn off all the channels in the system except for those DBK43A channels that are to be adjusted.

8. Click the Download button to send the current configuration to the LogBook.

9. Select Indictors \ Enable Input Reading Column from the menu bar to display the excitation values for each channel.

10. Set the voltage to V_D, as derived above, for each transducer. This is accomplished by adjusting the trimpots labeled GAIN and SCALE for the associated channel. The GAIN trimpot provides for course adjustment. The SCALE trimpot provides for fine tuning.

11. Select Indictors \ Disable Input Reading Column from the menu bar.

12. Return the physical NORM/CAL switches (of the applicable DBK43As) to the NORM position.

13. In LogView, open the *LogBook Hardware Configuration window* and return each DBK43A back to NORM.

Repeating the Process

Since adjusting the gain for the first time will have an affect on the offset, it is recommended that offset and gain adjustment be performed twice for each channel.

Creating a Units Conversion Transfer Function

To make the data from your gage more useful, it should be recorded in terms of units appropriate to your application, such as pounds, kilograms, inches, mm, or Hg. A transfer function is needed to convert volts to these more meaningful units.

For this purpose, LogView provides a means of assigning a mathematical scale and offset to each channel. Scale and offset information from that chapter has been repeated below for convenience.

							User Scaling	
#	Physical Channel	User Label	On/Off	Reading	Range	Units	Channel Type	Scale	Offset
1	P1_CH00	P1_CH00	On		0.1 to 500.1	lbs	Local	25.0	0.1
2	P1_CH01	P1_CH01	On		0.0 to 2000.0	apples	Local	100.0	0.0
3	P1_CH02	P1_CH02	On		-10.0 to 10.0	Volt	Local	1.0	0.0

In *User Scaling*, you can create a **transfer function.** The function allows LogView to display units that could be more useful to you than volts. For example, you could obtain readings with pounds as the designated **Units**. The reading (in pounds) will be based on the raw input value, typically Volts, and the indicated Scale and Offset adjustment.

To create the transfer function:

1. Type the desired unit name in the Units column.

2. Select an appropriate range (e.g. unipolar).

3. Enter the linear *scale* relation to Volts (e.g. 25 pounds per Volt).

4. Enter any *offset* from 0, for example, an empty basket used in an application reads 0.1 V.

The reading and range columns will automatically change to the adjusted values.
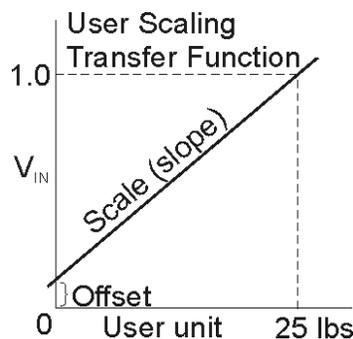
Periodic Calibration Without Trimpots

Once the trimpots have been adjusted during initial installation, periodic trimming can be performed through LogView's 2-Point software calibration. The LogView procedure does not require the use of trimmpots and should not be confused with the 2-point method discussed in this section of the manual.

Refer to the LogView chapter in the LogBook User's Manual for information regarding 2-point calibration via software.

DBK16 – Specifications

Name/Function: 2-Channel Strain-Gage Input Card

Input Connectors: Screw terminals for signal connections

Output Connector: DB37 male, mates with P1 using CA-37-x cable

Number of Channels: 2

Excitation Voltage Range: 1.50 to 10.50 VDC @ 50 mA (on-board adjustment for external source)

Gain Range: ×100-1250

Types of Bridges Accommodated:
Full Bridge, Kelvin Excitation (6-wire)
Full Bridge (4-wire)
Half Bridge (3-wire)
Quarter Bridge (2-wire)

Bridge Resistors: On-board provisions for 4 bridge-completion resistors per channel.

Type Input: Differential DC

Input Impedance: 100 MΩ (in parallel with 150 pF)

CMRR: 115 dB

Excitation Voltage Source: External 13-18 VDC @ 50 mA/circuit

Excitation Current Output: 50 mA max, current limited at 60 mA

Excitation Sensing: Local or Remote

Excitation Regulation:
Line Regulation: 0.025%
Load Regulation: 0.05%

Reference Voltages: 2.500 VDC
Reference Accuracy: 0.05%
Reference Drift: 3 ppm/ºC

Gain Calibration Reference: 5.00 mVDC
Reference Accuracy: 0.2%
Reference Drift: 20 ppm/ºC
Committed instrumentation amplifier [for each section], with a gain adjust
from ×100 to ×1250 via externally accessed 15-turn trimpot.

Gain Accuracy: 0.5%

Gain Drift: 50 ppm/ºC

Input Offset: 100 µV max

Offset Drift: 4 µV/ºC

Output Offset: 20 µV

Offset Drift: 200 µV/ºC

Offset Adjustment: 0-100% of range, 0-5.00 VDC (15-Turn trimpot)

Full-Scale Sensitivity Range:
@ 5.00 VDC Excitation: 0.8 to 10 mV/V
@ 10.00 VDC Excitation: 0.4 to 5 mV/V

Scaling Amplifier Gain Range: ×1 to ×10 (15-Turn trimpot)

Low-Pass Filter: 3 pole Butterworth, User By-Passable;
-9dB @ User-set Corner Frequency

Notes