

**KEITHLEY**

# EXP-800/1600

User's Guide

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# **EXP-800/1600 User's Guide**

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

**Responsible body** is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

**Operators** use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

**Maintenance personnel** perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

**Service personnel** are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.



The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If  or  is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

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**Keithley Instruments, Inc.**



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# Preface

This guide is intended to help you understand the installation, interface requirements, functions, and operation of the EXP-800 and the EXP-1600 expansion accessories. The EXP-800 is an accessory for the DAS-800 Series boards; the EXP-1600 is an accessory for DAS-1600/1400/1200 Series boards and the DASCard-1000 Series PCMCIA cards. In this guide, the term *EXP-800/1600* refers to the EXP-800 and/or the EXP-1600.

This guide focuses primarily on describing the EXP-800/1600 and its capabilities, setting up this accessory, and making typical hookups. There are also chapters on calibration and troubleshooting. To follow the information and instructions contained in this manual, you must be familiar with data-acquisition principles and application.

The *EXP-800/1600 User's Guide* is organized as follows:

- Chapter 1 describes the features and accessories of the EXP-800/1600.
- Chapter 2 describes operating features of the EXP-800/1600 in more detail. This chapter contains a block diagram and brief descriptions of the features as they relate to your options for setting up and using an EXP-800/1600.
- Chapter 3 contains instructions for inspecting and setting up the EXP-800/1600.
- Chapter 4 shows the preferred methods of making I/O (Input/Output) connections to a DAS board and available accessories.
- Chapter 5 discusses calibration requirements and instructions.
- Chapter 6 contains information on isolating and determining the source of operating problems. This chapter also contains instructions for obtaining technical support.

- Appendix A contains EXP-800/1600 specifications.
- Appendix B contains pin assignments for the DAS boards and EXP-800/1600 I/O connectors.
- Appendix C describes the assignment of logical channel numbers for a DAS board and all attached EXP-1800s for use in software such as the Control Panel utility.
- An index completes the manual.

# Overview

This chapter discusses the features, supporting software, and accessories of the EXP-800 and EXP-1600. The EXP-800 and EXP-1600 appear identical except for their channel-jumper blocks. They also differ in circuitry and in the number of output channels (the EXP-800 provides eight channels, while the EXP-1600 provides 16 channels).

## Features

---

Features of the EXP-800/1600 include the following:

- Contains 16 differential inputs.
- Multiplexes its inputs under control of the host DAS board.
- Connects in a daisy chain to additional EXP-800/1600s through ribbon cable to provide up to 128 inputs for a DAS-800 Series boards or 256 inputs for a DAS-1600/1400/1200 Series board or a DASCard-1000 Series card.
- Provides a jumper block for selecting one channel of a DAS board to receive signal input and for selecting a different channel of the DAS board to receive CJC (cold-junction compensation).
- Offers switch-selectable gains of 0.5, 1, 5, 10, 50, 100, 250, and 500.
- Works with optional, plug-in, field-wiring accessories containing convenient screw terminals.
- Provides mass-termination connector access for its own I/O channels and for the DAS board I/O.
- Accepts power from the computer or from an external source that switches in only while the computer is on.

- Provides holes for a 4-to-20 mA current-measuring resistor at each input (actual range is 100  $\mu$ A to 100 mA).
- Contains a switch-activated, 80 Hz, passive filter for each input.
- Contains a switch-activated, open-thermocouple-detection circuit for each input.
- Contains a switch-activated, low-side, bias resistor for each input. (Before you use this circuit, refer to the cautionary note on page 3-5.)
- Conforms to VME 6U card size and fits a variety of Eurocard enclosures, including the ENCL Series desktop enclosures from Keithley MetraByte.
- Contains trim pots for setting the RTI (referenced to input) and RTO (referenced to output) zeroes of the instrumentation amplifier and for adjusting the CJC gain.

## Supporting Software

---

Software for the DAS-800/1200/1400/1600 Series boards and the DASCARD-1000 Series cards also supports the EXP-800/1600. This software is described in the user's guides for the DAS boards/cards.

## Accessories

---

The following accessories are available for EXP-800/1600s:

- **CAB-3740** is the cable required to connect an EXP-800/1600 to a DAS board; this cable is available in two lengths, as follows: the CAB-3740/1 is 18 inches and the CAB-3740/2 is 36 inches.
- **CAB-3740/F** is a version of the CAB-3740 cable that is 4-inches long and connects an EXP-1600 to the cable of a DASCARD-1000 Series card.
- **CAB-40** is the cable you use to form a daisy chain of EXP-800/1600s; this cable is available in two lengths, as follows: the CAB-40 is 3 inches long and the CAB-40/1 is 18 inches long.



- **CAB-PWR** is the cable you use to connect external power to an EXP-800/1600 in a daisy chain; this cable is available in two lengths, as follows: the CAB-PWR is 4 inches long and the CAB-PWR/1 is 18 inches long.
- **FWA-EXP** is a field-wiring accessory containing screw terminals and a CJC circuit. This accessory plugs into connector J1 of the EXP-800/1600 to deliver signals from field wiring to the input channels.
- **FWA-37U** is a field-wiring accessory containing screw terminals. This accessory plugs into connector P4 on the EXP-800/1600 to route signals from field wiring directly to the attached DAS board/card.
- **ENCL Series** are enclosures for one (ENCL-1), two (ENCL-2), or four (ENCL-4) EXP-800/1600s with access for all required cabling and accessories.
- **PWR-5V** is a power supply for supplying external power to EXP-800/1600s; this supply converts 100 to 240 VAC at 50 to 60 Hz to +5 VDC.

# 2

## Functional Description

This chapter describes features of the EXP-800/1600. The descriptions are provided to familiarize you with the operating options and to enable you to make the best use of your EXP-800/1600. Figure 2-1 shows the block diagram for the EXP-800/1600.

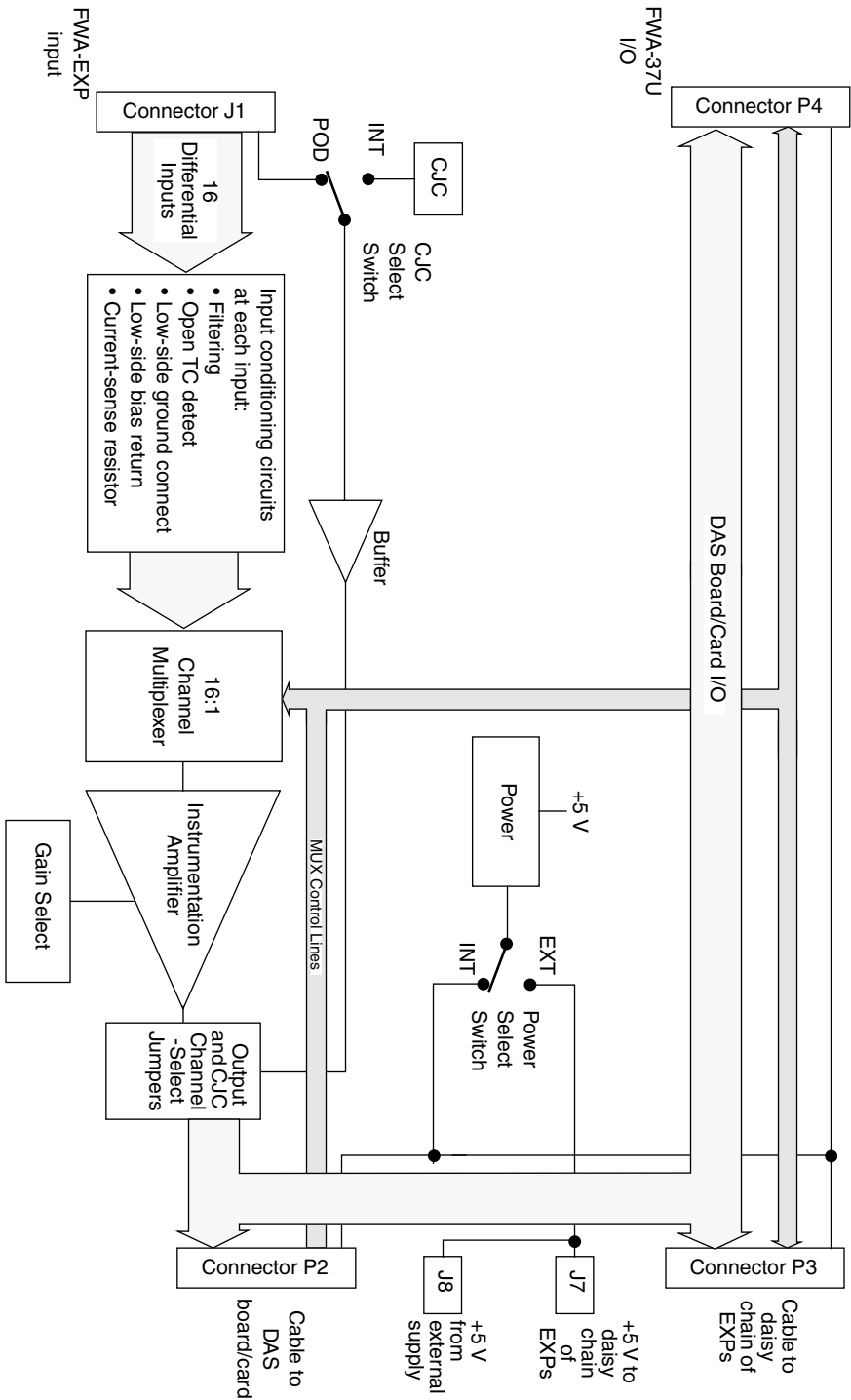


Figure 2-1. Block Diagram of EXP-800/1600

# Ground Types

An EXP-800/1600 contains separate grounds for low-level signals, analog power returns, digital signals, and chassis ground. The ground for analog signals is LL GND (low-level ground); as its title suggests, LL GND is for low-level analog input signals and is designed to be as noise-free as possible. The ground for analog power returns, bypass capacitors, and so on, is GND A. The ground for digital signals is GND D. Chassis ground is tied to the metal parts and back to GND D; chassis ground is CH GND.

## Input Conditioning Options

The input of each EXP-800/1600 channel contains the conditioning circuitry shown in Figure 2-2.

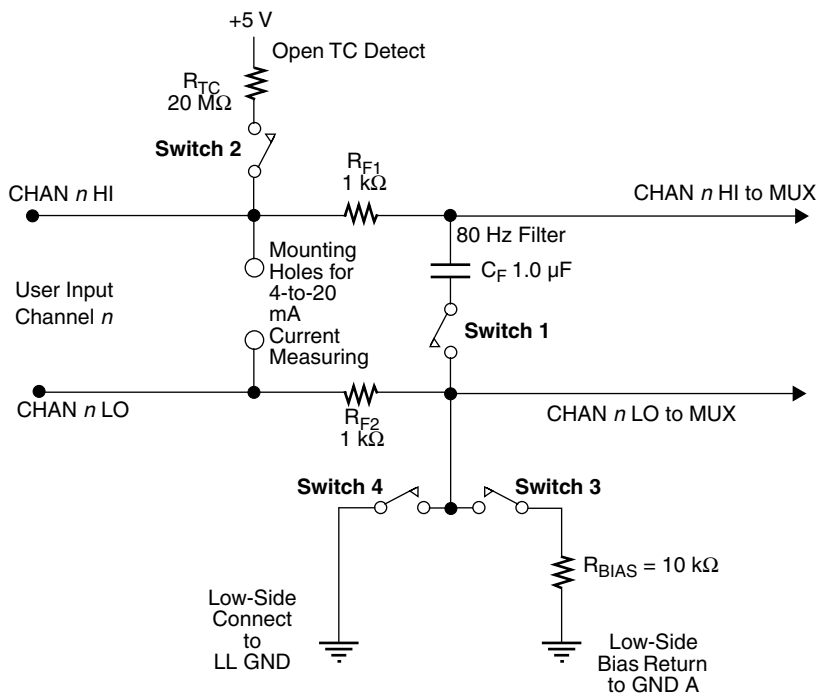


Figure 2-2. EXP-800/1600 Input Conditioning Circuits

Descriptions of the individual conditioning circuits are as follows:

- **Filtering** - Closing switch 1 activates an 80 Hz low-pass filter composed of  $R_{F1}$ ,  $R_{F2}$  and  $C_F$ .
- **Open-thermocouple detection** - Closing switches 2 and 3 activates an open-thermocouple detector composed of  $R_{TC}$  and  $R_{BIAS}$ .
- **Low-side bias return** - Closing switch 3 provides a reference to analog power ground (GND A) through  $R_{BIAS}$  for ungrounded differential inputs. This reference to ground provides some isolation from other channels.
- **Low-side ground connect** - Closing switch 4 enables you to reference an input directly to low-level ground (LL GND), making a single-ended input. Before using this switch, refer to the cautionary note on page 3-5.
- **Mounting holes for 4-to-20 mA current-measuring resistor** - Selecting and mounting a resistor in these holes allows you to make 4-to-20 mA measurements.

Refer to “Setting the Input-Conditioning Options” on page 3-4 for information on setting up the input conditioning options.

## Multiplexer

---

An EXP-800/1600 multiplexes signals from 16 differential analog input channels into one signal for the analog output. The sequence of channel sampling in the multiplexer is selected by a 4-bit TTL/CMOS-compatible address on the mux control lines, which are labelled OUT 0 to OUT 3 on EXP-800/1600 I/O connectors P2, P3, and P4 (see Appendix B for pin assignments). An address of 0h selects channel 0, 1h selects channel 1, 2h selects channel 2, and so on.

You set up the multiplexer channel-sampling sequence using the DAS board/card’s Function Call Driver (see the user’s guide for the DAS board/card’s Function Call Driver) or a software package. The DAS board/card delivers the address codes to the EXP-800/1600 mux control lines through outputs OP1 to OP4. Digital output control is transparent.

---

**Caution:** To ensure good data (when using a software package other than the Keithley MetaByte Function Call Driver), program the multiplexer switching to allow sufficient time for the multiplexer to settle after switching. You need a delay, in microseconds, that is approximately 40% of the gain; for example, you need a delay of 200  $\mu$ s at a gain of 500.

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## Instrumentation Amplifier

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The multiplexer output feeds to an instrumentation amplifier (IA) with switch-selectable gains of 1, 10, 100, and 500. The EXP-800/1600 also contains a slide switch that allows multiplication of the gain setting by factors of 1 or  $\frac{1}{2}$ . Table 2-1 shows examples of the effects of the multiplier switch.

**Table 2-1. Examples of Gain Settings on Input Voltages**

Gain Setting	With S2 = X1, $V_{in}$ Needed for $\pm 5$ V Out	With S2 = X $\frac{1}{2}$ , $V_{in}$ Needed for $\pm 5$ V Out
1	$\pm 5$ V	$\pm 10$ V
10	$\pm 0.5$ V	$\pm 1$ V
100	$\pm 0.05$ V	$\pm 0.10$ V
500	$\pm 0.01$ V	$\pm 0.02$ V

In addition to setting the gain with switches alone, you can adjust the gain by setting the switches for a gain of 1 and then selecting and installing a resistor in special mounting holes on the EXP-800/1600. Refer to “Setting the Gain” on page 3-6 for information on setting the gain by switch and/or resistor.

The overall gain you set on the EXP-800/1600 combines with the gain of the attached DAS board/card to produce a possible system gain of up to 4000. EXP-800/1600 gains are accurate to 0.02%.

# CJC Circuits

---

The EXP-800/1600 and the FWA-EXP include CJC circuitry that delivers 0.0 mV at 0 °C and 24.4 mV/°C. The latter value corresponds to the digital values shown in Table 2-2.

**Table 2-2. Digital Values for 24.4 mV/°C**

Input Mode	Input Range	Digital Value
Unipolar	0 to 10 V	10 bits/°C
	0 to 5 V	20 bits/°C
Bipolar	±10 V	5 bits/°C
	±5 V	10 bits/°C

You can connect the CJC output voltage to any DAS board/card channel using a jumper (refer to “Positioning the Output-Channel-Select and CJC-Channel-Select Jumpers” on page 3-8).

## Power

---

The host computer can supply power sufficient to support a DAS board/card and up to two attached EXP-800/1600s. If you need to attach more than two EXP-800/1600s, you must power each additional EXP-800/1600 from an external supply.

EXP-800/1600 circuitry for an external power supply contains a relay activated by the +5 V supply of the host computer. When closed, the relay carries power to the built-in DC/DC converter from an external +5 V supply. The relay energizes to close its contacts only when the +5 V of the host computer is available and connected to the activation circuit through a slide switch. Refer to “Setting the Power-Select Switch” on page 3-9 for information on setup.

# Inspection and Setup

This chapter describes how to inspect and set up an EXP-800/1600. Read this chapter before attempting to use your EXP-800 or EXP-1600.

## Unwrapping and Inspecting Your EXP-800/1600

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**Caution:** Your computer must be turned OFF and grounded before you perform the following procedure.

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After you remove your wrapped EXP-800/1600 from its outer shipping carton, proceed as follows:

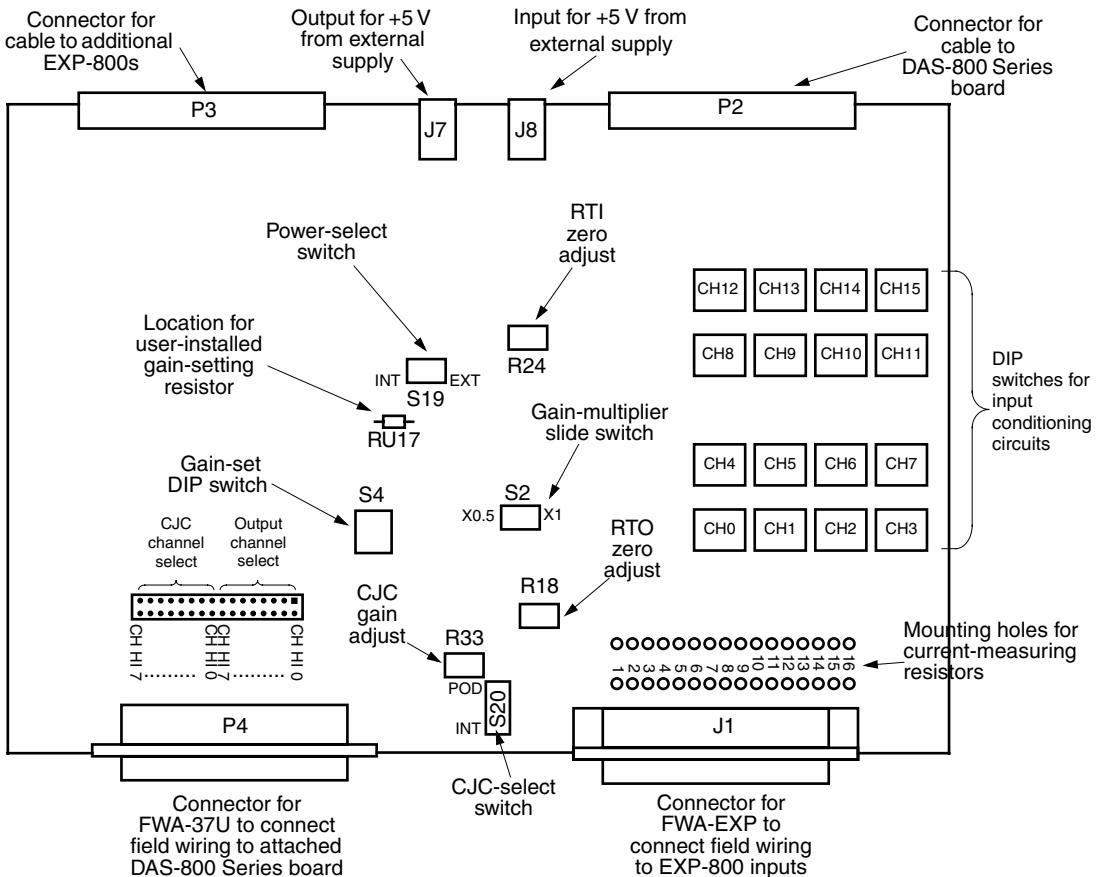
1. The factory packages your EXP-800/1600 in an anti-static wrapper that must not be removed until you have discharged any static electricity using either of the following methods:
  - If you are equipped with a grounded wrist strap, you discharge static electricity as soon as you hold the wrapped EXP-800/1600.
  - If you are not equipped with a grounded wrist strap, discharge static electricity by holding the wrapped EXP-800/1600 in one hand while placing your other hand firmly on a metal part of the computer chassis.
2. Carefully remove the anti-static wrapping material. (You may wish to store the wrapping material for future use.)
3. Inspect the EXP-800/1600 and any other items from the package for signs of damage. If damage is apparent, return the damaged item to the factory (see “Technical Support” on page 6-4).



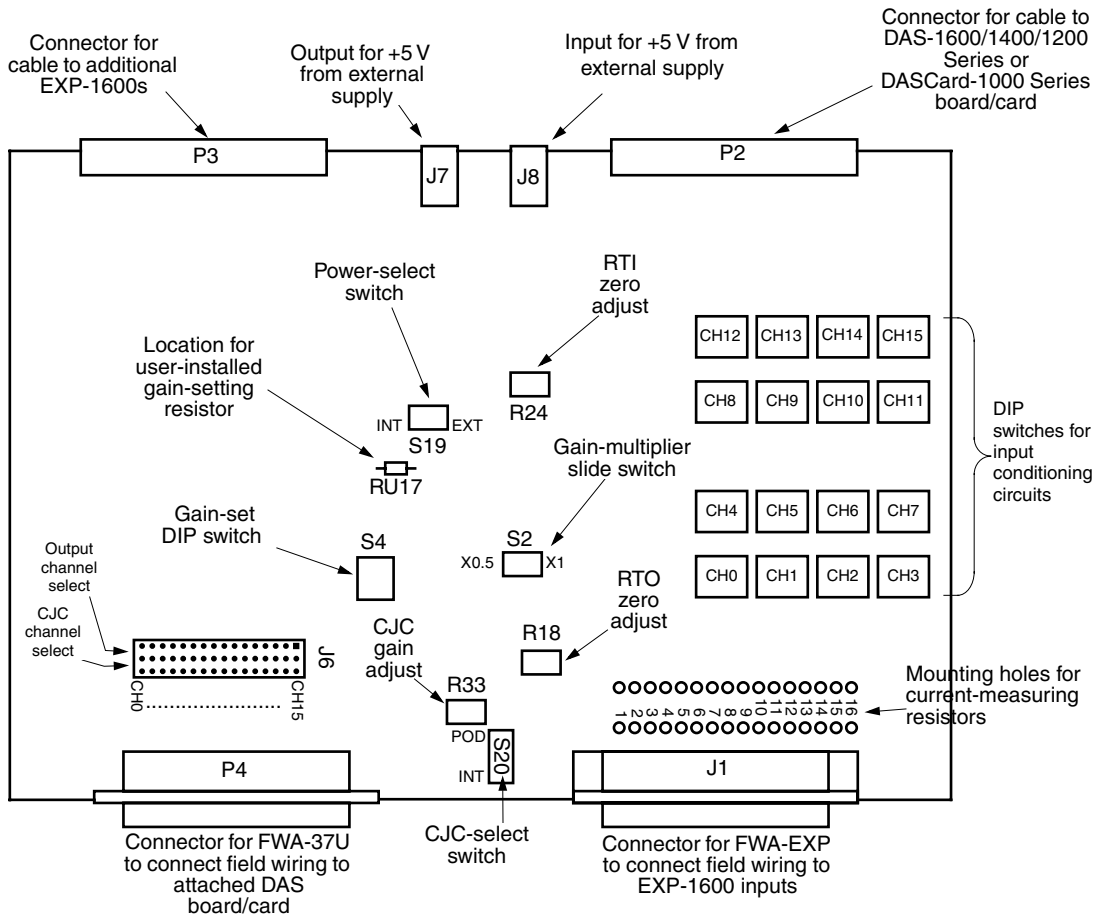
4. Check the contents of your package against the packing list. Report any missing items, immediately.
5. When the inspection is complete, proceed with the setup.

## Component Locations

Figure 3-1 shows the locations of all configurable EXP-800 components while Figure 3-2 shows the locations of all configurable EXP-1600 components.



**Figure 3-1. Configuration Component Locations on the EXP-800**



**Figure 3-2. Configuration Component Locations on the EXP-1600**

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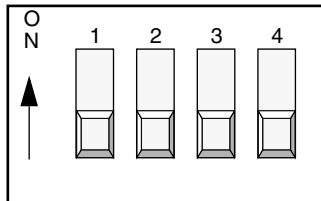
**Note:** R18, R24, and R33 are potentiometers requiring adjustment only during the calibration process. Since your EXP-800/1600 is factory calibrated, re-calibration should not be necessary until the initial calibration period ends. Refer to Chapter 5 for calibration requirements and procedures.

---

# Setting the Input-Conditioning Options

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The four switches in the input conditioning circuits for each channel are contained in a 4-pole DIP switch that appears as shown in Figure 3-3. Note that the switch numbers in the diagram of Figure 2-2 on page 2-3 correspond to the numbers printed on the DIP switch.



**Figure 3-3. A 4-Pole DIP Switch for Input Conditioning Options (switches closed when ON)**

Generally, you leave all switches open for a pure differential input. You close only switch 1 for a differential input that is to have low-pass filtering. You close switches 1, 2, and 3 together for thermocouple measurements. You close only switch 4 for a wide-band, single-ended input. You close switches 1 and 4 together for a single-ended input that requires low-pass filtering.

---

**Note:** Do not close switches 3 and 4 together, as this combination of settings shorts  $R_{BIAS}$  to ground and seriously degrades performance.

---

The following subsections describe the use of each of the input-conditioning circuits and their switches.

## Signal Filtering (Switch 1)

Closing switch 1 combines resistors  $R_{F1}$  and  $R_{F2}$  with capacitor  $C_F$  to form an 80 Hz low-pass filter. Opening switch 1 disables the filter to give faster settling time. A closed setting is recommended for thermocouple measurements. The default setting for switch 1 is open.

## Open-Thermocouple Detection (Switches 2 and 3)

Closing switch 2 puts the 20 M $\Omega$  resistor,  $R_{TC}$ , between the high side of a thermocouple input and the +5 V supply. Closing switch 3 completes the open-thermocouple-detection circuit by putting the 10 k $\Omega$  resistor,  $R_{BIAS}$ , between the low side of a thermocouple input and ground. Resistors  $R_{TC}$  and  $R_{BIAS}$  respond to an open thermocouple by changing the input voltage to +5 V. As +5 V is much larger than the output voltage of a thermocouple, you can develop a software routine to sense any input voltage above a certain threshold and flag the open thermocouple. The default setting for switches 2 and 3 is open.

## Ground Selection (Switches 3 and 4)

Closing switch 3 provides a reference to analog power ground (GND A) for differential circuits that are not grounded. Switch 3 must be closed when you wish to activate open-thermocouple detection. The default setting for switch 3 is open.

Closing switch 4 enables you to reference an input to low-level ground (LL GND). The default setting for switch 4 is open.

---

**Caution:** Use care when you short channels to LL GND using switch position 4. Switching a single channel to LL GND is not generally a problem. However, shorting multiple channels to LL GND can cause significant ground current to flow (as a result of common-mode potential between channel sources); the resulting noise and offsets can degrade not only the channels so connected, but all other active channels. In this case, using switch position 3 ( $R_{bias}$  to GND A) may give better results.

---

## 4-to-20 mA Current Measuring

The 4-to-20 mA current-measuring option requires the installation of a resistor in the mounting holes for the desired channel input. These mounting holes are located as shown in Figure 3-1 on page 3-2 and Figure 3-2 on page 3-3. A typical resistor value for 4-to-20 mA current measuring is 250  $\Omega$ . (with 0.1% accuracy).

While 4 to 20 mA is the more frequently used measuring range, the actual measuring range of this option is 100  $\mu$ A to 100 mA, at a nominal 0.03% accuracy. To determine a resistance value for a particular current value, use the relationship

$$R_{Sample} = \frac{\pm 10V}{(DASGain) \cdot (EXPGain) \cdot (I_{FullScale})}$$

where  $R_{Sample}$  is the value of the current-measuring resistor,  $\pm 10$  V is the full-scale input range, DASGain is the gain of the DAS board/card, EXPGain is the gain of the EXP-800/1600, and  $I_{FullScale}$  is the anticipated current flow. For example, for a DAS board gain of 8, an EXP-800/1600 gain of 100, and a full-scale current of 100  $\mu$ A, the resistance becomes

$$R_{Sample} = \frac{10}{(8) \cdot (100) \cdot (0.0001)}$$

for a resistance value of 125  $\Omega$ .

## Setting the Gain

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You can set EXP-800/1600 gain in the following ways:

- Using 2-pole DIP switch S4, you can set the gain to one of four values, as follows:

Pole 1	Pole 2	Gain
On	On	1
On	Off	10
Off	On	100
Off	Off	500

- Using 2-position slide switch S2, you can select a multiplier value of 1 or  $\frac{1}{2}$  for the gain set with switch S4. At its  $\times \frac{1}{2}$  setting, S2 converts the gain values you can set with S4 from 1, 10, 100, or 500 to 0.5, 5, 50, or 250.

- Using resistor-mounting holes labelled *RU17*, you can select and install a resistor to set a gain that differs from any of the switch-selected values. To calculate a resistance value for *RU17*, use the relationship

$$R_I = \frac{2R_F}{G - 1}$$

where  $R_I$  is the resistance value for *RU17*,  $R_F$  is a fixed resistance value of 5.11 k $\Omega$   $\pm$ 1%, and  $G$  is the desired gain.

---

**Note:** *RU17* is effective only when switch *S4* is set for a gain of 1. When *S4* is set for a gain of 10, 100, or 500, the presence of *RU17* has no effect.

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## Setting the CJC-Select Switch

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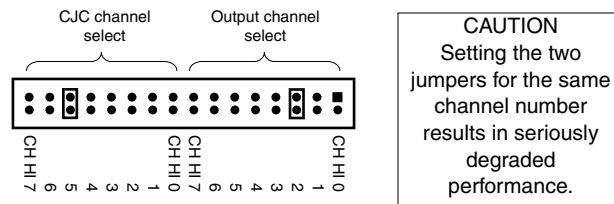
Switch *S20* determines whether your data acquisition system uses the CJC circuit on the EXP-800/1600 or the CJC circuit on the FWA-EXP. The two positions for this switch are clearly marked as *POD* (for using the CJC on the FWA-EXP) and *INT* (for using the CJC on the EXP-800/1600).

While the CJC circuits on the EXP-800/1600 and the FWA-EXP are the same, the CJC on an attached FWA-EXP gives the more accurate measurement of temperature at the field-wiring connections. Therefore, if you are using an attached FWA-EXP for thermocouple measurements, set switch *S20* to *POD*.

# Positioning the Output-Channel-Select and CJC-Channel-Select Jumpers

An EXP-800/1600 contains a 16-position jumper block (J6) that allows you to select one channel for the EXP-800/1600 output and a separate channel the CJC output. Figure 3-4 shows the EXP-800 jumper block set as follows:

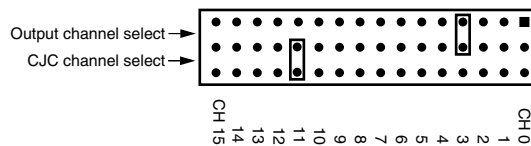
- The output-channel-select jumper is set for channel 2.
- The CJC-channel-select jumper is set for channel 5.



**Figure 3-4. EXP-800 Jumper Block**

Figure 3-5 shows the EXP-1600 jumper block set as follows:

- The output-channel-select jumper is set for channel 3.
- The CJC-channel-select jumper is set for channel 11.



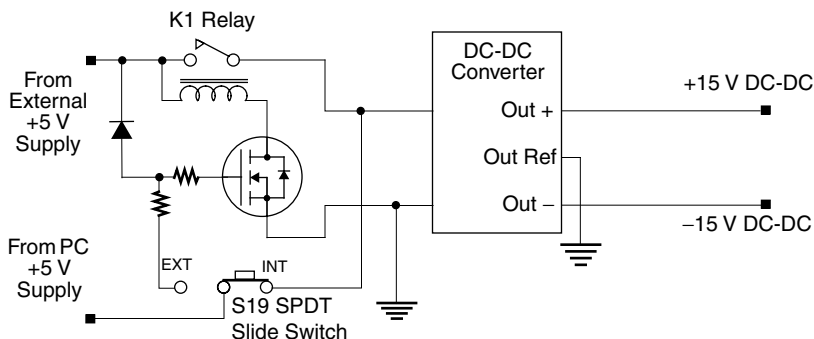
**Figure 3-5. EXP-1600 Jumper Block**

## Setting the Power-Select Switch

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When you attach more than two EXP-800/1600s to a DAS board/card, you must use external power for the additional EXP-800/1600s. In addition, you must set the power-select switch (S19) of each additional EXP-800/1600 to EXT.

Refer to Chapter 4 for additional instructions on connecting EXP-800/1600s to an external power source. Figure 3-6 shows switch S19 positioned at INT to power the DC-DC converter with power from the +5 V supply of the host computer.



**Figure 3-6. Power-Select Circuit**

## Installing in an ENCL Series Enclosure

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Each version of an ENCL Series enclosure contains slotted card guides and a rear panel that accommodates the rear connectors of each installed EXP-800/1600. Figure 3-7 shows an ENCL-4 enclosure (without rear panel) with four pairs of slotted card guides. Screw holes for front-panel screws of the EXP-800/1600s are shown on the front face of each card guide.





**Figure 3-7. ENCL-4 Enclosure with Four Pairs of Slotted Card Guides (rear panel not shown)**

To install an EXP-800/1600 in an ENCL Series enclosure, perform the following steps:

1. Remove the four standoffs from each EXP-800/1600 to be installed.
2. Insert an EXP-800/1600 into the slots of a pair of card guides.
3. Gently push the EXP-800/1600 toward the rear of the desktop enclosure until the front-panel screws meet the tapped holes on the card guides.
4. Fasten the front-panel screws to the card guides.

An ENCL-4 containing four EXP-800/1600s appears as shown in Figure 3-8.



CAUTION  
Do not mix EXP-800s with EXP-1600s  
in an enclosure.

**Figure 3-8. ENCL-4 Enclosure with Four EXP-800/1600s Installed**

Refer to Chapter 4 for cabling instructions.

# 4

## Cabling and Wiring

This chapter describes how to make connections to your EXP-800/1600.

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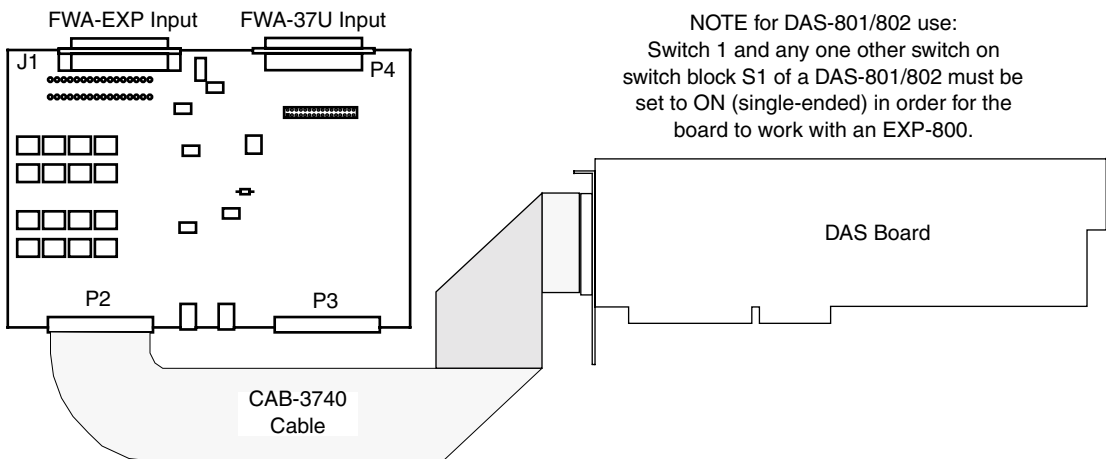
**Caution:** Avoid electrical damage by turning off power to all your data acquisition system equipment before making connections.

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### Connecting to a DAS-800/1600/1400/1200 Series Board

---

Before connecting an EXP-800/1600 to a DAS board, configure the channels of the DAS board as single-ended inputs. An EXP-800/1600 connects directly to the main I/O connector of a DAS board through a CAB-3740 cable, as shown in Figure 4-1.



**Figure 4-1. Connecting an EXP-800/1600 to a DAS Board**

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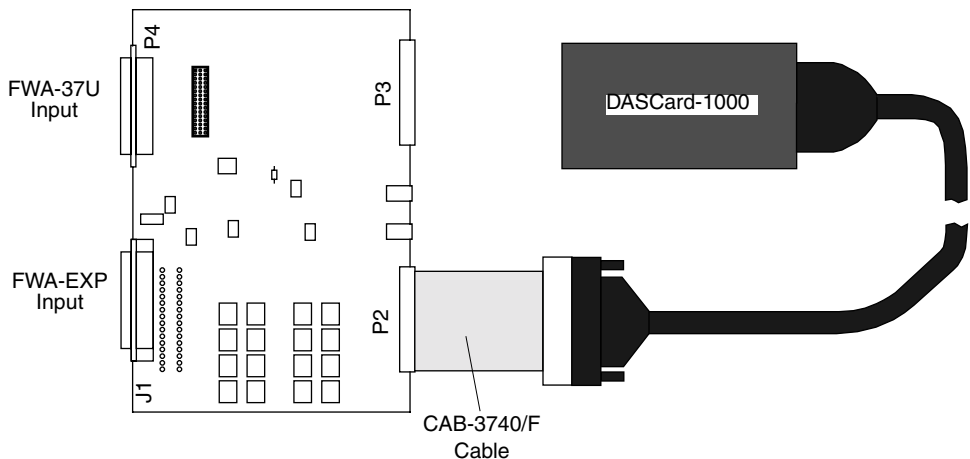
**Caution:** Connecting an EXP-800 to a DAS-1600/1400/1200 Series board or an EXP-1600 to a DAS-800 Series board can damage either or both boards.

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## Connecting to a DASCard-1000 Series Card

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Before connecting an EXP-1600 to a DASCard-1000 Series card, configure the channels of the DAS card as single-ended inputs. An EXP-1600 connects to the DAS card cable through a CAB-3740/F cable, as shown in Figure 4-2.

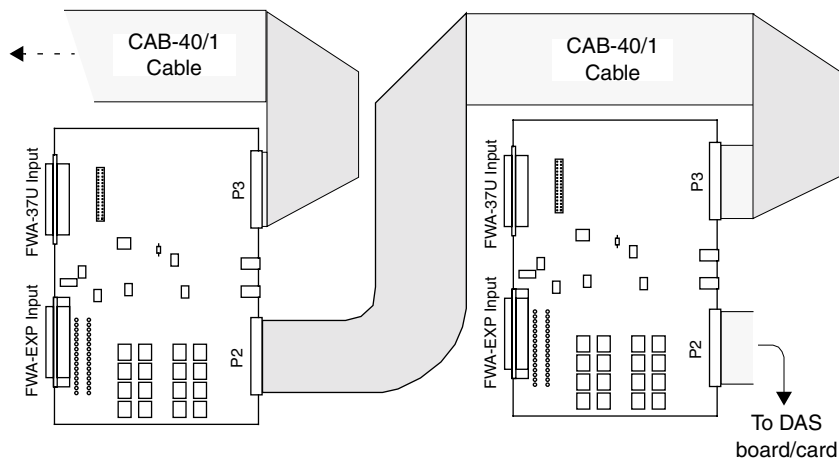


**Figure 4-2. Connecting an EXP-1600 to a DASCard-1000 Series Card**

Use external power for an EXP-1600 connected to a DASCard-1000 Series card to eliminate any unnecessary drain on the battery of the portable computer. When use connect external power to the EXP-1600, set the power-select switch to EXT.

# Connecting Multiple EXP-800/1600s on Standoffs

You can attach up to 16 EXP-1600s to a DAS-1600/1400/1200 Series board or DASCARD-1000 Series card or up to eight EXP-800s to a DAS-800 Series board. To connect one or more additional EXP-800/1600s that are mounted on standoffs (EXP-800/1600s are factory-fitted with standoffs), use CAB-40/1 cables as shown in Figure 4-3.



### CAUTION

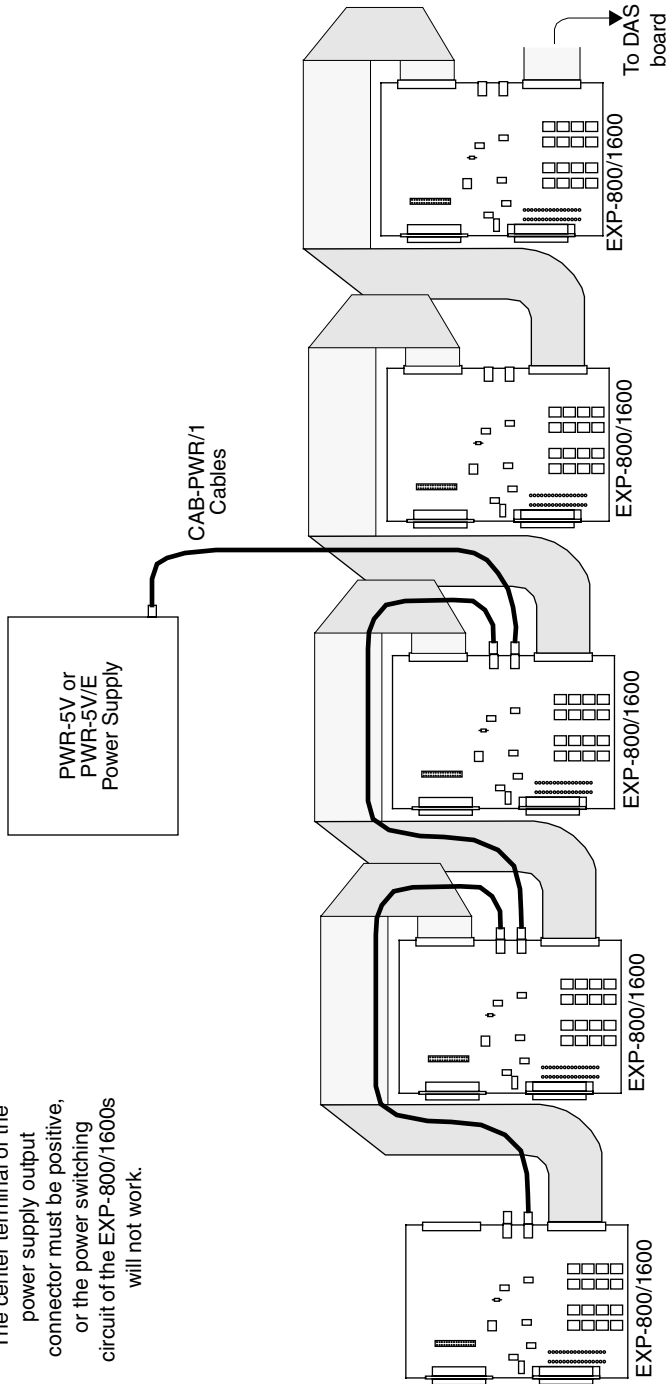
Do not mix EXP-800s with EXP-1600s in a daisy chain.

**Figure 4-3. Connecting Multiple EXP-800/1600s on Standoffs**

If you are connecting multiple EXP-800/1600s to a DAS board, the computer furnishes power through the DAS board for the first two EXP-800/1600s in a daisy chain. If you attach more than two EXP-800/1600s to a DAS board you must use external power for the additional EXP-800/1600s. Connect the external power as shown in Figure 4-5.

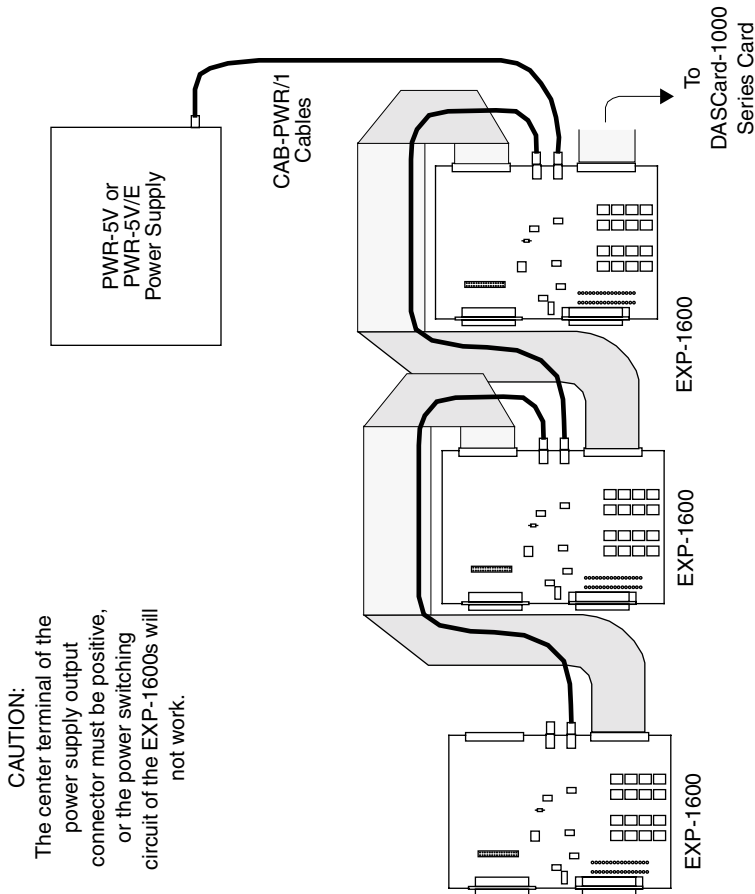
**Note:** When you connect more than one EXP-800 /1600 in a daisy chain, the digital lines to all EXP-800/1600s are in parallel and therefore delivering the same multiplexer channel-selection sequence to all attached EXP-800/1600s simultaneously.

**CAUTION:**  
The center terminal of the power supply output connector must be positive, or the power switching circuit of the EXP-800/1600s will not work.



**Figure 4-4. Connecting External Power for EXP-800/1600s (on Standoffs) Attached to a DAS Board**

If you are connecting multiple EXP-1600s to a DASCard-1000 Series card, you must use external power for all the EXPs in the daisy chain. Although the power supply in a portable computer can power an EXP-1600, the resulting drain of battery power is substantially faster than normal. Connect the external power as shown in Figure 4-5.

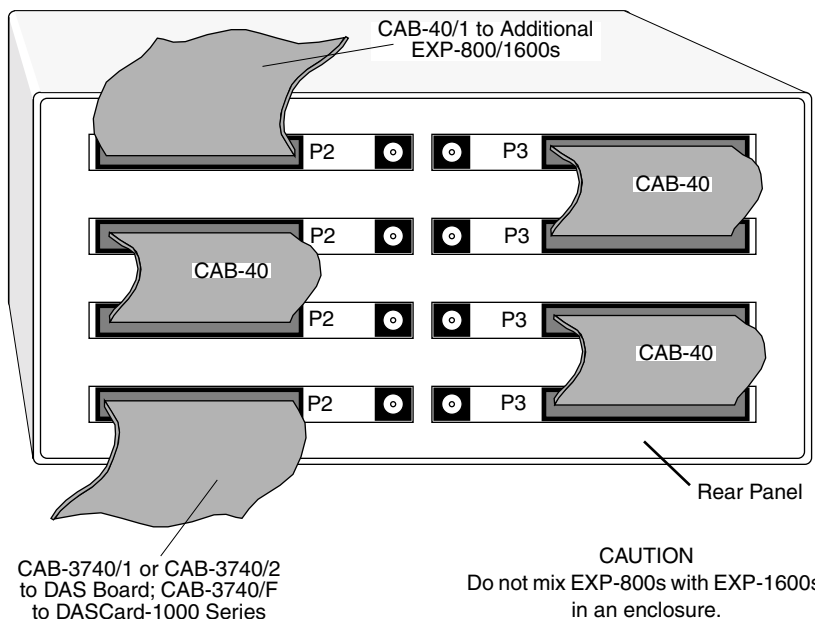


**Figure 4-5. Connecting External Power for EXP-800/1600s (on Standoffs) Attached to a DASCard-1000 Series Card**

Set the power-select switch (S19) to EXT on each EXP-800/1600 connected to the external power supply. When you connect the CAB-PWR/1 cables as shown in Figure 4-5, you can power up to four EXP-800/1600s from a single power supply (this limitation is caused by wire size). If you use parallel connections from the power supply, the only limitation is the current capacity of the power supply.

# Connecting Multiple EXP-800/1600s in an ENCL Series Enclosure

To connect one or more additional EXP-800/1600s that are mounted in an ENCL Series enclosure, use CAB-40 cables as shown in Figure 4-6. You can attach up to 16 EXP-1600s to a DAS-1600/1400/1200 Series board or DASCARD-1000 Series card or up to eight EXP-800s to a DAS-800 Series board in this manner.



**Figure 4-6. Connecting Multiple EXP-800/1600s in an ENCL Series Enclosure**

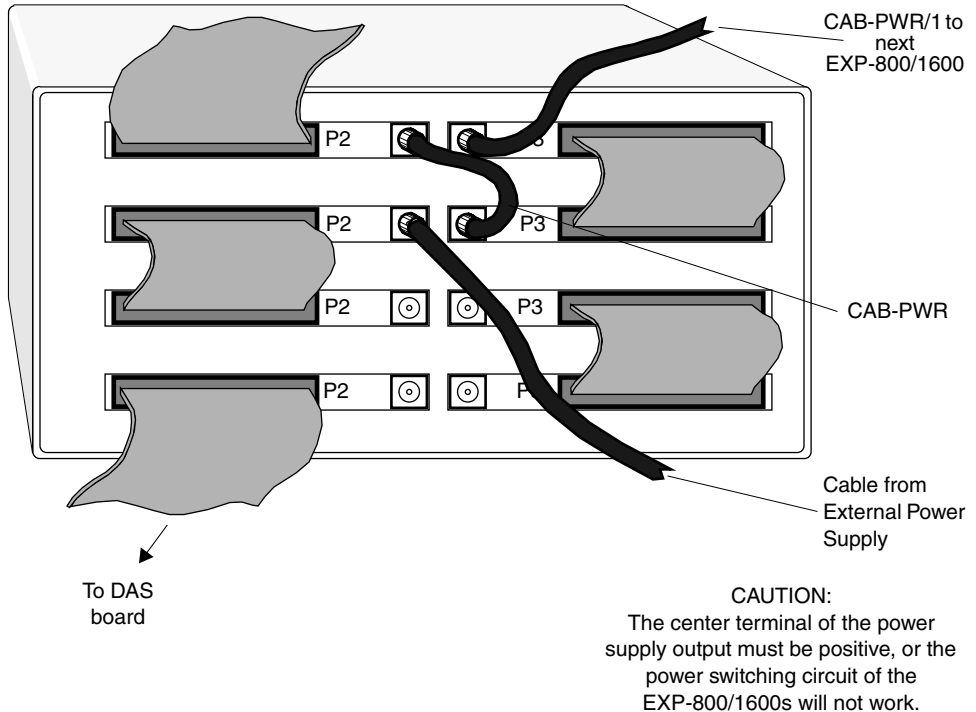
The DAS board furnishes power for the first two EXP-800/1600s in a daisy chain. When you attach a DAS board to more than two EXP-800/1600s mounted in an ENCL Series enclosure, you must use external power for the additional EXP-800/1600s, as shown in Figure 4-7.



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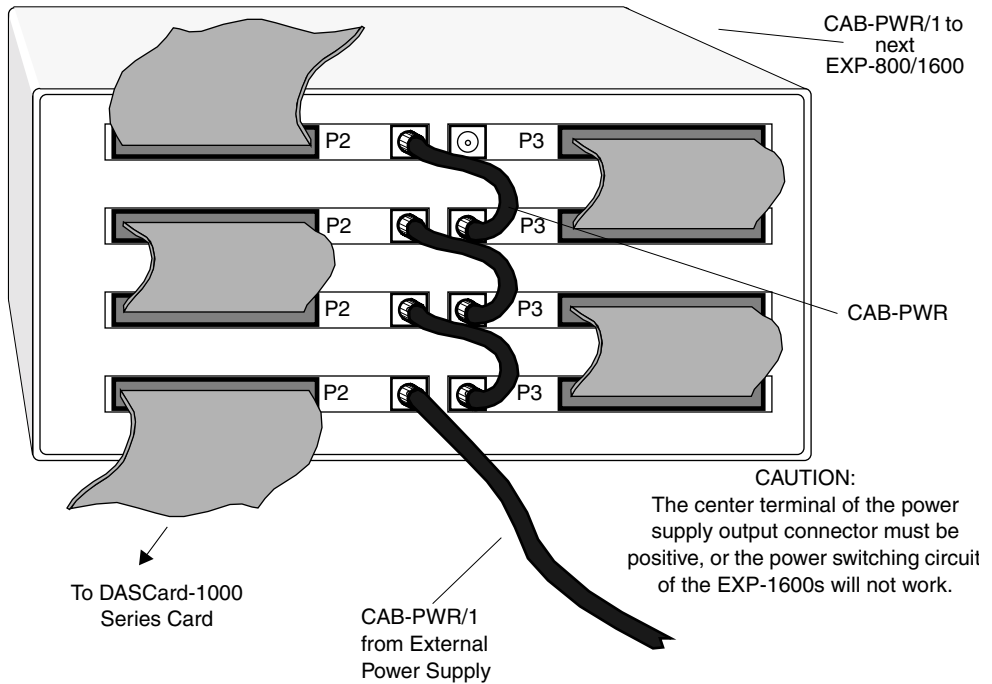
**Note:** When you connect more than one EXP-800 /1600 in a daisy chain, the digital lines to all EXP-800/1600s are in parallel and therefore delivering the same multiplexer channel-selection sequence to all attached EXP-800/1600 simultaneously.

---



**Figure 4-7. Connecting External Power to EXP-800/1600s in an ENCL Series Enclosure (lower two EXP-800/1600s are powered by DAS board)**

If you are connecting multiple EXP-1600s to a DASCARD-1000 Series card, you must use external power for all the EXPs in the daisy chain. Although the power supply in a portable computer can power an EXP-1600, the resulting drain of battery power is substantially faster than normal. Connect the external power as shown in Figure 4-8.



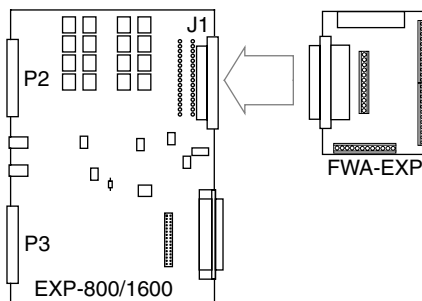
**Figure 4-8. Connecting External Power to EXP-1600s in an ENCL Series Enclosure Attached to a DASCARD-1000 Series Card**

Set the power-select switch (S19) to EXT on each EXP-800/1600 connected to the external power supply. When you connect the CAB-PWR and CAB-PWR/1 cables as shown in Figure 4-7 on page 4-7, you can power up to four EXP-800/1600s from a single power supply (this limitation is caused by wire size). If you use parallel connections from the power supply, the only limitation is the current capacity of the power supply.

## Connecting an FWA-EXP

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The FWA-EXP field wiring accessory is a compact, screw-terminal panel that plugs into connector J1 of an EXP-800/1600. This accessory provides an interface between field wiring and circuits of the EXP-800/1600. The FWA-EXP contains a CJC circuit that can be connected to any DAS board/card channel by setting switch S20 to POD and setting the CJC-channel-select jumper on the EXP-800/1600. Before attaching the FWA-EXP, remove the two retainer screws from connector J1 on the EXP-800/1600. Attach the FWA-EXP as shown in Figure 4-9. Secure the FWA-EXP to J1 using the two retainer screws.



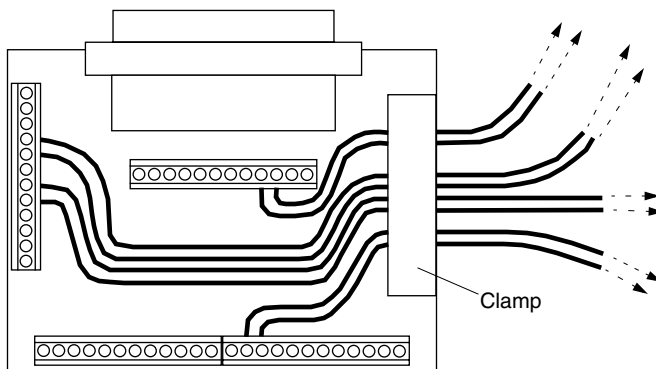
**Figure 4-9. Attaching an FWA-EXP to an EXP-800/1600**

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**Note:** The CJC screw terminals on the FWA-EXP require no connections. You make all connections between the CJC and a DAS board/card channel by setting the CJC jumper and switch S20 on the EXP-800/1600.

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The clamp on the side of the FWA-EXP is provided to serve as a strain relief for field wiring attached to the screw terminals. Run all field wiring through the clamp as shown in Figure 4-10.

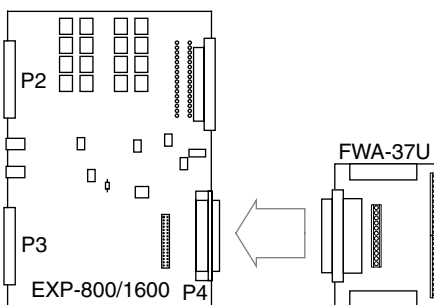


**Figure 4-10. Clamping Wire Pairs Attached to Screw Terminals of the FWA-EXP**

## Connecting an FWA-37U

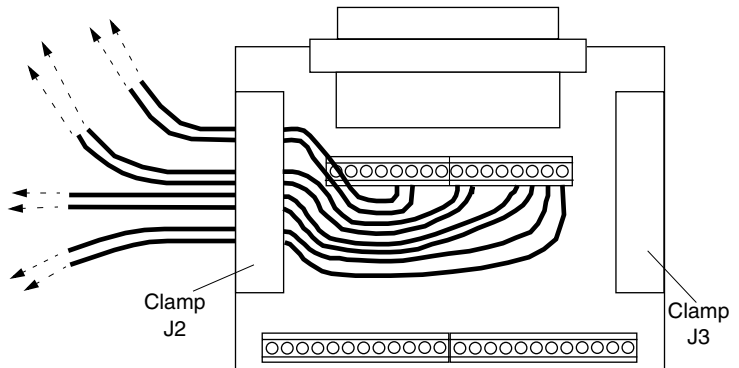
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The FWA-37U field wiring accessory is a compact, screw-terminal panel that plugs into connector P4 of an EXP-800/1600. This accessory provides direct access to the DAS board/card main I/O connector. The FWA-37U attaches to an EXP-800/1600 as shown in Figure 4-11.



**Figure 4-11. Attaching an FWA-37U to an EXP-800/1600**

Clamp J2 on the side of the FWA-37U is provided to serve as a strain relief for field wiring attached to the screw terminals. Run all field wiring through clamp J2 as shown in Figure 4-12.



**Figure 4-12. Clamping Wire Pairs Attached to Screw Terminals of the FWA-37U**

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**Note:** A breadboard area of plated-through holes contains three rows of bussed holes labeled LLGND, GNDD, and 5V+PC. Because none of these holes connects to any signal track on the panel, you must wire each of the three rows of bussed holes to a screw terminal that carries the corresponding signal (to determine what screw terminals carry what signals, refer to the pin assignments for your DAS board in Appendix B).

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## Connecting Signals

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This section contains precautionary advice on making I/O connections. The section also shows some circuits for wiring signal sources to inputs of an EXP-800/1600.

The circuit diagrams in this section represent a single signal source wired to a single channel (channel  $n$ ). In reality, you can wire separate signal sources to all the channels.

## Precautions

If you expect to use a DAS board/card at high gain, read the precautionary information in the following subsection. Other considerations for I/O connections are offered under “Additional Precautions” on page 4-12.

### ***Precautions for Using a DAS Board/Card at High Gains***

Operating a DAS board/card with an EXP-800/1600 above gains of 50 can lead to problems if your application setup is sensitive to noise. At a gain of 250, each bit of analog output corresponds to 10  $\mu\text{V}$  of analog input. Thus, with the high speed and bandwidth of this system, analog noise and performance degradation occur easily unless you take precautions to avoid them. The following collection of ideas and suggestions is aimed at avoiding these problems:

- Minimize noise from crosstalk and induced-voltage pickup in flat cables and screw-terminal accessories by using shielded cable. Connect the shield to CH GND and the inner conductors to Channel LO and HI. Channel LO and LL GND should have a DC return (or connection) at some point; this return should be as close to the signal source as possible. Induced noise from RF and magnetic fields can easily exceed tens of microvolts, even on one- or two-foot cables; shielded cable eliminates this problem.
- Avoid bi-metallic junctions in the input circuitry. For example, the kovar leads, used on reed relays, typically have a thermal emf to copper of 40  $\mu\text{V}/^\circ\text{C}$ . Thermals can introduce strange random variations caused by air currents, and so on.
- Consider filtering. This approach can use hardware (resistors, capacitors, and so on) but is often accomplished more easily with software. Instead of taking a single channel reading, take 10 or more readings in quick succession and average them. If the noise is random and gaussian, averaging the multiple readings will reduce the noise by the square-root of the number of readings.

### ***Additional Precautions***

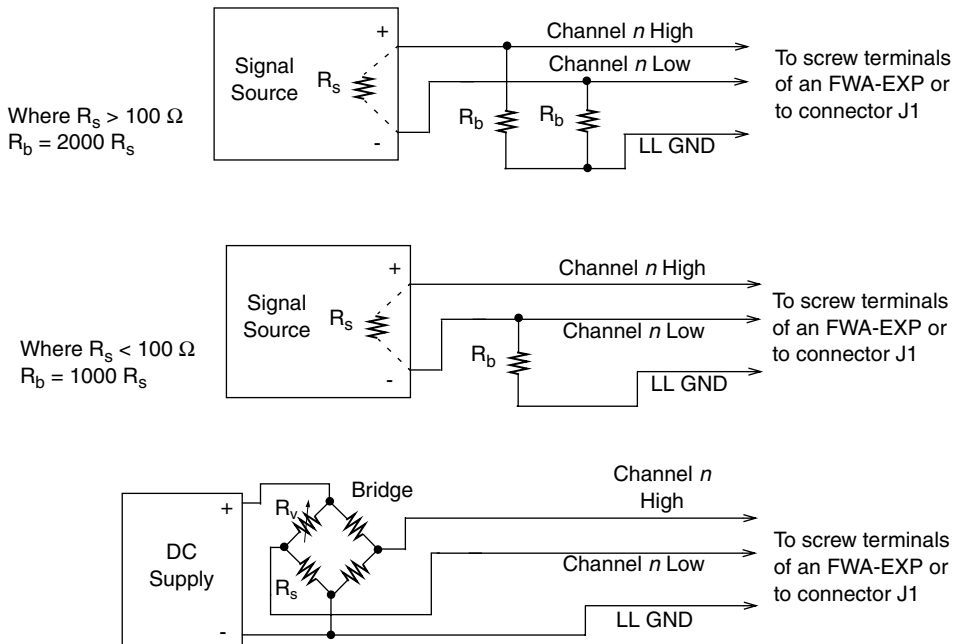
Do NOT mix your data acquisition inputs with the AC line, or you risk damaging the computer. Data acquisition systems give you access to inputs of the computer. An inadvertent short between data and power lines can cause extensive and costly damage to your computer. The

manufacturer can accept no liability for this type of accident. To prevent this problem, take the following precautions:

- Avoid direct connections to an AC line.
- Make sure all connections are tight and sound so that signal wires are not likely to come loose and short to high voltages.
- Use isolation amplifiers where necessary.

## Common Connection Schemes for Differential Inputs

Figure 4-13 shows three connection schemes for wiring a floating signal source to a channel of an FWA-EXP or to connector J1 on an EXP-800/1600.



**Figure 4-13. Three Types of Connections for Wiring a Signal Source to an FWA-EXP or to Connector J1**

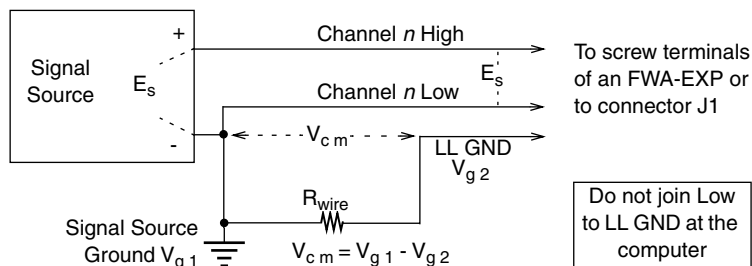
The upper two circuits of the diagram require the addition of resistors to provide a bias-current return. You can determine the value of the bias return resistors ( $R_b$ ) from the value of the source resistance ( $R_s$ ), using the following relationships:

- When  $R_s$  is greater than  $100 \Omega$ , use the connections in the upper circuit. The resistance of each of the two bias return resistors must equal  $2000 R_s$ .
- When  $R_s$  is less than  $100 \Omega$ , use the connections in the middle circuit. The resistance of the bias return resistor must be greater than  $1000 R_s$ .

In the lower circuit of Figure 4-13, bias current return is inherently provided by the source. The circuit requires no bias resistors.  $R_s$  is the signal source resistance while  $R_v$  is the resistance required to balance the bridge.

## Avoiding Ground Loops with Differential Inputs

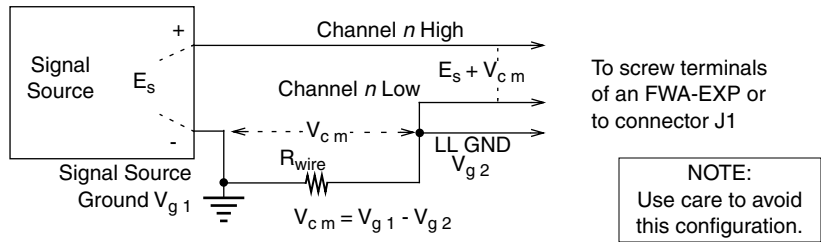
Very often, the signal-source ground and the EXP-800/1600 ground are not at the same voltage level because of the distances between equipment wiring and the building wiring. This difference is referred to as a *common-mode voltage* ( $V_{cm}$ ) because it is normally common to both sides of a differential input (it appears between each side and ground). Since a differential input responds only to the difference in the signals at its high and low inputs, its common-mode voltages cancel out and leave only the signal. However, if your input connections contain a ground loop, your input could see the sum of the signal-source and common-mode voltages. Figure 4-14 shows the proper way to connect a differential input.



**Figure 4-14. Differential Input Configuration that Avoids a Ground Loop**



Figure 4-15 illustrates the effect inadvertently adding a ground loop to your input configuration.



**Figure 4-15. Differential Input Configuration with a Ground Loop**

# 5

## Calibration

Your EXP-800/1600 is initially calibrated at the factory. You are advised to check the calibration of a board every six months and to calibrate again when necessary. This chapter describes the requirements and procedures for calibrating an EXP-800/1600.

### General

---

The EXP-800/1600 has two circuit sections that require calibration. The first is the analog offset (RTI/RTO) adjustments in the gain circuit. The second is the CJC gain adjustment in the CJC gain circuit. If you do not plan to make CJC measurements, you can omit CJC calibration.

### Equipment Requirements

---

The equipment requirements for calibrating an EXP-800/1600 are as follows:

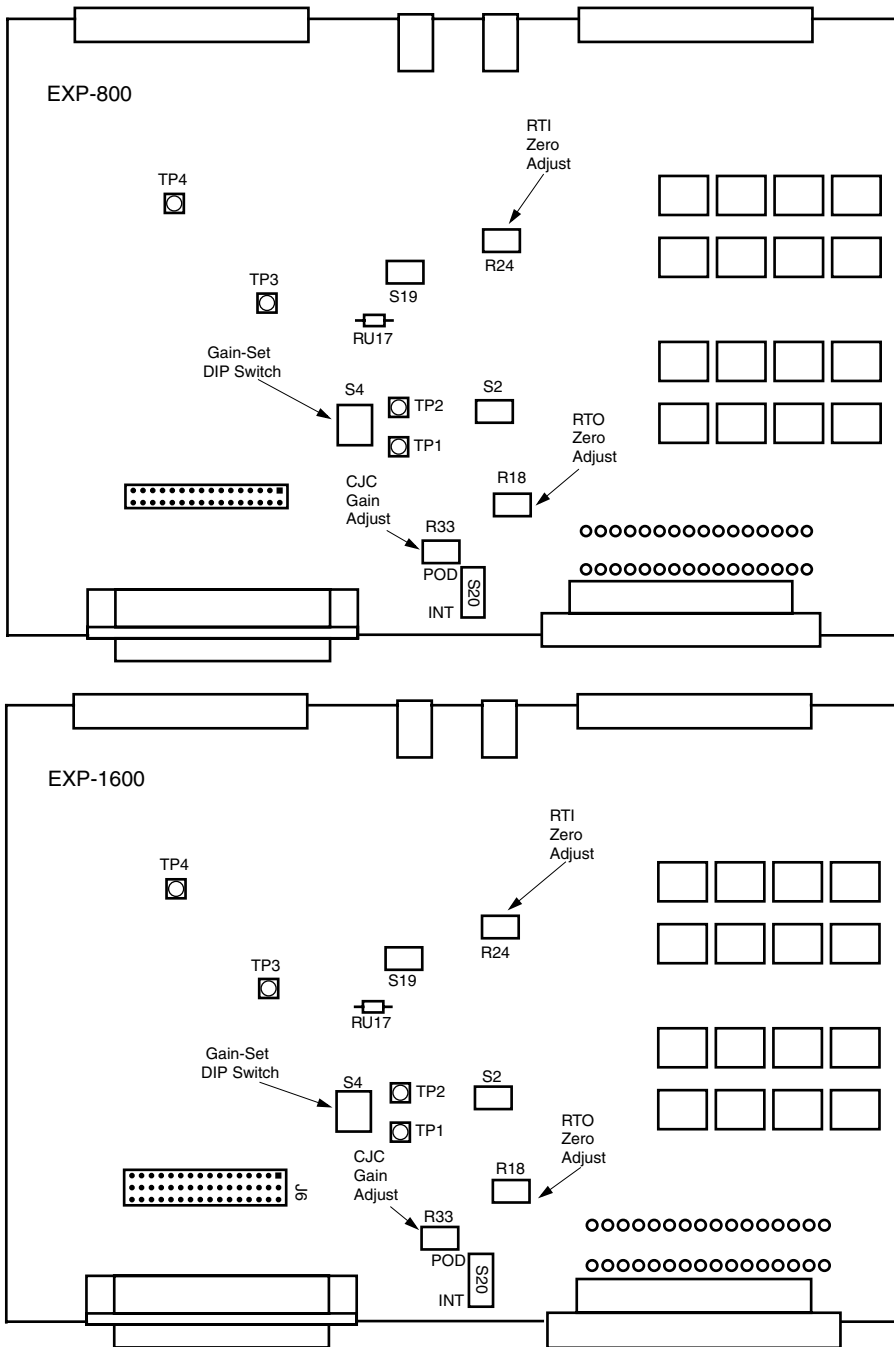
- **DAS board/card.** Use one of the following DAS boards/cards to control the EXP-800/1600 channel-selection circuit during analog offset calibration:
  - For EXP-800 calibration, use a DAS-800, DAS-801, or DAS-802.
  - For EXP-1600 calibration, use a DAS-1600, DAS-1400, or DAS-1200 Series board, or a DASCARD-1000 Series card.

- **Control Panel utility.** Use one of the following Control Panel utilities (provided with the DAS board software package) to control EXP-800/1600 operation:
  - For EXP-800 calibration, use either the DAS-800 Control Panel utility for MS DOS (CTL800.EXE) or for Windows (CTL800W.EXE).
  - For EXP-1600 calibration with a DAS board, use either the DAS-1600 Control Panel utility for DOS (CTL1600.EXE) or for Windows (CTL1600W.EXE).
  - For EXP-1600 calibration with a DASCARD-1000 Series card, use the DASCARD-1000 Series Control Panel utility for DOS (CTL1000.EXE) or for Windows (CTL1000W.EXE).
- **DMM.** Use a 4½ digit digital voltmeter.
- **FWA-EXP optional accessory.** Attach an FWA-EXP (or mass-termination connector) to EXP-800/1600 I/O connector J1.
- **CAB-3740 cable.** Use a CAB-3740 cable to connect an EXP-800/1600 to a DAS board.
- **CAB-3740/F cable.** Use a CAB-3740/F cable to connect an EXP-1600 to a DASCARD-1000 Series card.
- **Temperature-measurement device.** If you need to calibrate CJC circuitry, use a digital thermometer or other type of temperature-measurement device with an accuracy of  $\pm 2$  °C.

## Potentiometers

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Figure 5-1 shows the locations of the potentiometers used in the calibration of an EXP-800/EXP-1600. The calibration procedure, described in the next section, directs you to these components and explains how to use them during the calibration process.



**Figure 5-1. Calibration-Component Locations on the EXP-800/1600**

# Calibration Procedure

---

This section contains the procedures for calibrating an EXP-800/1600.

## Calibration Setup

To set up the calibration of an EXP-800 or EXP-1600, perform the following steps:

1. If the EXP-800/1600 is installed in an ENCL Series enclosure, remove the EXP from the enclosure and attach the four standoffs to allow access to the component side of its PC board (refer to “Installing in an ENCL Series Enclosure” on page 3-9).
2. On the FWA-EXP (or mass-termination connector), wire CH15 HI to CH15 LO and CH15 LO to GND A.
3. Set the following switches on the EXP:

---

**Note:** Before making any changes, note the original positions and settings of all jumpers and switches on the EXP-800/1600 for later reference.

---

- If you are going to calibrate the CJC circuit located on the EXP-800/1600, set CJC-select switch S20 to INT; if you are going to calibrate the CJC circuit located on the FWA-EXP, set CJC-select switch S20 to POD.
  - Set power-select switch S19 to INT if you are using internal power or to EXT if you using external power (refer to “Setting the Power-Select Switch” on page 3-9).
4. Select a DAS board/card to be connected to the EXP-800 or EXP-1600 according to the DAS board/card list under “Equipment Requirements” on page 5-1.

---

### Warning

Connecting an EXP-800 to a DAS-1600/1400/1200 Series board or a DASCARD Series card, or connecting an EXP-1600 to a DAS-800 Series board can damage either or both boards.

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5. Make sure the DAS board/card is functioning properly (refer to the DAS board/card user's guide for more information).
6. Connect the EXP-800/1600 to the DAS board using a CAB-3740 cable or to a DASCard-1000 Series card using a CAB-3740/F cable.

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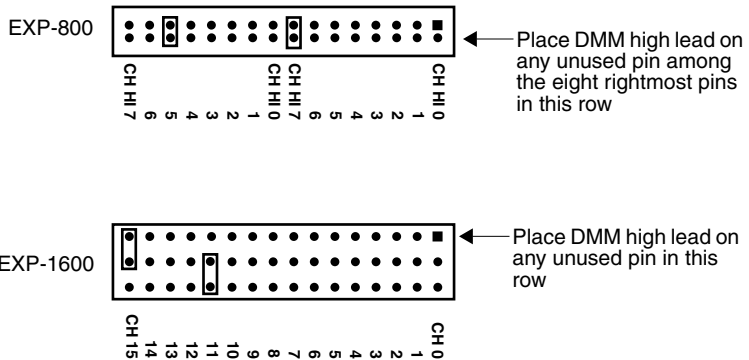
**Note:** Connect only one EXP-800/1600 to the DAS board/card, and make no connections to P4 of the EXP-800/1600.

---

## Analog Offset Adjustment

Using the DAS Control Panel utility for the DAS board (refer to Control Panel utility under "Equipment Requirements" on page 5-1) perform the following steps to adjust analog offset:

1. After you select the DAS board/card configuration file, select the *Panels* option from the menu bar at the top of the first screen of the Control Panel utility.
2. Select the *Digital and Counter/Timer* option from the menu.
3. On the Digital and Counter/Timer panel, type the value  $F$  into the digital output box.
4. Invoke the Output control to set the DAS board/card digital output lines to the value 15 decimal (Fh), which addresses channel 15 of the EXP-800/1600.
5. Set the DMM function to DC (auto range).
6. Connect the DMM low lead to LL GND on the FWA-EXP (or mass-termination connector) and the high lead to any unused (not having a jumper) J6 output-channel-select pin on the EXP-800/1600 to monitor the output level of the instrumentation amplifier. The output-channel-select pins are located as shown in Figure 5-2.



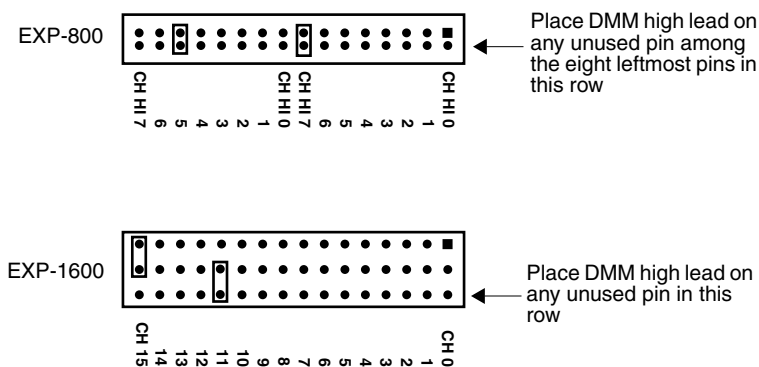
**Figure 5-2. Output-Channel-Select Pin Locations on the EXP-800/1600 Jumper Block J6**

7. For RTO, set switch S4 for a gain of 1 (refer to “Setting the Gain” on page 3-6) and adjust potentiometer R18 until the DMM indicates a reading of  $0.0 \pm 0.001$  V.
8. For RTI, set switch S4 for a gain of 500 and adjust potentiometer R24 until the DMM indicates a reading of  $0.0 \pm 0.002$  volts.
9. Because potentiometers R18 and R24 are interactive, you must repeat both the RTO and RTI adjustments until the DMM indicates you have obtained the voltage levels stated in steps 7 and 8.

## CJC Calibration

Use the following steps to calibrate the CJC circuit:

1. Use the temperature-measuring device to obtain a measurement ( $t_{\text{meas}}$  in °C) at the CJC you selected in step 4 under “Calibration Setup” on page 5-4.
2. Connect the DMM low lead to LL GND on the FWA-EXP (or mass-termination connector) and the high lead to any unused (not having a jumper) J6 CJC-channel-select pin on the EXP-800/1600 to monitor the output level of the CJC circuit. The CJC-channel-select pins are located as shown in Figure 5-3.



**Figure 5-3. CJC-Channel-Select Pin Locations on the EXP-800/1600 Jumper Block J6**

3. Use the following equation to calculate  $V_{\text{equ}}$ , the voltage that equates to the temperature measurement obtained in step 1:

$$V_{\text{equ}} = 24.4 \text{ mV}/^{\circ}\text{C} \times t_{\text{meas}}$$

4. Adjust R33 until the DMM indicates a voltage of  $V_{\text{equ}}$  (mV).
5. Remove the DMM leads from the connection points on the EXP-800/1600 and FWA-EXP.



6. Disconnect the EXP-800/1600 from the DAS board/card and the FWA-EXP.
7. Restore the EXP-800/1600 switches and jumper settings to their original settings.
8. If the EXP-800/1600 was removed from an ENCL Series enclosure, remove the standoffs and return the EXP-800/1600 to the enclosure.

# 6

## Troubleshooting

This chapter describes how to respond to a problem in the operation of your data acquisition system. If the problem appears serious enough to warrant technical support, refer to “Technical Support” on page 6-4 for information on how to contact an applications engineer.

### Problem Isolation

---

Use the instructions in this section to isolate the cause of a problem before calling Keithley MetraByte for technical support. Table 6-1 lists some symptoms and possible solutions for problems with an EXP-800/1600.

**Table 6-1. Troubleshooting Information**

Symptom	Possible Cause	Possible Solution
Computer does not boot.	The power supply of the computer is too small to handle all the system components.	Check the needs of all system components and obtain a larger power supply or use external power.
System lockup	A timing error occurred.	Press <b>[Ctrl] + [Break]</b> .
EXP-800/1600 appears not to operate	Configuration is incorrect.  If using external power, polarity is wrong.  The EXP-800/1600 is damaged.	Check the configuration of your EXP-800/1600 and of the DAS board/card.  Polarity of center contact on external power supply cables must be positive.  Contact the Keithley MetraByte Applications Engineering Department; see page 6-4.

**Table 6-1. Troubleshooting Information (cont.)**

Symptom	Possible Cause	Possible Solution
Intermittent operation	<p>The most common cause of this problem is that the I/O bus speed is in excess of 8 MHz.</p> <p>Vibrations or loose connections exist.</p> <p>The EXP-800/1600 is overheating.</p> <p>Electrical noise exists.</p>	<p>Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, see your computer documentation for instructions on running BIOS setup).</p> <p>Cushion source of vibration and tighten connections.</p> <p>Check ambient temperature. See the documentation for your computer.</p> <p>Provide better shielding or reroute unshielded wiring.</p>
Data appears to be invalid	<p>The most common cause of this problem is that the I/O bus speed is in excess of 8 MHz.</p> <p>An open connection exists.</p> <p>Transducer is improperly connected to channel being read.</p> <p>Transducer is a differential type.</p> <p>Programming for application does not allow sufficient multiplexer settling time.</p>	<p>Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See the documentation for your computer for instructions on running BIOS setup.</p> <p>Check wiring to screw terminals.</p> <p>Check the transducer connections.</p> <p>Check transducer specifications and board configuration.</p> <p>Refer to the caution under “Multiplexer” on page 2-4.</p>

If your board is not operating properly after using the information in Table 6-1, continue with the next two sections to isolate the problem.

## Testing the Board/Card and Host Computer

To isolate the problem to the EXP-800/1600 or to the DAS board/card and host computer, use the following steps:

1. Turn off and disconnect power connections to the host computer.
2. Turn off and disconnect any external power connections to the EXP-800/1600.

---

**Caution:** Disconnecting a DAS board/card or accessory with the power on can cause damage to your accessory, your board, and/or your computer.

---

3. While keeping connections to accessories intact, unplug the accessory cable connector from the DAS board/card.
4. Visually check the EXP-800/1600 for damage. If there is obvious damage, refer to “Technical Support” on page 6-4 for information on returning the board.
5. With the EXP-800/1600 disconnected, check the DAS board/card for proper operation. If the DAS board/card does not operate properly, refer to its user’s guide for troubleshooting instructions.

If the computer and DAS board/card are operating properly and you have another EXP-800/1600 that is functional, you can test the input connections using the instructions in the next section. If you do not have another board, refer to the instructions on page 6-4 before calling Keithley Technical Support.

## Testing the Input Connections

When you are sure that the computer and DAS board/card are operating properly, test the EXP-800/1600 input connections using another EXP-800/1600 that is functional. To test the input connections, follow these steps:

1. Turn computer power off and connect an EXP-800/1600 accessory that is functional. Do not make any connections to the EXP-800/1600 inputs.

2. Turn computer power ON and check operation with the functional EXP-800/1600 in place.
3. If the EXP-800/1600 now functions, reconnect and check the operation of the input connections, one at a time.
4. If operation fails for an input connection, check the input for shorts and opens.
5. If operation remains normal to this point, the problem is in the originally attached EXP-800/1600.
6. If you cannot isolate the problem, refer to the next section for instructions on obtaining assistance.

## Technical Support

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Before returning any equipment for repair, call the Keithley Applications Engineering Department at:

**1-888-KEITHLEY**

**Monday - Friday, 8:00 A.M. - 5:00 P.M., Eastern Time**

An applications engineer will help you diagnose and resolve your problem over the telephone. Please make sure you have the information on the following page available before you call.

<b>EXP-800/1600</b>	Model	_____
	Serial #	_____
	Revision code	_____
	Number of channels	_____
	Invoice/order #	_____
<b>DAS board/card Configuration</b>	Model	_____
	Serial #	_____
	Revision code	_____
	Base address setting	_____
	Interrupt level setting	_____
	Number of channels	_____
	Input (S.E. or Diff.)	_____
	Mode (uni. or bip.)	_____
	DMA chan(s)	_____
	Number of SSH-8s	_____
Number of EXPs.	_____	
<b>Computer</b>	Manufacturer	_____
	CPU type	_____
	Clock speed (MHz)	_____
	KB of RAM	_____
	Video system	_____
	BIOS type	_____
<b>Operating system</b>	DOS version	_____
	Windows version	_____
	Windows mode	_____
<b>Software package</b>	Name	_____
	Serial #	_____
	Version	_____
	Invoice/Order #	_____
<b>Compiler (if applicable)</b>	Language	_____
	Manufacturer	_____
	Version	_____
<b>Accessories</b>	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____

If a telephone resolution is not possible, the applications engineer will issue you a Return Material Authorization (RMA) number and ask you to return the equipment. Include the RMA number with any documentation regarding the equipment.

When returning equipment for repair, include the following information:

- Your name, address, and telephone number.
- The invoice or original purchase order number and date of equipment purchase.
- Non-warranty repair purchase order number.
- A description of the problem or its symptoms.
- The RMA number on the **outside** of the package.

Repackage the equipment, using the original anti-static wrapping, if possible, and handling it with ground protection. Ship the equipment to:

ATTN.: RMA# \_\_\_\_\_  
Repair Department  
Keithley Instruments, Inc.  
28775 Aurora Road  
Cleveland, Ohio 44139-1891

Telephone 1-888-KEITHLEY  
FAX (440) 248-6168

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**Notes:** If you are submitting your equipment for repair under warranty, you must include the invoice number and date of purchase.

To enable Keithley to respond as quickly as possible, you must include the RMA number on the outside of the package.

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# A

## Specifications

Tables A-1 lists specifications for the EXP-800/1600.

**Table A-1. General Specifications**

<b>Feature</b>	<b>Specification</b>
Number of inputs	16 differential inputs
Amplifier	
Configuration	Instrumentation amplifier with gains of 1, 10, 100, and 500
Gain accuracy	$\pm 0.01\%$ of reading, typical $\pm 0.02\%$ of reading, maximum
Relative accuracy	$\pm 0.001\%$ of reading, typical
Input characteristics	
Input offset current	0.6 nA maximum @ 25°C 50 nA maximum @ 0 to 70°C
Input bias current	1 nA maximum @ 25°C 100 nA maximum @ 0 to 70°C
Input Offset Voltage	6.0 mV maximum, trimmable to zero
CMRR for 0 Hz to 1 kHz range	90 dB typical @ gain = 1 100 dB typical @ gain = 10 110 dB typical @ gain = 100 110 dB typical @ gain = 500
Input filter response	Single-pole RC @ 80 Hz $\pm 20\%$ Two 1 k $\Omega$ resistors connected differentially across 1 $\mu$ F capacitor



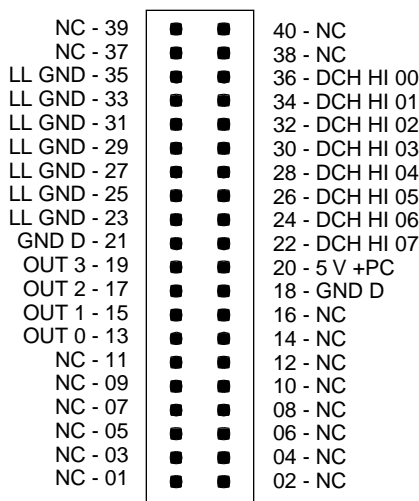
**Table A-1. General Specifications (cont.)**

<b>Feature</b>	<b>Specification</b>
Temperature coefficients	
Gain	$\pm 5$ ppm/ $^{\circ}$ C
Offset	$\pm 10$ $\mu$ V for gain = 1, typical $\pm 2$ $\mu$ V for gain = 50, typical
Bandwidth (no filter)	
Full-power bandwidth	150 kHz @ gain = 1 4 kHz @ gain = 500
Small-signal bandwidth	180 kHz @ gain = 1 5 kHz @ gain = 500
Noise	
rms	1 mV @ gain = 1; 8 $\mu$ V @ gain = 500
p-p	5 mV at gain = 1; 50 $\mu$ V @ gain = 500
CJC (on FWA-EXP)	
Output	+24.4 mV/ $^{\circ}$ C
Accuracy	@ 25 $^{\circ}$ C: $\pm 0.4^{\circ}$ C typical; $\pm 1.0^{\circ}$ C maximum
Power requirements	
From +5 V	160 mA typical; 250 mA maximum

# B

## Connector Pin Assignments

This appendix contains pin assignments for connectors of the EXP-800/1600s, DAS-800/1600 Series boards, DASCard-1000 Series cards, and accessories for the EXP-800/1600s.



**Figure B-1. Pin Assignments for Connectors P2 and P3 of the EXP-800**

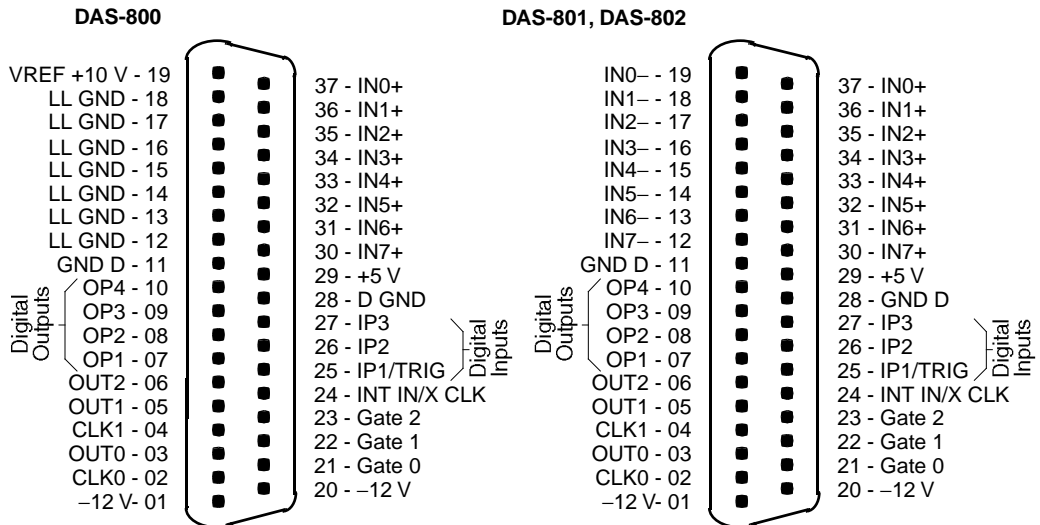
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**Note:** In the pin assignment diagrams, NC stands for *no connection*.

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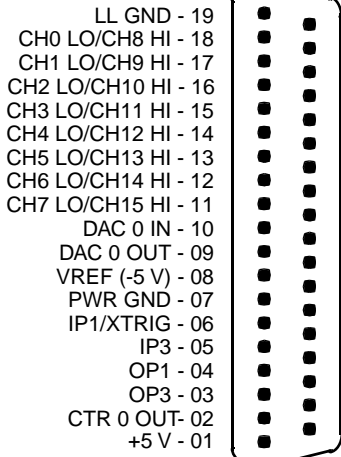
NC - 39	■	■	40 - NC
LLGND - 37	■	■	38 - NC
DCH HI 08 - 35	■	■	36 - DCH HI 00
DCH HI 09 - 33	■	■	34 - DCH HI 01
DCH HI 10 - 31	■	■	32 - DCH HI 02
DCH HI 11 - 29	■	■	30 - DCH HI 03
DCH HI 12 - 27	■	■	28 - DCH HI 04
DCH HI 13 - 25	■	■	26 - DCH HI 05
DCH HI 14 - 23	■	■	24 - DCH HI 06
DCH HI 15 - 21	■	■	22 - DCH HI 07
NC - 19	■	■	20 - LL GND
NC - 17	■	■	18 - LL GND
NC - 15	■	■	16 - NC
GND D - 13	■	■	14 - NC
NC - 11	■	■	12 - NC
NC - 09	■	■	10 - NC
OUT 1 - 07	■	■	08 - OUT 0
OUT 3 - 05	■	■	06 - OUT 2
NC - 03	■	■	04 - NC
5 V + PC - 01	■	■	02 - NC

**Figure B-2. Pin Assignments for Connectors P2 and P3 of the EXP-1600**



**Figure B-3. Pin Assignments for Main I/O Connectors of DAS-800 Series Boards and for Connector P4 of the EXP-800**

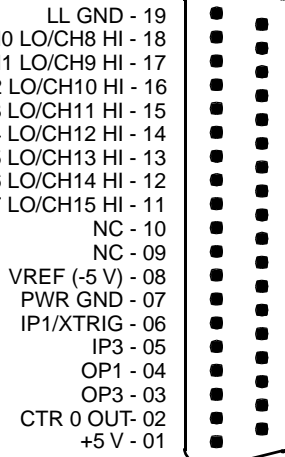
**DAS-1600, DASCard-1000**



LL GND - 19  
 CH0 LO/CH8 HI - 18  
 CH1 LO/CH9 HI - 17  
 CH2 LO/CH10 HI - 16  
 CH3 LO/CH11 HI - 15  
 CH4 LO/CH12 HI - 14  
 CH5 LO/CH13 HI - 13  
 CH6 LO/CH14 HI - 12  
 CH7 LO/CH15 HI - 11  
 DAC 0 IN - 10  
 DAC 0 OUT - 09  
 VREF (-5 V) - 08  
 PWR GND - 07  
 IP1/XTRIG - 06  
 IP3 - 05  
 OP1 - 04  
 OP3 - 03  
 CTR 0 OUT- 02  
 +5 V - 01

37 - CH0 HI IN  
 36 - CH1 HI IN  
 35 - CH2 HI IN  
 34 - CH3 HI IN  
 33 - CH4 HI IN  
 32 - CH5 HI IN  
 31 - CH6 HI IN  
 30 - CH7 HI IN  
 29 - LL GND  
 28 - LL GND  
 27 - DAC 1 OUT  
 26 - DAC 1 IN  
 25 - IP0/EXT CLK  
 24 - IP2/CTR 0 Gate  
 23 - OP0  
 22 - OP2  
 21 - CTR 0 CLK IN  
 20 - CTR 2 OUT

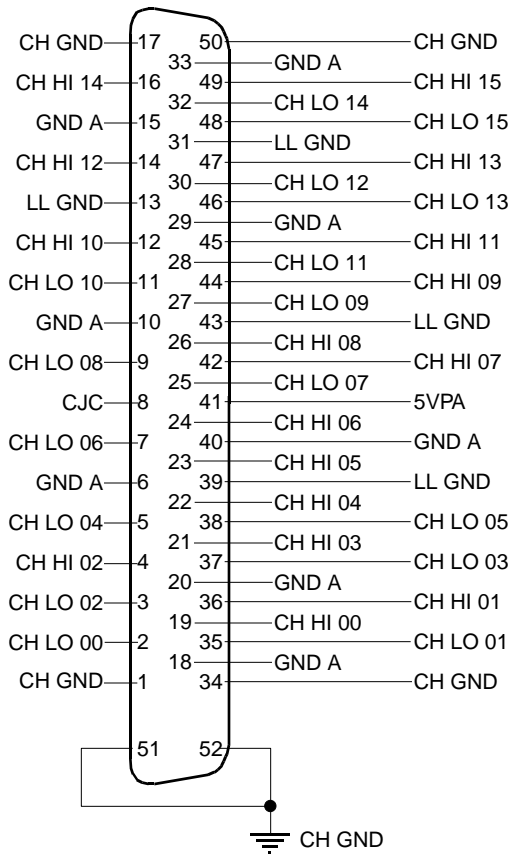
**DAS-1400, DAS-1200**



LL GND - 19  
 CH0 LO/CH8 HI - 18  
 CH1 LO/CH9 HI - 17  
 CH2 LO/CH10 HI - 16  
 CH3 LO/CH11 HI - 15  
 CH4 LO/CH12 HI - 14  
 CH5 LO/CH13 HI - 13  
 CH6 LO/CH14 HI - 12  
 CH7 LO/CH15 HI - 11  
 NC - 10  
 NC - 09  
 VREF (-5 V) - 08  
 PWR GND - 07  
 IP1/XTRIG - 06  
 IP3 - 05  
 OP1 - 04  
 OP3 - 03  
 CTR 0 OUT- 02  
 +5 V - 01

37 - CH0 HI IN  
 36 - CH1 HI IN  
 35 - CH2 HI IN  
 34 - CH3 HI IN  
 33 - CH4 HI IN  
 32 - CH5 HI IN  
 31 - CH6 HI IN  
 30 - CH7 HI IN  
 29 - LL GND  
 28 - LL GND  
 27 - NC  
 26 - NC  
 25 - IP0/EXT CLK  
 24 - IP2/CTR 0 Gate  
 23 - OP0  
 22 - OP2  
 21 - CTR 0 CLK IN  
 20 - CTR 2 OUT

**Figure B-4. Pin Assignments for the Main I/O Connectors of DAS-1600/1400/1200 Series Boards, the Cable for DASCard-1000 Series Cards, and Connector P4 of the EXP-1600**



**Figure B-5. Pin Assignments for Connector J1 of the EXP-800/1600**

# C

## Channel Numbers for Software

This appendix describes the assignment of channel numbers for a DAS board/card and all attached EXP-800/1600s for use in software such as the Control Panel utility.

### Channel Numbering for DAS-800 Series Boards

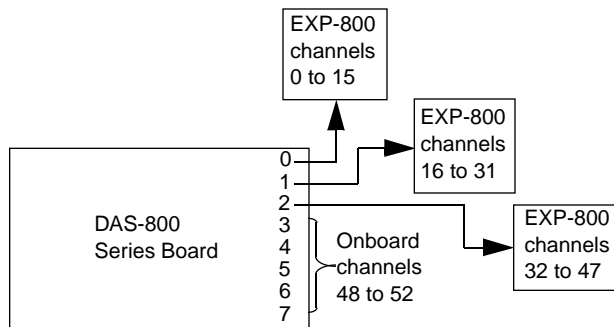
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DAS-800 Series boards contain eight analog input channels, numbered 0 through 7. If you require additional channels, you can use up to eight 16-channel EXP-800 expansion accessories to increase the number of available channels to 128. Expansion accessories are assigned to consecutive analog input channels of the DAS-800 Series board, beginning with onboard channel 0. Table C-1 lists the software (logical) channels associated with each expansion accessory.

**Table C-1. Channels in Maximum EXP-800 Configuration**

<b>DAS-800 Series Onboard Channel</b>	<b>EXP-800 Software (Logical) Channels</b>
0	0 to 15
1	16 to 31
2	32 to 47
3	48 to 63
4	64 to 79
5	80 to 95
6	96 to 111
7	112 to 127

Figure C-1 illustrates the use of three EXP-800s and the five remaining onboard channels on a DAS-800 Series board configured for single-ended mode. In software such as the Control Panel utility, you refer to the physical channels on the EXP-800 attached to analog input channel 0 as logical channels 0 to 15, the physical channels on the EXP-800 attached to analog input channel 1 as logical channels 16 to 31, and the physical channels on the EXP-800 attached to analog input channel 2 as logical channels 32 to 47. You refer to the remaining 13 onboard analog input channels (physical channels 3 through 7) in software as logical channels 48 through 52.



**Figure C-1. Analog Input Channel Numbering for Software Control**

You can perform an analog input operation on a single channel or on multiple channels.

## **Channel Numbering for the DAS-1600/1400/1200 and DASCARD-1000 Series**

---

DAS-1600/1400/1200 Series boards are switch-configurable for either 16 single-ended analog input channels (numbered 0 through 15) or eight differential analog input channels (numbered 0 through 7). If you require more than the 16 single-ended onboard channels, you can use up to 16 EXP-1600s to increase the number of available channels to 256.

EXP-1600s are assigned to consecutive onboard analog input channels, beginning with onboard channel 0. Table C-2 lists the software (or logical) channels associated with each EXP-1600.

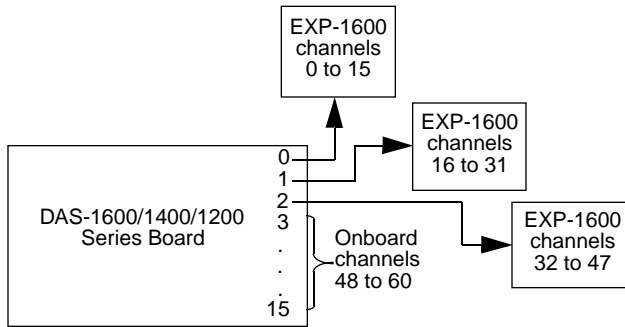
**Table C-2. Channels in Maximum EXP-1600 Configuration**

<b>Onboard Channel</b>	<b>EXP-1600 Software (Logical) Channels</b>
0	0 to 15
1	16 to 31
2	32 to 47
3	48 to 63
4	64 to 79
5	80 to 95
6	96 to 111
7	112 to 127
8	128 to 143
9	144 to 159
10	160 to 175
11	176 to 191
12	192 to 207
13	208 to 223
14	224 to 239
15	240 to 255

Figure C-2 illustrates the use of three EXP-1600s and the 13 remaining onboard channels on a DAS-1600/1400/1200 Series board configured for single-ended mode. In software such as the Control Panel utility, you refer to the physical channels on the EXP-1600 attached to analog input channel 0 as logical channels 0 to 15, the physical channels on the EXP-1600 attached to analog input channel 1 as logical channels 16 to 31, and the physical channels on the EXP-1600 attached to analog input



channel 2 as logical channels 32 to 47. You refer to the remaining 13 onboard analog input channels (physical channels 3 to 15) in software as logical channels 48 to 60.



**Figure C-2. Analog Input Channels**

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