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User Manual

Tektronix

SD-20
Sampling Head

070–7531–02

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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:

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

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Introduction

The SD-20 Sampling Head is a high-performance 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.

The SD-20 Sampling Head provides the following features:

- A one-channel feed thru path for signal acquisition and measurements.
- A 17.5 ps acquisition rise time.
- A 20 GHz typical bandwidth for high-speed signal capture.
- Displayed noise is 750 μV_{RMS} typical without smoothing and 350 μV_{RMS} typical with smoothing on.
- Precision 3.5 mm connectors.
- A SELECT CHANNEL button for quick trace acquisition and selection from the sampling head front panel.

As shown in Figure 1, the SD-20 Sampling Head has a single acquisition channel with a feed thru or loop path (labeled LOOP on the front panel), an INPUT connector, and a FEED THRU connector (both of these connectors are also located on the front panel).

The strobe drive signal from the instrument controls the timing of the strobe assertion to the Acquisition system.

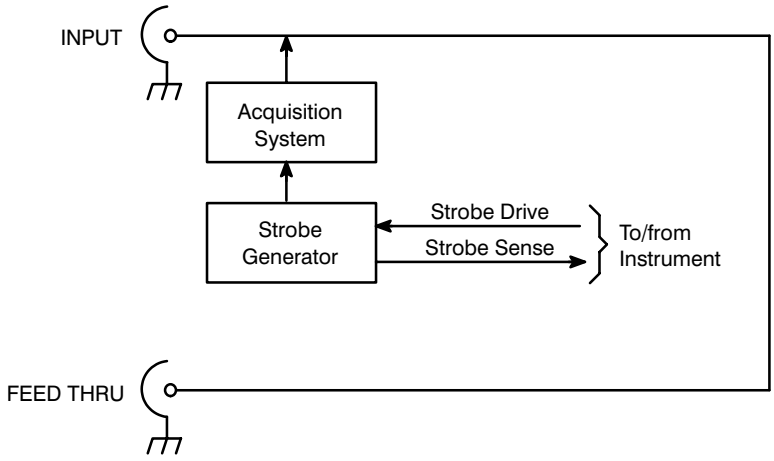


Figure 1: Block Diagram of the Sampling Head

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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 inside the instrument to maintain correct strobe timing.

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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. 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 insulators.

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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.

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Electrostatic Discharge

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

Acquisition circuitry in the sampling heads is very susceptible to damage from electrostatic discharge and from overdrive signals and DC voltages. Be sure to operate the sampling head only in a static-controlled environment. Be sure to discharge to ground any electrostatic charge that may be present on cables before attaching the cable to the sampling head.



To prevent damage from electrostatic discharge, install short-circuit terminations on the sampling head connectors before removing from an instrument or storing a sampling head. Store the sampling head in a static-free container, such as the shipping container. Whenever you move the sampling head from one instrument to another, use a static-free container to carry the sampling head.

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

Since the SD-20 Sampling Head has no internal terminations, use the following additional precautions:

- Never allow both the front panel connectors (INPUT and FEED THRU) to be open-circuited
- Only remove the terminations when absolutely necessary
- Internally terminate external generators (for example, the generators used in the TDR applications)

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Connector Care

The front of the sampling head has two precision 3.5 mm connectors: INPUT and FEED THRU. These connectors are for attaching the signal cable, device under test, or other device to the loop. These are high-precision connectors with a mechanical tolerance that is closer than the tolerance in standard SMA cables. Never attach a cable to a sampling head connector if the cable has a worn or damaged connector because the sampling head connector may be damaged.

Use extra care when attaching or removing a cable from the connectors. Turn only the nut, not the cable. When attaching a cable to a sampling head connector, align the connectors carefully before turning the nut. Use light finger pressure to make this initial connection. Then tighten the nut lightly with a wrench.

For best repeatability and to prolong the life of both connectors, use a torque wrench and tighten the connection to the range of 7–10 lb-in (79–112 N-cm).

If you are using sampling head connectors extensively, such as in a production environment, you should install adapters (for example, connector savers) on the sampling head to make connections to the device under test.

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Installing the Sampling Head

The SD-20 Sampling Head fits into the front panel of a compatible instrument, such as the 11801 Series Digital Sampling Oscilloscopes or CSA 803 Series Communications Signal Analyzers. Figure 2 shows the front panels 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.

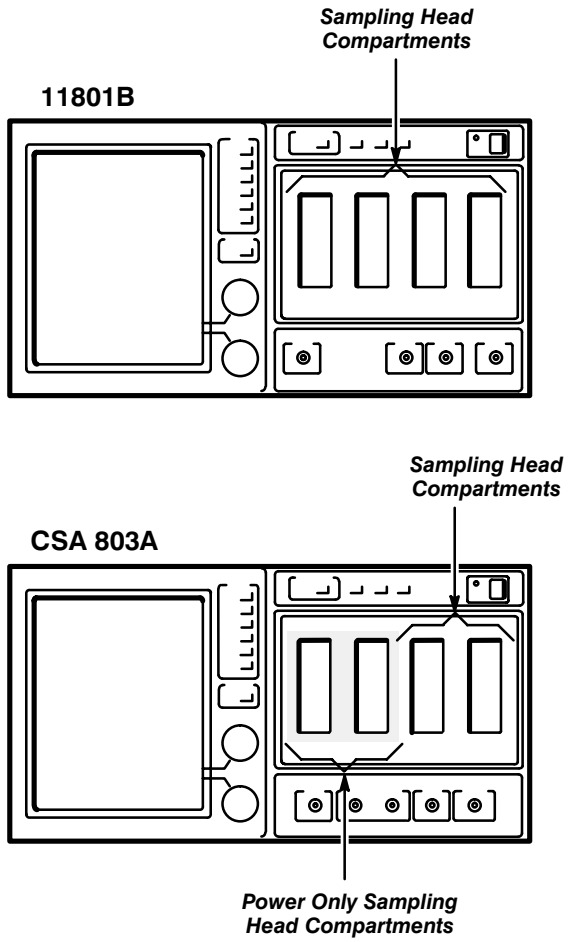


Figure 2: Sampling Head Compartments in an 11801B and a CSA 803A

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

CAUTION

To prevent damage to the sampling head or instrument, never install or remove a sampling head when the instrument's PRINCIPAL POWER SWITCH is ON (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 sampling head into place. See Figure 3.

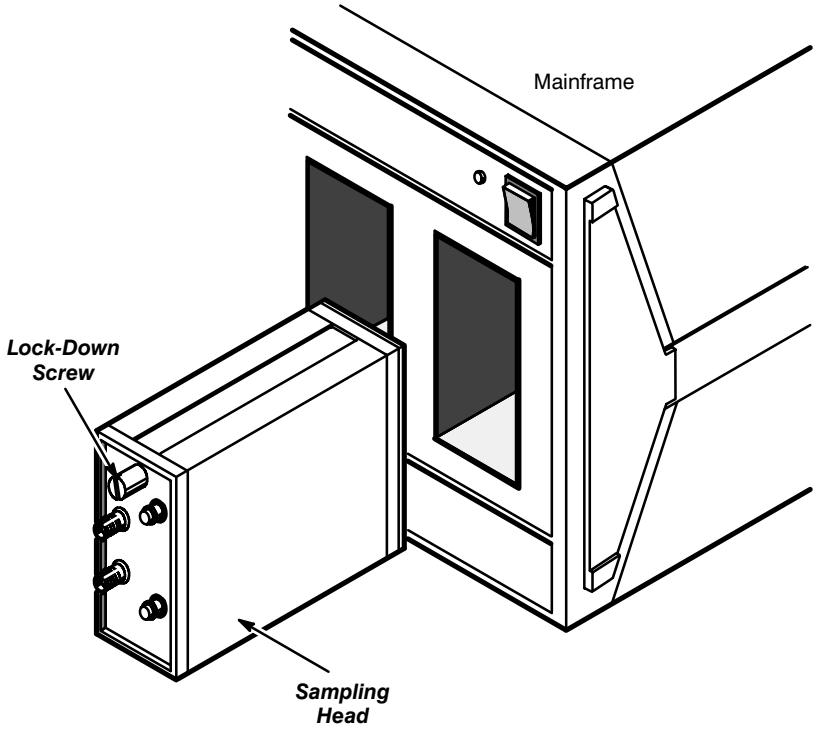


Figure 3: Installing a Sampling Head in an Instrument

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Using the Sampling Head

Figure 4 shows the front panel of the sampling head and identifies the buttons, lights, and connectors.

The loop has two 3.5 mm connectors for signal INPUT and FEED THRU, a SELECT CHANNEL button, and a yellow channel indicator light.

CAUTION

Applying a voltage outside the range ±3 V can result in damage to the sampling head or instrument. Use a wrist strap to prevent electrostatic damage to the sampling head or instrument.

The input diodes used in the sampling heads are very susceptible to damage from overdrive signals, DC voltages and electrostatic discharge. Never apply a voltage outside the range of ±3 V. Only operate the instrument and sampling head in a static-controlled environment.

Always use a wrist strap when handling sampling heads or making connections.

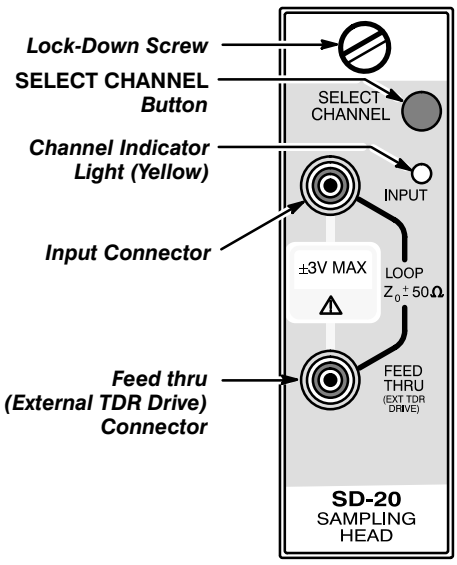


Figure 4: Sampling Head Front Panel

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Connecting Signals

The signal connectors allow you to connect a signal that you want to sample. These are precision 3.5 mm connectors that are mechanically compatible with the SMA standard.

The impedance of the loop is 50 Ω.

Typically, the signal is applied to the INPUT connector and a precision 50 Ω termination (for example, standard-accessory part number 011−0155−00) is installed on the FEED THRU connector. You can reverse connections to these connectors; however, you will no longer attain optimum performance.

Use extra care with the sampling head connectors. See Connector Care earlier in this manual.

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Button and Light

The sampling head 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 now 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 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.

Note that for the SD-20 Sampling Head, the instrument only recognizes the upper channel (for example, CH 1) labeled on the instrument, since the SD-20 Sampling Head is a one-channel sampling head. (The Tektronix SD-Series of sampling heads does include two-channel sampling heads, in which case the instrument recognizes both the upper and lower channels labeled on the instrument.)

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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. From the instrument you can also select smoothing and External Channel Attenuation. Smoothing reduces the noise in the signal before it is digitized.

External Channel Attenuation enables you to enter a number representing any external attenuation you have added to a channel.

Smoothing

There are two ways to set smoothing: from the instrument front panel or by sending a command from an ASCII interface.

To control smoothing from the front panel, access the Waveform major menu and the **Sampling Head Fnc's** pop-up menu. Figure 5 shows these two menus.

First select the channel for which you want to set smoothing. The **Selected Channel** section of the pop-up menu selects the channel. Touch the **Smoothing** selector to turn smoothing on or off.

The remaining selectors in this pop-up menu are for enabling time domain reflectometry (TDR) features if you are using the sampling head with an external step generator.

For more information on these remaining selectors, refer to Taking TDR Measurements later in this manual.

To set smoothing on or off from a remote interface (IEEE-488 or RS-232-C) use the following command:

- `CH<alpha><ui> SMOOTHING: ON | OFF`

where *<alpha>* indicates the unit letter (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 affect. For complete information about how to use the sampling head to display traces, see the appropriate *User Manual* for your instrument.

External Attenuation

To set External Channel Attenuation, use the following command:

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

where *<alpha>* indicates the unit letter (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 affect. For complete information about how to use the sampling head to display traces, see the appropriate *User Manual* for your instrument.

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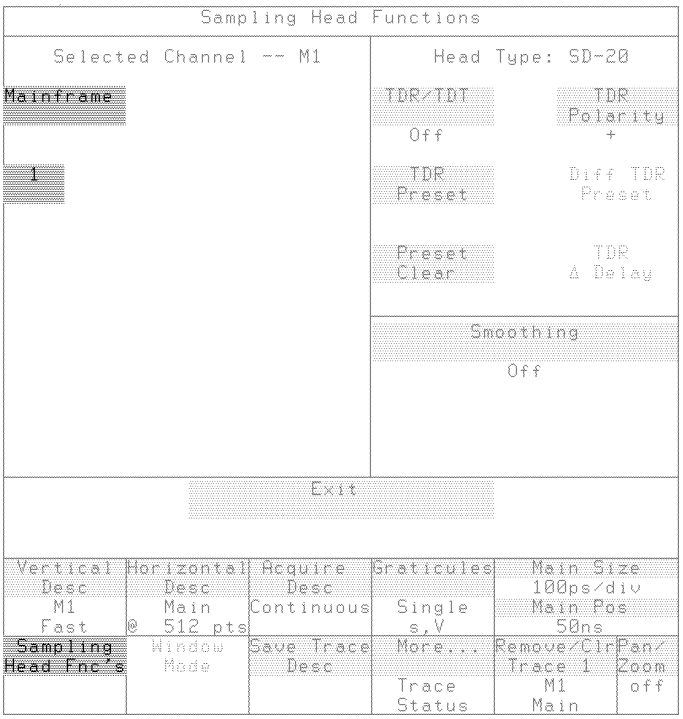


Figure 5: The Sampling Head Fnc's Pop-Up Menu

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Displaying a Trace

The following example shows you how to acquire and display a trace with the sampling head and using an 11800 Series or CSA 803 Series instrument. For this procedure you will need one 8-inch SMA cable.

- ☐ **Step 1:** Initialize the instrument to default settings using the **Initialize** selector which appears in the Utility major menu.
- ☐ **Step 2:** Connect your wrist strap to the antistatic connector on the front of your instrument.
- ☐ **Step 3:** Install a 50 Ω termination on the FEED THRU connector (for example, standard part number 011−0155−00).
- ☐ **Step 4:** Connect an SMA cable from the CALIBRATOR output to the sampling head.
- ☐ **Step 5:** From the Trigger major menu, set the trigger source to internal.
- ☐ **Step 6:** Press the SELECT CHANNEL button on the sampling head.

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 AUTOSET button above the sampling heads.

A display should appear similar to Figure 6.

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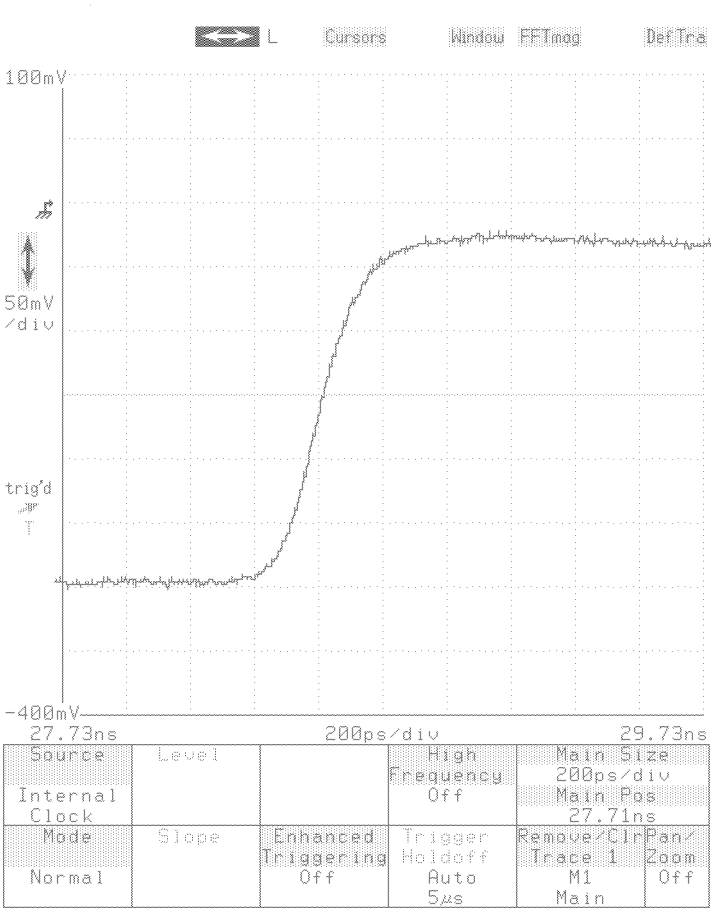


Figure 6: The Calibrator Signal after Pressing Autoset

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

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Adjusting Parameters

To get the best performance from your sampling head, you may need to adjust sampling head parameters. These parameters affect how the sampling head acquires signals and affect the accuracy of the resulting trace.

Typically, you may want to adjust sampling head parameters whenever you have moved the sampling head to another slot or if the ambient temperature has changed ±5° C since the parameters were last adjusted. At the factory, the parameters are set in an environment with an ambient temperature of 25° C.

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

NOTE

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

You can adjust the following two parameters on your sampling head:

- Loop gain
- Offset null

The actual procedure for performing the adjustment depends on the instrument. For the 11800 Series Oscilloscopes and the CSA 803 Series Communications Signal Analyzers, you can use the Enhanced Accuracy feature to adjust sampling head parameters. It is a quick and simple process. See the appropriate instrument's *User Manual* for instructions to perform these adjustments.

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Stored Parameters

The sampling head contains nonvolatile memory that stores two values, the factory default value and the user constant, for each of the above 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 many conditions.

If you decide to adjust a sampling head parameter, the new parameter is immediately applied to the head, but 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 instrument mainframe, the user constants for the sampling head parameters are unaffected.

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 appropriate instrument's *User Manual* for more information.

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Loop Gain

Loop gain determines the accuracy with which the sampling head accurately follows an input voltage change that occurs between two adjacent samples. The accuracy of the sampling head output as it 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.

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

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

Figure 7 shows displayed trace results for the three loop gain conditions.

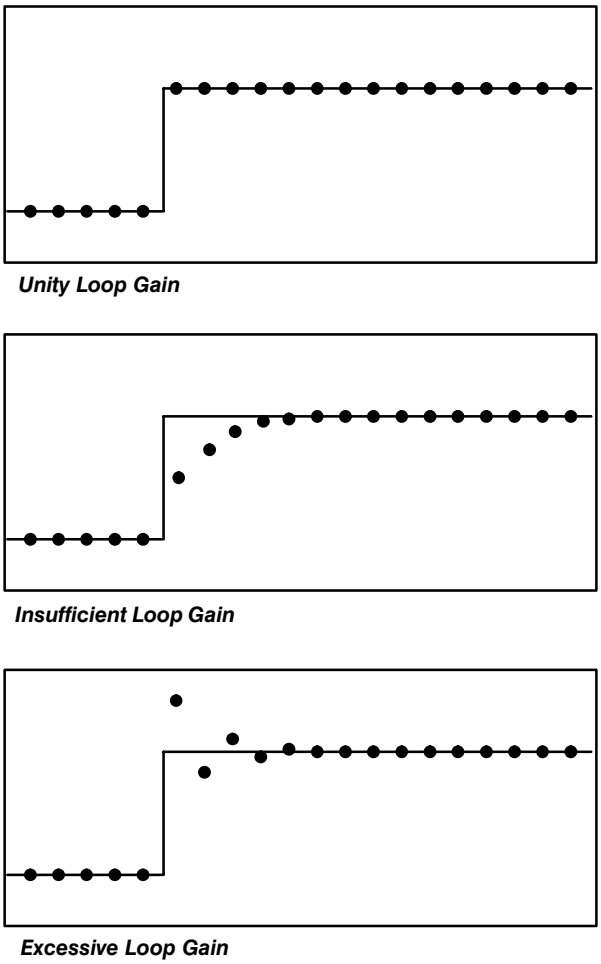


Figure 7: Displayed Trace at Various Loop Gain Settings

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Adjusting Loop Gain

You can adjust loop gain automatically or manually from the Enhanced Accuracy menu. If you prefer to adjust loop gain manually, the 11800 Series and CSA 803 Series instruments also provide a divide-by-two feature. This feature is helpful if you are using the Calibrator signal to adjust loop gain. You can also use the divide-by-two feature if you are using the trigger output of the instrument to trigger an external generator.

You might consider adjusting the loop gain whenever you are sampling a trace that has peak-to-peak voltages and transition-speed characteristics that are substantially different from the previous trace. In this case, you can use the actual signal that you want to measure and turn off vectoring so that you can see each sample individually.

For instructions on how to adjust the loop gain, see the Enhanced Accuracy section in the *User Manual* for your instrument.

The sampling head contains nonvolatile memory that stores two values, the factory default value and the user value, for the loop gain adjustment. These were discussed at the beginning of this section.

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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, measurements taken at the instrument will be incorrect. The absolute voltage values for any cursors displayed in the trace will also be incorrect.

Adjusting Offset Null

For the 11800 Series and the CSA 803 Series instruments, you can adjust offset null automatically or manually from the Enhanced Accuracy menu. If you prefer to adjust offset null manually, be sure to adjust the loop gain first.

To adjust offset null, terminate the channel INPUT connector with a 50 Ω termination and adjust the offset null (using the knob) so that the displayed trace is set to the 0 V position on the screen.

If you adjust offset null manually, the offset null setting is valid only for the current setting of the smoothing parameter (on or off).

For example, if smoothing is set to off and you adjust offset null manually, the offset null value will be invalid if you then turn smoothing on. However, the sampling head retains the offset null values when smoothing is on and off, so if you change the smoothing setting, the correct offset null value is applied.

Note that the sampling head stores four offset null values: the two factory default values for when smoothing is on and smoothing is off, and the two user constants for when smoothing is on and when smoothing is off.

Also, if you adjust offset null automatically using the Enhanced Accuracy menu, the 11800 Series and the CSA 803 Series instruments adjust both offset null values (smoothing on and smoothing off).

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Taking TDR Measurements

This section describes how to use the SD-20 Sampling Head to perform time domain reflectometry (TDR) measurements.

TDR Step Generator

An external step generator is necessary to use the SD-20 in a TDR system. Figure 8 shows a typical TDR setup using a Tektronix PG 502 Pulse Generator (where the DUT is the device under test).

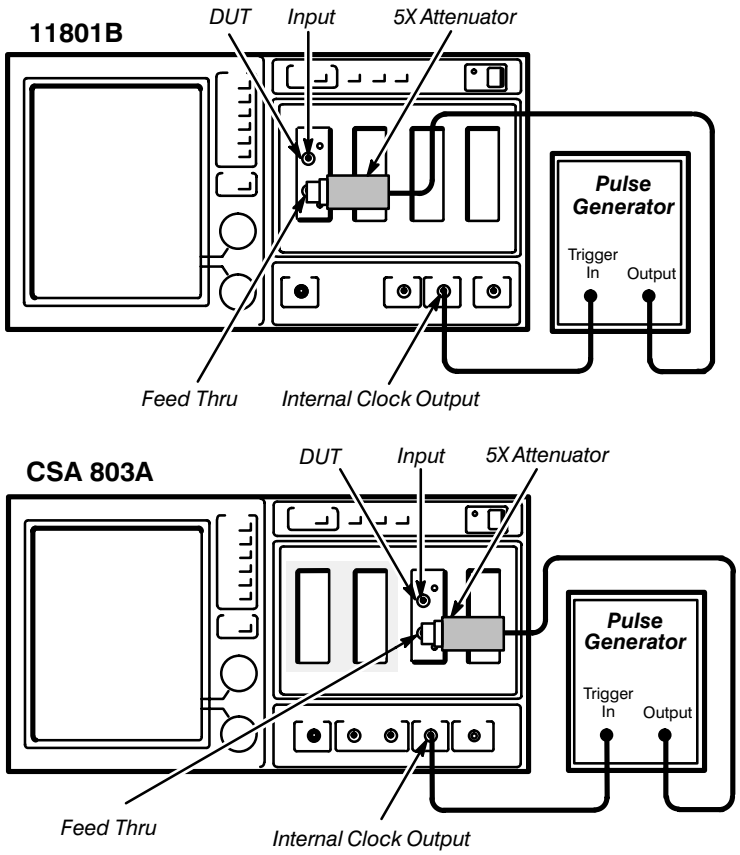


Figure 8: Typical TDR Setup

Instrument Mainframe

PRINCIPAL POWER SWITCH . . . . . ON

Pulse Generator

Back terminator button . . . . . Pull out

Trigger source . . . . . Ext trig

Duration . . . . . Square wave

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The output voltage of the step depends on the driver circuitry of the step generator as well as the DC resistance to ground of the device under test. The following sections describe the typical traces obtained with a short circuit, an open circuit, and a 50 Ω load, using a PG 502 Pulse Generator.

Operation with a Short Circuit

Assume for these cases that the step generator is modelled as an ideal switched current source shunted by a 50 Ω load, as shown in Figure 9 (you can model a PG 502 Pulse Generator using this configuration as well).

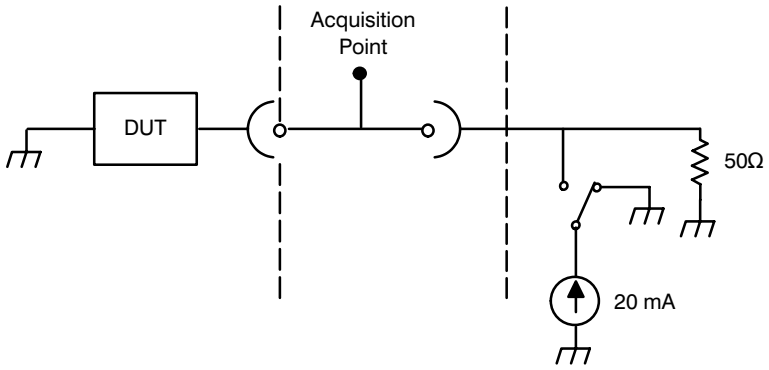


Figure 9: SD-20 Sampling Head and Step Generator Simplified Schematic Diagram

Initially, the switch is open and the voltage at the acquisition point is 0 V.

When the switch closes, apparent resistance to ground at the acquisition point (and at the channel connector) is 25 Ω, because the step generator termination resistance is 50 Ω and the connector impedance is 50 Ω. The voltage at the acquisition point rises to +500 mV. See Figure 10.

The transition propagates to the short in the device under test and is negatively reflected back to the acquisition point; cancelling the transition. The time displayed from the first transition to the second transition is the propagation time from the acquisition point to the short in the device under test and back.

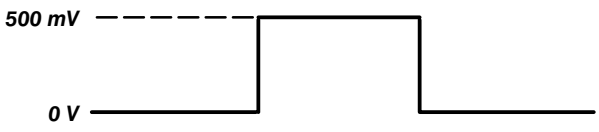


Figure 10: Step Generator with a Shorted Output

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Operation with a 50 Ω Load

Initially, the switch is open and the voltage at the acquisition point is 0 V. When the device under test is a 50 Ω load, the resistance to ground at the acquisition point is 25 Ω (because the step generator termination resistance is also 50 Ω). When the switch closes, the 20 mA current source places +500 mV at the acquisition point. See Figure 11.

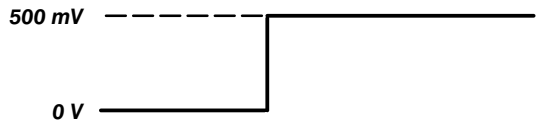


Figure 11: Step Generation with a 50 Ω Load

The matched impedance then allows the acquisition point then to remain at +500 mV.

Operation with an Open Circuit

Initially, the switch is open and the voltage at the acquisition point is 0 V. When the device under test is an open circuit, the resistance to ground at the acquisition point is 50 Ω (because the step generator termination resistance is 50 Ω impedance).

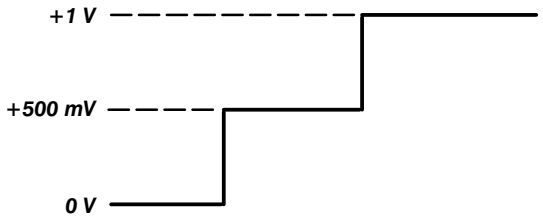


Figure 12: Step Generation with an Open Circuit

When the switch closes, the apparent resistance to ground at the acquisition point (and at the channel connector) is 25 Ω, because the internal circuit impedance is 50 Ω and the connector impedance is 50 Ω. The voltage at the acquisition point rises to +500 mV. See Figure 12.

The transition propagates to the open circuit in the device under test and is reflected back to the acquisition point, causing the voltage at the acquisition point to rise to +1 V. At the acquisition point, the time displayed from the first step to the second step is the propagation time from the acquisition point to the open in the device under test and back. See Figure 12.

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Baseline Correction

Baseline correction is a feature of the11800 Series and the CSA 803 Series instruments. This feature holds the displayed baseline of a trace in one location despite variations of the offset in the sampling head or in the external step generator. These offset variations are caused by changes in impedance at the device under test.

Baseline correction is especially useful with TDR/TDT measurements. Without baseline correction, changes in the DC resistance to ground for the cable or device under test might cause the entire step to move vertically on the display.

Baseline correction maintains the baseline in one location vertically. You can enable baseline correction from the **Graticules** pop-up menu. For more information on baseline correction, see the *User Manual* for your instrument.

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Example: Taking TDR Measurements

This example demonstrates the TDR feature of the SD-20 Sampling Heads. TDR is a method of examining and measuring a network or transmission line. Specifically, this method sends a step into a network and monitors the reflections.

For this example you will need a mainframe with at least one SD-20 installed and an external step generator. Also, you will need one SMA cable, preferably of 5 ns length. See Figure 13 for the equipment setup for this example.

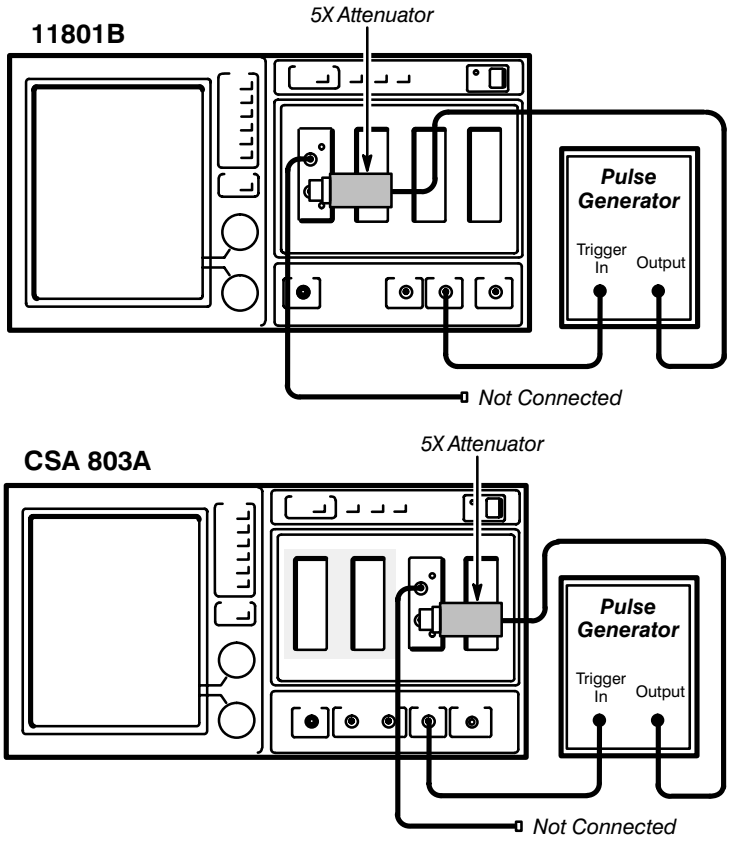


Figure 13: Setup for TDR Demonstration

- ☐ **Step 1:** Connect your wrist strap to the antistatic connector on the front of your instrument.
- ☐ **Step 2:** Connect an external step generator (as shown in Figure 13).
- ☐ **Step 3:** Initialize the oscilloscope (press UTILITY and touch **Initialize**).
- ☐ **Step 4:** Attach one end of the cable to the SD-20 Sampling Head INPUT (the other end should be unattached).
- ☐ **Step 5:** Press the SELECT CHANNEL button on the sampling head input channel that you have connected the cable.

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☐ **Step 6:** Press the WAVEFORM button and touch **Sampling Head FNCs** and **TDR Preset**.

☐ **Step 7:** Adjust the display sizes and positions to show a trace similar to that shown in Figure 14. You can also use AUTOSET and the vertical (↕) and horizontal (↔) icons to perform the fine adjustments.

NOTE

Leave at least one division of baseline trace to the left of the first rise.

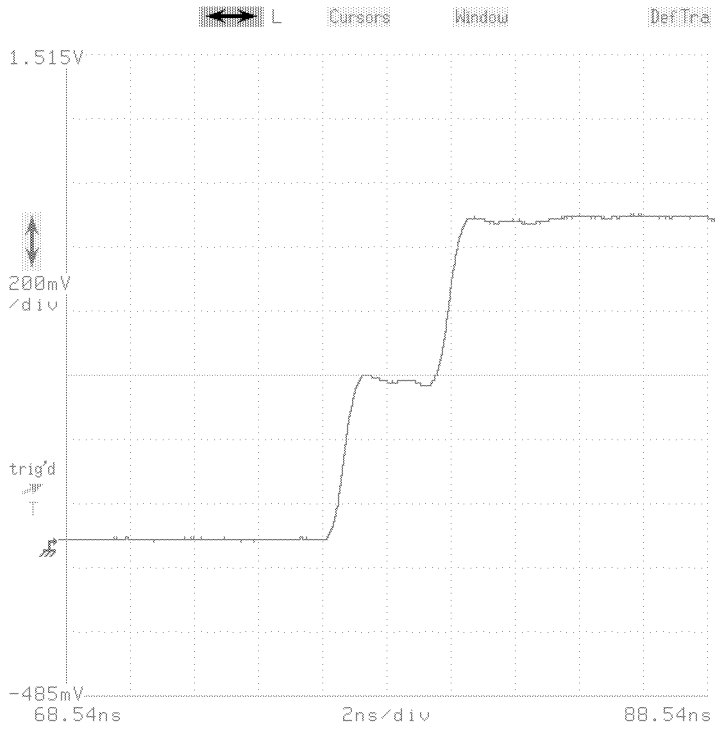


Figure 14: TDR Step and Reflection

The first rise of this trace is the incident TDR step leaving the sampling head; the second rise is the reflection of the step returning from the end of the cable.

Changing Graticule Units for TDR

The units of measure commonly used in TDR are units of rho (ρ), measured on the vertical axis, and time, measured on the horizontal axis. You can change the measurements by using the **Graticules** selector on the WAVEFORM major menu. See Figure 15.

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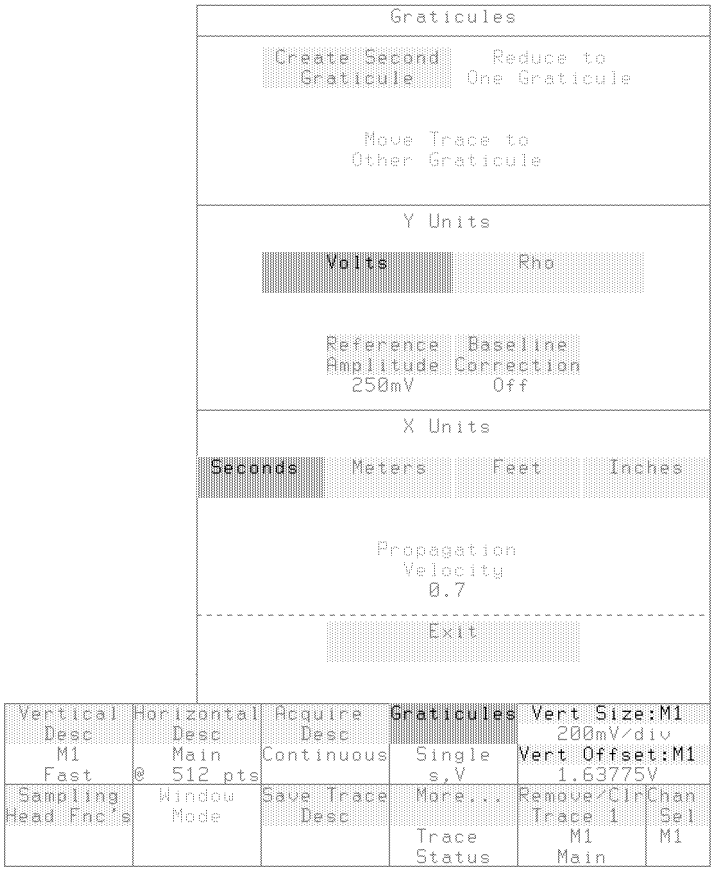


Figure 15: The Graticules Pop-Up Menu

Since the sampling head has no internal TDR generators, it has not been necessary to set TDR on/off, TDR polarity, and reference amplitude selectors. However, in order to properly scale the vertical axis to ρ units, you will need to set these selectors as described in the steps that follow.

☐ **Step 8:** Touch **Graticules** in the WAVEFORM major menu and **Inches**, **Feet**, or **Meters** in the pop-up menu. If you know that the propagation velocity of your cable differs from the default, touch the **Propagation Velocity** selector and adjust this parameter. If you do not know the velocity or are using Tektronix SMA cables, accept the 0.7 default value. This unitless number represents the fraction of the speed of light at which signals pass through your network or transmission line.

The horizontal axis is now calibrated in your chosen units of measurement.

NOTE

Measurements and cursor readouts are always expressed in the same units as the graticule axes.

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To set the vertical axis to rho, you need to enable **TDR**/**TDT** operation **Sampling Head Functions** pop-up menu, specify the amplitude (in volts) of the incident step that the external step generator sends through the cable, and specify TDR polarity as + or −. Then touch **Reference Amplitude** in the **Graticules** pop-up menu to assign both knobs to the incident step amplitude you specified.

- ☐ **Step 9:** Touch **Waveform** and then **Sampling Head FNCs** to verify that TDR/TDT is set to **On**. (If you used TDR preset, then TDR/TDT should be in this state.)
- ☐ **Step 10:** Select **TDR Polarity** as **+** or **−** according to the polarity of the external generator.
- ☐ **Step 11:** Touch the **Rho**.
- ☐ **Step 12:** If you need to set the reference amplitude, touch **Reference Amplitude** and use the knobs to set the desired value.
- ☐ **Step 13:** Touch **Exit** to remove the pop-up menu and view the trace and graticule.

The vertical axis is now displayed in rho.

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Other Triggering Configurations

If the external TDR generator lacks a trigger input capability, then the following alternate methods of using the sampling head to configure a TDR setup are available:

External Generator with Pre-Trigger Out

If the external generator has a pre-trigger out that leads the step out by the maximum insertion delay of your mainframe (24 ns for the 11801B) or more, you can connect a TDR system as shown in Figure 16. (For the 11800 Series Oscilloscopes, you will need to select **Source** in the TRIGGER major menu and **External** in the **Trigger Source** pop-up menu.)

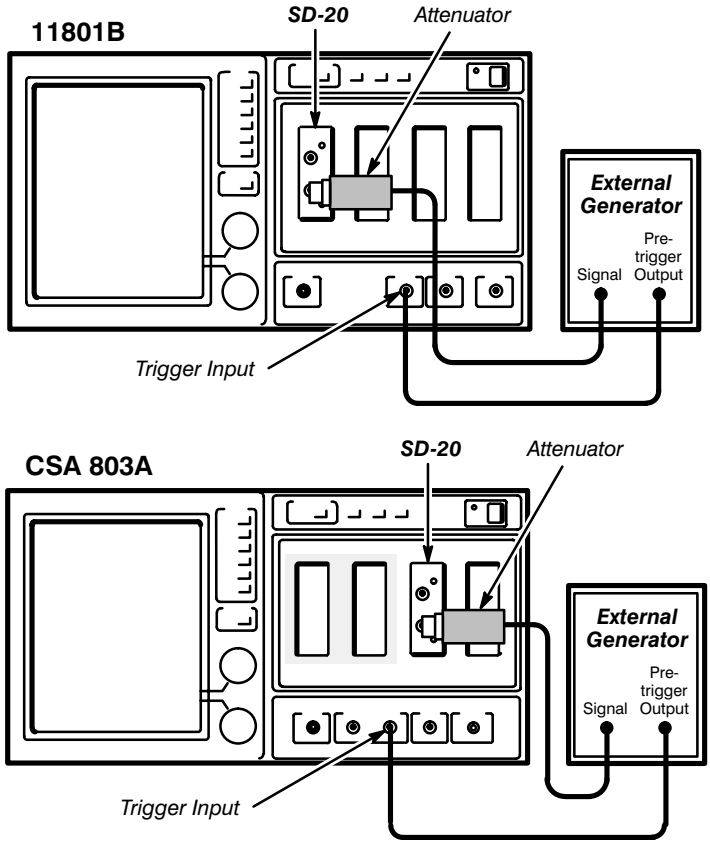


Figure 16: Setup for External Generator with Pre-Trigger Out

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External Free-Running Generator

If the external generator does not have a trigger in or a pre-trigger out capability, you can connect the TDR system as shown in Figure 17.

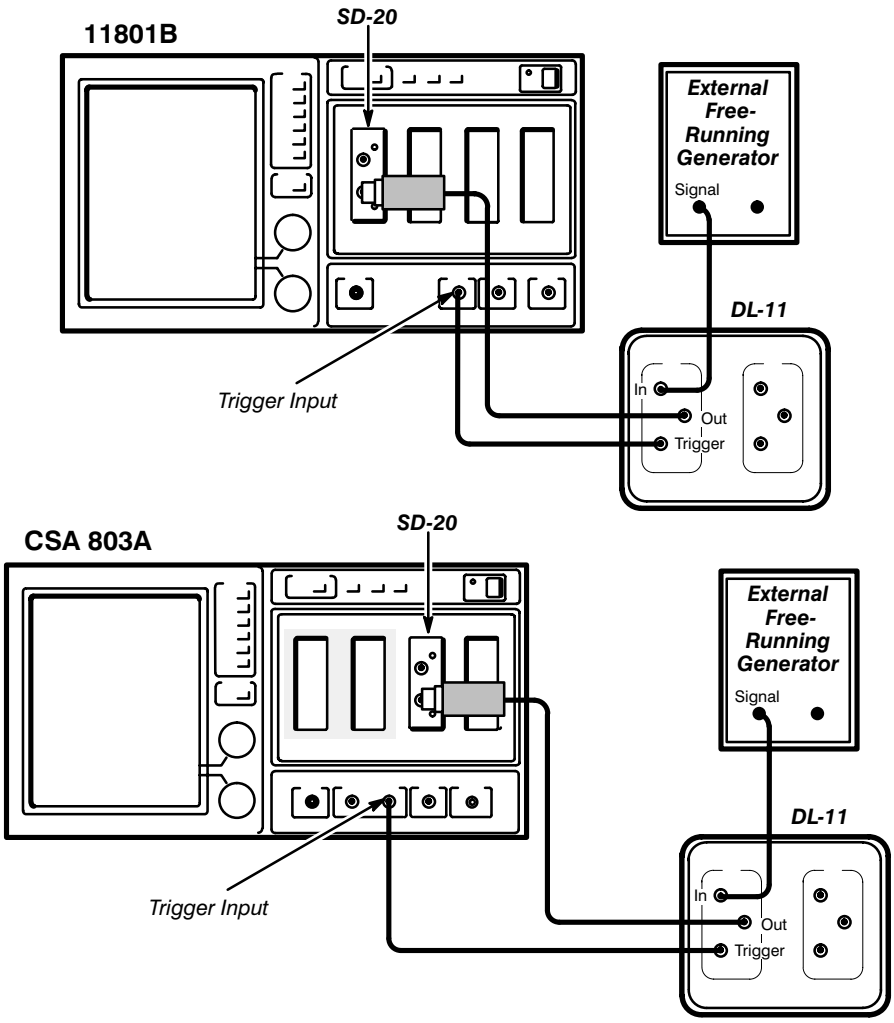


Figure 17: Setup for External Free-Running Generator

For the 11801 Oscilloscope, select **External Trigger**.

For more information on the DL-11 Delay Line, refer to the *DL-11 User Manual*.

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Specifications

Table 1: Acquisition Electrical Specifications

Characteristics	Specifications
Bandwidth	20 GHz typical
Sampling Repetition Rate	
Maximum	200 kHz
Minimum	100 Hz
Rise Time	17.5 ps or less, 10% to 90%
Reflected Rise Time	33 ps or less, 10% to 90%
Aberrations	
10 ns to 20 ps before step	±3% or less, typical
<300 ps after step	+10%, −5% or less, typical
300 ps to 5 ns after step	±4% or less, typical
5 ns to 100 ns	±1% or less, typical
elsewhere	±0.5% or less, typical
Maximum Safe Input Signal Voltage	±3 V
Maximum Operating Input	1.6 V_{p-p} (AC plus offset)
Maximum Signal Voltage	1.0 V_{p-p}
Dot Transient Response	
Accuracy after calibration at operating temperature	±5% for signals up to 0.5 V_{p-p}
Adjustment Range	Adjustable to unity for signals up to 1.0 V_{p-p}
Displayed Noise	
Unity Dot Response	1.2 mV_{RMS} max, 750 μV_{RMS} typical
With Smoothing	550 μV_{RMS} max, 350 μV_{RMS} typical

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Table 2: Environmental and Mechanical Specifications

Characteristics	Specifications
Weight	314 grams (11 oz)
Height	71.05 mm (2.9 in)
Width	23.28 mm (0.95 in)
Depth	91.39 mm (3.8 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)
MilSpec	Meets MIL−T−28800E, Type III, Class 5
Electromagnetic Compatibility	
United States	MIL−STD−461B: CE−03 Pt 4 Curve 1, CS−01 Pt 7, CS−02 Pt 4, CS−06 Pt 5, RE−02 Pt 7, RS−01 Pt 4, RS−02, Pt 5, RS−03 Pt 7 (limited to 1 GHz)

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Glossary

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

Baseline Correction
The process of maintaining the displayed vertical placement of a trace, correcting for changes in the signal levels that would ordinarily move the trace up or down.

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.

Incident Step
When making TDR measurements, the initial transmitted step on a single conductor.

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

Internal Clock
A trigger source that is synchronized with the Calibrator signal.

Reflected Step
When making TDR measurements, the step returned due to the reflection of the incident step, due to a mismatch in impedance.

Rho (ρ)
When making TDR measurements, the ratio of the incident step to the reflected step. A value of one (1) indicates complete reflection.

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

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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.

Time Domain Reflectometry (TDR)

A method of characterizing a transmission line or network by transmitting a signal from one end and monitoring the electrical reflections.

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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