User Manual

Models 9100A, 9200A and 9400

SINGLE/DUAL/FOUR-CHANNEL, HIGH VOLTAGE WIDEBAND POWER AMPLIFIER

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Tabor Electronics Ltd.

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FOR YOUR SAFETY

Before undertaking any troubleshooting, maintenance or exploratory procedure, read carefully the **WARNINGS** and **CAUTION** notices.

This equipment contains voltage hazardous to human life and safety, and is capable of inflicting personal injury.

If this instrument is to be powered from the AC line (mains) through an autotransformer, ensure the common connector is connected to the neutral (earth pole) of the power supply.

Before operating the unit, ensure the conductor (green wire) is connected to the ground (earth) conductor of the power outlet. Do not use a two-conductor extension cord or a three-prong/two-prong adapter. This will defeat the protective feature of the third conductor in the power cord.

Maintenance and calibration procedures sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures and heed warnings to avoid “live” circuit points.

Before operating this instrument:

1. Ensure the proper fuse is in place for the power source to operate.

2. Ensure all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If the instrument:

- fails to operate satisfactorily
- shows visible damage
- has been stored under unfavorable conditions
- has sustained stress

Do not operate until, performance is checked by qualified personnel.

DECLARATION OF CONFORMITY

We: Tabor Electronics Ltd.
9 Hatasia Street, Tel Hanan
ISRAEL 36888

declare, that the 400Vp-p Signal Amplifiers

Models 9100A, 9200A and 9400

meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility and complies with the requirements of the Low Voltage Directive 73/23/EEC amended by 93/68/EEC, according to testing performed at ORDOS/E.M.I TEST LABs (#6TBR1083SX, May 2006). Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

Safety:
IEC/EN 61010-1 2nd Edition:2001+ C1, C2

EMC:
EN 50081-1 Emissions:
EN 55022 - Radiated, Class B
EN 55022 - Conducted, Class B
EN 50082-1 Immunity:
IEC 801-2 (1991) - Electrostatic Discharge
IEC 801-3 / ENV50140 (1993) - RF Radiated
IEC 801-4 (1991) - Fast Transients

Models 9100A, 9200A and 9400 are built on the same platform and share specifications and features except the 9100A is a single channel version, while the 9200A has two channels and 9400 has four channels. The tests were performed on a typical configuration.

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Chapter 1
Installation

Installation Overview

This chapter contains information and instructions necessary to prepare the 9400 for operation. Details are provided for initial inspection, grounding requirements, repackaging instructions for storage or shipment and installation information.

NOTE

This manual is common to Models 9100A, 9200A and Model 9400. All instruments are built on the same platform and share specifications and features except the 9100A is a single channel version, the 9200 has two channels and 9400 has four channels.

Unpacking and Initial Inspection

Unpacking and handling of the generator requires normal precautions and procedures applicable to handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to determine that the shipment is complete.

Safety Precautions

Extreme safety precautions should be observed before using this product. 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 persons who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. The following sections contain information and cautions that must be observed to keep the 9400 operating in a correct and safe environment.

CAUTION

For maximum safety, do not touch the product, test cables, or any other instrument parts while power is applied to the circuit under test. ALWAYS remove power from the entire test system before connecting cables or 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 keep your hands dry while handling the instrument.

Operating Environment

The 9400 is intended for indoor use and should be operated in a clean, dry environment with an ambient temperature within the range of 0 °C to 40 °C.

WARNING

The 9400 must not be operated in explosive, dusty, or wet atmospheres. Avoid installation of the module close to strong magnetic fields.

The design of the 9400 has been verified to conform to EN 61010-1 2nd addition safety standard per the following limits: Installation (Overvoltage) Category I (Measuring terminals) Pollution Degree 2.

Pollution Degree 2 refers to an operating environment where normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.

Power Requirements

The 9400 operates from one of the following nominal sources: 100V, 115V, or 230V ac. Voltage selection is done using the rear-panel power line selector switch. The instrument operates over the power mains frequency range of 47 to 63 Hz. Always verify that the operating power mains voltage is the same as that specified on the rear panel voltage selector switch.

The 9400 is supplied with the correct power line setting. If this setting needs to be change, use a flat-head screwdriver to set the Line Selector switch on the rear panel to the required position.

The instrument is not intended for operation from two phases of a multi-phase ac system or across the legs of a single-phase, three-wire ac power system. Crest factor (ratio of peak voltage to rms) should be typically within the range of 1.3 to 1.6 at 10% of the nominal rms mains voltage.

WARNING

DO not connect the line cord to the 9400 before you verify the correct power line setting. Failure to switch the instrument to match the operating line voltage will damage the instrument and may void the warranty.

Grounding Requirements

To conform to the applicable safety and EMC requirements, ensure that the Model 9400 is “earth” grounded. Always connect the power using the supplied power cord with the earth pin connected securely to the wall mount socket.

Signals connected to the amplifier inputs and to the amplifier outputs are grounded through the outer shell of the BNC connectors. Never attempt to float the signal from case ground as it may damage the source equipment.

Calibration

The recommended calibration interval is three years. Calibration should be performed by qualified personnel only.

Abnormal Conditions

Operate the 9400 only as intended by the manufacturer. If you suspect the product has been impaired, remove the power cord and secure against any unintended operation. The 9400 protection is likely to be impaired if, for example, the instrument fails to perform the intended operation or shows visible damage.

WARNING

Any use of the 9400 in a manner not specified by the manufacturer may impair the protection provided by the instrument

Long Term Storage or Repackaging For Shipment

If the instrument is to be stored for a long period of time or shipped immediately, proceed as directed below. If you have any questions, contact your local Tabor representative or the Tabor Customer Service Department.

1. Repack the instrument using the wrappings, packing material and accessories originally shipped with the unit. If the original container is not available, purchase replacement materials.
2. Be sure the carton is well sealed with strong tape or metal straps.
3. Mark the carton with the model and serial number. If it is to be shipped, show sending and return address on two sides of the box.

NOTE

If the instrument is to be shipped to Tabor for calibration or repair, attach a tag to the instrument identifying the owner. Note the problem, symptoms, and service or repair desired. Record the model and serial number of the instrument. Show the returned authorization order number (RMA) as well as the date and method of shipment. ALWAYS OBTAIN A RETURN AUTHORIZATION NUMBER FROM THE FACTORY BEFORE SHIPPING THE INSTRUMENT TO TABOR.

Preparation for Use

Preparation for use includes removing the instrument from the box, the bag and installing the 9400 either on the bench or in a 19” rack. Chapter 2 of the manual contains operating instructions. Make sure you read and understand the instructions in Chapter 2 before turning on the device.

Bench Installation

The 9400 dissipates large amount of power. No special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 40 °C, when the relative humidity exceeds 80% or condensation appears anywhere on the instrument. Avoid operating the instrument close to strong magnetic fields, which may be found near high power equipment such as motors, pumps, solenoids, or high power cables. Always leave 4 cm (about 1.5 inches) of ventilation space on all sides of the instrument.

Rack Mounting

The 9400 can be rack mounted inside a standard 19” rack. It can be mounted using one of two configurations: 1) single, or 2) side-by-side. Tabor offers rack-mounting ears for both options. Consult the factory for the appropriate part number.

Using the single rack mounting option, the 9400 is supplied with a blank panel that covers the empty side. The case can be mounted either on the left or the right of the rack with the blank panel covering the empty space.

Side-by-side option is available only with other Tabor products. In this case, the two boxes are latched in the middle and side ears connect the assembly to the rack. Figure 1-1 shows how the 9400 can be mounted next to a dual-channel arb – Model 2572.

Use care when rack mounting to locate the instrument away from sources of excessive heat or magnetic fields. Always leave 4 cm (1.5 inches) of ventilation space on top and bottom sides of the power amplifier.

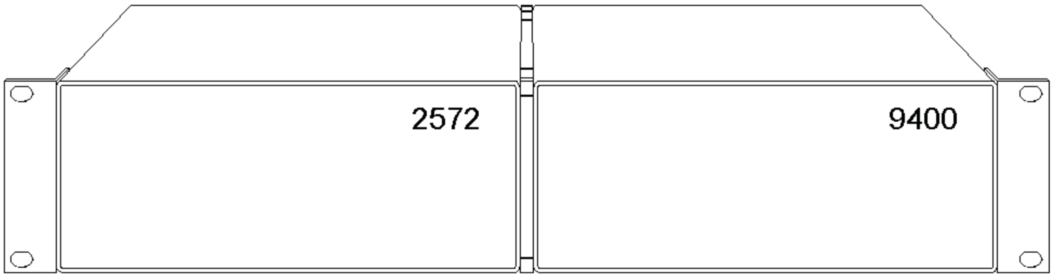

Figure 1-1, Dual Rack Mounting Option

Chapter 2
Introduction and Operating Instructions

What's in This Chapter

This chapter contains general and functional description of the Models 9100A, 9200A and 9400 – high voltage, wideband amplifier series. It also describes the front and rear panel connectors, operational modes and all features available with the instruments.

Introduction

Description

Models 9100A, 9200A and 9400 were designed as a general purpose series, wide band and high voltage amplifier however, with specific applications in mind. It has up to four channels built in a small case size to save space and cost but without compromising bandwidth and signal integrity. The Model 9100A is shown in Figure 2-1, model 9200A is shown in Figure 2-2 and model 9400 in Figure 2-3. All instruments are built on the same platform and share specifications and features except the 9100A is a single channel version, the 9200A is a dual channel version and the 9400 has four channels.

NOTE

This manual is common to Models 9100A, 9200A and Model 9400. All instruments are built on the same platform and share specifications and features except the 9100A is a single channel version, the 9200 has two channels and 9400 has four channels.

The 9400 is intended to operate as an amplifying buffer for signals such as available from waveform, function, or pulse generators. Most of these generators can produce signals that are limited to 20 Vp-p into high impedance, so the 9400 can be used to convert these voltages to levels as high as 400 Vp-p.

The amplifier case was designed to stack on top or below other Tabor products. It measures 2U high and ½ rack size. It also can be mounted next to a Tabor generator in a standard 19" rack, as shown in Figure 2-4. The arbitrary waveform and amplifier combination is a perfect fit for almost every high-voltage, wide bandwidth application.

Four Channels

Each channel can output signals from -200 V to +200 V with continuous currents up to 50 mA. The output has a fixed gain of x50 and its output signal is driven from a 0.1 Ω source impedance. Normal loads are expected to be of resistive nature however, with some degradation of its bandwidth, the output can drive capacitive loads up to 1 nF, while maintaining its full amplitude range. Each channel has a rear-panel monitor output that divides the main output signal by 100. Having an output monitor is extremely useful in such applications that require monitoring of the output signal with low voltage sensors.

Modes of Operation

The amplifier can be used in one of two modes of operation. The first is normal mode where each channel amplifies and outputs bipolar signals. In this mode, the input signal is amplified and delivered to the output terminals without modification of its original properties, except its amplitude level. Using this mode of operation, each channel can be used separately to amplify a unique signal.

The second mode of operation is the unipolar mode where the signal is applied to one input, rectified, amplified and output through two separate outputs. Using this mode, the amplifier is converted to a two-input, four-output system, specifically designed to operate the up/down and right/left actuators of a typical MEMS micro engine, as well as for other applications requiring the precise conversion of bipolar to unipolar signals.

Safety

Safety played a major role during the design of the Model 9400. The high voltage path to the amplifier circuit is blocked by a front panel mechanical switch and accidental application of high power to the UUT is prevented by a safety latch. The Model 9400 will output high voltage signals only after the safety latch has been lifted and the high voltage switch flipped to ON position. In emergency situations, one can hit the protective latch to immediately remove the high voltage power from the output terminals. Also, red light glows on the front panel whenever the high voltage is turned on. For added safety measures, the output connectors are covered with protective caps to prevent accidental touch of the inner pin of the output connector.

Figure 2-1, Model 9100A – Single-channel High Voltage Power Amplifier

Figure 2-2, Model 9200A – Dual-channel High Voltage Power Amplifier

Figure 2-3, Model 9400 – Four-channel High Voltage Power Amplifier

Conventions Used in this Manual

The following symbols may appear in this manual:

NOTE

A Note symbol contains information relating to the use of this product

CAUTION

A Caution symbol contains information that should be followed to avoid personal damage to the instrument or the equipment connected to it.

WARNING

A Warning symbol alerts you to a potential hazard. Failure to adhere to the statement in a WARNING message could result in personal injury.

9100A/9200A/9400 Feature Highlights

- Single, Dual or Four independent channels
- Precise signal amplification for multiple applications
- -200 to +200 V (400 Vp-p)
- Output current up to 50 mA per channel (100 mA per channel in 9200A and 150 mA in 9100A)
- Full power bandwidth from DC to >500 kHz
- Special unipolar mode for MEMS engine drivers
- Monitor Outputs for each channel
- High voltage safety latch and output protective caps prevent accidental shock hazards
- Compatible with any of the Tabor arbitrary waveform generators
- Small case size

Options

There are no options offered with the model 9400.

Manual Changes

Manual changes and addendums (if any) are added at the end of the manual.

Specifications

Instrument specifications are listed in Appendix A. These specifications are the performance standards or limits against which the instrument is tested. Specifications apply under the following conditions:

1. Output terminated into matching impedance
2. 30 minutes of warm up time
3. Within the temperature range of 20°C to 30°C. Specifications outside this range are degraded by 0.1% per °C.

Front Panel Controls and Indicators

There are a few controls and indicators on the front panel. These control and indicate the status of the Mains power and of the high voltage output status. These controls are described in the following. Refer to Figure 2-3 throughout the description.

Mains Power Switch and Indicator

The mains power switch turns the instrument on and off. The light next to the switch illuminates when the power is on and turns off when the power is removed from the amplifier. Note however, that by turning the mains power on the high voltage path remains disconnected from the internal circuit. Information how to turn the high voltage on is given in the following.

High Voltage Switch and Indicator

The high voltage switch, latch and indicator are part of the safety measures taken to avoid exposure to lethal voltage hazards. Note the position of the latch. When in the down position, the high voltage path to the output amplifiers is disconnected and no hazardous voltages are present at the output terminals. One can turn on the power to the output terminals only by lifting the safety latch and switching the high voltage on with the HI-V switch. High voltage on is indicated by a clear light at the center of the front panel. Use extreme caution when the high voltage light is on to avoid contact with the inner conductor of the BNC connector.

In case of emergency, hit the latch from the top. The mechanical construction of the latch is specially made to flip the high voltage switch to the off position and hence remove the high voltage from the output terminals.

Unipolar Mode Indicator

The Unipolar mode indicator illuminates when the unipolar mode has been selected. For normal mode of operation, where all four channels are used separately, the Unipolar indicator should be turned off. Information how to use the unipolar mode is given later in this chapter.

Front Panel Connectors

The 9400 has 8 BNC connectors on its front panel, four are designated as INPUT and four are marked as OUTPUT. These connectors are described below. Notice that for safety purpose, the output connectors are covered with special caps. The caps are permanently connected to the front panel with chains to keep them from getting lost. For safety, always keep the caps latched on the connectors except when connecting the outputs to the device under test.

Inputs

The input connector accepts signals within the range of DC to over 500 kHz and amplifies them by a fixed gain of x50. Input impedance is 1MΩ.

Note that the amplifier input can not tolerate high voltage therefore, before applying the cable to the input connector, make sure your signal does not exceed the input rating, as specified in Appendix A of this manual.

When used in normal operating mode (Unipolar light is off), the 9400 can be used as four independent amplifier channels so each of the input connectors can be connected to a different signal source.

Outputs

The output connectors output amplified signals. Output source impedance is 0.1Ω. Each output connector can generate signals from -200 V to +200 V with continuous currents up to 50 mA.

When used in normal operating mode (Unipolar light is off), the 9400 can be used as four independent amplifier channels so each of the output connectors can be connected to a different load circuit. Normal loads are expected to be of resistive nature however, with some degradation of its bandwidth, the output can drive capacitive loads up to 1 nF, while still maintaining its full amplitude range.

WARNING

Applying the output signal on highly inductive or highly capacitive loads may damage the amplifier.

Notice that for safety purpose, the output connectors are covered with special caps. The caps are permanently connected to the front panel with chains to keep them from getting lost. For safety reasons, always keep the caps latched on the output connectors except when connecting the outputs to the device under test.

Rear Panel

There are a number of connectors and controls on the rear panel. These are used for applying mains power, selecting and protecting

Controls and Connectors

the line voltage. Unipolar mode selector and output monitor connectors are also available on the rear panel. Information on the various controls and connectors on the rear panel is given in the following. Refer to Figure 2-4 throughout the following description.

Figure 2-4, Model 9400 – Rear Panel Controls and Connectors

Mains Input Receptacle

The mains input receptacle is used for connecting mains power to the instrument. The receptacle is a standard, three prong connector. Mating cable is supplied with the instrument. Before you connect the mains cable to the wall socket, make sure the AC Voltage Selector switch is set to the correct voltage setting as required for individual countries. Information how to install the instrument and how to select the correct voltage setting is described in Chapter 1.

You can leave the mains cable connected both the instrument end and the wall socket as long as you power the amplifier down using the front panel Power switch.

AC Voltage Selector

The AC voltage switch is used for selecting the mains voltage level as required by individual countries. Two nominal voltage settings are available: 115 V and 230 V. Special input setting is available for countries using nominal 100 V and 200 V mains voltage however, such special must be specified at the time of the purchase.

If specified at the time of purchase, the instrument will be supplied with the switch set to the required voltage level however, it is always considered good practice to check the setting before connecting the instrument to the wall socket.

Mains Fuse

The Mains fuse protects the mains input voltage from over current and overload conditions. Fuse rating is specified in the manual and instructions how to replace the fuse are given in Chapter 1. Always replace the fuse with the same type and rating as specified in the manual.

Note that there are two types of fuses used for various mains voltage settings. Therefore, to avoid blowing fuses, always check that your AC voltage selector switch is set to the appropriate voltage setting before connecting the instrument to the wall socket.

Unipolar Mode Selector

The unipolar mode selector switch selects between two basic operating modes, normal and unipolar. Information on these modes is given in the following. The Model 9400 is operating in normal mode when the switch is set to its outside position. The instrument is operating in unipolar mode when the switch is pushed in and the front panel Unipolar indicator illuminates.

Output Monitor Connectors

The output monitor connectors duplicate the signal at the front panel output connectors except the output signal is divided by 100. These outputs are used for monitoring the output signal with low voltage sensors.

The bandwidth of the output monitor connectors is the same as specified for the main output connectors. There are four connectors, designated as Channel 1 through 4, one for each output channel.

Grounding Considerations

Understanding how to connect your ground path could be critical to preserving the integrity of your output signal. If you are using a single-ended output then it will probably be safe for you to connect the circuit ground to case ground. However, in applications requiring floated ground connection, it is imperative that the amplifier ground be made floating as well. Since the model 9400 has its signal ground always connected to the case ground, it is recommended that you consult the factory for a special version of floated signal ground.

Always bear in mind the following warning:

WARNING

Input and output grounds are tied together and therefore, it is absolutely forbidden to connect the output ground to a different level than the input ground. Failure to adhere to this limitation may damage the 9400 and the surrounding equipments, that are connected to its I/O connectors.

Basic Operating Instructions

Being a passive device, there are no controls, nor computer programming required to operate the 9400. The following procedure is recommended for proper operation of the high voltage power amplifier:

1. Make sure your amplifier is turned off and that the High Voltage latch is forced to its down position. This will assure that the high voltage path to the output connectors will be blocked when power is applied to the amplifier

2. If you intend to operate the amplifier using its standard, bipolar operating mode, make sure the rear panel switch is set to Unipolar Mode OFF position (push the switch in and out to feel the action and select the outward position of the switch). Information how to use the amplifier in unipolar mode is given later in this manual.

3. Connect the mains power cord to the rear panel AC Line Input receptacle

4. Connect the mains power cord to the wall power socket

5. Turn power on using the front panel POWER switch. Not that the power on light illuminates

6. Using standard BNC to BNC cables (not supplied with the instrument), connect the source signal(s) to the amplifier input(s). Make sure the source signal level does not exceed the level as specified in Appendix A of this manual

7. Remove the protective caps from the output connector(s). As precaution, leave the protective caps on the unused output

connectors

8. Using standard BNC to BNC cables (not supplied with the instrument), connect the terminals to your load

9. (Optional step) Using standard BNC to BNC cables (not supplied with the instrument), connect the rear panel output monitors to a sensing device. Sensing device could be such as an oscilloscope, DMM, digital recorder, or any other sensing device, as long as its input impedance matches the impedance as specified in Appendix A of this manual

WARNING

The following steps involve application of high voltage to the output terminals. Voltage level could be lethal, if any of the output wires is being touched. Always keep safety distance from the 9400, its output terminals and the high voltage path to the load circuit when high voltage is turned on.

10. Note the warning above and flip open the high voltage safety latch on the high voltage switch

11. Flip the high voltage switch to its ON position and note that the front panel High Voltage ON light illuminates. Amplified signal is now available at the load circuit and the signal itself can be monitored on the rear panel connectors

Operating Modes

The amplifier can be used in one of two modes of operation. The first is normal mode where each channel amplifies and outputs bipolar signals. The second mode of operation is the unipolar mode where the signal is applied to one input, rectified, amplified and output through two separate outputs. Description how to select the operating mode and how to use the 9400 in each mode is given below.

Selecting an Operating Modes

The 9400 operating mode is selected using a rear panel switch, which is labeled as UNIPOLAR MODE. Normal (bipolar) operating mode is selected in the out position and unipolar mode is selected when the switch is pushed in.

Using the Normal Output Mode

Using the normal, bipolar mode, the input signal is amplified and delivered to the output terminals without modification of its original properties, except its amplitude level. Using this mode of operation, each channel can be used separately to amplify a unique signal. So, normal mode of operation provides four separate amplifier channels, labeled CH1 through CH4. Figure 2-5 shows an amplified signal using the normal mode of operation.

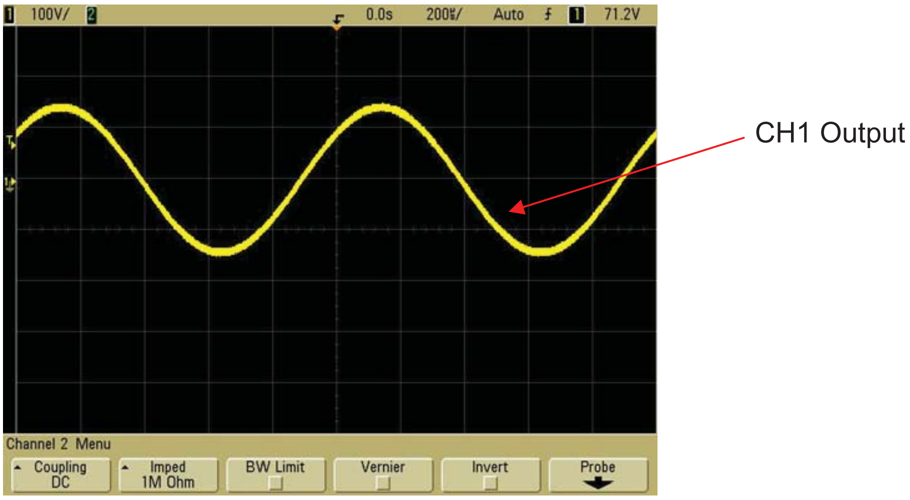

Figure 2-5, Normal, Bipolar Amplified Sine Waveform

Using the Unipolar Output Mode

Using the unipolar mode, the amplifier is converted to a two-input, four-output system. Typical applications for this mode of operation are to operate the up/down and right/left actuators of a typical MEMS micro engine, as well as for other applications requiring the precise conversion of bipolar to unipolar signals. Figure 2-6 shows typical sine waveform which is rectified and converted to two unipolar half sines. Note that channel 2 signal is shifted by 180° from the channel 1 output.

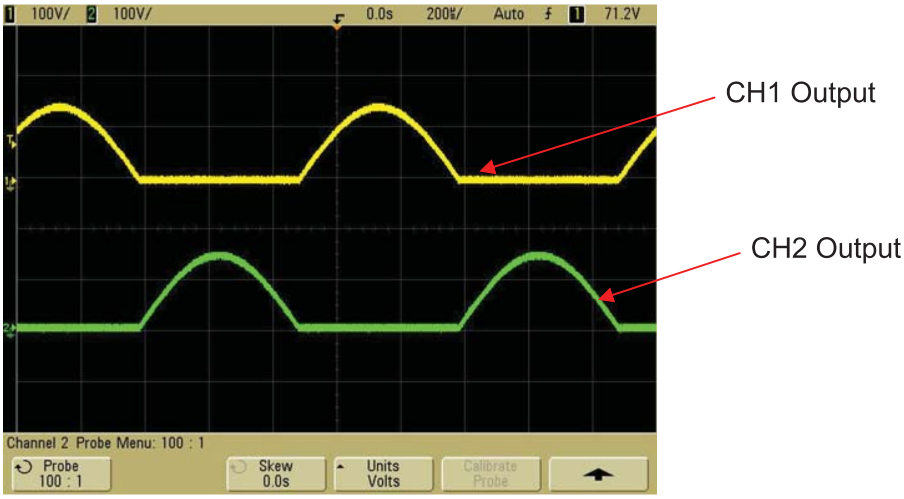

Figure 2-6, Amplified Unipolar Sine Waveform

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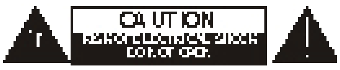
Chapter 3

Performance Checks and Adjustments

What's in This Chapter

This chapter provides performance tests necessary to troubleshoot the Model 9400 – four-channel, wideband power amplifier. If you purchased the Models 9100A or 9200A, please ignore all references to the third and forth channels.



WARNING

The procedures described in this section are for use only by qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

CAUTION

ALWAYS PERFORM PERFORMANCE TESTS IN A STATIC SAFE WORKSTATION.

Performance Checks

The following performance checks verify proper operation of the instrument and should normally be used:

1. As a part of the incoming inspection of the instrument specifications;

2. As part of the troubleshooting procedure;

3. After any repair or adjustment before returning the instrument to regular service.

Environmental Conditions

Tests should be performed under laboratory conditions having an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure.

Warm-up Period

Most equipment is subject to a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the 9400 and allow it to warm-up for at least 30 minutes before beginning the performance test procedure.

Initial Instrument Setting

To avoid confusion as to which initial setting is to be used for each test, it is required that the high voltage be turned off prior to each test. To turn the high voltage off, hit on the top of the latch and observe that the High Voltage On light turns off.

Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed in Table 3-1 below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

Table 3-1, Recommended Test Equipment

Equipment	Model No.	Manufacturer
Oscilloscope	LT342	LeCroy
Distortion Analyzer	6900B	Krohn Hite
Digital Multimeter	2000	Keithley
Waveform Generator	WW2572	Tabor Electronics
100:1 High voltage Probe	6498	Pomona Electronics
4 kΩ/20W Load Resistance		Tabor Electronics

Test Procedures

Use the following procedures to check the Model 9400 against the specifications. A complete set of specifications is listed in Appendix A. The following paragraphs show how to set up the instrument for the test, what the specifications for the tested function are, and what acceptable limits for the test are. If the instrument fails to perform within the specified limits, the instrument must be calibrated or tested to find the source of the problem.

WARNING

The output connectors of the Model 9400 produce voltages up to 400Vp-p. The procedures described in this section are for use only by trained and qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if extreme safety precautions are not observed. Do not attempt to perform any of the following tests except if you were trained and advised specifically on the hazards involve. Never have your hands on the cables while performing the test procedures.

In case of emergency, hit the high voltage latch from the top; This action will remove the high voltage from the output amplifiers and will provide safe access to the unit under test.

Amplifier Gain Accuracy

Amplifier gain accuracy checks the gain accuracy of the power amplifier. Each channel has its own power amplifier and therefore, the accuracy is tested on each channel separately.

Gain Accuracy Tests

Equipment: DMM, Arbitrary Waveform Generator, Load Resistance, 50Ω feedthrough terminator

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 200V
2. Connect the 9400 Channel 1 output to the DMM input. Attach the load resistance at the input terminals of the DMM
3. Configure the Waveform Generator as follows:
   Frequency: 1kHz
   Output: On
   Amplitude: As required for the test
4. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Perform Gain Accuracy tests on channel 1 output using Table 3-2
2. Use the same procedure to check channels 2, 3 and 4

Table 3-2, Gain Accuracy Tests

Arb Amplitude Setting	Error Limits	DMM Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
2 Vp-p	35.4 V, ±0.7 V						
4 Vp-p	70.75 V, ±1.4 V						
6 Vp-p	106.1V, ±2.1 V						
8 Vp-p	141.4 V, ±2.8 V						

Amplifier Bandwidth

Amplifier bandwidth checks the bandwidth of the output. Each channel has a different response and therefore, the bandwidth is tested on each channel separately. The amplifier responds differently to small and large signals and therefore its bandwidth is checked for each type of level

Bandwidth, Large Signals

Equipment: Oscilloscope, Arbitrary Waveform Generator, Load Resistance, x100 high voltage probe, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   Time Base: 200 μs/div
   Amplitude: 50 V/div
2. Connect the 9400 Channel 1 output to the load resistance
3. Connect the x100 high voltage probe across the load resistance
4. Configure the Waveform Generator as follows:
   Amplitude: 8 V
   Output: On
   Frequency: As required for the tests
5. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions
2. Perform bandwidth, large signals tests on channel 1 output using Table 3-3
3. Use the same procedure to check channels 2, 3 and 4

Table 3-3, Output Bandwidth, Large Signals Tests

Arb Frequency Setting	**Error Limits**	**Oscilloscope Reading**				**Pass**	**Fail**
		CH1	**CH2**	**CH3**	**CH4**		
1 kHz	6 Divisions						
100 kHz	6 ±0.5 Divisions						
400 kHz	6 ±1 Divisions						
550 kHz	6 ±1.8 Divisions						

Bandwidth, Small Signals

Equipment: Oscilloscope, Arbitrary Waveform Generator, Load Resistance, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   Time Base: 200 μs/div
   Amplitude: 5 V/div
2. Connect the 9400 Channel 1 output to the Oscilloscope input. Attach the load resistance at the input terminals of the oscilloscope
3. Configure the Waveform Generator as follows:
   Amplitude: 200 mV
   Output: On
   Frequency: As required for the tests
4. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions

2. Perform bandwidth, small signals tests on channel 1 output using Table 3-4
3. Use the same procedure to check channels 2, 3 and 4

Table 3-4, Output Bandwidth, Small Signals Tests

Arb Frequency Setting	Error Limits	Oscilloscope Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
1 kHz	6 Divisions						
500 kHz	6 ±0.5 Divisions						
1 MHz	6 ±1.8 Divisions						
1.8 MHz	6 ±1.8 Divisions						

Amplifier Pulse Response

Amplifier pulse response checks the aberrations, which include rise and fall times, overshoot and undershoot. Each channel has a different response and therefore, the pulse response is tested on each channel separately.

Rise/Fall Time Tests

Equipment: Oscilloscope, Arbitrary Waveform Generator, Load Resistance, x100 high voltage probe, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   - Time Base: 500ns
   - Amplitude: 100 V/div
2. Connect the 9400 Channel 1 output to the load resistance
3. Connect the x100 high voltage probe across the load resistance
4. Configure the Waveform Generator as follows:
   - Amplitude: 8 V
   - Function: Square wave
   - Output: On
   - Frequency: 50 kHz
5. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions
2. Perform rise/fall time tests on channel 1 output using Table 3-5
3. Use the same procedure to check channels 2, 3 and 4

Table 3-5, Rise/Fall Time Tests

Parameter Tested	Error Limits	Oscilloscope Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
Rise Time	<1 μs						
Fall Time	<1 μs						

Overshoot Tests

Equipment: Oscilloscope, Arbitrary Waveform Generator, Load Resistance, x100 high voltage probe, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   - Time Base: 500ns
   - Amplitude: 100 V/div
2. Connect the 9400 Channel 1 output to the load resistance
3. Connect the x100 high voltage probe across the load resistance
4. Configure the Waveform Generator as follows:
   - Amplitude: 6.4 V
   - Function: Square wave
   - Output: On
   - Frequency: 50 kHz
5. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions
2. Perform overshoot tests on channel 1 output using Table 3-6
3. Use the same procedure to check channels 2, 3 and 4

Table 3-6, Overshoot Tests

Parameter Tested	Error Limits	Oscilloscope Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
Overshoot	10%						

Amplifier Distortion

Amplifier distortion checks the quality of the output against pure sine waveforms characteristics. Each channel has a different response and therefore, the distortion is tested on each channel separately.

Distortion Tests

Equipment: Distortion Analyzer, Arbitrary Waveform Generator, Load Resistance, x100 high voltage probe, 50Ω feedthrough terminator

Preparation:

1. Connect the 9400 Channel 1 output to the load resistance
2. Connect the x100 high voltage probe across the load resistance
3. Connect the high voltage probe to the distortion analyzer input
4. Configure the Waveform Generator as follows:
   - Amplitude: 8 V
   - Function: Sine wave
   - Output: On

Frequency: As required for the tests

5. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Perform Aberrations tests on channel 1 output using Table 3-7
2. Use the same procedure to check channels 2, 3 and 4

Table 3-7, Distortion Tests

Arb Frequency Setting	Error Limits	Distortion Meter Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
5 kHz	<0.08%						
50 kHz	<0.08%						
100 kHz	<0.15%						
200 kHz	<0.65%						

Monitor Output Characteristics

The monitor outputs are used for monitoring the high voltage signals using low amplitude tools. In general, the gain, bandwidth, pulse response and sinewave distortions should be very similar to those characterized by the main outputs however, since the outputs are used for monitoring purpose only, some of the characteristics are relaxed. Each channel has its own monitor output and therefore, the characteristics are tested on each channel separately.

Gain Accuracy Tests

Equipment**:** DMM, Arbitrary Waveform Generator, 50Ω feedthrough terminator

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 4V
2. Connect the 9400 Channel 1 monitor output to the DMM input
3. Configure the Waveform Generator as follows:
   Frequency: 1kHz
   Output: On
   Amplitude: As required for the test
4. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Perform Gain Accuracy tests on channel 1 monitor output using Table 3-8
2. Use the same procedure to check channels 2, 3 and 4

Table 3-8, Monitor Outputs Gain Accuracy Tests

Arb Amplitude Setting	Error Limits	DMM Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
2 V	350 mV, ±3 mV						
4 V	710 mV, ±70 mV						
6 V	1.06 V, ±100 mV						
8 V	1.41 V, ±140 mV						

Bandwidth Tests

Equipment: Oscilloscope, Arbitrary Waveform Generator, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   Time Base: 200 μs/div
   Amplitude: 1 V/div
2. Connect the 9400 Channel 1 output monitor to the Oscilloscope input
3. Configure the Waveform Generator as follows:
   Amplitude: 8 V
   Output: On
   Frequency: As required for the tests
4. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions
2. Perform bandwidth tests on channel 1 output monitor using Table 3-9
3. Use the same procedure to check channels 2, 3 and 4

Table 3-9, Output Monitor Bandwidth Tests

Arb Frequency Setting	Error Limits	Oscilloscope Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
1 kHz	6 Divisions						
100 kHz	6 ±0.5 Divisions						
400 kHz	6 ±1 Divisions						
550 kHz	6 ±1.8 Divisions						

Rise/Fall Time Tests

Equipment: Oscilloscope, Arbitrary Waveform Generator, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   Time Base: 500

Amplitude: 1 V/div

2. Connect the 9400 Channel 1 output monitor to the Oscilloscope input.
3. Configure the Waveform Generator as follows:
   Amplitude: 8 V
   Function: Square wave
   Output: On
   Frequency: 50 kHz
4. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions
2. Perform rise/fall time tests on channel 1 output using Table 3-10
3. Use the same procedure to check channels 2, 3 and 4

Table 3-10, Output Monitor Aberrations Tests

Parameter Tested	Error Limits	Oscilloscope Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
Rise Time	<1 μs						
Fall Time	<1 μs						

Distortion Tests

Equipment: Distortion Analyzer, Arbitrary Waveform Generator, 50Ω feedthrough terminator

Preparation:

1. Connect the 9400 Channel 1 output monitor to the distortion analyzer input.
2. Configure the Waveform Generator as follows:
   Amplitude: 8 V
   Function: Sine wave
   Output: On
   Frequency: As required for the tests
3. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Perform Aberrations tests on channel 1 output using Table 3-11
2. Use the same procedure to check channels 2, 3 and 4

Table 3-11, Output Monitor Distortion Tests

Arb Frequency Setting	Error Limits	Distortion Meter Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
1 kHz	<0.08%						
50 kHz	<0.08%						
100 kHz	<0.15%						
200 kHz	<0.65%						

Unipolar Mode Characteristics

The unipolar mode is used for generating half wave unipolar sine signals for applications such as actuating MEMS micro engines. Using this mode, single sine input is routed through a bridge rectifier and converted to the two halves of sine waveforms, which are 180° phase offset between the two halves and both waveforms have unipolar positive amplitude span. The following tests check the characteristics of the unipolar circuit.

Unipolar Mode Indication

Equipment**:** Model 9400

Preparation:

1. Locate the Unipolar Mode selector switch on the rear panel
2. Locate the Unipolar Mode indicator light on the front panel

Test Procedure

1. Press the rear-panel switch in and out and note the front panel Unipolar Mode indications:
   a. The light should be ON when the switch is depressed, indicating the Unipolar Model has been selected
   b. The light should be OFF when the switch is in its outward position, indicating the Unipolar Model has been removed

Test Results	Pass		Fail	

NOTE

The following tests check the characteristics of the 9400 when placed in Unipolar Mode. Depress the rear-panel Unipolar Mode switch and make sure the front-panel Unipolar Mode indicator is turned on. DO not change this mode for the remaining of the performance tests.

Gain Accuracy Tests

Equipment: DMM, Arbitrary Waveform Generator, Load Resistance, 50Ω feedthrough terminator

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 200V
2. Connect the 9400 Channel 1 output to the DMM input. Attach the load resistance at the input terminals of the DMM
3. Configure the Waveform Generator as follows:
   Frequency: 1kHz
   Output: On
   Amplitude: As required for the test
4. Connect the waveform generator to Channel 1 input. Terminate the waveform generator using the 50Ω feedthrough terminator at the 9400 input

Test Procedure

1. Perform Gain Accuracy tests on channel 1 and channel 2 outputs using Table 3-12
2. Use the same procedure to check channels 3 and 4

Table 3-12, Unipolar Mode Gain Accuracy Tests

Arb Amplitude Setting	Error Limits	DMM Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
2 Vp-p	19.30 V, ±2 V						
4 Vp-p	38.45 V, ±4 V						
6 Vp-p	57.95 V, ±6 V						
8 Vp-p	76.80 V, ±8 V						

Bandwidth

Equipment: Oscilloscope, Arbitrary Waveform Generator, Load Resistance, x100 high voltage probe, 50Ω feedthrough terminator

Preparation:

1. Configure the Oscilloscope as follows:
   Time Base: 200 µs/div
   Amplitude: 20 V/div
2. Connect the 9400 Channel 1 output to the load resistance
3. Connect the x100 high voltage probe across the load resistance
4. Configure the Waveform Generator as follows:
   Amplitude: 8 V
   Output: On
   Frequency: As required for the tests

Test Procedure

1. Using the variable vertical adjustment on the oscilloscope, adjust the vertical trace to show exactly 6 vertical divisions
2. Perform bandwidth, large signals tests on channel 1 and channel 2 outputs using Table 3-13
3. Use the same procedure to check channels 3 and 4

Table 3-13, Unipolar Mode Output Bandwidth, Large Signals Tests

Arb Frequency Setting	Error Limits	Oscilloscope Reading				Pass	Fail
		CH1	CH2	CH3	CH4		
1 kHz	6 Divisions						
100 kHz	6 ±0.5 Divisions						
200 kHz	6 ±1 Divisions						

Adjustments Procedure

WARNING

The procedures described in this section are for use only by qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

CAUTION
RISK OF ELECTRICAL SHOCK
DO NOT OPEN

Introduction

This section contains the calibration procedure for the 9400 – high voltage quad power amplifier. A list of specifications is given in Appendix A of the Operations Manual. The adjustments that are described in this document are for use by qualified service personnel only. Do not perform these procedures unless qualified to do so. This procedure is intended to be used once before complete and final performance verification to verify that the 9400 meets its published specifications.

Performance Checks

Do not attempt to calibrate the amplifier before you verify that there is no problem with the functionality of the product. A complete set of specification is listed in Appendix A. If the instrument fails to perform within the specified limits, the instrument must be tested to find the source of the problem.

In case there is a reasonable suspicion that an electrical problem exist within the 9400, perform a complete performance checks as given in this chapter to verify proper operation of the instrument.

Environmental Conditions

The 9400 can operate from 0°C to 40°C. Calibration should be performed under laboratory conditions having an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. Turn on the power to the 9400 and allow it to warm up for at least 15 minutes before beginning the adjustment procedure. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure.

Required Equipment

Recommended equipment for calibration is listed in Table 3-1. Instruments other than those listed may be used only if their specifications equal or exceed the required minimal characteristics. Also listed below are accessories required for calibration.

Initial Checks

Proper calibration depends on healthy functionality of the 9400. These initial checks are performed with the cover removed so take extra precautions not to touch components or metal parts inside the 9400. Always turn the power off and remove the power cord from the rear panel Mains receptacle, if you are not sure or feel safe with any part you are about to touch.

Before you perform the adjustments, verify that the 9400 operates within the following conditions:

1. Turn Power on and observe that the power light turns on and the fan is rotating and blowing air. Air is normally circulated from the inside of the box.

2. Identify C105. Using a DMM measure the voltage drop across this capacitor. Measurement should verify 12 Vdc, ±5%

3. Lift the front panel high voltage protection latch and turn on the high voltage. Note that the High Voltage light turns on.

4. Identify C38, C65, C84 and C110. Using a DMM measure the voltage drop across these capacitors. Measurement should verify 218 Vdc, ±2%

5. Identify C37, C83, C63 and C109. Using a DMM measure the voltage drop across these capacitors. Measurement should verify -218 Vdc, ±2%

6. Close the covers and allow the 9400 to stabilize its operating voltage conditions.

Calibration Procedures

Use the following procedures to calibrate the Model 9400. The following paragraphs show how to set up the instrument for calibration and what the acceptable calibration limits are. Calibration must be performed with the high voltage turned on. To turn the high voltage on, lift the protective latch and flip the high voltage switch ON.

Gain Adjustment

Equipment: Waveform Generator, DMM, Load Resistance, 50Ω feedthrough terminator

Preparation (use the same procedure for channels 1 through 4):

1. Configure the DMM as follows:

Function: ACV
Range: 200 V

2. Connect the 9400 Channel 1 (then 2, 3 and 4) output to the DMM input. Terminate the signal with the load resistance at the DMM input
3. Configure the waveform generator as follows:
   Waveform: Sine
   Frequency: 1 kHz
   Amplitude: 8 V
4. Connect the waveform generator output to the 9400 Channel 1(then 2, 3 and 4) input. Use 50Ω feedthrough terminator at the 9400 input

Adjustment:

1. Identify the trimmers for each channel and make the adjustments below for a DMM reading of 141.42 Vac, ±1%
2. For channel 1, adjust RV6 (course) and RV1 (fine)
3. For channel 2, adjust RV8 (course) and RV2 (fine)
4. For channel 3, adjust RV10 (course) and RV3 (fine)
5. For channel 4, adjust RV12 (course) and RV4 (fine)

Bandwidth Adjustment, Main Outputs

Equipment: Waveform Generator, Oscilloscope, x100 high voltage probe, Load Resistance, 50Ω feedthrough terminator

Preparation (use the same procedure for channels 1 through 4):

1. Configure the oscilloscope as follows:
   Time Base: 100 ns/div
   Amplitude: 10 V initially, then use variable mode to adjust to 6 vertical divisions
2. Connect the 9400 Channel 1 (then 2, 3 and 4) output to the load resistance. Connect the oscilloscope using the x100 probe across the load resistance
3. Configure the waveform generator as follows:
   Waveform: Square
   Frequency: 50 kHz
   Amplitude: 8 V
4. Connect the waveform generator output to the 9400 Channel 1(then 2, 3 and 4) input. Use 50Ω feedthrough terminator at the 9400 input

Adjustment:

1. Identify the trimmers for each channel and make the adjustments below for rise/fall time of <1 μs
2. For channel 1, adjust C43
3. For channel 2, adjust C64
4. For channel 3, adjust C85
5. For channel 4, adjust C113

Bandwidth Adjustment, Monitor Outputs

Equipment: Waveform Generator, Oscilloscope, x100 high voltage probe, Load Resistance, 50Ω feedthrough terminator

Preparation (use the same procedure for channels 1 through 4):

1. Configure the oscilloscope as follows:
   - Time Base: 50 ns/div
   - Amplitude: 10 V initially, then use variable mode to adjust to 6 vertical divisions
2. Connect the 9400 Channel 1 (then 2, 3 and 4) output to the load resistance.
3. Connect the Channel 1 (then 2, 3 and 4) monitor output to the oscilloscope
4. Configure the waveform generator as follows:
   - Waveform: Square
   - Frequency: 1 kHz
   - Amplitude: 8 V
5. Connect the waveform generator output to the 9400 Channel 1(then 2, 3 and 4) input. Use 50Ω feedthrough terminator at the 9400 input

Adjustment:

1. Identify the trimmers for each channel and make the adjustments below for rise time of 1 µs, ±100 ns
2. For channel 1, adjust RV5
3. For channel 2, adjust RV7
4. For channel 3, adjust RV9
5. For channel 4, adjust RV11
6. Modify the waveform generator frequency to 50 kHz and check the adjustments. If results are not within the specified limits alternate between 1 kHz and 50 kHz until adjustments until the best result is achieved.

TIP

Always compare the pulse response from the monitor outputs to the main outputs. Place the traces from both outputs on the oscilloscope and, if necessary, re-touch the adjustments (steps 2 through 5 above) until main and monitor waveforms overlap as best as practical and rise/fall times measurements fall within the specified limits.

Appendix A

9100A/9200A/9400 SPECIFICATIONS

Configuration

Amplifier Channels

9100	One single-ended output, bipolar voltage span;
9200	4 separate inputs and four single-ended outputs, bipolar voltage span; 1 input, having two output channels with 180° phase offset, unipolar voltage span
9400	2 separate inputs and two single-ended outputs, bipolar voltage span; 2 separate inputs, each having two output channels with 180° phase offset, unipolar voltage span

Input Characteristics

Connectors	BNC
Impedance	1MΩ.
Coupling	DC
Amplitude Level	8 Vp-p (-4 to +4 V peaks)
Frequency Range	DC to >500 kHz (full power bandwidth); DC to >200 kHz, unipolar mode

Output Characteristics

General

Connector	BNC
Impedance	0.1Ω
Load impedance	Resistive, recommended for full power bandwidth spec, load resistance limited by the output current ; Capacitive, up to 100 pF has minimal effect on bandwidth, 1 nF reduces the full power bandwidth to 100 kHz
Coupling	DC
Protection	Short-circuit, 10 seconds
Gain	x50, fixed
Polarity	Output normal; half wave rectified
Amplitude	0 to 400 Vp-p (-200 to +200 V); 0 to +200 V, unipolar mode

Square Wave Characteristics

Transition Time	<1µs
Aberrations	<10%

Sine Wave Characteristics

Small Signal Bandwidth (-3dB)	1.5 MHz, at 20 Vp-p
Large Signal Bandwidth (-3dB)	500 kHz, at 400 Vp-p
Accuracy	±(2% of full-scale amplitude range + 50 mV), Square wave at 1 kHz
THD	<0.1%, 10 Hz to 50 kHz; <0.8%, 50 kHz to 200 kHz

Output Monitor Characteristics

Connectors	BNC (rear panel)
Source Impedance	3 kΩ
Load impedance	1 MΩ
Ratio	100:1, ±10%

General

Physical Size	2U, half-rack size
Power Requirements	100V/115V/230V, 47 to 63 Hz, <150 VA; <120W
Weight:	Approximately 14 lbs (6.5 kg)
Signal Ground	Connected to case ground
EMC Certification	CE marked
Reliability	MTBF per MIL-HDBK-217E, 25 °C, Ground Benign
Safety	Designed to meet IEC EN61010-1, UL 3111-1
Workmanship Std.	Conform to IPC-A-610D
Warranty:	3 years standard. Extended warranty available upon request

Environmental

Operating Temperature	0 °C - 40 °C, RH 80% (non-condensing)
Storage Temperature	-30 °C to +80 °C