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Reference Notes:

- In regard to calculating system power requirements, refer to the section *Power Requirements* in the *DBK Basics* section located at the beginning of the manual.
- Chapter 2, *System Connections and Pinouts*, includes pinouts for P1, P2, P3, and P4. Refer to the pinouts that are applicable to your system, as needed.

Note: Because of the DBK43A's flexibility in configuration, please review the entire section before attempting setup and operation.

Overview

The DBK43A will condition signals from most bridge-circuit transducers that have a signal output of less than 50 mV. Strain gages and load cells are common types. As needed, refer to the block diagram (below) and the board layout (later).

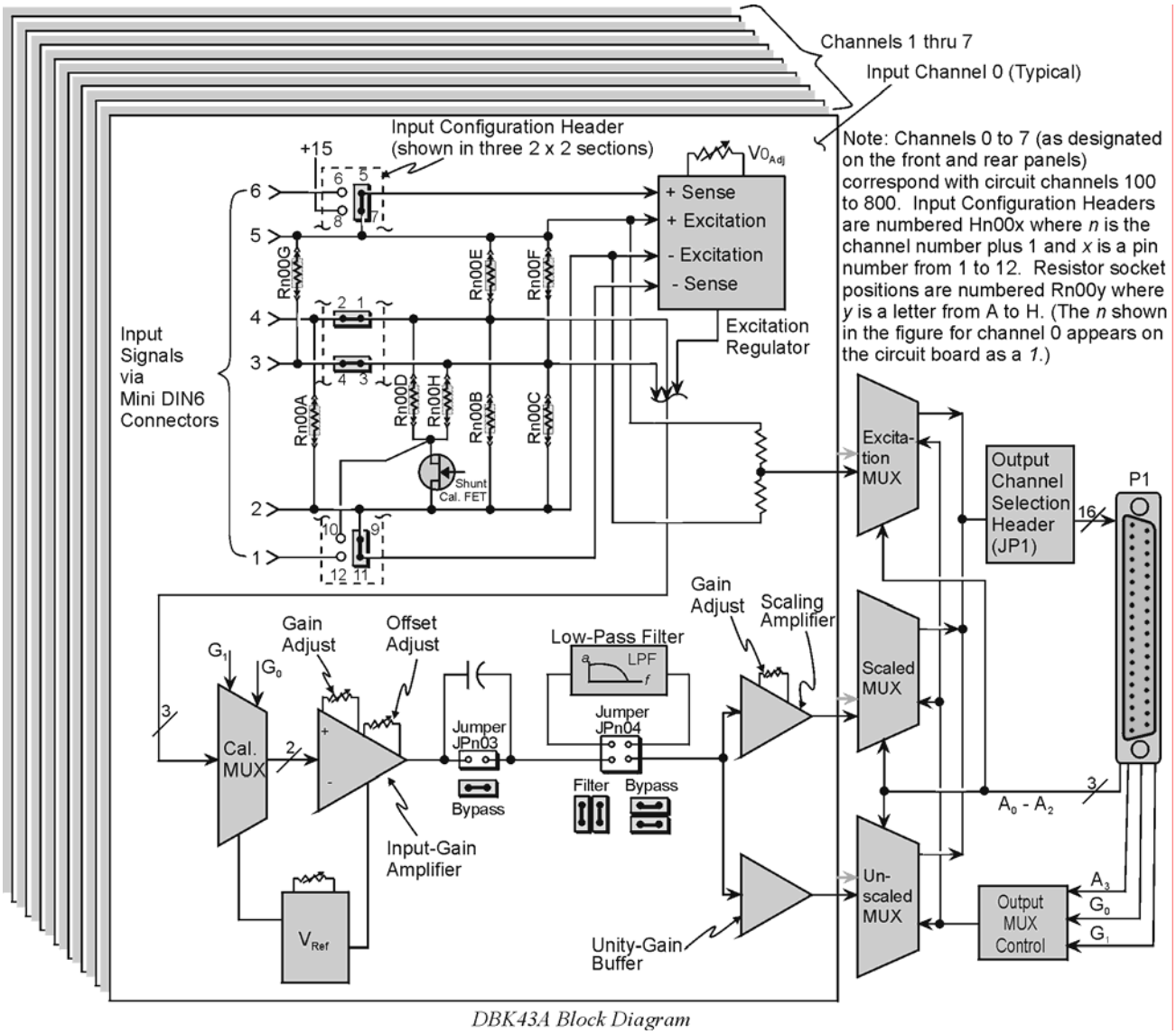


For *half-bridge* and *quarter-bridge* strain gages, the DBK43A can accommodate user-supplied BCRs (bridge-completion resistors) that complete the bridge circuit. The bridge circuit must be complete for the DBK43A to operate correctly.

Each channel of the DBK43A offers a selectable 3-pole, low-pass filter with a user-set cut-off frequency. Remote-sense terminals are provided to make 6-wire Kelvin connections. Up to 2 DBK43A modules can be connected to each of 16 analog base channels for up to 256 input signals.

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The DBK43A provides an amplifier gain range of ×100 to ×1250 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.



DBK43A Block Diagram

The module'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.

The DBK43A includes an internal excitation voltage source. The wide-range excitation regulator is adjustable from 1.5 to 10.5 VDC with a current limit of 50 mA.

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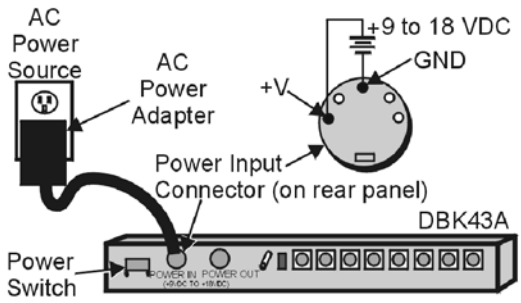
Hardware Connection

Power Connection

The DBK43A requires input voltage between +9 and +18 VDC. The DC source should be filtered but not necessarily regulated—the DBK30A is recommended for portable use. The DBK43A's isolated DC/DC converter-based power supply provides all excitation voltages and biasing for its amplifier circuits. Each of the eight on-board excitation regulators can be adjusted from 1.5 to 10.5 VDC. These outputs have remote sensing terminals and feature 50 mA current limiting to prevent damage from short-circuit or overload. The regulators' wide voltage range can accommodate any resistive or semi-conductive gage type.

The DBK43A may be powered with the supplied AC adapter that plugs into any standard AC wall outlet or from any isolated 9-18 VDC source of 16 W (see figure). Before plugging unit in, make sure the power switch is in the "0" (OFF) position.

- If using an AC power adapter, plug it into an AC outlet and attach the low voltage end to the jack on the DBK43A.
- If using another 9 VDC to 18 VDC source, make sure the leads are connected to the proper DIN terminals.



DBK43A Power Connections

CAUTION

POWER IN : The power connectors are rated at 5 amps maximum DC current. The power supply provided with the DBK43A can power the unit but not any auxiliary devices. If using the DBK43A's power supply, do not use the POWER OUT terminal. If using another power supply to power auxiliary devices from the POWER OUT terminal, make sure that power supply is current-rated for the units connected (up to 5 amps DC).

POWER OUT : Maximum output current is 3 amps DC. Use a power supply capable of supplying 5 amps DC at POWER IN.

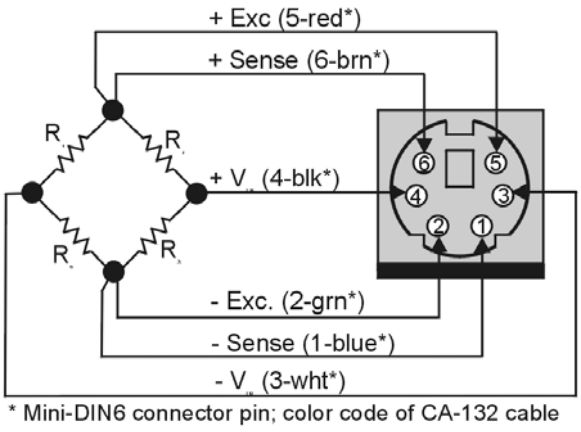
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Signal Connection

CAUTION

The maximum channel signal input from input pin #4 (V+) to pin #3 (V-) is 50 mV. There is no common-mode isolation between inputs (common-mode voltage between inputs must be 0 V).

The following figure shows the 6-pin signal connector (1 of 8) on the back of the DBK43A, and a full-bridge with remote sensing configuration.



DBK43A Signal Input Connection

Hardware Configuration

Factory Defaults:

- **Bridge configuration: Full**
- **Coupling: DC**
- **Low pass filter: Disabled (bypassed)**

  Unless special arrangements have been made, the cutoff frequency is disabled (bypassed) when DBK43A is shipped from the factory. If the low pass filter is enabled it will have a default value of 3.7 Hz.* You can enable the low pass filter [on an individual channel basis] by orienting the associated channel's Filter Jumper (JP104 for channel 0 through JP804 for channel 7) to the vertical position. Refer to the following board layout in regard to jumper location and orientation.

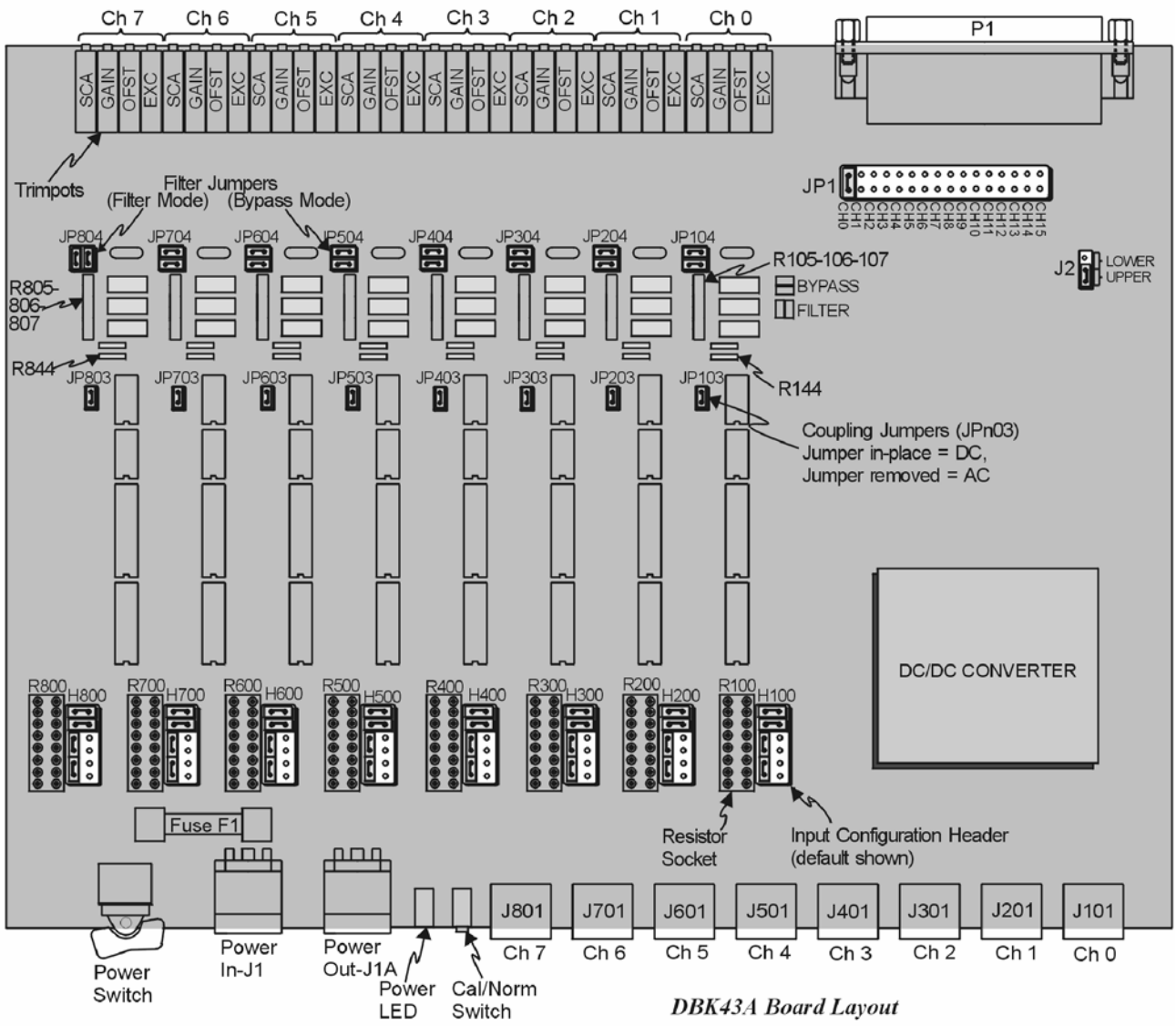
  *Note that DBK43A is shipped with a factory default that uses a 100 kΩ resistor in each of eight channel filter locations. The resistors are installed in locations R105-106-107 through R805-806-807 (for channels 0 through 7 respectively). Refer to the following board layout.

Configuration options on the DBK43A are:

- Bridge Applications using various bridge-completion resistors and jumpers
- AC Coupling and Low-Pass Filter Options
- P1 Output Channel and Card Address Selection

The following board layout can be referred to for jumper, switch, and resistor locations.

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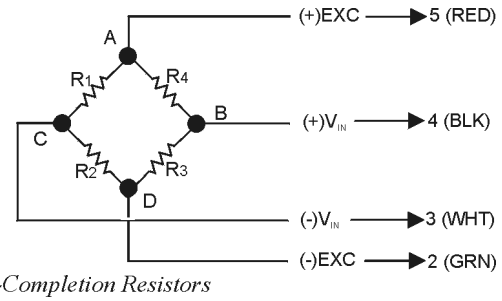
DBK43A Board Layout

Bridge Applications

There are several ways to hook-up strain gages—all are configured into a 4-element bridge (the 4 legs in a bridge circuit). The *quarter-*, *half-* or *full-* designation for a strain gage refers to how many elements in the bridge are strain-variable. A quarter bridge has 1 strain-variable element; a half bridge has 2 strain-variable elements; and a full bridge has four strain-variable elements. Each channel of the DBK43A has locations for bridge-completion resistors when using quarter- and half-bridge strain gages. These resistors are fixed values necessary to fill out the 4-element bridge configuration.

The following is a standard symbol for a 4-element bridge type strain gage. The figure makes use of bridge-completion resistor designations for a DBK43A channel.

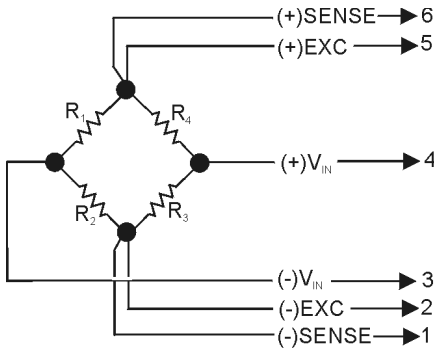
If R1 - R4 is a fixed resistor,
it may be placed internally
in the Rn locations on the resistor
plug. "n" is the channel number +1.
R1 = Rn00F
R2 = Rn00C
R3 = Rn00E
R4 = Rn00B
Example:
R3 in channel 7 = R800E location



Bridge-Completion Resistors

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Any or all of the 4 resistive elements may be strain-variable. Where an element is a fixed resistor, the fixed resistor may be installed in the internal location provided. (The n is the channel number +1; for an internal resistor on channel 7, the location is R800E.)



Kelvin-type Excitation Leads

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 DBK43A. 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. This connection works with as little as 10 feet of 22 gauge lead wire if accuracy is critical. (See *Full-Bridge with Remote Excitation Sensing Configuration* in full-page figure.)

The Kelvin connection using the remote sensing lines performs best when the entire bridge is localized (no bridge-completion resistors inside the DBK43A) and all leads are contained in a multi-conductor cable. If individual wire leads are used, the two sense wires should be tightly twisted to form a pair. Likewise, the two excitation wires and the two bridge-output wires should be twisted together).

The internal excitation source is attached to a voltage regulator in the DBK43A circuitry. This regulator provides the excitation to the actual transducer (there is a separate regulator for each transducer, hence 8 regulators per DBK43A). Each regulator has a maximum current of 50 mA. The maximum excitation voltage that can be provided by the DBK43A excitation regulator is: 0.05 × R (where R = the resistance in ohms of 1 element in the bridge circuit).

CAUTION

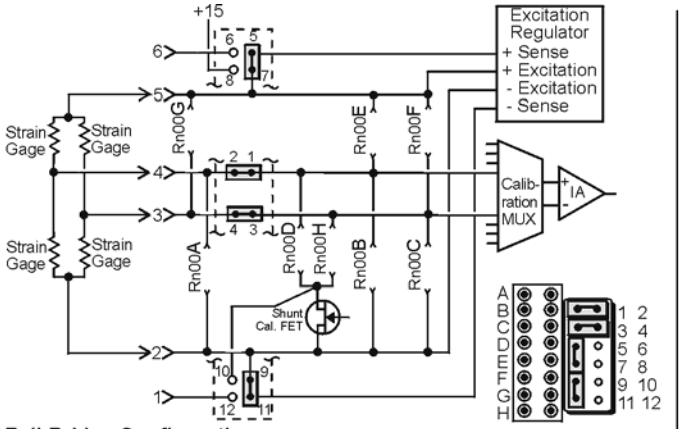
Setting the excitation voltage above the maximum voltage allowed can cause the DBK43A to fail. The maximum allowable excitation voltage is determined by the following equation.

$V_{MAX[EXC]} = 0.05 \times R$

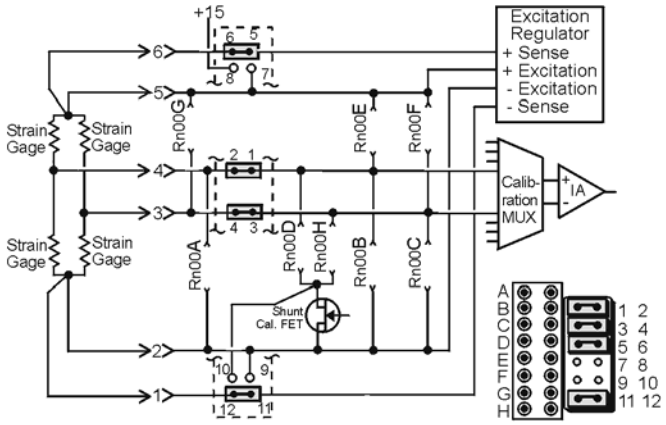
R is the resistance in ohms of 1 element in the bridge circuit.

The following full-page figure shows various strain-gage configurations.

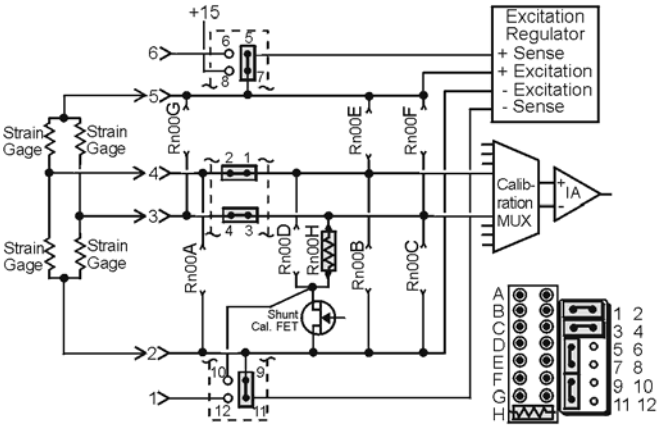
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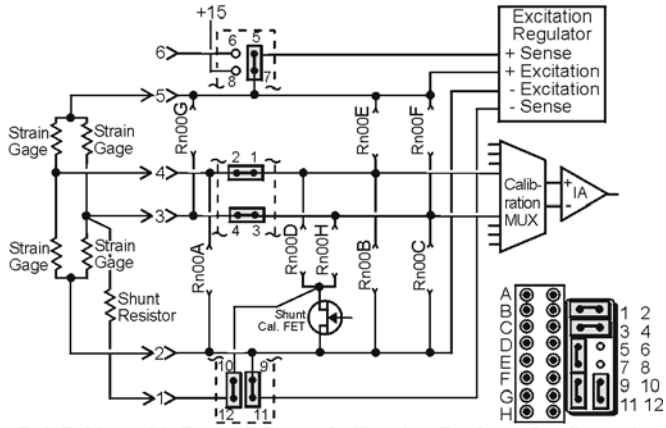
Full-Bridge Configuration



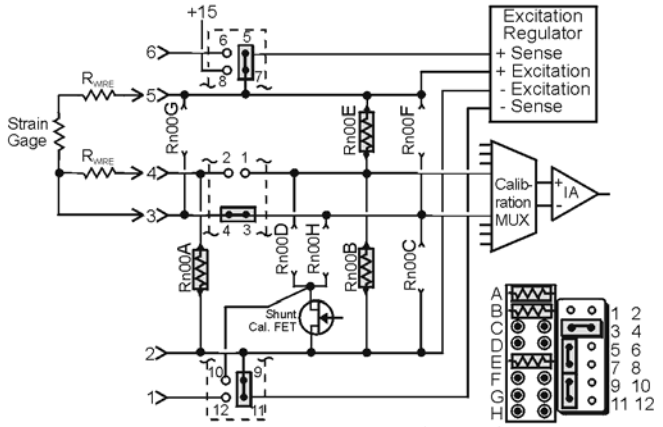
Full-Bridge with Remote Excitation Sensing Configuration



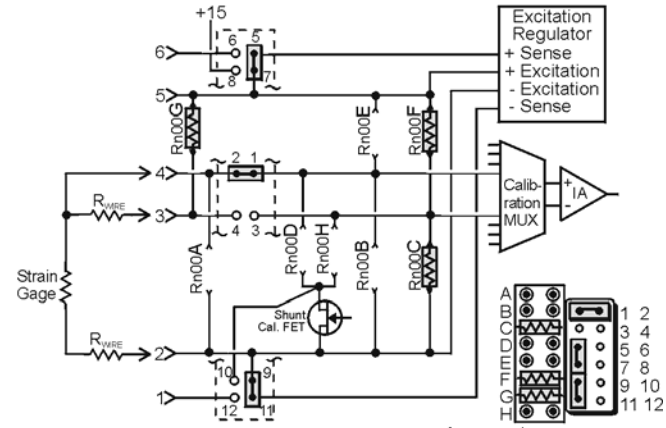
Full-Bridge with Internal Shunt Calibration Resistor Configuration



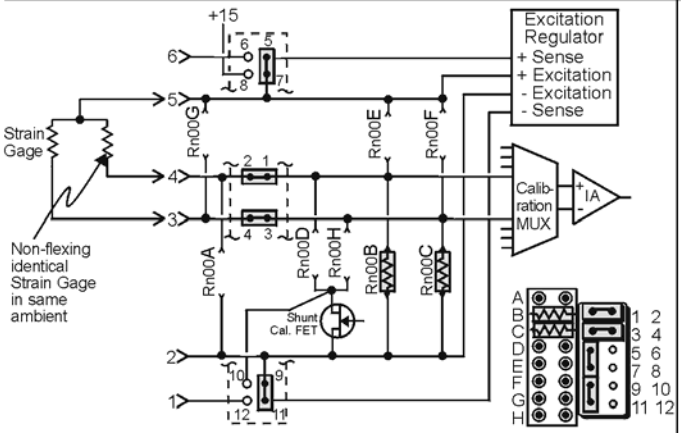
Full-Bridge with Remote Shunt Calibration Resistor Configuration



3-Wire Quarter (-)Bridge Configuration ($\Delta R\uparrow \rightarrow \Delta E_{OUT}\uparrow$)



3-Wire Quarter (+)Bridge Configuration ($\Delta R\downarrow \rightarrow \Delta E_{OUT}\uparrow$)



3-Wire Temperature-Compensated Half-Bridge Configuration ($\Delta R\uparrow \Rightarrow \Delta E_{OUT}\uparrow$)

Configuration Notes:

Solder the resistors to the supplied plugs in the positions indicated for your configuration.

1- Handle plugs with care to avoid damaging pins.
2- To prevent heat damage to the plug and ensure proper fit, perform soldering with plug in a mating socket.
3- To prevent contact with other components, snip resistor leads after soldering, just long enough to mount on the forked support.
4- Install or remove these pre-configured plugs into the appropriate sockets as needed.

Bridge-completion resistor values are typically 350±0.1% ohm or 120±0.1% ohm. Use the resistor value to match the particular strain gage in use.

DBK43A Bridge-Configuration Settings

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Input Configuration Headers

Eight 2×6 pin-headers with pin numbers 1 to 12 are on the board, 1 for each channel designated H100 (channel 0) to H800 (channel 7). The user can position jumpers on this header to configure inputs from a variety of bridge types.

- Jumping header pins 1-to-2 and 3-to-4 connects the +Vin and -Vin to the calibration MUX for different bridge configurations.
- Jumping pins 5-to-7 and 9-to-11 allows **internal sense regulation** of the excitation regulator.
- Jumping pins 5-to-6 and 11-to-12 allows for **remote excitation sensing**.
- Jumping pin 10-to-12 allows the use of a remote shunt-calibration resistor.

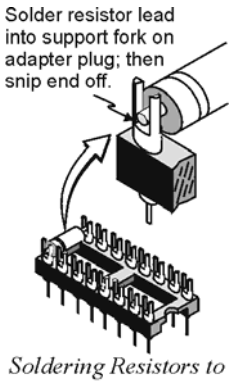
See previous figure for header configurations that correspond with different bridge-wiring schemes.

Resistor Sockets and Adapter Plugs

Eight 2×8 resistor sockets with rows numbered A to H are on the board; 1 socket for each channel and designated R100 (channel 0) to R800 (channel 7). An adapter plug for soldering resistors is included for each channel; user-soldered plugs facilitate changing configurations as needed.

- Bridge-completion resistors include: Rn00B, Rn00C, Rn00E, and Rn00F. Resistors Rn00A and Rn00G are used to complete 3-wire strain-gage configurations.
- Rn00D and Rn00H are internal shunt resistors from +V in and -V in respectively to -excitation.

Just inserting resistors into the socket makes an unreliable connection and is not recommended. To achieve a reliable connection, solder resistors to the adapter plug to match the proper row as shown in the previous figure, *DBK43A Bridge-Configuration Settings*. Soldering should be done with the plug inserted into the resistor socket; otherwise, heat from soldering can distort the shape of the plug. After soldering, the resistor leads should be snipped off close to the support to prevent contact with other components.



Soldering Resistors to Adaptor Plug



Handle the adaptor plugs with care to prevent pin damage.

Shunt-Calibration Resistors

The DBK43A provides physical locations for internal shunt-calibration resistors. Each channel has resistor locations that can be shunted across one or the other of the lower bridge arms by a hardware and software-accessible solid state switch (FET transistor) to create a repeatable bridge imbalance with a precision resistor.

For any balanced bridge, a resistance value can be applied in parallel with one of the four bridge elements to create a predictable imbalance and output voltage. For example, a 350Ω 2mV/V strain gage will deliver full output if one arm drops by 0.8% (about 2.80Ω) to 347.2Ω. A 43.4 KΩ resistance shunted across one or the other lower bridge elements will result in full-positive (Rn00H) or full-negative (Rn00D) output. For best results, Rn00H and Rn00D should be across the strain element when it is switched in.

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A formula used to calculate the shunt-cal resistance value is:

$$R_{Shunt} = [R_{Gage} / F_G(\varepsilon)] - R_{Gage}$$

Where:

R_{Shunt} = the shunt calibration resistor value
R_{Gage} = the resistance of the gage
F_G = the gage factor
ε = the strain value of the gage

Example:

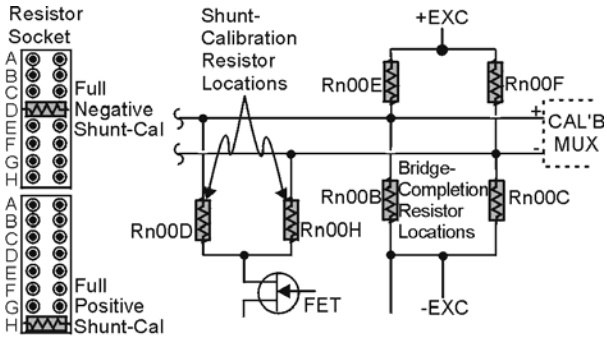
An engineer wants to know the shunt calibration resistor value for a strain gage with the following parameters.

resistance: 120 Ω
gage factor: 2.0
strain: 5000 micro-strain, i.e., 5000 x 10^{-6}

Plugging the values into the equation, we get:

$$R_{Shunt} = [R_{Gage} / F_G(\varepsilon)] - R_{Gage}$$
$$= [120 / 2.0(5000 \times 10^{-6})] - 120$$
$$= [120 / .01] - 120$$
$$= 12000 - 120$$
$$= 11{,}880\ \Omega$$

In all cases, the resistance of the solid-state switch will be negligible when compared to the shunt resistance. Changing the CAL/NORM switch (on the rear panel) to the CAL position while reading the bridge will activate the shunt-calibration resistors. After reading the offset, return the switch to the NORM position for normal bridge readings.



Shunt-Calibration Resistors can be used with any full-, half-, or quarter-bridge configuration.

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AC Coupling and Low-Pass Filter Options

Per channel, the DBK43A accommodates coupling and low-pass filter options including:

- AC coupling, or DC coupling
- Using or bypassing the filter
- Choice of the filter's corner frequency via a SIP resistor network
- Filter gain (default of ×2 can be changed to ×1).

The AC coupling, or DC coupling choice on each channel is set by the presence or absence of shunt jumpers on 2-pin headers. If the shunt jumper is in place, the coupling is DC. If the shunt jumper is absent, the coupling is AC. See table for channels and corresponding headers.

Channel	Header
0	JP103
1	JP203
2	JP303
3	JP403
4	JP503
5	JP603
6	JP703
7	JP803

The choice of using or bypassing the low-pass filter for each channel is made by the orientation of two shunt jumpers on a 2×2 pin header. When the shunt jumpers are oriented horizontally (like the "bypass" symbol on the circuit board) the filter is bypassed. When the shunt jumpers are oriented vertically (like the "filter" symbol), the filter is in the signal path.

Channel	Header
0	JP104
1	JP204
2	JP304
3	JP404
4	JP504
5	JP604
6	JP704
7	JP804

The corner frequency of a low-pass filter is determined by three resistor values in each filter circuit. The resistors are listed in the following table. These resistor locations have been physically arranged to allow the use of a 6-pin SIP network as a convenient means of changing all 3 resistors. The machined-pin socket will also allow you to insert individual resistors.

Channel	Resistors
0	R105-R106-R107
1	R205-R206-R207
2	R305-R306-R307
3	R405-R406-R407
4	R505-R506-R507
5	R605-R606-R607
6	R705-R706-R707
7	R805-R806-R807

The next table is a list of some common frequencies, the nominal resistance value, and a Bourns part number for a suitable network.

Frequency	Resistance (Ω)	Bourns P/N
133kHz	10	4606X-102-100
66.7kHz	20	4606X-102-200
26.6kHz	50	4606X-102-500
13.3kHz	100	4606X-102-101
6.67kHz	200	4606X-102-201
2.66kHz	500	4606X-102-501
1.33kHz	1K	4606X-102-102
667Hz	2K	4606X-102-202
266Hz	5K	4606X-102-502
133Hz	10K	4606X-102-103
66.7Hz	20K	4606X-102-203
26.6Hz	50K	4606X-102-503
13.3Hz	100K	4606X-102-104

The active low-pass filters on the DBK43A have a gain of ×2. This gain can be factored into the setup calculations, or the filter gain can be changed to ×1. To change the gain to ×1 (unity) for the corresponding channels, de-solder (or snip leads) and remove the resistors shown in the table.

Note: The default ×2 gain option meets the needs of most applications.

Channel	R (10K)
0	R144
1	R244
2	R344
3	R444
4	R544
5	R644
6	R744
7	R844

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P1 Output Channel and Card Address Selection

All 8 channels on the DBK43A are multiplexed into 1 of the LogBook or Daq Device base channels (0 to 15). The base channel (that the DBK43A is multiplexed into) is set by the shunt jumper on the 16×2 header designated JP1.

Each base channel can have up to 16 expansion channels multiplexed into it. Since the DBK43A represents 8 expansion channels, 2 DBK43A modules can be multiplexed into each LogBook base channel. To distinguish channels, there is a 3-pole header (designated J2) with a shunt jumper that can be placed in 1 of 2 positions for either LOWER (0 to 7) or UPPER (8 to 15) expansion channels.

With the LogBook or Daq device's 16 base channels, up to 32 DBK43As can be used for a maximum of 256 channels. These channels are identified differently in the API for custom programming and in DaqView and GageCal.

For the API, the base channels are designated 0 to 15; and expansion channels are designated 16 to 271. Channel 16 is the first channel on the first expansion board (for DBK43A, channel 0 on lower DBK43A with JP1 set to CH0) and channel 271 is the last channel on the last expansion board (for DBK43A, channel 7 on upper DBK43A with JP1 set to CH15). The table shows the base channel and the first expansion channel number (N) associated with that particular base channel. To calculate the actual input channel, add "N" to "n". (If J2 is set to LOWER, the n-values for input channels 0 to 7 range from n = 0 to n = 7; if J2 is set to UPPER, the n-values range from
n = 8 to n = 15.) This expansion channel number is also needed when writing a program to read from that particular channel.

Daq Device 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

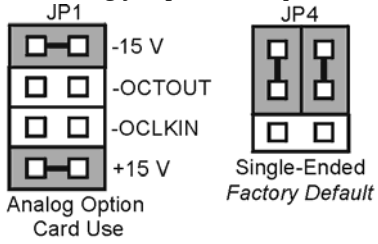
For DaqView , LogView and GageCal, these same 256 channels are identified from ch0-0-0 to ch15-2-7. The first field (0 to 15) is the base channel; the second field is the lower (1) or upper (2) sub-channel selected on J2; and the third field (0 to 7) is the 8 channels on a single DBK43A.



Reference Note:
For more information on channel multiplexing, refer to Chapter 1, *Signal Management.*

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

Use of the DBK43A requires setting jumpers in DaqBooks/100 Series & /200 Series devices



DaqBook/DaqBoard Jumpers for DBK43A

and ISA-type DaqBoards.

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 DBK43A via the internal ±15 VDC power supply. If using auxiliary power (DBK32A or DBK33), you must remove both JP1 jumpers. Refer to *Power Management* in the *DBK Basics* section [at the front of the manual] and to the DBK32A and DBK33 document modules as needed.

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

Note: To use a DBK43A with a Daq PC-Card, you must an appropriate power module must be used.

DaqBook/2000 Series and DaqBoard/2000 Series Configuration

No Jumper configurations are required for these /2000 series devices.

Hardware Adjustment

Bridge circuit transducers are used for many different applications, and the DBK43A is flexible enough to support most of them. Each DBK43A 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.

Trimpots

The DBK43A's front panel has a slot to allow access to 4 potentiometers to trim (adjust) the accuracy for each channel circuit. The trimpots are labeled to represent the following adjustments:

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

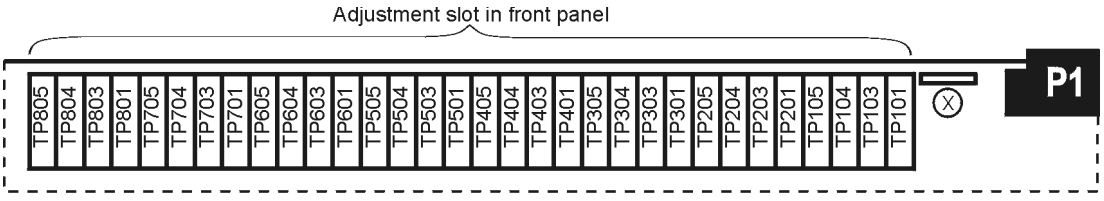
GAIN **for setting the gain of the input amplifier**

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

SCALE **for setting the gain of the scaling amplifier**

Trimpot	Channel Number							
	CH0	CH1	CH2	CH3	CH4	CH5	CH6	CH7
EXC	TP101	TP201	TP301	TP401	TP501	TP601	TP701	TP801
GAIN	TP104	TP204	TP304	TP404	TP504	TP604	TP704	TP804
OFFSET	TP103	TP203	TP303	TP403	TP503	TP603	TP703	TP803
SCALE	TP105	TP205	TP305	TP405	TP505	TP605	TP705	TP805

The figure shows trimpot locations.



DBK43A Trimpot Locations

CAL/NORM Switch

The CAL/NORM switch is located between the CH7 input and the power LED on the rear panel.

- In the NORM position, the function of the primary data acquisition is identical with that of the DBK43.
- In the CAL position, the shunt calibration offset and the excitation voltage can be read depending on the software function control described next.

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Software-Controlled Setup

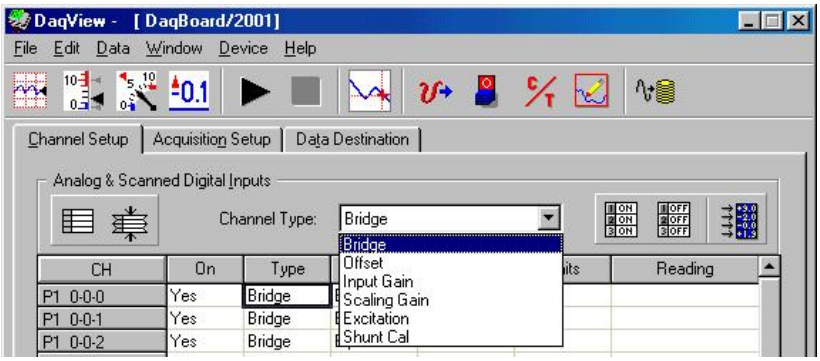
Proper setup includes the use of software to control the calibration multiplexer in each circuit. The calibration multiplexer is used to switch the bridge circuit out and apply internal reference voltages to the input for use in the DBK43A setup. The calibration multiplexer also allows the recording of the individual adjustments.

The next two tables identify functions available through DaqView and LogView, respectively. Note that DaqView uses the term "Channel Type;" and LogView uses the term "Mode." The tables include equations in which "V_{OUT}" (voltage out) represents the voltage recorded by the primary data acquisition device, i.e., a LogBook, DaqBook, DaqBoard, or other Daq device.

Selecting Channel Types in DaqView

Reference Notes:

- LogView user's refer to *Selecting Channel Modes in LogView* on page DBK43A-14.
- Typical setup steps with embedded examples begin on page DBK43A-15. The steps can be used for LogBook and Daq device applications.



Selecting Channel Type for DBK43A In DaqView

Using DBK43A Channel Types in DaqView		
Channel Type	**CAL/NORM Switch[1]**	**Function and Associated V_{OUT} Equation**
Bridge	NORM	Sets the channel to read the value of the bridge circuit with all gains and offsets in effect. This is the normal operation. Vout = (Scaling Gain)(Filter Gain*)[(InputGain)(bridge circuit voltage) - offset voltage]
Offset	NORM	Applies a grounded input to the channel. Sets the channel to read the circuit offset voltage multiplied by the input amplifier and the low-pass filter gain. Vout = (Filter Gain*)(Input Gain)(-offset voltage)
Input Gain	NORM	Applies 5 mV to the input channel. Sets the channel to read the voltage out of the circuit through the input gain amplifier and the low-pass filter [if enabled]. Vout = (Filter Gain*)(Input Gain)(5 mV) - offset voltage
Scaling Gain	NORM	Applies 5 mV to the input channel. Sets the channel to read the voltage out of the circuit through the input gain amplifier, the low-pass filter [if enabled], and the scaling gain amplifier. Vout = Filter Gain*(Scaling Gain[(Input Gain)(5 mV) - offset voltage])
Excitation	CAL	Sets excitation. Vout = (Excitation Voltage)
Shunt Cal	CAL	Activates shunt-cal resistors. Vout = (Scaling Gain)(Filter Gain*)[(Input Gain)(bridge circuit voltage with shunt) - offset voltage]

[1]The physical CAL/NORM Switch [on the DBK43A Module] is located next to the Power LED.

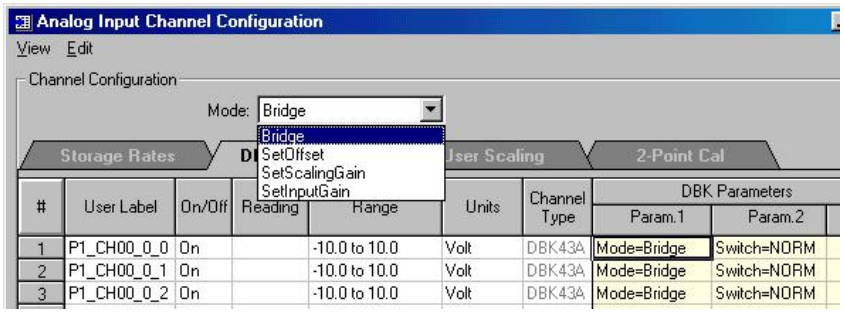
* In the equations, the asterisk indicates the conditional clause, "if the filter is enabled."

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Selecting Channel Modes in LogView

Reference Notes:

- DaqView users refer to *Selecting Channel Types in DaqView* on page DBK43A-13.
- Typical setup steps with embedded examples begin on page DBK43A-15. The steps can be used for LogBook and Daq device applications.



Selecting Channel Mode for DBK43A In LogView

Using DBK43A Channel Modes in LogView		
Mode	**CAL/NORM Switch[1]**	**Function and Associated V_{OUT} Equation**
Bridge	NORM	Sets the channel to read the value of the bridge circuit with all gains and offsets in effect. This is the normal operation. Vout = (Scaling Gain)(Filter Gain*)[(InputGain)(bridge circuit voltage) - offset voltage]
SetOffset	NORM	Applies a grounded input to the channel. Sets the channel to read the circuit offset voltage multiplied by the input amplifier and the low-pass filter gain. Vout = (Filter Gain*)(Input Gain) - offset voltage
SetInputGain	NORM	Applies 5 mV to the input channel. Sets the channel to read the voltage out of the circuit through the input gain amplifier and the low-pass filter [if enabled]. Vout = (Filter Gain*)(Input Gain)(5 mV) - offset voltage
SetScaling Gain	NORM	Applies 5 mV to the input channel. Sets the channel to read the voltage out of the circuit through the input gain amplifier, the low-pass filter [if enabled], and the scaling gain amplifier. Vout = Filter Gain*(Scaling Gain[(Input Gain)(5 mV) - offset voltage])
Excitation	CAL	Sets excitation. Vout = (Excitation Voltage)
Shunt Cal	CAL	Activates shunt-cal resistors. Vout = (Scaling Gain)(Filter Gain*)[(Input Gain)(bridge circuit voltage with shunt) - offset voltage]

[1]The CAL/NORM Switch is located on the DBK43A Module, next to the Power LED.

* In the equations, the asterisk indicates the conditional clause, “if the filter is enabled.”

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A Typical Setup Procedure, with Embedded Examples



Reference Notes:

- Prior to using DBK43A with DaqView you must select the DBK43A from DaqView's ***Configure Hardware Settings*** screen. If needed, refer to Chapter 3, *DBK Setup in DaqView*.
- Prior to using DBK43A with LogView you must select the DBK43A from LogView's ***Hardware Configuration*** screen. If needed, refer to Chapter 4, *DBK Setup in LogView*.
- The board layout on page DBK43A-5 can be referred to for jumper locations, jumper setting orientations, and trimpot locations.
- For **Calibration of DBK43A** – DaqView users should refer to the *GageCal* segment beginning on page DBK43A-19 . LogView users should refer to the section titled *Calibrating DBK16 and DBK43A for LogBook Applications*, beginning on page DBK43A-23.

1. Verify that the low-pass filters are set to BYPASS. The filters are set via jumpers JPn04 where n is the channel number (1 through 8); for example, JP104 sets the filter for channel 1, and JP804 sets the filter for channel 8.

   Note: If you plan to use filters during your acquisition, you should still select BYPASS at this point. Enabling the filters comes into play later in the procedure. However, if you do plan to enable filters, note the gain in the filter stage (default ×2, or ×1 with resistor removed) and allow for it in your setup.

2. Coupling is set via jumpers JPn03 where n is the channel number (1 through 8). Verify that the "Coupling" jumpers are installed. When installed, the channels are set for DC coupling.

   Note: If you plan to use AC Coupling during your acquisition, you should still select DC Coupling at this point. Selecting AC Coupling comes into play later in the procedure.

3. Determine the *excitation for the transducer*. This is based on the transducer specifications and from the current limitations of the DBK43A excitation regulator.

4. Determine the *maximum voltage* that can result from the transducer for a strain gage or for a load cell. The values can be calculated as follows:

   Strain Gage Example

   Most strain gages come with Gage Factors (GF). To calculate the approximate output of the bridge circuit with a typical strain value, use the formula:

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

   In this strain gage example, lets assume the following:

   - We have a 120 ohm strain gage.
   - The gage factor is 2.1.
   - The excitation voltage is 5 V. This is due to the current limitation of the excitation regulator on the DBK43A [note that the excitation voltage must be less than 6 V]
   - We are measuring 4000 micro-strain

   By applying these values to the preceding equation we find that the bridge output voltage is 10.5 mV.

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

   *linear estimate (some strain gages are not linear); refer to strain-gage theory for more information.

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Load Cell Example

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. The following equation applies:

Load Cell Output Voltage = ($Load_{Applied}/Load_{Rated}$)(Excitation Voltage)(Load Cell Rating)

For this example, lets assume the following:

- We have a 350 ohm, 3000 pound load cell.
- The load cell is rated at 2.05 mV/V
- We are using an excitation of 10 V

By applying these values to the preceding equation we find that the Load Cell Output Voltage is 20.5 mV.

$$\textbf{Load Cell Output Voltage} = (3000/3000)(10)(2.05\times10^{-3}) = \textbf{20.5 mV}$$

For 1000 pounds applied load, the Load Cell Output Voltage would be one third of the 20.5 mV value, i.e., 20.5 mV/3 = 6.833 mV. If we used the entire equation we would see:

$$\textbf{Load Cell Output Voltage} = (1000/3000)(10)(2.05\times10^{-3}) = \textbf{6.833 mV}$$

Now that we know our sensor's full-scale voltage, we can calculate the DBK43A's voltage gain. The proper voltage gain allows the full-scale sensor output to correspond to the full-scale input of the data acquisition device. Full-scale 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 Series in unipolar mode
-10 to +10 V for DaqBoard/2000 Series in bipolar mode and for Daq PC-Card
-10 to +10V for LogBooks in bipolar mode
0 to +20 V for LogBooks in unipolar mode

5. Calculate the *channel total gain* based on the full-scale LogBook or Daq device.

   The following equation is used to calculate DBK43A total gain.

   $Gain_{TOTAL}$ = (Sensor Output $Voltage_{FULL\text{-}SCALE}$ – $Voltage_{OFFSET}$) / Strain or Load $Voltage_{OUTPUT}$

   In this example we will use:

   - a full-scale sensor output voltage of +5 V [for a DaqBook in bipolar mode].
   - a 0.5 V offset (from full-scale) to prevent saturation
   - the 10.5 mV Bridge Output Voltage [for 4000 microstrain] from Example 1.

   Using the gain equation we get:

   $$\textbf{Gain}_{TOTAL} = (5.0\text{ V} - 0.5\text{ V}) / 10.5\text{ mV} = 4.5\text{ V} / 0.0105\text{ V} = 428.6$$

6. Determine how the total gain will be distributed between the input amplifier gain, filter gain, and scaling amplifier gain.

   An Example of Total Gain Distribution: If we round the gain of x428.6 [calculated in the previous step] down to ×420, then the gain distributions indicated by the following table are possible.

Gain Distribution Options for a Total Gain of x420				
Gain Stage & Associated Range	**Possible Gain Distributions**			
	Option A	**Option B**	**Option C**	**Option D**
Input Gain x100 to x1250	×420	×100	×240	×300
Filter Gain x1 or x2	Disabled	×2	×1	Disabled
Scaling Gain x1 to x10	×1	×2.1	×1.75	×1.4
Total Gain	×420	×420	×420	×420

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After we decide on a distribution option, the sensor can be hooked up to the DBK43A, the bridge completion resistors can be installed, the excitation voltage set, followed by setting the gains. In this example we will be using DaqView. Steps for other programs will be similar.

7. Connect the transducer to the DBK43A according to the figures in the *Signal Connection* (page 4) and *Bridge Applications* (page 5). Install the appropriate bridge-completion resistors if applicable.

8. Adjust the **Excitation** voltage.
   Note: For DaqView versions 5.05 and higher the reading will already be correctly scaled.
   (a) Set the DBK43A's CAL/NORM switch to "CAL." In addition, LogView users set the software CAL/NORM switch, in Hardware Configuration, to "CAL."
   (b) Select "Excitation" for the Channel Type.
   (c) With the Reading column enabled, set the excitation voltage for the transducer by adjusting the trimpot labeled EXC. Note that each of the eight channels has a channel-specific trimpot for excitation.
   (d) After the excitation voltage is set, stop the Readings.
   (e) Return the CAL/NORM switch to the NORM position. In addition, LogView users set the software CAL/NORM switch to "NORM."

9. Adjust the **Offset**.
   (a) Verify that the DBK43A's CAL/NORM switch is in the NORM position. In addition, LogView users verify that the software CAL/NORM switch is selected to "NORM."
   (b) DaqView user's: select "Offset" for the Channel Type.
   LogView users: select "SetOffset" for the Mode.
   (c) With the Reading column enabled, adjust the OFFSET trimpot (OFST) to obtain a channel reading of 0.00 volts. This removes all offset from the DBK43A channel circuit. Note that each of the eight channels has a designated, channel-specific, trimpot for offset.
   (d) After the Offset is adjusted to 0.00, stop the Readings.

10. Adjust the **Input Gain**.
    (a) DaqView users: select "Input Gain" for the Channel Type.
    LogView users: select "SetInputGain" for the Mode.
    (b) With the Reading column enabled, adjust the GAIN trimpot to obtain a voltage reading equal to 0.005 x G_I, where "G_I" is the desired input amplifier gain. Note that each of the eight channels has a channel-specific trimpot for Input Gain.
    (c) Stop the Readings.



For very high system gains you may need to first, set the Input Gain low, then set the Scaling Gain, and then reset the Input Gain.

Typical input gain settings are shown in the following table.

Input Gains and Typical Readings	
Input Gain	**Reading**
x100	0.5 volts
x200	1.0 volts
x300	1.5 volts
x400	2.0 volts
x500	2.5 volts
x600	3.0 volts
x700	3.5 volts
x750	3.75 volts
x800	4.0 volts
x900	4.5 volts
x1000	5.0 volts
x1200	6 volts *

* requires primary acquisition device to be in unipolar mode.

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11. Adjust the **Scaling Gain**.
    (a) DaqView users: select "Scaling Gain" for the Channel Type.
    LogView users: select "SetScalingGain" for the Mode.
    (b) With the Reading column enabled, adjust the SCALE trimpot (SCA) for a voltage reading equal to .005 x G_I x G_S, where "G_I" is the desired input amplifier gain and "G_S" is the desired scaling amplifier gain. Note that each of the eight channels has a channel-specific, trimpot for Scaling Gain.
    (c) Stop the Readings.

Scaling Gains Typical with an Input Gain of x200	
Scaling Gain	**Reading**
x2	2.0 volts
x4	4.0 volts
x6	6.0 volts*
x8	8.0 volts*
x10	10.0 volts*

* requires primary acquisition device to be in unipolar mode.

12. Adjust the **Offset** while the bridge circuit is being read.
    (a) Select "Bridge."
    (b) With the Reading column enabled, and 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.
    (c) After adjusting the Offset to 0.00, stop the Readings.



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, swap the V_{in}+ (4) and V_{in}- (3) wire connections, or reduce the Input Gain and increase the Scaling Gain.

13. *If required for your application*, enable the low-pass filters. The filters are set via jumpers JPn04 where n is the channel number (1 through 8); for example, JP104 sets the filter for channel 1, and JP804 sets the filter for channel 8.
14. *If required for your application*, set AC Coupling. Coupling is set via jumpers JPn03 where n is the channel number (1 through 8). To set AC Coupling, remove the JPn03 jumpers.
15. Calculate the LogBook or Daq device voltage/transducer units. Do this using the transducer specifications and the total gain of the DBK43A channel. Apply the units to your readings.
16. Verify the software settings by using a known load or strain and comparing the value to that observed in DaqView's Reading column.

Note: Gain adjustments can be made by activating a shunt-cal resistor that is calculated to be at maximum load.

To enable shunt-cal resistors:
    (a) Select "Shunt Cal" as the Channel Type.
    (b) Place the DBK43A's CAL/NORM switch in the CAL position.
    (c) LogView users: set the software CAL/NORM switch, in Hardware Configuration, to "CAL."

Settings can be verified via shunt-calibration.



After the final offset is made, the gain readings will be incorrect unless the circuit offset is removed.

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GageCal, Calibration Program for DBK16 and DBK43A in Daq Applications

GageCal is intended for DBK16, DBK43, and DBK43A load cell applications in conjunction with Daq devices.

GageCal is not used for LogBook applications.

GageCal is a calibration aid for use with DBK16, DBK43, and DBK43A devices that are being used in Daq device data acquisition systems. The program, which is independent of DaqView, provides an on-screen walk-through for setting jumpers, switches and adjusting trimpots.

With GageCal you can:

- Use a graphic representation of a strain-gage board as a guide to configure switches, jumpers, and other hardware settings.
- Enter all the parameters pertaining to your strain gage application.
- Follow step by step prompting to adjust trimpots for scale gain, input gain, and offset to ensure the channel provides the desired input range.

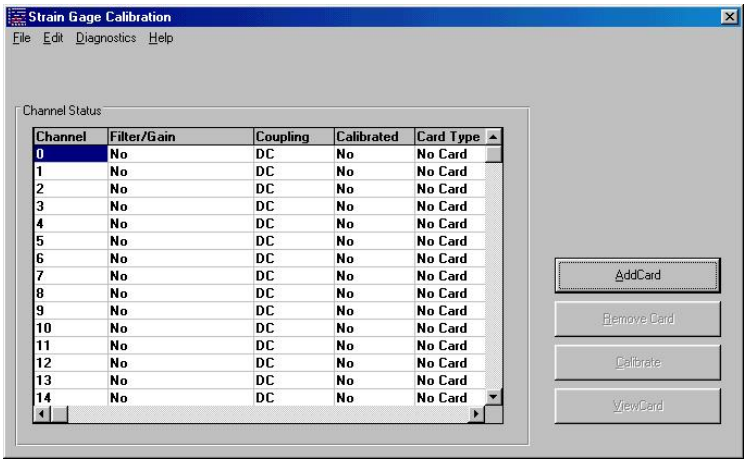
GageCal is installed from the Master Setup screen of the data-acquisition CD-ROM as part of the DaqBook/DaqBoard Support option. After your DaqBook/DaqBoard support has been installed you can access and use GageCal as follows.

1. Access GageCal from a desktop shortcut, or by navigating from the desktop as follows:
   Start ⇒ Programs ⇒ IOtech DaqXSoftware [or Omega DaqXSoftware] ⇒ GageCal
   A Select Device window will appear, similar to that shown in the following figure.



GageCal – Select Device

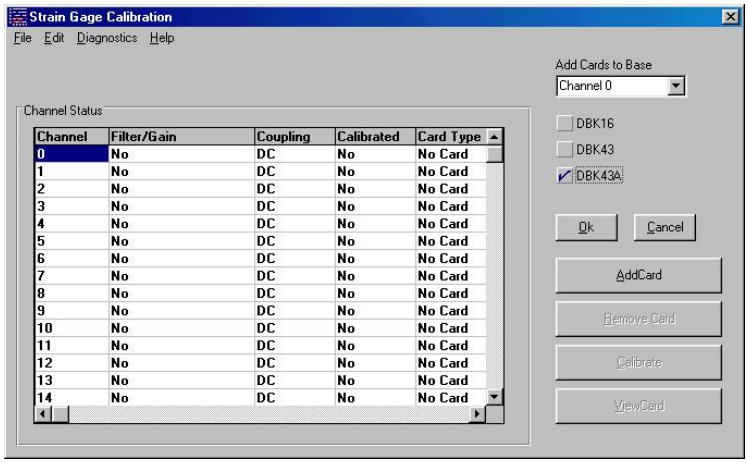
2. From the Select Device window, highlight the applicable DaqBook or DaqBoard, thin click the <OK> button. The Strain Gage Calibration window will appear.



GageCal's Strain Gage Calibration Window

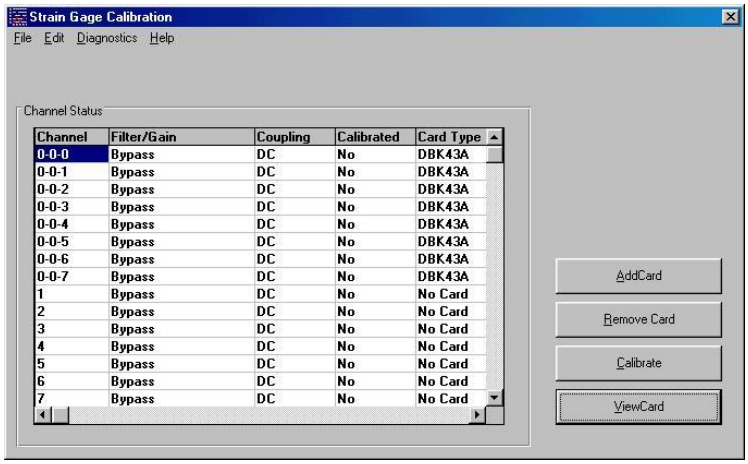
3. Click the <AddCard> button. Then select one of the following, as applicable: DBK16, DBK43, or DBK43A. See following figure.

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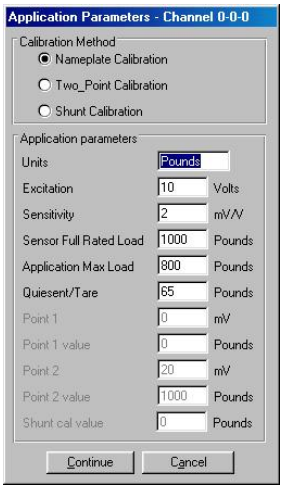
Selecting DBK43A

4. Click the <OK> button. The Strain Gage Calibration window will provide 3 digit channel numbers in the form of "n_1-n_2-n_3;" where n_1 is the card number, n_2- is the bank number on the card, and n_3 is the channel number. See following figure.



Strain Gage Calibration Window after Adding a Card

5. Click the <Calibrate> button. An Applications Parameter box appears. See following figure.



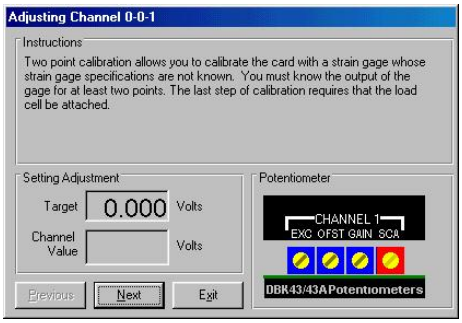
Application Parameters for Channel 0-0-0

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6. Select the type of calibration to be performed, i.e., Nameplate, Two-Point, or Shunt. Then edit the Application Parameters, if applicable. A brief description of the three calibration methods follows. When done, click the <Continue> button.

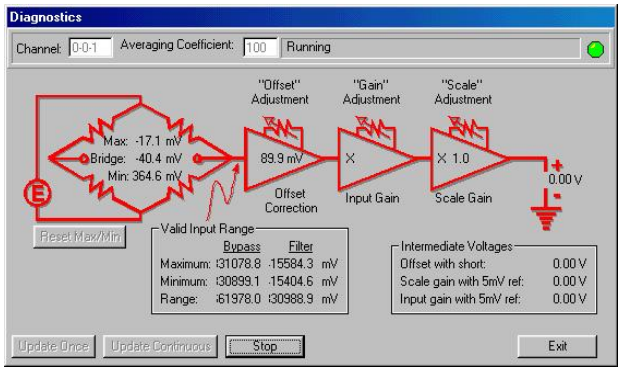
    - **Nameplate calibration** provides a way to enter parameters for your strain gage and its application. The final step of the procedure includes attaching the strain gage (load cell).
    - **Two-Point calibration** provides a way to calibrate a DBK16, DBK43, or DBK43A that is using a strain gage with unknown specifications. In this method, the user enters two points of transducer output [milli-volts] vs. engineering units, e.g., pounds. Gage call provides set up instructions based on the parameters entered. The final step of the procedure includes attaching the strain gage (load cell).
    - **Shunt calibration** provides a means calibrating channels with use of user-supplied shunts to simulate a physical load. With this method, 1 or 2 shunt resistors (Rn00D and Rn00H) are added for each of the 8 channels to be calibrated. You must set J3 to the position closest to TP9 for the shunt calibration to work correctly. Shunt calibration is performed with the load-cell attached.

7. Follow GageCal's screen prompts to complete the calibration.



Example Screen Shot from GageCal

Note: You can use GageCal's "Diagnostics" feature to view a graphic representation of the strain gage and the card's gain stages.



GageCal Diagnostics

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

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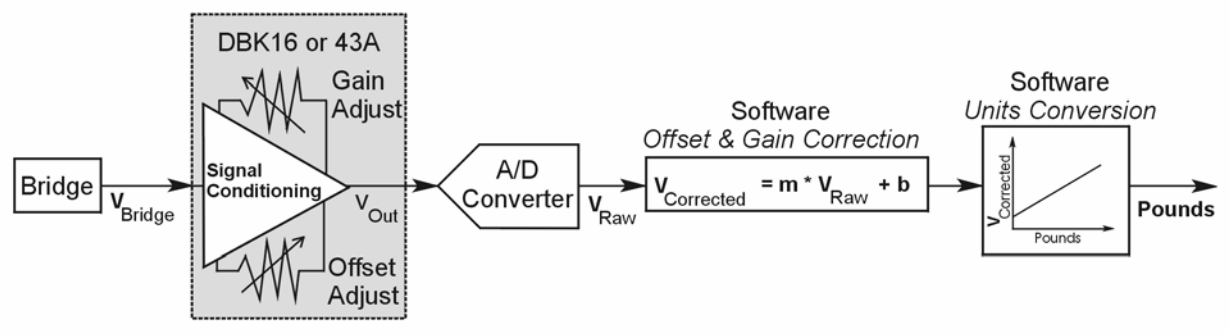
Calibrating DBK16 and DBK43A for LogBook Applications

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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.

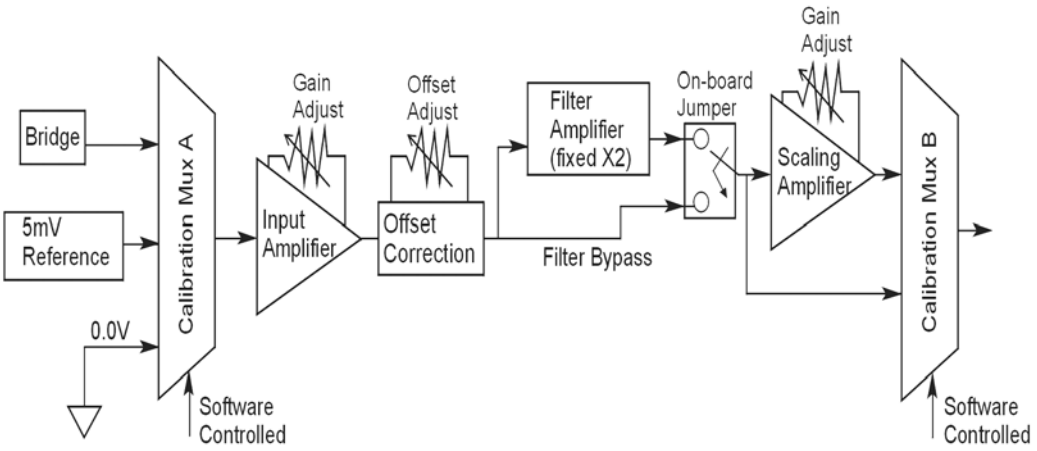
Bridge circuit transducers are used for many different applications, and the strain gage signal conditioning modules are flexible enough to support most of them. Each channel circuit has an excitation regulator, a high gain (x100 to x1250) input amplifier with offset adjustment, a low-pass filter, a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

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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.

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 – Used to setup the channel using 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 – Used to setup the channel using 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.

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Shunt – Used to setup the channel using a shunt resistor applied 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

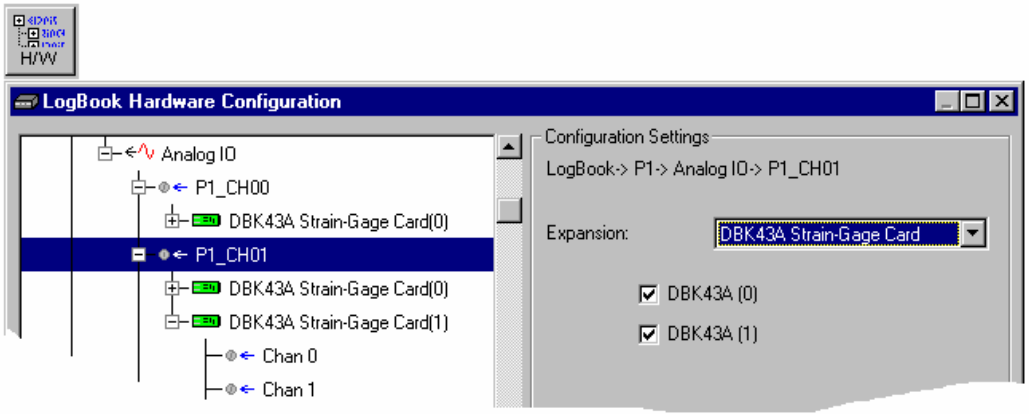
Since the applied calibration-signals are DC, set DC coupling for all the channels that are being adjusted. ***If your application requires AC coupling***, don't forget to remove the jumpers when the adjustment procedure has been completed.

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

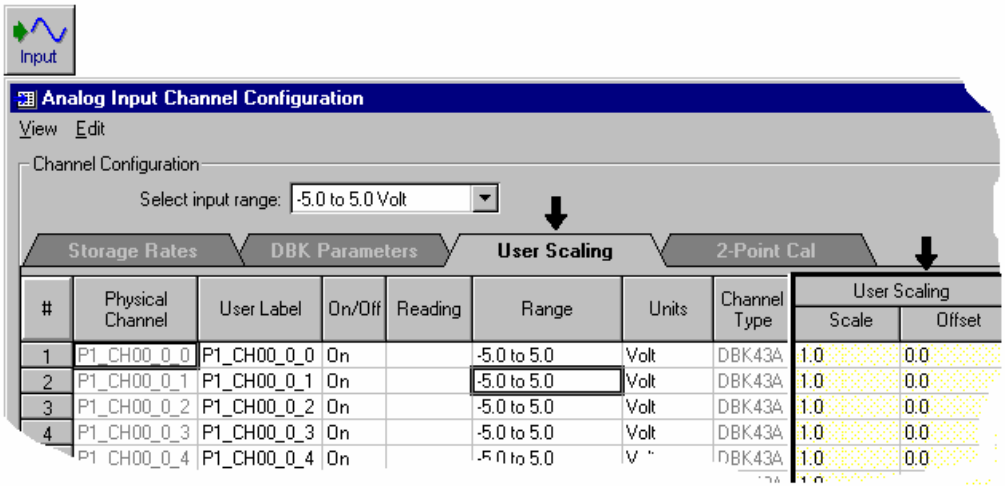
Launch LogView and use the *LogBook Hardware Configuration window* (hardware tree) to configure all of the DBK options that are to be used in the system. If needed, refer to the LogView chapter of the LogBook User's Manual (p/n 461-0901).



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.

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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 ±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.

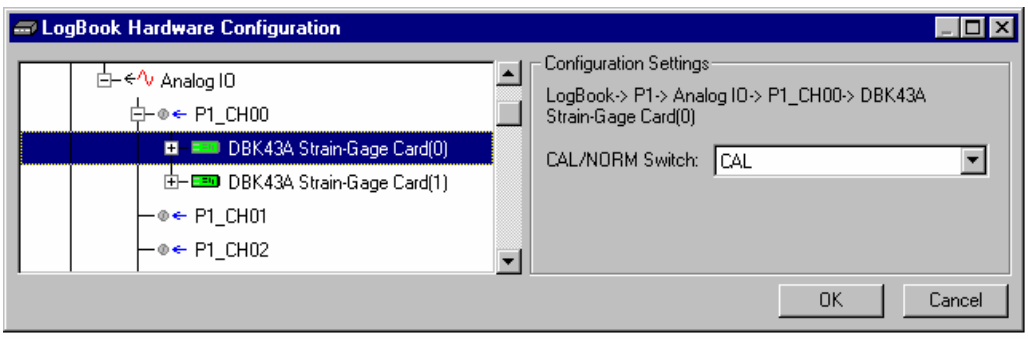
Adjust the Excitation - *DBK16*

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:

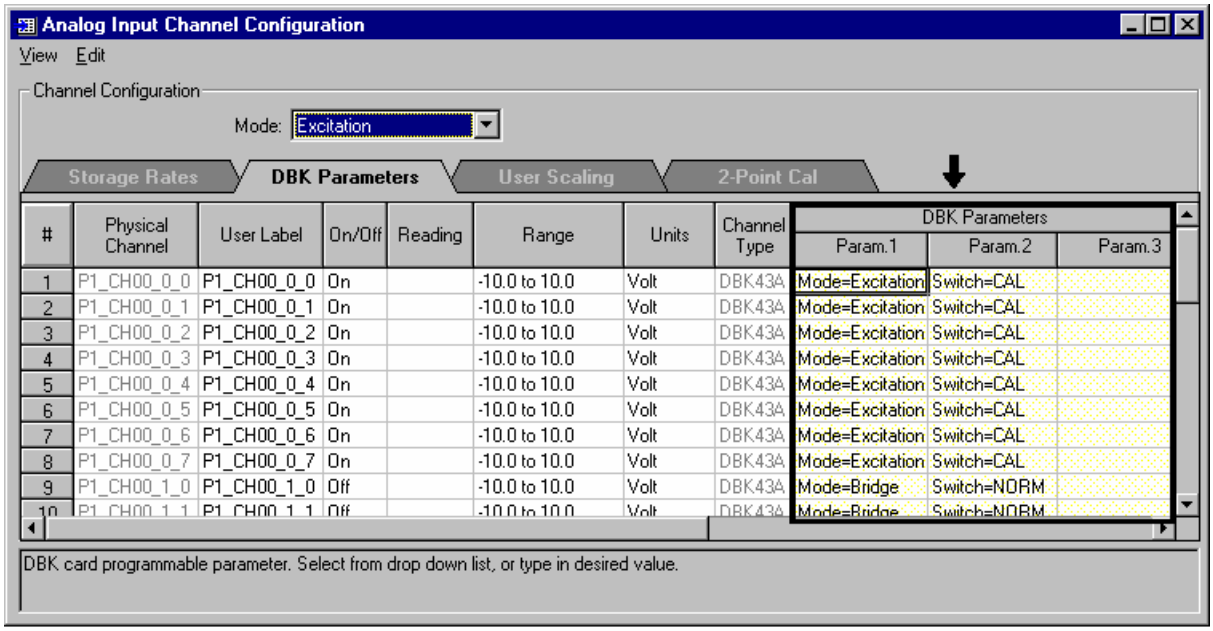
1. Reposition the DBK43A's "physical" calibration switch (located next to the Power LED) to the CAL position.
2. Select CAL in LogView. This is detailed in the following paragraph.
   Open the *LogBook Hardware Configuration window* and select DBK43A (see following figure). In the Configurations settings 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"

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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.

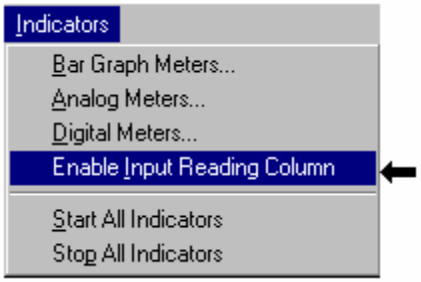


Selecting "Mode = Excitation" for DBK Parameter 1



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

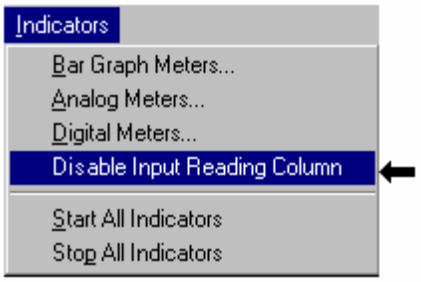
7. Select Indictors \ Enable Input Reading Column from the menu bar to display the excitation values for each channel.



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.

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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.

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

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:

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

Where: $\mathbf{V_{BR}}$ = Bridge output voltage

$\mathbf{V_{EXC}}$ = 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, $\mathbf{V_{BR} = (V_{EXC} * G * S * B) / 4}$ 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.

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

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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.

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

Where: $\mathbf{V_{LC}}$ = Load cell output voltage

$\mathbf{R}$ = Load cell spec (mv/V)

$\mathbf{V_{EXC}}$ = 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.

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

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

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

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 ±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.

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

Where: $\mathbf{G}$ = Gain

$\mathbf{V_{LB}}$ = LogBook input range

$\mathbf{V_{GO}}$ = Maximum gage output

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

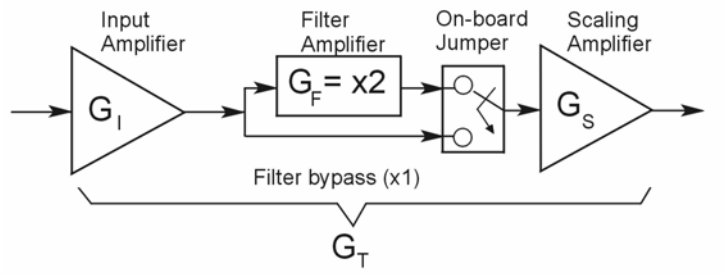
$$G = 5.0V / (0.0105V + 0.0105V * 0.05) = 453.5$$

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

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

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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 ±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.

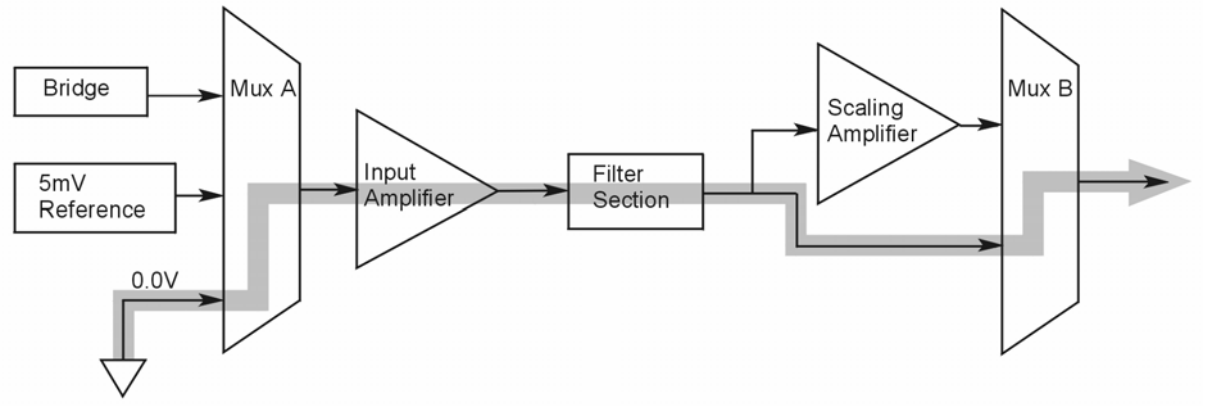
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Channel Calibration Procedure

Adjust the Offset

The following steps are used to adjust the offset.

1. In the Param1 column (see page 27 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.

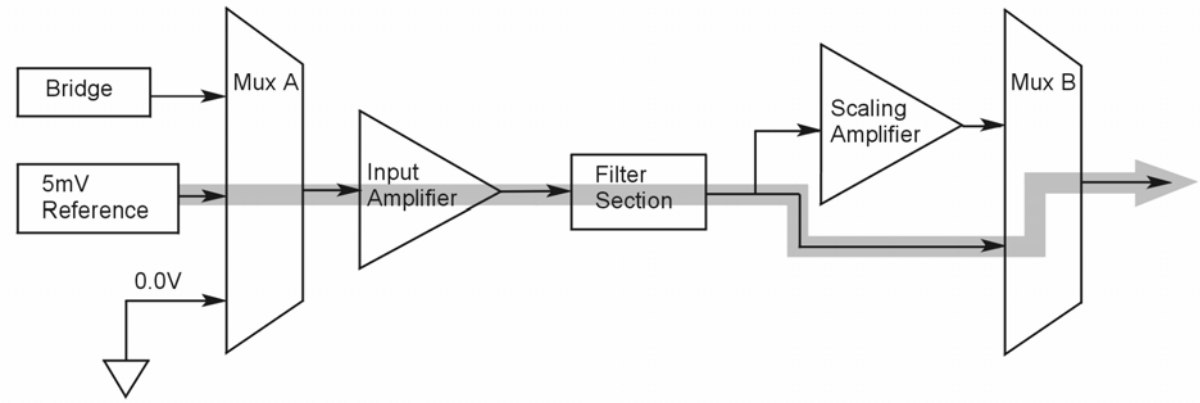
Adjust the Input Amplifier Gain

Perform the following steps to adjust the Input Amplifier Gain.

1. In the Param1 column (see page 27 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.

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"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.

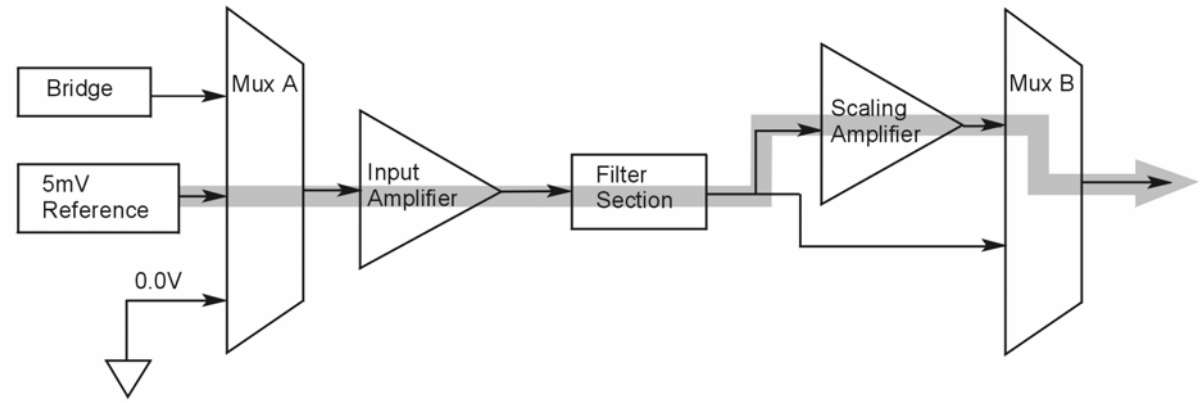
7. Select Indictors \ Disable Input Reading Column from the menu bar.

Adjust the Scaling Amplifier Gain

Adjust the Scaling Amplifier Gain as follows:

1. In the Param1 column (see page 27 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

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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.

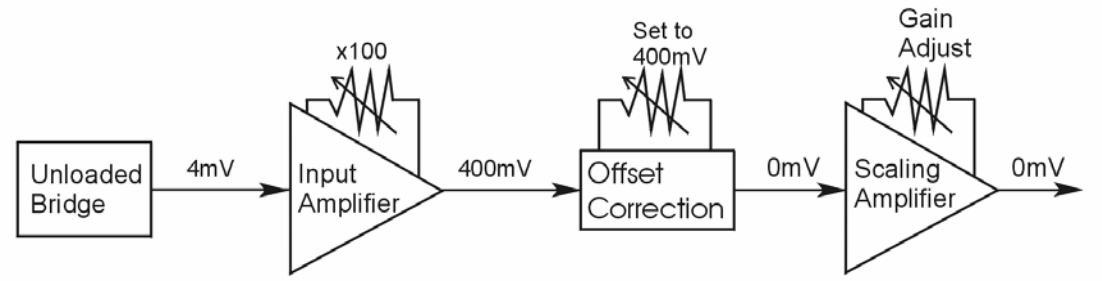
   Example: If G_T = 435.5, the SCALE trimpot would be adjusted to obtain 2.17 V.
7. Select Indictors \ Disable Input Reading Column from the menu bar.

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.



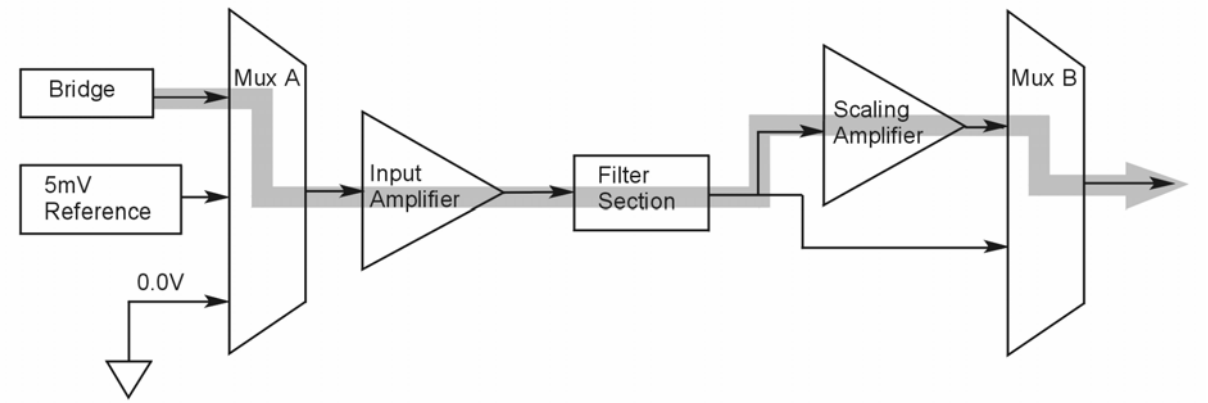
Trimming Bridge Quiescent Load

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 27 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.

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"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 27 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.

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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:

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

   Where: $\mathbf{V_D}$ = Desired voltage for 2nd point of calibration

   $\mathbf{L_A}$ = Applied load used in calibrating the 2nd point

   $\mathbf{L_M}$ = Maximum load expected during usage

   $\mathbf{V_I}$ = 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 ±5V. The desired output voltage of the strain gage signal conditioning electronics is:

   $$\mathbf{V_D = (100/150) * 5 * 0.90 = 3V}$$

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

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

$$\mathbf{V_D = (150/150) * 5 * 0.90 = 4.5V}$$

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.

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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 150 lbs. The programmable input range of the data acquisition system is set for ±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.

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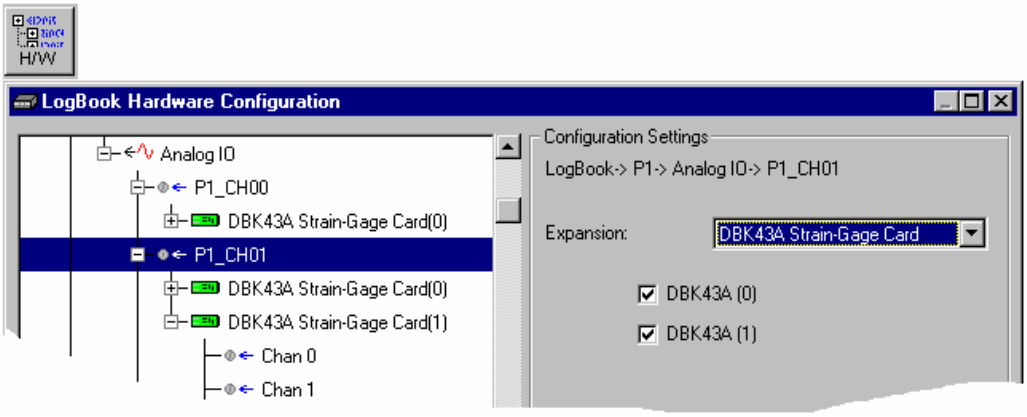
If 150lbs is applied to the gage, a voltage of 4.5V will be measured.

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

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.

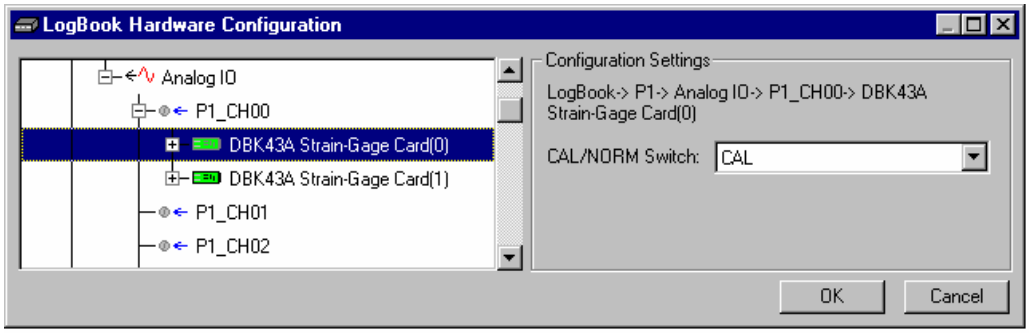
2. In LogView, open the *LogBook Hardware Configuration window* and select the DBK43A.



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 27 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.

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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.

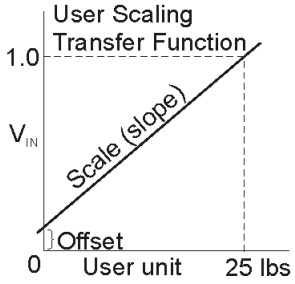
Storage | DBK Parameters | **User Scaling** | 2-Point Cal

#	Physical Channel	User Label	On/Off	Reading	Range	Units	Channel Type	User Scaling	
								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.

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DBK43A – Specifications

Name/Function: Strain-Gage Module

Connectors: DB37 mates with P1; mini-DIN6 provided for strain-gage or external excitation connections

Number of Channels: 8

Excitation Voltage Adjustment Ranges: 1.50 to 10.50 VDC @ 50 mA

Input Gain Range: ×100-1250; separate instrumentation amplifier for each channel with gain adjustable via externally accessible 15-turn trimpot

Accommodated Bridge Types:
Full bridge, Kelvin excitation (6-wire)
Full bridge (4-wire)
Half bridge (3-wire)
Quarter bridge (2-wire)

Bridge-Completion Resistors: On-board resistor socket locations (Rn00A, Rn00B, Rn00C, Rn00E, Rn00F, and Rn00G) for 6 bridge-completion resistors per channel

Input Type: Differential

Input Impedance: 100 MΩ

CMMR: 115 dB

Excitation Current Output: 50 mA max (current limited @ 60 mA)

Excitation Sensing: Local or remote

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

Reference Voltages: 2.5 VDC

Reference Accuracy: 0.05%

Reference Drift: 3 ppm/°C

Gain Calibration Reference: 5 mVDC

Gain Calibration Reference Accuracy: 0.2%

Gain Calibration Reference Drift: 20 ppm/°C

Gain Accuracy: 0.5%

Gain Drift: 50 ppm/°C

Input Offset: 100 µV max

Offset Drift: 4 µV/°C

Output Offset: 20 µV

Offset Drift: 200 µV/°C

Offset Adjustment: 0-100% of range, 0-5 VDC (15-turn trimpot)

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

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

Low-Pass Filter:
3-pole, user-selected
Corner frequency (Fc) set by user component
Attenuation -3 dB at Fc
Gain ×2

Power: 9 to 18 VDC, external supply provided, 16 Watts maximum

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