# User's Guide

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*An OMEGA Technologies Company*

http://www.omega.com
e-mail: info@omega.com

**OMB-DAQBOOK/DAQBOARD
Volume 1 - Hardware Guide**

Data Acquisition for
Notebook & Desktop PCs

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**WARNING:** These products are not designed for use in, and should not be used for, patient connected applications.

# *How To Use This Manual*

This manual explains setup and operation of the Daq* family of data acquisition systems. Everyone should read chapter 1, one of chapters 2/3/4, and relevant parts of chapter 5. Users of DaqView software should read chapter 6. Beginners to data acquisition in general (or Daq* systems in particular) should read chapter 7 on signal management.

**Note**: If you are custom-programming your application, read the separate *Programmer s Manual* in addition to this *User s Manual.*

This manual is divided into a table of contents, 8 chapters, 2 appendices, and an index as follows:

Chapter 1 - The manual begins with an *Overview* of data acquisition systems and the Daq* family. System design, scope, flexibility, and expansion are briefly explained.

Chapter 2 - *DaqBook Hardware and Installation* describes the DaqBook physically and functionally and then explains installation procedures including the use of DaqTest.

Chapter 3 - *DaqBoard Hardware and Installation* describes the DaqBoard physically and functionally and then explains installation procedures.

Chapter 4 - *Daq PC-Card Hardware and Installation* describes the Daq PC-Card physically and functionally and then explains installation procedures.

Chapter 5 - *DBK Option Cards and Modules* begins with an overview of DBK features and expansion options. A section on power management describes system power requirements and power availability from the various DBKs. Then, each DBK is described in a similar format that includes an overview (usually with a block diagram), hardware and software setup, specifications, and additional information as needed. **Note**: the outside edge of the header on every page identifies which DBK is described on that page—making it easy to navigate (the DBKs are arranged in numeric order).

Chapter 6 - *DaqView, PostView, DaqViewXL* explains the use and features of DaqView (including PostView) and the optional DaqViewXL. Screen prints show you the controls, indicators, and fields discussed in the text.

Chapter 7 - *Signal Management and Troubleshooting Tips* explains the basics of data acquisition including terminology, signal management techniques, channel identification, signal modes, etc. A troubleshooting section explains solutions to common noise, wiring, and configuration problems.

Chapter 8 - *Specifications* lists the physical and performance specifications for all the Daq*s and DBKs.

*Appendix A* describes the compatibility of Daq* systems with non-Daq* products.

*Appendix B* describes the general requirements for complying with CE standards: what standards and conditions apply and how Daq* products meet these standards.

The *Index* alphabetically lists major headings and selected terms for quick page reference.

| CAUTION |
|---|
| Using this equipment in ways other than described in this manual can cause personal injury or equipment damage. Before setting up and using your equipment, you should read *all* documentation that covers your system. Pay special attention to cautions and warnings formatted like this one. |

# Table of Contents

✍ *Notes*

# Overview

## *Data Acquisition Systems*

A data acquisition system monitors a process or series of tests by collecting readings of various physical measurements. These readings are processed and stored so the resulting data can be presented in a useful format. The figure shows the 4 parts of data acquisition:

- A **sensor/transducer** reacts to a physical quantity (such as stress, strain, frequency, temperature, acceleration, or light intensity) and encodes that quantity in an electrical signal. A wide variety of transducers produce signals that vary in type and strength—some generate a voltage; some alter a voltage, current, or resistance according to the physical quantity. The signal can vary with the measured value directly or inversely and in a linear or non-linear way. To be useful, these raw signals must first be conditioned.

- The **signal conditioner** changes the raw transducer signal into a standardized voltage output to send to the ADC. Depending on signal quality, several steps and processes may be involved (e.g., linearization, isolation of high voltages, amplification of weak signals, attenuation of strong signals, filtering of noise and irrelevant frequencies, differential voltage measurement, simultaneous sample and hold, and pulse/current-to-voltage conversions). The many DBK option modules are each designed for a particular type of transducer input signal. The signal conditioner's output voltage is "normalized" to correspond to a user-selected range for the measured quantity. The output voltage range is 0 to 10 V in unipolar mode and ±5 V in bipolar mode.

- The **analog to digital converter (ADC)** changes a conditioned analog signal into a corresponding digital number. A 12-bit converter uses 4096 numbers ($2^{12}$); a 16-bit converter uses 65,536 numbers ($2^{16}$). Such numbers are easily used by a computer with compatible software. To meet your particular needs, the ADC function can be performed by various Daq* models (DaqBook, DaqBoard, Daq PC-Card) with varying capabilities (12/16-bit, digital I/O, etc).

- The **computer** (typically a laptop or desktop PC) can apply further processing to the digital data and then graph or store the result in various ways. Several software options are available. DaqView (or DaqViewXL as an Excel add-on) and other programs (LabVIEW, etc) process the data and provide a control interface (often a virtual instrument panel to fit the application). The Application Programming Interface (API) and a standard data format allow users to develop custom software for their application.

Sensor/Transducer at test site

Signal Conditioner (DBK Option Cards & Modules)

Analog-to-Digital Converter (ADC) (Daq* unit)

Computer with data acquisition software and user interface (DaqView, etc)
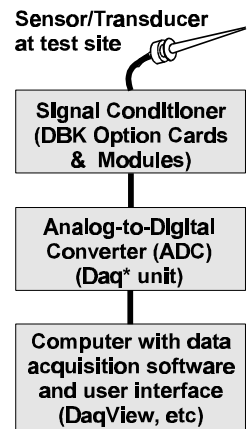
*Block Diagram of Data Acquisition System*

## *The Daq\* Family*

The equipment and software described in this manual form a modular and interrelated family of data acquisition products. As a group, they provide the tools to handle most any data acquisition task for use with PCs and various transducers. Thus, users wishing to expand their system with compatible equipment have many options to choose from. The figure below shows the relation among these products divided into 3 main branches:

- Analog-to-Digital Conversion (ADC) is at the heart of the system. The data source of transducers and signal conditioners are on one side of the ADC; and the PC data processor is on the other side. The ADCs include several models of the DaqBook, DaqBoard, and Daq PC-Card—collectively referred to as Daq\*.
- Signal Conditioning. Over 30 DBK cards and modules (the number is constantly growing) provide various types of signal conditioning and system expansion.
- Software. DaqView comes with the ADC and provides a ready-to-use basic data acquisition program. The ADC also comes with several drivers to interface all the equipment and software options including custom programming in several languages.

*Daq\* Family Tree*
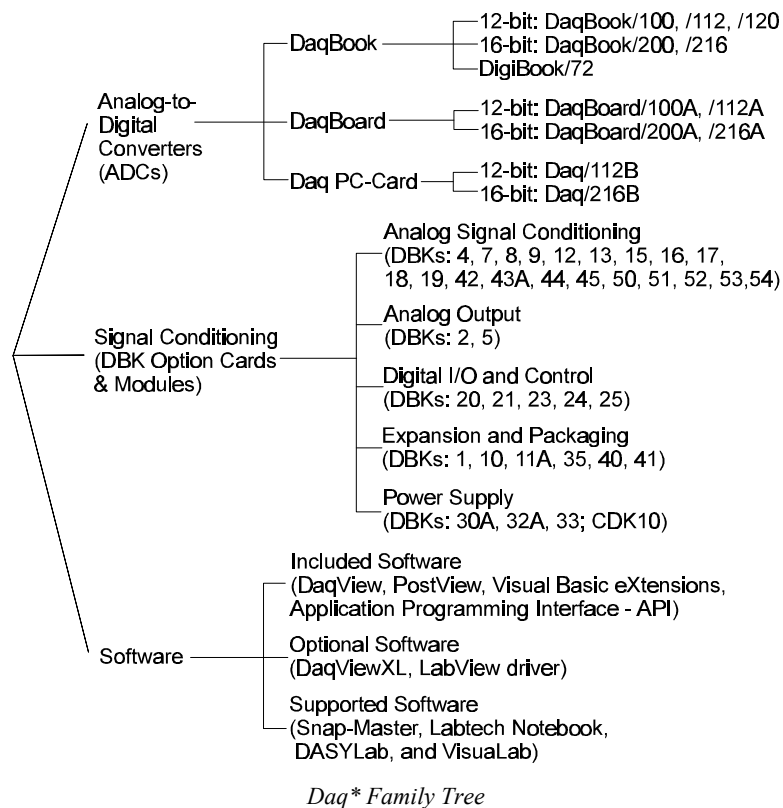
## Analog to Digital Conversion   DaqBook, DaqBoard, and Daq PC-Card

Daq\*s connect to one or more DBKs on their signal input side and a computer on their output side. Each Daq type connects to the computer in a different way:

- The **DaqBook** is an external module that connects to a computer's parallel port or an EPP PC-Card.
- The **DaqBoard** is an internal card that plugs into an ISA-bus slot within the computer.
- The **Daq PC-Card** is inserted in the PCMCIA slot of a laptop/notebook computer.

Features common to the Daq*s include:
- 100-kHz channel-to-channel scan *and* gain switching (10 μs).
- 512-location sequence memory that can be loaded with any combination of channels and gains.
- Ability to access up to 256 different channels of DBK signals while maintaining the 100-kHz channel-to-channel scan rate.  The DBK expansion options can accommodate mixed-signal inputs from thermocouples and RTDs to isolated high-voltage inputs and strain gages.
- Ability to handle 8 differential or 16 single-ended signal inputs without DBK expansion units.
- Ability to handle fixed digital I/O up to 4 TTL lines in and 4 TTL lines out (accessible only if no analog expansion cards are in use).

Each type of Daq has several models to meet various needs.  The table lists these models and their features.

| Daq* Models and Features | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | A/D Resolution | Analog Output Channels @ 12 bit | Unipolar/ Bipolar Selection | Single- ended/ Differential Selection | Programmable Digital I/O Lines | Program mable Counter/ Timers | Size (inches) | Current Use |
| **DaqBook Models** | | | | | | | | |
| DaqBook/100 | 12 bit | 2 | Jumper | Jumper | 16 high speed 24 gen  purpose | 5 ch 7 MHz | 8.5×11 ×1.375 | 510 mA |
| DaqBook/112 | 12 bit | 2 | Jumper | Jumper | N/A | N/A | 8.5×11 ×1.375 | 360 mA |
| DaqBook/120 | 12 bit | 2 | Jumper | Jumper | 16 high speed 24 gen  purpose | 5 ch 7 MHz | 8.5×11 ×1.375 | 510 mA |
| DaqBook/200 | 16 bit | 2 | Software | Software | 16 high speed 24 gen  purpose | 5 ch 7 MHz | 8.5×11 ×1.375 | 620 mA |
| DaqBook/216 | 16 bit | 2 | Software | Software | N/A | N/A | 8.5×11 ×1.375 | 600 mA |
| **DaqBoard Models** | | | | | | | | |
| DaqBoard/100A | 12 bit | 2 | Sequencer | Software | 16 high speed 24 gen  purpose | 5 ch 7 MHz | 4.5×13.125 | 1330 mA |
| DaqBoard/112A | 12 bit | 2 | Sequencer | Software | N/A | N/A | 4.5×13.125 | 970 mA |
| DaqBoard/200A | 16 bit | 2 | Sequencer | Software | 16 high speed 24 gen  purpose | 5 ch 7 MHz | 4.5×13.125 | 1700 mA |
| DaqBoard/216A | 16 bit | 2 | Sequencer | Software | N/A | N/A | 4.5×13.125 | 1340 mA |
| **Daq PC-Card Models** | | | | | | | | |
| Daq112B | 12 bit | N/A | Bipolar Only | Software | N/A | N/A | 3.375×0.2 | 510 mA |
| Daq216B | 16 bit | N/A | Bipolar Only | Software | N/A | N/A | 3.375×0.2 | 510 mA |

## Signal Conditioning    the DBK Cards and Modules

A transducer connects to one of a variety of DBK Option Cards and Modules.  These DBK signal-conditioning units are designed for use with the Daq*s.  However, the DBKs can also be used with ISA bus-based data acquisition boards from vendors such as Omega, Keithley/MetraByte, Computer Boards, and Avantech.  The DBKs perform best when used with an ADC (such as the Daq*) that can dynamically select both channel and gain/range.  Dynamic channel and gain/range selection allows high channel-to-channel scan rates with a wide variety of transducers.

No matter what the transducer input, the DBKs output signals suitable for use by an ADC.  The output signals can be bipolar  (-5 to +5 V) or unipolar (0 to 10 V).  The user can select a range of relevant values to correspond to the lowest (-5 or 0 V) and highest (5 or 10 V) signal—this range selection guarantees the highest resolution in 12- or 16-bit conversion by the ADC.

For complex signal-conditioning, high-capacity modules have more circuitry than can fit on a compact card.  The modules attach to the same Daq* P1 bus as the cards.  Modules share the same footprint as the DaqBook and a typical notebook PC for easy stacking.  Most modules have their own power supply that can run on an AC or DC power source.

Several options exist for packaging and powering the DBKs and are discussed later in this chapter (*System Design and Expansion*).  The table lists the DBKs in their functional groups.  Chapter 5 describes each DBK in detail including use, setup, programming, and power management.

| DBK Option Cards and Modules | | |
|---|---|---|
| **Product** | **Name/Description** | **Capacity** |
| **Analog Signal Conditioning** | | |
| DBK4 | Dynamic Signal Input Card | 2 channels |
| DBK7 | Frequency-to-Voltage Input Card | 4 channels |
| DBK8 | High-Voltage Input Card | 8 channels |
| DBK9 | RTD Measurement Card | 8 channels |
| DBK12 | Low-Gain Analog Multiplexing Card | 16 channels |
| DBK13 | High-Gain Analog Multiplexing Card | 16 channels |
| DBK15 | Universal Current/Voltage Input Card | 16 channels |
| DBK16 | Strain-Gage Measurement Card | 2 channels |
| DBK17 | Simultaneous Sample & Hold Card | 4 channels |
| DBK18 | Low-Pass Filter Card | 4 channels |
| DBK19 | High-Accuracy Thermocouple Card | 14 channels |
| DBK42 | 5B Isolated Signal-Conditioning Module | 16 channels |
| DBK43A | Strain-Gage Measurement Module | 8 channels |
| DBK44 | 5B Isolated Signal-Conditioning Card | 2 channels |
| DBK45 | SSH and Low-Pass Filter Card | 4 channels |
| DBK50 | Isolated High-Voltage Input Module | 8 channels |
| DBK51 | Isolated Low-Voltage Input Module | 8 channels |
| DBK52 | Thermocouple Input Module | 14 channels |
| DBK53 | Low-Gain Analog Multiplexing Module | 16 channels |
| DBK54 | High-Gain Analog Multiplexing Module | 16 channels |
| **Analog Output** | | |
| DBK2 | Voltage Output Card | 4 channels |
| DBK5 | Current Output Card | 4 channels |
| **Digital I/O / Control** | | |
| DBK20 | General-Purpose Digital I/O Card (Screw Terminals) | 48 channels |
| DBK21 | General-Purpose Digital I/O Card (DB37 Connectors) | 48 channels |
| DBK23 | Optically Isolated Digital-Input Module | 24 channels |
| DBK24 | Optically Isolated Digital-Output Module | 24 channels |
| DBK25 | Relay Output Card | 8 channels |
| **Expansion and Connection** | | |
| DBK1 | 16-Connector BNC Adapter Module | 16 connectors |
| DBK10 | 3-Slot Expansion Chassis | 3 cards |
| DBK11A | Screw-Terminal Option Card (DB37-Screw Terminal Block) | Component sockets |
| DBK35 | PCMCIA Interface Card | N/A |
| DBK40 | BNC Interface | 18 connectors |
| DBK41 | Analog Expansion Enclosure | 10 cards |
| **Power Supply** | | |
| CDK10 | Expansion/Power/Battery Module | +5 and ±15 VDC |
| DBK30A | Rechargeable Battery/Excitation Module | +12 to 14,  +24 to 28 VDC |
| DBK32A | Auxiliary Power Supply Card | 15 VA |
| DBK33 | Triple-Output Power Supply Card | ±15 V @ 250 mA; +5 V @ 1 A |

## Daq* Software

The Daq*s have software options capable of handling most applications.  Three types of software are available: a ready-to-use graphical program (DaqView); drivers for third-party, icon-driven software; and various language drivers to aid custom programming.

Ready-to-use programs are convenient for fill-in-the-blank applications that do not require programming for basic data acquisition and display:

- DaqView is a Windows-based program for basic set-up and data acquisition.  DaqView lets you select desired channels, gains, transducer types (including thermocouples), and a host of other parameters with a click of a PC's mouse.  DaqView lets you stream data to disk and display data in numerical or graphical formats.  PostView is a post-acquisition waveform-display program within DaqView.  PostView permits the simultaneous viewing of up to 16 data channels.

- DaqViewXL allows you to interface directly with Microsoft Excel to enhance data handling and display.  Within Excel you have a full-featured Daq* control panel and all the data display capabilities of Excel.
- DaqTest (for DaqBook only) is a self-diagnostic program that is run at initial startup and during troubleshooting to test DaqBook and PC communication.

The Daq* family works with popular, icon-based software for data acquisition including: Snap-Master, DASYLab, LABTECH NOTEBOOK, and LabVIEW.

Each Daq* system comes with a standard and an enhanced Application Programming Interface (API). API-language drivers include: QuickBASIC, C, C++, Delphi, Turbo Pascal, and Visual Basic. **Note**: Programming topics are covered in the separate *Programmer s Manual*.

## *Daq\* System Design and Development*

Data acquisition systems can be set up in many ways to fit various applications.  You must focus on the setup that works best for you.  To assemble a successful system, you must know how to:

- **Use your hardware effectively**.  Chapters 2, 3, and 4 explain hardware specifics (functional descriptions and setup requirements) for the DaqBook, DaqBoard, and Daq PC-Card.  Chapter 5 explains all the DBKs that can be used with a Daq* including function and setup.  **You should read all the chapters and sections that apply to your system.**  Other sections can be skipped unless you wish to expand or enhance your system with such capabilities.
- **Use your software effectively**.  Chapters 2, 3, and 4 explain how to install DaqView for each of the Daq*s.  The use of DaqView is explained in chapter 6.  A separate *Programmer s Manual* can help you program a custom application.
- **Apply data acquisition ideas to your application**.  Presumably, you know what you want to measure and how to use the data; but there are many steps in between.  Chapter 7 (*Signal Management and Troubleshooting Tips*) explains signal management and how to avoid measurement problems.  Some of the DBK sections in chapter 5 explain the concepts and physics related to the DBK's proper operation.

Applications vary widely, but you should consider the following generic setup procedure.  Obviously, your specific application may alter the order and complexity of the following steps:

1. Determine the channel assignments, and layout the whole system.  Before applying power, plan out the location of transducers, cable runs, DBKs, the Daq*, and the computer.  Assign channel numbers; and label your transducers, cables, and connectors to prevent confusion later on.
2. Determine how your data will be saved and used.  What units, ranges, sampling rates, etc are best for your data?  Will the data be charted graphically, statistically processed, or exported to other programs?  The end use of the data can affect how you set up and program the system.
3. Configure the Daq*.  The DaqBook and DaqBoard have setting internal jumpers and switches that you must set manually to match your application.  You may need to refer to the related DBK sections for their requirements on the Daq*.  Some DaqBook models are partially configured in software, and some require you to open the box and manually set jumpers and switches.  The Daq PC-Card is configured entirely in software.
4. Configure all the DBK cards and modules for your application.  Several jumpers and DIP switches may need to be set (channel, gain, filters, signal mode, etc).  Using several DBKs or transducers that require excitation current may require an extra power supply like the DBK32A.  Perform all hardware configurations before connecting signal and power lines.
5. Route and connect all signal and power cables while all power is turned OFF.  To minimize electrical noise, route all signal lines away from any RF or high-voltage devices.  Connect your computer to the Daq* and the Daq* to the DBK and/or signal source.
6. Load the software in your PC, and set software parameters as needed for your application.  The software must recognize all the hardware in the system and use measurement units and ranges that suit your purpose.  Set all channels in the proper mode for your DBK or other signal source.
7. Energize the Daq* and DBKs, and initiate a data acquisition.
8. Verify proper data acquisition and storage.  Can data be acquired, stored, retrieved, and used as needed?
9. Verify system accuracy; adjust ranges or calibrate as needed.

Information on system setup and expansion can be found in the individual Daq* chapters and the DBK chapter.  You may need to read the DBK10/41 sections for system expansion and the DBK30A/32A/33 and the CDK10 sections for power management.  The figure shows some typical expansion configurations.
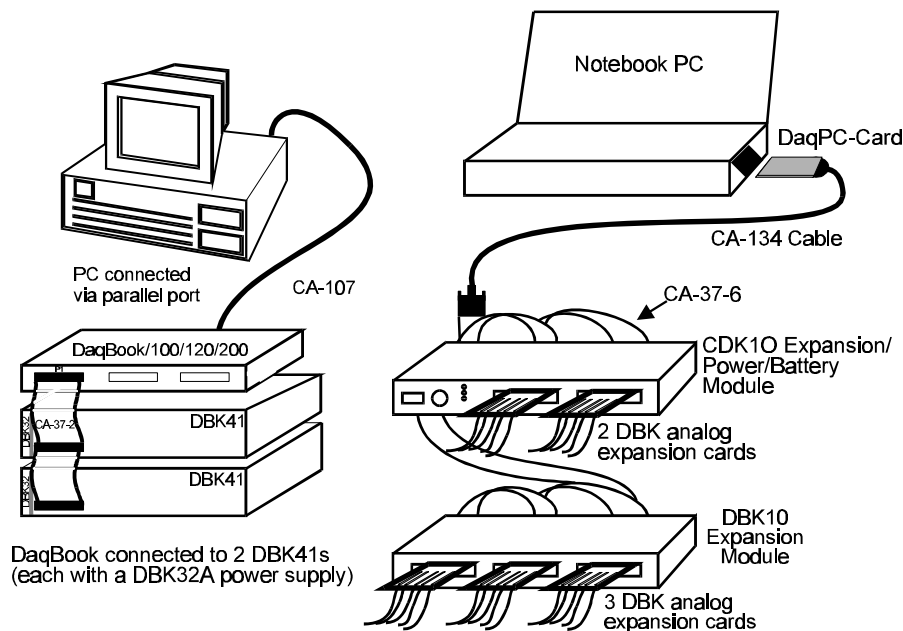


*Typical Expansion Configurations*

Since DBK modules are controlled by the Daq*'s channel sequencer, external channels can be scanned at the same high speed as internal channels.  Each main (base) channel can support up to 16 sub-channels and thereby provide expansion up to 256 input channels.  DBK cards and modules can be daisy-chained off the P1 connector of the Daq* or expansion module.  DBKs add another level of multiplexing and programmable gain to each channel.  Setting up channel parameters often requires both hardware and software setup.

Convenient modules for packaging DBK expansion cards are available with 3 slots (DBK10) or 10 slots (DBK41)—some DaqBooks also have expansion slots.  The best option depends on the number of DBK cards in your system.  For just a few cards, use the stackable 3-slot DBK10 low-profile expansion enclosure.  For more than six cards, use the 10-slot DBK41.  Multiple DBK41s can be daisy-chained to handle a large number of DBKs in a system.

Additional power supplies (essential with the Daq PC-Card) may be needed to handle the load.  The DBK power options accommodate a wide range of applications from laboratory to automotive and other field applications.  The power systems can use any 10 to 20 VDC source or an AC source with the included adapter.  For portable applications, the compact DBK30A rechargeable power supply can provide power to the DBK10 or DBK41.  The DBK30A also includes a 28 V output for powering 4 to 20 mA transducers.  For applications with many DBK cards (initially or in future expansion), the DBK32A or DBK33 can be installed into any expansion slot.  The DBK32A provides ±15 VDC and the DBK33 provides ±15 VDC *and* +5 VDC.

For systems with many modules, stacking units together helps conserve space and assure easy cable runs.  Such stacking is facilitated in 2 ways:

- **Velcro tabs**.  DBK power cards and DaqBooks are shipped with installation kits that include Velcro/adhesive tabs that allow modules to be stuck together and easily removed as needed.
- **Fastener panels**.  A splice plate kit (included with the CDK10 and several DBK modules) provides more rigid stacking.  The kit includes metal plates that screw onto the sides of a module to form a vertical rack of two or more modules.  This method allows the "enclosure" to size itself as needed rather than wasting space in a 1-size-fits-all enclosure.  In addition, a handle can attach to the plate for convenience in portable applications.
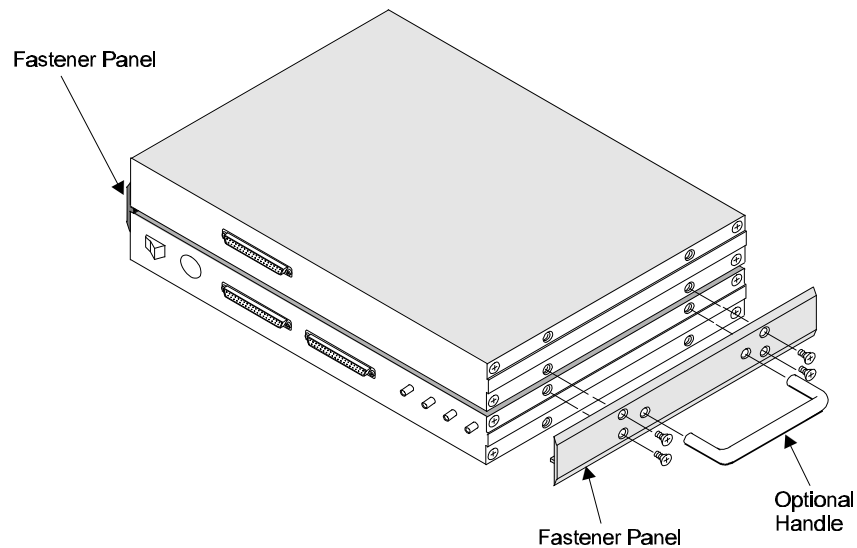


*Stacking Units With Fastener Panels*

🖎 *Notes*

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**2**

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# DaqBook Hardware and Installation

## Overview

This chapter describes the DaqBook physically and functionally including installation. It is best to read all the related documentation for your system before beginning the installation (for the DBKs in your system, read those sections of chapter 5, *DBK Option Cards and Modules)*.

## DaqBook Description

The DaqBook module is enclosed in a 8.5" × 11" × 1.375" metal box external to the computer. The DaqBook attaches to a PC's parallel port via 25-wire parallel port cable and can transfer data bidirectionally at up to 170 Kbytes/s for a standard printer port (SPP) and up to 800 Kbytes/s for an enhanced parallel port (EPP). Data is stored in the PC's memory and hard drive, not in the DaqBook.

Input power for a DaqBook can come from various sources (e.g., a 12 V car battery, the included AC adapter, or a rechargeable ni-cad battery module). This power flexibility is ideal for portable and remote data acquisition, such as automotive and aviation in-vehicle testing.

Output power from the P1 connector includes +5 VDC (pin 1) and ±15 VDC (pins 21 and 2). The section External Analog Expansion Power (JP1) explains how to set JP1 based on power use in the system. Also, refer to the section *Power Management* at the beginning of chapter 5, *DBK Options Cards and Modules*.

The DaqBooks have capabilities that in the past have required several plug-in DAS boards. All DaqBooks provide 16 analog inputs (expandable up to 256), 2 analog outputs, and 4 digital inputs and outputs. Some models have built-in expansion slots and other models have additional digital I/O and counter/timer capabilities.
- The DaqBook/112 and /216 models provide 1 slot for an expansion DBK card.
- The DaqBook/100, /120, and /200 models do not have the expansion slot but do have 24 general-purpose digital I/O channels (expandable up to 192), 16 high-speed digital inputs, and 5 frequency/pulse I/O channels. **Note**: The /120 adds an EPP port capability to the /100.

The various DaqBook models have either 12-bit or 16-bit binary resolution.
- 12-bit models include model #s /100, /112, and /120.
- 16-bit models include model #s /200 and /216.

Analog input capabilities are very flexible. The A/D maximum sample rate is 100 kHz (divide by number of channels for scan rate) with a 16-channel multiplexer and a programmable-gain input amplifier. Users can expand channel capacity to 256 analog inputs via expansion modules for multiplexing RTDs, thermocouples, strain gages, anti-aliasing filters, and simultaneous sample and hold amplifiers. Expansion cards and modules attach to the P1 I/O connector (refer to *Connector Pinouts* later in this chapter). The P1 DB-37 interface is compatible with multiplexers and signal conditioners from several manufacturers.

The DaqBooks perform 100 kHz scan sequences with programmable delays from 10 μs to 10 hours. The 100 kHz conversion rate fixes the time skew between channels at 10 μs. The 512-location scan sequencer allows selection of the input amplifier gain for each channel. The DaqBook/100, /120, and /200 can scan 16 digital inputs in the same sequence used for analog inputs (such inputs are thus time-correlated). Optional simultaneous sample and hold cards enable DaqBooks to sample up to 256 channels at the same instant. Scanning and timing specifications are met even with a full complement of expansion modules. All types of transducers are scanned within the same scan group without PC intervention.

DaqBooks offer a wide selection of triggering capabilities. The DaqBook can be triggered by software, a TTL signal, or an analog input level (including slope). The analog input trigger is hardware-based and minimizes trigger latency to less than 10 μs.

The figure shows block diagrams of the DaqBook models.
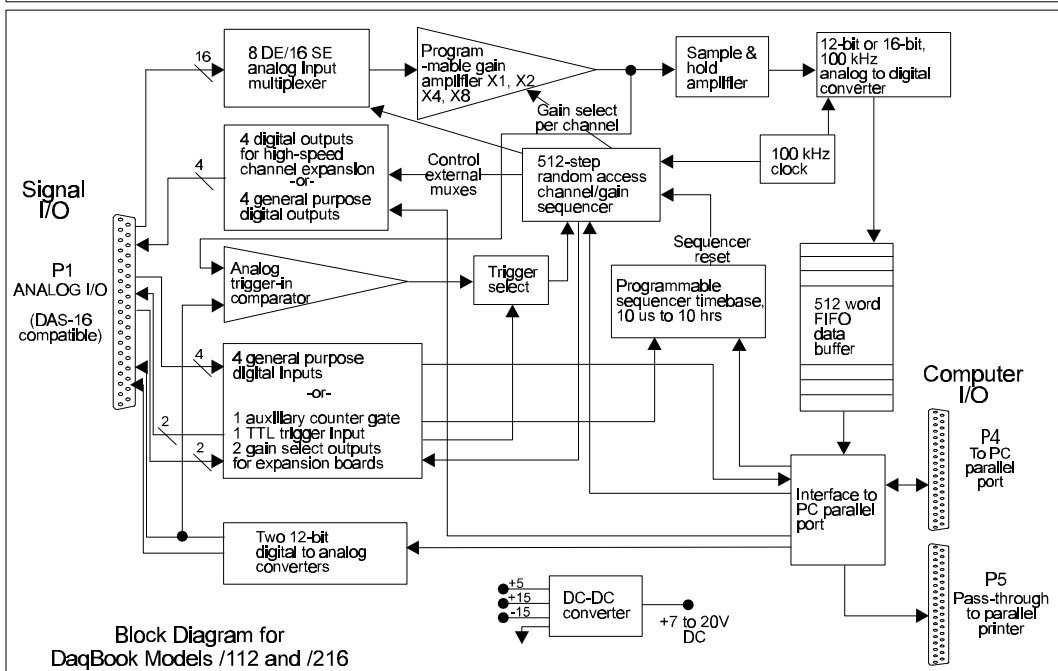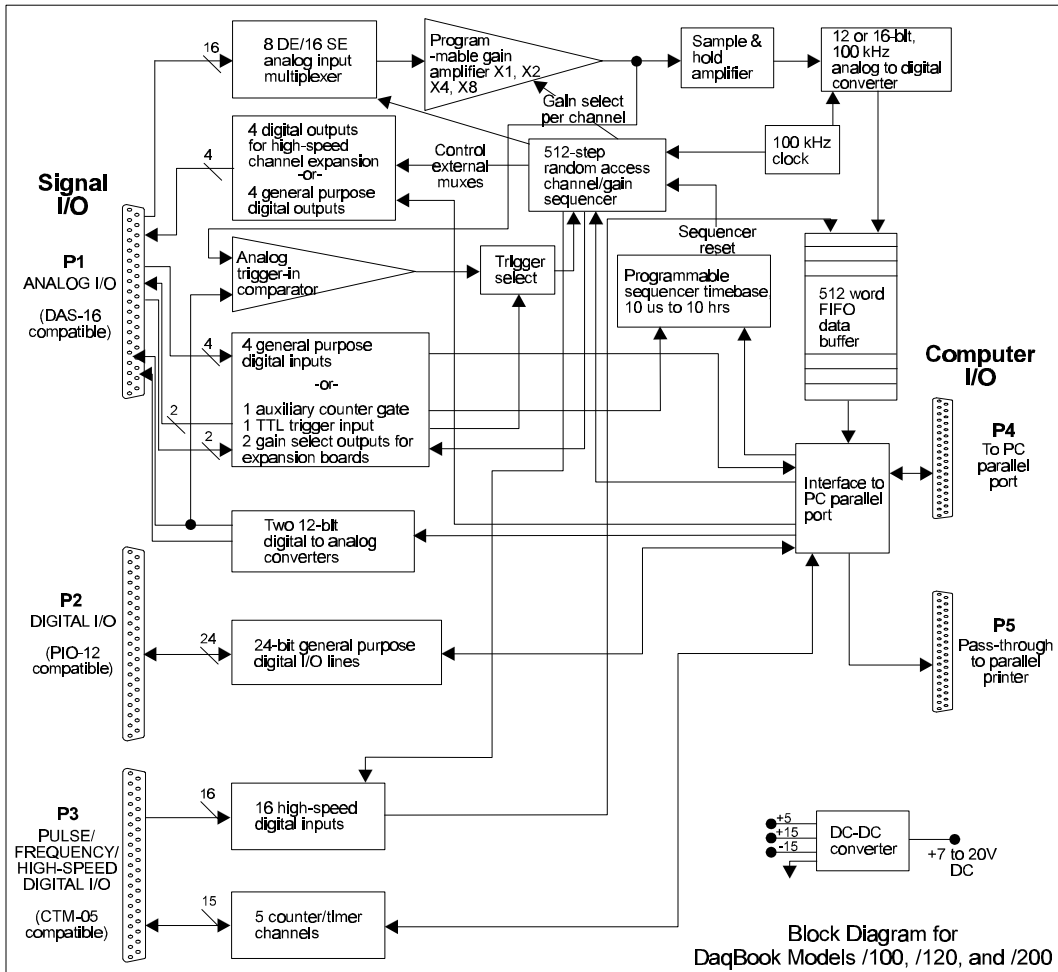


*DaqBook Block Diagrams*

# DaqBook Controls and Connectors

The figure shows the location of controls and connectors on the DaqBook exteriors.  These locations vary by model (DaqBook/100, /120, and /200 versus the DaqBook/112 and /216).
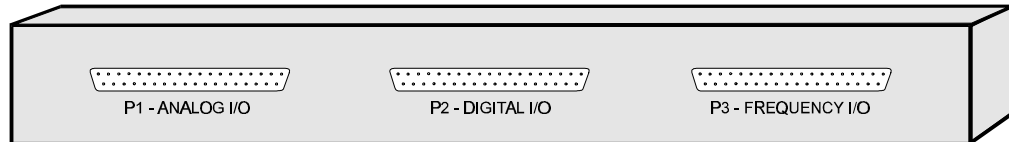


Front Panel of DaqBook/100/120/200
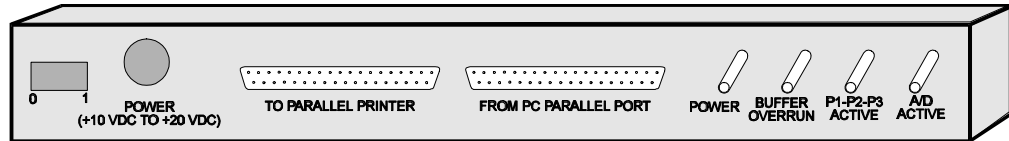
Rear Panel of DaqBook/100/120/200
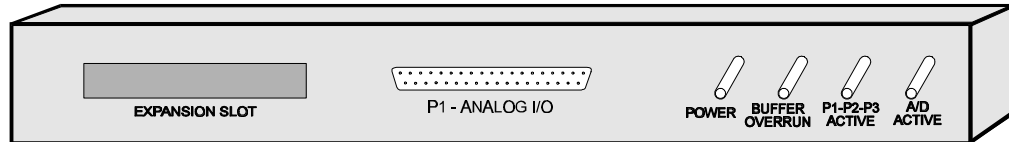
Front Panel of DaqBook/112/216
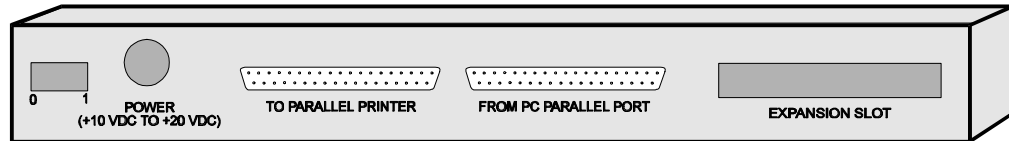
Rear Panel of DaqBook/112/216

| DaqBook Controls and Connectors | |
|---|---|
| **Switch** | |
| POWER | Depressing the "1" side of this rocker-arm switch turns the power on. |
| **Connectors** | |
| POWER INPUT | This DIN5 input connector accepts +10 to +20 VDC. |
| TO PARALLEL PRINTER | This port allows the computer to use any standard parallel printer in a pass-through mode. |
| FROM PC PARALLEL PORT | This port connects to the computer's standard or enhanced parallel port. |
| P1 - ANALOG I/O | Provides 16 analog input channels, 2 analog output channels, 2 16-bit counter/timers, 4 TTL inputs and outputs, and various signals for driving expansion cards. |
| P2 - DIGITAL I/O | Provides 3 8-bit TTL programmable I/O ports and external interrupt input. |
| P3 - FREQUENCY I/O. | Provides 5 16-bit counters and 16 high-speed digital inputs and external interrupt input. |
| **Indicators** | |
| POWER | This LED lights when power is applied to the DaqBook and the power switch is in the "1"  (ON) position. |
| P1-P2-P3 ACTIVE | This LED lights when the DaqBook is in an active state.  This LED is off when the DaqBook is disabled or in the printer-pass-through mode.  P1, P2, and P3 are software accessible from the computer. |
| BUFFER OVERRUN | This LED lights for a buffer overrun error.  This occurs when A/D signals are converted faster than the PC collects the data.  Depending on the application, this indication may not be an error. |
| A/D ACTIVE | This LED lights during an A/D scan sequence.  If the sequence has a low number of steps and occurs infrequently, this indicator will only flash briefly. |

## *DaqBook Installation*

The hardware installation varies with the model used and the application.  You can skip over unrelated sections, but remember to read chapter 5 if you plan to use DBKs in your system.

| CAUTION |
|---|

⚠ **Turn off  power to the DaqBook and externally connected equipment while connecting cables and setting configuration jumpers and switches or before opening the lid.  Electrical shock or damage to equipment can result even under low-voltage conditions.  In dry, static-prone environments, take ESD precautions (packaging, proper handling, grounded wrist strap, etc).**

Performing installation tasks in the proper order can help prevent equipment damage.  A generic order for tasks is:
1.  Initial Inspection
2.  Turn off all power to systems being handled.
3.  Configure on-board jumpers and switches.
4.  Connect cables.
5.  Apply power.
6.  Install and configure software.
7.  Apply signal(s).
8.  Verify performance.

### Initial Inspection

Carefully unpack all items from the shipping carton, and check for shipping damage.  Immediately report any damage to the shipping agent.  Retain all shipping materials in case you must return the unit to the factory.  All returns must be have an RMA # (Return Material Authorization Number).  For an RMA #, call the factory or your sales agent.

DaqBooks are shipped with the following items:
- DaqBook Data Acquisition System (module)
- DaqBook/DaqBoard/Daq PC-Card User's Manual, warranty card, license agreement
- DaqBook/DaqBoard series software #232-0601
- Accessory Kit, including: CA-107 parallel port cable and AC Power Supply/Adapter (TR-25 for 100/120 VAC; TR-21E for 220/240 VAC).

### DaqBook Configuration

Proper installation requires that several jumpers and switches be set correctly for your application.  These jumpers and switches are located inside the DaqBook enclosure and possibly on your DBKs.  Jumpers for the various DaqBook models are configured similarly except for the jumpers' relative locations (see figure for the motherboard diagram of your model).  Jumpers and switches are also identified by silk-screening on the motherboard.  **Note**: Even if using the default settings, you should verify actual jumper positions.

The DaqBook configuration jumpers include:
- JP1 - External Analog Expansion Power
- JP2 - DAC Voltage Reference
- JP3* - Unipolar/Bipolar
- JP4* - Differential/Single Ended
- JP5 - Time Base
- JP6 - Watchdog Timer Enable
- JP7 - Calibration (refer to *Calibration* section at the end of this chapter)

*The DaqBook/200 and /216 do not have JP3 and JP4 jumpers—these settings are made via software.

Configure the DaqBook as follows:

1. Place the unit on a flat, stable surface.  No power or signals should be connected.
2. Remove the screw on the top rear of the case.
3. Slide out the top cover.  All jumpers and switches are accessible from above the board, and no further disassembly is required.
4. Set jumpers as needed for your application.  Read the descriptions of the configuration options below (JP1 to JP6), and use the figure to find the jumper on your model.
5. Replace and secure the cover before applying power and signals.
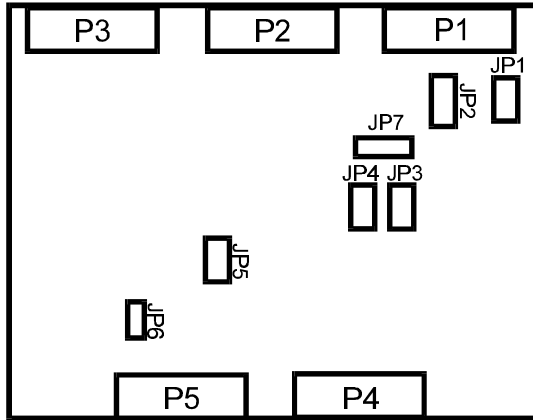
DaqBook/100/120 Motherboard
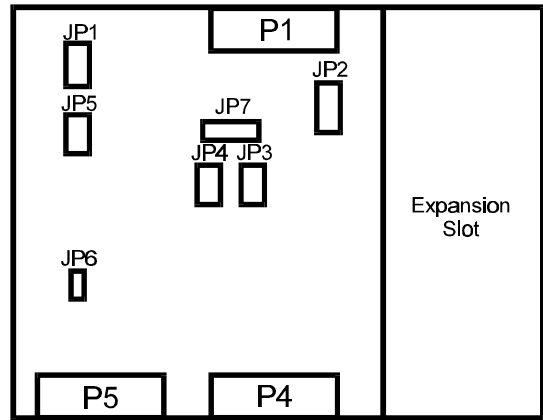
DaqBook/112 Motherboard
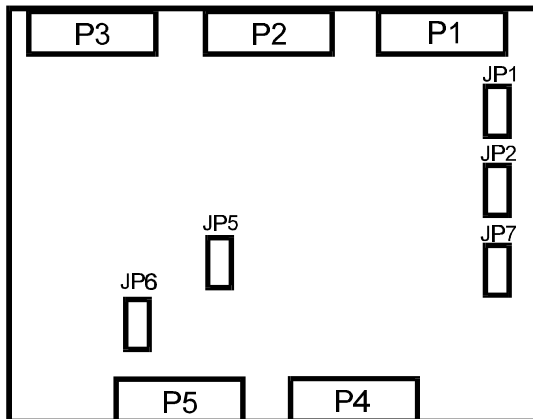
DaqBook/200 Motherboard
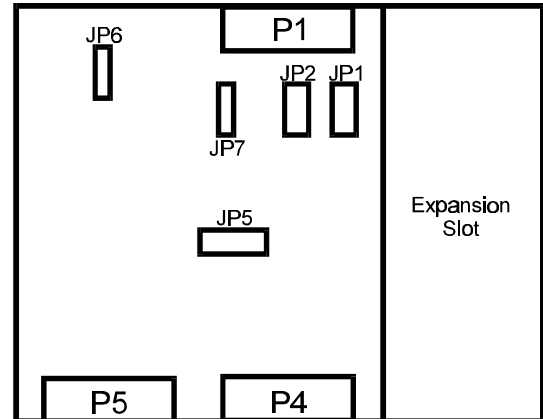
DaqBook/216 Motherboard

*Location of DaqBook Jumpers*

## External Analog Expansion Power (JP1)

This 4×2 header (JP1) has 3 possible settings. If analog option cards (DBKs) are used, the JP1 pins are set to provide +15 and -15 VDC to the cards. If such cards are not used, the counter/timer CTR0 is available, and JP1 must be set accordingly. The default setting is for use of analog option cards.



*JP1 External Analog Expansion Settings*

**Caution**: if using a DBK32A Auxiliary Power Supply or a DBK33 Triple-Output Power Supply Card, **the JP1 shunt jumpers must be entirely removed**. Placing the jumpers on -OCTOUT and -OCLKIN will damage the 8254 timer chip. Refer also to the *Power Management* section in chapter 5, *DBK Option Cards and Modules*.

## DAC Reference Selection (JP2)

This 5×2 header (JP2) allows you to select internal or external voltage references for the two separate analog outputs. If the internal -5 VDC reference is selected, either DAC can output from 0 to +5 VDC as the register count varies from 0 to 4095 (12-bit). If an external voltage reference is desired (up to 10 VDC in either polarity), the shunt jumpers must be set accordingly. There is also a provision to allow the outputting of a simultaneous Sample-Hold command signal on the DAC1-REFIN pin with the DAC1 set up for an internal reference. (The SSH setting cannot be used at the same time as a DAC1 external reference due to a potentially damaging conflict on P1 pin #26.) The defaults are both DAC0 and DAC1 set to Internal Reference. **Note**: the SSH setting is used with DBKs: 2, 5, 7, 17, 50, and 51. Refer to DBK chapter (5) as needed.



*JP2 DAC Reference Settings*

## Bipolar or Unipolar A/D Operation (JP3)*

*Hardware Setting For DaqBook/100, /112, and /120 Only

The A/D converter in the DaqBook can be operated in two modes, bipolar or unipolar. In the bipolar mode (default setting), input voltages up to ±5 VDC can be applied (on the ×1 gain range). In the unipolar mode, positive voltages up to 10 VDC may be applied (×1 gain range). Refer to the table for gain/range information.

| Gain | Mode | Volts Range |
|------|------|-------------|
| ×1 | BI | ±5 |
| ×2 | BI | ±2.5 |
| ×4 | BI | ±1.25 |
| ×8 | BI | ±0.625 |
| ×1 | UNI | 0 to +10 |
| ×2 | UNI | 0 to +5 |
| ×4 | UNI | 0 to +2.5 |
| ×8 | UNI | 0 to +1.25 |

*JP3 Unipolar/Bipolar Operation Settings*

> ## CAUTION
> ⚠ The JP3 is a double-wide jumper that must be positioned vertically. Misplacing this jumper in a horizontal position will damage the unit.

**Note**: For the DaqBook/100, /112, and /120, set the jumpers to the desired position as shown in figure. For the DaqBook/200 and /216, the Unipolar/Bipolar option is selected via software by the daq200SetMode and daq200Set Scan commands.
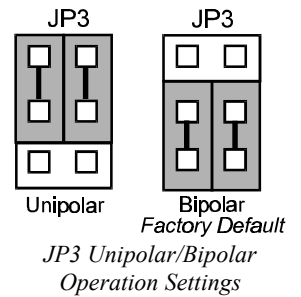
### Single-ended or Differential Analog Input Channels (JP4)*

*Hardware Setting For DaqBook/100, /112, and /120 Only


*JP4 Single-Ended/ Differential Settings*

> ## CAUTION
> ⚠ The JP4 is a double-wide jumper that must be positioned vertically. Misplacing this jumper in a horizontal position will damage the unit.

This 3×2 pin header (JP4) is used to configure the 16 analog input lines as 16 single-ended channels or as 8 pairs of differential channels. In general, if the DaqBook is going to be used in the stand-alone mode (no analog expansion cards), either mode can be used. If analog expansion cards (each DBK capable of 16 single-ended or differential inputs) are used, the single-ended mode must be used. The default setting is thus single-ended. Place the jumpers in the desired position (see figure). For the DaqBook/200 and /216, the Unipolar/Bipolar option is selected via software by the daq200SetMode and daq200Set Scan commands.
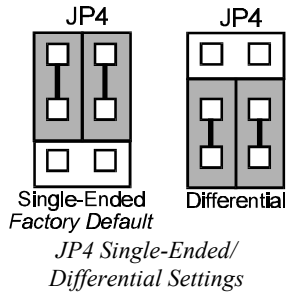
### Time Base Selection (JP5)

This 2×3 header (JP5) allows you to apply 1 of 3 oscillator-derived frequencies to the 8254 timer chip. The frequencies are 100 kHz, 1 MHz, and 10 MHz. The default setting is 1 MHz. **Note**: A special version 8254 timer chip is required for 10 MHz. All IOtech and 3rd party software assume the 1 MHz time base.


*JP5 Time Base Settings*
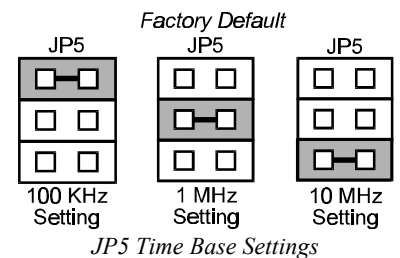
### Watchdog Timer Enable/Disable (JP6)

This 3-pin header (JP6) allows the elective use of the watchdog timer. The watchdog timer is used to assure consistent operation of the pass-through printer port during data collection and to restore pass-through printing if the computer is reset. Enable the watchdog timer if you:

- Use a printer on the pass-through printer port
- Expect the computer to be suddenly reset during DaqBook operation
- Want the DaqBook to reset itself rather than having to manually toggle the DaqBook's power switch.


*JP6 Watchdog Timer Settings*

Place the shunt jumper in the desired position as shown in the figure. The default setting is Disabled. **Note:** The watchdog timer can mistake a computer pause for a reset and then impede background measurements. For this reason, the watchdog timer should normally be disabled unless automatic restoration of pass-through printing is required.
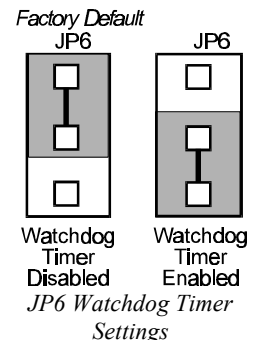
# Hardware Connection

The DaqBook connects to the computer's parallel printer port (female DB25) with the supplied cable (CA-107). Connect the male end to the computer and the female end to the DaqBook connector labeled FROM PC PARALLEL PORT. Any printer port (LPT1, LPT2, or LPT3) may be used but should be noted for software setup. When using a printer, attach the original printer cable (male DB25) into the DaqBook connector labeled TO PARALLEL PRINTER. **Note**: printing cannot occur during data acquisition.


*DaqBook to Computer (Printer) Connection*
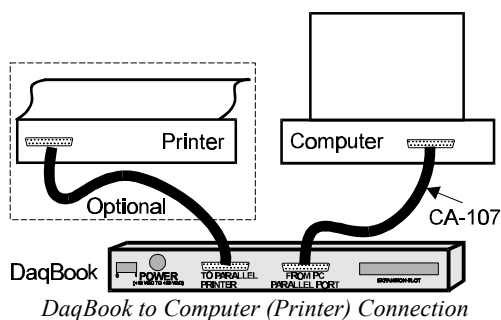
The DaqBook may be powered with a supplied AC adapter that plugs into any standard AC wall outlet or from any isolated 10-20 VDC source of 1-2 Amps (see figure). Before plugging unit in, make sure the power switch is in the "0" (OFF) position.

- If using an AC power adapter, plug it into an AC outlet and attach the low voltage end to the jack on the DaqBook.
- If using another 10-20 VDC source, make sure leads are connected to the proper DIN terminals.


*DaqBook Power Connections*
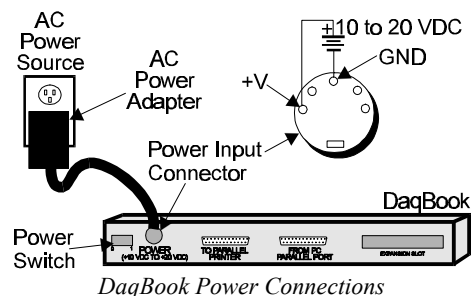
To verify connections, turn ON the power switch by rotating the rocker-arm switch to the "1" position, and the POWER LED should light up. If using a printer, check operation by issuing a <PRINT SCREEN> or equivalent command. **Note**: software installation is necessary before the DaqBook can perform any functions.

## *Parallel Port Capabilities*

The DaqBook/112, /120, /200, and /216 (but not the /100) models can take advantage of enhanced parallel port (EPP) communication. Standard LPT ports on an IBM-compatible PC have 4-bit and 8-bit modes to read data from the printer port. The 8-bit mode is faster than the 4-bit, but not all printer ports support this mode. EPP ports are parallel ports with additional hardware that allows the DaqBook to communicate with the PC faster (3 to 10 times) than standard parallel ports.

EPPs require special hardware, and only certain computers are EPP-capable. Most laptop computers that use the Intel 386SL or 486SL chip set (which includes the 82360 I/O controller) are EPP-capable. For computers with plug-in card slots, EPP adapter cards are available. You may wish to consult your computer documentation for details about your machine and possible adapter cards. For more information about supported EPP hardware and machine-specific issues, refer to the README file supplied with the software. **Note**: the EPPs may be configured for any available I/O address but must be configured for either interrupt 5 or 7. The DaqBook driver does not support the use of interrupts 10, 11, 12, or 15.

In addition to supporting the special hardware required for EPP capability, some computers and parallel port cards come equipped with special BIOS or device drivers which support the EPP BIOS Draft Revision 3 (and possible Draft Revision 5) standard. This standard specifies a software level interface between applications and the EPP hardware itself. The DaqBook/DaqBoard software driver supports computers and parallel ports equipped with EPP BIOS Draft Revision 3.

### Connector Pinouts

To gain access to DaqBook port connectors, signals can be connected via a CA-37-x cable through a D-shell 37-pin female connector or a DBK11 screw-terminal card with component sockets. The following tables detail P1, P2, and P3 pinouts and how each line is used.

| **P1 - Analog I/O** (compatible with Metrabyte DAS-16) | |
|---|---|

Top row pins (1–19): 1 +5V PWR, 2 CTR 0 OUT/-15VDC, 3 OP3/CHS3, 4 OP1/CHS1, 5 IP3/GS1, 6 IP1/GS0, 7 POWER GND, 8 VREF (-5V), 9 D/A 0 OUT, 10 D/A 0 REF IN, 11 CH7 LO IN/CH15 HI IN, 12 CH6 LO IN/CH14 HI IN, 13 CH5 LO IN/CH13 HI IN, 14 CH4 LO IN/CH12 HI IN, 15 CH3 LO IN/CH11 HI IN, 16 CH2 LO IN/CH10 HI IN, 17 CH1 LO IN/CH9 HI IN, 18 CH0 LO IN/CH8 HI IN, 19 L.L. SENSE GND

Bottom row pins (20–37): 20 CTR 2 OUT, 21 CTR 0 CLOCK IN/+15VDC, 22 OP2/CHS2, 23 OP0/CHS0, 24 IP2/CTR 0 GATE, 25 IP0/TRIG 0, 26 SSH/D/A 1 REF IN, 27 D/A 1 OUT, 28 LL GND, 29 LL GND, 30 CH7 HI IN, 31 CH6 HI IN, 32 CH5 HI IN, 33 CH4 HI IN, 34 CH3 HI IN, 35 CH2 HI IN, 36 CH1 HI IN, 37 CH0 HI IN

| Pin | Signal Name | Description for P1 Pin Use |
|---|---|---|
| 1 | +5 PWR | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 2 | CTR 0 OUT/-15 VDC | Counter 0 output (8254 chip)/ -15 V supply (Refer to *Power Management* in chapter 5) |
| 3 | OP 3/CHS 3 | Digital out bit 3/channel select line for expansion cards |
| 4 | OP 1/CHS 1 | Digital out bit 1/channel select line for expansion cards |
| 5 | IP 3/GS 1 | Digital in bit 3/gain select line for expansion cards |
| 6 | IP 1/GS 0 | Digital in bit 1/gain select line for expansion cards |
| 7 | POWER GND | Digital ground |
| 8 | VREF (-5V) | -5 V supply @ 10 mA max |
| 9 | D/A 0 OUT | Digital to analog converter output ch 0 |
| 10 | D/A 0 REF IN | Digital to analog converter reference in ch 0 (must invert) |
| 11 | CH 7 LO IN/CH 15 HI IN | Ch 7 LO IN (differential mode)/ch 15 HI IN (single-ended mode) |
| 12 | CH 6 LO IN/CH 14 HI IN | Ch 6 LO IN (differential mode)/ch 14 HI IN (single-ended mode) |
| 13 | CH 5 LO IN/CH 13 HI IN | Ch 5 LO IN (differential mode)/ch 13 HI IN (single-ended mode) |
| 14 | CH 4 LO IN/CH 12 HI IN | Ch 4 LO IN (differential mode)/ch 12 HI IN (single-ended mode) |
| 15 | CH 3 LO IN/CH 11 HI IN | Ch 3 LO IN (differential mode)/ch 11 HI IN (single-ended mode) |
| 16 | CH 2 LO IN/CH 10 HI  IN | Ch 2 LO IN (differential mode)/ch 10 HI IN (single-ended mode) |
| 17 | CH 1 LO IN/CH  9 HI IN | Ch 1 LO IN (differential mode)/ch 9 HI IN(single-ended mode) |
| 18 | CH 0 LO IN/CH  8 HI IN | Ch 0 LO IN (differential mode)/ch 8 HI IN (single-ended mode) |
| 19 | L.L. GND | Low-level ground (analog ground - use with analog inputs and outputs) |
| 20 | CTR 2 OUT | Counter 2 output (8254 chip) |
| 21 | CTR 0 CLOCK IN/+15 VDC | Counter 0 clock in (8254 chip)/+15 V supply (Refer to *Power Management* in chapter 5) |
| 22 | OP 2/CHS 2 | Digital output bit 2/ channel select line for expansion cards |
| 23 | OP 0/CHS 0 | Digital output bit 0/channel select line for expansion cards |
| 24 | IP 2/CTR 0 GATE | Digital input bit 2/counter 0 gate |
| 25 | IP 0/TRIG 0 | Digital input bit 0/trigger 0 |
| 26 | D/A 1 REF IN/SSH | Digital-to-analog converter reference in ch 1 (must invert)/ SSH |
| 27 | D/A 1 OUT | Digital-to-analog converter output ch 1 |
| 28 | L.L. GND | Low-level ground (analog ground - use with analog inputs and outputs) |
| 29 | L.L. GND | Low-level ground (analog ground - use with analog inputs and outputs) |
| 30 | CH 7 HI IN | Ch 7 HI IN (single-ended mode or differential mode) |
| 31 | CH 6 HI IN | Ch 6 HI IN (single-ended mode or differential mode) |
| 32 | CH 5 HI IN | Ch 5 HI IN (single-ended mode or differential mode) |
| 33 | CH 4 HI IN | Ch 4 HI IN (single-ended mode or differential mode) |
| 34 | CH 3 HI IN | Ch 3 HI IN (single-ended mode or differential mode) |
| 35 | CH 2 HI IN | Ch 2 HI IN (single-ended mode or differential mode) |
| 36 | CH 1 HI IN | Ch 1 HI IN (single-ended mode or differential mode) |
| 37 | CH 0 HI IN | Ch 0 HI IN (single-ended mode or differential mode) |

Note: Software configuration commands determine P1 digital I/O pin functions. Actual shunt-jumper placement is required to provide ±15 VDC to expansion cards or disconnect internal DAC references to allow externally selected DAC references. Digital I/O cannot be used with DBKs. "/" indicates the pin can be used for either function but not both at the same time.

| **P2 Digital I/O**<br>The P2 interface is available on the DaqBook/100, /120, and /200. |  |
| --- | --- |

| Pin | Signal Name | Description for P2 Pin Use |
| --- | --- | --- |
| 1 | IR INPUT | Interrupt line input (no functions to access this) |
| 2 | IR ENABLE | Interrupt line enable (no functions to access this) |
| 3 | PORT B 7 | Digital input/output - port B bit 7 |
| 4 | PORT B 6 | Digital input/output - port B bit 6 |
| 5 | PORT B 5 | Digital input/output - port B bit 5 |
| 6 | PORT B 4 | Digital input/output - port B bit 4 |
| 7 | PORT B 3 | Digital input/output - port B bit 3 |
| 8 | PORT B 2 | Digital input/output - port B bit 2 |
| 9 | PORT B 1 | Digital input/output - port B bit 1 |
| 10 | PORT B 0 | Digital input/output - port B bit 0 |
| 11 | GND | Digital ground |
| 12 | N/C | Pin not connected/not used |
| 13 | GND | Digital ground |
| 14 | N/C | Pin not  connected/not used |
| 15 | GND | Digital ground |
| 16 | N/C | Pin not connected/not used |
| 17 | GND | Digital ground |
| 18 | +5 V | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 19 | GND | Digital ground |
| 20 | +5 V | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 21 | GND | Digital ground |
| 22 | PORT C 7 | Digital input/output - port C bit 7 |
| 23 | PORT C 6 | Digital input/output - port C bit 6 |
| 24 | PORT C 5 | Digital input/output - port C bit 5 |
| 25 | PORT C 4 | Digital input/output - port C bit 4 |
| 26 | PORT C 3 | Digital input/output - port C bit 3 |
| 27 | PORT C 2 | Digital input/output - port C bit 2 |
| 28 | PORT C 1 | Digital input/output - port C bit 1 |
| 29 | PORT C 0 | Digital input/output - port C bit 0 |
| 30 | PORT A 7 | Digital input/output - port A bit 7 |
| 31 | PORT A 6 | Digital input/output - port A bit 6 |
| 32 | PORT A 5 | Digital input/output - port A bit 5 |
| 33 | PORT A 4 | Digital input/output - port A bit 4 |
| 34 | PORT A 3 | Digital input/output - port A bit 3 |
| 35 | PORT A 2 | Digital input/output - port A bit 2 |
| 36 | PORT A 1 | Digital input/output - port A bit 1 |
| 37 | PORT A 0 | Digital input/output - port A bit 0 |
| NOTE:  No local lines are available if digital expansion cards are in use. | | |

| P3 - Pulse/Frequency /High-Speed Digital I/O | |
|---|---|
| The P3 interface is available on the DaqBook/100, /120, and /200. | |

| Pin | Signal Name | Description for P3 Pin Use |
|---|---|---|
| 1 | IR INPUT | Interrupt line input (used with counters) |
| 2 | IR ENABLE | Interrupt line enable (used with counters) |
| 3 | SDI 7 | High-speed digital input  bit 7 (low byte) |
| 4 | SDI 6 | High-speed digital input  bit 6 (low byte) |
| 5 | SDI 5 | High-speed digital input  bit 5 (low byte) |
| 6 | SDI 4 | High-speed digital input  bit 4 (low byte) |
| 7 | SDI 3 | High-speed digital input  bit 3 (low byte) |
| 8 | SDI 2 | High-speed digital input  bit 2 (low byte) |
| 9 | SDI 1 | High-speed digital input  bit 1 (low byte) |
| 10 | SDI 0 | High-speed digital input bit 0 (low byte) |
| 11 | GND | Digital ground |
| 12 | CTR 5 GATE | Counter 5 gate (9513 chip) |
| 13 | CTR 5 IN | Counter 5 input (9513 chip) |
| 14 | CTR 4 GATE | Counter 4 gate (9513 chip) |
| 15 | CTR 4 IN | Counter 4 input (9513 chip) |
| 16 | CTR 3 GATE | Counter 3 gate (9513 chip) |
| 17 | CTR 3 IN | Counter 3 input (9513 chip) |
| 18 | CTR 2 GATE | Counter 2 gate (9513 chip) |
| 19 | CTR 2 IN | Counter 2 input (9513 chip) |
| 20 | +5 V | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 21 | D IN STROBE | NC |
| 22 | SDI  15 | High-speed digital input  bit 15 (high byte) |
| 23 | SDI  14 | High-speed digital input  bit 14 (high byte) |
| 24 | SDI  13 | High-speed digital input  bit 13 (high byte) |
| 25 | SDI  12 | High-speed digital input  bit 12 (high byte) |
| 26 | SDI  11 | High-speed digital input  bit 11 (high byte) |
| 27 | SDI  10 | High-speed digital input  bit 10 (high byte) |
| 28 | SDI  9 | High-speed digital input  bit 9  (high byte) |
| 29 | SDI  8 | High-speed digital input  bit 8  (high byte) |
| 30 | OSC. OUT | Oscillator output - fout (9513 chip) |
| 31 | CTR 5 OUT | Counter 5 output (9513 chip) |
| 32 | CTR 4 OUT | Counter 4 output (9513 chip) |
| 33 | CTR 3 OUT | Counter 3 output (9513 chip) |
| 34 | CTR 2 OUT | Counter 2 output (9513 chip) |
| 35 | CTR 1 OUT | Counter 1 output (9513 chip) |
| 36 | CTR 1 IN | Counter 1 input (9513 chip) |
| 37 | CTR 1 GATE | Counter 1 gate (9513 chip) |

## *Software Installation*

The software installation consists of two steps: making a backup copy of the system software and installing the user-selected files. The software can be installed under Windows 3.1 or Windows 95/NT. **Note**: any previous installation of the Daq* drivers should be removed before installing a new version.

## Making a Backup Copy

Make a backup copy of the release disks as follows:

1. Boot up the system according to the manufacturer's instructions.
2. Enter the DOS operating system (if in another operating system, follow diskcopy procedures).
3. Type the command CD\ to go back to your system's root directory.
4. Place driver disk #1 into drive A (or whatever floppy disk drive you are installing from).
5. Type DISKCOPY A: A: and follow the instructions given by the DISKCOPY command.
6. This process may require swapping the release and backup disks several times.
7. When the disk copy is complete, repeat the process for all disks in the installation set.

## Installation Under Windows 3.1

The Daq* Windows install program copies the user-selected files and creates a Windows program group and icons.

1. To begin installation, put disk #1 into your floppy disk drive. From the program manager choose File/Run to run the **SETUP.EXE** file.
2. The Windows Setup dialog box asks you for a destination directory.
3. From the next dialog box, select the Typical, Compact, or Custom/Full installation (see figure). After the options have been selected, the bottom of the screen will display the amount of hard disk space required for the installation and the amount of disk space remaining after installation. Make sure there is room available for installation before continuing.
4. After installing the files from disk #1, the program will prompt you to place the rest of the disks from the installation set into the floppy drive.
5. A final message will display when the installation is complete.

**Note**: To verify proper performance, DaqTest (described in the next section) should be run after installation under Windows 3.1 (installation under Windows 95/NT has its own hardware test).
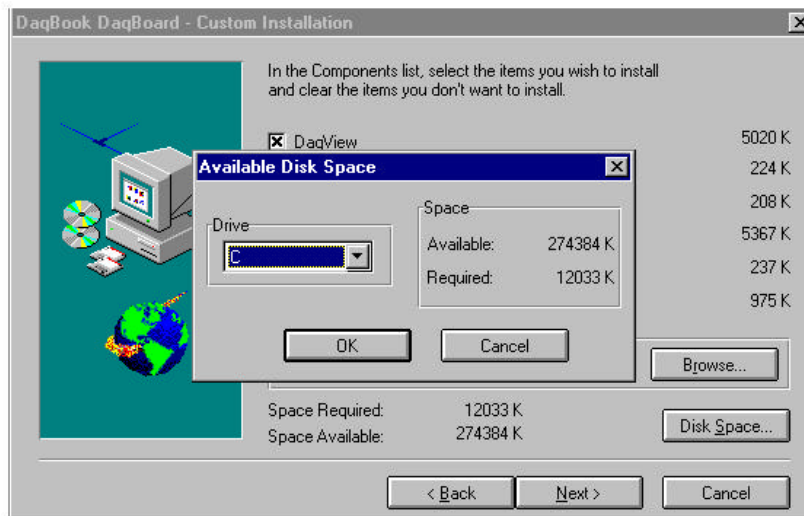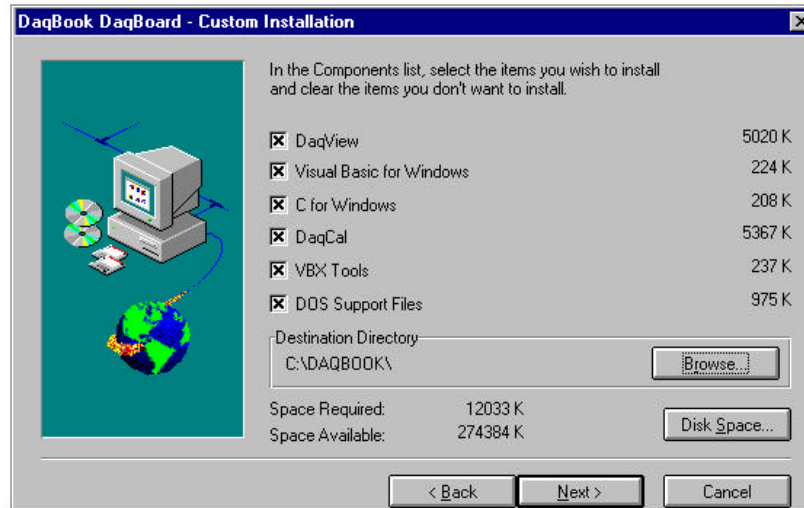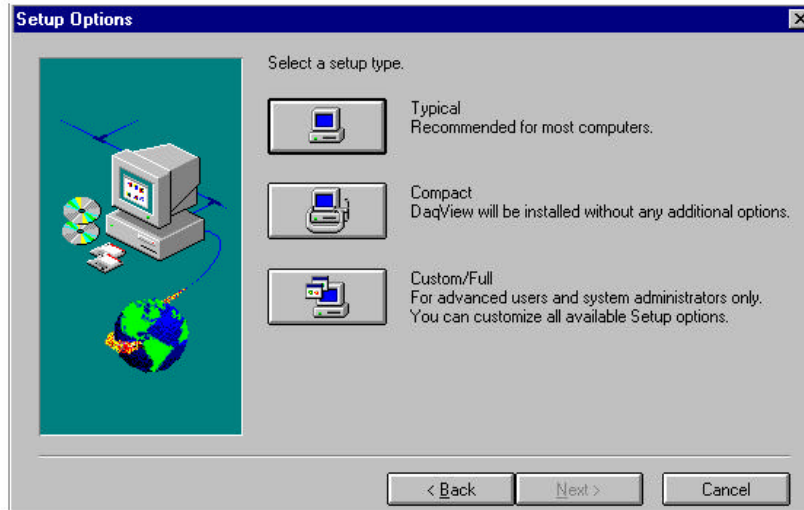
*User-Selected Software Options*

## DaqTest

The DaqBook test program (DaqTest.exe) should be run after installation and whenever a communication problem is suspected. DaqTest verifies the PC's printer port capabilities (standard and enhanced) and estimates the port's maximum performance. DaqTest also checks for interrupt operation.

To run the DaqTest, change to the DaqBook directory and type **daqTest** at the DOS prompt. (You can also run DaqTest from its Windows icon.) The opening screen is shown in the figure.

For proper Enhanced Parallel Port (EPP) operation, both DaqTest and the DaqBook driver must be informed of the specific EPP implementation available on your computer. If you select Y to test for EPP operation, DaqTest provides a selection of known EPP computers and interfaces and allows you to choose which one to test.

```
                    DAQBook Test Program 2.0

Do you wish to test high-speed (enhanced parallel port) operation (Y/N)?  N

                    DAQBook Test Summary

                        LPT1            LPT2        LPT3
I/O Address             0378            0278        03bc
EPP Type                ---             ---         ---
DaqBook Detected        Yes             No          No
Reliable Operation      8-bit           ---         ---
Output Speed            67 kB/sec       ---         ---
EPP Input Speed         ---             ---         ---
8-bit Input Speed       131 kB/sec      ---         ---
4-bit Input Speed       86 kB/sec       ---         ---
```

*DaqTest Opening Window*

When DaqTest is complete, a test summary will display. It verifies the following:

| DaqTest Summary Items and Descriptions | |
|---|---|
| IOAddress | The I/O base address of the LPT port. All available ports are automatically detected by daqTest. |
| EPP Type | If "Yes" was selected to test EPP, this field will display the type of EPP implementation used. |
| DaqBook Detected | "Yes," if a DaqBook was detected on the port under test. If "No," the following tests are not run. |
| Reliable Operation | Returns the types of DaqBooks supported (4-bit, 8-bit, etc.) |
| Output Speed | An estimated rate at which data can be sent out to the DaqBook. |
| EPP Input Speed | An estimated rate at which data can be read from the A/D of the DaqBook in EPP mode. Note that this will vary depending on the printer port and computer. |
| 8-bit Input Speed | An estimated rate at which data can be read from the A/D of the DaqBook in 8-bit mode. |
| 4-bit Input Speed | An estimated rate at which data can be read from the A/D of the DaqBook in 4-bit mode. |
| Interrupts Working | "Yes" if this printer port is capable of responding to DaqBook interrupts. |
| Interrupts Used | The interrupt request (IRQ) used for this printer port test. |

If DaqTest determines the printer port does not support interrupts, make sure the printer port is configured to use the IRQ you chose. The IRQ used should appear in the list of available IRQs shown at the end of DaqTest, or an interrupt conflict (more than one adapter using the same IRQ) may exist in your computer. If so, either change the IRQ of one of the conflicting adapters, or use a different printer port. The DaqBook can be used even if the printer port does not support interrupts (only interrupt-driven background operation will not work). If DaqTest is unable to identify a reliable method of communication, contact the factory. **Note**: Refer to chapters *Programmer s Guide* and *Daq\* Command Reference* for information how to use the **daqSetProtocol** command for EPP operation.

## Installation Under Windows 95 and Windows NT

This section describes the installation of DaqBook software under the Windows 95 and Windows NT operating systems. Installation for both Windows 95 and Windows NT are operationally equivalent. In fact, they use the same installation disk set. The installation program automatically detects which operating system is running and then proceeds accordingly.

**Note**: The following figures show screens for a Windows NT installation; however, identical procedures apply for a Windows 95 installation.

Two preliminary steps are to:

- Locate the disk set labeled *DaqBook/DaqBoard Software for Windows95/NT* and make a backup copy of the disk set before proceeding.
- (If the DaqBook is to be used immediately) Attach the DaqBook to the desired LPT port and power-on the system before starting the software installation.

Now insert the diskette labeled *Disk 1* into the floppy drive.  Locate the drive and double-click on the file `Setup.Exe`.  The installation process begins and displays the screen in the next figure.  This screen displays copyright and other information regarding the product.  Click <u>N</u>ext> to continue with the installation.  Click Cancel to exit without installing the software.



The next screen allows you to specify the program group in which to install the software.  A list of current program groups can be used or you can specify a new one.  Click <u>N</u>ext> to continue with the installation.  Click Cancel to exit without installing the software.

The next screen displays component installation options.  All selected items (indicated by the check-mark) are installed.  By default, all options are selected.  To de-select an item, click the corresponding check box for that item.  To select a de-selected item, click the corresponding check box for the item.  The bottom of screen displays the amount of hard disk space required for installation and the amount of disk space remaining after installation.  Make sure adequate memory is available before continuing.  Click Next> to continue with the installation.  Click Cancel to exit without installing the software.



The next screen shows the progress of the installation of the software components.



As the installation progresses, you may be asked to periodically insert the next disk into the floppy drive.  When prompted, locate the disk and replace the current disk with the next disk.  When the software component installation is complete, the following screen will appear.  You are given 3 options:

- Exit and perform device configuration (If the DaqBook is to be used immediately, you should select this configuration option and proceed to the next section).
- Exit and review the readme file for up-to-date information on the current release version.
- Exit completely and return to your operating system.

## DaqBook Configuration Under Windows 95/NT

This section describes the configuration of DaqBook devices under the Windows 95 and Windows NT operating systems. A configuration utility is supplied via a control panel applet. The **Daq Configuration** applet allows you to add a device, remove a device, or change existing configuration settings. Daq Configuration also has a built-in test utility to test the device. The test utility provides feedback on the validity of the current configuration settings as well as providing relevant performance summaries.

Daq Configuration can be found in the Windows 95/NT control panel and can be executed any time that it is desirable to add, remove or change device configuration settings. Daq Configuration may also be entered during driver installation. The following description applies to either method.

If entering Daq Configuration with a DaqBook and a DaqBoard configured, the screen at right will appear. This opening screen will display all currently configured devices in the Device Inventory field. Displayed devices are indicated by their name and an identifying icon which indicates the device type. If no devices are currently configured, no devices will appear in this field.

The 4 buttons across the bottom of the Daq Configuration screen are used as follows:

- **Properties**. Current configuration settings for a device can be changed or modified by bringing up the corresponding properties screen. To do so, double-click the device icon or single-click the device and then double-click the Properties button.
- **Remove**. The Remove button is used to remove a device from the configuration. A device may be removed if it is no longer installed or if the device's configuration no longer applies. **Note**: if a device is removed, applications may no longer access the device. However, the device can be re-configured at any time using the Add Device function described below.
- **Close**. The Close button may be used at any time to exit the Daq Configuration applet.
- **Add**. The Add Device button is used to add a device configuration whenever a new device is added to the system. Failure to perform this step will prevent applications from properly accessing the device. Double-clicking the Add Device button will display the following window (Note: screen shows DaqBook/100 currently selected):

Use the scroll bar to find the DaqBook device type to be configured.  Once found, click the device type (the type should then appear in the main edit box).  Now double-click the OK button.  The following window should appear:

This screen displays the properties for the DaqBook device with the default configuration settings. Fields include:

- The **Device Name** field is displayed with the default device name.  However, this field can be changed to any descriptive name as desired.  This device name is the name to be used with the `daqOpen` function (see enhanced API chapter) to open the device.  This name will also be displayed in the device lists for opening the device in the DaqView, DaqCal, and GageCal applications.
- The **Device Type** field should indicate the device type which was initially selected.  However, it can be changed here if necessary.
- The **Protocol** field is used to set the parallel port protocol for communicating with the DaqBook.  Depending on the DaqBook type and computer limitations, not all protocols may be available.
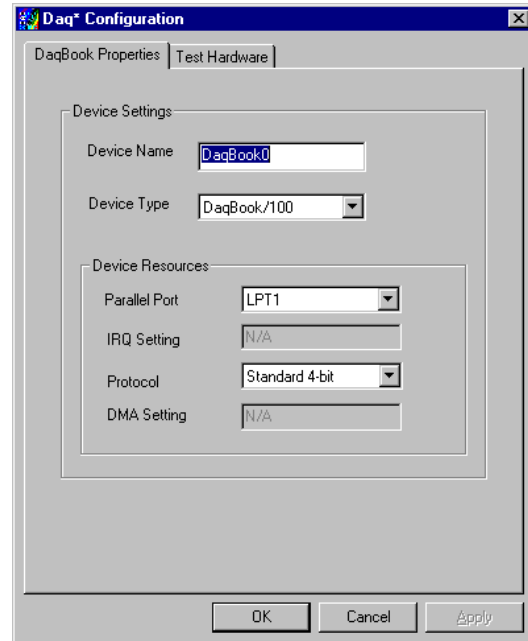
**Note: IRQ Setting** and **DMA Setting** for the DaqBook are currently not configurable.  These fields are reserved for future use.

When all fields have been changed to the desired settings, you can click:

- the **Apply** button to store the configuration.
- the **OK** button to store the configuration and exit the current property screen.
- the **Cancel** button to exit the current device configuration property screen without storing any changes.
- the **Test Hardware** tab to test the current stored configuration for the device.  This selection will bring up the Test property screen (**Note**: the screen shown displays results from a previously run test.  Initially screen will show no test results.):
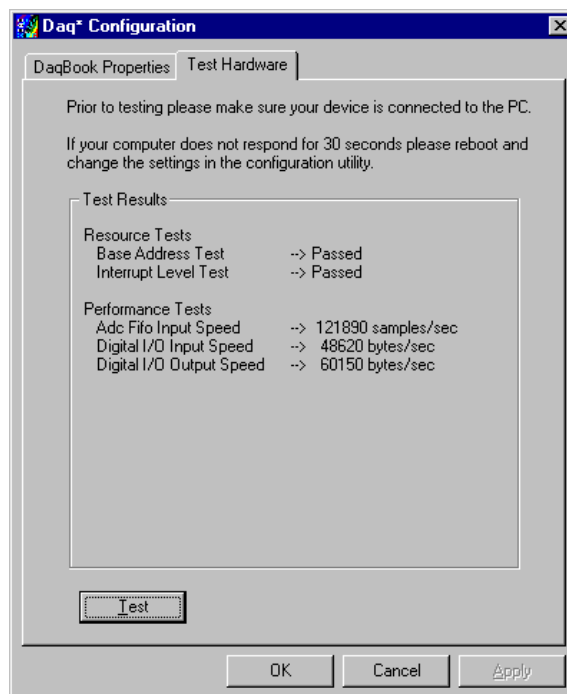
Before testing the DaqBook, make sure the device has been properly installed and powered-on. Make sure the parallel port cable is firmly in place on both the DaqBook and the proper LPT port in the computer.

**Note:** Testing the DaqBook device may, in some cases, cause the system to hang. If test results are not displayed in 30 seconds or the system does not seem to be responding, reboot the system. Upon power-up, re-enter the Daq Configuration and change the DaqBook configuration settings to those that work properly.

To test the current stored configuration for the DaqBook device, click the Test button. Test results should be displayed within a few seconds. The test results have 2 components: Resource Tests and Performance Tests.

### Resource Tests

The resource tests are intended to test system capability for the current device configuration. These tests are pass/fail. Resource test failure may indicate a lack of availability of the resource or a possible resource conflict.

- *Base Address Test* - This test will test the base address for the selected parallel port. Failure of this test may indicate that the parallel port is not properly configured within the system. See relevant operating system and computer manufacturer's documentation to correct the problem.
- *Interrupt Level Test* - This test will test the ability of the parallel port to generate interrupts. Failure of this test may indicate that the parallel port may be currently unable to generate the necessary hardware interrupt. **Note**: other parallel port devices may work OK in this mode. Some parallel port devices (such as printers) do not require interrupts to work properly. See relevant operating system and computer manufacturer's documentation to correct the problem.

### Performance Tests

The performance tests are intended to test various DaqBook functions with the current device configuration. These tests give quantitative results for each supported functional group. The results represent maximum rates at which the various operations can be performed. These rates depend on the selected parallel port protocol and will vary according to port hardware capabilities.

- *ADC FIFO Input Speed* - This test will test the maximum rate at which data can be transferred from the DaqBook's internal ADC FIFO to computer memory through the parallel port. Results are given in samples/second (sample is 2 bytes in length representing a single A/D count).
- *Digital I/O Input Speed* - This test will test the maximum rate at which DIO input data can be transferred from the DaqBook's Digital I/O ports to computer memory through the parallel port. Results are given in bytes/second.
- *Digital I/O Output Speed* - This test will test the maximum rate at which DIO output data can be transferred from the computer's memory to the DaqBook's Digital I/O ports through the parallel port. Results are given in bytes/second.

## *Calibration*

Daq*s are factory-calibrated. Adjustments are interrelated. If adjustments prove to be needed, make them in the preferred order:

1. PGA Input and Output Offset
2. Sample/Hold Offset
3. A/D Offset and Gain
4. VDC Voltage Reference
5. (DaqBook and DaqBoard only) DAC0 Full-Scale
6. (DaqBook and DaqBoard only) DAC1 Full-Scale

A Windows program, DaqCal.exe, is used to calibrate the Daq and its analog expansion cards with a 4½ digit DMM, adjustable voltage calibrator, and ambient temperature meter. To use this program, install and launch the program DaqCal.exe; and then, follow the on-screen instructions that include graphics. Depending on the type of calibration selected, you may be asked to connect the DMM to specific pins or short out specific pins of the JP7 jumper.

*Notes*

# DaqBoard Hardware and Installation

## *Overview*

This chapter describes the DaqBoard physically and functionally including installation.  It is best to read all the related documentation for your system before beginning the installation (for the particular DBKs in your system, read the corresponding sections of chapter 5, *DBK Option Cards and Modules*.

## *DaqBoard Description*

DaqBoards are ISA-bus plug-in cards that provide analog-to-digital conversion with a wide selection of signal-conditioning, signal expansion, and software support.  DaqBoards feature an on-board 512-location sequencer that allows you to select any channel and gain combination and configure each channel for unipolar or bipolar operation.

Input power for the DaqBoard comes from the host computer's bus.  Output power from the P1 connector includes +5 VDC (pin 1) and ±15 VDC (pins 21 and 2).  The section External Analog Expansion Power (JP1) explains how to set JP1 based on power use in the system.  Also, refer to the section *Power Management* in chapter 5, *DBK Option Cards and Modules*.

All the DaqBoards provide 16 analog inputs (expandable up to 256), 2 analog outputs, and 4 digital inputs and outputs.  Models /100A and/200A have additional digital I/O and counter/timer capabilities.  The various DaqBoard models have either 12-bit or 16-bit resolution.
- 12-bit models include model #s /100A and /112A.
- 16-bit models include model #s /200A and /216A.

Analog input capabilities are very flexible.  The A/D maximum sample rate is 100 kHz (divide by number of channels for scan rate) with a 16-channel multiplexer and a programmable-gain input amplifier.  Users can expand channel capacity to 256 analog inputs via expansion modules for multiplexing RTDs, thermocouples, strain gages, anti-aliasing filters, and simultaneous sample and hold amplifiers.  Expansion cards and modules attach to the P1 I/O connector (refer to *Connector Pinouts* later in this chapter).  The P1 DB-37 interface is compatible with multiplexers and signal conditioners from several manufacturers.

The DaqBoard performs 100 kHz scan sequences and provide programmable delays from 10 μs to 10 hours.  The unit's 100 kHz conversion rate fixes the time skew between channels at 10 μs.  The 512-location scan sequencer allows selection of the input amplifier gain for each channel.  The DaqBoard/100A and /200A can scan 16 digital inputs in the same sequence used for analog inputs (such inputs are thus time-correlated).  Optional simultaneous-sample-and-hold cards enable DaqBoards to sample up to 256 channels at the same instant.  Scanning and timing specifications are met even with a full complement of expansion modules.  All types of transducers are scanned within the same scan group without PC intervention.

DaqBoards offer a wide selection of triggering capabilities.  The DaqBoard can be triggered by software, a TTL signal, or an analog input level (including slope).  The trigger is hardware based which minimizes trigger latency to less than 10 μs.

Three data transfer modes are supported:
- DMA
- Interrupt-driven
- Fast I/O to data memory via block move instruction REP INSW.

Real-time data can be collected at 100 K readings/s.

The figure shows block diagrams of the DaqBoards.
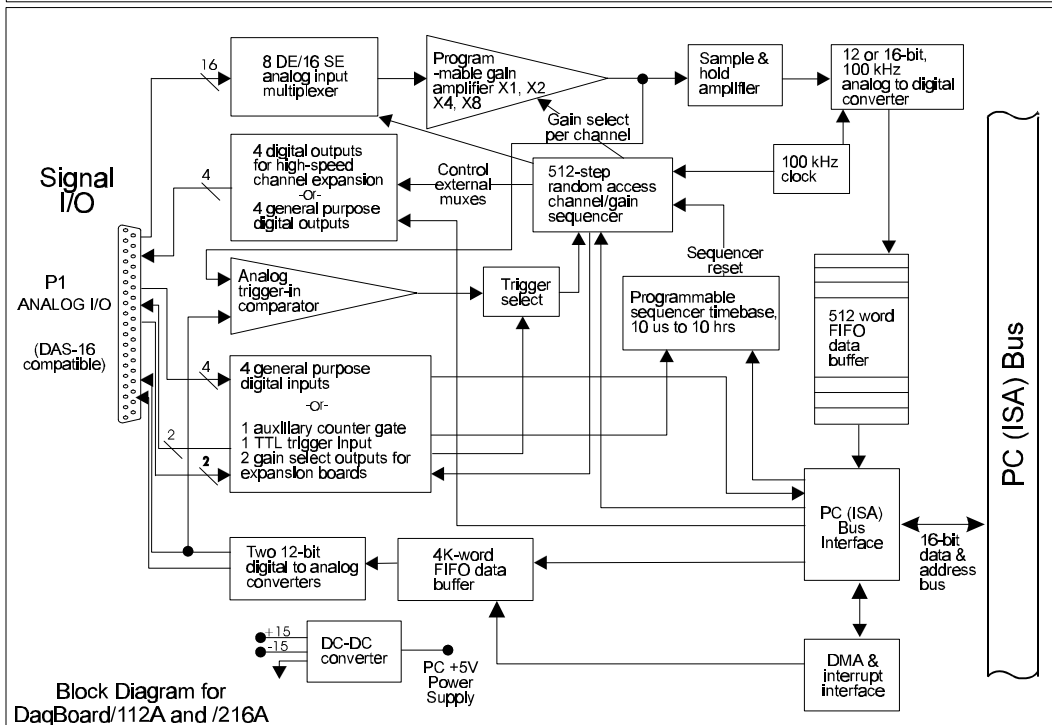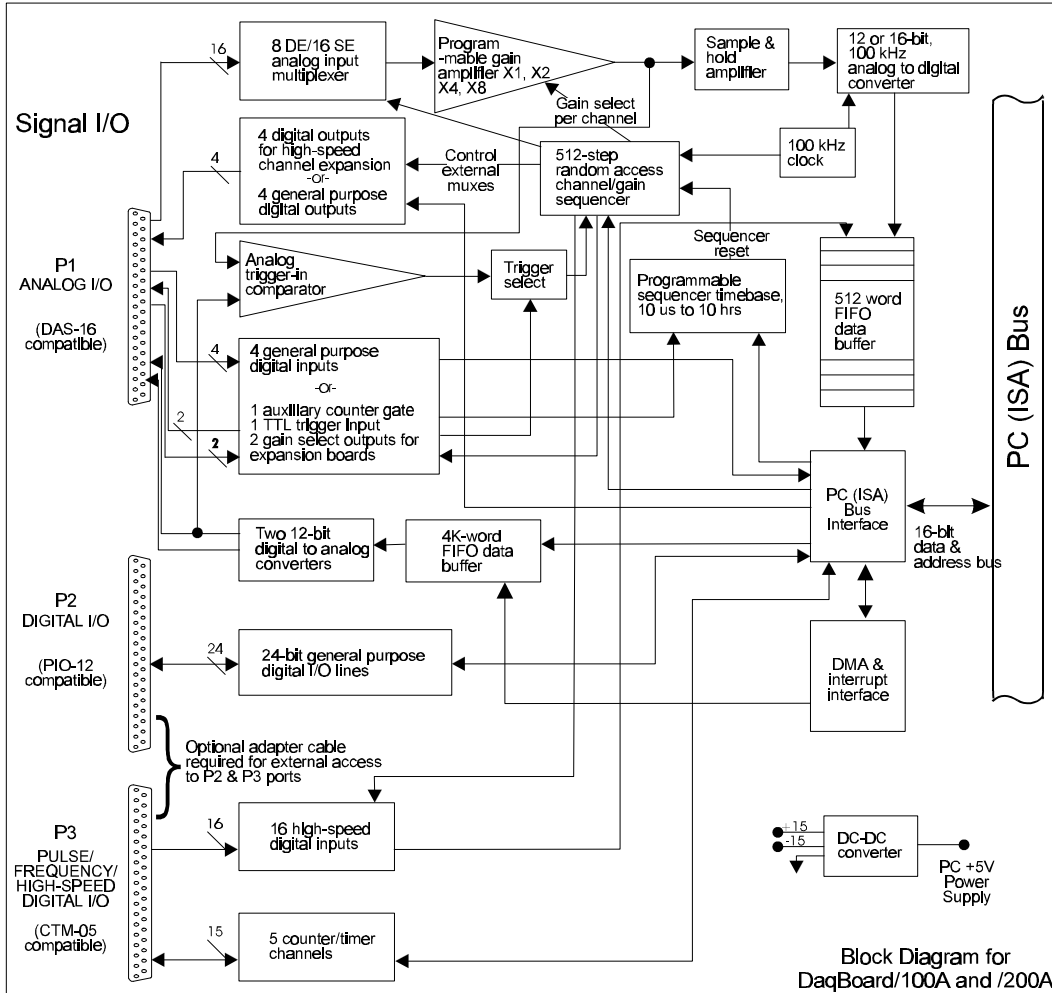


*DaqBoard Block Diagrams*

## *DaqBoard Installation*

The hardware installation varies with the model used and the application. You can skip over unrelated sections, but remember to read chapter 5 if you plan to use DBKs in your system.

| ⚠ | **CAUTION** |
|---|---|
| | **Turn off power to the host computer and all externally connected equipment while connecting cables and setting configuration jumpers and switches. Electrical shock or damage to equipment can result even under low-voltage conditions. In dry, static-prone environments, take ESD precautions (packaging, proper handling, grounded wrist strap, etc).** |

Performing installation tasks in the proper order can help prevent equipment damage. A generic order for tasks is:

1. Initial Inspection
2. Turn off all power to systems being handled.
3. Configure on-board jumpers and switches.
4. Connect cables.
5. Apply power.
6. Install and configure software.
7. Apply signal(s).
8. Verify performance.

### Initial Inspection

Carefully unpack all items from the shipping carton, and check for shipping damage. Immediately report any damage to the shipping agent. Retain all shipping materials in case you must return the unit to the factory. All returns must be have an RMA # (Return Material Authorization Number). For an RMA #, call the factory or your sales agent.

DaqBoards are shipped with the following items:

- DaqBoard Data Acquisition System (board)
- *DaqBook/DaqBoard/Daq PC-Card User s Manual*, warranty card, license agreement
- DaqBook/DaqBoard series software #232-0601
- 1.5 A fuse

### DaqBoard Configuration

The configuration of all 4 DaqBoard models is similar except for jumper locations. (Refer to the diagram which matches your model.) The internal configuration of each DaqBoard model consists of setting the following switches and jumpers for the desired mode of operation:

- SW1 - Base Address
- JP1 - External Analog Expansion Power
- JP2 - DAC Voltage Reference Header
- JP7 - Calibration (refer to *Calibration* section at the end of this chapter)
- JP8 - Interrupt & DMA
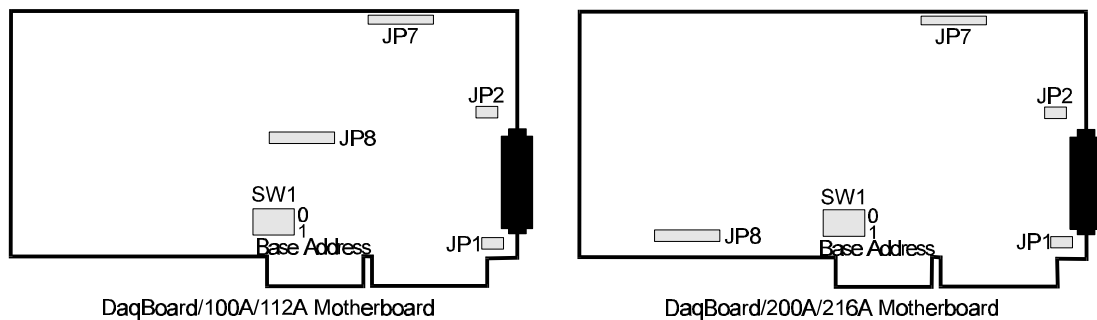


*Location of DaqBoard Jumpers*

## Base Address  (SW1)

The computer must know the DaqBoard's base address. Check the base address setting (3-digit hex) on the Base Address switch (see figure).  The factory default is 300 Hex (within the standard range for a prototype card; see table).  If the default value does not work, you must select an address within 1FF to 3FF (256 to 1023 Decimal).  In addition, the address must be on a 4-byte boundary, and it must not conflict with addresses already in use.

| INDUSTRY STANDARD I/O ADDRESSES Note; all systems are different. This is only a guide. ||
| Hex Range | Device |
| --- | --- |
| 000-1FF | Internal system |
| 200-207 | Game I/O |
| 20C-20D | Reserved |
| 21F | Reserved |
| 278-27F | Parallel printer port 2 |
| 2B0-2DF | Alternate enhanced graphics adapter |
| 2E1 | GPIB (Adapter 0) |
| 2E2 & 2E3 | Data acquisition (Adapter 0) |
| 2F8-2FF | Serial port 2 |
| 300-31F | Prototype card |
| 360-363 | PC network (low  address) |
| 364-367 | Reserved |
| 368-36B | PC network (high address) |
| 36C-36F | Reserved |
| 378-37F | Parallel printer port 1 |
| 380-38F | SDLC, bisynchronous 2 |
| 390-393 | Reserved |
| 3A0-3AF | Bisynchronous 1 |
| 3B0-3BF | Monochrome display and printer adapter |
| 3C0-3CF | Enhanced graphics adapter |
| 3D0-3DF | Color/Graphics monitor adapter |
| 3F0-3F7 | Diskette Controller |
| 3F8-3FF | Serial port 1 |
| NOTE: I/O addresses, hex 000 to 0FF, are reserved for the system board I/O.  Hex 100 to 3FF are available on the I/O channel. ||
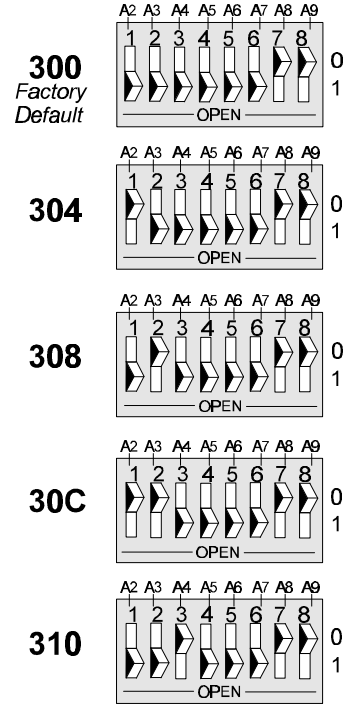
*Sample Base Addresses on SW1*

## External Analog Expansion Power (JP1)

This 4×2 header (JP1) has 3 possible settings.  If analog option cards (DBKs) are used, the JP1 pins are set to provide ±15 VDC to the cards.  If such cards are not used, the counter/timer CTR0 is available, and JP1 must be set accordingly.  The default setting is for use of analog option cards.

*JP1 External Analog Expansion Settings*

**Caution**: if using a DBK32A Auxiliary Power Supply or a DBK33 Triple-Output Power Supply Card, **the JP1 shunt jumpers must be entirely removed**.  Placing the jumpers on -OCTOUT and -OCLKIN will damage the 8254 timer chip.  Refer also to the *Power Management* section in chapter 5, *DBK Option Cards and Modules*.

## *DAC Reference Selection (JP2)*

This 5×2 header (JP2) allows you to select internal or external voltage references for the two separate analog outputs. If the internal -5 VDC reference is selected, either DAC can output from 0 to +5 VDC as the register count varies from 0 to 4095 (12-bit). If an external voltage reference is desired (up to 10 VDC in either polarity), the shunt jumpers must be set accordingly. There is also a provision to allow the outputting of a simultaneous Sample-Hold command signal on the DAC1-REFIN pin with the DAC1 set up for an internal reference. (The SSH setting cannot be used at the same time as a DAC1 external reference due to a potentially damaging conflict on P1 pin #26.) The defaults are both DAC0 and DAC1 set to Internal Reference. **Note**: the SSH setting is used with DBKs: 2, 5, 7, 17, 50, and 51. Refer to DBK chapter (5) as needed.



*JP2 DAC Reference Settings*

## *DMA and Interrupt Selection (JP8)*

This 11×2 header (JP8) selects both the interrupt IRQ level and the Direct Memory Access (DMA) channel for control of background data transfers. The preset default is DMA channel 5 and interrupt 10 (see figure).

- **Interrupt Selection**. The DaqBoard may be set to interrupt the PC when certain hardware conditions occur. The main board interrupt may be set to IRQ level 10, 11, 12, 14 or 15. The DaqBoard's IRQ level cannot be shared with any other device. Interrupt assistance and background transfers can be disabled by setting the JP8 interrupt jumper to OPEN.
- **DMA Selection**. Direct Memory Access allows high-speed data transfer either from the ADC FIFO or to the DAC FIFO. Only DMA channels 5-7 (of an ISA AT machine's seven channels) are available for the DaqBoard. Set both the DRQ and DACK jumpers to the desired DMA channel (the DaqBoard does not share DMA channels). Set the DMA jumpers to OPEN when DMA channels 5, 6 and 7 are used by other devices.



*JP8 DaqBoard DMA and Interrupt Selection*
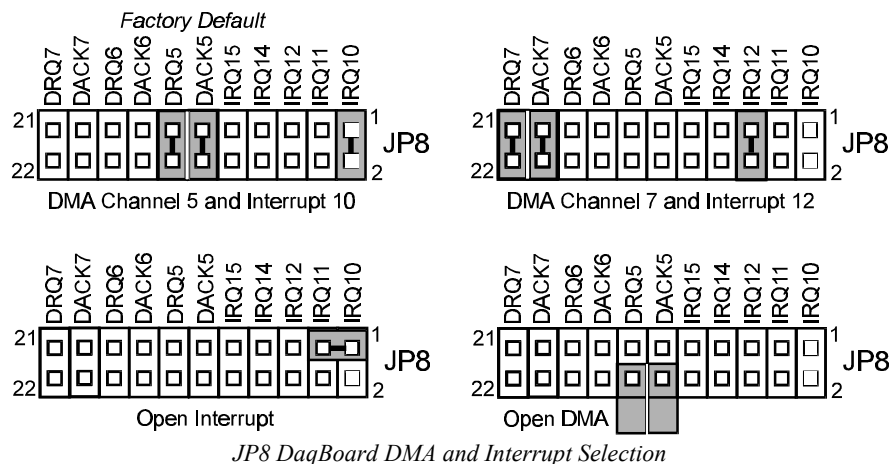
## Hardware Connection

### *DaqBoard Connection*

To install a DaqBoard in an IBM PC-AT or compatible, proceed as follows.

---
### CAUTION

⚠️  **Any attempt to insert or remove a DaqBoard board with the computer powered on could damage your computer and the DaqBoard.**

---

1. Turn power OFF to the PC and all attached equipment.
2. Remove the cover of the PC.
3. Choose an empty 16-bit slot. Loosen and remove the screw at the top of the slot's blank adapter plate. Then slide the plate up and out to remove.
4. Hold the DaqBoard in one hand placing your other hand on any metallic part of the PC/AT chassis (but not on any of its components). This will safely discharge any static electricity from your body.
5. Make sure the board switches, jumpers, and cables have been properly set (as described in the preceding section).
6. Align the board connector with the desired accessory slot and with the corresponding rear-panel slot. Gently press the board downward into the socket. Secure the board by inserting the rear-panel adapter-plate screw.
7. Route CA-60 cables as needed and secure the rear panels.
8. Replace the computer's cover.
9. Plug in all cords and cables, and apply power. You are now ready to make any necessary system connections and install the software.

### *DaqBoard I/O Connectors*

The DaqBoard accepts all analog and digital I/O signals via one standard I/O connector (P1) and two on-board 40-pin headers (P2 and P3 on the DaqBoard/100A/200A). The CA-60 cable can be used as an interface between the onboard P2 and P3 and a DB37 connector on the outside of the computer's enclosure.

- P1 Analog I/O. Provides 16 analog input channels, 2 analog output channels, a 16-bit counter/timer, 4 TTL inputs and outputs, and various signals for driving expansion cards.
- P2 Digital I/O. Provides (3) 8-bit TTL programmable I/O ports and external interrupt input.
- P3 Frequency I/O. Provides (5) 16-bit counters and 16 high-speed digital inputs and external interrupt input.
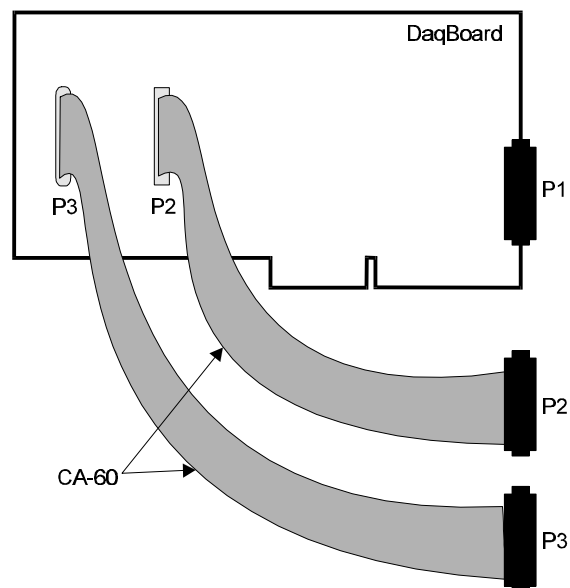


*DaqBoard s I/O Connectors*

To gain access to the DaqBoard port connectors, signals can be connected via CA-131-x cable through a D-shell 37-pin female connector or a DBK11 screw-terminal option card with component sockets. The following tables detail the DaqBoard pinouts for P1, P2, and P3.

**P1 - Analog I/O**
(compatible with
Metrabyte DAS-16)

Top row pins (1-19): 1 +5V PWR, 2 CTR 0 OUT/-15VDC, 3 OP3/CHS3, 4 OP1/CHS1, 5 IP3/GS1, 6 IP1/GS0, 7 POWER GND, 8 VREF (-5V), 9 D/A 0 OUT, 10 D/A 0 REF IN, 11 CH7 LO IN*CH15 HI IN, 12 CH6 LO IN*CH14 HI IN, 13 CH5 LO IN*CH13 HI IN, 14 CH4 LO IN*CH12 HI IN, 15 CH3 LO IN*CH11 HI IN, 16 CH2 LO IN*CH10 HI IN, 17 CH1 LO IN*CH9 HI IN, 18 CH0 LO IN*CH8 HI IN, 19 LL SENSE GND

Bottom row pins (20-37): 20 CTR 2 OUT, 21 CTR 0 CLOCK IN/+15VDC, 22 OP2/CHS2, 23 OP0/CHS0, 24 IP2/CTR 0 GATE, 25 IP0/TRIG 0, 26 SSH/D/A 1 REF IN, 27 D/A 1 OUT, 28 LL GND, 29 LL GND, 30 CH7 HI IN, 31 CH6 HI IN, 32 CH5 HI IN, 33 CH4 HI IN, 34 CH3 HI IN, 35 CH2 HI IN, 36 CH1 HI IN, 37 CH0 HI IN

| Pin | Signal Name | Description for P1 Pin Use |
|---|---|---|
| 1 | +5 PWR | 5 V Supply (Refer to *Power Management* section in chapter 5) |
| 2 | CTR 0 OUT/-15 VDC | Counter 0 output (8254 chip)/ -15 V (Refer to *Power Management* section in chapter 5) |
| 3 | OP 3/CHS 3 | Digital out bit 3/channel select line for expansion cards |
| 4 | OP 1/CHS 1 | Digital out bit 1/ channel select line for expansion cards |
| 5 | IP 3/GS 1 | Digital in bit 3/gain select line for expansion cards |
| 6 | IP 1/GS 0 | Digital in bit 1/gain select line for expansion cards |
| 7 | POWER GND | Digital ground |
| 8 | VREF (-5V) | -5 V supply @ 10 mA max |
| 9 | D/A 0 OUT | Digital-to-analog converter output ch 0 |
| 10 | D/A 0 REF IN | Digital-to-analog converter reference in ch 0 (must invert) |
| 11 | CH 7 LO IN/CH 15 HI IN | Ch 7 LO IN (differential mode)/ch 15 HI IN (single-ended mode) |
| 12 | CH 6 LO IN/CH 14 HI IN | Ch 6 LO IN (differential mode)/ch 14 HI IN (single-ended mode) |
| 13 | CH 5 LO IN/CH 13 HI IN | Ch 5 LO IN (differential mode)/ch 13 HI IN (single-ended mode) |
| 14 | CH 4 LO IN/CH 12 HI IN | Ch 4 LO IN (differential mode)/ch 12 HI IN (single-ended mode) |
| 15 | CH 3 LO IN/CH 11 HI IN | Ch 3 LO IN (differential mode)/ch 11 HI IN (single-ended mode) |
| 16 | CH 2 LO IN/CH 10 HI  IN | Ch 2 LO IN (differential mode)/ch 10 HI IN (single-ended mode) |
| 17 | CH 1 LO IN/CH  9 HI IN | Ch 1 LO IN (differential mode)/ch 9 HI IN (single-ended mode) |
| 18 | CH 0 LO IN/CH  8 HI IN | Ch 0 LO IN (differential mode)/ch 8 HI IN (single-ended mode) |
| 19 | L.L. GND | Low-level ground (analog ground - use with analog inputs and outputs) |
| 20 | CTR 2 OUT | Counter 2 output (8254 chip) |
| 21 | CTR 0 CLOCK IN/+15 VDC | Counter 0 clock in (8254 chip)/+15 V (Refer to *Power Management* section in chapter 5) |
| 22 | OP 2/CHS 2 | Digital output bit 2/channel select line for expansion cards |
| 23 | OP 0/CHS 0 | Digital output bit 0/ channel select line for expansion cards |
| 24 | IP 2/CTR 0 GATE | Digital input bit 2/counter 0 gate |
| 25 | IP 0/TRIG 0 | Digital input bit 0/trigger 0 |
| 26 | D/A 1 REF IN/SSH | Digital-to-analog converter reference in ch 1 (must invert)/SSH |
| 27 | D/A 1 OUT | Digital-to-analog converter output ch 1 |
| 28 | L.L. GND | Low-level ground (analog ground - use with analog inputs and outputs) |
| 29 | L.L. GND | Low-level ground (analog ground - use with analog inputs and outputs) |
| 30 | CH 7 HI IN | Ch 7 HI IN (single-ended mode or differential mode) |
| 31 | CH 6 HI IN | Ch 6 HI IN (single-ended mode or differential mode) |
| 32 | CH 5 HI IN | Ch 5 HI IN (single-ended mode or differential mode) |
| 33 | CH 4 HI IN | Ch 4 HI IN (single-ended mode or differential mode) |
| 34 | CH 3 HI IN | Ch 3 HI IN (single-ended mode or differential mode) |
| 35 | CH 2 HI IN | Ch 2 HI IN (single-ended mode or differential mode) |
| 36 | CH 1 HI IN | Ch 1 HI IN (single-ended mode or differential mode) |
| 37 | CH 0 HI IN | Ch 0 HI IN (single-ended mode or differential mode) |

Note:  Software configuration commands determine P1 digital I/O pin functions. Actual shunt-jumper placement is required to provide ±15 VDC to expansion cards or disconnect internal DAC references to allow externally selected DAC references.  Digital I/O cannot be used with DBKs.  "/" indicates the pin can be used for either function but not both at the same time.

| P2 Digital I/O | |
|---|---|
| **P2 Digital I/O**<br>The P2 interface is available on the DaqBoard/100A and /200A. | <br>DB37 Connector via CA-60 Interface Cable<br>P2 40-pin header uses same pin numbers as DB37 at left |

| Pin | Signal Name | Description for P2 Pin Use |
|---|---|---|
| 1 | IR INPUT | Interrupt line input (no functions to access this) |
| 2 | IR ENABLE | Interrupt line enable (no functions to access this) |
| 3 | PORT B 7 | Digital input/output - port B bit 7 |
| 4 | PORT B 6 | Digital input/output - port B bit 6 |
| 5 | PORT B 5 | Digital input/output - port B bit 5 |
| 6 | PORT B 4 | Digital input/output - port B bit 4 |
| 7 | PORT B 3 | Digital input/output - port B bit 3 |
| 8 | PORT B 2 | Digital input/output - port B bit 2 |
| 9 | PORT B 1 | Digital input/output - port B bit 1 |
| 10 | PORT B 0 | Digital input/output - port B bit 0 |
| 11 | GND | Digital ground |
| 12 | N/C | Pin not connected/not used |
| 13 | GND | Digital ground |
| 14 | N/C | Pin not  connected/not used |
| 15 | GND | Digital ground |
| 16 | N/C | Pin not connected/not used |
| 17 | GND | Digital ground |
| 18 | +5 V | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 19 | GND | Digital ground |
| 20 | +5 V | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 21 | GND | Digital ground |
| 22 | PORT C 7 | Digital input/output - port C bit 7 |
| 23 | PORT C 6 | Digital input/output - port C bit 6 |
| 24 | PORT C 5 | Digital input/output - port C bit 5 |
| 25 | PORT C 4 | Digital input/output - port C bit 4 |
| 26 | PORT C 3 | Digital input/output - port C bit 3 |
| 27 | PORT C 2 | Digital input/output - port C bit 2 |
| 28 | PORT C 1 | Digital input/output - port C bit 1 |
| 29 | PORT C 0 | Digital input/output - port C bit 0 |
| 30 | PORT A 7 | Digital input/output - port A bit 7 |
| 31 | PORT A 6 | Digital input/output - port A bit 6 |
| 32 | PORT A 5 | Digital input/output - port A bit 5 |
| 33 | PORT A 4 | Digital input/output - port A bit 4 |
| 34 | PORT A 3 | Digital input/output - port A bit 3 |
| 35 | PORT A 2 | Digital input/output - port A bit 2 |
| 36 | PORT A 1 | Digital input/output - port A bit 1 |
| 37 | PORT A 0 | Digital input/output - port A bit 0 |
| NOTE:  No local lines are available if digital expansion cards are in use. | | |

| P3 - Pulse/Frequency /High-Speed Digital I/O |
|---|
| The P3 interface is available on the DaqBoard/100A/200A. |



DB37 Connector via CA-60 Interface Cable

P3 40-pin header uses same pin numbers as DB37 at left

| Pin | Signal Name | Description for P3 Pin Use |
|---|---|---|
| 1 | IR INPUT | Interrupt line input (used with counters) |
| 2 | IR ENABLE | Interrupt line enable (used with counters) |
| 3 | SDI 7 | High-speed digital input  bit 7 (low byte) |
| 4 | SDI 6 | High-speed digital input  bit 6 (low byte) |
| 5 | SDI 5 | High-speed digital input  bit 5 (low byte) |
| 6 | SDI 4 | High-speed digital input  bit 4 (low byte) |
| 7 | SDI 3 | High-speed digital input  bit 3 (low byte) |
| 8 | SDI 2 | High-speed digital input  bit 2 (low byte) |
| 9 | SDI 1 | High-speed digital input  bit 1 (low byte) |
| 10 | SDI 0 | High-speed digital input bit 0 (low byte) |
| 11 | GND | Digital ground |
| 12 | CTR 5 GATE | Counter 5 gate (9513 chip) |
| 13 | CTR 5 IN | Counter 5 input (9513 chip) |
| 14 | CTR 4 GATE | Counter 4 gate (9513 chip) |
| 15 | CTR 4 IN | Counter 4 input (9513 chip) |
| 16 | CTR 3 GATE | Counter 3 gate (9513 chip) |
| 17 | CTR 3 IN | Counter 3 input (9513 chip) |
| 18 | CTR 2 GATE | Counter 2 gate (9513 chip) |
| 19 | CTR 2 IN | Counter 2 input (9513 chip) |
| 20 | +5 V | +5 V supply (Refer to *Power Management* section in chapter 5) |
| 21 | D IN STROBE | NC |
| 22 | SDI  15 | High-speed digital input  bit 15 (high byte) |
| 23 | SDI  14 | High-speed digital input  bit 14 (high byte) |
| 24 | SDI  13 | High-speed digital input  bit 13 (high byte) |
| 25 | SDI  12 | High-speed digital input  bit 12 (high byte) |
| 26 | SDI  11 | High-speed digital input  bit 11 (high byte) |
| 27 | SDI  10 | High-speed digital input  bit 10 (high byte) |
| 28 | SDI  9 | High-speed digital input  bit 9  (high byte) |
| 29 | SDI  8 | High-speed digital input  bit 8  (high byte) |
| 30 | OSC. OUT | Oscillator output - fout (9513 chip) |
| 31 | CTR 5 OUT | Counter 5 output (9513 chip) |
| 32 | CTR 4 OUT | Counter 4 output (9513 chip) |
| 33 | CTR 3 OUT | Counter 3 output (9513 chip) |
| 34 | CTR 2 OUT | Counter 2 output (9513 chip) |
| 35 | CTR 1 OUT | Counter 1 output (9513 chip) |
| 36 | CTR 1 IN | Counter 1 input (9513 chip) |
| 37 | CTR 1 GATE | Counter 1 gate (9513 chip) |

## *Software Installation*

The software installation consists of two steps: making a backup copy of the system software and installing the user-selected files.  The software can be installed under Windows 3.1 or Windows 95/NT. **Note**: any previous installation of the Daq* drivers should be removed before installing a new version.

## Making a Backup Copy

Make a backup copy of the release disks as follows:

1.  Boot up the system according to the manufacturer's instructions.
2.  Enter the DOS operating system (if in another operating system, follow diskcopy procedures).
3.  Type the command CD\ to go back to your system's root directory.
4.  Place driver disk #1 into drive A (or whatever floppy disk drive you are installing from).
5.  Type DISKCOPY A: A: and follow the instructions given by the DISKCOPY command.
6.  This process may require swapping the release and backup disks several times.
7.  When the disk copy is complete, repeat the process for all disks in the installation set.

## Installation Under Windows 3.1

The Daq* Windows install program copies the user-selected files and creates a Windows program group and icons.  Proceed as follows:

1.  To begin installation, put disk #1 into your floppy disk drive.  From the program manager, choose File/Run to run the **SETUP.EXE** file.
2.  The Windows Setup dialog box asks you for a destination directory.
3.  From the next dialog box, select the Typical, Compact, or Custom/Full installation (see figure). After the options have been selected, the bottom of the screen will display the amount of hard disk space required for the installation and the amount of disk space remaining after installation. Make sure there is room available for installation before continuing.
4.  After installing the files from disk #1, the program will prompt you to place the rest of the disks from the installation set into the floppy drive.
5.  A final message will display when the installation is complete.

*User-Selected Software Options*

## Installation Under Windows 95 and Windows NT

This section describes the installation of DaqBoard software under the Windows 95 and Windows NT operating systems. Installation for both Windows 95 and Windows NT are operationally equivalent. In fact, they use the same installation disk set. The installation program automatically detects which operating system is running and then proceeds accordingly.

**Note**: The following figures show screens for a Windows NT installation; however, identical procedures apply for a Windows 95 installation.

Two preliminary steps are to:
- Locate the disk set labeled *DaqBook/DaqBoard Software for Windows95/NT* and make a backup copy of the disk set before proceeding.
- Complete hardware installation as previously described and power-on the system before starting the software installation.

Now insert the diskette labeled *Disk 1* into the floppy drive. Locate the drive and double-click on the file `Setup.Exe`. The installation process begins and displays the screen in the next figure. This screen displays copyright and other information regarding the product. Click Next> to continue with the installation. Click Cancel to exit without installing the software.



The next screen allows you to specify the program group in which to install the software. A list of current program groups can be used or you can specify a new one. Click Next> to continue with the installation. Click Cancel to exit without installing the software.

The next screen displays component installation options. All selected items (indicated by the check-mark) are installed. By default, all options are selected. To de-select an item, click the corresponding check box for that item. To select a de-selected item, click the corresponding check box for the item. The bottom of screen displays the amount of hard disk space required for installation and the amount of disk space remaining after installation. Make sure adequate memory is available before continuing. Click Next> to continue with the installation. Click Cancel to exit without installing the software.



The next screen shows the progress of the installation of the software components.

As the installation progresses, you may be asked to periodically insert the next disk into the floppy drive. When prompted, locate the disk and replace the current disk with the next disk. When the software component installation is complete, the following screen will appear. You are given 3 options:

- Exit and perform device configuration (If the DaqBoard is to be used immediately, you should select this configuration option and proceed to the next section).
- Exit and review the readme file for up-to-date information on the current release version.
- Exit completely and return to your operating system.
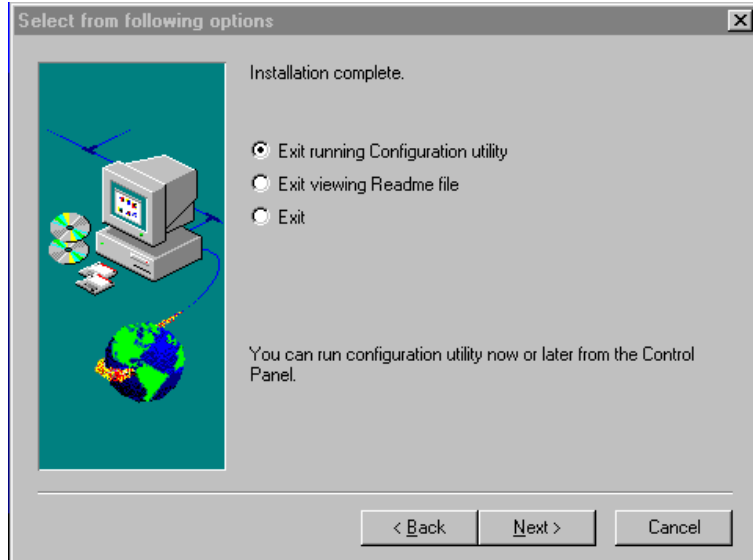


## DaqBoard Configuration Under Windows 95/NT

This section describes the configuration of DaqBoard devices under the Windows 95 and Windows NT operating systems. A configuration utility is supplied via a control panel applet. The **Daq Configuration** applet allows you to add a device, remove a device, or change existing configuration settings. Daq Configuration also has a built-in test utility to test the device. The test utility provides feedback on the validity of the current configuration settings as well as providing relevant performance summaries.

Daq Configuration can be found in the Windows 95/NT control panel and can be executed any time that it is desirable to add, remove or change device configuration settings. Daq Configuration may also be entered during driver installation. The following description applies to either method.

If entering Daq Configuration with a DaqBook and a DaqBoard configured, the screen at right will appear. This opening screen will display all currently configured devices in the Device Inventory field. Displayed devices are indicated by their name and an identifying icon which indicates the device type. If no devices are currently configured, no devices will appear in this field.



The 4 buttons across the bottom of the Daq Configuration screen are used as follows:

- **Properties**. Current configuration settings for a device can be changed or modified by bringing up the corresponding properties screen. To do so, double-click the device icon or single-click the device and then double-click the Properties button.
- **Remove**. The Remove button is used to remove a device from the configuration. A device may be removed if it is no longer installed or if the device's configuration no longer applies. **Note**: if

a device is removed, applications may no longer access the device. However, the device can be re-configured at any time using the <u>A</u>dd Device function described below.

- **<u>C</u>lose**. The <u>C</u>lose button may be used at any time to exit the Daq Configuration applet.
- **<u>A</u>dd**. The <u>A</u>dd Device button is used to add a device configuration whenever a new device is added to the system. Failure to perform this step will prevent applications from properly accessing the device. Double-clicking the <u>A</u>dd Device button will display the following window (Note: screen shows DaqBook/100 currently selected):

Use the scroll bar to find the DaqBoard device type to be configured. Once found, click the device type (the type should then appear in the main edit box). Now double-click the OK button. The following window should appear:

This screen displays the properties for the DaqBoard device with the default configuration settings. Fields include:

- The **Device Name** field is displayed with the default device name. However, this field can be changed to any descriptive name as desired. This device name is the name to be used with the `daqOpen` function (see enhanced API chapter) to open the device. This name will also be displayed in the device lists for opening the device in the DaqView, DaqCal, and GageCal applications.
- The **Device Type** field should indicate the device type which was initially selected. However, it can be changed here if necessary.
- The **Base Address** field is used to select the Base Address at which the DaqBoard is configured. This Base Address must match the Base Address configured on the DaqBoard for the DaqBoard to work properly. See *DaqBoard Installation   Base Address (SW1)* for related.
- The **Protocol** field is used to set the bus interface protocol for communicating with the DaqBoard. Currently, this field can only be set to *ISA*.
- The **IRQ Setting** field can be used to select the IRQ for the DaqBoard. If this field does not match the hardware setting for the device's IRQ, the DaqBoard may operate improperly. Also, the setting of this field to an IRQ which is already in use by another device may cause the DaqBoard to operate improperly.
- The **DMA Setting** field can be used to select the DMA channel for the DaqBoard. It is not required to use DMA with the DaqBoard. Setting this field to *None* will disable DMA on the DaqBoard.
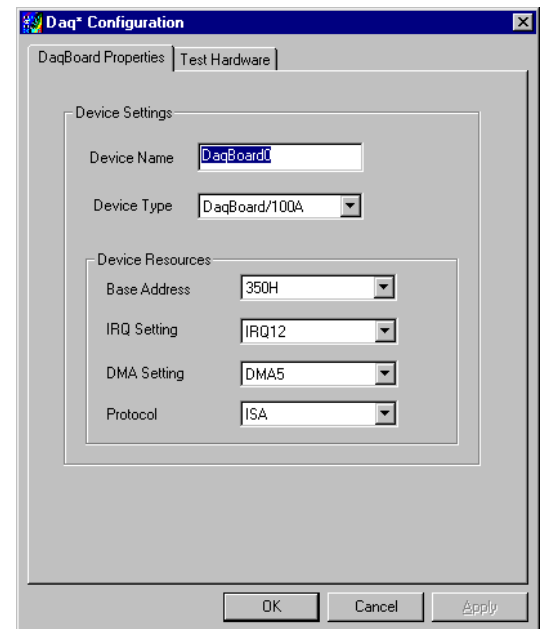
When all fields have been changed to the desired settings, you can click:
- the **Apply** button to store the configuration.
- the **OK** button to store the configuration and exit the current property screen.
- the **Cancel** button to exit the current device configuration property screen without storing any changes.
- the **Test Hardware** tab to test the current stored configuration for the device.  This selection will bring up the Test property screen (**Note**: the next screen displays results from a previously run test.  Initially, your screen will show no test results.):

Before testing the DaqBoard, make sure the device has been properly installed.  See the *DaqBoard Installation* section.

**Note:**  Testing the DaqBoard device may, in some cases, cause the system to hang.  If test results are not displayed in 30 seconds or the system does not seem to be responding, reboot the system.  Upon power-up, re-enter Daq Configuration and change the DaqBoard configuration settings to those that work properly.

To test the current stored configuration for the DaqBoard device, click the Test button.  Test results should be displayed within a few seconds.  The test results have 2 components: Resource Tests and Performance Tests.

**Resource Tests**

The resource tests are intended to test system capability for the current device configuration.  These tests are pass/fail.  Resource test failure may indicate a lack of availability of the resource or a possible resource conflict.
- *Base Address Test* - This test will test the base address for the selected DaqBoard.  Failure of this test may indicate that the DaqBoard is not properly configured for the selected Base Address.  See the *DaqBoard Installation   Base Address (SW1)* section to verify that the Base Address selected matches the Base Address currently configured on the DaqBoard.
- *Interrupt Level Test* - This test will test the ability of the DaqBoard to generate interrupts.  Failure of this test may indicate that the DaqBoard may not be currently configured to use the selected IRQ.  Check the *DaqBoard Installation   DMA and Interrupt Selection (JP8)* section to make sure that the IRQ level configured matches the IRQ level selected in this utility.  Also check IRQs for other devices in the system to prevent IRQ conflicts with them.
- *DMA Channel Test* - This test will test the ability of the DaqBoard to perform ADC transfers using the specified DMA channel.  Failure of this test may indicate that the DMA channel may not be properly configured on the DaqBoard.  Check the *DaqBoard Installation   DMA and Interrupt Selection (JP8)* section and make sure that the DMA channel configured matches the DMA channel selected in this utility.  Also check for DMA channel conflicts with other devices.  This test will also fail if the DMA channel field is set to *None*.

**Performance Tests**

The performance tests are intended to test various DaqBoard functions with the current device configuration.  These tests give quantitative results for each supported functional group.  The results represent maximum rates at which the various operations can be performed.  These rates depend on the selected parallel port protocol and will vary according to port hardware capabilities.
- *ADC FIFO Input Speed* - This test will test the maximum rate at which data can be transferred from the DaqBoard's internal ADC FIFO to computer memory.  Results are given in samples/second (sample is 2 bytes in length representing a single A/D count).
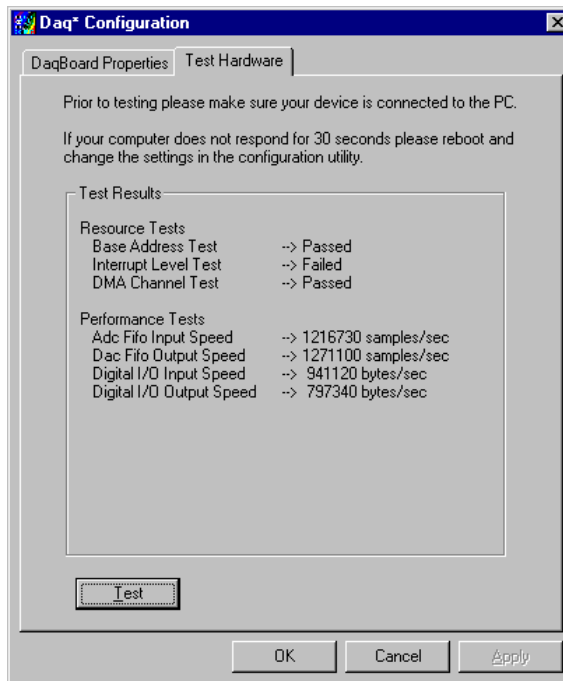
- • *Digital I/O Input Speed* - This test will test the maximum rate at which DIO input data can be transferred from the DaqBoard's Digital I/O ports to computer memory. Results are given in bytes/second.
- • *Digital I/O Output Speed* - This test will test the maximum rate at which DIO output data can be transferred from the computer's memory to the DaqBoard's Digital I/O ports. Results are given in bytes/second.

## *Calibration*

DaqBoards are factory-calibrated. Adjustments are interrelated. If adjustments prove to be needed, make them in the preferred order:

1. PGA Input and Output Offset
2. Sample/Hold Offset
3. A/D Offset and Gain
4. VDC Voltage Reference
5. (DaqBook and DaqBoard only) DAC0 Full-Scale
6. (DaqBook and DaqBoard only) DAC1 Full-Scale

A Windows program, DaqCal.exe, is used to calibrate the Daq and its analog expansion cards with a 4½ digit DMM, adjustable voltage calibrator, and ambient temperature meter. To use this program, install and launch the program DaqCal.exe; and then, follow the on-screen instructions that include graphics. Depending on the type of calibration selected, you may be asked to connect the DMM to specific pins or short out specific pins of the JP7 jumper.

🖎 *Notes*

**4**

# Daq PC-Card Hardware and Installation

## *Overview*

This chapter describes the Daq PC-Card physically and functionally including installation.  It is best to read all the related documentation for your system before beginning the installation (for the particular DBKs in your system, read the corresponding sections of chapter 5, *DBK Option Cards and Modules)*.

## Daq PC-Card Description

The Daq PC-Card for notebook PCs complies with PC Card Standard Specification 2.1, PCMCIA Type II (5mm) compatible.  The Daq/112B and Daq/216B provide 12- or 16- bit, 100 kHz data acquisition via 8 differential or 16 single-ended analog inputs.  A wide variety of signal-conditioning, expansion, and software options are available.  The Daq PC-Card connects to DBK cards and modules that support the DB37 (P1) connector.

Input power for the Daq PC-Card comes from the host computer.  No output power is available.  Thus, power for DBKs must be provided by a CDK10.  A CDK10 expansion chassis also has two card slots to hold DBKs.  For expansion, the DBK41 (10-Slot Chassis) with the DBK32A or DBK33 can be used with multiple DBK Cards.

The on-board 512-location scan sequencer allows you to select any channel and gain to scan different types of transducers, from thermocouples to strain gauges, within the same scan group without a software slow down.  The sequencer scans at a 10 µs/channel rate and can be programmed to repeat a sequence at intervals from 10 µs to 10 hr.  Optional simultaneous sample and hold cards can sample up to 256 channels at the same instant.  Scanning and timing specifications are met even with a full complement of expansion modules (maximum of 256 input channels).

The Daq PC-Card includes DOS-based client software that is compatible with PCMCIA Card Services Specification 2.1.  This software allows easy insertion and removal into any Type II socket with automatic configuration on insertion for DOS and Windows 3.x..  (CardSoft™ Card and Socket Services are available on most notebook PCs or from IOtech.  If using Windows 95, the installation disk has a configuration file and does not require additional PCMCIA software.)

The figure shows the Daq PC-Card block diagram.
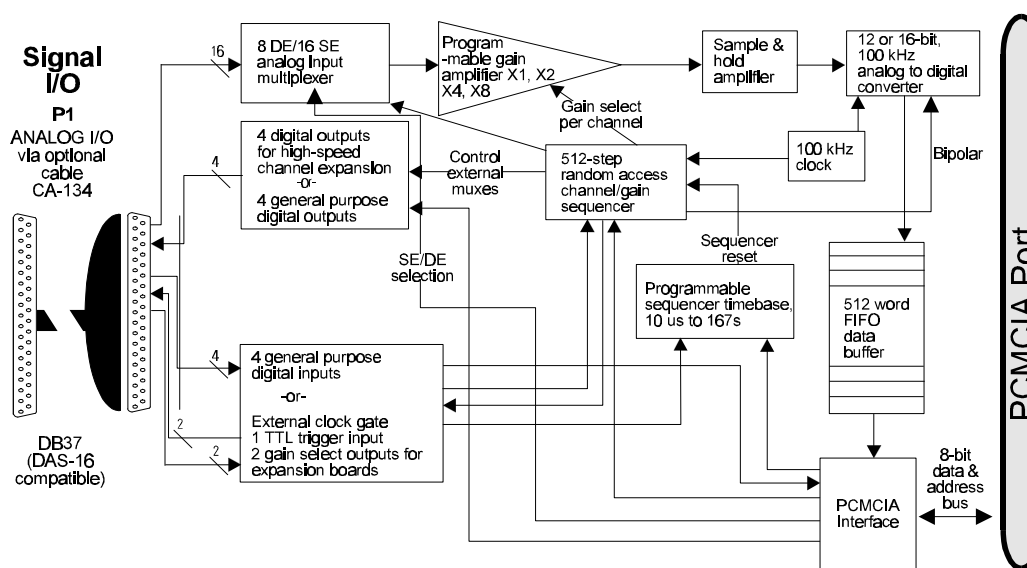


*Daq PC-Card Block Diagram*

## *Daq PC-Card Installation*

The hardware installation varies with the model used and the application. You can skip over unrelated sections, but remember to read the sections of chapter 5 that discuss any DBKs in your system.

| CAUTION |
|---|
| ⚠ **Turn off power to the host computer and all externally connected equipment while connecting cables and setting configuration jumpers and switches on related equipment (DBKs). Electrical shock or damage to equipment can result even under low-voltage conditions. In dry, static prone environments, take ESD precautions (packaging, proper handling, grounded wrist strap, etc).** |

Performing installation tasks in the proper order can prevent equipment damage. A generic order for tasks is:

1. Initial Inspection
2. Turn off all power to systems being handled.
3. Configure on-board jumpers and switches for DBKs (the Daq PC-Card configuration is all done in software).
4. Connect cables.
5. Apply power.
6. Install and configure software.
7. Apply signal(s).
8. Verify performance.

### Initial Inspection

Carefully unpack all items from the shipping carton, and check for shipping damage. Immediately report any damage to the shipping agent. Retain all shipping materials in case you must return the unit to the factory. All returns must be have an RMA # (Return Material Authorization Number). For an RMA #, call the factory or your sales agent.

Daq PC-Cards are shipped with the following items:

- Daq Data Acquisition System (module)
- *DaqBook/DaqBoard/Daq PC*-Card *User s Manual*, warranty card, license agreement
- Daq Series Software #428-0601

**Note**: Notebook and laptop computers must also have:

- Type II PCMCIA Socket
- CardSoft or equivalent software (optional)
- DOS, Windows 3.x or 95

### Daq PC-Card Configuration

The Daq PC-Card differs from the DaqBook/DaqBoard in that no hardware configuration is necessary. No jumpers, no switches—all configuration occurs in software. You will have to install the software before performing the configuration. **Note**: you may need to set jumpers in your DBKs or other system components.

#### *I/O Configuration*

Data is transferred to the host computer via the PCMCIA interface. This interface provides access to the PC's data bus, allowing real-time data collection and storage to disk at 100 K readings/s. The built-in 512-word FIFO prevents data loss. Two data transfer modes are supported:

- The programmed I/O mode allows the computer to acquire individual data samples or large blocks of data under application control.
- The interrupt transfer mode allows the computer to perform other tasks until the Daq PC-Card has acquired a programmed amount of data. This mode provides the most efficient use of computer resources and data transfer.

Digital I/O is supported and includes four general-purpose digital inputs and four general-purpose digital outputs. These TTL-level digital I/O lines can be accessed by the PC when the Daq PC-Card is

not transferring data from the A/D converter.  These I/O lines are not available if using P1 expansion cards or DBKs.

## *Windows 95 Configuration*

Windows 95 has built-in Card and Socket Services and does not require additional PCMCIA software. The supplied software (disk 1) includes a Windows 95 configuration file with the driver.  If this configuration file is not available, the PCMCIA card can be configured as a Non-Standard Device. Descriptions follow for both these configuration options. **Note**: If Windows 95 installs the Daq PC-Card at Interrupt 9 (unsupported in DaqView), the interrupt must be changed under System, Device Manager to another free interrupt.  Some computers have sound cards whose resources are not accounted for in the system file (e.g., ThinkPad 755).  To change the interrupt or address of the Daq PC-Card, go into the Properties screen, select Resources, deselect "Use automatic settings" check box, highlight the interrupt or address setting to be changed, and then select "Change settings".

### Windows 95 Configuration Using Configuration Disk

Set up the Daq PC-Card (112B or 216B) using the supplied configuration disk as follows:
1.  While running Windows 95, insert the Daq/112B/216B into a PCMCIA socket.  A "New Hardware Found" window should appear.
2.  Choose "Driver from disk supplied by hardware manufacturer".
3.  Insert Windows 95 Configuration Disk (disk 1) into a floppy drive selected, and click "OK".

To determine system resources used by the Daq PC-Card using the supplied configuration disk:
1.  Go into "Controls Panels" from the Start menu, and select System.
2.  Select the Device Manager tab at the top of the window, and then select the Data Acquisition Icon.
3.  From Data Acquisition, select PCMCIA...
4.  Select resources.  The Base Addr and the IRQ settings for the Daq/112B216B should appear.

### Windows 95 Configuration As a Non-Standard Device

Set up the Daq PC-Card (112B or 216B) as a Non-Standard Device as follows:

1.  While running Windows 95, insert the Daq/112B/216B into a PCMCIA socket.  A "New Hardware Found" window should appear.
2.  Choose "Select from a list of alternative drivers".  A "Select Hardware Type" window will appear.
3.  Choose "Other Devices".  A "Select Hardware Type" window will appear.
4.  Make sure "Unsupported device" is highlighted, and click "OK" at the bottom of the screen.

To determine system resources used by the Daq PC-Card when configured as a Non-Standard Device:
1.  Go into "Controls Panels" from the Start menu, and select System.
2.  Select the Device Manager tab at the top of the window, and then select "? Other Devices?.
3.  Select "? Unsupported Device", and click "Properties" at the bottom of the screen.
4.  Note the Interrupt and Address used by the Daq PC-Card for use with DaqView or other data acquisition software.

## *DOS and Windows 3.x Configuration*

When used with DOS and Windows 3.x, the Client Driver or Enabler (either one, but not both) will need to be loaded on your system.  This software facilitates changing (if needed) the IRQ level, Communication Port/Socket #, and Base Address settings.

The Daq PC-Card is shipped with Client Driver and Enabler files that conform to the PCMCIA (PC Card) Card Services Specification 2.1.  When used with CardSoft Card and Socket Services or compatible software, the Daq PC-Card will automatically configure itself upon system start-up.  Use of CardSoft is not required, but the chosen software must be compatible with the PCMCIA (PC-Card) Card Services Specification 2.1.

The Client Driver or Enabler sets the IRQ, Communication Port/Socket # (if more than one PCMCIA socket is available), and an Address Range.  These settings become the "default".  Depending on your

system configuration, these default settings may conflict with the IRQ, Communication Port/Socket #, and Address Range that your system has already allocated to another device. If this is the case or you would like more control of your software configuration, perform the following steps:

1. Choose between the Client Driver (CDQ_CL.SYS) or Enabler (CDQ_EN.EXE) files for the one that best suits your needs. The choice depends on the computer environment and the desire for plug-and-play functionality. The table describes the differences between the Client Driver and the Enabler. Generally, with Card and

| Feature | Client Driver (CDQ_CL.SYS) | Enabler (CDQ_EN.EXE) |
|---|---|---|
| Card & Socket Service Required | Yes | No |
| Hot - Swap Capability | Yes | No |
| Host Adapter Independent | Yes | No |
| Requires Intel 82365SL Compatible Adapter | No | Yes |
| Daq PC-Card Insertion After Boot | Yes | No |

Socket Services, use the Client Driver; without Card and Socket Services, you must use the Enabler. The Client Driver is preferred because Card and Socket Services provide better overall system management for all sockets, adapters and cards present in the host computer (however, Card and Socket Services can limit your flexibility). The Client Driver allows the insertion/removal of the card at any time for plug-and-play (except during an acquisition session). The Enabler, however, requires the card be present at boot time for proper operation.
2. If you choose the Client Driver file option, you will need to update your CONFIG.SYS file by adding the following command line: DEVICE=path\CDQ_CL.SYS options.
3. If you choose the Enabler File option, you will need to update your AUTOEXEC.BAT file with the following command line: path\CDQ_EN.EXE  options. Refer to the end of this chapter for more details.

The next 2 sections describe the details for the Client Driver and the Enabler.

## Client Driver

The client driver should be installed if Card and Socket Services are installed on the host computer. As mentioned earlier, the Client Driver allows for plug and play operation and registration with Card and Socket Services. This registration allows Card and Socket Services to more easily manage the resources (especially important for systems with other adapters installed). So, if possible, use the Client Driver rather than the Enabler. **Note**: If Card and Socket Services are not installed, you must use the Enabler.

To install the Client Driver perform the following:
1. Using a text editor, edit the system's CONFIG.SYS file.
2. In CONFIG.SYS, place the following entry **after** the line(s) that install the Card and Socket Services software: **DEVICE=*path*\CDQ_CL.SYS *options***
   Where *path* is the drive and path of the Client Driver and *options* are the command line options (to be discussed later).
3. Exit and save the CONFIG.SYS file.
4. Insert the Daq PC-Card into one of the PCMCIA slots
5. Reboot the host computer.

When the system comes up, the Client Driver should be loaded and a listing of the configuration options should be displayed. If  "Card and Socket Services Not Found" appears, then check to insure the card and socket services was properly installed. If the message "Invalid Command Line Option" appears, then an incorrect or ill-formed option was specified. Refer to the following section for the correct option syntax. If the Daq PC-Card is configured correctly, the driver message will appear with the base address and interrupt parameters that were assigned to the Daq PC-Card. Take note of parameters for use with the software. If, after this, you are still having problems, use the Enabler.

 (As mentioned), the Client Driver is loaded by the system's CONFIG.SYS file with the following format: DEVICE=*install path*\CDQ_CL.SYS *options; w*here *path* is the drive and path that the Client Driver is located, and where *options* are the options for which the PCMCIA interface will be configured. This section describes those options and how to use them.

The table lists the options available to the Client Driver.

| Option | Description | Valid Values |
|---|---|---|
| **/B**add**r** | Where **addr** specifies base I/O address of the Daq PC-Card A/D Card (Hex) | 100H-3f8H (8-byte Boundary) |
| **/I**irq | Where **irq** specifies interrupt level (IRQ) of the Daq PC-Card A/D Card (Dec) | 3, 4, 5, 7, 9, 10, 11, 12, 14, 15 (o-No IRQ) |
| **/S**socket | Where **socket** specifies the PCMCIA socket to configure (Dec.) | 0-15 (Dec.) |
| **Note: If any or all of the above options are omitted, the Client Driver will attempt to configure the Daq at the first available resource for the omitted option.** | | |

The Client Driver (CDQ_CL.SYS) will process the command line parameters from left-to-right. If the specified resource for the option is not available, the driver will attempt to allocate the next available resource. If so, the response after loading the Client Driver will indicate the new allocated resource.

**Example 1:** DEVICE=C: *install path* \CDQ_CL.SYS /B300 /I5

This example will attempt to install the Daq PC-Card at base address 300H (300H-307H) with Interrupt Level (IRQ) of 5 if they are available. Since the socket number was not specified, the Daq PC-Card will be configured at the first available socket.

**Example 2:** DEVICE=C: *install path* \CDQ_CL.SYS /B300  /B330 /I5

This example will attempt to install the Daq PC-Card at base address 300H (300H-307H) if the address is available. If not, the Daq PC-Card will be configured at 330H (330H-337H) if the address is available. If none of the addresses specified are available, the Daq will be configured at the first available address. Also, the Daq PC-Card will be configured for Interrupt Level (IRQ) of 5 if it is available. Otherwise, the first available IRQ will be assigned. Since the socket number was not specified, the first available socket will be used.

**Example 3:** DEVICE=C: *install path* \CDQ_CL.SYS /B300 /I3 /I5 /I7

This example will attempt to install the Daq PC-Card at base address 300H (300H-307H) if the address is available. If not, the Daq PC-Card will be configured at the first available address (IRQ 3, then IRQ 5, then IRQ 7, then any available IRQ).

**Example 4:** DEVICE=C: *install path* \CDQ_CL.SYS

This examples specifies no options for base address, interrupt level, or socket number. Therefore, the Daq PC-Card will be configured at the first available base address, interrupt level and socket number as assigned by Card and Socket Services.

**Enabler**

For systems without Card and Socket Services, the Enabler *must* be used to configure the Daq PC-Card.  The Enabler (CDQ_EN.EXE) can be found in the root of the directory where the Daq* software was installed.  Make sure that the Enabler is present before attempting system configuration.  The Enabler is designed to work with any DOS system using the Intel 82365SL host adapter or any PCIC compatible host adapter which includes the Cirrus Logic CL-PD6710, the VLSI VL82C146 and the Vadem VG-365.

The Enabler **does not** support plug-and-play capabilities and automatic configuration of adapters upon insertion.  Therefore, the Daq PC-Card *must* be installed before execution of the Enabler (CDQ_EN.EXE).  Also, the Enabler must be used to release the resources used by the adapter before it is removed from the socket.  The Enabler must be used to allocate or de-allocate PCMCIA resources.

The following command line shows the format of the Enabler.  To configure the Daq PC-Card at system bootup, this command line could be placed in the system's AUTOEXEC.BAT file:

> *path*\CDQ_EN.EXE *options*

Where *path* is the drive and path that the Enabler (CDQ_EN.EXE) is located.  And where *options* are the options for which the PCMCIA interface will be configured.

The table lists the options available to the Enabler:

| Option | Description | Valid Values | Required |
|--------|-------------|--------------|----------|
| **/Ssocket** | Where socket specifies the PC-Card socket to configure (Dec) | 0-7 (default = 0) | No |
| **/Rsocket** | Where socket specifies the PC-Card socket to release (Dec) | 0-7 (default=0) | No |
| **/Badd** | Where addr specifies base I/O address of the Daq PC-Card A/D Card (Hex) | 100H-3F8H (8-byteboundary) | Yes |
| **/Iirq** | Where irq specifies interrupt level (IRQ) of the Daq PC-Card A/D Card (Dec) | 3,4,5,7,9,10, 11, 12, 14, 15 (0-No IRQ) | Yes |
| **Note:  The /B and the /I parameters must be present in the command line. If these parameters are not present, the Enabler cannot properly configure the Daq PC-Card.** | | | |

The Enabler (CDQ_EN.EXE) will process the command line parameters from left-to-right.  When using this command, remember that the /B (Base Address) and /I (IRQ) must always be specified.  However, when releasing the Daq PC-Card resource /R, they are not required.

**Example 1:** CDQ_EN /B300 /I5

This example will configure the Daq PC-Card located in Socket 0 with a Base Address of 300H and Interrupt Level (IRQ) of 5.  The Daq PC-Card must be in Socket 0 when this command is performed.

**Example 2:** CDQ_EN /R1

This example will release the Daq PC-Card located in Socket 1.  The resources are now available to other devices.  It is not necessary to specify the Base Address or the Interrupt Level.  The Daq PC-Card must be in Socket 1 when this command is performed

**Example 3:** CDQ_EN /B300 /I5
        CDQ_EN /S1 /B330 /I3

This example will configure the Daq PC-Card located in Socket 0 with a Base Address of 300H and Interrupt Level (IRQ) of 5.  It will also configure a Daq PC-Card in Socket 1 with a Base Address of 330H and Interrupt Level (IRQ) of 3.  There must be Daq PC-Card in Socket 0 and in Socket 1 when these commands are performed.

## System Configuration

The Daq PC-Card can be expanded beyond its 16 built-in channels up to 256 channels of analog inputs. For expansion, the CDK10 module provides a rechargeable battery, power supply, and 2 expansion slots for DBK option cards. (Neither the PC nor the Daq PC-Card provides power for the expansion DBK cards.) For dedicated or OEM applications, you can power the expansion options by simply supplying +5 V and ±15 V to the appropriate pins on the DB37 P1 connector.

All expansion cards can be scanned at the same 10 μs/channel rate as the built-in channels. The gain of each expansion board channel can be switched on a per-channel basis by the Daq PC-Card sequencer. This allows different channels on the same board within a scan sequence to have different gains. DaqView lets you select desired channels, gains, transducer types, etc with a click of your mouse.

Several system configurations are shown in the figure.
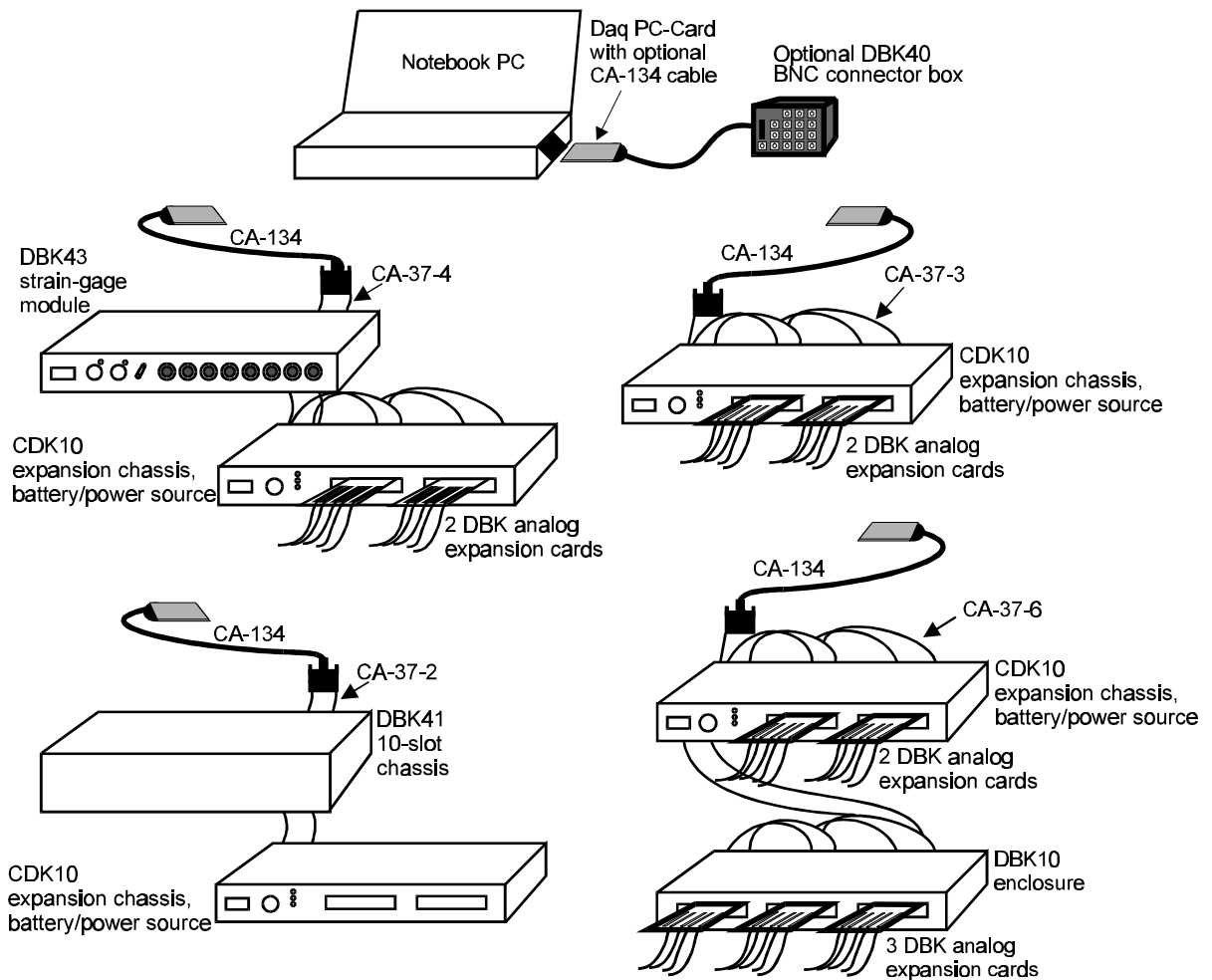
*Typical Daq PC-Card Configurations*

## Hardware Connection

This section will cover:
- Interface & Connectors
- Daq PC-Card / Interface Cable connection
- Insertion of Daq PC-Card into a notebook PC
- Interface Cable connection with allowable DBK modules

### *Daq PC-Card Interface & Connectors*

The Daq PC-Card uses a Type II (5mm) PCMCIA socket interface. To communicate with a DBK, a CA-134 Interface Cable is used. The Daq PC-Card connects to the CA-134 via the socket slot-connector found along its bottom edge (see figure). The opposite end of the CA-134 is terminated in a socket P1 DB37.
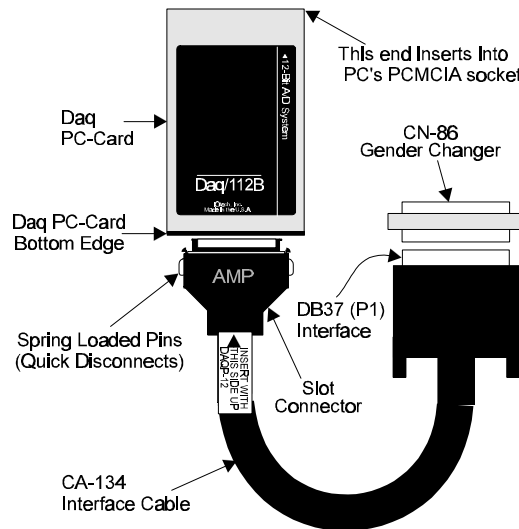


*Daq PC-Card Interface and Cables*

The CA-134 Interface Cable provides a female P1 port to connect a single passive card such as the DBK11 or the DBK40. A gender changer (CN-86) is included to provide a male P1 port for the CA-134 to interface with the CA-37-x expansion cable. This gender changer is also used with a CDK10 module. (The P1 interface is detailed in the pinout table at the end of this section.)

### *Interface Cable Connection*

Follow these steps to connect the Daq PC-Card to the Interface Cable (CA-134). The PCMCIA socket and the Slot Connector of the Interface Cable are keyed to assure proper connection from only one of two orientations. **Do not force the Daq PC-Card / Interface Cable mating if it is not an easy connection.** Damage to the card or cable may result if not installed properly (see figure above).
1. Hold the Daq PC-Card so that the company logo is face up and the bottom edge is facing you.
2. In the other hand, hold the Slot Connector end of the Interface Cable (CA-134) so the Slot Connector label is face up and the cable leads downward. Place thumb and forefinger on the spring loaded quick disconnects.
3. Depress the quick-disconnect pins, and insert the Slot Connector correctly into the Daq PC-Card. Make sure the connectors slide together at a level angle. Do not force this connection! The keyed connector helps prevent improper connection but does not prevent damage if excessive or angular force is applied.
4. After a good connection is made, release the quick-disconnect pins. The Daq PC-Card should now be firmly seated on the Interface Cable.
5. Check for proper connection, and proceed.

### *Daq PC-Card Installation into Notebook PC*

Though not required, it is best to power down a notebook PC before installing the Daq PC-Card.  The Daq PC-Card includes DOS-based client software that is compatible with PCMCIA Card and Socket Services Specification 2.1.  This software enables insertion and removal of the card into any Type II socket at any time and automatically configures the card.  **Note**: CardSoft™ Card and Socket Services are available on the majority of notebook PCs currently sold.  If your notebook software is not compatible, contact your sales representative.

1.  With your Notebook PC turned off, insert the Daq PC-Card into the PC's socket with the company logo face up (for most Notebook PCs).
2.  Push the Daq PC-Card into the PCMCIA socket like loading a floppy into a disk drive.
3.  Stop when the card is engaged into the socket.  This is marked by hearing a click and seeing that the socket eject button has been pushed out.

### *Interface Cable Connection with DBK Modules*

Only DBK modules that support the DB37 (P1) connector can be used with the Daq PC-Card.

1.  Plug the DB37 (P1) connector end of the Interface Cable into the compatible DBK module.
2.  Verify all connections before powering up the system.

The table describes the P1 pinout (partially compatible with Metrabyte DAS-16)

**Note: no power or analog output is available from P1**.

| P1 - Analog I/O | | |
|---|---|---|
| | |  |

| Pin | Signal Name | Description for P1 Pin Use in the Daq PC-Card |
|---|---|---|
| 1 | +5 PWR | Not Connected |
| 2 | CTR 0 OUT/-15 VDC | Not Connected |
| 3 | OP 3/CHS 3 | Digital out bit 3/channel select for expansion cards |
| 4 | OP 1/CHS 1 | Digital out bit 1/channel select for expansion cards |
| 5 | IP 3/GS 1 | Digital in bit 3/gain select for expansion cards |
| 6 | IP 1/GS 0 | Digital in bit 1/gain select for expansion cards |
| 7 | POWER GND | Not Connected |
| 8 | VREF (-5V) | Not Connected |
| 9 | D/A 0 OUT | Reserved |
| 10 | D/A 0 REF IN | Reserved |
| 11 | CH 7 LO IN/CH 15 HI IN | Ch 7 LO IN (differential mode)/ch 15 HI IN (single ended mode) |
| 12 | CH 6 LO IN/CH 14 HI IN | Ch 6 LO IN (differential mode)/ch 14 HI IN (single ended mode) |
| 13 | CH 5 LO IN/CH 13 HI IN | Ch 5 LO IN (differential mode)/ch 13 HI IN (single ended mode) |
| 14 | CH 4 LO IN/CH 12 HI IN | Ch 4 LO IN (differential mode)/ch 12 HI IN (single ended mode) |
| 15 | CH 3 LO IN/CH 11 HI IN | Ch 3 LO IN (differential mode)/ch 11 HI IN (single ended mode) |
| 16 | CH 2 LO IN/CH 10 HI  IN | Ch 2 LO IN (differential mode)/ch 10 HI IN (single ended mode) |
| 17 | CH 1 LO IN/CH  9 HI IN | Ch 1 LO IN (differential mode)/ch 9 HI IN (single ended mode) |
| 18 | CH 0 LO IN/CH  8 HI IN | Ch 0 LO IN (differential mode)/ch 8 HI IN (single ended mode) |
| 19 | L.L. GND | Low level ground (analog ground - use with analog inputs) |
| 20 | CTR 2 OUT | Not Connected |
| 21 | CTR 0 CLOCK IN/+15 VDC | Not Connected |
| 22 | OP 2/CHS 2 | Digital output bit 2/channel select for expansion cards |
| 23 | OP 0/CHS 0 | Digital output bit 0/channel select for expansion cards |
| 24 | IP 2/CTR 0 GATE | Digital input bit 2 |
| 25 | IP 0/TRIG 0 | Digital input bit 0/trigger 0 |
| 26 | D/A 1 REF IN/SSH | SSH |
| 27 | D/A 1 OUT | Reserved |
| 28 | L.L. GND | Low level ground (analog ground - use with analog inputs) |
| 29 | L.L. GND | Low level ground (analog ground - use with analog inputs) |
| 30 | CH 7 HI IN | Ch 7 HI IN (single ended mode or differential mode) |
| 31 | CH 6 HI IN | Ch 6 HI IN (single ended mode or differential mode) |
| 32 | CH 5 HI IN | Ch 5 HI IN (single ended mode or differential mode) |
| 33 | CH 4 HI IN | Ch 4 HI IN (single ended mode or differential mode) |
| 34 | CH 3 HI IN | Ch 3 HI IN (single ended mode or differential mode) |
| 35 | CH 2 HI IN | Ch 2 HI IN (single ended mode or differential mode) |
| 36 | CH 1 HI IN | Ch 1 HI IN (single ended mode or differential mode) |
| 37 | CH 0 HI IN | Ch 0 HI IN (single ended mode or differential mode) |
| Note:  Software configuration commands determine P1 digital I/O pin functions.  "/" indicates the pin can be used for either function but not both at the same time. | | |

## Software Installation

The software installation consists of 3 steps:
- Installing either Client Driver or Enabler.
- Making a backup copy of system software.
- Installing the user-selected files.  The software can be installed through Windows.  **Note**: any previous installation of the Daq* drivers should be removed before installing a new version.

### *Making a Backup Copy*

Make a backup copy of the release disks as follows:

1. Boot up the system according to the manufacturer's instructions.
2. Enter the DOS operating system (if in another operating system, follow diskcopy procedures).
3. Type the command CD\ to go back to your system's root directory.
4. Place driver disk #1 into drive A (or whatever floppy disk drive you are installing from).
5. Type DISKCOPY A: A: and follow the instructions given by the DISKCOPY command.
6. This process may require swapping the release and backup disks several times.
7. When the disk copy is complete, repeat the process for all disks in the installation set.

### *Installation*

The Daq* Windows install program copies the user-selected files and creates a Windows program group and icons.

1. To begin installation, put disk #1 into your floppy disk drive.  From the program manager (or Start/Run in Windows 95), choose File/Run to run the **SETUP.EXE** file.
2. The Windows Setup dialog box asks you for a destination directory.  Click Next (in Windows 95) to choose the default, or Browse for other options.
3. From the next dialog box, select Typical, Compact, or Custom/Full installation (see figure).  After the options have been selected, the bottom of the screen will display the amount of hard disk space required for the installation and the amount of disk space remaining after installation.  Make sure there is room available for installation before continuing.
4. After installing the files from disk #1, the program will prompt you to place the rest of the disks from the installation set into the floppy drive.
5. A final message will display when the installation is complete.
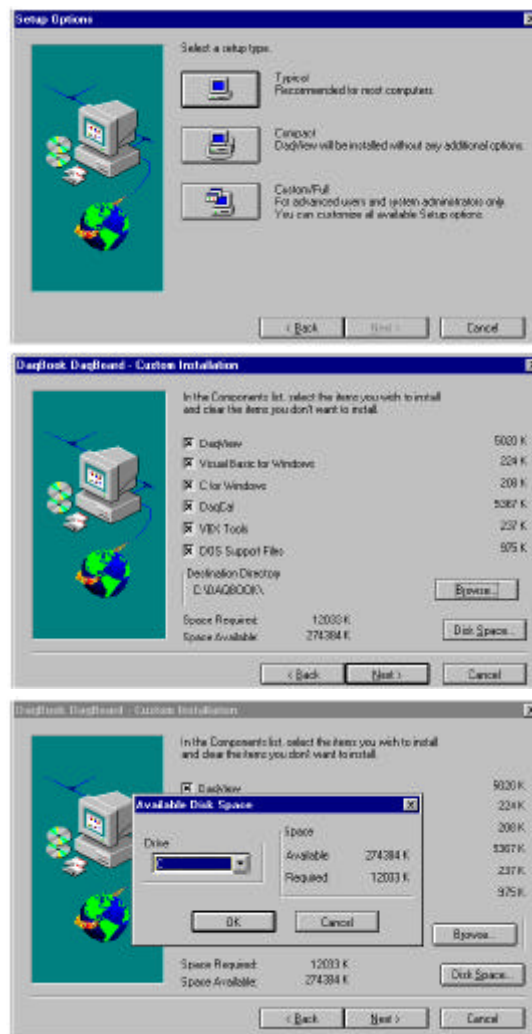
*User-Selected Software Options*

## Startup and Calibration

Daq*s are factory-calibrated.  If needed, a Windows program, DaqCal.exe, is used to calibrate the Daq PC-Card and its analog expansion cards with a 4½ digit DMM, adjustable voltage calibrator, and ambient temperature meter.  To use this program, install and launch the program DaqCal.exe; and then, follow the on-screen instructions.  No hardware adjustments can be made to the Daq PC-Card.

# DBK Option Cards and Modules 5

# *Overview*

This table organizes the DBKs by their function:

| DBK Option Cards and Modules | | |
|---|---|---|
| **Product** | **Name/Description** | **Capacity** |
| **Analog Signal Conditioning** | | |
| These DBKs attach to transducers and condition their outputs into analog voltages that the Daq*'s A/D Converter can measure. There are a wide variety of signal conditioning solutions available (and more are in development). DBK high-capacity modules require more circuitry than can fit on a compact card. | | |
| DBK4 | Dynamic Signal Input Card | 2 channels |
| DBK7 | Frequency-to-Voltage Input Card | 4 channels |
| DBK8 | High-Voltage Input Card | 8 channels |
| DBK9 | RTD Measurement Card | 8 channels |
| DBK12 | Low-Gain Analog Multiplexing Card | 16 channels |
| DBK13 | High-Gain Analog Multiplexing Card | 16 channels |
| DBK15 | Universal Current/Voltage Input Card | 16 channels |
| DBK16 | Strain-Gage Measurement Card | 2 channels |
| DBK17 | Simultaneous Sample & Hold Card | 4 channels |
| DBK18 | Low-Pass Filter Card | 4 channels |
| DBK19 | High-Accuracy Thermocouple Card | 14 channels |
| DBK42 | 5B Isolated Signal-Conditioning Module | 16 channels |
| DBK43A | Strain-Gage Measurement Module | 8 channels |
| DBK44 | 5B Isolated Signal-Conditioning Card | 2 channels |
| DBK45 | SSH and Low-Pass Filter Card | 4 channels |
| DBK50 | Isolated High-Voltage Input Module | 8 channels |
| DBK51 | Isolated Low-Voltage Input Module | 8 channels |
| DBK52 | Thermocouple Input Module | 14 channels |
| DBK53 | Low-Gain Analog Multiplexing Module | 16 channels |
| DBK54 | High-Gain Analog Multiplexing Module | 16 channels |
| DBK56 | Dynamic Signal Input Module | 4 channels |
| **Analog Output** | | |
| DBK2 | Voltage Output Card (14-bit DAC with bipolar reference) | 4 channels; ±5 V or ±10 V |
| DBK5 | Current Output Card (modulates externally powered loop) | 4 channels; 4 to 20 mA |
| **Digital I/O / Control** | | |
| DBK20 | General-Purpose Digital I/O Card (Screw Terminals) | 48 channels |
| DBK21 | General-Purpose Digital I/O Card (DB37 Connectors) | 48 channels |
| DBK23 | Optically Isolated Digital-Input Module | 24 channels |
| DBK24 | Optically Isolated Digital-Output Module | 24 channels |
| DBK25 | Relay Output Card | 8 channels |
| **Expansion and Connection** | | |
| These DBKs offer expansion and connection options. For just a few DBKs, you can use the stackable 3-slot DBK10 low-profile enclosure. For more DBKs, you can use the 10-slot DBK41. Multiple DBK41s can be daisy-chained to accommodate many DBKs within a single system. Connections are provided for screw terminals and BNC connectors. | | |
| DBK1 | 16-Connector BNC Adapter Module | 16 connectors |
| DBK10 | 3-Slot Expansion Enclosure | 3 cards |
| DBK11A | Screw-Terminal Option Card (DB37 to Screw Terminal Block) | Component sockets |
| DBK35 | PCMCIA Interface Card (Notebook PC to DaqBook, DigiBook, TempBook) | N/A (documented elsewhere) |
| DBK40 | BNC Interface Module | 18 connectors |
| DBK41 | 10-Slot Expansion Module | 10 cards |
| **Power Supply** | | |
| These DBKs (and CDK10 for use with a Daq PC-Card) offer power options for laboratory, automotive, and field applications. Input power can come from any 10 to 20 VDC source or from an AC source by using the included AC adapter. The compact DBK30A rechargeable power supply can provide power to DaqBooks and DBK modules where AC mains are not available. The DBK30A also has a 28 V output for powering transducers. For a large number of DBK cards, the DBK32A or DBK33 can be installed into any expansion slot. The DBK33 is used when +5 V is required in addition to ±15 VDC. The DBK34 provides a steady 12 or 24 VDC while working with vehicle electrical systems that may be turned on or off during testing. | | |
| CDK10 | Expansion/Power/Battery Module | +5 and ±15 VDC |
| DBK30A | Rechargeable Battery/Excitation Module | +12-14, 24-28 VDC (3.4 A-hr @ 14 VDC) |
| DBK32A | Auxiliary Power Supply Card | ±15 V @ 500 mA |
| DBK33 | Triple-Output Power Supply Card | ±15 V @ 250 mA; +5 V @ 1 A |
| DBK34 | Vehicle UPS Module | 12/24 VDC (5 A-hr @12VDC) |

The DBK series of cards and modules perform various data acquisition functions including signal conditioning, analog output, digital I/O, expansion, and power supply. The DBKs work with Daq*s and ADC boards from other manufacturers including Omega, Keithley/MetraByte, Computer Boards, and Avantech. DBK performance is best when used with the Daq*'s dynamic channel programming. The

ability to select both channel and gain/range is crucial for obtaining high channel-to-channel scan rates with a wide variety of transducers. The Daq* sequencer has a 512-location memory to hold channels and gains for up to 256 data input channels. The 100 kHz channel-to-channel scan rate is maintained even with a fully loaded system of DBKs.

This chapter begins with common installation, configuration, and power management concepts for typical DBKs. Then, the specifics for each DBK are discussed in its respective section. You will also need to read the corresponding Daq* chapter (2, 3, or 4).

The DBKs are presented in numerical order for easy access. (The outside edge of the header includes the DBK number.) Each DBK is described in detail under the following headings (some DBKs vary from this general outline):

- **Overview** (usually with a block diagram) describes the basic features and operation of the DBK.
- **Hardware Setup** describes configuration and connections for both the DBK and Daq*. **Note**: general system connections are described starting on page 5-5; DBK-specific setups are described in their respective sections.
- **Software Setup in DaqView** describes how to setup DaqView with DBK-specific parameters.
- **Hardware Function** describes special hardware concerns if beyond the scope of the *Overview*.
- **Programming a DBK#** provides information for users who custom-program their system. Commands and program examples use the standard API syntax. Programmers should also refer to the separate *Programmer s Manual* as needed. Users of DaqView or other turnkey packages can skip this section since their program performs such functions automatically or with minimum setup.
- **Specifications** are given at the end of each DBK section and in the *Specifications* chapter.

**Note**: This chapter describes all the DBKs available at the time this manual was printed. New DBKs are constantly being developed. If you purchased a DBK not described in this section or need a new DBK-type capability, contact your sales agent for the latest information.

## *Installation and Configuration*

A successful installation involves setting up several pieces of equipment and setting software parameters. You may need to consult related sections of this manual to get the complete picture (chapter 2, 3, or 4 for the Daq* used; the related DBK sections of this chapter; one or more software chapters; and possibly the *Signal Management and Troubleshooting* chapter for basic concepts of data acquisition).

The DBKs and Daq*s are usually configured before the connections are made and power is applied. This order of installation can prevent equipment damage and help ensure proper operation on startup.

Many DBKs have on-board jumpers and/or DIP switches used for setting channels and other variables. These settings are discussed in the individual DBK sections.

For systems with many modules, stacking units together helps conserve space and assure easy cable runs. Such stacking is facilitated in 2 ways:

- **Velcro tabs**. DBK power cards and DaqBooks are shipped with installation kits that include Velcro/adhesive tabs that allow modules to be stuck together and easily removed as needed.
- **Fastener Panels**. A splice kit provides a more rigid stacking arrangement and comes with the CDK10 and several DBK modules. The kit includes metal plates that screw onto the sides of a module and form a vertical rack of several modules. An optional handle is available for portable use.

# *Power Management*

Depending on your system's use of power, you may need to add auxiliary power supplies. The misuse of power can cause equipment damage; so, it is important to read this and related sections of the manual carefully. This section shows you how to calculate your system's use of power. If additional power is needed, refer to later sections about the CDK10, DBK30A, DBK32A, or DBK33.

Consider power use in terms of supply, demand, and distribution.

- **Supply** of power for the DBKs comes from a DaqBook or DaqBoard (but never from a Daq PC-Card which must use the CDK10). Current from the DaqBook and DaqBoard is limited as shown in a later table. If needed, the DBK32A and DBK33 can provide additional power to meet the demand. All the Daq*s and DBK power supplies work off low-voltage DC that can come from the supplied AC adapter or a DC source such as a car battery. **Note**: the DBK30A battery module can supply 14 and 28 VDC for a DaqBook and certain DBK modules.
- **Demand** for power comes from DBK cards and modules (and in some systems, from powered transducers). The DBK Power Requirement Work Table helps you calculate the system's power needs. You must fill out the work table and compare the total demand to the supply.
- **Distribution** of power to most DBKs is via the P1 interface. Pin 1 is +5 VDC; pin 2 is -15 VDC, pin 21 is +15 VDC; and pin 7 is ground. To prevent ±15 VDC power interference on P1, the DaqBook and DaqBoard have a JP1 jumper that is opened if a power DBK card is used. Similarly the DBK41 expansion chassis has a jumper to isolate +5 VDC power from P1. **Note**: some DBK modules have their own power supply and require only 10 to 20 VDC.

## Use of the DBK Power Cards

The DBK32A or DBK33 power card attaches directly to the P1 analog expansion bus and supplies power to analog expansion cards. The DBK32A/33 can be powered from an included AC adapter, an optional DBK30A battery module, or from a +10 to +20 VDC source such as a car battery. When installed in the DBK10 three-slot expansion chassis, the DBK32A or DBK33 is attached via the CA-37-x cable. If used with the DBK41 ten-slot expansion enclosure, it simply installs into one of the analog expansion slots on the unit's backplane. When used with a DaqBook/112 or /216, the power card can be installed in the internal expansion slot. **Note**: If using a DBK32A/33 with a DaqBook or DaqBoard, you must entirely remove the shunt jumpers from JP1 or damage to the 8254 timer chip will result. Refer to the power card sections later in this chapter and to the related Daq* chapter for JP1 location and configuration.

## Transducer Power

Some transducers (e.g., 2-wire 4-20 mA transmitters, bridge-configured sensors, etc) require an excitation voltage in order to work properly. The DBK30A supplies 14 and 28 VDC. Consult transducer documentation before applying power.

## Daq* Power Requirements

If your Daq* power comes from the AC mains (with appropriate adapter), you need not worry about its power use. However, if using battery-powered systems for both your Daq* and DBKs, you can compute operational endurance from your battery's watt×hr rating and this and following tables. The Daq PC-Card and DaqBoard use power from their host computer. The DaqBook uses no power from the host computer but requires 10-20 VDC from a suitable source such as the supplied AC adapter. (Various AC adapter models support power grids of USA, Europe, Japan, and Asia).

| Daq* Model | Power Required (Watts) |
|---|---|
| DaqBook/100 | 510 mA @ 12 VDC = 6.12 W |
| DaqBook/112 | 360 mA @ 12 VDC = 4.32 W |
| DaqBook/120 | 510 mA @ 12 VDC = 6.12 W |
| DaqBook/200 | 620 mA @ 12 VDC = 7.44 W |
| DaqBook/216 | 600 mA @ 12 VDC = 7.2 W |
| DaqBoard/100A | 1330 mA @ 5 VDC = 6.65 W |
| DaqBoard/112A | 970 mA @ 5 VDC = 4.85 W |
| DaqBoard/200A | 1700 mA @ 5 VDC = 8.5 W |
| DaqBoard/216A | 1340 mA @ 5 VDC = 6.7 W |
| Daq PC-Card /112B/216B | Normal Operation: 160 mA @ 5 VDC = 0.8 W Power Down Mode: 40 mA @ 5 VDC = 0.2 W |

## Calculating Your Power Needs

Use the work table below to calculate the power load of the DBKs in your system; use the chart at right to determine the available power. If the load exceeds available power, you must add a power card or module such as a DBK32A, DBK33, or CDK10.

The work table calculation proceeds as follows:
1. In the Quantity column (5th), list the number of DBKs of that type in your system.
2. In the Sub Total column (7th), enter the product of column 5 and column 6.
3. Add the Sub Total column, and enter the sum at the bottom right of the table. This number is your power requirement in mW.

| Available Power Chart | Supply |
|---|---|
| **Product** | **Available mW** |
| DaqBook/100 | 2100 |
| DaqBook/112 | 2400 |
| DaqBook/120 | 2100 |
| DaqBook/200 | 4000 |
| DaqBook/216 | 4000 |
| DaqBoard/100A | 3300 |
| DaqBoard/112A | 3300 |
| DaqBoard/200A | 3000 |
| DaqBoard/216A | 3000 |
| Daq PC-Card (/112B and /216B) | 0 |
| CDK10 | 4500 |
| DBK32 | 7500 |
| DBK32A | 15000 |
| DBK33 | 7500 |

**Note**: In some cases you may need to manage +5 VDC usage. If the +5 VDC requirement exceeds 200 mW, a DBK33 is required. The DBK33 can supply 1000 mW at +5 VDC. The CDK10 can supply 150 mA at +5 VDC. The DBK32 and DBK32A do not supply any +5 VDC.

| DBK Power Requirement Work Table | Demand | | | | | |
|---|---|---|---|---|---|---|
| **DBK** | **Voltage Reference** | | | **Calculation** | | |
| **Options** | **+15 VDC** | **-15 VDC** | **+5 VDC** | **Quantity** | **× mW** | **= Sub Total** |
| DBK1 | 0 | 0 | 0 | | 0 | |
| DBK2 | 18 mA | 18 mA | 5 mA | | 565 | |
| DBK4 | 95 mA | 80 mA | 25 mA | | 2750 | |
| DBK5 | 2 mA | 2 mA | 15 mA | | 135 | |
| DBK7 | 14 mA | 8 mA | 18 mA | | 420 | |
| DBK8 | 15 mA | 15 mA | <1 mA | | 455 | |
| DBK9 | 21 mA | 16 mA | <1 mA | | 560 | |
| DBK11A | 0 | 0 | 0 | | 0 | |
| DBK12 | 15 mA | 15 mA | <1 mA | | 455 | |
| DBK13 | 15 mA | 15 mA | <1 mA | | 455 | |
| DBK14 | 16 mA | 16 mA | <1 mA | | 485 | |
| DBK15 | 16 mA | 16 mA | <1 mA | | 485 | |
| DBK16 | 37 mA | 32 mA | <1 mA | | 1040 | |
| DBK17 | 30 mA | 30 mA | <1 mA | | 905 | |
| DBK18 | 36 mA | 36 mA | <1 mA | | 1085 | |
| DBK19 | 6 mA | 7 mA | <1 mA | | 200 | |
| DBK20 | 0 | 0 | <10 mA | | 50 | |
| DBK21 | 0 | 0 | <10 mA | | 50 | |
| DBK23* | 0 | 0 | <2 mA | | 10 | |
| DBK24* | 0 | 0 | <2 mA | | 10 | |
| DBK25 | 0 | 0 | <2 mA | | 10 | |
| DBK35 | 0 | 0 | 0 | | 0 | |
| DBK40 | 0 | 0 | 0 | | 0 | |
| DBK41 | 0 | 0 | 0 | | 0 | |
| DBK42 | <1 mA | <1 mA | <1 mA | | 35 | |
| DBK43A* | <1 mA | <1 mA | <1 mA | | 35 | |
| DBK44 | <1 mA | <1 mA | 60 mA | | 330 | |
| DBK45 | 52 mA | 52 mA | <1 mA | | 1565 | |
| DBK50* | <1 mA | <1 mA | <1 mA | | 35 | |
| DBK51* | <1 mA | <1 mA | <1 mA | | 35 | |
| DBK52 | 6 mA | 7 mA | <1 mA | | 200 | |
| DBK53 | 15 mA | 15 mA | <1 mA | | 455 | |
| DBK54 | 15 mA | 15 mA | <1 mA | | 455 | |
| DBK55 | 100 mA | 100 mA | <1 mA | | 3005 | |
| DBK56 | | | | | | |
| **Total Power Requirement in mW** | | | | | | |
| * Module with internal power supply, powered separately | | | | | | |

## Power Supplies and Connectors

The 2 power supplies most commonly used with Daq* systems are:
- The TR-25* is shipped with all DaqBooks. Input is 120 VAC, 60 Hz @ 19 W via a plug intrinsic to the module. Output is 15 VDC @ 900 mA via a DIN5 connector on a 6 ft cord.
- The TR-21* is shipped with the CDK10 for use with a Daq PC-Card. Input is 120 VAC, 60 Hz @ 15 W via a plug intrinsic to the module. Output is 9 VDC @ 1 A via a DIN5 connector on a 6 ft cord.

***Note**: the TR-21E replaces the TR-25 and TR-21 for use with 220/240 VAC, 50 or 60 Hz.

The DIN5 is the system's basic power connector (see figure). The CA-115 is a 6-in. cable with a male DIN5 connector on both ends. The CA-115 connects DBK32As or DBK33s in parallel to be powered by the same power supply.

**Note**: the DBK30A in the DBK31 mode has a DIN5 pin active with 28 VDC—refer to DBK30A section.

Power output connector (plug) on power supply cable and both ends of CA-115 cable

Power input (or daisy-chain) connector (socket) on device powered (DaqBook, DBK32A, DBK33, CDK10)

*DIN5 Power Connector*
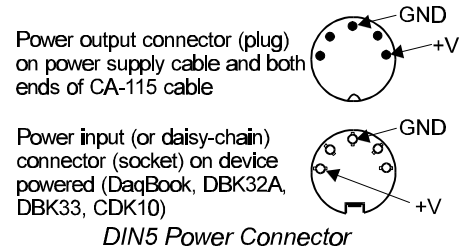
# System Connections

The Daq* family is designed to accommodate various configurations—more than can be documented here. The following subsections describe typical connections for DBKs and their Daq* unit. If using an expansion chassis (such as a DBK10 or DBK41), refer to those sections for related information.

## CAUTION

**Turn off power to all devices connected to the system while connecting cables or setting configuration jumpers and switches. Electrical shock or damage to equipment can result even under low-voltage conditions.**

**Take ESD precautions (proper packaging and handling, grounded wrist strap, etc) especially in dry or static-prone conditions.**

## DBK to DaqBook Connection

The DBKs connect to the DaqBook or expansion module via a DB37 I/O connector. The DBK cards can slide into the expansion slot of a DaqBook/112 or /216 or one of the multiple slots of a DBK10 or DBK41. These multi-card enclosures can easily be stacked to accommodate many cards. (If suitably secured and protected, DBK cards can be used alone without an enclosure.)

The P1 connector on each DBK is a DB37 male connector that mates with the DB37 male connector on the DaqBook. The female-ended connecting cable is a CA-37-x where the x is the number of option cards to be connected. For a single expansion card attached to the DaqBook, a CA-37-1 is used. Multiple option cards can be daisy-chained. For example, the figure shows three expansion cards connected to the P1 analog I/O connector of the DaqBook. The P1 connector can still support more analog expansion cards up to a total of 256 analog input channels.

*DaqBook Multi-Card Cabling*

The DaqBook/100, /120, and /200 have 2 additional DB37 connectors:
- P2 can support up to 192 digital expansion channels
- P3 can support 1 terminal block card with no expansion.
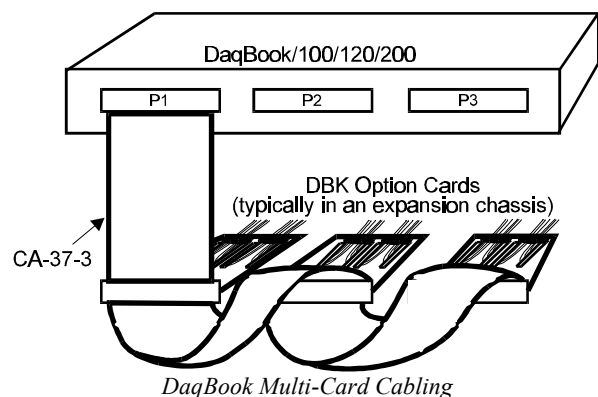
## DBK to DaqBoard Connection

Expansion cards connect to the DaqBoard via its 1 externally accessible P1 DB37 I/O connector or 2 on-board 40-pin headers for P2 and P3 connections on the DaqBoard/100A and /200A. The expansion cards can be used without an enclosure or in one of the slots of a DBK10 or DBK41. Multi-card enclosures can be easily stacked to accommodate many expansion cards.



*DaqBoard Multi-Card Cabling*

The P1 DB37 connector mates with a P1 DB37 connector. The female-ended connecting cable is a CA-131-x where the x is the number of option cards to be connected. If a single expansion card is to be attached to the DaqBook, a CA-131-1 is used. Multiple option cards can be daisy-chained to one DaqBoard.
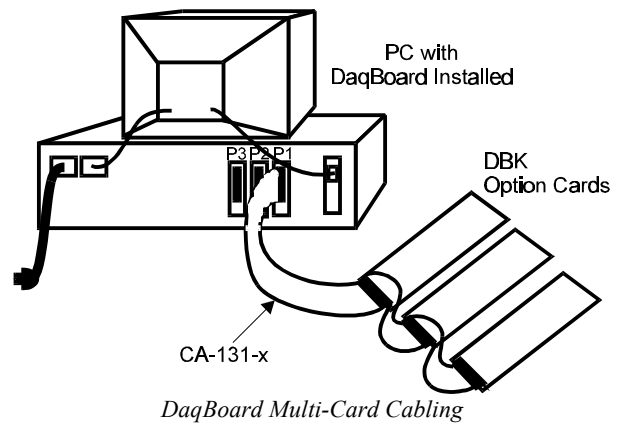
On DaqBoard/100A and /200A with the P2 and P3 ports, a CA-60 cable is required to connect the 40-pin header on the DaqBoard with a DB37 connector outside the PC and then to the expansion card.

**Important: before connecting DBKs to the DaqBoard, <u>power-down all connected units</u>. Failure to do so may damage the DBK or DaqBoard.**

## DBK to Daq PC-Card Connection

A CA-134 Interface Cable is used to supply the standard DB37 P1 connection. The CA-134 can connect to a single passive card, such as the DBK11A or the DBK40. A gender changer (CN-86) is available to provide a male P1 connection to a CA-37-x expansion cable and then to the DBKs. This gender changer is also used with a CDK10 module.



*Daq PC-Card Multi-Card Cabling*

The Daq PC-Card does not provide power to the DBKs. The CDK10 or DBK33 power source is required. The CDK10 has an AC adapter or can operate from its own rechargeable batteries. When using multiple DBK cards in a DBK41 expansion module, power can be provided via a DBK33 from an AC adapter or a DBK30A (power use should be computed as previously described).



*Daq PC-Card Power Configurations*
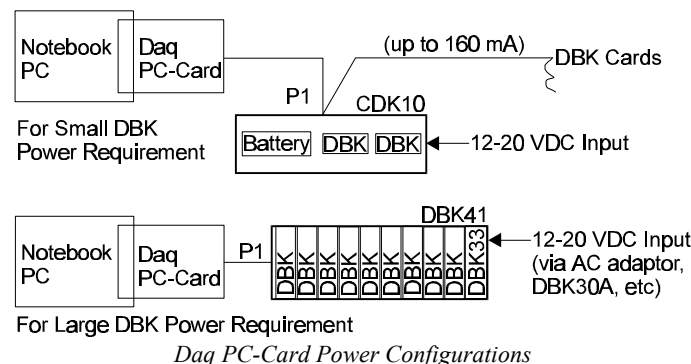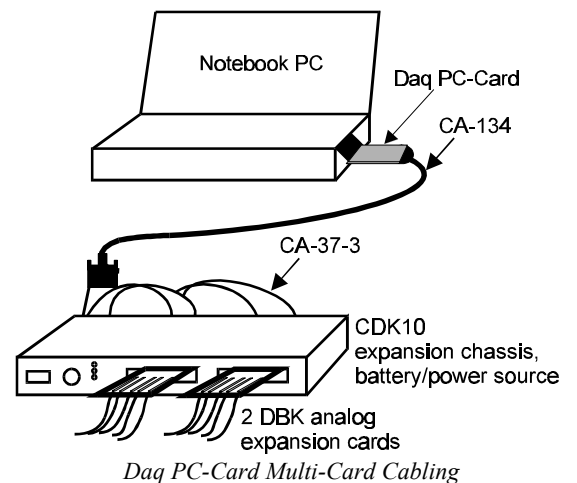
# CDK10  Expansion/Power/Battery Module

## Overview

The CDK10 provides power to DBK signal conditioning cards to be used with the Daq PC-Card.  (The Daq PC-Card cannot, by itself, power a DBK.)

- Electrically, the CDK10 provides +5 and ±15 VDC power to P1 from an external DC source or from its internal batteries.  The Daq PC-Card can manage power use in the CDK10 to conserve energy when not performing a data acquisition.
- Physically, the CDK10 is a metal enclosure with 2 expansion slots.  DBK cards can slide into the slots without removing the signal connections.  The CDK10 has the same footprint as other DBK modules and many notebook computers for easy stacking with included splice plate kit or optional Velcro-style tabs.

The CDK10's ±15 V capacity of 160 mA can power 8 low-power DBKs or 2 high-power DBKs.  Several system configurations are possible depending on the power load and the number of DBKs.  A typical setup might be 2 DBKs in the CDK10 and 3 DBKs in a DBK10.  For applications that require more than 6 cards, use the DBK41 with a DBK33 (see figure).  **Note**: See *Power Management* at the beginning of this chapter for details how to compute power requirements.
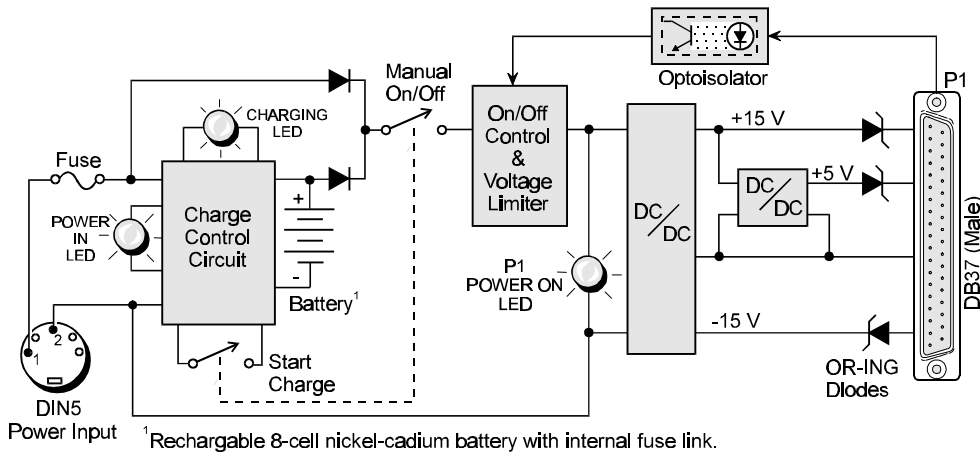


*CDK10 Block Diagram*
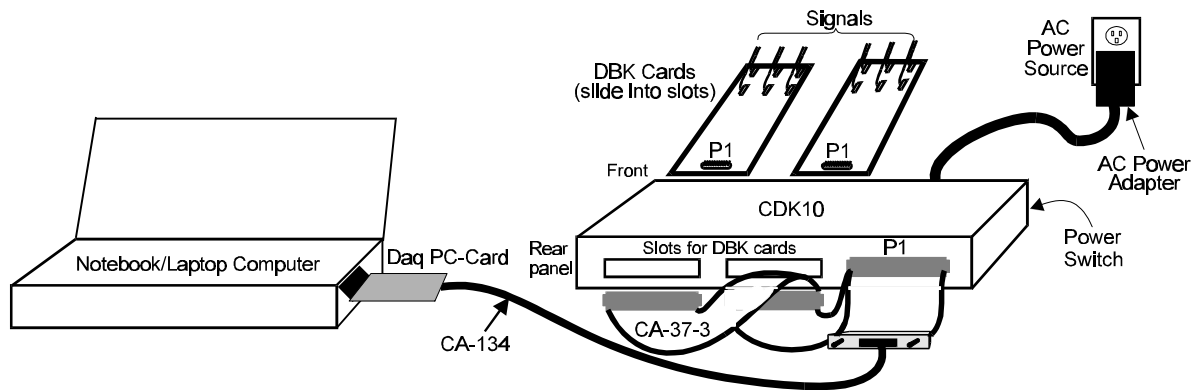
## Hardware Setup



*Typical CDK10 Installation*

The CDK10 has 2 card slots for easy access to the analog expansion cards.  The figure shows a typical CDK10 configuration.  Hardware setup usually includes the following steps:

1. Assure that power to all units to be connected is OFF.
2. Complete all DBK card configuration to fit your application and channel assignments.

3. Attach signal input wires (with strain relief as needed) or BNC connectors before inserting card into CDK10 slot.
4. Secure card(s) in slot by tightening thumbscrew and washer to hold card securely in place.
5. Attach the card's DB37 connector to the P1 connector with the appropriate cable (CA-37-x to DBKs, CA-134 with gender changer to Daq PC-Card) to daisy-chain all units.
6. Hookup a power supply suitable for your application. DC input power can come from the supplied TR-21 wall-mount AC power adapter or any source of 12 to 20 VDC. The input power connects to the CDK10 front panel through a 5-pin, circular DIN connector.

## Software Setup

None required.

## Hardware Function

The CDK10 rear panel has the power input connector, output power switch, and status LEDs. The parts are shown in the figure and described in the table.



*CDK10 Rear Panel*
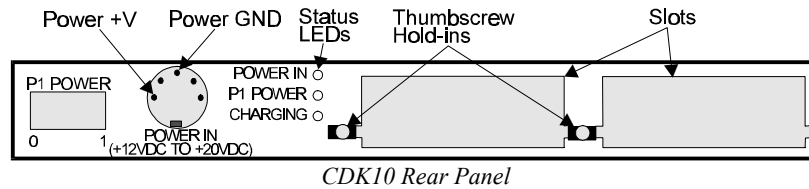
| Item | Description |
|---|---|
| P1 Power Switch | This rocker-arm switch turns the DC output power to the DBK cards ON when the "1" side of the switch is depressed. |
| Power Input Jack | This DIN5 connector accepts +12 to +20 VDC and ground. |
| Power In LED | This LED is ON when power is applied to the power input connector. |
| P1 Power LED | This LED is ON when power is being supplied to the P1 DB37 connector on the front panel. |
| Charging LED | This LED is ON when the internal batteries are being charged. It will flash when fast charging is complete and the batteries are being trickle-charged. |

The CDK10 uses power from its internal batteries or from an external power source (even while charging its own batteries). To supply power from its internal batteries, the CDK10's batteries must be charged. The batteries will begin charging as soon as an external power supply is connected to the power input. The CDK10 can be used to supply output power during the battery charge cycle. The charge cycle will take from 2 to 4 hours depending on whether or not the CDK10 is providing output power while charging.

The CDK10 has a "power save" mode. Even with the power switch ON, the P1 power LED will not turn ON until the Daq PC-Card tells the CDK10 to do so when the Daq PC-Card is taking readings.

## CDK10 - Specifications

**Name/Function:** Expansion/Power/Battery Module
**Size:** 11" long x 8½" wide x 1 3/8" high
**Output Voltages/Current:**
    +15 VDC (nominal - de-rate by 42% of the +5 V current usage) @ 160 mA max
    -15 VDC (nominal) @ 150 mA max
    +5 VDC (nominal) @ 150 mA max
**Maximum Output Power:** 5 W max
**Input Voltage Range:** 12 to 20 VDC
**Input Current Draw:** 1.2 A max
**Efficiency:** 70% typical
**Parallel Provision:** OR-ing diodes in output lines

**Battery Type:** Nickel Cadmium
**Run Time with 2 DBK cards:** 5 to 7 hours typical
**Charge Circuit:** Internal
**Charge Time:** 2 to 4 hours
**Input Connections:** DIN5
**Output Connections:** DB37 Male
**Controls:** ON/OFF Rocker-arm switch
**Indicators:** LEDs for input power, P1 output power, and battery charging
**Operating Temperature Range:** 0 to 50°C
**Input Fuse Size:** 2 A (Littlefuse 251002)

# DBK1  16-Connector BNC Adapter Module

## Overview

The DBK1 provides a convenient means of attaching analog input signals from BNC cables to a Daq* via the P1 interface.  Each of the 16 inputs has a switchable 100 KΩ bias resistor to accommodate floating signal sources.   The 16 inputs can be used as 16 single-ended inputs (channel 0 to 15) or as 8 differential pairs (channel 0 to 7).  The BNC inputs are grouped to reflect use in the differential mode (ch 0, ch 8, ch 1, ch 9, ch 2, ch 10 ...) where channel 8 serves as the low signal line of channel 0 and so forth.



*DBK1 Block Diagram*
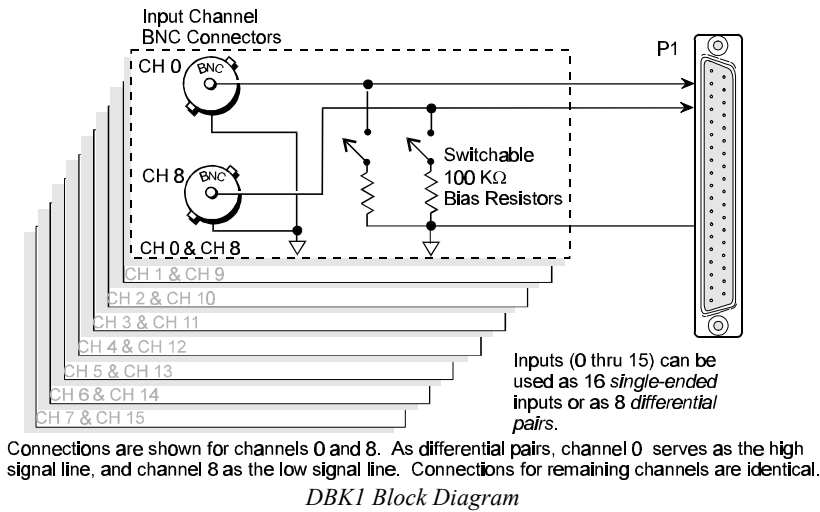
## Hardware Setup

### Configuration

The only configuration option is to enable or disable the 100 KΩ bias resistors, 1 per channel.  Two resistor networks (RN1 and RN2) contain the resistor elements that are switched by SW1 and SW2 DIP switches.  The rocker-arm switches must be depressed in the desired orientation: OPEN for disabled (shunted).  Default is enabled.  Enable bias resistors to make differential measurements of signal sources with floating voltages. As shown in the figure and silk-screened on the board,

- SW1 controls channels 0, 8, 1, 9, 2, 10, 3, 11
- SW2 controls channels 4, 12, 5, 13, 6, 14, 7, 15



### DaqBook Configuration

With a DaqBook/100, /112, or /120, you must set JP4 for single-ended or differential input as needed (refer to chapter 2).
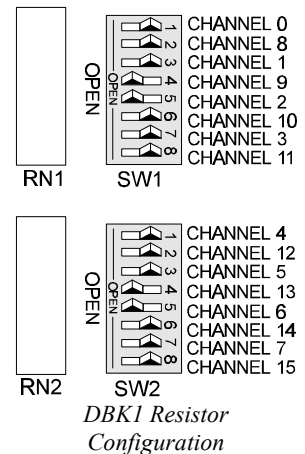
*DBK1 Resistor Configuration*

## DBK1 - Specifications

**Name/Function: 16-Connector BNC Adapter Module**
**Connectors**:
    DB37 male, mates with Daq* P1
    BNC connectors for signal input
**Analog Input Connection**: 1 BNC connector for each of 16 analog input channels
**Dimensions**: 221 mm wide × 285 mm long × 25 mm high (8.5" × 11" × 1.375")
**Weight**: 1.3 kg (3 lb)

## *DBK2 Four-Channel Voltage Output Card*

### Overview

The DBK2 provides the ability to generate precise, bipolar output voltages.  The DBK2 connects to the Daq* P1 port.  Like other P1-compatible DBK cards, the DBK2 is addressed using one of 16 base channels.  Up to 4 DBK2s can share a single base channel for a maximum of 256 channels.  The DBK2 can control an array of external devices including programmable power supplies, proportional actuators, analog indicators, and process controllers.

The DBK2 generates output voltages using a 4-channel 14-bit digital-to-analog converter (DAC).  A precision bipolar reference is used onboard to provide accurate and stable output voltages.  Each output channel is independently jumper configurable for either $\pm5$ V or $\pm10$ V operation.  A 14-bit DAC can have values from 0 to 16,383 (a value of 8192 should produce a voltage of 0).  Thus in the $\pm5$ V mode, the voltage out $V_{OUT} = [10 \text{ V} \times (DAC/16383)] - 5 \text{ V}$.
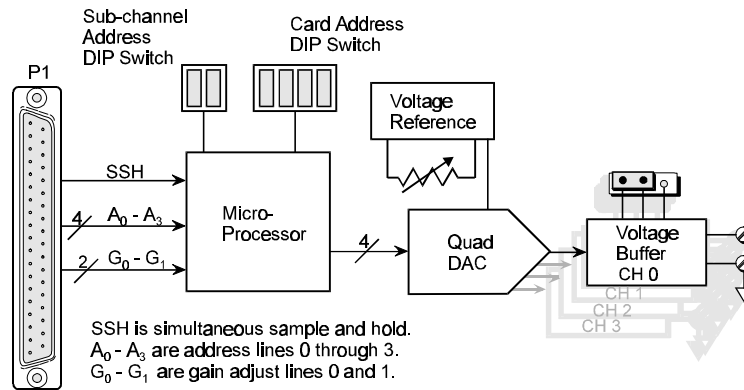


*DBK2 Block Diagram*

### Hardware Setup

#### *Card Configuration*

The Daq* channel and the output level must be configured.

A 6-position DIP switch provides for address selection.  The card address refers to the Daq* base channel.  Any card address in the range of 0 to 15 is valid.  The sub-address allows up to 4 DBK2s to share a single base channel.  Any sub-address in the range of 0 to 3 is valid.  (With 4 local channels on a card and 4 cards on each of 16 base channels, a maximum of 256 channels are possible.)  The DIP switch uses binary weighted values.  To select the desired address, set the corresponding switch values to one.  For example, if the desired card address is 11 then switches 1, 3, & 4 should be set to one.  To set a switch to a value, depress the corresponding side of the rocker-arm switch.



*DBK2 Configuration Settings*
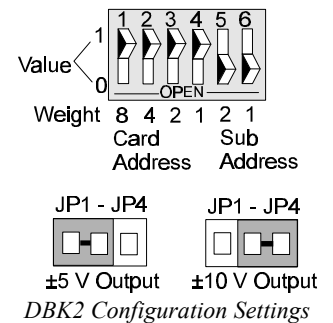
Each local channel can be set for either $\pm5$ V or $\pm10$ V output.  Four 3-pin headers (JP1 through JP4) correspond to output channels 0 through 3.  To configure a channel for $\pm5$ V output, place the shunt jumper across positions 1 & 2  (default setting) of the corresponding header  (see figure).  To configure a channel for $\pm10$ V output, place the shunt jumper across positions 2 & 3 of the channel header.

#### *Card Connection*

Output voltage connections are provided via convenient screw terminals.  Each terminal has an adjacent analog common terminal for convenience.  After all connections are in place, secure the wires to the card for strain relief.  Small nylon tie wraps (not included) work well for this purpose.  For convenience, there are also footprints on the board to accommodate BNC connectors.

### DaqBook/DaqBoard Configuration

Use of the DBK2 requires setting jumpers in the DaqBook/DaqBoard.

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 DBK2 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).



*DBK2 Jumper Configuration*

2. Place the JP2 jumper in the SSH position. **Note**: **you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).
3. *Place the JP4 jumper in single-ended mode (*applies only to DaqBook/100, /112 and /120).
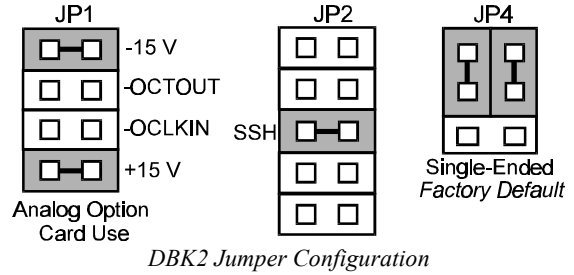
## Software Setup in DaqView

This section shows you how to set up DaqView for the DBK2 and your application. Refer to chapter 6, *DaqView*, for further details and screen captures.

From DaqView's main screen (v5),
1. Pull down the Device menu, and select Configure Hardware Settings. The Configure System Hardware screen appears and shows the channel assignments.
2. Under Analog Input Option Cards External Connection, select the expand button for the chosen Daq* channel. A drop down menu lists the available option cards.
3. Select the DBK2 Voltage Output Card. A smaller, sub-address setup window will appear.
4. In the sub-address setup window, select up to 4 cards to use. The software switch settings must match the hardware setting of the DBK2's S1 DIP switch.
5. When all the channels and sub-addresses are set correctly, select OK to return to the DaqView main screen.
6. Open the Analog Output window.
7. Set the desired output voltage.
8. Execute.

## Programming a DBK2

**Note**: Users of DaqView or other turnkey packages can skip this section.

To send DAC output values to a DBK2, you must:
- Tell the software driver that DBK2s are attached to a certain range of channels
- Write the output channel DAC value(s)

The commands to perform these steps and some background information are described below. The driver software defines the concept of a channel bank. Each of the Daq*'s 16 base channels are referred to as a channel bank. Each channel bank contains 16 expansion channels. In this way a maximum of 256 analog input or output channels are provided via P1 expansion. The channel numbering of expansion channels starts at 16. Channels 0 to 15 are reserved, within the driver, for Daq* base channels. The table illustrates the channel numbering scheme (see also the section *Channel Control and Expansion* in the chapter *Signal Management and Troubleshooting Tips*).

| Card Address (Base Channel) | Sub Address | API Expansion Channel |
|---|---|---|
| 0 | 0 | 16-19 |
| 0 | 1 | 20-23 |
| 0 | 2 | 24-27 |
| 0 | 3 | 28-31 |
| 1 | 0 | 32-35 |
| 1 | 1 | 36-39 |
| 1 | 2 | 40-43 |
| 1 | 3 | 44-47 |
| 2 | - all - | 48-63 |
| etc | etc | etc |

The effective channel number of a particular DBK2 channel can be calculated simply using the relationship.

$$effChan = 16 + (cardAddr * 16) + (subAddr * 4) + chan$$

where     effChan = effective (expansion) channel number
           cardAddr = card address (Daq* base channel)
           subAddr = sub address
           chan = DBK2 channel number

The driver must, in certain cases, be informed of the type of DBK card attached to a channel bank by using daqAdcSetBank. Function parameters include an effective channel number and the DBK type. Once called, the driver assumes that all sub channels within that channel bank are of the same DBK type. The following example function call tells the driver that DBK2(s) are attached on bank 1 (expansion channel 38 is in bank 1).

> daqAdcSetBank(38, bankDBK2)

To write DAC values to the DBK2 one of two functions can be used: daqDacWt and daqDacWtMany.

The **daqDacWt** function is used to update a single output channel. This function takes the expansion channel and DAC value as parameters. The following sample function call sets the DAC value on channel 38 to 12288 (in the ±5 V mode, a voltage of 2500 mV = 10 (12288/16383) - 5).

> daqDacWt(38, 12288)

The **daqDacWtMany** function allows multiple DAC channels to be updated simultaneously. As many as 16 channels can be updated at once. However, only expansion DAC channels on one bank can be updated at one time. If DBK2 cards are attached on banks 0 and 1, for instance, the daqDacWtMany function would have to be called twice. In the daqDacWtMany function, the first parameter is the first channel to be written to. The second parameter is a pointer to an array of DAC values. The third parameter is the number of values in the array (and the number of DAC channels to be updated). The following example function call updates the DACs on channels 32 through 39 with the values in the array dac_vals.

> daqDacWtMany(32, dac_vals, 8)

The DAC data format used in the DBK2 is offset binary. A DAC value of 0 corresponds to negative full-scale and a DAC value of 16383 corresponds to positive full-scale. The DAC value to send for a particular output voltage can be calculated from the formula:

$$DAC\_val = \frac{[Vout + (Vref/2)] \times 16384}{Vref}$$

where: DAC_val = DAC value sent to the DBK2 channel
Vref = 10 V for ±5 V operation
Vref = 20 V for ±10 V operation

**Note**: the DBK2 should not be programmed during an active acquisition. Doing so will cause the acquisition to terminate prematurely.

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK2 - Specifications

**Name/Function: 4-Channel Voltage Output Card**
**Connectors**: DB37 male, mates with P1 Screw terminals for signal output
**Resolution**: 14-Bits (Monotonic)
**Output Ranges**: ±5 V or ±10 V (Jumper Selectable per Channel)

**Accuracy**: 0.05% of FS
**Linearity**: 0.02% of FS
**Hysteresis**: 0.01% of FS

# DBK4  2-Channel Dynamic Signal Input Card

## Overview

The DBK4 is a 2-channel signal conditioner for dynamic signals.  The DBK4 provides the hardware to interface piezoelectric transducers that include accelerometers, microphones, force/pressure transducers, and others.  The DBK4 interfaces with the Daq* P1 connector.  The block diagram shows the card's function and is explained in the section *Hardware Description*.
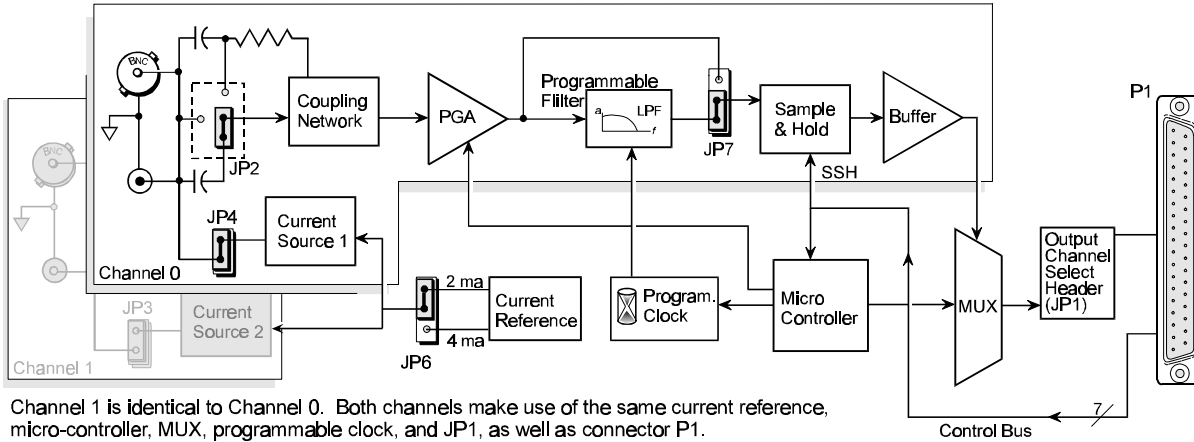


Channel 1 is identical to Channel 0.  Both channels make use of the same current reference, micro-controller, MUX, programmable clock, and JP1, as well as connector P1.
In regard to jumpers, JP6 is common to both channels; and in place of Channel 0's JP2, JP4, and JP7, Channel 1 uses JP5, JP3, and JP8,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

*DBK4 Block Diagram*

## Hardware Setup

**Note**: if using a DaqBook/200 or /216 or a DaqBoard/200A or /216A that is serial numbered 103350 or earlier, you must contact the factory for a hardware upgrade (EO-1911) before using the DBK4.

### Card Configuration

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.
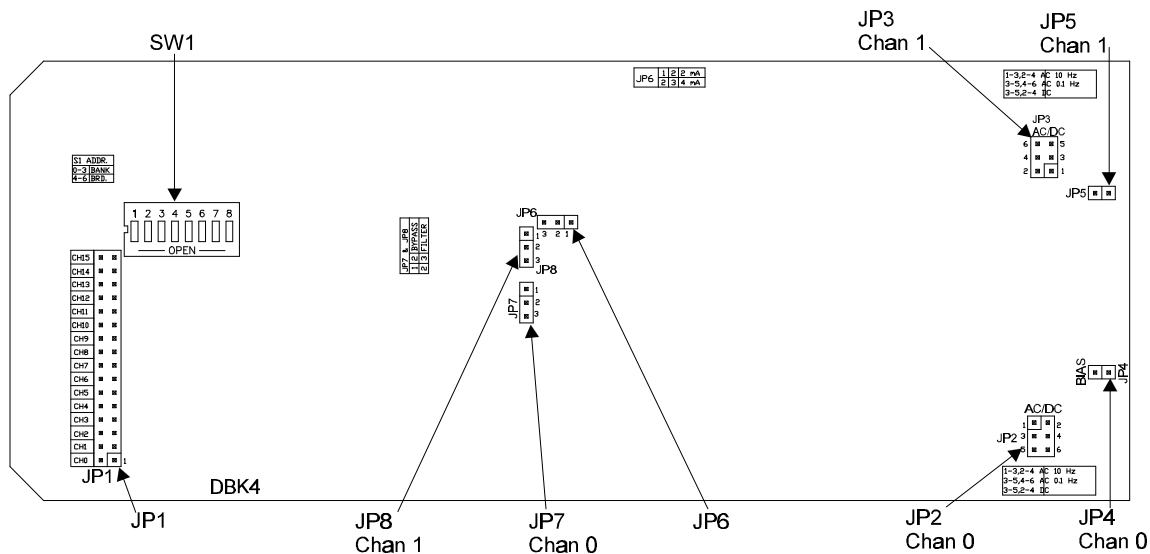


*DBK4 Jumper & Switch Locations*

### Main Channel and Sub Channel Selection

Up to 8 DBK4 cards can use 1 of 16 main Daq* channels.  Each DBK4 has 2 inputs; thus the maximum input channel capacity is 256 (2 inputs × 8 cards × 16 main channels).  The figure shows the channel hierarchy including a few API channel numbers.  (Channel identification is described in the *Channel Control and Expansion* section of the chapter *Signal Management and Troubleshooting Tips*.)

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.  If channel settings conflict, your Daq* will not function properly.  **Note:**  Once the channels are determined, record all settings and label transducers accordingly for future reference when expanding your system.



*DBK4 Channel Hierarchy*
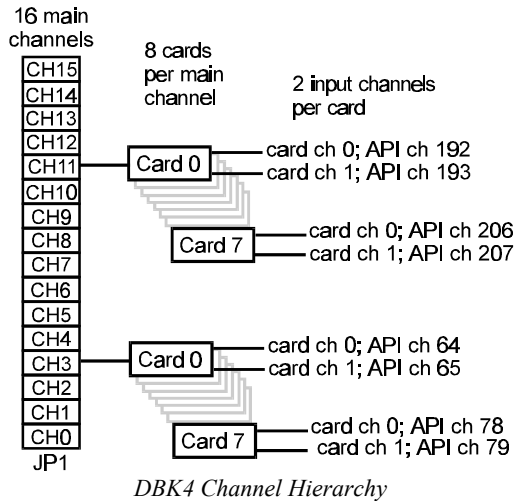
JP1 on the DBK4 is a 2×16 header located on the far left side of the card.  A shunt jumper setting on JP1 allows a card to reside in 1 of 16 possible main channels.  Any main channel in the range 0-15 is valid.  The figure below shows that sub-switches s1 to s4 of SW1 can be set by binary values to equal 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 Daq* main channel to use up to 8 DBK4s.  The figure below shows 16 switch settings for the Daq* main channel and 8 settings for the sub-channel (card) selection.



*DBK4 SW1 Channel Settings*
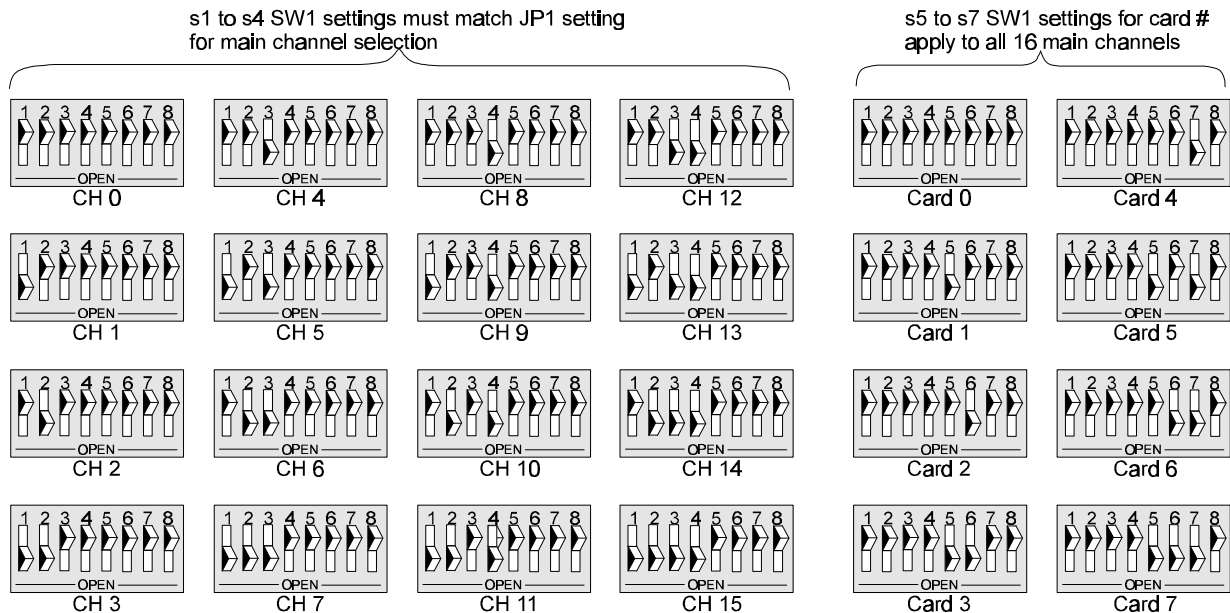
## Signal Coupling (JP2 & JP3)

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. Selecting the 10 Hz HPF will suit most applications when performing acceleration measurements on "light" structures. When performing seismic measurements or measurements on "massive" structures, the 0.1 Hz HPF will reject the DC bias component while preserving the low-frequency signals.

DC coupling may be used when making a voltage mode measurement. **Note**: when the input signal is DC-coupled, the current source must be deselected (Jumper JP4 and/or JP5 removed) to protect the transducer.
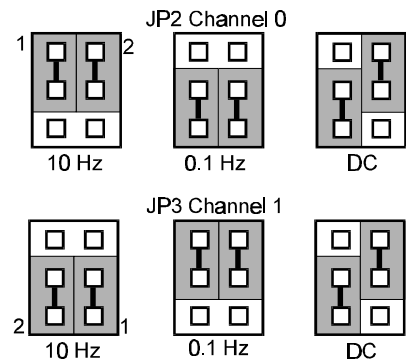


*JP2 & JP3 Signal Coupling Settings*

## Current Source (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.

**Note:** 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.
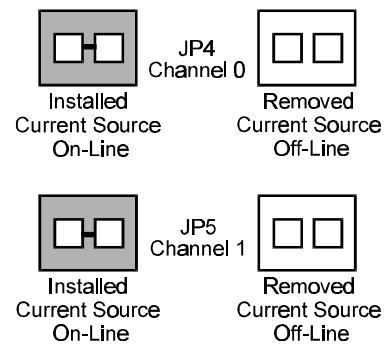


*JP4 & JP5 Current-Enable Setting*

## 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. (For more information, refer to the Cable Driving section of the Accelerometer Tutorial later in this section.)
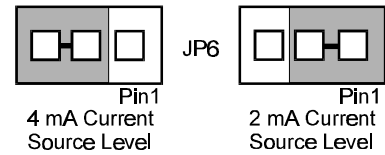


*JP6 Current Level*

## 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 ×10 and the bypass mode gain is ×15.83.
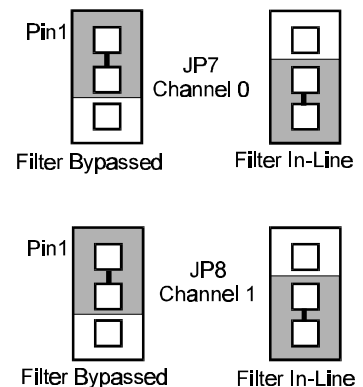


*JP7 & JP8 Filter Bypass Setting*

### Card Connections

The DBK4 connects to the Daq*'s P1 port or a P1 port on a DBK Expansion Module as described at the beginning of this chapter.

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.

### DaqBook/DaqBoard Configuration

Several setup steps at the DaqBook/DaqBoard are required to use DBK4 cards in a system (the Daq PC-Card is configured in software and cannot supply power to the DBKs).

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 DBK4 via the internal ±15 VDC power supply.  If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers. (The DBK4 is very power intensive; refer to *Power Management* at the beginning of this chapter to calculate system power requirements).



2. Place the JP2 jumper in the SSH position.  **Note: you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).
3. *Place the JP3 jumpers in bipolar  mode.
4. *Place the JP4 jumpers in single-ended mode.

**\*Note**: *applies only to DaqBook/100, /112 and /120.
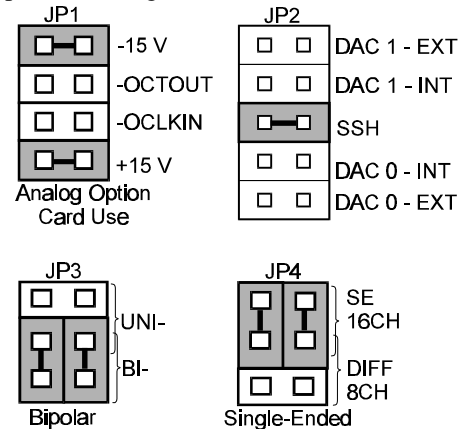
*DaqBook/Board Settings for the DBK4*

# Software Setup in DaqView

This section shows how to set the DaqView parameters to accommodate the DBK4 and the application.  Refer to chapter 6,  DaqView, for further details and screen captures.  **Note:**  If the version of DaqView, presently being used, does not support the DBK4 expansion card, then delete it and reinstall the latest version.  **DO NOT** install the new version over the old version.

1. Once DaqView is opened (launched), pull down the Device menu, and select **Configure Hardware Settings**.  The **Configure System Hardware** screen appears and shows you channel assignments.
2. Under Analog Input Option Cards, select the main channel for the DBK4 option card by selecting its expand button.  The chosen channel must correspond with the J1 jumper setting on the DBK4 card.  A drop down menu lists all the card options available in software.  The Analog Input Option Cards selection allows you to assign DBK expansion cards to the Daq*'s analog inputs.  Selecting a DBK expansion board will add channels in the main window's analog input spreadsheet.
3. Select the DBK4 Dynamic Signal Card.  A smaller sub-channel setup window will appear as shown in the figure below.  If the DBK4 option does not appear, you must exit the program and load an updated version of DaqView.
4. In the sub-channel setup window, select up to four channels to use.  Note the 7, 6, 5 switch settings in the selection box.  The "0" and "1" must correspond with the hardware setting on the S1 DIP switch on the corresponding DBK4 card.
5. Select the **Config** button.  The DBK4 **Configuration Settings** screen will appear.  The left column lists the base-channel, sub-channel, and input channel for the sub-channels selected in step 4.  The other columns list 3 parameters for each input channel.
6. When all the channels are set correctly, select OK to return to the DaqView main screen.
7. Verify settings on main screen, and resume normal operation.

# Hardware Description

### *Current Source (Transducer Biasing)*

Each channel has a constant-current source which 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 MΩ having a negligible loading effect on the transducer's output. If bias is not required, the current source can be disabled by removing a jumper and coupling the signals directly to the input preamplifier. **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, it is recommended that the baseline be set via software to the 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: When the input signal is DC coupled, the current source must be  off-line  (disabled, JP4 or JP5 removed) to protect the transducer.**

### *Amplifier*

The DBK 4 includes a Programmable Gain Amplifier (PGA) with three gain settings (×1, ×10, ×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 (Fc) 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. This error can be reduced by limiting the measurement range. A typical measurement range is 70% to 80% of the 3 dB cut off frequency.

For narrowband measurements the antialias 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. **Note**: 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. **Note:** the DaqBook or DaqBoard SSH jumper (JP2) must be set to the SSH mode.

### 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 microcontroller decodes the configuration message, sets the PGA and filter controls, and illuminates the on-board LED.  However, if transmission errors are detected, the microcontroller 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.

## Programming a DBK4

**Note**: Users of DaqView or other turnkey packages can skip this section.

The Applications Programming Interface (API) provides two functions to support the configuration of and data acquisition from the DBK4.  The following features have been added to the Daq* API:
1. A method for the user to specify the configuration parameters for the DBK4 cards in the system.  The configuration parameters needed are: card channel number, gain, maximum frequency; and baseline.
2. A method for the user to control the power management features for the DBK4 cards in the system.  The power management parameters needed are: card channel number, excitation enable/disable, and clock enable/disable.
3. A method to provide software calibration and compensation of Daq* readings from the DBK4.

These methods are achieved through a combination of existing API functions and a new function.  The functional descriptions, prototypes, and parameter explanations of these new functions are explained below (standard API) and also in the separate *Programmer s Manual*.

Software calibration requires a set of constants unique to each DBK4 card.  These constants are supplied on a diskette identified by a serial number.  This serial number should match that of the DBK4 card.  To install these calibration constants, follow the instructions found in the "READ.ME" file included on the calibration diskette.

**Note:**  The first channel in a scan should not be an SSH channel (refer to the Sample & Hold section above).  If the scan has only SSH type channels, the first reading should be discarded because it will be 10 μs earlier than the others.

daqAdcSetBank

The **daqAdcSetBank** function must be called using the bankDBK4 definition to configure the DaqBook/Board software for any DBK4 cards connected.  When daqAdcSetBank is called using the bankDBK4 definition, the specified bank will be configured.  This configuration includes all channels on the DBK4.  If the bank was configured to something other than bankDBK4, daqAdcSetBank must first be called with the Bank Not Defined parameter to disable the existing bank configuration before reconfiguring it to a bankDBK4.  The acquisition parameters (e.g., scan group and trigger source) may change.

daqAdcSetScan

The **daqAdcSetScan** or equivalent function can be used to set the gain configuration of the DBK4 channels.  The gain definitions found in the following table have been added to support the ×1, ×10, ×100 and ×1000 gains and filter/bypass modes of the DBK4 coupled with the ×1, ×2, ×4 and ×8 gains of the main DaqBook/DaqBoard.  As shown in the bypass gain definitions, there is an extra gain of ×1.583 when in bypass mode.  This function is also used to send the DBK4 configuration information to the actual hardware.

## Filter Mode Gain Definition

| | | | |
|---|---|---|---|
| Dbk4FilterX1 | Dbk4FilterX2 | Dbk4FilterX4 | Dbk4FilterX8 |
| Dbk4FilterX10 | Dbk4FilterX20 | DbK4FilterX40 | Dbk4FilterX80 |
| Dbk4FilterX100 | Dbk4FilterX200 | Dbk4FilterX400 | Dbk4FilterX800 |
| Dbk4FilterX1000 | Dbk4FilterX2000 | Dbk4FilterX4000 | Dbk4FilterX8000 |

## Bypass Mode Gain Definition

| | | |
|---|---|---|
| Dbk4BypassX1_583<br>  Dbk4BypassX12_664 | DbK4BypassX3_166 | Dbk4BypassX6_332 |
| Dbk4BypassX15_83<br>  Dbk4BypassX126_64 | Dbk4BypassX31_66 | Dbk4BypassX63_32 |
| Dbk4BypassX158_3<br>  Dbk4BypassX1266_4 | Dbk4BypassX316_6 | Dbk4BypassX633_2 |
| Dbk4BypassX1583<br>  Dbk4BypassX12664 | Dbk4BypassX3166 | Dbk4BypassX6332 |

---

daqDbkSetChanOption

---

The **daqDbkSetChanOption** function takes the configuration information and configures the specified DBK4 channel.  After one or more calls to daqDbkSetChanOption are made, daqAdcSetScan, daqAdcSetMux, or daq200SetScan should be called.  daqAdcSetBank (described above) should be called before daqDbkSetChanOption.

**PROTOTYPE**   int **daqDbkSetChanOption**
        unsigned int chan,
        unsigned int optionTypechar risingEdge,
                //enum   DcotMaxFreq = 3
                        DcotSetBaseline = 4
                        DcotExcitation = 5
                        DcotClock = 6
        double optionValue unsigned char)
                // if optionType = DcotMaxFreq,
                enum    DcovFreq18000Hz = 0
                        DcovFreq9000Hz = 1
                        DcovFreq4500Hz = 2
                        DcovFreq2250Hz = 3
                        DcovFreq1125Hz = 4
                        DcovFreq563Hz = 5
                        DcovFreq281Hz = 6
                        DcovFreq141Hz = 7
        if optionType = DcotSetBaseline,
                enum    DcovBaselineNever = 0
                        DcovBaselineOneShot = 1
        if optionType = DcotExcitation,
                false/zero disables the excitation source
                true/non-zero enables the excitation source
        if optionType = DcotClock,
                false/zero disables the SC clock
                true/non-zero enables the SC clock

**chan**

        The channel number whose frequency, excitation or clock option type and value is provided in the corresponding parameters of the function.  From the channel information the bank address, sub address, and board channel values can be derived.  (From 16 to 271)

**optionType**

A constant that specifies which option is to be set by the optionValue parameter.  For the DBK4, optionType can be one of DcotMaxFreq, DcotSetBaseline, DcotExcitation or DcotClock.

**optionValue**

A constant containing the value of the specified option.
- For the DcotMaxFreq option, optionValue specifies the high limit of the bandwidth (DcovFreq…Hz).
- For the DcotSetBaseline option, optionValue specifies the if the baseline will be set the next time that daqAdcSetScan is called (DcovBaselineNever = do not set baseline, DcovBaselineOneShot = set baseline in next daqAdcSetScan only—recommended when using 0.1 Hz coupling).
- For the DcotExcitation option, optionValue specifies if the excitation current source is enabled or disabled (non-zero = enabled, zero = disabled).
- For the DcotClock option, optionValue specifies if the switched capacitor clock is enabled or disabled (non-zero = enabled, zero = disabled).  **Note**: must be enabled if using the filter.

## Sample Program

This program (standard API) demonstrates the use of the calibration conversion functions to calibrate readings from a DBK4.  Both channels of the DBK4 should be jumpered for the filter mode.

```
#include  <stdio.h>
#include  "daqbook.h"
unsigned  int   buf[30];        // data buffer to hold 10 3-channel scans
void
main(void)
 {
 unsigned  int  chan, x, y;
          // initialize the DaqBook
 daqInit(LPT1, 7);
          // read in the cal file containing the DBK4 cal constants
 daqReadCalFile("daqbook.cal");
          // set channel 16 to be a DBK4, this will configure all channels
 on
          // the DBK4 which includes channels 16 and 17 (2-channel card)
 daqAdcSetBank(16, bankDBK4);
          // set channel options unique to each channel
 daqDbkSetChanOption(16, DcotMaxFreq, DcovFreq141Hz);
 daqDbkSetChanOption(17, DcotMaxFreq, DcovFreq281Hz);
          // set channel option common to both channels
 for (chan = 16; chan <<= 17; chan++)
 {
 daqDbkSetChanOption(chan, DcotSetBaseline, DcovBaselineNever);
 daqDbkSetChanOption(chan, DcotExcitation, 1);
 daqDbkSetChanOption(chan, DcotClock, 1);
 }
// acquire 10 samples from channels 15 to 17 at 3000Hz, each channel is
 sampled at 1 kHz.  Channel 15 is a dummy channel, acquired while channel 16
 & 17 are simultaneously sampled.
 daqAdcRdScanN(15,     // start channel
          17,    // end channel
          buf,   // data buffer
          10,    // number of scans
          DtsPacerClock,      // trigger source
          0,     // one-shot mode
          0,     // trigger level
          3000,  // scan frequency
 Dbk4FilterX1);         // gain setting
               // calibrate all the data in one step
 daqCalSetupConvert(  3,     // number of channels in scan
               1,     // position of first channel to cal in scan
               2,     // number of channels to cal
               DcalDBK4Filter,    // cal type
               Dbk4FilterX1,      // channel gain
               16,    // first channel number to cal
```

```
                    1,      // bipolar setting
                    0,      // no offset
                    buf,    // data buffer
                    10);    // number of scans to cal
            // print results
         printf("\nResults of AdcRdScanN:");
         for (x = 0; x<10; x++)
         {
         printf("\nScan %2u:", x);
         for (y = 0; y<2; y++)
            {
            printf(" %5u", buf[(x * 2) + y]);
            }
         }
         // close and exit
         daqClose();
         }
```

# Accelerometer Tutorial

### *What is a Low-Impedance Piezoelectric Accelerometer?*

A low-impedance piezoelectric accelerometer consists of a piezoelectric crystal and an electronic amplifier. When stretched or compressed, the crystal's 2 surfaces develop a charge variation that is related to the amount of stress, shock, or vibration on the crystal. The amplifier transforms the sensor's high impedance to the output impedance of a few hundred ohms. Low-impedance piezoelectric transducers are used to measure pressure and force as well as acceleration.

The accelerometer circuit requires only 2 wires (coax or twisted pair) to transmit both power and signal. At low impedance, the system is insensitive to externally induced or "triboelectric" cable noise. Sensitivity is not affected by cable length.



*Accelerometer Circuit*
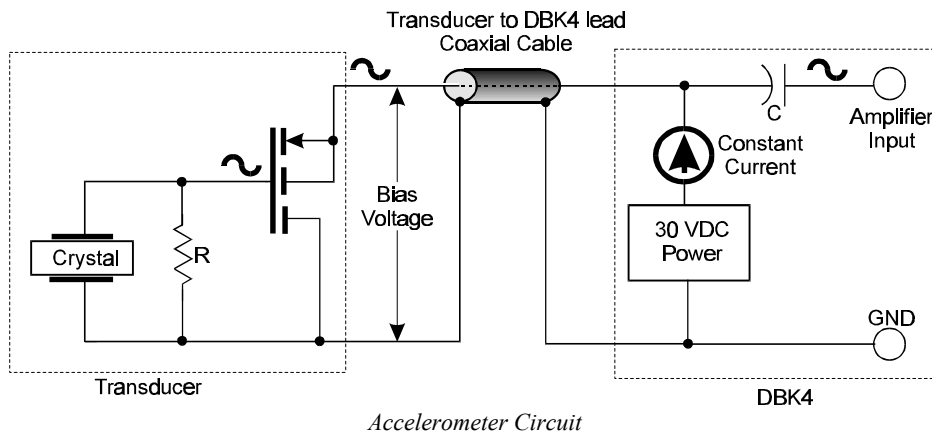
The figure shows a simplified accelerometer-DBK4 connection. The voltage developed across R is applied to the gate of the MOSFET. The MOSFET is powered from a constant current source of 2 or 4 mA and 27 volts.

In the quiescent state, the MOSFET circuit will bias off at about 12 V. As the system is excited, voltage develops across 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 DBK 4 input amplifier through the capacitor C. The low-frequency corner is controlled by the value of R and the internal capacitance of the piezoelectric crystal. 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 lowest discernible amplitude (minimum "g") that can be measured. There are two main sources of noise.

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

### Sensitivity

The sensitivity of a low-impedance 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 Earth's gravitational acceleration which is 32.2 ft/(sec)(sec), 386.1 in/(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).

Ex: 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. Calibration values for individual sensors are typically provided by the manufacturer.

### Transverse Sensitivity

Accelerometers are designed to have one major axis of sensitivity, usually perpendicular to their 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.

### Frequency Response

The frequency response of an accelerometer is defined as the ratio of the sensitivity of the accelerometer 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).

### 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 µVrms versus 10-20 µVrms for the high voltage.

### 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 accelerometer sensitivity, bias voltage level, power supply voltage, and noise floor.

### Thermal Shock - Temperature Transients

Piezoelectric accelerometers exhibit a transient output which is a function of "rate-of-change" temperature. This phenomenon., called "thermal shock", is usually expressed in g/°C, and is related to:

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

In practice, the effect is quasi-static, producing a low-frequency voltage input to the MOSFET amplifier. While usually occurring well below the low-frequency corner, the effect can momentarily reduce the peak clipping level and cause loss of data. The phenomenon does not affect the basic sensitivity of the

accelerometer and does not affect the data unless the thermal shift in the operation bias level results in clipping. Where drastic thermal shifts are expected, the use of 12 V bias models is recommended. The effect's severity is related to the mass of the accelerometer. In 100 mV/g industrial units, the effect is usually negligible. The effect can be reduced significantly by using rubber thermal boots provided for that purpose.

### Base-Strain Sensitivity

Strain sensitivity in an accelerometer is defined as the output caused by deformation of the base due to bending in the mounting structure. In measurements made on large structures with low natural frequencies, significant bending may occur—units with low base strain sensitivity should be selected.

Base strain effects can be substantially reduced by inserting a washer smaller than the accelerometer base diameter, under the accelerometer base to reduce the contact surface area. This technique lowers the usable upper frequency range.

### Connector

This 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). In cases where there is no connector on the sensor, an integral cable is specified with the length and particular connector, i.e., integral 6 ft to 10-32.

### Acoustic Sensitivity

High-level acoustic noise can induce outputs unrelated to vibration input. In general, the effect diminishes as the accelerometer mass increases. This effect may be reduced by using a light, foam-rubber boot.

### Overload Recovery

Recovery from clipping due to over-ranging is typically less than one millisecond. Recovery from quasi-static overloads which generate high DC bias shifts are controlled by the accelerometer input RC time constant which 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.

## *Physical Setup*

### Mounting Effects

Adding an accelerometer to a test object may influence the test 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 the mass of an automobile, will affect measurements on the hood when placed directly in the 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:

$$\Delta f = fn \left\{ 1 - [m/(m - ma)] \right\}^{\frac{1}{2}}$$

Where:

$\Delta f$ = Change in Resonant Frequency
fn = Original Resonance Frequency without Accelerometer
m = Spring Mass
ma = 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 yields the best results because it fuses the accelerometer and test surface. When the stud mount method is impractical, an adhesive installation is a good alternative depending on the application.

### Adhesive Mounts

Some accelerometers are designed to be glued directly to the test surface. Others must use mounting adapters (bases) for adhesive mounting. 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 is actually a spring and has the effect of creating a new spring-mass system with lower high frequency response. To avoid a thick glue line, the Cyanocrylate family of adhesives work well for the following reasons:

- 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 are readily dissolved with acetone.

### Removal of Adhesive Accelerometers

Many accelerometers and adhesive adapters have been damaged or destroyed by improper removal. A safe way of removing the accelerometer is to torque it or the adapter with a wrench using the flats provided. Adhesives are generally weakest in the shear mode and will readily yield under steady torque. ***Never strike an accelerometer to remove it***. The trauma will likely damage the accelerometer and affect calibration.

*Accelerometer Mounting*
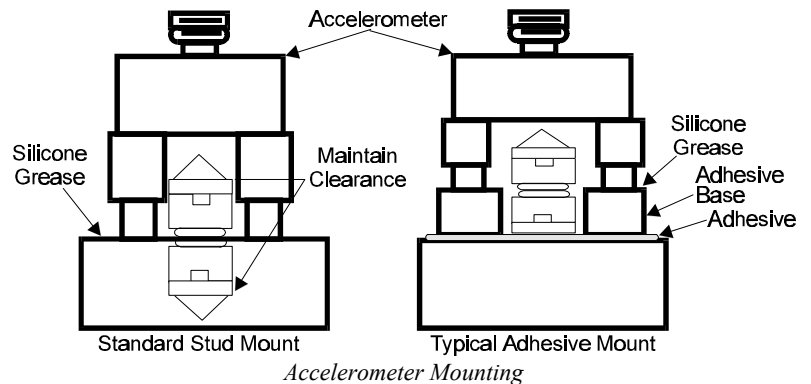
### Magnetic Mounting Adapters

Magnetic mounting adapters are used to attach accelerometers to ferromagnetic surfaces such as machinery and structures where the instrument 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, magnetic adapters should be used with caution and never trusted beyond 1 kHz. Again, expect response degradation in direct proportion to the weight of the accelerometer. To ensure the best possible accuracy from the magnetic mount installation, follow these steps:

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 internal impedance matching electronics 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 these units are used, care must be exercised to avoid errors due to ground noise.

### Isolated-Base Design

To prevent ground noise error many accelerometers have base-isolated design. In these models 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 exceptional strength and mechanical stiffness to preserve high-frequency performance.

## *Accelerometer Practical Limitations*

### Mass Loading

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

### Upper Frequency Response

Piezoelectric accelerometers will naturally attenuate below the low frequency 3db point, but will amplify data at or near their mounted resonant frequency. The mounted resonant frequency of the accelerometer should be approximately 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 where broader tolerances are permissible, 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 bristled brush (such as a glue brush or small paint brush 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 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 (jack) to avoid contamination of the electrical contact.

The 10-32 and smaller connectors are fragile due to their small size. 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 where their small size is required.

### Cables

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

The figure shows the preferred methods of cable routing to the connector by causing the flexure to occur away from this 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*
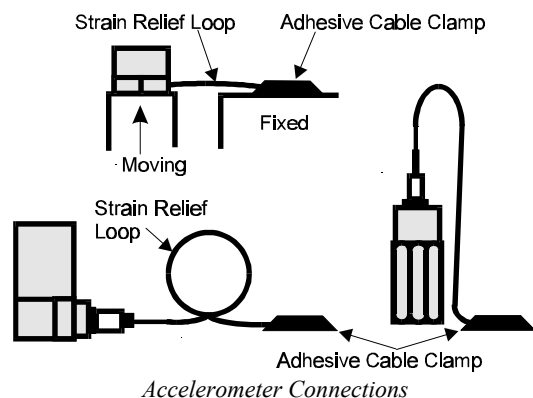
**Triboelectric Noise**

Triboelectric noise is caused by the potential developed in a flexing cable. The triboelectric noise voltage or charge is coupled to the signal leads by means of inner conductor capacitance, and may be represented by a voltage source in series with a capacitance. In general, triboelectric noise is associated with flexural displacement of the signal cable and is most prevalent where low-frequency vibrations (below 10Hz) are being measured. It is difficult to detect without external references but, if repositioning or securing the signal cable alters the measured output, 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.

The cost of long cables can be reduced by coupling a short (1 m) adapter cable from the accelerometer to a long low-cost cable like RG-58U or RG-62U with BNC connectors. Since cable failure tends to occur at the accelerometer connection where the 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 vibration and shock measurements above 2000 Hz and cables longer than 100 ft, the possibility of either 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 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:

$$ f = \frac{K}{2\text{p}C\left(\dfrac{V}{Icc - Ib}\right)} $$

Where:
f = Maximum frequency in Hz
C = Cable capacitance in picoFarads
V = Maximum peak measured voltage from sensor in volts
Icc = Constant current from current source in mA
Ib = Current required to bias the internal electronics, typically 1 mA
K = $3.45 \times 10^9$ (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.)

| 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 |

# 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 M$\Omega$

        **Compliance**: 27 VDC

        **Current Levels**: 2 & 4 mA

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

    **Input Impedance**: 150 k$\Omega$

    **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**

        **Bypass Mode**: @ 1 kHz: -83 dB;  @ 10 kHz: -80 dB

        **Filter Mode**: @ 1 kHz: -75 dB;  @ 10 kHz: -72 dB

        **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: ±6°

        **Accuracy Passband Center**: ± 0.5 dB

# DBK5 4-Channel Current Output Card

## Overview

The DBK5 can control four 4 to 20 mA current loops.  The DBK5 connects to the Daq*'s P1 port and uses one of the Daq*'s 16 base channels.  Up to 4 DBK5s can share a single base channel for a maximum of 256 channels.  The DBK5 neither sources nor sinks current; instead, it modulates current in an externally powered loop.  In this way, the DBK5 acts as a current-loop transmitter.  The DBK5 is compatible with regulated or unregulated loop supplies of 12 to 45 V and with loop resistance up to 1.95 KΩ according to the relationship:

$$V_{SUPPLY} = V_{TRANSMITTER} + (I_{LOOP} * R_{LOOP})$$

where: $V_{TRANSMITTER}$ = 6 V, and $I_{LOOP}$ = 20 mA max

| DAC | mA |
|---|---|
| 0 | 4 |
| ... | ... |
| 1000 | 7.9 |
| ... | ... |
| 4095 | 20 |

The DBK5 provides loop-current control through 12-bit digital-to-analog converters (DACs).  The 12-bit range of 0 to 4095 corresponds with 0 to 100% of full-span and an output of 4 to 20 mA.  As shown in the table, the current output $I_{OUT}$ = 4 mA + (DAC/4095 × 16 mA).  Thus, the DAC values for currents between 4 and 20 mA = 255.94 × ($I_{OUT}$ - 4 mA).

The 4 channels are optically isolated from the Daq* and from each other.  Isolation allows the loop voltages to float beyond the Daq*'s common mode range.  An externally powered loop allows the DBK5 to continue to modulate the loop current in the event of a fault or power loss in the Daq*.  If the loop is powered-up before the Daq*, the DBK5 will maintain the loop current at 4 mA.  After a fault, the DBK5 will maintain the loop current at the last level set.



SSH is simultaneous sample and hold.
$A_0$ - $A_3$ are address lines 0 through 3.
$G_0$ - $G_1$ are gain adjust lines 0 and 1.

Circuits for Channels 1, 2, and 3 are the same as shown for Channel 0.

*DBK5 Block Diagram*
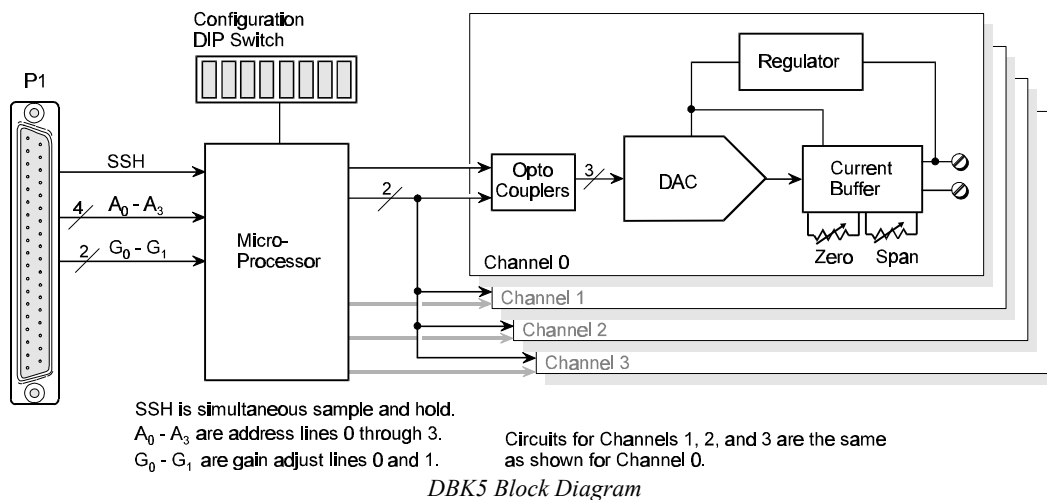
## Hardware Setup

### Card Configuration

Up to 4 DBK5s can use a single Daq* channel.  With 4 inputs on a card and 16 main channels, a maximum of 256 inputs are possible.  Each card must appear unique to the Daq*.  An onboard DIP switch sets the card and sub address selection.  The 8-position DIP switch uses the first four switches to set 1 of 16 main Daq* channels (any card address in the range of 0 to 15 is valid.).  The last two switches set the sub address. The sub address distinguishes each of 4 DBK5s on a single channel (any sub address in the range of 0 to 3 is valid).  The card and sub address selection DIP switches form a set of binary-weighted values.  To select the desired address, set the corresponding switches to the proper binary settings.  For example, if the desired card address is 11 then switches 1, 3, & 4 should be set to 1.  To set a switch to a value, depress the corresponding side of the rocker-arm switch.  (Switch positions 5 and 6 are not used.)



*DBK5 Configuration Settings*
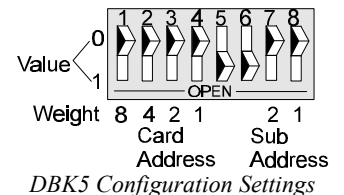
### Card Connection

Current-loop connections are provided via dual screw terminal connections.  The **+** and **-** loop connections are shown in the figure.  Once all connections are in place, secure wires to the board at captive areas at the end of the board.  Nylon tie wraps (not included) work well for this purpose.  **Note 1: An external loop-voltage supply must be provided.  Note 2: to meet CE safety specifications, an edge guard (kit p/n 232-0806) must be attached to the DBK5 card before insertion into a DBK41 expansion chassis.  This guard helps prevent accidental access to high-voltage circuits.**



*DBK5 Current Loop Configuration*
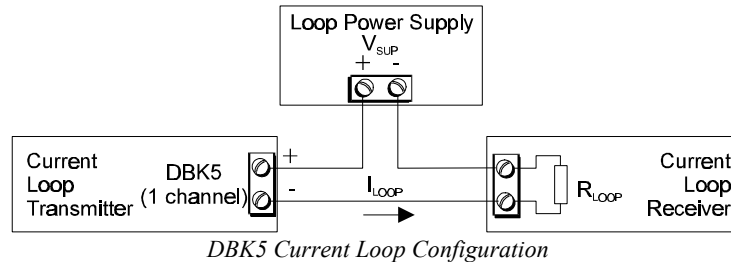
### DaqBook/DaqBoard Configuration

Use of the DBK17 requires setting jumpers in the DaqBook/DaqBoard.

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 DBK5 via the internal ±15 VDC power supply.  If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).



*DBK5 Jumper Configuration*

2.  Place the JP2 jumper in the SSH position.  **Note**: **you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).
3.  *Place the JP4 jumper in single-ended mode (*applies only to DaqBook/100, /112 and /120).
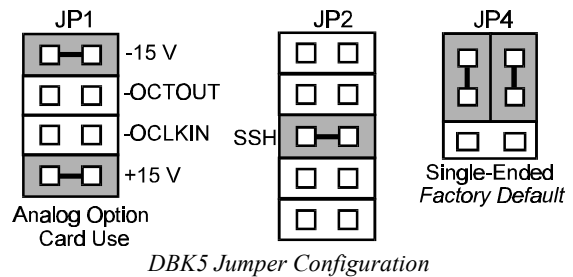
## Software Setup in DaqView

This section shows you how to set up DaqView for the DBK5 and your application.  Refer to chapter 6, *DaqView*, for further details and screen captures.  From DaqView's main screen (v5),

1.  Pull down the Device menu, and select Configure Hardware Settings.  The Configure System Hardware screen appears and shows the channel assignments.
2.  Under Analog Input Option Cards External Connection, select the expand button for the chosen Daq* channel.  A drop down menu lists the available option cards.
3.  Select the DBK5 Current Output Card.  A smaller, sub-address setup window will appear.
4.  In the sub-address setup window, select up to 4 cards to use.  The software switch settings must match the hardware setting of the DBK5's S1 DIP switch.
5.  When all the channels and sub-addresses are set correctly, select OK to return to the DaqView main screen.
6.  Select Analog Output under window menu.
7.  Set the mA value for each channel.
8.  Execute.

## Programming a DBK5

**Note**: Users of DaqView or other turnkey packages can skip this section.

**Note**: the DBK5 should not be programmed during an active acquisition. Doing so will cause the acquisition to terminate prematurely.

To send DAC output values to a DBK5, you must:
- Tell the software driver that DBK5(s) are attached to a certain range of channels
- Write the output channel DAC value(s)

The commands to perform these steps and some background information are described below. The driver software defines the concept of a channel bank. Each of the Daq*'s 16 base channels are referred to as a channel bank. Each channel bank contains 16 expansion channels. In this way a maximum of 256 analog input or output channels are provided via P1 expansion. The channel numbering of expansion channels starts at 16. Channels 0 - 15 are reserved, within the driver, for Daq* base channels. The table illustrates the channel numbering scheme (see also the section *Channel Identification* in the chapter *Signal Management and Troubleshooting Tips*).

| Card Address (Base Channel) | Sub Address | API Expansion Channel |
|---|---|---|
| 0 | 0 | 16-19 |
| 0 | 1 | 20-23 |
| 0 | 2 | 24-27 |
| 0 | 3 | 28-31 |
| 1 | 0 | 32-35 |
| 1 | 1 | 36-39 |
| 1 | 2 | 40-43 |
| 1 | 3 | 44-47 |
| 2 | - all - | 48-63 |
| etc | etc | etc |

The effective channel number of a particular DBK5 channel can be calculated simply using the relationship.

$$effChan = 16 + (cardAddr * 16) + (subAddr * 4) + chan$$

where     effChan = effective (expansion) channel number
                cardAddr = card address
                subAddr = sub address
                chan = DBK5 channel number

The driver must, in certain cases, be informed of the type of DBK card attached to a channel bank by using daqAdcSetBank. Function parameters include an effective channel number and the DBK type. Once called, the driver assumes that all sub channels within that channel bank are of the same DBK type. The following example function call tells the driver that DBK5(s) are attached on bank 1 (expansion channel 38 is in bank 1).

      daqAdcSetBank(38, bankDBK5)

To write DAC values to the DBK5, one of two functions can be used: daqDacWt and daqDacWtMany. The **daqDacWt** function is used to update a single output channel. This function takes the effective channel and DAC value as parameters. The following function call sets the DAC value on channel 38 to 2048, which corresponds to 12 mA (computed: 4 mA + [2048/4095 × 16] = 12.002 mA).

      daqDacWt(38, 2048)

The **daqDacWtMany** function allows multiple DAC channels to be updated simultaneously. As many as 16 channels can be updated at once. However, only expansion DAC channels on one bank can be updated at one time. If DBK5 cards are attached on banks 0 and 1, for instance, the daqDacWtMany function would have to be called twice. In the daqDacWtMany function, the first parameter is the first channel to be written to. The second parameter is a pointer to an array of DAC values. The third parameter is the number of values in the array (and the number of DAC channels to be written to). The following sample function call updates the DACs on channels 32 through 39 with the values in the array dac_vals.

      daqDacWtMany(32, dac_vals, 8)

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK5 - Specifications

**Name/Function: 4-Channel 4-20 mA Current Output Card**
**Connectors**: DB37 male, mates with P1. Screw terminals for signal output.
**Accuracy/Linearity**: 0.1% FS
**Resolution**: 4 μA / LSB, monotonic

**Hysteresis**: 0.02% FS
**Regulation**: 0.05% FS
**Compliance**: $R_{LOOP} = (V_{SUPPLY} - 6) / 0.020$ max
**Isolation**: 500 V

# DBK7  4-Channel Frequency-To-Voltage Input Card

## Overview

The DBK7 can be used for diverse frequency-monitoring applications.  Typical uses include measuring the flow of liquids with a flowmeter and measuring rotation (rpm) with a shaft encoder.  The monitored process must generate a series of electrical pulses whose frequency is related to the desired variable.

Features of the DBK7 include:
- Inputs can be analog (high or low level) or digital.
- Each channel has a programmable frequency range.
- Noise effects can be minimized by debounce, attenuation, and low-pass filtering.
- Up to 64 DBK7s can be used with a single Daq* for a maximum of 256 channels.

The block diagram (see figure) shows the card's basic function.  Each channel:
- Conditions an input signal
- Selects the signal's rising or falling edge
- Debounces the edge
- Measures the signal's frequency.

The D/A converter outputs a voltage from -5 V to +5 V to correspond with the selected frequency range. (The Daq*  must be configured for bipolar operation.) The Daq* directs the card's D/A converter to convert the data from the proper input channel.
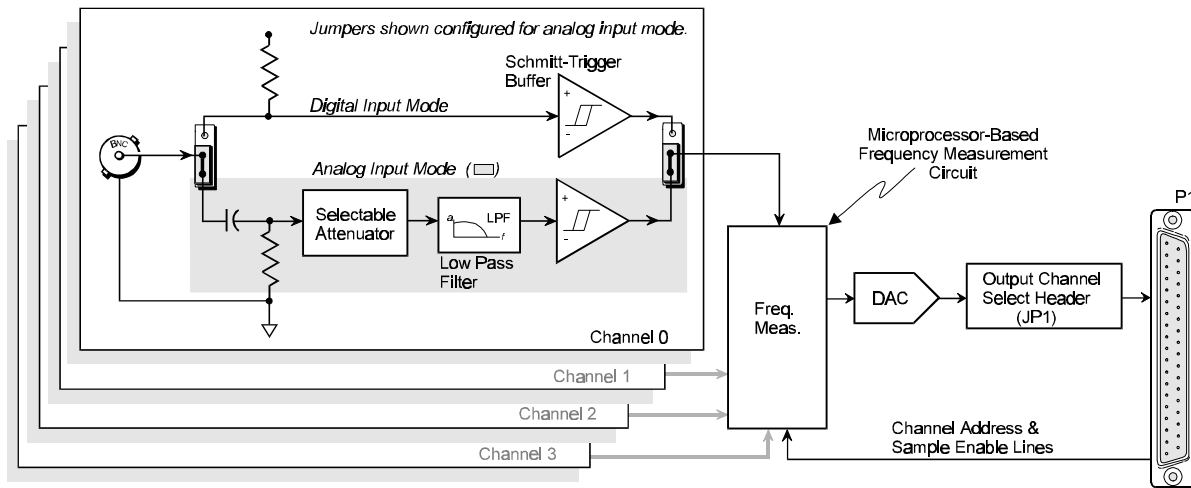


*DBK7 Block Diagram*

## Hardware Setup

Setting up the DBK7 hardware includes:

- Configuring onboard jumpers and switches for the application.  To prevent card damage, the DBK7 must be configured before connecting to inputs and outputs.
- Connecting the input cables to sensors and the output cable to a Daq*.  The Daq* must be configured for bipolar operation.  For the DaqBook/100, /112, or /120, this requires a hardware setting of jumper JP3.

### Card Configuration

Several jumper and switch settings must be made on the DBK7 card to match both the system setup and the signal conditioning requirements. This section describes a typical configuration. The figure shows the location of jumpers and switches the user must set during card configuration.



*Jumper and Switch Location*
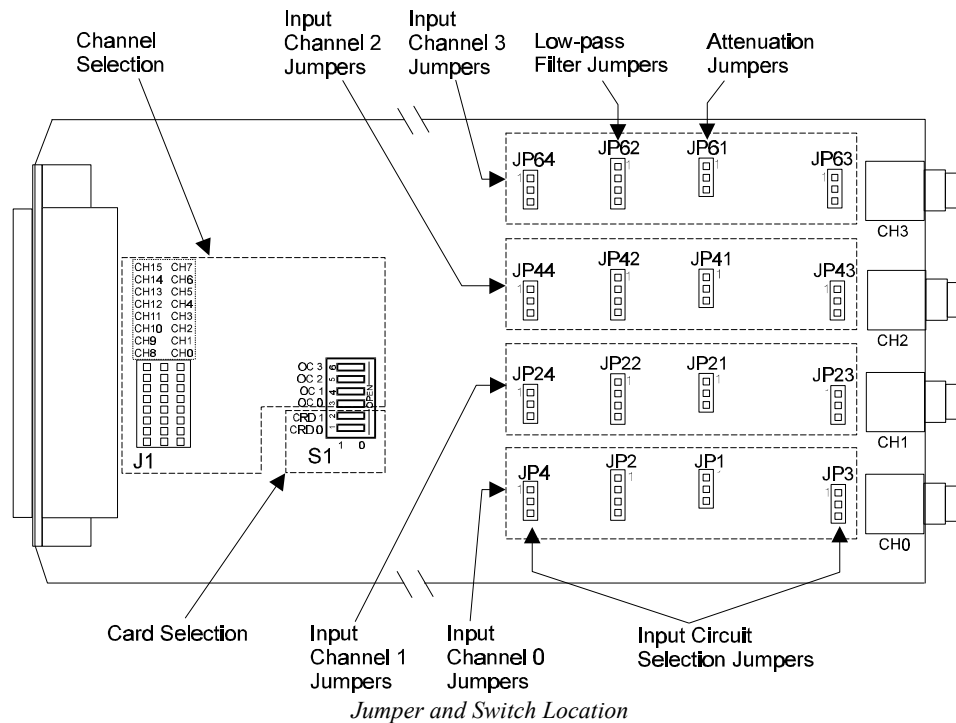
### Channel and Card Selection Configuration

Up to 4 DBK7 cards can connect to a single Daq* channel. Thus, a 16-channel Daq* can connect to 64 DBK7 cards. Since each card has 4 input channels, a fully populated system can use 256 input sensors. To keep these inputs organized, the card is configured by physically setting a jumper (J1) and a DIP switch (S1).

- J1 is a 24-pin (3×8) header requiring two pins in a row to be connected. Up to 4 cards can share the same channel.
- S1 is a 6-position DIP switch (positions 3-6 set the Daq* channel). Each card sharing a Daq* channel can have one of four sub-addresses (card number) as set by S1 (positions 1 & 2).

**Note**: J1, S1, and the software must all be set to the same channel.

Set the main channel and sub-address as follows:

1. Determine the Daq* channel and card number for each DBK7 used. It may be necessary to check the software setup and other cards in the system to avoid a conflict. Note that a DBK7 may share a channel with 3 other DBK7s. Each card sharing a Daq* base channel must use a unique card number sub-address.
2. Set the J1 jumper across the 1st and 2nd or the 2nd and 3rd pin of a row to the desired channel. Refer to the silk screening just above the jumper for proper positioning (see figure).
3. Set S1 DIP switches 3-6 (OC0 to OC3) to match the channel selected on J1, and verify both settings (S1 and J1) are correct (see figure).
4. Set S1 DIP switches 1 & 2 (CRD0 and CRD1) to give the card a unique sub-address with the chosen Daq* channel. Any unused sub-address in the range 0-3 is valid (see figure).
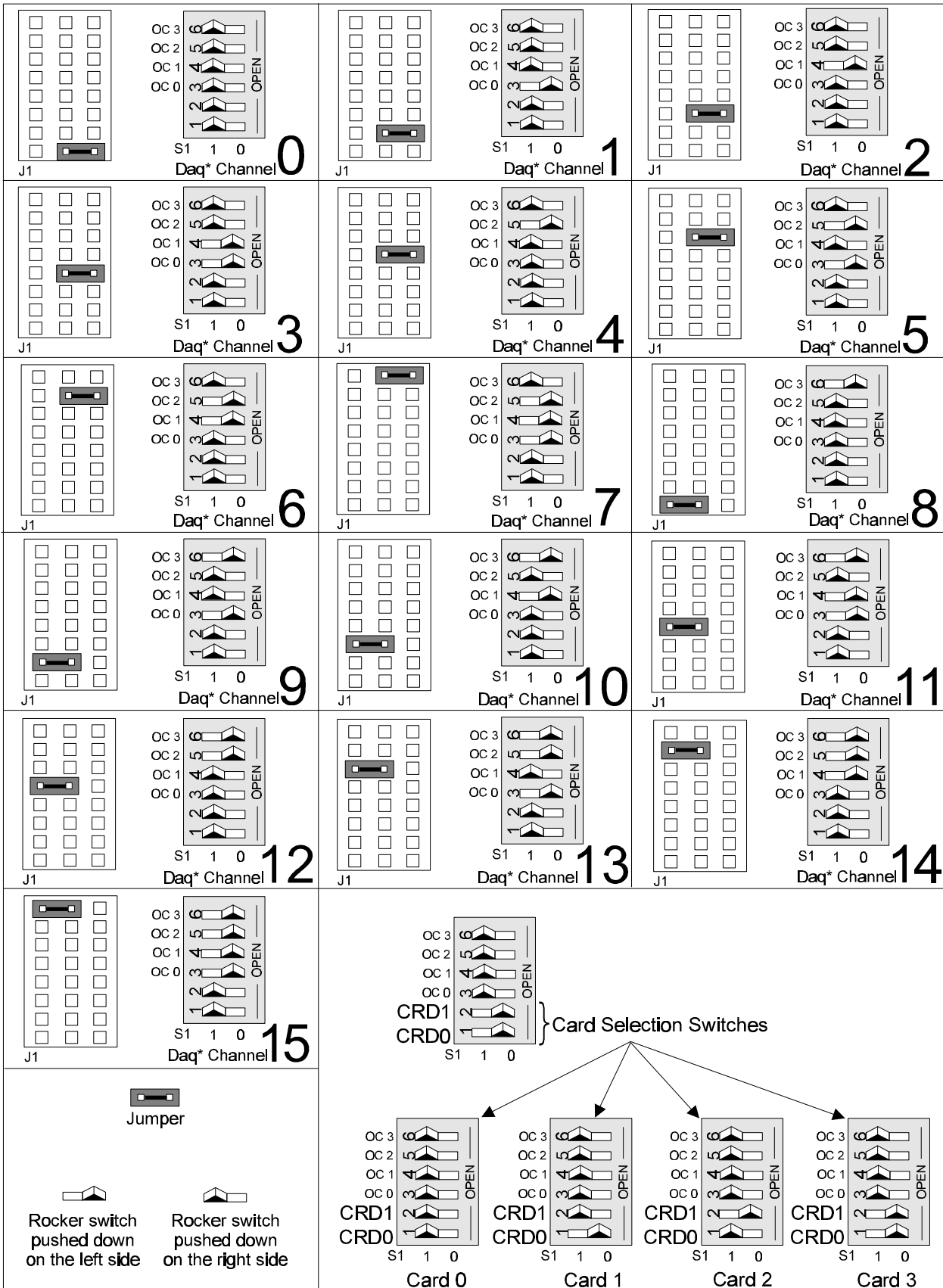
*DBK7 Channel Configuration*

## Input Signal Conditioning Configuration

Hardware settings affect 3 aspects of signal conditioning:
- Input circuit selection: analog or digital
- Attenuation selection
- Low-pass filter selection.

### *Input Circuit Selection*

Each input channel can be set for the analog or digital circuit. Two jumpers must be set for each channel.

Select the input circuit for each input channel as follows:

1. Determine the best circuit type for each channel.

    - The digital input circuit works best for DC-coupled signals where the low level is less than 0.5 V and the high level is above 2.5 V and the voltage does not exceed ±15 V. By using a pull-up resistor, switches and relays can create the signal. Frequencies can be as high as 960 kHz. The digital input circuit does not attenuate or filter the input signal.

    - The analog input circuit is AC-coupled and is sensitive to signals from 100 mV to 84 V p-p. It also provides attenuation and low-pass filtering to reduce the effects of noise.

2. Position the input circuit jumpers for analog or digital (see figure). Verify that both jumpers for a channel are set the same (JP3 and JP4 for channel 0; JP23 and JP24 for channel 1; JP43 and JP44 for channel 2; and JP63 and JP64 for channel 3).



*Input Circuit Selection Jumpers*
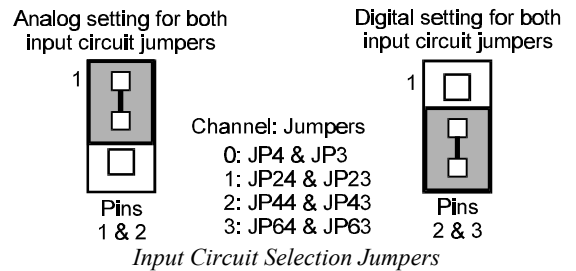
### *Attenuation Selection (Analog Input Circuit Only)*

When measuring strong analog signals, the attenuator can reduce the input sensitivity and the effects of noise. If enabled, the attenuator reduces the input sensitivity by a factor of about 20.

Set the attenuation for each channel as follows:

1. Determine the best attenuation for each channel.

    - Use attenuation and reduced sensitivity if the input signal's peak level exceeds 1 V.

    - Disable attenuation for full sensitivity if the input signal's peak level is less than 1 V.

2. For attenuation, position the jumper across pins 1 and 2. Attenuation is enabled (the default setting). (See figure.)

3. To disable attenuation, position the jumper across pins 2 and 3. The full-strength signal is used.

4. Verify the jumper position for each input channel (JP1 for channel 0, JP21 for channel 1, JP41 for channel 2, and JP61 for channel 3).



*Attenuation Selection Jumpers*
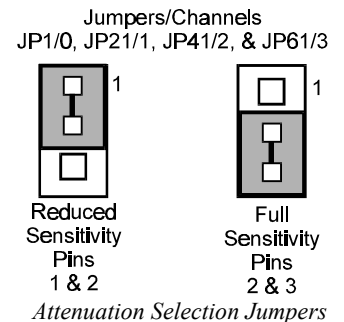
*Low-Pass Filter Selection (Analog Input Circuit Only)*

The low-pass filter removes high-frequency noise that could otherwise fool the DBK7 into detecting a higher frequency.  To set the low-pass filter:

1. Determine the highest frequency you expect to measure on each input channel.
2. Select the next higher cutoff frequency (30 Hz, 300 Hz, or 100 kHz) for each corresponding channel (see figure *Typical Sine-Wave Sensitivity vs Frequency* later in this section), and verify that the DBK7's sensitivity will accommodate the expected input signal strength.
3. Set jumpers JP2 (channel 0), JP22 (channel 1), JP42 (channel 2), and JP62 (channel 3) accordingly (see figure).



Jumpers/Channels
JP2/0, JP22/1, JP42/2, and JP62/3

100 kHz Pins 1 & 2    300 Hz Pins 2 & 3    30 Hz Pins 3 & 4

*Low-Pass Filter Jumpers*
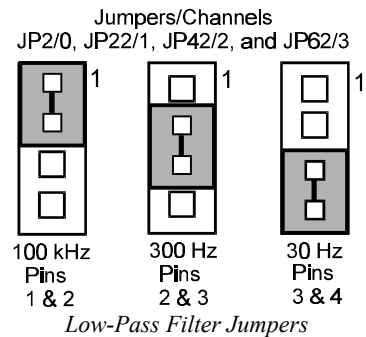
### Card Connection

After the DBK7 hardware is configured, it can be safely connected to the system.  On the input side, up to 4 sensors connect to the card's input BNC connectors.  On the DB37 (P1) side, the DBK7 connects to the Daq*  (possibly through an expansion module) via a CA-37-x (or CA-131-x) cable.

---

### CAUTION

⚠ **Do not allow sensor input voltages to exceed 30 Vrms (42 Vpeak, 84 Vp-p) for analog or ±15 V for digital.  Stronger signals may damage the DBK7 card or present an electrical shock hazard.**

---

Connect the DBK7 card as follows:

1. Connect each sensor BNC connector to a mating connector on the card.  Channel labels (CH0 to CH3) are printed just below the corresponding connector.  Tag each sensor with its corresponding Daq* channel, card sub-address, and DBK7 input channel.
2. For a single DBK7 card, connect one end of the Daq* cable to the card's male DB37 output connector.  **Note:** with a DaqBook, use a CA-37-1; with a DaqBoard, use a CA-131-1; with a Daq PC-Card, use a CDK10 (expansion, power module) with CA37-1 and CA-134 cables.
3. Connect the other end of the cable to the P1 port of the Daq*.  For multiple DBK7 cards, use a CA-37-x (or CA-131-x) cable to daisy-chain several cards or an expansion module.  For example, three DBK7s (or 2 DBK7s and an expansion module) can be connected to a DaqBook with a CA-37-3.
4. For multiple cards from a Daq PC-Card, cable CA-134 must first connect to an expansion module (a CDK10 or a DBK41 with a DBK33 power card) then through a CA-37-x to the DBK7s.

**Note**: For longer cable runs, use a CA-113 to add 6 ft of cable length where needed.

### For CE Compliance

To maintain the EMI emission and immunity standards for CE compliance, the DBK7 must be placed in a DBK41/CE 10-slot analog expansion module that is connected to the Daq* by a CA-143-x cable rather than the CA-37-x (refer to the DBK41 section).  In the presence of 3 V/m RF fields,

- 500 mVpp signals are required to maintain 0.1% accuracy.
- Metal shells of the BNC connectors must be directly connected to the chassis ground in order to maintain 100 mV sensitivity and 0.1% accuracy.
- The host computer must be properly grounded.
- The host computer and peripheral equipment must be CE compliant.

### DaqBook/DaqBoard Configuration

Several setup steps at the DaqBook/DaqBoard are required to use DBK7 cards in a system.

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 DBK42 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. Place the JP2 jumper in the SSH position. **Note**: **you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).
3. *Place the JP3 jumpers in bipolar mode.
4. *Place the JP4 jumpers in single-ended mode.

*Note: applies only to DaqBook/100, /112 and /120.

*DaqBook/Board Settings for DBK7*

## Software Setup in DaqView

This section shows you how to set up DaqView for the DBK7 and your application. Refer to chapter 6, *DaqView,* for further details and screen captures.

From DaqView's main screen (v5):

1. Pull down the Device menu, and select Configure Hardware Settings. The Configure System Hardware screen appears and shows the channel assignments.
2. Under Analog Input Option Cards External Connection, select the expand button for the Daq* channel chosen for the DBK7. A drop down menu lists the available option cards. The selected channel number must match the J1 and S1 settings on the DBK7 card.
3. Select the DBK7 4-Channel Frequency-to-Voltage Card. A smaller, sub-address setup window will appear.
4. In the sub-address setup window, select up to four cards to use. Note the "crd0" and "crd1" settings to the right of the selection box. The "0" and "1" must match the hardware setting on the DBK7's S1 DIP switch (positions 1 & 2).
5. Select the Config button. The DBK7 Configuration Settings screen will appear. The left column lists the Daq* channel, the card sub-address, and the sensor input channel for the sub-address selected in step 4. The user-input columns list 4 parameters for each input channel. Set these parameters independently, or use the Fill Down box to apply the same value to several entries in a column.
6. In the Edge column, select the Rising or Falling edge to give the cleanest, most stable signal. The default setting (Rising) will usually give acceptable results. If not, try the Falling edge.
7. In the Debounce(ms) column, select a delay interval (0, 0.6, 2.5, or 10 ms). Use "0" (debounce disabled) for clean, high-frequency signals. Increase the debounce as needed for noisy, low-frequency signals such as from switches and relays.
8. In the MinFreq(Hz) column, select the low end of the desired frequency range. A process with a wide variation in signal frequency requires a wide range, and the DBK7 can measure a wide range faster than narrow range. If a high degree of accuracy is desired in a narrow range, the measurement speed will slow down accordingly.
9. In the MaxFreq(Hz) column, select the high end of the desired frequency range.
10. When all the channels are set correctly, select OK three times to return to the DaqView main screen.
11. Verify settings on the main screen (Sequence Rep Rate, Data Destination, etc.), and resume normal operation. DBK7 readings are usually displayed in Hz.

# Hardware Function

This section explains DBK7 functions that affect user settings to ensure the best performance. For setup questions or noise problems, refer to the related section. The figure provides an overview of signal conditioning function blocks and can be referred to for the following discussions.



*DBK7 Function Diagram*

## Input Signal Conditioning

The DBK7 conditions the input signal in several ways to provide the best output accuracy. Reducing noise and limiting the bandwidth are the first steps in the conditioning process and are done in hardware. Software can further clean up the signal by selecting the cleanest edge to read and by setting a debounce delay to ignore spurious signals.

### Analog Input Signal Conditioning

The equivalent analog input circuit is shown in the figure. Input voltages should be at least 50 mV peak-to-peak. The maximum analog input signal is 30 Vrms (42 Vpeak, 84 Vp-p). Stronger signals may damage the DBK7 or present an electrical shock hazard.
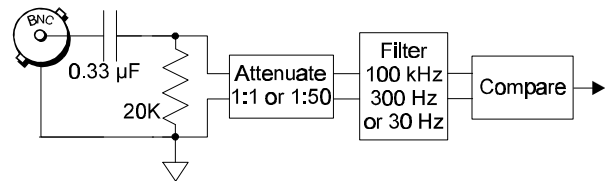


*DBK7 Analog Equivalent Input Circuit*

When the input circuit jumpers are set for analog, the center conductor of the BNC connector is AC-coupled through a 0.33 μF capacitor to the attenuator. The outside conductor connects directly to ground. With the attenuator disabled for full sensitivity, input-protection diodes limit the signal to about 1.5 Vp-p. Larger signals will see an impedance of 6.7 KΩ (rather than 20 KΩ) in series with 0.33 μF. With the attenuator enabled, the input impedance remains 20 KΩ regardless of the input level.

After AC-coupling, attenuation and filtering, a comparator converts the input signal into a clean digital signal. The comparator output is high when the center-pin signal is higher than the outside-conductor signal (and low when the center-pin is lower). The comparator has hysteresis to reduce the effects of noise by ignoring small signals.

The graph shows typical sine-wave sensitivity in peak-to-peak voltage vs frequency from 5 Hz to 500 kHz. Six combinations of attenuation (on/off) and low-pass filtering (30 Hz, 300 Hz, and 100 kHz) are graphed.



*DBK7 Typical Sine-Wave Sensitivity*
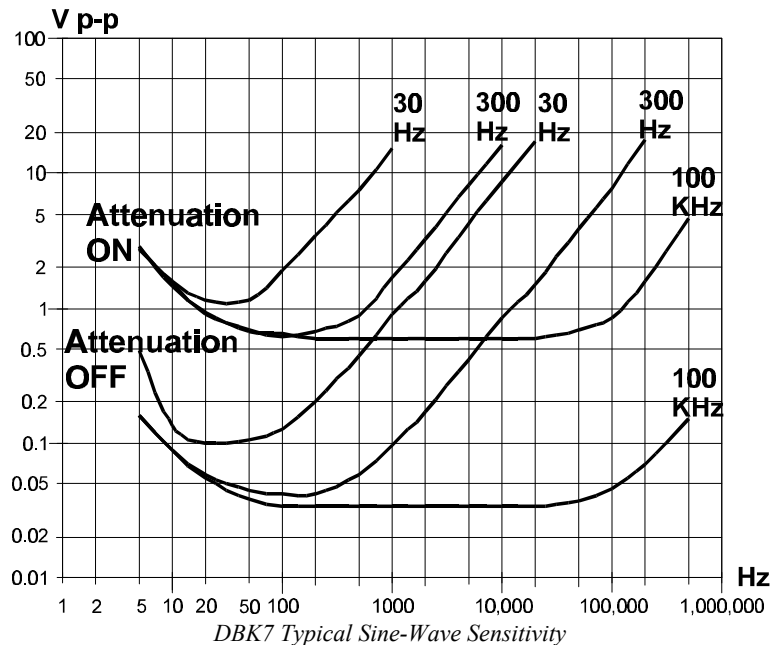
## Digital Input Signal Conditioning

The equivalent digital input circuit is shown in the figure. The input signal may range from -15 to +15 V. Higher voltages may damage the DBK7.

When the input circuit jumpers are set for digital, the outside (shield) conductor of the BNC connector connects directly to ground. The center conductor is pulled up with 27 KΩ to +5 V and then passes through a 2.7 KΩ protection resistor before being detected by a Schmitt-trigger buffer with input-protection diodes.
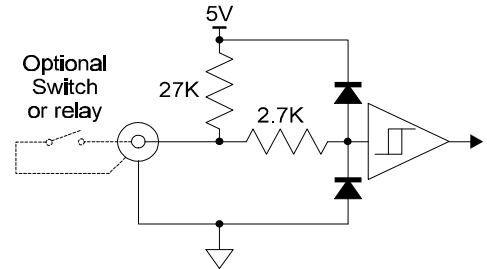


*DBK7 Digital Equivalent Input Circuit*

The input thresholds are fixed TTL levels. Below 0.5 V (0.8 V typical), the Schmitt-trigger buffer output is low. Above 2.1 V (1.6 V typical), the buffer output is high. The 27 KΩ pull-up resistor allows the digital inputs to sense switches or relays connected directly to the DBK7 as shown in the figure. The debounce circuit can remove noise effects of switching.

The input impedance for digital signals depends on the signal level. For signals between 0 and 5 V, the input-protection diodes do not conduct, and the digital input impedance is just the 27 KΩ pull-up resistance. For signals less than 0 V or greater than 5 V, the input-protection diodes conduct and the impedance drops to about 2.4 KΩ. The figure shows the approximate digital-input current/voltage relationship.

| V (volts) | I (mA) |
|-----------|--------|
| -15       | -6.3   |
| 0         | -0.2   |
| 5         | 0      |
| 15        | 4.1    |
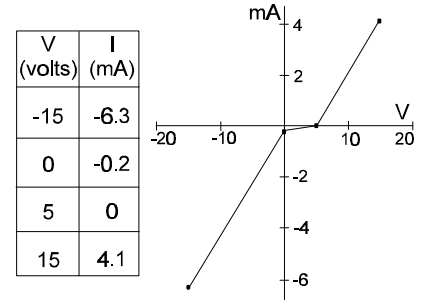


*DBK7 Digital I/V Relationship*

### Edge Selection

The DBK7 determines the frequency by measuring the time between successive rising or falling edges of the input signal. Which edge is electrically cleaner depends on the application and related components. If rising edges are used, the edge selection circuit does not modify the signal. If falling edges are used, the circuit inverts the signal so falling edges appear as rising edges to the subsequent circuits. Through software, each channel can be independently set for rising- or falling-edge.

### Debouncing

Debouncing is a process of ignoring signals too short to be real events. When a relay or switch closes, the electrical contacts may not initially make good contact. Mechanical vibrations can occur, and contact is made and broken several times stabilizing. Counting all these signals would yield too high a frequency. The debounce circuit solves this problem by ignoring rising edges not preceded by a sustained low signal. The sustain interval can be set in software to 0, 0.6, 2.5, or 10 ms for each channel. Debouncing may be disabled (0 ms) for clean, high-frequency signals. Long debounce times will limit high-frequency response (e.g., a 10 ms debounce will limit the frequency to about 100 Hz).

The figure shows the effect of 10 ms debouncing on a noisy signal. To be counted, a rising edge must be preceded by a low sustained for at least 10 ms without any other edges. Rising edges **a** and **f** are counted because they are preceded by low signal levels sustained for at least 10 ms (the debounce time). All other rising edges (**b**, **c**, **d**, and **e**) are ignored. Any falling edge makes (or keeps) the debounced output low, regardless of preceding edges. Thus, the DBK7 can detect short pulses even with debouncing.
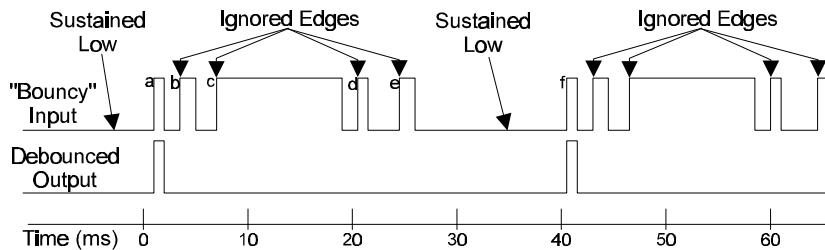


*DBK7 Debouncing Effects*

### Frequency Measurement

After debouncing, the signal's frequency is ready to be measured. Frequencies are measured to 12-bit accuracy between a minimum frequency ($F_{min}$) and maximum frequency ($F_{max}$). This frequency range can be programmed individually for each channel. The limitations on $F_{min}$ and $F_{max}$ are:

- The frequency range must be within 0 to 1 MHz.
- $F_{max} - F_{min}$ must be at least 1 Hz.
- $F_{max} / F_{min}$ must be at least 100/99 (1.010101).

Based on $F_{min}$ and $F_{max}$, the DBK7 measures the frequency by counting input cycles during a variable time interval. The length of the interval depends on the difference between $F_{min}$ and $F_{max}$.

- For a wide range (when $F_{min}$ and $F_{max}$ are far apart), each bit of the 12-bit result represents a large frequency change and can be measured quickly.
- For a narrow range (when $F_{min}$ and $F_{max}$ are close together), each bit of the 12-bit result represents a small frequency change and takes longer to measure.

The following equation determines the time interval needed to measure a frequency:

$$\text{Minimum Measurement Period (sec)} = (4096 \times 0.5 \text{ μs}) [F_{max}/(F_{max} - F_{min})]$$

In this equation: 4096 derives from 12-bit precision; 0.5 μs is the resolution of the DBK7's timing circuits; and $F_{max} / (F_{max} - F_{min})$ is the ratio the measurement time must be increased to achieve 12-bit accuracy over the selected range.

To see how the measurement period varies, consider two examples:

- To measure frequencies from 59 to 61 Hz, the measurement period is at least 4096 x 0.5 μs x 61/2 = 62.5 ms, or about 16 measurements per second.
- To measure frequencies from 1 to 61 Hz, the measurement period is at least 4096 x 0.5 μs x 61/60 = 2.1 ms. Note that as the DBK7 only measures frequency once per cycle, it would take from 1 to 61 measurements per second.

Thus, measuring frequencies over a narrow range takes longer than over a wide range as the ratio of $F_{max}/(F_{max} - F_{min})$. The actual measurement time is the sum of several items: the minimum measurement period (from the equation above), the actual input period, and a variable processing time of 0 to 4 ms. **Note**: If the Sequence Rep Rate (on DaqView's main screen) is set faster than the measurement rate, multiple readings of the same measurement will occur.

After the frequency (F) is measured to the required accuracy, it is scaled to a 12-bit number (D) for use by the Digital to Analog Converter (DAC). This 12-bit number is determined by the formula:

$$D = 4096 [(F - F_{min}) / (F_{max} - F_{min})]; \text{ where } 0 \leq DAC < 4096$$

If the measured frequency is $F_{min}$, then the scaled result is 0. If the measured frequency is $F_{max}$, then the scaled result would be 4096 but is limited to 4095. Measured frequencies below $F_{min}$ are scaled as 0; frequencies above $F_{max}$ are scaled as 4095. The highest frequency that produces an accurate result is the one that converts to a DAC value of 4095; that is, $F_{min} + 4095/4096 (F_{max} - F_{min})$ which is the same as $F_{max} - 1/4096 (F_{max} - F_{min})$.

### D/A Conversion

The 12-bit scaled result is stored in the DAC to be read by the data acquisition system. Instead of having 4 DACs with their associated circuits, the DBK7 shares a single DAC among the four channels. (The Daq* reads one channel at a time.) Using the DAC this way makes the DBK7 more reliable, cost-efficient, and easier to calibrate. Each time the Daq* addresses a different DBK7 channel, the DAC supplies the corresponding voltage ($V_{out}$) according to the formula:

$$V_{out} = 10.0 (D/4096) - 5.0 \text{ V}$$

Since DAC values (D) range from 0 to 4095, DBK7 output voltages range from -5.0000 to +4.9976 V.

Calibration for the DBK7 is automatic. When the DBK7 is initialized through software, its gain and offset errors are measured. The output circuits are then adjusted so the Daq* measurements correspond to the DAC setting. The DBK7's software-adjustable gain and offset can correct for small errors in the DBK7 or the Daq*. This automatic calibration eliminates the periodic need for manual calibration.

# Programming a DBK7

**Note**: Users of DaqView or other turnkey packages can skip this section.

To support the DBK7, the following features were added to the Daq* API (Application Programming Interface):

- A method to specify the channel setup for the DBK7 cards in the system. The configuration parameters are: base-channel, sub-address (card number), input channel, rising/falling edge selection, debounce time constant, minimum frequency and maximum frequency.
- A method to convert ADC data into frequencies. (Refer to the model section *Linear Conversions* in the separate *Programmer s Manual*.)

## *Card Configuration Functions*

The **daqAdcSetBank** function [standard API] must be called using the **bankDBK7** definition to configure the Daq* software for a DBK7 card. When daqAdcSetBank is called using the bankDBK7 definition, the specified bank will be auto-calibrated. This calibration includes all channels on the DBK7. If the bank was configured to something other than BankDBK7, daqAdcSetBank must first be called with the **bankNotDefined** parameter to disable the existing bank configuration before reconfiguring it to a bankDBK7. The acquisition parameters (e.g., scan group and trigger source) will change. **Note**: "Bank" refers to the 16 sub-channels within 1 Daq* base channel.

The **daqDbkSetChanOption** function takes the configuration information and configures the specified DBK7 channel. After one or more calls to daqDbkSetChanOption are made, daqAdcSetScan, daqAdcSetMux, or daq200SetScan should be called. daqAdcSetBank (described above) should be called before daqDbkSetChanOption.

The **daqAdcSetScan** or equivalent function are used to send the current DBK7 option settings to the actual hardware. A new gain definition, Dbk7X1, has been added to the API. This is the correct gain definition to use for the DBK7.

### daqDbkSetChanOption

```
int daqDbkSetChanOption(
unsigned int chan,
unsigned int option Type //enum DcotSlope=0
                                    DcotDebounceTime = 1
                                    DcotMinFreq = 2
                                    DcotMaxFreq = 3
double optionValue)       //if optionType = DcotSlope
                                    true/non-zero = rising edge
                                    false/zero = falling edge
                          if optionType = DcotDebounceTime
                                    DcovDebounceNone = 0
                                    DcovDebounce600us = 1
                                    DcovDebounce2500us = 2
                                    DcovDebounce10ms = 3
                          if optionType = DcotMinFreq or DcotMaxFreq,
                                    minimum or maximum frequency value
```

chan

> The channel number whose slope, debounce time, or frequency option type and value is provided in the corresponding parameters of the function. The bank address, sub-address, and board channel values are derived from the channel information (16 to 271).

optionType

> A constant that specifies which option is to be set by the optionValue parameter. For the DBK7, optionType can be one of DcotSlope, DcotDebounceTime, DcotMinFreq or DcotMaxFreq.

optionValue

A constant containing the value of the specified option.

- For the DcotSlope option, optionValue specifies either a rising or falling edge (Non-zero = rising edge; zero = falling edge).
- For the DcotDebounceTime option, optionValue specifies no debounce time or a debounce time of 0.6 ms, 2.5 ms or 10 ms (DcovDebounceNone, DcovDebounce600us, DcovDebounce2500us, DcovDebounce10ms).
- For the DcotMinFreq option, optionValue specifies the minimum frequency (from 0 to 990000 Hz). Must be 1% and at least 1 Hz less than MaxFreq.
- For the DcotMaxFreq option, optionValue specifies the maximum frequency (from 1 to 1000000 Hz).

### *Sample Program Excerpt*

The following program excerpt (standard API) is discussed in greater detail in the *Programmer s Manual*.

```
// Set channel 16 to be a DBK7.  This step will configure and auto
// calibrate all channels on the 4-channel DBK7 card including channels
// 16, 17, 18 and 19 (if used).
daqAdcSetBank(16, bankDBK7);

// Set channel option common to all channels
for (chan = 16; chan <= 19; chan++)
    {
    daqDbkSetChanOption(chan, DcotSlope, 1);
    daqDbkSetChanOption(chan, DcotDebounceTime, DcovDebounceNone);
    daqDbkSetChanOption(chan, DcotMinFreq, 50.0);
    daqDbkSetChanOption(chan, DcotMaxFreq, 60.0);
    }
```

## Specifications - DBK7

**Name/Function: 4-Channel Frequency-to-Voltage Input Card**
**Input Channels per Card**: 4
**Maximum Cards per System**: 64
**Maximum Channels per System**: 256
**Input Connector**: 1 BNC connector per channel
**Daq\* Connector**: DB37 male, mates with P1
**Frequency Ranges**: (programmable) 0 Hz to 960 kHz
**Output Voltage Range**: -5 V to +5 V
**Debounce Delays**: (software selectable) 0, 0.6, 2.5, 10 ms
**Measurement Rate**: up to 500 per second per channel, 1000 per second total
**Accuracy**: 0.1%
**Analog Input**
 **Low-level**:
 50 mV typical (100 mV max) p-p sine wave @ 10 Hz to 100 kHz
 Any edge of 50 (100 max) mV amplitude and 5 V/s rate.
 Input impedance: AC-coupled (0.33 µF), in series w/ 20 KΩ to ground.
 15 mV hysteresis.

**High-level**:
 0.75 V typical (1.25 V max) p-p sine wave @ 10 Hz to 100 kHz
 Any edge of 0.75 V (1.25 V max) amplitude and 50 V/s rate.
 Input impedance: AC-coupled (0.33 µF), in series w/ 20 KΩ to ground.
 250 mV hysteresis.
 **Maximum Input Voltage**: 30 Vrms (84 Vp-p)
 **Low Pass Filters**: (hardware selectable) 30 Hz, 300 Hz, 100 kHz
**Digital Input**
 **TTL-Level**: 0.001 to 960 kHz.
 **Input Impedance**: 27 KΩ pull-up to +5 V || 50 pF
 **V Low ( 0 )**: 0.8 V typ, 0.5 V min
 **V High ( 1 )**: 1.6 V typ, 2.1 V max
 **Hysteresis**: 400 mV min
 **Pulse Width (high or low)**: 520 nsec min.
 **Maximum Input Voltage**: -15 V to +15 V.

# DBK8  Eight-Channel High-Voltage Input Card

## Overview

The DBK8 reads voltages up to ±100 V from DC to 10 kHz.  The inputs are balanced differential and referenced to the Daq* analog common.  No external biasing resistors are used.  The input impedance of each DBK8 channel is 10 MΩ to minimize loading of the circuit being measured.  Two DBK8s can share the same Daq* base channel to allow a maximum of 32 DBK8s and 256 high-voltage inputs.

Each DBK8 channel has 3 user-set voltage ranges: 10, 50, and 100 V.  The ranges are selected by the placement of shunt jumpers on pin headers for each channel.  While the channel-to-channel resistance is 10 MΩ, there is no other inherent isolation between the channels.  The common of the host computer has a direct connection to the Daq* analog common.  Either side of any input channel is 5 MΩ from analog common.

The DBK8 has 3 attenuation factors.
- The ±100 V range attenuates the input by a factor of 20.
- The ±50 V range attenuates the input by a factor of 10.
- The ±10 V range attenuates the input by a factor of 2.

**Note**: the signal coming from the DBK8 into the Daq* does not exceed ±5 V.
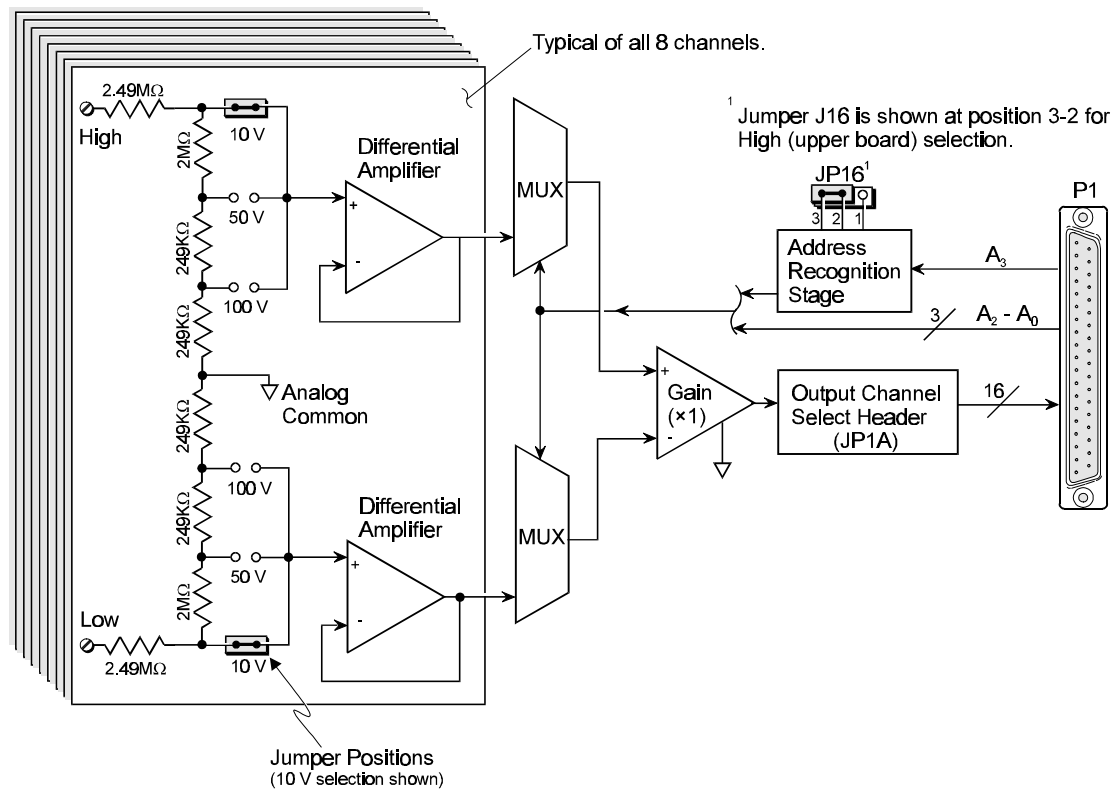


*DBK8 Block Diagram*

# Hardware Setup

### Card Configuration

Inputs from 1 or 2 DBK8s are multiplexed into 1 of the Daq* base channels. Channel selection is made on 2×16-pin header JP1A by placing the shunt jumper on the pair of pins next to the chosen base channel.

The Daq* addressing scheme allows for 16 inputs on each analog channel. The DBK8 is an 8-input card; and 2 DBK's can use the same channel if one is configure for low channels and the other for high channels. Placing the shunt jumper on JP16 in the 2-1 position sets the card address for the lower 8 channels (0-7) in an address group. Placing the shunt jumper on JP16 in the 2-3 position sets the card address for the upper 8 channels (8-15).

Each of the 8 input channels has 3 voltage ranges that are manually selected by the placement of a pair of shunt jumpers on a channel range select header. It is important that both jumpers are placed on the same range value or incorrect voltage readings will be received by the system.



*DBK8 Configuration Settings*
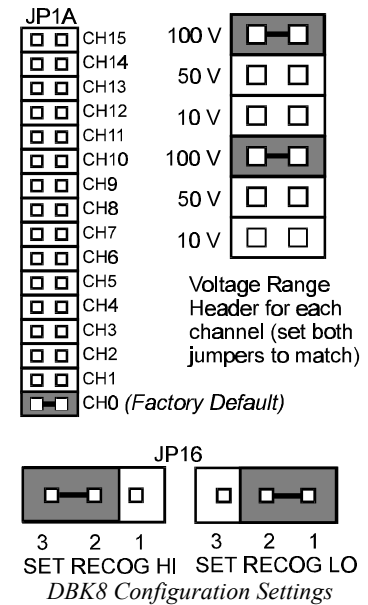
### Card Connection

The DBK8 is equipped with screw terminal connectors for easy access to all of the analog inputs. Connections are provided as 8 pairs of input terminals. There is a high and a low terminal in each channel pair to maintain consistent polarity signs with voltage readings. For AC signals, the polarity is arbitrary unless multiple signals are being connected with an interest in channel-to-channel phase relationships. Once all connections are in place, captive areas are provided at the end of the DBK8 for securing the wires to the board. Nylon tie wraps (not included) work well for this purpose. **Note**: the DBK8 has a footprint on the card to install a DB37 connector to accommodate input signals. The pinouts are the same as P1 for the 16 main channels, but the other pins are not wired. Pins 30 to 37 correspond to channels 7 to 0; pins 11 to 18 correspond to channels 15 to 8 (or low 7 to 0 in differential mode)—see chapter 2, 3, or 4 for P1 pinout locations. **Note: to meet CE safety specifications, an edge guard (kit p/n 232-0806) must be attached to the DBK8 card before insertion into a DBK41 expansion chassis. This guard helps prevent accidental access to high-voltage circuits.**

### DaqBook/DaqBoard Configuration

Use of the DBK8 expansion card with a DaqBook/DaqBoard requires 3 jumper settings.

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 DBK42 via the internal +15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. *Place the JP3 jumper in bipolar Mode.
3. *Place the JP4 jumper in Single-Ended mode.

**\*Note**: Only applies to the DaqBook/100, /112, and /120. All other Daq*s are set via software.



*DaqBook/DaqBoard Jumpers for the DBK8*
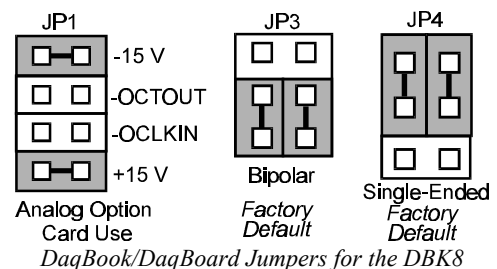
### Daq* Connection

Several options exist for placement of the DBK8 card in a system. Because the inputs can be high-voltage, the card should be physically secure and out of harm's way. The DBK8 will install readily in the 3-position DBK10 chassis, the 10-position DBK41 card cage, a CDK10, the card slot in either the DaqBook/112 or /216, or in a section of a snap-in mounting track mounted to a secure surface or used as an insulated holder for a loose DBK8.

## Software Setup in DaqView

This section shows you how to set up DaqView for the DBK8 and your application.  Refer to chapter 6, *DaqView*, for further details and screen captures.

From DaqView's main screen (v5):
1. Pull down the Device menu, and select Configure Hardware Settings.  The Configure System Hardware screen appears and shows the channel assignments.
2. Under Analog Input Option Cards External Connection, select the expand button for the chosen Daq* channel.  (The chosen channel must match the DBK8 hardware setting of JP1A.)  A drop-down menu lists the available option cards.
3. Select the DBK8 Voltage Input Card.  A smaller, setup window will appear.
4. Choose RecogLo or RecogHi (or both if using 2 DBK8s on the selected base channel) by clicking the proper checkbox(es).  The software selection of low or high channels must match the DBK8 hardware selection on JP16.
5. When all the channels and sub-addresses are set correctly, select OK to return to the Configure System Hardware screen, and set other channels as needed.
6. When done, select OK to return to the DaqView main screen.  The main window now has 8 channels for each DBK8 selected.  The channels are identified by three numbers: main channel, card (lower-0 or upper-1), and input channel number.  Set other spreadsheet columns as desired.

## Programming a DBK8

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following example shows how to get a sample from the DBK8 expansion card.  An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command.  This command will use the expansion card # and channel to calculate the channel # used by the daqAdcRd command.

```
expCard = 2;      /*DBK8 JP1A position*/
expAddr = 1;      /*DBK8 JP16 position*/
                  /* 0 forJP16 on 1&2 */
                  /* 1 forJP16 on 2&3 */
expConn = 0;      /*DBK8 channel number*/
expChan= expAddr*8 + expConn;  /*DBK8 connection*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, DgainX1);
```

For more information on specific software commands, refer to the *Programmer s Manual*.

## DBK8 - Specifications

**Name/Function: 8-Channel High-Voltage Input Card**
**Connectors**: DB37 male, mates with Daq* P1 pinouts; screw terminals and DB37 footprint for signal inputs.
**Voltage Input Ranges**: ±10 VDC, ±50 VDC, ±100 VDC; selection by jumper for each channel.
**Input Impedance**: 10 MΩ
**Attenuation**:
    @ 10 V, Vout=Vin/2
    @ 50 V, Vout=Vin/10
    @ 100 V, Vout=Vin/50
**Output Voltage Range**: ±5 VDC (into Daq*)
**Bandwidth**: 15 kHz
**Attenuation Accuracy**:  0.5%
**Offset Voltage**: Typical: 0.5 mV;  Maximum: 2.0 mV
**Offset Drift** : Typical: 4 µV/ºC;  Maximum: 10 µV/ºC

# DBK9  Eight-Channel RTD Card

## Overview

The Daq* measures temperatures sensed by RTDs that are attached to the Daq* through the DBK9 RTD expansion card.  Up to eight RTDs can attach to each DBK9 and up to 8 DBK9s can attach to the Daq* for measuring a maximum of 256 temperatures.  The DBK9 card supports 3- or 4-wire RTDs and operates by reading 3 voltages and using them in the following equation:

$$RTD = [Va - Vd - 2(Va - Vb) Rsense] / Vd \qquad \text{(Result in Ohms)}$$

Where: Rsense = 100 Ω (a constant derived from the actual hardware)

The result of this equation is converted into a temperature via software (using a complex formula and lookup tables).  The DBK9 features an on-board Programmable Gain Amplifier for measuring 100 Ω, 500 Ω, or 1000 Ω type RTDs.  For each RTD, the DBK9 can measure temperatures in a range of -200 to +850°C.



*DBK9 Block Diagram*
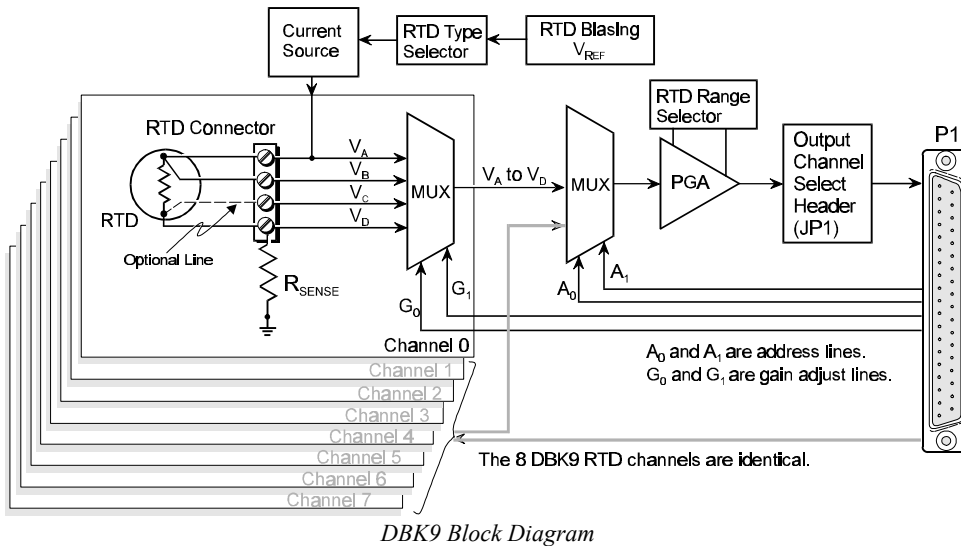
## Hardware Setup

### Card Connection

The DBK9 is equipped with screw terminals for the connection of 3-wire or 4-wire RTDs as shown in the figure.



*RTD Connections*
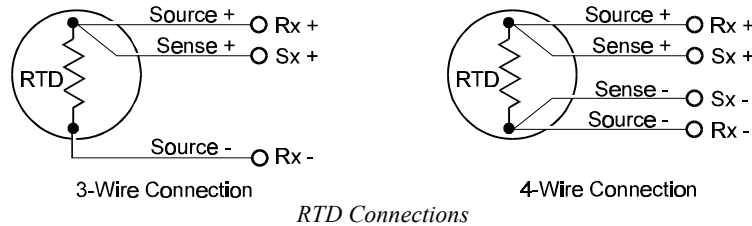
### Card Configuration

Two aspects of card configuration are the channel address and the RTD type.

#### Channel Address Jumpers

One or two DBK9s may be connected to each Daq* channel ($2\times8$ signals $\times$ 16 channels for a maximum of 256 inputs). Since this is a daisy-chain type of interface, each card must appear unique to the Daq*. This is accomplished by setting the Channel Select jumper (JP1) and the Channel Group Select jumper (JP4) of each DBK9. JP4 selects either Upper (8-15) or Lower (0-7) channels. No two cards in a Daq* system should be set with the same channel settings.



*DBK9 Configuration*
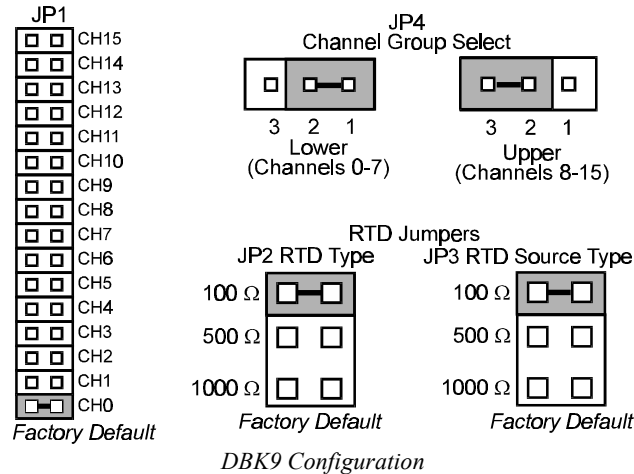
#### RTD Type Selection Jumpers

The DBK9 was designed to measure 100 Ohm, 500 Ohm, and 1000 Ohm RTDs (all 8 RTDs must be the same type for each DBK9). The different RTD types can be selected by changing the RTD Type jumper (JP2) and the RTD Voltage Source jumper (JP3). The default settings are shown in the figure. **Note**: JP2 and JP3 must use the same setting.

### DBK9 Calibration

The DBK9 is default-calibrated for a 100 $\Omega$ RTD. To use the DBK9 with a 500 $\Omega$ or a 1000 $\Omega$ RTD, the user must calibrate the card as follows:

1. Purchase the resistors above for the given RTD type. **Note**: These resistors are theoretical values that correspond to 795°C.
2. Measure the resistor with a reliable meter, and record the exact value.
3. Refer to the charts, and match up the proper temperature with the measured Resistance.
4. Connect the resistor to Channel 0 on the DBK9 (Select the proper JP2 & JP3 settings for the RTD type that is being calibrated).
5. Run DaqCal from the Windows support for DBK9.
6. Adjust RP1 for the temperature that was found in the charts.
7. After the temperature is matched, the DBK9 is calibrated.
8. Repeat this procedure to use a different RTD type.

| RTD Type | Required Resistor |
|----------|-------------------|
| 100 $\Omega$ | 374 $\Omega$, 1.0% |
| 500 $\Omega$ | 1870 $\Omega$, 1.0% |
| 1000 $\Omega$ | 3740, 1.0% |



*DBK9 Calibration Setup*
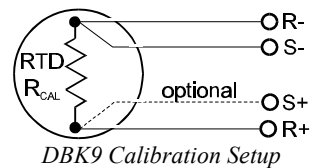
### *DaqBook/DaqBoard Configuration*

Use of the DBK9 expansion card with a DaqBook/DaqBoard requires 3 jumper settings.

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 DBK9 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2.  *Place the JP3 jumper in bipolar Mode.
3.  *Place the JP4 jumper in Single-Ended mode.

**Note**: Only applies to the DaqBook/100, /112, and /120.  All other Daq*s are set via software.



*DaqBook/DaqBoard Jumpers for the DBK9*
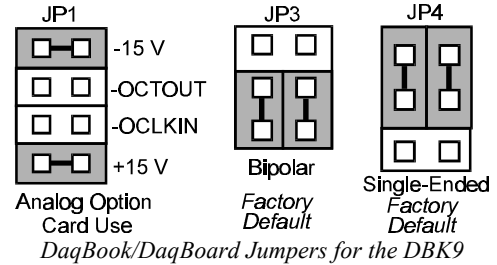
## Software Setup in DaqView

This section shows you how to set up DaqView for the DBK9 and your application.  Refer to chapter 6, *DaqView*, for further details and screen captures.

From DaqView's main screen (v5):

1.  Pull down the Device menu, and select Configure Hardware Settings.  The Configure System Hardware screen appears and shows the channel assignments.
2.  Under Analog Input Option Cards External Connection, select the expand button for the chosen Daq* channel.  (The chosen channel must match the DBK9 hardware setting of JP1.)  A drop-down menu lists the available option cards.
3.  Select the DBK9 RTD Card.  A smaller, setup window will appear.
4.  Choose Lower or Upper (or both if using 2 DBK9s on the selected base channel) by clicking the proper checkbox(es).  The software selection of low or high channels must match the DBK9 hardware selection on JP4.
5.  When all the channels and sub-addresses are set correctly, select OK to return to the Configure System Hardware screen, and set other channels as needed.
6.  When done, select OK to return to the DaqView main screen.  A pop-up box suggests using scan count averaging of at least 10—this value can be set from the main window; when the averaging checkbox is selected the default value of 100 appears.  The main window now has 8 channels for each DBK8 selected.  The channels are identified by three numbers: main channel, card (lower-0 or upper-1), and input channel number.
7.  Set other spreadsheet columns as desired.  The Units column allows you to see results in mx+b or temperature formats (°C, °F, K, or °R).  The Type column allows you to set the RTD resistance type to 100, 500, or 1000 ohms.

## Programming a DBK9

**Note**: Users of DaqView or other turnkey packages can skip this section.

When developing a custom program, driver functions must be used to convert the DBK9's raw data into temperatures. The driver software currently supports 100-, 500-, and 1000-ohm RTDs.

Four readings must be taken for each RTD channel; then, they are mathematically reduced to provide one temperature value. These 4 readings must be grouped together in the scan and must be in this order: Dbk9VoltageA (gain=0), Dbk9VoltageB (gain=1), Dbk9VoltageD (gain=3), Dbk9VoltageD (gain=3).  The RTDs must be of the same type, and the reading groups must follow each other in the scan sequence.

The temperature conversion functions input one or more data scans from a Daq*.  They take 4 voltage readings for each RTD channel; apply the specified averaging method; convert the voltages to a resistance; and then, using the appropriate curves for the RTD type, convert the resistance into a temperature.  For example, consider these readings:

| | Readings Channel 0 | | | | Readings Channel 1 | | | |
|---|---|---|---|---|---|---|---|---|
| Scan | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Ch 0 Va | Ch 0 Vb | Ch 0 Vd | Ch 0 Vd | Ch 1 Va | Ch 1 Vb | Ch 1 Vd | Ch 1 Vd |
| 2 | Ch 0 Va | Ch 0 Vb | Ch 0 Vd | Ch 0 Vd | Ch 1 Va | Ch 1 Vb | Ch 1 Vd | Ch 1 Vd |
| 3 | Ch 0 Va | Ch 0 Vb | Ch 0 Vd | Ch 0 Vd | Ch 1 Va | Ch 1 Vb | Ch 1 Vd | Ch 1 Vd |
| 4 | Ch 0 Va | Ch 0 Vb | Ch 0 Vd | Ch 0 Vd | Ch 1 Va | Ch 1 Vb | Ch 1 Vd | Ch 1 Vd |
| 5 | Ch 0 Va | Ch 0 Vb | Ch 0 Vd | Ch 0 Vd | Ch 1 Va | Ch 1 Vb | Ch 1 Vd | Ch 1 Vd |

If this scan data is passed to daqRTDConvert (through the counts parameter) with averaging disabled (avg parameter set to 1), the function will return the parameters in the table.  **Note**: Temperatures will be returned in tenths of a degree Celsius.

| | Temperatures | |
|---|---|---|
| Scan | 0 | 1 |
| 1 | Ch 0 °C | Ch 1 °C |
| 2 | Ch 0 °C | Ch 1 °C |
| 3 | Ch 0 °C | Ch 1 °C |
| 4 | Ch 0 °C | Ch 1 °C |
| 5 | Ch 0 °C | Ch 1 °C |

Or, if the scan data is passed to daqRTDConvert (in the "buf" parameter) with averaging set to block averaging (avg parameter set to 0), the function will return the parameters in the table.

| | Temperatures | |
|---|---|---|
| | 0 | 1 |
| Average of all Temperatures | Ch 0 °C | Ch 1 °C |

The conversion process is divided into two steps: setup and conversion.  The setup step describes the characteristics of the temperature measurement, and the conversion step actually converts the data from raw readings to temperatures.

The setup function is daqRTDSetup.  The C-language version is similar to other programming languages and is defined as follows:

daqRTDSetup
uint nReadings    The total number of readings in a scan (valid range 1-512)
uint startPosition  Position of the first RTD reading group in the scan (valid range 1- 509)
uint nRtd         Number of RTD reading groups in the scan (valid range 1- 128)
uint rtdValue     Value of RTD being used.
                  Dbk9RtdType100- 100 Ω RTD
                  Dbk9RtdType500- 500 Ω RTD
                  Dbk9RtdType1K- 1000 Ω RTD
uint avg          Type of averaging to be used.
                  0 = block averaging
                  1 = no averaging
                  2 to (number of scans -1) = moving average

The conversion function is daqRTDConvert:
daqRTDConvert
uint *counts      Raw A/D data readings from one or more scans.
uint scans        Number of scans of raw data in contained in *counts.
int *temp         Array to hold converted temperatures.
uint nTemp        Size of temperature array.  Should be the number of RTDs times the number of scans for no averaging and moving averages or the number of RTDs for block averaging.

For convenience both setup and conversion can be performed at once by daqRTDSetupConvert:
daqRTDSetupConvert
uint nReadings    The total number of readings in a scan (valid range 1-512)
uint startPosition  Position of the first RTD reading group in the scan (valid range 1- 509)
uint nRtd         Number of RTD reading groups in the scan (valid range 1- 128)
uint rtdValue     Value of RTD being used.
                  Dbk9RtdType100- 100 ohm RTD
                  Dbk9RtdType500- 500 ohm RTD
                  Dbk9RtdType1K- 1000 ohm RTD

| uint avg | Type of averaging to be used. |
| | 0 = block averaging |
| | 1 = no averaging |
| | 2 to (number of scans -1 ) = moving average |
| uint *counts | Raw A/D data readings from one or more scans. |
| uint scans | Number of scans of raw data in contained in *counts. |
| int *temp | Array to hold converted temperatures. |
| uint nTemp | Size of temperature array. Should be the number of RTDs times the number of scans for no averaging and moving averages or the number of RTDs for block averaging. |

**Note**: Refer to the separate *Programmer s Manual* for a specific programming example.

# DBK9 - Specifications

Name/Function: 8-Channel RTD Measurement Card
Connector: DB37 male, mates with Daq* P1 pinout; screw terminals for signal connections
Configurations: 3-wire or 4-wire
Alpha: 0.00385
Inputs: 8 channels
Temperature Ranges: 100, 500, or 1000 Ω: -200 to +850°C
RTD Excitation Current:

| 100 Ω | 500 µA |
| 500 Ω | 227 µA |
| 1000 Ω | 160 µA |

Accuracy: ±0.5°C
Resolution: 0.3°C
Range and RTD Type Adjustments: Jumpers on circuit board

# DBK10  3-Slot Expansion Chassis

## Overview

The DBK10 is a metal enclosure that holds up to 3 expansion cards.  Cards can slide into their slots without removing the signal connections.  Two DBK10s are ideal for applications that require 6 or fewer DBK cards.  Multiple enclosures can be stacked to accommodate many cards.  For applications that require more than 6 cards, the DBK41 is recommended.  When using a Daq PC-Card, use the CDK10 first and thereafter the DBK10 or DBK41.  **Note**: cards can be used alone without an enclosure if they are secured and protected as needed.

## Hardware Setup

The DBK10 has 3 card slots for easy access to the analog expansion cards.  Set up hardware as follows:

1. Complete all DBK card configuration to fit your application and channel assignments.
2. Attach signal input wires (with strain relief as needed) or BNC connectors before inserting card into DBK10 slot.
3. Secure card in slot by tightening screw and washer to hold card securely in place.
4. Attach the card's DB37 connector to the Daq* P1 connector with the appropriate cable (CA-37-x or CA-131-x) to daisy-chain all cards installed in the DBK10(s).



*Installing a DBK Card in a DBK10*
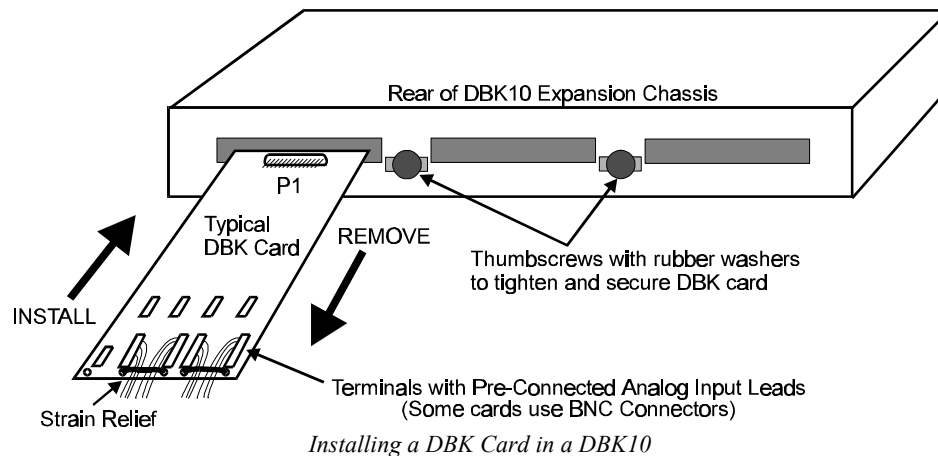
## DBK10 - Specifications

**Name/Function**: 3-Slot Expansion Chassis
**Size:** 11" long x 8½" wide x 1 3/8" high
**Weight:** 3 lb (empty); add 8 to 12 oz for each card
**Capacity:** Accommodates any 3 expansion cards
**Material:** Aluminum
**Finish:** Black, powder-coated

# DBK11A Screw-Terminal Option Card

## Overview

The DBK11A provides access to all pins on a Daq* DB37 connector and includes sockets for optional passive-filtering components. DB37 pins connect to screw terminals while passing through an optional prototype area on the PC board. This area can accommodate resistors, capacitors, and custom wiring. The user can choose appropriate values to fit the application. **Note**: the DBK11A is compatible with P1, P2, P3, DigiBook/72, and any DB37 connector. The DBK11A card has footprints for 4 BNC connectors; and the DBK11A includes 4 BNCs that the user can solder onto the card.



*DBK11A Block Diagram*

## Hardware Setup



*DBK11A Board Layout*
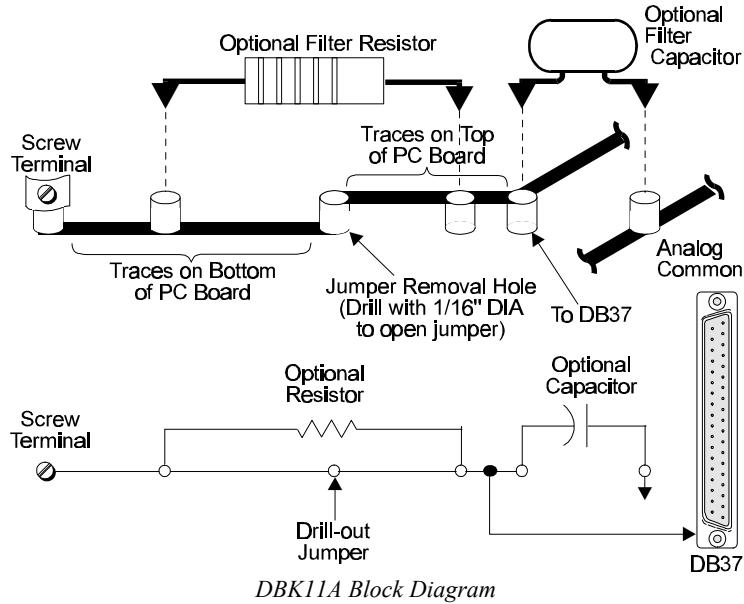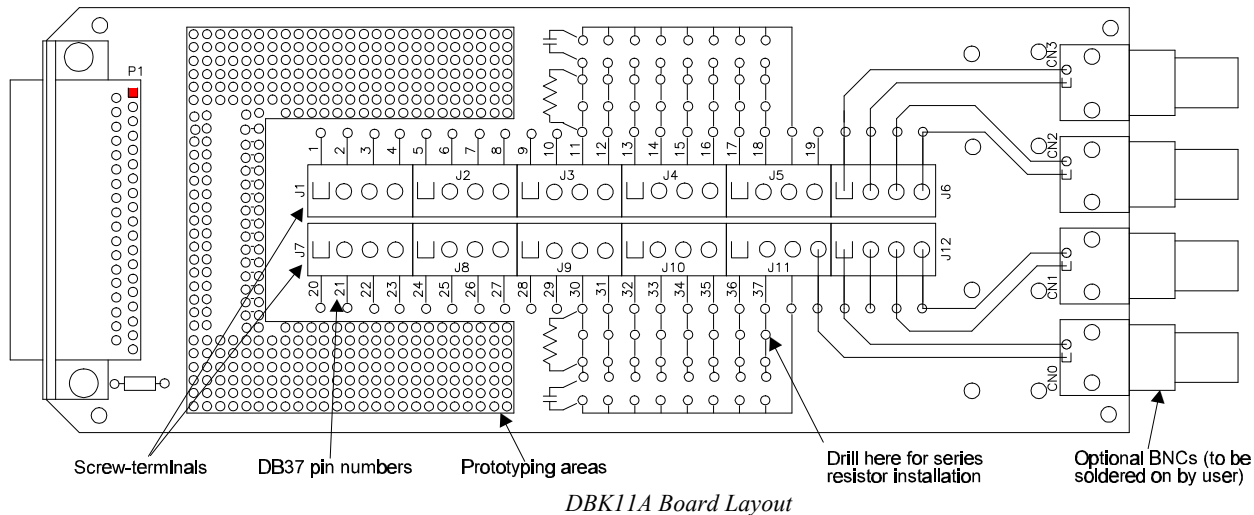
### *Card Connection*

The DBK11A has screw-terminal connectors for easy access to analog inputs and outputs. The terminal blocks have numbers which relate to pin numbers on the DB37 connector. There are also areas on the board with standard 0.1" hole spacing for the user to install additional circuitry. The optional BNCs are connected to screw terminals on J6 and J12. These screw terminals can be jumpered to the screw terminals for specific P1 pin numbers as needed.

1. Make the appropriate connections to terminal blocks as required for your application. **Note**: wire size for the screw terminals should be in the range 14 to 26 ga.
2. Once all connections are in place, secure all wires to the board at the captive areas at the end of the DBK11A board. Nylon tie wraps (not included) work well for this purpose.

### *Card Configuration*

There are 2 rows of screw terminals for direct connection to DB37 pins. For additional circuitry such as RC networks, there are 9 spare terminals, several hundred unconnected solder pads and signal paths to the analog input terminals (pins 11-18 and 30-37). The default circuit path is just a straight connection with no options. Before adding components, you must drill out the jumper removal hole (ℜ 1/16", see figure). On the 16 pins corresponding to the analog input channels, there are locations for optional RC filters.

### *DaqBook/DaqBoard Configuration*

Due to the DBK11A's simplicity and flexibility, no configurations are required other than those that may depend on the nature of the signal source.

## Software Setup in DaqView

To use a DBK11A, you must first configure DaqView for Direct Signal Connect on the appropriate channel. From the DaqView main window, select the Device menu and then Configure Hardware Settings. On the left side of this window, the Analog Input Option Cards selection allows you to assign DBK expansion cards to the 16 analog inputs. Select the Direct Signal Connect option for all channels not used by any other expansion card. These channels are then available on the DBK11A from within DaqView. The digital I/O window of DaqView can access a DBK11A connected to P2; and the counter/timer window can access a DBK11A connected to P3.

## Programming a DBK11A

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from analog input channel 5 using a DBK11A connected to P1.

daqAdcRd(5, &sample, DgainX1);

Similar digital I/O and counter/timer commands can be used with a DBK11A expansion card connected to ports P2 and P3. For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK11A - Specifications

**Name/Function: Screw-Terminal Card**
**Connector**: DB37 male, attaches to P1, P2 or P3 connector
**Wire Size Range**: 14 to 26 ga
**BNC Option**: DBK11A includes 4 BNCs for user-soldered connection

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# DBK12 and DBK13 Analog Input Multiplexer Cards

## Overview

Both the DBK12 and DBK13 provide 16 single-ended or 16 differential analog inputs.
- The DBK12 's amplifier offers ×1, 2, 4, or 8 gain (programmable per channel).  These gains can be combined with the standard Daq* gains of 1, 2, 4, or 8 to yield gains of 1, 2, 4, 8, 16, 32, and 64.
- The DBK13's amplifier offers ×1, 10, 100, or 1000 gain (programmable per channel).  These gains can be combined with the standard Daq* gains of 1, 2, 4, or 8 for net gains of 1, 2, 4, 10, 20, 40, 80, 100, 200, 400, 800, 1000, 2000, 4000,  and 8000.

Up to 16 such cards can be attached to one the Daq*'s 16 base channels for a total of 256 single-ended or differential inputs.  The Daq* 512-location scan sequencer can directly program the expansion cards to scan external signals at the same 10 μs/channel rate as on-board channels.

**Note**: The DBK12 and DBK13 use the same printed circuit board and look quite similar.  If the label becomes unreadable, distinguish them as follows: the U6 integrated circuit is a PGA203 in the DBK12 and a PGA202 in the DBK13.
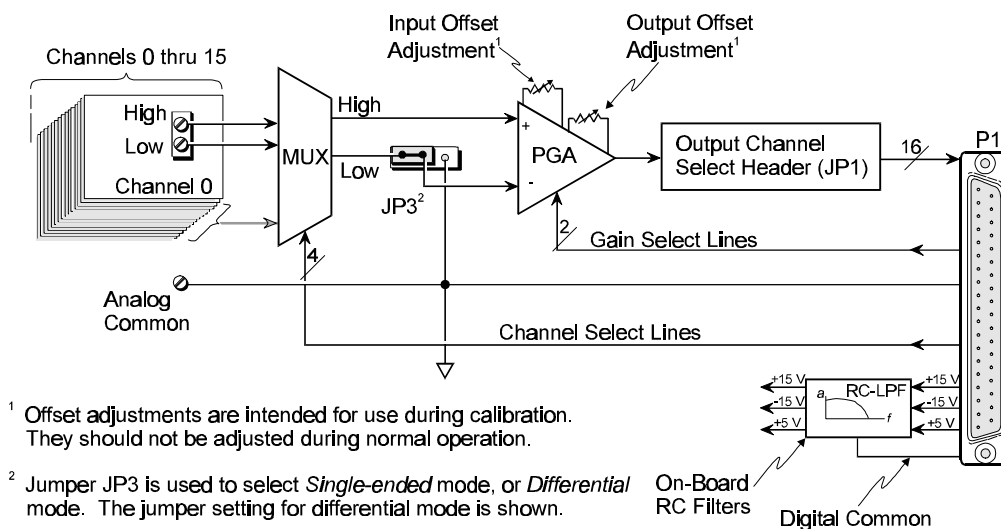


*DBK12/13 Block Diagram*

## Hardware Setup

### Card Connection

The DBK12 and DBK13 are equipped with screw terminal connectors for easy access to all of the analog inputs, as well as several analog ground access points.  Connections are provided for 16 single-ended or 16 differential inputs.  There are also areas on the board to install bias resistors.  These resistor areas connect to the analog input terminals and analog common.  They are labeled by channel number and H and L for high and low analog inputs.

1. For single-ended operation, connect the signal's high end to the high input of the desired channel and the low end to analog common (J5).
2. For differential operation, connect the signal's high end to the high input and the low end to the low input of the desired channel.  When using differential input, ground referencing to analog common is important for accuracy.  If necessary, use bias resistors.  The two differential measurement configurations (floating and referenced) are discussed in the chapter *Signal Management and Troubleshooting Tips*.
3. After all connections are in place, secure wires to the card at the captive areas at the end of the card.  Nylon tie wraps (not included) work well for this purpose.

**Note**: Always have a path to analog common either by direct connection or through bias resistors.

### Card Configuration

The two variables of card configuration are input mode to the card and channel output to the Daq*.

1. Set the signal input mode on jumper JP3 (see figure).
   - For single-ended inputs, find the SE/DIFF Select jumper (JP3) located near the connector and place the jumper in the SE position.
   - For differential inputs, select the DIFF position.
2. To configure the channel, locate the 16×2-pin header near the front of the board labeled JP1. Note the 16 jumper locations on this header labeled CH0 through CH15 to match one of the Daq*'s base channels. Place the jumper on the channel you wish to use. Only one jumper is used on a single card; all cards in a daisy-chain must have unique jumper settings. Up to 16 DBK12s/13s may be connected to your Daq*. (The optional DBK10 enclosure may be used.)



*DBK12/13 Configuration*
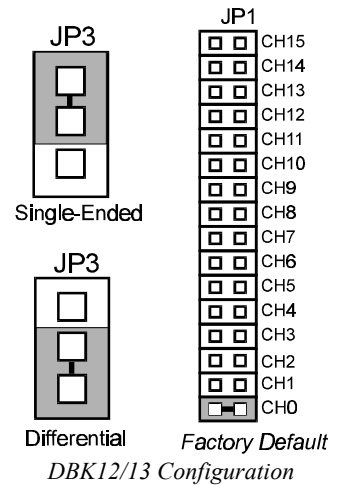
### DaqBook/DaqBoard Configuration

Use of the DBK12/13s require two setup steps in the DaqBook/DaqBoard.

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 DBK12/13 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. *Place the JP3 jumper in either the unipolar or bipolar mode as needed (bipolar shown).
3. *Place the JP4 jumper in the DaqBook/DaqBoard in single-ended mode. **Note**: Analog expansion cards convert all input signals to single-ended voltages referenced to analog common.
   *Applies only for DaqBook/100, /112, and /120.



*DBK12/13 Configuration Settings*
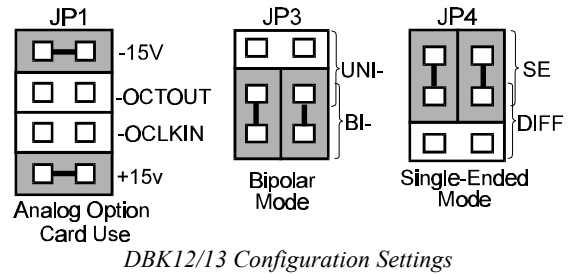
## Software Setup in DaqView

To use the DBK12/13 within DaqView, you must configure several DaqView parameters.

1. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters help interpret the incoming data and provide the controls to access the hardware. As expansion cards are added, make sure Hardware Setup reflects the present configuration. On the left side of this window, the Analog Input Option Cards selection allows the user to assign DBKs to the 16 analog inputs of the base unit. Selecting a DBK will add channels in the main window's analog input spreadsheet.
2. Select the DBK12/13 Multiplexer Card option. The main window now has 16 channels for this one board.
3. Set the parameters for each channel. You can define the channel gains by using the "Type" column of the analog input spreadsheet. Each channel can be configured for unipolar or bipolar mode using the "Pole" column.

---

## Programming a DBK12/13

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the DBK12/13. An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command. This command will use the expansion card # and channel to calculate the channel # used by the daqAdcRd command; e.g., daqAdcRd(soft Chan, &sample, Dbk12/13×1). For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK12 - Specifications

**Name/Function: Analog Multiplexing Card (Low Gain)**
**Output Connector:** DB37 male, mates with P1
**Input Connector:** Screw terminals
**Gain Ranges:** ×1, ×2, ×4, ×8
**Inputs:** 16 differential or single-ended (switch selectable as a group)
**Voltage Range:**
    DaqBook/DaqBoard: 0 to ±5 VDC bipolar; 0 to 10 V unipolar
    DaqPC-Card: 0 to ±10 VDC bipolar
**Input Impedance:** 100 MΩ (in parallel with switched 150 pF)
**Gain Accuracy:** ±0.05% typ, ±0.25% max
**Maximum Input Voltage:** ±35 VDC
**Slew Rate:** 20 V/µs typ, 10 V/µs min
**Settling Time:** 2 µs to 0.01%
**CMRR:** 80 dB min
**Non-Linearity:** 0.002% typ, 0.015% max
**Bias Current:** 150 pA, 0.2 µA max
**Offset Voltage:** ±(0.5 + 5/G) mV typ; ±(2.0 + 24/G) mV max
**Offset Drift:** ±(3 + 50/G) µV/°C typ; ±(2.0 + 24/G) µV/°C max

## DBK13 - Specifications

**Name/Function: Analog Multiplexing Card (High Gain)**
**Output Connector:** DB37 male, mates with P1
**Input Connector:** Screw terminals
**Gain Ranges:** ×1, ×10, ×100, ×1000
**Inputs:** 16 differential or single-ended (switch selectable as a group)
**Voltage Range:**
    DaqBook/DaqBoard: 0 to ±5 VDC bipolar; 0 to 10 V unipolar
    DaqPC-Card: 0 to ±10 VDC bipolar
**Input Impedance:** 100 MΩ (in parallel with switched 150 pF)
**Gain Accuracy:**
    ±0.05% typ @ G < 1000
    ±0.25% max @ G < 1000
    ±0.10% typ @ G = 1000
    ±100% max @ G = 1000
**Maximum Input Voltage:** ±35 VDC
**Slew Rate:** 20V/µs typ, 10V/µs min
**Settling Time:**
    2 µs to 0.01% @ G < 1000
    10 µs to 0.01% @ G = 1000
**CMRR:**
    80 dB @ G=1 min
    86 dB @ G=10 min
    92 dB @ G=100 min
    94 dB @ G=1000 min
**Non-Linearity:**
    0.002% typ @ G < 1000
    0.015% max @ G < 1000
    0.02% typ @ G = 1000
    0.06% max @ G = 1000
**Bias Current:** 150 pA typ; 0.2 µA @ 25ºC max
**Offset Voltage:** ±(0.5 + 5/G) mV @ 25ºC typ; ±(2.0 + 24/G) mV @ 25ºC max
**Offset Drift:** ±(3 + 50/G) µV/ºC typ; ±(12 + 240/G) µV/ºC max

# DBK15 Universal Current/Voltage Input Card

## Overview

The DBK15 features a 16-channel multiplexer and a programmable gain input amplifier. Component sockets accept resistors that configure each channel for current-to-voltage conversion or for voltage attenuation. The differential signal input from the transducer must use 3 leads: high, low, and common.

When configured by appropriate resistors, the DBK15 can measure voltages up to 30 VDC or currents up to 1 A. Each of the 16 input channels has a resistor "A" location and a resistor "B" location. Installing various resistors in these locations yields channel-to-channel flexibility. The DBK15's input amplifier is software programmable for ×1 or ×2 gain per channel, providing unipolar 0 to +10 V or bipolar -5 to +5 V ranges per channel.
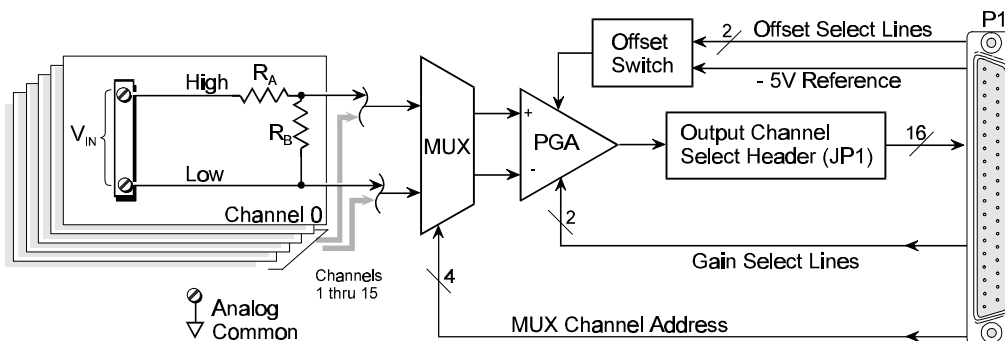


$$V_{OUT} = V_{IN} \left( \frac{R_B}{R_A + R_B} \right) \left( GAIN \right) + OFFSET$$

*DBK15 Block Diagram*

## Hardware Setup

### Card Configuration

1. Determine the Daq*'s Analog Input Channel for each DBK15 in your system. As few as one or as many as 16 DBK15's may be connected to your Daq*. Since this is a daisy-chain type interface, each card must appear unique to the Daq*. This is accomplished by assigning each card to a different Analog Input on the Daq*.
2. Locate the 16×2 pin header labeled JP1 near the front of the board. Note the 16 jumper locations on this header labeled CH0 through CH15 corresponding to the Daq*'s Analog Input Channels.
3. Set JP1 jumper on the pins for your intended output channel (CH0-CH15, see figure). Only one jumper is used on a single card. No two cards in the same system can have the same jumper setting.
4. Determine the values for $R_A$ and $R_B$ for each input signal channel. Standard RN55D (¼ watt, 1%, metal film) resistors or 22 ga bare wire (short) plug into the pin sockets (see table).
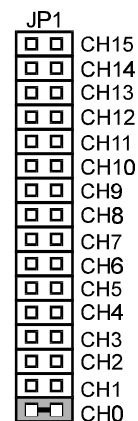


*Factory Default*
*JP1 Channel Configuration*

| Input Range | $R_A$ | $R_B$ | Gain | Polarity |
|---|---|---|---|---|
| ±5 VDC | Short | Open | ×1 | Bipolar |
| ±10 VDC | 2K | 2K | ×1 | Bipolar |
| ±30 VDC | 10K | 2K | ×1 | Bipolar |
| ±20 mA | Short | 249 | ×1 | Bipolar |
| ±20 mA | Short | 124 | ×2 | Bipolar |
| ±2 mA | Short | 1240 | ×2 | Bipolar |
| Note: You can configure 8 channels identically with 16-pin, 8-resistor DIP-8 resistor networks. With no resistors, the DBK15 provides 16 differential voltage inputs for +5 V full-scale inputs. | | | | |

5. Install resistors in $R_A$ and $R_B$ sockets for each channel as desired.  See figure.



*DBK15 Input Configuration*
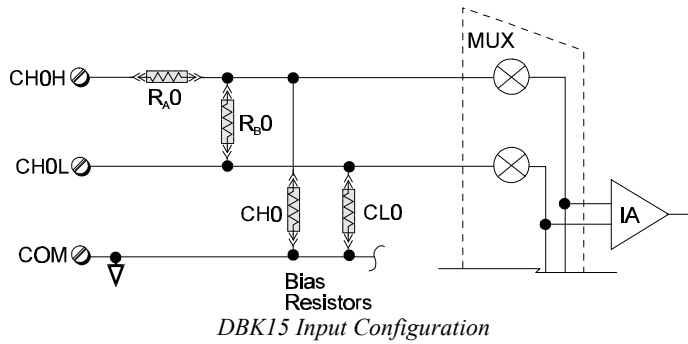
**Note**: A multiplexed input in sampled data systems must have low impedance to allow for accurate measurements.  For 12-bit accuracy at 100 kHz, equivalent attenuator impedance's should be less than 1000 ohms and signal sources must have impedance's less than 1/4000 of the attennuator input impedance.  For example, a 2:1 attenuator using 2K resistors will have 1K of equivalent impedance, but the source impedance must be less than 1/2 ohm (1/4000 of 2000) for 12-bit measurement accuracy to be attained.

### Card Connection

1. Connect the signal input wires to the appropriate screw terminals.  The DBK15 is equipped with screw terminal connectors for easy access to inputs and ground access points.  Connectors are provided for 16 differential inputs.  There are also areas on the board to install bias resistors.  These resistor areas connect to the analog input terminals and analog common.  They are labeled by channel number and H and L for high and low analog inputs.
   **Note**: The DBK15 card only supports differential inputs (not single-ended).  Connect the high end of the signal to the High input and the low end to the Low input of the desired channel.  Ground referencing to Analog Common is important for optimum accuracy.  If necessary, use bias resistors.  Two differential measurement configurations can be used: floating or referenced differential  (refer to the chapter *Signal Management and Troubleshooting Tips* for more information.)

2. It is suggested that you strain relieve the wires with nylon tie wraps (not included) to the pre-drilled holes at the rear edge of the board.  Verify that all wires are secured in a way that will not allow mechanical stress to affect signal connection.

### DaqBook/DaqBoard Configuration

Use of the DBK15 expansion card requires three specific setup steps in the DaqBook/DaqBoard.

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 DBK15 via the internal ±15 VDC power supply.  If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).



*Jumper Settings for DBK15*
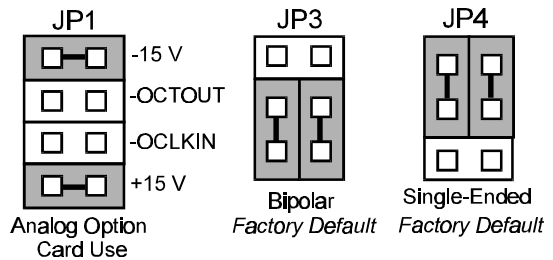
2. *Place the JP3 jumper in Bipolar mode.
3. *Place the JP4 jumper in single-ended mode.  **Note**: Analog expansion cards convert all input signals to single-ended voltages referenced to analog common.
*Applies to DaqBook/100, /112, and /120.

## Software Setup in DaqView

To use the DBK15 within DaqView, you must configure several DaqView parameters.

1. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters help interpret the incoming data and provide the controls to access the hardware. As expansion cards are added, make sure Hardware Setup reflects the present configuration. On the left side of this window, the Analog Input Option Cards selection allows the user to assign DBKs to the 16 analog inputs of the base unit. Selecting a DBK will add channels in the main window's analog input spreadsheet.
2. Select the DBK15 Multiplexer Card option. The main window now has 16 channels for this one board.
3. Set the parameters for each channel. You can define the channel gains by using the "Type" column of the analog input spreadsheet. Each channel can be configured for unipolar or bipolar mode using the "Pole" column. The engineering units column (including the use of *mx+b*) is used to convert raw readings to a volts or amps as configured at the DBK15.

## Programming a DBK15

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following example is a program segment that demonstrates how to get a sample from the DBK15 expansion card.

```
expCard = 2;      /*DBK15 JP1 position*/
expChan= 15;      /*DBK15 screw terminal connection*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dbk15UniX2);
```

If the DBK15 was configured with $R_A$ shorted and a 124 Ω resistor in $R_B$, the sample read by the DaqBook/DaqBoard can be converted to an actual 20 mA full-scale reading with the equation:

$$milliamps = sample * 20 / 65536$$

**Note**: Similar equations can be used with other hardware configurations. Refer to the separate *Programmer s Manual*.

## DBK15 - Specifications

**Name/Function: Universal Current/Voltage Input Card**
**Input Connectors:** Screw terminals for signal connections
**Output Connector:** DB37 male, mates with P1 on the DaqBook, using CA-37-x cable
**Attenuation/Shunt Resistor Connector:** Machine sockets accommodate standard ¼-watt resistors
**Gain Ranges:** ×1, ×2
**Inputs:** 16 differential
**Voltage Input Ranges:** ±5 VDC max
**Current Input Range:** ±20 mA max
**Attenuator Resistors:**
      Accuracy: +1%
      Temperature Coefficient:  100 ppm/ºC
**Gain Accuracy:** ±0.05% typ, ±0.25% max
**Maximum Input Voltage:** ±35 VDC
**Slew Rate:** 10 V/µs
**Settling Time:** 2µs to 0.01%
**CMRR:** 80 dB min
**Non-Linearity:** 0.002% typ, 0.015% max
**Unattenuated Bias Current:** 150 pA typ, 0.2 µA max @ 25ºC
**Offset Voltage:**
      ±(0.5 + 5/G) mV @ 25ºC typ
      ±(2.0 + 24/G) mV @ 25ºC max
**Offset Drift:**
      ±(3 + 50/G) µV/ºC typ
      ±(12 + 240/G) µV/ºC max

# DBK16  2-Channel Strain-Gage Card

## Overview

The DBK16 will condition signals from most types of bridge circuit configuration transducers that have a signal output of less than 50 mV.  Strain gages and load cells are common types of these transducers.  For half- and quarter-bridge strain gages, the DBK16 can accommodate user-supplied bridge completion resistors that complete the bridge circuit.  The **bridge circuit must be complete** for the DBK16 to operate correctly.  Each channel of the DBK16 offers a selectable 3-pole, low-pass filter with a user-set cut-off frequency.  Up to 8 DBK16 boards can be connected to each of 16 analog Daq* base channels for a maximum of 256 input signals.  Remote-sense terminals are used with 6-wire Kelvin connections.
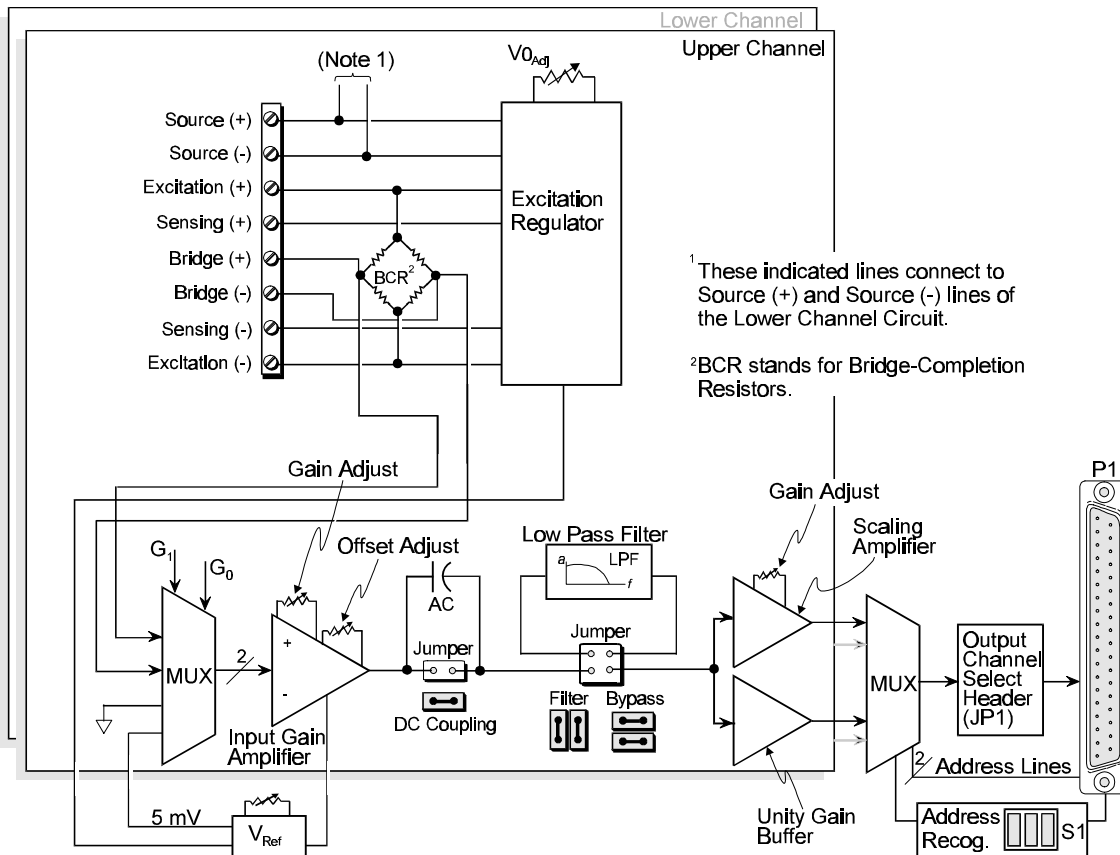
*DBK16 Block Diagram*

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

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

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

# Hardware Setup

### Card Connection

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

The following standard symbol for a 4-element bridge-type strain gage is referenced to the upper and lower channel bridge completion resistor designations for the DBK16. **Note**: bridge resistors are used in either the DBK16 or the strain gage but not in both at the same time.
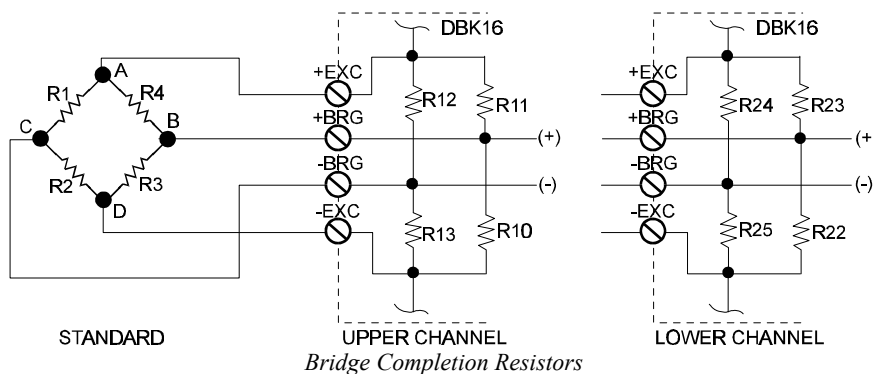


*Bridge Completion Resistors*

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



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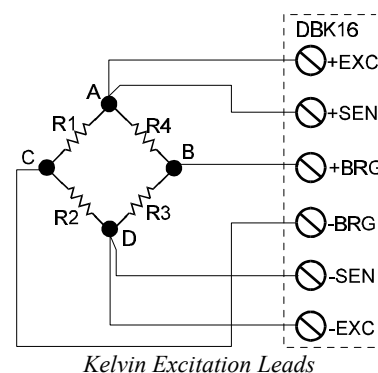
To supply excitation voltage to a single DBK16:
1. Connect J1 (terminals SRC+ and SRC-) to a source of filtered (not necessarily regulated) DC between 12 and 15 V.

To supply excitation to multiple DBK16s:
1. Connect J1 (terminals SRC+ and SRC-) to a source of filtered (not necessarily regulated) DC between 12 and 15 V.
2. Connect J2 of the powered DBK16 to J1 of the next DBK16 (see figure). The excitation power terminals are wired in parallel to daisy-chain multiple DBK16s in systems with more than 2 transducers.



*Connecting Multiple DBK16s*
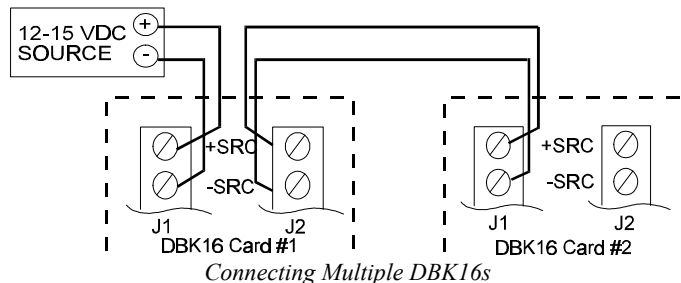
The user-supplied excitation source is attached to a voltage regulator in the DBK16 circuitry. This regulator provides the excitation to the actual transducer (there is a separate regulator for each transducer, hence 2 regulators per DBK16). Each regulator has a maximum current of 50 mA. The maximum amount of excitation that can be provided by the DBK16 excitation regulator is:

$$0.05 \times R \text{ (where R = the resistance of 1 element in the bridge circuit)}$$

<div style="border: 1px solid black;">

## CAUTION

⚠️ **Do not set the excitation above the maximum amount allowed. This can cause the DBK16 to fail.**

</div>

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

Excitation voltage/R + 5 mA (where R = the resistance of 1 element in the bridge circuit)

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

### *Card Configuration*

The next few sections explain several configuration options on the DBK16:

- AC Coupling and Low-Pass Filter Options
- Channel and Card Address Selection
- Hardware and Set-up

The figure shows the DBK16 board layout for locating jumpers, switches, etc for user-access.
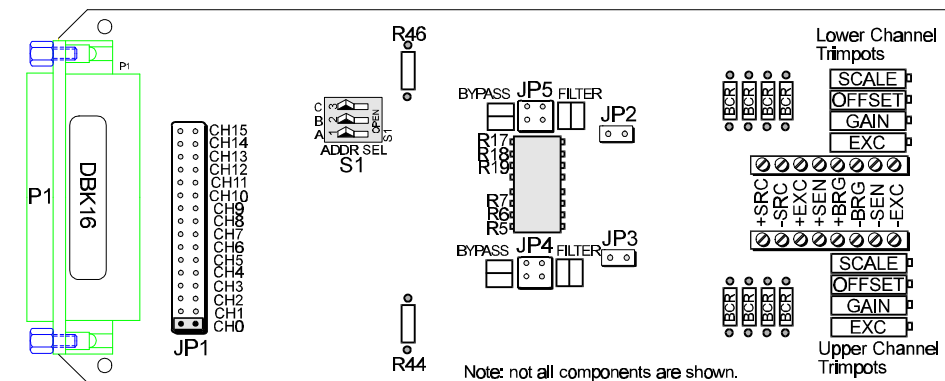


*DBK16 Board Layout*

### AC Coupling and Low-Pass Filter Options

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

The AC or DC coupling choice on each channel is set by the presence or absence of 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. JP3 sets the upper channel; JP2 sets the lower channel.

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 in the same way as the "bypass" symbol (horizontal, parallel with labels on card), the filter is bypassed. When the shunt jumpers are oriented in the same way as the "filter" symbol (vertical), the filter is in the signal path. JP4 sets the upper channel; JP5 sets the lower channel.

The corner frequency of the low-pass filters is determined by three resistor values in each filter circuit. Located in the center of the card, the lower channel resistors are R17-R18-R19; and the upper channel resistors are R5-R6-R7. These resistor locations have been arranged to allow the use of an 8-position DIP network as a convenient means of changing all 6 resistors together. The machined-pin socket will also allow the user to insert individual resistors if the two filter sections are to have different corner frequencies. The table is a list of

| Frequency | Resistance (Ω) | Bourns Part Number |
|---|---|---|
| 10 Hz | 27,000 | 4606X-102-273 |
| 20 Hz | 12,000 | 4606X-102-123 |
| 50 Hz | 5,600 | 4606X-102-562 |
| 100 Hz | 2,700 | 4606X-102-272 |
| 200 Hz | 1,200 | 4606X-102-122 |
| 500 Hz | 560 | 4606X-102-561 |
| 1,000 Hz | 270 | 4606X-102-271 |
| 2,000 Hz | 120 | 4606X-102-121 |
| 5,000 Hz | 56 | 4606X-102-560 |
| 10,000 Hz | 27 | 4606X-102-270 |
| 20,000 Hz | 12 | 4606X-102-120 |

common frequencies, the nominal resistance value and a Bourns part number for a suitable network.

The active low-pass filters on the DBK16 have an inherent gain of ×2.  You must factor this gain into your setup calculations.  To change the gain to ×1, remove the following 10 KΩ resistors: R44 for the upper channel, R46 for the lower channel.  **Note**: due to settling time, the filter should not be enabled during the DBK16 setup.

### Channel and Card Address Selection

The lower and upper channels on the DBK16 are multiplexed into 1 of the Daq* base channels (0 to 15).  The Daq* base channel (that the DBK16 is multiplexed into) is set by the shunt jumper on the 16×2 header designated JP1.

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

Each Daq* base channel can have up to 16 expansion channels multiplexed into it.  Since the DBK16 represents 2 expansion channels, 8 DBK16 cards can be multiplexed into each Daq* base channel.  To distinguish channels, there is a card address bank of 3 switches on each DBK16.  These switches are binary-weighted with 8 possibilities (0-7).  The switch settings are as follows: open = 0, closed = 1 (enabled).  The weights when closed are: A = 1, B = 2, C = 4.  The first table shows the switch settings and the card channels (n) with respect to the Daq* base channel.

The Daq* has 16 base channels, so up to 128 DBK16s can be used with a Daq* for a maximum of 256 channels.  To keep track of all the base and expansion channels, all the base channels are designated 0 to 15; and expansion channels are designated 16 to 271 where channel 16 is the first channel on the first expansion board (for DBK16, lower channel on card address 0 with JP1 set to CH0) and channel 271 is the last channel on the last expansion board (for DBK16, upper channel on card address 7 with JP1 set to CH15).  The next table shows the Daq* base channel and the first expansion channel number (N) associated with that particular base channel.  To calculate the actual input channel to the Daq*, add "N" to "n".  This expansion channel number is also needed when writing a program to read from that particular channel.  For more information on Daq* channel multiplexing, see the chapter *Signal Management and Troubleshooting Tips*.

| Daq* 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 |

### Hardware and Setup

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

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

EXC          for adjusting the Excitation Voltage to the transducer

GAIN        for setting the gain of the input amplifier

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

SCALE      for setting the gain of the scaling amplifier

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

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

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

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

A typical setup procedure is as follows:

1. Disable the low-pass filters (JP4 and/or JP5) and set DC coupling (install JP2 and/or JP3) for all the channels that are being setup. If you plan on using the filter during your acquisition, take note of the gain in the filter stage (default ×2, or ×1 with resistor removed) and allow for it in your setup.
2. Determine what the excitation for the transducer will be from the transducer specifications and the current limitations of the DBK16 excitation regulator.
3. Determine what the maximum voltage will be from the transducer at maximum load or strain, and calculate what the DBK16 channel total gain should be based on a full-scale Daq* (bipolar -5 V to +5 V, unipolar 0 to 10 V, Daq PC-Card -10 V to +10 V). (See example at end of chapter.)
4. Determine how the total gain will be distributed between input amplifier gain, filter gain and scaling amplifier gain. (See example at end of chapter.)
5. Hook up the transducer to the terminal strips labeled Lower or Upper according to the figures in the *Card Connection* section. Install the appropriate bridge completion resistors if applicable.
6. Set the excitation voltage for the transducer by adjusting the trimpot labeled EXC and measuring the voltage with a voltmeter across the +EXC and -EXC terminals on the DBK16.
7. Send the DBK16SetOffset command (usually through a gain setting in the software support). Adjust the OFFSET trimpot for a reading of 0.00 volts. This removes all offset from the DBK16 channel circuit.
8. Send the DBK16SetInputGain command (usually through a gain setting in the software support). Adjust the GAIN trimpot for a voltage reading equal to (.005)(the desired input amplifier gain).
9. Send the DBK16SetScalingGain command (usually through a gain setting in the software). Adjust the SCALE trimpot for a voltage reading equal to (.005)(the desired input amplifier gain)(the desired scaling amplifier gain).
10. Send the DBK16ReadBridge command (default). With the quiescent (normal or inactive) load or strain applied, adjust the OFFSET trimpot for a reading of 0.00 volts. This adds offset to the circuit to compensate for the quiescent load and allows maximum resolution for the measurement.
11. Enable the low-pass filter and/or AC coupling if required for your application.
12. From the transducer specifications and the total gain of the DBK16 channel, calculate the Daq* voltage/transducer units and apply it to your Daq* voltage readings through software.
13. Apply a known load or strain and verify the DBK16 and software settings.

**Set-Up Notes:**
- The offset adjustment is unipolar 0 to 5 V on the input amplifier output. If the offset can not be adjusted to 0.00 V at the end of the setup procedure, try swapping the +BRG and -BRG wire connections or dropping the input gain and increasing the scaling gain.
- For very high system gains, the Scaling Gain might have to be set first with the Input Gain low and then set the Input Gain (the Daq* can only measure up to 10 V).

### *Daq* Configuration

Use of the DBK16 requires setting jumpers in the DaqBook/DaqBoard.

1.  If not using auxiliary power, place the JP1 jumper in the expanded analog mode.  **Note**: this default position is necessary to power the interface circuitry of the DBK16 via the internal ±15 VDC power supply.  If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2.  *Place the JP4 jumper in single-ended mode (*applies only to DaqBook/100, /112 and /120).
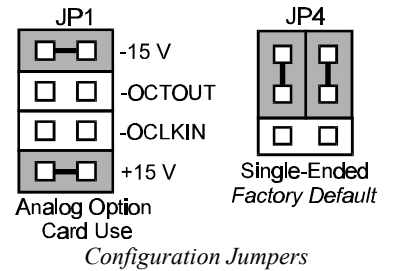
**Note**: To use a DBK16 with a Daq PC-Card, you must use a CDK10.

*Configuration Jumpers*

## Software Setup in DaqView

To use the DBK16 Expansion card within DaqView, you must first configure the DaqView software with the hardware setup.

1.  From the DaqView main window, select the Device pull-down menu and then the Configure Hardware Settings.  The information in the Configure System Hardware window is used to interpret the incoming analog input data and to provide the controls necessary to access the hardware.  As expansion cards are added, make sure the setup reflects the present hardware configuration.  On the left side of the main window, the Analog Input Option Cards selection allows the user to assign DBK expansion cards to the 16 analog inputs.  Selecting a DBK expansion board will add channels in the main window's analog input spreadsheet.
2.  To use the DBK16, select the pull down box assigned to the Daq* base channel that JP1 is set for on the DBK16.  Use the down scroll arrows to find the "DBK16 Strain-Gage Card" and select it.
3.  Another dialog box will appear that allows you to add multiple boards if you have them.  The dialog box shows a representation of the Card address DIP switches (off = 0, on = 1).  Check the boxes that represent the extra cards in your system and then click OK.
4.  Click OK in the Configure System Hardware screen to return to the main DaqView screen.  Now the DBK16 channels that you have available are listed in the DaqView spread sheet.  The software commands for performing the setup described in the Hardware and Set-Up section can be accessed in the "Type" column of the DaqView spreadsheet.

## GageCal Program

>Note: GageCal is best suited for a load cell application

To install the GageCal program on your computer, close all other programs and run SETUP.EXE on Disk 1 from Windows 3.1, 3.11, or Windows 95. Follow the installation instructions from the setup program.

Execute GAGECAL.EXE from a Windows environment to start the program. The first screen that appears will set up the Daq* interface. Input the correct Daq* interface information and click OK. If the program does not detect the Daq*, please check connections and try again or refer to the troubleshooting tips in chapter 11.

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

1. Highlight the expansion channel number you want to configure and calibrate. Notice the channel numbers are listed 16 to 271 with respect to the Daq* (if necessary, see the section *Channel and Card Address Selection*).
2. Click on the CONFIGURE button. Setup and verify your hardware setting with the diagram on the screen. Please note that the coupling must be set to DC and the filter must be disabled to calibrate the DBK16. After the hardware is setup and verified, click on the ACCEPT button to configure the next channel or ACCEPT CONFIGURATION AND EXIT to return the main GageCal screen.
3. Highlight the first configured channel and click on the button labeled CALIBRATE. The Application Parameters screen appears. There are 2 types of calibration that the DBK16 can accommodate. **Nameplate calibration** allows you to enter specifications of your transducer and application; **Two-Point calibration** allows you to enter two points of millivoltage out of the transducer vs pounds or other physical units. From the parameters you enter, GageCal instructs you how to set up the DBK16.
**Note: All application parameters entered will be used in the DBK16 setup. Any inaccuracies will result in the DBK16 being configured incorrectly.**
4. Click on the CONTINUE button, and follow the instructions from the GageCal program. GageCal has a help file that will explain any questions on the different screens or menus. If you have trouble in your setup, a DIAGNOSTIC window can show a DBK16 circuit to help you troubleshoot the problem.

## Programming a DBK16

>Note: Users of DaqView or other turnkey packages can skip this section.

The following example is a program segment that demonstrates how to get a sample from the DBK16 strain gage card.

An easy way to determine which software channel number corresponds with a physical channel is to use the **daqAdcExpToChan** command. This command will use the expansion card # and channel to calculate the channel # used by the **daqAdcRd** command.

```
expCard = 2;        /*DBK16 JP1 position*/
expAddr= 3;         /*DBK16 S1 switch setting valid values 0-7*/
expChan = 0;        /*DBK16 channel valid values 0-1*/
expChan= expAddr*2 + expChan;
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dbk16ReadBridge);
```

This example demonstrates how to take a reading from the bridge itself. Other definitions, **Dbk16SetOffset**, **Dbk16SetInputGain** and **Dbk16SetScalingGain** can be used in place of **Dbk16ReadBridge** when calibrating the DBK16.

## Example

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

A **strain gage** example:

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

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

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

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

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

A **load cell** example:

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

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

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

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

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

-5 to +5 V for DaqBook/DaqBoard in bipolar mode

0 to +10 V for DaqBook/DaqBoard in unipolar mode

-10 to +10 V for Daq PC-Card

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

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

4.5 V/10.5 mV = 428.6

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

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

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

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

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

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

Typical Input Gain settings:

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

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

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

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

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

### *Using the DBK16 with 3-Wire Strain Gages*

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

1. Install bridge completion resistors R12 and R13 (R24 and R25 for lower channel).
2. Attach the 1-wire side of the gage element to the -EXC and -SEN terminals.
3. Attach one wire on the 2-wire side of the gage to +BRG terminal.
4. Attach one more bridge completion resistor to the end of the other wire on the 2-wire side of the gage element.
5. Attach the other side of the 3rd bridge completion resistor to the +EXC terminal.

# DBK16 - Specifications

**Name/Function: 2-Channel Strain-Gage Input Card**
**Input Connectors**: Screw terminals for signal connections
**Output Connector**: DB37 male, mates with P1 on the DaqBook, using CA-37-x cable
**Number of Channels**: 2
**Excitation Voltage Range**: 1.50 to 10.50 VDC @ 50 mA (on-board adjustment for external source)
**Gain Range**: ×100-1250
**Types of Bridges Accommodated**:
　　Full Bridge, Kelvin Excitation (6-wire)
　　Full Bridge (4-wire)
　　Half Bridge (3-wire)
　　Quarter Bridge (2-wire)
**Bridge Resistors**: On-board provisions for 4 bridge-completion resistors per channel.
**Type Input**: Differential DC
**Input Impedance**: 100 MΩ  (in parallel with 150 pF)
**CMRR**: 115 dB
**Excitation Voltage Source**: External 13-18 VDC @ 50 mA/circuit
**Excitation Current Output**: 50 mA max, current limited at 60 mA
**Excitation Sensing**: Local or Remote
**Excitation Regulation**:
　　**Line Regulation**: 0.025%
　　**Load Regulation**: 0.05%

**Reference Voltages**: 2.500 VDC
　　**Reference Accuracy**: 0.05%
　　**Reference Drift**: 3 ppm/ºC
**Gain Calibration Reference**: 5.00 mVDC
　　**Reference Accuracy**: 0.2%
　　**Reference Drift**: 20 ppm/ºC
Committed instrumentation amplifier for each section with gain adjust from ×100 to ×1250 via externally accessed 15-turn trimpot.
**Gain Accuracy**: 0.5%
**Gain Drift**: 50 ppm/ºC
**Input Offset**: 100 µV max
**Offset Drift**: 4 µV/ºC
**Output Offset**: 20 µV
**Offset Drift**: 200 µV/ºC
**Offset Adjustment**: 0-100% of range, 0-5.00 VDC (15-Turn trimpot)
**Full Scale Sensitivity Range**:
　　**At 5.00 VDC Excitation**: 0.8 to 10 mV/V
　　**At 10.00 VDC Excitation**: 0.4 to 5 mV/V
**Scaling Amplifier Gain Range**: ×1 to ×10 (15-Turn trimpot)
**Low Pass Filter**:
　　3 pole Butterworth, User By-Passable;  -9dB @ User-set Corner Frequency

# DBK17 Simultaneous Sample and Hold Card

## Overview

Each DBK17 simultaneous sample-and-hold (SSH) card provides 4 channels of voltage input to a Daq* system. Each of the Daq*'s 16 analog input channels can accept 4 DBK17 cards, for a maximum of 256 analog input channels. The simultaneous sample-hold function is activated at the beginning of each channel scan and freezes all signals present on DBK17 inputs for the duration of the scan, allowing for non-skewed readings of all channels. **Note**: a DBK17 channel should never be the 1st channel in a scan due to timing of the SSH line.

The DBK17 features an instrumentation amplifier for each channel, with switch-selected gains of ×1, ×10, ×100, ×200 and ×500. A socket is provided for a user-selected gain resistor for custom gain selection instead of the unity gain (×1) setting.

Four separate sample-hold stages follow the 4 input stages. The outputs are connected to a 4-channel multiplexer stage. The enabled-output MUX allows up to 4 DBK17s to share a common Daq* analog input channel.

The input connectors are BNC type connectors. The differential inputs are provided with switchable 100 KΩ bias resistors to analog common. User gain can be set to any value between unity and ×500 by installing a resistor in the user-location of each channel.



*DBK17 Block Diagram*
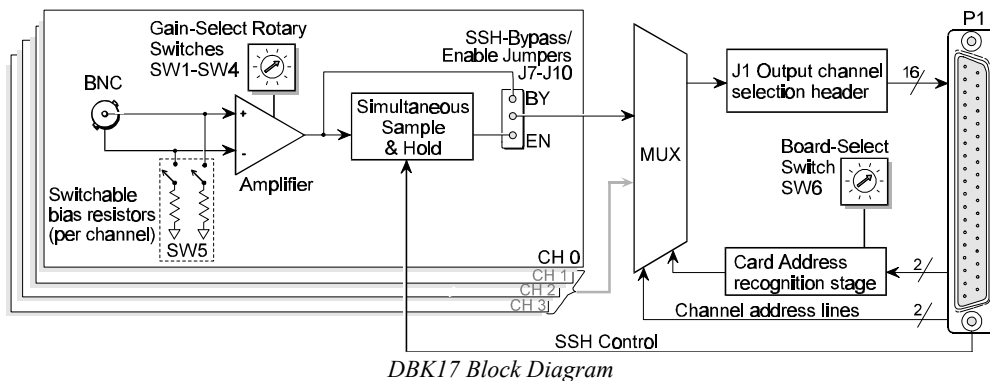
## Hardware Setup

### Card Connection

The DBK17 is equipped with BNC connectors for easy access to all of the analog inputs. Connections are provided for 4 differential inputs.

### Card Configuration

#### Input Termination

The DBK17 provides two 100 KΩ bias resistors for each analog input. For balanced 200 KΩ input impedance, both resistors should be switched in. An 8-position DIP switch (SW5) can selectively engage the bias resistors. The input circuit and switch positions are shown in the figure. The switches must be in the closed position to engage the termination resistors. For unbalanced high input, only the (-) resistor should be used. If neither resistor is used, some external bias current path is required.



*Input Impedance/Termination*

#### SSH Configuration

Each channel's Simultaneous-Sample-and-Hold circuit can be enabled (EN) or bypassed (BY) by placement of the jumper on J7 for channel 0, J8 for channel 1, J9 for channel 2, or J10 for channel 3. The factory-default setting is **enabled (EN)** for each channel.

### Gain Settings

On the card, each channel has a gain-set switch labeled GAIN 1 (SW1) to GAIN 4 (SW4) and holes for gain resistors labeled RG1 to RG4. The table in the figure shows gain values for switch settings 0 to 4. If a custom gain is desired, the switch is set to position 0; and a gain resistor must be mounted and soldered onto the card. The value of the gain resistor is determined by the formula:



Gain Values   Gain Switch
0 ×1
1 ×10
2 ×100
3 ×200
4 ×500

*Setting Channel Gains*

$$R_{GAIN} = [40,000 / (Gain -1)] - 80 \ \Omega$$

### Address Configuration

Up to 4 DBK17s can be connected to each Daq* analog channel. With 16 Daq* channels and 4 inputs per DBK17, a maximum of 256 inputs are possible. Since this is a daisy-chain interface, each card must have a unique address (channel and card number).

To configure the card, locate the 16 × 2-pin header (labeled J1) near the front of the board. The 16 jumper locations on this header are labeled CH0 through CH15. Place the jumper on the channel you wish to use. Only one jumper is used on a single card. Four cards in the daisy-chain can have the same channel number as long as their card number is unique.

Set switch SW6 for each of 4 DBK17s on a single channel. Verify that only one card in the system is set to a particular channel *and* card number.



*Address Configuration*
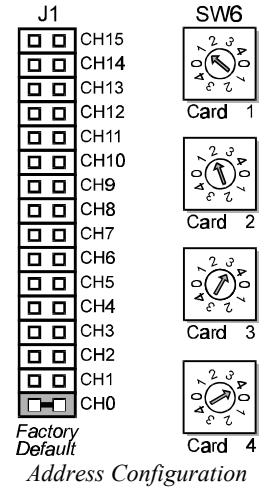
### *DaqBook/DaqBoard Configuration*

Use of the DBK17 requires setting jumpers in the DaqBook/DaqBoard.

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 DBK17 via the internal +15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).

2. Place the JP2 jumper in the SSH position. **Note**: **you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).

3. *Place the JP4 jumper in single-ended mode (*applies only to DaqBook/100, /112 and /120).



*Configuration Jumpers*
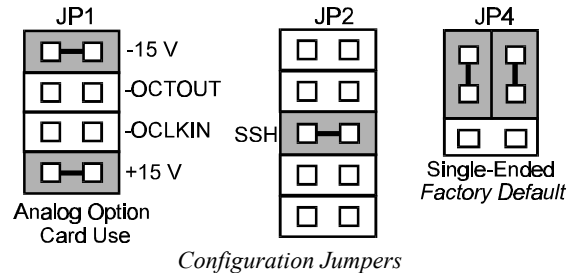
## Software Setup in DaqView

To use the DBK17 within DaqView, you must first configure the DaqView software. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters are used to interpret the incoming data and provide the controls to access the hardware. As expansion cards are added, make sure the Hardware Setup reflects the present hardware configuration.

On the left side, the Analog Input Option Cards selection allows you to assign DBK expansion cards to the 16 analog inputs. Selecting a DBK will add channels in the analog input spreadsheet. Select the DBK17 Sample/Hold Card option. A DBK17 configuration window will appear. Click the checkbox for each board connected according to the SW6 hardware setting on the DBK17. The main window now has 4 card-channels for each DBK17 selected. You can define the channel gains by using the Type column of the analog input spreadsheet.

## Programming a DBK17

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following example demonstrates how to get a sample from the DBK17 expansion card. An easy way to determine which software channel corresponds with a physical channel is to use the daqAdcExpToChan command. This command will use the expansion card # and channel to calculate the channel # used by the command.

```
expCard = 2;        /*DBK17 JP1 position*/
expAddr = 3;        /*DBK17 switch setting*/
expConn = 0;        /*DBK17 connector number*/
expChan = (expAddr-1)* 4 + expConn;
                    /*SW5 setting and the BNC number for DBK17 screw term cnct.*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dgain×1);
```

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK17 - Specifications

**Name/Function: Simultaneous Sample-Hold Card**
**Number of Channels**: 4
**Input Connections**: 4 BNC connectors
**Output Connector**: DB37 male, which mates with P1 on the DaqBook using CA-37-x cable
**Number of Cards Addressable**: 64
**Input Type**: Differential
**Voltage Input Ranges**:
    0 to ±5000 mVDC
    0 to ±500 mVDC
    0 to ±50 mVDC
    0 to ±25 mVDC
    0 to ±10 mVDC
**Input Amplifier Slew Rate**: 12 V/µs minimum
**Acquisition Time**:
    0.6 µs (10 V excursion to 0.1%)
    0.7 µs (10 V excursion to 0.01%)
**Channel-to-Channel Aperture Uncertainty**: 50 ns
**Output Droop Rate**: 0.1 µV/µs
**Input Gains**: ×1, ×10, ×100, ×200, ×500 and User-Set
**Input Offset Voltage**: 500 µV + 5000/G maximum (nullable)
**Input Offset Drift**: ±5 + 100/G µV/°C maximum
**Input Bias Current**: 100 pA maximum
**Input Offset Currents**: 50 pA maximum
**Input Impedance**: $5 \times 10^{12}$ parallel with 6 pF
**Switchable Bias Resistors**: 100 KΩ each to analog common

**Gain Errors**:
    0.04% @ ×1
    0.1% @ ×10
    0.2% @ ×100
    0.4% @ ×200
    1.0% @ ×500
**Gain vs Temperature**:
    ×1 @ ±20 ppm/°C
    ×10 @ ±20 ppm/°C
    ×100 @ ±40 ppm/°C
    ×200 @ ±60 ppm/°C
    ×500 @ ±100 ppm/°C
**Non-Linearity**:
    ×1 to ±0.015% full-scale
    ×10 to ±0.015% full-scale
    ×100 to ±0.025% full-scale
    ×200 to ±0.025% full-scale
    ×500 to ±0.045% full-scale
**Common-Mode Rejection Ratio (CMRR)**:
    70 dB minimum @ ×1
    87 dB minimum @ ×10
    100 dB minimum @ ×100
    100 dB minimum @ ×200
    100 dB minimum @ ×500

# DBK18 Low-Pass Filter Card

## Overview

Each DBK18 low-pass filter (LPF) card provides 4 input channels to a Daq* system. Each of 16 Daq* channels can accept 4 DBK18 cards for a maximum of 256 analog inputs. The input connectors are BNC type connectors. The differential inputs are provided with switchable 100 KΩ bias resistors to analog common.

The DBK18 features an instrumentation amplifier for each channel, with switch-selected gains of ×1, ×10, ×100, ×200 and ×500. A socket is provided for a gain resistor for custom gain selection instead of unity gain (×1). Gain for any channel can be set to any value between unity and ×500 by installing an appropriate resistor. Four separate filter stages follow the 4 input stages. The outputs are connected to a 4-channel multiplexer stage. The enabled output MUX allows up to 4 DBK18s to share a common Daq* analog base channel.
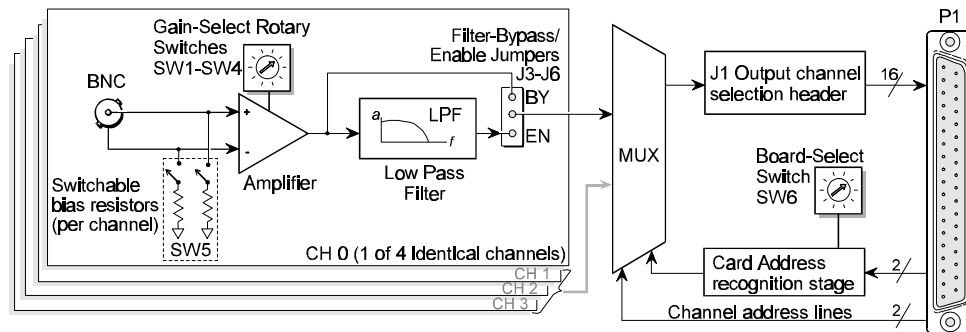


*DBK18 Block Diagram*

## Hardware Setup

### Card Connection

The DBK18 is equipped with BNC connectors for easy access to all of the analog inputs. Connections are provided for 4 differential inputs.

### Card Configuration

#### Input Termination

The DBK18 provides two 100 KΩ bias resistors for each analog input. For balanced 200 KΩ input impedance, both resistors should be switched in. An 8-position DIP switch (SW5) can selectively engage the bias resistors. The input circuit and switch positions are shown in the figure. The switches must be in the closed position to engage the termination resistors. For unbalanced high input (single-ended), only the (-) resistor should be used. If neither resistor is used, some external bias current path is required.



*Input Impedance/Termination*

#### Gain Settings

On the card, each channel has a gain-set switch labeled GAIN 1 (SW1) to GAIN 4 (SW4) and holes for gain resistors labeled RG1 to RG4. The table in the figure shows gain values for switch settings 0 to 4. If a custom gain is desired, the switch is set to position 0; and a gain resistor must be mounted and soldered onto the card. The value of the gain resistor is determined by the formula:



*Setting Channel Gains*

$$R_{GAIN} = [40{,}000 \, / \, (\text{Gain } -1)] - 80 \; \Omega$$

## Address Configuration

Up to 4 DBK18s can be connected to each Daq* analog channel. With 16 Daq* channels and 4 inputs per DBK18, a maximum of 256 inputs are possible. Since this is a daisy-chain interface, each card must have a unique address (channel and card number).

To configure the card, locate the 16 × 2-pin header labeled JP1 near the front of the board. The 16 jumper locations on this header are labeled CH0 through CH15. Place the jumper on the channel you wish to use. Only one jumper is used on a single card. Four cards in the daisy-chain can have the same channel number as long as their card number is unique.

Set switch SW6 for each of the 4 DBK18s on a single channel. Verify that only one card in a system is set to a particular channel and card number.

*Address Configuration*
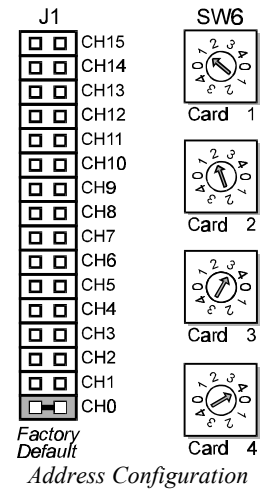
### DaqBook/DaqBoard Configuration

Use of the DBK18 requires setting jumpers in the DaqBook/DaqBoard.

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 DBK18 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. *Place the JP4 jumper in single-ended mode. **Note**: Analog expansion cards convert all input signals to single-ended voltages referenced to analog common. *Applies to DaqBook/100, /112, and /120 only.

*Configuration Jumpers*
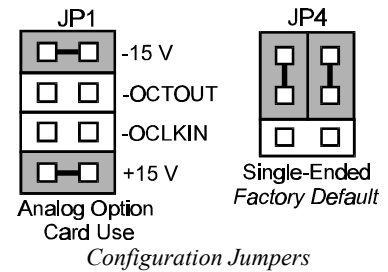
### Configuring DBK18 Filter Sections

There are 4 low-pass, 3-pole active filters on the DBK18. Each filter can be enabled (EN) or bypassed (BY) by placement of the jumper on J3 for channel 0, J4 for channel 1, J5 for channel 2, or J6 for channel 3. The factory-default setting is **enabled (EN)** for each channel. Each filter can be configured as a Butterworth, Bessel, or Chebyshev filter with corner frequencies up to 50 kHz. Filter properties depend on the values of resistors and capacitors installed in several circuit locations. Above 10 Hz, installing capacitors is unnecessary because capacitors in the ICs are sufficient. In all cases, three resistors are required to complete the active filter circuits contained mostly within the UAF42 ICs.

The circuit diagram shows the active filter IC in a typical section of the DBK18. The resistors and capacitors outside the IC have a physical location in a DIP-16 socket (dual in-line, 16 pins) with an RCnn designator. The RC indicates the needed part is a resistor or capacitor; the 3rd character is the channel number; and the 4th character corresponds to the socket position (A-H).

*Filter Circuit Diagram*

The figure shows the DIP-16 component pattern typical of the 4 filter sections. A machined-pin IC socket in each filter RC location can accept resistors and capacitors that plug directly into the socket. A better approach is to install these components on plug-in headers. This allows solder connections to the components and gold-to-gold, plug-in connections between the header and the sockets. **Note**: no part or "n" means open circuit.


*DIP-16 Component Pattern*

Pin 7 of the DIP-16 socket:
- connects to pin 8 for low-pass filtering
- connects to pin 6 for band-pass filtering

The next table lists values of components for common corner frequencies in Butterworth filters. If you wish to design your own filter, software from Burr-Brown provides the component values to create the desired filter. (The design math is outside the scope of this manual.)

| 3-POLE BUTTERWORTH FILTER COMPONENTS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3dB (Hz) | RCnA | RCnB | RCnC | RCnD | RCnE | RCnF | RCnG | RCnH |
| 0.05 | 3.16 M | 1 µF | none | 3.16 MΩ | 1 µF | 3.16 MΩ | none | 1 µF |
| 0.10 | 1.58 MΩ | 1 µF | none | 1.58 MΩ | 1 µF | 1.58 MΩ | none | 1 µF |
| 0.20 | 787 KΩ | 1 µF | none | 787 KΩ | 1 µF | 787 KΩ | none | 1 µF |
| 0.50 | 3.16 MΩ | 1 µF | none | 3.16 MΩ | 0.1 µF | 3.16 MΩ | none | 0.1 µF |
| 1 | 1.58 MΩ | 0.1 µF | none | 1.58 MΩ | 0.1 µF | 1.58 MΩ | none | 0.1 µF |
| 2 | 787 KΩ | 0.1 µF | none | 787 KΩ | 0.1 µF | 787 KΩ | none | 0.1 µF |
| 5* | 3.16 MΩ | 0.01 µF | none | 3.16 MΩ | 0.01 µF | 3.16 MΩ | none | 0.01 µF |
| 10* | 1.58 MΩ | 0.01 µF | none | 1.58 MΩ | 0.01 µF | 1.58 MΩ | none | 0.01 µF |
| 20 | 787 KΩ | 0.01 µF | none | 787 KΩ | 0.01 µF | 787 KΩ | none | 0.01 µF |
| 50 | 3.16 MΩ | none | none | 3.16 MΩ | none | 3.16 MΩ | none | none |
| 100* | 1.58 MΩ | none | none | 1.58 MΩ | none | 1.58 MΩ | none | none |
| 200 | 787 KΩ | none | none | 787 KΩ | none | 787 KΩ | none | none |
| 500* | 316 KΩ | none | none | 316 KΩ | none | 316 KΩ | none | none |
| 1000* | 158 KΩ | none | none | 158 KΩ | none | 158 KΩ | none | none |
| 2000 | 78.7 KΩ | none | none | 78.7 KΩ | none | 78.7 KΩ | none | none |
| 5000 | 31.6 KΩ | none | none | 31.6 KΩ | none | 31.6 KΩ | none | none |
| 10000 | 15.8 KΩ | none | none | 15.8 KΩ | none | 15.8 KΩ | none | none |
| *These pre-configured Butterworth frequency modules are available from the manufacturer. | | | | | | | | |

You have the option to configure the filter sections as band-pass filters rather than low-pass filters. The component selection program provides band-pass component values. The program also computes and displays phase and gain characteristics of the filter sections as a function of frequency.

## Software Setup in DaqView

To use the DBK18 within DaqView, you must first configure the DaqView software. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters are used to interpret the incoming data and provide the controls to access the hardware. As expansion cards are added, make sure the setup reflects the present hardware configuration.

On the left side, the Analog Input Option Cards selection allows you to assign DBK expansion cards to the 16 analog inputs. Selecting a DBK expansion board will add channels in the analog input spreadsheet.

Select the DBK18 Filter Card option. A DBK18 configuration window will appear. Click the checkbox for each board connected according to the SW6 hardware setting on the DBK18. The main window now has 4 card-channels for each DBK18 selected. You can define the channel gains by using the Type column of the analog input spreadsheet.

## Programming a DBK18

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following example demonstrates how to get a sample from the DBK18 expansion card.

An easy way to determine which software channel corresponds with a physical channel is to use the daqAdcExpToChan command. This command will use the expansion card # and channel to calculate the channel # used by the command.

```
expCard = 2;      /*DBK18 JP1 position*/
expAddr = 3;      /*DBK18 switch setting*/
expConn = 0;      /*DBK18 connector number*/
expChan = (expAddr-1)* 4 + expConn;
                  /*SW5 setting and the BNC number for DBK18 screw term cnct.*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dgain×1);
```

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK18 - Specifications

**Name/Function: Low-Pass Filter Card**
**Number of Channels**: 4
**Input Connections**: 4 BNC connectors
**Output Connector**: DB37 male, which mates with P1 on the
    DaqBook using CA-37-x cable
**Number of Cards Addressable**: 64
**Input Type**: Differential
**Voltage Input Ranges**:
    0 to ±5000 mVDC
    0 to ±500 mVDC
    0 to ±50 mVDC
    0 to ±25 mVDC
    0 to ±10 mVDC
**Input Amplifier Slew Rate**: 12 V/µs minimum
**Input Gains**: ×1, ×10, ×100, ×200, x500 and user-set
**Input Offset Voltage**: 500 µV + 5000/G maximum (nullable)
**Input Offset Drift**: ±5 + 100/G  µV/°C maximum
**Input Bias Current**: 100 pA maximum
**Input Offset Currents**: 50 pA maximum
**Input Impedance**: $5 \times 10^{12}$ parallel with 6 pF
**Switchable Bias Resistors**: 100 KΩ each to analog common
**Gain Errors**:
    0.04% @ ×1
    0.1% @ ×10
    0.2% @ ×100
    0.4% @ ×200
    1.0% @ ×500

**Gain vs Temperature**:
    ×1 @ ±20 ppm/°C
    ×10 @ ±20 ppm/°C
    ×100 @ ±40 ppm/°C
    ×200 @ ±60 ppm/°C
    ×500 @ ±100 ppm/°C
**Non-Linearity**:
    ×1 to ±0.015 % full-scale
    ×10 to ±0.015 % full-scale
    ×100 to ±0.025 % full-scale
    ×200 to ±0.025 % full-scale
    ×500 to ±0.045 % full-scale
**Common-Mode Rejection**:
    70 dB minimum @ ×1
    87 dB minimum @ ×10
    100 dB minimum @ ×100
    100 dB minimum @ ×200
    100 dB minimum @ ×500
**Active Filter Device**: UAF42 (Burr-Brown)
**Number of Poles/Filter**: 3
**Types of Filters**: Bessel, Butterworth, Chebyshev
**Frequency Range**: 0.1 Hz to 20 kHz
    The frequency is set by installation of 4-6 resistors and/or
    capacitors in sockets.
**Default Frequency**: 1 Hz
Other frequencies may be implemented by the user by soldering
    resistors and/or capacitors to locations on the 4 blank plug-in
    headers provided.  Values for common frequencies and their
    component values are provided with the blank headers.

# DBK19 Thermocouple Card

## Overview

The DBK19 can attach to 14 thermocouples (T/C) for temperature measurements.  The DBK19 features an on-board cold junction sensor and a programmable-gain amplifier for measuring type J, K, T, E, N28, N14, S, R, or B thermocouples.  The table shows the temperature range for each thermocouple type.

| Thermocouple Type | J | K | T | E | N28 | N14 | S | R | B |
|---|---|---|---|---|---|---|---|---|---|
| Temperature Range °C | -200 to 760 | -200 to 1260 | -200 to 400 | -270 to 1000 | -270 to 400 | 0 to 1300 | 0 to 1780 | 0 to 1780 | 0 to 1820 |

True differential measurements of thermocouples require a bias current referenced to analog common; therefore, resistors connect each input terminal to the analog common.  Filter capacitors across each input operate with input protection resistors to form single-pole RC low-pass filters.

Each DBK19 includes a cold-junction compensation circuit wired to channel 0.  Channels 2 through 15 accept external thermocouples.  The DBK19s can be used with other analog expansion cards and feature screw terminals for direct connection.  Up to 16 DBK19s can be attached to a single Daq* to measure a maximum of 224 (16 × 14) temperatures.

**Note**: the DaqView software includes functions for the conversion and linearization of thermocouple readings into temperature data.  Programmers should refer to related sections in the separate *Programmer's Manual*.
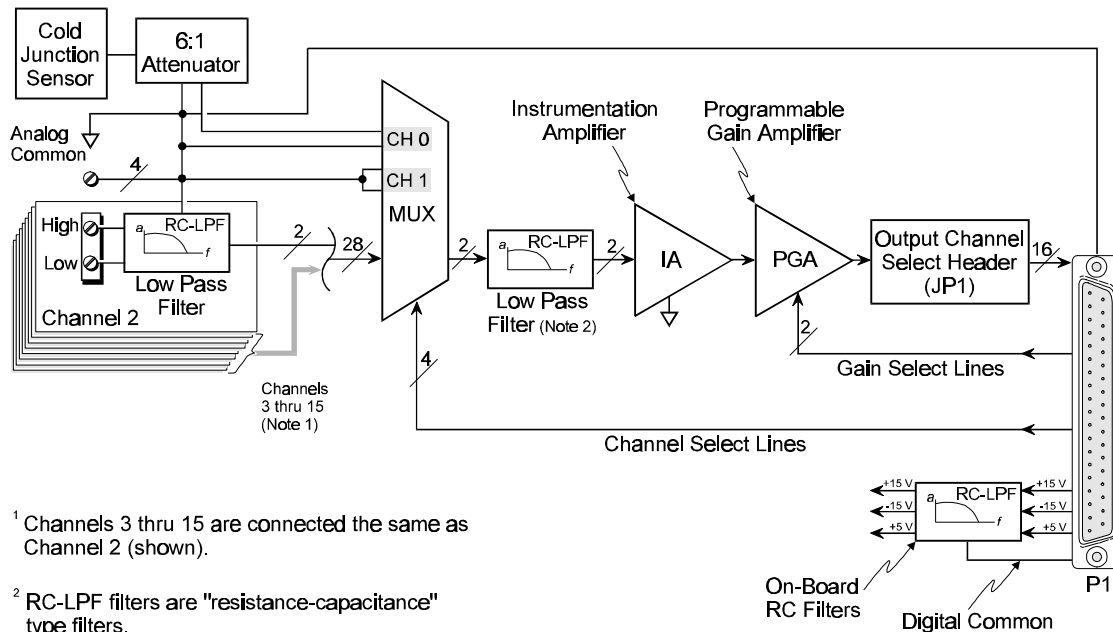


*DBK19 Block Diagram*

## Hardware Setup

### Card Connection

Connect the T/C input wires to the proper terminal.  The DBK19 uses screw terminals to connect different types of thermocouples as well as several analog ground access points.  Connections are provided for 14 thermocouples.

Thermocouples have polarities which must be observed. Thermocouple types J, K, T, E, N28, N14, S, R and B can be connected to DBK19 channels CH2 through CH15.

- CH0 is reserved for the cold-junction compensation sensor (factory installed).
- CH1 is permanently shorted to common to allow software-driven auto-zero to compensate for temperature drift.

Thermocouple wire is standardized and color-coded as shown in the table. T/Cs have a very small output. Long T/C leads can pickup lots of noise. Use shielding as needed, and average several readings in software to minimize noise effects.

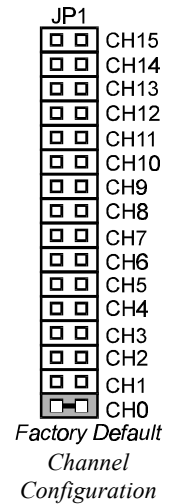| T/C Type | (+) Lead to Channel-Hi | (-) Lead to Channel-Lo |
|---|---|---|
| J | White | Red |
| K | Yellow | Red |
| T | Blue | Red |
| E | Violet | Red |
| N28 | Orange | Red |
| N14 | Orange | Red |
| S | Black | Red |
| R | Black | Red |
| B | Gray | Red |

After all connections are in place, secure wires to captive areas (pre-drilled holes) at the rear edge of the board. Nylon tie wraps (not included) work well for this purpose.

### Card Configuration

Assign a Daq* channel number to the DBK19 card. Up to 16 DBK19s can connect to a Daq*. (Optional DBK10 expansion card enclosure may be used.) Since this is a daisy-chain interface, each card must have a unique channel address.

To configure the card, locate the 16×2-pin header (labeled JP1) near the front of the board. The 16 jumper locations on this header are labeled CH0 through CH15. Place the jumper on the channel you wish to use. Only one jumper is used on a single card; each card in the system must have a unique jumper setting.

JP1

CH15
CH14
CH13
CH12
CH11
CH10
CH9
CH8
CH7
CH6
CH5
CH4
CH3
CH2
CH1
CH0

*Factory Default*
*Channel*
*Configuration*

### DaqBook/DaqBoard Configuration

Use of the DBK19 requires setting jumpers in the DaqBook/DaqBoard.
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 DBK19 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. Place the JP4 jumper in the DaqBook/DaqBoard in single-ended mode (applies only to DaqBook/100, /112, and /120. **Note**: Analog expansion cards convert all input signals to single-ended voltages referenced to analog common.

JP1
-15 V
-OCTOUT
-OCLKIN
+15 V
Analog Option
Card Use

JP4
Single-Ended
*Factory Default*

*Configuration Jumpers*
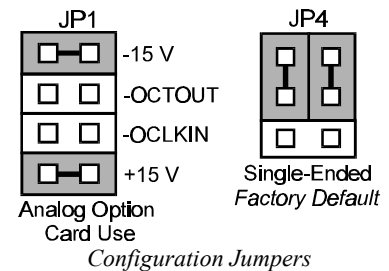
## Software Setup in DaqView

To use the DBK19 within DaqView, you must configure the DaqView software for the hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters are used to interpret the incoming data and provide controls to access the hardware. As expansion cards are added, make sure the setup window reflects the present hardware configuration.

On the left side of this window, the Analog Input Option Cards selection allows you to assign DBK expansion cards to the Daq*'s 16 analog inputs. Selecting a DBK expansion board will add channels in the main window's analog input spreadsheet.

Select the DBK19 Thermocouple Card option.  The main window now has 14 thermocouple channels and one cold junction channel for this one board.  The DBK19 selection allows the user to define the thermocouple types by using the Type column of the analog input spreadsheet.

Each DBK19 card is shipped with a calibration disk with constants used to correct gain and offset errors inherent in the hardware.  This calibration is done automatically by DaqView when the file, DAQBOOK.CAL, exists in the /WIN/UTILS directory and is configured with the calibration constants for each card.  See the DBK19 readme.txt file on the disk shipped with the board for details on creating this file.

## Programming a DBK19

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the DBK19.  An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command.  This command will use the expansion card number and channel to calculate the channel number used by the daqAdcRd command.

```
expCard = 2;      /*DBK19 JP1 position*/
expChan= 15;      /*DBK19 screw terminal connection*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dbk19BiGainJ);
```

The analog reading contained in the sample is in raw A/D counts.  This value will change with fluctuations in temperature.  To obtain a reading that can be converted to a real temperature, refer to the Thermocouple Linearization section of the separate *Programmer s Manual*.

## DBK19 - Specifications

**Name/Function: High-Accuracy Thermocouple Card**
**Connector**: DB37 male mates with P1 pinouts.  Thermocouples attach to on-board screw terminals.
**Thermocouple Types**: J, K, S, T, E, B, R, N
**Gain Ranges**: ×60, ×90, ×180, ×240
**Inputs**:
    14 differential thermocouples
    1 cold-junction compensation
    1 auto zero
**Cold Junction Sensor Output**: 100mV/°C
**Voltage Ranges Gains**:
    0 to 80 mV @ ×60
    0 to 50 mV @ ×90

0 to 25 mV @ ×180
0 to 20 mV @ ×240
0 to ±10 mVDC
**Input Impedance**: 20 KΩ
**Input RC Filter**: -3 dB Frequency: 15.9 kHz
**Gain Accuracy**:
    **Uncalibrated**: 0.15%
    **Calibrated**: 0.02%
**Maximum Input Voltage**: 35 VDC
**CMRR (Input Stage)**: 110 dB type DC to 60 Hz
**Offset**: Software compensated
**Type/Range/Accuracy/Resolution**: see table

| Type | Range | | Accuracy | | Resolution | | | |
|------|-------|-----|----------|----------|-------------|-------------|-------------|-------------|
| | **Min** | **Max** | **(<0°C)** | **(>0°C)** | **12-bit <0°C** | **12-bit >0°C** | **16-bit <0°C** | **16-bit >0°C** |
| **J** | -200°C | 760°C | 0.6°C | 0.6°C | 1.2°C | 0.5°C | 0.1°C | 0.1°C |
| **K** | -200°C | 1260°C | 1.6°C | 1.0°C | 1.1°C | 0.8°C | 0.1°C | 0.1°C |
| **T** | -200°C | 400°C | 1.4°C | 0.8°C | 0.8°C | 0.3°C | 0.1°C | 0.1°C |
| **E** | -270°C | 1000°C | 1.4°C | 0.9°C | 1.6°C | 0.7°C | 0.1°C | 0.1°C |
| **N28** | -270°C | 400°C | 0.8°C | 0.8°C | 1.0°C | 1.0°C | 0.1°C | 0.1°C |
| **N14** | 0°C | 1300°C | | 1.0°C | | 5.0°C | | 5.0°C |
| **S** | 0°C | 1780°C | | 1.6°C | | 1.3°C | | 0.1°C |
| **R** | 0°C | 1780°C | | 1.6°C | | 1.7°C | | 0.1°C |
| **B** | 0°C | 1820°C | | 1.8°C | | 1.5°C | | 0.1°C |

# DBK20 & DBK21 Digital I/O Cards

## Overview

The DBK20 and DBK21 are general purpose digital I/O cards which can increase available digital I/O lines by 48 per card. The DBK20 uses screw terminals; the DBK21 uses DB37 connectors. Both cards connect to the P2 digital I/O port via the interface cable (CA-37-x). **Note**: not applicable to Daq*s without the P2 interface, such as the Daq PC-Card.

Up to 4 DBK20s or DBK21s can be attached for a maximum of 192 lines (4×48). The local I/O lines cannot be used while expansion cards are attached. Thus, the first expansion card increases the number of usable digital I/O lines from 24 to 48, and subsequent cards each add 48 additional lines of programmable digital I/O.
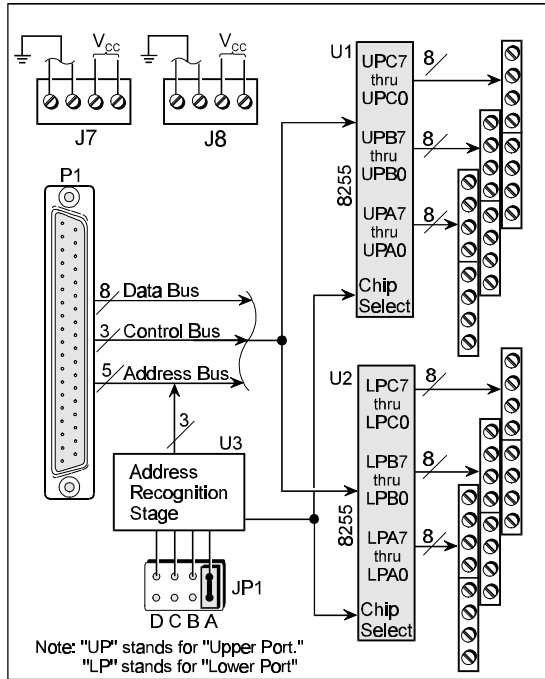


*DBK20 Block Diagram*                              *DBK21 Block Diagram*
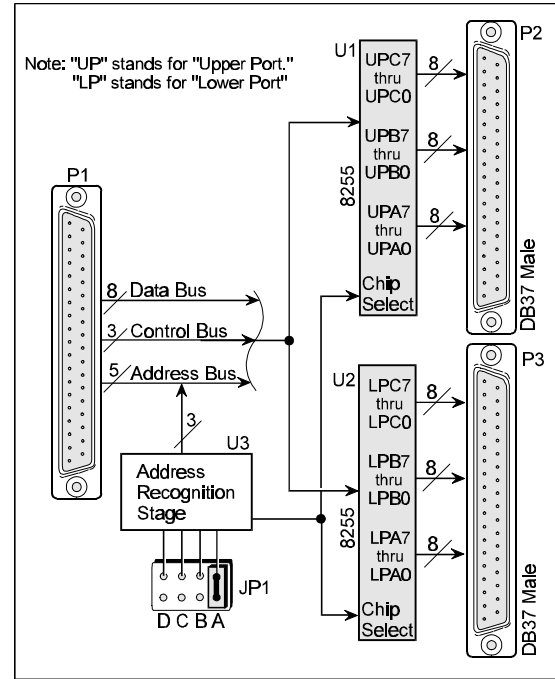
## Hardware Setup

### Card Connection

1. Connect wire leads to terminal blocks (if using a DBK20) or ribbon cable(s) terminated in 37-pin female connectors (if using a DBK21).
2. Once all connections are in place, secure wires to the board at captive areas at the end of the card. Nylon tie wraps (not included) work well for this purpose.

### Card Configuration

The header shunt must be set on the proper JP1 position for the intended address. The table shows the 4 choices available. (**Note**: in multiple card systems, only 1 card at a time can have any given setting).

Set JP1 header for the desired base address by placing the shunt jumper in one of the positions noted in the table (A to D). JP1 is labeled ADDRESS SELECT and is located at the card's lower left side. The hex value can be used in custom programming to access a particular card.

| Address Select | Hex Value |
|---|---|
| A | 0x63 |
|   | 0x67 |
| B | 0x6B |
|   | 0x6F |
| C | 0x73 |
|   | 0x77 |
| D | 0x7B |
|   | 0x7F |

### *DaqBook/DaqBoard Connection*

The DBK20 or DBK21s attach to the DaqBook/DaqBoard's P2 digital I/O connector.

1. If using the optional DBK10 enclosure, slide the DB37 end of the board into a rear opening, and secure with hold-in screw-washer at rear panel.
2. Connect an accessory ribbon cable (with -x indicating the number of cards to be connected) from the digital I/O port (P2) of the Daq* to the DB37 connector at the end of the option card. **Note**: A series of interface cables are available for connection of up to 4 DBK20 or DBK21 option cards.

### *DaqBook/DaqBoard Configuration*

There are no hardware configuration setups internal to the DaqBook/DaqBoard to allow expanded TTL I/O usage.

## Software Setup in DaqView

To use the DBK20 or DBK21 Expansion card within DaqView, you must first configure the DaqView software with the hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings.

Under Digital Option cards (on right side of screen), select DBK20 or DBK21 in one of the P2 channels. Your selection will take up two of the 8 base channels. When channels are set, select OK and return to the main menu. Now select the Digital I/O icon from below the pull-down menu (fifth from the right). The Digital I/O window will display. Select the desired parameters and then Execute.

## Programming a DBK20/21

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the DBK20 or DBK21 expansion card.

```
daqDigGetConf(1, 0, 1, 1, &conf);  /*port B = output, port A & C = input*/
daqDigConf(DdcExp0, conf);
daqDigWtByte(DdpExp0B, 55);
daqDigRdByte(AdpExp0A, &byte);
```

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK20 - Specifications

**Name/Function: General Purpose Digital I/O Card**
**Number of Channels**: 48 I/O channels
**Connector**: Screw terminals
**Device**: 82C55 x 2
**Output Voltage Levels**:
  Minimum "1" Voltage: 3.0 @ 2.5 mA sourcing
  Maximum "0" Voltage: 0.4 @ 2.5 mA sinking

**Output Currents**:
  Maximum Source Current: 2.5 mA
  Maximum Sink Current: -2.5 mA
**Input Voltage Levels**:
  Minimum Required "1" Voltage Level: 2.0 V
  Maximum Allowed "0" Voltage Level: 0.8 V
**Output Float Leakage Current**: 10 µA

## DBK21 - Specifications

**Name/Function: General Purpose Digital I/O Card**
**Number of Channels**: 48 I/O channels
**Connector**: DB37 male, corresponds to DaqBook series P2
  pinout & to DigiBook P1, P2, P3 pinouts
**Device**: 82C55 x 2
**Output Voltage Levels**:
  Minimum "1" Voltage: 3.0 @ 2.5 mA sourcing
  Maximum "0" Voltage: 0.4 @ 2.5 mA sinking

**Output Currents**:
  Maximum Source Current: 2.5 mA
  Maximum Sink Current: -2.5 mA
**Input Voltage Levels**:
  Minimum Required "1" Voltage Level: 2.0 V
  Maximum Allowed "0" Voltage Level: 0.8 V
**Output Float Leakage Current**: 10 µA

# DBK23 Isolated Digital Input Chassis

## Overview

The DBK23 is a 3-port by 8-bit digital input chassis that connects to the DaqBook/DaqBoard's P2 Digital I/O Port. The DBK23 provides 500 V isolation from the DaqBook/DaqBoard system and also from channel-to-channel. Up to 8 DBK23s can attach to the DaqBook/DaqBoard (not the Daq PC-Card), offering up to 192 bits of isolated digital input.

The DBK23 provides screw terminal access to each of its 24 isolated inputs. A slide-out PCB allows easy access to the controls and connectors. The input circuitry allows input voltages ranging from 0 to 30.0 V. **Note**: the local digital I/O cannot be used while any DBK23s are attached.
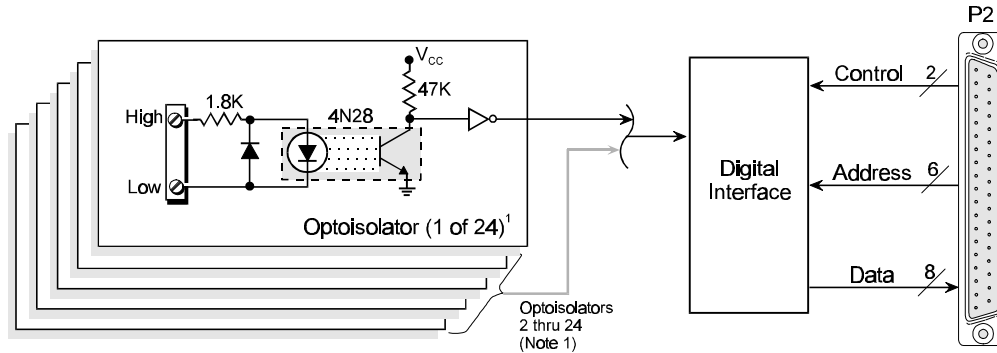


[1]The optoisolator illustrated is typical of the remaining 23 optoisolators.

*DBK23 Block Diagram*

## Power Requirements

The DBK23 can be powered by an included AC adapter, a standard 12-V car battery, or an optional rechargeable nickel-cadmium battery module (DBK30A). This power flexibility makes the DBK23 ideal for field and remote data acquisition applications.

Power supplied to the DBK23 powers the on-board regulator. Connect the power supply (AC adapter) to the 5-pin DIN (labeled POWER IN) located on the front panel of the DBK23 chassis. Note the two power indicators on the rear panel of the DBK23. Check that both SYSTEM and LOCAL power LEDs are on at all times during operation. The second 5-pin DIN connector (labeled POWER OUT) can be cascaded to another DaqBook/DaqBoard accessory. A single power source can supply multiple DBK23 units. **Note**: When daisy-chaining power, be careful not to overload the supply.



*Daisy-chaining Power to DBK23s*
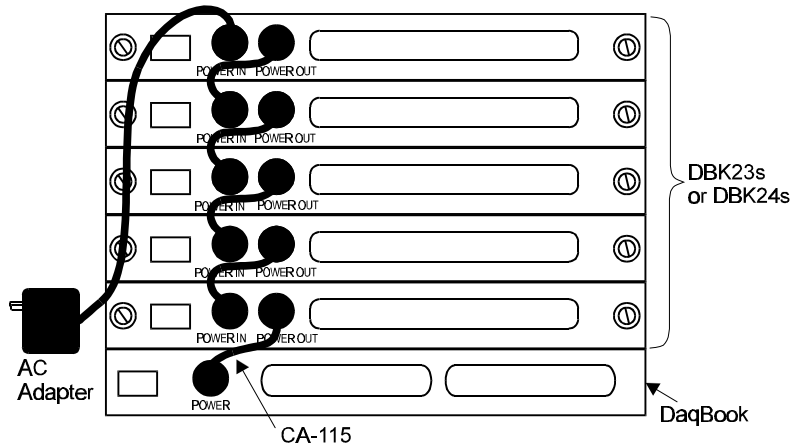
# Hardware Setup

### Card Connection

Open the DBK23 case by loosening the two retaining screws on the chassis front panel. Slide out the DBK23 board in order to connect wires to terminal blocks. Each input channel (or bit) is equipped with a discrete two-pole screw terminal block for isolated HI and LOW termination. The terminals accept 12 to 22 AWG wire. Insulated wire types selected should meet or exceed 500 V isolation specifications.



*Typical Circuit Use*

Strip insulation from the ends of wires (no more than 1/4"). Insert wire into the screw terminal receptacle so that only the bare portion of wire extends into the opening. Bare wire should not extend more than 1/16" beyond the receptacle. These steps are essential to maintaining proper voltage isolation. Once the wire ends are in place, turn the slot head screw at the top of the block until the receptacle grips the wire firmly. Do not over tighten. Captive holes have been placed in appropriate locations to secure groups of wires to the board. Nylon lock ties (not included) work well for this purpose.



*DBK23 Card/Signal Connection*

### Card Configuration

The DaqBook/DaqBoard can support up to eight DBK23s in a daisy-chain configuration using an accessory cable. Each unit is then configured via the on-board DIP switch (S1) for its unique base ad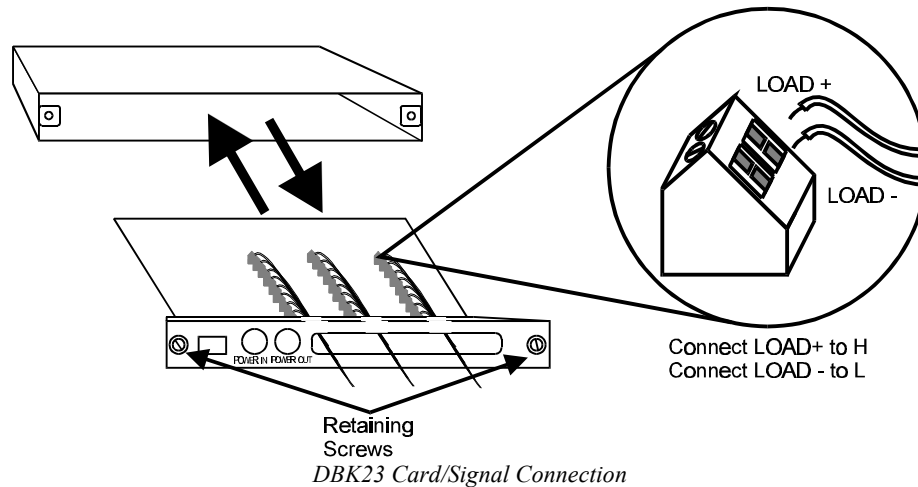dress. No more than one unit in a common chain may have the same S1 setting. Below is a table of possible switch settings and addresses. The XI/O addresses can be used by programmers to access specific ports on specific cards.

**Software Note**: Software constants have been predefined in the API as follows: DdpExpnA; DdpExpnB; DdpExpnC. Where "n" is replaced by the card number shown in the address table; and A, B, or C is the port for that card.

| Card No. | S1 Configuration | | | XI/O Address Value (Hex) | | |
|---|---|---|---|---|---|---|
| | C | B | A | Port C | Port B | Port A |
| 0 | 0 | 0 | 0 | 0x62 | 0x61 | 0x60 |
| 1 | 0 | 0 | 1 | 0x66 | 0x65 | 0x64 |
| 2 | 0 | 1 | 0 | 0x6A | 0x69 | 0x68 |
| 3 | 0 | 1 | 1 | 0x6E | 0x6D | 0x6C |
| 4 | 1 | 0 | 0 | 0x72 | 0x71 | 0x70 |
| 5 | 1 | 0 | 1 | 0x76 | 0x75 | 0x74 |
| 6 | 1 | 1 | 0 | 0x7A | 0x79 | 0x78 |
| 7 | 1 | 1 | 1 | 0x7E | 0x7D | 0x7C |

### DaqBook/DaqBoard Connection

Connect the P2 digital I/O port of the DaqBook/DaqBoard to the P2 connector of the DBK23 using an accessory cable. Select up to 8 positions for a total of 192 programmable isolated inputs.
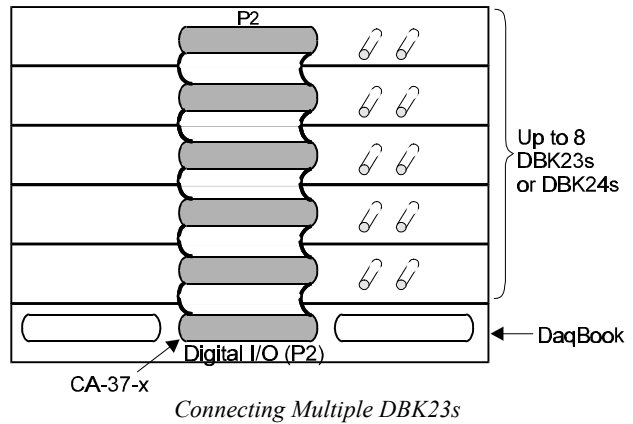


*Connecting Multiple DBK23s*

### DaqBook/DaqBoard Configuration

There are no hardware configuration setups internal to the DaqBook/DaqBoard required for the DBK23.

## Software Setup in DaqView

To use the DBK23 within DaqView, you must first configure the DaqView software with the hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings.

Under Digital Option cards (on right side of screen), select DBK23 in one of the P2 channels. When channels are set, select OK and return to the main menu. Now select the Digital I/O icon from below the pull-down menu (fifth from the right). The Digital I/O window will display. Select the desired parameters and Execute.

## Programming a DBK23

**Note**: Users of DaqView or other turnkey packages can skip this section.

The DBK23 uses three simple function calls (common to all languages) to exercise all functions of the DBK23. The calls and their definitions are listed below.

> daqDigConf%     Configures the DaqBook/DaqBoard system for expanded digital operation.
> daqDigRdBit%    Reads a single isolated input.
> daqDigRdByte%   Reads all eight bits of a single port of isolated inputs.

For more information about function calls and definitions, see the language interface file installed by the DaqBook/DaqBoard driver for the desired language and refer to the *Programmer s Manual*.

The following QuickBASIC programs configure the DaqBook/DaqBoard system for expanded digital operation and read all eight isolated inputs of a single port on a single DBK23.

> DIM ByteVal%   Declare the variable to store the read value.
> REM% = QBdaqDigConf% ( &H63,0 )
> > Configure the DaqBook/DaqBoard system for expanded digital operation by configuring for the first expanded output address. Since there is no actual port at this address, the second argument may be null.
> REM% = QBdaqDigRdByte% ( &H60, ByteVal% )
> > Read the Byte Value of port A of expansion unit #0 and store the value in the variable ByteVal%

- OR -

> DIM BitVals%( 8 )           Dimension array to store 8 individual bit values.
> REM% = QBdaqDigConf% ( &H63,0 )
> > Configure the DaqBook/DaqBoard system for expanded digital operation.
> FOR n% = 0 TO 7           Start For/Next loop to sequentially read 8 bits.
> REM% = QBdaqDigRdBit%( &H63, n%, BitVals%(n%)
> NEXT n%           In this example, n% specifies the bit number (0..7)

# DBK23 - Specifications

**Name/Function: General Purpose Optically Isolated Digital Input Module**
**Channels**: 24 I/O channels
**Connector**: Screw terminals for signal outputs
**Input Voltage Levels**:
    **Range**: 3 to 30 VDC
    **Input Current**: 1.5 to 15 mA
    **Operating Voltage Range**: 9 to 24 VDC

**Module Power Requirements**: 0.25 W; AC adapter included
**120 VAC Adapter Supplied**: 15 VDC @ 0.9 A
**Isolation Voltage**:
    **Channel-to-channel**: 500 V
    **Channel-to-system**: 500 V
**Channel Address**: Set by DIP switch

# DBK24 Isolated Digital Output Chassis

## Overview

The DBK24 is a 3×8-channel digital output chassis that connects to the DaqBook/DaqBoard's P2 Digital I/O Port.  The DBK24 provides 500 V isolation from the system and from channel-to-channel.  Up to 8 DBK24s can attach to the DaqBook/DaqBoard (not the Daq PC-Card), offering up to 192 bits of isolated digital output.
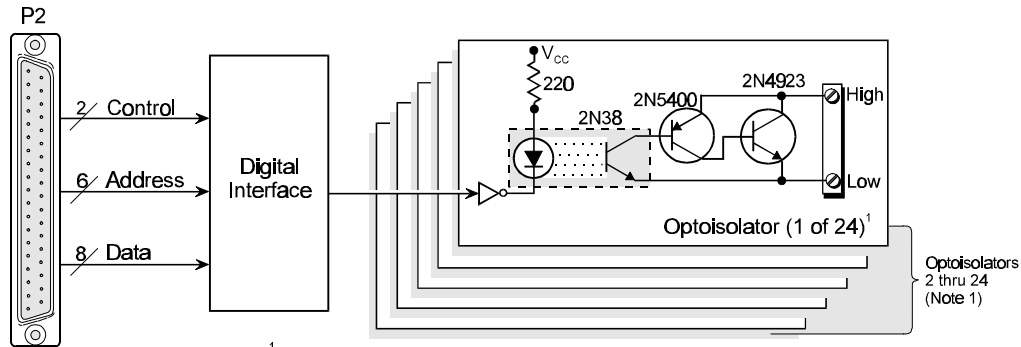


*DBK24 Block Diagram*

The DBK24 provides screw-terminal access to each of its 24 isolated outputs.  A slide-out PCB allows easy access to the controls and connectors.  The output circuitry allows output voltages as high as 60 V at currents up to 1 A.  **Note**: the local DaqBook/DaqBoard digital I/O cannot be used while any DBK24s are attached.

## Power Requirements

The DBK24 can be powered by an included AC adapter, a standard 12-V car battery, or an optional rechargeable nickel-cadmium battery module (DBK30A).  This power flexibility makes the DBK24 ideal for field and remote data acquisition applications.

Power supplied to the DBK24 powers the on-board regulator.  Connect the power supply (AC adapter) to the 5-pin DIN (labeled POWER IN) located on the front panel of the DBK24 chassis.  Note the two power indicators on the rear panel of the DBK24.  Check that both SYSTEM and LOCAL power LEDs are on at all times during operation.  The second 5-pin DIN connector (labeled POWER OUT) can be cascaded to another DaqBook/DaqBoard accessory.  A single power source can supply  multiple DBK24 units.  **Note**: When daisy-chaining power, be careful not to overload the supply.
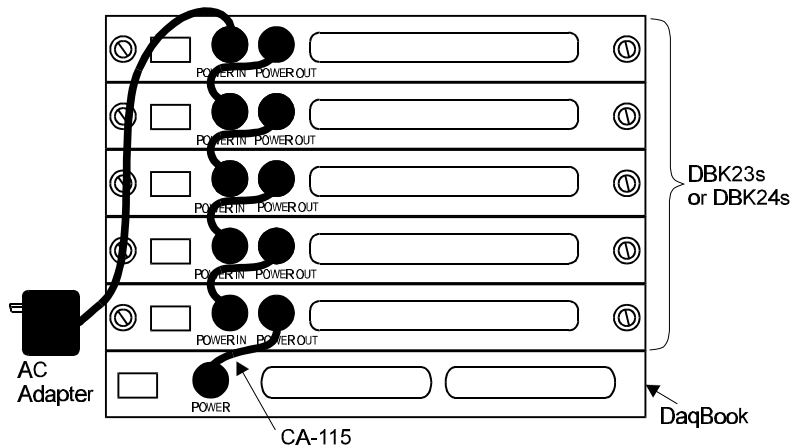


*Daisy-chaining Power to DBK24s*

# Hardware Setup

### *Card Connection*

Open the DBK24 case by loosening the two retaining screws on the chassis front panel. Slide out the DBK24 board in order to connect wires to terminal blocks. Each input channel (or bit) is equipped with a discrete two-pole screw terminal block for isolated HI and LOW termination. The terminals accept 12 to 22 AWG wire. Insulated wire types selected should meet or exceed 500 V isolation specifications.



*Typical Circuit Use*



*DBK24 Card/Signal Connection*

Strip insulation from the ends of wires (no more than 1/4"). Insert wire into the screw terminal receptacle so that only the bare portion of wire extends into the opening. Bare wire should not extend more than 1/16" beyond the receptacle. These steps are essential to maintaining proper voltage isolation. Once the wire ends are in place, turn the slot head screw at the top of the block until the receptacle grips the wire firmly. Do not over tighten. Captive holes have been placed in appropriate locations to secure groups of wires to the board. Nylon lock ties (not included) work well for this purpose.

### *Card Configuration*

#### Presetting the Outputs

Each of the 24 outputs of the DBK24 can be configured to be ON or OFF at system power-on time. Each port has an 8-pole DIP switch. Before applying power to the DaqBook/DaqBoard or the DBK24, locate the DIP switch for the bit you wish to preset. Move the switch to the desired state for the output when powered on. First power on the DBK24, then the DaqBook/DaqBoard. All outputs will be operating in accordance with their corresponding DIP switch as shown in the figure. **Note**: The first write command received by the DBK24 will override the switch settings until the unit is again power-cycled. Subsequently, until the first write command is received, the switches may also be used to control the outputs.
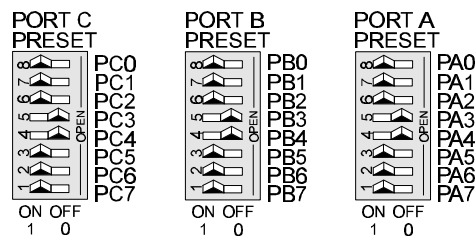


*Setting DBK24 DIP Switches*

### User Output Configuration

The outputs of the DBK24 are designed to switch levels as high as 60 V at 1 A. The next figure shows a typical output hookup with a protective flyback diode in parallel with the load. When driving inductive loads without built-in flyback protection, you must provide this diode. **Failure to provide adequate flyback protection may result in damage to the output stage of the DBK24.**
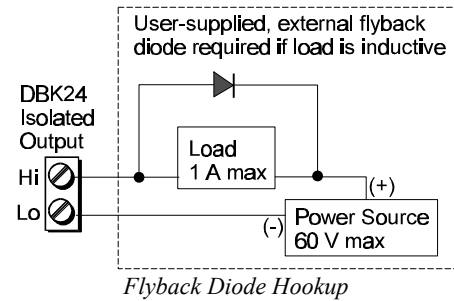


*Flyback Diode Hookup*

Each unit is then configured via the on-board DIP switch (S1) for its unique base address. No more than one unit in a common chain may have the same S1 setting. Below is a table of possible switch settings and addresses.

| Card No. | S1 Configuration | | | Address Value (Hex) | | |
|---|---|---|---|---|---|---|
| | C | B | A | Port C | Port B | Port A |
| 0 | 0 | 0 | 0 | 0x62 | 0x61 | 0x60 |
| 1 | 0 | 0 | 1 | 0x66 | 0x65 | 0x64 |
| 2 | 0 | 1 | 0 | 0x6A | 0x69 | 0x68 |
| 3 | 0 | 1 | 1 | 0x6E | 0x6D | 0x6C |
| 4 | 1 | 0 | 0 | 0x72 | 0x71 | 0x70 |
| 5 | 1 | 0 | 1 | 0x76 | 0x75 | 0x74 |
| 6 | 1 | 1 | 0 | 0x7A | 0x79 | 0x78 |
| 7 | 1 | 1 | 1 | 0x7E | 0x7D | 0x7C |

**Software Note**: Software constants have been predefined in the DaqBook/DaqBoard driver language interface files for all languages as follows: DdpExpnA, DdpExpnB, DdpExpnC; where "n" is replaced by the card number in the address table; and A, B, or C is the port for that card.

### *DaqBook/DaqBoard Connection*

Connect the P2 digital I/O port of the DaqBook/DaqBoard to the P2 connector of the DBK24 using an accessory cable (with -x indicating the number of expansion units to be connected). Select up to 8 positions for a total of 192 programmable isolated inputs.



*Connecting Multiple DBK24s*
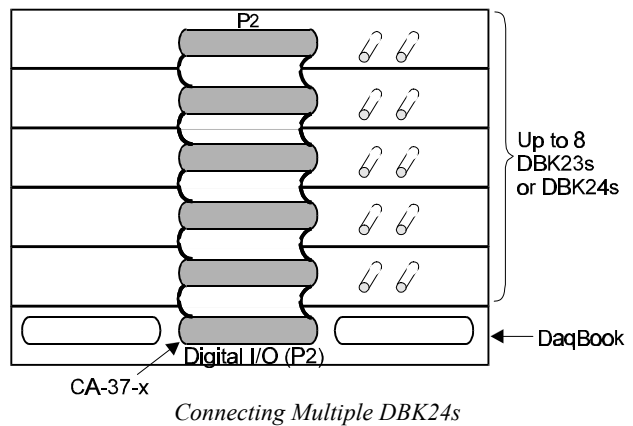
### *DaqBook/DaqBoard Configuration*

The DBK24 requires no hardware configuration setups internal to the DaqBook/DaqBoard.

## Software Setup in DaqView

To use the DBK24 within DaqView, you must first configure the DaqView software with the hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings.

Under Digital Option cards (on right side of screen), select DBK24 one of the P2 channels. When channels are set, select OK and return to the main menu. Now select the Digital I/O icon from below the pull-down menu (fifth from the right). The Digital I/O window will display. Select the desired output and then Execute.

## Programming a DBK24

**Note**: Users of DaqView or other turnkey packages can skip this section.

The DBK24 uses three simple function calls (common to all languages) to exercise all functions of the DBK24. The calls and their definitions are listed below.

daqDigConf%    Configures the DaqBook/DaqBoard system for expanded digital operation.
daqDigRdBit%    Reads a single isolated input.
daqDigRdByte%  Reads all eight bits of a single port of isolated inputs.

For more information about function calls and definitions, see the language interface file installed by the DaqBook/DaqBoard driver for the desired language and refer to the separate *Programmer s Manual*.

The following QuickBASIC programs configure the DaqBook/DaqBoard system for expanded digital operation and read all eight isolated inputs of a single port on a single DBK24.

REM% = QBdaqDigConf% ( &H63,0 )
>Configure the DaqBook/DaqBoard system for expanded digital operation by configuring for the first expanded output address. Since there is no actual port at this address, the second argument may be null.

REM% = QBdaqDigRdByte% ( &H60, ByteVal% )
>Read the Byte Value of port A of expansion unit #0 and store the value in the variable ByteVal%

- OR -

REM% = QBdaqDigConf% ( &H63,0 )
>Configure the DaqBook/DaqBoard system for expanded digital operation.

FOR n% = 0 TO 7      Start For/Next loop to sequentially read 8 bits.
REM% = QBdaqDigRdBit%( &H63, n%, BitVals%(n%)
NEXT n%      In this example, n% specifies the bit number (0..7)


## DBK24 - Specifications

**Name/Function: General Purpose Optically Isolated Digital Output Module**
**Channels**: 24 I/O channels
**Connector**: Screw terminals for signal outputs
**Output Channel Ratings**:
   **Maximum current/channel**: 1 A
   **Voltage drop @ 1 A and 25°C**: 1 V
   **Maximum open circuit voltage**: 60 VDC
   **Off-state leakage**: 10 µA

**Module Power Requirements**: 1.5 W
**120 VAC Adapter Supplied**: 15 VDC @ 0.9 A
**Isolation Voltage**:
   **Channel-to-channel**: 500 V
   **Channel-to-system**: 500 V
**Channel Address**: Set by DIP switch
**Maximum Module Power Dissipation**:
   @ 25°C   12 W
   @ 50°C    6 W

# DBK25 8-Channel Relay Card

## Overview

The DBK25 provides 8 normally-open relay contacts for isolated switching of AC or DC loads or signals via the Daq*'s P2 digital port. The P2 digital port, operating in the expanded-I/O mode can address up to 32 DBK25s (256 relays max). The DigiBook/72, with 3 P2 ports can address 96 DBK25s for a maximum of 768 relay contacts. The relays are 2-coil sub-miniature latching relays and do not require continuous current to stay closed. Such bi-stable relays can act as an 8-bit non-volatile write-only memory byte.
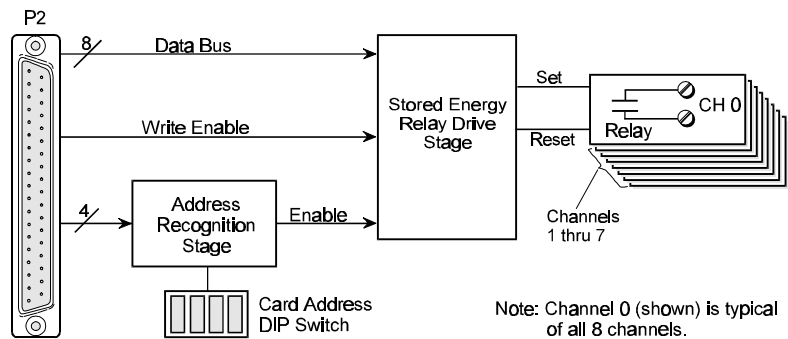


*DBK25 Block Diagram*

The steady-state power drain of the DBK25 is very low, less than 1 mA at 5 VDC. It is practical, even operating on a battery, to have hundreds of relay contacts. The stored-energy operation of the DBK25 does limit the practical on/off speed, or the ability to generate 50% duty cycles, to about 10 Hz. The actual operating time of the relays is less than 15 ms.

## Hardware Setup

### Card Connection

There are 16 screw terminals on the DBK25 to connect to 8 separate pairs of output contacts. Holes are provided at the end of the board for wire ties (not supplied) to serve as strain relief.

### Card Configuration

You must set DIP switch S1 to a 5-bit address to correspond to the desired card address. (S1 is located next to the DB37 connector.) The following table lists the switch settings for 32 system card numbers. The XI/O addresses can be used in custom programming to access specific cards.

### DaqBook/DaqBoard Configuration

No hardware configuration setups internal to the DaqBook/DaqBoard are needed for use of expanded TTL I/O.

| System Card # | XI/O Address | S1 Switch Position OPEN = OFF | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| 0 | H60 | OFF | OFF | OFF | OFF | OFF |
| 1 | H61 | OFF | OFF | OFF | OFF | ON |
| 2 | H62 | OFF | OFF | OFF | ON | OFF |
| 3 | H63 | OFF | OFF | OFF | ON | ON |
| 4 | H64 | OFF | OFF | ON | OFF | OFF |
| 5 | H65 | OFF | OFF | ON | OFF | ON |
| 6 | H66 | OFF | OFF | ON | ON | OFF |
| 7 | H67 | OFF | OFF | ON | ON | ON |
| 8 | H68 | OFF | ON | OFF | OFF | OFF |
| 9 | H69 | OFF | ON | OFF | OFF | ON |
| 10 | H6A | OFF | ON | OFF | ON | OFF |
| 11 | H6B | OFF | ON | OFF | ON | ON |
| 12 | H6C | OFF | ON | ON | OFF | OFF |
| 13 | H6D | OFF | ON | ON | OFF | ON |
| 14 | H6E | OFF | ON | ON | ON | OFF |
| 15 | H6F | OFF | ON | ON | ON | ON |
| 16 | H70 | ON | OFF | OFF | OFF | OFF |
| 17 | H71 | ON | OFF | OFF | OFF | ON |
| 18 | H72 | ON | OFF | OFF | ON | OFF |
| 19 | H73 | ON | OFF | OFF | ON | ON |
| 20 | H74 | ON | OFF | ON | OFF | OFF |
| 21 | H75 | ON | OFF | ON | OFF | ON |
| 22 | H76 | ON | OFF | ON | ON | OFF |
| 23 | H77 | ON | OFF | ON | ON | ON |
| 24 | H78 | ON | ON | OFF | OFF | OFF |
| 25 | H79 | ON | ON | OFF | OFF | ON |
| 26 | H7A | ON | ON | OFF | ON | OFF |
| 27 | H7B | ON | ON | OFF | ON | ON |
| 28 | H7C | ON | ON | ON | OFF | OFF |
| 29 | H7D | ON | ON | ON | OFF | ON |
| 30 | H7E | ON | ON | ON | ON | OFF |
| 31 | H7F | ON | ON | ON | ON | ON |

## Software Setup in DaqView

To use the DBK25 expansion card within DaqView, you must first configure the DaqView Software for the hardware configuration. From the DaqView main window, select Device from the pull-down menu and then Configure Hardware Settings. Under Digital Option cards (on the right side of screen), select DBK25. A smaller window to set channels and DIP switch S1 will appear to assist in setting up to 4 cards per channel (4×8=32 possible cards). Verify that the software settings match the intended use.

## Programming a DBK25

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to write bytes to the DBK25 expansion card.

```
daqDigWtByte(DdpPort0, 0x55)     /*write hex 55 to System Card = 0(address = H60)*/
daqDigWtByte(DdpPort17, 0xAA) /*write hex AA to System Card = 17(address = H71)*/
```

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK25 - Specifications

**Name/Function: 8-Channel Relay Output Card**
**Connectors**: Screw terminals for signal outputs
**Max Number of Cards**: 32
**Contact Rating**:
    2 A @ 28 VDC
    0.6 A @ 120 VAC
**Isolation**:
    **Channel-to-System**: 250 V
    **Channel-to-Channel**: 150 V

# DBK30A Rechargeable Battery Module

## Overview

The DBK30A contains a rechargeable nickel-cadmium battery that can power a DaqBook/DBK in portable applications. The unit's rugged metal package is the same size as a DaqBook and related DBK modules for convenient stacking with included fastener panels and Velcro tabs. **Note**: See *Power Management* at the beginning of this chapter for details how to compute power requirements.

Power input comes from the included AC adapter that converts AC mains power into 24 VDC to charge the unit's 2 battery packs. Automatic charging circuits recharge the internal batteries quickly and safely when connected to the supplied AC adapters. For trouble-free operation, you must fully charge the batteries before use. The charged battery runtime will depend, of course, on the current load and mode of operation.

The 2 modes of operation are the DBK30 and DBK31 modes (the DBK30A replaces these models). An internal slide switch SW2 determines whether the DBK30A will act as a DBK30 (default) or DBK31.

- **The DBK30 mode provides 14 VDC** for 3.4 A-hr. The typical battery runtime for DaqBook operation is from 3 to 6 hours depending on the load.
- **The DBK31 mode provides both 14 VDC and 28 VDC**. 14 VDC is used for unregulated bridge excitation for bridge-configured sensors (such as load cells) and power to DaqBook products. 28 VDC is used for loop currents for 2-wire 4-20 mA transmitters (1.7 A-hr). The battery run-time ranges from 1 to 6 hours, depending on the application and the attached option cards.

Note: Unless you need 28 V, leave the DBK30A in the default DBK30 mode. In the DBK31 mode, only 1 of the 2 battery packs provides 14 VDC (instead of both packs in parallel in the DBK30 mode); thus, runtime is reduced in the DBK31 mode.



*DBK30A Block Diagram*
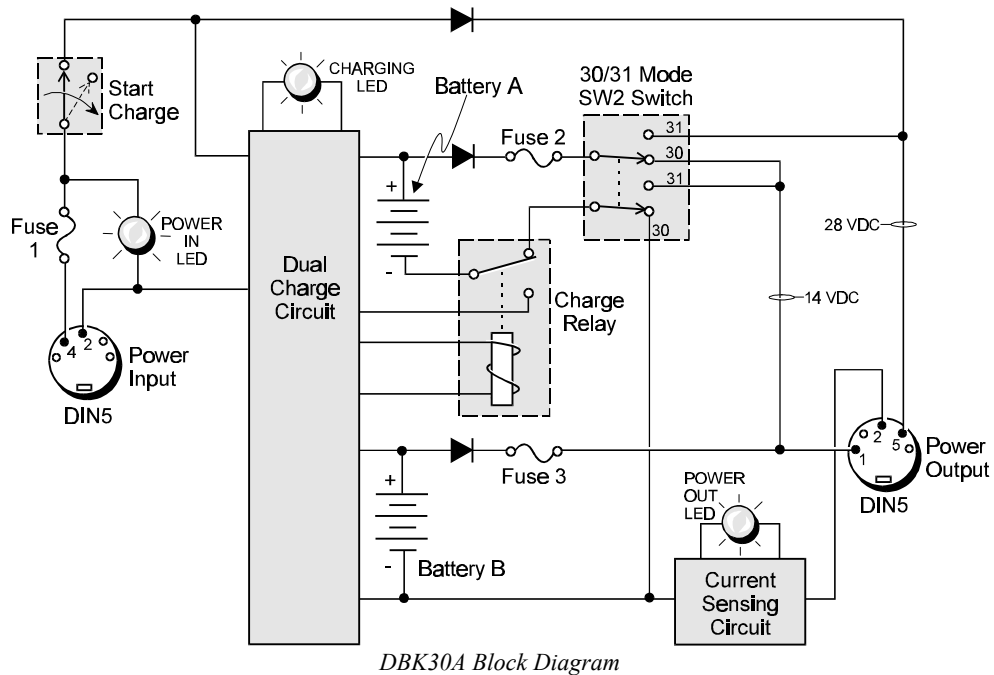
# Hardware Setup

## Configuration

The only configuration option is the choice of modes as discussed above. If you do not need to use 28 V, leave SW2 in the default position (for previously used units, you may need to verify the proper position). The SW2 slide switch is located inside the module on the printed circuit board near the front center of the unit. To configure the DBK30A's mode:

1. Remove the top cover by unscrewing one screw and sliding the cover forward until it separates from the module.
2. Locate SW2 and position it for the desired mode. Slide SW2 to the right for DBK30 operation providing 14 VDC only. Slide SW2 to the left for DBK31 operation providing both 14 and 28 VDC.
3. Replace top cover and secure with screw.

## Connection

The figure shows the pinout for the POWER OUT DIN5 connector. The 28 V pin is only active in the DBK31 mode. The 14 V pin is always active.
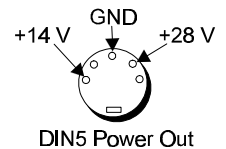


The DBK30A package includes a short connecting cable (CA-115) to connect to the DaqBook. This cable connects the POWER OUT connector on the DBK30A to the POWER IN connector on the DaqBook (see next figure).



*DBK30A to DaqBook Connection*
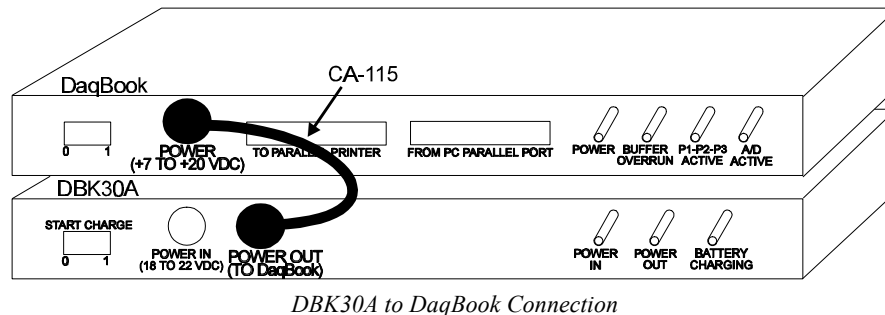
# Connections for the DBK31 Mode

The primary purpose of the DBK31 mode is to power external user-supplied loop transmitters. The hookup is simple, as shown below. A DIN5 connector allows easy connection of lead wires.



*Connecting Lead Wires*
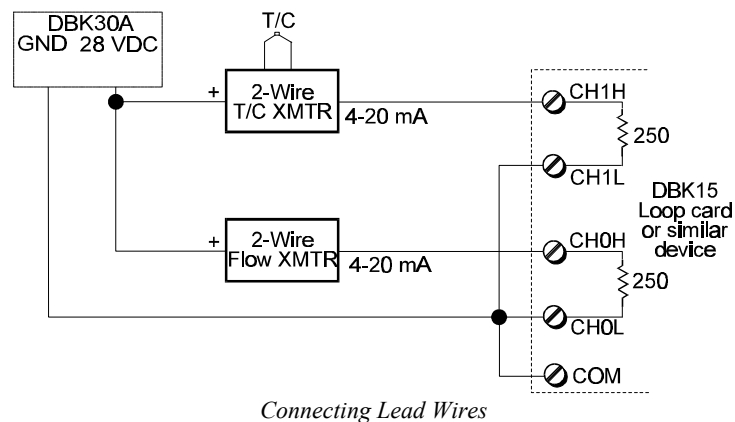
Another use for the DBK31 mode is providing an excitation source for bridge-type sensors such as load cells (strain gages).  The excitation voltage is not regulated by the DBK30A; so, this voltage must be externally regulated to 10.00 V for most load cells.



*Using Load Cells*
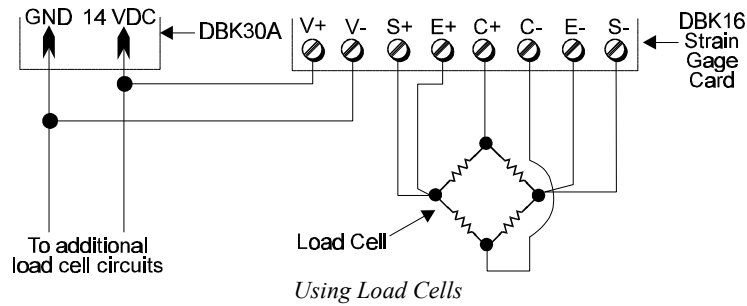
## Charging the Battery Module

The DBK30A package includes a charger for the intended line voltage (120 VAC or 230 VAC).  To charge the battery module, plug the output cable from the charger into the POWER IN connector on the DBK30A, and plug the charger into AC power.  The charge cycle begins automatically whenever AC power is applied after an interruption.  The charge cycle ends when the batteries are fully charged.



*Connecting the Charger*
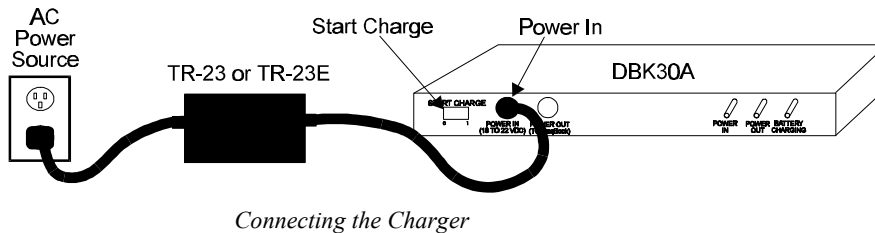
To manually initiate a charge cycle, press the START CHARGE momentary rocker-arm switch. Subsequent charge cycles applied to a fully-charged DBK30A will have no ill effect.  The module will sense the fully-charged status and revert to the trickle-charge state within a few minutes.

Three LEDs on the DBK30A provide status information on the charging process or the external load.

| LED | Meaning |
|---|---|
| POWER IN | Illuminates when the charger is connected to a source of AC power and to the battery module. |
| BATTERY CHARGING | Illuminates steadily while battery is in the high current (2 A) charge mode.  Flashes briefly, one or two flashes at a time, when the internal batteries are fully charged. |
| POWER OUT | Illuminates steadily when an external DaqBook product is connected and drawing current from the battery modules. |

## CAUTION

⚠ The DBK30A must periodically be fully discharged or the cells may develop   lazy chemistry   that may limit storage capacity. (This   memory   is characteristic for nickel-cadmium batteries.)  To manually discharge a battery pack, connect a DaqBook and leave it turned on until the indicator lights go dark.

## Using the Battery Module While Charging

Both operating modes are capable of powering the DaqBook products while being charged; however, the charging current is reduced, and charging time is increased. If AC power is interrupted, a new charge cycle will begin automatically when AC power returns.

| CAUTION |
| --- |
| ⚠ Even with the AC adapter, the batteries will eventually discharge under a DaqBook operating load. Charging DOES NOT BEGIN AUTOMATICALLY (except on power-up). You must manually initiate the next charge cycle. Do not expect a DaqBook powered by a DBK30A to operate indefinitely. |

## DBK30A - Specifications

**Name/Function: Rechargeable Battery Module**
**Battery Type**: Nickel-cadmium
**Number of Battery Packs**: 2
**Battery Pack Configuration**: 12 series-connected sub-C cells
**Output Voltage**: 14.4 V or 28.8 V (depending on the selected mode)
**Output Fuses**: 2 A

**Battery Amp-Hours**: 3.4 A-hr (1.7 A-hr/pack)
**Charging Voltage from Supplied AC Adapter**: 22 to 26 VDC @ 2 A
**AC Adapter Input**: 95 to 265 VAC @ 47 to 63 Hz
**Charge Time**: 2 hours
**Charge Termination**: Peak detection
**Size**: 11" long × 8 1/2" wide × 1 3/8" high

# DBK32A Auxiliary Power Supply Card

## Overview

The DBK32A provides added power in configurations where the number of expansion cards exceeds the power available from a DaqBook/DaqBoard or CDK10. For power, the DBK cards rely on voltages supplied via the P1 connection. The DBK32A supplies ±15 V via the P1 bus and is compatible with all analog DBK cards. **Notes**: The DBK32A does not provide +5 V; if +5 V is required by the DBKs in use, you should use the DBK33 Triple-Output Power Supply Card. See *Power Management* at the beginning of this chapter for details how to compute your power requirements.
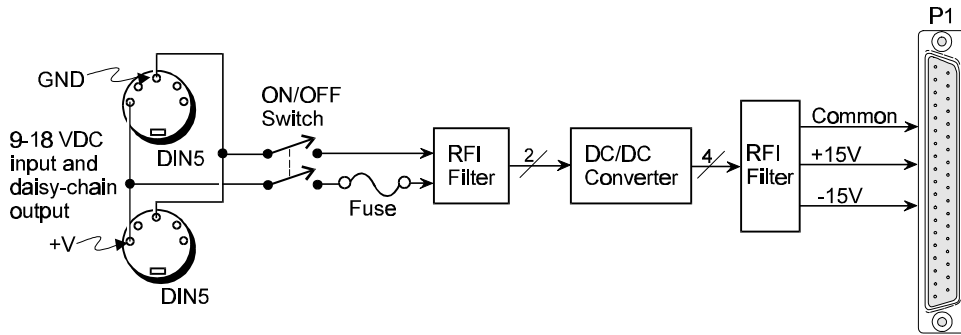


*DBK32A Block Diagram*

## Hardware Setup

| CAUTION |
|---|
| ⚠ **You must configure the DaqBook/DaqBoard before connecting the DBK32A. Do not connect the P1 cable without first removing the shunt jumpers from JP1 inside the DaqBook/DaqBoard. Failure to remove these jumpers can result in damage to the DBK32A and/or DaqBook/DaqBoard.** |

### DaqBook/DaqBoard Configuration

Using a DBK32A requires you to entirely remove the shunt jumpers from header JP1 inside the DaqBook/DaqBoard, as shown in the figure. DaqBook/DaqBoards are shipped with these shunts positioned to deliver analog power to P1. **The JP1 default position will not work with a DBK32A**. The DBK32A power supply must not be connected until these shunt jumpers have been removed or equipment damage will result.



*Auxiliary Power Configuration*

**Caution**: Do not place jumpers on the -OCTOUT and -OCKLIN pins. If so connected, damage to the 8254 timer chip will result.
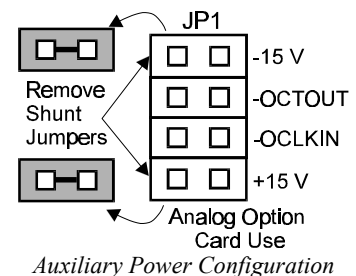
### DaqBook/DaqBoard Connection

The DBK32A has two DIN5 power connectors to allow daisy-chaining of multiple DBK32As or to share a common power source with a DaqBook/DaqBoard. The DBK32A can be powered from the included AC adapter, a DBK30A battery module, or a 10-20 VDC source (e.g., a car battery).

Connect the DBK32A much like any other expansion card on a ribbon cable or inside an expansion chassis. The DBK32A can be installed directly into the DaqBook/112/216's internal expansion slot or used with a 3-Slot DBK10 or a 10-Slot DBK41 expansion chassis.

> **Note**: The DBK32A is shipped from the factory with a protective shield. A DBK32A will not install into a DBK10 or a DaqBook/112/216 expansion slot with the shield in place. To remove this shield, remove the five screws from the bottom side of the DBK32A board and lift off the shield and spacers as one unit. For all other applications, leave the shield in place.

Guidelines for positioning a DBK32A include:
- Any slot within the DBK10 may be used.
- If a 3-port DaqBook (/100/120/200) is used with a DBK41, the right-hand end slot of the DBK41 is the best location for the DBK32A.

This figure shows example systems using a DBK32A and a cascading power connection.
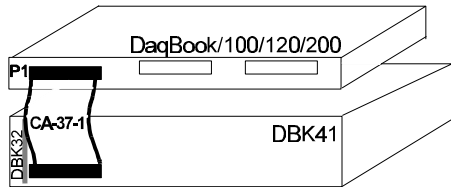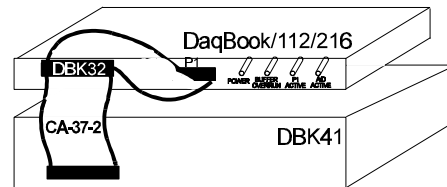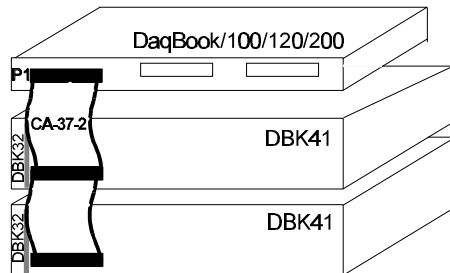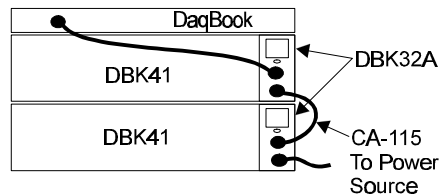


*Connecting the DBK32A*

## DBK32A - Specifications

**Name/Function**: Auxiliary Power Supply Card
**Isolation, Input to Output**:
  DBK32A: 500 VDC
  (DBK32: 250 VDC)
**Output Voltages**:
  **DBK32A**: +15 VDC (nominal) @ 500 mA
         -15 VDC (nominal) @ 500 mA
  (**DBK32**: +15 VDC (nominal) @ 250 mA
         -15 VDC (nominal) @ 250 mA)
**Line Regulation**: 0.5% (maximum)
**Load Regulation**: 1.0% (maximum)
**Total Output Power**: 7.5 VA (full load)
**Input Voltage Range**: 10-24 VDC

**Input Current Range**: 0.8 - 2.0 A
**Size**: 3-1/4" × 8-1/4" × 3/4"
**Efficiency**: 60% Typical
**Input Connections**: DIN-5 (×2 for daisy-chaining)
**Output Connections**: DB37 Male
**Parallel Provision**: OR-ing diodes in output lines
**Controls**: ON/OFF rocker arm switch
**Indicators**: LED driven by positive output
**Over-Voltage Protection**: Hardware SCR crowbar on (+) side
**Switching Frequency**: 150 kHz
**Operating Temperature Range**: 0-50°C
**Input Fuse Size**: 2 A (Littlefuse 251002)

# DBK33 Triple-Output Power Supply Card

## Overview

The DBK33 provides added power (±15 VDC and +5 VDC) via P1 in configurations where the expansion cards require more power than available from a DaqBook/DaqBoard or other power source.  The card is compatible with all analog DBK cards and typically can support up to 12 DBK cards.  **Notes**: If +5 V is not needed by the DBKs in use, you can use the DBK32A.  See *Power Management* at the beginning of this chapter for details how to compute power requirements.
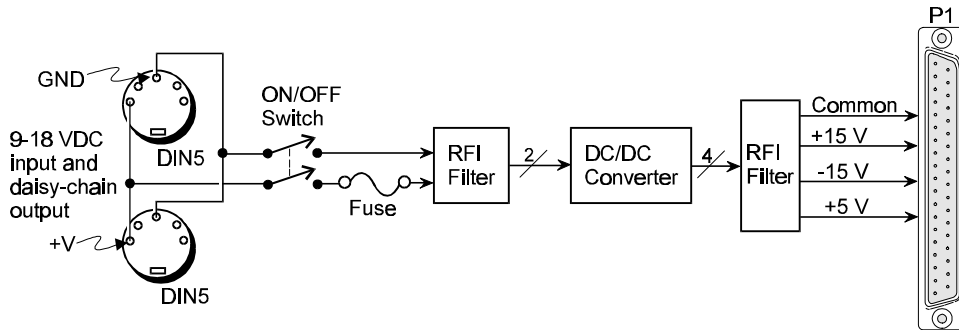


*DBK33 Block Diagram*

## Hardware Setup

> ## CAUTION
>
> **You must configure the DaqBook/DaqBoard before connecting the DBK33.  Do not connect the P1 cable without first removing the shunt jumpers from JP1 inside the DaqBook/DaqBoard.  Failure to remove these jumpers can result in damage to the DBK33 and/or DaqBook/DaqBoard.**

### DaqBook/DaqBoard Configuration

Using a DBK33 requires you to entirely remove the shunt jumpers from header JP1 inside the DaqBook/DaqBoard, as shown in the figure. DaqBook/DaqBoards are shipped with these shunts positioned to deliver analog power to P1.  **The JP1 default position will not work with a DBK33**.  The DBK33 power supply must not be connected until these shunt jumpers have been removed.



*Auxiliary Power Configuration*

**Caution**: Do not place jumpers on the -OCTOUT and -OCKLIN pins.  If so connected, damage to the 8254 timer chip will result.
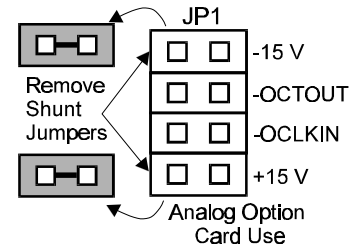
### DaqBook/DaqBoard and Cascading Power Connection

The DBK33 has 2 DIN5 power connectors to allow daisy-chaining of multiple DBK33s or to share a common power source with a DaqBook/DaqBoard.  The DBK33 can be powered from the included AC adapter, a DBK30A battery module, or a 9-18 VDC source (e.g., a car battery).

Connect the DBK33 much like any other expansion card in a 10-Slot DBK41 expansion chassis.  If a 3-port DaqBook (/100/120/200) is used with a DBK41, the right-hand end slot of the DBK41 is the best location for the DBK33.

**Note: A jumper on the motherboard of the DBK41 must be removed to disconnect the host s P1 +5 VDC from the internal +5 VDC output.**

This figure shows example systems using a DBK33 and a cascading power connection.
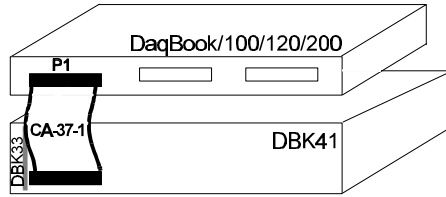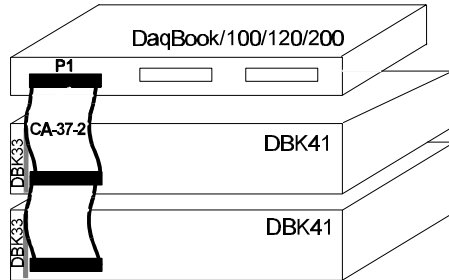


Connecting the DBK33

## DBK33 - Specifications

**Name/Function: Triple-Output Power Supply Card**
**Isolation, Input to Output**: 500 VDC
**Output Voltages**:
  +15 VDC nominal @ 250 mA
  -15 VDC nominal @ 250 mA
  +5 VDC nominal @ 1000 mA
**Line Regulation**: 0.2% max (+5 V); 5% max (±15 V)
**Load Regulation**: 0.5% max (+5 V); 5% max (±15 V)
**Total Output Power**: 15 VA (full load)
**Input Voltage Range**: 9 to 18 VDC
**Included AC Adapter**: 15 VDC @ 0.9 A
**Size**: 3-1/4" × 8-1/4" × 3/4"
**Full-Load Efficiency**: 80% Typical

**Full-Load Input Current Range**:
  2.10 A @ 9VDC
  1.05 A @ 18 VDC
**Input Connections**: DIN5 (×2 for daisy-chaining)
**Output Connections**: DB37 Male
**Parallel Provision**: OR-ing diodes on output lines allow use of multiple DBK33s in larger systems
**Controls**: ON/OFF rocker-arm switch
**Indicators**: LED driven by input voltage
**Over-Voltage Protection**: Fuse followed by 19 V zener clamp
**Switching Frequency**: 100 kHz min
**Operating Temperature Range**: -20 to 70°C
**Input Fuse**: 3 A (Littelfuse 251003)

# DBK34  Vehicle UPS Module

## Overview

The DBK34 can power a data acquisition system in portable and in-vehicle applications (both 12 and 24 V systems).  Power storage capacity is 5 A-hr @ 12 VDC or 2.5 A-hr @ 24 VDC.  For reliable data acquisition in a vehicle, the DBK34 provides clean and consistent operating power:

- Prior to engine/generator start
- During engine start-up (battery sag due to the high-current demand of starter motor and solenoid)
- After engine turn off.

The DBK34 contains 2 sealed-lead rechargeable batteries and associated charging circuits and current indicators.  Typically, these batteries can last more than 300 full cycles and up to 10 years standby lifetime at room temperature.  Recharging is fast, and extreme temperature performance is good.  The DBK34 can be used with the LogBook, DaqBook, WaveBook, and related DBKs and WBKs.  The unit's rugged metal package has a compatible 8×11" footprint for convenient stacking with Velcro tabs and optional fastener panels and handles for carrying.

Main and auxiliary power input comes from 12 or 24 VDC via a terminal block on the unit's front panel (12/24 V modes are set by front-panel jumpers).  Automatic charging circuits recharge the internal batteries quickly and safely.  For trouble-free operation, you must fully charge the batteries before use.  The charged battery runtime will depend on the load and mode of operation.  **Note**: See *Power Management* at the beginning of this chapter for details how to compute power requirements.
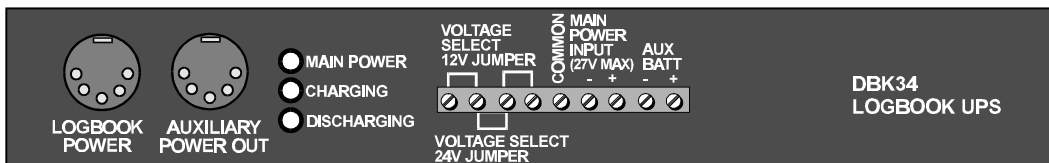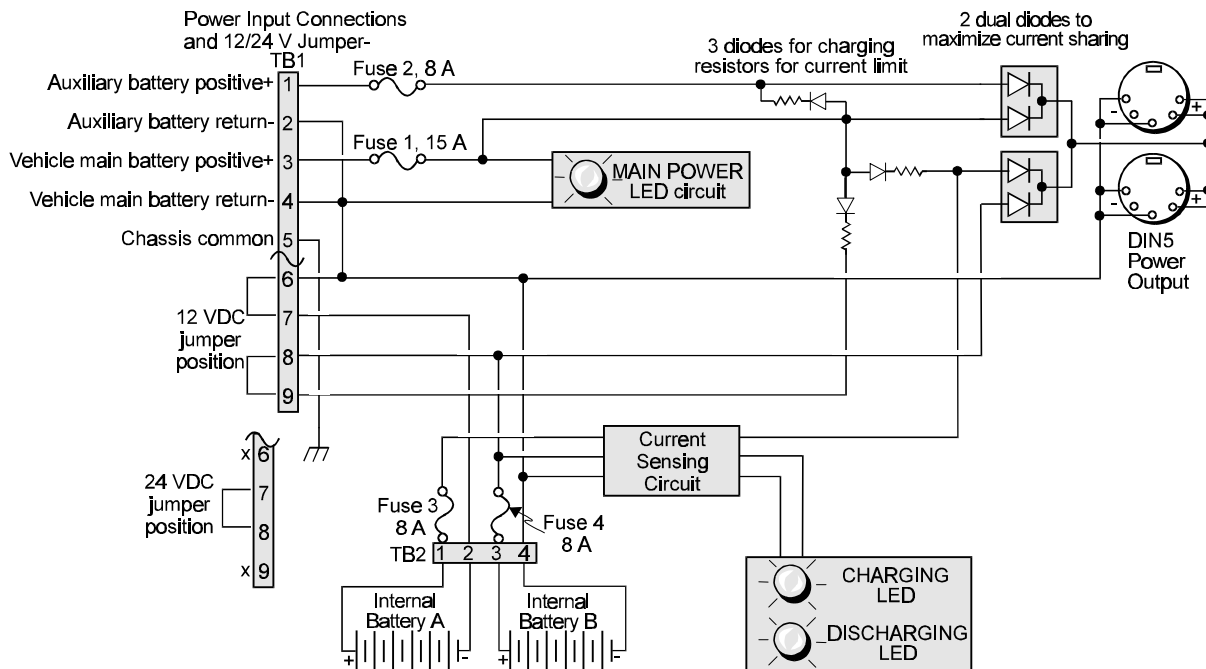


*DBK34 Block Diagram and Front Panel*

**Note**: TB1 pin numbers read from right to left as viewed from the front panel.

## Hardware Setup

### *Configuration*

The 12 or 24 V configurations are selected as follows:
- for 12 V operation, set 2 jumpers on terminals 6-7 and 8-9 of TB1
- for 24 V operation, set 1 jumper on terminals 6-7 of TB1

### *Connection*

Power In - (vehicle main/auxiliary batteries, 12 or 24 VDC only) Connect main battery positive to terminal 3 of TB1 and main negative to terminal 4. If an auxiliary battery is used, connect its positive to terminal 1 and negative to terminal 2.



*DBK34's DIN5 power output connectors (2 sockets)*
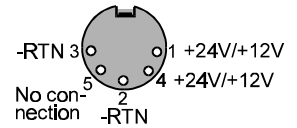
Power Out - The figure shows the pinout for the POWER OUT DIN5 connectors. The DBK34 package includes a short connecting cable (CA-115) to connect to the powered device. This cable connects the POWER OUT connector on the DBK34 to the POWER IN connector on the LogBook, DaqBook, or DBK module.

## DBK34 Operation

**Indicators**: 3 LEDs on the DBK34 provide status information on the power and charging process.

| LED | Meaning |
|---|---|
| MAIN POWER | Lights when the DBK34 is connected to a live vehicle (main) battery. |
| CHARGING | Lights when internal batteries are being charged at a rate of 0.025 to 0.050 A or greater. |
| DISCHARGING | Lights when internal batteries are discharging at a rate of 0.025 to 0.050 A or greater. |

**Runtime**: Approximate runtime under various loads can be computed from the storage capacity (5 A-hr in 12 V mode; 2.5 A-hr in 24 V mode) and the load (main unit and other DBKs). See section *Power Management* at the beginning of this chapter. Factory testing determined the following run-times:

| Run-time | Load Conditions |
|---|---|
| 240 minutes | DBK34 with 0 watt external load @ 23°C |
| 190 minutes | DBK34 with 2.34 watt external load @ 23°C |
| 120 minutes | DBK34 with 6.79 watt external load @ 23°C |

**Charging**: In general, lead-acid batteries require charging at 120% of drain energy (e.g., the 5 A-hr DBK34 requires a charge equal to or greater than 6 A-hr). Charging times vary; but 4 to 5 hours at 14 V is typical for a totally empty battery.

| CAUTION |
|---|
| ⚠ **Voltage applied to charge a DBK34 must not exceed 15 VDC in 12 V mode or 30 VDC in 24 V mode. If not charging from the vehicle, a generic automobile battery charger (3 A) in 12 V mode is recommended.** |

## Environmental Concerns

| CAUTION |
|---|
| ⚠ **The DBK34 s batteries contain toxic materials (Pb and $H_2SO_4$). After the battery s life cycle is over (up to 300 full cycles or 5-10 years of use), sealed-lead batteries must be recycled or properly disposed of.** |

## DBK34 - Specifications

**Name/Function: Vehicle UPS Module**
**Battery Type**: Sealed-lead rechargeable
**Number of Battery Packs**: 2
**Battery Pack Configuration**: 6 series-connected D cells
**Output Voltage**: 12 V or 24 V (depending on jumpers)
**Output Fuses**: 8 A on each internal battery (2)

**Battery Capacity (Amp-Hours)**:
  5 A-hr in 12 V mode (parallel)
  2.5 A-hr in 24 V mode (series)
**Operating Temperature**: -20°F to 122°F (-29°C to 50°C)
**Size**: 8½ x 11 x 1¾ in. ( 216 x 279 x 44 mm)
**Weight**: 7.2 lb (3.27 kg)

# DBK40 BNC Analog Interface

## Overview

The DBK40 termination box allows convenient attachment of analog signals from BNC cables to a Daq*. The DBK40 has 18 BNC connectors for 16 analog input channels and 2 analog output channels. One BNC connector can be switch-selected as either the TTL trigger input or as the second analog output channel.

## Hardware Setup

### Connecting the DBK40 to a Daq*

The DBK40 has a male DB37 connector that is pin-compatible with the Daq* P1 port. A 6-foot ribbon cable is provided to attach the DBK40 to the Daq*.

---

### CAUTION

⚠️ **Connecting the DBK40 to a port other than P1 may result in damage to the DaqBook/DaqBoard.**

---

Connect one end of the ribbon cable to the DB37 connector of the DBK40 and the other end of the cable to the Analog I/O Port (P1), as shown in the figure.



*Connecting the DBK40*
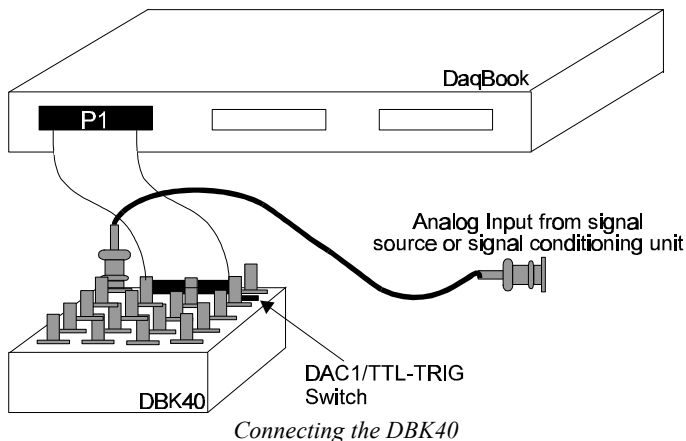
## Using the DBK40

The DBK40 is equipped with BNC connectors for 16 single-ended or 8 differential inputs. Also provided are BNC terminals for DAC0 and DAC1 analog outputs.

The DAC1 connector may be used for access to the DaqBook/DaqBoard Analog I/O TTL trigger input. This option is enabled by moving the slide switch on the top of the DBK40. Verify that this switch is in the correct position for your application.

| Switch Setting | Description |
|---|---|
| TTL/TRIG | Allows connector to be used for the DaqBook/DaqBoard's TTL trigger input. |
| DAC-1 | Allows same connector to be used for the DaqBook/DaqBoard's DAC-1 output. |

The collars of all of the BNC connectors are common to each other and analog ground. When the TTL trigger input is selected (via the slide switch), the isolated ground plane of the TTL-TRG/DAC1 connector is referenced to digital or TTL ground. Most of the top area of the DBK40's PC board is ground plane which provides excellent low-impedance, low-noise signal interfacing. Connect your analog signals to the unit as you would to any other BNC connector. The outer shell is ground; the center pin is the signal.

The figure below shows connections for single-ended and differential inputs.  In the differential mode, channels 0 to 7 are high; 8 to 15 are low (0 & 8, 1 & 9, 2 &10, etc).



*DBK40 Inputs*
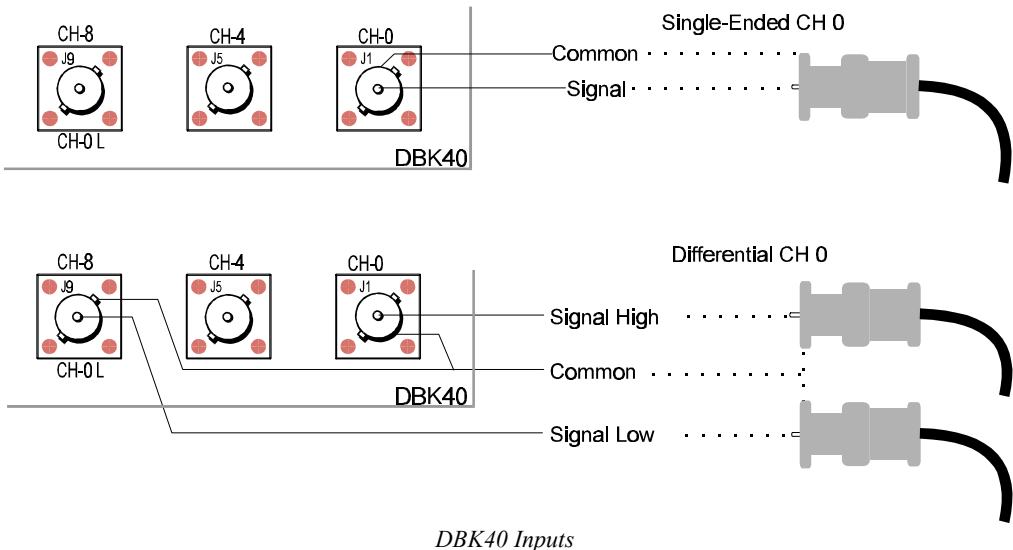
## DBK40 - Specifications

**Name/Function: BNC Analog Interface Module**
**DaqBook Connection**: Male DB37 mates with DaqBook P1.
**Analog Input Connection**: One BNC connector for each of 16 analog input channels.
**Single-Ended Mode**: Center conductor carries signal, outer conductor carries signal ground.
**Differential Mode**: Center conductor of two adjacent BNC connectors carries high and input low signals; outer conductor of both is attached to system ground.

**Analog Output Connection**: One BNC connector for each of 2 analog output channels; center conductor carries signal, outer conductor carries signal ground.
**TTL Trigger Input Connection**: One analog output BNC connector can be switched to provide a TTL trigger input connection; in TTL mode, the second analog output channel is unavailable on the BNC connector.
**Size**: 6.8" wide × 5.3" long × 2.3" high
**Weight**: 21 oz
**Length of Supplied Cable**: 6 ft

# DBK41 Ten-Slot Expansion Module

## Overview

The DBK41 is a metal enclosure that holds up to 10 DBK cards.  The exterior front panel has a male DB37 connector that leads to the Daq* or further expansion via a CA-37-x cable.  On the inside of the front panel, a backplane printed circuit board (PCB) uses 10 female DB37s with their pins connected in parallel to distribute the P1 interface (can also be used with P2 or P3).  From the rear panel, the DBKs' signal input lines exit to their respective transducers.  The interface and physical layout are compatible with the Keithley/Metrabyte's DAS 16 series and allow the use of a wide selection of signal-conditioning cards.  An optional EMI kit provides shield plates for the rear panel to make the DBK41 CE-compliant and prevent EMI from DBKs entering the test environment (or vice-versa).  The EMI kit also functions as an electrical safety barrier.

The use of power is an important concern—some DBK cards use more power than others.  The DBK cards can obtain power externally from a DaqBook/DaqBoard/CDK10 or internally from a DBK32A/33.  (See *Power Management* at the beginning of this chapter and the power card sections).  A power card in any slot (other than the slot leftmost from rear view) will power the other cards via the backplane.  A front panel LED will light whenever power from any source is on the backplane.  The JP1 jumper can disable the +5 V power line from the external DB37 to prevent a DBK33 power supply from interfering with other devices.
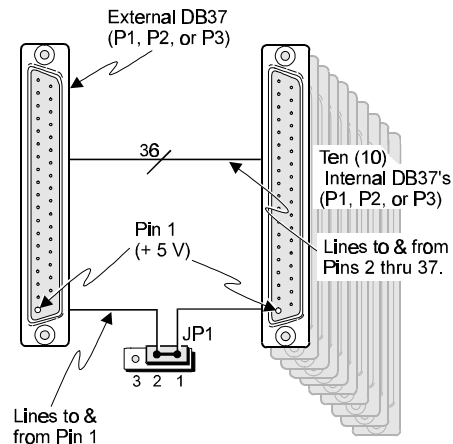


*DBK41 Block Diagram*

## Hardware Setup

Mounting the DBK41 is facilitated by industrial-strength Velcro-style tabs to stack a DaqBook or notebook PC on top of the unit.  Setup concerns include card and power configuration, careful card insertion, and the use of EMI shield plates.  Fastener panels are metal plates that can rigidly splice one unit on top of another (see end of chapter 1).

### Card Configuration

DBK cards may need to be configured depending on system configuration and the use of power.  All DBK cards should be configured before they are inserted into the DBK41 (refer to individual DBK sections of this chapter as needed).

### Power Configuration

Power use must also be configured to prevent multiple power supplies from interfering with each other via the P1 interface.  Both the DBK41 and the DaqBook/DaqBoard have JP1 jumpers (with different functions) that must be set to fit the application.

### JP1 in the DBK41

On the DBK41 backplane, JP1 is a 3-pin jumper positioned between DB37 connectors for card number 4 (CN4) and CN5.  Two settings are possible:

- Pin 1 and 2 connected (5 V line **enabled** to external P1).  The 5 V (VCC) is externally supplied to pin 1 of CN1 through CN10.  The power can come from a DaqBook, DaqBoard, or CDK10 through a CA-37-x cable on pin 1 of P1.
- Pin 2 and 3 connected (5 V line **disabled** from external P1).  When using a DBK33 power card in the DBK41, you must reposition the JP1jumper on pin 2 and 3 (effectively making no connection).  This setting prevents +5 V from the DBK33 from interfering with external devices via the P1 interface.  If not using a DBK33, JP1 should be enabled.

**Note**: jumper pin numbers read from right to left and are printed on the circuit board.

*DBK41 Power Configuration*
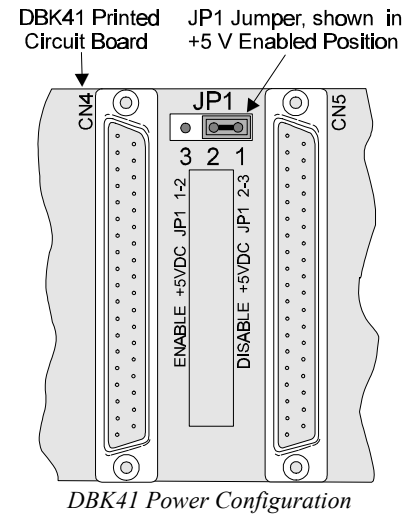
### JP1 in the DaqBook/DaqBoard

If a DBK32A or DBK33 is used, you must remove the shunt jumpers from header JP1 inside the DaqBook/DaqBoard.  DaqBook/DaqBoards are shipped with these shunts positioned to deliver ±15 V analog power to P1.  **The DBK power cards must not be connected until these jumpers have been removed or equipment damage may result**.  **Note**: Unless interfering with card operation (counter-timer), the jumpers can be placed on the OCTOUT and OCLKIN pins.

*DaqBook/DaqBoard Configuration*
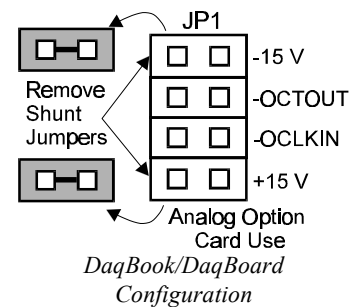
### *Card Insertion*

Each DBK card has a DB37 male connector which mates with the DB37 female connectors inside the DBK41 chassis.  To insert DBK cards into the DBK41 chassis, refer to the figure and perform the following steps.  **Note**: Cards using screw-connectors for signal input lines must be wired before insertion.

1. Disconnect power from all units to be connected.
2. Place the DBK41 on a flat surface; loosen the two thumbscrews on rear of the case; and remove the top cover by sliding it off.
3. Align the DBK card with the DBK41 connector to be used (CN1 to CN10).  The first slot must always be occupied; however, a DBK32A or DBK33 power card may not occupy the first slot.  Any of the remaining 9 slots can be used or unused.
4. To clear the lip on the rear panel, tilt the rear of the card upward.  Engage the P1 connectors of the card and chassis, and press together gently to avoid damage to the pins.
5. Press down the rear of the card, aligning it within the metal dimples at the rear of the DBK41.
6. After cards are in place, reassemble the DBK41's top cover and attach optional shield plates (described next); then re-connect and power up the system.

*Inserting Cards into a DBK41*
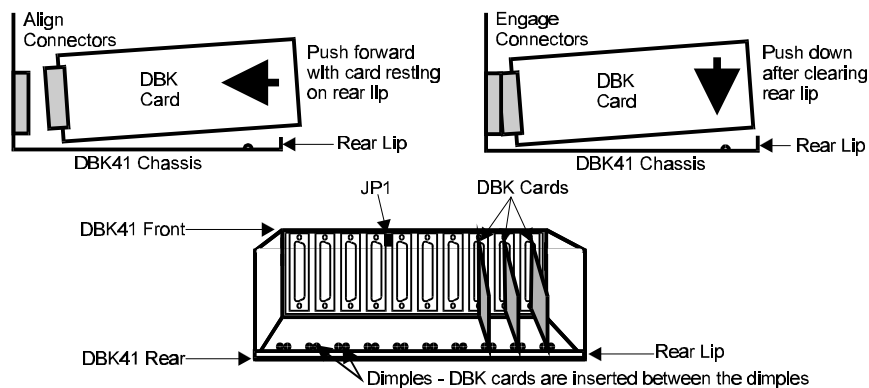
## EMI Shield Plates for CE Compliance

To reduce electro-magnetic interference (EMI) escaping from (or entering into) the enclosure, a CE kit provides shield plates that attach to the rear of the DBK41. The kit also functions as an electrical safety barrier. With shield plates attached (a combination of 3 types supplied), the system meets CE standards. The kit includes:

- Full shield plates to cover empty (unused) slots
- Partial shield plates to surround DBKs in a slot (except a power card)
- Partial shield plates to surround a DBK32A or DBK33 power card
- Screws and star washers to secure the shields to the chassis

**Note**: The CE kit is included with the DBK41/CE and an optional accessory for a DBK41.

The shields have a support tab that slides over the edge of the bottom plate and a screw hole for attachment to the top plate. When tightened, the screws cause the washers to pierce the surface coating into the metal to make a good contact with chassis ground.
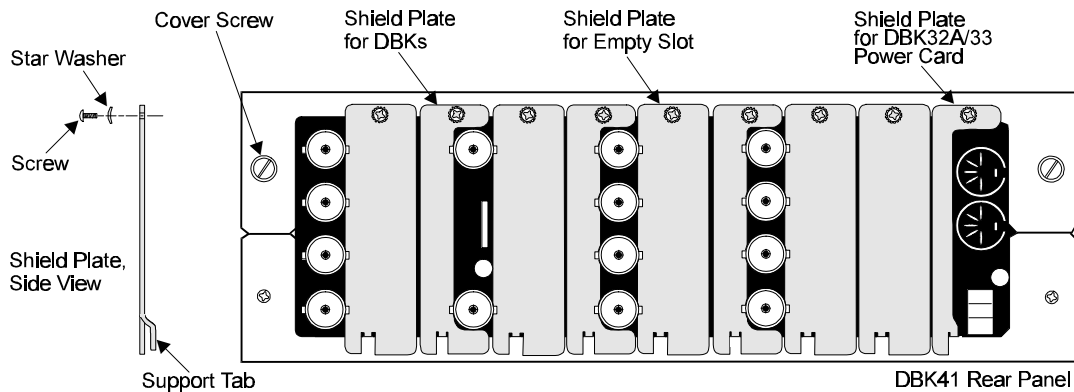


*Shield Plates on DBK41 Rear Panel*

## System Connection

A short ribbon cable (CA-37-x) attaches the DBK41 to the main unit. Connecting the DBK41 to any port other than P1 may damage the DaqBook/DaqBoard. Likewise, only analog expansion cards may be installed in the DBK41. The figure below shows typical setups. **Note**: For CE compliance, the CA-37-x cable must be replaced with a CA-143-7 or CA-143-18. Multiple chassis require a "T" connector (part # CN-143) for branching.
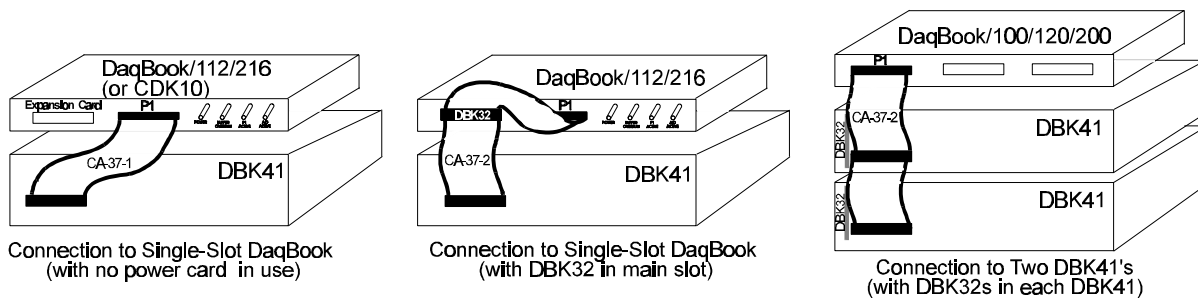


*Typical DBK41 Systems*

## DBK41 - Specifications

**Name/Function: 10-Slot Analog Expansion Module**
**Card Capacity**: 10 slots to hold standard DBK option cards
**Weight**: 4 lb (with no cards installed)
**Cable (optional)**: 8" ribbon with DB37 female to DB37 female (CA-37-x)
**Power Indicator**: LED powered by DaqBook 5 VDC
**DaqBook Connection**: Male DB37, mates via CA-37-x cable with Daq* P1

# DBK42 16-Slot 5B Signal Conditioning Module

## Overview

The DBK42 allows Daq* systems to work with up to 16 5B signal conditioning modules. Modules are available for various signal types (e.g., low-level thermocouple signals, strain-gage signals, etc). The DBK42 offers 500 V isolation from the system and between channels. The DBK42 is compatible with all 5B output modules, and the configuration is very flexible. You can select the type of signal attached to each channel.

An accessory cable connects the DBK42's output to the Daq* P1 analog input connector. One Daq* can support up to 16 DBK42 units with a maximum of 256 isolated analog input channels. The Daq* scans the DBK42 channels at the same 10 μs/channel rate as other DBKs (256 scans in 2.56 ms in a full system).

The DBK42 can obtain power from an included AC adapter, an optional DBK30A rechargeable battery module, or directly from a 12 VDC source (such as a car battery). The built-in power supply can serve a fully-configured system using bridge excitation.

Each terminal block contains 4 terminals (per channel) for access to input and excitation features of 5B modules. The optional CN-71 and CN-72 signal connection blocks provide a convenient way of connecting analog signals to the DBK42.

- The CN-71 is for non-thermocouple use.
- The CN-72 (with cold junction sensors) is for thermocouple use. The CN-72 has a clear plastic shield over its screw terminals to protect you from high voltage on the input terminals.
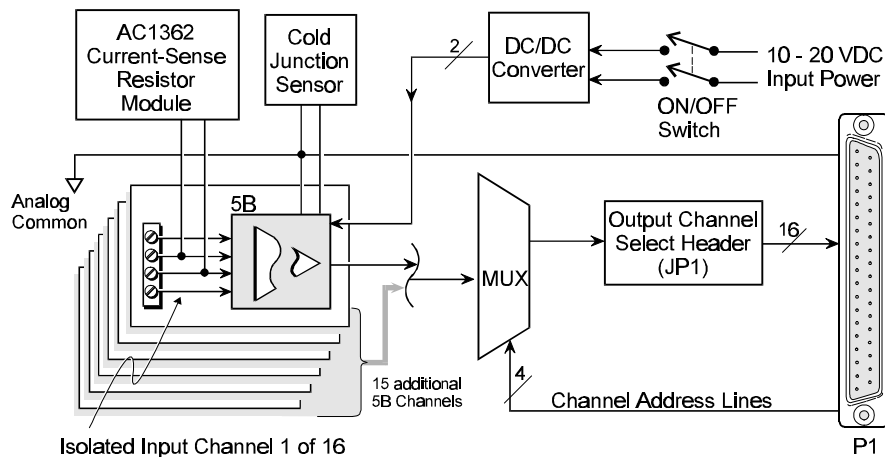


*DBK42 Block Diagram*

## Hardware Setup

### DBK42 Connection

The DBK42 has screw-terminal connectors for easy access to the analog inputs. 2-wire and 4-wire hookups are shown later in this section. Analog channels are isolated from each other, and no analog ground is provided.

### DBK42 Configuration



JP1

CH15
CH14
CH13
CH12
CH11
CH10
CH9
CH8
CH7
CH6
CH5
CH4
CH3
CH2
CH1
CH0

*Factory Default*
*JP1 Channel*
*Configuration*

Up to 16 DBK42s can connect to a Daq*.  As a daisy-chain interface, each module must appear unique to the Daq* and use a different channel.

To configure the module, locate the 16×2-pin header (JP1) near the front of the DBK42 board.  Note the 16 jumper locations labeled CH0 through CH15 representing the Daq* Analog Input Channels.  Place the jumper on the channel you wish to use.  Only one jumper is used on a single DBK42; no two cards in a system can use the same setting.
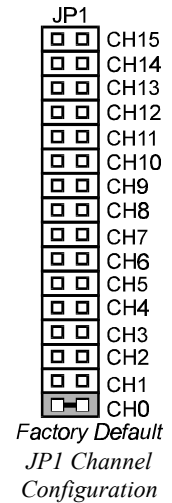
### 5B Module Connection

Each input of the DBK42 is processed through a user-installed 5B signal-conditioning module.  Different 5B modules are used with different transducer and signal sources.  To install the modules:

1.  Match the footprint of the module with the footprint on the circuit board (see figure).
2.  Gently place the module into the footprint, and screw it down.
3.  When installing current input modules (SC-5B32 series), install the supplied current-sense resistor (SC-AC-1362) in the resistor footprint adjacent to the module mounting footprint.
4.  Record the module's channel number; label all units and connectors for identification.



*Module Installation*
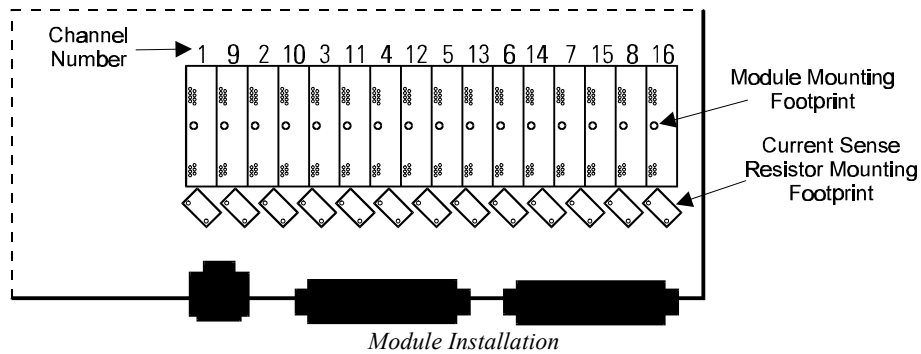
### Power Considerations

The DBK42 has an internal, isolated switching-type power supply which operates on 10-20 VDC at varying input currents depending on the input voltage and 5B-module loading.  The power drain at a given output load is constant; input current will vary inversely with the input voltage.

A DBK42 populated with strain-gage modules will draw more current than with other types of input modules.  The table shows the DC input requirements for the worst-case setup (with 16 strain-gage modules or 16 thermocouple modules).

| Input Volts | With Strain-Gage Modules | With Thermocouple Modules |
|---|---|---|
| | Input Amperes | Input Amperes |
| 10 VDC | 3.0 A | 0.60 A |
| 11 VDC | 2.7 A | 0.54 A |
| 12 VDC | 2.4 A | 0.48 A |
| 13 VDC | 2.2 A | 0.44 A |
| 14 VDC | 2.0 A | 0.40 A |
| 15 VDC | 1.9 A | 0.38 A |
| 16 VDC | 1.8 A | 0.36 A |
| 17 VDC | 1.7 A | 0.34 A |
| 18 VDC | 1.6 A | 0.32 A |
| 19 VDC | 1.5 A | 0.30 A |
| 20 VDC | 1.4 A | 0.28 A |

Power sources include:

- The standard TR-25 AC plug-in power pack (provided with the DBK42) can supply 900 mA at 15 VDC.  The optional TR-26 can supply 2000 mA at 15 VDC.
- The DBK30A battery pack can supply power for a typical DBK42 configuration; however, in a fully-populated strain-gage configuration, the battery run-time will be limited to about 1½ hours.
- A 12 V lead-acid gel-cell type battery can easily power a fully-populated strain-gage configuration.  The battery drain will be about 2.4 A-hr; battery size should be considered for systems with long run-times.  (For example, a common-size 5.0 A-hr battery will operate for about 2 hours).  A typical automotive 12 V lead-acid battery (e.g., 60 A-hr) can easily power a DBK42 for long run-times (about 24 hours).

The input fuse is a 4 A Slo-Blo 1-1/4" × 1/4" glass type such as Littlefuse 313004 or Bussman MDL-4.

### Terminal Block Connection

Input signals (and excitation leads) must be wired to the DBK42 signal termination panel.  Sixteen 4-terminal blocks accept up to 16 inputs.  These connectors are located on a removable PC board that plugs into two DIN96 rectangular connectors on the rear panel.

| WARNING |
|---|
| Shock Hazard.  The DBK42 is designed to sense signals that may carry dangerous voltages.  De-energize circuits connected to the DBK42 before changing the wiring or configuration. |

Terminal blocks are connected internally to their corresponding signal conditioning module.  The terminal blocks accept up to 14-gage wire into quick-connect screw terminals.  Terminals on each block are numbered 1 through 4.  Each type of input signal or transducer (such as a thermocouple or strain gage) should be wired to its terminal block as shown in the figure.  Wiring is shown for RTDs, thermocouples, 20 mA circuits,  mV/V connections, and for full- and half-bridge strain gages.



*DBK42 Terminal Connections*
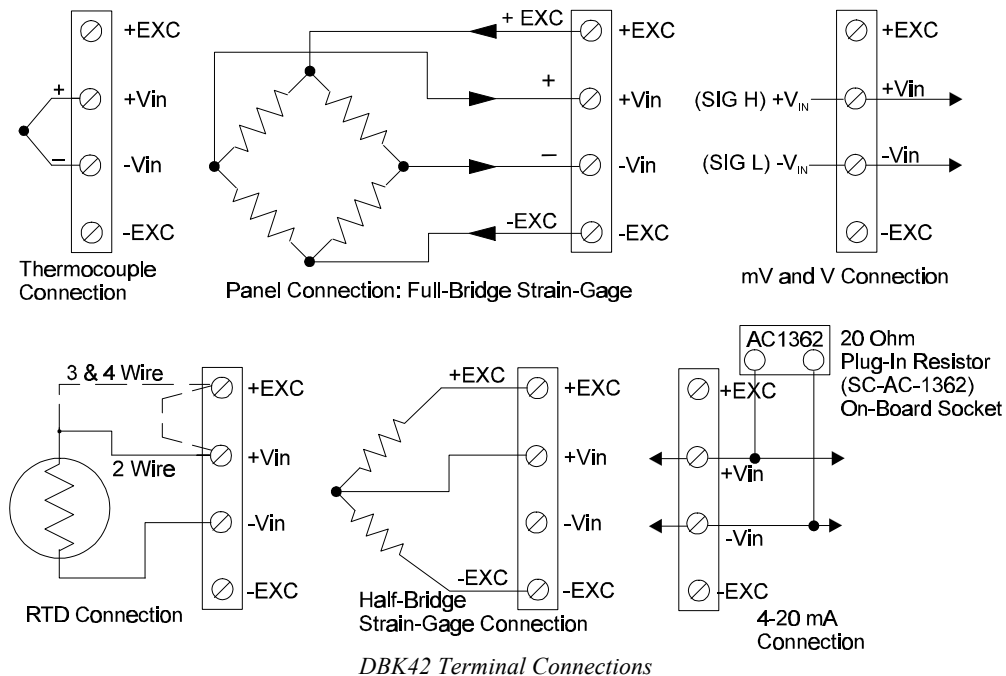
### Daq* Connection

The DBK42 attaches to the Daq* P1 analog I/O connector. (Up to 16 units can be attached to 1 Daq*.)

Connect the appropriate ribbon cable (with -x indicating the number of cards to be connected) from the Daq*'s P1 port to the DB37 connector at the end of the option card. **Note**: A series of interface cables are available for connecting up to 16 DBK42s.



*Daisy-Chaining DBK42s*

### DaqBook/DaqBoard Configuration

The DBK42 requires two setup steps in the DaqBook/DaqBoard— jumpers JP4 and JP1.

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 DBK42 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).



*Jumper Configuration for DBK42*

2.  *Place the JP4 jumper in the DaqBook/DaqBoard in single-ended mode. **Note**: Analog expansion cards convert all input signals to single-ended voltages referenced to analog common. *Applies only to DaqBook/100, /112, and /120.

## Software Setup in DaqView

To use the DBK42 within DaqView, you must first configure the DaqView software for the hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters help interpret the incoming analog input data and provide controls to access the hardware. As expansion modules are added, make sure the setup reflects the actual hardware. On the left side of this window, the Analog Input Option Cards selection allows you to assign DBK expansion modules to the 16 analog inputs in the analog input spreadsheet.

Select the DBK42 16-Channel 5B Box option. The main window now has 16 channels for this one board. A gain of ×1 is the only available gain listed under the Type column because the 5B module's output is typically 0 to 5 V. By default, DaqView displays readings in volts. To change the default, click on the Engr. Unit column for your choice. The *mx+b* calculations for most 5B modules are already within DaqView and will appear when you select the module. (A pull-down 5B module selection box will appear when you place the cursor in the Units column.)

For example, a SC-5B47-T-06 module converts a T-type thermocouple input from -100°C to +400°C into a linear voltage from 0 to 5 V. DaqView must first determine the range of °C (e.g., 500°C). This range is then divided by the range in volts (5 V). The resulting number is *m* (e.g., 100). Next the offset, *b*, is determined. *b* is the difference between the lower level and 0 (e.g., -100). The configured setting for the 5B47-T-06 module is an *m* of 100, a *b* of -100 and a unit of °C to display a reading in degrees Celsius. DaqView performs this calculation. The only visible change will be °C in the Units column.

## Programming a DBK42

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the expansion module.  An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command.  This command will use the expansion card # and channel to calculate the channel # used by the daqAdcRd command.

```
expCard = 2;        /* JP1 position*/
expChan= 15;        /* module channel number*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, DgainX1);
```

When using the Daq* driver, analog input values are returned in counts.  Depending on the model, the returned value will be 12 or 16 bits.  12-bit values are left justified with the least significant 4 bits (used as a channel tag) in the returned unsigned integer.  5B signal conditioners produce an output voltage proportional to the measurement (i.e.  strain, temperature, mA).

For all DBK42 measurements, the Daq* should be set to a gain of ×1 since the 5Bs typically output signals up to 5 V.  To convert the incoming unsigned integer values into engineering units, an mx+b calculation must be performed.  The following example reads a value from a type T thermocouple module (SC-5B47-T-06), then converts the unsigned integer to units of °C.

```
expCard = 2;              /* JP1 position */
expChan= 15;              /* module channel number*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, DgainX1);
V=(32768.0 * sample/5.0) - 5.0;    /* Convt raw counts to volts*/
m=100;          /* m  value from table */
b=-100;         /* b value from table */
C=m* v + b;     /* Cnvt volts to dgrs C*/
```

The *mx+b* calculations for most 5B modules are included within DaqView software.  The table shows the *m* and *b* values for all of the 5B modules.

| 5B Module | m Value | b Value | Engineering Unit(s) |
|---|---|---|---|
| **Isolated Voltage Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B31-01 | 1/5 | 0 | mV, V |
| SC-5B31-02 | 1 | 0 | mV, V |
| SC-5B31-03 | 2 | 0 | mV, V |
| SC-5B31-04 | 2/5 | -1 | mV, V |
| SC-5B31-05 | 2 | -5 | mV, V |
| SC-5B31-06 | 4 | -10 | mV, V |
| **Isolated Wideband Voltage (5 V Current Requirement, 30mA)** | | | |
| SC-5B41-01 | 1/5 | 0 | V |
| SC-5B41-02 | 1 | 0 | V |
| SC-5B41-03 | 2 | 0 | V |
| SC-5B41-04 | 2/5 | -1 | V |
| SC-5B41-05 | 2 | -5 | V |
| SC-5B41-06 | 4 | -10 | V |
| **Isolated Millivolt Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B30-01 | 2 | 0 | mV |
| SC-5B30-02 | 10 | 0 | mV |
| SC-5B30-03 | 20 | 0 | mV |
| SC-5B30-04 | 4 | -10 | mV |
| SC-5B30-05 | 20 | -50 | mV |
| SC-5B30-06 | 40 | -100 | mV |
| **Isolated Wideband Millivolt (5 V Current Requirement, 30 mA)** | | | |
| SC-5B40-01 | 2 | 0 | mV |
| SC-5B40-02 | 10 | 0 | mV |
| SC-5B40-03 | 20 | 0 | mV |
| SC-5B40-04 | 4 | -10 | mV |
| SC-5B40-05 | 20 | -50 | mV |
| SC-5B40-06 | 40 | -100 | mV |
| **Isolated Linearized T/C Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B47-J-01 | 152 | 0 | °C |

| 5B Module | m Value | b Value | Engineering Unit(s) |
|---|---|---|---|
| SC-5B47-J-02 | 80 | -100 | °C |
| SC-5B47-J-03 | 100 | 0 | °C |
| SC-5B47-K-04 | 200 | 0 | °C |
| SC-5B47-K-05 | 100 | 0 | °C |
| SC-5B47-T-06 | 100 | -100 | °C |
| SC-5B47-T-07 | 40 | 0 | °C |
| SC-5B47-E-08 | 200 | 0 | °C |
| SC-5B47-R-09 | 250 | +500 | °C |
| SC-5B47-S-10 | 250 | +500 | °C |
| SC-5B47-S-11 | 260 | +500 | °C |
| **Isolated RTD Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B34-01 | 40 | -100 | °C |
| SC-5B34-02 | 20 | 0 | °C |
| SC-5B34-03 | 40 | 0 | °C |
| SC-5B34-04 | 120 | 0 | °C |
| SC-5B34-C-01 | 24 | 0 | °C |
| SC-5B34-C-02 | 24 | 0 | °C |
| SC-5B34-N-01 | 24 | 0 | °C |
| **Isolated Current Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B32-01 | 3.2 | 4 | mA |
| SC-5B32-02 | 4 | 0 | mA |
| **Voltage Switch Input** | | | |
| SC-AC-1367 | 1 | 0 | V |

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK42 - Specifications

**Name/Function: 16-Slot 5B Signal Conditioning Module**
**Module Capacity**: 16 (input only) 5B modules
**Size**:  8.5" × 11" × 3.5"  (11" × 11" × 3.5" with optional CN-71 or CN-72)
**Weight**: 4 lb (with no modules installed)
**Cable (optional)**: CA-37-1
**Power Requirements**: 10-24 VDC @ 2.6 - 0.3 A
    With 16 thermocouple-type modules:
        12 VDC @ 0.50 A
        15 VDC @ 0.40 A
        18 VDC @ 0.35 A
    With 16 strain-gage type modules:
        12 VDC @ 1.9 A
        15 VDC @ 1.5 A
        18 VDC @ 1.3 A
DC Input Fuse: 3 A

**Power Indicator**: LED powered by internal 5 VDC
**Power Connection**: DIN5 ×2 for daisy-chaining
**AC Power Pack**:
    120 VAC to 15 VDC converter
    120 VAC to 15 VDC @ 2.0 A (optional)
**Input Connections**: DIN96 rectangular, standard, screw terminal adapter (optional)
**Daq\* Connection**: Male DB37 mates via CA-37-1 cable with Daq\* P1
**DC/DC Converter**: 10-24 VDC to 5 VDC (isolated)
**Isolation**:
    Input Power to Daq\*: 500 VDC
    Signal Inputs to Daq\*: 1500 VDC
    Input Channel-to-Channel: 500 VDC

# DBK43A Eight-Channel Strain-Gage Module

Because of the DBK43A's flexibility in configuration, please read the entire section before setup and operation. The section is divided into the following sections:

- *Overview* describes the unit's basic operation.
- *Hardware Connection* describes power and signal hookups.
- *Hardware Configuration* shows how to configure: various strain gages (*Bridge Applications*), AC coupling and low-pass filter options, channel selection, and Daq* configuration.
- *Hardware Adjustment* describes the setup procedure to adjust the trimpots for: the excitation voltage, gain of the input and scaling amplifiers, and circuit offsets for each channel.
- *Software Setup in DaqView* shows how to use the DBK43A with DaqView.
- *GageCal Program* explains a utility calibration program, helpful in a load cell application.
- *Programming a DBK43A* offers pointers for use with custom programming via the API.
- *Example* walks you through typical setups for a strain gage and a load cell.
- *DBK43A Specifications* lists performance specifications.

## Overview

The DBK43A will condition signals from most types of bridge-circuit transducers that have a signal output of less than 50 mV. Strain gages and load cells are common types. The block diagram (below) and the board layout (later) should be referenced while reading the text.



*DBK43A Block Diagram*
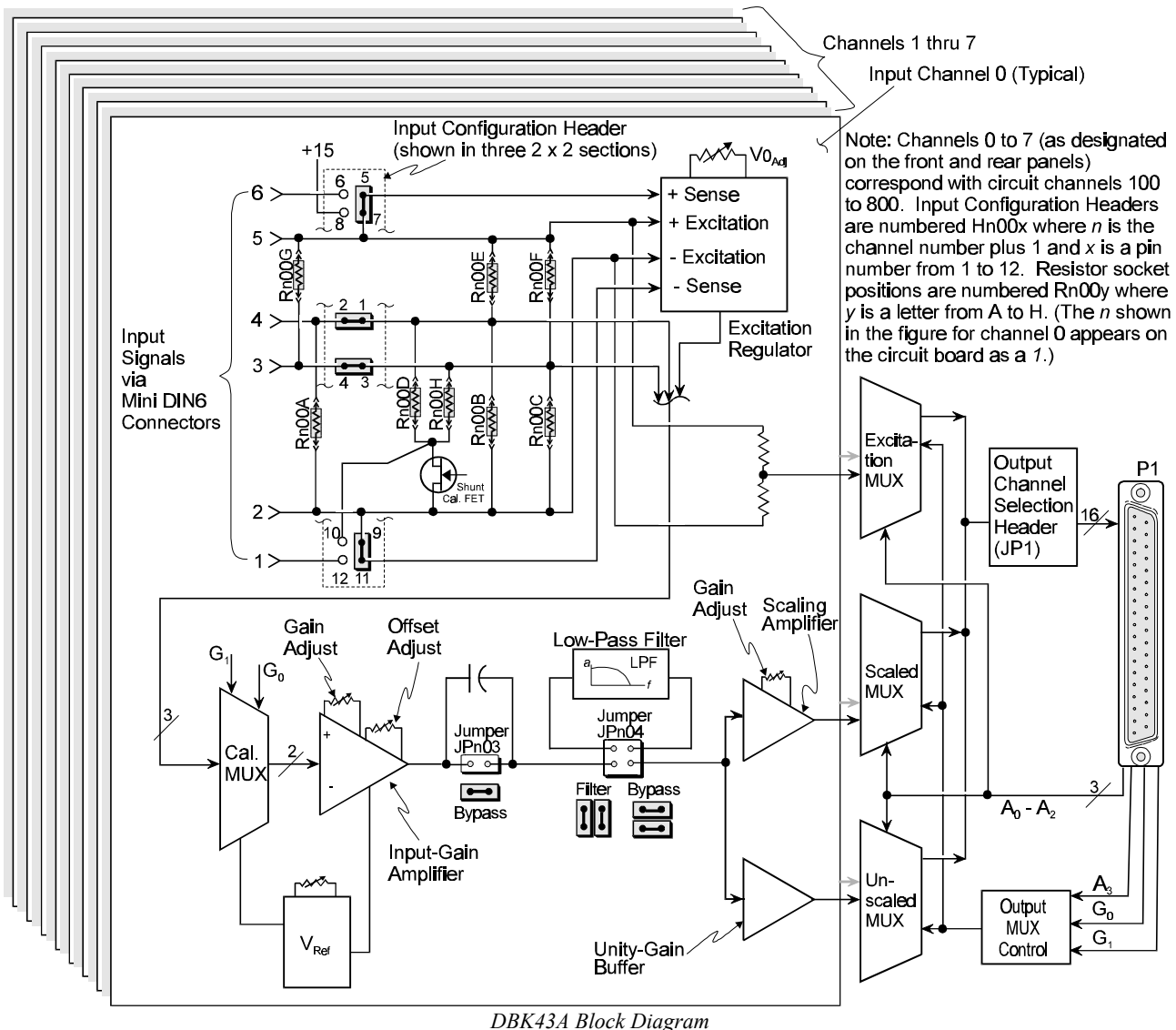
For half- and quarter-bridge strain gages, the DBK43A can accommodate user-supplied bridge-completion resistors that complete the bridge circuit. The **bridge circuit must be complete** for the DBK43A to operate correctly. Each channel of the DBK43A offers a selectable 3-pole, low-pass filter with a user-set cut-off frequency. Remote-sense terminals are provided in order to make 6-wire Kelvin connections. Up to 2 DBK43A modules can be connected to each of 16 analog Daq* base channels for a maximum of 256 input signals.

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.

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.

## Hardware Connection

This section is divided into 2 subsections: *Power Connection* and *Signal Connections*.

### *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 module'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 9-18 VDC source, make sure leads are connected to the proper DIN terminals.
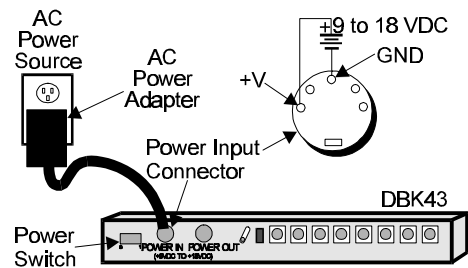


*DBK43A Power Connections*

| 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.** |

### Signal Connection

The figure shows the 6-pin signal connector (1 of 8) on the back of the DBK43A.  **Note**: figure shows full-bridge with remote sensing configuration.



| CAUTION |
|---|
| 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). |
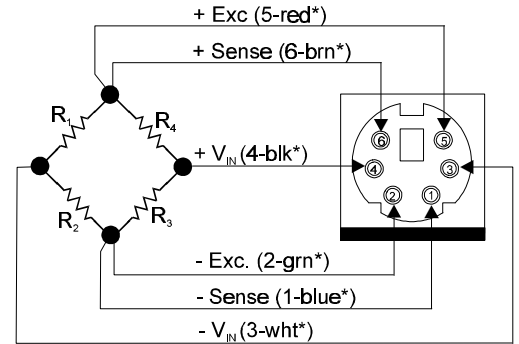
*DBK43A Signal Input Connection*

## Hardware Configuration

There are several configuration options on the DBK43A:

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

The figure shows the DBK43A board layout for locating jumpers, switches, resistors, etc.  You may need to refer to this figure to locate components referred to later in the text.
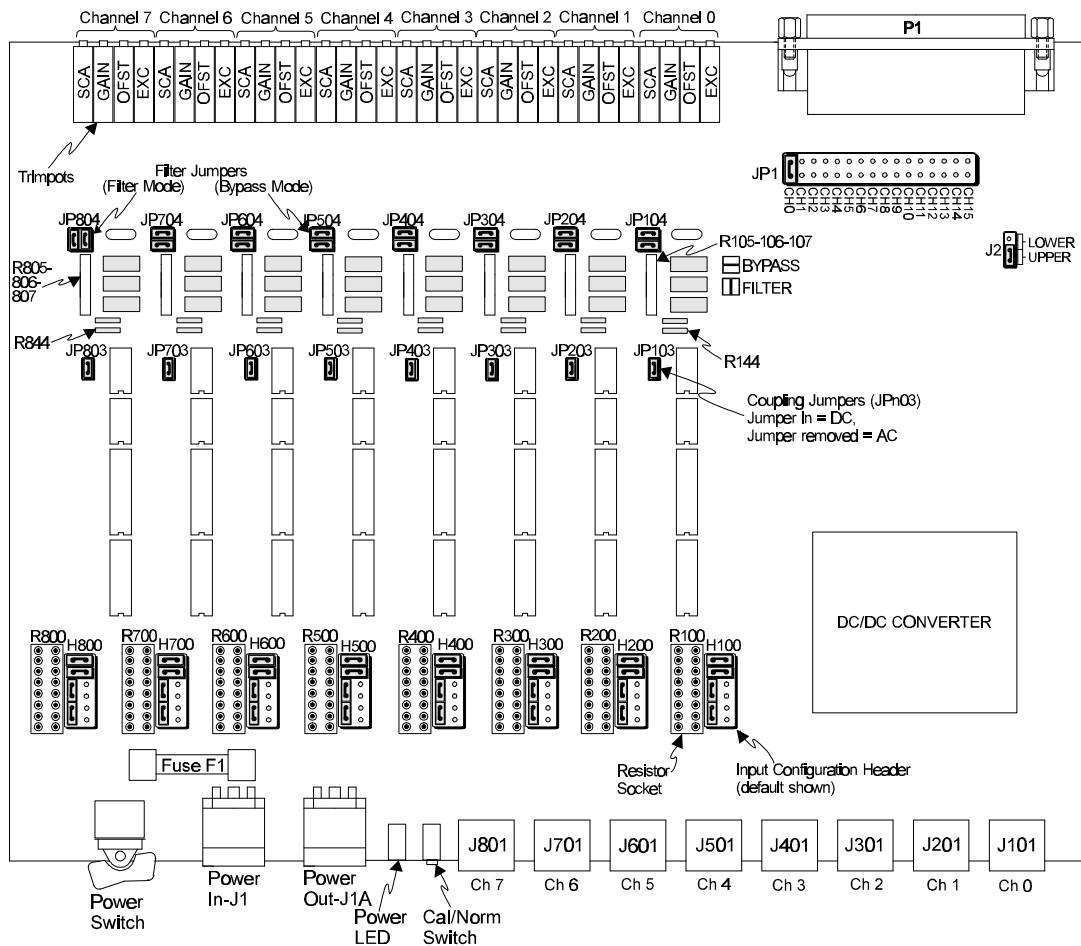


*DBK43A Board Layout*

### Bridge Applications

There are several hook-up possibilities for strain gages—all configured into a 4-element bridge. There are 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 standard symbol for a 4-element bridge type strain gage is referenced to the channel bridge-completion resistor designations for the DBK43A.

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
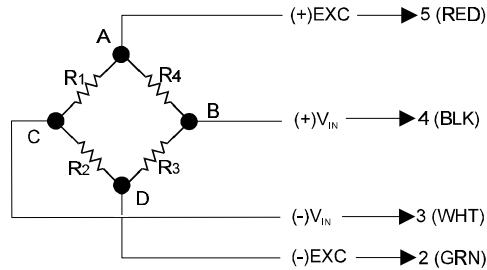


*Bridge-Completion Resistors*

Any or all of the 4 resistive elements may be strain variable. In the case where one or more elements 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.)

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 next figure.)
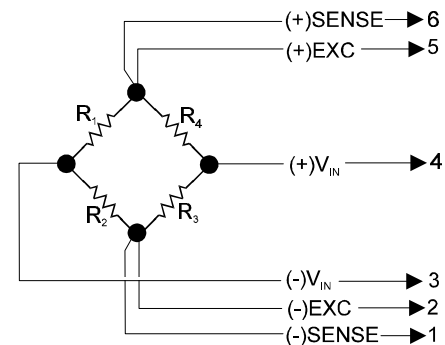


*Kelvin-type Excitation Leads*

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 for the two excitation wires and the two bridge output wires).

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: $0.05 \times R$ (where R = the resistance in ohms of 1 element in the bridge circuit).

---

## CAUTION

⚠️ **Do not set the excitation above the maximum voltage allowed. This can cause the DBK43A to fail.**

---

The full-page figure shows various strain-gage configurations.
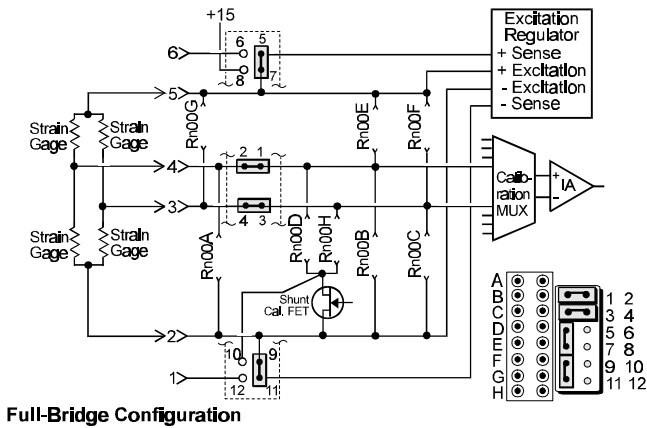
**Full-Bridge Configuration**
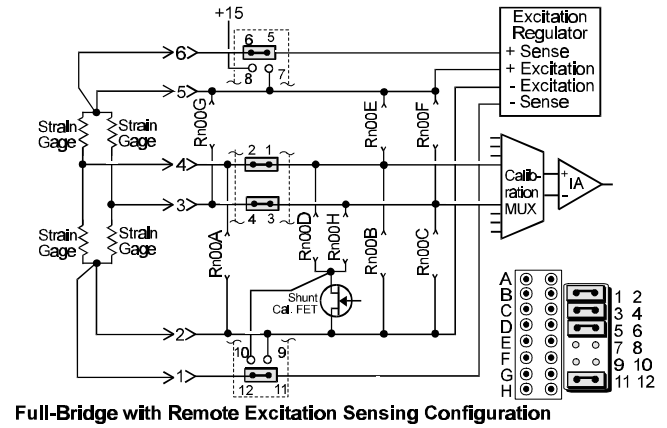


**Full-Bridge with Remote Excitation Sensing Configuration**
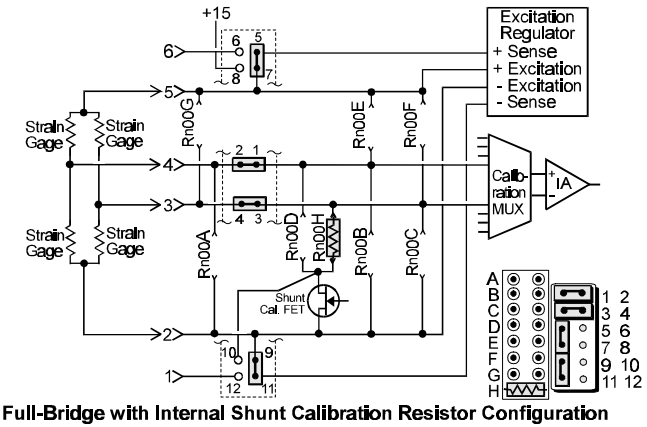


**Full-Bridge with Internal Shunt Calibration Resistor Configuration**
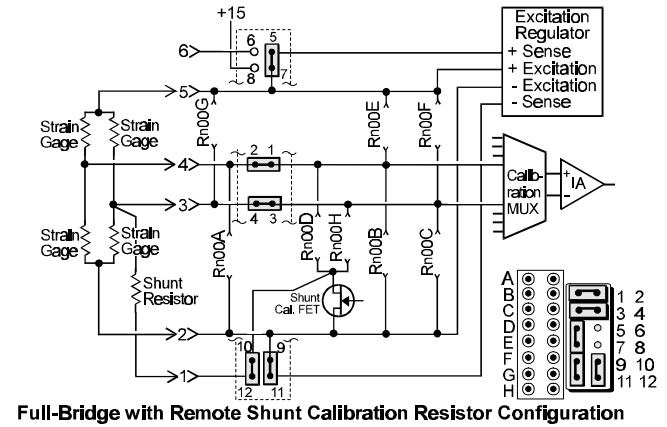


**Full-Bridge with Remote Shunt Calibration Resistor Configuration**
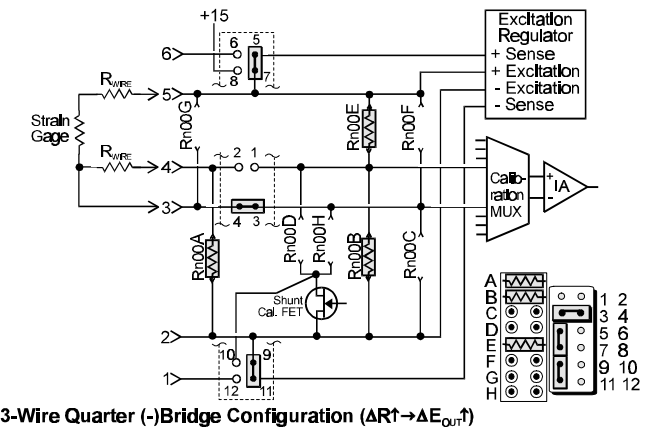


**3-Wire Quarter (-)Bridge Configuration ($\Delta R\uparrow \rightarrow \Delta E_{OUT}\uparrow$)**
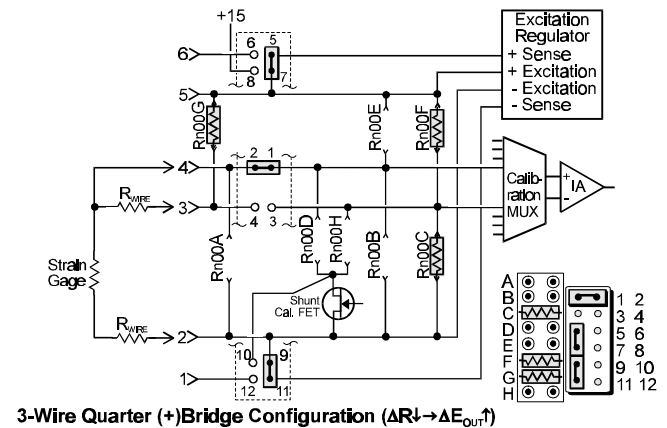


**3-Wire Quarter (+)Bridge Configuration ($\Delta R\downarrow \rightarrow \Delta E_{OUT}\uparrow$)**
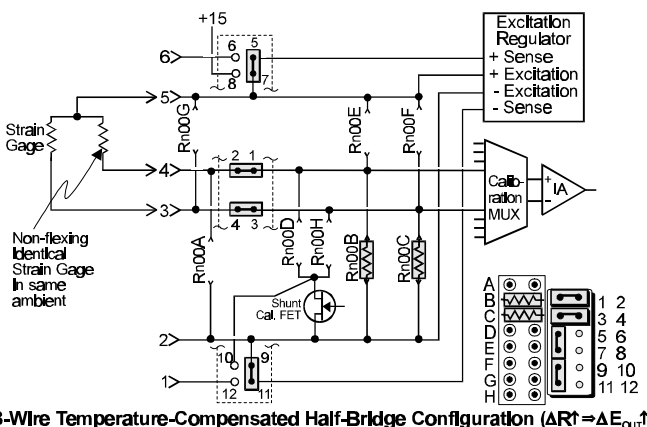


**3-Wire Temperature-Compensated Half-Bridge Configuration ($\Delta R\uparrow \rightarrow \Delta E_{OUT}\uparrow$)**

Configuration Notes:
Resistors can be soldered to the supplied plugs in the positions indicated for your particular configuration. These pre-configured plugs can then be plugged into the appropriate channel socket as needed. After soldering, snip resistor leads just long enough to mount on the forked resistor support but prevent contact with other components. To prevent heat damage to the plug and ensure proper fit, perform soldering with plug in a mating socket. Handle plugs with care to avoid damaging pins.

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

*DBK43A Bridge-Configuration Settings*

### 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.

Inserting resistors directly 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 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. **Handle the plugs with care to prevent damage to the pins.**
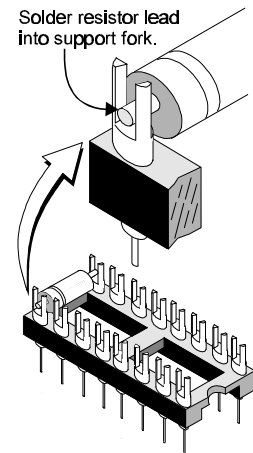


*Soldering Resistors to Adapter Plug*

### 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, there is a resistance value which can be applied in parallel with one of the four bridge elements to create a predictable imbalance and output voltage. For example, a 350 Ω  2 mV/V strain gage will deliver full output if one arm drops by 0.8% (about 2.80 Ω) to 347.2 Ω. 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.

An approximate formula for the shunt-cal resistance value is: $R_{Shunt} = R_{Bridge\ Arm} [V_{Excitation} / 4 (V_{Out})]$.

Example: $R_{Shunt} = 350 [10 / 4(0.020)]$
$= 43,750\ \Omega$

In all cases, the resistance of the solid-state switch will be negligible when compared to the value of 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.
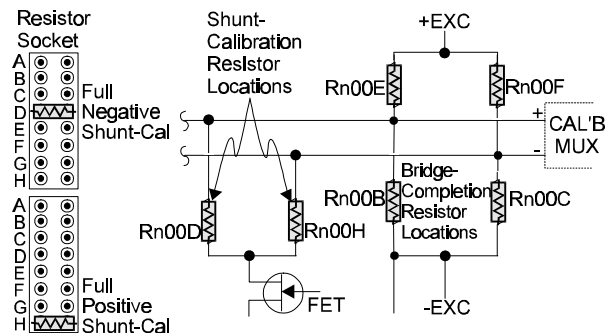


*Shunt-Calibration Resistors can be used with any full-, half-, or quarter-bridge configuration.*

### *AC Coupling and Low-Pass Filter Options*

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

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

| 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 |

| Frequency | Resistance (Ω) | Bourns Part Number |
|-----------|----------------|--------------------|
| 10 Hz | 27,000 | 4606X-102-273 |
| 20 Hz | 12,000 | 4606X-102-123 |
| 50 Hz | 5,600 | 4606X-102-562 |
| 100 Hz | 2,700 | 4606X-102-272 |
| 200 Hz | 1,200 | 4606X-102-122 |
| 500 Hz | 560 | 4606X-102-561 |
| 1,000 Hz | 270 | 4606X-102-271 |
| 2,000 Hz | 120 | 4606X-102-121 |
| 5,000 Hz | 56 | 4606X-102-560 |
| 10,000 Hz | 27 | 4606X-102-270 |
| 20,000 Hz | 12 | 4606X-102-120 |

The active low-pass filters on the DBK43A have an inherent 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 following resistors (see table). **Note**: the default ×2 gain option meets most application needs.

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

### P1 Output Channel and Card Address Selection

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

Each Daq* 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 Daq* 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.

The Daq* has 16 base channels, so up to 32 DBK43As can be used with a Daq* 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 Daq* base channel and the first expansion channel number (N) associated with that particular base channel. To calculate the actual input channel to the Daq*, 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* 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 and GageCal, these same 256 channels are identified from ch0-0-0 to ch15-2-7. The first field (0 to 15) is the Daq* 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. For more information on Daq* channel multiplexing, see the chapter *Signal Management and Troubleshooting Tips*.

### Daq* Configuration

Use of the DBK43A requires setting jumpers in the DaqBook/DaqBoard.

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/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).



*Configuration Jumpers*

2. *Place the JP4 jumper in single-ended mode (*applies only to DaqBook/100, /112 and /120).
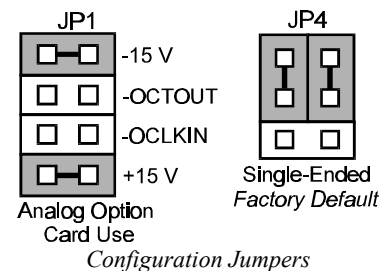
**Note**: To use a DBK43A with a Daq PC-Card, you must use a CDK10.

# 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 |

The figure shows trimpot locations.

| | 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 |



*DBK43A Trimpot Locations*
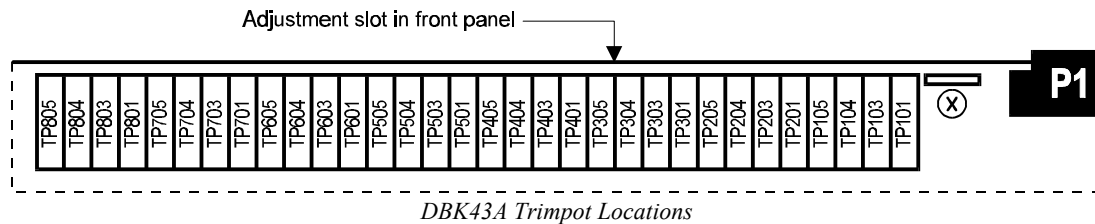
## CAL/NORM Switch

The CAL/NORM switch is located between the CH7 input and the power LED on the rear panel.
- In the NORM position, the unit's function is identical with 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.

## Software-Controlled Setup

Proper setup includes the use of software commands that control the calibration multiplexer in each circuit. The calibration multiplexer is used to switch the bridge circuit out and apply internal reference voltages to the input for use in the DBK43A setup. The calibration multiplexer also allows the Daq* to record the individual adjustments. The next table shows the setup commands, their binary codes, and a description of their function. These commands are accessible through DaqView and the Daq* driver as gain settings and through most third party software support as well as GageCal.

| CAL/ NORM | Setup Command | Code | Description |
|---|---|---|---|
| NORM | Dbk43ReadBridge | 00 | Reads bridge circuit with all gains and offsets included (normal operation) |
| NORM | Dbk43SetOffset | 01 | Applies a grounded input and allows the user to read the circuit offset voltage multiplied by the input amplifier and the low-pass filter gain. |
| NORM | Dbk43SetScalingGain | 10 | Applies 5 mV to the input and allows the user to read the voltage out of the circuit through the input gain amplifier, the low-pass filter* and the scaling gain amplifier. |
| NORM | Dbk43SetInputGain | 11 | Applies 5 mV to the input and allows the user to read the voltage out of the circuit through the input gain amplifier and low-pass filter* only. |
| CAL | Dbk43SetOffset | 01 | Sets excitation. |
| CAL | Dbk43ReadBridge | 00 | Activates shunt-cal resistors. |
| * if the filter is enabled | | | |

The following equations represent the voltage recorded by the Daq* when the calibration mux is set in 1 of 4 possible settings and the effect of the CAL/NORM switch.

| CAL/NORM | Code | Equation |
|---|---|---|
| NORM | 00 | Vout = (Scaling Gain)(Filter Gain*)[(InputGain)(bridge circuit voltage) - offset voltage] |
| NORM | 01 | Vout = (Filter Gain*)(Input Gain)(-offset voltage) |
| NORM | 10 | Vout = Filter Gain*(Scaling Gain[(Input Gain)(5 mV) - offset voltage]) |
| NORM | 11 | Vout = (Filter Gain*)(Input Gain)(5 mV) - offset voltage |
| CAL | 01 | Vout = (Excitation Voltage) / 2.11**              **already scaled in DaqView rev 5.05+ |
| CAL | 00 | Vout = (Scaling Gain)(Filter Gain*)[(Input Gain)( bridge circuit voltage with shunt) - offset voltage] |
| * if the filter is enabled | | |

## DBK43A Setup Procedure

A typical setup procedure is as follows:
1. Disable the low-pass filters JPx04 (x = 1-8 for channels 0-7), and set DC coupling (install JPx03) for all the channels that are being setup.  If you plan on using the filter during your acquisition, take note of the gain in the filter stage (default ×2, or ×1 with resistor removed) and allow for it in your setup.
2. Determine what the excitation for the transducer will be from the transducer specifications and the current limitations of the DBK43A excitation regulator.
3. Determine what the maximum voltage will be from the transducer at maximum load or strain, and calculate what the DBK43A channel total gain should be based on a full-scale Daq* (bipolar -5 V to +5 V, unipolar 0 to 10 V, Daq PC-Card -10 V to +10 V).  (See example at end of chapter.)
4. Determine how the total gain will be distributed between input amplifier gain, filter gain and scaling amplifier gain. (See example at end of chapter.)
5. Hook up the transducer to the DBK43A according to the figures in the *Signal Connection* and *Bridge Applications* section.  Install the appropriate bridge completion resistors if applicable.
6. To read the excitation voltage, the CAL/NORM switch must be in the "CAL" position.  Send the DBK43SetOffset command (usually through a gain setting in the software support).  Set the excitation voltage for the transducer by adjusting the trimpot labeled EXC.  To obtain the actual excitation voltage, multiply the voltage read by a factor of 2.11 (because the DaqBook reads only to 5 V and a voltage divider is used in the circuit).  Alternatively, divide the voltage value you want for your excitation by 2.11 and adjust the EXC trimpot until you achieve that reading.  After the excitation voltage is set, return the CAL/NORM switch to NORM position.
7. Send the DBK43SetOffset command (usually through a gain setting in the software support).  Adjust the OFFSET trimpot for a reading of 0.00 volts.  This removes all offset from the DBK43A channel circuit.
8. Send the DBK43SetInputGain command (usually through a gain setting in the software support).  Adjust the GAIN trimpot for a voltage reading equal to (.005)(the desired input amplifier gain).
9. Send the DBK43SetScalingGain command (usually through a gain setting in the software).  Adjust the SCALE trimpot for a voltage reading equal to (.005)(the desired input amplifier gain)(the desired scaling amplifier gain).
10. Send the DBK43ReadBridge command (default).  With the quiescent (normal or inactive) load or strain applied, adjust the OFFSET trimpot for a reading of 0.00 volts.  This adds offset to the circuit to compensate for the quiescent load and allows maximum resolution for the measurement.
11. Enable the low-pass filter and/or AC coupling if required for your application.
12. From the transducer specifications and the total gain of the DBK43A channel, calculate the Daq* voltage/transducer units and apply it to your Daq* voltage readings through software.
13. Apply a known load or strain and verify the DBK43A and software settings.

**Set-Up Notes:**
- The offset adjustment is unipolar 0 to 5 V on the input amplifier output.  If the offset can not be adjusted to 0.00 V at the end of the setup procedure, try swapping the Vin+ (4) and Vin- (3) wire connections or dropping the input gain and increasing the scaling gain.
- For very high system gains, the Scaling Gain might have to be set first with the Input Gain low and then set the Input Gain (the Daq* can only measure up to 10 V).
- Gain adjustments can be made by activating a shunt-cal resistor that is calculated to be at maximum load (set DBK43A read bridge with the CAL/NORM switch in the CAL position).
- Settings can be verified via shunt-cal.

## Software Setup in DaqView

To use the DBK43A with DaqView, you must first configure DaqView with the hardware setup.

1. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The information in the Configure System Hardware window is used to interpret the incoming analog input data and to provide the controls necessary to access the hardware. As expansion cards/modules are added, make sure the setup reflects the present hardware configuration. On the left side of the main window, the Analog Input Option Cards selection allows the user to assign DBK expansion options to the 16 analog inputs. Selecting a DBK expansion card/module will add channels in the main window's analog input spreadsheet.
2. To use the DBK43A, select the pull down box assigned to the Daq* base channel that JP1 is set for on the DBK43A. Use the down scroll arrows to find the "DBK43A Strain-Gage Module" and select it.
3. Another dialog box will appear that allows you to add a second module if needed. The dialog box shows a representation of the J2 Upper/Lower jumper. Check the boxes that represent the DBK43As in your system and then click OK.
4. Click OK in the Configure System Hardware screen to return to the main DaqView screen. Now the DBK43A channels that you have available are listed in the DaqView spread sheet. The software commands for performing the setup described in the Software-Controlled Set-Up section can be accessed in the "Type" column of the DaqView spreadsheet.

**Note**: if "Excitation" or "Shunt-Cal" is selected, the DBK43A's CAL/NORM switch must be in the CAL position.

## GageCal Program

**Note:** GageCal is best suited for a load cell application

To install the GageCal program on your computer, close all other programs and run SETUP.EXE on Disk 1 from Windows 3.1, 3.11, or Windows 95. Follow the installation instructions from the setup program.

Execute GAGECAL.EXE from a Windows environment to start the program. The first screen that appears will set up the Daq* interface. Input the correct Daq* interface information and click OK. If the program does not detect the Daq*, please check connections and try again or refer to the troubleshooting tips in chapter 11.

Through GageCal, DBK43A channels can be configured and calibrated as needed. The typical procedure for using GageCal with a DBK43A is as follows:

1. Highlight the expansion channel number you want to configure and calibrate. Notice the channel numbers are listed 16 to 271 with respect to the Daq* (if necessary, see the section *Channel and Card Address Selection*).
2. Click on the CONFIGURE button. Setup and verify your hardware setting with the diagram on the screen. Please note that the coupling must be set to DC and the filter must be disabled to calibrate the DBK43A. After the hardware is setup and verified, click on the ACCEPT button to configure the next channel or ACCEPT CONFIGURATION AND EXIT to return the main GageCal screen.
3. Highlight the first configured channel and click on the button labeled CALIBRATE. The Application Parameters screen appears. There are 3 types of calibration that the DBK43A can accommodate. **Nameplate calibration** allows you to enter specifications of your transducer and application; **Two-Point calibration** allows you to enter two points of millivoltage out of the transducer vs pounds or other physical units. From the parameters you enter, GageCal instructs you how to set up the DBK43A. **Shunt calibration** allows you to add 1 or 2 resistors (Rn00D and Rn00H for 8 channels) to the DBK43A and tell GageCal what it should expect when the resistors are shunted in and measured. You must set J3 to the position closest to TP9 for the shunt calibration to work correctly. **Note**: return J3 to the opposite position for normal strain data. **Note: All application parameters entered will be used in the DBK43A setup. Any inaccuracies will result in the DBK43A being configured incorrectly.**
4. Click on the CONTINUE button, and follow the instructions from the GageCal program. GageCal has a help file that will explain any questions on the different screens or menus. If you have trouble in your setup, a DIAGNOSTIC window can show a DBK43A circuit to help you troubleshoot the problem.

## Programming a DBK43A

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the DBK43A strain gage module. An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command. This command will use the expansion card # and channel to calculate the channel # used by the daqAdcRd command.

```
expCard = 2;              /*DBK43A JP1 position*/
expUpper = 1;             /*DBK43A uppr/lwr jmpr sttng*/
expConn = 0;              /*DBK43A connector number*/
expChan= (expUpper) * 8 + expConn;
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dbk43ReadBridge);
```

This example demonstrates how to take a reading from the bridge itself. Other definitions, Dbk43SetOffset, Dbk43SetInputGain and Dbk43SetScalingGain can be used in place of Dbk43ReadBridge when calibrating the DBK43A. For more information on DBK43A definitions and DaqBook/DaqBoard software commands, refer to the separate *Programmer s Manual*.

## Example

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

A **strain gage** example:

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

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

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

If we have a 120 ohm strain gage with a gage factor of 2.1 and excitation voltage of 5 V (due to the current limitation of the excitation regulator on the DBK43A, it must be less than 6 V) and we are measuring 4000 microstrain:

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

A **load cell** example:

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

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

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

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

Now that we know what our full-scale voltage will be from our sensor, we can calculate what the voltage gain should be on the DBK43A so the full-scale sensor output will correspond to the full-scale Daq* input. Full-scale Daq* inputs are:

- -5 to +5 V for DaqBook/DaqBoard in bipolar mode
- 0 to +10 V for DaqBook/DaqBoard in unipolar mode
- -10 to +10 V for Daq PC-Card

To calculate the needed DBK43A gains, use the maximum voltage you want to represent the full-scale of the sensor (usually full-scale Daq* input with about 500 mV leeway to prevent saturation) divided by the full-scale sensor output.

**Example:** The strain gage above at 4000 microstrain will output 10.5 mV. If using a DaqBook in bipolar mode, full-scale is +5 V. Also, we will allow 0.5 V space on the full-scale input. The DBK43A gain should be:

$$4.5 \text{ V}/10.5 \text{ mV} = 428.6$$

Now we must determine how to distribute the gain in the DBK43A (typical setup procedure step 4). There is the input amplifier that has a gain range of ×100 to ×1250, the filter gain (×1 or ×2) and the scaling amplifier that has a range of ×1 to ×10. If we round off our gain to ×420, any of these possible settings will work.

| | | | | |
|---|---|---|---|---|
| Input Gain | ×420 | ×100 | ×240 | ×300 |
| Filter Gain (enabled) | No | Yes (×2) | Yes (×1) | No |
| Scaling Gain | ×1 | ×2.1 | ×1.75 | ×1.4 |
| Total DBK43A Gain | ×420 | ×420 | ×420 | ×420 |

After we determine how all our gains will be distributed, the sensor can be hooked up to the DBK43A, the bridge completion resistors installed, and the excitation voltage set. Then we can proceed to set the gains. We will use DaqView for this.

Start DaqView and set it up for the DBK43A at the correct Daq* input channel determined by the setting of JP1 and J2. On return to the DaqView main spreadsheet, notice the **type** column in the spreadsheet. All the DBK43A channels should say **bridge**. Changing the type will allow us to set the offset and gains in the DBK43A. When setting up the DBK43A gains, enable only the channel you are setting up. In DaqView, turn all the other channels off. Also, set DC coupling and disable the on-board filter during the gain and offset settings.

First, set the excitation voltage by setting the CAL/NORM switch to the CAL position. Also, set the type in DaqView to Excitation. Enable the input reading column from the Acquire menu or the tool bar. While reading the reading in the spreadsheet, adjust the trimpot labeled EXC to the desired excitation voltage level. (DaqView 5.05+ has the reading already scaled correctly.) Disable the input reading column, and set the CAL/NORM switch back to the NORM position.

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

Then, set the type to **Input Gain.** This allows us to set the input amplifier gain. The DBK43A has a 5 mV signal on the input, so the reading that we want to set the trimpot labeled GAIN to is (.005)(Input Gain). Enable the input reading column and set the Input Gain. Disable the input reading column. Typical input gain settings are shown in the table.

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

Next set the type to **Scaling Gain**. This allows us to set the scaling amplifier gain. When setting the scaling gain, the input gain is also present and must be considered when making the adjustment. The scaling gain reading you want to read is (.005)(input gain)(scaling gain). Enable the input reading column, and set the Scaling Gain. Disable the input reading column. **For an input gain of 200**, typical scaling gains are shown in the table.

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

Now all the gains are set correctly, and we have to adjust the offset for any bridge circuit imbalance or quiescent loads. Enable the on-board filter. Set the type to **Bridge.** Make sure the quiescent load is applied. Enable the input reading column and adjust the trimpot labeled OFFSET for a reading of 0.00. If you can not adjust it to 0.00, try dropping your input gain and compensate for the drop by raising your scaling gain. If it still does not adjust to 0.00, swap the Vin+ (4) and Vin- (3) wires to reverse the polarity of the signal. The offset adjustment is unipolar and only affects the input gain. **After the final offset is made, the gain readings will be incorrect (if you want to go back and check them) unless the circuit offset is removed.** (Step 7 in typical setup procedure.) If your application requires AC coupling, remove JPx03.

# DBK43A - Specifications

**Name/Function: Strain-Gage Module**
**Connectors**: DB37 mates with Daq* 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

# DBK44 2-Channel 5B Signal-Conditioning Card

## Overview

The 2-channel DBK44 allows Daq* systems to use any combination of 5B signal-conditioning modules. 5B modules can accommodate a wide variety of signals (low-level thermocouple signals to strain-gage signals, etc). Configuration options are flexible. You can select the type of signal attached to each channel. One Daq* can support up to 128 DBK44 cards, providing a maximum of 256 isolated, analog input channels. The Daq* scans the DBK44's channels at the same 10 μs/channel rate as other DBKs (256 scans in 2.56 ms in a full system). Each user-installed 5B module offers 500 V isolation from the system and between channels. The DBK44 has convenient screw-terminal blocks for signal inputs and excitation outputs (for use with a strain gage or RTD). Cold junction compensators (CJC) are installed and ready to use with thermocouple 5B modules. Sockets are provided for AC1362 current-sense resistor modules.
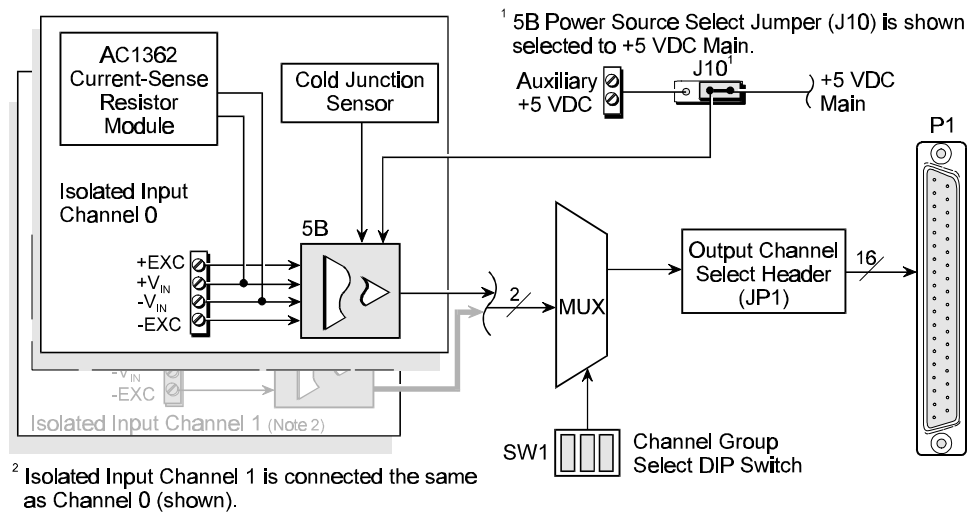


*DBK44 Block Diagram*

## Hardware Setup

### Power Considerations

The DBK44 requires +5 and ±15 VDC from a Daq* or auxiliary power supply. In some applications, the DBK44 can draw enough power from the DaqBook's internal power supply via the P1 connector. However, the 5B power requirements (+5 VDC only) may be greater than the DaqBook/DaqBoard can provide (see table). The Daq PC-Card must use a CDK10 Power Module. The 5B38 series strain-gage modules with excitation output require an external power source. Auxiliary power is also necessary in systems equipped with more than one DBK44. **Note:** for applications with more than 4 channels, it may be better to use the DBK42 16-channel module with a built-in power supply.

| 5B Model | Current Required |
|---|---|
| 5B30 | 30 mA |
| 5B31 | 30 mA |
| 5B32 | 30 mA |
| 5B34 | 30 mA |
| 5B37 | 30 mA |
| 5B38 | 200 mA |
| 5B39 | *170 mA |
| 5B40 | 30 mA |
| 5B41 | 30 mA |
| 5B47 | 30 mA |
| * Maximum output load resistance is 750 Ω | |

External power can be obtained from any regulated 5 V source or from a TR-4 power supply. External power attaches to the DBK44 via onboard screw terminal connections (the Auxiliary Power Input J9 Combicon terminal at the rear of the board). The J10 jumper selects between main or auxiliary power. When using auxiliary power, you must select the AUXL position on the Power Source Select Jumper (J10).

| CAUTION |
|---|
| Auxiliary power input must not exceed +5 VDC. The DBK44 does not regulate auxiliary power input. |

### Card Configuration

Up to 128 DBK44s may connect to a Daq* system.  Since this is a daisy-chain interface, each module must appear unique and use a different analog input channel to the Daq*.  To configure the card's channel, you must set the JP1 jumper and the SW1 DIP switch to your chosen channel as follows.

1. Locate the 16×2-pin header (labeled JP1) near the front of the card.  Note the 16 jumper locations labeled CH0 through CH15 to match the Daq* main channel.
2. Place the JP1 jumper on the channel you wish to use.  Only one jumper is used per card, but up to 8 DBK44s can occupy one main channel and use the same JP1 setting (but with different SW1 settings).
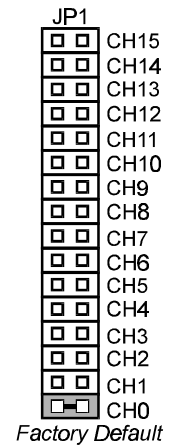3. Locate the SW1 DIP switch that serves as a channel group select switch and can distinguish up to 8 cards on a channel.
4. Place the 3 mini switches (CBA) in the position that corresponds to your chosen channel as shown in the table.  For each JP1 setting, there are 8 possible SW1 settings to allow two input channels per card).

```
JP1
┌──────┐
│ □ □  │ CH15
│ □ □  │ CH14
│ □ □  │ CH13
│ □ □  │ CH12
│ □ □  │ CH11
│ □ □  │ CH10
│ □ □  │ CH9
│ □ □  │ CH8
│ □ □  │ CH7
│ □ □  │ CH6
│ □ □  │ CH5
│ □ □  │ CH4
│ □ □  │ CH3
│ □ □  │ CH2
│ □ □  │ CH1
│ ▣▪▣  │ CH0
└──────┘
```
*Factory Default*

| Channel Pair Determined by JP1 and SW1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| JP1 Jumper | SW1 DIP Switch Setting | | | | | | | |
| | CBA | CBA | CBA | CBA | CBA | CBA | CBA | CBA |
| | 0 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1 0 0 | 1 0 1 | 1 1 0 | 1 1 1 |
| CH0 | 16-17 | 18-19 | 20-21 | 22-23 | 24-25 | 26-27 | 28-29 | 30-31 |
| CH1 | 32-33 | 34-35 | 36-37 | 38-39 | 40-41 | 42-43 | 44-45 | 46-47 |
| CH2 | 48-49 | 50-51 | 52-53 | 54-55 | 56-57 | 58-59 | 60-61 | 62-63 |
| CH3 | 64-65 | 66-67 | 68-69 | 70-71 | 72-73 | 74-75 | 76-77 | 78-79 |
| CH4 | 80-81 | 82-83 | 84-85 | 86-87 | 88-89 | 90-91 | 92-93 | 94-95 |
| CH5 | 96-97 | 98-99 | 100-101 | 102-103 | 104-105 | 106-107 | 108-109 | 110-111 |
| CH6 | 112-113 | 114-115 | 116-117 | 118-119 | 120-121 | 122-123 | 124-125 | 126-127 |
| CH7 | 128-129 | 130-131 | 132-133 | 134-135 | 136-137 | 138-139 | 140-141 | 142-143 |
| CH8 | 144-145 | 146-147 | 148-149 | 150-151 | 152-153 | 154-155 | 156-157 | 158-159 |
| CH9 | 160-161 | 162-163 | 164-165 | 166-167 | 168-169 | 170-171 | 172-173 | 174-175 |
| CH10 | 176-177 | 178-179 | 180-181 | 182-183 | 184-185 | 186-187 | 188-189 | 190-191 |
| CH11 | 192-193 | 194-195 | 196-197 | 198-199 | 200-201 | 202-203 | 204-205 | 206-207 |
| CH12 | 208-209 | 210-211 | 212-213 | 214-215 | 216-217 | 218-219 | 220-221 | 222-223 |
| CH13 | 224-225 | 226-227 | 228-229 | 230-231 | 232-233 | 234-235 | 236-237 | 238-239 |
| CH14 | 240-241 | 242-243 | 244-245 | 246-247 | 248-249 | 250-251 | 252-253 | 254-255 |
| CH15 | 256-257 | 258-259 | 260-261 | 262-263 | 264-265 | 266-267 | 268-269 | 270-271 |

### 5B Module Connection

Each input of the DBK44 is processed through a user-installed 5B signal-conditioning module.  Different 5B modules are used with different transducer and signal sources.  To install the modules:

1. Remove all power from the DBK44.
2. Match the footprint of the module with the footprint on the circuit board (see figure).
3. Gently place the module into the footprint, and screw it down.



*5B Module Installation*
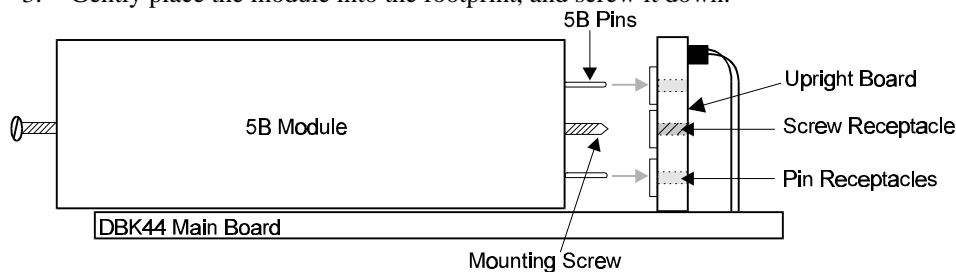
4. Record the channel the module was placed in.

When installing current input modules (SC-5B32 series), be sure to install the current-sense resistor (SC-AC-1362 shipped with the SC-5B32) in the resistor socket near the input screw-terminal block for the desired channel (see figure).


*Install Current-Sense Resistor*
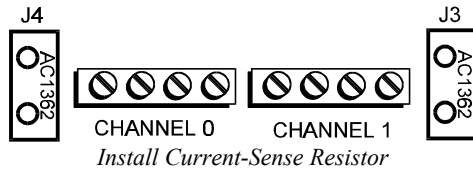
### Terminal Block Connection

<div style="border:1px solid">

## WARNING

Shock Hazard. De-energize circuits connected to the DBK44 before changing the wiring or configuration. The DBK44 is designed to sense signals that may carry dangerous voltages.

</div>

Input signals (and excitation leads) must be wired to the DBK44 via the 4-contact terminal blocks at the end of the card. These terminal blocks connect internally to their corresponding signal conditioning module. The terminal blocks accept up to 14-gage wire into quick-connect screw terminals that are labeled as to their function. Each type of input signal or transducer (such as a thermocouple or strain gage) should be wired to its terminal block as shown in the figure. Wiring is shown for RTDs, thermocouples, 20 mA circuits, mV/V connections, and for full- and half-bridge strain gages.


*DBK44 Terminal Connections*
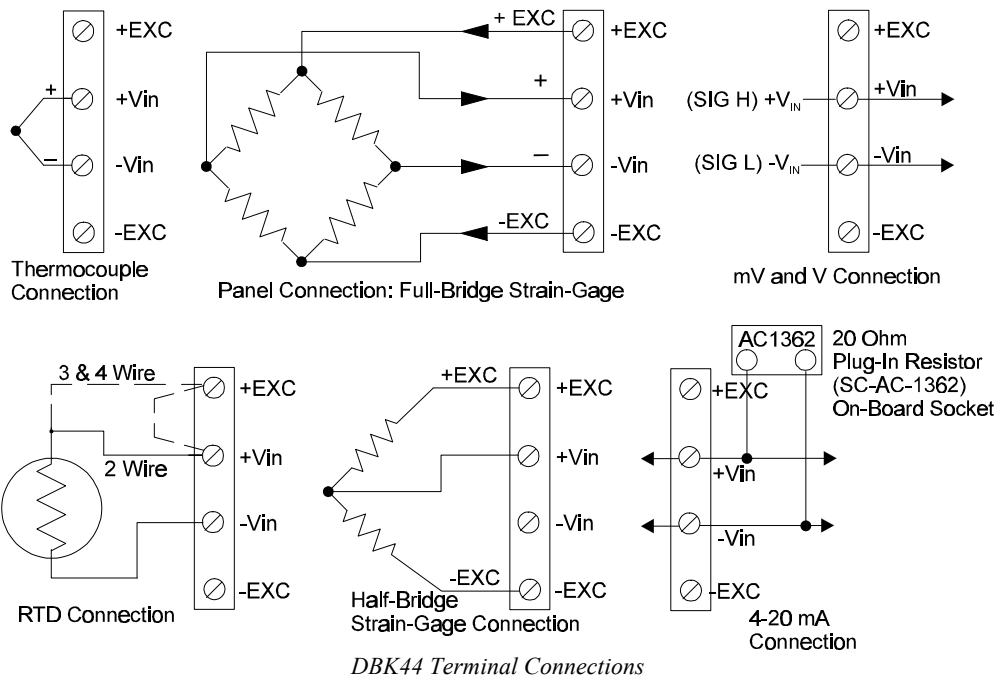
### Daq* Connection

The DBK44 attaches to the Daq*'s P1 analog I/O connector (see figure). Connect the CA-37-x accessory ribbon cable (with *x* indicating the number of cards to be connected) from P1 to the DB37 connector at the end of the DBK44 card.  **Note**: A series of interface cables are available to connect up to 128 DBK44s.  (You can also use a DBK41 10-slot expansion chassis.)

**Note: to meet CE safety specifications, an edge guard (kit p/n 232-0805) must be attached to the DBK44 card before insertion into a DBK41 expansion chassis.  This guard helps prevent accidental access to high-voltage circuits.**



*Daisy-Chaining DBK44s*
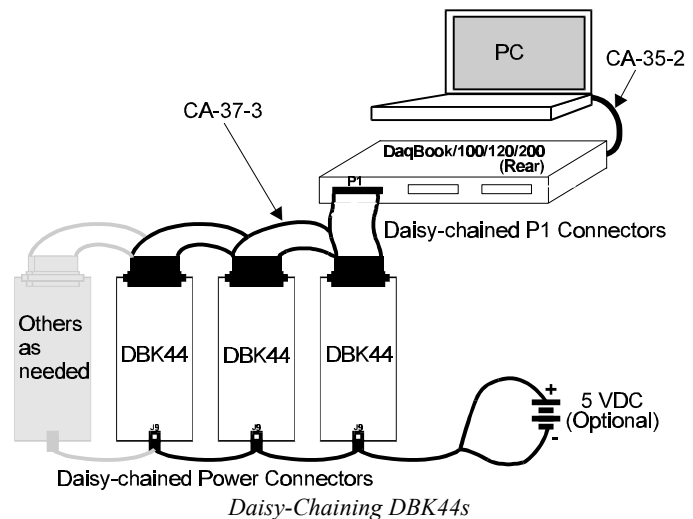
### DaqBook/DaqBoard Configuration

The DBK42 requires two setup steps in the DaqBook/DaqBoard— jumpers JP4 and JP1.

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 DBK44 via the internal ±15 VDC power supply.  If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).



*Configuration Jumpers*

2.  *Place the JP4 jumper in the DaqBook/DaqBoard in single-ended mode.  **Note**: Analog expansion cards convert all input signals to single-ended voltages referenced to analog common.  *Applies to DaqBook/100, /112, and /120.

**Note**:  The configuration of the JP3 jumper depends on the output range of the 5B module.  For example, a 5B31 volt input module has an output range of -5 to +5 V in bipolar mode.  A 5B47 T/C module (output 0 to +5 V) could use bipolar mode, but unipolar mode is more appropriate.

## Software Setup in DaqView

To use the DBK44 within DaqView, you must first configure DaqView for your hardware setup.  From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings.  The Configure System Hardware parameters help interpret the incoming analog input data and provide controls to access the hardware.  As expansion modules are added, make sure the setup reflects the actual hardware.  On the left side of this window, the An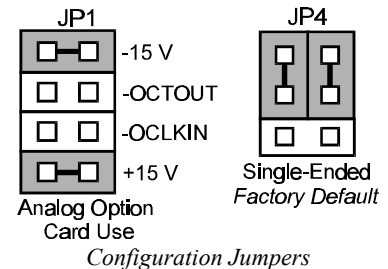alog Input Option Cards selection allows you to assign DBK expansion modules to the 16 analog inputs in the analog input spreadsheet.

Select the DBK44 2-Channel 5B Card.  The main window now has 2 channels for this 1 card.  A gain of ×1 is the only available gain in the Type column because the 5B module's output is typically 0 to 5 V.  By default, DaqView displays readings in volts.  To change the default, click on the Engr Unit column for your choice of units.  The *mx+b* calculations for most 5B modules are already within DaqView and will appear when you select the module.  (A pull-down 5B module selection box will appear when you place the cursor in the Units column.)

For example, a SC-5B47-T-06 module converts a T-type thermocouple input from -100°C to +400°C into a linear voltage from 0 to 5 V.  DaqView must first determine the range of °C (e.g., 500°C).  This range is then divided by the range in volts (5 V).  The resulting number is *m* (e.g., 100).  Next the offset, *b*, is determined.  *b* is the difference between the lower level and 0 (e.g., -100).  The configured setting for the 5B47-T-06 module is an *m* of 100, a *b* of -100 and a unit of °C to display a reading in degrees Celsius. DaqView performs this calculation.  The only visible change will be °C in the Units column.  (Refer to the chapter *DaqView* for more information about the *mx+b* column.)

## Programming a DBK44

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment (standard API) shows how to get a sample from the expansion module. An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command. This command will use the expansion card # and channel to calculate the channel # used by the daqAdcRd command.

```
expCard = 2;  /*DBK44 JP1 position*/
expAddr= 8;  /*DBK44 switch setting*/
expConn = 0;  /*DBK44 connector number*/
expChan= (expAddr-1) * 8 + expConn;
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, DgainX1);
```

When using the DaqBook/DaqBoard driver, analog input values are returned in counts. Depending on the model, the returned value will be 12 or 16 bits. 12-bit values are left justified with the least significant 4 bits (used as a channel tag) in the returned unsigned integer. 5B signal conditioners produce an output voltage proportional to the measurement (i.e. strain, temperature, mA).

For all DBK44 measurements, the DaqBook/DaqBoard should be set to a gain of ×1 since the 5Bs typically output signals up to 5 V. To convert the incoming unsigned integer values into engineering units, an mx+b calculation must be performed. The following example reads a value from a type T thermocouple module (SC-5B47-T-06), then converts the unsigned integer to units of °C.

```
expCard = 2;              /* JP1 position */
expChan= 15;              /* module channel number*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, DgainX1);
V=(32768.0 * sample/5.0) - 5.0;      /* Convt raw counts to volts*/
m=100;          /* m  value from table */
b=-100;          /* b value from table */
C=m* v + b;      /* Cnvt volts to dgrs C*/
```

The *mx+b* calculations for most 5B modules are included within DaqView software. The following table shows the *m* and *b* values for all of the 5B modules.

| 5B Module | m Value | b Value | Engineering Unit(s) |
|---|---|---|---|
| **Isolated Voltage Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B31-01 | 1/5 | 0 | mV, V |
| SC-5B31-02 | 1 | 0 | mV, V |
| SC-5B31-03 | 2 | 0 | mV, V |
| SC-5B31-04 | 2/5 | -1 | mV, V |
| SC-5B31-05 | 2 | -5 | mV, V |
| SC-5B31-06 | 4 | -10 | mV, V |
| **Isolated Wideband Voltage (5 V Current Requirement, 30mA)** | | | |
| SC-5B41-01 | 1/5 | 0 | V |
| SC-5B41-02 | 1 | 0 | V |
| SC-5B41-03 | 2 | 0 | V |
| SC-5B41-04 | 2/5 | -1 | V |
| SC-5B41-05 | 2 | -5 | V |
| SC-5B41-06 | 4 | -10 | V |
| **Isolated Millivolt Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B30-01 | 2 | 0 | mV |
| SC-5B30-02 | 10 | 0 | mV |
| SC-5B30-03 | 20 | 0 | mV |
| SC-5B30-04 | 4 | -10 | mV |
| SC-5B30-05 | 20 | -50 | mV |
| SC-5B30-06 | 40 | -100 | mV |
| **Isolated Wideband Millivolt (5 V Current Requirement, 30 mA)** | | | |
| SC-5B40-01 | 2 | 0 | mV |
| SC-5B40-02 | 10 | 0 | mV |
| SC-5B40-03 | 20 | 0 | mV |
| SC-5B40-04 | 4 | -10 | mV |
| SC-5B40-05 | 20 | -50 | mV |
| SC-5B40-06 | 40 | -100 | mV |

| 5B Module | m Value | b Value | Engineering Unit(s) |
|---|---|---|---|
| **Isolated Linearized T/C Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B47-J-01 | 152 | 0 | °C |
| SC-5B47-J-02 | 80 | -100 | °C |
| SC-5B47-J-03 | 100 | 0 | °C |
| SC-5B47-K-04 | 200 | 0 | °C |
| SC-5B47-K-05 | 100 | 0 | °C |
| SC-5B47-T-06 | 100 | -100 | °C |
| SC-5B47-T-07 | 40 | 0 | °C |
| SC-5B47-E-08 | 200 | 0 | °C |
| SC-5B47-R-09 | 250 | +500 | °C |
| SC-5B47-S-10 | 250 | +500 | °C |
| SC-5B47-S-11 | 260 | +500 | °C |
| **Isolated RTD Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B34-01 | 40 | -100 | °C |
| SC-5B34-02 | 20 | 0 | °C |
| SC-5B34-03 | 40 | 0 | °C |
| SC-5B34-04 | 120 | 0 | °C |
| SC-5B34-C-01 | 24 | 0 | °C |
| SC-5B34-C-02 | 24 | 0 | °C |
| SC-5B34-N-01 | 24 | 0 | °C |
| **Isolated Current Input (5 V Current Requirement, 30 mA)** | | | |
| SC-5B32-01 | 3.2 | 4 | mA |
| SC-5B32-02 | 4 | 0 | mA |
| **Voltage Switch Input** | | | |
| SC-AC-1367 | 1 | 0 | V |

For more information on specific software commands, refer to the separate *Programmer s Manual*.

# DBK44 - Specifications

**Name/Function: 2-Channel 5B Signal Conditioning Card**
**Module Capacity**: 2 (input only) 5B modules
**Weight**: 8 oz. (with no modules installed)
**Cable (optional)**: CA-37-x
**DC Input Fuse**: 4 A
**Daq\* Connection**: Male DB37 mates via CA-37-1 cable with Daq\* P1
**Isolation**:
    Input Power to Daq\*: 0 VDC
    Signal Inputs to Daq\*: 1500 VDC
    Input Channel-to-Channel: 500 VDC
**Environmental**:
    Operating Temperature: 0 to 50°C
    Humidity: 0 to 80% RH @ 30°C; de-rate 3%/°C
    Altitude: 0 to 2000 m

# DBK45  4-Channel SSH and Low-Pass Filter Card

## Overview

The DBK45 combines the features of the DBK17 (SSH) and the DBK18 (low-pass filter) cards.  Each DBK45 provides 4 input channels to a Daq* system.  Each of the Daq*'s 16 analog input channels can accept 4 DBK45s, for a maximum of 64 DBK45s and 256 analog input channels.  The simultaneous sample-hold function is activated at the beginning of each channel scan and freezes all signals present on DBK45 inputs for the duration of the scan, allowing for non-skewed readings of all channels.  **Note**: a DBK45 channel should never be the 1st channel in a scan due to timing of the SSH line.

For each of the 4 channels, a separate filter and sample-hold stage follow the input stage.  The outputs are connected to a 4-channel multiplexer stage.  The enabled-output MUX allows 4 DBK45s to share a common Daq* analog input channel.

The DBK45 features an instrumentation amplifier for each channel, with switch-selected gains of ×1, ×10, ×100, ×200 and ×500.  A socket is provided for a gain resistor for custom gain selection instead of the 5 factory-default gains.  Gain for any channel can be set to any value between unity and ×500 by installing an appropriate  resistor.  Four separate filter stages follow the 4 input stages.  The outputs are connected to a 4-channel multiplexer stage.  The enabled output MUX allows 4 DBK45s to share a common Daq* analog base channel.

The input connectors are BNC type connectors.  The differential inputs are provided with switchable 100 KΩ bias resistors to analog common.
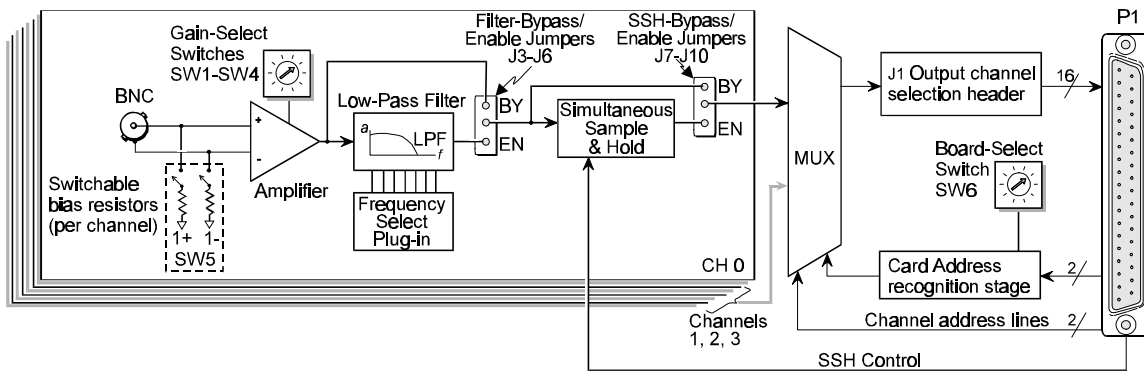


*DBK45 Block Diagram*

## Hardware Setup

### Card Connection



### CAUTION

**Input voltage levels must not exceed ±5 V bipolar or 10 V unipolar**.

The DBK45 is equipped with BNC connectors for easy access to analog inputs.  Connections are provided for 4 differential inputs.

### Card Configuration

#### Input Termination

The DBK45 provides two 100 KΩ bias resistors for each analog input.  For balanced 200 KΩ input impedance, both resistors should be switched in.  An 8-position DIP switch (SW5) can selectively engage the bias resistors (see figure).  The switches must be in the closed position to engage the termination resistors.  For unbalanced high input, only the (-) resistor should be used.  If neither resistor is used, some external bias current path is required.
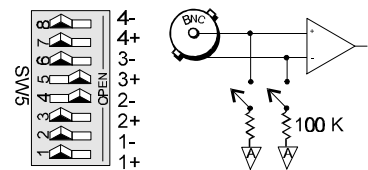


*Input Impedance/Termination*

## Gain Settings

On the printed circuit board, each channel has a gain-set switch labeled GAIN 1 to GAIN 4 (see figure) and holes for gain resistors labeled RG1 to RG4. The table in the figure shows the 5 gain values for switch settings 0 to 4. If a custom gain is desired, the switch is set to position 0; and a gain resistor must be mounted and soldered onto the board. The value of the gain resistor is determined by the formula: $R_{GAIN} = [40,000 / (Gain - 1)] - 80 \ \Omega$

Gain Values  Gain Switch
0  ×1
1  ×10
2  ×100
3  ×200
4  ×500

*Setting Channel Gains*

## Address Configuration

Up to 4 DBK45s can be connected to each Daq* analog channel. With 16 Daq* channels and 4 inputs per DBK45, a maximum of 256 inputs are possible. Since this is a daisy-chain interface, each DBK45 must have a unique address (channel and card number).

To configure the module, locate the $16 \times 2$-pin header (labeled J1) near the front of the board by P1. The 16 jumper locations on this header are labeled CH0 through CH15. Place the jumper on the channel you wish to use. Only one jumper is used. Two DBK45s in the daisy-chain can have the same channel number as long as their card number is unique.

Set switch SW6 for each DBK45 on a single channel. Verify that only one card in the system is set to a particular channel *and* card number.

*Address Configuration*
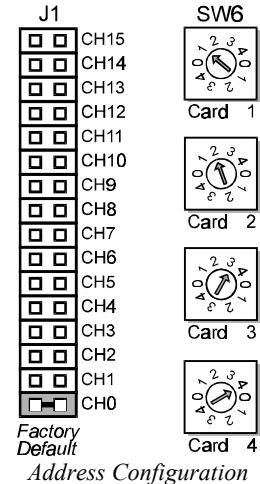
## SSH Configuration

Each channel's Simultaneous-Sample-and-Hold circuit can be enabled (EN) or bypassed (BY) by placement of the jumper on J7 for channel 0, J8 for channel 1, J9 for channel 2, or J10 for channel 3. The factory-default setting is **enabled (EN)** for each channel.

## *Configuring DBK45 Filter Sections*

There are 4 low-pass, 3-pole active filters on the DBK45. Each filter can be enabled (EN) or bypassed (BY) by placement of the jumper on J3 for channel 0, J4 for channel 1, J5 for channel 2, J6 for channel 3. The factory-default setting is **enabled (EN)** for each channel. Each filter can be configured as a Butterworth, Bessel, or Chebyshev filter with corner frequencies up to 50 kHz. Filter properties depend on the values of resistors and capacitors installed in several circuit locations. Above 10 Hz, installing capacitors is unnecessary because capacitors in the ICs are sufficient. In all cases, three resistors are required to complete the active filter circuits contained mostly within the UAF42 ICs.

The circuit diagram shows the active filter IC in a typical section of the DBK45. The resistors and capacitors outside the IC have a physical location in a DIP-16 socket (dual in-line, 16 pins) with an RCnn designator. The RC indicates the needed part is a resistor or capacitor; the 3rd character is the channel number; and the 4th character corresponds to the socket position (A-H).

*Filter Circuit Diagram*

The figure shows the DIP-16 component pattern typical of the 4 filter sections. A machined-pin IC socket in each filter RC location can accept resistors and capacitors that plug directly into the socket. A better approach is to install these components on plug-in headers. This allows solder connections to the components and gold-to-gold, plug-in connections between the header and the sockets. **Note**: no part or "n" means open circuit.


*DIP-16 Component Pattern*

Pin 7 of the DIP-16 socket:
- connects to pin 8 for low-pass filtering
- connects to pin 6 for band-pass filtering

The next table lists values of components for common corner frequencies in Butterworth filters. If you wish to design your own filter, included software from Burr-Brown provides the component values to create the desired filter. (The design math is outside the scope of this manual.)

| 3-POLE BUTTERWORTH FILTER COMPONENTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3dB (Hz) | RCnA | RCnB | RCnC | RCnD | RCnE | RCnF | RCnG | RCnH |
| 0.05 | 3.16 M | 1 µF | none | 3.16 MΩ | 1 µF | 3.16 MΩ | none | 1 µF |
| 0.10 | 1.58 MΩ | 1 µF | none | 1.58 MΩ | 1 µF | 1.58 MΩ | none | 1 µF |
| 0.20 | 787 KΩ | 1 µF | none | 787 KΩ | 1 µF | 787 KΩ | none | 1 µF |
| 0.50 | 3.16 MΩ | 1 µF | none | 3.16 MΩ | 0.1 µF | 3.16 MΩ | none | 0.1 µF |
| 1 | 1.58 MΩ | 0.1 µF | none | 1.58 MΩ | 0.1 µF | 1.58 MΩ | none | 0.1 µF |
| 2 | 787 KΩ | 0.1 µF | none | 787 KΩ | 0.1 µF | 787 KΩ | none | 0.1 µF |
| 5* | 3.16 MΩ | 0.01 µF | none | 3.16 MΩ | 0.01 µF | 3.16 MΩ | none | 0.01 µF |
| 10* | 1.58 MΩ | 0.01 µF | none | 1.58 MΩ | 0.01 µF | 1.58 MΩ | none | 0.01 µF |
| 20 | 787 KΩ | 0.01 µF | none | 787 KΩ | 0.01 µF | 787 KΩ | none | 0.01 µF |
| 50 | 3.16 MΩ | none | none | 3.16 MΩ | none | 3.16 MΩ | none | none |
| 100* | 1.58 MΩ | none | none | 1.58 MΩ | none | 1.58 MΩ | none | none |
| 200 | 787 KΩ | none | none | 787 KΩ | none | 787 KΩ | none | none |
| 500* | 316 KΩ | none | none | 316 KΩ | none | 316 KΩ | none | none |
| 1000* | 158 KΩ | none | none | 158 KΩ | none | 158 KΩ | none | none |
| 2000 | 78.7 KΩ | none | none | 78.7 KΩ | none | 78.7 KΩ | none | none |
| 5000 | 31.6 KΩ | none | none | 31.6 KΩ | none | 31.6 KΩ | none | none |
| 10000 | 15.8 KΩ | none | none | 15.8 KΩ | none | 15.8 KΩ | none | none |
| *These pre-configured Butterworth frequency modules are available from the manufacturer. | | | | | | | |

You have the option to configure the filter sections as band-pass filters rather than low-pass filters. The component selection program provides band-pass component values. The program also computes and displays phase and gain characteristics of the filter sections as a function of frequency.

### *DaqBook/DaqBoard Configuration*

Use of the DBK45 requires setting jumpers in the DaqBook/DaqBoard.


*Configuration Jumpers*

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 DBK45 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. Place the JP2 jumper in the SSH position. **Note**: **you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).
3. *Place the JP4 jumper in single-ended mode (*applies only to DaqBook/100, /112 and /120).
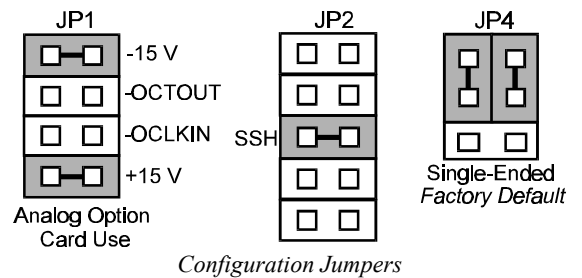
## Software Setup in DaqView

To use the DBK45 within DaqView, you must first configure the DaqView software. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters are used to interpret the incoming data and provide the controls to access the hardware. As expansion units are added, make sure the Hardware Setup reflects the present hardware configuration.

On the left side, the Analog Input Option Cards selection allows you to assign expansion DBKs to the 16 analog inputs. Selecting a DBK will add channels in the analog input spreadsheet. Select the DBK45 option. (**Note**: if your version of DaqView does not support the DBK45, use the DBK18 setup.) A DBK45 configuration window will appear. Click the checkbox for each board connected according to the SW6 hardware setting on the DBK45. The main window now has 4 channels for each DBK45 selected. You can define the channel gains by using the Type column of the analog input spreadsheet.

## Programming a DBK45

**Note for programmers**: For information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK45 - Specifications

**Name/Function: Simultaneous Sample and Hold and Low-Pass Filter Card**
**Number of Channels**: 4
**Input Connections**: 4 BNC connectors
**Output Connector**: DB37 male, which mates with Daq* P1 using CA-37-x cable
**Number of Cards Addressable**: 64
**Dimensions**: 8.25" × 3.25"
**Input Type**: Differential
**Voltage Input Ranges**:
- 0 to ±5000 mVDC
- 0 to ±500 mVDC
- 0 to ±50 mVDC
- 0 to ±25 mVDC
- 0 to ±10 mVDC

**For Custom Gains**: $R_{GAIN}$ = [40,000/(Gain-1)] - 80 $\Omega$
**Input Amplifier Slew Rate**: 12 V/µs minimum
**Acquisition Time**:
- 0.6 µs (10 V excursion to 0.1%)
- 0.7 µs (10 V excursion to 0.01%)

**Channel-to-Channel Aperture Uncertainty**: 50 ns
**Output Droop Rate**: 0.1 µV/µs
**Input Gains**: ×1, ×10, ×100, ×200, x500, and user-set up to ×500
**Input Offset Voltage**: 500 µV + 5000/G maximum (nullable)
**Input Offset Drift**: ±5 + 100/G µV/°C maximum
**Input Bias Current**: 100 pA maximum
**Input Offset Currents**: 50 pA maximum
**Input Impedance**: 5 × 10$^{12}$ $\Omega$ parallel with 6 pF
**Switchable Bias Resistors**: 100 K$\Omega$ each to analog common

**Gain Errors**:
- 0.04% @ ×1
- 0.1% @ ×10
- 0.2% @ ×100
- 0.4% @ ×200
- 1.0% @ ×500

**Temperature vs Gain**:
- ±20 ppm/°C @ ×1
- ±20 ppm/°C @ ×10
- ±40 ppm/°C @ ×100
- ±60 ppm/°C @ ×200
- ±100 ppm/°C @ ×500

**Non-Linearity**:
- ±0.015 % full-scale @ ×1
- ±0.015 % full-scale @ ×10
- ±0.025 % full-scale @ ×100
- ±0.025 % full-scale @ ×200
- ±0.045 % full-scale @ ×500

**Common-Mode Rejection**:
- 70 dB minimum @ ×1
- 87 dB minimum @ ×10
- 100 dB minimum @ ×100
- 100 dB minimum @ ×200
- 100 dB minimum @ ×500

**Active Filter Device**: UAF42 (Burr-Brown)
**Number of Poles/Filter**: 3
**Types of Filters**: Bessel, Butterworth, Chebyshev
**Frequency Range**: 0.1 Hz to 50 kHz
The frequency is set by installation of 4-6 resistors and/or capacitors in provided socket locations.
**Frequency Modules**: Optional frequency module kits are available that consist of 4 plug-in resistor/capacitor (RC) headers pre-configured for any of the following frequencies: 5 Hz, 10 Hz, 100 Hz, 500 Hz, or 1 kHz—all are Butterworth-type filters.

# DBK50/51 Voltage Input Modules

## Overview

Except for their ranges, the DBK50 (high-voltage) and the DBK51 (low-voltage) are identical. Both have 8 channels isolated from themselves (750 V) and from the Daq* analog common (1250 V). Each channel's input impedance is over 10 MΩ to minimize loading of the circuit being measured. Voltages can be read from DC to more than 20 kHz. One of 3 voltage ranges can be chosen via software:

- for the DBK50, the ranges are 10 V, 100 V, and 300 V.
- for the DBK51, the ranges are 100 mV, 1 V, and 10 V.

With standard plug-in attenuator assemblies, the voltage ranges are interchangeable. The gain or attenuation factor depends on the range, but the full-scale output for any range is +5 V. **Note**: a fourth "range" delivers a shorted input voltage reading to allow offset compensation in some applications.



*DBK50/51 Block Diagram*
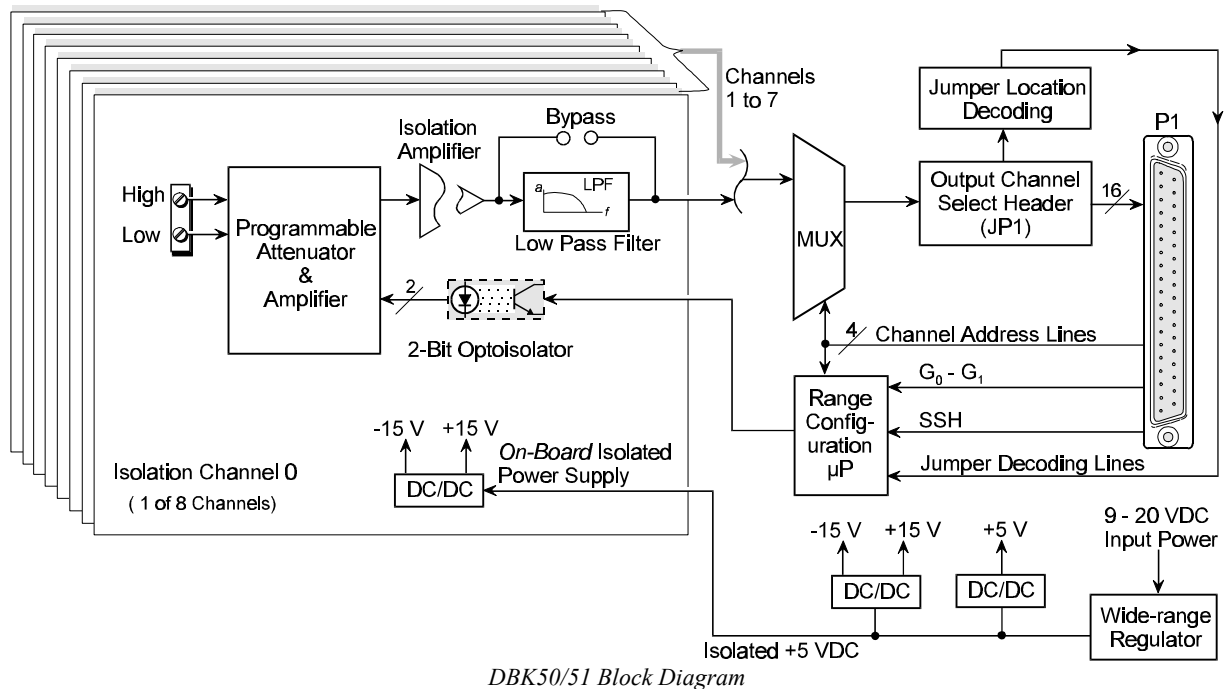
### Input Attenuation/Gain Factors

Gain and attenuation may be calculated using the formula:

$$K = V_{in} / V_{out}$$

where: **K** is the attenuation or gain factor (the values of **K** for available voltage ranges are given in the table).
**Vin** is the voltage applied to the module input channel.
**Vout** is the amplified or attenuated voltage from the module output back to the main unit.

| Input Range | Function | K |
|---|---|---|
| 300 V Range | Attenuates | 60 |
| 100 V Range | Attenuates | 20 |
| 10 V Range | Attenuates | 2 |
| 1 V Range | Amplifies | 0.2 |
| 100 mV Range | Amplifies | 0.02 |
| Note: not all input ranges are available on a single unit. | | |

# Hardware Setup

## Module Connection

The DBK50/51 rear panel has 8 plug-in screw terminals for easy access to the 8 analog input channels. There is a high (left side) and a low (right side) terminal in each channel pair to maintain consistent polarity. For AC signals, the polarity is arbitrary unless multiple signals must maintain their phase relationship. The figure shows an analog input access connector.



*Input Channel Access Connector*
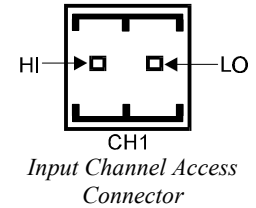
## Module Configuration

Several jumpers must be set on the DBK50/51 to match your application:
- 2 jumpers on JP1 or JP1B to select the Daq* main channel to use
- 1 jumper on JP1C for upper or lower sub channels
- 1 jumper on JPn02 to use or bypass the low-pass filter—one for each channel number (n)

The main output channel is one of the 16 Daq* channels. Each DBK50/51 has 8 input channels and can be set to an upper or lower sub-channel that allows 2 modules to share a single Daq* channel. (Thus, a fully-populated system can have 256 input channels.)

After determining a main channel number for the module, set two jumpers on JP1A or JP1B for the desired channel (both jumpers must be used side-by-side on the selected channel—see figure). Next, set the JP1C jumper for the upper or lower sub channel. Two modules may share the same main channel if one is set to the upper sub channel and the other set to the lower sub channel.



*DBK50/51 Channel Configuration*
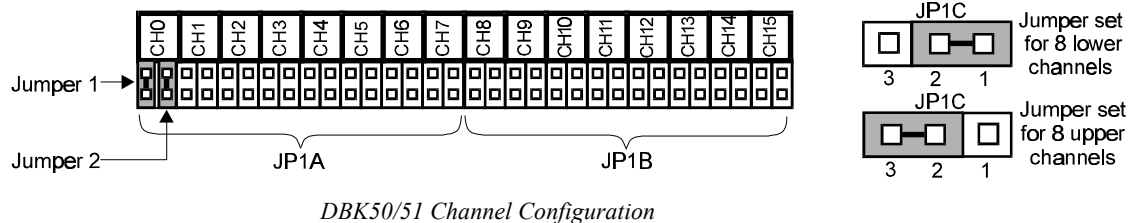
Each of the 8 input channels has a 3-pole low-pass filter which may be manually selected or bypassed by positioning 2 shunt jumpers on 2×2 headers for each channel. Orient the jumpers parallel/horizontal (enable) or perpendicular/vertical (bypass) to the header label (JP102 to JP802 for each of 8 channels—see figure for orientation).



*DBK50/51 Filter Configuration*
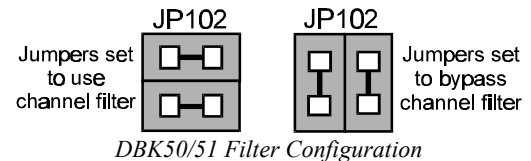
The low-pass filter sections have a default corner frequency of 3.5 Hz when the jumpers are in the LPF-selected positions. This frequency may be readily changed by installing a different value of SIP resistor network in the 6-pin SIP socket of each filter section. Each channel has its own SIP located next to the channel filter bypass jumper and labeled RN(1-8)01A. The table lists values of common networks and their corner frequencies.

| Corner Frequency | R-SIP | Bournes Part # |
|---|---|---|
| 7500 Hz | 47 Ω | 4606X-102-470 |
| 3500 Hz | 100 Ω | 4606X-102-101 |
| 1750 Hz | 200 Ω | 4606X-102-201 |
| 750 Hz | 470 Ω | 4606X-102-471 |
| 350 Hz | 100 kΩ | 4606X-102-102 |
| 175 Hz | 2 kΩ | 4606X-102-208 |
| 75 Hz | 4.7 kΩ | 4606X-102-208 |
| 35 Hz | 10 kΩ | 4606X-102-103 |
| 17.5 Hz | 20 kΩ | 4606X-102-203 |
| 7.5 Hz | 47 kΩ | 4606X-102-473 |
| 3.5 Hz | 100kΩ | 4606X-102-104 |

### DaqBook/DaqBoard Configuration

Several setup steps at the DaqBoard/DaqBook are required to use DBK50/51 modules in a system.

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 DBK50 via the internal ±15 VDC power supply. If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. Place the JP2 jumper in the SSH position. **Note**: **you must not use an external voltage reference for DAC1 when using the SSH output** (a conflict on P1 pin #26 would cause equipment damage).
3. *Place the JP3 jumpers in bipolar mode.
4. *Place the JP4 jumpers in single-ended mode.
   *Applies only to DaqBook/100, /112 and /120).

*DaqBook/Board Settings for DBK50/51*
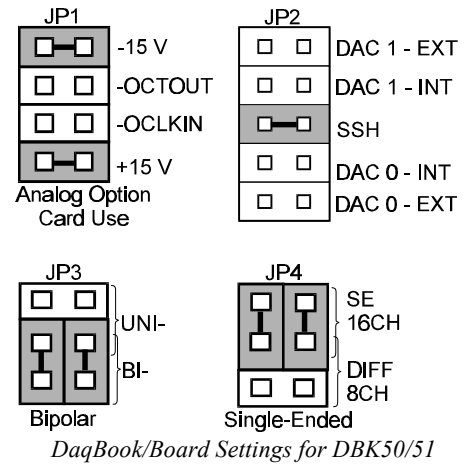
## Software Setup in DaqView

To use the DBK50/51 within DaqView, you must configure DaqView for your hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters are used to interpret incoming data and provide controls to access the hardware. As expansion cards are added, make sure the Hardware Setup window reflects the actual hardware.

On the left side of this window, the Analog Input Option Cards selection allows you to assign DBKs to the Daq*'s 16 analog inputs. Selecting a DBK will add channels in the analog input spreadsheet. Select the DBK50 or DBK51 Isolation Card option. A configuration window will display for selecting multiple modules. Click the check box for each module according to the position of the module's JP1C jumper (upper/lower). The main window will have 8 channels for each DBK50/51 selected.

You can select a voltage range for each channel by setting the value in the Type column of the analog input spreadsheet. The Type column includes ranges for both high and low voltage modules, but you must select from only those ranges resident in your module. High voltage ranges begin with an H, low ranges with an L. The shorted value is valid for both high and low modules.

**Note**: The DaqBook or DaqBoard must have the Simultaneous Sample and Hold (SSH) jumper in place when using a DBK50/51. DaqView will remind you of this fact when you exit the Hardware Setup with a DBK50/51 selected.

## Programming a DBK50/51

**Note**: Users of DaqView or other turnkey packages can skip this section.

The on-board microprocessor monitors the SSH and G0 lines looking for a software "key". This key allows the microprocessor to program the gain range of a channel. Any number of channels may be programmed within a channel configuration command.

The software key protocol is defined as a translation of the SSH line from low to high for a period of 10 μs, followed by a low for 10 μs, followed by a high for 10 μs, followed by a low and the G0 line going high for 10 μs. The G0 line also acts as the data sync pulse and all data is transferred to the microprocessor in 10 μs data windows.

The first data window begins 10 μs after the data sync pulse on G0. This data window carries the count of channel configuration information to follow. The count can be found on the A0-A3 lines. Note that a count

of zero is equal to one count and a count of seven is equal to eight counts. The next data window carries the expansion card channel number on the A0-A3 lines. Finally, the channel configuration information arrives. In summary, each data window is 10 μs wide; the G0-G1 lines carry the setting for the PGA; and the A0-A3 lines carry the channel number.

The function call **daqADCSetBank** internally sets which channels are DBK50/51 so the gains may be programmed just ahead of the acquisition. The prototype is:

**void daqAdcSetBank ( int chan, int type )**

Where *chan* is the channel number from the DBK50/51 card.

The defined constants for all the cards that require a bank type to be set include:

```
bankNotDefined        = 0x00,  /* Bank is unknown */
bankDBK50             = 0x01,  /* DBK50 or DBK51 option */
bankDBK5              = 0x02,  /* DBK5 option */
bankDBK2              = 0x03,  /* DBK2 option */
bankDBK4              = 0x04,  /* DBK4 option */
bankDBK7              = 0x05,  /* DBK7 option */
```

Setting the bank type for any channel on a particular card will set the bank type for every channel on that card. For example if you have a DBK51 at channels 16 to 23, making the following function call would set the bank type for all 8 channels:

daqAdcSetBank ( 16, bankDBK50 ); // **Note: bankDBK50 is used for both DBK50 and 51.**

The following are the gain constants for the DBK50 and DBK51:

```
/* DBK50 Range (Gain) Codes */
Dbk50Range0     = 0x00
Dbk50Range10    = 0x01
Dbk50Range100   = 0x02
Dbk50Range300   = 0x03

/* DBK51 Range (Gain) Codes */
Dbk51Range0      = 0x00
Dbk51Range100mV= 0x01
Dbk51Range1      = 0x02
Dbk51Range10     = 0x03
```

The following short program (standard API) demonstrates data acquisition in a system with two DBK50s and one DBK51 attached to a DaqBook:

```
void_far_pascal myhandler(int error_code);
unsigned char chans[24], gains[24];
unsigned int buf[240], chan;
void main(void)
{
  // Set error handler and initialize DaqBook
daqSetErrHandler(myhandler);
daqInit(LPT1,7);
// This example is written for a system with the following attached:
// DBK50 at channels 16-23
  // DBK50 at channels 24-31
  // DBK51 at channels 32-39
  // Set the bank types for each of the 3 expansion modules in our system
daqAdcSetBank( 16, bankDBK50);  // first DBK50
daqAdcSetBank( 24, bankDBK50);  // second DBK50
daqAdcSetBank( 32, bankDBK50);  // DBK51
  // Define arrays of channels and gains
for (chan=16; chan<32; chan++) {
chans[chan-16] = chan;
gains[chan-16] = DBK50Range10;
{
for(chan=32; chan<40; chan++) {
chans[chan-16] = chan;
gains[chan-16] = DBK51Range100mV;
}
```

```
                    // Load scan sequence FIFO
     daqAdcSetScan(chans, gains, 24);
        // Set Scan Frequency to 1Khz
   daqAdcSetFreq(1000.0);
        // Define and arm trigger : source: software, one shot: continuous
        // level: 0, ctr0Mode: 0, pacerMode: 1
   daqAdcSetTrig(DtsSoftware, 0, 0, 0, 1);
        // Trigger
     daqAdcSoftTrig();
        // Read the data : 10 scans
     daqAdcRdNFore(buf, 10);
        // Close and exit */
   daqClose();
   {
   void_far_pascal
   myhandler(int error_code)
   {
   printf("|nError! Program aborted|n Error: 0x%|n:,error_code);
   exit(1);
   }
```

For more information on custom programming, refer to the separate *Programmer s Manual*.

## DBK50/51 - Specifications

**Name/Function: 8-Channel Isolated Voltage Input Module**
**Connectors**: Male DB37, mates with P1
**Inputs**:  Removable screw terminals
**Number of Channels**:  8, individually isolated
**Isolation**:
    Channel-to-Channel: 750 V
    Channel-to-System: 1250 V
**Input Impedance**: >10 MΩ
**Bipolar Input Ranges**: ±300 V, ±100 V, ±10 V, ±100 mV, ±1 V,
    ±10 V
**Output Voltage Range**: ±5 VDC

**Attenuation Ratios**: K= Vin/ Vout
    100 mV,   K = 0.02 (gain = 50)
    1 V,  K = 0.2 (gain = 5)
    10 V,  K = 2.0 (gain = 0.5)
    100 V, K = 20.0 (gain = 0.05)
    300 V, K = 60.0 (gain = 0.017)
**Bandwidth**: 20 kHz (LPF bypassed)
**Low-Pass Filter**:  Factory installed 3-pole, 3.5Hz (bypass or
    user-set)
**Operating Power Voltage Range**: +9 to +20 VDC
**Module Power Requirements**: 7.5 W
**Included AC Adapter**: 15 VDC  0.9 A
**Size**: 8½" × 11" × 1-3/8"

# DBK52 Thermocouple Input Module

## Overview

The DBK52 provides Daq* users with the ability to scan and input thermocouple data for various computer-based temperature-monitoring systems.  Features include:
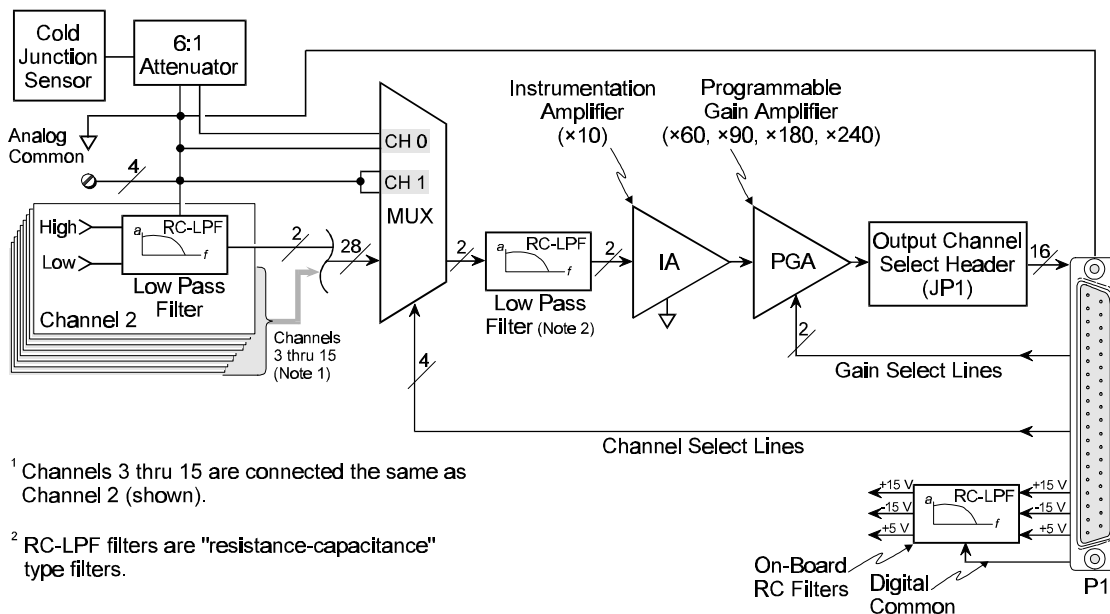
- Each DBK52 can connect up to 14 thermocouples.  Up to 16 DBK52s may attach to a single Daq* to measure a maximum of 224 ($16 \times 14$) temperatures.
- Standard, miniature jacks can connect to all T/C types.  The contact  material is copper.
- Onboard cold junction sensor (CJS) circuitry is accessible via a built-in channel to the system.
- A built-in short-to-ground channel back to the system eliminates offset errors via software.
- RC low-pass input filters reject high frequency noise for thermocouple shields.
- An external analog common access jack provides a bias-current return path for differential signal inputs.
- An onboard  programmable gain amplifier supports most thermocouple types and temperature ranges.
- Software-based linearization (in DaqView) converts analog signals into temperature values.  (Programmers should refer to related sections in the separate *Programmer s Manual*.)

The table shows the temperature range for each thermocouple type.

| Thermocouple Type | J | K | T | E | N28 | N14 | S | R | B |
|---|---|---|---|---|---|---|---|---|---|
| Temperature Range °C | -200 to 760 | -200 to 1260 | -200 to 400 | -270 to 1000 | -270 to 400 | 0 to 1300 | 0 to 1780 | 0 to 1780 | 0 to 1820 |

Thermocouple accuracy depends on the thermocouple itself, the cold-junction sensor, A/D conversion, and linearization.  The DBK52 and the Daq* systems use quality components and software compensation to minimize error from these sources.  Systems achieve a $\pm 1°C$ CJS accuracy that contributes to the overall accuracy.  When the software is calibrated, gain and offset errors are virtually eliminated.  The DBK52's built-in auto-zero channel dynamically eliminates any other system offset errors.

True differential measurements of T/Cs require bias-current referenced to the analog common.  Resistors from each input T/C are connected to the analog common.  Filter capacitors across each input operate with input protection resistors to form a single-pole RC low-pass filter.



[1] Channels 3 thru 15 are connected the same as Channel 2 (shown).

[2] RC-LPF filters are "resistance-capacitance" type filters.

*DBK52 Block Diagram*

# Hardware Setup

## Module Connection

The DBK52 has miniature T/C jacks to connect different types of thermocouples and an analog ground access point.   Connections are provided for 14 thermocouples.  Thermocouples have polarities which must be observed.  Thermocouple types J, K, T, E, N28, N14, S, R and B are supported by the DaqView software and may be connected to DBK52 board channels CH2 through CH15.

| T/C Type | (+) Lead to Channel-Hi | (-) Lead to Channel-Lo |
|---|---|---|
| J | White | Red |
| K | Yellow | Red |
| T | Blue | Red |
| E | Violet | Red |
| N28 | Orange | Red |
| N14 | Orange | Red |
| S | Black | Red |
| R | Black | Red |
| B | Gray | Red |

- CH0 is reserved for the cold-junction compensation sensor (factory installed).
- CH1 is permanently shorted to allow software-driven auto-zero to compensate for temperature drift.

Thermocouple wire is standardized and color-coded as shown in the table.  T/Cs have a very small output.  Long T/C leads can pickup lots of noise.  Use shielding as needed, and average several readings in software to minimize noise effects.

After all connections are in place, secure wires to captive areas (pre-drilled holes) at the rear edge of the board.  Nylon tie wraps (not included) work well for this purpose.

## Module Configuration

Up to 16 DBK52s may be connected to a Daq*.  As a daisy-chain interface, each module must appear unique to the Daq*.  Each module uses a different analog input channel on the Daq*.  To configure the module:

1. Assign a channel number to the module.  This number must not be used by any other DBK card or module.
2. Locate the 16×2-pin header near the front of the board labeled JP1, and place the jumper on the Daq* channel you wish to use.  There are 16 jumper locations on this header labeled CH0 through CH15.  Only one jumper setting is used on a single module; no other module in a common daisy-chain can use the same jumper setting.



*Factory Default Channel Configuration*
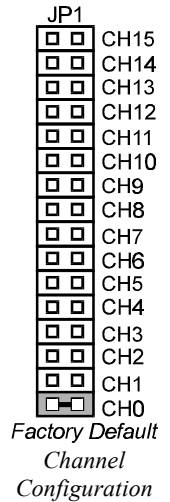
## DaqBook/DaqBoard Configuration

Three setup steps and needed to configure the DaqBook/DaqBoard for a DBK52.

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 DBK52 via the internal ±15 VDC power supply.  If using auxiliary power (DBK32A/33), you must remove both JP1 jumpers (refer to *Power Management* at the beginning of this chapter and the DBK32A/33 sections).
2. *Place the JP3 jumper in bipolar mode.
3. *Place the JP4 jumper in single-ended mode.  **Note**: the 200-series DaqBooks and DaqBoards do not have a JP4.  The single-ended or differential choice is made via software configuration commands.

*applies only to DaqBook/100, /112 and /120.



*Configuration Jumper Settings*
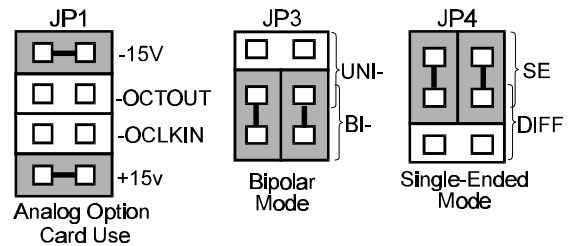
## Software Setup in DaqView

To use the DBK52 Expansion module within DaqView, you must configure DaqView with the hardware setup. From the DaqView main window, select the Device pull-down menu and then Configure Hardware Settings. The Configure System Hardware parameters are used to interpret the incoming data and provide the controls to access the hardware. As expansion modules are added, make sure the setup window reflects the actual hardware. On the left side of this window, the Analog Input Option Module selection allows you to assign DBK modules to the Daq*'s 16 analog inputs. Selecting a DBK will add channels in the main windows analog input spreadsheet.

Select the DBK52 Thermocouple Module Option. The main window now shows 14 thermocouple channels and one cold junction channel for this one board. The DBK52 selection allows the user to define the thermocouple types by using the Type column of the analog input spreadsheet. In addition, each DBK52 module is shipped with a calibration disk that includes calibration constants to correct gain and offset errors. DaqView makes these corrections automatically when the file, DAQBOOK.CAL, exists in the /WIN/UTILS directory and is configured with the calibration constants for each module. See the DBK52 readme.txt file on the disk shipped with the module for details on creating this file.

## Programming a DBK52

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the DBK52 expansion module. An easy way to determine which software channel number corresponds with a physical channel is to use the **daqAdcExpToChan** command. This command will use the expansion module number and channel to calculate the channel number used by the daqAdcRd command.

```
expCard = 2;      /*DBK52 JP1 position*/
expChan= 15;      /*DBK52 thermocouple jack connection*/
daqAdcExpToChan(expCard, expChan, &softChan);
daqAdcRd(soft Chan, &sample, Dbk52BiGainJ);
```

The analog reading contained in the sample is in raw A/D counts. This value will change with fluctuations in the thermocouple temperature (nonlinear). Refer to the separate *Programmer s Manual* for related commands and parameters.

## DBK52 - Specifications

**Name/Function: Thermocouple Input Module**
**Connectors**:
    DB37 male, mates with P1 pinouts on the DaqBook.
    Thermocouples attach directly to on-board jacks.
**Thermocouple Types**: J, K, S, T, E, B, R, N
**Gain Ranges**: ×60, ×90, ×180, ×240
**Inputs**:
    14 differential thermocouples
    1 cold-junction compensation
    1 auto zero
**Cold Junction Sensor Output**: 100 mV/°C
**Voltage Ranges/Gains**:
    0 to 80 mV ×60

0 to 50 mV ×90
0 to 25 mV ×180
0 to 20 mV ×240
0 to ±10 mVDC
**Input Impedance**: 20 kΩ
**Input RC Filter -3 dB Frequency**: 15.9 kHz
**Gain Accuracy**:
    Uncalibrated: 0.15%
    Calibrated: 0.02%
**Maximum Input Voltage**: 35 VDC
**CMRR (Input Stage)**: 110 dB type DC to 60 Hz
**Offset**: Software compensated
**Type/Range/Accuracy/Resolution**: see table

| Type | Range | | Accuracy | | Resolution | | | |
|------|-------|-----|----------|---------|----------------|----------------|-----------------|-----------------|
|      | Min   | Max | (<0°C)   | (>0°C)  | 12-bit <0°C | 12-bit >0°C | 16-bit <0°C | 16-bit >0°C |
| J    | -200°C | 760°C  | 0.6°C | 0.6°C | 1.2°C | 0.5°C | 0.1°C | 0.1°C |
| K    | -200°C | 1260°C | 1.6°C | 1.0°C | 1.1°C | 0.8°C | 0.1°C | 0.1°C |
| T    | -200°C | 400°C  | 1.4°C | 0.8°C | 0.8°C | 0.3°C | 0.1°C | 0.1°C |
| E    | -270°C | 1000°C | 1.4°C | 0.9°C | 1.6°C | 0.7°C | 0.1°C | 0.1°C |
| N28  | -270°C | 400°C  | 0.8°C | 0.8°C | 1.0°C | 1.0°C | 0.1°C | 0.1°C |
| N14  | 0°C    | 1300°C | —     | 1.0°C | —     | 5.0°C | —     | 5.0°C |
| S    | 0°C    | 1780°C | —     | 1.6°C | —     | 1.3°C | —     | 0.1°C |
| R    | 0°C    | 1780°C | —     | 1.6°C | —     | 1.7°C | —     | 0.1°C |
| B    | 0°C    | 1820°C | —     | 1.8°C | —     | 1.5°C | —     | 0.1°C |

# DBK53/54 Low/High-Gain Analog Multiplexing Modules

## Overview

Except for their gain ranges, the DBK53 (low gain) and DBK54 (high gain) are similar.  Both:
- Have 16 channels of differential or single-ended analog inputs.  Up to 16 modules can attach to one Daq* for a maximum of 256 single-ended or differential inputs.
- Are based on the DBK12 and DBK13 multiplexer cards.
- Are fully enclosed modules with easy user connection using BNC-type connectors and an analog common pin jack.
- Use power via the P1 connection from the Daq* or expansion module/power supply.
- Use one of the Daq*'s 16 analog input channels via the P1 connection to measure the multiplexed output.  Both modules receive channel-selection and gain-selection programming via digital signals via P1.  The Daq*'s 512 location scan sequencer can directly program the expansion modules to scan external signals at the same 10 μs/channel rate as on-board channels.  (The time skew between channels is constant.)

The amplification gains for each module are:
- The DBK53 has 4 gain ranges of ×1, ×2, ×4, and ×8 that are scan-programmable per channel.  These gains can be combined with the standard Daq* gains of ×1, ×2, ×4, and ×8 for net gains of ×1, ×2, ×4, ×8, ×16, ×32, and ×64.
- The DBK54 has 4 gain ranges of ×1, ×10, ×100 and ×1000 that are scan-programmable per channel.  These gains can be combined with the standard Daq* gains of ×1, ×2, ×4, and ×8 for net gains of ×1, ×2, ×4, ×10, ×20, ×40, ×80, ×100, ×200, ×400, ×800, ×1000, ×2000, ×4000, and ×8000.
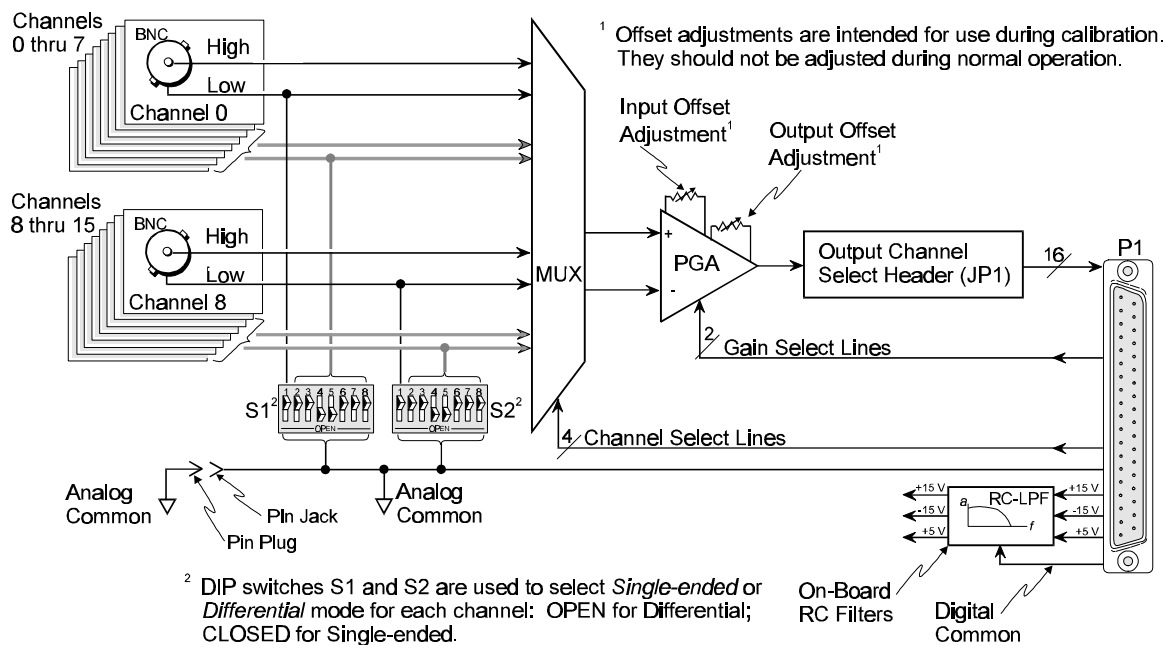


*DBK53/54 Block Diagram*

# Hardware Setup

### Differential Mode

The DBK53 and DBK54 are designed for floating-type differential measurements. Neither the high nor the low of the analog input has an inherent bias current return path to the analog common on the module. An external common pin jack is provided on the outside panel for this bias-current return path. The figure shows a typical differential connection.



*Differential Input Mode*
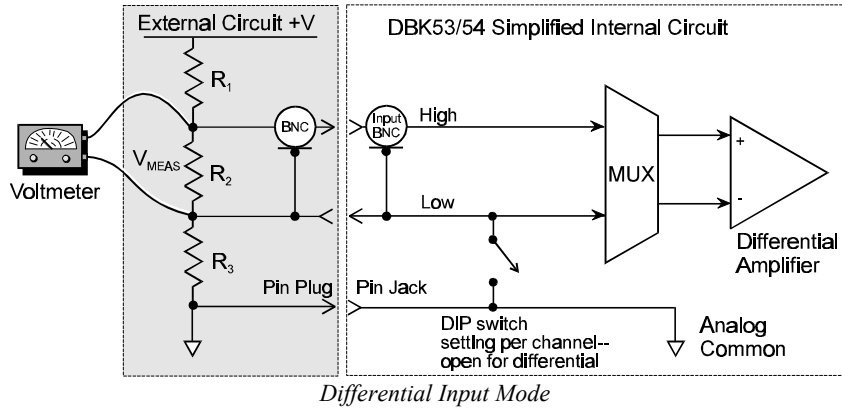
### Single-Ended Mode

Ground referencing must also be observed with single-ended measurements. The figure shows a typical single-ended hookup.



*Single-Ended Input Mode*
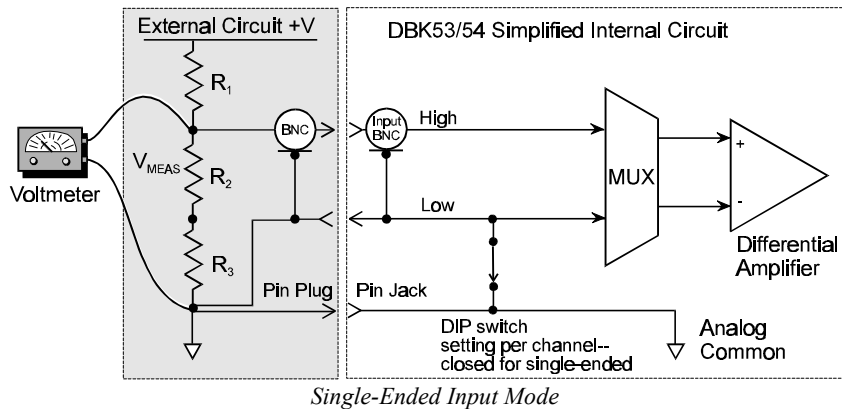
### Module Connection

When connecting analog inputs, carefully consider the requirements for signal connection and ground referencing. Use BNC-terminated cables (test leads) to interface with the channel inputs. Be sure to provide the necessary analog common connection.

### Module Configuration

Up to 16 DBK53/54s may be connected to a Daq*.  As a daisy-chain interface, each
module must appear unique to the Daq*.  Each module uses a different analog input
channel on the Daq*.

To configure the module:

1. Assign a channel number to the module.  This number must not be used by any other
   DBK card or module.
2. Locate the 16×2-pin header near the front of the board labeled JP1, and place the
   jumper on the Daq* channel you wish to use.  There are 16 jumper locations labeled
   CH0 through CH15 on this header.  Only 1 jumper setting is used on a single
   module; no other module in a common daisy-chain can use the same jumper setting.

*Factory Default*
*Channel*
*Configuration*

### DaqBook/DaqBoard Configuration

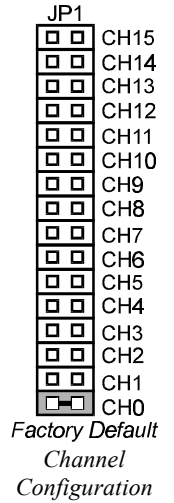Three setup steps and needed to configure the DaqBook/DaqBoard for a DBK53/54.

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 DBK54 via the
   internal ±15 VDC power supply.  If using
   auxiliary power (DBK32A/33), you must
   remove both JP1 jumpers (refer to *Power
   Management* at the beginning of this chapter
   and the DBK32A/33 sections).
2. *Place the JP3 jumper in bipolar mode.
3. *Place the JP4 jumper in single-ended mode.  **Note**:  the 200-series DaqBooks and DaqBoards do not
   have a JP4; the single-ended or differential choice is made via software configuration commands.
   *Applies to DaqBook/100, /112, and /120.

*Configuration Jumper Settings*
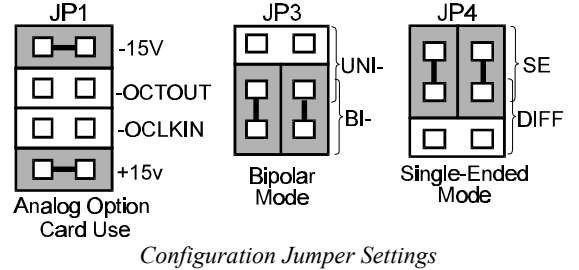
## Software Setup in DaqView

To use the DBK53/54 within DaqView, you must configure several DaqView parameters.

1. From the DaqView main window, select the Device pull-down menu and then Configure Hardware
   Settings.  The Configure System Hardware parameters help interpret the incoming data and provide
   the controls to access the hardware.  As expansion cards are added, make sure Hardware Setup
   reflects the present configuration.  On the left side of this window, the Analog Input Option Cards
   selection allows the user to assign DBKs to the 16 analog inputs of the base unit.  Selecting a DBK
   will add channels in the main window's analog input spreadsheet.
2. Select the DBK53 or DBK54 Multiplexer Card option.  The main window now has 16 channels for
   this one board.
3. Set the parameters for each channel.  You can define the channel gains by using the "Type" column
   of the analog input spreadsheet.  Each channel can be configured for unipolar or bipolar mode using
   the "Pole" column.

## Programming a DBK53/54

**Note**: Users of DaqView or other turnkey packages can skip this section.

The following program segment shows how to get a sample from the DBK53/54.  An easy way to determine which software channel number corresponds with a physical channel is to use the daqAdcExpToChan command.  This command will use the expansion module # and channel to calculate the channel # used by the daqAdcRd command.

```
expmodule = 2;    / * DBK54 JP1 position * /
exChan = 15;       / * DBK54 screw terminal connection * /
daqAdcExpToChan (expmodule, expChan, &softChan);
daqAdcRd (soft Chan, &sample, DBK54x1);
```

For more information on specific software commands, refer to the separate *Programmer s Manual*.

## DBK53/54 - Specifications

**Name/Function:**
   **DBK53 16-Channel Low-Gain Analog Multiplexing Module**
   **DBK54 16-Channel High-Gain Analog Multiplexing Module**
**Output Connector**:  DB37 male, mates with P1
**Input Connector**: BNC - DIFF. Inputs; Pin Jack - Analog Common
**Gain Ranges**:
   DBK53: ×1, ×2, ×4, ×8
   DBK54: ×1, ×10, ×100, ×1000
**Inputs**: 16 differential or single-ended jumper selectable as a group)
**Voltage Range**:
   DaqBook/DaqBoard: 0 to ±5 VDC bipolar; 0 to 10 V unipolar
   DaqPC-Card: 0 to ±10 VDC bipolar

**Input Impedance**: 100 MΩ (in parallel with switched 150 pF)
**Gain Accuracy**:  0.05% typ, 0.25% max
**Maximum Input Voltage**: 35 VDC
**Slew Rate**:  20 V/s typ, 10 V/s min
**Settling Time**: 2 s to 0.01%
**CMRR**:  80 dB min
**Non-Linearity**: 0.002% typ, 0.015% max
**Bias Current**: 150 pA, 0.2 A max
**Offset Voltage**:
   ±(0.5 + 5/G) V/°C typ
   ±(2.0 + 24/G) mV max
**Offset Drift**:
   ±(3 + 50/G) V/°C typ
   ±(2.0 + 24/G) V/°C max

# DaqView, PostView, DaqViewXL

## Overview

DaqView is a Windows-based data acquisition program for operating the DaqBook, DaqBoard, or Daq PC-Card with DBK option cards and modules.  DaqView was designed for ease-of-use; programming expertise is not required.  DaqView allows you to:

- Set up system parameters (selecting channels, gains, transducer types, etc) to acquire data.
- Save data to disk and to transmit data to spreadsheets and databases.
- Automatically re-arm the trigger function and save data in new files as needed.
- Configure and operate the DBK option modules.
- Configure the counter/timer into one of three modes for measuring frequency, totaling, or generating pulse trains.
- Use the 2 analog outputs, including waveform generation for DaqBoards.
- Use digital I/O (for Daq*s with digital I/O).

PostView can be launched from DaqView to view waveforms for up to 16 data channels.

DaqViewXL is an "add-in" for Microsoft Excel and is discussed at the end of this chapter.

## DaqView s Main Window

The figure shows DaqView's main window and basic components.
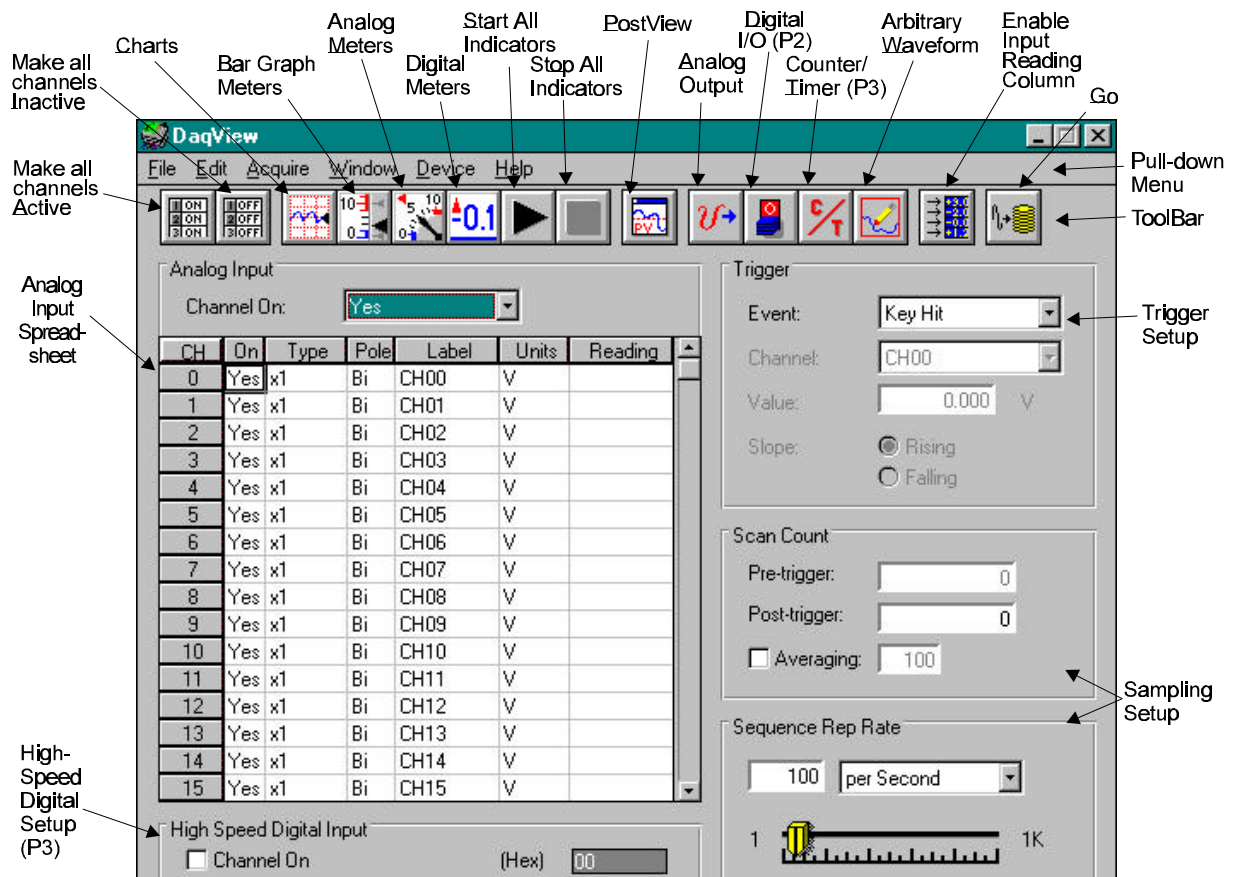


*DaqView s Main Window*

---

# Starting DaqView

Before running DaqView, the program and related libraries must be properly installed—if necessary, refer to the installation chapter.  Computer requirements include:
- 386 PC/AT or higher
- 8 Mbytes of RAM
- Windows 3.x or Windows 95
- IOtech data acquisition hardware
- (for DaqViewXL) Excel 5.0 or higher

To run DaqView, (double) click the DaqView icon.  Depending on existing files, DaqView StartUp will begin in 1 of 3 ways:
- **Auto-Device Select with Full Setup**.  DaqView looks for a special auto-start file named *daqview.daq* in the startup directory.  If found, DaqView loads this setup with the specified device and configuration.  This setup file (if it exists) was created during a previous session.
- **Auto-Device Select with Default Setup**.  If the auto-start file is not found, DaqView will try to use settings from the program configuration file (*daqview.ini*) in the Windows directory.  The default setup (equivalent to the "file, New" menu item) uses DaqBook as the device on parallel port 1 (LPT1).
- **Manual Device Select with Default Setup**.  If DaqView cannot connect to a device via a setup file or defaults, it prompts you with a series of dialog boxes:
    - The first dialog box allows you to retry a connection, select a device, or load a setup file.
    - The Select Device button opens a device interface box; you can choose the hardware installed or a simulated instrument.  If you select a Daq, another dialog box will ask for device parameters (printer port, interrupt level, and port protocol for the DaqBook; base address and interrupt level for the DaqBoard and Daq PC-Card).  **Note**: If the hardware is not available or you just want to explore the software, select *Simulated Instrument;* the main window will open.
    - The Load File button allows you to find and open an existing setup file.

If the hardware is found, the DaqView's main window will open.  If no hardware is found, the system alerts you and gives you another chance to select the working parameters.  (For a DaqBook communication problem, exit DaqView and run the DaqTest utility program.)

## Beginner s Tour of DaqView

A quick tour of DaqView will show you some of its basic features that are explained later.  Proceed as follows:

1.  Open DaqView as described above.  If your Daq or DBK signal conditioning units are not connected, select *Simulated Instrument* as your device.

2.  Select the next to last tool in the toolbar menu, Enable Input Reading Column.
    - If in the Simulated Instrument mode, the Reading column of the Analog Input Spreadsheet will display simulated data.  Selecting the Enable Input Reading Column button again will freeze the Reading column's display.
    - If working hardware is connected, the readings will quantify actual signals.

3.  From the toolbar, select Bar Graph Meters, Analog Meters, or Digital meters and then the triangular Start Indicator on the new window's toolbar.  Incoming data will be displayed in your chosen format.  The last item in the meter window's toolbar allows you set the number of channels to be displayed.

4.  From the DaqView main window toolbar, select Charts (third item from left), and the DaqView Channel Display window will appear.  If inactive, you must first enable the desired channel in the pull-down box to the right of the chart.  You can start or stop the data display with the Start or Stop Indicators buttons.  After stopping the indicators, you can reset the number of channels to be displayed.

5.  As an introduction to system configuration, select Device from the pull-down menu and then Configure Hardware Settings.  The window Configure System Hardware will appear.  On the left

side of the window, select any channel's pull-down box to reveal the external connection options. Besides the default, direct signal connection, you can choose among the DBK option cards and modules. The right side of the screen sets up digital connections if your Daq* is so equipped.

## *Analog Input Spreadsheet*

The analog input spreadsheet (left half of main window) displays the analog input channels and allows you to configure them. Each row shows a single channel and its configuration. The number of rows may vary, but each row has seven columns. Some columns allow blocks of cells to be altered at the same time (clicking a column header can select the entire column). Other columns allow only a single cell to change. The table summarizes the function of each row.

| Analog Input Spreadsheet Parameters on DaqView s Main Window | |
|---|---|
| **Column** | **Use and Description** |
| CH | The channel number (cannot be changed from this window). This number includes the main channel number and the expansion board number and channel (if used). Expansion channels are configured using the Hardware Configuration window described later in this chapter. |
| On | This column allows you to select whether data will be collected from that channel. When a cell or block of cells in this column is selected, a selection box will appear that allows "Yes" to enable or "No" to disable the channel. Double-clicking a cell in this column will toggle the channel status. The Edit menu allows you to Make All Channels Active or Make All Channels Inactive. |
| Type | This column allows you to set the gain or input type for each channel. The gains and types will vary among the option cards. A block of cells in this column can be selected for multiple channels with the same type of option card. Double-clicking a cell will select the next available gain or type. |
| Pole | This column shows the channel polarity (unipolar or bipolar) for each channel. The polarity can be programmed here on a per channel basis when using a DaqBook/200, /216 and any DaqBoard or a DBK15 Universal Current/Voltage expansion card. When using any other Daq*s, this column is set in the Hardware Setup window. For selected cells that can be changed, a selection box will display "Uni" or "Bi". Double-clicking in a cell will toggle the polarity. If the hardware cannot program the polarity, no selection box will be displayed. |
| Label | This column contains a descriptive name for the input channel. The default label is the channel number, but it can be changed to any 8 characters. This label is used when selecting a channel in the analog trigger and chart selection lists. |
| Units | This column allows you to change the engineering units of each channel and apply a linear equation to the Daq data. When a cell or block of cells in this column is selected, the analog input box displays entry options in a pull-down box. Selecting "mx+b" allows you to define *m* and *b* and the engineering units label. The engineering units will then be displayed in the "Units" column and the "mx+b" equation will be applied to the reading from the Daq before the reading is displayed or written to disk. The *X* in this equation is the voltage read back from the Daq (or degrees Celsius for a DBK14). For example, if a Daq channel is configured as bipolar and unity (×1) gain, the default voltage would be ±5 V. This corresponds to an *m* of 1, a *b* of 0, and a unit of *V*. *V* can be changed to millivolts by setting *m* to 1000 and units to *mV*. The Units column can also be used to perform a software calibration of the Daq. This is done by reading known inputs at two different points of the input voltage range (usually at 0 and full-scale) and solving the equation $y = mx + b$. The full-scale voltage, which changes according to the gain of the channel, is 5 V/gain for bipolar channels and 10 V/gain for unipolar channels. |
| Reading | This column displays the Daq*'s analog input readings. This column cannot be altered by the user and is enabled by selecting Enable Input Reading Column under the Acquisition menu or by selecting "Start/Stop All Indicators" under the window menu. This column will update the readings as fast as the computer will allow. The spreadsheet cannot be altered while the input reading column is enabled. |
| **Note**: In addition to the analog inputs, there is a 16-bit digital input channel accessible on the DaqBook's P3 connector. This high speed digital input, which is read at the same rate as any analog input, can be enabled or disabled by clicking in the checkbox below the analog input spreadsheet. | |

## *Acquisition Configuration*

Next to the analog input spreadsheet on the right side of the main window is the acquisition configuration section. The 3 main parts of this section include setup parameters for the trigger, the scan, and sampling. These settings will be used when an acquisition to disk is started by selecting "Go" (last item in the toolbar). When the trigger is satisfied, the scans are collected at the selected scan frequency and stored to disk in the designated file. **Note**: the high-speed digital input channel is on the lower left of the screen and can be used with Daq*s that support it.

| Acquisition Configuration Options in DaqView s Main Window | |
|---|---|
| **Parameter** | **Options, Use, or Description** |
| Trigger Event | Selects the source of the trigger. The 4 possible trigger sources are: <br> *Immediately*   arms and executes the trigger immediately <br> *Key Hit*   arms the acquisition and waits for the user to hit a key <br> *External TTL*   waits for a falling or rising edge on pin 25 of connector P1 <br> *Channel Value*   monitors level on selected channel; executes trigger when parameter is satisfied |
| Trigger Slope | Specifies whether the trigger responds to a rising or falling slope on the external TTL. |
| Analog Trigger Level Setup | Sets the trigger based on a specified signal value on a particular channel. |
| Sequence Rep Rate | The scan frequency can be set in units of seconds, milliseconds, minutes, or hours via a pull-down box. Moving the slide switch or typing directly into the numeric field changes the rate. The maximum scan frequency is dependent on the number of channels that are enabled and whether or not averaging is enabled. Enabling more channels or averaging will lower the maximum scan frequency. |
| Scan Count | The number of scans can range from 1 to 10,000,000. A scan includes all of the channels that are marked as "On" in the analog input configuration spreadsheet. The Pre-trigger scans is the number of the scans to acquire before the executing the trigger event (available for Channel Value trigger only). **Note**: If Pre-trigger scans are greater than 0, Pre-trigger and Post-trigger samples cannot exceed 32508. If Pre-trigger scans equals 0, Post-trigger scans cannot exceed 10,000,000. |
| Averaging | The checkbox allows averaging of the analog input data to be enabled or disabled. Averaging can be used to increase the effective accuracy of a noisy signal. Averaging will increase the actual scan frequency and number of scans, but the perceived scan frequency and number of scans (which is set by DaqView) does not change. |
| **Note:** Once the acquisition starts, these parameters cannot be altered. | |

## *Pull-Down Menu Items*

Some (but not all) items in the pull-down menu can also be enabled from the toolbar. Their description in the toolbar section is more detailed than presented in this section.

### File

| File Menu Items and Descriptions | |
|---|---|
| New | Set all parameters to their startup, default setting. |
| Open | Set all parameters as directed by a specified setup file. |
| Save | Save the existing configuration for later recall (overwrites the existing version). |
| Save As | Saves the existing configuration for later recall; asks whether to overwrite the original version or save under a new filename. |
| Convert Binary to ASCII | Convert a previously acquired binary file to an ASCII file that can be read by spreadsheets or other analysis programs. |
| Convert Binary to PostView Binary | Convert a previously acquired binary file to a binary file that can be read by PostView. |
| Exit | Leave the DaqView program. |

## Edit

| Edit Menu Items and Descriptions | |
|---|---|
| Make All Channels Inactive | This command places a "No" in the On field of all channels. To scan only a few channels, it may be easier to make all channels inactive, then turn on the desired channels. |
| Make All Channels Active | This command places a "Yes" in the On field of all of the channels. |
| Go To Channel F7 | This command pops up a dialog box which requires a channel number. For hardware configurations with hundreds of channels, this is a quick way to get around. |
| Fill Down F8 | For multiple cells selected within a column, this command copies the value in the top cell to all the cells below. |

## Acquire

| Acquire Menu Items and Descriptions | |
|---|---|
| Go | This command arms the hardware for an acquisition to disk. When the trigger is satisfied, the acquisition begins. All of the interactive I/O controls are disabled while the system is armed. No acquisition parameters can be altered at this time. |
| Enable Input Reading Column | This command reads the analog inputs and puts the numeric values in the spreadsheet in the "Reading" column. If the Reading column is already enabled, this command disables it. |
| Data File Setup | This section determines the filename and type of file(s) that exist after an acquisition. A filename can be typed in directly, or the *Browse Files* button can be pressed to open a file selection dialog box (the selected file will be placed directly into the filename field). During an acquisition, a raw binary file is created and updated as data is read. After acquisition, an ASCII text file and PostView binary file can be created if their checkboxes are enabled. Both of these files can be read by the PostView. If the raw binary checkbox is not enabled, the raw binary file will be deleted after creating the PostView or ASCII file. The Multiple Destination (Auto Re-Arm) box directs DaqView to create successive files for long data runs as needed. The "Validate File Overwrite" checkbox (if checked) will require confirmation for overwriting existing binary, ASCII, or IO files. |

## Window

| Window Menu Items and Descriptions | |
|---|---|
| Charts | Displays the charts window. |
| Bar Graph Meters | Displays incoming data on a bar graph. |
| Analog Meters | Displays incoming data on an analog dial. |
| Digital Meters | Displays incoming data numerically. |
| Start All Indicators | Starts displaying data in the Reading column and any open Chart or meters window. |
| Stop All Indicators | Stops displaying data in the Reading column and any open Chart or meters window. |
| PostView | Launches an instance of the PostView application. |
| Analog Output | Displays the analog output window. |
| Digital I/O | Displays the digital I/O window. |
| Counter/Timer | Displays the counter/timer window. |
| Arbitrary Waveform | Displays the arbitrary waveform window. |

# Device

| Device Menu Items and Descriptions | |
|---|---|
| Select<br>  DaqBook | Brings up a dialog box to enter the printer port (<u>LPT1</u> to LPT4), the interrupt level (3 to <u>7</u>), and the port protocol (<u>8-bit standard</u>, 4-bit standard and several EPP options).  **Note**: for Fast EPP and SMC666 port protocols, interrupt levels include 3-7, 10, 11, 12, 14, 15. |
|   DaqBoard | Brings up a dialog box to enter a base address (0330 default) and interrupt level (<u>10</u>, 11, 12, 14, 15). |
|   Daq PC-Card | Brings up a dialog box to enter a base address (0330 default) and interrupt level (5, 6, 7, <u>10</u>, 11, 12, 14, 15). |
| | **Note**: DaqView attempts to open a new session and communicate with the selected device.  If the hardware is found, the  main window is opened.  If no hardware is found, the user is alerted to reconfigure and try again.  If the hardware still is not found, exit DaqView and try the DaqTest program. |
|   Simulated Device | Opens a DaqView session but does not attempt to communicate with hardware.  Instead, the application simulates the interaction between software and hardware.  If DaqView is attached to real hardware, this command will close that session. |
| Configure<br>  Hardware<br>  Settings | Opens the hardware configuration window which allows the user to tell the software how the hardware is set up.  Setup sections include: Analog Input Option Cards (DBKs), Digital Option Cards, Input Polarity, A/D Signal Reference, and D/A External Reference. |

## *The Configure System Hardware Window*

Select *Device* in the pull-down menu and then *Configure System Hardware* to set up the software for your hardware.  DaqView needs this information to interpret the data and provide controls to access the hardware.

The Analog Input Option Cards section allows the user to assign DBK expansion cards to the 16 analog input channels.  If no expansion cards are added, leave the default value (Direct Signal Connection) on all 16 channels.  As expansion cards are added, this window must be updated.



*Configure System Hardware Window*

Selecting a DBK expansion board will add channels in the main window's analog input spreadsheet.  Channels associated with DBK expansion boards will also have more gains or modes to choose from in the analog input spreadsheet.  If needed, a dialog box will appear and allow you to set sub-channel addresses or other parameters.

If using the DaqBook/100, DaqBook/112 orDaqBook/120, set the radio buttons for *Single-Ended* or *Differential* and *Bipolar* or *Unipolar* to match the settings of the corresponding hardware jumpers (the default hardware settings are *Single-Ended* and *Bipolar)*.  When *Differential* is selected, only 8 analog inputs are available.  When analog expansion boards are connected, set the Daq for *Single-Ended*.

If using the DaqBook/100, DaqBook/200, DaqBoard/100A or DaqBoard/200A, the Digital Option card section allows you to configure the digital I/O hardware.  If no DBK20 digital expansion boards are connected, three 8-bit I/O ports are accessible from the main window.  Six additional 8-bit ports are made available in the main window for each DBK20 added.  Make sure this window is kept updated for the actual hardware used.
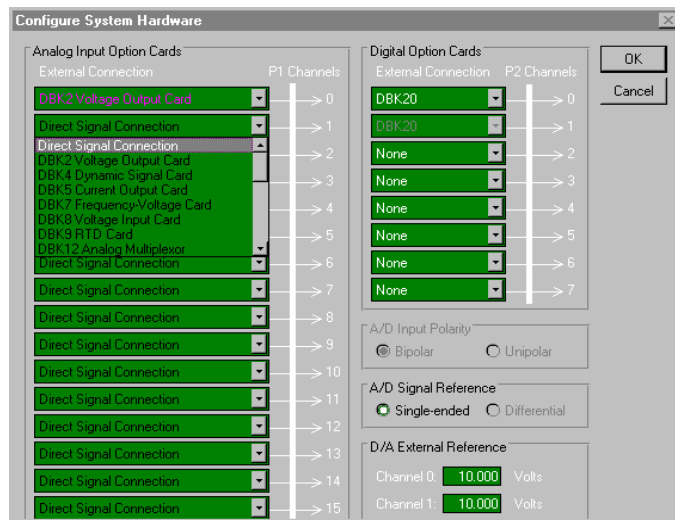
## Help

The Help menu provides access to the on-line Help file.  *About DaqView* gives you the current software version number.

# *Toolbar Items*

Each item in the toolbar has its own icon and is also accessible from the pull-down menu.  Placing the cursor on the icon and clicking the mouse button enables the tool or opens the corresponding window.

## Make All Channels Active (or Inactive)

The first 2 toolbar buttons can turn all the channels ON or OFF at a single stroke.  This feature is convenient during setup and troubleshooting or if only 1 or 2 channels must be set differently from the rest.  Both these commands are also available from the Edit pull-down menu.

## Charts

The third toolbar item displays real-time data in a strip-chart format for several channels on the DaqView Channel Display window.  Charts are enabled by selecting the triangular "Play" button on the top left (see figure).  Before "playing", at least one chart must be assigned to an active channel through the drop-down list on the right side of the chart.  For the selected channel, you can change the minimum and maximum values as needed.  This command can also be enabled from the Window pull-down menu.

Data is read and displayed in the charts, meters, and Readings column as fast as the computer will allow.  When an acquisition to disk has begun using the *Go* command,  the charts, meters, and the Reading column take a lower priority, updating only when there is time in the acquisition-to-disk task. Thus, the data seen in the
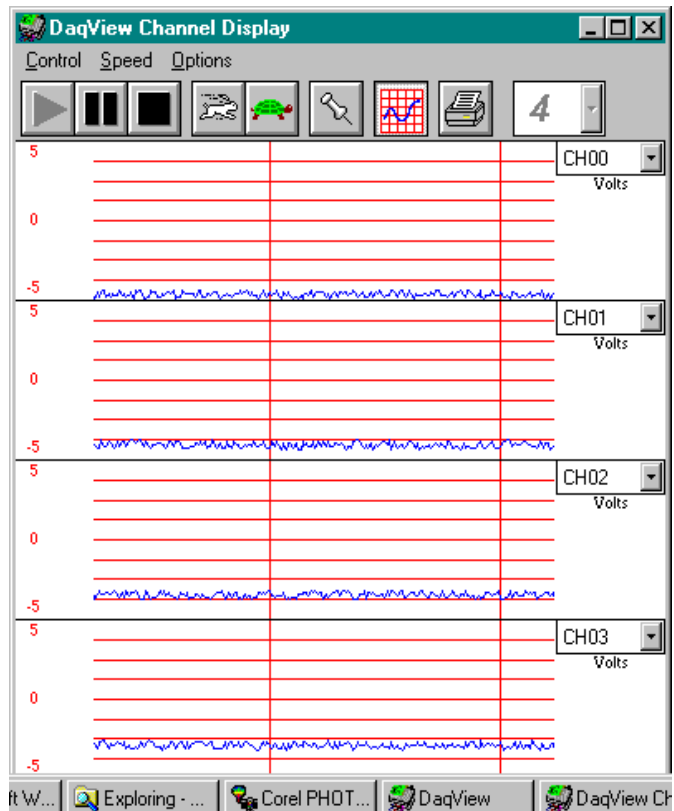
*DaqView Display Charts*

charts may not be the same as on the disk.  As the scan rate is increased, the  acquisition-to-disk task will take up more processor time and the charts will be unable to keep up.
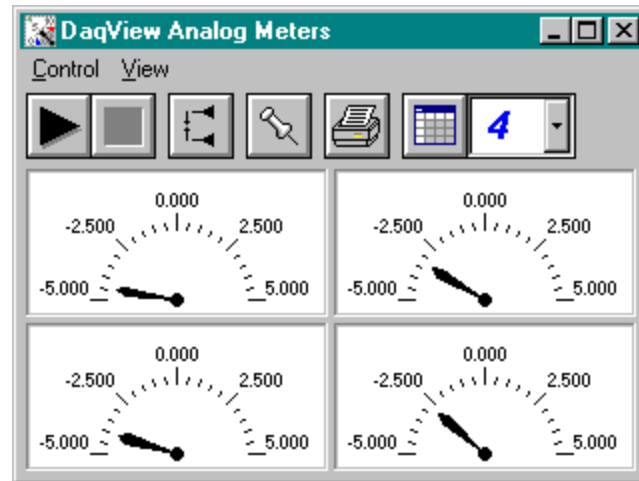
## Bar Graph Meters

Selecting the Bar Graph Meter icon brings up the Bar Graph window to display several channels in bar graph format. To activate the display, select the Start button on the left side of the toolbar (or Start All Indicators in the pull-down menu or in the toolbar). You can vary the number of channels displayed by selecting the input box at the end of the toolbar. The Grid tool (next to last item on toolbar) is used to arrange the display for convenient reading. The pushpin icon in the center of the toolbar locks this window on top of other windows until you unlock it by selecting the pushpin again.
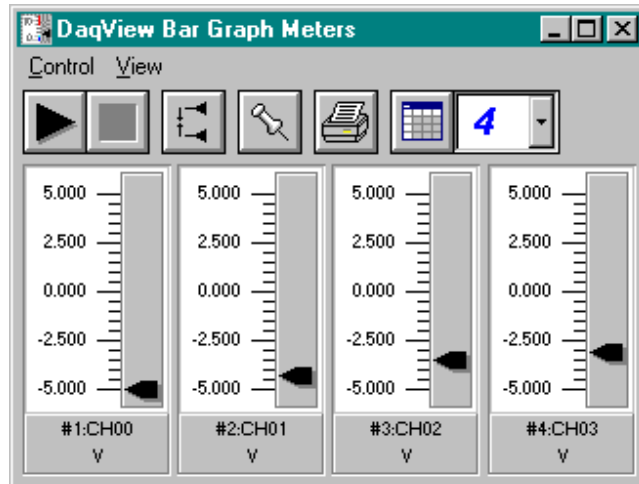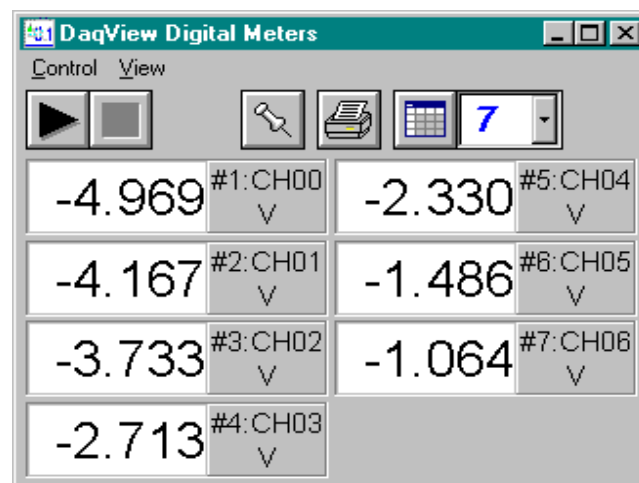


*Bar Graph Window*

## Analog Meters

Selecting the Analog Meter icon brings up the Analog Meters window to display several channels in a dial/gage format. To activate the display, select the Start button on the left side of the toolbar (or Start All Indicators in the pull-down menu or in the toolbar). You can vary the number of channels displayed by selecting the input box at the end of the toolbar. The Grid tool (next to last item on toolbar) is used to arrange the display for convenient reading. The pushpin icon in the center of the toolbar locks this window on top of other windows until you unlock it by selecting the pushpin again.



*Analog Meters Window*

## Digital Meters

Selecting the Digital Meters icon brings up the Digital Meters window to display several channels in numeric format. To activate the display, select the Start button on the left side of the toolbar (or Start All Indicators in the pull-down menu or in the toolbar). You can vary the number of channels displayed by selecting the input box at the end of the toolbar. The Grid tool (next to last item on toolbar) is used to arrange the display for convenient reading. The pushpin icon in the center of the toolbar locks this window on top of other windows until you unlock it by selecting the pushpin again.



*Digital Meters Window*

## Properties of Meter Windows

The meter windows simulate the look of 3 popular meter types: the bar graph, the analog dial, and the digital readout. Within each meter type, you can adjust their display properties to fit your needs. While in the meter window, **place the cursor in the display area and click the right mouse button**; then select Properties. A Properties window will appear and allow you to:

- Channels - select a new channel for display
- Scale - set the high and low points and the format (number of decimal places)
- Limits - set the high and low points and whether to display these limits
- Misc - set option to show the Trend Indicator and/or the Peak Hold Indicators.
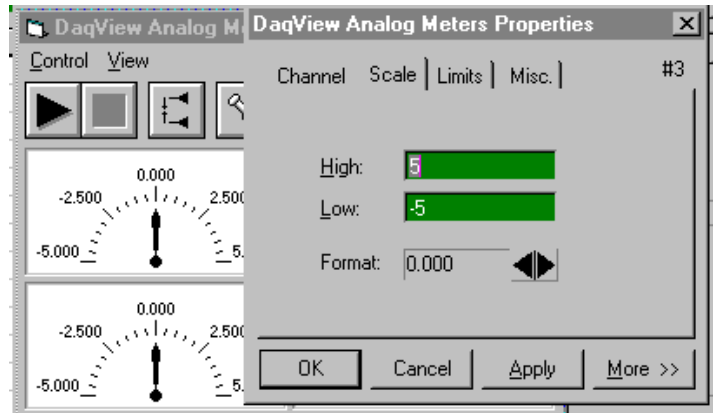
## Start (or Stop) All Indicators

These buttons use the same icons as many CD players (right-pointing triangle for start; square for stop). To change some parameters, you may have to stop the data display. The Start and Stop All Indicator buttons affect several windows if open, including: Reading column, Charts, Bar Graph Meters, Analog Meters, and Digital Meters. **Note**: You can start or stop any of these active windows separately using their own Start, Stop (or Pause) buttons.

## Analog Output Window

The analog output window provides interactive access to the two analog outputs on the DaqBook/DaqBoard. When set to the default internal reference, these outputs can be set from 0 to +5 VDC. An external reference can be connected ranging from -10 to +10 V allowing unipolar output from 0 to the inverse of the applied reference voltage.

The output voltage can be changed by moving the slide control or placing the cursor in the numeric field and entering a valid voltage value. Selecting the *Execute* button sends the voltage values to the outputs.

Two versions of this window exist. If a DBK2 or DBK5 are active in the Analog Input Spreadsheet, the window will accommodate voltage and current output in addition to the DAC reference. **Note: This window is not available when the arbitrary waveform window is visible.**
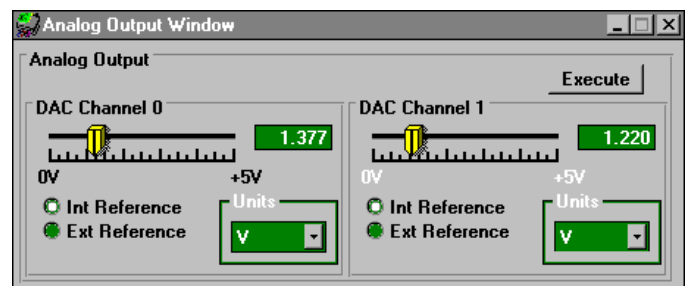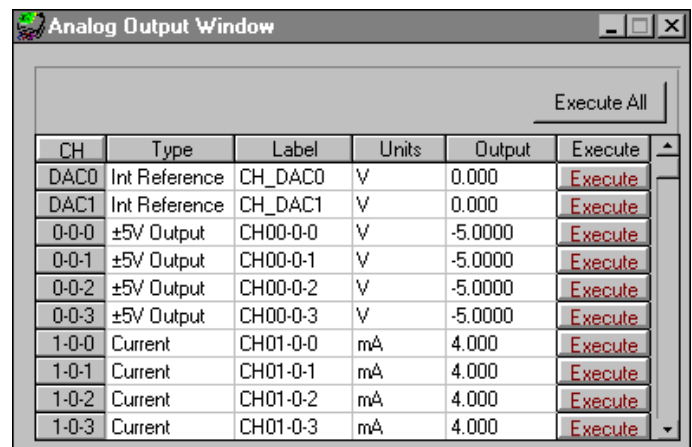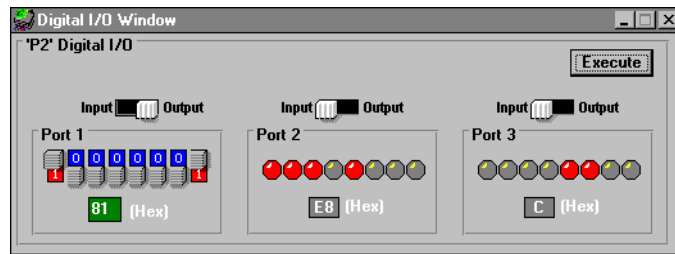
*Analog Output Window (with and without DBK2 & DBK5)*

## Digital I/O Window

For DaqBook/100, DaqBook/200, DaqBoard/100A and DaqBoard/200A Only

The digital I/O window is displayed when digital I/O button on the main window is selected. This window provides interactive control of all configured digital I/O ports (as configured in the Hardware Setup Window). The base unit has three 8-bit ports that can be configured as either inputs or outputs. Up to twenty 8-bit ports can be accessed



*Digital I/O Window*

when expansion boards are added. When the *Execute* button is pressed, all ports configured as outputs will be updated and all input ports will be read.

## Counter/Timer Window

(For DaqBook/100, DaqBook/200, DaqBoard/100A or DaqBoard/200A Only)

The counter/timer window is displayed when the counter/timer (the red C/T button) is selected from the toolbar. Selecting the *Execute* button begins the selected function. When the mode is selected via the drop-down list, the controls change accordingly  (see figure). Three C/T modes are available:

- Totals - counts signals from the related pin on P3. Each channel has its own Reset button.
- Pulse train generation - frequency and the high (+5 VDC) percentage of a cycle can be set for 5 channels.
- Frequency measurement - 2 ranges are available.

As used by DaqView, the 9513 chip for C/T functions has all 5 channels assigned to 1 of 3 modes. **Note**: full function



*3 Modes of the Counter/Timer*

(using separate channels and modes) of the 9513 is possible via API programming (refer to the daqCtr* commands in the *Programmer s Manual*).

## Arbitrary Waveform Window

Unlike the DaqBook, the DaqBoard has a waveform mode for its two analog output channels. DaqView allows either or both DaqBoard DACs to be configured in interactive mode or waveform mode.

With a DaqBoard, both the *Analog Output* and the *Arbitrary Waveform* are enabled. Selecting *Analog Output* will pop-up the standard analog output window for both DaqBoard and DaqBook (see previous section). Selecting *Arbitrary Waveform* will pop-up the arbitrary waveform window for one or both analog outputs.

**Note: This window is not available when the analog output window is visible.**

In the Waveform box, you can select a standard function generator waveform (sine, square, triangle, sawtooth) or a freehand drawing. In Freehand, move the mouse to the waveform window and draw a waveform using the left mouse button.

*Arbitrary Waveform Window*

In the Channel Selection box, you can designate the channel for the waveform output. The DaqBoard contains a waveform buffer with 4096 locations. If the two DACs are programmed to generate two different waveforms, the buffer is split into two 2048-location buffers.

The Point Count field holds the number of points desired for the waveform. Using only one DAC (or both DACs outputting the same waveform), a maximum of 4096 points are available. If two DACs are outputting different waveforms, a maximum of 2048 points are available for each.

The Frequency Setup section sets up the waveform's play rate. Two clock sources are available:
- D/A pacer with a rate set in the Sample Update Rate field. When using the D/A pacer, the Sample Update Rate field controls the speed at which the DAC is updated.
- A/D pacer, the clock used by the analog input section of the DaqBoard. Using the A/D pacer clock synchronizes the update of the DAC output with the analog input data collection.

The following example uses the A/D pacer clock as the update source. The DAC waveform is linearly ascending voltage starting at count 1 and increasing by 1 count on every update. The analog input frequency is set to 1 kHz.
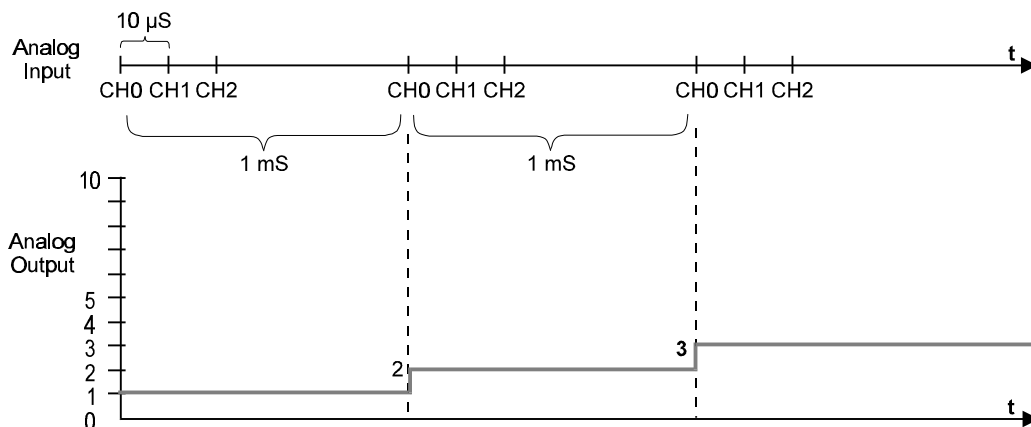
*Synchronization of D/A and A/D*
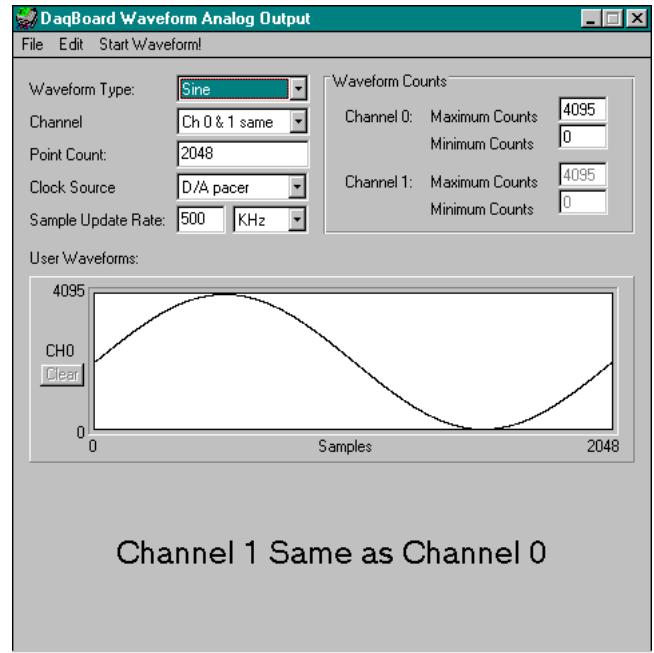
The following example shows a DAC waveform with the clock source set to D/A pacer and the Sample Update Rate field set to 5 kHz.
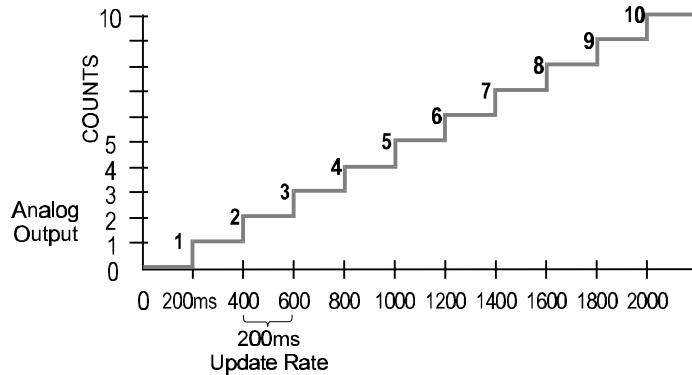


*DAC Waveform*

The Waveform Attributes section contains fields for setting the max and min for the Y-axis.  The DaqBoard's DACs are 12-bit devices, providing 4096 discrete voltage outputs.  If the default, internal voltage reference is applied, the count of 4096 represents 5 V and 0 represents 0 V.  The following equation shows the relationship between counts and volts:

$$Vout = Count * (Vref / 4096)$$

Under the File menu item, Load and Save Waveform commands allow you to save the displayed waveform(s) to disk in an ASCII format.  The files created are compatible with spreadsheets and word processors, allowing you to numerically inspect and/or alter the saved waveforms.  The Load Waveform command reads any ASCII file of numbers up to the number of points specified in the Point Count field.  The table shows the file format.

| Sample Waveform File Formats | |
| --- | --- |
| 1-channel: | 2-channel: |
| 2043<CR> | 2432<TAB>293<CR> |
| 1019<CR> | 394<TAB>345<CR> |
| 300<CR> | 2934<TAB>3456<CR> |
| 923<CR> | 743<TAB>875 <CR> |
| **Note**: In the two-channel example, the first column is channel 1, and the second column (after the TAB) is channel 2. | |

Under the Edit menu, Copy and Paste use the system clipboard to post and receive waveform data.  The data formats are identical to the Save and Load operations.  Copy and Paste are recommended for use with spreadsheets to numerically inspect and/or modify waveforms.

To start the waveforms playing on the DACs, click the *Start Waveform!* item in the menu bar.

**Note**: When the analog input section is set for analog input triggering, DAC1 is used internally to supply the desired threshold voltage.  In this case, DAC1 is not available for waveform output.

## Enable Input Reading Column

The next to last toolbar item enables/disables the Reading column of the Analog Input Spreadsheet to provide a numeric view of incoming data.  This function toggles on and off when the button is repeatedly selected.  Some windows require the Reading column to be disabled while changing channels or other parameters.  This command is also available from the Acquire pull-down menu.

## Go

The Go selection, the last icon on the toolbar, activates an acquisition of data to file.  The *Event* option under the *Trigger Setup* portion of  the Main window determines when the Go process is initiated.  The *Event* selections are detailed in the *Acquisition Configuration* section of this chapter.  After Go is selected, the process is automatic beginning with the *DaqView Armed* screen.  This screen posts the *Trigger Armed* time as well as the *Trigger Event* information.  The Go process makes use of the *Data File Setup* parameters to format data collection.

Once the *Trigger Event* occurs, the *DaqView Triggered* screen appears. This screen allows you to witness the data sampling parameters you set in the Main window prior to initiating the Go process as well as the progress of the data acquisition.

If file conversion is selected, the Go process is concluded by converting the generated .BIN file from binary to ASCII data. The resulting file is saved under a user-specified directory and file name or as a default under the DaqView subdirectory as DAQV.TXT. This .TXT file is available for data processing or analysis by various software packages such as DaqViewXL.

# *PostView 1.5*

PostView is an independent program that allows you to view waveforms recorded by DaqView, TempView, and WaveView. As the data file is being created, a descriptor file used by PostView is also created.
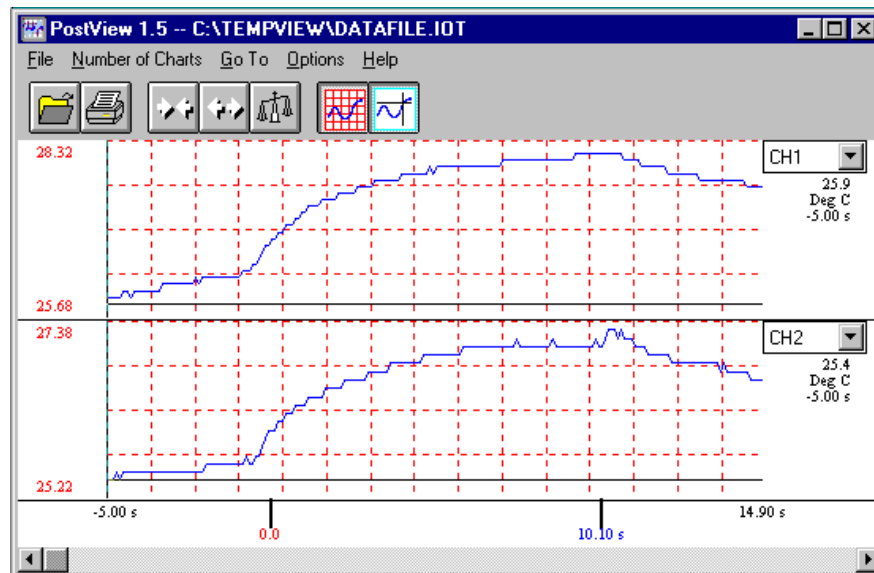


The program can be started from a toolbar PostView icon, or from a pull-down menu. PostView can also be started independent of DaqView, TempView, and WaveView. Multiple sessions of PostView can be invoked concurrently to view several data files. To view a data file from within PostView, select *Open* under the File menu. When PostView is started from DaqView, TempView, or WaveView, it automatically opens the selected destination file. To view other files, use *Open* under the File menu for the applicable program's data files. To place channel waveforms into the window, select the number of charts from 1 to 16 under the *Number of Charts* menu item. Selecting *N* number of charts will automatically place the first *N* channels in the charts. Use the *Channel Select List Box* (Upper right corner of each chart) to view the desired channel. The Channel Select List Boxes contain labels that were assigned to the recorded channels by DaqView, TempView, or WaveView.

The next table explains PostView toolbar items and is followed by a description of PostView Menu items. Menu and toolbar items are identified by the following figure.

| PostView Toolbar Items | |
| --- | --- |
| Open | Accesses the Open Data File window. |
| Print | Sends the PostView chart(s) to an assigned printer. |
| Zoom Out (><) | The Zoom Out button doubles the visible timebase, showing more of the waveform.  For example, if 10 seconds of information is visible, clicking the Zoom Out button will show 20 seconds. |
| Zoom In (<>) | The Zoom In button halves the visible timebase, showing less of the waveform.  For example, if 10 seconds of information is visible, clicking the Zoom In button will show 5 seconds. |
| Autoscale | Clicking the Auto Scale button adjusts the Y-axis labels so that the visible waveform fills 90% of the chart's range. |
| Y-axis Adjust | The Y-axis Adjust fields show the chart's minimum and maximum for visible charts in the engineering units shown.  Clicking the Auto Scale button automatically adjusts the Y-axis Adjust fields.  To adjust any chart's minimum or maximum, place the cursor in the desired Y-axis Adjust field, and type in a new value. |
| Show Grid | Places a grid on the chart (s), or removes the grid if already present. |
| Show Markers | Each chart contains a cross-hair marker that shows the numerical values of time and magnitude at its present location in the waveform.  The Markers start out at the far left of every chart, showing the time and magnitude of the first visible point.<br>• Left mouse button allows the user to drag the  marker of each chart *independently*.<br>• Right mouse button moves the markers from all the charts *in unison*.<br>The Options menu contains a function which allows you to turn markers on and off.  When a check appears in front of this item, its associated indicator is on or visible.  Selecting the menu item toggles the indicator (and the check mark) on and off. |
| *Trigger Event Marker* | The Trigger Event Marker on the time axis shows the location of the trigger point. |
| *Stop Event Marker* | The Stop Event Marker on the time axis shows the location of the stop point. |
| The Scroll Bar at the bottom of the PostView window (see figure on previous page) allows the waveforms to be scrolled right or left in two ways:<br>1. When clicked on, the small left and right arrow boxes scroll the waveforms approximately 20%.<br>2. The plain scroll button shows the relative location of the visible region of the waveforms and can be dragged along the scroll bar to any location desired. | |

## PostView Menu Items

The following tables pertain to functions allowed by the pull-down menus.

| **File** | |
| --- | --- |
| Open | Opens a data file created by DaqView, TempView, or WaveView.  PostView automatically detects whether the file contains ASCII or binary data. |
| Print Window | Prints the present PostView window. |
| Exit | Exits the File menu. |
| **Number of Charts** | |
| 1-16 | After a data file has been opened, the number of desired charts can be selected.  You can also use this menu selection to change the number of charts displayed. |
| **Go To** | |
| Percentage | Automatically scrolls to the desired percent of the data file.  For example, selecting 50% would display a waveform segment from the middle of the data file. |
| Scan Number | Automatically scrolls the waveforms so the desired scan number is in view.  This menu selection invokes a dialog box which displays the number of scans in the file. |
| Time | Automatically scrolls the waveforms so the desired time is in view. |
| Trigger Point | Automatically scrolls the waveforms so the trigger point (t = 0) is in view. |
| **Options** | |
| Zoom Out | Allows more of a chart(s) to be seen by decreasing the dimensions. |
| Zoom In | Zooms in on a chart(s), providing more detail to a smaller area of the chart(s). |
| Autoscale | Automatically generates a scale, in contrast to manually assigning the scale. |
| Show Grid (Ctrl+G) | Allows grids to be turned off and on for all visible graphs.  When a check appears in front of an item, its indicator is on or visible. |
| Show Markers (Ctrl+K) | Allows markers to be turned off and on for all visible graphs.  When a check appears in front of an item, its indicator is on or visible. |

| **<u>Help</u>** | |
|---|---|
| Contents | The initial PostView help screen provides an overview and listing of the help file contents.  A single topic can be selected for quick access to help information. |
| Search | Type a word or select one from the Show Topics list for quick access to help information. |
| Help on Help | Provides instructions on how to use a Windows Help system. |
| About | Provides the PostView version number, for example: Version 1.5. |

## The PostView Timebase

PostView automatically detects the timebase of the data file and shows the time in seconds in the X-axis labels.
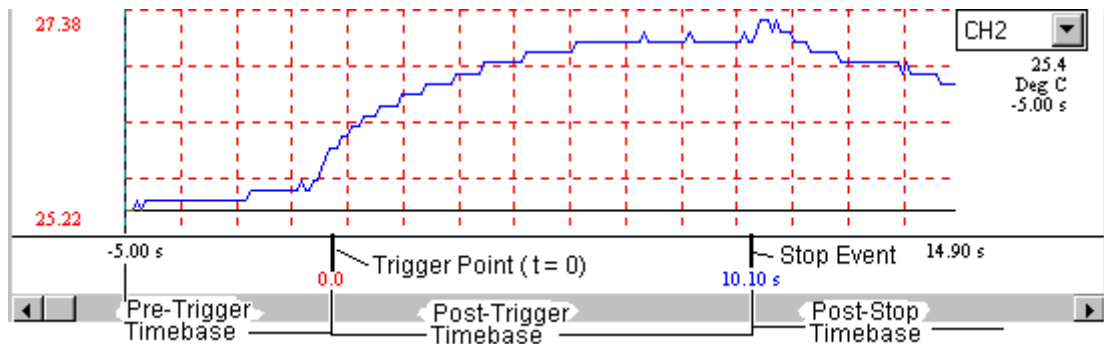


Note: Post -Stop Timebase does not apply to DaqView or WaveView.

PostView can create files containing multiple timebases, pre-trigger and post-trigger data for DaqView, TempView and WaveView programs.  In addition, with TempView you can create files which include post-stop data.

The following comments apply to DaqView, TempView and WaveView, except when noted otherwise.
- Note that the trigger point (t = 0) is not necessarily the first point in the data file.
- If pre-trigger scans are available, they will be shown prior to the trigger point and labeled with negative time numbers.
- If a dual timebase was used when collecting the data, PostView will show a discontinuity in the time axis when the timebase changes.  When a dual timebase is used, the post-trigger scans are collected at one frequency while the pre-trigger and post-stop scans are collected at another.
**Note:  DaqView does not support dual timebase.**
- For **TempView**, if post-stop data is available (scans collected after the Stop Event), they are displayed after the Stop Event marker.
**Note:  This feature does not apply to DaqView and WaveView.**

## Data File Accessibility

Depending on the source program, file accessibility is as follows:
- **DaqView** and **WaveView** - PostView can access these program files only after the entire acquisition is complete.
- **TempView** - PostView can access the program files at any time, even during the acquisition.  If PostView reaches the end of a file while TempView is still collecting data, PostView will automatically display the new data as it becomes available.

**Note:**  For the fastest display of waveforms, select binary data storage.  This applies to DaqView, TempView and WaveView.

# *DaqViewXL*

DaqViewXL is a software component add-in that installs into Microsoft Excel and provides complete setup and data acquisition within Excel under Windows 3.x or Windows 95. Acquired data is immediately placed in an active spreadsheet, updating cells and graphics. Data is then analyzed and graphically displayed. DaqViewXL:

- Augments Microsoft's Excel spreadsheet software with data acquisition capability
- Provides strip-chart graphics for real-time data display
- Automatically converts data to engineering units

Once DaqViewXL is installed within Excel, the spreadsheet provides a floating toolbar that contains all the data acquisition controls. This DaqViewXL tool bar (also accessible from Excel's menu) can enable all configuration and data acquisition tasks. The features of Excel and DaqView are seamlessly combined to form a powerful data acquisition solution.

DaqViewXL performs like DaqView despite a slightly different user-interface. To set up your data acquisition system, you just click on the Configure button in the Excel tool bar. DaqViewXL's main window appears with all of the controls required to configure data acquisition including setting up input and output channels on an easy-to-use grid. Each column of the channel-configuration grid corresponds to specific parameters in the data acquisition system and allows you to set these parameters on a per-channel basis.

Excel provides a wealth of functions such as entering and editing data, building formulas to calculate values, and creating graphics. Excel offers high-powered analysis functions including frequency domain functions such as fast Fourier transforms (FFTs). The newest version, 5.0, includes additional features for retrieving and analyzing data. Such features make it easy to set up a spreadsheet for processing raw data, generating graphs, and printing reports. Excel is a perfect tool for repetitive tests where consistency is important.

You can obtain automated reports by taking advantage of the Software Components concept. For example, you can embed an Excel spreadsheet object into a Word document. When the spreadsheet object is activated, it gives you access to DaqViewXL. In this case, the Word document holds all text, as well as an embedded Excel spreadsheet object that holds raw and calculated data and graphics. Double-clicking on the Excel object in Word can access DaqViewXL to efficiently prepare a statistical report. This compound document lets you collect, configure, analyze, graph, and annotate data with a few clicks of a mouse button.

## Program Requirements

DaqViewXL requires the following software:

- IOtech DaqBook/DaqBoard Series driver version 4.2 or later. (Installed components must include the DaqView Windows utility program.)
- Microsoft Excel, version 5 or 7
- Microsoft Windows Operating System (Windows 3.1x, Windows for Workgroups 3.1x, Windows 95)

## Installation of DaqViewXL Software

While running Windows (3.X, NT, or 95) insert DaqViewXL disk1 into the disk drive. From the *Run* dialog box initiate the software installation by running the setup.exe file. Follow the on screen directions (dialog boxes) to finish the software installation.

**Note:** If you are installing a new version of DaqViewXL over a previous version, you should perform the steps in the section (Removing DaqViewXL from Excel) before installing the new version.

## Running DaqViewXL for the First Time

DaqViewXL is an Excel *Add-In* that must be loaded into the Excel environment before it can be used. Perform the following steps to install DaqViewXL:

1. Start Excel (refer to Microsoft documentation as needed).

2.  Select the "Tools" menu and click on "Add-Ins...".  This will open the "Add-Ins" dialog box, as shown to the right.
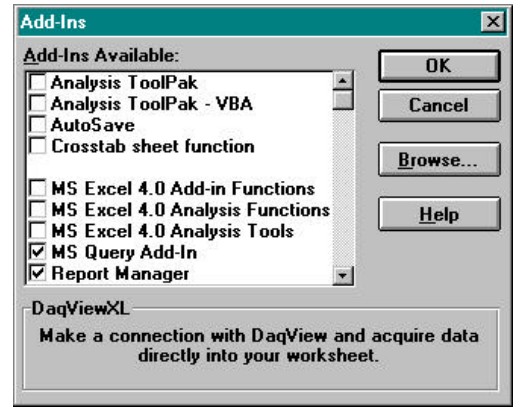
*Excel Add-Ins Dialog Box*

3.  Click the "Browse" button and locate the file DAQVIEW.XLA.  It should be in the install directory specified in the setup program. Click OK.

*Browse Option Dialog Box*

4.  DaqViewXL should now be in the "Add-Ins Available" list box.  Make sure there is a check next to it and click OK.
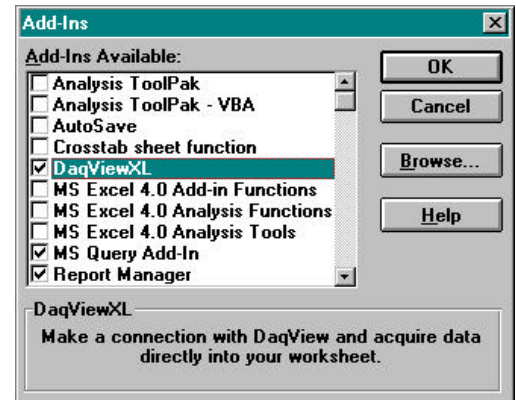
*Add-Ins Dialog Box (post addition)*

5.  Excel loads the add-in which creates a Toolbar and adds a menu item to the "Tools" menu.  Click on the "Tools" selection to see the new DaqViewXL menu item.
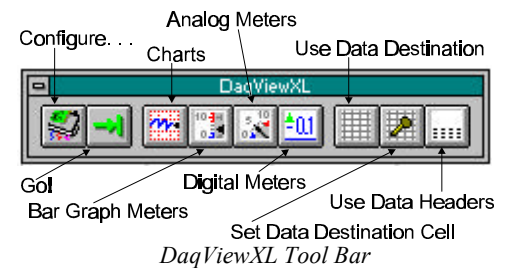
*DaqViewXL Tool Bar*

6.  After DaqViewXL is loaded in this manner, it will automatically load whenever you run Excel.  If DaqView is not running at the time you launch Excel (with DaqViewXL activated), the following dialog box will appear.
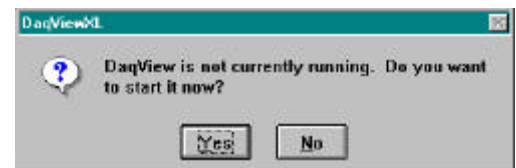
*DaqView Start Up Confirmation*

## Removing DaqViewXL from Excel

If you do not want DaqViewXL to load each time you run Excel, perform the following steps:

1. Start Microsoft Excel.
2. Select the "Tools" menu and click on "Add-Ins...". This will open the "Add-Ins" dialog box.
3. Find the DaqViewXL line in the "Add-Ins Available" list box and click on it. This should remove the checkmark next to the name. Click OK.

DaqViewXL will no longer auto-load with Excel. The next time you want to use DaqViewXL repeat the above steps, this time checking the DaqViewXL line instead of unchecking it. DaqViewXL will then load and once again become part of the Excel environment.

## Basic Function of DaqViewXL

DaqViewXL performs much like the standard DaqView. With Excel's macro capabilities, you can tailor DaqViewXL to meet various requirements. Your knowledge of Excel will help you use all its tools for better data acquisition and processing. The following sections give you the basics of how DaqViewXL can organize and analyze your data. These basic ideas will give you the ability to explore all DaqViewXL has to offer. The discussion mirrors previous sections and highlights the differences between DaqViewXL and DaqView. The *Hints and Tips* section gives you tools and suggestions to improve your productivity with DaqViewXL.
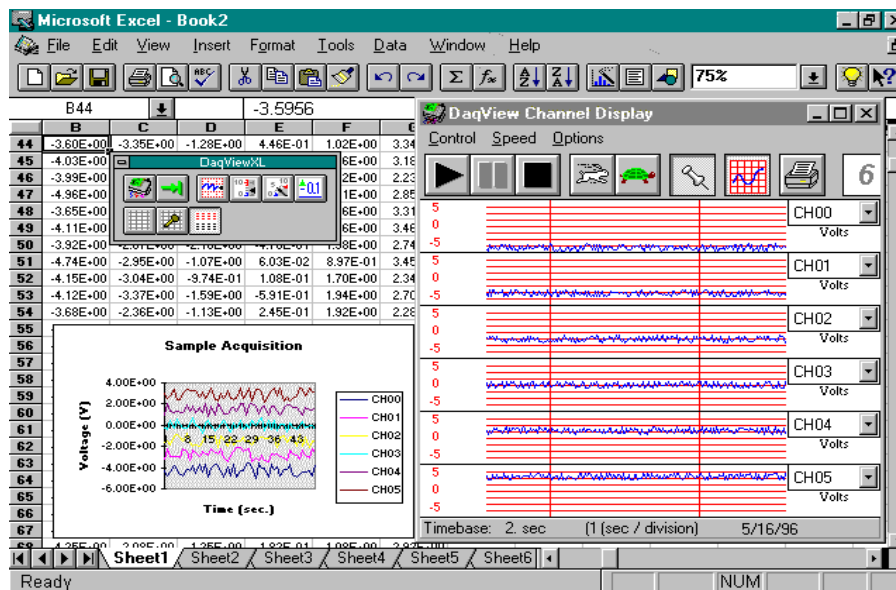


*DaqViewXL Toolbar and Displays*

### Configuring an Acquisition

After installing DaqViewXL and entering Excel, click the *Configure...* icon (first in the DaqViewXL toolbar) to set up your system. This launches DaqViewXL's main screen (see following figure). This screen is slightly different from the stand-alone version shown at the beginning of the chapter. (Specifically, DaqViewXL does not have a PostView button—Excel performs those functions better. Also, the Go button is now the 2nd button on the toolbar window rather than the main screen.) The earlier discussion of DaqView configuration still applies.
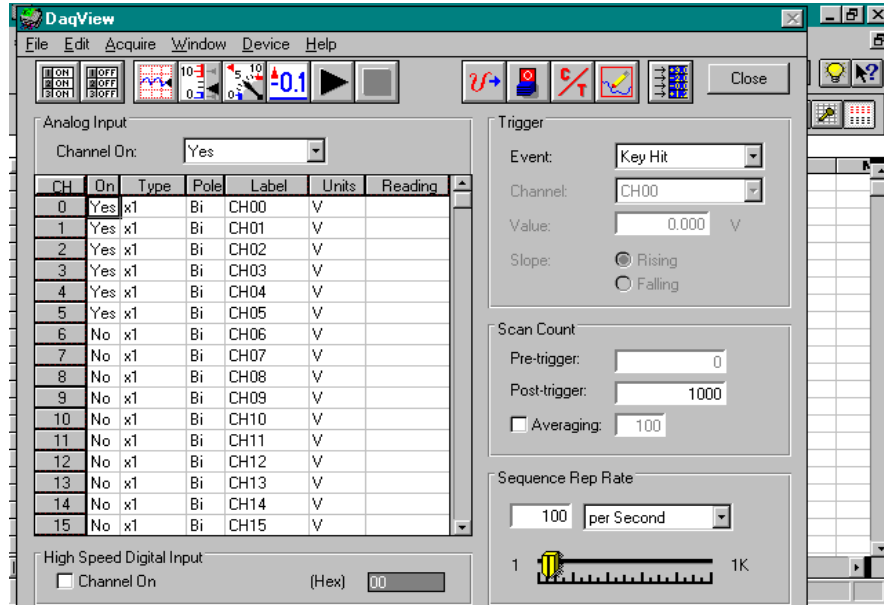


*DaqView Screen Within Excel*

### Real-Time Charting

DaqViewXL provides a real-time strip-chart window (same as in DaqView) for graphical presentation of data. You can select up to 16 channels of data assigning a channel to each graph. The strip-chart representation is continuous while data is being collected at up to 100 kHz. All 16 charts are synchronized and have an adjustable scrolling speed that can be set independent of the sampling rate. Selecting the *Charts* icon in the DaqViewXL toolbar will activate the following window. The chart selection must be made prior to initiating an acquisition (selecting the *Go!* icon).
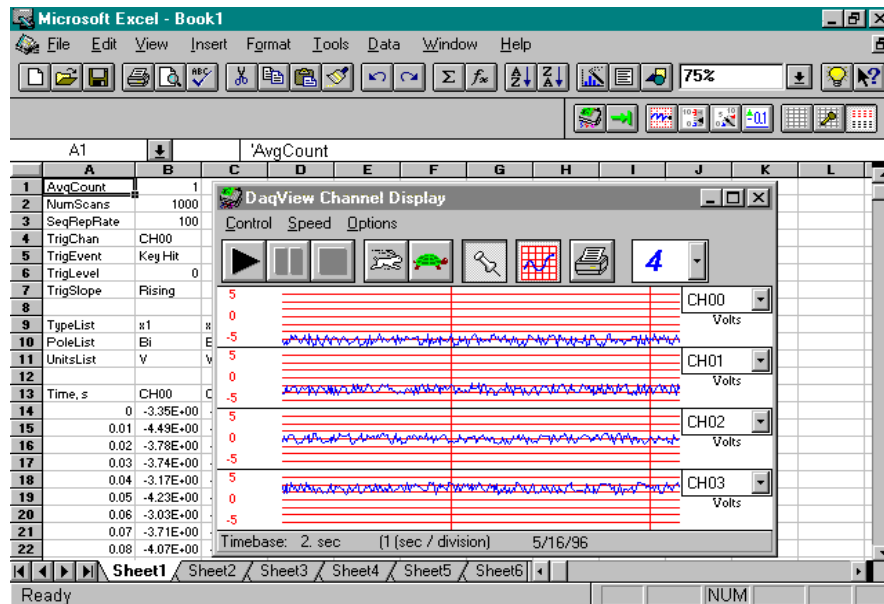


*DaqViewXL Real-Time Charting*

### Data Header

DaqViewXL's optional data header supplies the global acquisition parameters and the configuration of each channel and places this information directly in the spreadsheet along with acquired data. This information includes channel gain or thermocouple type, bipolar/unipolar setting, units, and channel label. To activate Data Headers select the *Use Data Headers* icon in the DaqViewXL toolbar.
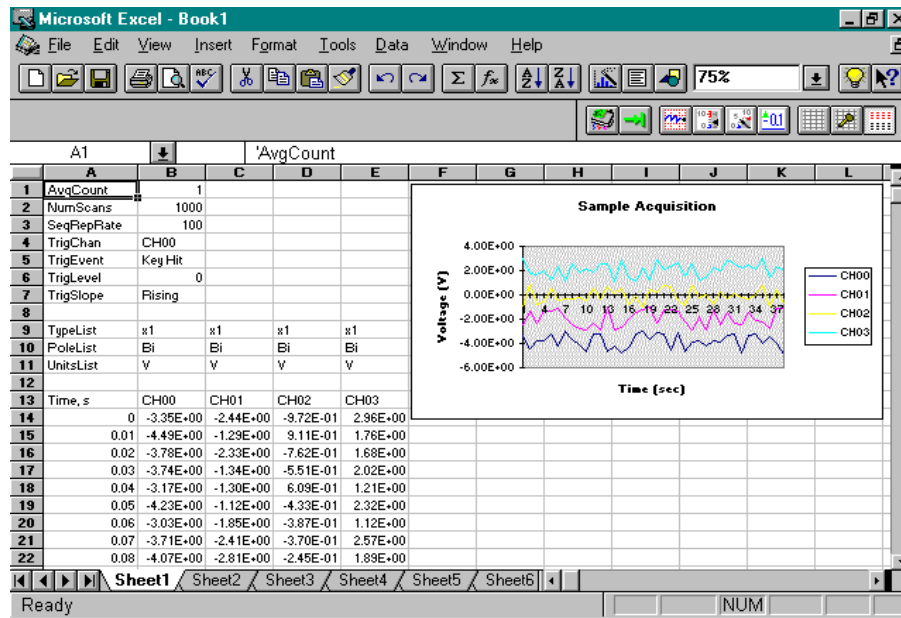
*DaqViewXL Data Header*

### Analog Output

DaqViewXL provides an analog output window to set the output voltage from the D/A converters. The window features a slider and a text-entry field for each D/A converter. With DaqBoards, you can manually draw a waveform using your mouse and output that waveform at up to 500 kHz per channel via the DaqBoard's two 12-bit D/A converters. Once the DaqView screen is open, select the *Arbitrary Waveform* icon from the DaqView toolbar. The DaqView options previously discussed still apply.
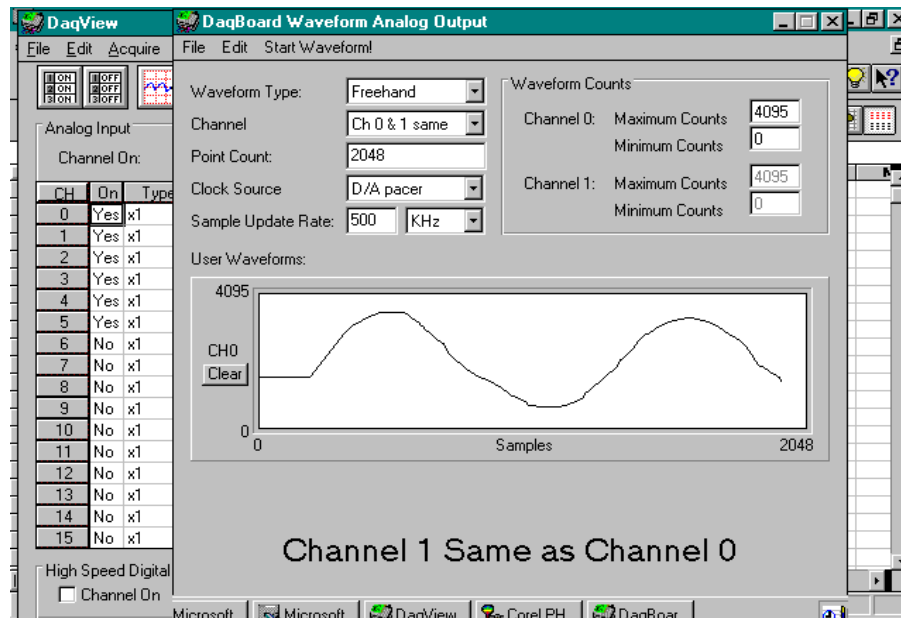
*DaqViewXL Static Voltages & Arbitrary Waveforms*

### *Digital I/O and Counter-Timers*

DaqView's digital I/O and counter-timer windows provide you with full interactive control of the hardware's on-board digital I/O and all digital expansion channels (up to 192). This window allows you to configure each port as either an input or output. The *Counter/Timer* and *Digital I/O* icons are also selectable from the DaqView toolbar. The counter-timers provide a pulse-train generator, which allows you to specify the frequency and duty-cycle for digital output; a totalizer function, which counts pulses; and a frequency measurement function.
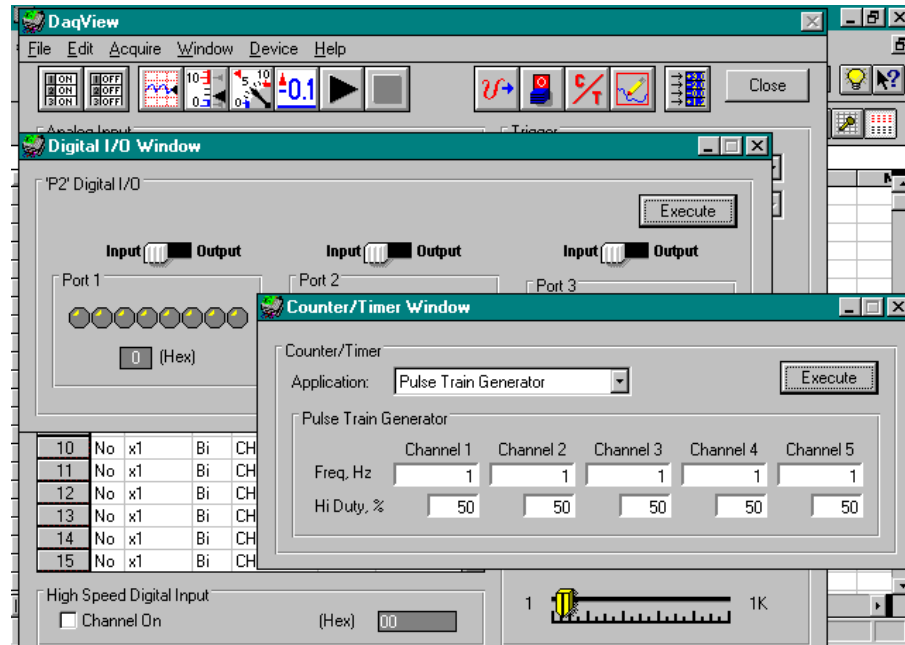


*DaqViewXL Digital I/O & Counter-Timers*

### *Hardware Support*

DaqView XL supports all models of the Daq Family including all DBK expansion modules and signal-conditioning cards. To add DBK options to your system, you must select the desired signal conditioning in the DaqViewXL Hardware Configuration window. Once configured, DaqViewXL automatically provides access to new channels from within Excel. The channel configuration grid provides a means of configuring each channel.

DaqViewXL also provides the engineering unit output required by each DBK option. For example, data from a DBK current card is returned in amps, while data from a thermocouple or RTD card is returned in degrees. When you see the mx+b feature in DaqViewXL's units column, the collected data for the associated channel is automatically converted to custom units and then scaled and offset before appearing in the spreadsheet. The mx+b conversion features is especially handy for transducers such as strain gages because it converts the return voltage value to units such as pounds or units of pressure. Depending on DBK used, DaqViewXL accommodates special gains and other capabilities.

## Hints and Tips for DaqViewXL

- Do not run DaqView first and then try to use DaqViewXL. When DaqViewXL runs DaqView it puts it into a special "server" mode which supports transactions with "client" applications such as Excel. Normally DaqView does not run in this mode and cannot support DaqViewXL.

- When you acquire data into a worksheet, some of the data may be displayed as a string of hash marks (e.g. ######). Excel will do this whenever the column is not wide enough to display all the digits of a number. To eliminate the hash marks, just widen the column. An easy way to do this is to use the "Format, Column, Auto Fit Selection" menu command. Immediately after an acquisition, all the rows and columns of data are selected. Click this menu item to automatically fit all the columns to the new data.

- DaqViewXL does not have to be used as an Excel Add-In; it can also be loaded like a workbook. To do so, open DAQVIEW.XLA using the File Open dialog box. The DaqViewXL toolbar and menu items will be added to Excel and behave exactly as they would if DaqViewXL had been loaded as an Add-In. You can also load DaqViewXL via the Icon created by the setup program. When you do it this way, Excel does not automatically create a blank workbook for you. After Excel loads with DaqViewXL, access the File, New menu item to create one. When you load DaqViewXL like a workbook, it will not automatically load the next time you run Excel. However, it will appear in the recently-used list at the bottom of the File menu, making it easy to load the next time you run Excel.

- You can start an acquisition from an Excel macro as shown in the following VBA macro code example:

```
Sub Macro1()
Application.Run Macro:="menuGoDoIt"
End Sub
```

This is equivalent to clicking the Go! button on the DaqViewXL toolbar. It arms the hardware for an acquisition, and if DaqView is set up to trigger on "External TTL" or "Channel Value", the acquisition will take place automatically when the trigger condition is met. For acquisitions configured to trigger on a "Key Hit", the acquisition will not start until the user presses the "Manual Trigger" button on the "DaqView Armed" dialog box.

To automatically press this button after arming DaqView use the following macro:

```
Sub ArmAndKeyHit()
Application.Run Macro:="menuGoDoIt"      'presses the Go! button
SendKeys "{ENTER}"            'presses the space bar
End Sub
```

This macro will start a "Key Hit" acquisition immediately. (Note: Macro1, shown above, was generated by Excel's macro recorder).

- If you chose to customize DaqViewXL's toolbar, you should avoid removing buttons. If DaqViewXL detects missing buttons it will prompt you to allow it to remove the toolbar and recreate it with all buttons. You can decline to do so, but DaqViewXL will continue to ask you to recreate the toolbar each time it starts-up. You can add buttons, rearrange them, and re-size the toolbar without getting this prompt.

- If DaqView cannot connect to your hardware on start-up, it will automatically switch to the Simulated Instrument mode when loaded from DaqViewXL.

# Signal Management and Troubleshooting Tips

## *Overview*

This chapter explains how Daq* systems can handle signals in an optimum way and avoid noise problems. The first part of the chapter explains channel expansion and configuration. Then, most of the chapter explains how to apply basic concepts of data acquisition. The discussion centers on signals: how to manage them, how to use different types of signals, and how to reduce common noise problems. Lastly, the chapter offers basic troubleshooting tips.

This table defines data acquisition terms *as used in this manual*.

| Data Acquisition Terms and Meanings | |
|---|---|
| Acquisition | A collection of scans acquired at a specified rate as controlled by the sequencer. |
| Analog | A signal of varying voltage or current that communicates data. Typical analog signals have the form of sine waves. |
| Analog-to-Digital Converter (ADC) | A circuit or device that converts analog values into digital values, such as binary bits, for use in digital computer processing. |
| API | Application Program Interface. The interface program within the Daq* system's driver that includes function calls specific to Daq* hardware and can be used with user-written programs (several languages supported). |
| Bipolar | A range of analog signals that includes positive and negative values (e.g., -5 to +5 V); see *unipolar*. |
| Buffer | *Buffer* refers to a circuit or device that allows a signal to pass through it, while providing isolation, or another function, without altering the signal. *Buffer* usually refers one of the following:<br>(a) A device or circuit which allows for the temporary storage of data during data transfers. Such storage is often necessary to compensate for differences in data flow rates. A FIFO (First In - First Out) buffer is one in which the data that is stored first, is also the first data to leave the buffer.<br>(b) A follower stage which is used to drive a certain number of gates without overloading the preceding stage.<br>(c) An amplifier which accepts high source impedance input and results in low source impedance output (effectively, an impedance buffer).<br>(d) Buffer Amplifier (see *Buffer Amplifier*). |
| Buffer Amplifier | An amplifier used primarily to match two different impedance points, and isolate one stage from a succeeding stage in order to prevent an undesirable interaction between the two stages. (Also see, *Buffer*). |
| Channel | In reference to Daq*, *channel* simply refers to a single *input*, or *output* entity.<br>In a broader sense, an *input channel* is a signal path between the transducer at the point of measurement and the data acquisition system. A channel can go through various stages (buffers, multiplexers, or signal conditioning amplifiers and filters). Input channels are periodically sampled for readings.<br>An *output channel* from a device can be digital or analog. Outputs can vary in a programmed way in response to an input channel signal. |
| Common mode | Common mode pertains to signals that are identical in amplitude and duration; also can be used in reference to signal components. |
| Crosstalk | An undesired transfer of signals between systems or system components. Crosstalk causes signal interference, more commonly referred to as *noise*. |
| Digital | A digital signal is one of discrete value, in contrast to a varying signal. Digital data is represented by combinations of binary digits (0s and 1s). |
| Digital-to-Analog Converter (DAC) | A circuit or device that converts digital values (binary bits), into analog signals. |
| DIP Switch | A DIP switch is a group of miniature switches in a small *Dual In-line Package* (DIP). Typically, users set these switches to configure their particular application. |
| Differential mode | The differential mode measures a voltage between 2 signal lines for a single channel. (Also see *single-ended mode*). |
| ESD | Electrostatic discharge (ESD) is the transfer of an electrostatic charge between bodies having different electrostatic potentials. This transfer occurs during direct contact of the bodies, or when induced by an electrostatic field. ESD energy can damage an integrated circuit (IC); so safe handling is required. |
| Excitation | Some transducers [e.g. strain gages, thermistors, and resistance temperature detectors (RTDs)] require a known voltage or current. Typically, the variation of this signal through the transducer corresponds to the condition measured. |
| Gain | The degree to which an input signal is amplified (or attenuated) to allow greater accuracy and resolution; can be expressed as ×n or ±dB. |

| Data Acquisition Terms and Meanings | |
|---|---|
| Isolation | The arrangement or operation of a circuit so that signals from another circuit or device do not affect the *isolated* circuit. In reference to Daq*, *isolation* usually refers to a separation of the direct link between the signal source and the analog-to-digital converter (ADC). Isolation is necessary when measuring high common-mode voltage. |
| Linearization | Some transducers produce a voltage in linear proportion to the condition measured. Other transducers (e.g., thermocouples) have a nonlinear response. To convert nonlinear signals into accurate readings requires software to calibrate several points in the range used and then interpolate values between these points. |
| Multiplexer (MUX) | A device that collects signals from several input channels and outputs them on a single channel. |
| Sample (reading) | The value of a signal on a channel at an instant in time. When triggered, the ADC reads the channel and converts the sampled value into a 12- or 16-bit value. |
| Scan | The channels that are selected for sampling. |
| Sequencer | A programmable device that manages channels and channel-specific settings. |
| Simultaneous Sample-and-Hold | An operation that gathers samples from multiple channels at the same instant and holds these values until all are sequentially converted to digital values. |
| Single-ended mode | The single-ended mode measures a voltage between a signal line and a common reference that may be shared with other channels. (Also see *differential mode*). |
| Trigger | An event to start a scan or mark an instant during an acquisition. The event can be defined in various ways; e.g., a TTL signal, a specified voltage level in a monitored channel, a button manually or mechanically engaged, a software command, etc. Some applications may use pre- and post-triggers to gather data around an instant or based on signal counts. |
| TTL | Transistor-Transistor Logic (TTL) is a circuit in which a multiple-emitter transistor has replaced the multiple diode cluster (of the diode-transistor logic circuit); typically used to communicate logic signals at 5 V. |
| Unipolar | A range of analog signals that is always zero or positive (e.g., 0 to 10 V). Evaluating a signal in the right range (unipolar or bipolar) allows greater resolution by using the full-range of the corresponding digital value. See *bipolar.* |

## *Channel Control and Expansion*

In a Daq* system, DBK expansion cards and modules can increase the number of analog input channels from 16 base channels to 256 input channels ($16 \times 16$). The configuration will vary depending on the DBK's channel capacity; for example, four 4-channel DBKs or two 8-channel DBKs can share the same base channel. As part of the multiplexing scheme, each DBK card provides a single output which must be directed to one of the 16 base channels via the DBK's JP1 jumper setting.
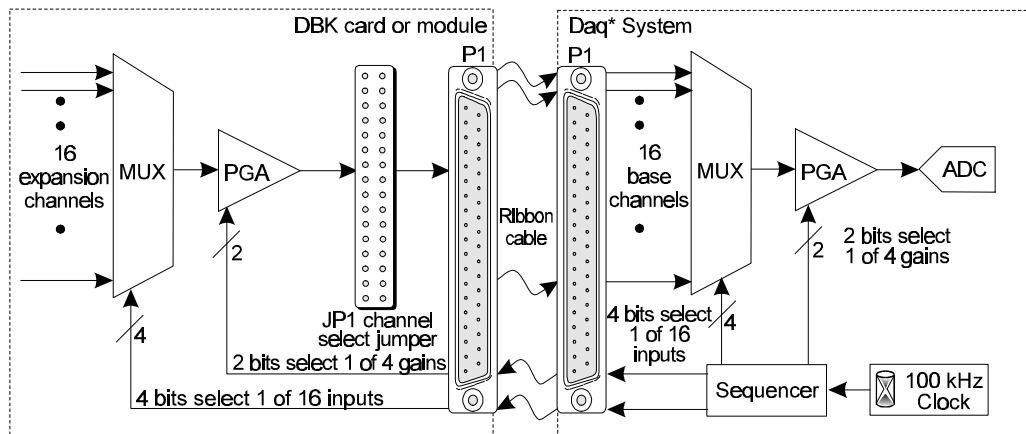


The figure above shows the functional parts related to channel control and expansion:

- The **Daq* sequencer** selects the channel and gain by controlling multiplexers (MUX) and programmable gain amplifiers (PGA) in both the Daq* and the DBK. The sequencer uses 4 expansion address lines to provide 16 unique channel addresses for each base channel. The sequencer is controlled by a 100 kHz clock and user programming of the scan sequence.
- The **DBK multiplexer** selects 1 of 16 (max) channels as directed by the sequencer. The selected signal goes to the PGA, then to the channel-selection jumper, and then to the Daq* via P1.

- The **Daq\* multiplexer** selects 1 of 16 base channels from P1 input lines as directed by the sequencer. The selected signal goes to the PGA and then to the A/D converter (A/D).
- The **PGAs** can vary the gain on a per channel basis as directed by the sequencer. For DBKs with a PGA, the sequencer can combine the gains of the DBK PGA and the Daq\* PGA for a wide variety of gain settings.
- The **P1 interface** has a signal line for each of the 16 base channels and control lines for gain setting (pins 5, 6) and sub-channel selection (pins 3, 4, 22, 23).
- The **JP1 channel select jumper** in the DBK can be placed on pins for channel 0 through channel 15. Until the base channel capacity is filled (16 max), multiple cards can use the same JP1 channel setting if their DIP switches are set to identify unique sub-channel card numbers. **Note**: channel select header on DBK17 and DBK18 is lableled J1 instead of JP1.

| Daq* Channel Numbering | | |
|---|---|---|
| **DaqView Channel**[1] | **Signal Source** | **API Channel** |
| 0 to 15 | Local channels 0 to15[2] | 0 to 15 |
| 0-0 to 0-15 | 0 to 15 of A/D exp. card 0 | 16 to 31 |
| 1-0 to 1-15 | 0 to 15 of A/D exp. card 1 | 32 to 47 |
| 2-0 to 2-15 | 0 to 15 of A/D exp. card 2 | 48 to 63 |
| 3-0 to 3-15 | 0 to 15 of A/D exp. card 3 | 64 to 79 |
| 4-0 to 4-15 | 0 to 15 of A/D exp. card 4 | 80 to 95 |
| 5-0 to 5-15 | 0 to 15 of A/D exp. card 5 | 96 to 111 |
| 6-0 to 6-15 | 0 to 15 of A/D exp. card 6 | 112 to 127 |
| 7-0 to 7-15 | 0 to 15 of A/D exp. card 7 | 128 to 143 |
| 8-0 to 8-15 | 0 to 15 of A/D exp. card 8 | 144 to 159 |
| 9-0 to 9-15 | 0 to 15 of A/D exp. card 9 | 160 to 175 |
| 10-0 to 10-15 | 0 to 15 of A/D exp. card 10 | 176 to 191 |
| 11-0 to 11-15 | 0 to 15 of A/D exp. card 11 | 192 to 207 |
| 12-0 to 12-15 | 0 to 15 of A/D exp. card 12 | 208 to 223 |
| 13-0 to 13-15 | 0 to 15 of A/D exp. card 13 | 224 to 239 |
| 14-0 to 14-15 | 0 to 15 of A/D exp. card 14 | 240 to 255 |
| 15-0 to 15-15 | 0 to 15 of A/D exp. card 15 | 256 to 271 |
|  | High-speed digital I/O (DaqBook/100/200 and DaqBoard/100A/200A) | 272 |
| [1]Note: DaqView identifies channels for some DBKs (e.g., DBK4) with a 3-part number for local channel, card, and sub-address. [2]Note: In differential mode, only channels 0 to 7 are valid. | | |

The table details how expansion channels are numbered in DaqView and the API.

Besides the base channel selection on JP1, many DBKs must be set the sub-channel (or card) number by a DIP switch labeled SW1. DBKs vary in their channel capacity and identification—refer to the respective DBK section.

Example (see figure): To select channel 15 on a DBK card connected to base channel 1, the sequencer expansion address would be set to 1111, the base address would be set to 0001, JP1 would be set to channel 1. Depending on the DBK, a DIP switch would be set to identify one of multiple cards on a single channel. The corresponding API channel number would be 47.
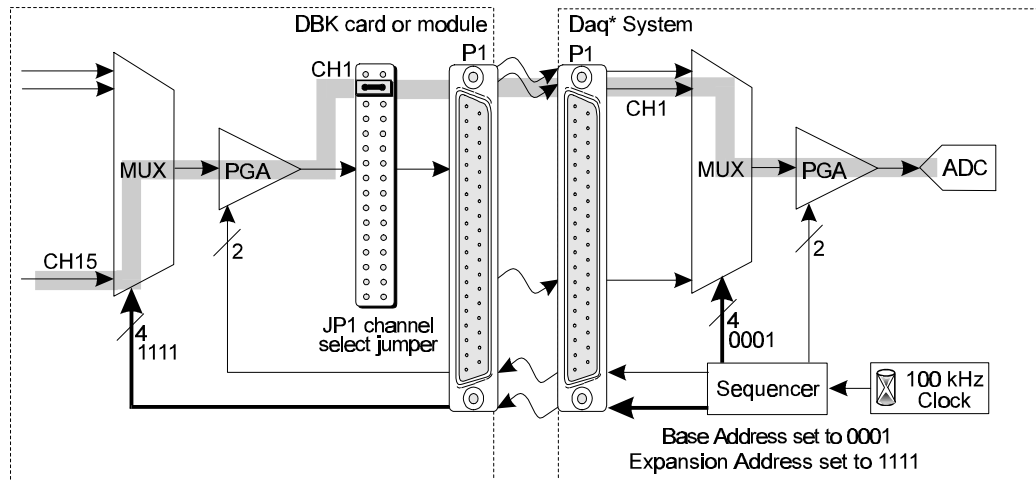


*Example Channel Selection*

# Signal Acquisition

## Daq* Sequencer

The hardware sequencer performs several functions:
- Allows each channel to have an independent gain.
- Ensures that channels are scanned at exactly 10 μs intervals.
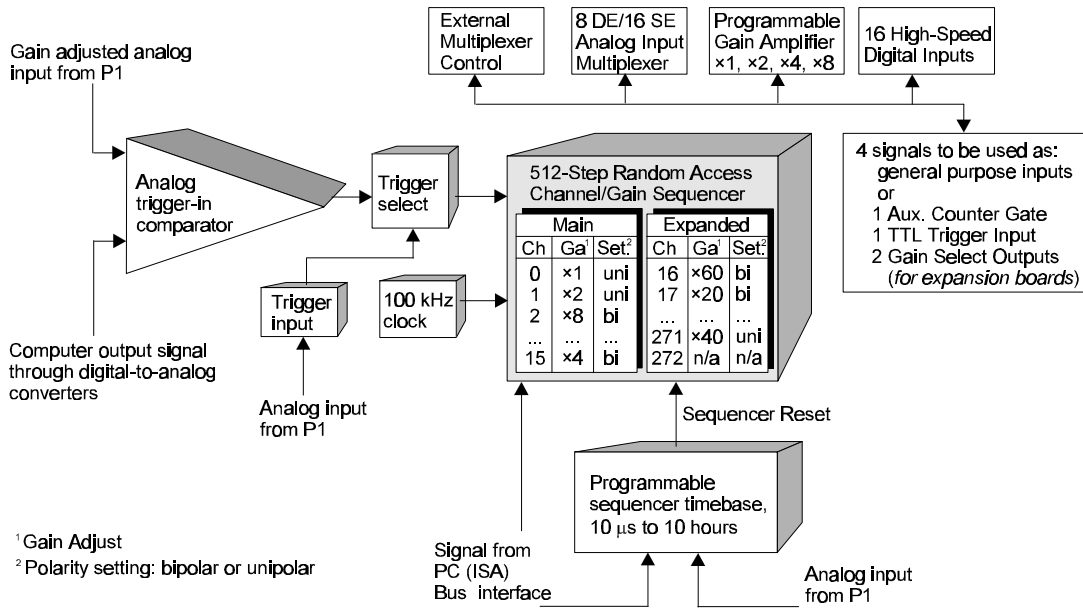- Allows channels to be accessed randomly in the scan rather than "start channel to end channel".
- Provides high-speed access to expansion modules.

Gain adjusted analog input from P1

External Multiplexer Control

8 DE/16 SE Analog Input Multiplexer

Programmable Gain Amplifier ×1, ×2, ×4, ×8

16 High-Speed Digital Inputs

Analog trigger-in comparator

Trigger select

512-Step Random Access Channel/Gain Sequencer

4 signals to be used as:
general purpose inputs
or
1 Aux. Counter Gate
1 TTL Trigger Input
2 Gain Select Outputs
(*for expansion boards*)

Trigger input

100 kHz clock

| Main | | | Expanded | | |
|------|------|------|------|------|------|
| Ch | Ga[1] | Set[2] | Ch | Ga[1] | Set[2] |
| 0 | ×1 | uni | 16 | ×60 | bi |
| 1 | ×2 | uni | 17 | ×20 | bi |
| 2 | ×8 | bi | ... | ... | ... |
| ... | ... | ... | 271 | ×40 | uni |
| 15 | ×4 | bi | 272 | n/a | n/a |

Computer output signal through digital-to-analog converters

Analog input from P1

Sequencer Reset

[1] Gain Adjust
[2] Polarity setting: bipolar or unipolar

Signal from PC (ISA) Bus interface

Programmable sequencer timebase, 10 μs to 10 hours

Analog input from P1

The Daq* holds the scan information in its internal sequencer. On every timebase "tick", the sequencer steps through all the programmed channels and sets the gain for each channel (also the unipolar/bipolar setting for the Daq* 200 series). Thus, each sample in a scan is read optimally. Besides controlling the Daq*, the sequencer also controls the programmable features on expansion cards via the P1 connector. This architecture ensures the same 10 μs sampling of external channels as internal channels.

Scan Group

All channels within scan group are measured at 10 μs/channel.

Time

Scan Period
(Immediate to 10 hours)

10 μs

Time

| Channel | #2 | #4 | #7 | #2 | Digital Input | #18 | #19 | #16 |
|---------|------|------|------|------|------|------|------|------|
| Gain | x1 | x8 | x8 | x2 | | x100 | x10 | x1000 |
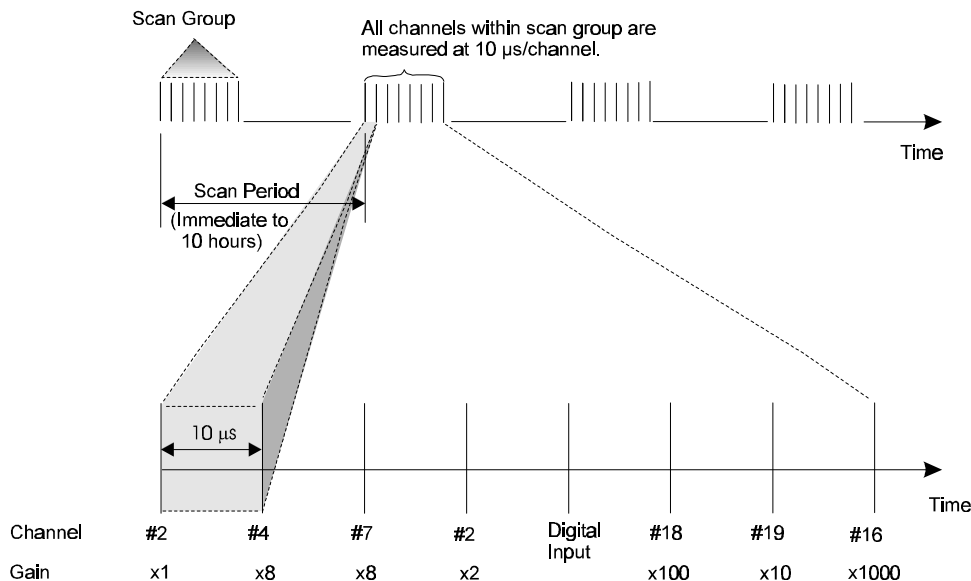
## Scan Rate

Most sampling of analog signals occurs on the timebase of the Daq* clock. The **scan period** is the time duration between successive scans. Inversely, the **scan rate**, or **scan frequency** is the number of scans per time interval, usually expressed in *scans per second*. The channels within the scan are always sampled at a fixed period of 10 μs (100 kHz rate). Generally, the sampling frequency must be greater than twice the highest signal frequency of interest to prevent aliasing error. **Note**: Except in the case of a single-channel scan, the sampling rate per channel can be much slower than the scan rate.

## Triggering

Triggering controls an acquisition cycle. Once the system is armed, a trigger is required to collect the data. Typically, three data collection parameters are specified: the pre-trigger count, the post-trigger scan count, and the trigger source. The user must determine the triggering requirement based on the nature of the measurement and the amount of data needed to satisfy the system's purpose.
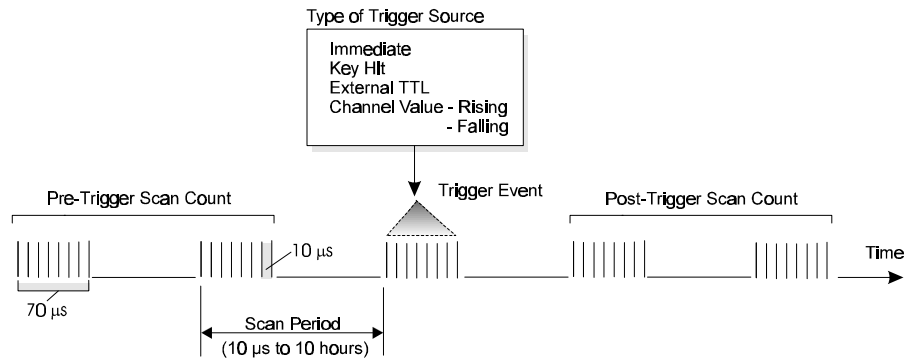


- The **pre-trigger scan count** specifies the number of scans that are to be collected before the trigger point. If the pre-trigger scan count is greater than zero, the system will continuously collect data until the trigger is satisfied. If no pre-trigger scans are required, the system sits idle until the trigger; then, it collects the post-trigger scans before it disarms.
- The **post-trigger scan count** specifies the number of scans to be collected after the trigger point. After the trigger, the post-trigger scans will be collected as programmed and then the system will disarm itself.
- The **trigger source** can be a software command, an external TTL input, etc. An analog input channel on reaching a specified voltage level can be used to trigger the system. (In this mode, an analog output channel is used to internally set the analog threshold—making it unavailable for other use.)

## Counter/Timer Functions

Counter/timer circuits are used for counting digital events, timing digital pulses, and generating square waves and pulses. The DaqBook/100/200 and DaqBoard/100A/200A have counter/timer functions available from the P3 interface. These functions are implemented on the 9513 chip and accessed via DaqView or custom programming. With proper programming the 9513's 5 channels can be independently configured into different operating modes. However, DaqView assigns all channels to the same mode. Refer to the *Programmer s Manual* for an explanation of the **daqCtr*** commands.

Three counter/timer modes are available:
- totaling
- pulse train generation
- frequency measurement

The table shows the P3 pinout for the 5 counter channels. Each channel has 3 lines:

- **IN -** a digital input that increments the counter and provides a timebase for counter operation.
- **GATE -** a digital input that enables or disables the counter/timer.
- **OUT -** an output of digital square waves and pulses.

An oscillator output is separate from the 5 counter channels. Pin 30 of P3 (osc out) can output timer signals at 100 Hz, 1 kHz, 10 kHz, 100 kHz, or 1 MHz.

| Counter/Timer Pins on P3 Connector | | |
|---|---|---|
| Pin | Signal Name | Description |
| 12 | CTR 5 GATE | Counter 5 gate (9513 chip) |
| 13 | CTR 5 IN | Counter 5 input (9513 chip) |
| 14 | CTR 4 GATE | Counter 4 gate (9513 chip) |
| 15 | CTR 4 IN | Counter 4 input (9513 chip) |
| 16 | CTR 3 GATE | Counter 3 gate (9513 chip) |
| 17 | CTR 3 IN | Counter 3 input (9513 chip) |
| 18 | CTR 2 GATE | Counter 2 gate (9513 chip) |
| 19 | CTR 2 IN | Counter 2 input (9513 chip) |
| 30 | OSC. OUT | Oscillator output - fout (9513 chip) |
| 31 | CTR 5 OUT | Counter 5 output (9513 chip) |
| 32 | CTR 4 OUT | Counter 4 output (9513 chip) |
| 33 | CTR 3 OUT | Counter 3 output (9513 chip) |
| 34 | CTR 2 OUT | Counter 2 output (9513 chip) |
| 35 | CTR 1 OUT | Counter 1 output (9513 chip) |
| 36 | CTR 1 IN | Counter 1 input (9513 chip) |
| 37 | CTR 1 GATE | Counter 1 gate (9513 chip) |

## Simultaneous Sample and Hold (SSH)

Some applications require every channel in a scan group to be read *at the same instant,* as opposed to being read with 10 μs between channels. Acquiring multiple readings at the same instant is accomplished with **Simultaneous Sample and Hold (SSH)**.
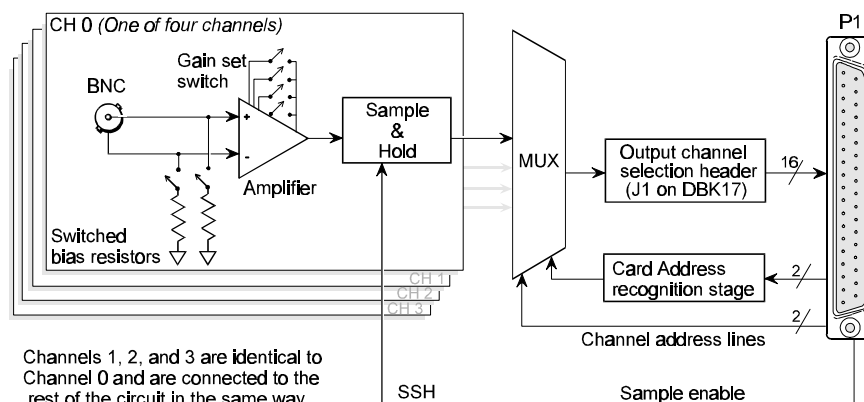


*Simultaneous Sample and Hold Circuit, DBK17 Example*

An example of an SSH application is as follows: a performance analysis of an engine needs to indicate cylinder pressure and temperature, piston strain and position, valve position, and engine rpm and vibration—all at the same instant. Simultaneous Sample and Hold (SSH) is a means of obtaining such instantaneous data on multiple channels while avoiding time-skew problems.

The figure shows how SSH is used in the DBK17 SSH Card. Each input signal continuously passes through an instrumentation amplifier and into a sample-and-hold stage. When the sample enable line goes high, each channel's sample-and-hold stage will "freeze" the current analog value. The values for all channels are separately "latched" within 50 ns of each other. These signals are held in a stable condition while the multiplexer switches through all channels and sends them one-by-one to the Daq*. At the Daq*, the ADC digitizes each reading. The resulting data is a snapshot of conditions at a selected instant even though the multiplexing and analog-to-digital conversion are spread out over a longer interval. The simultaneous sample and hold circuit allows you to gather up to 256 simultaneous samples via sixty-four DBK17s.

## Input Isolation

Three benefits of input isolation are circuit protection, noise reduction, and the rejection of high common mode voltage.

- **Circuit protection**. Input isolation separates the signal source from circuits that may be damaged by the signal. (Voltages higher than about 10 V can distort data or damage chips used in data acquisition.) High-voltage signals or signals with high-voltage spikes should therefore be isolated. The protection can also work the other way—to safeguard a sensitive signal conditioner from a failing device elsewhere in the system.
- **Noise reduction**. Isolation eliminates ground loops for high-gain systems and multi-unit systems that are grounded together. The chassis for each device can rest at a ground potential slightly different from the other devices. These irrelevant currents and the spikes they may have picked up by induction can thus be kept out of the measurement circuit.
- **Rejection of high common mode voltage**. There is a limit to the amount of voltage a differential amplifier can have applied between ground and the amplifier inputs. Fortunately, the differential amplifier rejects high common mode voltage signals. High common mode voltage and noise spikes are rejected (canceled out) in *in-phase* signals identical in amplitude and frequency that are present in both the high and low inputs at the same time.
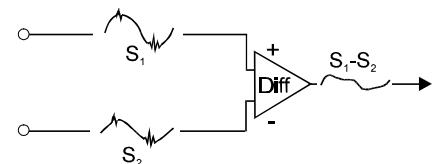
# *Signal Modes*

Daq* units operate in one of two modes, (1) single-ended mode, or (2) differential mode. These terms (*single-ended mode* and *differential mode*) apply to their use in this manual. In other sources these terms may be used in a different manner.

Daq* units can accommodate 8 *differential-mode* or 16 *single-ended mode* analog input signals. Expansion modules and the Daq* default setting use the 16 single-ended mode. Some DBKs use differential inputs for certain kinds of transducers; but DBK output to a Daq* is always single-ended. **Note:** For DaqBook/100, /112, /120, jumper settings determine the signal mode. Single-ended is the factory-set default. For DaqBoard and Daq PC-Card, choosing between differential and single-ended inputs is made by software command. The following text briefly describes the two signal modes.

***Single-ended mode*** refers to a mode, or circuit set-up, in which a voltage is measured between 1 signal line and common ground voltage (Vcm). The measured voltage may be shared with other channels. The advantage of a single-ended *non-differential* mode [over differential mode] is that it provides for a higher channel count (16 vs 8 channels).

***Differential-mode*** refers to a mode, or circuit set-up, in which a voltage is measured between 2 signal lines. The measured differential voltage which results, is used for a single channel. An advantage of using differential inputs is that they reduce signal errors and the induction of noise resulting from ground current. The following illustration is an example of how noise is reduced, or canceled-out, when using the differential mode.

In the schematic, voltage signal $S_2$ is subtracted from signal $S_1$, resulting in the output signal shown. The nature of noise spikes (having *the same polarity, phase, and magnitude in each input signal)* cancel out resulting in a clean differential signal ($S_1$ - $S_2$).



*Noise Reduction in Differential Mode*

In the schematic, signals $S_1$ and $S_2$ are shown in-phase; however, even if these signals were out of phase, the noise in each (indicated by jagged lines) would still have the same magnitude, phase, and polarity. For that reason, they would still cancel out.
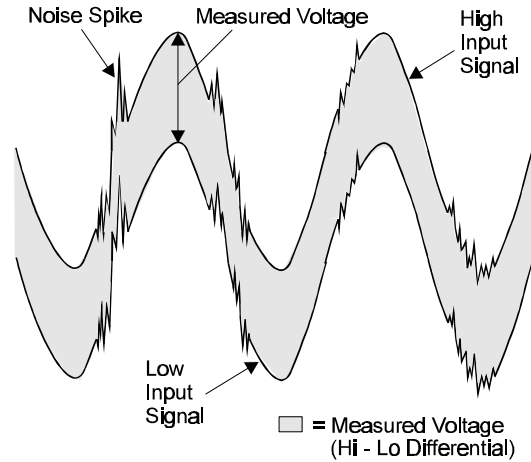
# References for Differential Modes

There are three basic types of measurement configuration related to differential mode, these are: ground-referenced, shunt-referenced, and floating.

## *Differential Mode, Ground-Referenced*

In ground-referenced configurations the signal, voltage is referenced to a local common ground. In most cases, the local ground will be at a potential different from the PC's ground.

Differential inputs provide attenuation of the common-mode noise. When in this mode, the amplifier sees the voltage differential between the high and low inputs (see figure). Common-mode noise reduction occurs since the noise in the high input signal is typically the same as the noise in the low input signal. Because of this phenomena, the voltage difference between the 2 signals remains essentially unaffected by noise spikes, since these spikes appear at the same instant and at the same magnitude in both the high and low input signals. In other words, the noise spikes cancel each other out.



*Common-Mode Voltage: Noise Cancellation with Differential Measurement*

As noted earlier, even if these signals were out-of-phase, the noise would still cancel out since the spikes in both signals would still be of the same magnitude and polarity. **Note**: In the simple example shown in the figure, the differential between the high and low signals would result in a straight line because the signals are equal in frequency, phase, and magnitude.

## *Differential Mode, Shunt-Referenced*

There are situations in which several voltages need to be measured but cannot share the same ground. As shown in the figure, an attempt to obtain the low path reference signal from the analog common line would result in errors. These errors would result from variations in current flows along the common line.
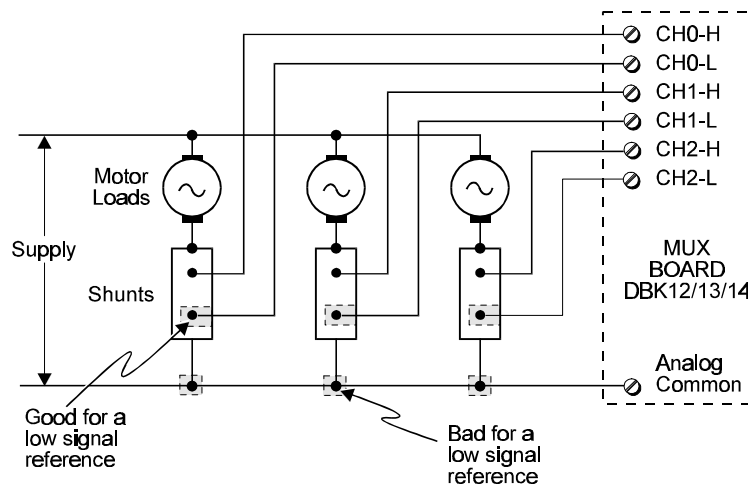


*Differential Circuit with Shunt-reference*

A way around this problem (*no available common ground)* is to measure the signal currents via shunts which share a common supply terminal. In the shunt-reference scenario, the low-path reference is effectively shifted from the analog common to the shunt. The low signal from the shunts then serves as a common reference for each of the channels.

### *Differential Mode, Floating (Isolated from Ground)*

Floating-differential measurements are made when low-level signals must be measured in the presence of high levels of common-mode noise (e.g., a non-grounded thermocouple).  When the signal source has no direct connection to the system analog common, one must be provided.  This can be done by connecting a resistor between one of the two signal lines (usually the lower in potential) and common.  A resistor of 10 to 100 KΩ is satisfactory (less noise with the lower values).

**Caution**: Differential signal hookups do not provide isolation or any kind of circuit protection.  Other ways to protect circuits from high-voltage spikes must be used.
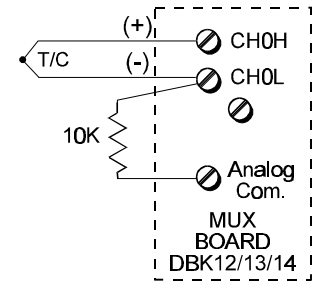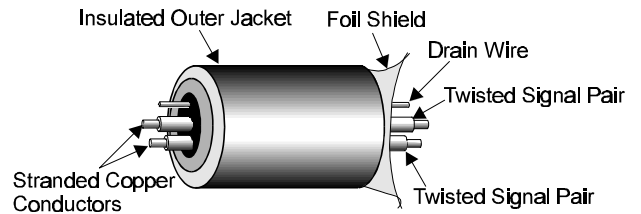
*Floating Differential Circuit*

### *Connecting Differential Amplifiers*

Wire connections must be solid; loose wires will add noise to the circuit.  Low grade cables will act as antennas, inducing more noise into the system.  For this reason, all applications using a differential amplifier require the use of quality signal cables and connectors.  The signal cable used should have the following in its construction:

- Insulated outer jacket
- Twisted signal pairs
- foil shield
- drain wire (copper stranded)

The twisted signal pairs should make use of low impedance, stranded copper conductors; and the foil shield should be of the type using multiple folds.

*Shielded Signal Cable*

The copper-stranded drain wire should be considered as part of the shield, and should be connected as described later in this section.  Proper use of a quality signal cable will result in a dramatic reduction of noise.

The signal circuit must be connected with only one ground from the shield, as indicated in the left side of the figure below.  A mistake, which is often made, is having two grounds (one at each end of the signal shield).  Having two grounds, as shown in the right side of the figure, creates a "ground loop." The ground loop provides a path for current to circulate, causing the induction of noise that can affect the signal.
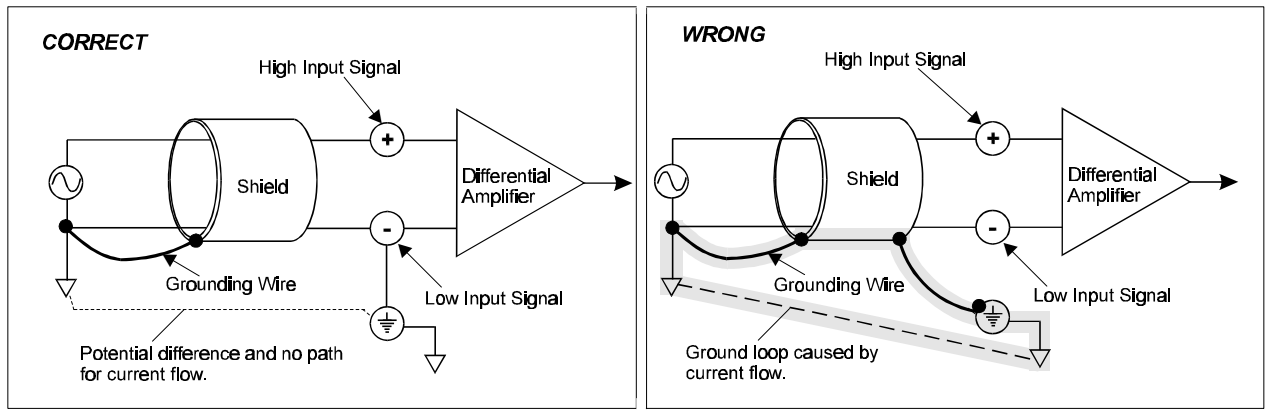
*No Noise-Inducing Ground Loop*                                        *Noise-Inducing Ground Loop*

Aside from eliminating noise-inducing ground loops, the use of bias resistors should also be considered with isolated signal sources. Bias resistors can be used to provide bias current for the positive and negative (high and low) input signals to the differential amplifier. The impedance value of the bias resistors depends on the output impedance of the signal source.

Locate bias resistors ($R_1$ and $R_2$) as close as possible to the differential amplifier.
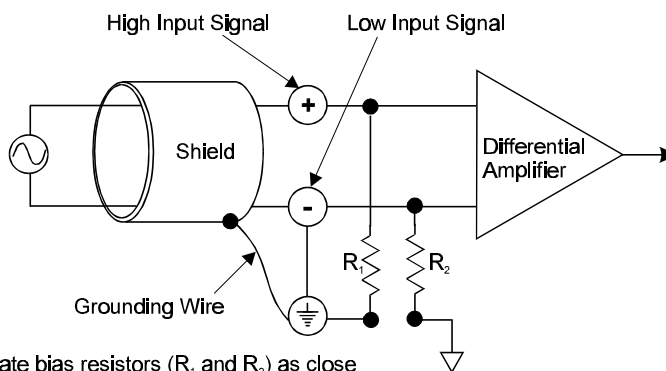
A basic rule of thumb is: *The value of the bias resistor should be at least 10 times the output impedance of the signal source, but less than 1 M$\Omega$.* Bias resistors should be located as close as possible to the differential amplifier. Ground only one end of the signal shield.

## Unipolar and Bipolar Measurement

Unipolar signals are always zero or positive. Bipolar signals can be negative or positive and typically range from -5 to +5 V. Using one or the other depends on the signal from the transducer and its signal conditioning. If the DBK (or other signal conditioner) outputs a bipolar signal, then the Daq* should be set to bipolar. If the Daq* sequencer is using the wrong mode for a channel, that channel's reading may be clipped or in error. Reading a bipolar signal in unipolar mode misses half the signal, and the half received is not converted with optimal resolution. **Note**: The different DBKs can use either or both signal modes. Refer to the DBK documentation, and verify both the DBK and the Daq* are set to the proper mode for each channel.

## 12-Bit vs 16-Bit Resolution

An analog-to-digital converter (ADC) converts an analog voltage to a digital number. The digital number represents the input voltage in discrete steps with finite resolution. ADC resolution is determined by the number of bits that represent the digital number. An *n*-bit ADC has a resolution of 1 part in $2^n$.

- 12-bit resolution is 1 part in 4096 ($2^{12}$) and corresponds to 2.44 mV for a 10 V range.
- 16-bit resolution is 1 part in 65,536 ($2^{16}$) and corresponds to 0.153 mV in a 10 V range.

# *Signal Problems*

## System Noise

Electrical noise can present problems even with good equipment; thus, controlling noise is imperative. Some techniques avoid or prevent noise sources from entering the system; other techniques remove noise from the signal.

Laboratory and industrial environments often have multiple sources of electrical noise. An AC power line is a source of 50/60 Hz noise. Heavy equipment (air conditioners, elevators, pumps, etc.) can be a source of noise, particularly when turned on and off. Local radio stations are a source of high-frequency noise, and computers and other electronic equipment can create noise in a multitude of frequency ranges. Thus, an absolute noise-free environment for data acquisition is not realistic. Fortunately, noise-reduction techniques such as averaging, filtering, differential voltage measurement, and shielding are available to reduce noise to an acceptable level. **Note:** Additional noise-reduction information is contained in the section, "Signal Modes," especially in the paragraphs pertaining to connections, signal cables, and ground loops.

## *Averaging*

Averaging is done in software after several samples have been collected. Depending on the nature of the noise, averaging can reduce noise by the square root of the number of averaged samples. Although averaging can be effective, it suffers from several drawbacks. Noise in measurements only decreases as the square root of the number of measurements—reducing RMS noise significantly may require many samples. Thus, averaging is suited to low-speed applications that can provide many samples. **Note**: averaging eliminates only random noise but not other system noise (as may occur with the same delay after the triggering event and look like a signal).

## *Analog Filtering*

A filter is an analog circuit element that attenuates an incoming signal according to its frequency. A low-pass filter attenuates frequencies above the cutoff frequency. Conversely, a high-pass filter attenuates frequencies below the cutoff. As frequency increases beyond the cutoff point, the attenuation of a single-pole, low-pass filter increases slowly. Multi-pole filters provide greater attenuation beyond the cutoff frequency but may introduce phasing problems that could affect some applications.

Filter circuits can be active or passive:

- **Active.** The DBK18 Low-Pass Filter Card has an instrumentation amplifier with variable gain and filter configurations. The DBK18 uses an active 3-pole filter (mostly contained within the UAFF42 ICs) that can be configured as a Butterworth, Bessel, or Chebyshev filter with corner frequencies up to 50 kHz. Filter properties depend on the values of resistors and capacitors that can be changed by the user.
- **Passive.** The DBK11 has a prototype area on the PC board for attaching non-powered components such as resistors and capacitors. The user chooses component values to produce the desired properties.

## *Input and Source Impedance*

As illustrated in the figure to the right, the input impedance ($R_i$) of an analog-to-digital converter combines with the transducer's source impedance ($R_s$) forming a voltage divider. This divider distorts the voltage being read at the analog-to-digital converter. The actual voltage read is represented by the equation:



$$\mathbf{V_{ADC} = V_T \times R_i / (R_s + R_i)}$$

The input impedance ($R_i$) of most ADCs is at least 1 MΩ; low source impedance ($R_s$) usually presents no problem. Some transducers, such as piezoelectric types, have high source impedance, and should therefore be used with a charge-sensitive amplifier of low output impedance. As described in the following paragraphs, multiplexing can greatly reduce the effective input impedance of an analog-to-digital converter.

**Crosstalk.** Crosstalk is a type of noise related to source impedance and capacitance, in which signals from one channel leak into an adjacent channel, resulting in interference or signal distortion. The impact of source impedance and stray capacitance can be estimated by using the following equation.

$$\mathbf{T = RC}$$

Where **T** is the time constant, **R** is the source impedance, and **C** is the stray capacitance.
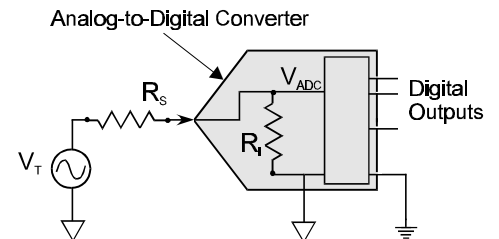
**Daq\* Channel Crosstalk.** High source (transducer) impedance can be a problem in multiplexed A/D systems like the Daq\*. When using the Daq\* with more than 1 channel, the channel input signals are multiplexed into the A/D. The multiplexer samples each signal for only 10 µs and then switches to the next input signal. A high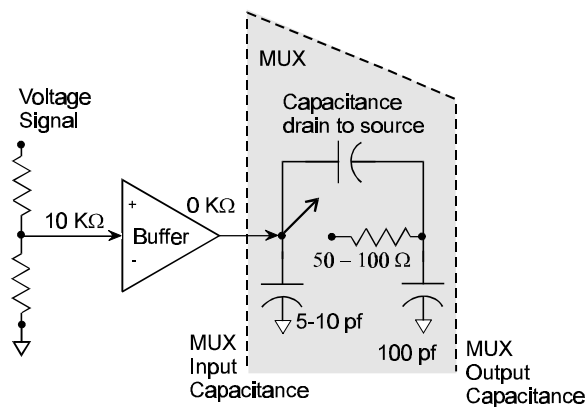-impedance input interacts with the multiplexer's stray capacitance and causes crosstalk and inaccuracies in the A/D sample. For Daq\* systems, the source impedance should be less than 1 kΩ. If the source impedance (in such a multiplexer) exceeds this value, sampling problems can be expected.



A solution to high source impedance in relation to multiplexers involves the use of buffers. The term buffer has several meanings; but in this case, *buffer* refers to an operational amplifier having high input impedance but very low output impedance. In the example illustrated, a buffer has reduced the source impedance from 10 kΩ to effectively 0 kΩ. Placing such a buffer on each channel (between the transducer and the multiplexer) prevents the multiplexer's stray capacitance from combining with the high input impedance (10 kΩ in the example). This use of a buffer also stops transient signals from propagating backwards from the multiplexer to the transducer.

# *Troubleshooting*

Users can solve some Daq\* problems on their own without factory assistance. Before calling for help, you should go through the troubleshooting checklist below. **Programmers Note**: a list of API error codes appears in the *Programmer s Manual*.

## Electrostatic Discharge (ESD)

The discharge of static electricity can damage some electronic components. Semiconductor devices are especially susceptible to ESD damage. You should always handle components carefully, and you should never touch connector pins or circuit components unless you are following ESD guidelines in an appropriate ESD controlled area. Such guidelines include the use of properly grounded mats and wrist straps, ESD bags and cartons, and related procedures.

## Troubleshooting Checklist

For most problems, proceed through the following checklist. When applicable, be sure to follow ESD prevention guidelines to avoid damaging components.

1. <u>Power</u>. Check power and fuses to all affected units. Sometimes cycling the power off and then back on may allow system parameters to reset themselves correctly.
2. <u>Signal</u>. Check signal lines and connectors. Connectors must be free of corrosion; lines should be undamaged free of sharp bends and twists. Signal paths should avoid potential sources of noise (high voltage and electromagnetic interference).
3. <u>DaqTest (DaqBook Only)</u>. Run the DaqTest.exe program to confirm that the Daq\* is properly connected to the PC—refer to the last section in chapter 2, *DaqBook Hardware and Installation*.
4. <u>Software</u>. Try to acquire data with the DaqView windows application. If you are unable to acquire data in both DaqView and another program, a hardware problem is likely. If you can make readings in DaqView by enabling the input reading column, but you cannot log data to disk with DaqView, an interrupt problem is likely.
5. <u>Interrupt</u>. Make sure the interrupt selected matches the interrupt used by the parallel port (for DaqBooks) or the interrupt selected by the hardware switches on the DaqBoard. The program MSD.EXE (comes with DOS 6.0 and later) reports the interrupt usage of the computer. In some cases, an interrupt conflict may arise due to a Windows printer driver stealing the interrupt. (Some Hewlett-Packard and LexMark printer drivers are known to do this.) For such a problem,

you must edit the SYSTEM.INI file and remove lines loading the printer drivers. In other cases, the hardware is incapable of accepting interrupts through the parallel port.

6. <u>Parallel port</u>. Make sure the parallel port selected is the same as the port to which the DaqBook is connected. Also, make sure the correct protocol is selected. (DaqTest.exe will verify this.)

7. <u>DaqBoard bus address</u>. Check that the bus address specified software matches the bus address setting on the DaqBoard and that there are not other devices in the computer using the same address.

8. <u>Software setup</u>. Make sure the device selected in software matches the hardware being used. Verify that setup parameters are correct for your application and attached DBK cards and modules.

9. <u>Power management</u>. The POWER.EXE power management program that is used by some notebook computers is known to affect proper operation of the parallel and PCMCIA ports. If you are having such trouble, remove the line loading this program from your AUTOEXEC.BAT file.

10. <u>Device drivers</u>. Some computers are pre-configured for numerous device drivers in their AUTOEXEC.BAT and CONFIG.SYS files. These drivers often conflict and can be a source of trouble. It is helpful for diagnostic purposes to boot the machine and test the system with the minimum number of device drivers loaded.

## Radio Frequency Interference

Daq* hardware complies with the limits for a Class B digital device according to FCC rules and CE specifications. These limits provide reasonable protection against harmful interference in a residential environment. If not installed or used correctly, this equipment can radiate radio frequency energy and interfere with radio communications. You can determine if the interference is caused by the Daq* system by turning power to the Daq* off and on and observing the effect on the interference. You can often correct radio interference by one or more of the following measures:

- **Antenna Adjustment:** Reorient or relocate the receiving antenna.
- **Spatial Separation:** Increase the separation between the Daq* equipment and the receiver.
- **Circuit Separation:** Connect the Daq* and receiver equipment to different circuits.

Otherwise, consult an experienced radio/television technician for help. The following booklet prepared by the FCC may also be helpful: *How to Identify and Resolve Radio-TV Interference Problems*. This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock Number 004-000-00345-4.

## Customer Assistance

To report problems and receive support, call the manufacturer's Applications department (phone numbers and address at the beginning of this manual). When you call, please have the following information available:

- Hardware model numbers
- Contents of your CONFIG.SYS, AUTOEXEC.BAT, and SYSTEM.INI files
- Software version numbers (including DOS and Windows)
- Type of computer and features
- Results of DaqTest (DaqBook only) or other performance tests.

All equipment returned to the factory must be accompanied by an RMA# (Return Merchandise Authorization number). Use original shipping containers or equivalent to prevent shipping damage. Include the information above plus:

- Contact person who can discuss the problems encountered
- Return shipping instructions
- Troubleshooting notes and comments on tests performed and all problem-related conditions.

**Note**: Before calling for assistance, take a few minutes to read all parts of the manual that may be relevant to the problem conditions. Also, work through the *Troubleshooting Checklist* in the previous section. If programming your own software, you may need to refer to the software error codes in the *Programmer s Manual*.

*Notes*

# Specifications

## ADCs (DaqBook, DaqBoard, Daq PC-Card)

### General

**Size**:

**DaqBook**: 8½"  11" × 1.375";  Weight: 5 lb.

**DaqBoard**: 4½" × 13.125"

**Daq PC-Card**: PCMCIA Standard Specification 2.1, PCMCIA Type II (5mm) Compatible

**DBK Card**: 8¼" long × 3¼" wide × ¾" high

**Power Consumption**:

**DaqBook/100/120**: 510 mA @ 12 VDC

**DaqBook /112**: 360 mA @ 12 VDC

**DaqBook /200**: 620 mA @ 12 VDC

**DaqBoard/100A**: 1.33A @ 5 VDC

**DaqBoard/112A**: 970 mA @ 5 VDC

**DaqBoard/200A**: 1.7 A @ 5 VDC

**DaqBoard/216A**: 1.34 A @ 5 VDC

**Daq PC-Card/112B**: 510 mA @ 5 VDC

**Operating Temperature**: 0º to 50ºC

**Storage Temperature**: 0º to 70ºC

**Humidity**: 0 to 95% RH, non-condensing

### Analog Inputs

12-bit DaqBook/100/112/120; 12-bit DaqBoard/100A/112A; 12-bit Daq PC-Card/112B

**Channels**: 16 single-ended, 8 differential, expandable up to 256 differential; single-ended/differential operation is switch selectable

**Connector**: DB37 male, P1

**Resolution**: 12 bits

**Ranges**: Unipolar/Bipolar operation is switch  selectable (DaqBook/100,112 & 120) and sequencer selectable on a per-channel basis (DaqBook/200,216 & DaqBoard). Daq112B is Bipolar only.

**Unipolar**: (DaqBook & DaqBoard)

0 to +10 V, 0 to +5 V

0 to +2.5 V, 0 to +1.25 V

**Bipolar**: (DaqBook & DaqBoard)

0 to +10 V, 0 to +5 V

0 to +2.5 V, 0 to +1.25 V

**Bipolar**: (Daq PC-Card)

-10 to +10 V, -5 to +5 V

-2.5 to +2.5 V, -1.25 to +1.25 V

**Maximum Overvoltage**: 30 VDC (DaqBook and DaqBoard); ±15 VDC(Daq only)

**Input Current**:

**Differential**: 150 pA typ, 0.2 $\lambda$A max

**Single-ended**: 250 pA typ, 0.4 $\lambda$A max

**Input Impedance**: >100 M$\Omega$ in parallel with 150 pF (typical)

**Gain Temperature Coefficient**: 3 ppm/ºC typ

**Zero Temperature Coefficient**: 12 $\lambda$V/ºC max

16-bit DaqBook/200/216; 16-bit DaqBoard/200A/216A

**Channels**: 16 single-ended, 8 differential, expandable up to 256 differential; single-ended/differential operation is software programmable

**Connector**: DB37 male, P1

**Resolution**: 16 bits

**Ranges**: Unipolar/Bipolar operation is software programmable on a per-channel basis

**Unipolar**:

0 to +10 V, 0 to +5 V

0 to +2.5 V, 0 to +1.25 V

**Bipolar**:

0 to +10 V, 0 to +5 V

0 to +2.5 V, 0 to +1.25 V

**Maximum Overvoltage**: 30 VDC

**Input Current**:

**Differential**: 150 pA typ, 0.2 $\lambda$A max

**Single-ended**: 250 pA typ, 0.4 $\lambda$A max

**Input Impedance**: >100MOhm in parallel with 150 pF (typical)

**Gain Temperature Coefficient**: 3 ppm/ºC typ

**Zero Temperature Coefficient**: 12 $\lambda$V/ºC max

### Triggering

DaqBook/100/120/200; DaqBoard/100A/112A/200A/216A; Daq/112B

**Analog Trigger**: (Not Applicable for Daq)

**Programmable Level Range**: 0 to ±5 V

**Trigger to A/D Latency**: 10 $\lambda$s max

**Digital Trigger**:

**Logic Level Range**: 0.8 V low/2.2 V high

**Trigger to A/D Latency**: 10 $\lambda$s max (Daq PC-Card,1 $\lambda$s max )

**Software Trigger**:

**Trigger to A/D Latency**: Dependent on PC speed

**Pre-Trigger**: Up to 65,536 scans

## Analog Channel Scanning

DaqBook/200/216; DaqBoard/100A/112A/200A/216A; Daq/112B

Randomly programmable for channel and gain, as well as for unipolar/bipolar (where applicable) ranges

**Depth**: 512 location

**Channel to Channel Rate**: 10 λs/channel, fixed

**Maximum Rep Rate**: 100 kHz

**Minimum Rep Rate**: 12 hours

**Expansion Channel Sample Rate**: Same as on-board channels, 10 λs/channel

## A/D Specifications

**Type:** Successive approximation

**Resolution:**

**DaqBook/100/112/120:** 12 bit

**DaqBoard/100A/112A:** 12 bit

**DaqBook/200/216:** 16 bit

**DaqBoard/200A/216A:** 16 bit

**Daq PC-Card/112B:** 12 bit

**Conversion Time:** 8 λs

**Monotinicity:** No missing codes

**Linearity:** ✎1 bit

**Zero Drift:** ✎10 ppm/ºC max / ✎2 ppm/ºC (Daq PC-Card/112B)

**Gain Drift:** ✎30 ppm/ºC max / ✎7 ppm/ºC (Daq/112B)

**Sample and Hold Amplifier:**

**Acquisition Time**: 2 λs

**Aperture Uncertainty**: 100 ps; (none for Daq PC-Card)

## Analog Output

DaqBook/100/120/200; DaqBoard/100A/112A/200A/216A

**Channels**: 2

**Connector**: DB37 male, P1

**Resolution**: 12-bits

**FIFO Depth**: 4 Kword (DaqBoard Only)

**Voltage Ranges**: 0 to 5 VDC with built-in reference; 0 to ✎10 with external reference

**Maximum Output Current**: 10 mA

**Maximum Analog Bandwidth**: 500 kHz (DaqBoard only)

**Update Rate**: Up to 1M samples/s (DaqBoard only)

## General Purpose Digital I/O

DaqBook/100, /120, /200 | DaqBoard/100A, /200A | Daq/112B

**Channels**:

4 Digital I/O channels (Daq/112B only)

24 I/O channels, expandable up to 192 (N/A for Daq)

**Connector**:

DB37 male, P2 (DaqBoard has on-board 40-pin DIN externally accessible via DB37 when optional CA-60 is ordered)

DB37 female for Daq/112B (gender changer CN-86 available)

**Device**: 82C55

**Output Voltage Levels**:

Minimum "1" Voltage: 2.0 @ 2.5mA sourcing

Maximum "0" Voltage: 0.4 @ 2.5 mA sinking

**Output Current**:

Maximum Source Current: 2.5 mA

Maximum Sink Current: -2.5 mA

**Input Voltage Levels**:

Minimum Required "1" Voltage Level: 2.0 V

Maximum Allowed "0" Voltage Level: 0.8 V

**Output Float Leakage Current**: 10 λA

## High-Speed Digital Inputs

DaqBook/100, /120, /200 | DaqBoard/100A, /112A, /200A, /216A

**Channels**: 16 input lines

**Connector**: DB37 male, P3 (DaqBoard has on-board 40-pin DIN externally accessible via DB37 when optional CA-60 is ordered)

**Maximum Sampling Rate**: 100 kHz

**Input Low Voltage**: 0.8 V max

**Input High Voltage**: 2.0 V min

**Input Low Current**: 10 nA

**Input High Current**: -10 µA

## High-Speed Digital Inputs

**Power Source Isolation Voltage to System**:

DaqBook/100/112/120/CE:  0 VDC

DaqBook/216/200/CE:  ±40 VDC

## Counter/Timer

DaqBook/100, /120, /200 | DaqBoard/100A, /112A, /200A, /216A

**Counter/timer channels**: 5

**Connector**: DB37 male, P3 (DaqBoard has on-board 40-pin DIN externally accessible via DB37 when optional CA-60 is ordered)

**Frequency/Pulse Counting Mode**: Up or down, binary or BCD

**Maximum Pulse Count**: 80-bit binary (5 channels cascaded)

**Maximum Input Rate**: 7 MHz

**Minimum High Pulse Width**: 70 ns

**Minimum Low Pulse Width**: 70 ns

**On-board Time Base**: 1 MHz

**Input Low Voltage**: 0.8 V max

**Input High Voltage**: 2.2 V min

**Input Low Current**: 10 $\lambda$A max

**Input High Current**: -10 $\lambda$A max

**Frequency/Pulse Generating Mode Maximum Output Frequency**: 1 MHz

**Duty Cycle**: Variable between limits of approximately 0.0015% & 99.99%

**Output High Voltage**: 2.4V min @ -200 $\lambda$A

**Output Low Voltage**: 0.4V max @ 3.2 mA

# *DBK Option Cards and Modules*

## CDK10 - Specifications

**Name/Function:** Expansion/Power/Battery Module

**Size:** 11" long × 8½" wide × 1 3/8" high

**Output Voltages/Current:**

+15 VDC (nominal - de-rate by 42% of the +5 V current usage) @ 160 mA max

-15 VDC (nominal) @ 150 mA max

+5 VDC (nominal) @ 150 mA max

**Maximum Output Power:** 5 W max

**Input Voltage Range:** 12 to 20 VDC

**Input Current Draw:** 1.2 A max

**Efficiency:** 70% typical

**Parallel Provision:** OR-ing diodes in output lines

**Battery Type:** Nickel Cadmium

**Run Time with 2 DBK cards:** 5 to 7 hours typical

**Charge Circuit:** Internal

**Charge Time:** 2 to 4 hours

**Input Connections:** DIN5

**Output Connections:** DB37 Male

**Controls:** ON/OFF Rocker-arm switch

**Indicators:** LEDs for input power, P1 output power, and battery charging

**Operating Temperature Range:** 0 to 50°C

**Input Fuse Size:** 2 A (Littlefuse 251002)

## DBK1 - Specifications

**Name/Function: 16-Connector BNC Adapter Module**

**Connectors**:

DB37 male, mates with Daq* P1

BNC connectors for signal input

**Analog Input Connection**: 1 BNC connector for each of 16 analog input channels

**Dimensions**: 221 mm wide × 285 mm long × 25 mm high (8.5" × 11" × 1.375")

**Weight**: 1.3 kg (3 lb)

## DBK2 - Specifications

**Name/Function: 4-Channel Voltage Output Card**

**Connectors**: DB37 male, mates with P1 screw terminals for signal output

**Resolution**: 14-bits (monotonic)

**Output Ranges**: ±5 V or ±10 V (jumper selectable per channel)

**Accuracy**: 0.05% of FS

**Linearity**: 0.02% of FS

**Hysteresis**: 0.01% of FS

## DBK4 - Specifications

**Name/Function: 2-Channel Dynamic Signal Input Card**

**Channels**: 2

**Signal Connection**:  1 BNC connector per channel

**Dimensions**:  8.28" W  × 3.25" H

**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 (B/w = 100 kHz)

**Input Impedance**: 150 kΩ

**Gain**:

    **Bypass Mode**:×1.583    ×15.83    ×158.3

    **Filter Mode**:         ×1      ×10      ×100

**Input Ranges (FS)**:±5 V       ±500 mV   ±50 mV

**Coupling**: AC, DC

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

        1-pole, 0.1 Hz HPF

**Input Signal/Noise**: >96 dB (B/w = 100 kHz)

**Filter(Typical)**:

    **Distortion**

    **Bypass Mode**: @ 1 kHz: -83 dB;  @ 10 kHz: -80 dB

    **Filter Mode**: @ 1 kHz: -75 dB;  @ 10 kHz: -72 dB

    **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: ±6°

    **Accuracy Passband Center**: ± 0.5 dB

## DBK5 - Specifications

**Name/Function**: **4-Channel 4-20 mA Current Output Card**

**Connectors**: DB37 male, mates with P1.  Screw terminals for signal output.

**Accuracy/Linearity**:  0.1% FS

**Resolution**: 4 µA / LSB, monotonic

**Hysteresis**:  0.02% FS

**Regulation**:  0.05% FS

**Compliance**:  $R_{LOOP} = (V_{SUPPLY} - 6) / 0.020$ max

**Isolation**: 500 V

## DBK7 - Specifications

**Name/Function: 4-Channel Frequency-to-Voltage Input Card**

**Input Channels per Card**: 4

**Maximum Cards per System**: 64

**Maximum Channels per System**: 256

**Input Connector**: 1 BNC connector per channel

**Daq\* Connector**: DB37 male, mates with P1

**Frequency Ranges**: (programmable) 0 Hz to 960 kHz

**Analog Input**

    **Low-level**: 50 mV typical (100 mV max) p-p sine wave  @ 10 Hz to 100 kHz.  Any edge of 50 (100 max) mV amplitude and 5 V/s rate.  Input impedance: AC-coupled (0.33 µF), in series w/ 20 KΩ to ground.  15 mV hysteresis.

    **High-level**: 0.75 V typical (1.25 V max) p-p sine wave @ 10 Hz to 100 kHz.  Any edge of 0.75 V (1.25 V max) amplitude and 50 V/s rate.  Input impedance: AC-coupled (0.33 µF), in series w/ 20 KΩ to ground.  250 mV hysteresis.

**Maximum Input Voltage**: 30 Vrms (84 Vp-p)

**Low Pass Filters**: (hardware selectable) 30 Hz, 300 Hz, 100 kHz

**Digital Input**

    **TTL-Level**: 0.001 to 960 kHz.

    **Input Impedance**:  27 KΩ pull-up to +5 V || 50 pF

    **V Low ( 0 )**: 0.8 V typ, 0.5 V min

    **V High ( 1 )**: 1.6 V typ, 2.1 V max

    **Hysteresis**:  400 mV min

    **Pulse Width (high or low)**: 520 nsec min.

    **Maximum Input Voltage**: -15 V to +15 V.

**Output Voltage Range**: -5 V to +5 V

**Debounce Delays**: (software selectable) 0, 0.6, 2.5, 10 ms

**Measurement Rate**: up to 500 per second per channel, 1000 per second total

**Accuracy**: 0.1%

## DBK8 - Specifications

**Name/Function: 8-Channel High-Voltage Input Card**

**Connector**: DB37 male, mates with P1 pinouts on the DaqBoard, DaqBook, or Daq; screw terminals for signal inputs.

**Voltage Input Ranges**: ±10VDC, ±50 VDC, ±100 VDC; selection by jumper for each channel.

**Input Impedance**: 10 MΩ

**Attenuation**:

    @ 10 V, Vout=Vin/2

    @ 50 V, Vout=Vin/10

    @ 100 V, Vout=Vin/50

**Output Voltage Range**: ±5 VDC

**Bandwidth**: 15 kHz

**Attenuation Accuracy**:  0.5%

**Offset Voltage**: Typ: 0.5 mV;  Max: 2.0 mV

**Offset Drift Typ**: 4 µV/ºC;  Max: 10 µV/ºC

## DBK9 - Specifications

**Name/Function: 8-Channel RTD Measurement Card**
**Connector**: DB37 male, mates with P1; screw terminals for signal connections
**Configurations**: 3-wire or 4-wire
**Alpha**: 0.00385
**Inputs**: 8 channels
**Temperature Ranges**: 100, 500, or 1000 $\Omega$: -200 to +850°C

**RTD Excitation Current**:
    500 µA @ 100 $\Omega$
    227 µA @ 500 $\Omega$
    160 µA @ 1000 $\Omega$
**Accuracy**: ±0.5°C
**Resolution**: 0.3°C
**Range and RTD Type Adjustments**: Jumpers on circuit board

## DBK10 - Specifications

**Name/Function: 3-Slot Expansion Chassis**
**Size:** 11" long × 8½" wide × 1-3/8" high
**Weight:** 3 lb  (empty); add 8 to 12 oz for each card

**Capacity:** Accommodates any 3 expansion cards
**Material:** Aluminum
**Finish:** Black, powder-coated

## DBK11A - Specifications

**Name/Function: Screw-Terminal Card**
**Connector**: DB37 male, attaches to P1, P2 or P3 connector
**Wire Size Range**: 14-26 ga
BNC Option: 4 BNCs for user-soldered connection

## DBK12 - Specifications

**Name/Function: Analog Multiplexing Card (Low Gain)**
**Output Connector**: DB37 male, mates with P1
**Input Connector**: Screw terminals
**Gain Ranges**: ×1, ×2, ×4, ×8
**Inputs**: 16 differential or single-ended (switch selectable as a group)
**Voltage Range**:
    DaqBook/DaqBoard: ±5 VDC bipolar; 0 to 10 V unipolar
    Daq PC-Card: ±10 VDC bipolar
**Input Impedance**: 100 M$\Omega$ (in parallel with switched 150 pF)

**Gain Accuracy**: ±0.05% typ,  ±0.25% max
**Maximum Input Voltage**: ±35 VDC
**Slew Rate**: 20 V/µs typ, 10 V/µs min
**Settling Time**: 2 µs to 0.01%
**CMRR**: 80 dB min
**Non-Linearity**: 0.002% typ, 0.015% max
**Bias Current**: 150 pA, 0.2 µA max
**Offset Voltage**: ±(0.5 + 5/G) mV typ;  ±(2.0 + 24/G) mV max
**Offset Drift**: ±(3 + 50/G) µV/°C typ;  ±(2.0 + 24/G) µV/°C max

## DBK13 - Specifications

**Name/Function: Analog Multiplexing Card (High Gain)**
**Output Connector**: DB37 male, mates with P1
**Input Connector**: Screw terminals
**Gain Ranges**: ×1, ×10, ×100, ×1000
**Inputs**: 16 differential or single-ended (switch selectable as a group)
**Voltage Range**:
    DaqBook/DaqBoard: ±5 VDC bipolar; 0 to 10 V unipolar
    Daq P-Card: ±10 VDC bipolar
**Input Impedance**: 100 M$\Omega$  (in parallel with switched 150 pF)
**Gain Accuracy**:
    ±0.05% typ @ G < 1000
    ±0.25% max @ G < 1000
    ±0.10% typ @ G = 1000
    ±100% max @ G = 1000
**Maximum Input Voltage**: ±35 VDC
**Slew Rate**: 20V/µs typ, 10V/µs min

**Settling Time**:
    2 µs to 0.01% @ G < 1000
    10 µs to 0.01% @ G = 1000
**CMRR**:
    80 dB @ G=1 min
    86 dB @ G=10 min
    92 dB @ G=100 min
    94 dB @ G=1000 min
**Non-Linearity**:
    0.002% typ @ G < 1000
    0.015% max @ G < 1000
    0.02% typ @ G = 1000
    0.06% max @ G = 1000
**Bias Current**: 150 pA typ; 0.2 µA @ 25ºC max
**Offset Voltage**: ±(0.5 + 5/G)  mV @ 25ºC typ; ±(2.0 + 24/G) mV @ 25ºC max
**Offset Drift**: ±(3 + 50/G) µV/ºC typ; ±(12 + 240/G) µV/ºC max

## DBK15 - Specifications

**Name/Function: Universal Current/Voltage Input Card**

**Input Connectors**: Screw terminals for signal connections

**Output Connector**: DB37 male, mates with P1 on the DaqBook, using CA-37-x cable

**Attenuation/Shunt Resistor Connector**: Machine sockets accommodate standard ¼-watt resistors

**Gain Ranges**: ×1, ×2

**Inputs**: 16 differential

**Voltage Input Ranges**: ±5 VDC max

**Current Input Range**: ±20 mA max

**Attenuator Resistors**:
Accuracy: +1%
Temp coefficient: 100 ppm/ºC

**Gain Accuracy**: ±0.05% typ, ±0.25% max

**Maximum Input Voltage**: ±35 VDC

**Slew Rate**: 10 V/µs

**Settling Time**: 2µs to 0.01%

**CMRR**: 80 dB min

**Non-Linearity**: 0.002% typ, 0.015% max

**Unattenuated Bias Current**: 150 pA typ, 0.2 µA max @ 25ºC

**Offset Voltage**:
±(0.5 + 5/G) mV @ 25ºC typ
±(2.0 + 24/G) mV @ 25ºC max

**Offset Drift**:
±(3 + 50/G) µV/ºC typ
±(12 + 240/G) µV/ºC max

## DBK16 - Specifications

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

**Input Connectors**: Screw terminals for signal connections

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

**Number of Channels**: 2

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

**Gain Range**: ×100-1250

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

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

**Type Input**: Differential DC

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

**CMRR**: 115 dB

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

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

**Excitation Sensing**: Local or Remote

**Excitation Regulation**:
**Line Regulation**: 0.025%

**Load Regulation**: 0.05%

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

**Gain Calibration Reference**: 5.00 mVDC
**Reference Accuracy**: 0.2%
**Reference Drift**: 20 ppm/ºC

Committed instrumentation amplifier for each section with gain adjust from ×100 to ×1250 via externally accessed 15-turn trimpot.

**Gain Accuracy**: 0.5%

**Gain Drift**: 50 ppm/ºC

**Input Offset**: 100 µV max

**Offset Drift**: 4 µV/ºC

**Output Offset**: 20 µV

**Offset Drift**: 200 µV/ºC

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

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

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

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

## DBK17 - Specifications

**Name/Function: Simultaneous Sample-Hold Card**

**Channels**: 4

**Input Connections**: 4 BNC connectors

**Output Connector**: DB37 male, which mates with P1 on the DaqBook using CA-37-× cable

**Number of Cards Addressable**: 64

**Input Type**: Differential

**Voltage Input Ranges**:

> 0 to ±5000 mVDC
> 0 to ±500 mVDC
> 0 to ±50 mVDC
> 0 to ±25 mVDC
> 0 to ±10 mVDC

**Input Amplifier Slew Rate**: 12 V/µs minimum

**Acquisition Time**:

> 0.6 µs (10 V excursion to 0.1%)
> 0.7 µs (10 V excursion to 0.01%)

**Channel-to-Channel Aperture Uncertainty**: 50 ns

**Output Droop Rate**: 0.1 µV/µs

**Input Gains**: ×1, ×10, ×100, ×200, ×500 and User-Set

**Input Offset Voltage**: 500 µV + 5000/G maximum (nullable)

**Input Offset Drift**: ±5 + 100/G µV/°C maximum

**Input Bias Current**: 100 pA maximum

**Input Offset Currents**: 50 pA maximum

**Input Impedance**: $5 \times 10^{12}$ Ω parallel with 6 pF

**Switchable Bias Resistors**: 100 KΩ each to analog common

**Gain Errors**:

> 0.04% @ ×1
> 0.1% @ ×10
> 0.2% @ ×100
> 0.4% @ ×200
> 1.0% @ ×500

**Gain vs Temperature**:

> ×1 +/-20 ppm/°C
> ×10 +/-20 ppm/°C
> ×100 +/-40 ppm/°C
> ×200 +/-60 ppm/°C
> ×500 +/-100 ppm/°C

**Non-Linearity**:

> ×1 to ±0.015% full-scale
> ×10 to ±0.015% full-scale
> ×100 to ±0.025% full-scale
> ×200 to ±0.025% full-scale
> ×500 to ±0.045% full-scale

**Common-Mode Rejection Ratio (CMRR)**:

> 70 dB minimum @ ×1
> 87 dB minimum @ ×10
> 100 dB minimum @ ×100
> 100 dB minimum @ ×200
> 100 dB minimum @ ×500

## DBK18 - Specifications

**Name/Function: Low-Pass Filter Card**

**Channels**:  4

**Input Connections**: 4 BNC connectors

**Output Connector**: DB37 male, which mates with P1 on the
    DaqBook using CA-37-× cable

**Number of Cards Addressable**: 64

**Input Type**: Differential

**Voltage Input Ranges**:
    0 to ±5000 mVDC
    0 to ±500 mVDC
    0 to ±50 mVDC
    0 to ±25 mVDC
    0 to ±10 mVDC

**Input Amplifier Slew Rate**: 12 V/µs minimum

**Input Gains**: ×1, ×10, ×100, ×200, ×500 and User-Set

**Input Offset Voltage**: 500 µV + 5000/G maximum (nullable)

**Input Offset Drift**: ±5 + 100/G  µV/°C maximum

**Input Bias Current**: 100 pA maximum

**Input Offset Currents**: 50 pA maximum

**Input Impedance**: $5 \times 10^{12}$ Ω parallel with 6 pF

**Switchable Bias Resistors**: 100 KΩ each to analog common

**Gain Errors**:
    0.04% @ ×1
    0.1% @×10
    0.2% @ ×100
    0.4% @ ×200
    1.0% @ ×500

**Gain vs Temperature**:
    ×1 ±20 ppm/°C
    ×10 ±20 ppm/°C
    ×100 ±40 ppm/°C
    ×200 ±60 ppm/°C
    ×500 ±100 ppm/°C

**Non-Linearity**:
    ×1 to ±0.015 % full-scale
    ×10 to ±0.015 % full-scale
    ×100 to ±0.025 % full-scale
    ×200 to ±0.025 % full-scale
    ×500 to ±0.045 % full-scale

**Common-Mode Rejection**:
    70 dB minimum @ ×1
    87 dB minimum @ ×10
    100 dB minimum @ ×100
    100 dB minimum @ ×200
    100 dB minimum @ ×500

**Active Filter Device**: UAF42 (Burr-Brown)

**Number of Poles/Filter**: 3

**Types of Filters**: Bessel, Butterworth, Chebyshev

**Frequency Range**: 0.1 Hz to 20 kHz

The frequency is set by installation of 4-6 resistors and/or
    capacitors in sockets.

**Default Frequency**: 1 Hz

Other frequencies may be implemented by the user by
    soldering resistors and/or capacitors to locations on the 4
    blank plug-in headers provided.  Values for common
    frequencies and their component values are provided with
    the blank headers.

## DBK19 - Specifications

**Name/Function: High-Accuracy Thermocouple Card**

**Connector**: DB37 male, mates with P1; thermocouples attach to on-board screw terminals.

**Thermocouple Types**: J, K, S, T, E, B, R, N

**Gain Ranges**: ×60, ×90, ×180, ×240

**Inputs**:

   14 differential thermocouples
   1 cold-junction compensation
   1 auto-zero

**Cold Junction Sensor Output**: 100mV/°C

**Voltage Ranges Gains**:

   0 to 80 mV @ ×60

   0 to 50 mV @ ×90
   0 to 25 mV @ ×180
   0 to 20 mV @ ×240
   0 to ±10 mVDC

**Input Impedance**: 20 KΩ

**Input RC Filter**: -3 dB Frequency: 15.9 kHz

**Gain Accuracy**:

   **Uncalibrated**: 0.15%
   **Calibrated**: 0.02%

**Maximum Input Voltage**: 35 VDC

**CMRR (Input Stage)**: 110 dB type DC to 60 Hz

**Offset**: Software compensated

**Type/Range/Accuracy/Resolution**:

| Type | Range | | Accuracy | | Resolution | | | |
|------|-------|------|----------|----------|-----------------|-----------------|-----------------|-----------------|
|      | **Min** | **Max** | **(<0°C)** | **(>0°C)** | **12-bit <0°C** | **12-bit >0°C** | **16-bit <0°C** | **16-bit >0°C** |
| **J** | **-200°C** | **760°C** | **0.6°C** | **0.6°C** | **1.2°C** | **0.5°C** | **0.1°C** | **0.1°C** |
| **K** | **-200°C** | **1260°C** | **1.6°C** | **1.0°C** | **1.1°C** | **0.8°C** | **0.1°C** | **0.1°C** |
| **T** | **-200°C** | **400°C** | **1.4°C** | **0.8°C** | **0.8°C** | **0.3°C** | **0.1°C** | **0.1°C** |
| **E** | **-270°C** | **1000°C** | **1.4°C** | **0.9°C** | **1.6°C** | **0.7°C** | **0.1°C** | **0.1°C** |
| **N28** | **-270°C** | **400°C** | **0.8°C** | **0.8°C** | **1.0°C** | **1.0°C** | **0.1°C** | **0.1°C** |
| **N14** | **0°C** | **1300°C** | | **1.0°C** | | **5.0°C** | | **5.0°C** |
| **S** | **0°C** | **1780°C** | | **1.6°C** | | **1.3°C** | | **0.1°C** |
| **R** | **0°C** | **1780°C** | | **1.6°C** | | **1.7°C** | | **0.1°C** |
| **B** | **0°C** | **1820°C** | | **1.8°C** | | **1.5°C** | | **0.1°C** |

## DBK20 - Specifications

**Name/Function: General Purpose Digital I/O Card**

**Channels**: 48 I/O channels

**Connector**: Screw terminals

**Device**: 82C55 × 2

**Output Voltage Levels**:

   **Minimum 1" Voltage**: 3.0 @ 2.5 mA sourcing
   **Maximum 0" Voltage**: 0.4 @ 2.5 mA sinking

**Output Currents**:

   **Maximum Source Current**: 2.5 mA
   **Maximum Sink Current**: -2.5 mA

**Input Voltage Levels**:

   **Minimum Required 1 Voltage Level**: 2.0 V
   **Maximum Allowed 0 Voltage Level**: 0.8 V

**Output Float Leakage Current**: 10 µA

## DBK21 - Specifications

**Name/Function: General Purpose Digital I/O Card**

**Channels**: 48 I/O channels

**Connector**: DB37 male, mates with Daq* P2 pinout & to DigiBook P1, P2, P3

**Device**: 82C55 × 2

**Output Voltage Levels**:

   **Minimum 1 Voltage**: 3.0 @ 2.5 mA sourcing
   **Maximum 0 Voltage**: 0.4 @ 2.5 mA sinking

**Output Currents**:

   **Maximum Source Current**: 2.5 mA
   **Maximum Sink Current**: -2.5 mA

**Input Voltage Levels**:

   **Minimum Required 1 Voltage Level**: 2.0 V
   **Maximum Allowed 0 Voltage Level**: 0.8 V

**Output Float Leakage Current**: 10 µA

## DBK23 - Specifications

**Name/Function: General Purpose Optically Isolated Digital Input Module**
**Channels**: 24 I/O channels
**Channel Address**: Set by DIP switch
**Connector**: Screw terminals for signal outputs
**Input Voltage Levels**:
    **Range**: 3 to 30 VDC

**Input Current**: 1.5 to 15 mA
    **Operating Voltage Range**: 9 to 24 VDC
**Module Power Requirements**: 0.25 W; AC adapter included
**120 VAC Adapter Supplied**: 15 VDC @ 0.9 A
**Isolation Voltage**:
    **Channel-to-channel**: 500 V
    **Channel-to-system**: 500 V

## DBK24 - Specifications

**Name/Function: General Purpose Optically Isolated Digital Output Module**
**Channels**: 24 I/O channels
**Channel Address**: Set by DIP switch
**Connector**: Screw terminals for signal outputs
**Output Channel Ratings**:
    **Maximum current/channel**: 1 A
    **Voltage drop @ 1 A and 25°C**: 1 V
    **Maximum open circuit voltage**: 60 VDC

    **Off-state leakage**: 10 µA
**Module Power Requirements**: 1.5 W
**120 VAC Adapter Supplied**: 15 VDC @ 0.9 A
**Isolation Voltage**:
    **Channel-to-channel**: 500 V
    **Channel-to-system**: 500 V
**Maximum Module Power Dissipation**:
    12 W @ 25°C
     6 W @ 50°C

## DBK25 - Specifications

**Name/Function: 8-Channel Relay Output Card**
**Connectors**: Screw terminals for signal outputs
**Max Number of Cards**:  32
**Contact Rating**:
    2 A @ 28 VDC

    0.6 A @ 120 VAC
**Isolation**
    **Channel-to-System**:  250 V
    **Channel-to-Channel**:  150 V

## DBK30A - Specifications

**Name/Function: Rechargeable Battery Module**
**Battery Type**: Nickel-cadmium
**Number of Battery Packs**: 2
**Battery Pack Configuration**:  12 series-connected sub-C cells
**Output Voltage**: 14.4 V or 28.8 V (depending on the selected mode)
**Output Fuses**: 2 A

**Battery Amp-Hours**: 3.4 A-hr (1.7 A-hr/pack)
**Charging Voltage from Supplied AC Adapter**: 22 to 26 VDC @ 2 A
**AC Adapter Input**: 95 to 265 VAC @ 47 to 63 Hz
**Charge Time**: 2 hours
**Charge Termination**: Peak detection
**Size**: 11" long × 8-1/2" wide × 1-3/8" high

## DBK32A - Specifications

**Name/Function: Auxiliary Power Supply Card**
**Isolation, Input to Output**:
  DBK32A: 500 VDC  (DBK32: 250 VDC)
**Output Voltages**:
  DBK32A: +15 VDC (nominal) @ 500 mA
          -15 VDC (nominal) @ 500 mA
  (DBK32: +15 VDC (nominal) @ 250 mA
          -15 VDC (nominal) @ 250 mA)
**Line Regulation**: 0.5% (maximum)
**Load Regulation**: 1.0% (maximum)
**Total Output Power**: 7.5 VA (full load)
**Input Voltage Range**: 10 to 24 VDC

**Input Current Range**: 0.8 to 2.0 A
**Size**: 3-1/4" × 8-1/4" × 3/4"
**Efficiency**: 60% Typical
**Input Connections**: DIN5 (×2 for daisy-chaining)
**Output Connections**: DB37 male
**Parallel Provision**: OR-ing diodes in output lines
**Controls**: ON/OFF rocker arm switch
**Indicators**: LED driven by positive output
**Over-Voltage Protection**: Hardware SCR crowbar on (+) side
**Switching Frequency**: 150 kHz
**Operating Temperature Range**: 0 to 50°C
**Input Fuse Size**: 2 A (Littlefuse 251002)

## DBK33 - Specifications

**Name/Function: Triple-Output Power Supply Card**

**Isolation, Input to Output**: 500 VDC

**Output Voltages**:

+15 VDC nominal @ 250 mA

-15 VDC nominal @ 250 mA

+5 VDC nominal @ 1000 mA

**Line Regulation**: 0.2% max (+5 V); 5% max (±15 V)

**Load Regulation**: 0.5% max (+5 V); 5% max (±15 V)

**Total Output Power**: 15 VA (full load)

**Input Voltage Range**: 9 to 18 VDC

**Included AC Adapter**: 15 VDC @ 0.9 A

**Size**: 3-1/4" × 8-1/4" × 3/4"

**Full-Load Efficiency**: 80% Typical

**Full-Load Input Current Range**:

2.10 A @ 9 VDC

1.05 A @ 18 VDC

**Input Connections**: DIN5 (×2 for daisy-chaining)

**Output Connections**: DB37 Male

**Parallel Provision**: OR-ing diodes on output lines allow use of multiple DBK33s in larger systems

**Controls**: ON/OFF rocker-arm switch

**Indicators**: LED driven by input voltage

**Over-Voltage Protection**: Fuse followed by 19 V zener clamp

**Switching Frequency**: 100 kHz min

**Operating Temperature Range**: -20 to 70°C

**Input Fuse**: 3 A (Littelfuse 25003)

## DBK35

**Name/Function: PCMCIA Interface Kit**

**Card Type**: Type II

**Connector**: DB25

**Bus Interface**: 8-bit PCMCIA Card Standard 2.1

**Power Consumption**: 5V @ 35 mA

**Included Cable**: 2 foot

## DBK40 - Specifications

**Name/Function: BNC Analog Interface Module**

**Daq\* Connection**: Male DB37 mates with P1.

**Analog Input Connection**: One BNC connector for each of 16 analog input channels.

**Single-Ended Mode**: Center conductor carries signal, outer conductor carries signal ground.

**Differential Mode**: Center conductor of two adjacent BNC connectors carries high and input low signals; outer conductor of both is attached to system ground.

**Analog Output Connection**: One BNC connector for each of 2 analog output channels; center conductor carries signal, outer conductor carries signal ground.

**TTL Trigger Input Connection**: One analog output BNC connector can be switched to provide a TTL trigger input connection; in TTL mode, the second analog output channel is unavailable on the BNC connector.

**Size**: 6.8" wide × 5.3" long × 2.3" high

**Weight**: 21 oz

**Length of Supplied Cable**: 6 ft

## DBK41 - Specifications

**Name/Function: 10-Slot Analog Expansion Module**

**Card Capacity**: 10 slots

**Weight**: 4 lb (with no cards installed)

**Cable (optional)**: 8" ribbon DB37 female to DB37 female (CA-37-×)

**Power Indicator**: LED powered by DaqBook 5 VDC

**Daq\* Connection**: Male DB37, mates via CA-37-× cable with P1

## DBK42 - Specifications

**Name/Function: 16-Slot, 5B Signal Conditioning Module**

**Module Capacity**: 16 (input only) 5B modules

**Size**:  8.5" × 11" × 3.5"  (11" × 11" × 3.5" with optional CN-71 or CN-72)

**Weight**: 4 lb (with no modules installed)

**Cable (optional)**: CA-37-1

**Power Requirements**: 10 to 24 VDC @ 2.6 to 0.3 A

 **With 16 thermocouple-type modules**:

    12 VDC @ 0.50 A

    15 VDC @ 0.40 A

    18 VDC @ 0.35 A

 **With 16 strain-gage type modules**:

    12 VDC @ 1.9 A

    15 VDC @ 1.5 A

    18 VDC @ 1.3 A

**DC Input Fuse**: 3 A

**Power Indicator**: LED powered by internal 5 VDC

**Power Connection**: DIN5 ×2 for daisy-chaining

**AC Power Pack**:

    120 VAC to 15 VDC converter

    120 VAC to 15 VDC @ 2.0 A (optional)

**Input Connections**: DIN96 rectangular, standard, screw terminal adapter (optional)

**Daq\* Connection**: Male DB37 mates via CA-37-1 cable with Daq\* P1

**DC/DC Converter**: 10 to 24 VDC into 5 VDC (isolated)

**Isolation**:

    **Input Power to Daq\***: 500 VDC

    **Signal Inputs to Daq\***: 1500 VDC

    **Input Channel-to-Channel**: 500 VDC

## DBK43A - Specifications

**Name/Function: 8-Channel Strain-Gage Module**

**Connectors**: DB37 mates with Daq\* 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

## DBK44 - Specifications

**Name/Function: 2-Channel 5B Signal Conditioning Card**

**Module Capacity**: 2 (input only) 5B modules

**Weight**: 8 oz (with no modules installed)

**Cable (optional)**: CA-37-×

**DC Input Fuse**: 4 A

**Daq\* Connection**: Male DB37 mates via CA-37-1 cable with Daq\* P1

**Isolation**:

    **Input Power to Daq\***: 500 VDC

    **Signal Inputs to Daq\***: 1500 VDC

    **Input Channel-to-Channel**: 500 VDC

## DBK45 - Specifications

**Name/Function: Simultaneous Sample and Hold and Low-Pass Filter Card**

**Number of Channels**: 4

**Input Connections**: 4 BNC connectors

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

**Number of Cards Addressable**: 64

**Dimensions**: 8.25" × 3.25"

**Input Type**: Differential

**Voltage Input Ranges**:
    0 to ±5000 mVDC
    0 to ±500 mVDC
    0 to ±50 mVDC
    0 to ±25 mVDC
    0 to ±10 mVDC

**For Custom Gains**: $R_{GAIN} = [40{,}000/(Gain-1)] - 80 \ \Omega$

**Input Amplifier Slew Rate**: 12 V/µs minimum

**Acquisition Time**:
    0.6 µs (10 V excursion to 0.1%)
    0.7 µs (10 V excursion to 0.01%)

**Channel-to-Channel Aperture Uncertainty**: 50 ns

**Output Droop Rate**: 0.1 µV/µs

**Input Gains**: ×1, ×10, ×100, ×200, x500, and user-set up to ×500

**Input Offset Voltage**: 500 µV + 5000/G maximum (nullable)

**Input Offset Drift**: ±5 + 100/G  µV/°C maximum

**Input Bias Current**: 100 pA maximum

**Input Offset Currents**: 50 pA maximum

**Input Impedance**: $5 \times 10^{12} \ \Omega$ parallel with 6 pF

**Switchable Bias Resistors**: 100 KΩ each to analog common

**Gain Errors**:
    0.04% @ ×1
    0.1% @ ×10
    0.2% @ ×100
    0.4% @ ×200
    1.0% @ ×500

**Temperature vs Gain**:
    ±20 ppm/°C @ ×1
    ±20 ppm/°C @ ×10
    ±40 ppm/°C @ ×100
    ±60 ppm/°C @ ×200
    ±100 ppm/°C @ ×500

**Non-Linearity**:
    ±0.015 % full-scale @ ×1
    ±0.015 % full-scale @ ×10
    ±0.025 % full-scale @ ×100
    ±0.025 % full-scale @ ×200
    ±0.045 % full-scale @ ×500

**Common-Mode Rejection**:
    70 dB minimum @ ×1
    87 dB minimum @ ×10
    100 dB minimum @ ×100
    100 dB minimum @ ×200
    100 dB minimum @ ×500

**Active Filter Device**: UAF42 (Burr-Brown)

**Number of Poles/Filter**: 3

**Types of Filters**: Bessel, Butterworth, Chebyshev

**Frequency Range**: 0.1 Hz to 50 kHz
    The frequency is set by installation of 4-6 resistors and/or capacitors in provided socket locations.

**Frequency Modules**: Optional frequency module kits are available that consist of 4 plug-in resistor/capacitor (RC) headers pre-configured for any of the following frequencies: 5 Hz, 10 Hz, 100 Hz, 500 Hz, or 1 kHz—all are Butterworth-type filters.

## DBK50/51 - Specifications

**Name/Function: 8-Channel Isolated Voltage Input Module**

**Connectors (DaqBook or DaqBoard)**: Male DB37, mates with P1

**Inputs**:   Removable screw terminals

**Number of Channels**:  8, individually isolated

**Isolation**
    **Channel-to-Channel**: 750 V
    **Channel-to-System**: 1250 V

**Input Impedance**: >10 MΩ

**Bipolar Input Ranges**: ±300 V, ±100 V, ±10 V, ±100 mV, ±1 V, ±10 V

**Output Voltage Range**: ±5 VDC

**Attenuation Ratios**: K= Vin/ Vout

    100 mV,   K = 0.02 (gain = 50)
    1 V,  K = 0.2 (gain = 5)
    10 V,  K = 2.0 (gain = 0.5)
    100 V, K = 20.0 (gain = 0.05)
    300 V, K = 60.0 (gain = 0.017)

**Bandwidth**: 20 kHz (LPF bypassed)

**Low-Pass Filter**:  Factory installed 3-pole, 3.5 Hz (bypass or user-set)

**Operating Power Voltage Range**: +9 to +20 VDC

**Module Power Requirements**: 7.5 W

**Included AC Adapter**: 15 VDC, 0.9 A

**Size**: 8½" × 11" × 1-3/8"

## DBK52 - Specifications

**Name/Function: Thermocouple Input Module**

**Connectors**:

    DB37 male, mates with P1

    Thermocouples attach directly to on-board jacks

**Thermocouple Types**: J, K, S, T, E, B, R, N

**Gain Ranges**: ×60, ×90, ×180, ×240

**Inputs**:

    14 differential thermocouples

    1 cold-junction compensation

    1 auto-zero

**Cold Junction Sensor Output**: 100 mV/°C

**Voltage Ranges/Gains**:

    0 to 80 mV  ×60

    0 to 50 mV  ×90

    0 to 25 mV  ×180

    0 to 20 mV  ×240

    0 to ±10 mVDC

**Input Impedance**:  20 kΩ

**Input RC Filter**: -3 dB Frequency:  15.9 kHz

**Gain Accuracy**:

    Uncalibrated: 0.15%

    Calibrated: 0.02%

**Maximum Input Voltage**: 35 VDC

**CMRR (Input Stage)**: 110 dB type DC to 60 Hz

**Offset**:  Software compensated

**Type/Range/Accuracy/Resolution**: see table

| | Range | | Accuracy | | Resolution | | | |
|---|---|---|---|---|---|---|---|---|
| **Type** | **Min** | **Max** | **(<0°C)** | **(>0°C)** | **12-bit <0°C** | **12-bit >0°C** | **16-bit <0°C** | **16-bit >0°C** |
| J | -200°C | 760°C | 0.6°C | 0.6°C | 1.2°C | 0.5°C | 0.1°C | 0.1°C |
| K | -200°C | 1260°C | 1.6°C | 1.0°C | 1.1°C | 0.8°C | 0.1°C | 0.1°C |
| T | -200°C | 400°C | 1.4°C | 0.8°C | 0.8°C | 0.3°C | 0.1°C | 0.1°C |
| E | -270°C | 1000°C | 1.4°C | 0.9°C | 1.6°C | 0.7°C | 0.1°C | 0.1°C |
| N28 | -270°C | 400°C | 0.8°C | 0.8°C | 1.0°C | 1.0°C | 0.1°C | 0.1°C |
| N14 | 0°C | 1300°C | — | 1.0°C | — | 5.0°C | — | 5.0°C |
| S | 0°C | 1780°C | — | 1.6°C | — | 1.3°C | — | 0.1°C |
| R | 0°C | 1780°C | — | 1.6°C | — | 1.7°C | — | 0.1°C |
| B | 0°C | 1820°C | — | 1.8°C | — | 1.5°C | — | 0.1°C |

## DBK53/54 - Specifications

**Name/Function:**

    **DBK53 16-Channel Low-Gain Analog Multiplexing Module**

    **DBK54 16-Channel High-Gain Analog Multiplexing Module**

**Output Connector**:  DB37 male, mates with P1

**Input Connector**: BNC - DIFF. Inputs; Pin Jack - Analog Common

**Gain Ranges**:

    **DBK53**: ×1, ×2, ×4, ×8

    **DBK54**: ×1, ×10, ×100, ×1000

**Inputs**:16 differential or single-ended jumper selectable as a group)

**Voltage Range**:

    DaqBook/DaqBoard: ±5 VDC bipolar; 0 to 10 V unipolar

    Daq PC-Card: ±10 VDC bipolar

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

**Gain Accuracy**:  0.05% typ, 0.25% max

**Maximum Input Voltage**: 35 VDC

**Slew Rate**:  20 V/s typ, 10 V/s min

**Settling Time**: 2 s to 0.01%

**CMRR**:  80 dB min

**Non-Linearity**: 0.002% typ, 0.015% max

**Bias Current**: 150 pA, 0.2 A max

**Offset Voltage**:

    ±(0.5 + 5/G) V/°C typ

    ±(2.0 + 24/G) mV max

**Offset Drift**:

    ±(3 + 50/G)  V/°C typ

    ±(2.0 + 24/G) V/°C max

# Daq* Compatibility

This appendix compares the Daq* and MetraByte conventions. In addition to industry-standard connectors, pinouts, and addressing, the Daq* hardware emulates the:

- DAS-16 with 16 channels, 12-bit analog inputs, 2-channel 12-bit analog outputs
- PIO-12 with 24 digital I/O
- CTM-05 with 5 16-bit counters

## *CIO16 Compatibility*

This section should only be used with existing programs that use the Computer Boards CIO16 Mode commands. This documentation does not describe how to use these commands, just the differences from the Daq* mode. The commands described in the *Command Reference* chapter should be used for new development. All CIO16 compatibility files are located in the DOS/MET directory of the Daq* software release directory. A README file in this directory contains updated information on CIO16 compatibility.

### General Differences

There is no CIO16.BIN driver file for GW BASIC support. QuickBASIC (supplied with MS-DOS 5.0) should be used instead. The Quick Library CIO16.QLB, can be loaded using the /L option of QuickBASIC. (Pascal and FORTRAN are not supported.)

The function **daqInit** (described in the *Command Reference* chapter) should be called before calling any of the CIO16 Mode commands to set the printer port and interrupt level of the DaqBook. This function replaces the base address used in Mode 0. All flags that have valid values of 0 or 1 in the CIO16 Mode commands can be 0 or non-zero in the DaqBook Mode commands. Non-zero means true, 0 means false.

### Mode Differences

| Mode | Description | Differences |
|------|-------------|-------------|
| Mode 0 | Initialize | Parameter 0, the board's base I/O address, is not used. The function daqInit should be called instead.<br>Parameter 1, the interrupt level, is not used. Use daqInit instead.<br>Parameter 2, the DMA channel, is not used. Use daqInit instead.<br>The Mode 0 command will reset the A/D default values. |
| Mode 1 | Set Mux Limits | |
| Mode 2 | Read Mux | |
| Mode 3 | Do One A/D | |
| Mode 4 | Do N A/D To Array | |
| Mode 5 | Do N A/D To Memory | |
| Mode 6 | Do N A/D Via DMA | The Mode 6 command is identical to Mode 5. It will use interrupts instead of DMA to perform the transfer because DMA is not available to the DaqBook. |
| Mode 7 | Disable Interrupt/ DMA | |
| Mode 8 | Read Interrupt/ DMA | |
| Mode 9 | Transfer Data To Array | |
| Mode 10 | Configure Counter 0 | |
| Mode 11 | Load Counter 0 | |
| Mode 12 | Read Counter 0 | |
| Mode 13 | Write Digital OPO-3 | |
| Mode 14 | Read Digital IPO-03 | |
| Mode15 | One D/A | |
| Mode 16 | Both D/A's | |
| Mode17 | Load A/D Pacer Clock Ctr 1 & 2 | |
| Mode 18 | D/A & A/D On Interrupt | Not implemented |
| Mode19 | Analog Trigger | Not implemented |
| Mode 20 | A/D Scan On Interrupt | |

| Mode | Description | Differences |
|------|-------------|-------------|
| Mode50 | Easy To Use A/D | |
| Mode 51 | Load Counter 1 & 2 With Hz | |
| Mode55 | Configure 24 DIO | |
| Mode 56 | Bit Set | |
| Mode57 | Bit Read | |
| Mode 58 | ByteSet | |
| Mode59 | Byte Set | |

# CTM05 Compatibility

This section should only be used with existing programs that use the Metrabyte CTM05 Mode commands. This documentation does not describe how to use these commands, just the differences from the Daq* Mode. The commands described in the *Daq* Command Reference* chapter should be used for new development. All CTM05 compatibility files are located in the DOS/MET directory of the DaqBook software release directory. A README file in this directory contains updated information on CTM05 compatibility.

## General Differences

There is no CTM05.BIN driver file for GW BASIC support. QuickBASIC (supplied with MS-DOS 5.0) should be used instead. The Quick Library CTM05.QLB, can be loaded using the /L option of QuickBASIC. (Pascal and FORTRAN are not supported.)

The function **daqInit** (described in the *Daq* Command Reference* chapter) should be called before calling any of the CTM05 Mode commands to set the printer port and interrupt level. This function replaces the base address used in Mode 0 and the interrupt level used in Mode 7. All flags that have valid values of 0 or 1 in the CTM05 Mode commands can be 0 or non-zero in the Daq* Mode commands. Non-zero means true, 0 means false.

## Mode Differences

| Mode | Description | Differences |
|------|-------------|-------------|
| Mode 0 | Initialize | Parameter 0, the board's base I/O address, is not used. The function daqInit should be called instead.<br>All other Parameters are the same. |
| Mode 1 | Set A Counter Mode Register | No Differences |
| Mode 2 | Multiple Counter Control Commands | No Differences |
| Mode 3 | Load Counter Load Register | No Differences |
| Mode 4 | Read Selected Counter Hold Register | No Differences |
| Mode 5 | Read The Digital Input Port | Not implemented. The digital input port was changed to a high-speed 16-bit digital input port that must be read as part of the A/D scan sequence. |
| Mode 6 | Write To The Digital Output Port | Not implemented. The digital output port was changed to a high-speed 16-bit digital input port that must be read as part of the A/D scan sequence. |
| Mode 7 | Latch counters & Save On Interrupt | Parameter 6 (the start on IPO flag) is not used because the digital input port was changed to a high speed 16-bit digital input port that must be read as part of the A/D scan sequence.<br>Parameter 7, the interrupt level, is not used. Use daqInit instead.<br>All other parameters are the same. |
| Mode 8 | Return Status Of Interrupts | No differences |
| Mode 9 | Transfer Data During/After Interrupt | |
| Mode 10 | Measure Frequency | No differences |
| Mode 11 | Latch Counters & Save On Interrupt; Dump Data To Selected Offset & Segment | Parameter 6 of Mode 7 (the start on IP0 flag) is not used because the digital input port was changed to a high-speed 16-bit digital input port that must be read as part of the A/D scan sequence.<br>Parameter 7 of Mode 7 is not used. Use daqInit instead.<br>All other parameters are the same. |

# CE-Compliance

## *Overview*

CE standards were developed by the European Union (EU) dating from 1985 and include specifications both for safety and for EMI emissions and immunity. Now, all affected products sold in EU countries must meet such standards. Although not required in the USA and elsewhere, these standards are considered good engineering practice because they enhance safety while reducing noise and ESD problems.

In contracted and in-house testing, most Daq* products met the required specifications. Those products not originally in compliance were redesigned accordingly. In some cases, alternate product versions, shield plates, edge guards, special connectors, or add-on kits are required. (For examples, refer to the section *CE Enhancements for Existing Products* at the end of this appendix.)

CE-compliant products bound for Europe bear the "CE" mark and include a *Declaration of Conformity* stating the particular specifications and conditions that apply. Test Records and supporting documentation that validate compliance are kept on file at the factory.

## *CE Standards and Directives*

The electromagnetic compatibility (EMC) directives specify 2 basic requirements:
- The device must not interfere with radio or telecommunications.
- The device must be immune from electromagnetic interference from RF transmitters etc.

The standards are published in the *Official Journal of European Union* under direction of CENELEC (European Committee for Electrotechnical Standardization). The specific standards relevant to Daq* equipment are listed on the product's Declaration of Conformity and include: CISPR22:1985; EN55022:1988 (Information Technology Equipment, Class A for commercial/industrial use); and EN50082-1:1992 for various categories of EMI immunity.

The safety standard that applies to Daq* products is EN 61010-1 : 1993 (*Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements*). Environmental conditions include the following:
- indoor use
- altitude up to 2000 m
- temperature 5°C to 40°C (41°F to 104°F)
- maximum relative humidity 80% for temperatures up to 31°C (87.8°F) decreasing linearly to 50% relative humidity at 40°C (104°F)
- mains supply voltage fluctuations not to exceed ±10% of the nominal voltage
- other supply voltage fluctuations as stated by the manufacturer
- transient overvoltages according to installation categories (overvoltage categories) I, II and III. For mains supply, the minimum and normal category is II.
- pollution degree 1 or 2 in accordance with IEC 664.

For clarification, terms used in some Declarations of Conformity include:
- **pollution degree**: any addition of foreign matter, solid, liquid or gaseous (ionized gases) that may produce a reduction of dielectric strength or surface resistivity. A pollution degree I has no influence on safety and implies: the equipment is at operating temperature with non-condensing humidity conditions; no conductive particles are permitted in the atmosphere; warm-up time is sufficient to avert any condensation or frost; no hazardous voltages are applied until completion of the warm-up period. Pollution degree II implies the expectation of occasional condensation.
- **overvoltage (installation) category**: classification with limits for transient overvoltages, dependent on the nominal line voltage to earth. Category I implies signals without high transient values. Category II applies to typical mains power lines with some transients.

## *Safety Conditions*

Users must comply with all relevant safety conditions in the user's manual and the Declarations of Conformity. This manual and Daq* hardware use the following Warning and Caution symbols: (If you see these symbols on a product, carefully read the related information and be alert to the possibility of personal injury).

This warning symbol is used in this manual or on the equipment to warn of possible injury or death from electrical shock under noted conditions.

This warning/caution symbol is used to warn of possible personal injury or equipment damage under noted conditions.

Daq* products contain no user-serviceable parts; refer all service to qualified personnel. The specific safety conditions for CE compliance vary by product; but general safety conditions include:
- The operator must observe all safety cautions and operating conditions specified in the documentation for all hardware used.
- The host computer and all connected equipment must be CE compliant.
- All power must be off to the device and externally connected equipment before internal access to the device is permitted.
- Isolation voltage ratings: do not exceed documented voltage limits for power and signal inputs. All wire insulation and terminal blocks in the system must be rated for the isolation voltage in use. Voltages above 30 Vrms or ±60 VDC must not be applied if any condensation has formed on the device.
- Current and power use must not exceed specifications. Do not defeat fuses or other over-current protection.

## *Emissions/Immunity Conditions*

The specific immunity conditions for CE compliance vary by product; but general immunity conditions include:
- Cables must be shielded, braid-type with metal-shelled connectors. Input terminal connections are to be made with shielded wire. The shield should be connected to the chassis ground with the hardware provided.
- The host computer must be properly grounded.
- In low-level analog applications, some inaccuracy is to be expected when I/O leads are exposed to RF fields or transients over 3 or 10 V/m as noted on the Declaration of Conformity.

## *CE Enhancements for Existing Products*

Several CE enhancements are described in the following sections:
- DBK41/CE
- Edge Guard (for the DBKs 5, 8, and 44)
- Special cables and connectors

## DBK41/CE

The DBK41/CE includes 3 variations of EMI shield plates that attach to the DBK41 enclosure. Besides acting as an electrical safety barrier, these shields reduce electromagnetic interference (EMI) escaping from (or entering into) the 10-slot expansion enclosure (see figure).  **Note**: This CE kit is included with the DBK41/CE and is an optional accessory for a non-CE DBK41.
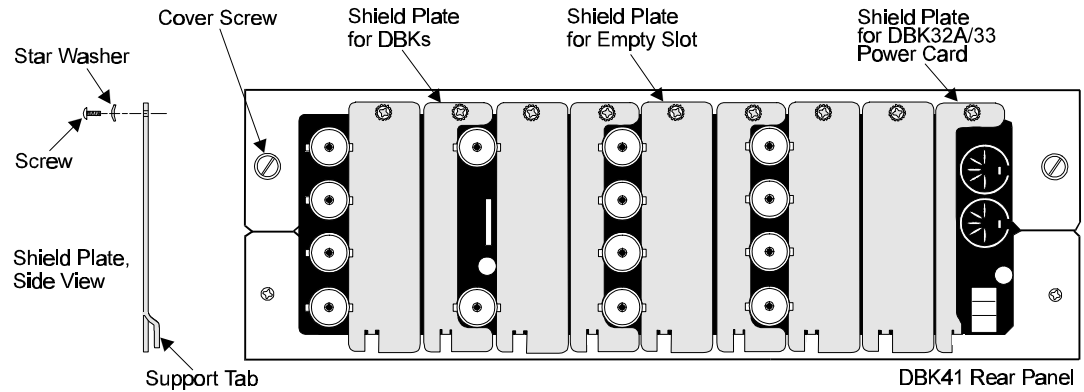


## Edge Guards for DBKs 5, 8, and 44

A plastic barrier attached to the end of a DBK card helps prevent access to leads or circuits carrying lethal voltages.  These edge guards attach to DBKs 5, 8, and 44 (see figure below) that are mounted in a DBK41/CE with EMI shield plates (see figure above).  The access slot allows insulated wires to pass through the barrier or for trimpot adjustments with a small screwdriver.
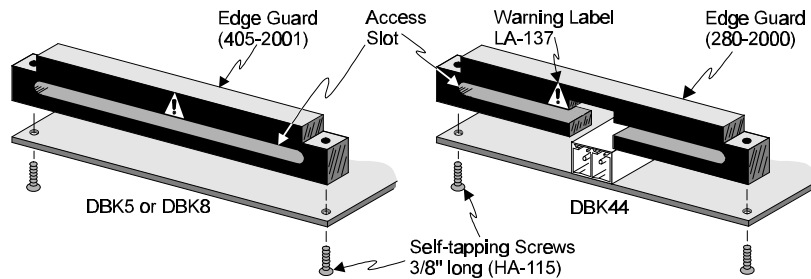


Fig 1.  Edge Guard Kit for DBK5 and DBK8 (p/n 232-0806)

Fig 2.  Edge Guard Kit for DBK44 (p/n 232-0805)

## Special Cables and Connectors

Some Declarations of Conformity specify particular cables or connectors that must be used for CE compliance; e.g., the special BNC connectors used with the DBK4, DBK17, DBK18, and some other BNC-equipped cards and modules.  The idea is to insulate the BNC connector from high-voltage sources such as static charges that can enter the circuitry via an exposed connector and cause ESD damage.  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.

*Notes*
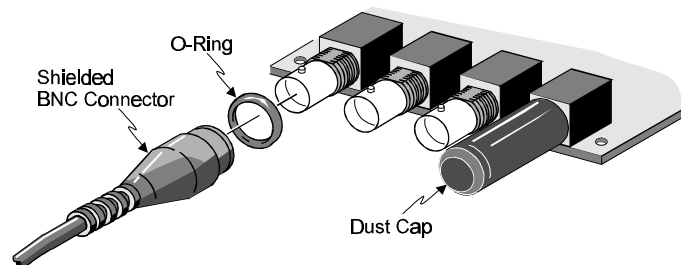
This index supplements the Table of Contents. Chapter titles are shown in ***bold italics***; major headings are shown in *italics*. The index also includes topics that are not specified in headings and that may appear in several chapters. Chapter numbers are shown in **bold**.

✍ *Notes*

# WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

**OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.**

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

# RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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# Where Do I Find Everything I Need for Process Measurement and Control? OMEGA...Of Course!

## TEMPERATURE
- ☑ Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- ☑ Wire: Thermocouple, RTD & Thermistor
- ☑ Calibrators & Ice Point References
- ☑ Recorders, Controllers & Process Monitors
- ☑ Infrared Pyrometers

## PRESSURE, STRAIN AND FORCE
- ☑ Transducers & Strain Gauges
- ☑ Load Cells & Pressure Gauges
- ☑ Displacement Transducers
- ☑ Instrumentation & Accessories

## FLOW/LEVEL
- ☑ Rotameters, Gas Mass Flowmeters & Flow Computers
- ☑ Air Velocity Indicators
- ☑ Turbine/Paddlewheel Systems
- ☑ Totalizers & Batch Controllers

## pH/CONDUCTIVITY
- ☑ pH Electrodes, Testers & Accessories
- ☑ Benchtop/Laboratory Meters
- ☑ Controllers, Calibrators, Simulators & Pumps
- ☑ Industrial pH & Conductivity Equipment

## DATA ACQUISITION
- ☑ Data Acquisition & Engineering Software
- ☑ Communications-Based Acquisition Systems
- ☑ Plug-in Cards for Apple, IBM & Compatibles
- ☑ Datalogging Systems
- ☑ Recorders, Printers & Plotters

## HEATERS
- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

## ENVIRONMENTAL MONITORING AND CONTROL
- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments

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