

# User Manual



## SD-14 Sampling Head

070-8286-01

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

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## **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:

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E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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

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# Introduction

The SD-14 Sampling Head is a high-performance, probe-equipped sampling head that can be installed in the 11800 Series Digital Sampling Oscilloscopes, the SM-11 Multi-Channel Unit, and the CSA 803 Series Communications Signal Analyzers.

## **NOTE**

*Be sure the firmware in your mainframe instrument is compatible with the SD-14. See page 10 for instructions on checking your instrument's firmware.*

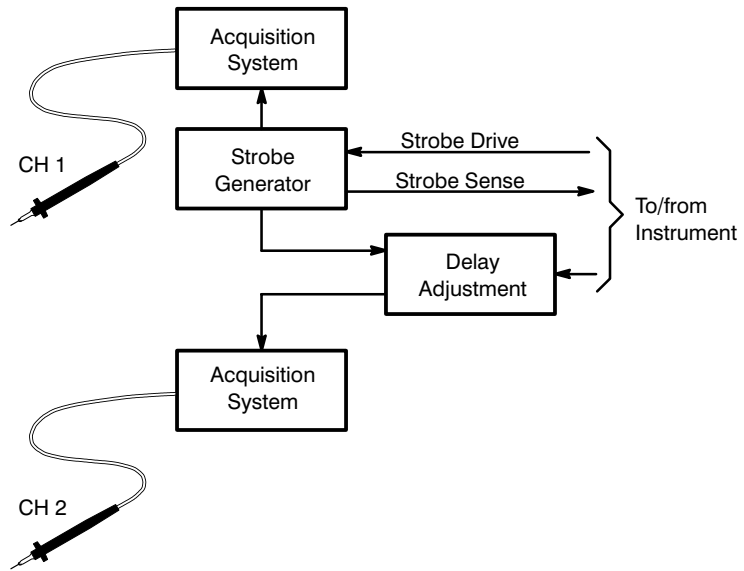
The instrument mainframe in which the SD-14 is installed must have firmware compatible with the SD-14. An 11801B Oscilloscope or CSA 803A must have Executive Processor and Time Base/Controller firmware version 4.00 or above. An 11801 or 11802 Oscilloscope must have Executive Processor and Time Base/Controller firmware version 10.00 or above.

The SD-14 Sampling Head provides the following features:

- Two independent probe channels for signal acquisition and measurements.
- 140 ps acquisition rise time.
- DC to 3 GHz typical bandwidth for high-speed signal capture.
- 100 k $\Omega$ /0.475 pF typical probe loading for minimum circuit disturbance.
- User-adjustable offset at the probe tip.
- Maximum displayed noise of 8 mV<sub>RMS</sub>, with 7 mV<sub>RMS</sub> typical.
- SELECT CHANNEL buttons for quick trace acquisition and selection from the sampling head front panel.
- Channel  $\Delta$  Delay adjustment range of 400 ps (typical), to allow channel deskew within the head.

As shown in Figure 1, the sampling head has two independent probe channels, each with its own acquisition circuitry.

The strobe drive signal from the instrument controls the timing of the strobe assertion to each acquisition system. A variable delay adjustment on channel 2 guarantees sampling coincidence between the two channels or allows intentional skewing between channels.



**Figure 1: Block Diagram of the Sampling Head**

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

# Safety

## Terms in Manuals

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

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

## Terms on Equipment

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

*DANGER* indicates 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 instrument in which it is installed. To avoid electric shock, make sure that the instrument is plugged into a properly wired receptacle where earth ground has been verified by a qualified service person. Without the protective ground, all parts of the instrument and the sampling head are shock hazards. This includes knobs and controls that may appear to be insulated.

### **Do Not Operate in Explosive Atmospheres**

The sampling head provides no explosion protection from static discharges or arcing components. Do not operate the instrument in an atmosphere of explosive gases.

# Electrostatic Discharge

To prevent electrostatic damage to the instrument and sampling probes, follow the precautions described in this manual and the manuals accompanying your sampling head and mainframe instrument.

Acquisition circuitry in the sampling probes is susceptible to damage from electrostatic discharge and from overdrive signals and DC voltages. Be sure to operate the sampling probes only in a static-controlled environment. Be sure to discharge to ground any electrostatic charge that may be present on cables or circuit board runs before connecting the sampling probe.



*To prevent damage to the probe tips, install the probe tip protective covers whenever the probes are not in use.*

*To prevent damage from electrostatic discharge, use a static-free container to carry the head whenever you move the sampling head from one instrument to another. Store the sampling head in a static-free container, such as the shipping container.*

*Always use a wrist strap (provided with your instrument) when handling sampling heads or making connections.*

## Electrostatic Discharge



# Probe and Probe Cable Care

The sampling head is permanently equipped with two sampling probes, one for each channel, attached to cables. These are high-precision assemblies with an integrated circuit sampler mounted on a small hybrid microcircuit.

The assembly is designed for normal lab use in a remote probing environment where conditions may be less than the optimum normally expected for a microelectronics environment. Nevertheless, reasonable care must be exercised to prevent probe breakage.

- Do not drop a probe or allow the tip to strike a hard object.
- Do not apply excessive force to the tip of the probe.
- Do not kink or deform the probe cable. Avoid cable bends sharper than a 2 inch (50 mm) radius. Avoid applying excessive side pressure to the cable, such as rolling a chair caster over the cable.
- Do not apply excessive pulling force to the cable. Do not pull a sampling head and instrument into position with a probe. If the sampling head is installed on an extender cable, do not allow the sampling head and extender cable to fall and be suspended by a probe.
- Use only 4 mm accessories on the probe tips. (See page 14 for descriptions of standard 4 mm accessories.)
- Install the probe tip protective cover whenever the probe is not in use.

**Probe and Probe Cable Care**

# Installing the Sampling Head

The sampling head fits into the front panel of a compatible instrument, such as the 11800 Series Digital Sampling Oscilloscope or the CSA 803 Series Communications Signal Analyzer. Figure 2 shows the front panel of an 11801B Digital Sampling Oscilloscope and a CSA 803A Communications Signal Analyzer and the locations of the sampling head compartments. Note that on the CSA 803 Series, only two compartments provide signal acquisition capability. The other two compartments only provide power, for example to power an optical-to-electrical converter.

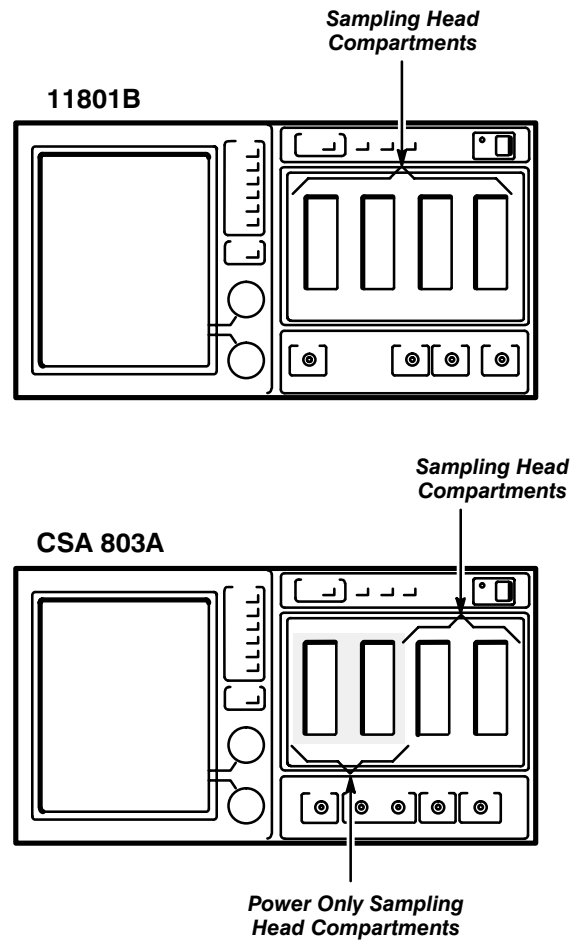


Figure 2: Sampling Head Compartments in an 11801B and a CSA 803A

**NOTE**

*Check the firmware level of your mainframe instrument before proceeding.*

The SD-14 Sampling Head will not operate with some older versions of 11800 Series or CSA 803 Series firmware. To check your instrument firmware, press the **UTILITY** button and select **Identify** from the Utility major menu. You will see a display similar to Figure 3. Check the Executive Processor and Time Base/Controller firmware levels against Table 1.

**Table 1: Mainframe Executive Processor and Time Base/Controller Firmware Versions Compatible with the SD-14**

<b>Mainframe Instrument</b>	<b>Firmware Version for SD-14 Operation</b>
11801, 11802	≥ 10.00
11801A, CSA 803	≥ 3.00
11801B, CSA 803A	≥ 4.00

If your mainframe's firmware does not satisfy the requirements listed in Table 1, contact your Tektronix sales representative for upgrade information.

System Identification					
Unit Select					
Mainframe					
-----					
11801B Mainframe ID#					
Executive Processor : 4.01					
Display : 4.00					
Time Base/Controller: 4.01					
Acquisition #1 : 9.02					
Acquisition #2 : 9.02					
-----					
Mainframe Sampling Heads					
Chan M1 :	10X	Chan M2 :	10X	SD-14	B43
Chan M3 :	0X	Chan M4 :	0X		
Chan M5 :	0X	Chan M6 :	0X		
Chan M7 :	0X	Chan M8 :	0X		
-----					
Options					
1T - Telecomm Standard Masks Installed					
1M - SM-11 Compatability Not Installed					
-----					
GPIB / RS232C	Identify	Color	Hardcopy	RS232 Baud	
			Bitmap Screen	19200bd	
				RS232 Delay	0s
Initialize Instrument Options	Labeling	Page to	Remove/Cln		
10:18:13	Off	Enhanced Accuracy	Trace 1	M1	
14-APR-93			Main		

Figure 3: The Identify Pop-Up Menu

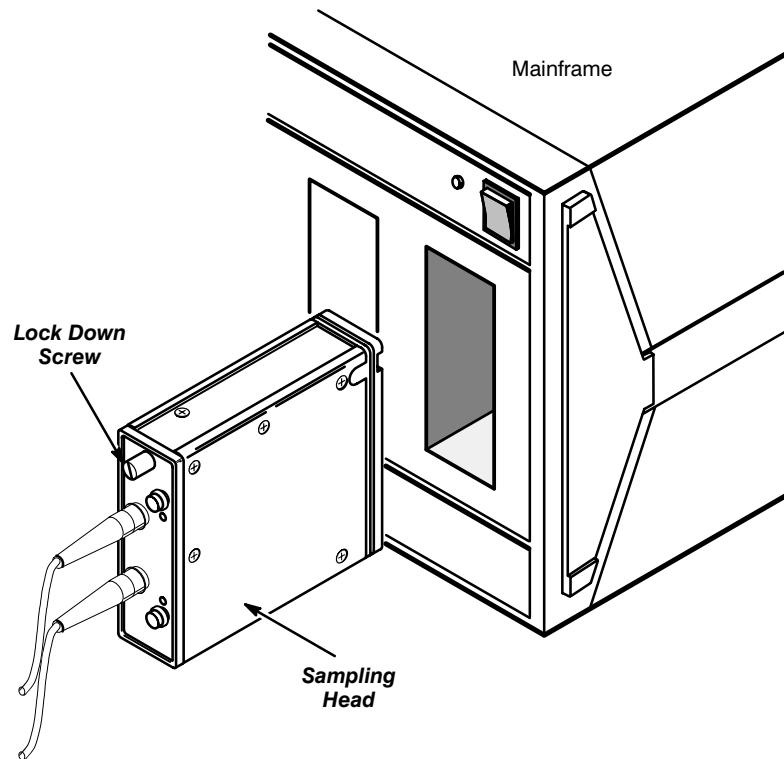
At least one sampling head must be installed in an 11800 Series or a CSA 803 Series instrument to sample signals.



*To prevent damage to either the instrument or the sampling head, never install or remove a sampling head when the instrument is powered on.*

To install a sampling head, first power-off the instrument. Then place the sampling head in a compartment and slowly push it in with firm pressure. Once the head is seated, turn the lock-down screw on the sampling head to tighten the head into place. See Figure 4.

## Installing the Sampling Head



**Figure 4: Installing a Sampling Head in an Instrument**

# Using the Sampling Head

Figure 5 shows the front panel of the sampling head and identifies the buttons, lights, and probes.



*To prevent damage to the sampling head, do not apply a voltage outside the range  $\pm 15$  V and always follow electrostatic discharge precautions.*

Each channel has a permanently attached sampling probe with a 4 mm tip for signal input, a SELECT CHANNEL button, and a yellow channel indicator light.

The input circuitry used in the sampling probes is susceptible to damage from overdrive signal or DC voltages and from electrostatic discharge. Never apply a voltage outside the range of  $\pm 15$  V. Operate the instrument and sampling head only in a static-controlled environment. Always use a wrist strap when handling sampling heads or making connections.

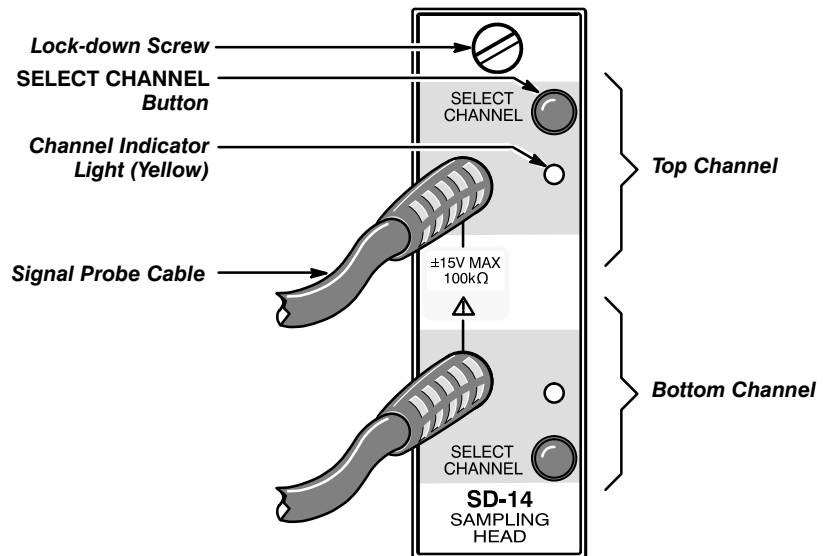


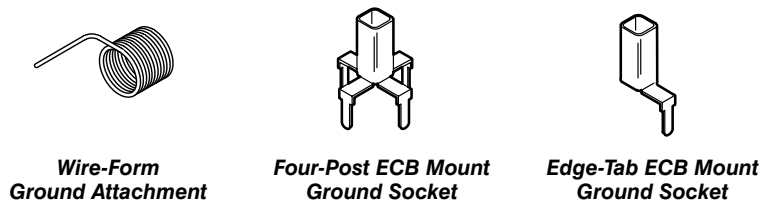
Figure 5: SD-14 Sampling Head Front Panel

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## Connecting Signals

The probes for each channel let you directly connect to the circuitry under test, many times without attaching any extra hardware to the circuitry itself. The SD-14 also has the following standard 4 mm accessories to facilitate probe attachment (see Figure 6):

- Wire-form ground attachment
- Four-post ECB mount ground socket
- Edge-tab ECB quick-mount ground socket



**Figure 6: Standard 4 mm Accessories for the SD-14 Sampling Head**

### **NOTE**

*Do not attempt to use other subminiature probe accessories with the SD-14.*

Note that these 4 mm accessories are not compatible with other accessories for subminiature probes, even though their appearance is similar. Do not attempt to use the SD-14 probes with any accessories other than those designated as “4 mm.”

To attach the wire-form ground attachment to the probe tip, slip it over the end of the probe tip and turn it as shown in Figure 7. Bend and cut the end of the wire to fit your ground conductor. Turn the attachment in the same direction to remove it.



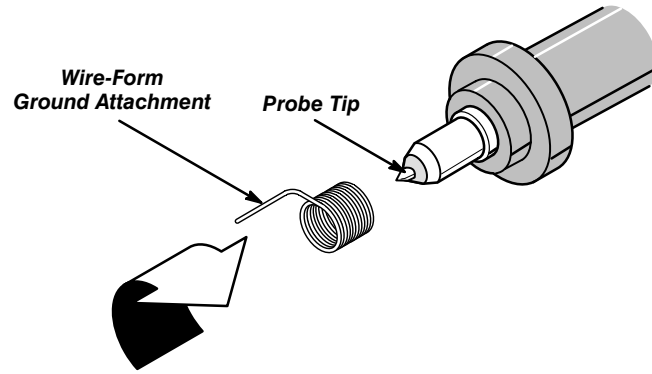


Figure 7: Attaching and Removing the Wire-Form Ground Attachment

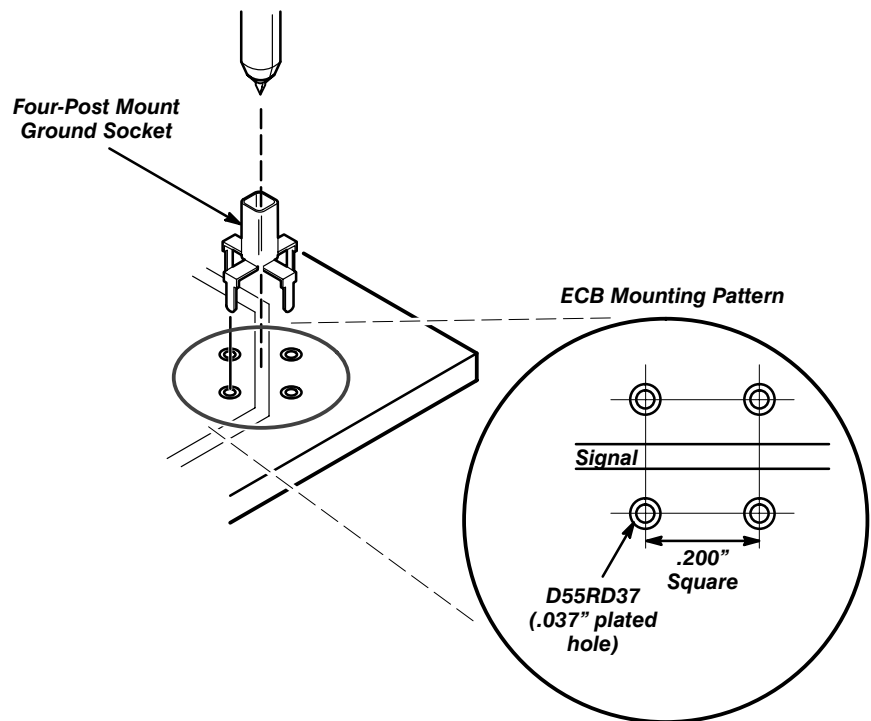


Figure 8: Use of the Four-Post ECB Mount Ground Socket and ECB Pattern

Figure 8 shows the ECB pattern for the four-post ECB mount ground socket. Figure 9 shows how to use the edge-tab ECB quick-mount ground socket.

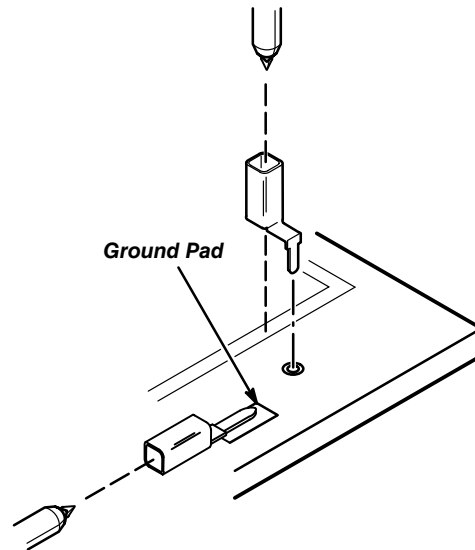


Figure 9: Use of the Edge-Tab ECB Quick-Mount Ground Socket

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## Buttons and Lights

Each channel has a SELECT CHANNEL button and a yellow channel light.

The channel light can have three states: off, on steady, or blinking. The operation of the channel button depends on the state:

- If the yellow light is off, then the channel is not acquiring trace data, and no trace is displayed from that channel. When the light is off and you press the SELECT CHANNEL button, the channel acquires trace data and displays a trace. The signal input from that channel creates the selected trace, so the yellow light blinks.
- If the yellow light is on steady, the channel is acquiring trace data. The trace data is displayed as a single trace and/or may be part of another displayed trace. However, the trace is not the selected trace. When the light is on steady and you press the SELECT CHANNEL button, the trace becomes selected and the light blinks.
- If the yellow light is blinking, the channel is a part of or all of the selected trace. When the light is blinking and you press the button, *all* traces displaying that channel are removed. The channel stops acquisitions and the yellow light turns off.

## Instrument/Sampling Head Interaction

The sampling head is a part of a larger system. Most of the sampling head functions are controlled automatically from the instrument. These functions include vertical scaling and horizontal sampling rate. You do not directly control these parameters; they are tasks that the instrument performs.

There are two sampling head functions, *Channel  $\Delta$  Delay* and *External Channel Attenuation*, that you can control directly from the mainframe instrument:

- Channel  $\Delta$  Delay adjusts the time delay of the channel 2 acquisition (the lower channel) with respect to the channel 1 acquisition (the upper channel).

If you change Channel  $\Delta$  Delay, you should also adjust offset. Refer to Adjusting Parameters on page 21 for information on offset.

- External Channel Attenuation enables you to enter a number representing any external attenuation that you have added to a channel. (The 10X internal probe attenuation factor is already accounted for; do not duplicate it in the external attenuation setting.)

To adjust Channel  $\Delta$  Delay or External Channel Attenuation, press the WAVEFORM menu button on your mainframe instrument and select **Sampling Head Fnc's** from the WAVEFORM major menu. (See Figure 10.) Touch the **Channel  $\Delta$  Delay** or **External Channel Attenuation** selector to set the knobs to control that parameter.

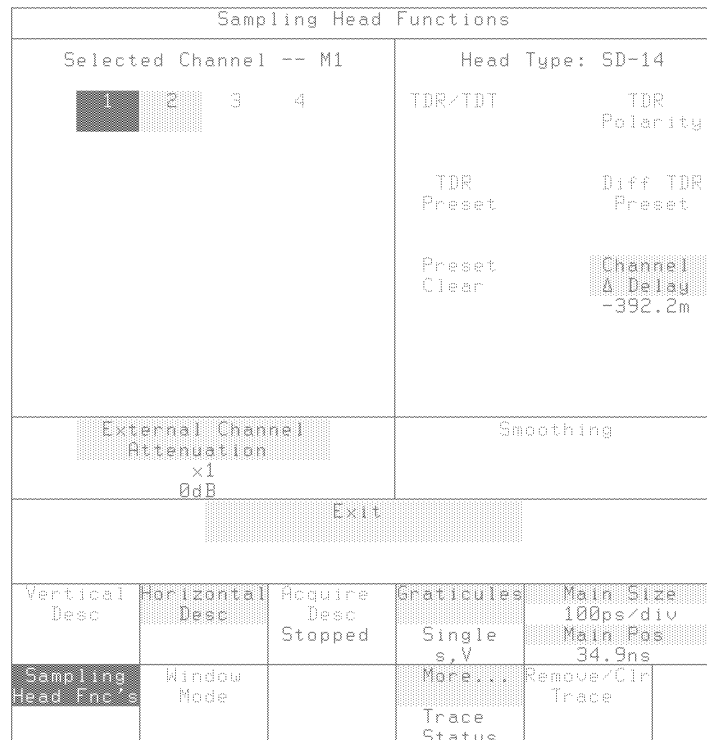


Figure 10: The Sampling Head Fnc's Pop-Up Menu

## Programming Interface Commands

Commands from a remote computer to the mainframe instrument (via the GPIB or RS-232-C Interface) can control the Channel  $\Delta$  Delay and External Channel Attenuation functions of the SD-14.

For these commands, *<alpha>* indicates the sampling head location (M for mainframe or A, B, C, or D for an SM-11 Multi-Channel unit; for the CSA 803 Series *<alpha>* is always M) and *<ui>* indicates the channel number for the channel you want to adjust.

- CH*<alpha>**<ui>* CDElay: *<NRx>*

This command specifies the delay of the channel 2 acquisition (lower channel) relative to channel 1 (upper channel). (*<ui>*) may be 1 or 2.)

- CH*<alpha>**<ui>* EXTAttenuation: *<NRx>*

This command specifies the External Channel Attenuation of the specified channel, where *<NRx>* is a floating-point attenuation factor. External Channel Attenuation is a feature of the mainframe. Refer to the *User Manual* for your instrument for more information on this feature.

For complete information about how to use the SD-14 to display traces, see the *User Manual* for your instrument.

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## Displaying a Trace

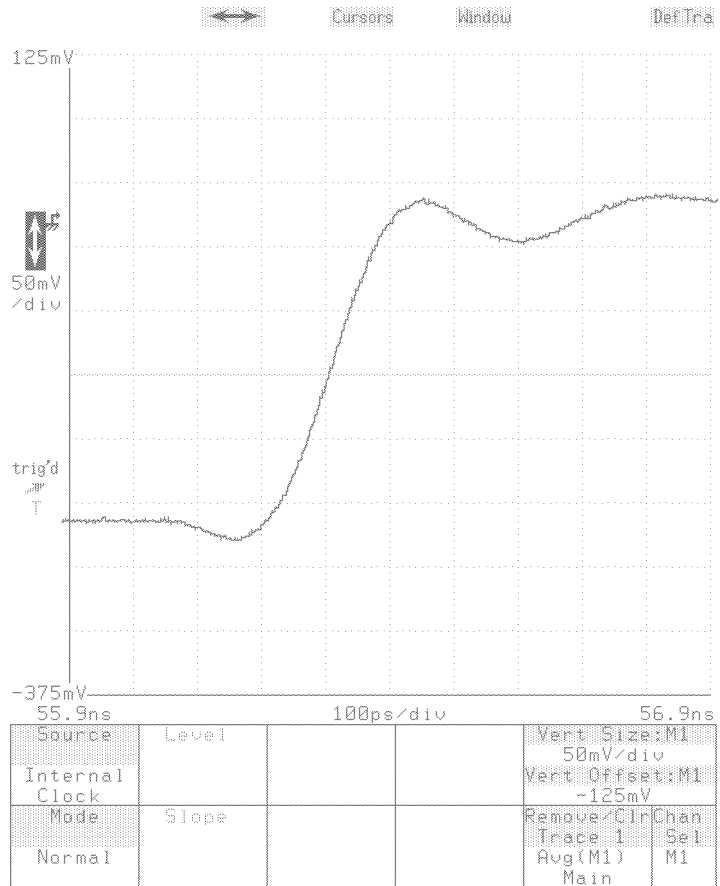
The following example shows you how to acquire and display a trace with the sampling head and an instrument. For this procedure you will need one SMA cable, 12 inches or longer, a 50  $\Omega$  termination, and the optional probe tip adapter fixture.

- Step 1:** Initialize the instrument to default settings using the **Initialize** selector, which appears in the UTILITY major menu.
- Step 2:** Connect the probe tip adapter fixture to the calibrator output using the SMA cable.
- Step 3:** Install the 50  $\Omega$  termination on the fixture.
- Step 4:** Connect the probe to the probe tip adapter fixture.
- Step 5:** From the Trigger major menu, set the trigger source to internal.
- Step 6:** Press the SELECT CHANNEL button nearest the sampling head input you have connected to the calibrator.

The yellow light on the sampling head blinks, indicating that the channel acquisition circuit is enabled and output from the channel is the selected trace.

- Step 7:** Press the AUTOSSET button above the sampling heads.

A display should appear that is similar to Figure 11.



**Figure 11: Calibrator Signal after Pressing Autoset (Edge Mode), Averaging On**

## Slew Rate Limitation

For high-voltage or high-frequency signals, the slew rate of the displayed signal may be limited. Refer to Specifications on page 27.

For detailed information about acquiring, displaying, and measuring traces, see the *User Manual* for your instrument.

## Using the Sampling Head

# Adjusting Parameters

The SD-14 Sampling Head is capable of performing over a wide range of conditions with only periodic calibration. However, you can use the controls of the mainframe instrument to optimize two parameters on the sampling head:

- Offset null
- Offset gain

To get the best accuracy from the SD-14 Sampling Head, you may want to adjust sampling head parameters whenever you have moved the sampling head to another compartment, if the ambient temperature has changed  $\pm 5^{\circ}\text{C}$  since the parameters were last adjusted, or if Channel  $\Delta$  Delay is adjusted. At the factory, the parameters are set in an environment with an ambient air temperature of  $25^{\circ}\text{C}$ .

## **NOTE**

*You should adjust the sampling head parameters only after a 20-minute warm-up period.*

You can adjust sampling head parameters at any time. However, during the instrument's warm-up period, the values may change as the temperature varies. You should adjust the sampling head parameters only after the instrument has been on for at least 20 minutes.

The actual procedure for performing these adjustments depends on the instrument. For an 11800 Series Oscilloscope or CSA 803 Series Communications Signal Analyzer, you can use the Enhanced Accuracy feature to adjust sampling head parameters.

## Stored Parameters

The sampling head contains nonvolatile memory that stores two values, the factory default value and the user constant, for each of the offset null and offset gain parameters. These values always remain in the sampling head, even if you remove the sampling head from the instrument.

The factory default values for the sampling head parameters are set at the factory and are appropriate for most conditions.

If you decide to adjust a sampling head parameter, the new setting is immediately used to operate the head, but it is lost when you power off the instrument. However, you can store the new parameter value as the user constant. The user constants are stored in an EEPROM in the sampling head so that they are not lost at power-off and are restored at power-on.

Note that if you initialize the mainframe instrument, the user constants for the sampling head parameters are not affected.

If you are not confident in the current user value for a sampling head parameter, you can assign the user parameter value to equal the factory default value. The factory default value offers a reasonable parameter value for many conditions. See the *User Manual* for your mainframe instrument for more information.



## Offset Null and Offset Gain

The offset null adjustment removes unwanted DC offset that may be present in the sampling probe. This adjustment effectively zeroes the offset circuitry in the sampling probe so that a 0 V input signal delivers a 0 V output.

The offset gain adjustment matches the requested offset from the user to the sensitivity of the probe offset circuit.

If offset null and offset gain are not both adjusted correctly, measurements taken will be incorrect. The absolute voltage values for any cursors displayed in the trace will also be incorrect.

### Adjusting Offset Null and Offset Gain

For the instrument, offset null and offset gain are adjusted using an automatic procedure from the Enhanced Accuracy menu (see Figure 12). Both are measured and adjusted simultaneously.

To adjust offset null and offset gain, connect the probe tip to the exposed barrel, initiate the automatic offset procedure, and follow the instructions given.

Offset Calibration					
Selected Channel -- M1			Offset		
1	2	3	4	Manual Calibrate	Automatic Calibrate
Store Constants			Proceed		
Recall User			Recall Const Defaults		
Exit					
Blowby Compensate	Gain	Offset	Delay Adjust	Vert Size:M1	50mV/div
Calibrate All	Time Base Cal Mode	TDR Amplitude	Page to Utility2 Menu	Remove/Clr Trace 1 Avg(M1) Main	Chan Sel M1

Figure 12: Adjusting Offset Null and Offset Gain

## Adjusting Parameters

# Accessories

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## Standard Accessories

The following standard accessories are provided with the SD-14:

- *SD-14 Sampling Head User Manual* (this manual), Tektronix part number 070–8286–XX
- *SD-14 Sampling Head Service Manual*, Tektronix part number 070–8285–XX
- Probe tip protective covers, Tektronix part number 200–3961–XX
- Cable marker set, Tektronix part number 016–0633–XX
- Wire-form ground attachments, Tektronix part number 131–5307–XX
- Four-post ECB mount ground sockets, Tektronix part number 131–5308–XX
- Edge-tab ECB quick-mount ground sockets, Tektronix part number 131–5309–XX

To obtain replacements, refer to a Tektronix products catalog or contact your local Tektronix field representative.

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## Optional Accessories

The following optional accessories may be purchased for use with the SD-14. For detailed information and prices, refer to a Tektronix products catalog or contact your local Tektronix field representative.

- Calibration fixture, Tektronix part number 013–0271–00
- Sampling head extender cable, Tektronix part number 012–1220–00 (one meter); 012–1221–00 (two meter)



# Specifications

**Table 2: Acquisition Electrical Specifications**

<b>Characteristics</b>	<b>Specifications</b>
Small Signal Rise Time	140 ps or less, 10% to 90%
Small Signal Aberrations	
distal to 1.5 ns	+12% to -25% typical
1.5 ns to 4 ns	+1% to -3% typical
4 ns to 30 ns	±2% typical
after 30 ns	±1% typical
Bandwidth	3 GHz typical (-3 dB)
Sampling Repetition Rate	
Maximum	200 kHz
Minimum	100 Hz
Maximum Safe Input Signal Voltage	±15 V (DC + peak AC)
Dynamic Range	7 V <sub>p-p</sub> AC, limited above 570 MHz 1 dB compression points are: 4 V <sub>p-p</sub> AC at 1 GHz typical 2 V <sub>p-p</sub> AC at 2 GHz typical 1.33 V <sub>p-p</sub> AC at 3 GHz typical or, slew rate limited to < 12.5 V/ns typical (see Figure 13 for slew rate limitations)
Displayed noise	8 mV <sub>RMS</sub> maximum; 7 mV <sub>RMS</sub> typical
Offset range	±3.5 V
Offset accuracy	±(20 mV + 1%)
Input Impedance	100 kΩ typical 0.475 pF typical
Time matching	Adjustable; 350 ps range

## Specifications

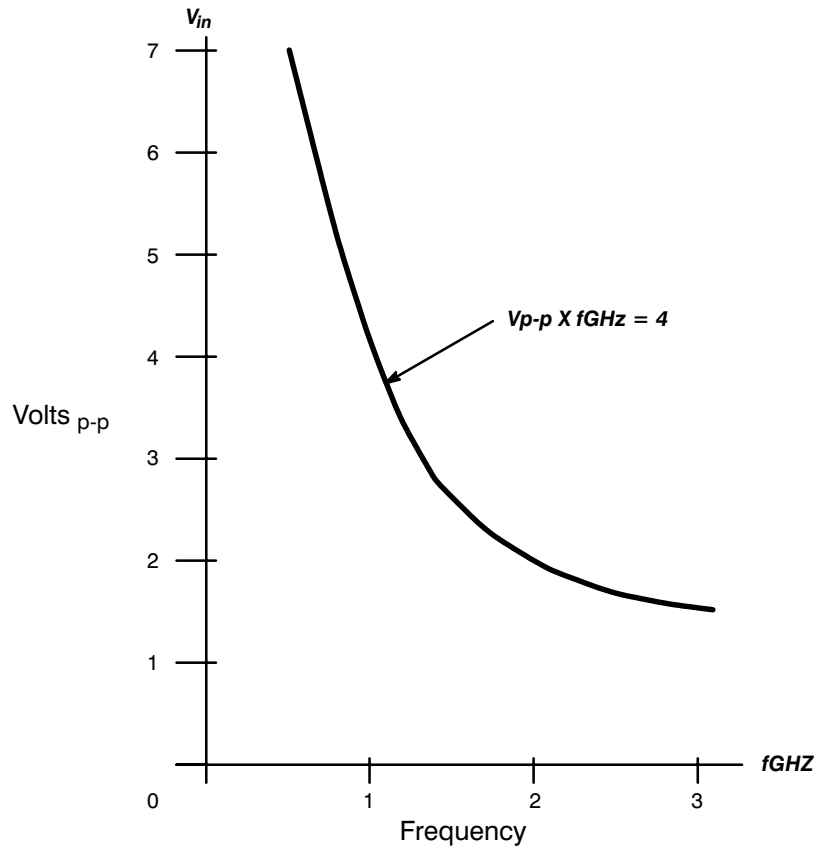


Figure 13: Slew Rate Limitation

**Table 3: Environmental and Mechanical Specifications**

<b>Characteristics</b>	<b>Specifications</b>
Weight	271 grams (9.6 oz)
Height	71.05 mm (2.9 in)
Width	23.28 mm (0.95 in)
Depth	91.39 mm (3.8 in)
Probe Length	1 m (39.4 in)
Ambient Temperature	
Operating	0° C to 50° C (32° F to 122° F)
Non-operating	-40° C to 75° C (-40° F to 167° F)
Altitude	
Operating	to 4.5 km (15,000 feet)
Non-operating	to 15 km (50,000 feet)
Humidity	to 95% relative humidity at up to 50° C (122° F)

## Specifications



# Glossary

**Autoset**

A means of letting the instrument mainframe set itself to provide a stable and meaningful display of a given trace.

**Channel**

A place to connect a signal or attach a network or transmission line to sampling heads. Also, the smallest component of a trace expression.

**Channel Number**

The number assigned to a specific signal input connector. The top channel of the left-most sampling head compartment of the instrument mainframe is always mainframe channel 1, regardless of any repositioning or omission of sampling heads.

**Default Measurement Parameter**

A value from the default set of measurement parameters. The operator can change the default values. Whenever a trace is created, the measurement parameters are copied from the default set.

**Initialize**

Setting the instrument mainframe to a completely known, default condition.

**Internal Clock**

A trigger source that is synchronized with the Calibrator signal.

**Setting**

The state of the front panel and system at a given time.

**Smoothing**

Processing applied by the sampling head prior to the digitization of a trace, to reduce apparent noise. With smoothing, the sampling head samples the signal 8 times instead of once, and the average of the samples is then used by hardware measurements and the digitizing circuitry.

**Trigger**

An electrical event that initiates acquisition of a trace as specified by the time base.

**Waveform**

The visible representation of an input signal or combination of signals. Identical to trace.



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