11300A SERIES TIMING MEASUREMENT PRIMER

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PREFACE

There was a time not too far back when scopes were scopes and counters were counters. Now, the line between scopes and other measurement systems, such as logic analyzers, counters, and digitizers has blurred. This primer provides solutions to difficult measurement problems in precision timing analysis of complex signals using an instrument that integrates a precision counter/timer and an oscilloscope.

Historically, these problems were addressed with conventional counters connected to scopes. However, that was a make-shift answer at best. Now the Tektronix 11300A Counter/Timer Oscilloscopes provide the best of both worlds: the accuracy of counter/timer measurements coupled with the confidence of a visual oscilloscope display. This synergistic combination sets new standards in ease of use and measurement productivity.

This document provides information gathered from a variety of sources. In particular, thanks are extended to Paul Thompson, LID Marketing, and Clark Foley, LID Engineering.

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INTRODUCTION

THE COUNTER/TIMER PRIMER

Accurate and high resolution measurement of time is one of the key features of the 11300A Series oscilloscope. This is made possible by the built-in 10 digit 750 MHz Counter/Timer. This primer describes the capabilities and operating principals of the Counter/Timer and provides several examples of its use. The primer gives you the basic knowledge you need when using the Counter/Timer in your own applications. It may also suggest additional uses for your 11300A Series oscilloscope that can add to your measurement capabilities.

You will also find in the back of this primer a step-by-step procedure for quickly setting up the traces that show Counter/Timer operation.

THE COUNTER/TIMER: WHAT IT IS AND HOW IT WORKS

The Counter/Timer is a part of the 11300A Series oscilloscope that precisely measures time intervals. It uses these measurements to calculate frequency, period, and width. It also computes total counts, time between events, and event ratio between two inputs. (An "event" is a time interval beginning and ending with the transition of a waveform through a trigger level.)

A block diagram is shown in Figure 1. The bold lines represent paths that relate directly to the Counter/Timer circuit.

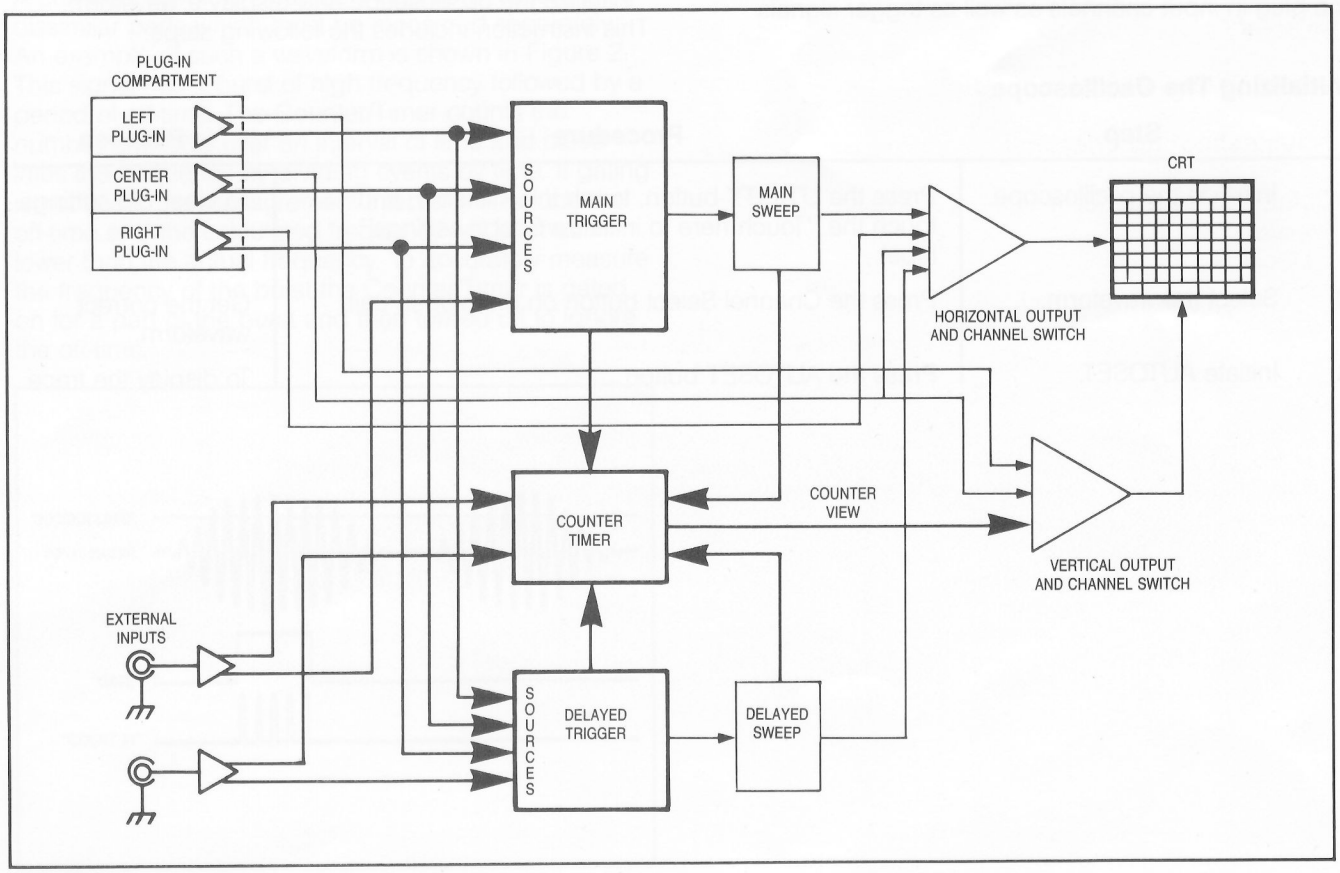

Figure 1. Counter/Timer block diagram.

There are six signal source paths entering the Counter/Timer. These paths originate from the:

- Main trigger circuit
- Delayed trigger circuit
- A external input
- B external input
- Main sweep (time base) generator
- Delayed sweep generator

The source paths to be measured by the Counter/Timer are selected from the touch screen Counter menus (which appear at the bottom of the screen when you press the MEASURE COUNTER button, located below the screen).

Note that the Counter/Timer does not make measurements directly on the plug-in signals. Instead, it measures time intervals between pulses received from the trigger circuits or from external trigger inputs. The plug-in signals are directed to the appropriate trigger circuits using the Trigger Source menu (shown on the screen when you press the TRIGGER SOURCE button, located beside the display screen).

COUNTER/TIMER FEATURES

A single-shot interval of time as small as 2 ns can be resolved by the Counter/Timer. In the averaging mode it can interpolate time intervals down to 10 ps when measuring repetitive waveforms. Frequency from less than 1 mHz up to 750 MHz can be accurately measured.

Measurements can be made on signals from any of the plug-in input channels as well as trigger signals from the A and B External Trigger/Counter Inputs. The Counter View feature displays traces on the screen that show exactly what part of the waveform is included in the timing measurement.

To measure a specific portion of a complex waveform, the trigger can be held off for a length of time or for a number of events.

Front-panel setups for Counter/Timer measurements can be stored in non-volatile memory. The stored setups can then be activated for a series of measurements with the touch of a button.

Reference values can be used in measurements to give delta readings for reduced operator error.

EQUIPMENT REQUIRED

In the following examples you are shown a typical measurement setup for each feature of the Counter/Timer. Many of the examples use waveforms that are taken from test points on the Tektronix CRS10/CRS30 demonstration unit. You do not have to have one of these units to use this primer, but you will need to use some other source that creates a similar signal. If you do have the demonstration unit you will find the number of each test point used in the setup listed in Table 2 at the back of this primer.

You will need an 11301A or 11302A oscilloscope with two 11A32 or 11A34 plug-in units and two P6134 probes.

For simplicity, each example begins with the instruction "Initialize the oscilloscope and display a waveform." This instruction includes the following steps:

Initializing The Oscilloscope

Step	Procedure	Purpose
1. Initialize the oscilloscope.	Press the UTILITY button, touch the Init label, and touch the "Touch here to initialize Scope settings" label.	To clear old settings.
2. Select the waveform.	Press the Channel Select button on the plug-in unit.	Get the correct waveform.
3. Initiate AUTOSET.	Press the AUTOSET button.	To display the trace.

GATED MEASUREMENTS

THE PURPOSE OF GATED MEASUREMENTS

When you want to make precise timing measurements on only a portion of a waveform, the Counter/Timer can be turned on for the duration of that portion, then turned off to exclude the remainder of the waveform. This is called a gated measurement. In this manner you can accurately measure a waveform feature buried in a complex waveform. Many conventional counter/timers can do this, but the user must supply the gating signal. This generally requires a separate oscilloscope to observe, position, and size the gating signal.

The 11300A Series Counter/Timer oscilloscope provides the gate necessary for most gated measurements, and provides the means of adjusting the interval and position of the gate to define the specific portion of the signal to be measured. The gate can be displayed on the screen along with the signal of interest so that there is no doubt that the measurement obtained is the one desired. Only the signal to be measured is applied to the oscilloscope; there is no need to create an external trigger signal.

If you wish to use an external gating signal instead of the internally generated gating signal, the gating signal is applied to the B Ext trigger input. Or a start/stop gating signal may be applied to the A and B Ext trigger inputs — the start-gate signal to the A Ext trigger input and the stop-gate signal to the B Ext trigger input.

A complex waveform may be made up of several dissimilar parts which must be measured separately. An example of such a waveform is shown in Figure 2. This signal has a burst of high frequency followed by a period of off-time. The Counter/Timer counts the number of events over an interval of time and calculates the frequency by dividing events by time. If gating is not used, the measurement interval will include the off-time and the calculated frequency will be much lower than the actual frequency. To accurately measure the frequency of the burst the Counter/Timer is gated on for a part of the burst and then turned off to ignore the off-time.

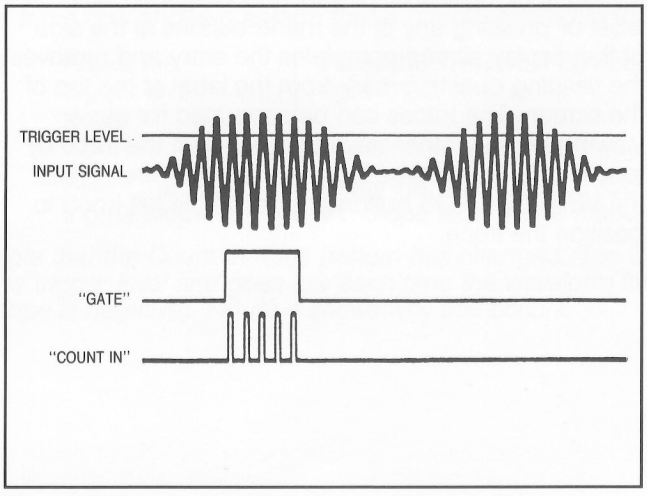

Figure 2. A gated measurement, showing the waveform, the Gate trace and the Count In trace.

SETTING UP FOR MEASUREMENTS

The following examples are performed with plug-ins in the left and center compartments. The probes are attached to Channel 1 of the left plug-in and Channel 1 of the center plug-in. These are named L1 and C1 respectively on the touch screen display. If you have a CRS10 with a CRS30 General Purpose board attached, the test point locations for the signals used in the examples are shown at the back of this primer in Table 2. If you do not have this demonstration signal source, you can use any other source that produces a waveform that is similar to that used in the example.

TURNING ON THE COUNTER/TIMER

The Counter/Timer is turned on by first pressing the MEASURE COUNTER button, located below the display screen. When this button is pressed twice, the Measure menu appears at the bottom of the screen. One of the Counter/Timer sub-menus appears at the bottom of the screen each time the Measure label is touched. All of these sub-menus and possible menu selections are shown in Table 1. The Counter/Timer begins measuring immediately when the sub-menu is selected if all necessary inputs are available to it.

Table 1

Counter/Timer Menus, Sub-menus, and Selections

(Button)

MEASURE COUNTER

(Touch Screen Menus)
Off Measure
Freq Measure
(Touch Screen Sub-menu and Selections)
Averages Auto, 1, 10^2, 10^4, 10^6, 10^8, 10^{10}
Gating B Ext, Ext A>B, Off, Dly1 Swp
Update Auto, Manual
Source Main Trig, Dly1 Trig, Dly2 Trig, A Ext
Period Measure
(Touch Screen Sub-menu and Selections)
Averages Auto, 1, 10^2, 10^4, 10^6, 10^8, 10^{10}
Gating B Ext, Ext A>B, Off, Dly1 Swp
Update Auto, Manual
Source Main Trig, Dly1 Trig, Dly2 Trig, A Ext
Width Measure
(Touch Screen Sub-menu and Selections)
Averages Auto, 1, 10^2, 10^4, 10^6, 10^8, 10^{10}
Gating B Ext, Ext A>B, Off, Dly1 Swp
Update Auto, Manual
Source Main Trig, Dly1 Trig, Dly2 Trig, A Ext
Total Measure
(Touch Screen Sub-menu and Selections)
Gating B Ext, Ext A>B, Off, Dly1 Swp>
Update Running, Stopped
Source M Trig, M&D1 Trig, A&B Ext, A Ext
Ratio Measure
(Touch Screen Sub-menu and Selections)
Averages Auto, 1, 10^2, 10^4, 10^6, 10^8, 10^{10}
Gating B Ext, Ext A>B, Off, Dly1 Swp
Update Auto, Manual
Source M&D1 Trig, M&B Ext, A&B Ext
Time A>B
(Touch Screen Sub-menu and Selections)
Averages Auto, 1, 10^2, 10^4, 10^6, 10^8, 10^{10}
Update Auto, Manual
Source M&D Trig, Swp Start, A&B Ext

COUNTER VIEW DISPLAY

The Counter View traces clearly indicate the part of the waveform that is included in the Counter/Timer measurement. Each trace is shown on the oscilloscope screen as a binary (two-level) waveform approximately one division in amplitude. The high level indicates activity and the low level indicates inactivity.

There are five Counter View traces. They are Count In, Gate, Sync Gate, A Ext and B Ext. They are initiated from the WAVEFORM menu.

Count In	Goes high for each event noted by the Counter/Timer.
Gate	Defines the interval within which the Counter/Timer can begin a measurement. It also defines the last event of the measurement interval.
Sync Gate	Displays the duration of the measurement interval.
A Ext	Displays the starting trigger signal.
B Ext	Displays the ending trigger signal.

The Waveform and Count View menus offer the following selections:

(Button)
WAVEFORM
(Touch Screen Menu Selections)
Scope
Ref
Count View
(Touch Screen Sub-menu Selections for Count View)
Count In
Gate
Sync Gate
A Ext
B Ext
Clear
Enter

When a selection is made by touching the label on the screen, that trace is displayed. Touching the Enter label or pressing any of the menu buttons at the side of the display screen completes the entry and removes the flashing question mark from the label at the top of the screen. The traces can be separated for easier viewing like any other waveform — select the trace by touching its label at the top of the screen, then press the VERTICAL POS button and rotate the left knob to position the trace.

THE COUNT IN TRACE

The Count In trace shows exactly what the Counter/Timer is measuring. By observing the Count In trace you can determine what part of the waveform is included by the Counter/Timer in its measurements. The trace goes to the high level each time an event is counted and remains high for the duration of the event interval.

For example, consider a sine wave. The Counter/Timer registers the start of an event when the sine wave first crosses the trigger level and the end of the event when the sine wave returns through the trigger level. If the trigger level is set to the mid-point of the sine wave, the Count In trace will appear as a square wave. If the trigger level is not set to the mid-point, then the event interval will be longer or shorter depending on the length of time between the crossings. An example is shown in Figure 3, with the trigger level set toward the upper part of the sine wave. The event interval, shown by the Count In trace beneath the sine wave, is greatly reduced. (The trigger level is shown in the figure by a manually positioned cursor line.)

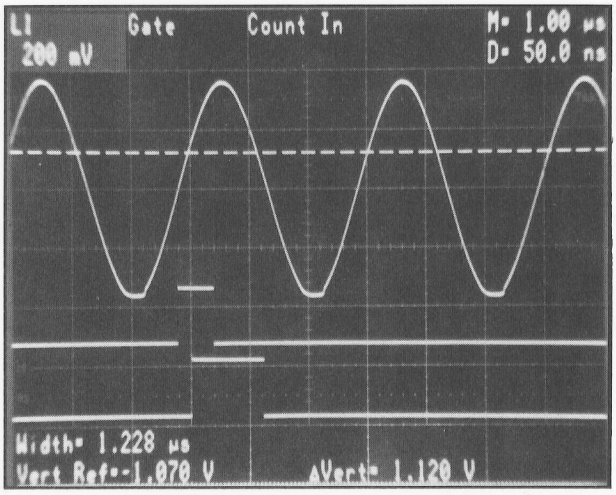

Figure 3. With the trigger set to a high level, the Count In event interval is reduced. Trigger level is indicated by the dashed cursor line.

Count in Trace

To view the Count In trace, initialize the oscilloscope, display a sine wave, and then:

Step		Procedure	Purpose
1.	Display the Waveform menu.	Press the WAVEFORM button.	To make menu selections.
2.	Display the Count View submenu.	Touch the Count View label.	For Counter View traces.
3.	Select the Count In trace.	Touch the Count In label.	To see the trace.
The Count In label appears at the top of the screen with a blinking question mark.			
4.	Complete the entry.	Touch the Enter label.	
This removes the question mark from the Count In label.			
5.	Remove the menu.	Press the WAVEFORM button again.	To display the traces.

At this point the Count In trace is a straight line if the Counter/Timer is turned off or is set to Time A > B. Turn on the Counter/Timer as described previously and select a measurement such as frequency or width. Note that the Count In trace now shows a pattern that is directly related to the crossing of the trigger level by the waveform.

6.	Adjust the trigger level.	Press the TRIGGER LEVEL button and rotate the right knob.	To set the Counter/Timer measurement starting point.
7.	Select the trigger slope.	Press the TRIGGER LEVEL button again and touch the Slope label in the menu.	To change the Count In trace.

Note that the Count In trace pattern has changed. The Count In trace goes high each time the waveform exceeds the trigger level and goes low each time the waveform falls below the trigger level (this is reversed when the trigger slope is negative). Figure 4 shows why this occurs.

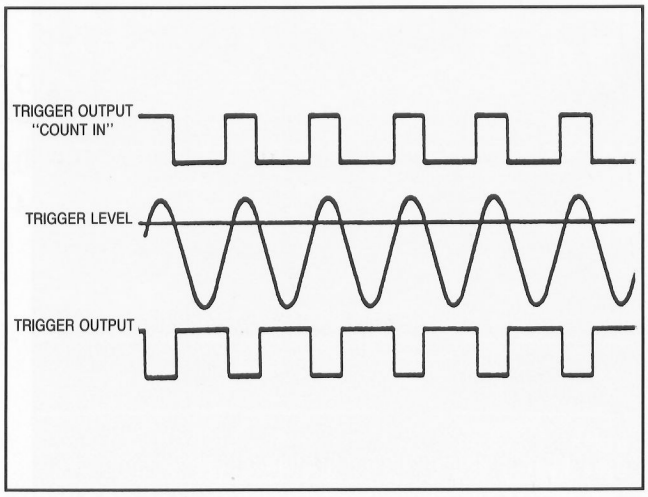

Figure 4. The Count In trace switches at each trigger level crossing.

The vertical position of the Count In trace can be changed to further separate the traces. Select the Count In trace by touching the Count In label at the top of the screen and then press the VERTICAL POS button and use the left knob to adjust the position.

If only a portion of the waveform is to be measured and the Counter/Timer is including unwanted areas of the waveform, you can use gated measurements to define the measurement interval.

THE SYNC GATE TRACE

The length of the measurement interval is shown by the Sync Gate trace. This is also useful for determining if the correct portion of the waveform is included in the measurement. When measuring frequency, for example, the number of events counted is divided by the duration of the Sync Gate. If the waveform is not uniform and the Sync Gate extends into the non-uniform area, then the frequency measurement may be meaningless.

Sync Gate Trace

To view the Sync Gate trace, initialize the oscilloscope, display the waveform, and then:

Step		Procedure	Purpose
1.	Display the Waveform menu.	Press the WAVEFORM button.	To make menu selections.
2.	Display the Count View submenu.	Touch the Count View label.	For Counter View traces.
3.	Select the Sync Gate trace.	Touch the Sync Gate label.	To view the measurement interval.
The Sync Gate label appears at the top of the screen with a blinking question mark.			
4.	Complete the entry.	Touch the Enter label.	
This removes the question mark from the Sync Gate label.			
5.	Remove the menu.	Press the WAVEFORM button again.	To view the traces.

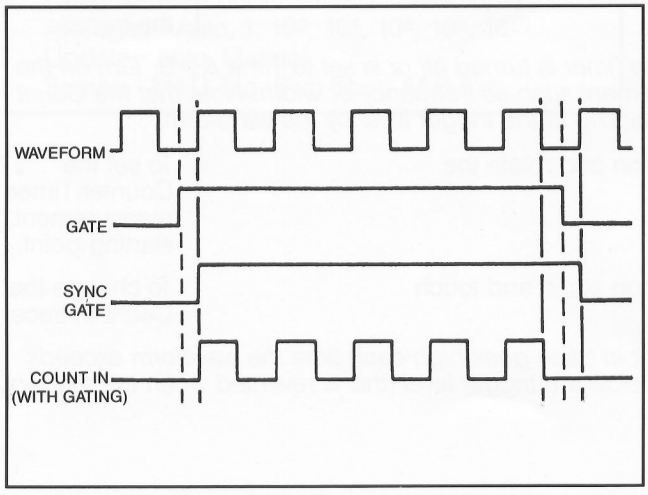

Figure 5. The relationship between a waveform and the Counter View traces.

In gated measurements the measurement interval begins at the start of the first event and continues to the end of the last event that began within the Gate interval. This relationship is shown in Figure 5. In non-gated measurements, the measurement interval lasts for the duration of the sweep.

GATED FREQUENCY MEASUREMENTS

A gated frequency measurement may be required when a complex waveform is examined. An example of a complex waveform is one containing bursts of high frequency.

Measurement accuracy requires that the counter is turned on only during the time that the waveform feature to be measured is present, and turned off during the time that the feature is not present.

The Gate does not control the length of time that the Counter/Timer runs. Its purpose is instead to define the point after which the first event will start the measurement. Once started, the Counter/Timer runs until the conclusion of the last event that began within the Gate interval. The Gate can be adjusted in width and positioned as desired.

Gated Frequency Measurement

To make a gated frequency measurement, initialize the oscilloscope, display a waveform, and then:

Step		Procedure	Purpose
1.	Move the trace to the top of the screen.	Press the VERTICAL POS button and rotate the left knob	For clearer viewing.
2.	Display the Counter/ Timer menu.	Press the MEASURE COUNTER button twice to display the menu.	To make menu selections.
3.	Display the Freq Measure sub-menu.	Touch the Measure label at the lower right of the screen to change sub-menus.	To make frequency measurements.
4.	Set to Dly1 Swp Gating.	Touch the Gating label to change to Dly1 Swp Gating.	To activate the Gate.

The position in time of the gating pulse is now controlled by the delay time of Dly1 Swp Gating. The Gate trace is not yet on the screen. The Gate trace is required in order to view the position and length of the Gate.

To view the Gate trace:

Step		Procedure	Purpose
5.	Display the Waveform menu.	Press the WAVEFORM button to display the menu.	To make menu selections.
6.	Turn on the Gate trace.	Touch the Gate label and then the Enter label.	To view the Gate location.
7.	Remove the menu.	Press the WAVEFORM button again.	To view the traces.

The waveform is now in the upper part of the screen and the Gate trace is at center screen.

The next step is to adjust the time position and size of the Gate to match the portion of the waveform to be measured. This is done as follows:

8.	Display the Horizontal menu.	Press the HORIZONTAL SIZE button twice.	To make menu selections.
9.	Select Del'd Time Base.	Touch the Time Base label to display Del'd Time Base.	To control Gate interval and position.
10.	Adjust the Gate interval.	Adjust the width (interval) of the Gate pulse with the right knob until it is more than half as wide but no wider than the portion of the waveform to be measured.	For control of the starting point.

The exact width of the Gate is not critical, so long as the waveform is uniform and at least the start of one cycle of the waveform is included in the Gate interval.

11.	Display the Delay menu.	Press the HORIZONTAL DELAY button twice to display the menu.	To make menu selections.
12.	Set to 1 Delay.	Touch the Delay label to set to 1 Delay.	To select Delay 1.
13.	Set to Runs After Delay.	Touch the After Dly label to set to Runs After Delay.	To select Runs After Delay.
14.	Position the Gate.	Rotate the right knob to change Gate position by adjusting the delay.	To set the measurement starting point.

The leading edge of the Gate indicates the end of the delay time (which is measured from the instant of the Main trigger pulse). When the Counter/Timer is in the Runs After Delay mode, the width of the Gate interval indicates the length of time during which events can be accepted to start the Counter/Timer. An event beginning before or after the Gate interval will not start the Counter/Timer. If no event begins within the Gate interval, the display will show "COUNTER: Waiting to Start Measurement."

Once started, the Counter/Timer will run until the completion of the last event that began during the gate interval. These relationships were shown in Figure 5.

If additional events occur within the width of the gate, the time between each event is measured and the measurements are averaged. The Count In trace shows the events included in the measurement and the Sync Gate trace shows the total measurement interval.

Count In Trace plus Gate Trace

To display the Count In trace in addition to the Gate trace, perform the following steps:

Step		Procedure	Purpose
1.	Display the Waveform menu.	Press the WAVEFORM button to display the menu.	To make menu selections.
2.	Select Count In.	Touch the following labels in the order shown: Count View, Count In, Enter.	To select the Count In trace.
3.	Remove the menu.	Press the WAVEFORM button to remove the menu.	To view the trace.
4.	Relocate the Count In trace.	Press the VERTICAL POS button and rotate the left knob to move the Count In trace to an open area of the screen.	For easier viewing.

Remember that the trigger level, Gate width, and Gate position control the portion of the waveform included in the measurement. The Count In trace visually confirms that only the correct portion is included. In Figure 6 a manually positioned cursor (dotted line) is used to show the trigger level, the Gate pulse appears at mid screen, and the Count In trace is at the bottom. Note that the leading edge of the Gate pulse (end of the delay time) is positioned ahead of the area to be measured. The measurement begins with the first positive transition to go above the trigger level, as verified by the first pulse of the Count In trace. Two more positive transitions occur within the Gate width, and these are also measured. The forth positive transition in the sequence occurs beyond the end of the Gate pulse, and is not included.

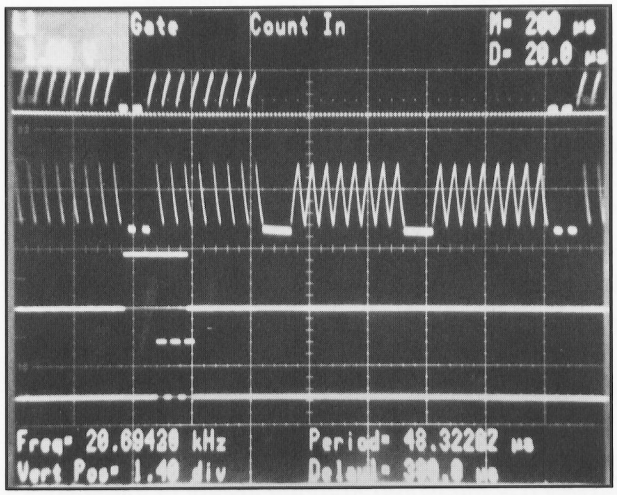

Figure 6. A complex waveform with trigger level, Gate pulse, and Count In trace displayed.

The Counter View traces blink each time that the Counter/Timer resets for the next measurement.

GATED WIDTH MEASUREMENTS

A typical measurement problem when working with digital circuits is determining the width of a single pulse in a mixed pulse train. Using gated width measurements, the oscilloscope can measure the width of one out of many disimilar pulses.

To make a gated width measurement, initialize the oscilloscope and display a waveform, then:

	Step	Procedure	Purpose
1.	Position the waveform to the top of the screen.	Press the VERTICAL POS button and rotate the left control knob to move the waveform to the top half of the screen.	For clearer viewing.
2.	Display the Counter/ Timer Measure menu.	Press the MEASURE COUNTER button twice to display the menu.	To make menu selections.
3.	Select the Width Measure sub-menu.	Touch the Measure label at the lower right corner of the screen to change sub-menus until the Width sub-menu appears.	To make width measurements.

The width measurement begins immediately, with measurement results displayed above the menu area. At this point it is not clear what portion of the waveform is being measured for width. The Counter View traces, Gate (to define the starting point) and Count In (to assure the correct pulse), are set up by the following steps to assure that only the pulse of interest is being measured.

4.	Set to Dly1 Swp Gating.	Touch the Gating label to change to Dly1 Swp Gating.	To turn on the Gate.

(The width measurement readout may be replaced by the message, "COUNTER: Waiting to Start Measurement.")

5.	Display the Waveform menu.	Press the WAVEFORM button to display the menu.	To make menu selections.
6.	Turn on the Gate trace.	Touch the labels in the following sequence: Count View, Gate, and Enter.	To view the Gate.
7.	Turn on the Count In trace.	Touch the Count In label then the Enter label.	To view the Count In trace.
8.	Remove the menu from the screen.	Press the WAVEFORM button again to remove the menu.	To view the traces.
9.	Separate the Count In trace from the Gate trace.	Press the VERTICAL POS button and rotate the left knob to move the Count In trace toward the bottom of the screen.	For easier viewing.

The Gate defines the starting point of the width measurement. It must be positioned so that the leading edge of the pulse to be measured lies within the width of the Gate. The slope of the pulse leading edge also must be defined.

10.	Display the Trigger menu.	Press the TRIGGER LEVEL button twice to display the menu.	To make menu selections.
11.	Select Dly1 Trigger.	Touch the Trigger label to make the selection.	For correct starting point.
12.	Select trigger slope.	Touch the Slope label to make the selection.	To set trigger slope.
13.	Activate the delay.	Press the HORIZONTAL DELAY button twice. The Delay label should display 1 Delay.	So that the Gate can be positioned.
14.	Position the Gate.	Move the Gate beneath the leading edge of the pulse to be measured, using the right control knob.	To set the measurement starting point.

Note that the Count In trace displays a pulse that is the same width as the measured pulse. Also note that the pulse width value is displayed near the bottom of the screen, just above the vertical position readout.

TIME INTERVAL WITHIN A PULSE TRAIN

When two events in a pulse train are separated by other events, the measurement of time between the two becomes more difficult with conventional counter/timers. The 11300A Series oscilloscope provides a simple solution to the problem. In the following example three methods of measurement are described. The first uses the Delta Delay feature to determine the time between window waveforms. The second uses the Counter/Timer to make the same measurement. The third, and most accurate, uses the Counter/Timer to measure the time between selected trigger points on the pulse train.

To make a measurement of time interval within a pulse train, first initialize the oscilloscope and display a waveform, then:

	Step	Procedure	Purpose
1.	Move the waveform to the top of the screen.	Press the VERTICAL POS button and rotate the left control knob to move the waveform to the top half of the screen.	For easier viewing.
2.	Display the Time Base menu.	Press the HORIZONTAL SIZE button twice to display the menu.	To make menu selections.
3.	Set to Dly'd Time Base.	Touch the Time Base label until Dly'd Time Base appears.	To select Dly'd Time Base.
4.	Display the Delay menu.	Press the HORIZONTAL DELAY button twice to display the menu.	To make menu selections.
5.	Turn on Window 1.	Touch the Window 1 label to display On Window 1.	To select Window 1

The Window 1 trace should now appear at mid-screen. If it does not, the intensity of the delayed trace or the horizontal size of Window 1 may require adjusting.

6.	Adjust size of Window 1.	Press the HORIZONTAL SIZE button and rotate the right control knob to change the size of the Window 1 trace.	To view Window 1.

Note that as you rotate the knob, the intensified zone on the waveform changes in length.

7.	Move the intensified zone to the pulse to be measured.	Press the HORIZONTAL DELAY button and rotate the right knob to move the intensified zone so that it encompasses the leading edge of the first pulse of interest.	To select the desired pulse.
8.	Turn on Window 2.	Press the HORIZONTAL DELAY button again and touch the Window 2 label to display On Window 2.	To view the second window.
9.	Move Window 2 to the leading edge of the second pulse.	Rotate the right knob to move the Window 2 intensified zone to the leading edge of the second pulse.	To select the desired pulse.

You should now have intensified zones on the leading edges of the two pulses and two window traces. You can now make measurements using the Delta Delay readout or the Counter/Timer.

Delta Delay Measurement

To use the Delta Delay for measuring time between delayed windows:

	Step	Procedure	Purpose
1.	Match the leading edges of the two window traces.	Superimpose the leading edges of the two window traces exactly, using the right knob.	For Delta Delay measurement.

You may need to press the FINE button next to the knob to increase knob resolution for a perfect match of the traces.

The Delta Delay readout near the bottom of the screen shows the time between the two events. This is a visual/mechanical measurement and is not as accurate as a Counter/Timer measurement.

Counter/Timer Measurements Between Delayed Windows

To use the Counter/Timer for measuring time between delayed windows:

	Step	Procedure	Purpose
1.	Display the Counter/ Timer menu.	Press the MEASURE COUNTER button twice to display the menu.	To make menu selections.
2.	Set to Time A>B.	Touch the Measure label until it displays Time A>B Measure.	To make time interval measurements.

The TimeD1>D2 display near the bottom of the screen shows the time between the delayed windows. This reading is more accurate than the Delta Delay reading, but should be within about one percent of that reading. For greatest accuracy, the measurements should be made between trigger points on the two events.

To use the Counter/Timer to measure time between events:

3.	Display the Trigger Level Menu.	Press the TRIGGER LEVEL button twice to display the menu.	To make menu selections.
4.	Select Dly1 Trigger.	Touch the Trigger label until it displays Dly1 Trigger.	To select the Dly1 Trigger.
5.	Set the trigger level.	Set the trigger level to a value somewhere near the midpoint of the pulse amplitude using the right knob.	For a consistent trigger point.
6.	Select Dly2 Trigger.	Touch the Trigger label until Dly2 Trigger appears.	To select the Dly2 Trigger.
7.	Match the trigger levels.	Set the Dly2 trigger level to exactly the same level set for the Dly1 trigger.	For an accurate measurement.

If the pulses are of different amplitudes, set the trigger levels to somewhere near the midpoint of each pulse. Press the FINE button next to the right knob if greater resolution is needed.

8.	Display the Delay menu.	Press the HORIZONTAL DELAY button twice to display the menu.	To make menu selections.
9.	Select Triggered After Delay	Touch the After Dly label to change to Trig'd After Dly.	For delayed trigger.
10.	Move the intensified zone to the leading edge.	Rotate the right knob to position the intensified zone on the leading edge of the selected event.	To select the event.

Note that as the knob is rotated, the intensified zone now jumps from one pulse to the next, rather than moving smoothly through the pulse train.

The right knob can move either intensified zone. The selection is made by touching the Delay label in the Horizontal Delay menu to select 1 or 2.

The Counter/Timer and Delta Delay readings may no longer agree. This is because the Delta Delay reads the difference between the delayed times at which the triggers are enabled, not the time between the trigger points themselves. As the trigger enable point moves nearer the actual trigger point (by rotating the right knob) the two measurements will come into closer agreement.

The diagram in Figure 7 shows the relationships between the measurement points.

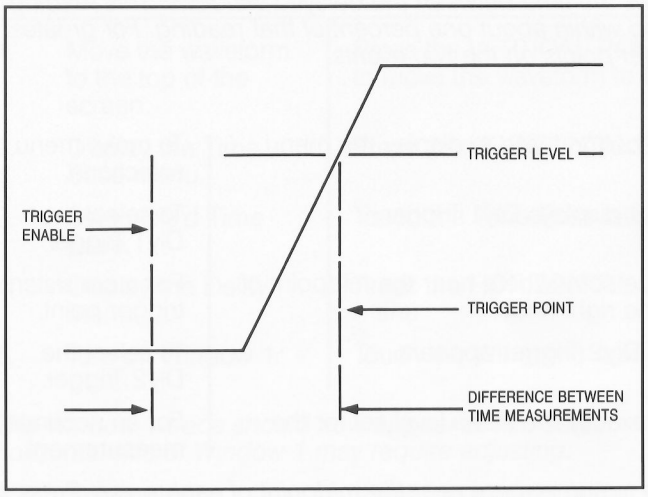

Figure 7. The measurement points are different for each measurement method.

TIME INTERVAL MEASUREMENTS

Measurement of time between events on two different complex waveforms is a simple task for the 11300A Counter/Timer oscilloscope. Measurements such as propagation delay and multi-phase clock timing can be made easily.

PROPAGATION DELAY

Signal delays through components or through circuit blocks can be critical to circuit performance. Race conditions, glitches, and bus contention can result, causing erratic operation or circuit failure. One of the most common measurements used to locate these problems is propagation delay.

There are several ways in which the Counter/Timer can make a propagation delay measurement. In the following example the M>D Trig mode is used. In this mode the Counter/Timer measures the time interval between the occurrence of a main trigger event and the next following occurrence of the delayed trigger event.

SETTING UP FOR MEASUREMENTS

Two inputs are used in the example. Channel L1 receives the leading signal and the lagging signal is fed to Channel C1. Any two channels could be used, so long as they are in separate plug-in compartments. This is because only one input from each plug-in compartment can be selected as a source for the trigger circuits. The M>D Trig mode cannot be used to measure two signals from the same plug-in.

Propagation Delay Measurement

To measure propagation delay, initialize the oscilloscope, display the two waveforms, then:

Step		Procedure	Purpose
1.	Separate the waveforms.	Press the VERTICAL POS button, select a waveform, then rotate the left knob to move a waveform toward the top half of the screen.	For clearer viewing.
2.	Display the Trigger Source menu.	Press the TRIGGER SOURCE button to display the source menu.	To make menu selections.
3.	Display the Main sub-menu.	Touch the Main label to display the possible sources.	To make menu selections.
4.	Select Channel L1.	Touch the L1 label and then the Enter label to select Channel L1. The readout at the left of the menu states "Main Trig=L1".	For the 1st trigger source.
5.	Display the Delayed Trigger sources.	Touch the Dly1 label at the lower left of the screen to display the possible Delayed Trigger 1 sources.	For source selection.
6.	Select Channel C1.	Touch the C1 label and then the Enter label to select Channel C1. The readout at the left of the menu states "Dly1 Trig=C1".	For the 2nd trigger source.
7.	Remove the menu.	Press the TRIGGER SOURCE button again to remove the menu.	To view the traces.
With the trigger sources selected, the next step is setting trigger level and slope.			
8.	Display the Trigger menu.	Press the TRIGGER LEVEL button twice to display the Trigger menu.	To make menu selections.
9.	Set to Main Trigger, if necessary.	Touch the Trigger label to display Main trigger.	To set up the Main trigger.

Propagation Delay Measurement (continued)

Step		Procedure	Purpose
10.	Set the level near the midpoint of the pulse amplitude.	Rotate the right knob to adjust the trigger level.	For proper triggering.
11.	Change trigger slope, if necessary.	Touch the Slope label to select + or −.	For proper slope.
12.	Set to Dly1 Trigger.	Touch the Trigger label to display Dly1 Trigger.	To set up the Delay 1 trigger.
13.	Set the Dly1 trigger level to the same level as the Main level.	Rotate the right knob to set the trigger level. If pulse amplitude is different, set the level somewhere near the midpoint of the pulse amplitude.	For a repeatable measurement.
14.	Change trigger slope, if necessary.	Touch the Slope label to select + or −.	For proper slope.

Now that the trigger level and slope are set, the Counter/Timer is brought into action.

15.	Display the Measure menu.	Press the MEASURE COUNTER button twice to display the menu.	To make menu selections.
16.	Set to Time A>B Measure.	Touch the Measure label to change to Time A>B Measure.	To measure delay.
17.	Set to M&D Trig Source.	Touch the Source label to change to M&D Trig Source.	To measure the delay between Main and Delay triggers.

The time difference between the main and delayed trigger points is displayed at the lower left of the screen, as shown in Figure 8. Note that the measured value is the time difference between the actual trigger points and is not related to the horizontal size of the display.

Trigger level plays an important part in propagation delay measurements. If the trigger level is adjusted away from the mid-point of the measured pulse, the delay time (time between trigger points) may change substantially. This is especially true for waveshapes other than clean square waves. As an example, the delay time measurement for the waveforms in Figure 8 changed by 65 percent when the trigger levels were set to the top of one pulse and the bottom of the other.

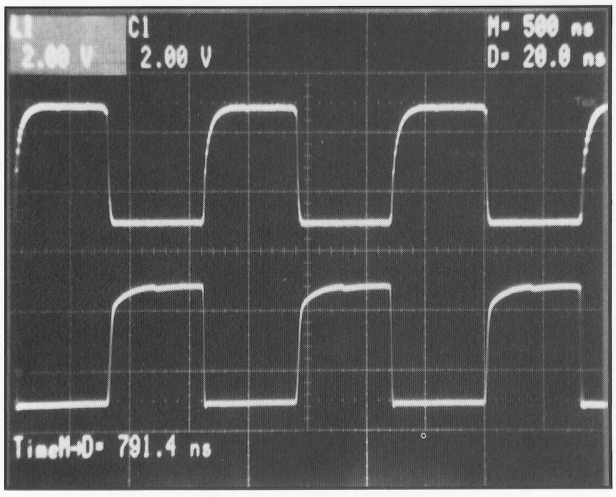

Figure 8. Propagation delay measurement between pulses from two channels.

EVENT RATIOS

When checking the operation of a phase locked loop, divider, or other circuit where two signals of different frequencies must maintain a fixed relationship with each other, the Counter/Timer provides an easy means for measuring the ratio.

Ratios between events occurring on separate signals are measured in the Counter/Timer Ratio measurement mode. During the measurement interval the number of events in one signal is divided by the number of events in the other signal.

The two signals are applied to the oscilloscope in one of three combinations: Main and Delay trigger, A and B External inputs, or Main trigger and B External input. The Delay trigger or B External input normally receive the higher frequency signal, which is divided by the Main trigger or A External input signal.

In Figure 9, the waveform at the top of the screen is applied to the Main trigger. The next trace is the Count In trace. The third trace is the signal applied to the Delay trigger and the bottom trace is the Sync Gate trace. The Count In trace recognizes a single event, due to Gate size and delay. The Sync Gate displays the total time interval. All events activating the Delay trigger during the measurement interval are counted and then divided by the number of events activating the Main trigger during the interval.

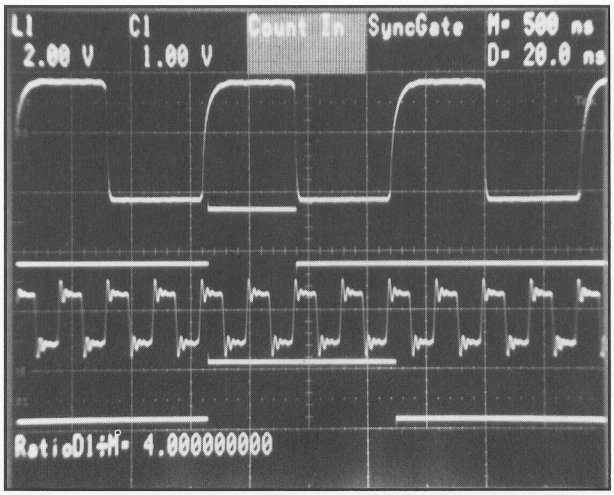

Figure 9. The Counter/Timer measures the ratio between the number of events on two signals over an interval of time.

Event Ratio Measurements

To measure event ratios between Main and Delay triggers, first initialize the oscilloscope, then:

	Step	Procedure	Purpose
1.	Apply the waveforms to two plug-in units.	Display both waveforms.	To provide a separate route to the Counter/Timer.
2.	Separate the waveforms.	Press the VERTICAL POS button and rotate the left knob to move each waveform. (Select the waveform by touching its label at the top of the screen.)	For clear viewing.
3.	Display the Counter menu.	Press the MEASURE COUNTER button twice to display the menu.	To make menu selections.
4.	Select Ratio Measure.	Touch the Measure label to change to Ratio Measure.	To measure ratio.
5.	Select Dly1 Swp Gating.	Touch the Gating label to change to Dly1 Swp Gating.	To turn on the Gate.
6.	Remove the menu.	Press the MEASURE COUNTER button again to remove the menu.	To clear the screen.

The Counter/Timer is now set up. Next, the Counter View traces are displayed and the trigger levels are set.

7.	Display the Waveform menu.	Press the WAVEFORM button to display the menu.	To make menu selections.
8.	Select Gate, Count In, and Sync Gate traces.	Touch the following labels in order: Count View, Gate, Enter, Count In, Enter, Sync Gate, Enter.	To view the Counter View Traces.
9.	Remove the menu.	Press the WAVEFORM button again to remove the menu.	To clear the screen.
10.	Display the Trigger menu.	Press the TRIGGER LEVEL button twice to display the menu.	To make menu selections.
11.	Change slope, if necessary.	Touch the Slope label to make the change.	For correct starting point.
12.	Adjust the trigger level.	Set the trigger level to about the mid-point of the waveform amplitude, using the right knob.	For correct starting point.

Event Ratio Measurements (continued)

	Step	Procedure	Purpose
13.	Select Dly1 Trigger	Touch the Trigger label to change to Dly1 Trigger.	To prepare delayed trigger.
14.	Display the Trigger menu.	Press the TRIGGER LEVEL button twice to display the menu.	To make menu selections.
15.	Change slope, if necessary.	Touch the Slope label to make the change.	For correct starting point.
16.	Adjust the trigger level.	Set the trigger level to about the mid-point of the waveform amplitude, using the right knob.	For correct starting point.
17.	Remove the Trigger menu.	Press the TRIGGER LEVEL button again to remove the menu.	To clear the screen.

Separate the Counter View traces with the Vertical Position button and left knob for easier viewing. The remaining task is to assign the waveforms to the correct trigger channels. Normally, the higher frequency waveform is applied to the Delay 1 trigger.

18.	Display the Trigger Source menu.	Press the TRIGGER SOURCE button to display the menu.	To make menu selections.
19.	Display the Main sub-menu.	Touch the Main label to display the sub-menu.	To make menu selections.
20.	Select the lower frequency channel.	Touch the label for the lower frequency channel. The display will now show Main Trig=(low frequency channel.)	
21.	Display the Dly1 sub-menu.	Touch the Dly1 label to make the selection.	To make menu selections.
22.	Select the higher frequency channel.	Touch the label for the higher frequency channel. The display will now show Dly1 Trig=(high frequency channel).	
23.	Remove the menu.	Press the TRIGGER SOURCE button again to remove the menu.	To clear the screen.
24.	Display the Horizontal menu.	Press the HORIZONTAL SIZE button twice to display the menu.	To make menu selections.
25.	Select Dly'd Time Base.	Touch the Time Base label to change to Dly'd Time Base.	
26.	Set the Gate interval.	Rotate the right knob to adjust the Gate interval.	To control the starting point.
27.	Position the Gate.	Press the HORIZONTAL DELAY button and rotate the right knob to position the gate.	To define the starting point.

If you are comparing two signals that are only rarely different (for example, a signal with an occasional missing or extra pulse) then the Counter/Timer total events counting may better serve your needs.

TOTAL MEASUREMENTS (EVENT COUNTING)

Intermittent operation of a digital circuit is sometimes the result of a missing or an extra pulse. The event counting capability of the Counter/Timer can often simplify the troubleshooting of this type of problem. It is especially effective when the problem occurs only once in perhaps millions of cycles. In the following two examples a method for locating low amplitude pulses and a method for finding extra pulses are given, using the Total measurement feature.

FINDING LOW AMPLITUDE PULSES

A pulse that occasionally lacks sufficient amplitude to drive a logic circuit may be difficult to locate. An easy way to track down low amplitude pulses is to use the Counter/Timer in Total mode. The oscilloscope's Main and Delayed trigger levels are set to the driven circuit's high and low input logic levels, as shown in Figure 10. If the driving pulse passes through both logic levels with each transition, the pulse amplitude is adequate. If the pulse passes through only one logic level, the result can be intermittent circuit operation. The counter can total the number of events (transitions) at each of the logic levels. The difference between the two totals is the number of errors that occurred.

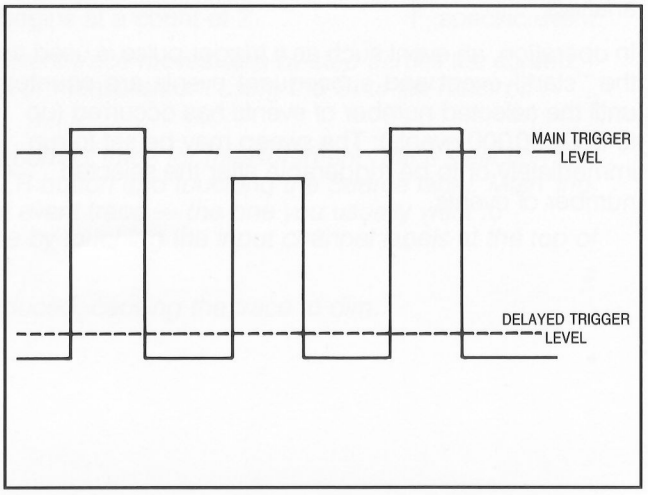

Figure 10. A low amplitude pulse is detected using the Counter/Timer in Total measurement mode.

FINDING EXTRA PULSES

Extra pulses, such as shown in Figure 11, sometimes appear in a circuit or on a bus. These could result from race conditions, switching transients, defects in logic devices, or many other causes. When these occur only once in perhaps millions of cycles, the Counter/Timer in Total mode can often help locate the source of the problem. This is done by comparing the number of events counted by the Main and the Delayed triggers. One trigger is driven by the input signal and the other trigger is driven by the output signal from a suspected device or circuit. If the total number of events counted are not the same (or correct ratio), then the problem area lies somewhere between the two signal test points.

The signals must have a one-to-one correspondence (or known ratio) in the number of events for this technique to work correctly. The width of the pulse must be at least 1 ns to be detected.

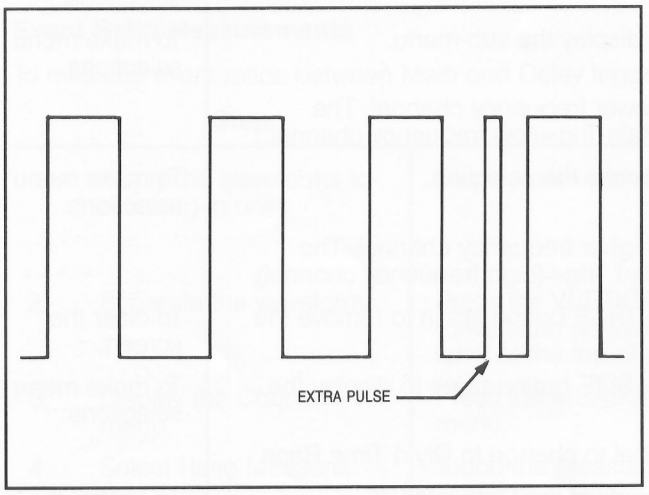

Figure 11. An extra pulse can often be detected using the Counter/Timer in Total measurement mode.

HOLDOFF BY EVENTS

Holdoff by events simplifies viewing of a particular pulse in a pulse train or complex waveform. Typical examples are the viewing of selected lines in a high-resolution video system, sector pulses and/or data bits in a disk drive, data bits within a clocked data stream, or events occurring at a particular point in rotational analysis.

In operation, an event such as a trigger pulse is used as the "start" event and subsequent events are counted until the selected number of events has occurred (up to 500,000,000 events). The sweep may be set to run immediately or to be triggerable after the selected number of events.

The start event can come from the Main trigger or the A Ext input. Holdoff by Events can also operate with no start event. The selected number of events, or "count" events can be supplied by the Counter/Timer clock (precise 2 ns time increments) or by the Main trigger, Delayed trigger, or B Ext input.

In the following example a specific event in a pulse train is captured for measurement. Another signal in the circuit that generates the pulse train provides the start event. The signals are applied to plug-in units in different compartments so that the trigger signals are on separate input paths to the trigger circuits. Figure 12 shows the start event in the upper trace and the pulse train in the lower trace. Figure 13 shows the 29th pulse expanded for easy viewing and measurement.

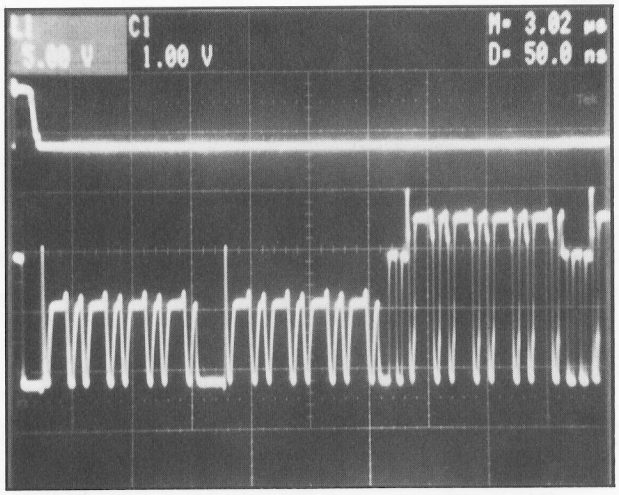

Figure 12. The trigger pulse and waveform are displayed prior to using the holdoff feature.

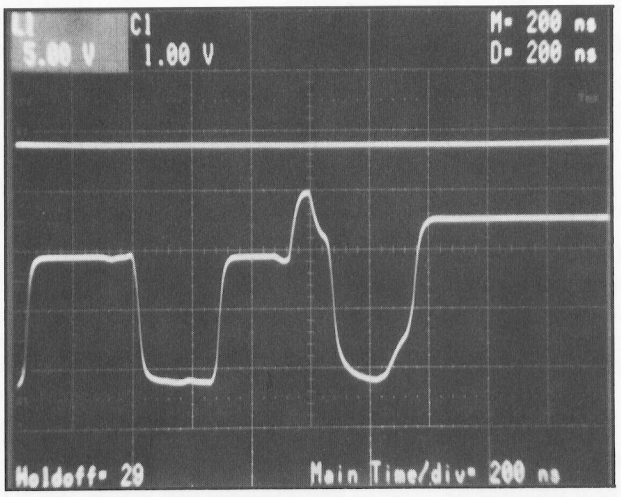

Figure 13. Using Holdoff, the 29th and 30th pulse following the trigger pulse are expanded for improved viewing or measurement.

Specific Event In Pulse Stream Selection

To select a specific event in a pulse train, initialize the oscilloscope, display the start event waveform, then:

	Step	Procedure	Purpose
1.	Input the count event signal to another plug-in.	Apply the count event signal to the input of another plug-in and adjust its horizontal and vertical size as desired.	To provide two signals to the trigger circuits.
2.	Display the Trigger Source menu.	Press the TRIGGER SOURCE button twice to display the Trigger Source menu.	To make menu selections.
3.	Set the start event signal to the Main trigger.	Touch the Main label and set Main Trig to the start event input channel.	For the start event.
4.	Set the count event signal to the Dly1 trigger.	Touch the Dly1 label and set Dly1 Trig to the count events input channel.	For the count event.
5.	Remove the menu.	Press the TRIGGER SOURCE again to remove the menu.	To clear the screen.
6.	Display the Trigger menu.	Press the TRIGGER LEVEL button twice to display the Trigger menu.	To make menu selections.
7.	Select the Main trigger.	Touch the Trigger label, if necessary, to set to Main Trigger.	To set up the Main trigger.
8.	Set to Norm mode.	Touch the Mode label to change to Norm mode.	For improved triggering.
9.	Change slope, if necessary.	Touch the Slope label to change slope polarity.	For correct starting point.
10.	Set to Dly1 Trigger.	Touch the Trigger label to change to Dly1 Trigger.	To set up the Dly1 Trigger.
11.	Change slope, if necessary.	Touch the Slope label to change slope polarity.	For correct starting point.
12.	Set the Dly1 Trig level to the mid-point of the count event signal.	Rotate the right knob to set the Dly1 Trig level. (In Figure 12 this is about 1 volt).	For best trigger repeatability.
13.	Display the Trigger menu.	Press the TRIGGER HOLDOFF button to display the menu.	To make menu selections.
14.	Set to Events Holdoff.	Touch the Holdoff label to change to Events Holdoff.	To use Events Holdoff.
15.	Set to Dly Trig Count.	Touch the Count label to set to Dly Trig Count.	To use Delayed Trigger events.
16.	Set left knob to high resolution.	Press the FINE button near the left knob to increase knob resolution.	For improved setability.
17.	Set the Holdoff count.	Rotate the left knob clockwise to increase the Holdoff count. Note that the Holdoff readout begins at a count of 2.	To select a specific event.

As the count increases with the rotation of the knob, the count event trace moves step-by-step across the screen. Any event can now be positioned on the screen for examination or measurement using the Counter/Timer or cursors.

When using the Counter/Timer or cursors, be sure to select the correct trace for measurement. Trace selection for the Counter/Timer is made by pressing the MEASURE COUNTER button and touching the Source label. Main Trig Source is the start event trace and Dly1 Trig Source is the count event trace — the one you usually want to measure. Selection of the trace for cursor measurement is made by touching the input channel labels at the top of the screen.

Note that as the holdoff count is increased the sweep rate is reduced, causing the trace to dim.

OFFSET MEASUREMENTS

The 11A32, 11A33, 11A34, and 11A52 amplifier plug-in units all contain a precise DC offset capability which enables the user to view small details of signals which are invisible with conventional oscilloscopes. With the 11A32, 11A34, and 11A52, details more than 60 dB below the main signal amplitude can be observed and measured. With the 11A33, details more than 84 dB below the main signal level can be observed and measured.

Offset has a range of 10 to 100 divisions, depending on the Vertical Size setting and the plug-in model used. Resolution for Offset is 40 steps per division. Accuracy is controlled by the plug-in specifications. For accurate measurements of small features located on high-amplitude waveforms, Offset is indispensable.

Offset takes place in the plug-in. If offset is changed the trigger point will also change. This is because the trigger circuit receives the waveform shifted by the amount of the offset.

A use of Offset can be demonstrated by viewing and measuring a small detail on a large signal. In Figure 14 the waveform has a small notch at about the center of the positive portion. This notch must be increased in size before its width can be measured.

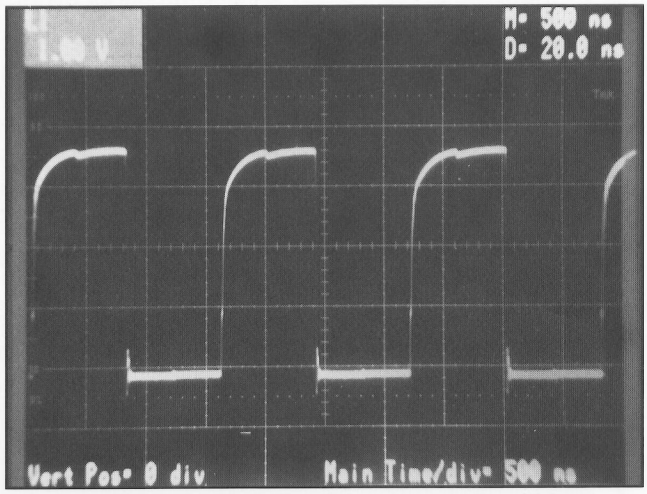

Figure 14. A waveform with a small notch on the top.

Offset Measurements

To use the Offset feature:

Step		Procedure	Purpose
1.	Display the waveform.	Display the waveform	To use Offset.
2.	Increase vertical size.	Press the VERTICAL OFFSET button and rotate the left knob.	To enlarge the detail.
3.	Adjust Vertical offset.	Press the VERTICAL OFFSET button and rotate the left knob.	To center the detail.
4.	Enlarge the detail.	Repeat steps 2 and 3 until the detail is a few divisions high.	For easier measurement.
5.	Reduce the high frequency limit.	Touch the VERTICAL SIZE or VERTICAL POS button twice to display the Channel menu. Touch the HF Limit label to display 20.0 MHz HF Limit.	To reduce noise.

The notch is now expanded on the screen and the Counter/Timer can measure the notch width at the trigger level.

6.	Position the Gate trace.	Use the procedure that follows for making the width measurement.	To control the starting point of the measurement.
7.	Adjust the trigger level.	Press the TRIGGER LEVEL button and rotate the right knob.	To define the measurement location.

Use the Gate trace to control the starting point and the Count In trace to be assured that the correct part of the notch is being measured. The example in Figure 15 shows the notch from the Figure 14 waveform amplified and offset for easy measurement. (A dashed cursor line was manually positioned in the photo to indicate the trigger level setting.)

Width Measurements

The width measurement in Figure 15 is done as follows:

Step		Procedure	Purpose
1.	Display the Waveform menu.	Press the WAVEFORM button.	To select traces.
2.	Select the Counter View traces.	Touch in sequence: Count View, Gate, Enter, Count In, Enter.	To display the traces.
3.	Remove the Waveform menu.	Press the WAVEFORM button again.	To view the traces.

Separate the traces for easier viewing as desired.

4.	Display the Counter/ Timer menu.	Press the MEASURE COUNTER button to display the Counter/Timer menu.	To set up the measurement.
5.	Select Width Measure.	Touch the Measure label repeatedly until Width Measure is displayed.	To start the width measurement.
6.	Select Dly1 Gating.	Touch the Gating label to display Dly1 Gating.	To activate gated measurements.
7.	Reduce Gate width to minimum.	Press the HORIZONTAL SIZE button and rotate the right knob.	For better control.
8.	Move the Gate to the notch position.	Press the HORIZONTAL DELAY button and rotate the right knob.	To control the starting point.

The leading edge of the notch should now be within the width of the Gate pulse and the Count In trace should include only the notch. If the Count In trace is not correctly positioned, you may need to adjust the Main Trigger level and slope. You may also wish to see where the measurement is actually made on the notch. This is done by finding the value of the trigger level and then placing a cursor at that level on the screen.

Determine Width Measurement Point

To determine the width measurement point:

Step		Procedure	Purpose
1.	Read the trigger level value.	Press the TRIGGER LEVEL button and read the value of the Main Trigger.	To determine the value.
2.	Display the Cursors menu.	Press the MEASURE CURSORS button.	To view the menu.
3.	Display the Veritcal Cursors.	Touch the Cursors label to display Vertical Cursors.	To view the cursors.

Both a dotted and a dashed horizontal line should now appear on the screen.

4.	Position the cursor to the trigger level.	Using the left knob, set the dotted line cursor Vert Ref to the same value as Main Trig.	To mark the trigger level.

This is the level where the Counter/Timer measurement is made.

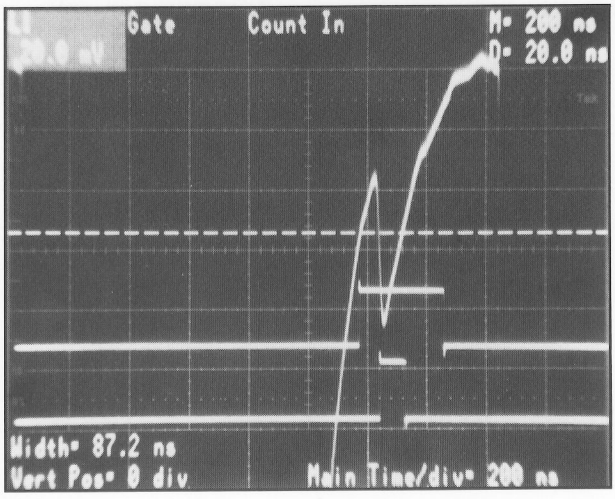

Figure 15. Offset is used to expand the small notch seen in Figure 14 and the Counter/Timer is used to measure the notch's width. The manually positioned dashed line indicates the level at which the width is measured.

Trigger Level

Gate Trace

Count In Trace

GLOSSARY

Binary Trace — A two-level "waveform" that indicates activity when in the high state and inactivity when in the low state.

Count In Trace — The Counter Input trace is a binary trace that indicates all events recognized by the Counter/Timer. The trace goes high at the beginning of each event and goes low at the end of the event.

Count View — This is the name of the Waveform sub-menu that contains the Counter View trace selections.

Counter/Timer — The time measurement feature of the 11300A Series oscilloscopes that enables precise measurement of frequency, period, pulse width, number of events, ratio of events, and time between events.

Counter View Traces — These binary traces can display on the oscilloscope screen the position and size of the Gate, the events that are being measured, the duration of the measurement interval, and the trigger signals derived from the A and B external inputs.

Event — An interval of time whose starting and ending points are defined by the transition of a signal through a trigger level. There may be two signals with different trigger levels for some measurements.

Event Interval — This is the length of time from the starting trigger to the ending trigger. The event interval may extend beyond the Gate interval if the event began within the Gate interval.

Gate Trace — The time position (delay) and size (Gate interval) of the Gate are shown on the oscilloscope screen by the binary Gate trace.

Gate Interval — This is the interval of time within which an event can start. (Once started, the event can extend beyond the Gate interval.) The size of the Gate interval is controlled by the delayed sweep size. The time position of the Gate interval is controlled by the horizontal delay.

Measurement Interval — The length of time from beginning to end of a measurement. This period normally begins with the start of the first event in the Gate interval and ends with the start of the first event following the Gate interval.

Sync Gate Trace — A Counter View binary trace that displays the measurement interval.

Table 2

CRS10/CRS30 Signal Test Points

Figure 3	TP F4 (or any sine wave generator)
Figure 6	TP 6
Figure 8	TP 15 and TP 16
Figure 9	TP 2 and TP 6
Figure 12	TP 2 and TP 6
Figure 13	TP 6
Figure 14	TP 17
Figure 15	TP 17

TROUBLESHOOTING CHECKLIST

PROBLEM	CHECK	MENU
No Gate	Trigger source must be selected.	TRIGGER SOURCE
	Measurement must have (Dly1) gate turned on.	MEASURE COUNTER
	Correct delay signal must be selected.	HORIZONTAL DELAY
No Count In	Correct delay signal and main trigger level and slope are required.	TRIGGER LEVEL

QUICK-SET INSTRUCTIONS

COUNTER/TIMER SETUP

To operate the Counter/Timer, the major selections to be made are:

SELECTION	MENU
Counter/Timer measurement function	MEASURE COUNTER
Source of trigger signal(s)	MEASURE COUNTER
Trigger level	TRIGGER LEVEL
Trigger slope	TRIGGER LEVEL

For precise control of the measurement zone, the major selections to be made are:

SELECTION	MENU
Source of gating signal	MEASURE COUNTER
Trigger level	TRIGGER LEVEL
Trigger slope	TRIGGER LEVEL
Gate size	HORIZONTAL SIZE
Gate position	HORIZONTAL DELAY

To view the Gate, Count In, and Sync Gate traces, follow the steps below.

GATE

The Gate trace shows the interval during which the Counter/Timer can begin its measurement and sets the last event measured. The leading edge of the Gate trace occurs at the end of the delay time.

To display the Gate trace:

1. Press the WAVEFORM button to display the Waveform menu.
2. Touch each label in the following sequence: Count View, Gate, Enter.
3. Press the WAVEFORM button again to remove the menu.

The Gate becomes active when the Gate source is selected for a Counter/Timer measurement function. Gate selection for one measurement function does not affect the settings for other measurement functions.

To turn on the Gate:

1. Press the MEASURE COUNTER button to display the Counter/Timer menu at the bottom of the screen.
2. Touch the Measure label to select the desired measurement function.
3. Touch the Gating label to set to Dly1 Swp Gating.

To set Gate width:

1. Press the HORIZONTAL SIZE button to display the Horizontal Size menu.
2. Touch the Time Base label to set to Dly'd Time Base.
3. Rotate the right knob to change the Gate width.

To set Gate position:

1. Press the HORIZONTAL DELAY button to display the Delay menu.
2. Touch the Delay label to set to 1 Delay.
3. Touch the After Delay label to set to Runs After Delay.
4. Rotate the right knob to change Gate position.

COUNT IN

The Count In trace shows each event recorded by the Counter/Timer.

To display the Count In trace:

1. Press the WAVEFORM button to display the Waveform menu.
2. Touch each label in the following sequence: Count View, Count In, Enter.
3. Press the WAVEFORM button again to remove the menu.

SYNC GATE

The Sync Gate shows the actual measurement interval.

To display the Sync Gate trace:

1. Press the WAVEFORM button to display the Waveform menu.
2. Touch each label in the following sequence: Count View, Sync Gate, Enter.
3. Press the WAVEFORM button again to remove the menu.

A EXT, B EXT

External trigger inputs are displayed by the A Ext and B Ext traces.

To display the Ext traces:

1. Press the WAVEFORM button to display the Waveform menu.
2. Touch the Count View label.
3. Touch the A Ext and Enter labels and/or the B Ext and Enter labels.
4. Press the WAVEFORM button again to remove the menu.

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