

Instruction Manual

Tektronix

ADA400A
Differential Preamplifier

070-9164-00

Warning

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Summary prior to performing service.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

Injury Precautions

- | | |
|---|---|
| Avoid Electric Overload | To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal. |
| Ground the Product | This product is grounded through the grounding conductor of the oscilloscope power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded. |
| Do Not Operate Without Covers | To avoid electric shock or fire hazard, do not operate this product with covers or panels removed. |
| Do Not Operate in Wet/Damp Conditions | To avoid electric shock, do not operate this product in wet or damp conditions. |
| Do Not Operate in Explosive Atmosphere | To avoid injury or fire hazard, do not operate this product in an explosive atmosphere. |

Product Damage Precautions

- | | |
|---|---|
| Do Not Operate With Suspected Failures | If you suspect there is damage to this product, have it inspected by qualified service personnel. |
| Do Not Immerse in Liquids | Clean the instrument using only a damp cloth. Refer to cleaning instructions. |

Safety Terms and Symbols

Terms in This Manual These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product The following symbols may appear on the product:



DANGER
High Voltage



Protective Ground
(Earth) Terminal



ATTENTION
Refer to
Manual



Double
Insulated

Preface

This manual contains both user and service information for the ADA400A Differential Preamplifier. The following is a brief overview of what each section of the manual contains.

- *Getting Started* includes a description of the product features and a list of standard and optional accessories. This section also describes how to supply power to the preamplifier and how to connect the preamplifier to an oscilloscope.
- *Operating Basics* contains a graphical overview and a brief description of each control and connector of the ADA400A Differential Preamplifier.
- The *Reference* section describes how to connect the ADA400A Differential Preamplifier to small signals and make the proper settings.
- *Specifications* lists the electrical and mechanical characteristics of the ADA400A Differential Preamplifier.
- *Performance Verification* contains procedures for verifying the warranted characteristics of the ADA400A Differential Preamplifier.
- The sections behind the warning page contain service information for the ADA400A Differential Preamplifier: *Adjustment Procedures*, *Maintenance* and *Replaceable Parts*.

Getting Started

Getting Started includes a description of the product features and a list of standard and optional accessories. This section also describes how to supply power to the preamplifier and how to connect the preamplifier to an oscilloscope.

Product Description

The ADA400A Differential Preamplifier allows direct oscilloscope measurements of very low amplitude voltages and signals that do not have a ground reference. These measurements are typical in setups that depend on transducers or other sensitive devices to supply the electrical signal.

Highlights of the ADA400A Differential Preamplifier are as follows:

- Selectable gains of X100, X10, X1, and X0.1 provide wide range of sensitivity.
- Common-mode rejection of greater than or equal to 100,000 to 1 in the frequency range of DC to 10 kHz removes unwanted common mode electrical noise from sensitive pickups.
- Bandwidth of greater than or equal to 1 MHz amplifies signals with fast transients. Selectable bandwidth limits of 100 Hz, 3 kHz, 100 kHz reject normal-mode noise.
- Input impedance of 1 M Ω in all settings and selectable impedance of infinite Ω ($> 10^{12} \Omega$) in X100 and X10 gain settings. The high input impedance prevents loading down signals with high source impedance.
- Adjustable differential offset allows the user to null out transducer bridge bias, galvanic potentials from the test setup, or other DC voltages.
- Special circuitry greatly reduces the annoying DC drift commonly found in older types of differential preamplifiers.
- TEKPROBE™ Interface provides power input and signal output connections.

Accessories

Standard accessories for the ADA400A Differential Preamplifier include the following items:

- This instruction manual
- Two spare input fuses

Recommended accessories for the ADA400A Differential Preamplifier include the following items:

- P6101B 1X Passive Probe
- 1103 Probe Power Supply for oscilloscopes that do not have the TEK-PROBE Interface.

Installation

Before you connect the output of the ADA400A Differential Preamplifier, determine whether or not your oscilloscope has the TEKPROBE interface. The interface provides connections for power, signal, and scale factor coding for compatible probes and accessories.

Oscilloscopes *with* the TEKPROBE Interface

The polarized output connector of ADA400A Differential Preamplifier connects to any oscilloscope with the TEKPROBE interface.

NOTE. *To avoid misleading scale factor readout of the ADA400A Differential Preamplifier on oscilloscopes other than the TDS400A Series, you must remove the preamplifier housing and disconnect the internal line that carries the scale factor coding.*

TDS 400A. The TDS 400A Series oscilloscopes are compatible with the scale factor coding of the ADA400A Differential Preamplifier. The factory configures the internal jumper to connect the scale factor coding. See Figure 1.

Other TDS and 11000 Series Models. If you do not have a TDS 400A Series oscilloscope, use the procedure that follows to disable the scale factor coding:

1. Remove the top housing of the preamplifier by following the procedures on page 48.
2. Identify the jumper on the data line (See Figure 1) and position the jumper to disable the scale factor coding.
3. Replace the top housing on the preamplifier box.

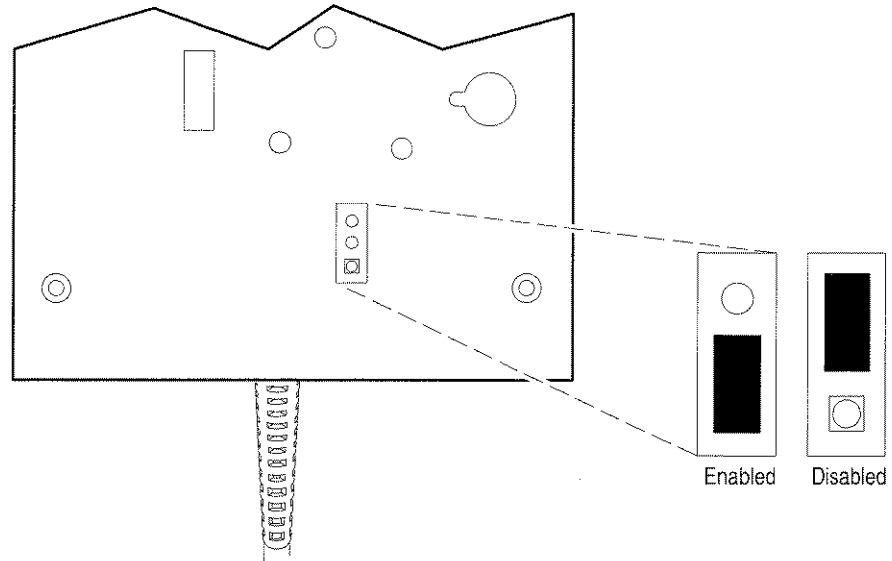


Figure 1: Configuration Jumper for Scale Factor Coding

Because the line that carries the scale factor coding is disabled, see the chart on page 8 to correctly interpret the volts/division setting of the oscilloscope.

Connecting the TEKPROBE Output. To engage the TEKPROBE output, align the fin on the output head counterclockwise with the clearance on the oscilloscope connector. Push the connector in and lock the fin clockwise.

Oscilloscopes *without* the TEKPROBE Interface

Use the 1103 TEKPROBE Power Supply to connect the ADA400A Differential Preamplifier to any oscilloscope that does not provide TEKPROBE power. The 1103 TEKPROBE Power Supply has connections for two probe channels.

NOTE. Use the offset controls of the ADA400A Differential Preamplifier to adjust the offset level. The offset controls on the 1103 TEKPROBE Power Supply do not operate with the ADA400A Differential Preamplifier.

Because the 1103 TEKPROBE Power Supply does not connect the line that carries the scale factor coding, see the chart on page 8 to correctly interpret the volts/division setting of the oscilloscope.

For more information about using the 1103 TEKPROBE Power Supply, refer to the instruction manual that comes with the power supply.

Check the Oscilloscope Input Impedance and Coupling

Always set the input impedance of the oscilloscope to 1 M Ω and the input coupling of the oscilloscope to DC. Setting the impedance to 50 Ω loads

(reduces) the amplitude of the output signal from the ADA400A Differential Preamplifier. AC coupling on the oscilloscope interferes with the signal output. Use the input coupling switch on the preamplifier to select other types of signal coupling.

Functional Check

The following procedure checks the output level of the ADA400A Differential Preamplifier and the functionality of the offset controls with no signal applied.

1. Without any connection on the input of the oscilloscope, power on the oscilloscope and make the following control settings:

Volts/Division	100 mV
Time/Division	100 μ s
Input Coupling	DC
Input Impedance	1 M Ω

2. Adjust the oscilloscope to display a flat signal trace at center screen.
3. Connect the output of the ADA400A Differential Preamplifier (or 1103 TEKPROBE Power Supply) to the input connector of the oscilloscope.
4. With no input signal or voltage connected, make the following control settings on the ADA400A Differential Preamplifier:

AC GND DC	GND (both inputs)
GAIN	0.1
OFFSET	OFF
UPPER BANDWIDTH	FULL (1 MHz)

5. Check that the trace on the oscilloscope centers around zero volts and the OVERRANGE indicator *does not* light.
6. Set the **GAIN** switch to each of the higher gain settings and check that the trace on the oscilloscope is adjustable to center screen.
7. With the GAIN switch on the highest setting, set the ON OFF switch for the OFFSET controls to **ON**.
8. Adjust the **COARSE** and **FINE** controls to bring the trace to center screen.
9. Set each input separately to **AC**, **DC**, and back to **GND** and check that the offset controls still bring the trace to center screen for each setting.
10. Return the GAIN setting to **.1** and the input coupling switches to **GND**.

The ADA400A Differential Preamplifier is now ready to use. For a complete performance verification procedure, refer to page 27.

Operating Basics

Operating Basics contains a graphical overview and a brief description of each control and connector of the ADA400A Differential Preamplifier. See Figures 2 through 4 and Table 1.

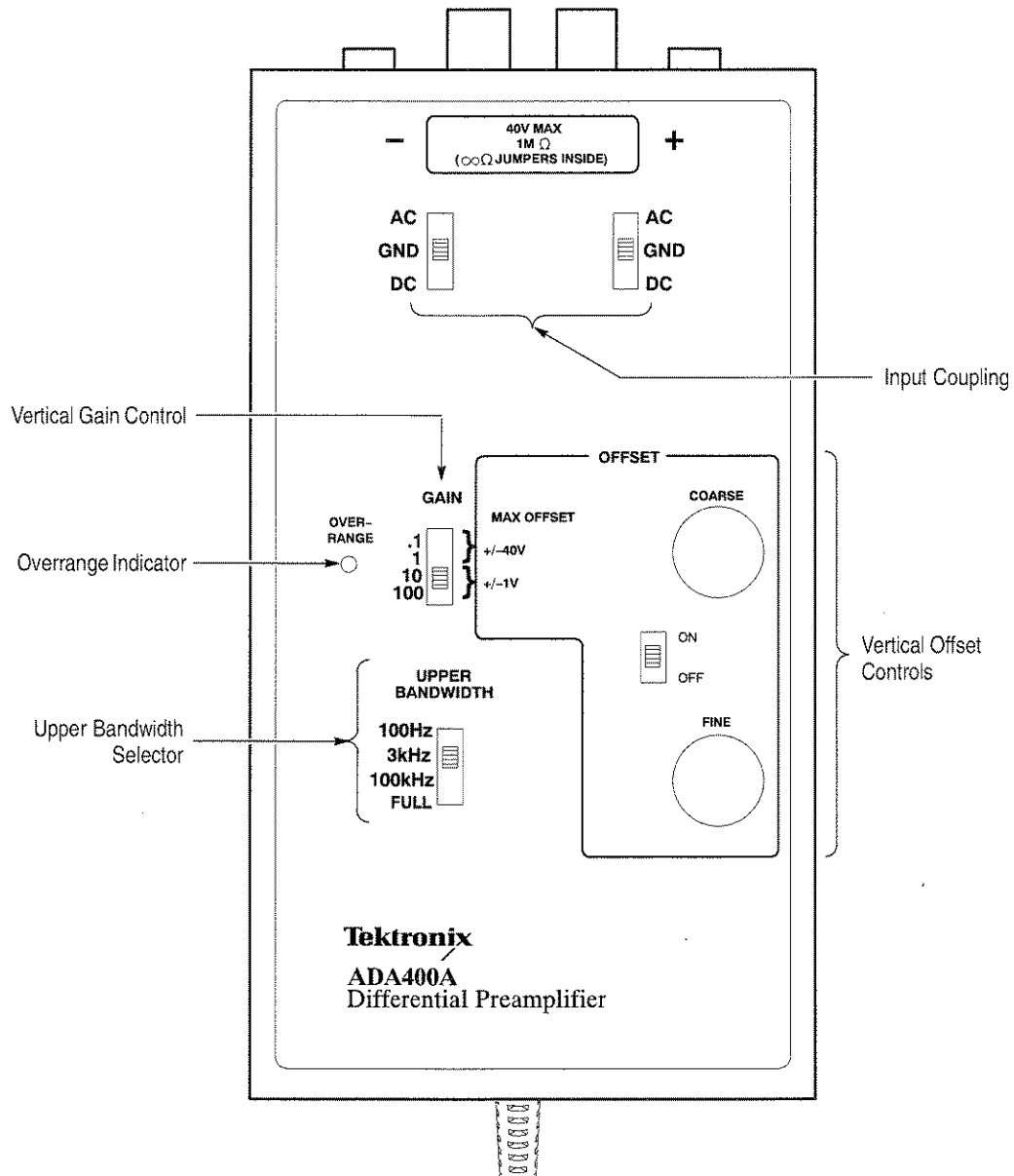


Figure 2: Front Panel Controls

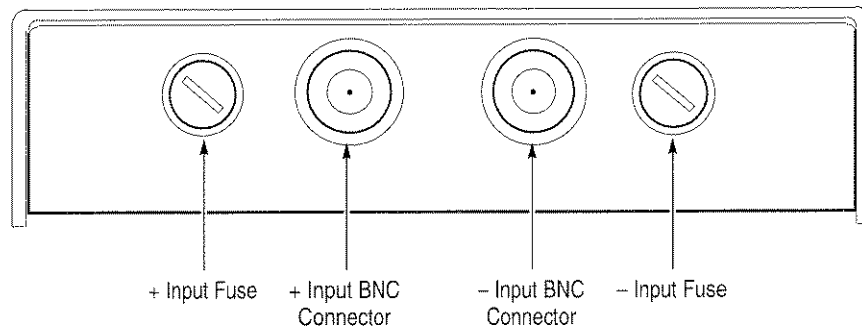


Figure 3: Input Connectors and Fuses

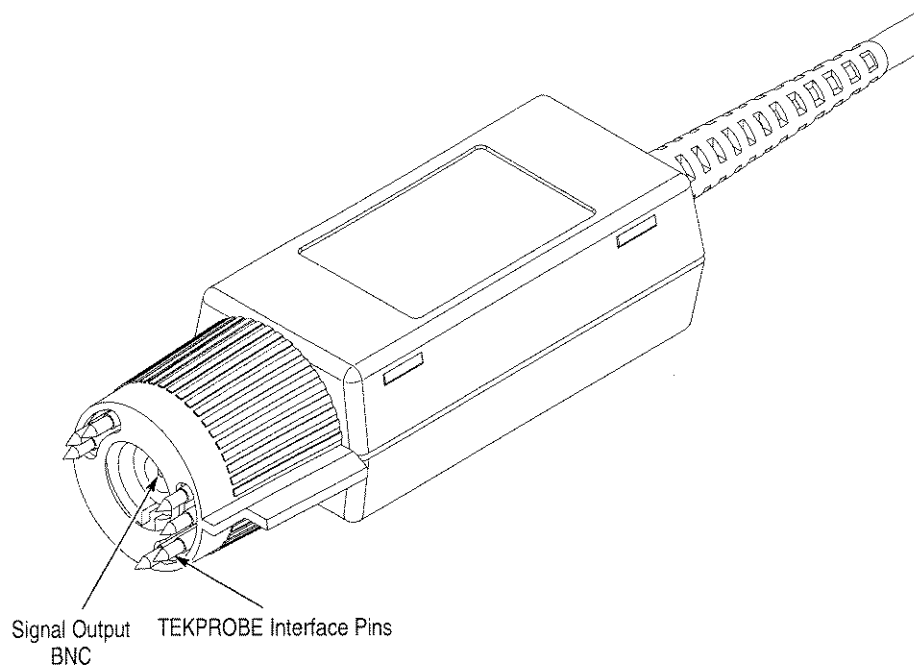


Figure 4: Output Connector

Table 1: Controls, Connectors, and Indicators

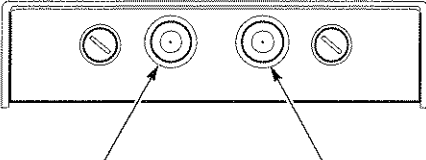
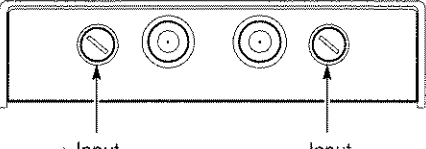

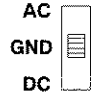

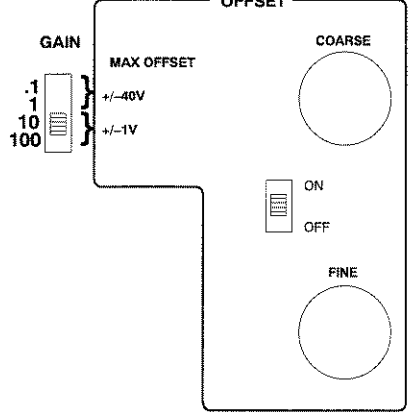
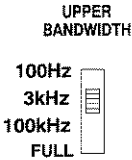
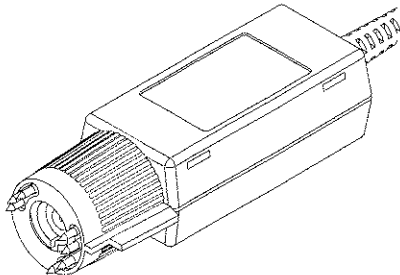
Feature	Description
 <p>+ Input BNC Connector</p> <p>- Input BNC Connector</p>	<p>Input BNCs. The BNC connectors provide the differential input connections to the preamplifier. These connectors accept coaxial cables, 1X probes, adapters, or other input leads that terminate with male BNC connectors. Before connecting the inputs, see page 9.</p> <p>NOTE. Avoid using attenuating probes. The slightest difference in attenuation match greatly lowers the common-mode rejection ratio.</p>
 <p>+ Input Fuse</p> <p>- Input Fuse</p>	<p>Input Fuses. The input fuses and internal circuitry protect the input circuits from excessive surge currents. To replace the fuses, see page 47.</p>
	<p>Selectable Impedance. Internal jumpers select infinite impedance for measuring signals with high source impedance. To select the input impedance, see page 10.</p>
 <p>AC</p> <p>GND</p> <p>DC</p>	<p>Input Coupling Switches. Use the input coupling switches to select the proper mode for coupling the input signals to the internal inputs of the preamplifier.</p> <p>The AC position couples the input signal through a capacitor and blocks any DC and AC components of the signal from 0 to 2 Hz.</p> <p>GND decouples the signal from the input and couples the internal input of the preamplifier to ground. This position also precharges the coupling capacitor to the DC level of the input signal (see page 14).</p> <p>The DC position couples both AC and DC components of the input signal.</p>
 <p>OVER-RANGE</p>	<p>Overrange Indicator. The OVERRANGE indicator lights red when the signal input exceeds the selected range of the amplifier. If the indicator is on, the output signal is not a true representation of the input signal(s). See page 14.</p>
 <p>GAIN</p> <p>.1</p> <p>1</p> <p>10</p> <p>100</p> <p>OFFSET</p> <p>MAX OFFSET</p> <p>+/-40V</p> <p>+/-1V</p> <p>COARSE</p> <p>ON</p> <p>OFF</p> <p>FINE</p>	<p>Gain Selector. The gain selectors set the gain of the preamplifier to X0.1, X1, X10, or X100. If the oscilloscope does not display the correct volts per division for each gain setting, refer to Table 2 on page 8.</p> <p>Offset Controls. The ON/OFF switch activates the offset controls. The COARSE and FINE controls provide a maximum of 40 volts offset in the X0.1 and X1 gain settings and a maximum of 1 volt offset in X10 and X100 gain settings. See page 14.</p>

Table 1: Controls, Connectors, and Indicators (Cont.)

Feature	Description
	<p>Upper Bandwidth Selector. The Upper Bandwidth Selector reduces electrical interference by limiting the frequency response of the amplifier to FULL (1 MHz), 100 kHz, 3 kHz, or 100 Hz.</p>
	<p>Output Connector. The output connector contains connections for the TEKPROBE interface and signal output.</p>

Determining the Effective Volts/Division

If your oscilloscope cannot read the scale factor information, see Table 2 to determine the effective volts/division setting. The effective volts per division is the volts per division setting of the oscilloscope divided by the gain setting of the ADA400A Differential Preamplifier. For example, if the volts/division setting on the oscilloscope is 500 mV/division and the gain setting is 10, the effective volts/division is 500 divided by 10 or 50 mV.

Table 2: Effective Volts Per Division Settings

Scope Volts/Div	Effective Volts Per Division			
	Gain = .1	Gain = 1	Gain = 10	Gain = 100
1	10	1	100 m	10 m
500 m	5	500 m	50 m	5 m
200 m	2	200 m	20 m	2 m
100 m	1	100 m	10 m	1 m
50 m	500 m	50 m	5 m	500 μ
20 m	200 m	20 m	2 m	200 μ
10 m	100 m	10 m	1 m	100 μ
5 m	50 m	5 m	500 μ	50 μ
2 m	20 m	2 m	200 μ	20 μ
1 m	10 m	1 m	100 μ	10 μ

Reference

The *Reference* section describes how to connect the inputs of the ADA400A Differential Preamplifier and make the proper control settings. To achieve the best performance it is important to make the proper signal and ground connections, set the controls to optimize the performance of the preamplifier, and reduce unwanted electrical interference.

Connecting the Inputs

Making the proper input connections is crucial to maintaining the fidelity of the signal as well as eliminating unwanted noise. The characteristics of the signal source and the type of measurement you wish to make, determine the type of input leads you should use and the way you should connect the inputs.



WARNING. *Do not attach the ADA400A Differential Preamplifier to human subjects for any testing or bio-monitoring. The ADA400A Differential Preamplifier is not safety certified for direct connection to humans.*

Input Devices

The ADA400A Differential Preamplifier is able to amplify extremely small signals that may or may not have a ground reference. Often the signals originate from low-level, low-frequency transducers, and other similar sources of small differential or floating voltages.

The inputs of the ADA400A Differential Preamplifier connect easily to devices or leads that terminate with male BNC connectors. There are numerous adapters readily available that can adapt other types of wire, cables, or plugs to a BNC connector.

NOTE. *Avoid using attenuating probes. The slightest difference in attenuation match greatly lowers the common-mode rejection ratio.*

Using the Proper Input Leads

To reduce unwanted electrical interference on the input leads, use shielded coaxial cable or the recommended 1X probes to connect signals to the preamplifier inputs. The shielding in these types of leads intercepts and shunts electrical noise to ground.

When you must use any length of unshielded wire, twist the wires together and connect the wires differentially. Twisting the wires together helps to introduce any electrical interference as common-mode noise that the differential preamplifier cancels out with a differential setup on the inputs.

For other tips on reducing signal interference, refer to page 17.

Input Voltages

Because the ADA400A Differential Preamplifier is designed to amplify small DC and AC voltages, do not connect voltages that exceed the input rating.



CAUTION. To avoid damaging the inputs of the ADA400A Differential Preamplifier, do not apply more than 40 volts (DC + peak AC) between any one input and ground or 80 volts (DC + peak AC) differential between the inputs.

Input Protection

To prevent damage to the input circuitry from the misapplication of large voltages, a fuse on each input opens if the input current exceeds 62 mA ($1/16$ A). To replace or check these fuses, refer to the procedure on page 47.

Input Impedance

Each input connector of the ADA400A Differential Preamplifier has a characteristic input impedance of 1 M Ω to ground in parallel with approximately 55 pF. For low source impedances, this 1 M Ω is more than adequate to prevent the inputs from loading the signal source.

If impedance of the signal source approaches 1 M Ω , the impedance of the inputs begin to load the signal source and reduce the amplitude. In effect, the extremely low current of the signal source is not able to develop a voltage across the 1 M Ω resistance and there is no signal to amplify. In this case you may want to select the infinite Ω position.

Infinite Ω . To measure signals from high impedance sources, you can internally disconnect the 1 M Ω resistance of the ADA400A Differential Preamplifier, and select the infinite Ω position. This position prevents the preamplifier from loading a high impedance signal source.

Observe the following operating limitations when you select the infinite Ω position:

- Select either the X100 or the X10 gain position. Operation in the 0.1X and 1X gain results in gain errors.
- Ensure that the source has some impedance to ground. The internal input amplifier requires some input bias current to operate. Typically this amount of input bias current is less than 25 pA.

- Select the DC coupling position when operating the preamplifier. The AC coupling position blocks the bias current that the preamplifier input requires to operate.
- Take steps to reduce interference from other sources (see page 17). Because the input impedance is essentially infinite you may notice an increased susceptibility to noise and DC drift.

Selecting the Infinite Ω Position. To select the infinite impedance, remove the knobs and top housing of the preamplifier. *Do not remove the inner shield.* With a pair of needle-nose pliers or tweezers, move the jumpers from the 1 M Ω to the infinite Ω position as Figure 5 illustrates.

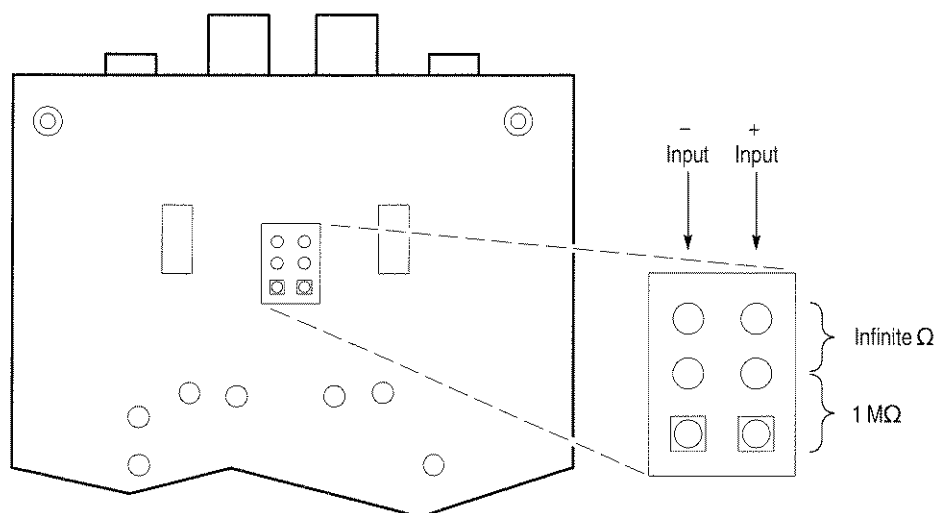


Figure 5: Selecting the Input Impedance

Input Configurations

There are two basic types of input configurations on the ADA400A Differential Preamplifier: single-ended or differential. Whether one or the other of these configurations is appropriate depends on the type of signal and the electrical environment of the test setup.

Single-Ended. To monitor a ground-referenced signal you only need to make a single input connection. All the controls on the preamplifier still operate. The only difference is that the preamplifier cannot cancel out common mode noise without using the other input connection. When making single-ended measurements, set the coupling for the unused input to GND.

Single-ended measurements, however, often yield unsatisfactory information because of interference resulting from ground-loop currents between the oscilloscope and the device under test. In other cases, it is desirable to eliminate

a common-mode DC voltage without using a DC blocking capacitor or the AC coupling capacitor of the preamplifier. These capacitors limit low-frequency response. Connecting the signals differentially virtually eliminates these effects.

Differential. Figure 6 shows two signals connected to the ADA400A Differential Preamplifier. One signal is connected to the + input and the other is connected to the – input. Because the preamplifier inverts the signal at the – input, the preamplifier amplifies only differential voltages between the inputs and rejects (cancels) voltages that are common to both inputs. The oscilloscope displays the waveform of the differential signal only.

NOTE. To avoid creating a fictitious differential offset, set both AC GND DC coupling switches to the same AC or DC switch position.

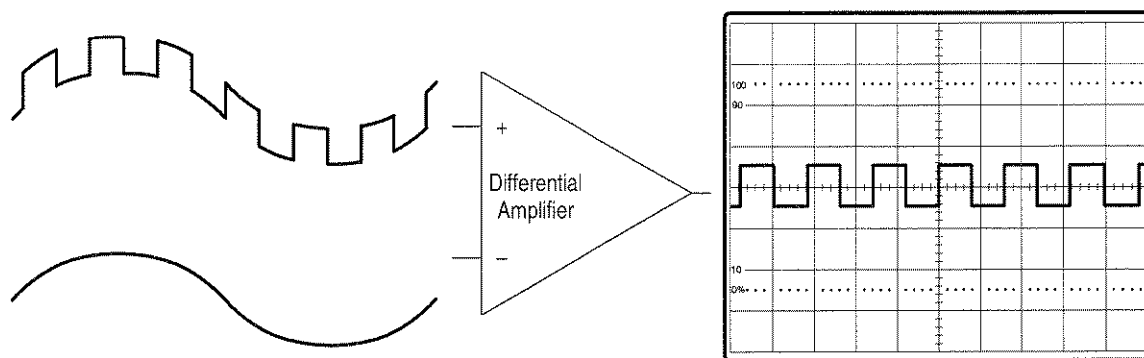


Figure 6: Differential Rejection of Common-Mode Signal

To avoid ground loops in a differential setup it is important to leave the grounds of the shielded coax disconnected and to route the chassis ground to the oscilloscope ground using a separate ground lead. Figure 7 on page 13 illustrates this type of connection.

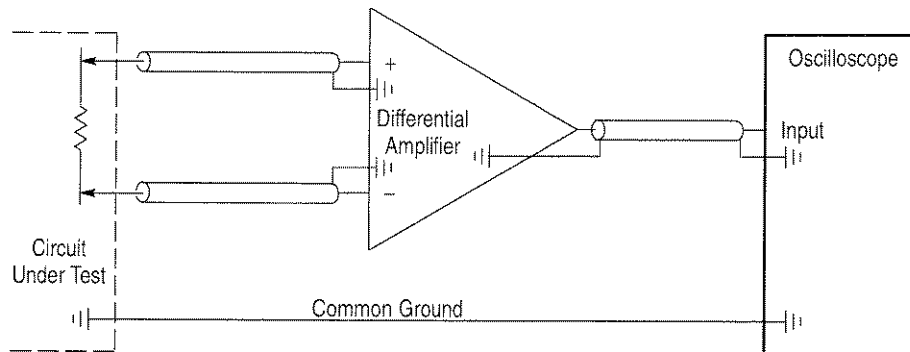


Figure 7: Eliminating Ground Loops in a Differential Setup

Oscilloscope Input Impedance and Coupling

Always set the input impedance of the oscilloscope to $1\text{ M}\Omega$ and the input coupling of the oscilloscope to DC. Setting the impedance to $50\ \Omega$ loads (reduces) the amplitude of the output signal from the ADA400A Differential Preamplifier. AC coupling on the oscilloscope interferes with the signal output. Use the input coupling switch on the preamplifier to select other types of signal coupling.

Setting the Controls

The controls of the ADA400A Differential Preamplifier determine signal coupling, amplification, DC offset, and the bandwidth limit.

Input Coupling

The type of input coupling you select depends on whether or not you want to pass or block the DC component of the input signal.

AC Coupling. Setting the coupling switch to AC places a capacitor in the signal path and blocks DC to about 2 Hz signals. Select the AC position to block DC components on the signal input and couple AC signals higher than approximately 2 Hz. This setup is useful when the test setup has a DC bias which drifts.

NOTE. To prevent the circuit under test from receiving the effects of charging and discharging the AC coupling capacitor, refer to the procedure for Precharging the Signal Input in the section that follows.

GND Coupling. The GND position decouples the signal from the input and couples the internal input of the preamplifier to ground. This position also precharges the AC coupling capacitor to the DC level of the signal. (See the following section, *Precharging the Signal Input.*)

DC Coupling. The DC position couples all signal components, AC and DC, to the preamplifier. (You can adjust the offset controls to null out DC biases.)

Precharging the Signal Input

Follow the procedure below when coupling AC signals that have a high DC voltage level or when probing between signals that differ greatly in DC levels. This procedure becomes especially useful when you disable the 1 M Ω input resistance and it takes a long time to charge the input capacitors back to the bias voltage.

1. Set the input coupling switch to GND before connecting the input to a signal source.
2. Connect the preamplifier input to the signal source.
3. Wait two seconds for the input coupling capacitor to charge to the DC level of the signal source.
4. Set the input coupling switch to AC. Position the AC signal within the graticule area on the oscilloscope display.

Gain, Input Range, and Offset Range

The gain selector sets amplification factor of the preamplifier to X0.1, X1, X10, or X100. Each gain setting has a characteristic differential or single-ended range, a common-mode (dynamic) range, and variable offset range. To prevent the signal from distorting or “clipping” (see Figure 10) you must use the appropriate gain setting and offset.

The amount of differential, common-mode, and offset range depends on the gain setting. Figures 8 through 11 beginning on page 15 show the common-mode, differential, and offset range for each gain setting of the preamplifier.

The OVERRANGE indicator lights when the input signal is outside the differential input range for a particular gain setting. This light indicates that the output signal is distorted or “clipped” and the oscilloscope display may not be accurate. Try a lower gain setting or check the position of the offset controls if the OVERRANGE indicator is on.

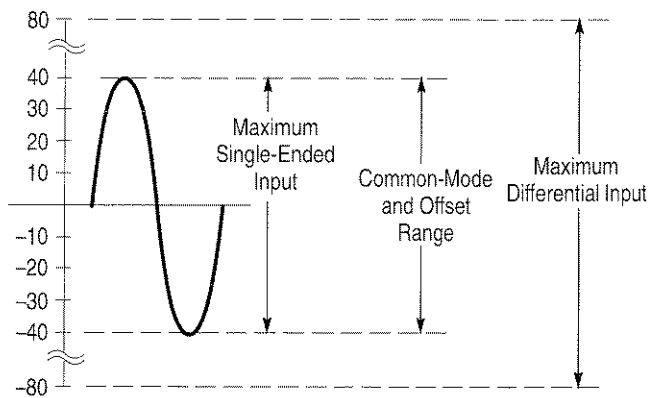


Figure 8: Input and Offset Range for X 0.1 Gain

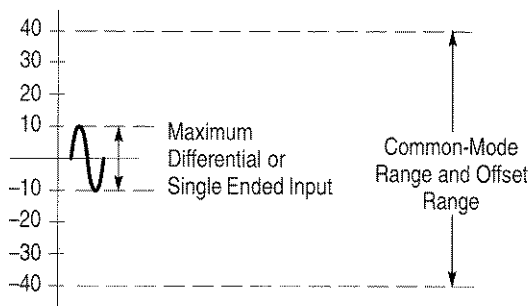


Figure 9: Input and Offset Range for X 1 Gain

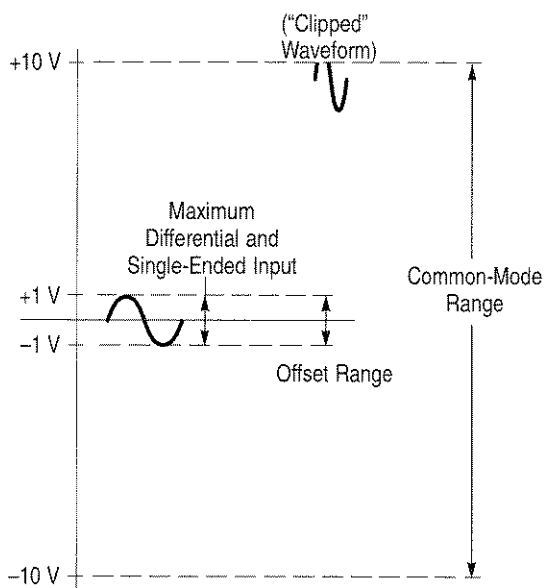


Figure 10: Input and Offset Range for X 10 Gain

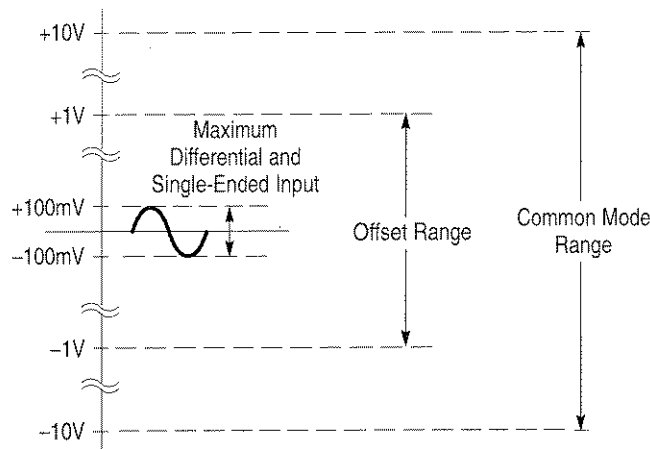


Figure 11: Input and Offset Range for X 100 Gain

Adjusting the Offset Controls

Setups that have a large DC offset, but must measure small changes in DC voltage or signal voltage below 2 Hz, require that you to adjust the offset controls of the preamplifier. Typical setups include those with transducers or setups that measure galvanic potentials.

To compensate for a DC offset, perform the following procedure:

1. Set the input coupling to **GND** on both inputs of the preamplifier and switch offset controls to **OFF**.
2. Preset the **GAIN** switch of the preamplifier and the volts/division switch of the oscilloscope to the appropriate settings based on the amount of offset you expect to measure. See Figures 8 through 11. (Select a lower gain setting if you are unsure of the amount of the offset.)
3. Center the oscilloscope display using the vertical position control on the oscilloscope.
4. Set the offset controls **ON** and center the display with the **COARSE** and **FINE** offset controls.
5. Set the input coupling to **DC** on the signal input(s) and, if necessary, measure the amount of DC offset.
6. Center the display using the **COARSE** and **FINE** controls and change the volts/division setting on the oscilloscope to better display the signal.

Limiting Bandwidth

The ADA400A Differential Preamplifier has a selector for limiting the upper bandwidth. Limiting the bandwidth is desirable in setups where electrical interference from higher frequency sources is a problem. The ADA400A

Differential Preamplifier allows you to select upper bandwidth limits of FULL (1 MHz), 100 kHz, 3 kHz and 100 Hz.

Tips for Reducing Signal Interference

Disruptive electrical interference or “noise” from sources near the test setup can affect measurements. The effects become even more apparent when measuring low-amplitude voltages.

The electric-power system, for example, generates a line frequency of 50 or 60 Hz and can couple electrical noise from other devices. Power switches or switching devices generate power line spikes. Unshielded or poorly grounded electric motors can generate disruptive transients. Power lines and transformers create magnetic fields that can induce a disruptive voltage in wires or input leads that are not properly twisted together.

Devices such as digital or microprocessor based systems can radiate signals that sensitive electronic detectors or amplifiers can receive and amplify. Switch-mode power supplies generate interference in the range of 20 to 100 kHz. Sources of interference can include florescent lights, laser printers, monitors, CRTs, even radio transmissions.

Proper setup of the ADA400A Differential Preamplifier minimizes or eliminates signal interference in most cases. There are three important strategies to reducing signal interference:

1. Use the proper signal and ground connections for the particular application.
2. Limit the bandwidth of the test setup.
3. Isolate or eliminate sources of signal interference.

Signal and Ground Connections

The techniques for proper signal and ground connections involve limiting noise to the input:

- Minimize length of input leads.
- Select input leads that have the same length and type of construction.
- Use shielded coaxial cable or “twisted-pair” leads on the inputs.
- Connect shield or ground leads close to signal source.
- Restrict movement of input leads.
- Eliminate ground loops.
- Reject common-mode noise by operating in differential mode.

Bandwidth Limiting

Limiting the bandwidth is a useful technique for keeping unwanted high frequency noise from interfering with the display of lower frequency signals. The ADA400A Differential Preamplifier allows you to limit the upper bandwidth to 100 Hz, 3 kHz, 100 MHz, and FULL (1 MHz).

Isolating or Eliminating Sources of Interference

Some pieces of electronic or electrical equipment can generate enormous amounts of electrical noise. One solution is to isolate or eliminate the noise that these devices emit:

- Move sources of noise away from test setup or isolate test setup.
- Shield test setup.
- Make sure all electronic equipment that is connected to the AC power line is properly grounded through the power cord.

Specifications

This section describes three classes of characteristics for the ADA400A Differential Preamplifier: nominal, warranted, and typical.

Nominal Characteristics

Nominal traits are described using simple statements of fact such as “Differential, ‘+’ and ‘-’” for the characteristic “Input Configuration,” rather than in terms of limits that are performance requirements.

Table 3: Nominal Characteristics — Signal Acquisition System

Name	Description	
Input Configuration	Differential, ‘+’ and ‘-’	
Input Coupling	DC, AC, or GND Ground coupling connects a ground reference to the input of the attenuator or differential amplifier and allows the AC coupling capacitor to charge up to the input voltage through a large resistance.	
Gain Settings	0.1, 1, 10, 100	
Analog Bandwidth Selections	100 Hz, 3 kHz, 100 kHz, and FULL (1 MHz)	
Offset Ranges	Gain Setting	Offset Range
	0.1	± 40 V
	1	± 40 V
	10	± 1 V
	100	± 1 V

Warranted Characteristics

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

NOTE. In these tables, those warranted characteristics that are checked in the procedure Performance Verification appear in **boldface type** under the column **Name**.

The performance limits in this specification are valid with these conditions:

- This instrument must have been calibrated/adjusted at an ambient temperature of $22 \pm 5^\circ \text{C}$.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.
- The instrument must have had a warm-up period of at least 20 minutes.
- The instrument must be used with a TDS400A Series oscilloscope for the readout function to operate correctly.

Table 4: Warranted Characteristics — Signal Acquisition System

Name	Description	
Input Resistance, DC Coupled	1 M Ω \pm 2%	
DC Gain Accuracy	\pm 2%	
Maximum Input Voltage	30 VAC _{RMS} , 42 V (DC + peak AC), between signal and common of the same input; derate at 20 dB/decade above 1 MHz.	
Differential Signal Range (DC OFFSET not used)	Gain Setting	Differential Input Signal Range
	0.1	\pm 80 V
	1	\pm 10 V
	10	\pm 1 V
	100	\pm 100 mV
Common Mode Signal Range	Gain Setting	Common Mode Input Signal Range
	0.1	\pm 40 V
	1	\pm 40 V
	10	\pm 10 V
	100	\pm 10 V

Table 4: Warranted Characteristics — Signal Acquisition System (Cont.)

Name	Description		
Common Mode Rejection Ratio (See Figures 14 to 15 on page 25.)	Frequency	Gain Setting	CMRR ¹ (DC coupled)
	100 Hz	10	85 dB
	10 kHz		85 dB
	100 kHz		60 dB
	100 Hz	100	90 dB
	10 kHz		90 dB
	100 kHz		60 dB

¹ The limits given are for the ambient temperature of $22 \pm 5^\circ \text{C}$

Table 5: Warranted Characteristics — Environmental

Name	Description
Atmospherics	Temperature Operating: 0°C to $+50^\circ \text{C}$ Non-operating: -55°C to $+75^\circ \text{C}$ Relative Humidity (tested to the following limits) Operating: 90–95% RH, $+30^\circ \text{C}$ to $+50^\circ \text{C}$ Non-operating: 90–95% RH, $+30^\circ \text{C}$ to $+60^\circ \text{C}$
Dynamics	Random Vibration Operating: 2.66 g rms overall, 3 axis, 20 min/axis (60 min total) Non-operating: 3.48 g rms overall, 3 axis, 20 min/axis (60 min total) Mechanical Shock Half Sine, 500 g's 3 axis, 3 drops each axis, 1 ms duration, 18 drops total

Table 5: Warranted Characteristics — Environmental (Cont.)

Name	Description
Electromagnetic Compatibility (EMC)	<p>Emissions: Meets or exceeds the requirements of the following standards:</p> <p>EN 55022 Class B limits for radiated emissions when operated as a system with a TDS460 series oscilloscope (FCC 47 CFR, Part 15, Subpart B for Class A equipment.)</p> <p>ADA400A Settings: Gain=100; Offset=off; DC coupled; Filter=1 MHz TDS 460 Settings: 500 ns/div; 5 mV/div; DC coupled</p> <p>Immunity: Radio Frequency Electromagnetic Field</p> <p>less than ± 2 divisions of leakage signal when the instrument is subjected to a 3 V/M electromagnetic field over the frequency range of 27 MHz to 500 MHz.</p> <p>Electrostatic Discharge (ESD)</p> <p>Up to 8 kV with no change to control settings of impairment of normal operation, and up to 15 kV with no loss of stored data or damage that prevents recovery of normal operation by the user.</p>

Typical Characteristics

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

Table 6: Typical Characteristics — Signal Acquisition System

Name	Description
Input Capacitance	55 pF \pm 20%
Analog Bandwidth Selection Accuracy	\pm 12% for 100 Hz, 3 kHz, 100 kHz selections \geq 1 MHz for the FULL (1 MHz) selection
Linearity	\pm 0.01% of linear dynamic range
Lower Frequency Limit, AC Coupled	\leq 2 Hz (lower -3 dB frequency)
Harmonic Distortion	\leq 0.002% measured using 3 V _{RMS} output at 100 Hz and 1 kHz
Recovery Time	\leq 1.5 μ s to recover to within 0.5% of zero level after over driving the amplifier by \pm 150%

Table 6: Typical Characteristics — Signal Acquisition System (Cont.)

Name	Description				
Zero Offset (Offset control off)	Gain Setting		Zero Offset Referred to the Input of the Amplifier		
	0.1		±50 mV		
	1		±5 mV		
	10		±500 μV		
	100		±50 μV		
DC Offset Drift with Temperature	Gain Setting	Offset On	Offset Off		
	0.1	0.750 mV/° C	0.250 mV/° C		
	1	0.300 mV/° C	0.200 mV/° C		
	10	10 μV/° C	5 μV/° C		
	100	5 μV/° C	3 μV/° C		
Input Current	Less than 25 pA at an ambient temperature of 22 ± 5° C				
Random Noise	RMS Noise				
	Bandwidth Selection	Gain of 0.1	Gain of 1	Gain of 10	Gain of 100
	1 MHz	≤5 mV	≤3 mV	≤50 μV	≤30 μV
	100 kHz	≤4 mV	≤1 mV	≤40 μV	≤10 μV
	3 kHz	≤4 mV	≤1 mV	≤40 μV	≤10 μV
	100 Hz	≤4 mV	≤1 mV	≤40 μV	≤10 μV
Common Mode Rejection Ratio (See Figures 12 to 15 on pages 24 to 26)	Frequency	Gain Setting	CMRR (DC coupled)	CMRR (AC coupled)	
	100 Hz	0.1	60 dB	45 dB	
	10 kHz		52 dB	50 dB	
	100 kHz		50 dB	50 dB	
	100 Hz	1	75 dB	50 dB	
	10 kHz		60 dB	55 dB	
	100 kHz		52 dB	52 dB	
	100 Hz	10	100 dB	75 dB	
	10 kHz		100 dB	95 dB	
	100 kHz		90 dB	90 dB	
	100 Hz	100	100 dB	80 dB	
	10 kHz		100 dB	100 dB	
	100 kHz		90 dB	90 dB	

Table 7: Typical Characteristics — Mechanical Characteristics

Name	Description
Weight	Shipping: 1.78 kg (3.92 lbs) including accessories Net Weight: 1.14 kg (2.51 lbs)
Overall Dimensions	Height: 36 mm (1.42 in) Width: 112 mm (4.41 in) Depth: 203 mm (8.00 in)
Cable Length	2 m (78.7 in)

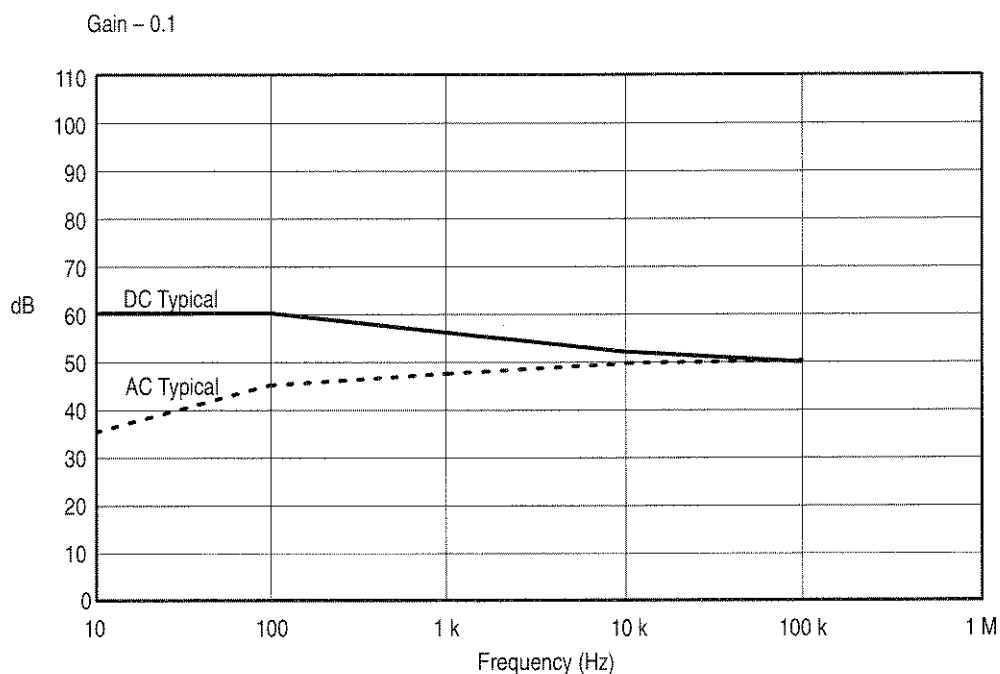


Figure 12: Typical DC and AC Coupled CMRR in X0.1 Gain

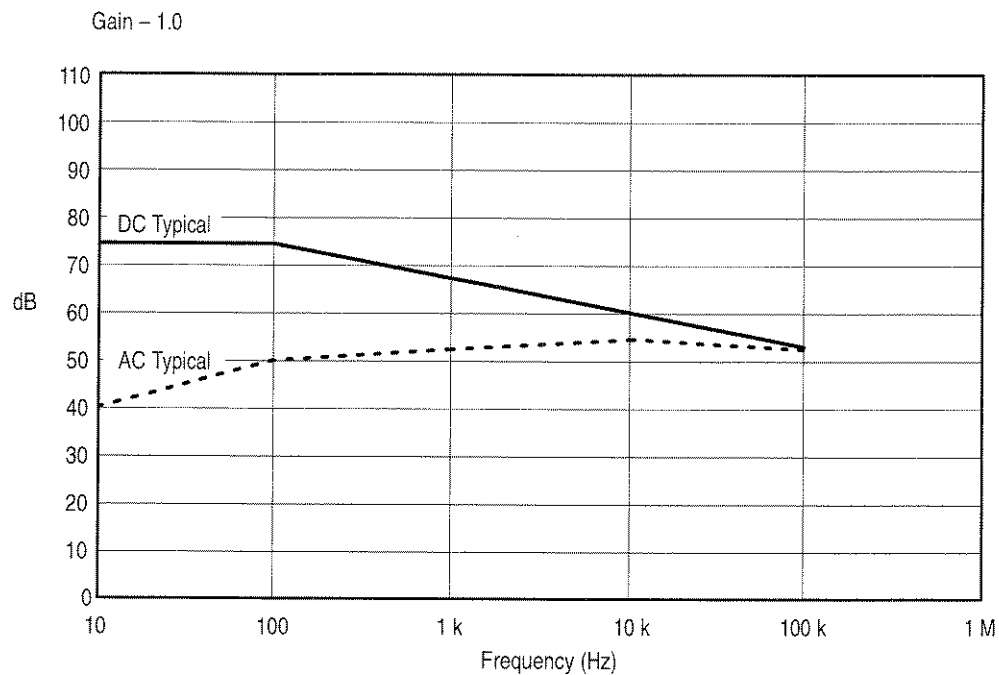


Figure 13: Typical AC and DC Coupled CMRR in X1 Gain

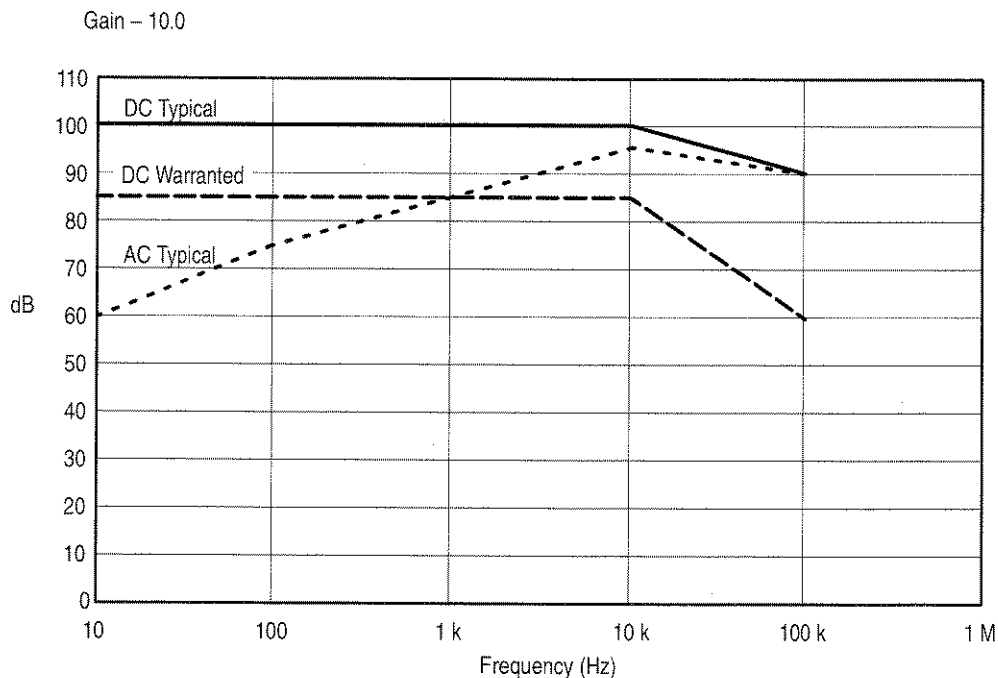


Figure 14: Typical and Warranted CMRR in X10 Gain

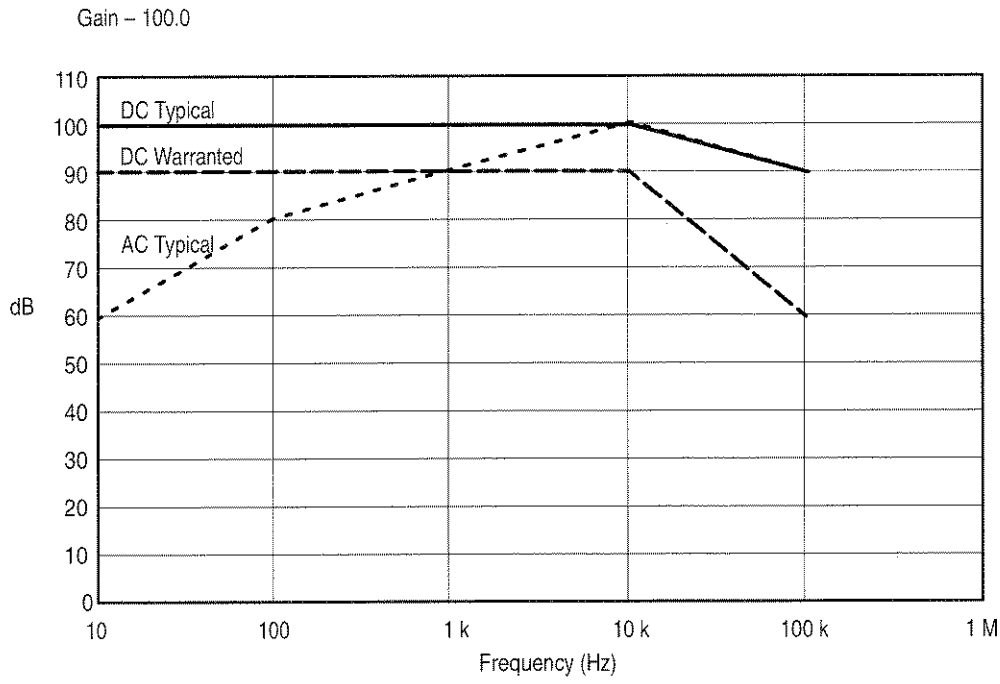


Figure 15: Typical and Warranted CMRR in X100 Gain

Performance Verification

This section contains procedures for checking that the ADA400A Differential Preamplifier meets warranted specifications.

Requirements for Performance

The performance limits of this procedure are valid with the following conditions:

- The ADA400A Differential Preamplifier is in an environment that is within the operating limits of temperature, altitude, humidity, and vibration described in *Specifications*.
- The data line jumper located inside the ADA400A Differential Preamplifier is properly configured depending on the type of oscilloscope you connect to the output. See the *Installation* section on page 2.
- The ADA400A Differential Preamplifier has a period of at least a 20 minutes to warm up prior to verification.

Equipment Required

Table 8 lists the equipment required to verify and adjust the ADA400A Differential Preamplifier. The *Adjustment Procedures* section begins on page 35.

Table 8: Test Equipment

Item Number and Description	Minimum Requirements	Example	Purpose
1. Digitizing Oscilloscope	Bandwidth: > 5 MHz Sensitivity: 1 mV/div Auto Measurement: Frequency, Amplitude Input Impedance: 1 M Ω	TDS460A	Supply power to and display output of ADA400A
2. Sine Wave Generator	Frequency Range: 1 Hz to 5 MHz	SG5030	CMRR checks and adjustments
3. Digital Multimeter	Resolution: \geq 3.5 digits Accuracy: \leq 0.5% Resistance Range: 200 Ω to 10 M Ω	DM2510	Input resistance check

Table 8: Test Equipment (Cont.)

Item Number and Description	Minimum Requirements	Example	Purpose
4. Calibration Generator	Calibrated Amplitude: Period: 1 ms Amplitude: 50 mVp-p to 20 V p-p into 1 M Ω Aberrations: \leq 2% p-p Accuracy: \leq 0.5% Fastrise: \leq 500 ns 1 Vp-p into 50 Ω	CG5011	Gain check and adjustment. LF Compensation adjustments
5. BNC Adapters	BNC Female to Dual Banana	Tektronix part number 103-0090-00	Signal connection
6. Dual Input Connector	Dual Input Cable BNC	Tektronix part number 067-0525-02	Signal connection
7. 50 Ω Terminators (2)	50 Ω , 2W, BNC	Tektronix part number 011-0049-01	Signal connection
8. 10X Attenuators (2)	10:1 Attenuator, 50 Ω , BNC	Tektronix part number 011-0059-02	Signal attenuation
9. Coaxial Cables (2)	50 Ω , 36 in. L, BNC male both ends	Tektronix part number 012-1341-00	Signal connection
10. Adjustment Tool, Probe	Plastic Insulated	Tektronix part number 003-0675-01	Adjustments (Adjustment Procedure only)

Procedures

Before beginning the procedures in this section, connect the output of the ADA400A Differential Preamplifier to the oscilloscope, turn the oscilloscope on, and let the ADA400A warm up for 20 minutes.

NOTE. Only TDS 400A Series oscilloscopes (TDS 460A, etc.) can display the proper scale factor. If you are using an oscilloscope other than a TDS 400A Series to perform these procedures, see page 2 to properly configure the scale factor coding.

To convert the volts/division settings for oscilloscopes that cannot read the scale factor from the ADA400A, multiply the volts/div setting in the procedure by the gain setting of the ADA400A.

Input Resistance

Equipment Required	One digitizing oscilloscope (item 1) to supply power to the ADA400A One digital multimeter (item 3) One BNC female to dual banana connector (item 5) One coaxial cable (item 9)
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1. Set digital multimeter to measure resistance.
2. Connect banana-to-BNC adapter to digital multimeter.

NOTE. To avoid an erroneous resistance measurement, make sure the 1 M Ω input resistance jumpers are installed.

3. Set ADA400A '+' input to **DC**.
4. Connect coaxial cable from '+' input of ADA400A to the BNC-to-banana adapter on the multimeter.
5. Check input resistance = 1 M Ω \pm 2% (980 k Ω to 1.02 M Ω).
6. Remove coaxial cable from ADA400A '+' input and connect it to the '-' input.
7. Set the ADA400A '-' input to **DC**.
8. Check input resistance = 1 M Ω \pm 2% (980 k Ω to 1.02 M Ω).

Gain

Equipment Required	One digitizing oscilloscope (item 1) One dual input coupler (item 6) One calibration generator (item 4) One coaxial cable (item 9)
---------------------------	---

1. Connect the ADA400A to Ch1 of the oscilloscope and make the equipment settings according to Table 9.

Table 9: Equipment Settings for Gain Checks

ADA400A Control	Setting
+ Input	DC
- Input	Gnd
Gain	100
Upper Bandwidth	100 kHz

Table 9: Equipment Settings for Gain Checks (Cont.)

ADA400A Control	Setting
Offset	Off
Oscilloscope Control	Setting
Channel Selection	Ch1
Vertical input impedance	1 M Ω
Vertical gain	10 mV/div
Time base	200 μ s/div
Vertical Coupling	DC
Vertical Position	0 V (mid-scale)
Trigger	Edge
Trigger position	50%
Trigger source	Ch4
Acquisition mode	Hi Res
Auto Measurement	Amplitude
Bandwidth	Full
Calibration Generator Control	Setting
Output	50 mV, 1 kHz

2. Connect a dual input connector to inputs of ADA400A.
3. Connect a coaxial cable from calibration generator output to dual input connector.
4. Adjust vertical position knob on the oscilloscope to center square wave on screen.
5. Check DC gain accuracy is $\pm 2\%$ (49 to 51 mV). (Use amplitude measurement function.)
6. Set ADA400A gain setting to 10.
7. Set calibration generator to 0.5 V amplitude.
8. Adjust vertical position knob on oscilloscope to center square wave on screen.
9. Check DC gain accuracy is $\pm 2\%$ (490 mV to 510 mV).
10. Set ADA400A gain setting to 1.
11. Set calibration generator to 5 V amplitude.

12. Adjust vertical position knob on oscilloscope to center square wave on screen.
13. Check DC gain accuracy is $\pm 2\%$ (4.9 V to 5.1 V).
14. Set ADA400A gain setting to 0.1.
15. Set calibration generator to 20 V amplitude.
16. Adjust vertical position knob on oscilloscope to center square wave on screen.
17. Check DC gain accuracy is $\pm 2\%$ (19.6 V to 20.4 V).
18. Disconnect setup from the inputs of the ADA400A.

CMRR

Equipment Required	One digitizing oscilloscope (item 1) One sine wave generator (item 2) One dual input coupler (item 6) One 50 Ω terminator (item 7) Two 10X attenuators (item 8) Two coaxial cables (item 9)
---------------------------	---

1. Connect the ADA400A to Ch1 of the oscilloscope and make the equipment settings according to Table 10.

Table 10: Equipment Settings for X100, 100 kHz CMRR Checks

ADA400A	Setting
+ Input	DC
- Input	Gnd
Gain	100
Upper Bandwidth	FULL (1 MHz)
Offset	Off
Oscilloscope	Setting
Vertical gain	2 mV/div
Time base	5 μ s/div
Acquisition mode	Average
Number of waveforms to average	20
Trigger source	Ch4

Table 10: Equipment Settings for X100, 100 kHz CMRR Checks (Cont.)

Sine Wave Generator	Setting
Output	100 kHz, 1 Vp-p into 50 Ω

2. Connect a coaxial cable from sine wave generator trigger output to Ch4 of the oscilloscope.
3. Connect dual input connector to inputs of ADA400A.
4. Connect 50 Ω terminator to dual input connector.
5. Connect two 10X attenuators to 50 Ω terminator.
6. Connect a coaxial cable from sine wave generator output to 10X attenuators.
7. Adjust trigger level for a steady display.
8. Adjust the amplitude of the sine wave generator for 5 divisions on screen.
9. Remove the two 10X attenuators and connect the cable directly to the 50 Ω terminator.
10. Set ADA400A '-' input to **DC**.
11. Set oscilloscope to 1 mV/div.
12. Measure signal is ≤ 1 division (1 mV, 60 dB).
13. Modify the equipment settings according to Table 11.

Table 11: Equipment Settings for X100, 10 kHz CMRR Checks

ADA400A	Setting
Upper Bandwidth	100 kHz
Oscilloscope	Setting
Vertical gain	2 mV/div
Time base	50 μ s/div
Sine Wave Generator	Setting
Output	10 kHz

14. Set '-' input to **GND**.
15. Do steps 5 to 10.
16. Set oscilloscope to 10 μ V/div. Measure trace is < 3.2 divisions wide (32 μ V, 90 dB).

17. Modify the equipment settings according to Table 12.

Table 12: Equipment Settings for X100, 100 Hz CMRR Checks

ADA400A	Setting
Upper Bandwidth	3 kHz
Oscilloscope	Setting
Vertical gain	2 mV/div
Time base	5 ms/div
Sine Wave Generator	Setting
Output	100 Hz

18. Set '-' input to **GND**.

19. Do steps 5 to 10.

20. Set oscilloscope to 10 μ V/div. Measure trace is < 3.2 divisions wide (32 μ V, 90 dB).

21. Modify the equipment settings according to Table 13.

Table 13: Equipment Settings for X10, 100 kHz CMRR Checks

ADA400A	Setting
Gain	10
Upper Bandwidth	1 MHz
Oscilloscope	Setting
Vertical gain	20 mV/div
Time base	5 μ s/div
Sine Wave Generator	Setting
Output	100 kHz

22. Set '-' input to **GND**.

23. Do steps 5 to 10 but with only one 10X attenuator.

24. Set oscilloscope to 1 mV/div. Measure trace is < 1 division wide (1 mV, 60 dB).

25. Modify the equipment settings according to Table 14.

Table 14: Equipment Settings for X10, 10 kHz CMRR Checks

ADA400A	Setting
Upper Bandwidth	100 kHz
Oscilloscope	Setting
Vertical gain	20 mV/div
Time base	50 μ s/div
Sine Wave Generator	Setting
Output	10 kHz

26. Set '-' input to **GND**.
27. Do steps 5 to 10 but with only one 10X attenuator.
28. Set oscilloscope to 100 μ V/div. Measure trace is < 0.56 division wide (56 μ V, 85 dB).
29. Modify the equipment settings according to Table 15.

Table 15: Equipment Settings for X10, 100 Hz CMRR Checks

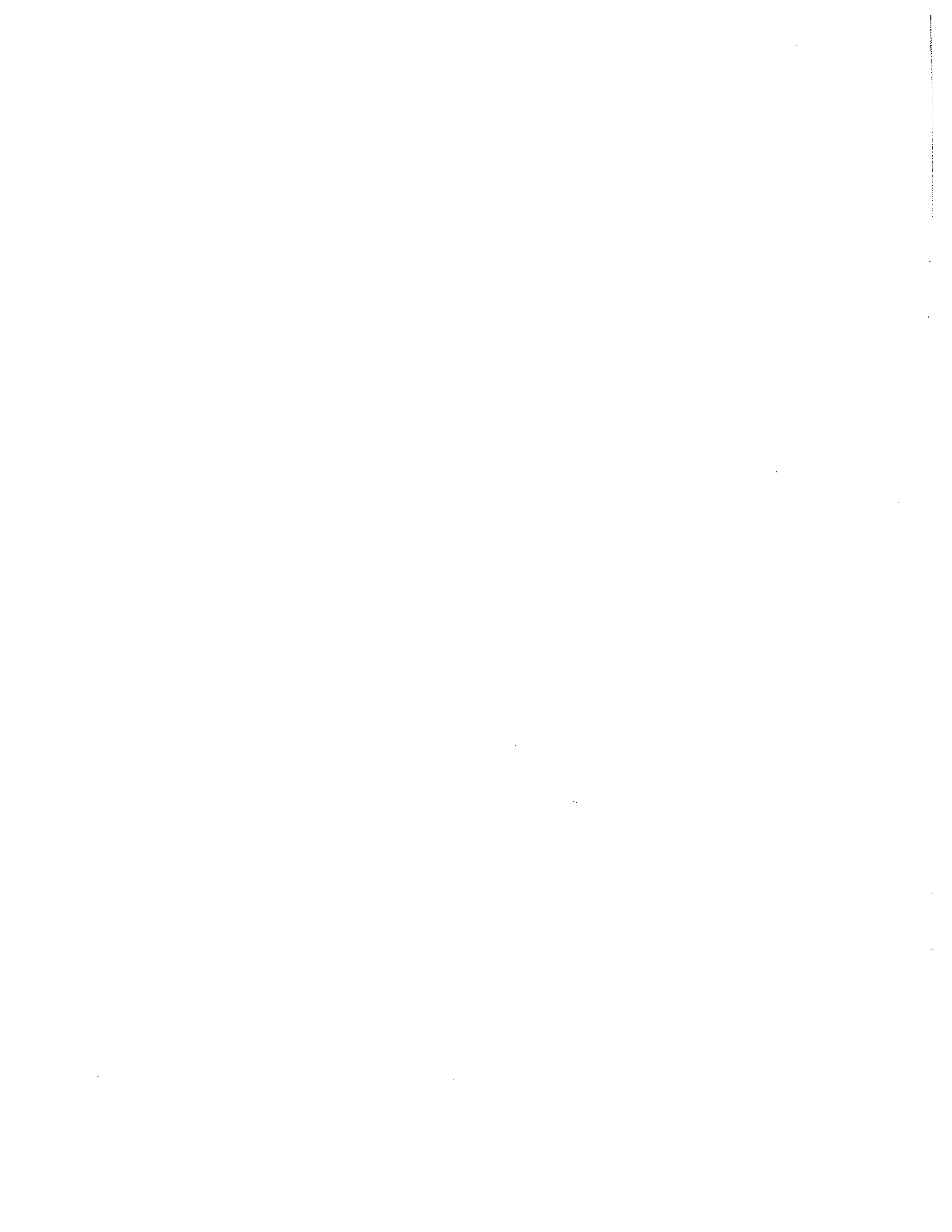
ADA400A	Setting
Upper Bandwidth	3 kHz
Oscilloscope	Setting
Vertical gain	20 mV/div
Time base	5 ms/div
Sine Wave Generator	Setting
Output	100 Hz

30. Set '-' input to **GND**.
31. Do steps 5 to 10 but with only one 10X attenuator.
32. Set oscilloscope to 100 μ V/div. Measure trace is < 0.56 division wide (56 μ V, 85 dB).
33. Disconnect setup.

This completes the performance verification procedure.

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid injury, do not perform any servicing other than that stated in the operating instructions unless you are qualified to do so. Refer to all Safety Summaries before performing any service.



Adjustment Procedures

Use the procedures in this section to return the ADA400A Differential Preamplifier to conformance with the *Warranted Characteristics* listed in the *Specifications* section on page 19.

Before performing any procedures in this section, please read the sections entitled *Requirements for Performance* and *Equipment Required*.

Requirements for Performance

Before performing these procedures, please address the following requirements:

- You must be a trained service technician to perform this procedure.
- You must adjust the ADA400A Differential Preamplifier in an environment in which temperature, altitude, humidity, and vibration are within the operating limits described in *Specifications*.
- You must calibrate the ADA400A Differential Preamplifier at the center temperature range of $22 \pm 5^{\circ} \text{C}$.
- You must warm up the ADA400A Differential Preamplifier for at least 20 minutes prior to adjustment.

Equipment Required

For a complete list of equipment required to perform the procedures in this section, see the *Equipment Required* section under *Performance Verification* on page 27.

Procedure

Before you begin these procedures, remove the top housing using the procedure on page 48. Leave the inner shield in place. See Figure 16 for a diagram of the adjustment locations.

NOTE. *To avoid contaminating the sensitive areas of the circuit board, do not remove inner shield or touch the circuit board. Access all adjustments through holes of inner shield*

Connect the output of the ADA400A Differential Preamplifier to the oscilloscope, turn the oscilloscope on, and let the ADA400A warm up for 20 minutes.

NOTE. *Only TDS 400A Series oscilloscopes (TDS 460A, etc.) can display the proper scale factor. If you are using an oscilloscope other than a TDS 400A Series to perform these procedures, see page 2 to properly configure the scale factor coding.*

To convert the volts/division settings for oscilloscopes that cannot read the scale factor from the ADA400A, multiply the volts/div setting in the procedure by the gain setting of the ADA400A.

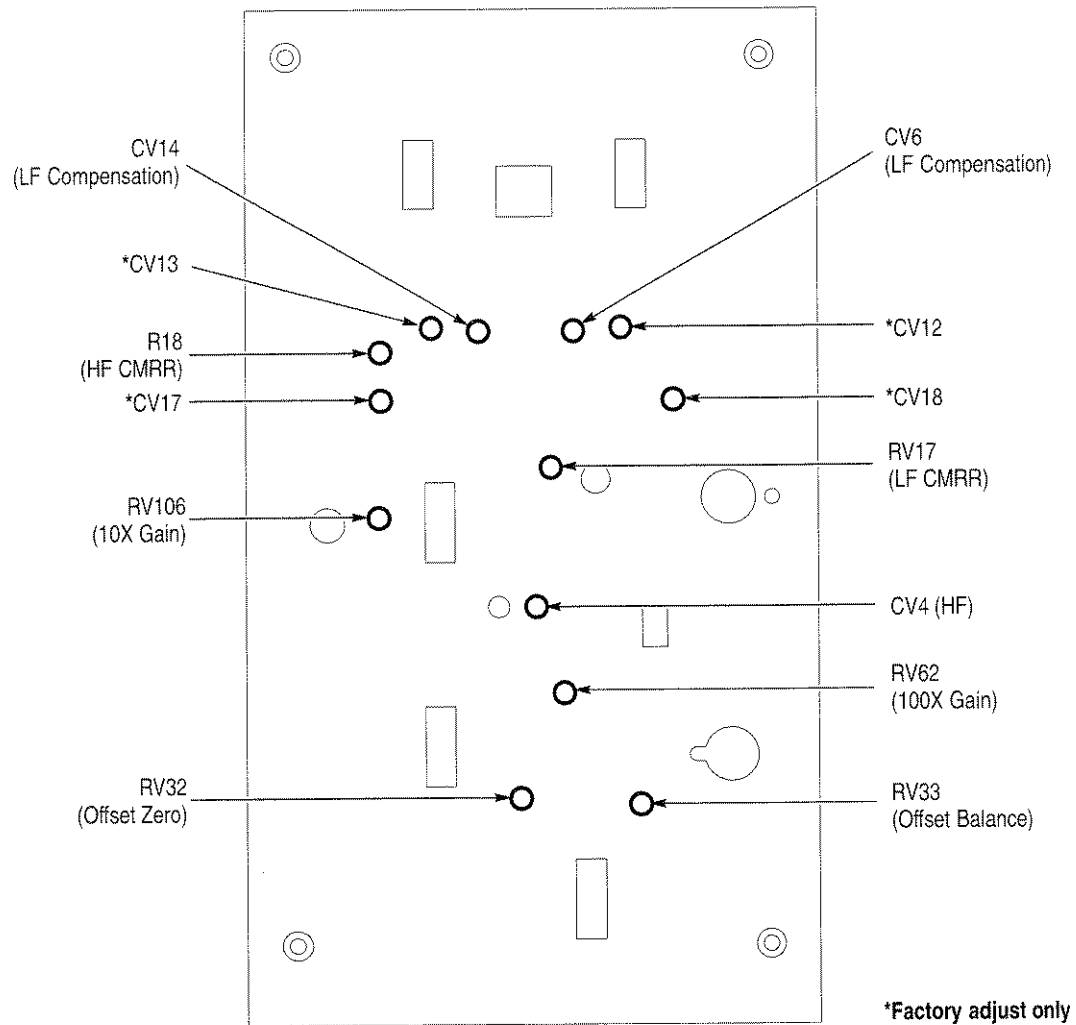


Figure 16: Location of Adjustments Underneath Inner Shield

Gain Adjustments

Equipment Required	One digitizing oscilloscope (item 1)
	One dual input coupler (item 6)
	One calibration generator (item 4)
	One coaxial cable (item 9)
	One adjustment tool (item 10)

1. Connect the ADA400A to Channel 1 and make the equipment settings according to Table 16.

Table 16: Equipment Settings for Gain Adjustments

ADA400A	Setting
+ Input	DC
- Input	Gnd
Gain	100
Upper Bandwidth	100 kHz
Offset	Off
Oscilloscope	Setting
Channel Selection	Ch1
Vertical input impedance	1 M Ω
Vertical gain	10 mV/div
Time base	200 μ s/div
Coupling	DC
Vertical Position	0 V (mid-scale)
Trigger	Edge
Trigger position	50%
Trigger source	Ch4
Acquisition mode	Hi Res
Auto Measurement	Amplitude
Bandwidth	Full
Calibration Generator	Setting
Output	50 mV calibrated, 1 kHz

2. Connect a dual input connector to inputs of ADA400A.
3. Connect a coaxial cable from the output of the calibration generator to the dual input connector.

4. Adjust vertical position knob on the oscilloscope to center square wave on screen.
5. Adjust RV62 for 5.0 divisions on screen (50 mV).
6. Set ADA400A gain setting to 10.
7. Set calibration generator to 0.5 V amplitude.
8. Adjust the vertical position knob on the oscilloscope to center square wave on screen.
9. Adjust RV106 to 5.0 divisions.

Zero Offset Adjustments

Equipment Required	One digitizing oscilloscope (item 1)
---------------------------	--------------------------------------

1. Connect the ADA400A to Channel 1 and make the equipment settings according to Table 17.

Table 17: Equipment Settings for Offset Adjustments

ADA400A	Setting
+ Input	Gnd
- Input	Gnd
Gain	10
Upper Bandwidth	100 Hz
Offset	Off (remains off through out the test)
Oscilloscope Control	Setting
Channel Selection	Ch1
Vertical input impedance	1 M Ω
Vertical gain	500 μ V/div
Time base	5 ms/div
Vertical Coupling	DC
Vertical Position	0 V (mid-scale)
Trigger mode	Auto
Acquisition mode	Hi Res
Bandwidth	Full

2. Check to make sure oscilloscope is at position 0 and vertical offset 0.

3. Switch the gain setting between 10 and 100 while adjusting RV33 for minimum shift in the oscilloscope trace.
 - a. Make note of trace position at gain setting of 10.
 - b. Switch gain setting to 100.
 - c. Adjust trace to where it was at the gain setting of 10.
 - d. Repeat steps a to c until there is a minimum amount of shift.
4. Adjust RV32 to center trace on screen.
5. Switch the gain setting from 0.1, 1, 10 and 100 and verify that trace does not shift more than one division from center.
6. Disconnect setup.

LF CMRR Adjustments

Equipment Required	One digitizing oscilloscope (item 1) One sine wave generator (item 2) One dual input coupler (item 6) One 50 Ω terminator (item 7) Two coaxial cables (item 9) One adjustment tool (item 10)
---------------------------	--

1. Connect the ADA400A to Channel 1 and make the equipment settings according to Table 18.

Table 18: Equipment Settings for Attenuator Balance Adjustments

ADA400A	Setting
+ Input	DC
- Input	Gnd
Gain	1
Upper Bandwidth	100 Hz
Oscilloscope	Setting
Vertical gain	1 V/div
Time base	20 ms/div
Trigger Source	Ch4
Sine Wave Generator	Setting
Output	10 Hz

2. Connect dual input connector to inputs of ADA400A.
3. Connect 50 Ω terminator to dual input connector.
4. Connect a coaxial cable from sine wave generator output to 50 Ω terminator.
5. Connect another coaxial cable from trigger output of sine wave generator to Ch4 of oscilloscope.
6. Adjust sine wave generator attenuator variable knob for 5 divisions (5 V) on screen.
7. Set ADA400A '-' input to DC.
8. Set oscilloscope volts/div to 1 mV.
9. Adjust RV17 for minimum signal amplitude.
10. Disconnect setup.

CMRR Adjustments

Equipment Required	One digitizing oscilloscope (item 1) One sine wave generator (item 2) One dual input coupler (item 6) One 50 Ω terminator (item 7) Two 10X attenuators (item 8) Two coaxial cables (item 9) One adjustment tool (item 10)
---------------------------	--

1. Connect the ADA400A to Channel 1 and make the equipment settings according to Table 19.

Table 19: Equipment Settings for CMRR Adjustments

ADA400A	Setting
+ Input	DC
- Input	Gnd
Gain	100
Upper Bandwidth	FULL (1 MHz)
Oscilloscope	Setting
Vertical gain, Ch 1	2 mV/div
Time base	5.0 μ s/div
Acquisition mode	Average

Table 19: Equipment Settings for CMRR Adjustments (Cont.)

Oscilloscope	Setting
Number of waveforms to average	20
Trigger source	Ch4
Sine Wave Generator	Setting
Output	100 kHz, 1 Vp-p into 50 Ω

2. Connect a coaxial cable from trigger output of sine wave generator to Ch4 of oscilloscope.
3. Connect dual input connector to inputs of ADA400A.
4. Connect 50 Ω terminator to dual input connector.
5. Connect two 10X attenuators to 50 Ω terminator.
6. Connect a coaxial cable from sine wave generator output to 10X attenuators.
7. Adjust trigger level for a steady display.
8. Adjust amplitude for 5 divisions (10 mV) on screen.
9. Remove the two 10X attenuators and connect the cable directly to the 50 Ω terminator.
10. Set ADA400A ‘-’ input to DC.
11. Set oscilloscope to 2 mV/div.
12. Adjust CV4 and R18 for minimum signal amplitude (≤ 1 mV).
13. Disconnect setup.

LF Compensation Adjustments

Equipment Required	
	One digitizing oscilloscope (item 1)
	One calibration generator (item 4)
	One dual input coupler (item 6)
	One 50 Ω terminator (item 7)
	Two coaxial cables (item 9)
	One adjustment tool (item 10)

1. Connect the ADA400A to Channel 1 and make the equipment settings according to Table 20.

Table 20: Equipment Settings for LF Adjustments

ADA400A	Setting
+ Input	DC
– Input	Gnd
Gain	1
Upper Bandwidth	Full (1 MHz)
Oscilloscope	Setting
Vertical gain, Ch1	200 mV/div
Time base	20 μ s/div
Calibration Generator	Setting
Output Mode	Fast Rise, 10 kHz

2. Connect dual input connector to ADA400A input.
3. Connect 50 Ω terminator to dual input connector.
4. Connect a coaxial cable to calibration generator fast rise output to 50 Ω terminator.
5. Connect a coaxial cable from trigger out of calibration generator to Ch4 of oscilloscope.
6. Adjust amplitude for 5 divisions on screen.
7. Adjust CV6 for flat response.
8. Make the second equipment settings according to Table 21.

Table 21: Second Equipment Settings for LF Adjustments

ADA400A	Setting
+ Input	DC
– Input	DC
Oscilloscope	Setting
Vertical gain	5 mV/div
Time base	20 μ s/div

9. Adjust CV14 for minimum trace.
10. Disconnect setup.

This completes the ADA400A adjustment procedures.

Maintenance

This section details the maintenance and replacement procedures for the ADA400A Differential Preamplifier.

Warranty Service

Tektronix warrants this product for three years from date of purchase. (A complete warranty statement appears at the front of this manual.) Tektronix provides warranty service at most Tektronix service locations worldwide. The Tektronix product catalog lists all service locations worldwide.

Should the ADA400A Differential Preamplifier require replacement under terms of the warranty, return the preamplifier to a Tektronix service center. Include the following information: name of purchaser, return address, name and phone number of a person that Tektronix may contact, date of purchase, and a description of the defect.

In the U.S., call 1-800-TEK WIDE (1-800-835-9433) for further assistance.

Preparation

This manual provides information for limited servicing of the ADA400A Differential Preamplifier

NOTE. *Only qualified service personnel should attempt any internal repair or maintenance of the ADA400A Differential Preamplifier.*

Before Servicing Before servicing the ADA400A Differential Preamplifier, please read the *General Safety Summary* starting on page iii.

Preventing ESD The ADA400A Differential Preamplifier contains internal components that are susceptible to damage from electrostatic discharge (ESD).



CAUTION. To prevent damaging internal components by means of electrostatic discharge (ESD), perform all service at a static-free work station and wear a grounded anti-static wrist strap.

Do not slide the internal module over any surface. Place internal module in static-free bag for transportation away from work station.

Cleaning

To prevent damage to the ADA400A Differential Preamplifier, avoid using chemicals that contain benzine, benzene, toluene, xylene, acetone, or similar solvents.

Do not immerse the ADA400A Differential Preamplifier or use abrasive cleaners.

Dirt on external surfaces may be removed with a soft cloth dampened with a mild detergent and water solution, or isopropyl alcohol.

NOTE. Certain areas of the circuit board are sensitive to surface contamination. Avoid touching the surfaces of the circuit board. Handle the circuit board by the edges. If the circuit board is contaminated, wash the board with Isopropyl Alcohol and rinse with warm deionized water.

Replacement Procedures

Refer to the procedures in this section before replacing any part on the ADA400A Differential Preamplifier. For a list of all customer replaceable parts, see the *Replaceable Parts* section that begins on page 53 and the exploded view on page 57.

Replacing TEKPROBE Interface Pins

Periodically check to see that each of the interface pins move freely and fully extends out of the interface. If any pin fails to move freely and fully extend, it should be replaced.

To remove a TEKPROBE interface pin, firmly grasp the pointed tip with pliers and pull the pin out of the connector. See Figure 17.

No tools are required to install a replacement pin. Insert a new pin into the connector socket as far as possible using finger pressure. If necessary, seat the pin into the connector by pressing the tip gently but firmly against a hard surface, such as a wood block or table top.

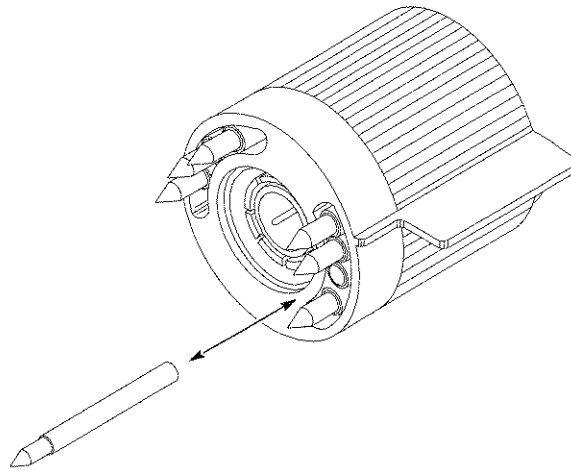


Figure 17: Replacing TEKPROBE Interface Pins

Replacing the TEKPROBE Interface Collar

To remove the TEKPROBE interface collar, firmly grasp the body of the output head with one hand, and the TEKPROBE interface collar with the other hand. Firmly pull the interface collar off.

To replace the collar, first note the pin configuration in the interface collar. The group of three pins fit through the smaller of the two holes in the interface collar. Align the tab to the slot and gently press the two pieces together. See Figure 18.

Once installed, the TEKPROBE collar should rotate freely to lock and unlock.

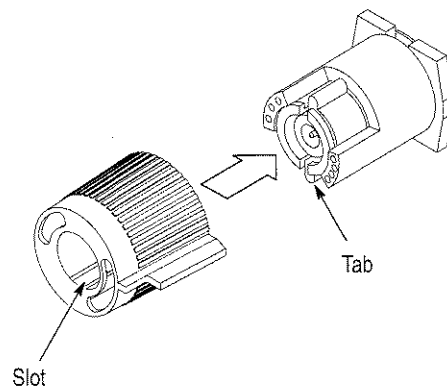


Figure 18: Replacing the TEKPROBE collar

Replacing the Input Fuses

To remove and replace an input fuse, insert a flat-blade screwdriver into the slot on the fuse cap, press in and turn counter clockwise to remove the fuse.



CAUTION. To properly protect the inputs of the ADA400A Differential Preamplifier, replace fuses with the type specified in the Replaceable Parts section.

Insert the replacement fuse into the cap on the fuse holder, insert, and use the flat-blade screwdriver to press in and lock the fuse cap counterclockwise.

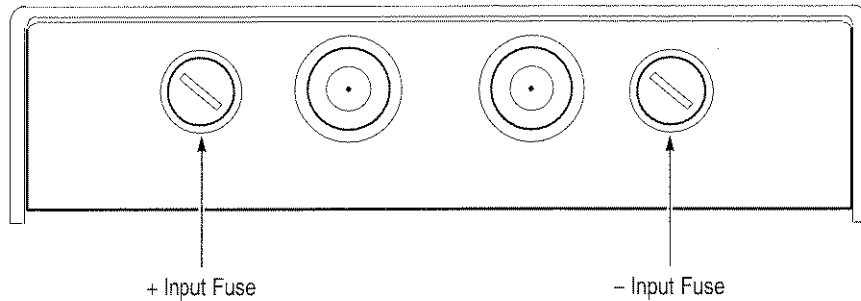


Figure 19: Input Connectors and Fuses

Accessing Internal Components

To access internal components of the ADA400A Differential Preamplifier, refer to the exploded view, Figure 22, on page 57 and perform the following procedure:

1. Using a 1/16-inch allen wrench, loosen the set screws on the COARSE and FINE controls and remove the knobs.
2. Remove the four screws that hold the top housing, separate the top housing from the bottom housing and set the top housing to one side.

STOP. If you intend to electrically adjust the ADA400A or move a jumper, do not proceed further. The adjustments and jumpers are accessible through holes in the circuit board shield. Proceed further only if you intend to replace parts under the shield.

3. Following the static precautions presented at the beginning of this section, remove the screws on the top of the shield and carefully lay the shield over to the side without straining the wires of the potentiometers.

Replacing the Potentiometers

After performing the procedure to access the internal components of the ADA400A Differential Preamplifier, replace one of the potentiometers as follows:

1. Unsolder the wires from the potentiometer.

2. Remove the nut on the shaft of the potentiometer and replace the potentiometer with the new part. Replace and tighten the nut and washer on the shaft.
3. Resolder the wires as Figure 20 illustrates.

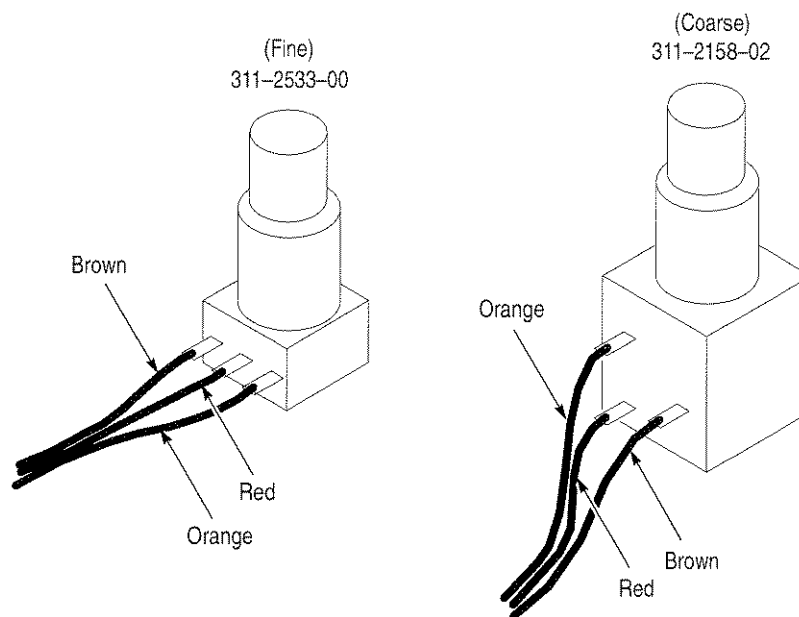


Figure 20: Potentiometer Connections

Replacing the Cable Assembly

After performing the procedure to access the internal components of the ADA400A Differential Preamplifier, replace the cable assembly as follows:

1. Remove the remaining two screws that hold the circuit board to the bottom housing.

NOTE. To prevent contaminating sensitive areas of the circuit board, handle the circuit board by the edges only.

2. Unsolder the four colored wires from the top of the circuit board and the three ground prongs from the bottom of the circuit board.
3. Note the color-code information on the circuit board. Replace the cable assembly and solder the new wires.
4. Place the circuit board and cable strain relief in the bottom housing and reinstall hardware.

Replacement Parts

Refer to the Replaceable Parts section beginning on page 53 for a list of customer replacement parts.

Theory of Operation

Figure 21 illustrates the functional blocks of circuitry from left to right in the order of input to output. The darker boxes in the illustration designate front panel controls and lines with arrows indicate the functional blocks that the controls affect.

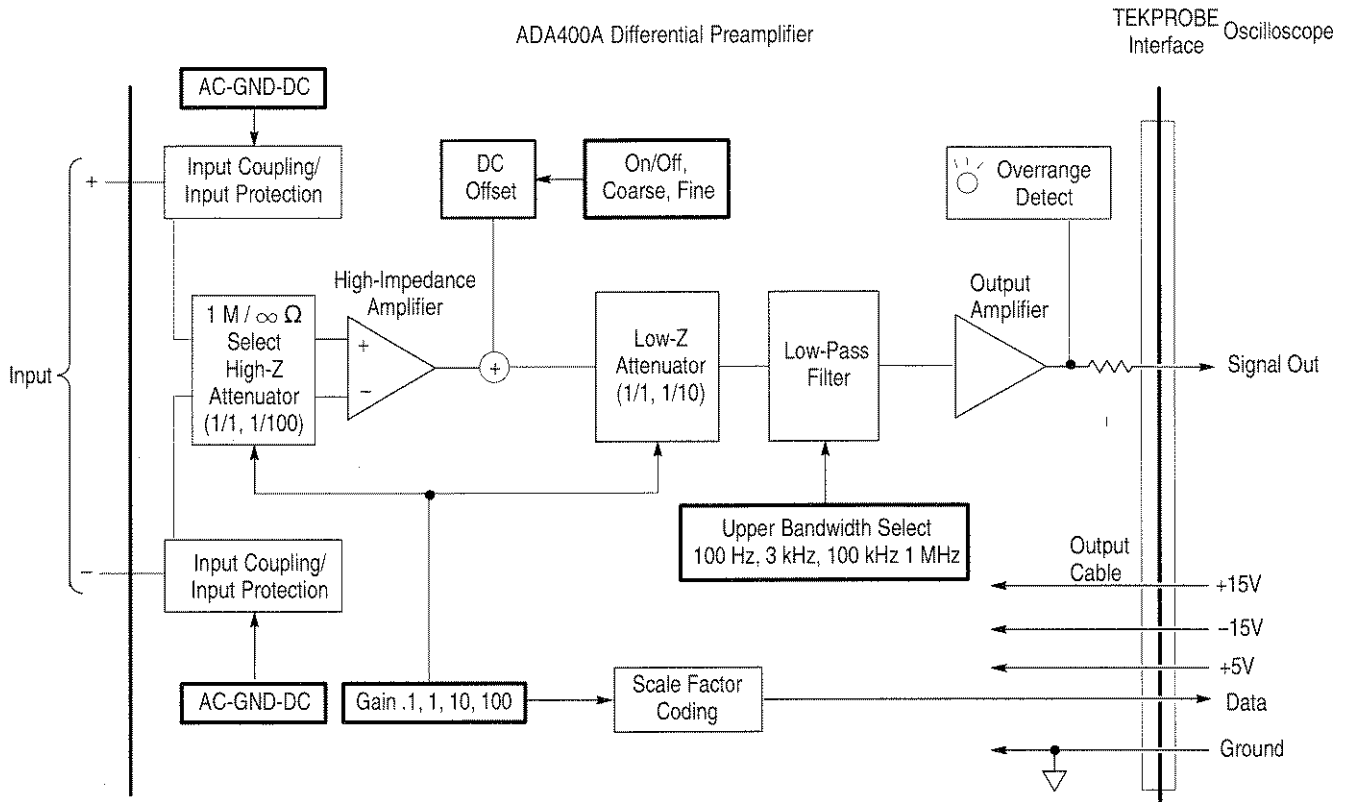


Figure 21: Diagram of the ADA400A Differential Preamplifier

Input Protection and Coupling

Any signals on the inputs of the ADA400A Differential Preamplifier must pass through the input protection and coupling circuits.

Input Protection. The input protection circuit shunts excessively high-voltage signals to ground and blows the protective fuse if the current exceeds 1/16 ampere for any length of time.

Input Coupling. The coupling switch for a particular input selects one of the following connections to the input of the preamplifier: AC, GND (ground), or DC. For more information on these switch positions, see page 13.

Input Impedance	Internal jumpers connect an input impedance of 1 M Ω in parallel with 55 pF. With the jumpers disconnected the input impedance is virtually infinite (10 ¹² Ω). For more information about these jumpers, see page 10.
Attenuation and Amplification	The gain switch sets the gain of the preamplifier by selecting the amount of attenuation at two different points in the circuitry: 1/1 or 1/100 attenuation in the high-impedance attenuator and 1/1 or 1/10 attenuation in the low-impedance attenuator. The lowest gain setting, for example, selects the highest total amount of attenuation.
DC Offset	The offset controls adjust the DC component of the input signal. To keep the signal from distorting, the signal must be within the dynamic range of the amplifier. For more information on the dynamic range characteristic, refer to the notes on page 14.
Low-Pass Filter	The Upper Bandwidth Control selects different RC networks in the low-pass filter. The bandwidth settings are 100 Hz, 3 kHz, 100 kHz, and 1 MHz.
Overrange Detect	Should the input signal exceed the dynamic range of the output amplifier, the overrange detection circuit activates the indicator on the front panel.
Scale-Factor Coding	The gain switch also selects a resistance that appears on the data pin. If the host oscilloscope is properly equipped (see <i>Installation</i> on page 2), this resistance determines the vertical scale factor on the oscilloscope display.
TEKPROBE™ Interface	The TEKPROBE interface provides power, signal, and data connections between the ADA400A Differential Preamplifier and the oscilloscope.

Troubleshooting

Table 22 lists symptoms of electrical faults, possible causes, and corrective actions.

Table 22: Electrical Faults

Symptom	Possible Cause	Corrective Action(s)
No power	Damage to TEKPROBE interface connections. Check interface pins and cable assembly wires for damage.	Replace interface pin(s) Replace or repair cable assembly
No output signal on connector end of cable assembly or output too high or low	Blown input fuse Damage to output cable	Check and replace fuse(s) Repair or replace cable assembly
Intermittent or difficult positioning	Defective position controls	Replace position control(s)
No signal output to cable assembly — interface power is present and fuses are not blown	Faulty module	Send unit to service center for exchange or replacement.

Repackaging Instructions

If the original packaging is unfit for use or not available, use the following packaging guidelines:

1. Use a corrugated cardboard shipping carton having inside dimensions at least one inch greater than the probe dimensions. The box should have a carton test strength of at least 200 pounds.
2. Put the probe into a plastic bag or wrap to protect it from dampness.
3. Place the probe into the box and stabilize it with light packing material.
4. Seal the carton with shipping tape.

Replaceable Parts

This section contains a list of the replaceable modules for the ADA400A Differential Preamplifier. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

Module Servicing

Modules can be serviced by selecting one of the following options. Contact your local Tektronix service center or representative for repair assistance.

Module Exchange. In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEK-WIDE, extension 6630.

New Modules. You may purchase replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the ADA400A Differential Preamplifier. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Parts List Column Descriptions

Column	Column Name	Description
1	Figure & Index Number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix Part Number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial Number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entries indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & Description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. Code	This indicates the code of the actual manufacturer of the part.
8	Mfr. Part Number	This indicates the actual manufacturer's or vendor's part number.

Abbreviations Abbreviations conform to American National Standard ANSI Y1.1-1972.

Mfr. Code to Manufacturer Cross Index The table titled Manufacturers Cross Index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

Manufacturers Cross Index

Mfr. Code	Manufacturer	Address	City, State, Zip Code
0JR05	TRIQUEST CORP	3000 LEWIS AND CLARK HWY	VANCOUVER WA 98661-2999
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
18359	PYLON CO INC	51 NEWCOMB ST	ATTLEBORO MA 02703-1403
22526	BERG ELECTRONICS INC (DUPONT)	857 OLD TRAIL RD	ETTERS PA 17319
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507-2114
61935	SCHURTER INC	1016 CLEGG COURT	PETALUMA CA 94952-1152
71400	BUSSMANN DIV OF COOPER INDUSTRIES INC	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRING KY 41076-9749
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIV	ST CHARLES ROAD	ELGIN IL 60120
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61108-5181

Replaceable Parts List

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
22-1	380-1098-00			1	HOUSING:TOP & BOTTOM,STEEL-ZINC PLATE	80009	380109800
-2	334-8900-00			1	MARKER,IDENT:INSTRUMENT LABEL	80009	334890000
-3	366-1861-03			2	KNOB:GREY,0.252 ID X 0.706 OD X 0.612 H, W/SET SCREWS	80009	366186103
-4	211-0541-00			4	SCREW,MACHINE:6-32 X 0.25,FLH,100 DEG,STL,CD PL, POZ	80009	211054100
-5	220-0495-00			2	NUT,PLAIN,HEX:0.375-32 X 0.438 HEX,BRS,CD PL	73743	ORDER BY DESC
-6	210-0012-00			2	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL	78189	1220-02-00-0541
-7	337-4037-00			1	SHIELD:0.040 STEEL,ZINC PLATE,7.5X 5.0	80009	337403700
-8	311-2158-02			1	RES,VAR,WW:PNL,5K OHM,5%,1W	32997	84A1C-B24-J13
-9				1	CIRCUIT BD ASSY:MAIN (EXCHANGE ONLY)		
-10	159-0024-00			2	FUSE,CARTRIDGE:3AG,0.062A,250V,0.3 SEC	71400	AGC 1/16
-11	200-2264-00			2	CAP,FUSEHOLDER:3AG FUSES	61935	FEK 031 1666
-12	131-0993-00			3	CONN,BOX:SHUNT,;FEMALE,STR,1 X 2,0.1 CTR, 0.385 H,30 GOLD,BLACK,JUMPER (SUBPART OF 22-9)	22526	65474-006
-13	220-0497-00			2	NUT,PLAIN,HEX:0.5-28 X 0.562 HEX,BRS CD PL	73743	ORDER BY DESC
-14	210-0986-00			2	WASHER,FLAT:0.5 ID X 0.672 OD X 0.035,STL CD PL	80009	210098600
-15	211-0711-00			4	SCR,ASSEM WSHR:6-32 X 0.250,PNH,STL,CDPL, T-15 TORX DR,MACHINE	0KB01	ORDER BY DESC
-16	210-1039-00			2	WASHER,LOCK:0.521 ID,INT,0.025 THK,SST	0KB01	1224-02-00-541
-17	348-0187-00			4	FOOT,CABINET:BLACK POLYURETHANE	80009	348018700
-18	211-0408-00			1	SCR,ASSEM WSHR:4-40 X 0.250,PNH,STL,CDPL, T-10 TORX DR	0KB01	211-0408-00
-19	131-3627-01			7	CONTACT,ELEC:GOLD PLATED TIP (SUBPART OF 22-21)	18359	P-6158-1
-20	205-0191-00			1	SHELL,ELEC CONN:BNC,ABS,DOVE GRAY (SUBPART OF 22-21)	80009	205019100
-21	174-3462-01			1	CABLE ASSY:CABLE W/COMP BOX	80009	174346201
-22	311-2533-00			1	RES,VAR,PANEL:CERMET;50K OHM,10%,1.0W,LINEAR TAPER,12.5 MM SQ,0.375DIA X 0.375 L BUSHING, SOLDER LUGS	32997	53AAA-B24-A18R7
-23	210-0004-00			5	WASHER,LOCK:#4 INTL,0.015 THK,STL	78189	1204-00-00-0541
-24	211-0394-00			5	SCREW,MACHINE:4-40 X 0.875,PNH,STL CD PL TORX, T10	93907	B20-69595-003
STANDARD ACCESSORIES							
	159-0024-00			2	FUSE,CARTRIDGE:3AG,0.062A,250V,0.3SEC	71400	AGC 1/16
	070-9164-xx			1	MANUAL,TECH:INSTRUCTION,ADA400A,DP	80009	0709164xx
OPTIONAL ACCESSORIES							
	P6101B			1	PROBE,PASSIVE:15MHZ 1X 2.0M	80009	P6101B

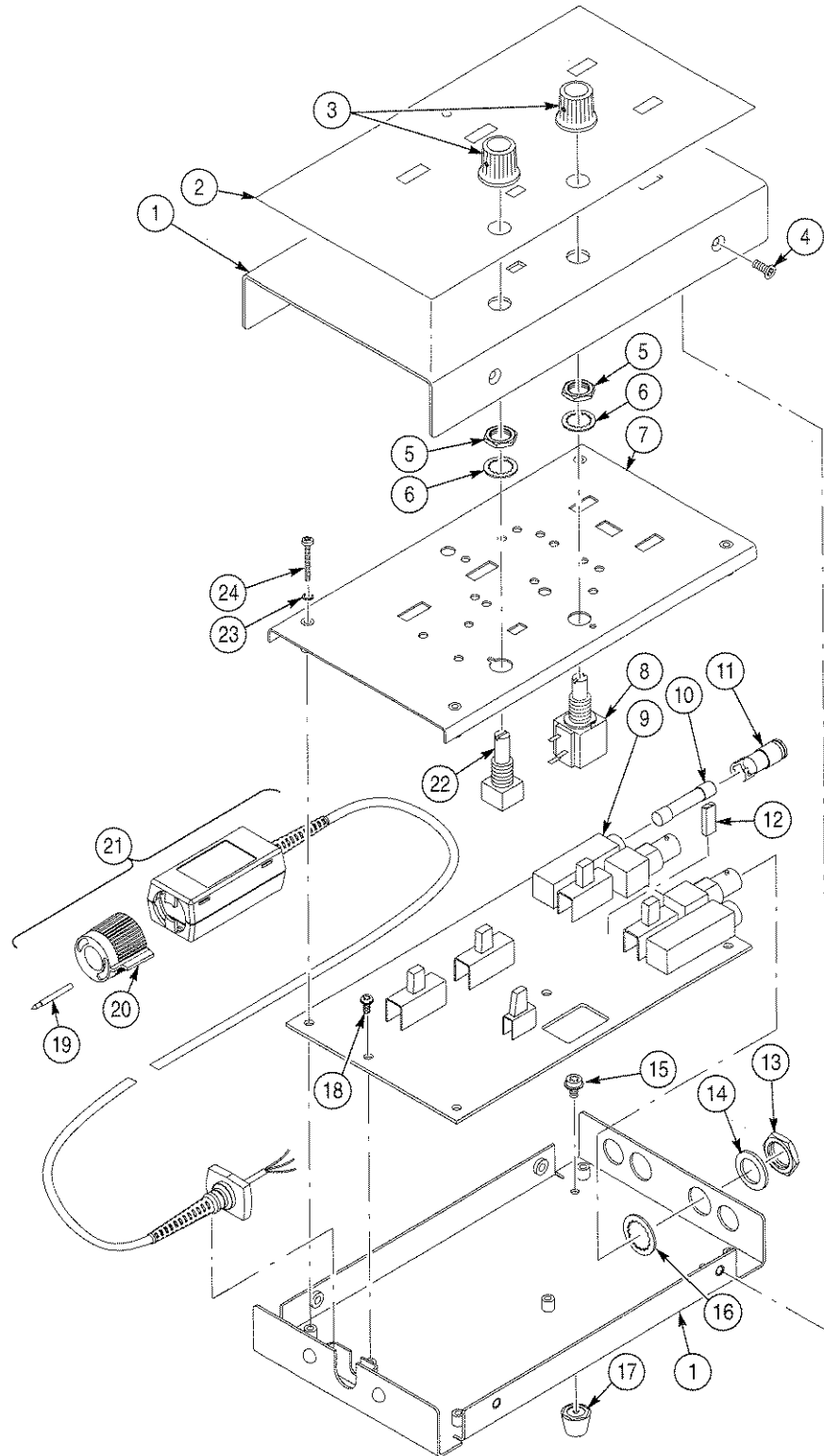


Figure 22: ADA400A Differential Preamp — Exploded View

Glossary

Alternating Current (AC)

An electric current whose instantaneous value and direction change periodically.

Amplitude

The difference between a high and a low point on a waveform. Signal amplitude can be measured in terms of “peak-to-peak” or “peak” for example.

Attenuation

The degree the amplitude of a signal is reduced when it passes through an attenuating device such as a probe or attenuator. That is, the ratio of the input measure to the output measure. For example, a 10X attenuator will attenuate, or reduce, the input voltage of a signal by a factor of 10.

Bandwidth

Bandwidth is the specified frequency range of the vertical system wherein the vertical response is greater than or equal to 0.707 (–3dB) of the specified frequency down to DC or 0 Hz.

Common mode

Signals on both preamplifier inputs that are identical in voltage and phase.

Common-Mode Rejection Ratio (CMRR)

The extent to which a differential amplifier rejects a common-mode voltage presented on the inputs. CMRR is the ratio of the differential gain to the common-mode gain and is usually expressed in decibels (dB).

Coupling

The method of connecting the input circuit to the signal source. A coupling circuit, for example, may pass only AC signals above a certain frequency.

Differential

Signals that are not identical in amplitude or phase and thereby present a difference on the inputs of the preamplifier.

Direct Current

An electric current that flows in only one direction with essentially constant value.

Frequency

A timing measurement that is the reciprocal of the period. Frequency is measured in Hertz (Hz) where 1 Hz = 1 cycle per second.

Floating

A signal or voltage that does not have a reference to ground.

Gain

Increase in signal strength.

Ground

A connection or reference to the zero voltage potential of earth ground.

Ground loop

Two or more paths between grounded points in a circuit in which a current circulates. This current may induce a voltage potential which corrupts sensitive measurements.

Hertz

The unit of frequency, one cycle per second.

Megahertz (MHz)

A frequency of one million Hz (cycles per second), or 10^6 Hz.

Noise

An unwanted voltage or current in an electrical signal.

Normal mode

The signal of interest without the common-mode element.

Peak

The difference in amplitude between the maximum value and the average or mean value of a waveform.

Peak-to-Peak

Amplitude measurement of the absolute difference between the maximum and minimum amplitude.

Period

A timing measurement of the time covered by one complete signal cycle. It is the reciprocal of frequency and is measured in seconds.

Phase

A timing measurement between two waveforms of the amount one leads or lags the other. Phase is expressed in degrees where 360° comprises one complete cycle of one of the waveforms.

RMS

Amplitude (voltage) measurement of the true Root-Mean-Square voltage.

Single ended

A connection to one input of the preamplifier only. The coupling of the other side must be set to ground (GND).

Waveform

The shape or form (visible representation) of a signal expressed as amplitude versus time (Y-T).

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