PREAMBLE INSTRUMENTS

OPERATOR'S MANUAL

1820/1822 DIFFERENTIAL AMPLIFIER

Revision D
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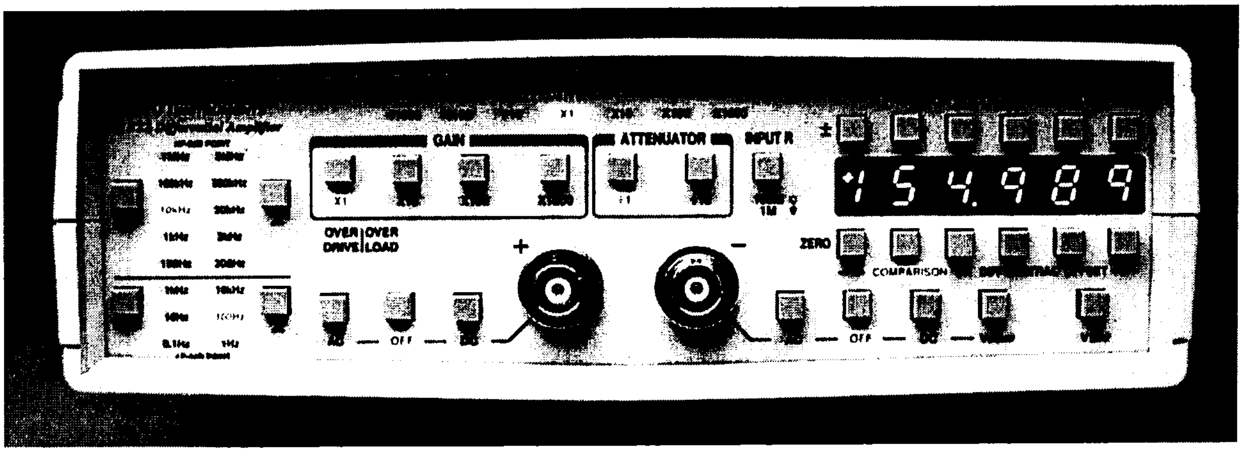
Section 1
Specifications



Introduction

The 1820 and 1822 are stand-alone high performance 100 MHz differential amplifiers. They are intended to act as signal conditioning preamplifiers for oscilloscopes, digitizers and spectrum analyzers, providing differential measurement capability to instruments having only a single-ended input.

The high gain of the 1820/1822 can extend the sensitivity of an oscilloscope with 1 mV/div to 1 µV/div. A built-in input attenuator may be separately set to attenuate signals by a factor of 10, allowing gains of 1000, 100, 10, 1, or 0.1 and common mode dynamic range of ±15.5 V (÷1) or ±155 V (÷10). Optional probes further increase the maximum input signal and common mode ranges in proportion to their attenuation ratio, but not exceeding the probe maximum input voltage rating. Effective gain of the 1822, including probe attenuation, amplifier gain and attenuator settings, is automatically displayed.

The 1820/1822 has a bandwidth of DC to 10 MHz, but the operator can select from a full complement of high and low frequency -3dB points. In critical measurements, the signal-to-noise ratio can be greatly improved by restricting the 1820/1822's bandwidth to the frequency range of interest.

The 1822 features a built-in Precision Voltage Generator (PVG) that can be set to any voltage between ±15.5 volts (±10 volts in Differential Offset) with 5 1/2 digit resolution. Each digit of the voltage generator output can be individually incremented or decremented. Positive or negative polarity can be selected. The PVG output can be selected as an input to the inverting (-) input of the amplifier for operation as a differential comparator or applied internally as a true differential offset voltage. The PVG voltage is also available to be used externally through a rear panel connector. In the 1820, this connector becomes an input through which the user can apply an external voltage to achieve the same differential offset and comparator functions.

The 1820/1822 operates from 100 to 250 VAC line without line switching.

A wide range of high performance differential probes are available from Preamble Instruments for use with the 1820/1822. These include the ÷1 XC200 low capacitance probe, XC100 selectable (÷10/÷100) attenuation probe, and the XC350 ÷100 high impedance (92 MΩ / 2.6 pF) probe. Differential probes with higher voltage ratings are also available from Preamble Instruments.

1820/1822 Specifications

Except where otherwise noted, the following specifications apply to model 1820, 1822, 1820-PR2 and 1822-PR2 Differential Amplifiers.

The specifications are valid for instruments when the following conditions have been met:

- The instrument is being operated from a power source which meets the line voltage and frequency specifications.
- The instrument has been operating for at least 30 minutes in an environment which is within the operating environmental specifications.
- The instrument has been calibrated within the last 12 months. Calibration was performed in a controlled environment of 25 ±5°C.

Nominal Characteristics

Nominal characteristics describe parameters and attributes which have are guaranteed by design, but do not have associated tolerances.

General

Input Configuration:	True Differential, + and - Inputs. Precision Voltage Generator (1822 and 1822-PR2 models), or external offset reference source (1820 and 1820-PR2 models) can be selected as - input source in V_{COMP} mode.
Offset Capability	The Precision Voltage Generator (1822 and 1822-PR2 models), or external offset reference source (1820 and 1820-PR2 models) can be used to provide true differential offset.
+ Input Coupling Selections	AC, Off (Precharge), DC
- Input Coupling Selections	AC, Off (Precharge), DC, V_{COMP}
Input Connectors	BNC. + Input incorporates Probe Attenuation Coding sensing connector (1822 Only).
Maximum Non-Destruct Input Voltage	Withstands up to ±250 V. Automatic input disconnect with manual reset
Output Configuration	Single Ended, Ground referenced.
Output Impedance	50 Ω
Intended Output Load	50 Ω
Output Connector	BNC
Amplifier Gain	X1, X10, X100, or X1000
Input Attenuation	÷1 or ÷10
Bandwidth Limit Filters (Upper Limit)	100 Hz, 300 Hz, 1 KHz, 3 KHz, 10 KHz, 30 KHz, 100 KHz, 300 KHz, 1 MHz, 3 MHz
Bandwidth Limit Filters (Lower Limit)	0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 KHz, 10 KHz
Bandwidth Limit Filter Characteristics	Single pole, 6 dB/octave
Autobalance	Amplifier initiates an automatic balance cycle when either gain button is depressed.
Effective Gain Indicator (1822 and 1822-PR2 models only)	LEDs indicate the effective gain by factoring Probe Attenuation, Attenuator and Gain settings. (Probes must have coding connectors. ÷1, ÷10, ÷100, and ÷1000 probes are recognized.)

Nominal Characteristics (continued)

Dynamic Ranges

Maximum Differential Linear Input:	
X1000 Gain, ÷1 Attenuator	±5 mV[1]
X100 Gain, ÷1 Attenuator	±50 mV[1]
X10 Gain, ÷1 Attenuator	±0.5 V[1]
X1 Gain, ÷1 Attenuator	±5 V[1]
X1000 Gain, ÷10 Attenuator	±50 mV[1]
X100 Gain, ÷10 Attenuator	±0.5 V[1]
X10 Gain, ÷10 Attenuator	±5 V[1]
X1 Gain, ÷10 Attenuator	±50 V[1]
Maximum Common Mode Input	
÷1 Attenuator	±15.5 V[1]
÷10 Attenuator	±155 V[1]
Differential Offset Range (V_{DIFF} Mode) (referred to input)	
X10, X100, X1000 Gain, ÷1 Attenuator	±1 V[1]
X1 Gain, ÷1 Attenuator	±10 V[1]
X10, X100, X1000 Gain, ÷10 Attenuator	±10 V[1]
X1 Gain, ÷10 Attenuator	±100 V[1]
Comparison Offset Range (V_{COMP} Mode) (referred to input)	
÷1 Attenuator	±15.5 V[1]
÷10 Attenuator	±155 V[1]
Output Range	Limited to ±5 V into 50 Ω load

[1] Voltages are referred amplifier input connector. Multiply by probe attenuation factor to obtain value refer to probe input. (e.g. ±50 mV[1] becomes ±0.5V at the probe tip when using a ÷10 probe.)

Precision Voltage Generator (1822 and 1822-PR2 models only)

Output Range	±15.5 V
Resolution	100 μV
Control	Individual increment and decrement buttons for each digit. Digit carries over to next decade.
Reference Type	Oven stabilized buried Zener
Output Routing	Can be applied to - input and available at rear panel BNC connector.
Autozero	Removes output offset when 0.0000 volts is selected and periodically thereafter.

Power Requirements

Line Voltage Range	100 - 250 VAC
Line Frequency Range	48 - 66 Hz

Warranted Characteristics

Warranted characteristics describe parameters which have guaranteed performance. Unless otherwise noted, tests are provided in the Performance Verification Procedure for all warranted specifications.

Gain Accuracy	±1% + Uncertainty of termination resistance
Bandwidth (- 3dB)	
X1 or X10 Gain	>10 MHz
X100 Gain	>2.5 MHz
X1000 Gain	>1 MHz
Rise Time (X1 or X10 Gain)	<35 ns (Calculated from Bandwidth)
Common Mode Rejection Ratio (X1 or X10 Gain)	
70 Hz	≥100,000:1 (100 dB)
100 KHz	≥100,000:1 (100 dB)
1 MHz	≥1,000:1 (60 dB)
Precision Voltage Generator Accuracy	0.05% of reading + 500 µV (15° to 45° C.)

Typical Characteristics

Typical characteristics describe parameters which do not have guaranteed performance. Tests for typical characteristics are not provided in the Performance Verification Procedure.

Input Resistance	
÷1 Attenuator	1 MΩ or 100 MΩ 1 MΩ only with attenuating probe
÷10 Attenuator	1 MΩ
Input Capacitance	20 pF
AC Input Coupling Capacitance	0.1 µF
÷10 Attenuator Accuracy	0.05%
DC Drift (X10 Gain, referred to input)	50 µV/°C
Input Leakage Current (X1 or X10 Gain, ÷1 Attenuator)	<10 pA (0° - 45° C.)
Differential Offset Accuracy	
X10, X100, X1000 Gain, ÷1 Attenuator	0.1% + 50 µV[2]
X1 Gain, ÷1 Attenuator	0.1% + 500 µV[2]
X10, X100, X1000 Gain, ÷10 Attenuator	0.15% + 500 µV[2]
X1 Gain, ÷10 Attenuator	0.15% + 5 mV[2]
Precision Voltage Generator Temperature Coefficient (1822 and 1822-PR2 models)	<5 mV/°C of full scale
Power Consumption	≈ 26 W, ≈ 36 VA (1820 and 1822) ≈ 52 W, ≈ 72 VA (1820-PR2 and 1822-PR2)

[2] Voltages are referred amplifier input connector. Multiply by probe attenuation factor to obtain value refer to probe input. (e.g. 0.1% + 50 µV[2] becomes 0.1% + 500 µV at the probe tip when using a ÷10 probe.)

Environmental Characteristics

The Environmental Characteristics are tested to specification MIL-T28800D Class 5. Refer to this specification if performance verification of environmental characteristics is required.

Temperature Range, operating	0° - 50° C.
Temperature Range, non-operating	-40° - 75° C.

Physical Characteristics

Height	7.29 cm (2.87") (1820 and 1822 models) 8.75 cm (3.4") (1820-PR2 and 1822-PR2 models)
Width	21.2 cm (8.36") (1820 and 1822 models) 43.9 cm (17.3") (1820-PR2 and 1822-PR2 models - without rack mounting ears installed)
Depth	23.2 cm (9.12") (1820 and 1822 models) 42.5 cm (16.7") (1820-PR2 and 1822-PR2 models)
Weight	2.15 kg (4 lbs. 12 oz.) (1820 and 1822 models) 9.5 kg (21 lbs.) (1820-PR2 and 1822-PR2 models)
Shipping Weight	3.12 kg (6 lbs. 14 oz.) (1820 and 1822 models) 11.3 kg (25 lbs.) (1820-PR2 and 1822-PR2 models)

Compliances

EC Declaration of Conformity	Designed to comply with EN61010-1:1993 Installation Category I, 42.2V, pollution degree 1. Conforms to Low Voltage Directive 73.72 EEC for product safety.

Section 2
Operating Instructions, Controls, and Indicators

Front Panel

Attenuator

Signals connected to the **+INPUT** and the **-INPUT** are connected either directly to the 1820/1822's amplifier inputs or to the input attenuators. The input attenuators are passive networks which divide each signal by ten.

In **÷1** mode the front panel input connectors are directly connected to the 1820/1822 amplifier's differential inputs.

In **÷10** mode each front panel input connector is connected to a passive 1 MΩ attenuator. The attenuator output is connected to the 1820/1822 amplifier's corresponding differential input. The signal at each input is attenuated by a factor of ten.

Gain

The 1820/1822 amplifier gain (amplification) is selectable **X1**, **X10**, **X100** and **X1000**. The amplified signal appears at the rear panel **AMPLIFIER OUTPUT** connector.

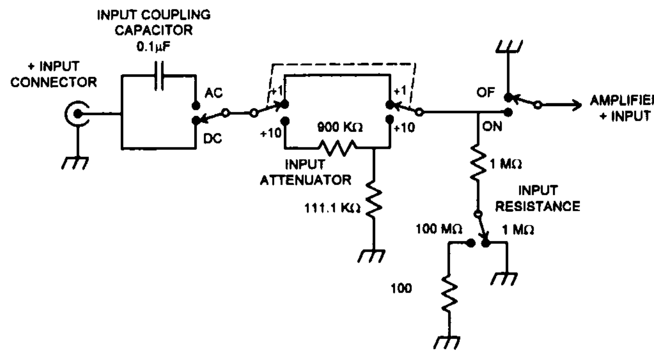
A signal connected to the **+INPUT** will maintain its polarity at the output connector. A signal connected to the **-INPUT** will be inverted in polarity.

Proper gain is obtained when the 1820/1822 drives a 50 Ω load such as an oscilloscope with input impedance set to 50 Ω. An oscilloscope with only 1 MΩ input impedance available should have a 50 Ω coaxial termination placed on its input connector. The 1820/1822 is then connected to the oscilloscope through the coaxial termination.

The amplifier gain and the input attenuator are individually selectable to provide versatility. For example, the comparison voltage range is changed from ±15.5000 to ±155.000 volts by changing the **ATTENUATOR** from **÷1** to **÷10**. The overall gain can still be set to 100, 10, 1 or 0.1 by selecting the **GAIN** mode, **X1000**, **X100**, **X10** or **X1**, as desired.

Autobalance is a feature invoked when any gain button is pushed, even if a different gain is not selected. Autobalance momentarily sets the **INPUT COUPLING** to **OFF** and determines the offset necessary to set the output at 0 volts within about 25μV. During this process the front panel input coupling controls are unresponsive. When finished, the **INPUT COUPLING** returns to its previous mode. Autobalance usually takes less than one second. This handy feature allows the operator to DC balance the 1820/1822 simply by pushing the **GAIN** button which is already illuminated. When changing gains, the Autobalance feature is automatically invoked, freshly adjusting the amplifier's DC balance.

+Input Coupling (AC-OFF-DC)



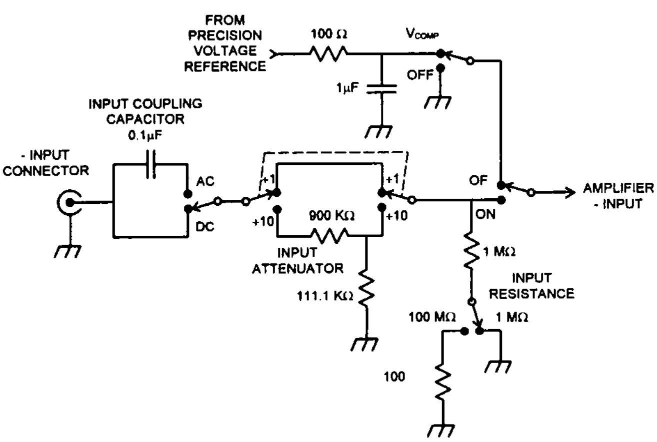
In **OFF** mode, the input connector is disconnected from the amplifier input, and the amplifier input is connected to ground. The AC coupling capacitor is connected between the **+INPUT** and ground through 1 MΩ (either the input attenuator or the input resistor), independent of the **INPUT RESISTANCE** selected. In this mode, the AC coupling capacitor is quickly charged to the average DC input voltage. **OFF** mode is also referred to as precharge mode. Precharge is particularly useful when planning to AC couple and measure voltages in excess of 19 volts. The 1820/1822 input coupling is set to **OFF** and connected to the circuit under test. When the **+INPUT** is changed from **OFF** to **AC** mode, the coupling capacitor is already charged, and the trace properly centered on the oscilloscope screen. Additionally, the risk of tripping the input overload detector and automatically disconnecting the input is eliminated.

In the **AC** mode, the **+INPUT** is connected through an AC coupling capacitor to the amplifier input or the input attenuator. The coupling capacitor retains its charge when the input is switched to **DC**, making it possible to return to the same circuit without the precharge time. But this also makes it possible to discharge the coupling capacitor into another circuit under test if its DC voltage differs by more than approximately 19 volts from the voltage on the coupling capacitor. Although the discharge current is limited to about 70mA, this could damage some circuits. It is therefore recommended that the +**INPUT COUPLING** first be changed to **OFF** (precharge) when measuring a new circuit point. This will safely recharge the AC coupling capacitor in less than 0.3 seconds. The value of the AC coupling capacitor is 0.1µF.

DC and low frequencies are attenuated by the AC coupling capacitor and the input resistance. With the **ATTENUATOR** set to **÷10**, or set to **÷1** with the **INPUT RESISTANCE** set to 1 MΩ, the low frequency cut off (-3dB point) is approximately 1.6Hz, lower than most oscilloscopes by a factor of 5. When the input attenuator is set to **÷1**, the **INPUT RESISTANCE** may be set to 100 MΩ, and the -3dB point is 0.016Hz. This extremely low frequency cut off is often handy in observing low frequency noise riding on large (up to 400 volts) DC voltages.

In the **DC** mode, the +**INPUT** connector is connected to the amplifier either directly or through the input attenuator, and the AC and DC attenuation are the same.

-Input Coupling (AC-OFF-DC-V_{COMP})



The -input has the same coupling modes as the +input plus one additional option, V_{COMP} (comparison voltage).

The 1822 generates a voltage controlled by the push buttons above and below the front panel numerical display. This voltage is called the Precision Voltage Generator (PVG).

In V_{COMP} mode, the 1822's PVG is connected to the amplifier's inverting input through an internal filter designed to eliminate radio and television signal interference. The 1820 does not have the PVG, but uses an externally supplied voltage. See Page 2-6 for V_{COMP} operation with the 1820.

The 1820/1822's amplifier subtracts the voltage applied to its inverting input from the voltage applied to its non-inverting input. The 1820/1822 output is therefore zero whenever these two voltages are equal. For this reason, the voltage applied to the inverting input is called a comparison voltage, V_{COMP}.

V_{COMP} is often used to make precise measurements of large signals by comparing the accurately known V_{COMP} with the unknown signal. It is also used to measure the actual voltage at any point of a waveform.

PVG output range is ±15.500 volts. The PVG is never attenuated by the input attenuator. Attenuation of the +**INPUT** signal by the **÷10** input attenuator will cause the PVG to null out an input voltage up to ±155.00 volts which is ten times larger than the actual PVG voltage. When the 1822 is used with attenuating probes that feature readout, the PVG display is changed to indicate the voltage at the +**INPUT** probe tip which will bring the amplifier output to zero.

The –**INPUT** connector is not useable when V_{COMP} is selected.

V_{DIFF} (differential offset voltage) is an instrument mode rather than a type of input coupling. The **VDIFF** mode allows the PVG (or an external source in the 1820) to inject an offset signal into the 1820/1822 while still using both inputs for full differential operation. This mode can be used as a position control to move the trace on the oscilloscope screen in preference to using the oscilloscope's position or offset control. The oscilloscope's position and offset controls should always be set to zero so that the 1820/1822's dynamic range is properly centered. Operation of the 1820/1822 using the V_{DIFF} function is the same as V_{COMP} except for the following:

- The –**INPUT** remains active, allowing full use of the 1820/1822 as a differential amplifier.
- The maximum range of the PVG (1822) or the external source (1820) is ±10.000 volts in X1 Gain and ±1.0000 volts in X10 to 1000X gain settings. The effects of the ÷10 input attenuator and probe attenuation are the same as when using V_{COMP}, i.e. any input attenuation multiplies the effective offset.

The 1822's PVG display is changed to indicate the voltage that, if applied between the +**INPUT** and –**INPUT**, would bring the amplifier output to zero. When the 1822 is used with attenuating probes that feature readout, the PVG display is scaled to include the effect of probe attenuation.

Input Resistance

When the input **ATTENUATOR** is set to ÷1 and no attenuating probe is connected, the input resistance can be increased from 1 MΩ to 100 MΩ by pressing the **100M/1M** button. This is advantageous when measuring high impedance circuits or when AC coupling is needed with a very low frequency cut off. When the input **ATTENUATOR** is set to ÷10 or an attenuating probe with readout capability is attached, 1 MΩ (**1M**) input resistance is automatically selected.

Unbalanced source impedances can have an adverse effect on common mode rejection. For example, a differential source with impedances of 1000 and 2000 Ω, each loaded with 1 MΩ will have a common mode rejection ratio (CMRR) of 1000 to 1. The common mode rejection ration can be improved to 100,000 to 1 by using 100 MΩ input resistance.

This limitation is also apparent when trying to make accurate measurements using V_{COMP}. A 10.000 volt reference with a 1000 Ω output impedance will be reduced to 9.9900 volts by the 1820/1822 1 MΩ input resistance, introducing a 10 mV error in the measurement. Increasing the input resistance to 100 MΩ decreases this error to 100μV.

Oscilloscope inputs have a small input current which can cause an offset when measuring high impedance circuits. The offset can be observed by opening and shorting the input to ground. The 1820/1822 has a temperature-compensated input current pull away (cancellation) which works in both the 1 MΩ and 100 MΩ **INPUT RESISTANCE** modes. Its input offset current is considerably less than that of most oscilloscopes.

Effective Gain (1822 Only)

Seven lights (LEDs) across the top of the 1822 front panel indicate the total gain from the instrument input to output. When the **X1** light is lighted, the overall amplifier voltage gain (amplification) is unity. Similarly, **X10** indicates an overall amplification of ten times. **÷10** indicates the voltage amplification is 0.1, and so forth.

When Preamble Instruments or other encoded probes are properly used, the effective gain includes the probe's attenuation factor.

Upper and Lower -3 dB Points

The 1820/22 allows the user to select both the upper and lower frequency -3 dB points. Selections for the high frequency -3 dB points are 3MHz, 1MHz, 300kHz, 100kHz, 30kHz, 10kHz, 3kHz, 1kHz, 300Hz and 100Hz. Selections for the lower -3 dB points are 0.1Hz, 1Hz, 10Hz, 100Hz, 1kHz and 10kHz. These filters make it possible to improve the signal-to-noise ratio when making measurements on microvolt magnitude signals.

Precision Voltage Generator (1822 Only)

The PVG generates the voltage which is used in the V_{COMP} and V_{DIFF} modes and appears at the rear panel **PRECISION VOLTAGE GENERATOR OUTPUT** connector.

Above each digit is a push button which increments the corresponding digit by one when pushed. When held, the digit continues to increment, eventually incrementing the next higher digit.

Similarly, below each digit is a push button which decrements the corresponding digit.

The ± button above the left-most digit changes the PVG output polarity. The **ZERO** button below the left-most digit sets the output to zero and invokes the Autozero function.

Autozero resets the PVG output to zero to eliminate any drift which may have occurred in the PVG due to low frequency noise, or long term drift. Autozero is invoked each time the **ZERO** button is pressed and re-invoked approximately every minute thereafter. This is useful when the instrument has been unplugged and a cold start is required.

Overdrive (yellow)

When a signal is applied to either input of the 1820/1822 that exceeds its ±15.5 volt input range the yellow **OVERDRIVE** indicator is lighted. The light remains on as long as the input remains larger than the linear range. The linear range is multiplied by the **ATTENUATOR** factor and by the use of an attenuating probe.

The yellow **OVERDRIVE** light is intended to warn the user of potentially distorted waveforms.

Overload (red)

When a signal which could damage to the 1820/1822 has been applied to either input connector, the 1820/1822 protects itself by disconnecting the signal. The input coupling mode changes to **OFF**, and the red **OVERLOAD** light is turned on.

The 1820/1822 is reset and the **OVERLOAD** light goes out when any of the input coupling modes is selected.

When the **ATTENUATOR** is set to **÷1**, a signal of approximately ±19 volts will cause the input to draw current and the **OVERLOAD** light to come on. Transients too rapid to be disconnected by the input coupling relay will draw up to about 70mA of input current. Inputs in excess of 250 volts may cause permanent damage to the 1820/1822.

The input is not disconnected when the **ATTENUATOR** is set to **÷10**.

Rear Panel

Power

Normal instrument operation is obtained in the **ON** position. The instrument reaches its specified performance in 30 minutes.

PRECISION VOLTAGE GENERATOR OUTPUT (1822 Only)

The rear panel **PRECISION VOLTAGE GENERATOR OUTPUT** BNC connector is a monitor of the Precision Voltage Generator (PVG). It is the same voltage that is applied to the **-INPUT** when the **-INPUT** coupling is **VCOMP** or internally to the 1822 when **VDIFF** is selected. The **PRECISION VOLTAGE GENERATOR OUTPUT** can be used either to monitor the PVG with a DVM (digital voltmeter) or as an input to one or more Preamble 1820s or 1822s. There is a 1.59kHz single-pole low pass filter between the PVG output and the **-INPUT** which removes radio frequency interference (RFI). This filter does not attenuate the PVG signal.

The PVG output is not attenuated by the input attenuator or probes, whereas the input signal is. Therefore the effective range of **VCOMP** is increased by a factor of 10 when the ÷10 attenuator is selected or a ÷10 attenuating probe is used to attenuate the input signal. The PVG numerical display reflects the attenuator setting and probe attenuation when the probe is readout encoded. As an example, if there are no probes attached, the **÷10** attenuator is selected and the display is set to read ±155.000, the PVG output will actually be ±15.5 volts.

The decimal in the display will be in the correct location to indicate the voltage at the PVG output when no probes are attached and **÷1** attenuator and **X1** gain are selected. The **PRECISION VOLTAGE GENERATOR OUT** BNC also presents the same voltage used internally for differential offset when **VDIFF** is selected. Because the PVG is applied to the amplifier to create a true differential offset, the relationship between **VDIFF** and the voltage at the PVG output BNC changes with the amplifier gain selection according to the following table:

Front Panel Settings			**Maximum PVG Output**
Gain	**Atten**	**V_{DIFF}**	
X1	÷1	±10V	±10V
X1	÷10	±100V	±10V
X10,X100, X1000	÷1	±1V	±10V
X10,X100, X1000	÷10	±10V	±10V

The maximum V_{DIFF} is multiplied by any probe attenuation factor. When using readout encoded probes which the 1822 senses, the PVG readout calculates the effective differential offset at the probe tip. Of course, both probes must have the same attenuation factor.

Amplifier Output

The amplifier's output BNC is intended to be used with an oscilloscope, spectrum analyzer or digitizer having a 50 Ω input resistance. The 1820/1822 output impedance is 50 Ω. Without the 50 Ω load, the amplifier gain is twice the amount indicated on the front panel. Additionally, the signal presented to an oscilloscope (spectrum analyzer or digitizer) is as large as ±10 volts.

Probe Coding Input (1822 Only)

This jack is to be used with Preamble Instruments probes and other probes that have multiple selectable attenuation factors. Other manufacturer's probes with standard probe coding capability will be properly decoded through the 1822's front panel **+INPUT** BNC connector.

Oscilloscope Settings

The Preamble Instruments 1820/1822 output is intended to connect directly to the input of an oscilloscope, spectrum analyzer or digitizer, but it is important to observe some rules so that the 1820/1822 delivers its specified performance.

Oscilloscope Input Impedance

The 1820/1822 output impedance is 50 Ω and the intended load impedance is also 50 Ω. Nominal gain (amplification) is obtained only when the oscilloscope (or digitizer) input impedance is set to 50Ω. The **EFFECTIVE GAIN** display is correct only when the 1822 is properly terminated into 50 Ω.

A factor of two additional gain is achieved by setting the oscilloscope input impedance to 1 M Ω. However, the operator needs to be aware that all the 1820/1822 gain indicators will be off by a factor of two.

Sensitivity, Position, and Offset

Oscilloscopes are designed to maintain their accuracy for that portion of a signal that is displayed on-screen. When the signal is large enough to drive the display off-screen, the oscilloscope's amplifier must limit the signal in a non-linear mode. Oscilloscopes are designed so that no matter how the sensitivity, position and offset controls are set, the operator cannot view this distorted portion of the signal.

The maximum 1820/1822 output is carefully controlled so it will not exceed ±5V when the output is properly terminated into a 50 Ω load.

The oscilloscope's gain and position controls should be properly set to avoid displaying the non-linear portion of the 1820/1822's output signal when it is in overdrive. This can be accomplished by observing the two following rules:

Turn the oscilloscope input coupling to "OFF" or "GND", set the oscilloscope position control to center screen, and do not change it! If the oscilloscope has an offset control, it too should be set to zero. Return the oscilloscope's input coupling to **"DC"**. Subsequently adjust the trace position on the oscilloscope screen using the 1822 PVG (an external source for the 1820) and **VDIFF** mode or **VCOMP** input. This assures that the oscilloscope is looking at the center of the 1820/1822's dynamic range.

Set the oscilloscope vertical sensitivity to no less than 500mV/div. The most useful range for the oscilloscope deflection factors will be between 1mV/div and 500mV/div. Using a deflection factor of 2V/Div will bring the nonlinear portion of the 1820/1822's output on screen. Digitizers should not expect accurate measurements for high frequency signals from the 1820/1822 exceeding ±2.5V into a 50 Ω load. This is equivalent to ±5 divisions of deflection at 500mV/div in an oscilloscope.

More sensitive settings (*e.g.* 100μV/div) available on some oscilloscopes are perfectly acceptable, but their usefulness may be limited by noise, particularly with the full bandwidth limit selection and without averaging. With the oscilloscope set to 1mV/div and the 1820/1822 in the **X1000** gain mode, the over all deflection factor will be 1μV/div.

In its **X10** gain mode, the 1820/1822 is somewhat quieter than most oscilloscopes, so it is preferable to use the 1820/1822 **X10** gain mode and a lower oscilloscope deflection factor rather than the other way around. For example, to obtain the best noise performance at 1mV/div, set the 1820/1822 to **X10** mode and the oscilloscope to 10mV/div rather than the use **X1** mode and 1mV/div. Other oscilloscopes give up bits of resolution to obtain 1mV or 2 mV/div sensitivity. The 1820/1822 is very quiet in its **X10** or greater gain mode, but no better than most oscilloscopes in the **X1** mode.

Any oscilloscope bandwidth limit setting may be used so long as the unlimited signal does not exceed full screen before invoking bandwidth limit. This is a good rule to follow in using oscilloscopes with or without the 1820/1822.

Model 1820 Operation

The performance and operation of the 1820 Differential Amplifier is identical to that of the 1822 except as follows:

1. The 1822 **EFFECTIVE GAIN** indicator is not included in the 1820. The 1820 operator will need to keep track of the various attenuator and gain settings to accurately account for the proper deflection factor on the oscilloscope.

2. The V_{COMP} and V_{DIFF} functions operate the same as in the 1822. The 1820 does not contain the Precision Voltage Generator, but the voltages required for the operation of **VCOMP** and **VDIFF** can be provided from an external source. This voltage source is applied to the 1820 through the **OFFSET VOLTAGE** connector on the rear panel. By using a stable voltage source and monitoring the level with a DVM, operation and accuracy similar to that of the 1822 can be achieved. The maximum input voltage that can be applied depends on whether the 1820 is operated in **VCOMP** or **VDIFF**.

The following charts will help the operator stay within the maximum input voltage limits and understand the relationship between the actual voltage applied and the effective voltage. Effective voltage is always referred to the input of the 1820 or the probe tip if a probe is used. When using probes, the maximum effective voltage range may be limited by the maximum voltage rating of the probe.

When operating the 1820 with an external voltage source, the applied voltage should not exceed 15.5 volts in Comparison mode and 10.0 volts in Differential Offset mode.

When these maximum external voltages are applied, the effective voltage as seen by the amplifier is as follows:

Front Panel Settings		Effective Full Scale Range	
GAIN	**ATTEN**	V_{COMP}	V_{DIFF}
X1	÷10	±155V	±100V
X10, x100, x1000	÷10	±155V	±10V
X1	÷1	±15.5V	±10V
X10, x100, x1000	÷1	±15.5V	±1V

Note that the effective voltage is always increased by the attenuator. It therefore follows that any probe will increase the effective voltage of both **VCOMP** and **VDIFF** by its attenuation factor. In other words, a probe with a ÷100 attenuation factor will increase the effective full scale range by 100.

Front Panel Settings		Effective Full Scale Range with ÷100 Probe	
GAIN	**ATTEN**	V_{COMP}	V_{DIFF}
X1	÷10	±15.5kV	±10kV
X10	÷10	±15.5kV	±1000V
X1	÷1	±1550V	±1000V
X10	÷1	±1550V	±100V

Although the full scale range may be 10kV or 15.5kV, most probes have a much lower maximum input voltage rating which must not be exceeded.

Section 3
General Operating Information

Getting Started

This section will help the first time user become familiar with the operation of the 1822 and how it interfaces with an oscilloscope. Operation of the 1820 is very similar except an external voltage source is needed for operation of the comparison and differential offset modes.

To carry out the following exercises, the operator will need an oscilloscope and a general purpose function generator.

Power Connection

Check to make sure the **POWER** switch located on the rear panel is in the **OFF** position. Connect the power cord to an appropriate power source. The 1822 will operate on a 50 or 60 Hz AC power source with a nominal voltage range from 100 volts to 250 volts.

Connection to and Setting up the Oscilloscope

Connect a 50 Ω coaxial cable between the **AMPLIFIER OUTPUT** BNC on the 1822 rear panel and the oscilloscope's input connector. If the oscilloscope has 1 M Ω and 50 Ω input capability, select 50 Ω. If the oscilloscope has only a 1 M Ω input, terminate the coaxial cable at the oscilloscope's input with a 50 Ω feed-through terminator. It is important that the 1822 be terminated into 50 Ω.

Set the oscilloscope scale factor to **50mV/div**. Set the oscilloscope's input coupling to **GND** or **OFF** and position the trace to center screen. **Do not move the oscilloscope position setting after this initial set-up**. Change the oscilloscope input coupling to **DC**.

1822 Front Panel Operation

Change the **POWER** switch located on the 1822's rear panel to **ON** and observe the 1822's front panel indicators. Initially, there will be about a 2 second delay and then each function, other than the upper and lower -3dB points, will have one indicator light lighted. The red **OVERLOAD** and yellow **OVERDRIVE** lights will be lighted as well as all segments in the Precision Voltage Generator display. After approximately 3 seconds, the 1822 will be set to its power-up reset state. This state is as follows:

+ INPUT	**OFF**
- INPUT	**OFF**
HF-3dB POINT	No lights on (full BW)
LF-3dB POINT	No lights on (DC)
GAIN	**X1**
ATTENUATOR	**÷10**
INPUT RESISTANCE	**1M**
PRECISION VOLTAGE GENERATOR	**+ 00.000**
COMPARISON or **DIFFERENTIAL**	**COMPARISON**
EFFECTIVE GAIN	**÷10**

Attenuator and Gain Operation

Connect the function generator output to the **+INPUT** BNC connector and apply a sinewave of 50 kHz and 0.5V peak amplitude. Push the **DC** button on the 1822's **+INPUT**. The signal on the oscilloscope should be 2 divisions peak to peak amplitude. Adjust the oscilloscope's time/division and trigger to display at least two complete cycles of the waveform.

Press the **÷1 ATTENUATOR** button. The waveform's magnitude on the oscilloscope's display will increase by a factor of 10 and extend off the top and bottom of the screen. The **X1** light will be lighted in the **EFFECTIVE GAIN** display. Reduce the function generator's output until the oscilloscope's display is again 2 divisions peak to peak. The overall sensitivity of the 1822 and the oscilloscope is now 50mV/div.

Now press the **X10 GAIN** button. Observe the following changes: The **+INPUT DC** light will momentarily go out and its **OFF** light will be lighted before returning to their previous states. This momentary change is the result of the 1822 automatically adjusting its DC Balance. The **X10** light will be lighted in the **EFFECTIVE GAIN** display and the display on the oscilloscope will again extend off screen. The overall sensitivity of the 1822 and the oscilloscope is now 5mV/div.

Comparison Voltage Operation (V_{COMP})

Leave the 1822 set up as in the previous exercise or set as follows:

+ INPUT	**DC**
- INPUT	**OFF**
HF-3dB POINT	No lights on (full BW)
LF-3dB POINT	No lights on (DC)
GAIN	**X10**
ATTENUATOR	**÷1**
INPUT RESISTANCE	**1M**
PRECISION VOLTAGE GENERATOR	**+ 0.0000**
COMPARISON or **DIFFERENTIAL COMPARISON**	
EFFECTIVE GAIN	**X10**

• **Function Generator output**: 50 kHz 50 mVpk sine wave. connected to the 1822's **+INPUT**.

• **Oscilloscope**: Set at 50mV/div (equivalent to 5 mV/div with 1822 at X10 GAIN) and time/division adjusted for 2 to 3 cycles.

Under these conditions, the display on the oscilloscope will extend off the top and bottom of the screen.

Press the **–INPUT VCOMP** button. This internally applies the Precision Voltage Generator's output to the 1822's **–INPUT** and the **OFF** light goes out (the **–INPUT** connector is disabled).

The positive and negative peaks of the waveform displayed on the oscilloscope are (respectively) 10 divisions above and below the display center line. Push the button above the digit that is two places right of the decimal (10 mV) in the Precision Voltage Generator (PVG) until the positive peak of the waveform appears in the oscilloscope's display. Continue incrementing and decrementing Precision Voltage Generator's digits until the peak of the waveform is at the centerline of the oscilloscope's display. The number in the Precision Voltage Generator display is the waveform's positive peak voltage.

Press the ± button in the Precision Voltage Generator. Observe that the negative peak of the signal is now at or near the oscilloscope's display centerline. By incrementing and decrementing the digits, the negative peak can be positioned to the oscilloscope's display center line. Now the number in the Precision Voltage Generator's display is the waveform's negative peak voltage.

Change the oscilloscope's sensitivity from 50 mV/div to 10mV/div. Overall sensitivity, including the 1822, is now 1mV/div. Temporarily change the oscilloscope's input coupling from DC to GND (or OFF) and re-center the trace to center screen using the oscilloscope's position control. Return its input coupling to DC. Now press the **X10** button on the 1822 to invoke its Autobalance function. (Note that pressing the gain button that is already selected causes the 1822 to adjust its DC balance, but does not change its gain.)

Change the Precision Voltage Generator's reading to again place the negative peak of the waveform at the oscilloscope's center screen. Note that the Precision Voltage Generator's display represents the negative peak voltage of the waveform with greater resolution.

Return the oscilloscope's sensitivity to 50mV/div and press the 1822's **-INPUT OFF** (or **AC** or **DC**) button. The Precision Voltage Generator will retain its setting and the display on the oscilloscope will be centered about the center line. Press the **-INPUT VCOMP** button again and observe that the Precision Voltage Generator's output is again connected to the minus input of the 1822's **–INPUT**.

Following are a few observations on using the 1822 comparison voltage mode (**VCOMP**):

- The negative input and its **AC**, **OFF** and **DC** coupling are disabled. Instead of being a differential amplifier, the 1822 becomes a differential comparator. It compares the voltage present at the **+INPUT** with the output of the Precision Voltage Generator and when they are equal, the output of the 1822 is zero volts.
- The value displayed by the Precision Voltage Generator indicates a waveform's voltage, with respect to ground, as it passes through the oscilloscope display's centerline. It is very important that the oscilloscope's trace be positioned to center screen if an accurate measurement is to be made using this method.
- By using the 1822 in the comparison voltage mode and the oscilloscope in a high sensitivity setting, highly accurate voltage measurements can be made.
- The Precision Voltage Generator can be used as a position control which allows the 1820/1822 to operate in its linear region.

Differential Offset Operation

Leave the 1822 set up as in the previous exercise or set it up as follows:

+ INPUT	**DC**
- INPUT	**VCOMP**
HF-3dB POINT	No lights on (full BW)
LF-3dB POINT	No lights on (DC)
GAIN	**X10**
ATTENUATOR	**)1**
INPUT RESISTANCE	**1M**
PRECISION VOLTAGE GENERATOR	**- 0.0500***
COMPARISON or **DIFFERENTIAL COMPARISON**	
EFFECTIVE GAIN	**X10**

*approximate

- Function Generator output: 50kHz 50mVpk sine wave. connected to the **+INPUT** of the 1822.

- Oscilloscope: set at 50mV/div (equivalent to 5mV/div with 1822 at X10 GAIN) and sweep adjusted for 2 to 3 cycles.

- Externally trigger the oscilloscope on the function generator's output (same signal as is applied to the 1822's +INPUT)

Under these conditions, the negative peak of the display on the oscilloscope should be very near center screen. Adjust the value in the Precision Voltage Generator until the negative peak is at center screen.

Press the V_{DIFF} button. This internally applies the output of the Precision Voltage Generator to a point within the 1822's amplifier that facilitates a true differential offset. Also note that the Precision Voltage Generator display was reset to zero (+ .00000) and the **-INPUT** coupling changed. The V_{COMP} light went out and the **OFF** light was lighted. In the line under the Precision Voltage Generator display (**COMPARISON** or **DIFFERENTIAL OFFSET**), the **COMPARISON** light went out and the **DIFFERENTIAL** light was lighted. This indicates that the Precision Voltage Generator will now be applied as a differential offset rather than as a comparison voltage as in the previous exercise. Both the **+INPUT** and the **–INPUT** inputs are now enabled.

The positive and negative peaks of the waveform displayed on the oscilloscope are 10 divisions above and below (respectively) the center line of the display. Push the button above the digit that is two places right of the decimal (10mV) in the Precision Voltage Generator until the positive peak of the waveform appears in the oscilloscope's display. Continue incrementing and decrementing the digits in the Precision Voltage Generator until the peak of the waveform is at the center line of the oscilloscope's display. The number in the Precision Voltage Generator display is the value of the waveform's positive peak voltage.

Press the ± button in the Precision Voltage Generator. Observe that the negative peak of the signal is now at or near the oscilloscope display's center line. By incrementing and decrementing the digits, the negative peak can be positioned to the oscilloscope display's center line. Now the number in the Precision Voltage Generator's display is the value of the waveform's negative peak voltage.

Change the oscilloscope's sensitivity from 50mV/div to 10mV/div. Overall sensitivity, including the 1822, is now 1mV/div. Temporarily change the oscilloscope's input coupling from DC to GND (or OFF) and re-center the trace to center screen using the oscilloscope's position control. Return its input coupling to DC. Now press the **X10** button on the 1822 to invoke its Autobalance function. (Note that pressing the gain button that is already selected causes the 1822 to adjust its DC Balance, but does not change its gain.)

Change the Precision Voltage Generator's reading to again place the negative peak of the waveform at the oscilloscope's center line. Note that the Precision Voltage Generator's display more accurately represents the negative peak voltage of the waveform.

Return the oscilloscope's sensitivity to 50 mV/div and again press the 1822's V_{DIFF} button. The V_{DIFF} light will go out and the display on the oscilloscope will be centered about the center line. Notice that the PVG retains its setting, but the output of the PVG is not applied to the amplifier. Press the V_{DIFF} button again and observe that the Precision Voltage Generator's output is reapplied internally to the 1822 amplifier.

Following are a few observations on using the differential offset mode (V_{DIFF}) of the 1820/1822:

- Both the positive and negative inputs (**AC**, **OFF** and **DC**) are enabled and the 1820/1822 remains a true differential amplifier.

- The value displayed by the Precision Voltage Generator indicates a waveform's differential voltage, with respect to the **–INPUT**, as it passes through the oscilloscope display's center line. It is very important that the oscilloscope's trace be positioned to center screen if an accurate measurement is to be made using this method. The voltage applied to the 1820's **EXTERNAL**

VOLTAGE INPUT also indicates the waveform's differential voltage with respect to its **–INPUT**.

- By using the 1822 in the differential offset mode and the oscilloscope in a high sensitivity setting, high resolution voltage measurements can be made. The **–INPUT** is the reference for these measurements.
- The Precision Voltage Generator can be used as a position control which allows the 1822 to operate in its most linear region.

Which Offset Mode Should be Used?

The operation of the Comparison ($\mathbf{V_{COMP}}$) and Differential Offset modes ($\mathbf{V_{DIFF}}$) are quite similar. The Comparison mode is easier to understand and has a wider range, 15.5 volts versus 10.0 volts. The Differential Offset mode provides offset operation while allowing the 1822 to function as a true differential amplifier.

For most applications, the Differential Offset ($\mathbf{V_{DIFF}}$) mode has advantages over the Comparison ($\mathbf{V_{COMP}}$) mode. When using the Comparison mode, the Precision Voltage Generator's output is subtracted from the **+INPUT**. Except for the PVG's offset, operation is the same as a standard single-ended oscilloscope - only one 1820/1822 input is available. In the Differential Offset mode, the 1820/1822 functions as a differential amplifier - both **+INPUT** and **–INPUT** function. This allows the operator to choose a measurement reference point other than ground. Even in ground referenced measurements, signal degradation can be reduced by using the **–INPUT** probe to select a ground reference point with the least noise. This method is especially useful in eliminating hum and noise from ground loops.

There is one instance in which the Differential Offset ($\mathbf{V_{DIFF}}$) mode might result in more noise. Magnetic pick-up is proportional to the area between the probes. If twisting the probe leads together is not sufficient to reduce magnetic pick-up, the Comparison Offset ($\mathbf{V_{COMP}}$) mode may be preferable.

Because the Comparison Offset mode uses the CMRR of the 1822 while the Differential Offset mode uses an internal amplifier, the Comparison Offset mode is slightly more accurate.

The Differential Offset ($\mathbf{V_{DIFF}}$) mode is usually the mode of choice if the wider range or higher accuracy of the Comparison ($\mathbf{V_{COMP}}$) mode is not needed.

User Traps to Avoid

There are a few situations the user of either the 1820 or 1822 should be aware of to avoid some potential measurement traps.

Exceeding the Common Mode Range

The 1820 and 1822 Differential Amplifiers have the largest common mode range available for this type of amplifier and are very good at measuring small differences between two large signals. However, care still must be taken not to allow a large common mode signal to exceed the available common mode range.

The maximum common mode range is ±15.5 volts when a signal is applied directly (**÷1 ATTENUATOR** and no probes) to the 1820/1822's + and - inputs. The yellow **OVERDRIVE** light illuminates to warn the user of possible waveform distortion caused by exceeding ±15.5 volts.

Attenuating the input signal extends the common mode range by the same factor as the attenuation. Pressing the **÷10 ATTENUATOR** button increases the common mode range to ±155 volts, and using a probe with a ÷10 attenuation factor will too. The effect of the internal **÷10 ATTENUATOR** and the attenuation factor of probes is multiplied just as the signal is attenuated. As an example, using the amplifier's **÷10 ATTENUATOR** with a probe having a ÷100 attenuation factor (total attenuation of ÷1000) results in a common mode range of 15,500 volts. In this case, the probe's maximum voltage rating probably limits the maximum common mode input voltage.

The gain setting of the amplifier has no effect on common mode range; it is the same in **X1000, X100, X10** or **X1** gains.

When making measurements on circuits that are line referenced, be sure to use enough total attenuation to keep the peak voltage at the amplifier input below 15.5 volts. **The US line can exceed 170 peak volts and therefore at least a total attenuation of ÷100 should be used.** Line voltages in some other countries are larger but their peak voltages do not exceed the 1550 volt common mode range that a ÷100 attenuation factor provides.

Moving the oscilloscope position setting away from center screen

When operating the 1820/1822 with an oscilloscope, it is very important to set the oscilloscope position and/or offset control to center screen. There are a couple of reasons for this:

First, the linear portion of the 1820/1822's ±5V output range is around zero volts. As the 1820/1822 approaches its limits, the output signal will be distorted. Moving the oscilloscope position control way from center screen can allow these distortions to appear on the oscilloscope's screen where they may be mistaken for part of the displayed signal.

Second, proper operation of the 1822's Precision Voltage Generator (PVG) depends on the operator knowing the location of zero volts on the display. The readout in the PVG is designed to display the voltage of the signal as it crosses the center line of the oscilloscope screen. If the oscilloscope position or offset control has been moved, incorrect readings could result.

Using Oscilloscope V/Div Settings Greater than 500 mV/Div

"I know the input to the 1820/1822 is a sinewave, but I am seeing a square wave on the oscilloscope." This comment is the result of the operator setting the oscilloscope sensitivity to something less than 1V/div. If the oscilloscope sensitivity is set to 2V/div, the 1820/1822 will limit at 2-1/2 divisions above and below center screen (zero volt point if the oscilloscope's position control is properly set). Thus, a sinewave large enough to overdrive the 1820/1822 will appear as a square wave on the oscilloscope.

The 1820/1822 is designed to cleanly limit the output signal to ±5V. Keeping the oscilloscope's position at center screen and using oscilloscope sensitivities between 500mV/div and 1 mV/div (or the oscilloscope's most sensitive setting) will insure good signal integrity. When the displayed signal contains mostly low frequency components, the operator can use the oscilloscope's 1V/div setting to allow large signals to be completely shown on screen.

Failure to Terminate the Amplifier into 50 Ω

"All the signals displayed on my oscilloscope seem to be twice as large as they should be." This comment results from not having the output of the 1820/1822 properly terminated into 50 Ω. The 1820/1822 output impedance is 50 Ω. The cable connecting the 1820/1822 to the oscilloscope or spectrum analyzer should be 50 Ω and be terminated with a 50 Ω load. If the termination at the end of the connecting coaxial cable is missing, the amplifier will not be properly terminated.

The gain of the amplifier will be twice that indicated by the front panel settings and the 1822's **EFFECTIVE GAIN** indicator will be off by a factor of two.

In some measurements, the operator can take advantage of this increased gain if the problems caused by not terminating the output are fully understood and taken into account.

Section 4
Performance Verification

Introduction

This procedure can be used to verify the warranted characteristics of the 1820 and 1822 series of Differential Amplifiers.

NOTE

Unless otherwise noted the 1820 refers to the 1820, and 1820-PR2. 1822 refers to the 1822, and 1822-PR2.

The –PR2 models contain two complete single channel amplifiers within a single housing. To verify the performance of the –PR2 models, complete the entire procedure on one channel, then repeat the procedure with the remaining channel.

The recommended calibration interval for the model 1820 and 1822 Differential Amplifiers is one year. The complete performance verification procedure should be performed as the first step of annual calibration. Test results can be recorded on a photocopy of the Test Record provided at the end of this section.

Performance verification can be completed without removing the instrument covers or exposing the user to hazardous voltages. Adjustment should only be attempted if a parameter measured in the Performance Verification Procedure is outside of the specification limits.

Adjustment should only be performed by qualified personnel. Removing the covers from the instrument may alter critical compensation adjustments, requiring the instrument to be re-calibrated. Re-establishing these adjustments requires the use of special calibration fixtures. Therefore, the covers should never be removed by the user. The Adjustment Procedure is part of this service manual.

Test Equipment Required

Table 4-1 on the following page lists the test equipment and accessories, or their equivalents, which are required for performance verification of the 1820/1822.

This procedure has been developed to minimize the number calibrated test instruments required.

Only the parameters listed in boldface in the Minimum Requirements column must be calibrated to the accuracy indicated.

Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required.

TABLE 4-1
List of required Equipment

Description	Minimum Requirements	Test Equipment Examples
Wide Band Oscilloscope	100 MHz bandwidth 2 mV-200 mV scale factors 1 ns-10 μs time/division 2% vertical accuracy 50 Ω termination	LeCroy LT342 or LeCroy LC584AM
Oscilloscope Preamplifier	200μV-10mV scale factors 10 MHz bandwidth	Wide band oscilloscope plus Preamble 1822.
Digital Multimeter	**DC: 0.2% accuracy** **AC: 0.2% accuracy** to measure 200 mV and 2 Vrms @ 1 kHz 6½ digit resolution	HP 34401A, or Fluke 8842A-09, or Keithley 2001
Oscillator/Function Generator	Sinewave output 5 Vp-p 50 Hz – 1 MHz frequency range	Stanford Research Model DS340, or Hewlett Packard 33120A, or Leader LAG-120B
Leveled Sine Wave Generator	**Relative output level accurate to 3% flatness from 1 – 100 MHz and 50 kHz.** Output adjustable to 2 Vp-p	Tegam SG503 with TM series mainframe with 012-0482-00 precision BNC cable. A semiautomatic software leveled signal source calibrated with a power meter may be substituted.
Terminator, in-line, BNC	50 Ω ± 1% coaxial termination	ITT Pomona 4119-50, or AIM 27-9008
Terminator, precision, BNC	50 Ω ± 0.05%	Tektronix 011-0129-00
Attenuator, BNC, (2 ea)	50 Ω ± 2%, ÷10 (20 dB),	ITT Pomona 4108-20dB, or
BNC coaxial cable, (2 ea)	Male-male BNC (approx. 1 meter)	ITT Pomona 5697-36
BNC coaxial cable, (2 ea)	Male-male BNC 4"-6" length	Pasternack Enterprises PE3067-5
BNC 'Y' connector	Male to dual female, BNC	AIM 27-9294
BNC Tee connector	Male to dual female, BNC	ITT Pomona 3285, or AIM 27-8140
BNC adapter	Female to female	AIM 25-7430, or ITT Pomona 3283
Banana Plug adapter	BNC female to banana plug.	ITT Pomona 1269

Note: **Boldface** indicates parameters required to be calibrated. Other parameters are compensated for in the procedure and can be approximate.

Preliminary Procedure

1. Connect the Differential Amplifier to an AC power source within the range listed in the Nominal Characteristics in the Specification section.
1. Allow at least 20 minutes warm-up time for the 1820/1822 and test equipment before performing the Verification Procedure.
2. Turn on the other test equipment and allow it to warm up for the time recommended by the manufacturer.

The warranted characteristics of the 1820/1822 series Differential Amplifiers are valid at any temperature within the Environmental Characteristics listed in Section 1. However, some of the other test equipment used to verify the performance may have environmental limitations required to meet the accuracy requirements needed for the procedure. Be sure that the ambient conditions meet the requirements of all the test instruments used in the procedure.

NOTE

When the oscilloscope input is connected to the 1820/1822 AMPLIFIER OUTPUT, the oscilloscope input impedance should be set to 50 Ω unless otherwise stated. Use a 50 Ω inline termination when using an oscilloscope without an internal 50 Ω termination.

Position the oscilloscope display to center screen. Unless otherwise noted, the oscilloscope position and offset must remain at zero for the duration of the adjustment procedure.

Set the 1820/1822 front panel controls as follows:

HF –3 dB POINT	All LEDs Off (Maximum bandwidth)
LF –3dB POINT	All LED's Off (DC)
GAIN	X1
ATTENUATOR	÷1
INPUT RESISTANCE	1 MΩ
+ INPUT	OFF
- INPUT	OFF
V_{COMP}	OFF
V_{DIFF}	OFF
PRECISION VOLTAGE GENERATOR	00.000 V

Procedure

1. Check X1 Gain Accuracy

a. Set the 1820/1822 **+INPUT** to **DC**.

b. Connect the High Amplitude Sine Wave generator via a 50 Ω BNC coaxial cable, a standard 50 Ω termination to a female BNC to banana plug adapter.

c. Set the DMM to measure AC volts.

d. Connect the banana plug adapter to the DMM.

e. Set the sine wave generator to 70 Hz and the output amplitude to read 2 Vrms ± 50 mV on the DMM.

f. Record the DMM reading to 100 µV resolution as 'Sine Wave Generator Output Voltage' in the Test Report.

g. Disconnect the sine wave generator output cable with the 50 Ω termination from the BNC to banana plug adapter on the DMM. Leave the banana plug adapter installed on the DMM for the remainder of the procedure.

h. Connect the sine wave generator via the coaxial cable with the standard 50 Ω termination to the **+INPUT** of the 1820/1822.

i. Connect the 1820/1822 **AMPLIFIER OUTPUT** connector via another coaxial cable and the precision 50 Ω termination to the banana plug adapter on the DMM.

j. Press the **X1 GAIN** button to remove any residual DC offset from the input. (A DC component may interfere with the RMS computation in some DMMs.)

k. After the DMM has stabilized, record the reading to 1 mV resolution as 'Amplifier Output Voltage' in the Test Record.

l. Divide the measured output voltage from step 1-k by the sine wave generator output voltage (amplifier input voltage) in step 1-f. Subtract 1.0 from the ratio and multiply the result by 100% to get the error in percent.

$$Error = \left(\frac{Measured\ Output\ Voltage}{Amplifier\ Input\ Voltage} - 1 \right) \times 100\%$$

m. Record the result to two decimal places (±0.xx%) as 'X1 Gain Error' in the Test Record.

n. CHECK — That the X1 GAIN error is less than ± 1%.

2. Check ÷10 Attenuator Accuracy.

NOTE

The accuracy of the internal ÷10 attenuator is not a warranted specification. However, the attenuator will be used in the X1000 gain test where it's absolute accuracy will be included in the calculations.

a. Verify that the measured output voltage is still the same value as recorded in step 1-k.

b. Set the 1820/1822 **ATTENUATOR** to **÷10**.

c. After the DMM has stabilized, record the reading as 'Amplifier Output Voltage' in the Test Record to 10 μV resolution.

d. Divide the output voltage recorded in step 1-k by the attenuated output voltage recorded in step 2-c. Record the result to four digit resolution in the Test Record. This is the 'Actual Attenuation'.

e. Divide the attenuation calculated in step 2-d by 10.0. Subtract the 1.0 from the result and multiply this number by 100% to get the attenuation error in percentage.

$$Error = \left(\frac{Actual\ \ Attenuation\ (Step\ 2-d)}{10} - 1 \right) \times 100\%$$

f. Record this value as '÷10 Attenuator Error' in the Test Record.

g. Add the attenuation error recorded in step 2-f to the X1 gain error recorded in step 1-k. Be sure to include the signs of the two terms when performing this addition. Record the result to two decimal places (±0.xx%) as 'X1 Gain + ÷10 Attenuation Error' in the Test Record.

h. CHECK — That the combined X1 Gain ÷10 Attenuation error is less than ± 1%.

3. Check the X10, X100 and X1000 Gain Accuracy.

NOTE

Because most DMMs do not provide the required accuracy on lower AC voltage ranges, the check for X10, X100 and X1000 Gain Accuracy uses a ratio technique with an external ÷10 attenuator. The actual attenuation of the attenuator is determined using higher amplitude signals.

i. Disconnect the amplifier output cable and the precision 50 Ω termination from the BNC to banana plug adapter on the DMM.

j. Disconnect the sine wave generator output cable from the **+INPUT** and remove the 50 Ω termination from the coaxial cable.

k. Connect one female end of the BNC Tee to the sine wave generator cable.

l. Connect a 50 Ω ÷10 attenuator to the male end of the BNC Tee followed by a standard 50 Ω termination.

m. Connect another coaxial cable from the banana plug on the DMM to the other female end of the BNC Tee.

n. Set the sine wave generator output amplitude to read 2.00 Vrms ± 50 mV on the DMM.

o. Record the reading to 1 mV resolution as 'Sine Wave Generator Output Voltage' in the Test Record.

p. Remove the DMM cable from the BNC Tee.

q. Connect the 50 Ω termination end of the termination/attenuator/BNC Tee combination of the sine wave generator cable to the DMM banana plug adapter.

r. Record the DMM reading to 100 μV resolution in the Test Record as ' Actual Amplifier Input Voltage'.
(Note: This reading should be approximately 200 mV. If it is not, verify that the in-line attenuator and termination are installed in the correct order. The 50 Ω termination should be closest to the DMM).

s. Divide the DMM reading in step 3-j into the output amplitude measured in step 3-g. This is the exact attenuation of the attenuator-termination combination.

t. Record the result to four digit resolution as ' Exact Attenuation' in the Test Record.

u. Disconnect the termination/attenuator/BNC Tee combination from the DMM.

v. Connect the terminated end of the termination/attenuator/BNC Tee combination to the 1820/1822 **+INPUT**.

w. Connect the DMM to the free female end of the BNC Tee connector.

x. Adjust the sine wave generator output amplitude to read 200 mVrms ± 50 mV on the DMM.

y. Record the DMM reading to 100 µV in the Test Record as 'Sine Wave Generator Output Voltage'.

z. Disconnect the DMM cable from the BNC Tee.

aa. Connect the DMM cable to the 1820/1822 **AMPLIFIER OUTPUT** connector.

bb. Insert the precision 50 Ω termination between this cable end the banana plug adapter on the DMM.

cc. Set the 1820/1822 **GAIN** to **X10**.

dd. Divide the sine wave generator amplitude recorded in step 3-q by the actual attenuation calculated in step 3-l. This represents the actual voltage on the input of the amplifier.

ee. Record the result as 'Actual Amplifier Input Voltage' in the Test Record.

ff. Multiply the actual input voltage as recorded in step 3-w by 10.0 to obtain the expected output voltage.

gg. Record the result to four digit resolution as 'Expected Amplifier Output Voltage' in the Test Record.

hh. After the DMM reading has stabilized, record the measured voltage to 100 µV resolution as 'Measured Amplifier Output Voltage' in the Test Record.

ii. Calculate the error by dividing the measured output voltage recorded in step 3-z by the expected output voltage recorded in step 3-y. Subtract 1.0 from this ratio and multiply by 100% to get the error in percent.

$$Error = \left(\frac{Measured\ Output\ Voltage}{Expected\ Output\ Voltage} - 1 \right) \times 100\%$$

jj. Record the calculated error to two decimal places (±0.xx%) in the Test Record as 'X10 Gain Error'.

kk. CHECK — That the calculated error is less than ± 1%.

ll. Press the **X100 GAIN** button on the 1820/1822.

mm. Multiply the actual input voltage of the 1820/1822 which was recorded in step 3-w by 100.0.

nn. Record the result to four digit resolution in the Test Record as 'Expected Amplifier Output Voltage'.

oo. After the DMM has stabilized, record the measured output voltage to 1 mV resolution as 'Measured Amplifier Output Voltage' in the Test Record.

pp. Calculate the error by dividing the measured output voltage recorded in step 3-gg by the expected output voltage recorded in step 3-ff. Subtract 1.0 from this ratio and multiply by 100% to get the error in percent.

$$Error = \left(\frac{Measured\ Output\ Voltage}{Expected\ Output\ Voltage} - 1 \right) \times 100\%$$

qq. Record the calculated error to two decimal places (±0.xx%) in the Test Record as X100 Gain Error.

rr. CHECK — That the calculated error is less than ± 1%.

ss. Press the ÷**10 ATTENUATOR** and then the **X1000 GAIN** button on the 1820/1822.

tt. Divide the actual input voltage recorded in step 3-w by the internal ÷10 attenuation factor, recorded in step 2-d. This represents the effective amplifier input voltage. Multiply this number by 1000 to get the expected output voltage.

uu. Record this reading as 'Expected Amplifier Output Voltage' in the Test Record.

vv. After the DMM has stabilized, record the measured output voltage to 1 mV resolution in the Test Record as 'Measured Amplifier Output Voltage'.

ww. Calculate the error by dividing the measured output voltage recorded in step 3-oo by the expected output voltage recorded in step 3. Subtract 1.0 from this ratio and multiply by 100% to get the error in percent.

$$Error = \left(\frac{Measured\ Output\ Voltage}{Expected\ Output\ Voltage} - 1 \right) \times 100\%$$

xx. Record the calculated error to two decimal places (±0.xx%) as 'X1000 Gain Error' in the Test Record.

yy. CHECK — That the calculated error is less than ± 1%.

4. Check X1 and X10 Bandwidth and Calculate Rise Time.

a. Connect the AMPLIFIER OUTPUT to channel 1 of the oscilloscope.

b. Set the channel input coupling to 50 Ω.

NOTE

If the oscilloscope does not have an internal 50 Ω input termination, inset the standard inline 50 Ω termination between the cable and the oscilloscope input.
Use the standard wide bandwidth 50 Ω termination. The precision termination is not accurate at frequencies higher than 100 kHz.

c. Set the 1820/1822 **GAIN** to **X1** and the **ATTENUATOR** to **÷10**.

d. Connect a BNC cable to the output of the leveled sine wave generator.

NOTE

Many leveled sine wave generators, including the SG503, are calibrated only when a special BNC cable is used on its output. Be sure to use a cable which is specified for the generator.

e. Insert a standard 50 Ω termination on the free cable end and connect the termination to the **+INPUT** of the 1820/1822.

f. Set the sine wave generator output frequency to 50 kHz, and the amplitude to approximately 3 Vp-p.

g. Set the oscilloscope V/div to 50 mV/div and the time/div to 20 μsec/div. Adjust the trigger level for a stable display.

h. Adjust the sine wave generator output for an amplitude of exactly 6 divisions (300 mV) on the oscilloscope.

i. Set the sine wave generator output frequency to 500 kHz. Be careful not to alter the output amplitude.

NOTE

The displayed waveform will be compressed in time to form a solid rectangle. It is not necessary to alter the time/div setting as long as the peak amplitude can be measured.

j. Slowly increase the output frequency of the sine wave generator until the displayed amplitude decreases to exactly 4.2 divisions. This is a 3 dB reduction in amplitude.

k. Record the frequency where the X1 Gain –3 dB amplitude is obtained in the Test Record as 'Measured –3 dB Frequency at X1 Gain'.

l. CHECK — That the frequency is > 10 MHz.

m. Divide the 0.35 by the –3 dB frequency recorded in step 4-k. The result is the 'Calculated Rise Time at X1Gain'. Record the result in the Test Record.

n. Set the sine wave generator output frequency to 50 kHz. and the amplitude to approximately 300 mVp-p

o. Set the 1820/1822 **GAIN** to **X10**.

p. Set the oscilloscope sensitivity to 5 mV/div.

q. Adjust the sine wave generator output for an amplitude of exactly 6 divisions (300 mV) on the oscilloscope.

r. Set the sine wave generator output frequency to 500 kHz. Be careful not to alter the output amplitude.

s. Slowly increase the output frequency of the sine wave generator until the displayed amplitude decreases to exactly 4.2 divisions. This is a 3 dB reduction in amplitude.

t. Record the frequency where the X10 Gain –3 dB amplitude is obtained in the Test Record as 'measured –3 dB Frequency at X10 Gain'.

u. CHECK — That the frequency is > 10 MHz.

v. Divide the 0.35 by the –3 dB frequency recorded in step 4-t. The result is the 'Calculated Rise Time at X10 Gain'. Record the result in the Test Record.

5. Check X100 and X1000 Bandwidth.

a. Continue with the same set up as in step 4.

b. Set the sine wave generator frequency to 50 kHz and an amplitude of approximately 30 mVp-p.

c. Set the 1820/1822 **GAIN** to **X100**.

d. Adjust the amplitude of the sine wave generator for a waveform amplitude of exactly 6 divisions on the oscilloscope.

e. Set the sine wave generator output frequency to 500 kHz. Be careful not to alter the output amplitude.

NOTE

The displayed waveform will be compressed in time to form a solid rectangle. It is not necessary to alter the time/div setting as long as the peak amplitude can be measured.

f. Slowly increase the output frequency of the sine wave generator until the displayed amplitude decreases to exactly 4.2 divisions. This is a 3 dB reduction in amplitude.

g. Record the frequency where the –3 dB amplitude is obtained in the Test Record as 'Measured –3 dB Frequency at X100 Gain'.

h. CHECK — That the frequency is > 2.5 MHz.

i. Insert a ÷10 attenuator between the sine wave generator cable and the 50 Ω termination.

j. Set the sine wave generator frequency to 50 kHz.

k. Set the 1820/1822 **GAIN** to **X1000**.

l. Adjust the amplitude of the sine wave generator for a waveform amplitude of exactly 6 divisions on the oscilloscope.

m. Set the sine wave generator output frequency to 500 kHz. Be careful not to alter the output amplitude.

n. Slowly increase the output frequency of the sine wave generator until the displayed amplitude decreases to exactly 4.2 divisions. This is a 3 dB reduction in amplitude.

o. Record the frequency where the –3 dB amplitude is obtained in the Test Record as 'Measured –3 dB Frequency at X1000 Gain'.

p. CHECK — That the frequency is > 1 MHz.

6. Check High Frequency CMRR.

NOTE

Common Mode Rejection Ratio (CMRR) is defined as the Differential Mode Gain divided by the Common Mode Gain (normalized inverse of the Common Mode Feedthrough). At higher frequencies where the bandwidth of the amplifier begins to attenuate the differential mode signal, both the differential mode gain and the common mode feedthrough must be measured to derive the CMRR.

a. Make the set-up the same as used for the bandwidth tests (Steps 4-a through e).

b. Connect a BNC cable from the Frequency Reference Signal Output of the high amplitude sine wave generator to the External Trigger Input connector of the oscilloscope. (If the sine wave generator does not have a Frequency Reference Signal Output, insert a BNC Tee adapter into the Output connector and attach the external Trigger BNC cable to the BNC Tee adapter.

c. Set the 1820/1822 **GAIN** to **x1**, **ATTENUATION** to **÷1**, **INPUT RESISTANCE** to **1 MΩ**, **BANDWIDTH** to **FULL**, **+INPUT** to DC, **-INPUT** to **OFF**.

d. Set the leveled sine wave generator output frequency to 50 kHz. If necessary, adjust the output amplitude for a display of exactly 6 divisions (300 mVp-p).

e. Without changing the output amplitude set the output frequency to 1 MHz.

f. Measure the peak to peak output amplitude of the 1820/1822. Record the answer as 'Amplifier Output Amplitude at 1 MHz' to two digit resolution (xx0 mV) in the Test Record.

g. Divide the measured output amplitude by 300 mV. Record the answer to two digit resolution (0.xx) as 'Differential Mode Gain at 1 MHz' in the Test Record. This is the Differential Mode Gain at 1 MHz.

h. Remove the leveled sine wave generator from the input of the 1820/1822.

i. Connect a BNC cable from the output of the high amplitude sine wave generator to the Channel 2 input of the oscilloscope. Do not terminate the cable into 50 Ω, and verify that channel 2 coupling is set to DC and 1 MΩ.

j. Set the oscilloscope to display channel 2, vertical scale to 1 V/div, horizontal scale to 500 ns/div, and trigger source to external ÷10. If necessary, adjust the trigger level for a stable display.

k. Set the sine wave generator frequency to 1 MHz, and the output amplitude to exactly 5 Vp-p (5 divisions on the oscilloscope).

l. Remove the sine wave generator output cable from the oscilloscope. On the free end of the BNC cable, install the female to female BNC adapter, BNC 'Y' adapter and two 6" BNC cables.

m. Set both the 1820/1822 **+INPUT** and – **INPUT** to **DC**.

n. Connect the two free ends of the 6" cables to the 1820/1822 **+INPUT** and **–INPUT**.

o. Set the oscilloscope to display channel 1 (1820/1822 output signal). Increase the vertical sensitivity to maximum. Verify that the oscilloscope is still triggered on the Frequency Reference Signal Output of the sine wave generator.

p. The displayed signal is the Common Mode Feedthrough. Measure the peak to peak amplitude. (Use the oscilloscope ZOOM function if needed to increase the size of the displayed waveform.

NOTE

The amplitude of the Common Mode Feedthrough should be very small. If the output waveform appears to be a 10 V square wave, check that both of the 1820/1822 inputs are set to DC.

q. Record the 'Common Mode Feedthrough at 1 MHz' amplitude to two digit resolution in the Test Record.

r. Calculate the Common Mode Gain by dividing the Common Mode Feedthrough (in mV) by 5,000 mV. Record the result to two significant places as 'Common Mode Gain at 1 MHz' in the Test Record. (Keep all of the leading zeros or use scientific notation.)

s. Calculate the Common Mode Rejection Ratio (CMRR) at 1 MHz by dividing the Differential Mode Gain at 1MHz (recorded in step 6-f) by the Common Mode Gain recorded in step 6-u. Record the result as 'Common Mode Rejection ratio at 1 MHz' to two significant places in the Test Record. (Keep all of the trailing zeros.)

t. CHECK — That the CMRR at 1 MHz is greater than 1,000:1 (60 dB).

u. Leave the test setup for the next tests.

7. Check Low Frequency CMRR.

NOTE

The attenuation of the 1820/1822 at 70 Hz and 100 kHz is so insignificant that the Differential Mode Gain can be assumed to be unity (1.0). However, the high value of the CMRR specification requires a preamplifier to boost the level of the common mode feedthrough to an amplitude where it can be measured.

a. Disconnect the output cable of the 1820/1822 under test from channel 1 of the oscilloscope. Install a 50 Ω inline BNC termination the free end of the cable.

b. Connect the terminated input to the + input of the oscilloscope preamplifier. Using another BNC cable connect the output of the oscilloscope preamplifier to the channel 1 input of the oscilloscope.

c. Set the input coupling termination of the oscilloscope channel 1 to what is required by the oscilloscope preamplifier (50 Ω if a 1822 is being used.)

d. Disconnect the output cable of the sine wave generator from the female to female BNC adapter. Reconnect the free end of the cable to the channel 2 input of the oscilloscope.

e. Set the oscilloscope to display channel 2, vertical scale to 5 V/div and horizontal scale to 10 ms/div.

f. Set the sine wave generator frequency to 70 Hz and the output amplitude to exactly 30 Vp-p (6 divisions). Adjust the oscilloscope trigger level for a stable display if necessary.

g. Verify that both the **+INPUT** and **–INPUT** of the 1820/1822 are set to **DC**.

h. Remove the output cable of the sine wave generator from the oscilloscope input and reconnect the cable to the female to female input of the BNC adapter and cables attached to the inputs of the 1820/1822.

i. Set the + Input Coupling of the oscilloscope preamplifier to AC, GAIN to X100, Offset Off, any bandwidth limiting controls to Off or Full Bandwidth.

j. Set the oscilloscope to display channel 1 and the vertical as necessary to measure the amplitude of the displayed waveform. Autozero the oscilloscope preamplifier if necessary to keep the displayed trace on screen.

k. The displayed signal is the Common Mode Feedthrough multiplied by 100 by the preamplifier.

l. Record the displayed Common Mode Feedthrough amplitude to two digit resolution in the Test Record as 'Common Mode Feedthrough X100 at 70 Hz'.

m. Divide the result recorded in step 7-l by 100 to determine the Common Mode feedthrough at the output of the 1820/1822 under test.

n. Record this as 'Common Mode Feedthrough at 70 Hz' to two digit resolution in the Test record. Keep all leading zeros or use scientific notation.

o. Calculate the Common Mode Gain by dividing the Common Mode Feedthrough (in μV) by 30,000,000 μV. Record the result to two significant places in the Test record as 'Common Mode Gain at 70 Hz'. (Keep all of the leading zeros or use scientific notation.)

p. Calculate the Common Mode rejection Ratio (CMRR) at 70 Hz by dividing the Differential Mode Gain at 70 Hz (1.0) by the Common Mode Gain recorded in step 7-o.

q. Record the result as 'Common Mode rejection ratio at 70 Hz' to two significant places in the Test Record. (Keep all of the leading zeros.)

r. CHECK — That the CMRR at 70 Hz is greater than 100,000:1 (100 dB).

s. Remove the sine wave generator output cable from the female to female BNC adapter

t. Reconnect the cable to the channel 2 input of the oscilloscope.

u. Set the oscilloscope to display channel 2, the vertical scale to 5 mV/div and the horizontal to 5 μV/div. If necessary, adjust the trigger level for a stable display.

v. Set the sine wave generator to 100 kHz.

w. Adjust the output amplitude of the sine wave generator to 30 Vp-p (6 divisions). Readjust the oscilloscope trigger level if necessary to maintain a stable display.

x. Remove the sine wave generator output cable and reconnect it to the female to female BNC adapter and cables attached to the 1820/1822.\ inputs.

y. Set the oscilloscope to display channel 1 (the output of the 100X preamplifier driven by the 1820/1822 output signal), and the vertical scale as necessary to measure the amplitude of the displayed signal. Autozero the oscilloscope preamplifier if necessary to keep the displayed signal on screen.

z. The displayed signal is the Common Mode Feedthrough multiplied by 100 by the preamplifier.

aa. Record the displayed Common Mode Feedthrough amplitude to two digit resolution in the Test Record as 'Common Mode feedthrough X100 at 100 kHz'.

bb. Divide the result recorded in step 7-aa by 100 to determine the Common Mode Feedthrough at the output of the 1820/1822 under test.

cc. Record the Common Mode Feedthrough amplitude to two digit resolution as 'Common Mode Feedthrough at 100 kHz' in the Test Record. Keep all leading zeros or use scientific notation.

dd. Calculate the Common Mode Gain by dividing the Common Mode Feedthrough (in μV) by 30,000,000 μV. Record the result to two significant places as 'Common Mode Gain at 100 kHz' in the Test Record. (Keep all leading zeros or use scientific notation.)

ee. Calculate the Common Mode Rejection Ratio (CMRR) at 100 kHz by dividing the Differential Mode Gain at 70 Hz (1.0) by the Common Mode Gain recorded in step 7-dd.

ff. Record the result as 'Common Mode rejection ratio at 100 kHz' to two significant places in the Test Record. Keep all of the trailing zeros.)

gg. CHECK — That the CMRR at 100 kHz is greater than 100,000:1 (100 dB).

hh. Remove all cables and connections from the 1820/1822.

8. Check the Precision Voltage Generator Accuracy (1822 Only).

a. Connect a BNC cable from the **OFFSET VOLTAGE** output connector on the rear panel to a DMM without a 50 Ω termination.

b. Push the **PVG ZERO** button.

c. Set the DMM to DC Volts on the most sensitive range. After the display has stabilized record the reading as 'PVG Zero Output Voltage' in the Test Record.

d. CHECK — That the measured 0.0000 V output is within ± 0.5 mV of zero.

e. Set the DMM range to read 15.5 V.

f. Press and hold MSB increment button (button to right of ± button) until the display reads +15.000 V. If necessary, press the ± button once to invert the polarity.

g. After the DMM display has stabilized record the reading as 'PVG Output Voltage at +15.5 V' in the Test Record with 100 μV resolution

h. CHECK — That the measured output is within15.4917 to 15.5082 V.

i. Press the ± button to change the output voltage to −15.5000 V.

j. After the DMM display has stabilized record the reading as 'PVG Output Voltage at -15.5 V' in the Test Record to 100 μV resolution.

k. CHECK — That the measured output is within -15.4917 to -15.5082 V.

l. Disconnect DMM and all cables from amplifier.

This completes the Performance Verification Procedure. File the test results as required to support your internal calibration procedures.

1820/1822 TEST RECORD

This record can be used to record the results of measurements made during the performance verification of the 1820/1822 series of instruments.

Photocopy this page and record the results on the copy. File the completed record as required by applicable internal quality procedures.

The section in the test record corresponds to the parameters tested in the performance verification procedure. The numbers preceding the individual data records correspond with the steps in the procedure which require data recording. Steps printed in **Boldface** type are the actual specification limit check. Other steps are for recording intermediate data used in the limit calculations.

Permission is granted to reproduce this page for the purpose of recording test results.

Model: ______________________

Serial Number: ______________________

Right or Left Channel: ______________________ (PR-2 models only)

Date: ______________________

Technician: ______________________

EQUIPMENT USED:

	Model	Serial Number	Calibration Due Date
Oscilloscope	____________	____________	____________
Preamplifier	____________	____________	____________
Digital Multimeter	____________	____________	____________
Oscillator/Function Generator	____________	____________	____________
Leveled Sine Wave Generator	____________	____________	____________
Power Meter (If used to level Sine Wave Generator)	____________	____________	____________

Notes: ____

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Step	Description	Intermediate Data	Test Result
X1 Gain Accuracy			
1-f	Sine Wave Generator Output Voltage	____________ V	
1-k	Amplifier Output Voltage	____________ V	
1-m	**X1 Gain Error** (Test Limit: < ± 1%)		____________ %
÷10 Attenuator Accuracy			
2-c	Amplifier Output Voltage	____________ V	
2-d	Actual Attenuation	____________	
2-f	÷10 Attenuator Error	____________ %	
2-h	**X1 Gain +÷10 Attenuator Error** (Test limit < ± 1%)		____________ %
X10, X100 and X1000 Gain Accuracy			
	X10 Gain Accuracy		
3-g	Sine Wave Generator Output Voltage	____________ V	
3-j	Actual Amplifier Input Voltage	____________ V	
3-l	Exact Attenuation	____________	
3-q	Sine Wave Generator Output Voltage	____________ V	
3-w	Actual Amplifier Input Voltage	____________ V	
3-y	Expected Amplifier Output Voltage	____________ V	
3-z	Measured Amplifier Output Voltage	____________ V	
3-bb	**X10 Gain Error** (Test Limit: < ± 1%)		____________ %
	X100 Gain Accuracy		
3-ff	Expected Amplifier Output Voltage	____________ V	
3-gg	Measured Amplifier Output Voltage	____________ V	
3-ii	**X100 Gain Error** (Test Limit: < ± 1%)		____________ %
	X1000 Gain Accuracy		
3-mm	Expected Amplifier Output Voltage	____________ V	
3-nn	Measured Amplifier Output Voltage	____________ V	
3-pp	**X1000 gain Error** (Test Limit: < ± 1%)		____________ %
X1 and X10 Bandwidth and Calculated Rise Time			
4-k	**Measured -3 dB Frequency at X1 Gain** (Test Limit: > 10 MHz)		____________ MHz
4-m	Calculated Rise Time at X1 Gain		____________ nsec
4-t	**Measured -3 dB Frequency at X10 Gain** (Test Limit: > 10 MHz)		____________ MHz
4-v	Calculated Rise Time at X10 Gain		____________ nsec

X100 and X1000 Bandwidth

5-g	**Measured –3 dB Frequency at X100 Gain** (Test Limit: >2.5 MHz)	______________	MHz
5-o	**Measured –3 dB Frequency at X1000 Gain** (Test Limit: >1 MHz)	______________	MHz

High Frequency CMRR

6-f	Amplifier Output Amplitude at 1 MHz	______________	V
6-g	Differential Mode Gain at 1 MHz	______________	
6-q	Common Mode Feedthrough at 1 MHz.	______________	V
6-r	Common Mode Gain at 1 MHz	______________	
6-s	**Common Mode Rejection Ratio at 1 MHz** (Test Limit: > 1,000:1)	______________	:1

Low Frequency CMRR

7-l	Common Mode Feedthrough x100 at 70 Hz	______________	V
7-n	Common Mode Feedthrough at 70 Hz at Amplifier Output	______________	V
7-o	Common Mode Gain at 70 Hz	______________	
7-q	**Common Mode Rejection Ratio at 70 Hz** (Test Limit: > 100,000:1)	______________	:1
7-aa	Common Mode Feedthrough at 100 kHz	______________	V
7-cc	Common Mode Feedthrough x100 at 100 kHz	______________	V
7-dd	Common Mode Gain at 100 kHz	______________	
7-ff	**Common Mode Rejection Ratio at 100 kHz** (Test Limit: > 100,000:1)	______________	:1

Precision Voltage Generator Accuracy

8-c	**PVG Zero Output Voltage** (Test Limit: ≤± 500 μV)	______________	V
8-g	**PVG Output Voltage at +15.5 V** (Test Limit: 15.4917 to 15.5082 V)	______________	V
8-j	**PVG Output Voltage at –15.5 V** (Test Limit: -15.4917 to -15.5082 V)	______________	V

WARRANTY

Preamble Instruments warrants the products it manufactures and sells to be free of defects in materials and workmanship for a period of three years, (one year for passive probes and probe accessories). Preamble Instruments will repair or replace, at its option, any product which proves defective within the warranty period.

To obtain warranty service, the customer must contact Preamble Instruments within the warranty period to obtain a Return Material Authorization. The customer shall be responsible for the proper packaging, insurance and shipping charges for the return of the product to Preamble Instruments. Preamble Instruments will pay the shipping charges for the return of the product to the customer.

This warranty does not apply to damage resulting from the improper use or abuse of the product. The warranty also excludes any damage resulting from repair or modifications of the product which were not performed by Preamble Instruments or its authorized service facility.

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