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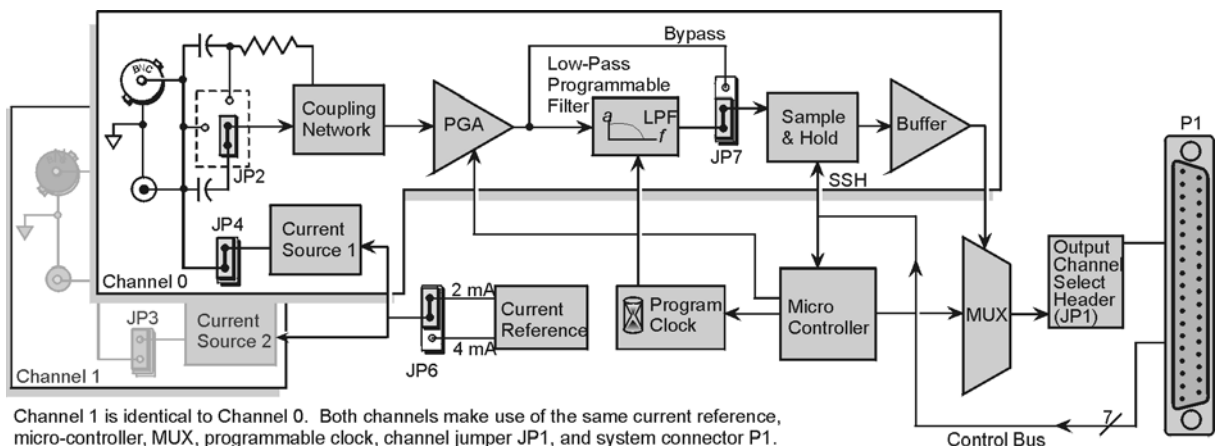


Reference Notes:

- Chapter 2 includes pinouts for P1, P2, P3, and P4. Refer to pinouts applicable to your system, as needed.
- In regard to calculating system power requirements refer to the DBK4 Power Notice on page 2 of this section and to *DBK Basics* located near the front of this manual.

Overview

DBK4 is a 2-channel signal conditioner for dynamic signals. The unit provides a means of interfacing the data acquisition device with piezoelectric transducers that include, but are not limited to: accelerometers, microphones, and force/pressure transducers. The DBK4 interfaces with the LogBook's or Daq Device P1 connector.



Channel 1 is identical to Channel 0. Both channels make use of the same current reference, micro-controller, MUX, programmable clock, channel jumper JP1, and system connector P1. In regard to jumpers, JP6 is common to both channels; and in place of Channel 0's JP2, JP4, and JP7, Channel 1 uses JP5, JP3, and JP8, respectively.

DBK4 Block Diagram

DBK4 Power Notice



DaqBook/100 cannot provide adequate power for a DBK4. For information regarding the use of power cards and power modules see *Power Requirements* in the *DBK Basics* section near the front of this manual.

CAUTION



Excessive power consumption can cause equipment damage. Calculate system power requirements before adding a DBK4 to the system.

Note: It is important to carefully read this DBK4 power notice and other sections of the manual that apply to your LogBook or Daq device system.

In comparison to other DBK cards, the DBK4 demands significant power. It is important that you calculate your system's power demand, as you may need to add auxiliary power supplies. This document provides a worktable for calculating system power demand.

To use the worktable: list the quantities of the applicable DBK options, and multiply these by the mW value. Place the results in the *Power* column and add them. The result is the *total power required*.



If the *power required* exceeds, or is close to the *available power*, you must add a power module or card (for example a DBK30A or DBK32A).

The following two charts provide information regarding available power.

A/D Available Power Chart	
Product	Available mW
LogBook/300, /360 (Note 2)	5000
DaqBook/100, /112, /120	2100
DaqBook/200, /216, /260	4000
DaqBook/2000A, E, X	15000
DaqBook/2001, /2005	10000
DaqOEM/2001, /2005	10000
DaqBook/2020	7500
DaqBoard/100A, /112A	3300
DaqBoard/200A, /216A	3000
DaqBoard/2000 Series	2250
DaqLab/2000 Series	10000
DaqScan/2000 Series	10000
Daq PC-Cards	0

Auxiliary Power Supplies	
Product	Available mW
DBK32A	15000 (Note 1)
<p>For information regarding Battery and UPS Modules, refer to the following sections of the DBK Options Manual:</p> <p>DBK30A DBK34A</p>	

Power-Requirement Worktable

Quantity x milli-Watts = power required				
Option	Qty	x	mW	= power
DBK1		x	0	=
DBK2		x	565	=
DBK4		x	2750	=
DBK5		x	135	=
DBK7		x	420	=
DBK8		x	455	=
DBK9		x	560	=
DBK11A		x	0	=
DBK12		x	455	=
DBK13		x	455	=
DBK15		x	485	=
DBK16		x	1040	=
DBK17		x	905	=
DBK18		x	1085	=
DBK19		x	200	=
DBK20		x	50	=
DBK21		x	50	=
DBK23**		x	10	=
DBK24**		x	10	=
DBK25		x	10	=
DBK40		x	0	=
DBK41		x	0	=
DBK42**		x	35	=
DBK43A**			35	=
DBK44		x	330	=
DBK45		x	1565	=
DBK46		x	2600	=
DBK50**		x	35	=
DBK51**		x	35	=
DBK52		x	200	=
DBK53		x	455	=
DBK54		x	455	=
DBK55		x	950	=
DBK65		x	35	=
DBK70**		x	35	=
DBK80		x	755	=
DBK81		x	1060	=
DBK82		x	1810	=
DBK83		x	1810	=
DBK84		x	1810	=
DBK85		x	755	=
DBK90			1400	=
DBK100		x	300	=
DBK101		x	2700	=
Total Power Required =>				
(Column Total)				

Note 1: DBK32A provides an additional 15000 mW of power for Daq and LogBook data acquisition systems. Its output is ± 15 VDC. DBK32A is not to be used for Daq PC-Cards.

Note 2: DBK2 and DBK5 are not to be used with LogBooks.

** Two asterisks indicate that the module has an internal power supply that is powered separately.

Hardware Setup



If using a DaqBook/200, DaqBook/216, DaqBoard/200A, or DaqBoard/216A that has a serial number of 103350 or earlier, you must contact the factory for a hardware upgrade (EO-1911) before using the DBK4.



Software calibration for each DBK4 requires a set of unique constants supplied on a diskette identified by a serial number matching the DBK4 card. To install these constants, follow instructions on the “readme” file included on the calibration disk.

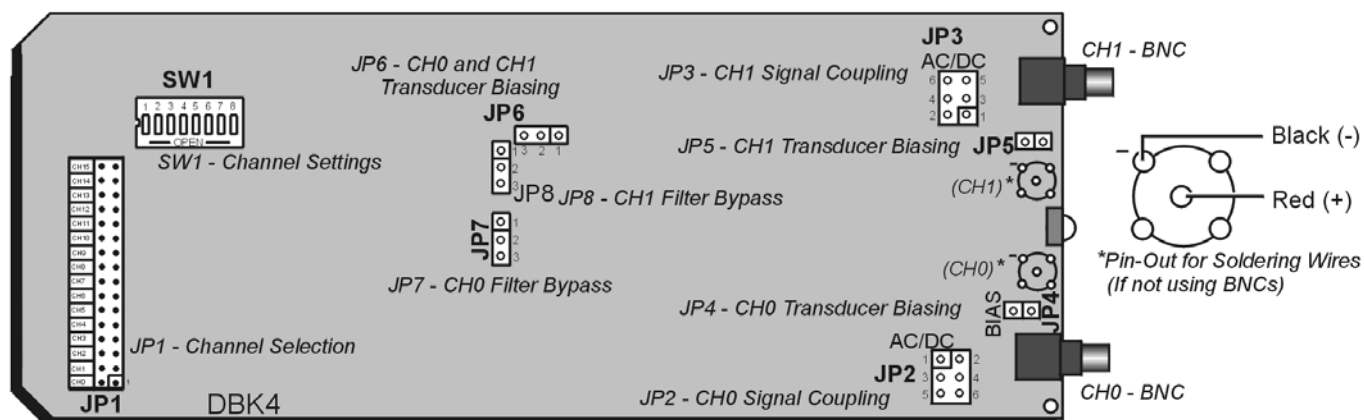
Card Configuration

Factory Defaults

- Current Level – 4ma
- Coupling – 10 Hz
- Current Source – On
- 40Khz Filter – In-Line

Both hardware and software are used in configuration. This section focuses on the hardware. Jumpers and switches are used to set: **current source (current level and source enable/disable)**, **filter bypass**, **signal coupling**, and **channel addressing**. It is best to remove power from the card to perform these selections. The figure reveals the jumper and switch locations.

Note: The hardware jumper settings referenced in the following subsections are per-channel selections unless otherwise specified.

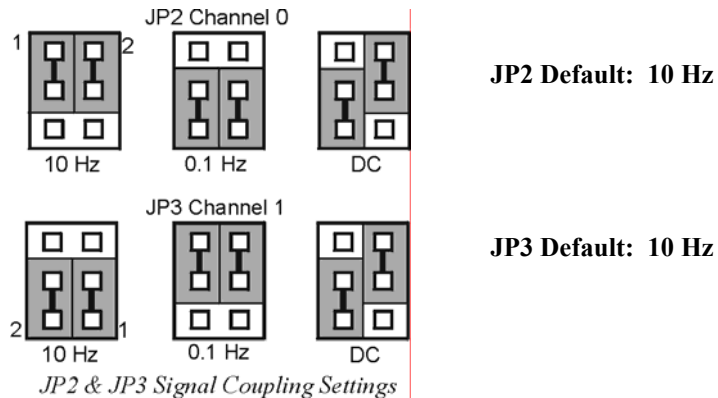


DBK4, Board Layout (not to scale)

Signal Coupling (JP2 & JP3)

The figure shows jumper settings for selecting AC coupling, 10 Hz or 0.1 Hz High Pass Filter (HPF), or DC coupling.

Signal coupling is application specific. 10 Hz HPF suits most applications for acceleration measurements on “light” structures. When performing seismic measurements (or measurements on “massive” structures) the 0.1 Hz HPF rejects the DC bias component while preserving the low-frequency signals.

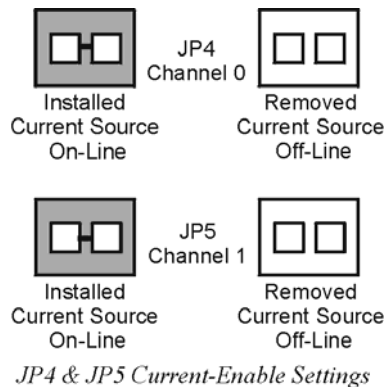


DC coupling may be used when making a voltage mode measurement.

CAUTION	
	<p>When the input signal is DC-coupled, the current source must be deselected (Jumper JP4 and/or JP5 removed). Failure to do so could result in damage to the transducer.</p>

Current Source for Transducer Biasing (JP4 & JP5)

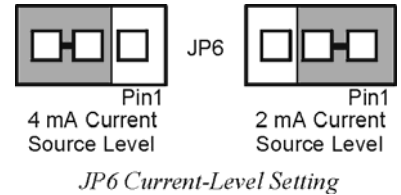
The DBK4 provides a current source for transducer biasing. Bias current is selected (enabled or disabled) via jumpers JP4 (channel 0) and JP5 (channel 1) as shown in the figure.



CAUTION	
	<p>When the input signal is DC coupled, the current source must be “off-line” (jumper removed) to protect the transducer. While DC coupled, the output voltage of the current source can approach 30 V depending on the output impedance of the transducer.</p>

Current Level (Transducer Biasing) (JP6)

Current level is not channel-specific. The level selected applies to both channels. The figure shows the JP6 jumper settings for current level. Most transducers operate with either 2 or 4 mA of bias current. However, biasing at 4 mA allows the transducer to drive longer cables.

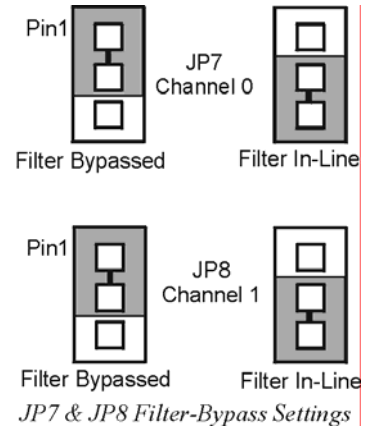


Reference Note:

For more information, refer to the *Cable Driving* section of the *DBK4 Accelerometer Tutorial*.

Filter Bypass (JP7 & JP8)

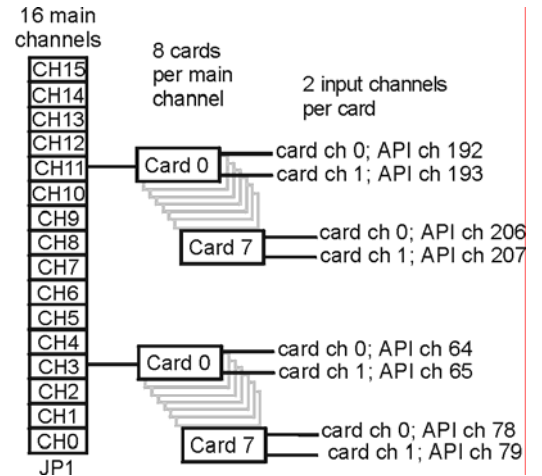
Jumpers JP7 and JP8 are used to enable or disable programmable filtering for channel 0 and 1 respectively. This selection determines the bandwidth of the signal to be processed. When disabled (bypassed) the DBK4 can process a signal with a bandwidth up to 40 kHz. The gain in bypass mode is greater than in the filter mode by a factor of 1.583. For example, When the PGA gain is set to 10, the filter-mode gain is $\times 10$ and the bypass-mode gain is $\times 15.83$.



Main Channel and Sub Channel Selection

Up to 8 DBK4 cards can use 1 of 16 main channels. Each DBK4 has 2 inputs; thus the input capacity is 256 channels (2 inputs \times 8 cards \times 16 main channels).

The DBK4 uses JP1 and SW1 for channel and sub-channel selection. (Position s8 on SW1 is not used.) The DBK4 card or a group of DBK4 cards (0-7) must have a dedicated main channel. Do not intermix DBK4 cards with other types of DBK cards in a channel. LogBook or Daq device will not function properly if channel settings are in conflict.



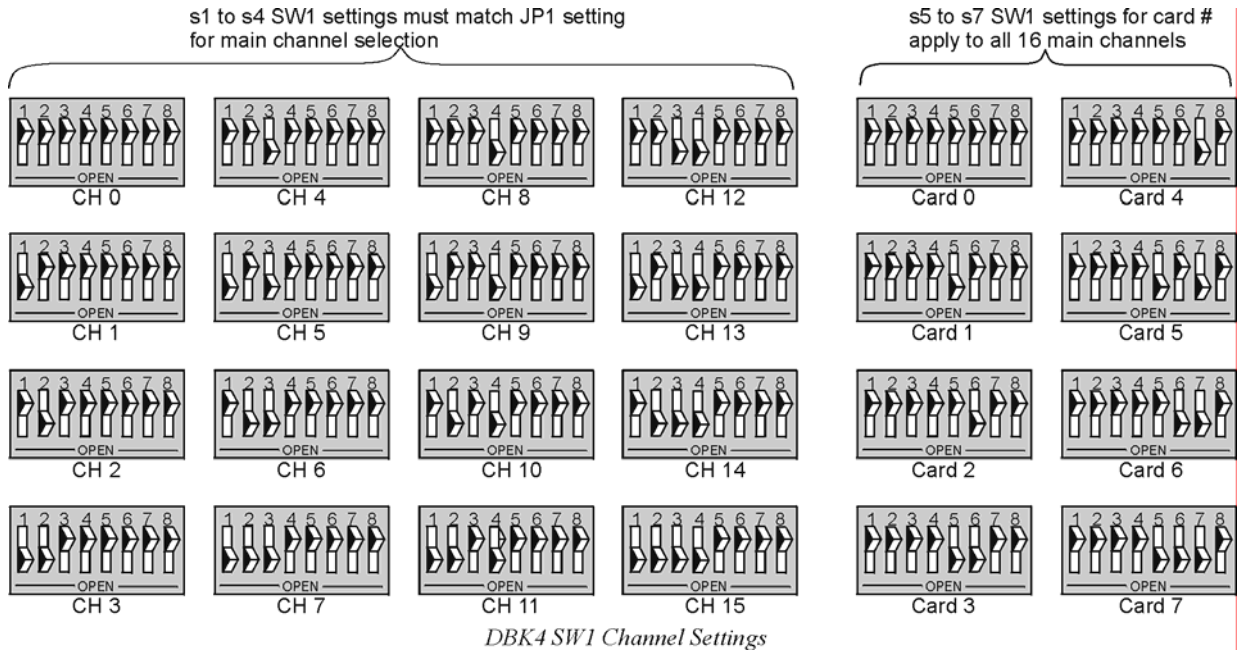
DBK4 Channel Hierarchy



Record all channel settings and label the transducers for future reference.

JP1 on the DBK4 is a 2 \times 16 header located on the far left side of the card. A shunt jumper setting on JP1 allows a card to reside in 1 of 16 possible main channels. Any main channel in the range 0-15 is valid. The figure below shows that sub-switches s1 to s4 of SW1 can be set by binary values to equal the main channel selection. This setting must match the jumper on JP1 so the onboard microcontroller knows the JP1 selection. The card then interprets and responds to only the correct card-related commands via P1.

The DBK4's sub-channel address is selected using switches s5 - s7 of DIP switch SW1 (located above and to the right of JP1). As a 2-channel card, 3 switches are used to select 8 sub-channel addresses. Therefore, it is possible for each main channel to use up to 8 DBK4s. The figure below shows 16 switch settings for the main channel and 8 settings for the sub-channel (card) selection.



Card Connections

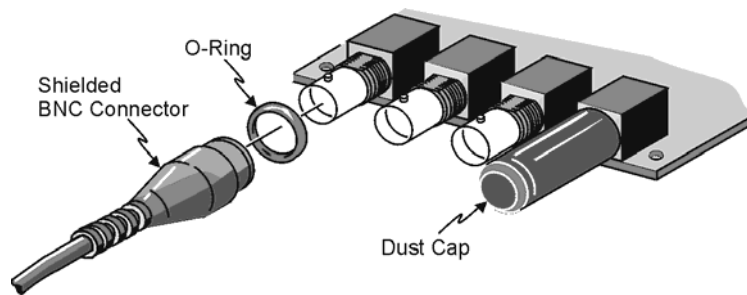
The DBK4 connects to the LogBook's or Daq device's P1 port or a P1 port on a DBK Expansion Module.

For signal inputs, a BNC connector interface is provided for each channel. The DBK4 PC Board has a microdot connector footprint that is wired in parallel with each BNC connector. The user is can customize the input connector as needed. As a factory default, the DBK4 is not populated with microdot connectors.

CE Compliance

Special Cables and Connectors for CE Compliance

To insulate BNC connectors from high-voltage sources such as static charges that can enter the circuitry via an exposed connector and cause ESD damage. Specific cables and connectors that must be used (as stated in the Declaration of Conformity), PVC dust caps (p/n CN-96) must cover all unused BNC connectors. With dust caps removed, special coaxial cables with insulated end-connectors and rubber O-rings (p/n 418-0800) must be used (see figure). Properly installed connectors and dust caps ensure that no metallic surfaces are exposed.

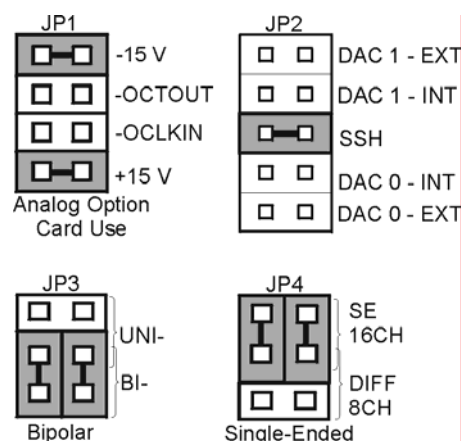


DaqBook/100 Series & /200 Series and DaqBoard [ISA type] Configuration

Several setup steps of DaqBooks /100 Series & /200 Series devices and DaqBoards [ISA type] are required to use DBK4 cards in a system. Note that the Daq PC-Card is configured in software; it cannot supply power to DBKs.

1. If not using auxiliary power, place the JP1 jumper in the expanded analog mode (Analog Option Card Use). In this mode jumpers are at JP1's -15 V and +15 V positions.

Note: This default position is necessary to power the interface circuitry of the DBK4 via the internal ± 15 VDC power supply. If using auxiliary power DBK32A or DBK33, you must remove both JP1 jumpers.




*DaqBook/100 & /200 & DaqBoard [ISA]
Settings for the DBK4*

The DBK4 is **power intensive**; refer to the DBK4 Power Notice (DBK4 page 2) and to *Power Requirements* in the *DBK Basics* section near the front of this manual.

2. Place the JP2 jumper in the SSH position.

CAUTION

 **When using the SSH output, do not use an external voltage reference for DAC1. Applying an external voltage reference for DAC1, when using the SSH output, will result in equipment damage due to a conflict on P1, pin #26.**

3. For DaqBook/100, DaqBook/112 and DaqBook/120 *only*, place the JP3 jumpers in *bipolar* mode.
4. For DaqBook/100, DaqBook/112 and DaqBook/120 *only*, place the JP4 jumpers in *single-ended* mode.

DaqBook/2000 Series & DaqBoard/2000 Series

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

Software Setup



Reference Notes:

- **DaqView users** - Refer to the chapter 2, *DBK Setup in DaqView*.
- **LogView users** - Refer to the chapter 3, *DBK Setup in LogView*.

Hardware Description

Current Source (Transducer Biasing)

Each channel has a constant-current source that can be jumper-set to 2 mA or 4 mA. The bias current is sourced through the center conductor of a coaxial lead and returns to the DBK4 from the transducer's case via the outer conductor. The current source provides a dynamic load of more than 1.4 M Ω and has a negligible loading effect on the transducer's output. If bias is not required, removing a jumper and coupling the signals directly to the input preamplifier can disable the current source.

Note: Use the 4 mA for long cables, high peak voltages, and high signal frequencies.

Signal Coupling

The input can be configured via jumpers to maximize the usable signal spectrum. The DBK4 provides two, 1-pole High-Pass Filters (HPF) and one DC path. The HPF can be set to 0.1 Hz, 3 dB cut-off frequency. In this case, the system frequency response is limited by the source characteristics. The HPF can also be set to 10 Hz, 3-dB cut off frequency, for high-frequency measurements. The 10 Hz setting is useful in attenuating setup-induced low-frequency signals that can reduce the dynamic range (e.g., when using tape recorders as signal sources).

Note: When using 0.1 Hz coupling, you should set the baseline (via software) to one-shot mode.

The DC path allows the DBK4 to be used in voltage-mode measurements that convey DC as well as AC information. For example, when motion is measured with a DC LVDT, the transducer is biased with an independent power supply and its output is referenced to ground.

CAUTION



JP4 or JP5, as applicable, must be removed to disable the current source whenever the input is DC-coupled. Failure to remove JP4 or JP5, when the input is DC-coupled, can result in transducer damage.

Amplifier

The DBK 4 includes a Programmable Gain Amplifier (PGA) with three gain settings ($\times 1$, $\times 10$, and $\times 100$). The gain settings are set for each channel via software. These gain settings are performed at configuration and remain unchanged during a measurement sequence. The PGA has a flat response up to 100 kHz for in-band and out-of-band frequencies.

Low-Pass Filter

To protect the in-band components from distortion caused by aliases of the out-of-band spectrum, the DBK4 features a 12-pole programmable Butterworth Low-Pass Filter (BLPF). There are eight 3 dB cut-off frequency (F_c) settings per channel, the lowest frequency is 141.6 Hz and the highest is 18 kHz. In general, high order BLPF introduce amplitude and phase distortion near the 3 dB cut off frequency. Limiting the measurement range can reduce this error. A typical measurement range is 70% to 80% of the 3-dB cut-off frequency.

For narrowband measurements, the anti-alias filter can be bypassed providing an extended bandwidth of 40 kHz. In this configuration, the channel has lower distortion and a gain factor of 1.583. This setup may be useful when calibrating accelerometers with sinusoidal motion. However, in this case, special attention should be given to external noise since high-frequency noise will be aliased into the signal band.



The switched capacitor clock must be turned on in software for the filter to work.

Sample and Hold

The card's sample and hold amplifier samples all channels within a system (up to 256) within 50 ns of one another and preserves their phase information. Measurement of transmissibility can be made between any two of the 256 possible channels.

The Simultaneous Sample and Hold (SSH) is triggered on the first channel of a scan sequence; after which, the A/D converter sequentially measures the output of each of the SSH amplifiers. In a scan sequence, the first channel should be a non-SSH channel. However, if the scan sequence contains only SSH channels the first channel will contain data taken in the sample mode. This data is inaccurate and therefore should be discarded; however, the second sample (valid) can be a repeat of the first.

Power Management

The DBK4 has circuits for a variety of measurement environments. When not needed, the filters and/or current source can be powered down via software. This feature can be useful in field units to reduce overall power consumption.

Software Controls

Power management, the PGA, and the low-pass filter's cut-off frequency are all software controllable. These parameters are sent via the external address bus in the P1 connector to the DBK4. The micro-controller decodes the configuration message, sets the PGA and filter controls, and illuminates the on-board LED. However, if transmission errors are detected, the micro-controller flashes the LED and ignores the message. The error is cleared when an error-free message is received. At power up, the current source and filters are powered off and the LED is off. The LED will remain off until the DBK4 is successfully addressed for the first time.

DBK4 – Specifications

Name/Function: 2-Channel Dynamic Signal Input Card

Physical Specifications

Channels: 2

Signal Connection: 1 BNC connector per channel

Dimensions: 8.28" W × 3.25" H

Operating Specifications

Power Consumption (typical): 20 mA @ +5 V, 95 mA @ +15 V, 80 mA @ -15 V

Current Source:

Output Impedance: >1.4 MΩ

Compliance: 27 VDC

Current Levels: 2 & 4 mA

Broadband Noise: 0.3 μA RMS (Bw = 100 kHz)

Input Impedance: 150 kΩ

Gain:

Bypass Mode: ×1.583 ×15.83 ×158.3

Filter Mode: ×1 ×10 ×100

Input Ranges: ±5 V ±500 mV ±50 mV FS

Coupling: AC, DC

AC: 1-pole, 10 Hz HPF
 1-pole, 0.1 Hz HPF

Input Signal/Noise: >96 dB (Bw = 100 kHz)

Filter(Typical):

Distortion (typical)

Bypass Mode: The jumpers JP7 and JP8 in the 1-2 position disabling the programmable low pass filter.

@ 100 Hz - 81 dB

@ 1 kHz - 82 dB

@ 5 kHz - 81 dB

Filter Mode: The jumpers JP7 and JP8 in the 2-3 position enabling the programmable low pass filter. With the following cutoff frequencies selected via software.

4.5 kHz cutoff frequency:

@ 100 Hz - 79 dB

@ 1 KHz - 75 dB

18 kHz cutoff frequency:

@ 100 Hz - 68 dB

@ 1 KHz - 68 dB

@ 5 kHz - 58 dB

*Note the filter mode measurements were taken at the +5 V range with the software enabled switched capacitor clock and excitation.

Cut-off(Fc):

18 kHz 9 kHz 4.5 kHz 2.25 kHz
1125 Hz 562.5 Hz 281.2 Hz 141.6 Hz

Flatness DC - 80% Fc: ± 0.2 dB

Channel Matching DC - 80% Fc: Phase: $\pm 6^\circ$

Accuracy Passband Center: ± 0.5 dB

Accelerometer Tutorial

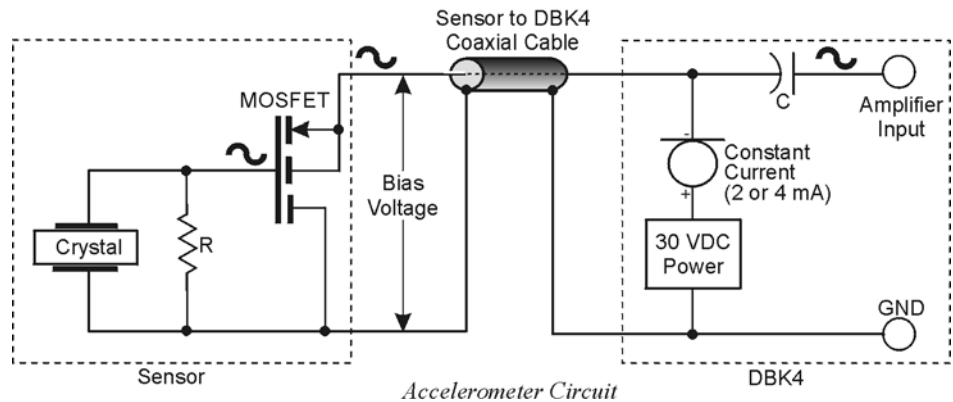
This accelerometer tutorial covers the following topics. Page numbers refer to DBK4 document module pages.

- What is a Piezoelectric Accelerometer?.....11**
- Accelerometer Specification Parameters.....11**
- Physical Setup.....13**
- Electrical Grounding.....14**
- Practical Limitations..... 15**
- Cable-Connector Handling Precautions..... 15**
- Cable Driving.....16**

What is a Piezoelectric Accelerometer?

A low-impedance piezoelectric accelerometer consists of a piezoelectric crystal and an electronic amplifier. When stretched or compressed, the two crystal surfaces develop a charge variation that is related to the amount of stress, shock, or vibration affecting the crystal. The amplifier outputs a corresponding signal and transforms the sensor's high impedance to a lower output impedance of a few hundred ohms. Besides acceleration, such sensors can measure pressure and force.

The circuit requires only 2 wires (coaxial or twisted pair) to transmit both power and signal. At low impedance, the system is insensitive to external or "triboelectric" cable noise. Cable length does not affect sensitivity.



The figure shows a simple sensor-DBK4 connection. The MOSFET is powered from a constant-current source of 2 or 4 mA at 27 volts. In the quiet state, the MOSFET circuit will bias off at about 12 V. As the system is excited, a voltage develops across R and the crystal and is applied to the gate of the MOSFET. This voltage will cause linear variation in the impedance of the MOSFET and a proportional change in bias voltage. This voltage change will be coupled to the DBK4 input amplifier through the capacitor C. The value of R and the internal capacitance of the crystal control the low-frequency corner. Units weighing only a few grams can provide high-level outputs up to 1 V/g with response to frequencies below 1 Hz.

Accelerometer Specification Parameters

Noise in Accelerometers

The noise floor or resolution specifies the lowest discernible amplitude (minimum "g") that can be measured. There are two main sources of noise:

- Noise from the crystal and circuit inside the accelerometer. Some types of crystals, such as quartz, are inherently more noisy than others. A good noise floor is 10 to 20 μV .
- Noise from electrical activity on the mounting surface. Since the signal is a voltage, 60 Hz or other voltages (induced or ground loop, etc) may interfere. The best protection is to electrically isolate the accelerometer.

Sensitivity

The sensitivity of an accelerometer is defined as its output voltage per unit input of motion. The unit of motion used is the “g”. One “g” is equal to the gravitational acceleration at the Earth’s surface, which is 32.2 ft/(sec)(sec) or 981 cm/(sec)(sec). The output is usually specified in millivolts per “g” (mV/g). Sensitivity is usually specified under defined conditions (frequency, testing levels, and temperature), for example: 100 mV/g at a frequency of 100 Hz, level +1 g, at 72°F.

While a given sensor model may have a “typical” sensitivity of 100 mV/g, its actual sensitivities may range from 95 to 105 mV/g when checked under stated conditions. The manufacturer typically provides sensor calibration values.

Transverse Sensitivity

An accelerometer is designed to have one major axis of sensitivity, usually perpendicular to the base and co-linear with its major cylindrical axis. The output caused by the motion perpendicular to the sensing axis is called the transverse sensitivity. This value varies with angle and frequency and typically is less than 5% of the basic sensitivity.

Base-Strain Sensitivity

An accelerometer’s strain sensitivity is the output caused by deformation of the base due to bending in the mounting structure. In measurements on large structures with low natural frequencies, significant bending may occur. Units with low base-strain sensitivity should be selected.

Inserting a washer smaller than the accelerometer base under the base to reduce the contact surface area can substantially reduce base-strain effects. This technique lowers the usable upper frequency range.

Acoustic Sensitivity

High-level acoustic noise can induce outputs unrelated to vibration input. In general, the effect diminishes as the accelerometer mass increases. Using a light, foam-rubber boot may reduce this effect.

Frequency Response

An accelerometer’s frequency response is the ratio of the sensitivity measured at frequency f to the basic sensitivity measured at 100 Hz. This response is usually obtained at a constant acceleration level, typically 1 g or 10 g. Convention defines the usable range of an accelerometer as the frequency band in which the sensitivity remains within 5% of the basic sensitivity. Measurements can be made outside these limits if corrections are applied. Care should be taken at higher frequencies because mounting conditions greatly affect the frequency range (see *Mounting Effects* below).

Dynamic Range

The dynamic measurement range is the ratio of the maximum signal (for a given distortion level) to the minimum detectable signal (for a given signal-to-noise ratio). The dynamic range is determined by several factors such as sensitivity, bias voltage level, power supply voltage, and noise floor.

Bias Level

Under normal operation, a bias voltage appears from the output signal lead to ground. There are two basic MOSFET configurations commonly used. One exhibits a 7-8 V bias and the second a 9-12 V bias. Operation of the two circuits is identical except for the available signal swing. The low-voltage version typically exhibits 5-10 μ Vrms versus 10-20 μ Vrms for the high voltage.

Thermal Shock - Temperature Transients

Piezoelectric accelerometers exhibit a transient output that is a function of a temperature’s “rate-of-change”. This “thermal shock” is usually expressed in $g/^\circ\text{C}$ and is related to:

- Non-uniform mechanical stresses set up in the accelerometer structure
- A pyroelectric effect in piezoelectric materials—an electrical charge is produced by the temperature gradient across the crystal.

This quasi-static effect produces a low-frequency voltage input to the MOSFET amplifier. This voltage is usually well below the low-frequency corner, but the effect can reduce the peak clipping level and cause loss of data. This effect does not affect the accelerometer's basic sensitivity or the data unless the thermal shift in the operation bias level results in clipping. Where drastic thermal shifts are expected, use 12 V bias models. The effect's severity is related to the mass of the accelerometer. In 100 mV/g industrial units, the effect is usually negligible. Using rubber thermal boots can reduce the effect significantly.

Overload Recovery

Recovery time from clipping due to over-ranging is typically less than 1 ms. Recoveries from quasi-static overloads that generate high DC bias shifts are controlled by the accelerometer input RC time constant that is fixed during manufacture.

Power Supply Effects

The nominal power supply voltage recommended by most manufacturers is 15 to 24 V. Units may be used with voltages up to 28 volts. Sensitivity variations caused by voltage change is typically 0.05%/volt. Power supply ripple should be less than 1 mVrms.

Connector

This parameter specifies the connector type and size (4-48, 6-40, 10-32 coaxial etc) and the location on the sensor, i.e., top or side (usually on the hex base). Where there is no connector on the sensor, an integral cable is specified with the length and the connector, i.e., integral 6-ft to 10-32.

Physical Setup

Mounting Effects

Adding an accelerometer to a test object may influence the object's mechanical resonance and/or reduce the resultant vibration level. The mass of the structure and accelerometer as well as the position on the structure can affect the measurement. For example, an accelerometer with a small mass relative to a car's mass will affect measurements on the hood when placed directly in the hood's center. The same accelerometer placed on the more massive frame will have little effect.

The resonance change in a simple spring-mass system caused by adding an accelerometer may be approximated by:

$$\Delta f = f_n \{1 - [m/(m - m_a)]^{1/2}\}$$

Where:

Δf = Change in Resonant Frequency

f_n = Original Resonance Frequency without Accelerometer

m = Spring Mass

m_a = Mass of Accelerometer

Threaded Stud Mount

The preferred method for attaching an accelerometer to the test surface is by the threaded stud mount. This method fuses the accelerometer and test surface. When the stud mount is impractical, an adhesive installation is usually a good alternative.

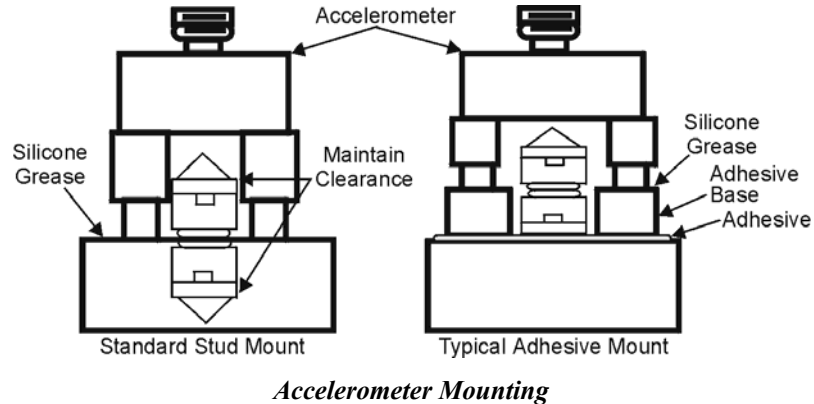
Adhesive Mounts

Some accelerometers can be glued directly to the test surface. Others must use mounting adapters (bases). These adapters are normally glued to the test surface and the accelerometers are stud-mounted to them. When applying a layer of adhesive, keep in mind that the adhesive creates a new spring-mass system with lower high-frequency response. To avoid a thick glue line, Cyanacrylate adhesives work well because:

- They cure quickly, within seconds.
- Glue lines can be kept ultra-thin by using glue sparingly and pressing the accelerometer to the surface with adequate force.
- Cleanup is easy since these adhesives will dissolve with acetone.

Removal of Adhesive Accelerometers

Many accelerometers and adhesive adapters have been damaged by improper removal. A safe removal method is to torque the accelerometer or its adapter with a wrench using the flats provided. Adhesives are generally weakest in the shear mode and will yield under steady torque.



CAUTION



Never strike an accelerometer to remove it. The trauma will likely damage the accelerometer and affect calibration.

Magnetic Mounting Adapters

Magnetic mounting adapters can attach accelerometers to ferromagnetic surfaces such as machinery and structures where the sensor is to be moved quickly from place to place. The accelerometer is attached to the magnet (usually by stud mount) and the assembly is then applied to the surface.

In general, use magnetic adapters with caution and never beyond 1 kHz. Expect response degradation in proportion to accelerometer mass. To ensure the best accuracy from the magnetic mount:

1. If possible, attach the magnet to bare metal. Paint will lessen the holding force of the magnet and can affect response.
2. Clean mounting area to remove oil, grease and foreign matter, which could reduce the contact for a strong magnetic bond.
3. Select a flat area to achieve maximum surface contact.
4. Attach the magnet to the test surface **CAREFULLY**. Remember that the pull of the magnet rises sharply just before contact with the ferromagnetic surface. This force could pull the assembly from your hand resulting in a severe metal-to-metal shock. This could over-range the accelerometer beyond its maximum shock limit and damage it.
5. If possible, calibrate the magnetic/accelerometer assembly.

Electrical Grounding

Case-Grounded Design

In case-grounded designs, the common lead on the impedance-matching circuit is tied to the accelerometer case. The accelerometer base/stud assembly forms the signal common and electrically connects to the shell of the output connector. Case-grounded accelerometers are connected electrically to any conductive surface on which they are mounted. When using these units, take care to avoid errors due to ground noise.

Isolated-Base Design

To prevent ground-noise error, many accelerometers have a base-isolated design. The outer case/base of the accelerometer is isolated electrically off ground by means of an isolation stud insert. The proprietary material used to form the isolation provides strength and stiffness to preserve high-frequency performance.

Practical Limitations

Mass Loading

The accelerometer mass should be less than 10% of the rigidly-coupled mass of the test object. The test object should be rigid at the mounting point, such as a bearing housing rather than a sheet metal cover.

Upper Frequency Response

Piezoelectric accelerometers will attenuate below the low-frequency 3-dB point, but they will amplify at or near their resonant frequency. The mounted resonant frequency of the accelerometer should be about five times the highest frequency of interest (for ± 0.5 dB accuracy). Refer to the frequency response data supplied with each accelerometer to establish the usable range. For general surveys or broader tolerances, smaller multiples may be used. For example, for frequencies up to 1/2 the mounted resonance, sensitivity would typically be 12% higher than nominal.

Cable-Connector Handling Precautions

Connectors

Clean the connector ends periodically with a stiff-bristle brush (such as a glue brush or small paintbrush with clipped bristles) dipped in a solvent. This will remove metal slivers (which can peel off connector threads and short across contacts), oil and other contaminants.

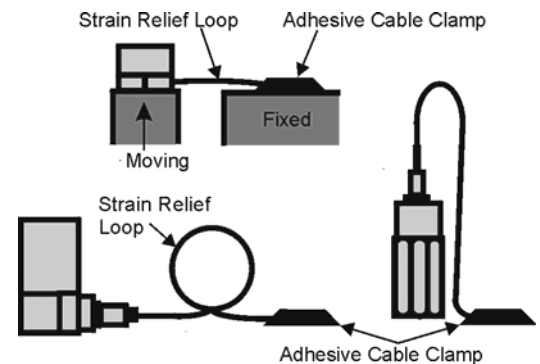
When connecting 10-32 or 5-44, thread the cables to sensor jacks. Do not use pliers to torque knurled coupling nuts in place. Hand tightening is sufficient for most applications. If the nut tends to loosen under severe shock or vibration, you may use a mild thread-locking compound. Use it very sparingly and apply only to the male thread to avoid contamination of the electrical contact.

Because of their size, 10-32 (and smaller) connectors are relatively fragile. Always hold the transducer steady and twist off the knurled coupling-nut. *Never hold the coupling-nut and twist the transducer.* Use 10-32 (and smaller) connectors only when necessary.

Cables

The weakest point on the cable assembly is at the intersection of the wire and connector; so, avoid stress at this point. Sharp bends can overstress the conductors and insulation causing shorting or breakage.

The figure shows the preferred methods of cable routing to the connector. The flexure occurs away from the intersection point. Relative cable motion at the sensor body or connector can cause erroneous output signals at frequencies where cable motion is amplified (cable “whip”). Miniature accelerometers are especially susceptible due to their small size and low mass. This problem is remedied by proper tie down as shown. A “strain relief loop” will ensure that cable flexure does not occur at the connector when the cable is fastened to a stationary surface.



Accelerometer Connections

Triboelectric Noise

Triboelectric noise is caused by the potential developed in a flexing cable. The cable shield may rub against the cable’s insulator, and the interior friction generates a charge that produces noise. The triboelectric noise voltage or charge is coupled to the signal leads by inner conductor capacitance and may be represented by a voltage source in series with a capacitance. In general, triboelectric noise is associated with bending of signal cables when low-frequency vibrations (below 10Hz) are being measured. If moving or securing the cable alters the output compared to an external reference, triboelectric noise is a likely suspect.

Cable Driving

Operation over long cables is a concern with all types of sensors. Concerns involve cost, frequency response, noise, ground loops, and distortion caused by insufficient current available to drive the cable capacitance.

Coupling a short (e.g., 1m) adapter cable from the accelerometer to a long, low-cost cable like RG-58U or RG-62U with BNC connectors can reduce the cost of long cables. Since most cable failures occur at the accelerometer connection where vibration is the greatest, only the short adapter cable would need replacement.

Capacitive loading in long cables acts like a low-pass, second-order filter and can attenuate or amplify high-frequency signals depending on the output impedance of the accelerometer electronics. Generally this is not a problem with low-frequency vibration (10 Hz to 2000 Hz). For measurements above 2000 Hz and cables longer than 100 ft, the possibility of high-frequency amplification or attenuation should be considered.

The DBK4 constant-current source provides 2 or 4 mA to integral electronics. Use the higher current setting (4 mA) for long cables, high peak voltages, and high signal frequencies.

The maximum frequency that can be transmitted over a given length of cable is a function of both the cable capacitance and the ratio of the maximum peak signal voltage to the current available from the constant current source:

$$f = \frac{K}{2\pi C \left(\frac{V}{I_{cc} - I_b} \right)}$$

Where:

f = Maximum frequency in Hz

K = 3.45×10^9 (K is the scale factor to convert Farads to picoFarads and Amperes to milliAmperes and a factor to allow cable capacitance to charge to 95% of the final charge.)

C = Cable capacitance in picoFarads

V = Maximum peak measured voltage from sensor in volts

I_{cc} = Constant current from current source in mA

I_b = Current required to bias the internal electronics, typically 1 mA

Drive Current (mA)	Cable Length @30 pF/ft (Ft)	Frequency Response to 5% of Maximum Output Signal Amplitude	
		± 1 V	± 5 V
2	10	185 kHz	37 kHz
2	100	18.5 kHz	3.7 kHz
2	1000	1.85 kHz	370 Hz
4	10	550 kHz	110 kHz
4	100	55 kHz	11 kHz
4	1000	5.5 kHz	1.1 kHz