# Service Manual

Tektronix

# SD-22 & SD-26
# Sampling Head

## 070-7227-02

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

**Please check for change information at the rear of this manual.**

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**www.tektronix.com**

**Instrument Serial Numbers**

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

| | |
|---|---|
| B010000 | Tektronix, Inc., Beaverton, Oregon, USA |
| E200000 | Tektronix United Kingdom, Ltd., London |
| J300000 | Sony/Tektronix, Japan |
| H700000 | Tektronix Holland, NV, Heerenveen, The Netherlands |

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

Printed in U.S.A.

## WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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# General Information

# General Information

This section gives all the information needed to apply power to the SD-22 & SD-26 Sampling Heads.

Safety information as well as information on installing and removing the sampling head, packaging for shipment, and environmental conditions such as operating temperature is included here.

## Introduction

The *SD-22 & SD-26 Sampling Head Service Manual* is designed for use by qualified service personnel. It contains information necessary to check and maintain the SD-22 & SD-26 Sampling Heads.

The SD-22 Sampling Head is a two-channel, low-noise, 28 ps rise time sampling head. The SD-26 Sampling Head is a two-channel, 17.5 ps rise time sampling head. The SD-22 & SD-26 Sampling Heads are designed for use in the 11800 Series Digital Sampling Oscilloscopes, the SM-11 Multi-Channel Unit, and the CSA 803 Series Communications Signal Analyzers.

## Safety Summary

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

### Terms in Manuals

*CAUTION* statements in manuals identify conditions or practices that could result in damage to the equipment or other property.

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

### Terms on Equipment

*CAUTION* on equipment means a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

*DANGER* on equipment means a personal injury hazard immediately accessible as one reads the marking.

### Symbols in Manuals

*Static Sensitive Devices*

### Symbols on Equipment

*DANGER*
*High Voltage*

*Protective*
*ground (earth)*
*terminal*

*ATTENTION*
*Refer to*
*manual*

### Grounding the Instrument

The sampling head is grounded through the grounding conductor of the oscilloscope's power cord. To avoid electric shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminal. A protective-ground connection, by way of the grounding conductor in the power cord, is essential for safe operation.

### Danger Arising from Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating), can render an electric shock.

## Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate the sampling head in an atmosphere of explosive gasses.

## Installing and Removing the Sampling Head

To avoid damage to the instrument, set the instrument's ON/STANDBY switch to STANDBY before installing or removing the sampling head.

The SD-22 & SD-26 Sampling Head slide into the one of the front panel compartments of the 11800 Series Digital Sampling Oscilloscopes or CSA 803 Series Communications Signal Analyzers. Figure 1-1 shows the front panel of an instrument and the locations of the sampling head compartments.

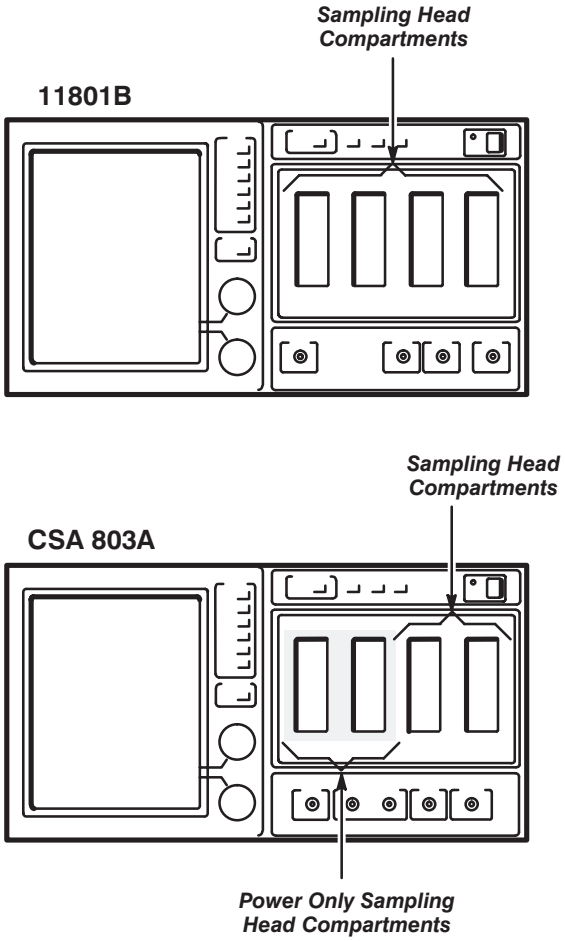



**Figure 1-1: Sampling Head Compartments in an 11801B and a CSA 803A**

With the ON/STANDBY switch set to STANDBY, place the sampling head in a compartment and slowly push it in with firm pressure. Once the sampling head is seated, turn the lock-down screw to tighten the sampling head into place. See Figure 1-2.

***CAUTION***

*To prevent damage to your instrument or sampling head, never install or remove a sampling head when the ON/STANDBY switch is ON.*

*If the green indicator light remains on when the STANDBY position is selected, then the switch has been left internally disabled after the servicing of the power supply. To enable the ON/STANDBY switch, refer to the Maintenance section of the Service Manual for your mainframe instrument.*

To remove the sampling head from an instrument, set the instrument's ON/STANDBY switch to STANDBY. Turn the lock-down screw and then slowly pull out the sampling head.

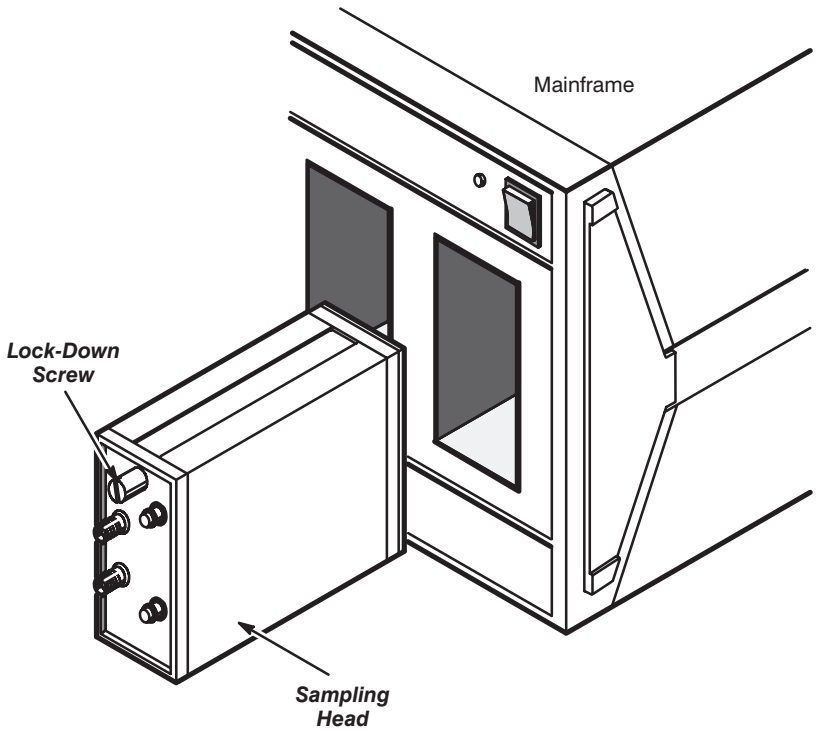



**Figure 1-2: Installing a Sampling Head in an Instrument**

## Packaging for Shipment

If possible, save and reuse the original carton and packaging to the package sampling head when shipping it by commercial transportation.

Attach a tag to the sampling head if it is shipped to your local Tektronix service center for service or repair. Include the following information on the tag:

- Name and address of the instrument and sampling head owner.
- Name of a person at your firm who can be contacted about the instrument and sampling head.
- Complete instrument and sampling head type and serial number.
- A description of the service required.

Package the sampling head as follows, if the original package is not available or is not fit for use:

☐ **Step 1:** Attach short-circuit terminations to the sampling head inputs.

☐ **Step 2:** Obtain a corrugated cardboard carton with inside dimensions at least six inches (15 cm) greater than the sampling head dimensions. Use a carton with a bursting test strength of at least 200 pounds per square inch.

☐ **Step 3:** Fully wrap the sampling head with antistatic sheeting, or its equivalent, to protect the finish.

☐ **Step 4:** Tightly pack dunnage or urethane foam between the carton and the sampling head to cushion the sampling head on all sides. Allow three inches of packing on each side.

☐ **Step 5:** Seal the carton with shipping tape or with industrial staples.

☐ **Step 6:** Mark the address of the Tektronix service center and your return address on the carton in one or more prominent places.

# Operating Environment

The following environmental requirements are provided to ensure proper operation and long sampling head life.

## Operating Temperature

Operate the sampling head where the ambient air temperature is between 0° C and +50° C. Store the sampling head in ambient temperatures from −40° C to +75° C. After storage at temperatures outside the operating limits, allow the chassis to reach the operating temperature range before applying power.

Allow a 20 minute warmup before performing the calibrations in the Enhanced Accuracy menu of the instrument mainframe. Calibrations should be repeated if the temperature changes more than ±5° C or if the sampling head is removed from the instrument.

# Checks and Adjustments

# Checks and Adjustments

This section contains procedures to check the specifications and measurement limits listed in Table 2-1. The Specification or Measurement Limit is listed at the beginning of each part as well. These procedures contain only check steps, since the SD-22 & SD-26 Sampling Heads have no internal adjustments.

The procedures in this section provide a logical sequence of checks for performing a comprehensive performance verification procedure to verify that the sampling head meets specifications. To functionally test the sampling head, perform the parts in Table 2-1 which have a “yes” in the Functional Test column.

Refer to the *SD-22 & SD-26 Sampling Heads User Manual* for more information about specifications and sampling head operation. Refer to Table 2-2 for information concerning test equipment used in the setups.

**Table 2-1: Measurement Limits and Specifications**

| Part and Description | Measurement Limit | Specification | Functional Test |
|---|---|---|---|
| Part 1 Power-On | none | none | yes |
| Part 2 Dot Transient Response | | | |
| 250 mV with automatic calibration | ≤5% error | | yes |
| 500 mV with automatic calibration | ≤5% error | | no |
| 500 mV with default settings | ±20% error | | no |
| 1.0 V without automatic calibration | | adjusted to 100% at 1 V | no |
| Part 3 Offset | | | |
| Offset | ±2 mV | | yes |
| Offset change with repetition rate | | ±5 mV | no |

**Table 2-1: Measurement Limits and Specifications (Cont.)**

| Part and Description | Measurement Limit | Specification | Functional Test |
|---|---|---|---|
| Part 4 Noise | | | no |
| SD-22 Sampling Head | | | |
| Smoothing, on | ≤ 400 $\mu V_{RMS}$ | | |
| Smoothing, off | ≤ 800 $\mu V_{RMS}$ | | |
| SD-26 Sampling Head (SN B020440 and above) | | | |
| Smoothing, on | ≤ 550 $\mu V_{RMS}$ | | |
| Smoothing, off | ≤ 1.2 $mV_{RMS}$ | | |
| SD-26 Sampling Head (SN B010339 and below) | | | |
| Smoothing, on | ≤ 900 $\mu V_{RMS}$ | | |
| Smoothing, off | ≤ 2 $mV_{RMS}$ | | |
| Part 5 Rise Time | | | yes |
| SD-22 Sampling Head | | 28 ps | |
| SD-26 Sampling Head | | 17.5 ps | |
| Part 6 Acquisition Aberrations (with 067−1338−00 source) | | | no |
| 0 to 300 ps | −7% to 12% | | |
| 300 ps to 5 ns | ±4% | | |
| 5 ns to 100 ns | ±1.2% | | |
| 100 ns and up | ±0.6% | | |
| −10 ns to −20 ps | ±4% | | |
| Part 7 Coincidence Between Channels | | 10 ps | no |
| Part 8 Maximum Signal Voltage | 1% of step amplitude | | no |
| Part 9 Isolation Between Channels | | 1% | no |

## Test Equipment

Table 2-2 lists test equipment suggested for use with this manual. Procedure steps are based on the test equipment examples given, but other equipment with similar specifications may be substituted. Test results, setup information, and related connectors and adapters may be altered by the use of different equipment.

**Table 2-2: Test Equipment**

| Description | Minimum Specification | Examples of Applicable Test Equipment |
|---|---|---|
| 11800 Series Oscilloscope or CSA 803 Series Communications Signal Analyzer | Tektronix digital sampling oscilloscope | Tektronix 11801/A/B, 11802 Digital Sampling Oscilloscope Tektronix CSA 803, CSA 803A Communications Signal Analyzer |
| Pulse Generator | 1 ns rise time, 5 V output, 10 Hz to 250 MHz frequency range | Tektronix PG 502 Pulse Generator with a TM 500 Series Power Module |
| Time Mark Generator | 1 ns through 5 s markers in a 1−2−5 sequence, at least 5 parts in $10^7$ accuracy | Tektronix TG 501A Time Mark Generator with a TM 500 Series Power Module |
| Calibration Generator | DC output, 0.5% accuracy 1 V output amplitude | Tektronix PG 506A Calibration Generator with a TM 500 Series Power Module |
| Calibration Step Generator | | Tektronix Part 067−1338−0X Calibration Step Generator (where X represents either a 0, 1, 2, 3, 5, or 6; depending on the power supply appropriate for your country. Refer to Section 5, *Replaceable Parts*) |
| System Controller | Any compatible controller with MS DOS and a serial port configured for COM 1 | IBM compatible PC with terminal emulation software |
| 50 Ω Termination, SMA connectors | Impedance 50 Ω, SMA male connector | Tektronix Part 015−1022−00 |
| 50 Ω Termination, BNC connectors | Impedance 50 Ω, BNC connectors | Tektronix Part 011−0049−01 |
| Short Circuit Termination, SMA connectors | Male SMA compatible | Tektronix Part 015−1020−00 |
| Coaxial Cable, 50 Ω (2 required) | 50 Ω, 36-inch, BNC male connectors | Tektronix Part 012−0482−00 |
| Serial Cable | 10-ft RS-232-C Cable | Tektronix Part 012−0911−00 |

**Table 2-2: Test Equipment (Cont.)**

| Description | Minimum Specification | Examples of Applicable Test Equipment |
|---|---|---|
| Adapter, SMA to BNC (2 required) | SMA male to BNC female | Tektronix Part 015−0554−00 |
| Attenuator, 2× | 6 dB attenuation, 50 Ω, one male and one female BNC | Tektronix Part 011−0069−02 |
| Attenuator, 5× | 14 dB attenuation, 50 Ω, one male and one female BNC | Tektronix Part 011−0060−02 |
| Wrist Strap | | Tektronix Part 006−3415−01 |
| Static Control Mat | | Tektronix Part 006−3414−00 |
| Needle-Nose Pliers | | |
| Pozidrive Screwdriver | P1 tip | |

## Using These Procedures

Each part begins with a setup illustration that shows the test equipment and how to connect it. Refer to Table 2-2 for an example of the test equipment for each part.

### Conventions in this Manual

In these procedures, the following conventions are used:

- CAPITAL letters within the body of text identify front panel controls, indicators, and connectors (for example, MEASURE) on the oscilloscope and sampling head.
- **Bold** letters identify menu labels and display messages.
- Initial Capital letters identify connectors, controls, and indicators (for example, Position) on associated test equipment. Initial Capital letters also identify adjustments inside the sampling head.

In some steps, the first word is italicized to identify a step that contains a performance verification and/or an adjustment instruction. For example, if *Check* is the first word in the title of a step, an electrical specification is checked. If *Adjust* appears in the title, the step involves an electrical adjustment. If *Examine* is the first word in the title, the step concerns measurement limits that indicate whether the sampling head is operating properly; these limits are not to be interpreted as electrical specifications.

### Initialized and Stored Settings

At the beginning of most steps, the user is instructed to **Initialize** the instrument as part of the setup. The **Initialize** feature, available through the UTILITY menu, presets all instrument controls and functions to known values. Initializing the instrument at the beginning of a step eliminates the possibility of settings from previous parts causing erroneous or confusing results.

### Menu Selections and Measurement Techniques

Details on measurement techniques and instructions for making menu selections are generally not included in this manual. Comprehensive descriptions of menus and instrument mainframe features are located in the *User Manual* for your instrument and the *SD-22 & SD-26 Sampling Heads User Manual*.

## Setup Illustrations

You can use any 11800 Series Digital Sampling Oscilloscope or the CSA 803 Series Communications Signal Analyzer as the mainframe instrument in these procedures. A “Mainframe Instrument” is shown in each procedure; the exact location of connectors on your mainframe instrument may differ from that shown in the illustration.

In particular, the 11802 Oscilloscope and CSA 803 Series Communications Signal Analyzer have only two sampling head acquisition compartments, as compared to four in the 11801 Series Oscilloscopes. Locations of controls and connectors on each instrument are shown in Figure 2-1.

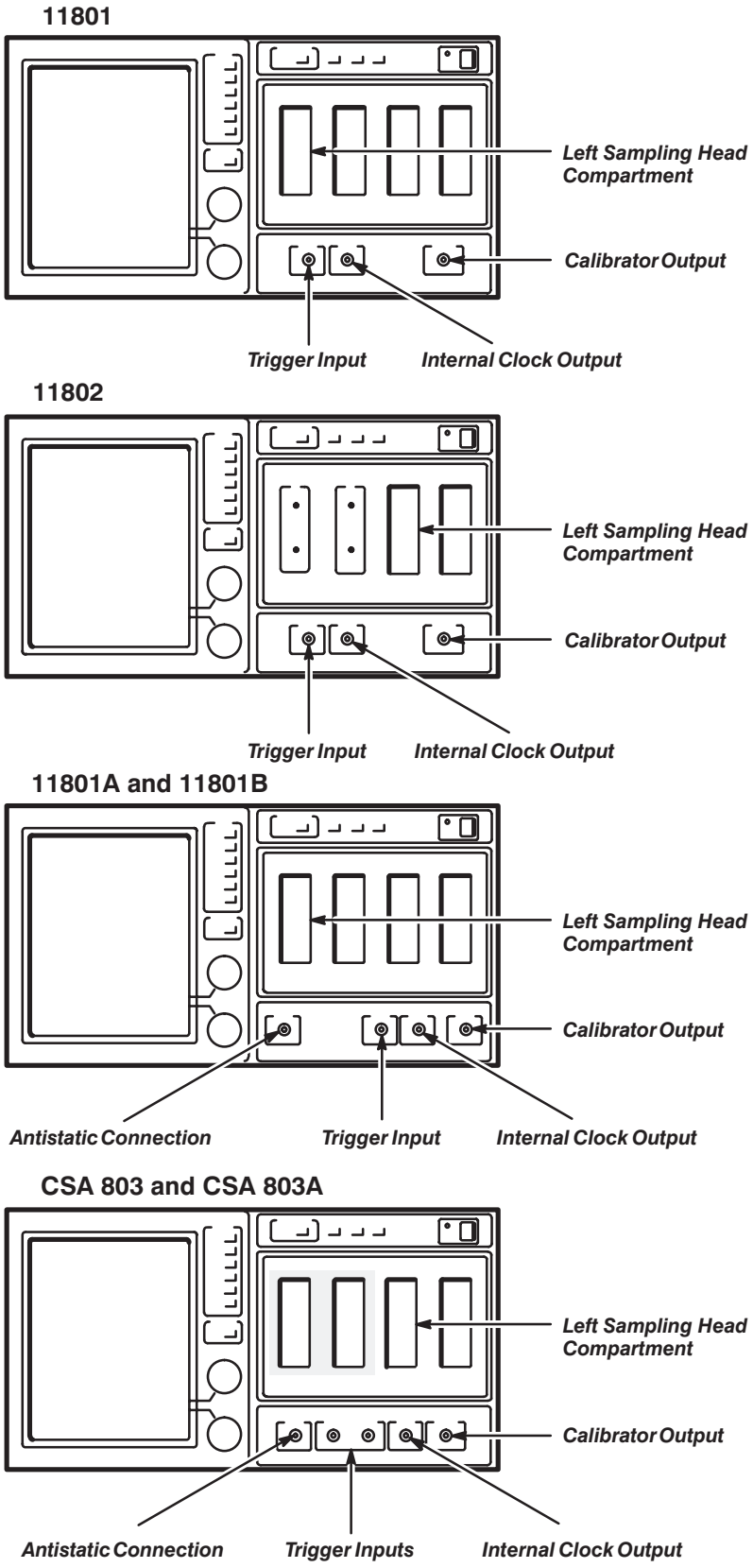


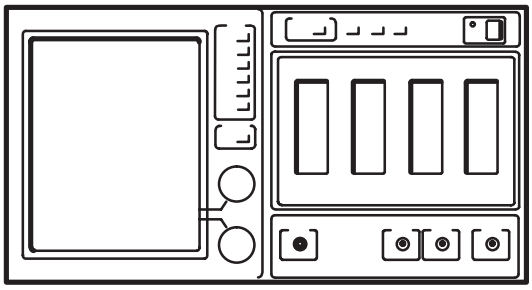

**Figure 2-1: Locations of Controls and Connectors on Mainframe Instruments**

# Part 1 Power-On

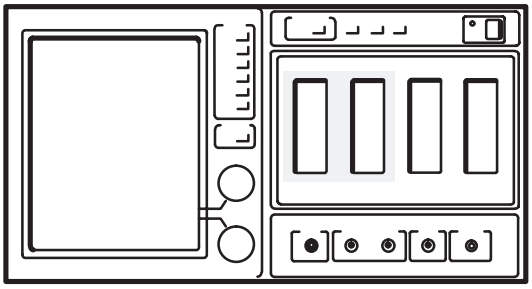
Perform this part within the ambient temperature range of +18° C to +28° C.

## Setup to Power-on

**11801B**




**CSA 803A**




## Procedure to Power-On

☐ **Step 1:** Set the following in the order listed:

Sampling Head
Not installed yet
Instrument Mainframe
ON/STANDBY switch . . . . . STANDBY

☐ **Step 2:** Install the SD-22 or SD-26 sampling head in the left plug-in compartment.

☐ **Step 3:** With the instrument's rear panel PRINCIPAL POWER SWITCH set to OFF, connect the instrument to a suitable power source.

☐ **Step 4:** Set the rear panel PRINCIPAL POWER SWITCH to ON and then the instrument's front panel ON/STANDBY switch to ON.

When the instrument is first installed, the rear panel PRINCIPAL POWER SWITCH should be set to and remain in the ON position. Then, use the front panel ON/STANDBY switch to perform all subsequent power switching.

☐ **Step 5:** Power-on the following test equipment, so that it is warmed up with the instrument to be tested:

- Calibration generator
- Calibration step generator
- Time mark generator
- Pulse generator

A complete list of test equipment is listed in Table 2-2.

- Allow a 20 minute warm up for the sampling head and test equipment before doing the performance checks.

# Part 2 Dot Transient Response

This part shows the setup and lists the procedures to check the dot transient response.The dot transient response is examined at 250 mV and 500 mV with automatic calibration settings, at 500 mV with default settings, and checked at 1 V with manual calibration settings.

## Measurement Limits

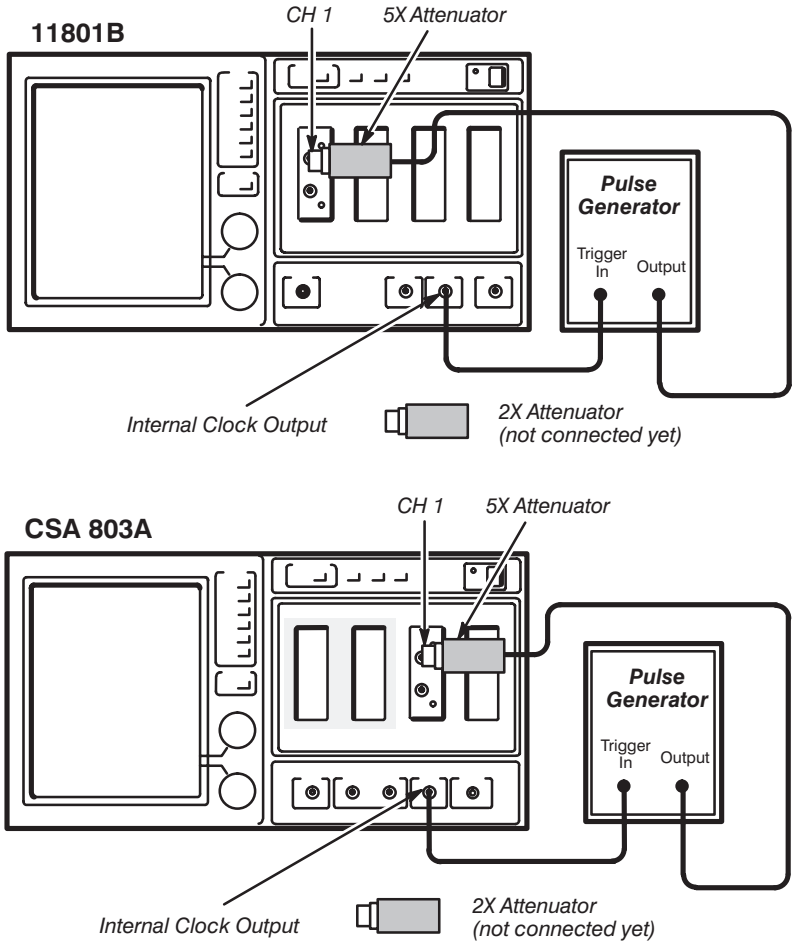
The measurement limits for the dot transient response error are:

- ≤5% error when measured at 250 mV and 500 mV with automatic calibration settings
- ±20% error when measured at 500 mV with default settings

## Specifications

The specification for the dot transient response at 1 V is that the amplitude is adjustable to 100%.

## Setup to Check Dot Transient Response




## Procedure to Check Dot Transient Response

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
- CH 1 SELECT CHANNEL On/Off . . . . . On

Instrument Mainframe
- **Vert Size: M1** . . . . . 50 mV/division
- TRIGGER button . . . . . press
  - **Source** . . . . . **Internal Clock**
- **Main Pos** . . . . . **Min**
- **Main Size** . . . . . 20 ns/division

Pulse Generator
- Back Terminator button . . . . . pull out
- Trigger Source . . . . . External Trigger
- Output . . . . . square wave

**Examine dot response at 250 mV with automatic calibration settings** — by performing Steps 2 through 32.

- ☐ **Step 2:** Set the pulse generator's amplitude for a 375 mV display.
- ☐ **Step 3:** Set the **Vert Offset : MI** so that the step is approximately centered on the screen.
- ☐ **Step 4:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).
- ☐ **Step 5:** Touch **Loop Gain**.
- ☐ **Step 6:** Touch **Automatic Calibrate,** and then **Proceed** in the **Loop Gain Calibration** pop-up menu.
- ☐ **Step 7:** Touch **Exit** in the **Loop Gain** Calibration pop-up menu.
- ☐ **Step 8:** Set the pulse generator's amplitude for a 250 mV step display.
- ☐ **Step 9:** Press the WAVEFORM button and then touch **Horizontal Desc**.
- ☐ **Step 10:** Touch **Main Record Length** in the **Horizontal Description** pop-up menu and then set the top knob for a **Main Record Length** of 512.
- ☐ **Step 11:** Press the UTILITY button and then **Instr Options**.
- ☐ **Step 12:** Set **Vectored Trace** to **Off** in the **Instrument Options** pop-up menu.
- ☐ **Step 13:** Touch **Display Intensity** in the **Instrument Options** pop-up menu, and then set the top knob for **90%** intensity.
- ☐ **Step 14:** Touch **Exit**.
- ☐ **Step 15:** Touch **Cursors** on the top of the screen.
- ☐ **Step 16:** Touch **Cursor Type** and then **Horizontal Bars** in the **Cursor Type** pop-up menu.
- ☐ **Step 17:** Touch **Exit.**
- ☐ **Step 18:** Set **Cursor 1** (top knob) to the average of the bottom of the pulse before the step.
- ☐ **Step 19:** Set **Cursor 2** (bottom knob) to the top of the step.
- ☐ **Step 20:** Read **ΔV** as the peak-to-peak step amplitude and then record this value as **V** for later use.
- ☐ **Step 21:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).
- ☐ **Step 22:** Touch **Loop Gain** and then the channel you are using in the **Loop Gain Calibration** pop-up menu.

☐ **Step 23:** Set the **Divide by Two Mode** to **On** in the **Loop Gain Calibration** pop-up menu.

☐ **Step 24:** Touch **Exit** in the **Loop Gain Calibration** pop-up menu.

☐ **Step 25:** Touch **Cursors** at the top of the screen.

☐ **Step 26:** Set **Cursor 1** to the average of the bottom of the pulse before the step.

☐ **Step 27:** Set **Cursor 2** to the average of the bottom of the pulse under the step.

☐ **Step 28:** Read **ΔV** and then record this value as $\mathbf{V_L}$ for later use.

☐ **Step 29:** Set **Cursor 2** to the average of the top of the pulse.

☐ **Step 30:** Read **ΔV** and then record this value as $\mathbf{V_H}$ for later use.

☐ **Step 31:** *Examine* that the negative dot response error $[(-\mathbf{V_L}/\mathbf{V_H}) \times 100\%]$ is $\pm 5\%$.

☐ **Step 32:** *Examine* that the positive dot response error $[100\% \times (\mathbf{V_H}-\mathbf{V})/(\mathbf{V}-\mathbf{V_L})]$ is $\leq 5\%$.

**Check dot response at 500 mV with automatic calibration settings** — by performing Steps 33 through 53.

☐ **Step 33:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).

☐ **Step 34:** Touch **Loop Gain**.

☐ **Step 35:** Set **Divide by Two Mode** to **Off** in the **Loop Gain Calibration** pop-up menu.

☐ **Step 36:** Touch **Exit**.

☐ **Step 37:** Set the **Vert Size:M1** to 100 mV/div.

☐ **Step 38:** Set the pulse generator's amplitude for a 500 mV step display.

☐ **Step 39:** Touch **Cursors** on the top of the screen.

☐ **Step 40:** Set **Cursor 1** to the average of the bottom of the pulse before the step.

☐ **Step 41:** Set **Cursor 2** to the average of the top of the pulse.

☐ **Step 42:** Read **ΔV** as the peak-to-peak step amplitude and then record this value as **V** for later use.

☐ **Step 43:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).

☐ **Step 44:** Touch **Loop Gain** and then the channel number you are using in the **Loop Gain Calibration** pop-up menu.

☐ **Step 45:** Set **Divide by Two Mode** to **On** in the **Loop Gain Calibration** pop-up menu.

☐ **Step 46:** Touch **Cursors** at the top of the screen.

☐ **Step 47:** Set **Cursor 1** to the average of the bottom of the pulse before the step.

☐ **Step 48:** Set **Cursor 2** to the average of the bottom of the pulse after the step.

☐ **Step 49:** Read the **ΔV** value and then record this value as $\mathbf{V_L}$ for later use.

☐ **Step 50:** Set **Cursor 2** to the average of the top of the pulse.

☐ **Step 51:** Read **ΔV**, and then record this value as $\mathbf{V_H}$ for later use.

☐ **Step 52:** *Examine* that the negative dot response error $[(-\mathbf{V_L}/\mathbf{V_H}) \times 100\%]$ is $\leq 5\%$.

☐ **Step 53:** *Examine* that the positive dot response error $[100\% \times (\mathbf{V_H} - \mathbf{V})/(\mathbf{V} - \mathbf{V_L})]$ is $\leq 5\%$.

**Check dot response at 500 mV with default settings** — by performing Steps 54 through 63.

☐ **Step 54:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).

☐ **Step 55:** Touch **Loop Gain**.

☐ **Step 56:** Touch **Recall Defaults** in the **Loop Gain Calibration** pop-up menu.

☐ **Step 57:** Touch **Exit**.

☐ **Step 58:** Touch **Cursors** at the top of the screen.

☐ **Step 59:** Set **Cursor 1** to the average of the bottom of the pulse before the step.

☐ **Step 60:** Set **Cursor 2** to the average of the bottom of the pulse after the step.

☐ **Step 61:** Read the **ΔV** value and then record this value as $\mathbf{V_L}$ for later use.

☐ **Step 62:** Set **Cursor 2** to the average of the top of the pulse and read **ΔV**. Record this value as $\mathbf{V_H}$.

☐ **Step 63:** *Examine* that the negative dot response error $[(-\mathbf{V_L}/\mathbf{V_H}) \times 100\%]$ is $\leq 20\%$.

**Check dot response at 1V with manual calibration settings** — by performing Steps 64 through 77.

- ☐ **Step 64:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).
- ☐ **Step 65:** Touch **Loop Gain**.
- ☐ **Step 66:** Set the **Divide by Two Mode** to **Off** in the **Loop Gain Calibration** pop-up menu.
- ☐ **Step 67:** Touch **Exit.**
- ☐ **Step 68:** Remove the 5× attenuator and then connect the 2× attenuator between the channel you are using and the coaxial cable.
- ☐ **Step 69:** Set the **Vert Size:M1** to 200 mV/div.
- ☐ **Step 70:** Set the pulse generator's amplitude for a 1 V ±2% step display.
- ☐ **Step 71:** Press the UTILITY button and touch **Enhanced Accuracy** (11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).
- ☐ **Step 72:** Touch **Loop Gain**.
- ☐ **Step 73:** Touch the channel number you are using in the **Loop Gain Calibration** pop-up menu.
- ☐ **Step 74:** Set the **Divide by Two Mode** to **On** and then touch **Manual Calibrate** in the **Loop Gain Calibration** pop-up menu.
- ☐ **Step 75:** Touch **Exit**.
- ☐ **Step 76:** *Check* that the amplitude of the pulse, measured from the average of the level under the pulse to the average of the top of the pulse, can be set with the manual calibration settings to be ≥1V.
- ☐ **Step 77:** Repeat Steps 2 through 76 for CH 2.

# Part 3 Offset

This part shows the setup and lists the procedure to examine offset and check offset with repetition rate.

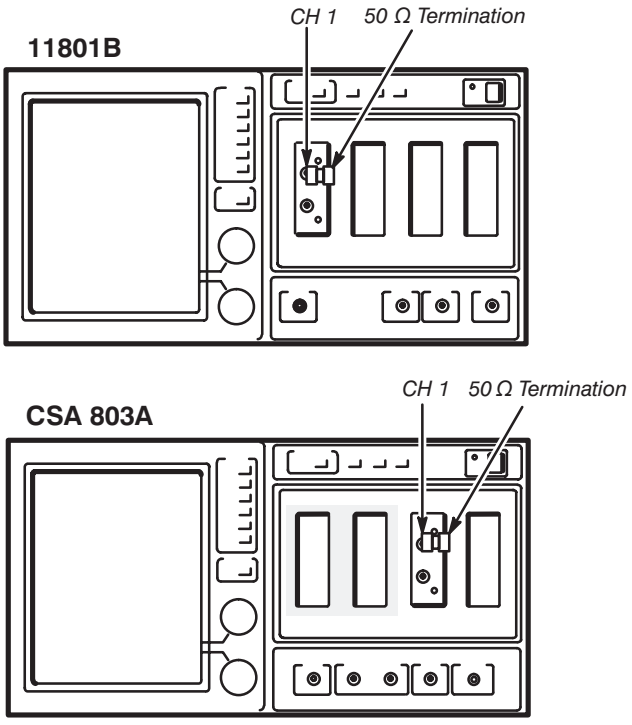
## Measurement Limits

The measurement limit for the offset is ±2 mV.

## Specifications

The specification for the offset change with repetition rate is ±5 mV.

## Setup to Examine Offset



## Procedure to Examine Offset

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
CH 1 SELECT CHANNEL On/Off . . . . . On
Instrument Mainframe
TRIGGER button . . . . . press
**Source** . . . . . **Internal Clock**
ENHANCED ACCURACY button (11801/2) . . . . . press
UTILITY button (11801A/B, CSA 803 Series) . . . . . press
**Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
**Calibrate All** pop-up menu . . . . . **Recall Defaults**

☐ **Step 2:** Touch **Offset Null** in the **Enhanced Accuracy** menu.

☐ **Step 3:** Touch **Manual Calibrate** in the **Offset Nulling** pop-up menu.

☐ **Step 4:** Touch the **Offset Null: M1** selector, **0**, and then **Enter** in the **Numeric Entry & Knob Res** pop-up menu.

☐ **Step 5:** Touch the vertical icon and then set **Vert Size: M1** to 50mV/div.

☐ **Step 6:** Press the MEASURE button.

☐ **Step 7:** Touch **Measurements** and then **Mean** in the **Measurements** pop-up menu.

☐ **Step 8:** Touch **Mean** in the MEASURE major menu and then set **Data Interval** to **whole zone** in the **Mean** pop-up menu.

☐ **Step 9:** *Check* that **Mean** is 0 V ±200 mV.

☐ **Step 10:** Press the UTILITY button and t(ouch **Enhanced Accuracy** 11801A/B and CSA 803 Series) or press the ENHANCED ACCURACY button (11801/2).

☐ **Step 11:** Touch **Offset Null**.

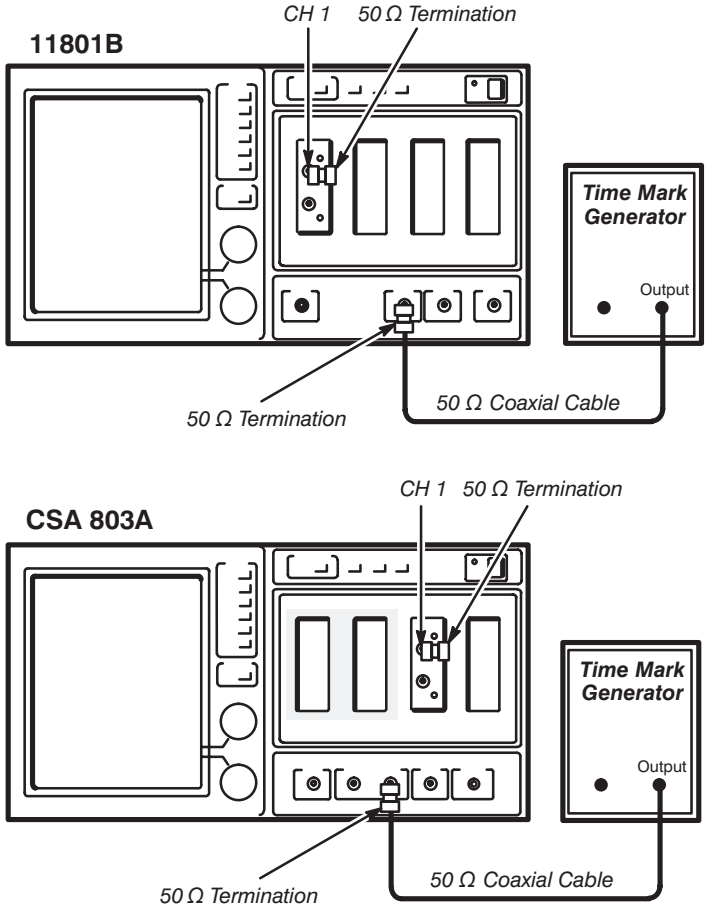
☐ **Step 12:** Touch **Automatic Calibrate** and then **Proceed** in the **Offset Nulling** pop-up menu.

☐ **Step 13:** Press the MEASURE button.

☐ **Step 14:** *Examine* that the **Mean** (offset) is 0 V ±2 mV.

☐ **Step 15:** Repeat Steps 2 through 14 for CH 2.

## Setup to Check Offset Change with Repetition Rate




## Procedure to Check Offset Change with Repetition Rate

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
- CH 1 SELECT CHANNEL On/Off . . . . . On

Instrument Mainframe
- ENHANCED ACCURACY button (11801/2) . . . . . press
- UTILITY button (11801A/B, CSA 803 Series) . . . . . press
  - **Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
  - **Calibrate All** pop-up menu . . . . . **Recall Defaults**

Time Mark Generator
- Marker (sec) . . . . . 0.2 µs

☐ **Step 2:** Press the TRIGGER button and then touch **Level**.

☐ **Step 3:** Adjust the **Trig Level** until a trace appears.

- ☐ **Step 4:** Touch the vertical ( ↕ ) icon and then set the **Vert Size: M1** to 2 mV/div.
- ☐ **Step 5:** Set **Vert Offset: M1** so that the trace is vertically centered on the screen.
- ☐ **Step 6:** Set the time mark generator's marker setting to 10 ms.
- ☐ **Step 7:** Press the WAVEFORM button and then touch **Acquire Desc**.
- ☐ **Step 8:** Set **Average N** to **On** and then touch **Set Avg N**.
- ☐ **Step 9:** Set **Average N** to **8** with the top knob.
- ☐ **Step 10:** Wait until the **Acquire Desc** selector in the WAVEFORM major menu shows that eight averages have been completed.
- ☐ **Step 11:** Press the MEASURE button.
- ☐ **Step 12:** Touch **Measurements** and then **Mean** in the **Measurements** pop-up menu.
- ☐ **Step 13:** Touch **Compare & References** in the MEASURE major menu.
- ☐ **Step 14:** Touch **Save Current Meas Values as References** and then set **Compare** to **On**.
- ☐ **Step 15:** Set the time mark generator's marker setting to 5 ms.
- ☐ **Step 16:** Wait until the **Acquire Desc** selector in the WAVEFORM major menu shows that eight averages have been completed.
- ☐ **Step 17:** *Check* that **ΔMean** (offset with a repetition rate) is 0 V ±5 mV.
- ☐ **Step 18:** Continue to decrease the time mark generator's marker setting and repeat Step 17 for each setting down to 0.1 µs.
- ☐ **Step 19:** Press the CH 2 SELECT CHANNEL button.
- ☐ **Step 20:** Disconnect the 50 Ω termination from the CH 1 input and connect it to the CH 2 input.
- ☐ **Step 21:** Repeat Steps 4 through 18 for CH 2.

# Part 4 Noise

This part shows the setup and lists the procedures to check noise from the sampling head.

## Measurement Limits SD-22

The measurement limits for noise is 800 $\mu V_{RMS}$ without smoothing and 400 $\mu V_{RMS}$ with smoothing.

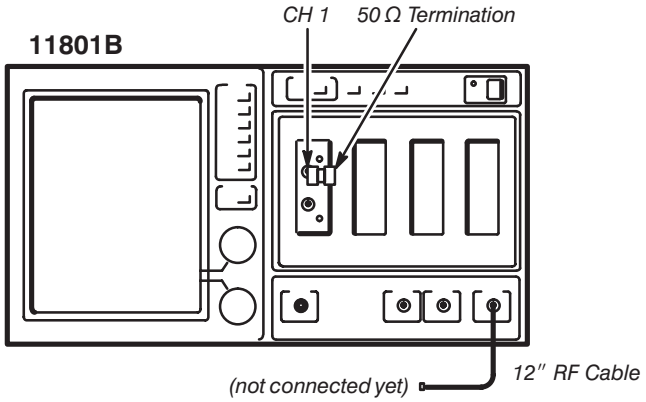
## Measurement Limits SD-26 (SN B020440 and above)

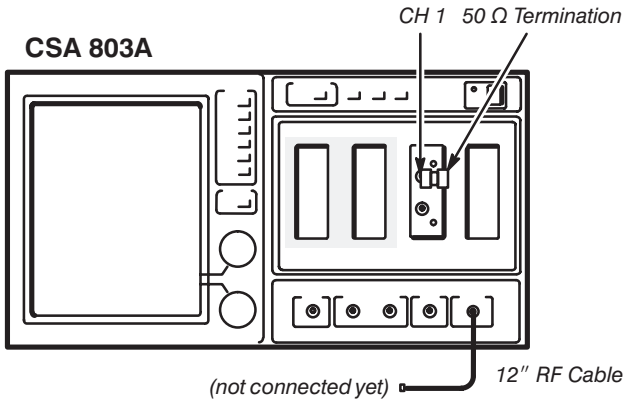
The measurement limit for noise is 1.2 $mV_{RMS}$ without smoothing and 550 $\mu V_{RMS}$ with smoothing.

## Measurement Limits SD-26 (SN B010339 and below)

The measurement limit for noise is 2.0 $mV_{RMS}$ without smoothing and 900 $\mu V_{RMS}$ with smoothing.

## Setup to Examine Noise



## Procedure to Examine Noise

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
CH 1 SELECT CHANNEL On/Off . . . . . On
Instrument Mainframe
TRIGGER button . . . . . press
**Source** . . . . . **Internal Clock**
ENHANCED ACCURACY button (11801/2) . . . . . press
UTILITY button (11801A/B, CSA 803 Series) . . . . . press
**Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
**Calibrate All** pop-up menu . . . . . **Recall Defaults**

☐ **Step 2:** Touch **Loop Gain** in the **Enhanced Accuracy** menu.

☐ **Step 3:** Disconnect the 50 Ω termination from the CH 1 input and connect the CALIBRATOR to the CH 1 input through the 12-inch RF cable.

☐ **Step 4:** Touch the channel number you are using, **Automatic Calibrate,** and then **Proceed** in the **Loop Gain Calibration** pop-up menu.

☐ **Step 5:** Disconnect the CALIBRATOR from the CH 1 input and reconnect the 50 Ω termination.

☐ **Step 6:** Press the WAVEFORM button and then touch **Acquire Desc.**

☐ **Step 7:** Set **Average N** to **On**.

☐ **Step 8:** Press the AUTOSET button.

☐ **Step 9:** Touch the vertical ( ) icon. Set the **Vert Size: M1** to 2 mV/div.

☐ **Step 10:** Touch **Def Tra** at the top of the screen.

☐ **Step 11:** In the **Vertical Description** pop-up menu, touch the following selectors in the order given:

**Mainframe** (11801 Series), **1**, **–**, **Avg (**, **Mainframe** (11801Series), **1**, **)**, **Enter Desc**

☐ **Step 12:** Press the MEASURE button and then touch **Measurements**.

☐ **Step 13:** Touch **RMS** in the **Measurements** pop-up menu and then **RMS** in the MEASURE major menu.

☐ **Step 14:** Set **Data Interval** to **whole zone** in the **RMS** pop-up menu.

☐ **Step 15:** *Examine* that **RMS** is $\leq$800 $\mu V_{RMS}$ for the SD-22 Sampling Head.

*Examine* that **RMS** is $\leq$1.2 $mV_{RMS}$ for the SD-26 Sampling Head (SN B020440 and above).

*Examine* that **RMS** is $\leq$2 $mV_{RMS}$ for the SD-26 Sampling Head (SN B010339 & below).

☐ **Step 16:** Press the WAVEFORM button.

☐ **Step 17:** Touch **Sampling Head Fnc's** and then set **Smoothing** to **On** in the **Sampling Head Functions** pop-up menu.

☐ **Step 18:** Press the MEASURE button.

☐ **Step 19:** *Examine* that **RMS** is $\leq$400 $\mu V_{RMS}$ for the SD-22 Sampling Head.

*Examine* that **RMS** is $\leq$550 $\mu V_{RMS}$ for the SD-26 Sampling Head (SN B020440 and above).

*Examine* that **RMS** is $\leq$900 $\mu V_{RMS}$ for the SD-26 Sampling Head (SN B010339 & below).

☐ **Step 20:** Repeat Steps 2 through 19 for CH 2.

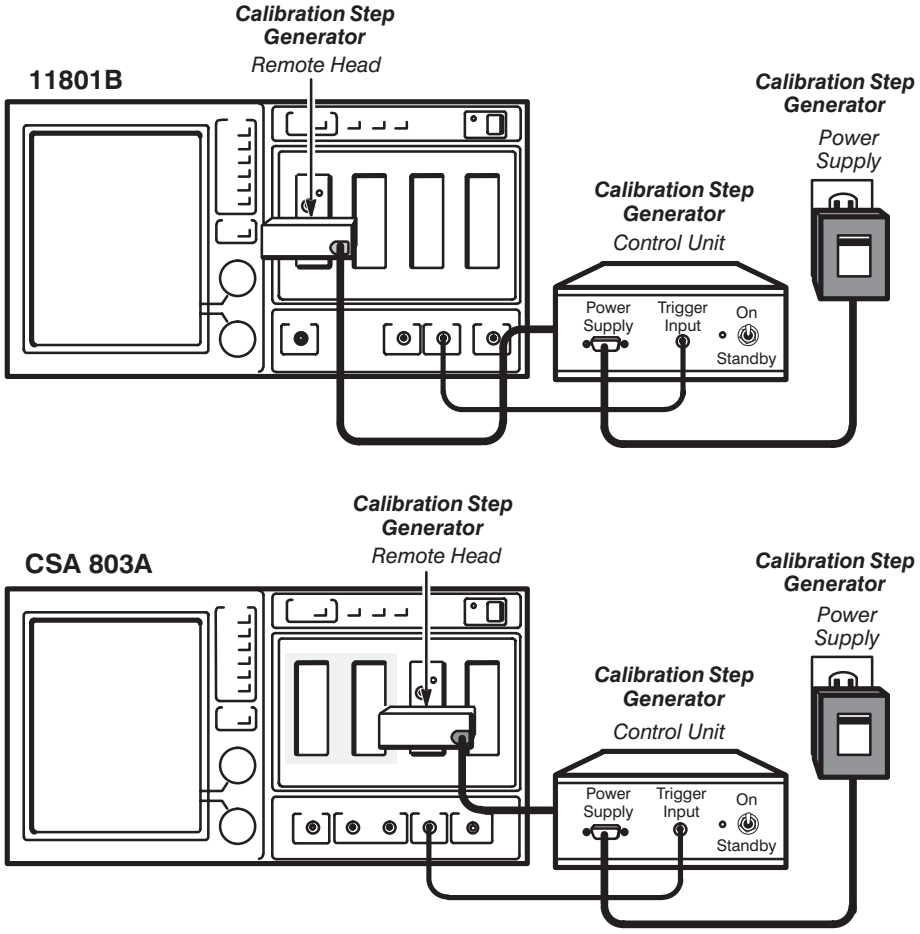
# Part 5
# Rise Time

This part shows the setup and lists the procedure to check the rise time.

## Specifications

The specification for the SD-22 Sampling Head rise time is 28 ps. The specification for the SD-26 Sampling Head rise time is 17.5 ps.

## Setup to Check Rise Time



## Procedure to Check Rise Time

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
CH 1 SELECT CHANNEL On/Off . . . . . On
Instrument Mainframe
ENHANCED ACCURACY button (11801/2) . . . . . press
UTILITY button (11801A/B, CSA 803 Series) . . . . . press
**Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
**Calibrate All** pop-up menu . . . . . **Recall Defaults**
TRIGGER button . . . . . press
**Source** . . . . . **Internal Clock**
Calibration step generator
ON/STANDBY switch . . . . . ON

☐ **Step 2:** Press the AUTOSET button.

☐ **Step 3:** Press the WAVEFORM button and then touch **Horizontal Desc**.

☐ **Step 4:** Touch **Main Record Length** and then set **Main Record Len** to 5120 with the top knob.

☐ **Step 5:** Touch **Acquire Desc** in the WAVEFORM major menu.

☐ **Step 6:** Set **Average N** to **On** and then touch **Set Avg N**.

☐ **Step 7:** Set **Average N** to 128 with the top knob.

☐ **Step 8:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 100 ns/div.

☐ **Step 9:** Touch **Main Pos** and then **Set to Min** in the **Numeric Entry & Knob Res** pop-up menu.

☐ **Step 10:** Press the MEASURE button.

☐ **Step 11:** Touch **Measurements** and then **Rise** in the **Measurements** pop-up menu.

☐ **Step 12:** Touch **Rise** in the MEASURE major menu and then set **Tracking** to **Off** in the **Rise** pop-up menu.

☐ **Step 13:** Set the **Main Size** to 5 ns/div.

☐ **Step 14:** Touch **Baseline** in the **Rise** pop-up menu.

☐ **Step 15:** Touch a blank portion of the screen to exit this menu.

☐ **Step 16:** Set the **Baseline** (bottom knob) to the average of the bottom of the pulse 10 ns before the step.

☐ **Step 17:** Touch the horizontal ( ↔ ) icon and then set the **Main Pos** so that the step is at the left-most edge of the screen.

☐ **Step 18:** Set the **Main Size** to 20 ps/div.

☐ **Step 19:** Set the **Main Pos** so that the step is approximately centered on the screen.

☐ **Step 20:** Touch **Rise** in the MEASURE major menu.

☐ **Step 21:** Record the **Mean**: value in the **Rise** pop-up menu for later use.

☐ **Step 22:** Calculate the sampling head rise time with the following formula:

$$\textit{sampling head rise time} = \sqrt{(\textbf{\textit{Mean}} : \textit{value})^2 - (\textit{Calibration Step Generator rise})^2}$$

***NOTE***

*Calibration Step Generation rise is read from the calibration step generator.*

☐ **Step 23:** *Check* that the SD-22 Sampling Head rise time is $\leq$28 ps or that the SD-26 Sampling Head rise time is $\leq$17.5 ps.

☐ **Step 24:** Repeat Steps 2 through 23 for CH 2 .

# Part 6 Acquisition Aberrations

This part shows the setup and lists the procedure to check acquisition aberrations.

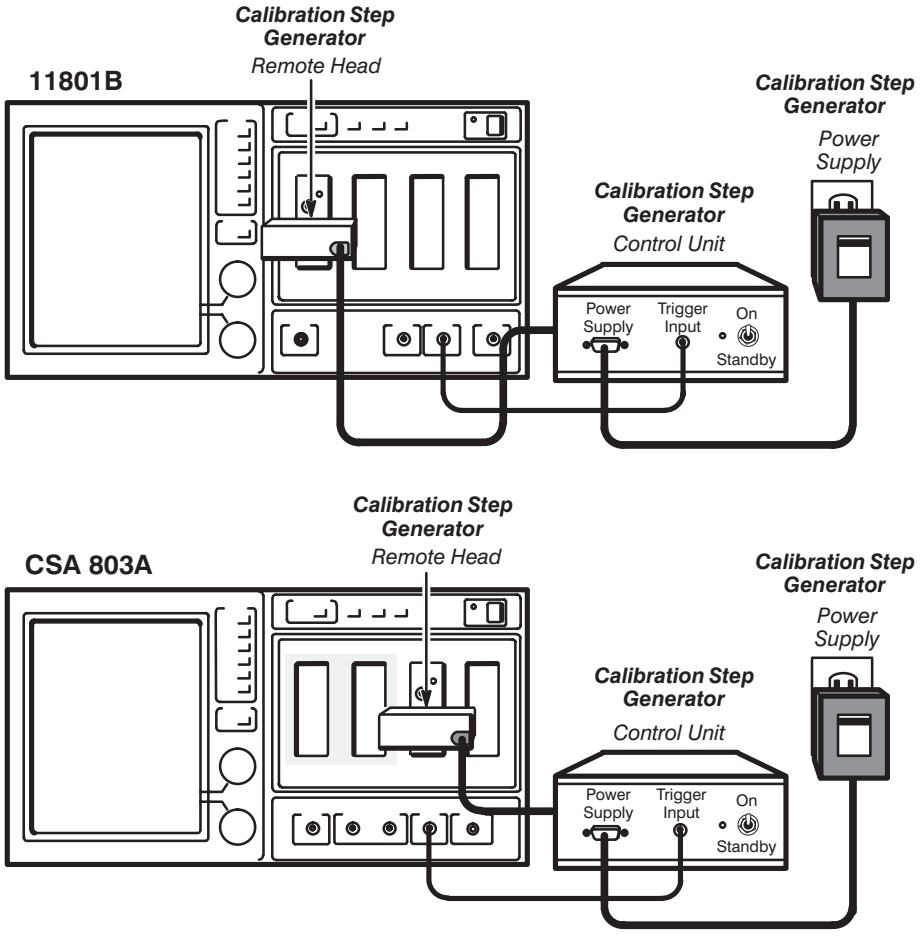
## Measurement Limits

The measurement limits for acquisition aberrations are listed in Table 2-3, Aberration Specifications.

**Table 2-3: Aberration Specifications**

| Time Difference from the Rising Edge of Waveform | Minimum Specification |
|---|---|
| 0 to 300 ps | −7% ≤ aberration % ≤12% |
| 300 ps to 5 ns | −4% ≤ aberration % ≤4% |
| 5 ns to 100 ns | −1.2% ≤ aberration % ≤1.2% |
| 100 ns and up | −0.6% ≤ aberration % ≤0.6% |
| −10 ns to −20 ps | −4% ≤ aberration % ≤4% |

## Setup to Examine Acquisition Aberrations




## Procedure to Examine Acquisition Aberrations

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
- CH1 SELECT CHANNEL On/Off . . . . . On

Instrument Mainframe
- ENHANCED ACCURACY button (11801/2) . . . . . press
- UTILITY button (11801A/B, CSA 803 Series) . . . . . press
  - **Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
  - **Calibrate All** pop-up menu . . . . . **Recall Defaults**
- TRIGGER button . . . . . press
  - **Source** . . . . . **Internal Clock**

Calibration Step Generator
- ON/STANDBY switch . . . . . ON

- ☐ **Step 2:** Press the WAVEFORM button and then touch **Acquire Desc**.
- ☐ **Step 3:** Set **Average N** to **On** and then touch **Set Avg N**.
- ☐ **Step 4:** Set **Average N** to 128 with the top knob.
- ☐ **Step 5:** Press the AUTOSET button.
- ☐ **Step 6:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 100 ns/div.
- ☐ **Step 7:** Set the **Main Pos** so that the rising edge of the step is at the left-most edge of the screen.
- ☐ **Step 8:** Touch the vertical ( ↕ ) icon and then set the **Vert Offset:M1** so that the average of the top of the pulse between 100 ns after the step and the right edge of the screen is at the horizontal centerline.
- ☐ **Step 9:** Set the **Vert Size: M1** to 2 mV/div.
- ☐ **Step 10:** Touch **Vert Offset: M1** and then **Fine** in the **Numeric Entry & Knob Res** pop-up menu.
- ☐ **Step 11:** Set **Vert Offset: M1** so that the average of the top of the pulse between 100 ns after the step and the right edge of the screen is at the horizontal centerline.
- ☐ **Step 12:** *Examine* that the magnitude of the maximum positive and negative aberrations that occur 100 ns after the step is $\leq$0.75 vertical divisions from the horizontal centerline (0.6% of the step amplitude).
- ☐ **Step 13:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 10 ns/div.
- ☐ **Step 14:** Set the **Main Pos** so that the rising edge of the step is at the left-most edge of the screen.
- ☐ **Step 15:** *Examine* that the magnitude of the maximum positive and negative aberrations that occur between 5 ns and 100 ns after the step is $\leq$1.5 vertical divisions from the horizontal centerline (1.2% of the step amplitude).
- ☐ **Step 16:** Set the **Main Size** to 500 ps/div and then the **Main Pos** so that the rising edge of the step is at the left-most edge of the screen.
- ☐ **Step 17:** *Examine* that the magnitude of the maximum positive and negative aberrations that occur between 300 ps and 5 ns after the step is $\leq$5.0 vertical divisions from the horizontal centerline (4.0% of the step amplitude).
- ☐ **Step 18:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 500 ns/div.
- ☐ **Step 19:** Touch the vertical ( ↕ ) icon and then set the **Vert Size:M1** to 10 mV/div.

☐ **Step 20:** Set the **Vert Offset:M1** so that the average of the top of the pulse between 100 ns after the step and the right edge of the screen is at the horizontal centerline.

☐ **Step 21:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 50 ps.

☐ **Step 22:** Set the **Main Pos** so that the rising edge of the step is at the left-most edge of the screen.

☐ **Step 23:** *Examine* that the magnitude of the maximum positive aberration that occurs in the first 300 ps after the step is ≤3.0 vertical divisions from the horizontal centerline (12% of the step amplitude).

☐ **Step 24:** *Examine* that the magnitude of the maximum negative aberration that occurs in the first 300 ps after the step is ≤1.75 vertical divisions from the horizontal centerline (7% of the step amplitude).

☐ **Step 25:** Touch the **Main Pos** selector and then **Set to Min** in the **Numeric Entry and Knob Res** pop-up menu.

☐ **Step 26:** Set the **Main Size** to 10 ns/div.

☐ **Step 27:** Touch the vertical ( ↕ ) icon and then set **Vert Offset:M1** so that the average of the bottom of the pulse 10 ns before the step is at the horizontal centerline.

☐ **Step 28:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 1 ns/div.

☐ **Step 29:** Set the **Main Pos** so that the rising edge of the step is at the right-most edge of the screen.

☐ **Step 30:** *Examine* that the magnitude of the maximum positive and negative aberrations that occur between 10 ns and 500 ps before the 10% point of the step is ≤1.0 vertical divisions from the horizontal centerline (4% of the step amplitude).

☐ **Step 31:** Set the **Main Size** to 50 ps/div and then the **Main Pos** so that the rising edge of the step is at the right-most edge of the screen.

☐ **Step 32:** *Examine* that the magnitude of the maximum positive and negative aberrations that occur between 500 ps and 20 ps before the 10% point of the step is ≤1.0 vertical divisions from the horizontal centerline (4% of the step amplitude).

☐ **Step 33:** Repeat Steps 2 through 32 for CH 2.

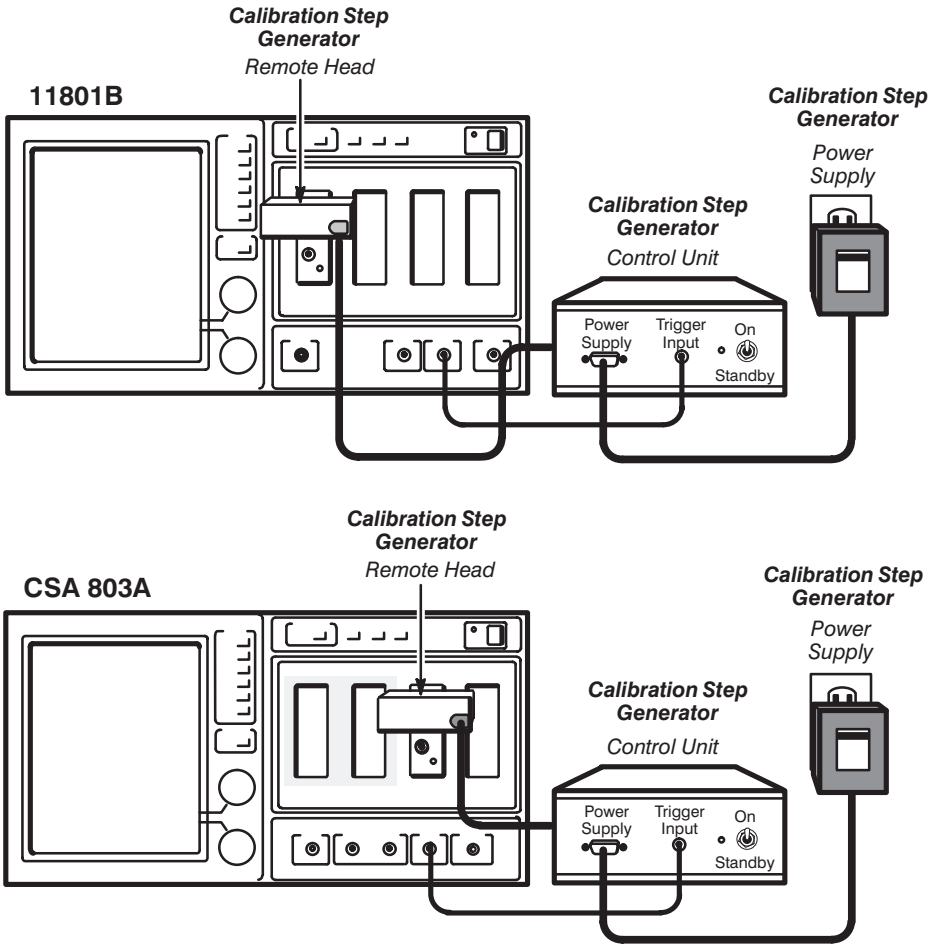
# Part 7 Coincidence Between Channels

This part shows the setup and lists the procedures to check the coincidence between channels.

## Specifications

The specification for the coincidence between channels is 10 ps.

## Setup to Check Coincidence Between Channels



## Procedure to Check Coincidence Between Channels

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
- CH 1 SELECT CHANNEL On/Off . . . . . On

Instrument Mainframe
- ENHANCED ACCURACY button (11801/2) . . . . . press
- UTILITY button (11801A/B, CSA 803 Series) . . . . . press
  - **Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
  - **Calibrate All** pop-up menu . . . . . **Recall Defaults**
- TRIGGER button . . . . . press
  - **Source** . . . . . **Internal Clock**

Calibration Step Generator
- ON/STANDBY switch . . . . . ON

☐ **Step 2:** Press the AUTOSET button.

☐ **Step 3:** Press the WAVEFORM button and then touch **Horizontal Desc**.

☐ **Step 4:** Touch **Main Record Length** and then set **Main Record Len** to 1024 with the top knob.

☐ **Step 5:** Touch **Acquire Desc** in the WAVEFORM major menu.

☐ **Step 6:** Set **Average N** to **On** and then touch **Set Avg N**.

☐ **Step 7:** Set **Average N** to 64 with the top knob.

☐ **Step 8:** Disconnect the calibration step generator remote head from CH 1, connect it to CH 2, and then press the CH 2 SELECT CHANNEL On/Off button.

☐ **Step 9:** Press AUTOSET.

☐ **Step 10:** Select the horizontal ( ↔ ) icon and then set the **Main Size** to 10 ps/div.

☐ **Step 11:** Touch **Acquire Desc** and then set **Average N** to **On** in the **Acquire Description** pop-up menu.

☐ **Step 12:** Touch **Exit**.

☐ **Step 13:** Set the **Main Pos** so that the step is approximately centered on the screen.

☐ **Step 14:** Press the STORE/RECALL button.

☐ **Step 15:** Touch **Trace 2** in the **Store Trace** pop-up menu.

☐ **Step 16:** Touch **Recall Trace** in the STORE/RECALL major menu.

☐ **Step 17:** Touch **STO 1** in the **Recall Stored Trace** pop-up menu.

☐ **Step 18:** Disconnect the calibration step generator remote head from CH 2, connect it to CH 1, and then press the CH 1 SELECT CHANNEL On/Off button.

☐ **Step 19:** Press the MEASURE button.

☐ **Step 20:** Touch **Measurements** and then **Prop Delay** in the **Measurements** pop-up menu.

☐ **Step 21:** Touch **Prop Delay** in the MEASURE major menu and then **Trace 3** in the **Prop Delay** pop-up menu.

☐ **Step 22:** *Check* that the magnitude of the **Prop Delay** is $\leq$10 ps.

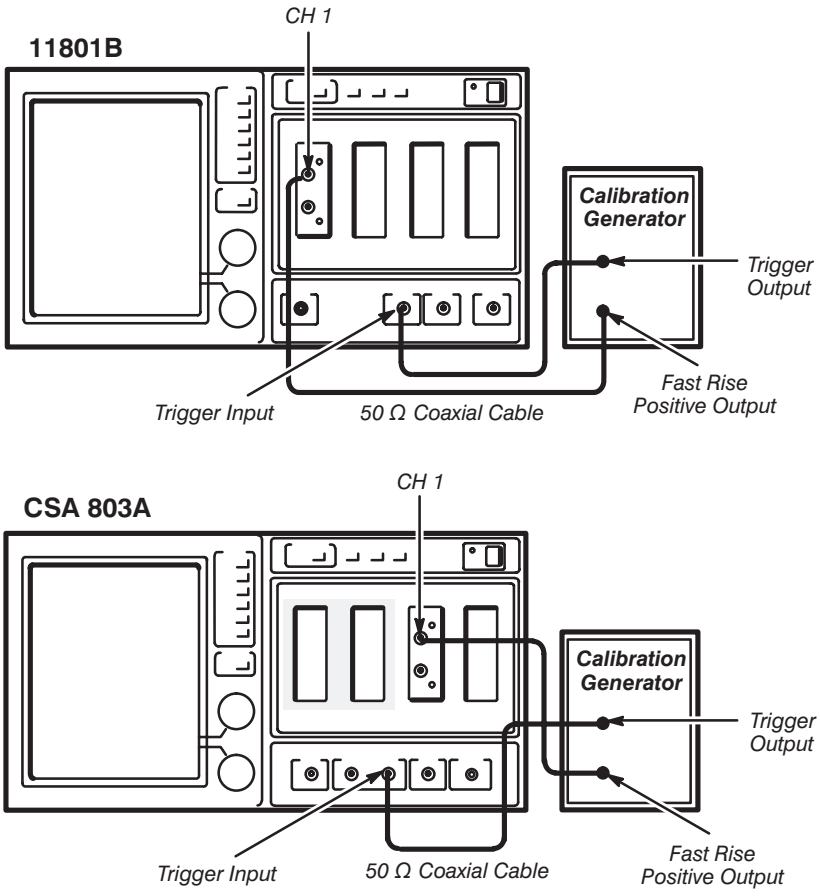
# Part 8 Maximum Signal Voltage

This part shows the setup and lists the procedure to examine the maximum signal voltage.

## Measurement Limit

The measurement limit for the maximum signal voltage is 1% of the step amplitude.

## Setup to Examine Maximum Signal Voltage



## Procedure to Examine Maximum Signal Voltage

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
- CH 1 SELECT CHANNEL On/Off . . . . . On

Instrument Mainframe
- ENHANCED ACCURACY button (11801/2) . . . . . press
- UTILITY button (11801A/B, CSA 803 Series) . . . . . press
  - **Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
  - **Calibrate All** pop-up menu . . . . . **Recall Defaults**
- TRIGGER button . . . . . press
  - **Slope** . . . . . –
- **Main Size** . . . . . 5 µs/div

Calibration Generator
- Amplitude . . . . . maximum amplitude
- Period . . . . . 10 µs
- Variable adjustment . . . . . mid range

☐ **Step 2:** Touch the vertical ( ↕ ) icon and then set the **Vert Offset: M1** so that the waveform is vertically centered on the screen.

☐ **Step 3:** Set the calibration generator's amplitude so that it displays a 1 V peak-to-peak square wave.

☐ **Step 4:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 500 ns/div.

☐ **Step 5:** Set the **Main Pos** so that the positive-going step is within 1/2-division to the right of the left-most edge of the screen.

☐ **Step 6:** Press the WAVEFORM button.

☐ **Step 7:** Touch **Acquire Desc** and then set **Average N** to **On** in the **Acquire Description** pop-up menu.

☐ **Step 8:** Touch **Set Avg N** and then set **Average N** to 128 with the top knob.

☐ **Step 9:** Touch the vertical ( ↕ ) icon and then set the **Vert Offset: M1** so that the average of the top of the pulse 500 ns after the step is on the horizontal centerline.

☐ **Step 10:** Set **Vert Size:M1** to 5 mV/div.

☐ **Step 11:** Touch **Vert Offset: M1** and then **Fine** in the **Numeric Entry & Knob Res** pop-up menu.

☐ **Step 12:** Set **Vert Offset: M1** so that the average of the top of the pulse 500 ns after the step is on the horizontal centerline.

☐ **Step 13:** Set the **Main Size** to 200 ns/div.

☐ **Step 14:** *Examine* that the magnitude of the maximum positive and negative aberrations that occur between 200 ns and 800 ns from the rising edge of the step is ≤2 vertical divisions from the horizontal centerline (1% of the step amplitude).

☐ **Step 15:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 20 ns/div.

☐ **Step 16:** Set the **Main Pos** so that the step is within 1/2-division of the left-most edge of the screen.

☐ **Step 17:** *Examine* that the magnitude of the maximum positive and negative aberrations between 10 ns and 200 ns from the rising edge of the step is ≤2 vertical divisions from the horizontal centerline (1% of the step amplitude).

☐ **Step 18:** Repeat all of Part 8 for CH 2.

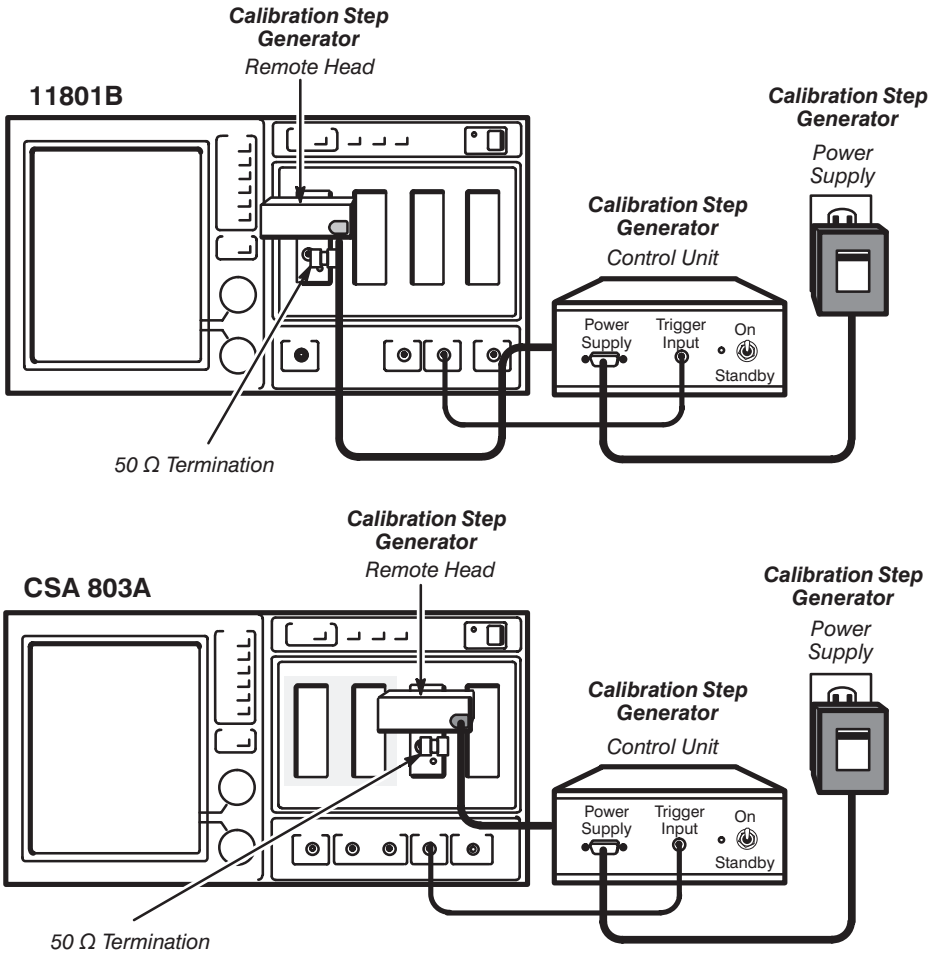
# Part 9 Isolation Between Channels

This part shows the setup and lists the procedures to check the isolation between channels.

## Specifications

The measurement limit for the isolation between channels is 1%.

## Setup to Check Isolation Between Channels



## Procedure to Check Isolation Between Channels

☐ **Step 1:** Initialize the instrument settings, then make the following settings in the order listed:

Sampling Head
- CH 1 SELECT CHANNEL On/Off . . . . . On

Instrument Mainframe
- ENHANCED ACCURACY button (11801/2) . . . . . press
- UTILITY button (11801A/B, CSA 803 Series) . . . . . press
  - **Enhanced Accuracy** (11801A/B, CSA 803 Series) . . . . touch
  - **Calibrate All** pop-up menu . . . . . **Recall Defaults**
- TRIGGER button . . . . . press
  - **Source** . . . . . **Internal Clock**

Calibration Step Generator
- ON/STANDBY Switch . . . . . ON

☐ **Step 2:** Press the AUTOSET button.

☐ **Step 3:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 200 ps/div.

☐ **Step 4:** Press the WAVEFORM button and then touch **Horizontal Desc**.

☐ **Step 5:** Touch **Main Record Length** and then set **Main Record Len** to 1024 with the top knob.

☐ **Step 6:** Touch **Acquire Desc** in the WAVEFORM major menu.

☐ **Step 7:** Set **Average N** to **On** and then touch **Set Avg N** in the **Acquire Description** pop-up menu.

☐ **Step 8:** Set **Average N** to 1024 with the top knob.

☐ **Step 9:** Press the CH 2 SELECT CHANNEL button on the sampling head.

☐ **Step 10:** Touch the vertical ( ↕ ) icon and then set the **Vert Size: M2** to 2 mV/div.

☐ **Step 11:** Touch **Acquire Desc** in the WAVEFORM major menu and then set **Avg N** to **On**.

☐ **Step 12:** Wait until the **Acquire Desc** selector in the WAVEFORM major menu shows that 1024 averages have been completed.

☐ **Step 13:** Touch the MEASURE button.

☐ **Step 14:** Touch **Measurements** and then **Peak-Peak** in the **Measurements** pop-up menu.

☐ **Step 15:** Record the CH 2 **Peak-Peak** measurement for later use.

☐ **Step 16:** Press the CH 1 SELECT CHANNEL button.

- ☐ **Step 17:** Touch **Measurements** and then **Peak-Peak** in the **Measurements** pop-up menu.
- ☐ **Step 18:** Record the CH 1 **Peak-Peak** measurement for later use.
- ☐ **Step 19:** *Check* that (CH 2 **Peak-Peak**/CH 1 **Peak-Peak**) $\times$ 100% $\leq$1%.
- ☐ **Step 20:** Disconnect the calibration step generator remote head from CH 1 and the 50 Ω termination from CH 2. Connect the calibration step generator to CH 2, connect the 50 Ω termination to CH 1, and then press the CH 2 SELECT CHANNEL On/Off button.
- ☐ **Step 21:** Press the AUTOSET button.
- ☐ **Step 22:** Touch the horizontal ( ↔ ) icon and then set the **Main Size** to 200 ps/div.
- ☐ **Step 23:** Press the CH 1 SELECT CHANNEL button.
- ☐ **Step 24:** Press the AUTOSET button.
- ☐ **Step 25:** Press the WAVEFORM button.
- ☐ **Step 26:** Wait until the **Acquire Desc** selector in the WAVEFORM major menu shows that 1024 averages have been completed.
- ☐ **Step 27:** Press the MEASURE button.
- ☐ **Step 28:** Record the CH 1 **Peak-Peak** measurement for later use.
- ☐ **Step 29:** Press the CH 2 SELECT CHANNEL button.
- ☐ **Step 30:** Record the CH 2 **Peak-Peak** measurement for later use.
- ☐ **Step 31:** *Check* that (CH 1 **Peak-Peak**/CH 2 **Peak-Peak**) $\times$ 100% $\leq$1%.

# Maintenance

# Maintenance

This section contains information for performing preventive maintenance and procedures for exchanging faulty sampling heads, removing and replacing sampling head internal circuitry, and changing the sampling head identification number.

## Preventive Maintenance

Preventive maintenance performed regularly can prevent breakdown and may improve reliability of the instrument or sampling head. The severity of the environment to which the sampling head is subjected determines the frequency of maintenance.

### Periodic Electrical Checks

To ensure accurate measurements, perform periodic electrical checks on the instrument and sampling head after each 2,000 hours of operation or every 24 months, if used infrequently. Procedures to perform periodic electrical checks are given in Section 2, *Checks and Adjustments*.

### Static-Sensitive Device Classification


*Static discharge can damage any semiconductor component in the instrument or sampling head. To prevent damage to the instrument or sampling head from electrostatic discharge, follow all precautions listed in this section.*

The instrument and sampling head contain electrical components that are susceptible to damage from static discharge. Table 3-1 gives relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

- ☐ **Step 1:** Minimize handling of static-sensitive components.
- ☐ **Step 2:** Transport the sampling heads in their original containers and store the sampling heads on a metal surface or conductive foam. Transport the sampling heads with short-circuit terminations on the inputs. Label any package that contains static-sensitive assemblies or components.

- ☐ **Step 3:** Discharge the static voltage from your body by wearing a wrist strap while handling these components. Service of static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel. Use a static control mat and wrist strap.
- ☐ **Step 4:** Clear the work station surface of anything that can generate or hold a static charge.
- ☐ **Step 5:** Keep the component leads shorted together whenever possible.
- ☐ **Step 6:** Pick up components by the body, never by the leads.
- ☐ **Step 7:** Do not slide the components over any surface.
- ☐ **Step 8:** Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.

**Table 3-1: Relative Susceptibility to Electrostatic Discharge (ESD)**

| Semiconductor Classes | Relative Susceptibility Levels[1] |
|---|---|
| MOS or CMOS microcircuits or discrete circuits, or linear microcircuits with MOS inputs (most sensitive) | 1 |
| ECL | 2 |
| Schottky signal diodes | 3 |
| Schottky TTL | 4 |
| High-frequency bipolar transistors | 5 |
| JFET | 6 |
| Linear microcircuits | 7 |
| Low-power Schottky TTL | 8 |
| TTL (least sensitive) | 9 |

**[1]Voltage equivalent for levels (voltage discharged from a 100 pF capacitor through resistance of 100 Ω):**

**1 = 100 to 500 V**
**2 = 200 to 500 V**
**3 = 250 V**
**4 = 500 V**
**5 = 400 to 600 V**
**6 = 600 to 800 V**
**7 = 400 to 1000 V (est.)**
**8 = 900 V**
**9 = 1200 V**

## Exchanging Sampling Heads

If a sampling head fails any of the procedures in Section 2, *Checks and Adjustments*, then it can be exchanged for a new sampling head.

Sampling head exchanges can be made with either your local Tektronix service center or the Central Tektronix Exchange Center in Beaverton, Oregon.

For more information on exchanging your sampling head, refer to Module Exchange in Section 5, *Replaceable Parts*.

## Removing and Replacing the Sampling Head Internal Circuitry

**CAUTION**

*To avoid damage to the sampling head, set the instrument ON/STANDBY switch to STANDBY and remove the sampling head from the instrument before removing or replacing the internal circuitry.*

Perform the following procedures to remove and replace the internal circuitry in the sampling head. See Figure 3-1.

- ☐ **Step 1:** Remove the SELECT CHANNEL On/Off button by gently pulling on the plastic knob with small needle-nose pliers.
- ☐ **Step 2:** Remove the three small Pozidrive screws on each side of the sampling head casing (see Figure 3-1).
- ☐ **Step 3:** Remove the short-circuit terminations, the front panel, and the casing from the internal circuitry.
- ☐ **Step 4:** Install the internal circuitry into the gray shipping casing.
- ☐ **Step 5:** Replace the short-circuit terminations on the sampling head inputs.
- ☐ **Step 6:** Return the internal circuitry (the circuit board and attached carrier) for sampling head exchange or repair.
- ☐ **Step 7:** To replace the internal circuitry, follow the removal procedures in reverse order.

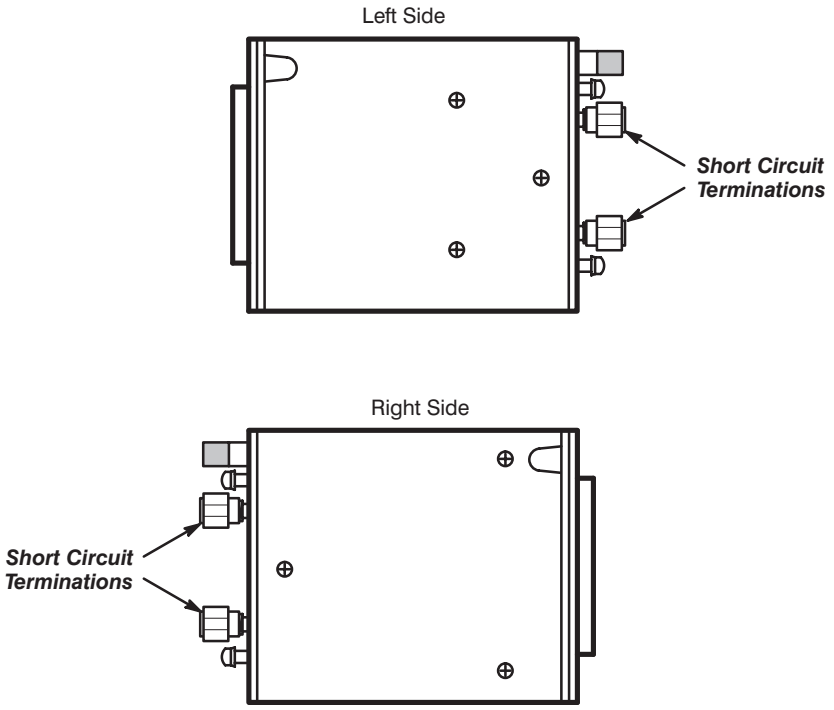



**Figure 3-1: Sampling Head Screw Locations**

## Changing the Sampling Head Identification Number

The following procedure allows you to change the sampling head identification number to fit the requirements of your application.

The following equipment, in addition to an 11800 Series or CSA 803 Series instrument and the sampling head, is necessary to perform this procedure:

- IBM PC or any other compatible PC that has MS DOS and an RS-232-C serial port configured for COM1
- a serial cable

Procedure to change the sampling head identification number:

☐ **Step 1:** Set the instrument's PRINCIPAL POWER SWITCH to OFF. Install one of the short-circuit jumpers across the two J860 pins on the A5 Time Base/Controller Board. These short-circuit jumpers are located on several jumper pins on the A5 Time Base/Controller Board. This board is located on the bottom of the instrument and can be accessed once the bottom panel is removed. Refer to the *Maintenance* section in the *Service Manual* for your instrument for more information on accessing this board. See Figure 3-2 for the location of jumper J860.

☐ **Step 2:** Boot up the PC with **MS DOS** operating.

☐ **Step 3:** Connect the serial cable to the instrument's RS-232-C port located at the rear of the instrument. Connect the other end of the cable to the COM1 port on the PC.

☐ **Step 4:** Install the sampling head in any sampling head compartment in the instrument.

☐ **Step 5:** Set the PRINCIPAL POWER SWITCH to ON and the ON/STANDBY switch to ON.

☐ **Step 6:** After the diagnostics are complete, press the UTILITY button and then touch **RS-232 Parameters**.

☐ **Step 7:** Set the **Baud Rate** to **4800 Bd**, the **Parity** to **none**, and the **Stop Bits** to **1** in the **RS-232 Parameters** pop-up menu.

☐ **Step 8:** Insert the Sampling Head Utility Software floppy disk (provided in this manual) into the "A" drive of the system controller.

☐ **Step 9:** On the PC, type **a:** and then press the return or enter key.

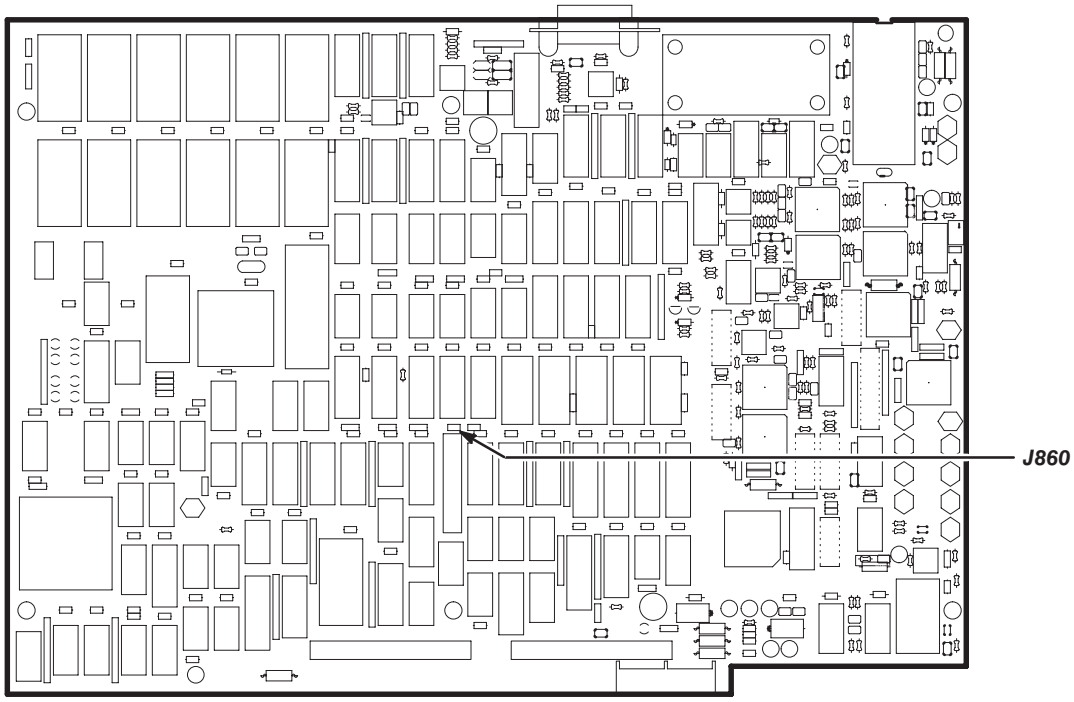



**Figure 3-2: A5 Time Base/Controller Board Jumper Location**

☐ **Step 10:** Type **id** and then press the return or enter key.

The PC then displays the following message:

**Make sure 11800 RS232 port is set up as follows:**

| | |
|---|---|
| **Baud Rate** | **4800** |
| **Parity** | **none** |
| **Stop bits** | **1** |

**Enter mainframe head number [1..4]**

***NOTE***

*When entering the sampling head number, the 11802 Oscilloscope and CSA 803 Series Communications Signal Analyzers only have head number 1 and head number 2. The 11801 Series Oscilloscopes have head number 1 through head number 4. The head numbers correspond to the sampling head compartments and are in ascending order (reading from left to right).*

☐ **Step 11:** To Enter the sampling head number, type in the correct sampling head number and then press the return or enter key.

The PC then displays the following message:

**Current ID number is: "XXXXXXXX"**
**Enter new ID number (8 characters max):**

***NOTE***

*The X's between the quotes represent the current ID number. Eight is the maximum number of digits allowed and one is the minimum. Any character is allowed, except a space ( ) character.*

☐ **Step 12:** Enter between one and eight characters for the new identification number.

The instrument will then flash the message:

**Change in channel M × configuration**

four times at the top of the screen.

☐ **Step 13:** Set the ON/STANDBY switch to STANDBY and then switch it back to ON.

☐ **Step 14:** To verify the new identification number, press the UTILITY button and then touch **Identify**.

The new identification number now appears under **Mainframe Sampling Heads** in the **System Identification** pop-up menu.

☐ **Step 15:** Remove the short-circuit jumper that was installed on J860 in Step 1.

# Theory of Operation

# Theory of Operation

The SD-22 Sampling Head is a two-channel, low-noise, 28 ps rise time sampling head. The SD-26 Sampling Head is a two-channel, 17.5 ps rise time sampling head.

## System Functional Overview

This section describes and illustrates the major functional blocks of the SD-22 & SD-26 Sampling Heads (see Figure 4-1).

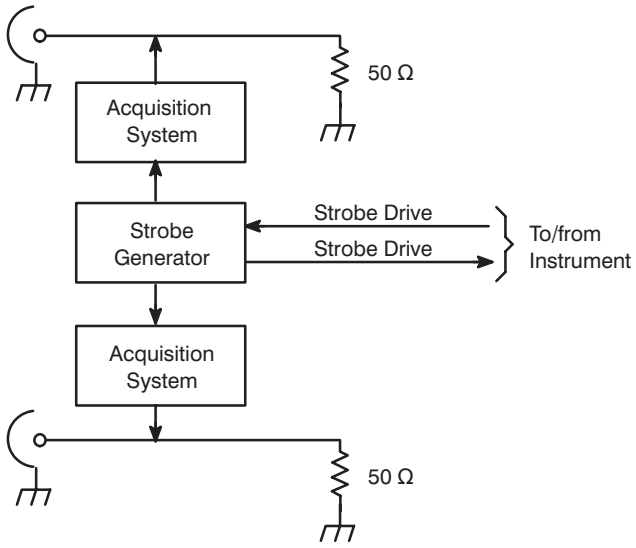



**Figure 4-1: SD-22 and SD-26 Sampling Head Block Diagram**

The strobe drive signal from the instrument mainframe controls the timing of the strobe assertion to each acquisition system and guarantees sampling coincidence between the two channels.

The strobe sense signal is a part of the strobe signal returned to the instrument. The instrument monitors the time duration of the strobe drive/strobe sense loop and adjusts a delay line inside the instrument to maintain correct strobe timing.

## Loop Gain

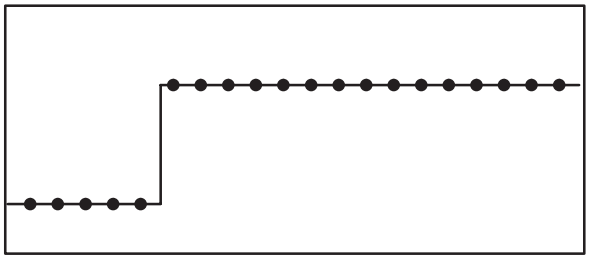
Loop gain determines the sampling head's ability to accurately follow an input voltage change that occurs between two adjacent samples. The accuracy with which the sampling head output follows the input signal is termed the dot transient response.

When loop gain is unity (1), the value of the first sample acquired after an input voltage change accurately reflects the voltage change, indicating a good dot transient response (see Figure 4-2).

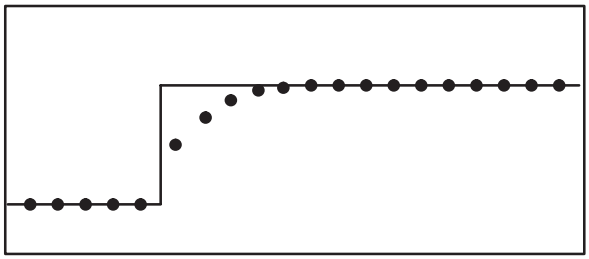
If loop gain is adjusted too low, then the value of the first sample acquired after an input voltage change will be between the value of the last sample and the new voltage.

If loop gain is adjusted too high, then the value of the first sample acquired after the input voltage change will be greater than the new voltage level.

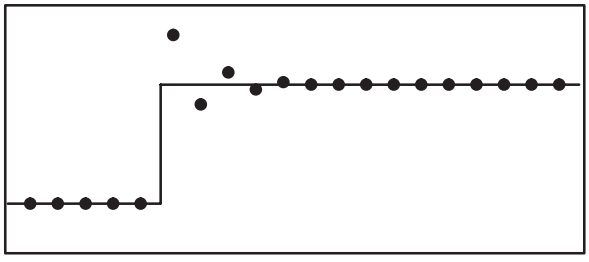
Figure 4-2 shows the displayed trace results for the three loop gain conditions.



*Unity Loop Gain*



*Insufficient Loop Gain*



*Excessive Loop Gain*

**Figure 4-2: Displayed Traces at Various Loop Gain Settings**

## Offset Null

The offset null adjustment removes unwanted DC offset that may be present in the sampling head. This adjustment effectively zeroes the sampling head so that an input signal with 0 V of amplitude delivers a 0 V output.

If offset null is not adjusted correctly, then measurements taken at the instrument will be incorrect. The absolute voltage values for any cursors displayed on the trace will be incorrect as well.

# Replaceable Parts

# Replaceable Parts

This section contains a list of the components that are replaceable for the SD-22 & SD-26 Sampling Heads. As described below, use this list to identify and order replacement parts.

## Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

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

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

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

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

### Module Replacement

The SD-22 & SD-26 Sampling Heads are serviced by module replacement so there are three options you should consider:

- **Module Exchange** — In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1−800−TEKWIDE, ext. 6630.
- **Module Repair** — You may ship your module to us for repair, after which we will return it to you.
- **New Modules** — You may purchase new replacement modules in the same way as other replacement parts.

## Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

### Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

### Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1.

## CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|---|---|---|---|
| TK0435 | LEWIS SCREW CO | 4300 S RACINE AVE | CHICAGO IL 60609–3320 |
| TK1163 | POLYCAST INC | 9898 SW TIGARD ST | TIGARD OR 97223 |
| TK1465 | BEAVERTON PARTS MFG CO | 1800 NW 216TH AVE | HILLSBORO OR 97124–6629 |
| 0GZV8 | HUBER AND SUHNER INC | 500 WEST CUMMINGS PARK | WOBURN MA 01801 |
| 0KB05 | NORTH STAR NAMEPLATE | 1281–S NE 25TH | HILLSBORO OR 97124 |
| 02660 | AMPHENOL CORP<br>INDUSTRIAL TECHNOLOGY DIVISION (ITD) | 720 SHERMAN AVENUE<br>PO BOX 4340 | HAMDEN CT 06514 |
| 13047 | MAURY MICROWAVE CORP | 8610 HELMS AVE | CUCAMONGA CA 91730–4520 |
| 20944 | WILTRON CO | 490 JARVIS DR | MORGAN HILL CA 95037–2809 |
| 66598 | CASCADE MICROTECH INC | 14255 SW BRIGADOON CT<br>SUITE C | BEAVERTON OR 97005–2360 |
| 80009 | TEKTRONIX INC | 14150 SW KARL BRAUN DR<br>PO BOX 500 | BEAVERTON OR 97077–0001 |
| 98291 | SEALECTRO CORP<br>BICC ELECTRONICS | 40 LINDEMAN DR | TURNBULL CT 06611–4739 |

| Fig. & Index No. | Tektronix Part No. | Serial No. Effective | Serial No. Dscont | Qty | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 5−1−1 | 366−0673−00 | | | 2 | KNOB:O.096 ID X 0.24 OD X 0.299H | TK1163 | ORDER BY DESC |
| −2 | 334−7624−00 | | | 1 | LABEL:FRONT PANEL,SD22 | 0KB05 | ORDER BY DESC |
| | 334−7363−00 | | | 1 | LABEL:MARKED SD26 PANEL FRONT | 0KB05 | ORDER BY DESC |
| | 334−7638−00 | | | 2 | MARKER,IDENT:MKD STATIC WARNING | 0KB05 | ORDER BY DESC |
| −3 | 211−0088−00 | | | 3 | SCREW,MACHINE:2−56 X 0.281,FLH,82 DEG,STL | TK0435 | ORDER BY DESC |
| −4 | 333−3427−01 | | | 1 | PANEL,FRONT: | 80009 | ORDER BY DESC |
| −5 | 380−0831−00 | | | 1 | HSG,SMPLG HEAD:ALUMINUM | TK1465 | ORDER BY DESC |
| −6 | 211−0087−01 | | | 3 | SCREW,MACHINE:2−56 X 0.188,FLH,82 DEG,STL | TK0435 | ORDER BY DESC |
| | 657−0069−50 | | | 1 | MODULAR ASSY:FIELD REPLACEABLE UNIT,SD22 | 80009 | 657006950 |
| | 657−0065−50 | B010100 | B020439 | 1 | MODULAR KIT:SD26,EXCHANGE MODULAR ASSY | 80009 | 657006550 |
| | 657−0065−51 | B020440 | | 1 | MODULAR ASSY:SD26,FIELD REPLACEABLE UNIT | 80009 | 657006551 |
| | | | | | **STANDARD ACCESSORIES** | | |
| | 015−1020−00 | | | 2 | TERM,COAXIAL:SHORT CIRCUIT,SMA | 0GZV8 | 64SMA−50−0−1 |
| | 070−7226−02 | | | 1 | MANUAL,TECH:USER,SD22/SD26 | 80009 | 070722602 |
| | 070−7227−02 | | | 1 | MANUAL,TECH:SERVICE,SD22/SD26 | 80009 | 070722702 |
| | | | | | **OPTIONAL ACCESSORIES** | | |
| | 011−0148−00 | | | 1 | TERM,COAX:50+/−0.1 OHM,PRECISION 3.5MM | 20944 | 28K50 |
| | 011−0149−00 | | | 1 | TERM,COAX:50 OHM,26.5GHZ,PRECISION 3.5MM | 20944 | 28KF50 |
| | 011−0150−00 | | | 1 | TERM,COAX:SHORT,34GHZ,PRECISION 3.5MM | 13047 | 360D |
| | 011−0151−00 | | | 1 | TERM,COAX:SHORTING,34 GHZ,3.5MM,MALE | 13047 | 360B |
| | 011−0152−00 | | | 1 | ATTEN,COAX:50 OHM,6DB,40.0 GHZ,2.92MM | 20944 | 41KC−6 |
| | 011−0153−00 | | | 1 | ATTEN,COAX:50 OHM,20DB,2.92MM | 20944 | 41KC−20 |
| | 015−0549−00 | | | 1 | CONN,RF ADPT:SMA,;50 OHM,MALE TO FEMALE | 0GZV8 | 33SMA−50−0−1 |
| | 015−0550−00 | | | 1 | ADPTR,RF,PRCN::3.5MM,FEMALE TO FEMALE | 20944 | 33SFSF50 |
| | 015−0551−00 | | | 1 | ADPTR,RF,PRCN::3.5MM,MALE TO MALE | 20944 | 33SS50 |
| | 015−0552−00 | | | 1 | ADPTR,APC,ELEC:3.5MM,MALE TO FEMALE | 02660 | 131−7053 |
| | 015−0553−00 | | | 1 | ADPTR,SMA,ELEC:MALE TO FEMALE | 98291 | 50−674−6324−99 |
| | 015−0557−00 | | | 1 | POWER DIVIDER:DC−40 GHZ,2.92MM,FEMALE | 20944 | K240C |
| | 015−0558−00 | | | 1 | TERMINATOR,ELEC:10 X 20DB,DC TO 10 GHZ | 66598 | 523−150 |
| | 015−0561−00 | | | 1 | CABLE,DLY,COAX:50 OHM,4NS,W/CONN,MALE | 0GZV8 | SF104PE,920MM,2 |
| | 015−0562−00 | | | 1 | CABLE,DLY,COAX:50 OHM,1NS,W/CONN,MALE | 0GZV8 | SF104PE,230MM,2 |
| | 015−0563−00 | | | 1 | CABLE,DLY,COAX:50 OHM,2NS,W/CONN | 0GZV8 | SF104PE,460MM,2 |
| | 015−0564−00 | | | 1 | CABLE,DLY,COAX:50 OHM,500PS,W/CONN | 20944 | K120−6 |
| | 020−1693−00 | | | 1 | COMPONENT KIT:SMA KIT | 80009 | 020169300 |
| | 067−1338−00 | | | 1 | FIXTURE,CAL:SAMPLING HEAD CAL UNIT (STANDARD) | 80009 | 067133800 |
| | 067−1338−01 | | | 1 | FIXTURE,CAL:SAMPLING HEAD CAL UNIT (EUROPEAN) | 80009 | 067133801 |
| | 067−1338−02 | | | 1 | FIXTURE,CAL:SAMPLING HEAD CAL UNIT (UNITED KINGDOM) | 80009 | 067133802 |
| | 067−1338−03 | | | 1 | FIXTURE,CAL:SAMPLING HEAD CAL UNIT (AUSTRALIAN) | 80009 | 067133803 |

| Fig. & Index No. | Tektronix Part No. | Serial No. Effective | Serial No. Dscont | Qty | Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| | 067−1338−05 | | | 1 | FIXTURE,CAL:SAMPLING HEAD CAL UNIT (SWITZERLAND) | 80009 | 067133805 |
| | 067−1338−06 | | | 1 | FIXTURE,CAL:SAMPLING HEAD CAL UNIT (JAPANESE) | 80009 | 067133806 |

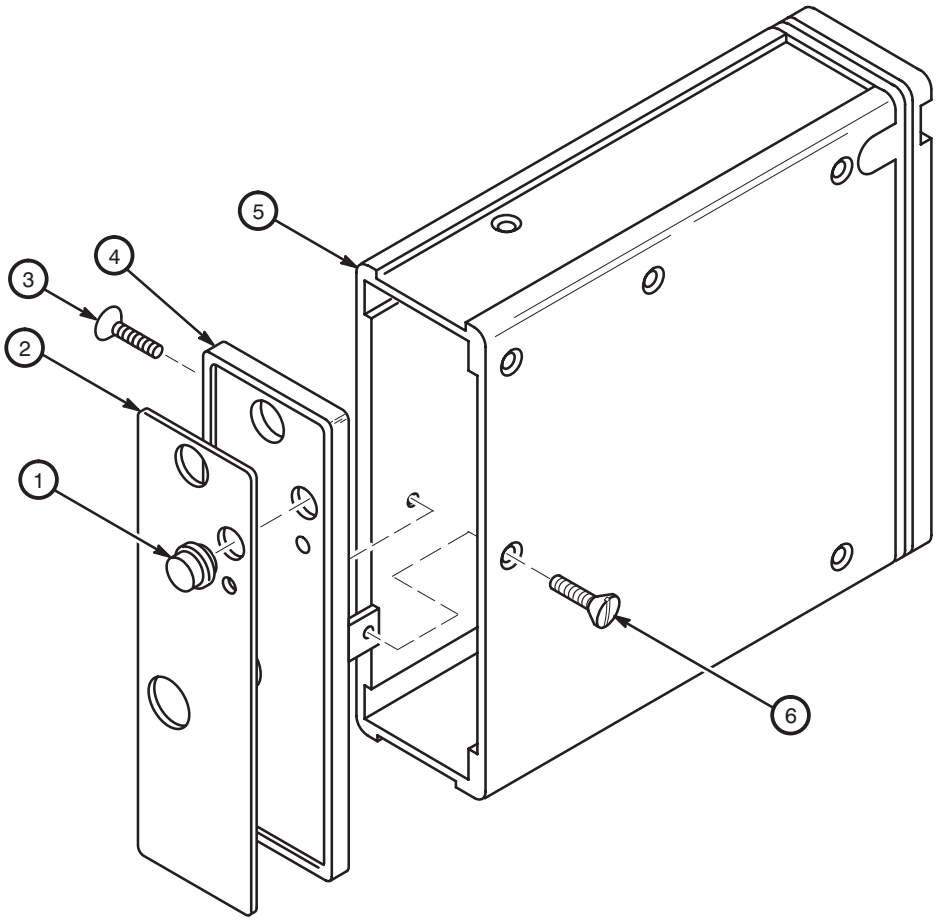



**Figure 5-1: Exploded View of the SD-22 & SD-26 Sampling Heads**