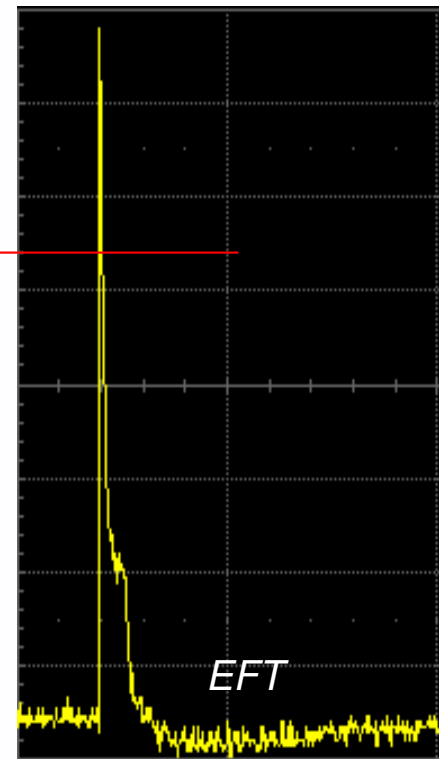
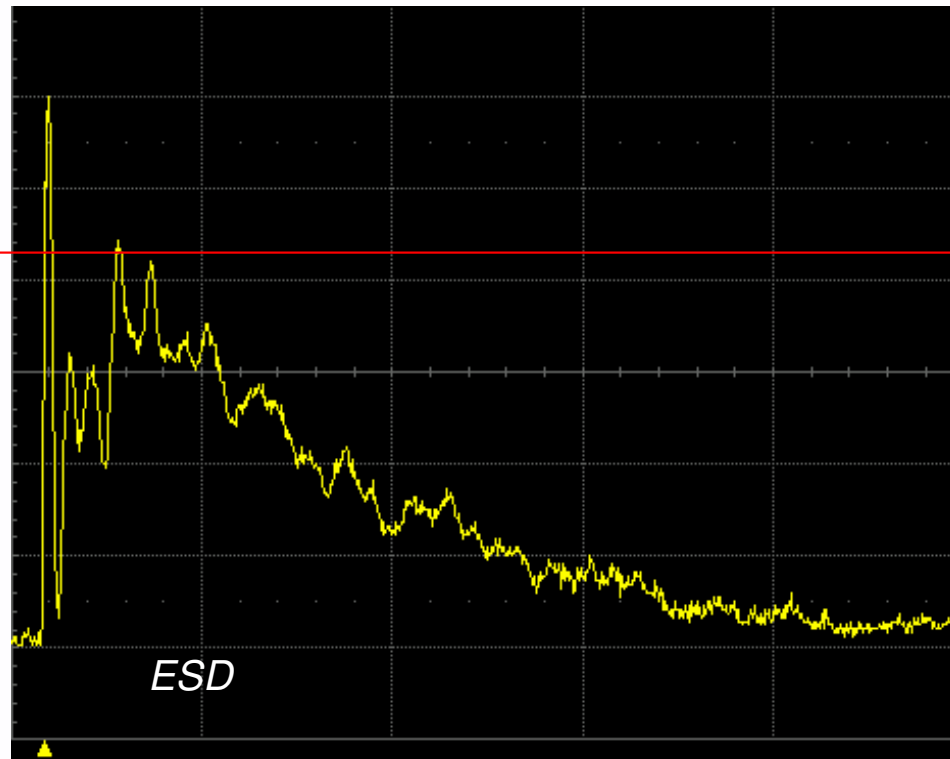
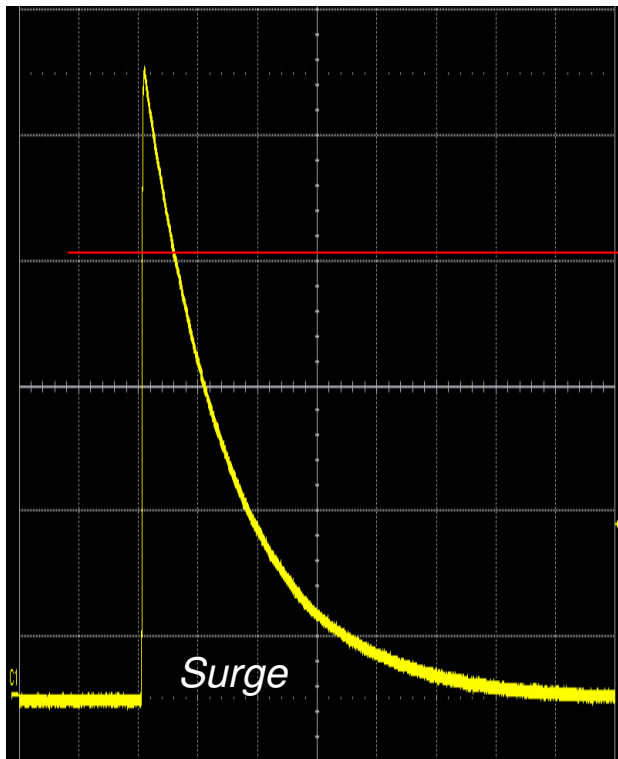


EMC Pulse Measurement and Custom Thresholding



Contents

- EMC measurement requirements
- How thresholds affect pulse measurement definitions and why standard pulse parameters will not work for EMC pulses
- Measurement thresholds for ESD pulses
- Sequenced acquisition for EFT (Electrical Fast Transient) pulses
- Parameter limiters applied to filter EMC pulse statistics
- Custom measurements

EMC

**Measurement
Requirements**

4 Quadrants of EMC/ESD Testing

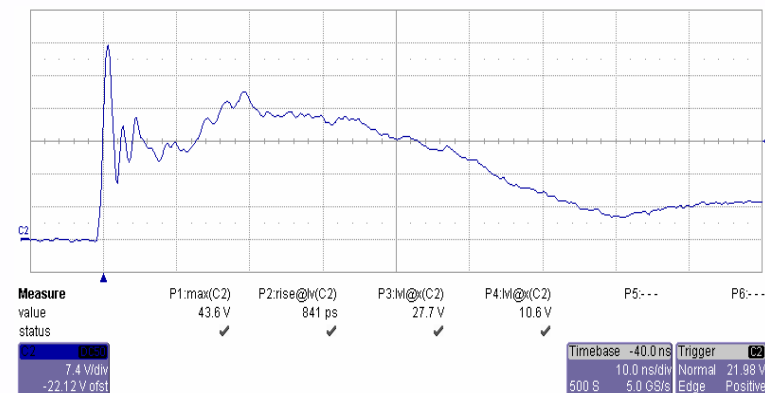
Radiated Emissions Will the EUT create emissions that interfere with the operation of other products?	Conducted Emissions How much noise voltage is injected back into the mains by the EUT?
Radiated Immunity Will the EUT be susceptible to emissions from other devices, either through the air or via cables?	Conducted Immunity Will the EUT be susceptible to transients generated by switching of capacitive or inductive components?

EUT = Equipment Under Test

- Oscilloscopes used for
 - Radiated Immunity
 - Conducted Immunity
- "Pulsed EMI tests:
 - ESD (Electrostatic Discharge)
 - EFT (Electrical Fast Transient)
 - Surge

Test Requirements

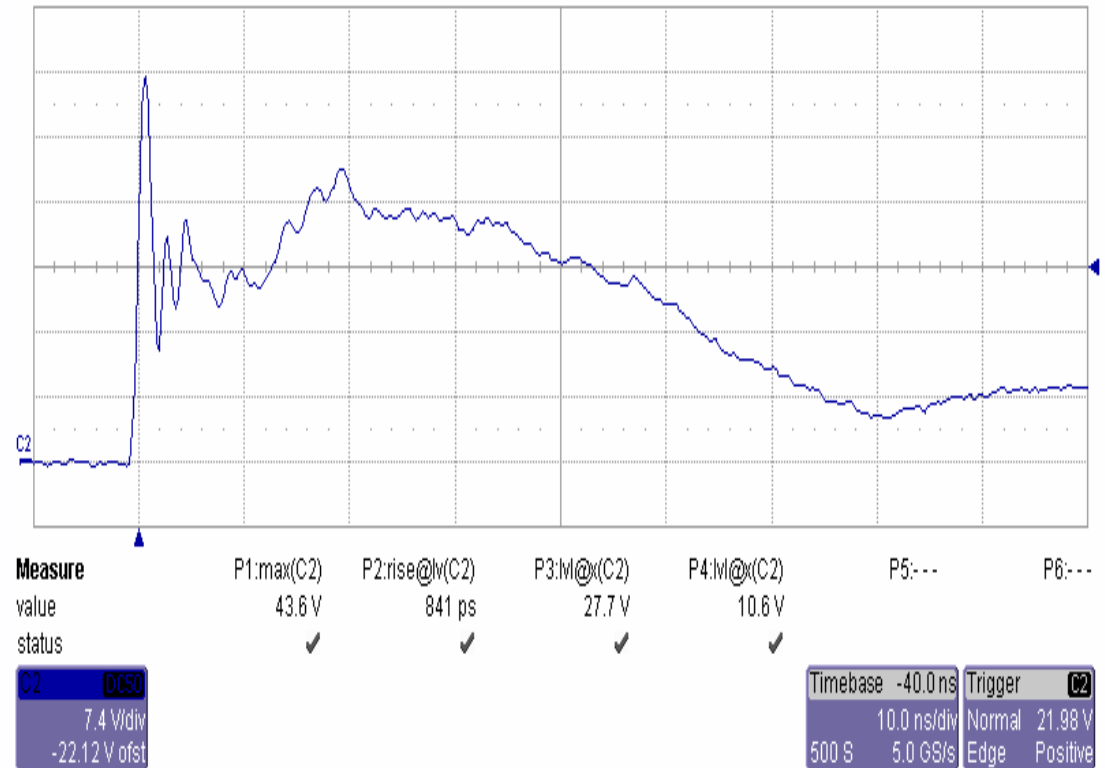
- Generate a Burst, Surge, or ESD pulse (for example, with an ESD gun)
- Verify the pulse shape(s) from the generator with an oscilloscope before each test
 - Rise Time
 - Fall Time
 - Width
- Ensure that the DUT still operates correctly during test, for example:
 - Automotive engine control unit still transmits proper messages
 - Telecom board serial data messages are uncorrupted
 - Consumer electronics item still functions
- ESD Standards:
 - IEC 61000-4, EN 61000-4, ITU, UL, FCC, Telcordia, ANSI, Bellcore, Proprietary (Military, Automotive), etc.
 - The majority of Immunity Testing follows the IEC 61000 (CE Mark)



ESD Testing – Electrostatic Discharge

Measurement Steps

- Pulse Characteristics
 - $T_{\text{rise}} = 0.7$ to 1.0 ns
 - $T_{\text{fall}} = 0.7$ to 1.0 ns
- Measurement Needs
 - Capture a Single Pulse
 - Measure one pulse, verify rise time for positive pulses, verify fall time for negative pulses
 - 1 GHz, 2 GHz, or 3 GHz+ scope depending on standard specification

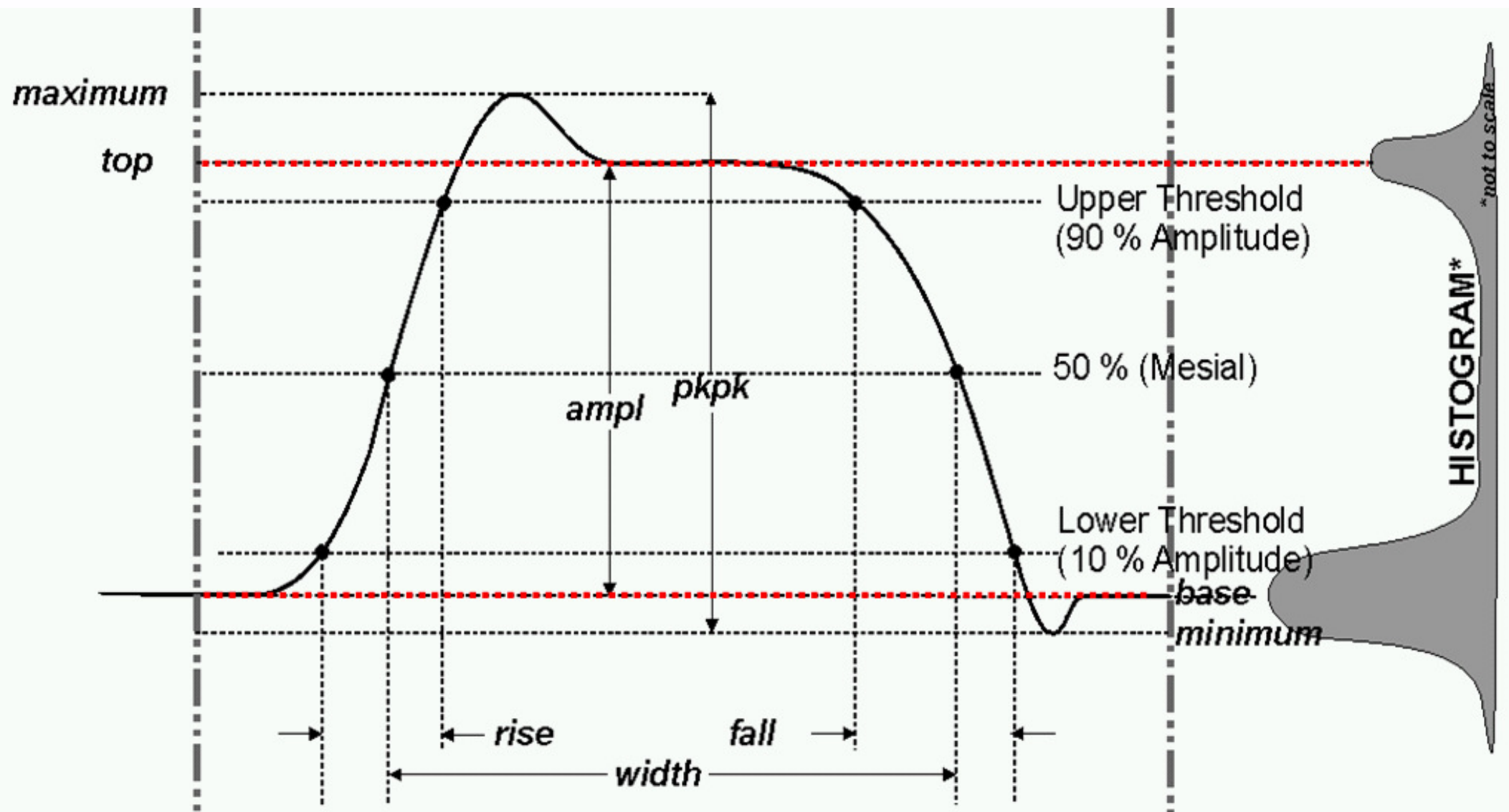


How is risetime defined on this ESD pulse?
10%-90% risetime is only meaningful if 0% and 100% levels exist and have been defined on the pulse.

Pulse Measurement Definitions

IEEE Standard Pulse Definitions

How Oscilloscopes Measure Pulse Parameters

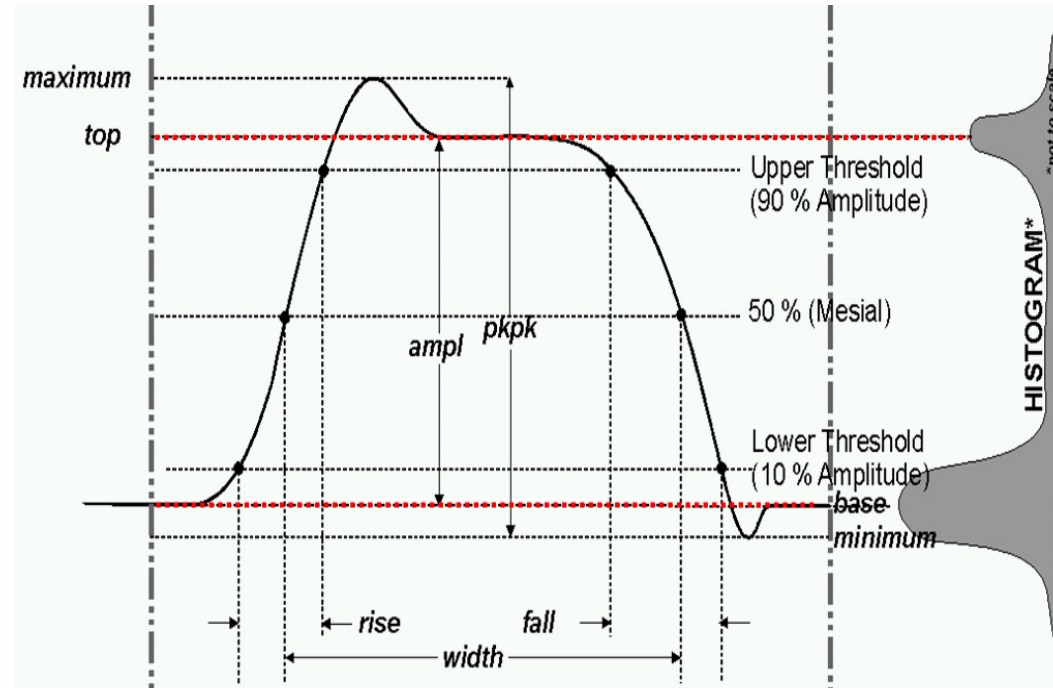


Oscilloscopes determine pulse parameters from Top and Base values

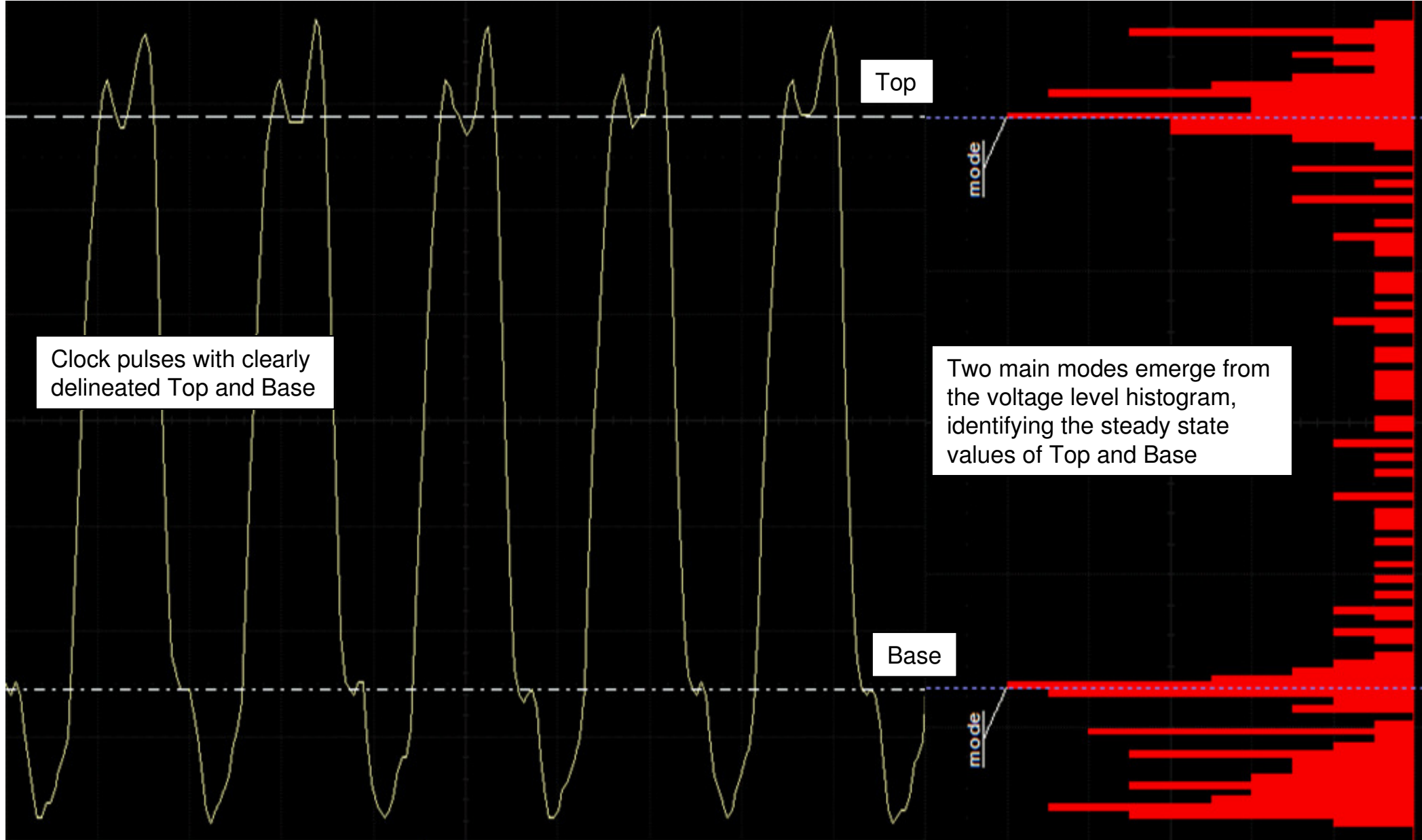
IEEE Pulse Definitions

How Pulse Measurements Are Determined

- Pulse measurement definitions are defined by the IEEE Std 181-2003 "IEEE standard on transitions, pulses, and related waveforms"
- Oscilloscopes conform to the IEEE pulse measurement definitions, and Top and Base are determined statistically based on the two modes of a voltage level histogram.
- Top and Base form the 100% and 0% reference levels which are used for measurements such as amplitude, risetime, falltime, period, frequency, width, duty cycle, overshoot, and virtually every timing measurement.
- Top and Base must first be calculated correctly in order for timing and amplitude measurements to produce the correct measurement result.



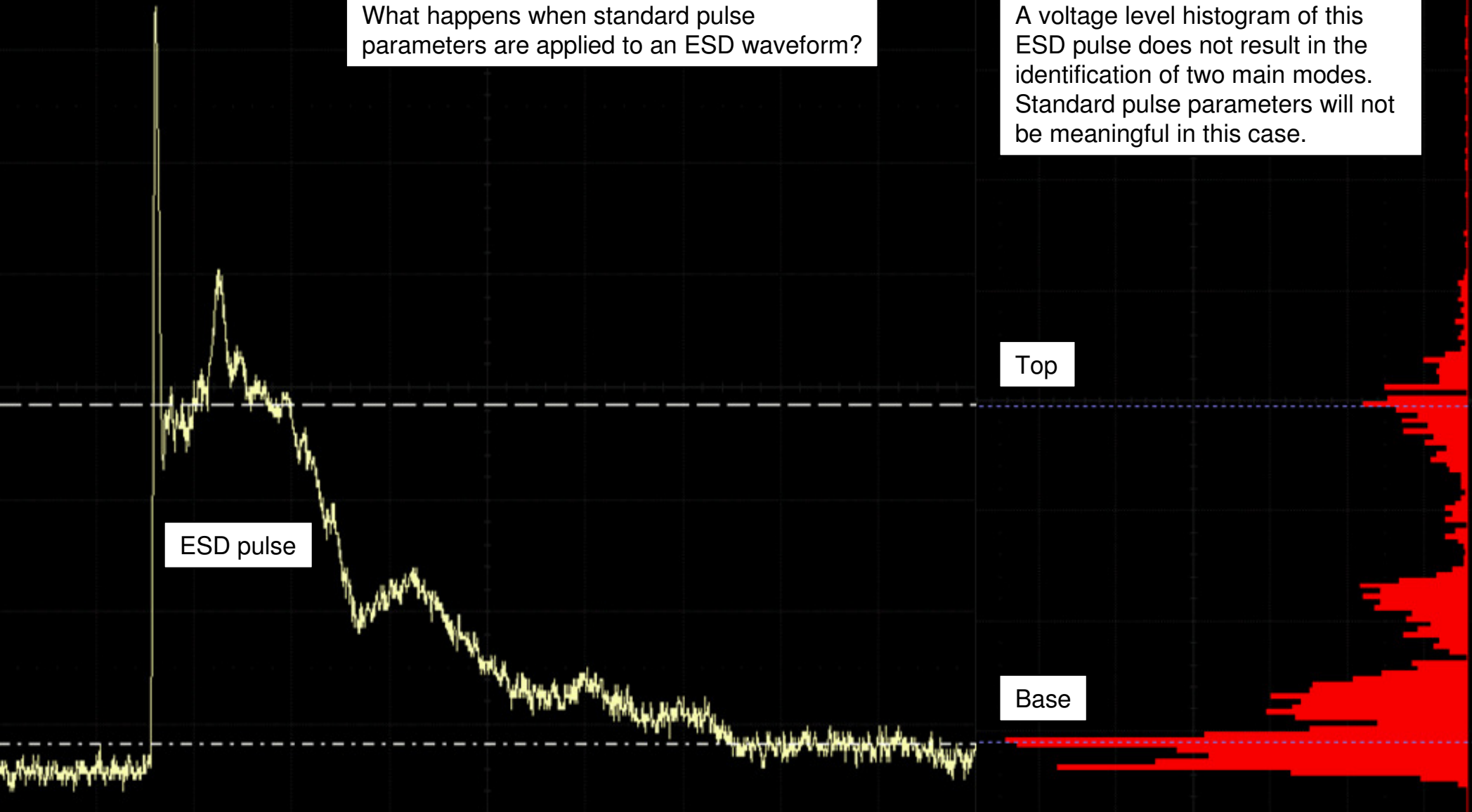
Clock Top and Base correctly determined from voltage histogram



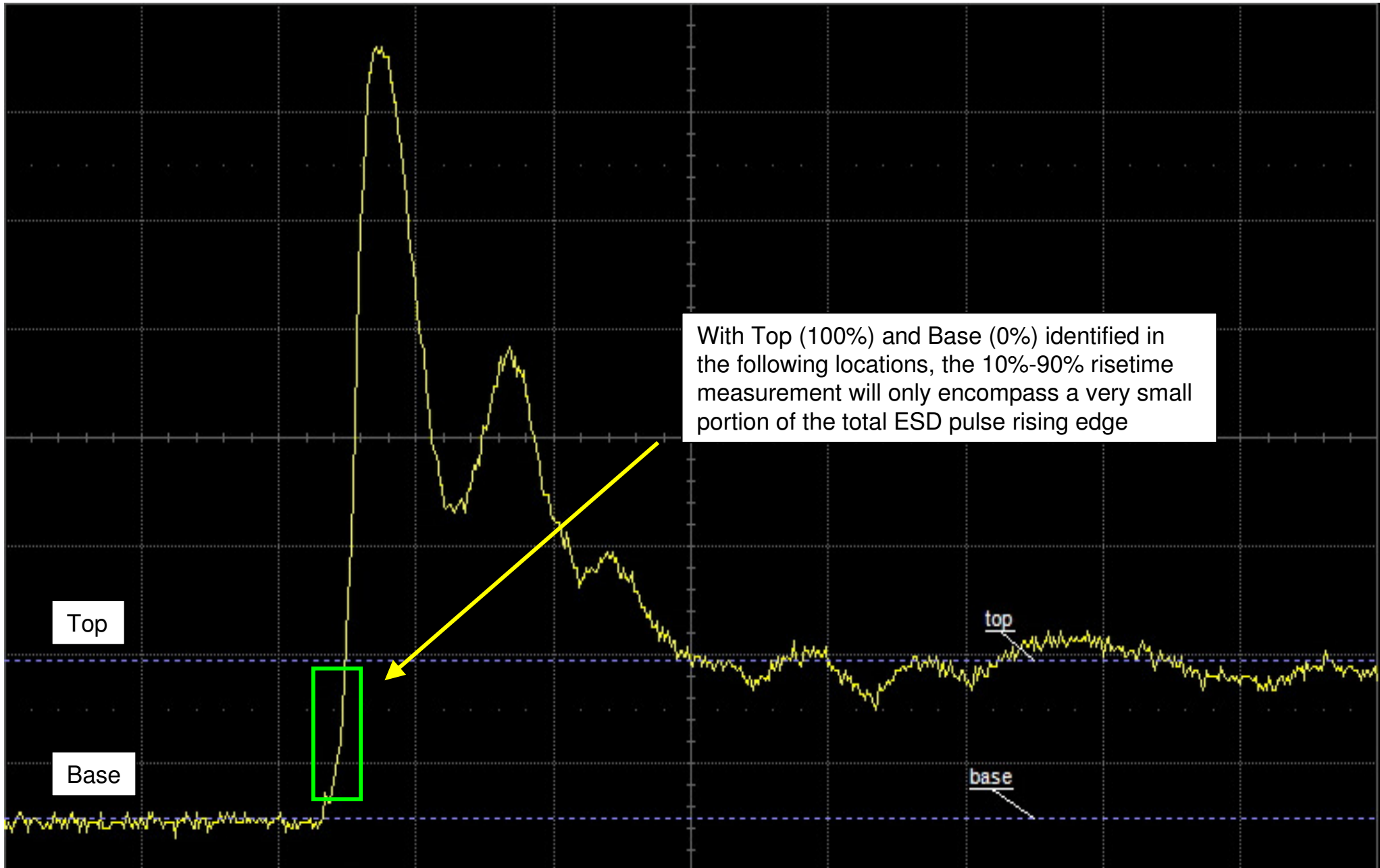
ESD Top and Base are not meaningful for pulse measurements

What happens when standard pulse parameters are applied to an ESD waveform?

A voltage level histogram of this ESD pulse does not result in the identification of two main modes. Standard pulse parameters will not be meaningful in this case.



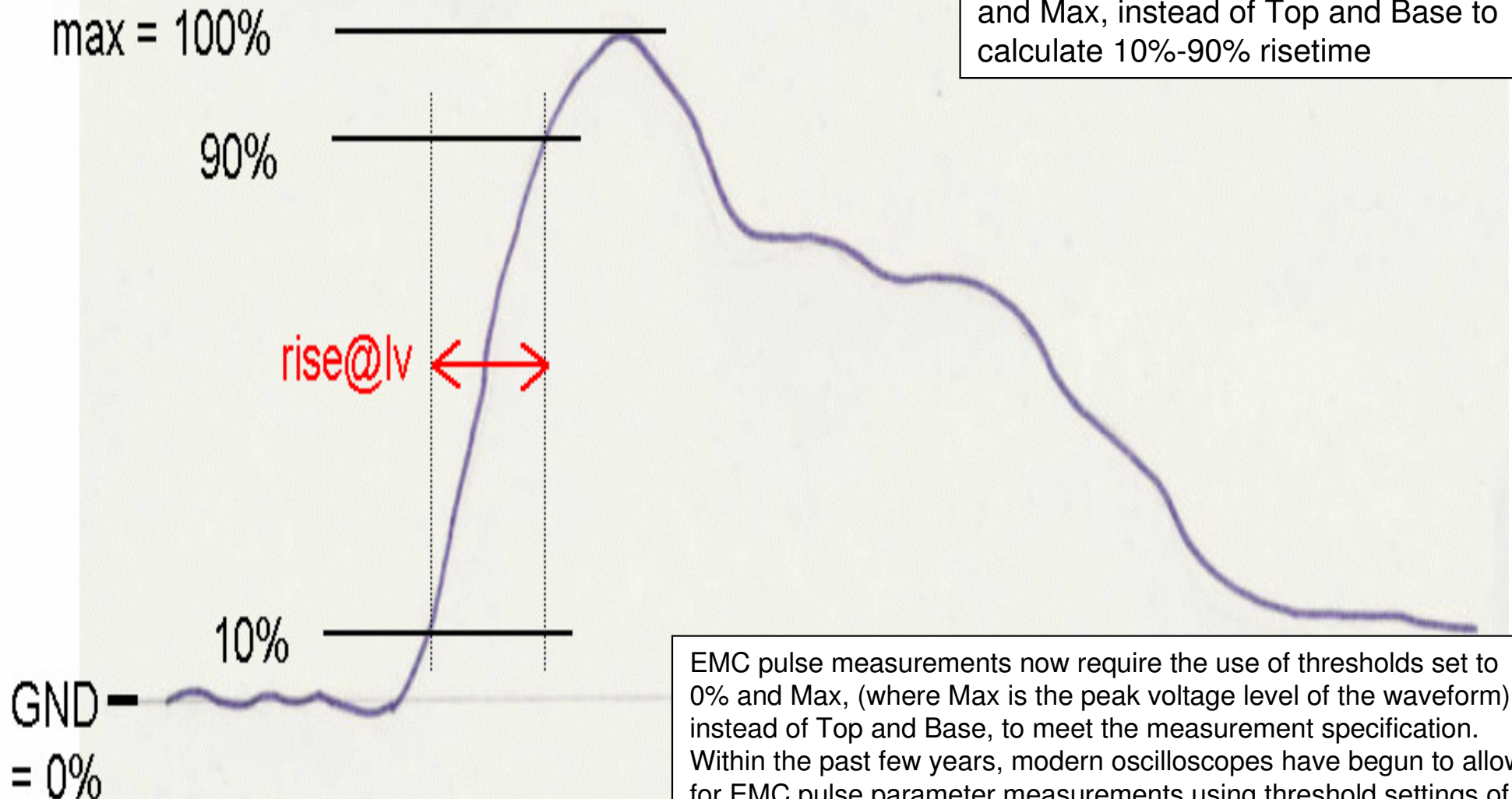
ESD Top and Base are not meaningful for pulse measurements



EMC Risetime Definitions use 0% and Max

An oscilloscope must use 0% and Max thresholds in order to perform the EMC-specific measurement

Differing from IEEE pulse definitions, EMC pulse definitions (for example the IEC 61000-4-2 standard) use 0% and Max, instead of Top and Base to calculate 10%-90% risetime



EMC pulse measurements now require the use of thresholds set to 0% and Max, (where Max is the peak voltage level of the waveform), instead of Top and Base, to meet the measurement specification. Within the past few years, modern oscilloscopes have begun to allow for EMC pulse parameter measurements using threshold settings of peak-to-peak, 0% to Max, and 0% to Min along with the standard absolute or percent levels.

Risetime calculated using standard IEEE pulse parameter definitions

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help P1: Setup...

Top

Base

M1

rise@lv

Measure value status

P1:rise@lv(M1) 494 ps

M1 50 V/div 5.00 ns/div

Timebase 0 ns 50.0 ns/div 5.00 kS 10 GS/s

Trigger C1 Stop 0.0 mV Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On Type Source1 M1 Measure Rise@level

measure on waveforms

math on parameters

advanced web edit

Summary rise@lv(M1)

Actions for P1 Histogram Trend Track

Help Markers Always On Detailed

Rise at level Gate Accept Close

Slew Rate for % or absolute levels of rising or falling edges.

Levels are Percent High percent 90 %

Set Levels to 10% and 90% Set Levels to 20% and 80% Low percent 10 %

LeCroy 11/27/2005 7:21:02 PM

Risetime is incorrectly calculated as 494 picoseconds on this ESD pulse. Note the risetime detailed marker location.

Risetime calculated using EMC thresholds

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help P1: Setup...

Max

0%

M1

rise@lv

Measure value status

P1:rise@lv(M1) 854 ps

M1 50 V/div 5.00 ns/div

Timebase 0 ns 50.0 ns/div 5.00 kS 10 GS/s

Trigger C1 Stop 0.0 mV Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On Type Source1 M1 Measure Rise@level

Summary rise@lv(M1)

Actions for P1 Histogram Trend Track

Help Markers Always On Detailed

Rise at level Gate Accept Close

Slew Rate for % or absolute levels of rising or falling edges.

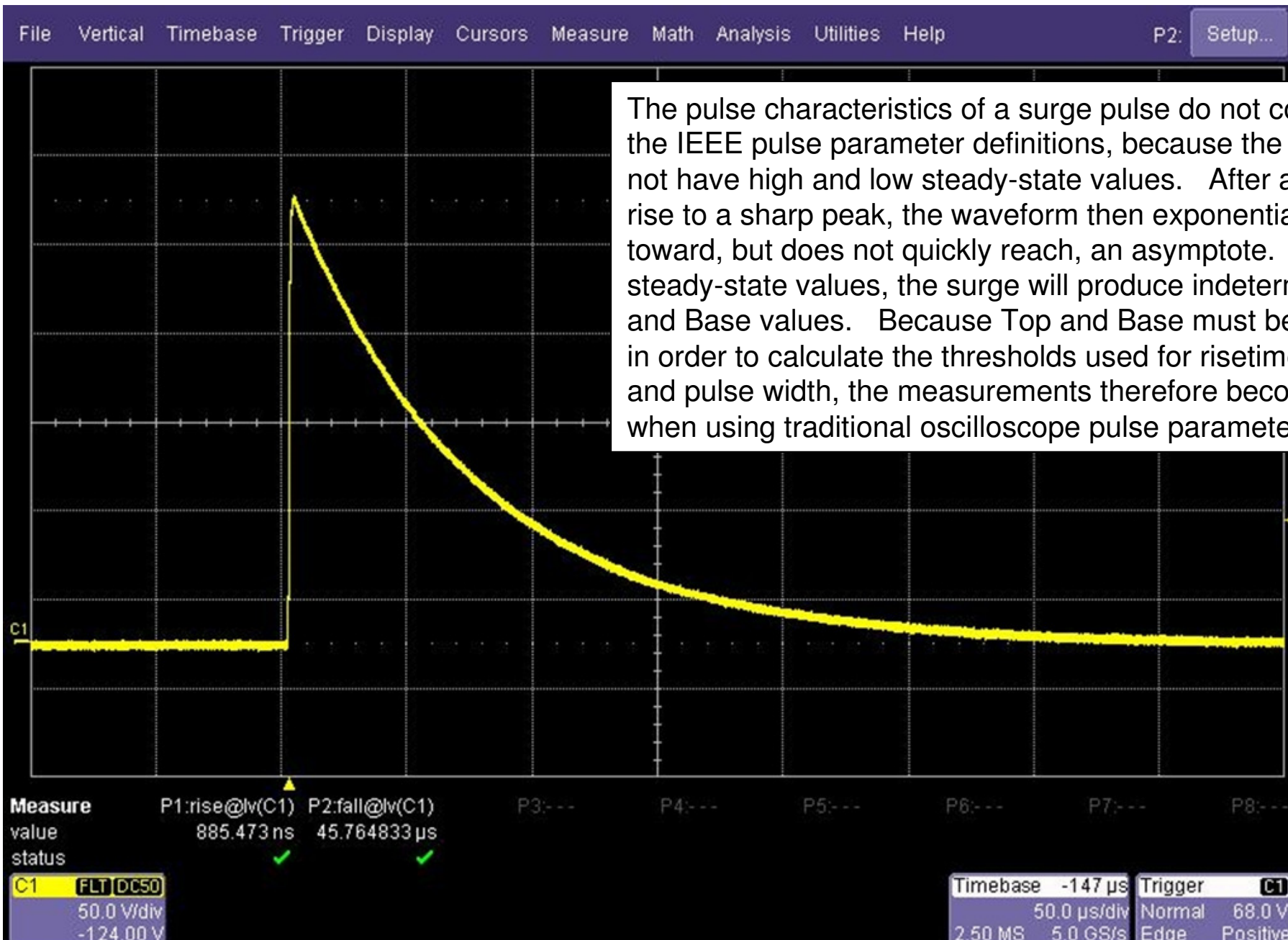
Levels are % 0-Max High percent 90 %

Set Levels to 10% and 90% Set Levels to 20% and 80% Low percent 10 %

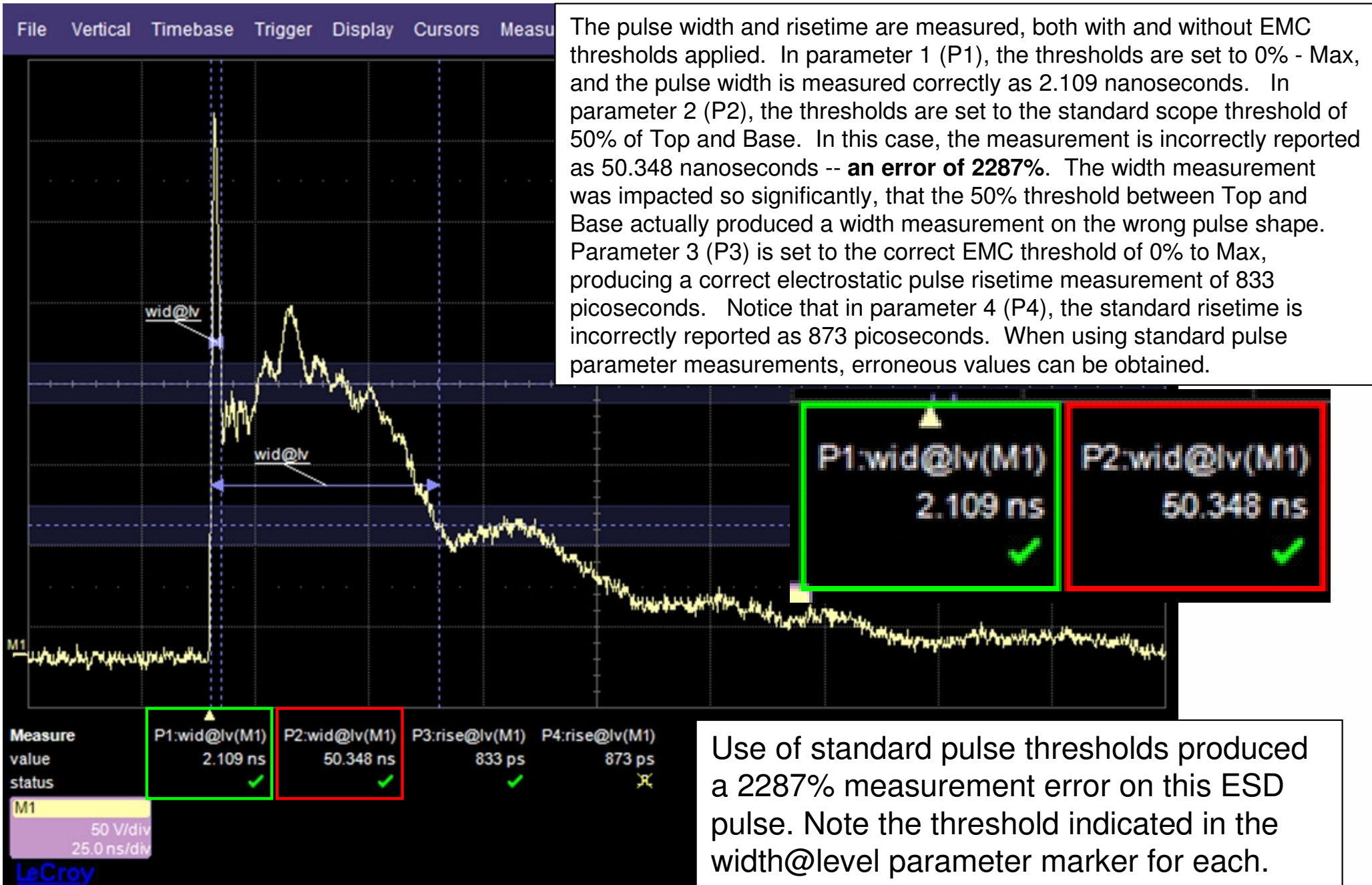
LeCroy 11/27/2005 7:20:05 PM

Risetime is correctly calculated as 854 picoseconds on this ESD pulse

A Surge pulse does not have a clearly-defined Top and Base



Standard and EMC thresholds for ESD pulse width

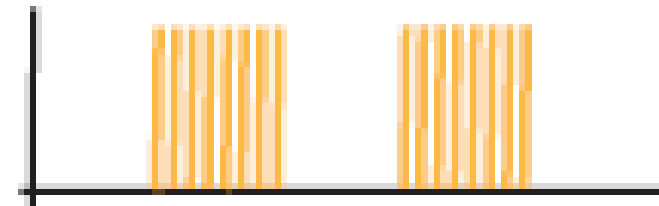
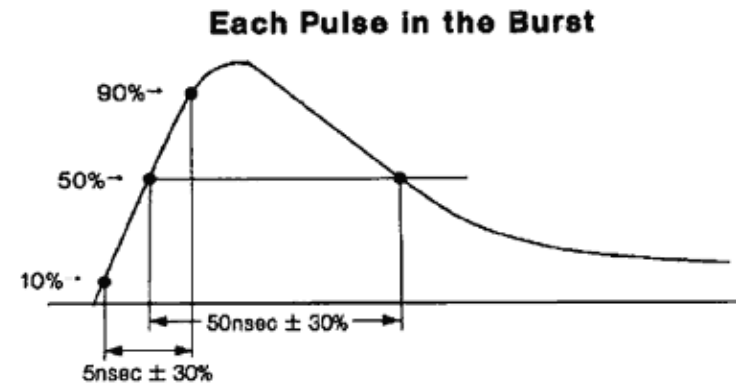


EFT Testing – Electrical Fast Transient

Measurement Steps

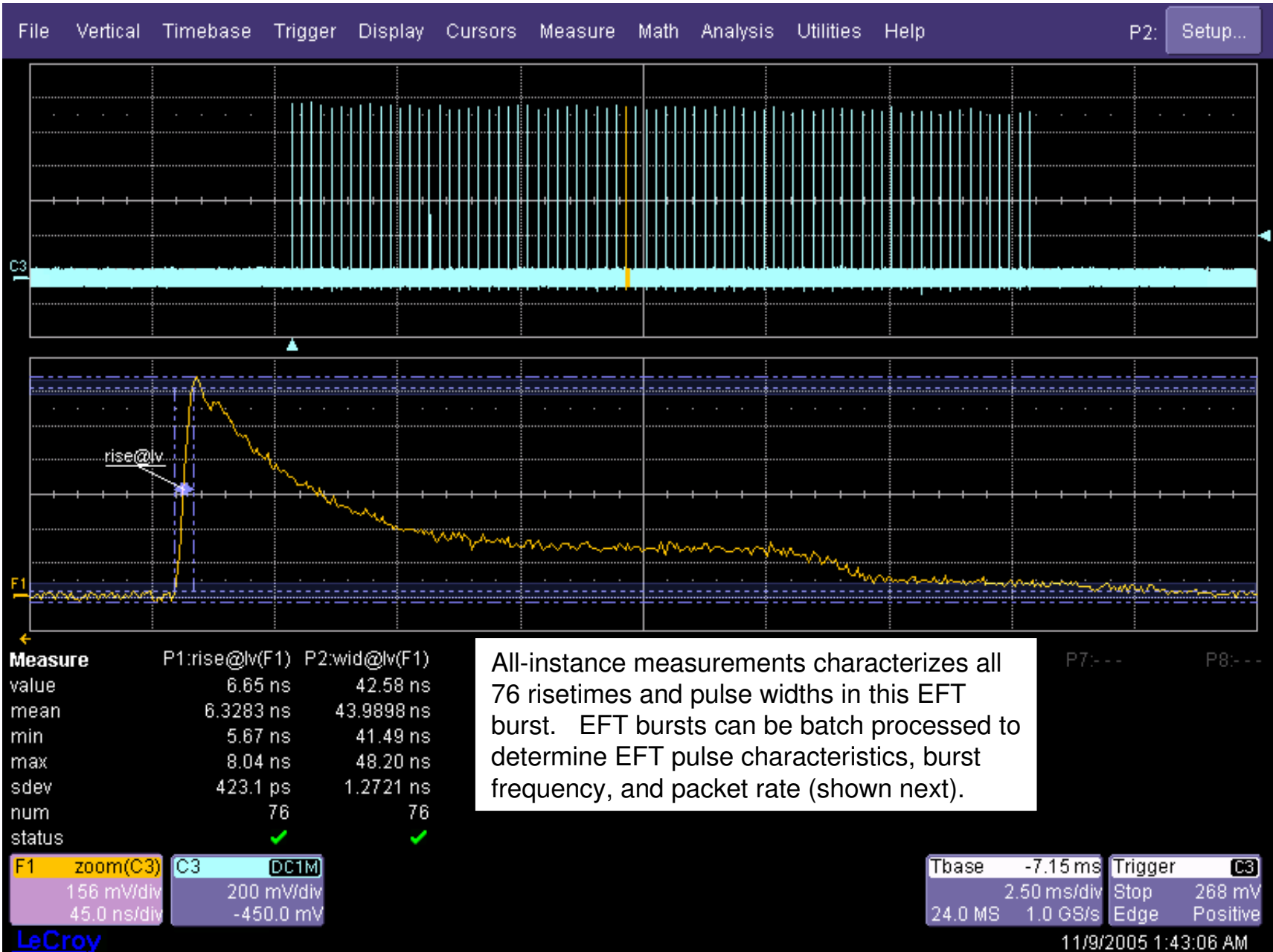
- Pulse Characteristics
 - $T_{\text{rise}} = 5\text{ns}$
 - $T_{\text{fall}} = 50\text{ns}$
 - Burst of many 5x50 pulses
- Measurement Needs
 - Capture 2ms of burst
 - Measure one pulse, verify shape (rise, fall, width)
 - Measure burst frequency (10-100 kHz)
 - Measure Capture time of burst packet (2ms)
 - Measure burst packet rate (300ms)

STANDARD EFT WAVEFORM



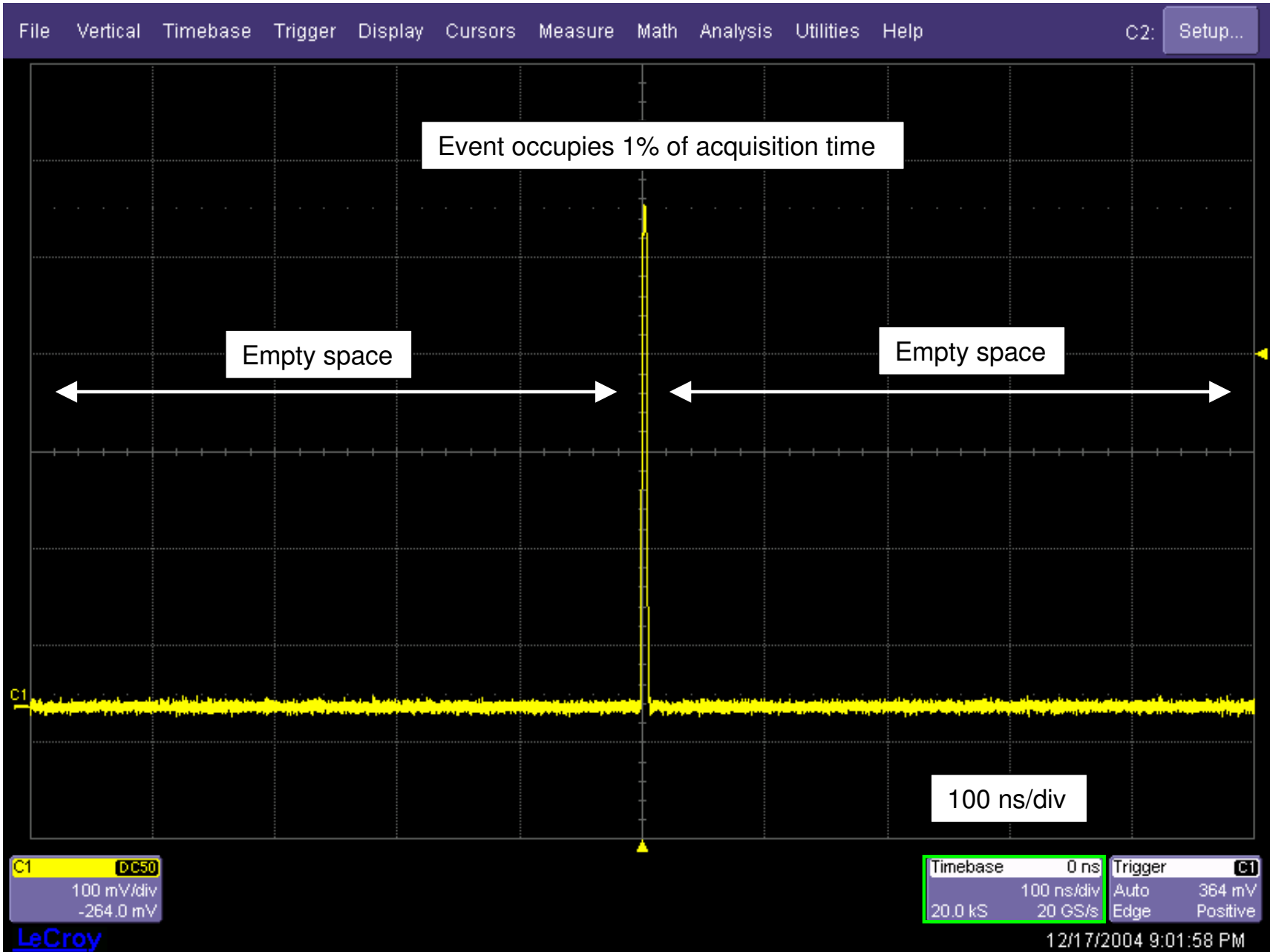
EFT Testing – Electrical Fast Transient

Measurement Statistics

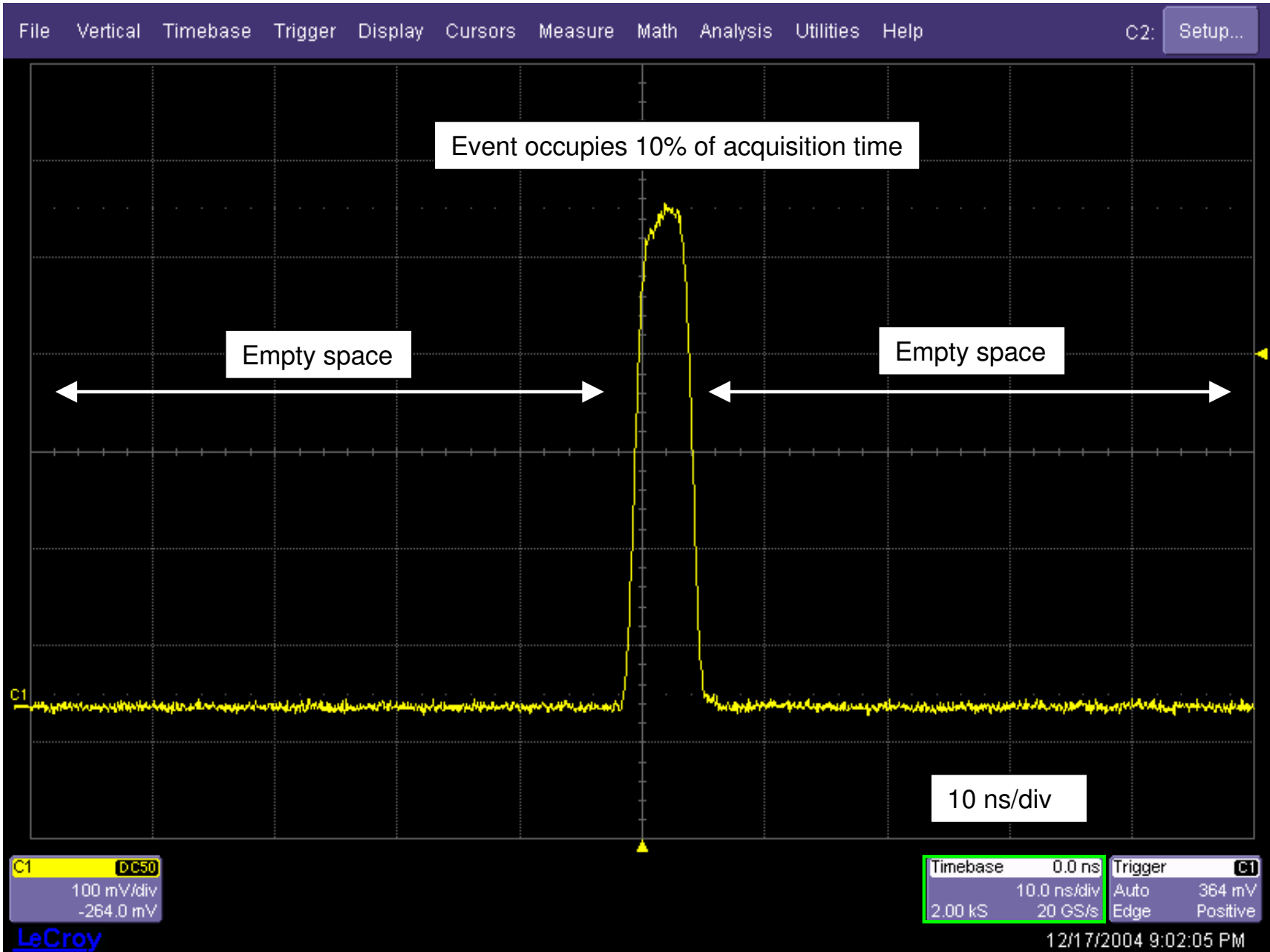


All-instance measurements characterizes all 76 risetimes and pulse widths in this EFT burst. EFT bursts can be batch processed to determine EFT pulse characteristics, burst frequency, and packet rate (shown next).

Maximizing Acquisition Memory for Events



Maximizing Acquisition Memory for Events



Maximizing Acquisition Memory for Events



Maximizing Acquisition Memory for Events

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help C2: Setup...

C1 D50 (1)
100 mV/div
-264.0 mV

Timebase -1.74 ns
Seq: 80 1.00 ns
200 S 20 GS/s

Trigger C1
Auto 364 mV
Edge Positive

Display Persistence Monitor

Auto Single Dual Quad
Octal XY XYSingle XYDual
Summary Mask PCIE

Grid
Grid Intensity 40 %
Grid on Top
Axis Labels

Trace
Line Points

XY
Input X C1
Input Y C2

Sequence
Display Mode Mosaic
Num Seg Displayed 80
Starting at 1

Close

LeCroy 12/17/2004 9:03:51 PM

Maximizing Acquisition Memory for Events

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help C2: Setup...

Mosaic of events is acquired while optimizing acquisition memory, and displayed without empty spaces between events

C1 D50 (1)
100 mV/div
-264.0 mV

Timebase -1.74 ns
Seq: 80 1.00 ns
200 S 20 GS/s

Trigger C1
Stop 364 mV
Edge Positive

Acquisition Trigger time C1...C4 F1...F4 F5...F8 XY M1...M4 Others Close

Time of Time

Channel	Seg	Time	since Segment 1	between Segment
M1	1)	17-Dec-2004 21:07:20		
M2	2)	17-Dec-2004 21:07:20	4.559 μ s	4.559 μ s
M3	3)	17-Dec-2004 21:07:20	8.611 μ s	4.052 μ s
M4	4)	17-Dec-2004 21:07:20	13.676 μ s	5.065 μ s
	5)	17-Dec-2004 21:07:20	19.248 μ s	5.572 μ s
	6)	17-Dec-2004 21:07:20	23.807 μ s	4.559 μ s
	7)	17-Dec-2004 21:07:20	28.365 μ s	4.559 μ s
	8)	17-Dec-2004 21:07:20	32.417 μ s	4.052 μ s
	9)	17-Dec-2004 21:07:20	37.482 μ s	5.065 μ s
	10)	17-Dec-2004 21:07:20	43.054 μ s	5.572 μ s

Select segment 1

F5...F8 XY
M1...M4 Others

Individual timestamps for each event listed with segment acquisition time and intersegment time. This will automatically measure the EFT burst packet rate.

LeCroy 12/17/2004 9:07:38 PM

Maximizing Acquisition Memory for Events

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help C2: Setup...

Mosaic of events is acquired while optimizing acquisition memory, and displayed without empty spaces between events

C1 D50 (1)
200 mV/div
-700.0 mV

Timebase -238 ns
Seq: 20000 100 ns
500 S 500 MS/s

Trigger C1
Stop 366 mV
Edge Positive

Acquisition Trigger time C1...C4 F1...F4 F5...F8 XY M1...M4 Others Close

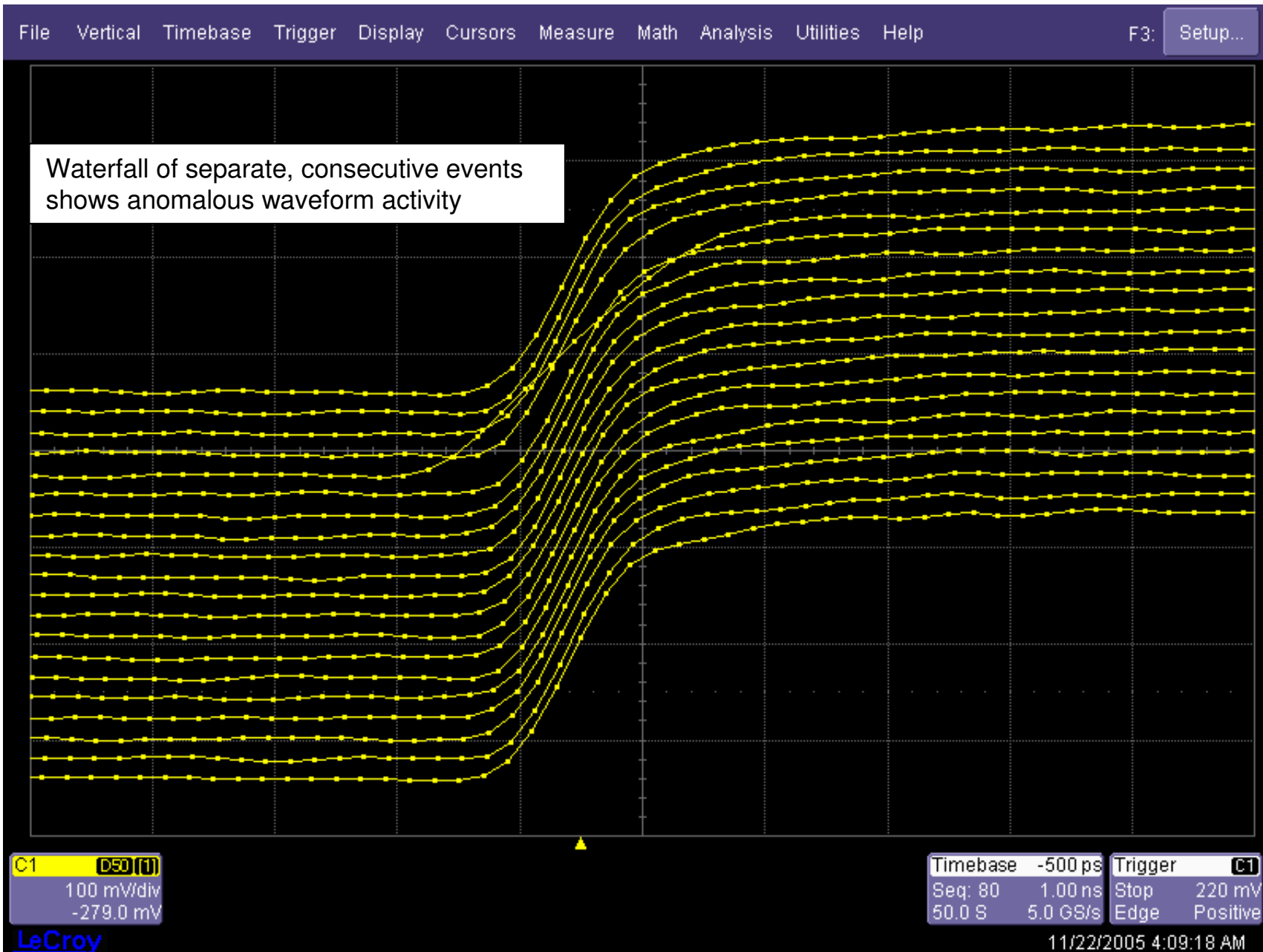
Time of Time Show Status For

Channel	Seg	Time	since Segment 1	between Segment
M1	19876)	17-Dec-2004 21:10:54	102.089102 ms	3.999 μ s
M2	19877)	17-Dec-2004 21:10:54	102.094101 ms	5.000 μ s
M3	19878)	17-Dec-2004 21:10:54	102.100102 ms	6.000 μ s
M4	19879)	17-Dec-2004 21:10:54	102.105102 ms	5.001 μ s
	19880)	17-Dec-2004 21:10:54	102.109102 ms	3.999 μ s
	19881)	17-Dec-2004 21:10:54	102.114102 ms	5.000 μ s
	19882)	17-Dec-2004 21:10:54	102.120102 ms	6.000 μ s
	19883)	17-Dec-2004 21:10:54	102.125102 ms	5.001 μ s
	19884)	17-Dec-2004 21:10:54	102.129102 ms	3.999 μ s
	19885)	17-Dec-2004 21:10:54	102.134102 ms	5.000 μ s

19,876th event selected

LeCroy 12/17/2004 9:11:46 PM

Sequence Waterfall shows anomaly

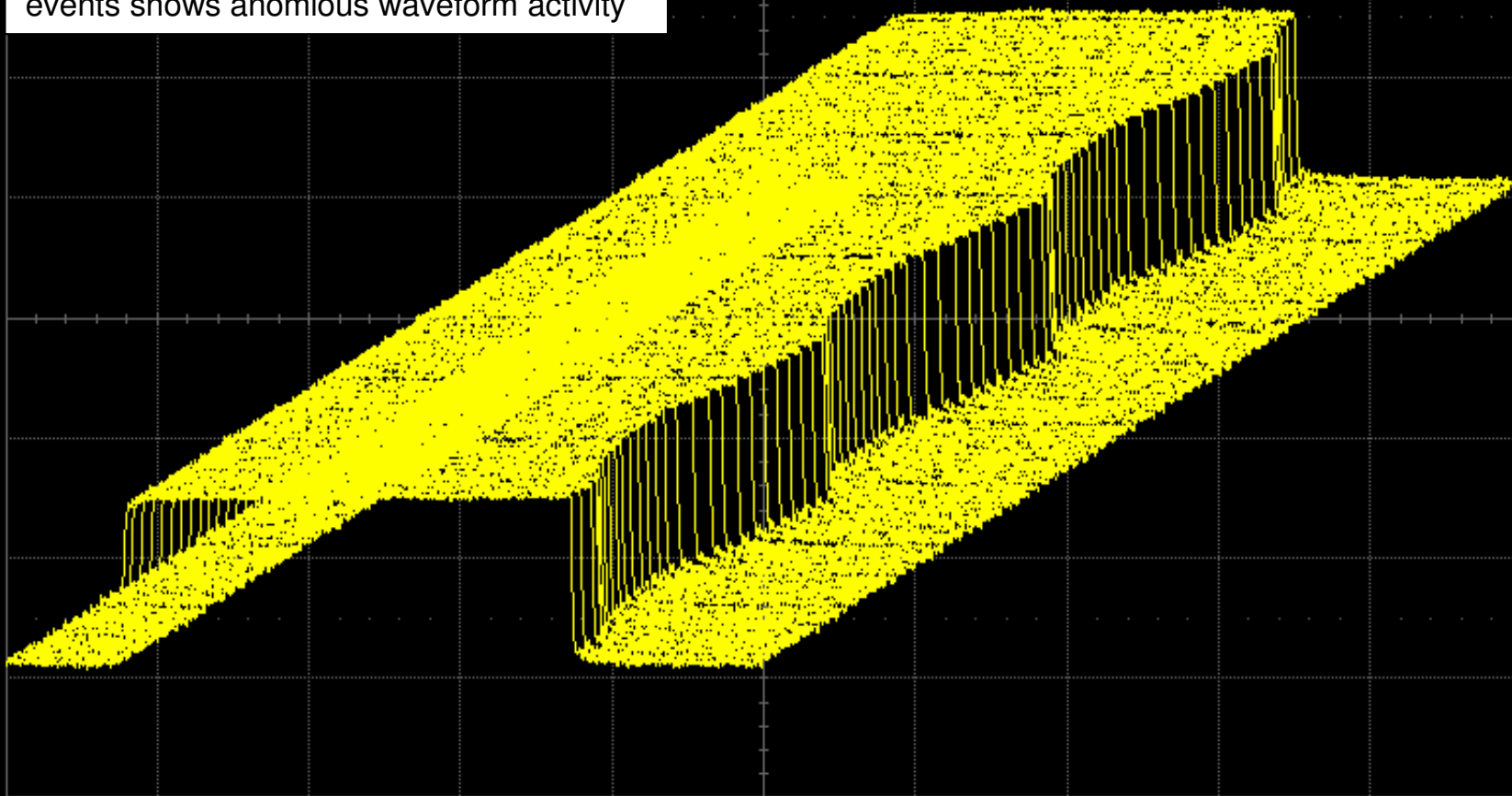


Sequence Perspective shows contour of acquired pulses

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help

C2: Setup...

Perspective of separate, consecutive events shows anomalous waveform activity

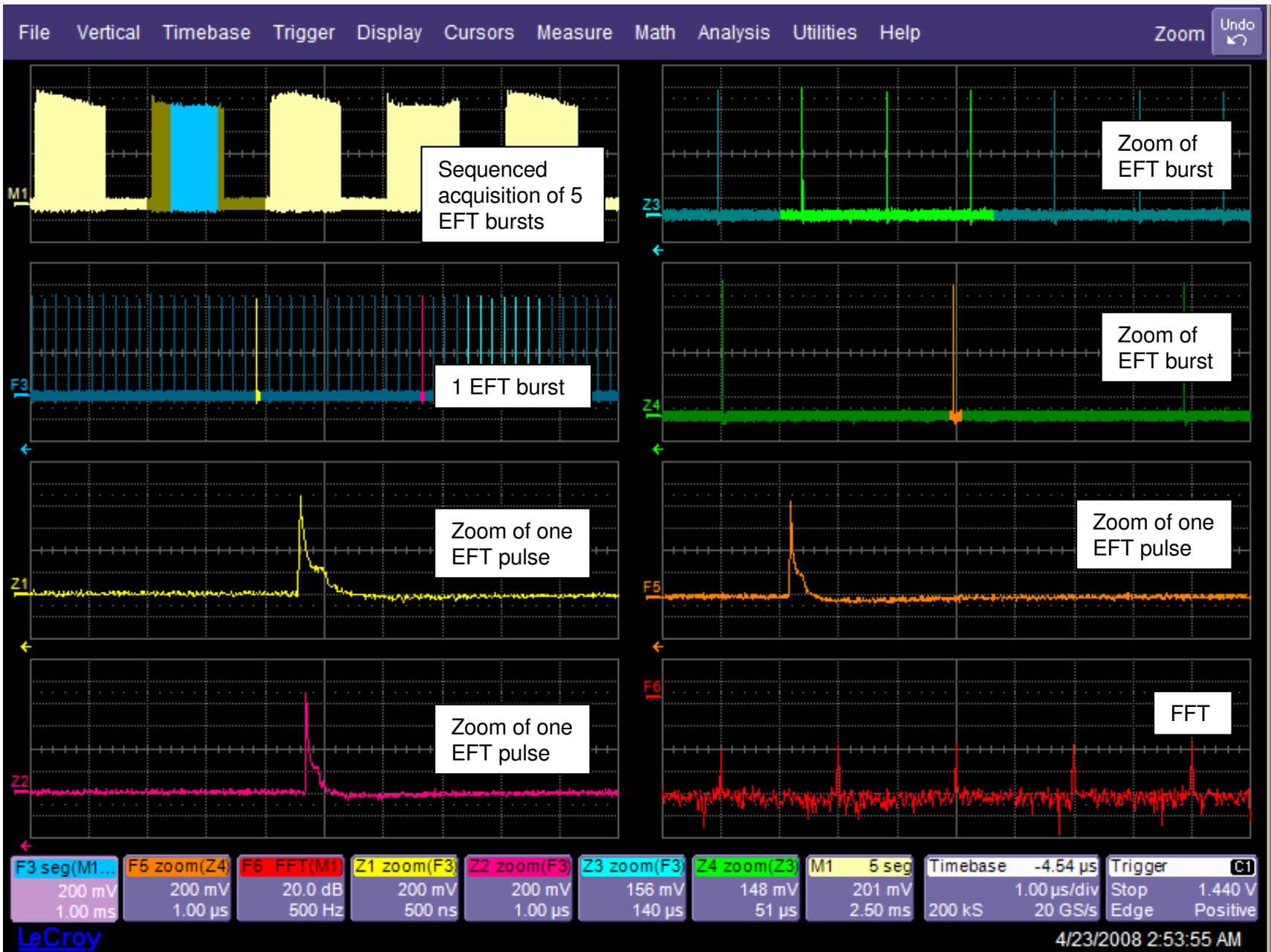


C1 D50 (1)
200 mV/div
-330.0 mV

Timebase	-534.2 ns	Trigger	C1
Seq: 80	10.0 ns	Stop	366 mV
2.00 kS	20 GS/s	Edge	Positive

EFT Testing – Electrical Fast Transient

Sequence Mode and Octal Grid



Parameter limiting technique for ESD width measurement

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help Zoom Undo

Measure	P1:top(Z1)	P2:base(Z1)	P3:wid@lv(Z1)	P4:P Limiter(P3)
value	693 mV	13 mV	4.901 ns	7.473 ns
mean	693.22 mV	13.00 mV	6.18682 ns	7.47257 ns
min	693 mV	13 mV	4.901 ns	7.473 ns
max	693 mV	13 mV	7.473 ns	7.473 ns
sdev	---	---	1.28574 ns	---
num	1	1	2	1
status	✓	✓	✓	✓

Z1 zoom(C1)
490 mV/div
19.0 ns/div

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type

Source1 P3

Math Operator P Limiter

measure on waveforms

math on parameters

advanced web edit

Summary

P Limiter(P3)

Actions for P4

Histogram Trend Track

Help

Markers Always On

Simple

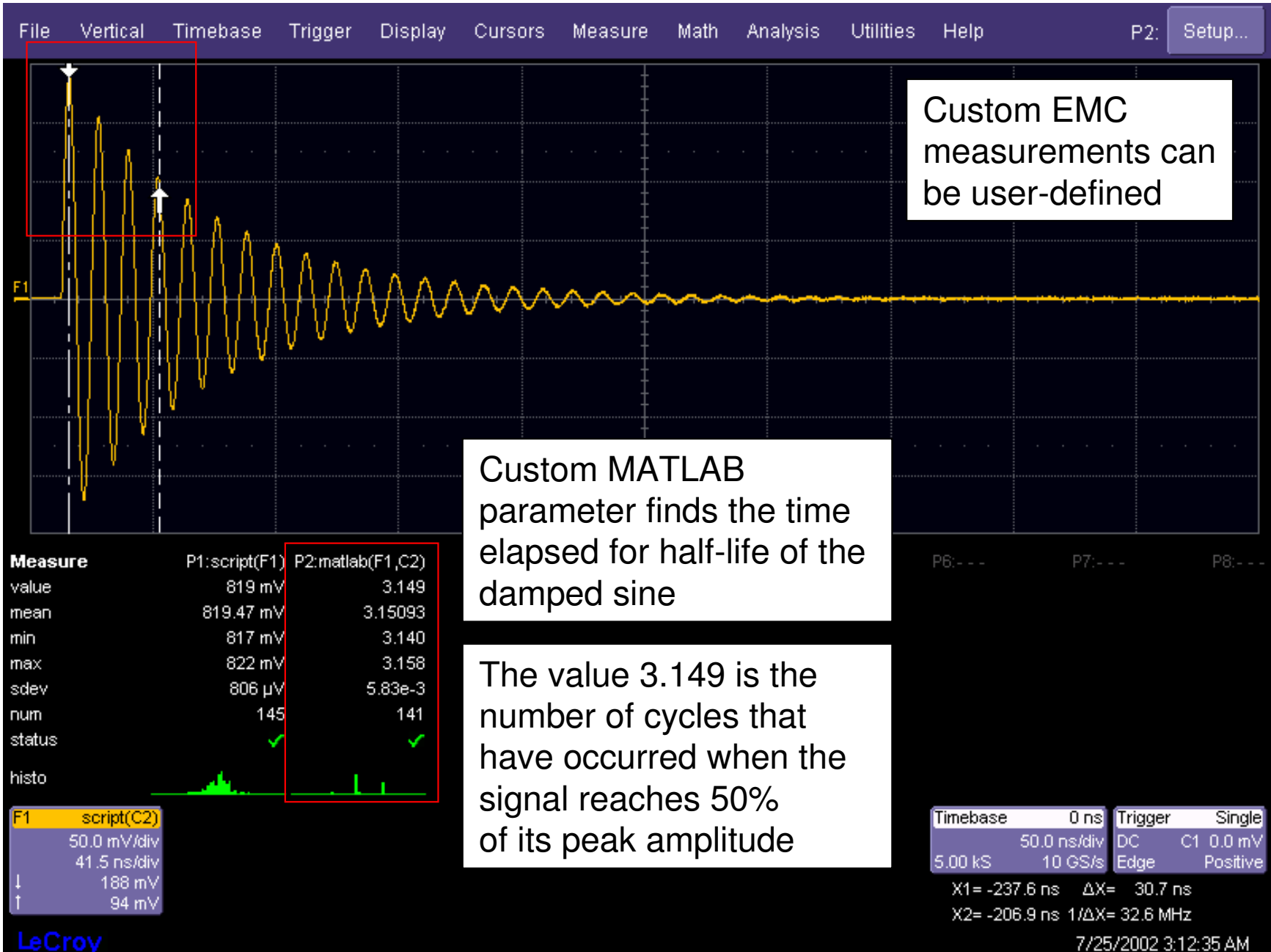
Used as a "filter" to limit the number of values passed through to the output.

Limit Nb Param

1

Because EMC pulses often have pulse perturbations on the falling edge of the pulse, these can result in false measurement readings when using standard parameters. For example, if the falling edge had ringing oscillations which repeatedly crossed the threshold, then multiple false width readings would be possible. For this reason, a measurement filtering capability which can limit the number of pulses the scope measures in an acquisition is needed. This measurement filtering capability, now available on modern scopes, allows for pulse-like perturbations on the falling edge of a pulse to be ignored and excluded from the measurement results. Parameter statistics could be accumulated on the first pulse in conjunction with parameter limiting subsequent perturbations.

Inline Custom Measurement



Real-Time Modification of Custom Measurement

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help P2: Setup...

Real-time modification of custom algorithm

Measure	P1:script(F1)	P2:matlab(F1)
value	820 mV	3.149
mean	819.47 mV	3.15347
min	817 mV	3.149
max	822 mV	3.158
sdev	801 μ V	4.95e-3
num	150	2
status	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
histo		

F1 script(C2)
 50.0 mV/div
 41.5 ns/div
 ↓ 188 mV
 ↑ 94 mV

Measure P1 P2 P3 P4 P5

Source1 F1
 Source2 C2

Actions for P2
 On
 Measurement Type
 measure on waveforms
 math on parameters
 Histogram

MatLab Editor

```

MatLabCod MATLAB Code
for k = edgepos(start):edgepos(start+1)
    if data(k) > 0.5 * maxdata
        halflife = start+(k-edgepos(start))/(edgepos(start+1)-edgepos(start))
        break
    end
end
ParamOut = halflife;
  
```

MatLab Res: MATLAB Response

```

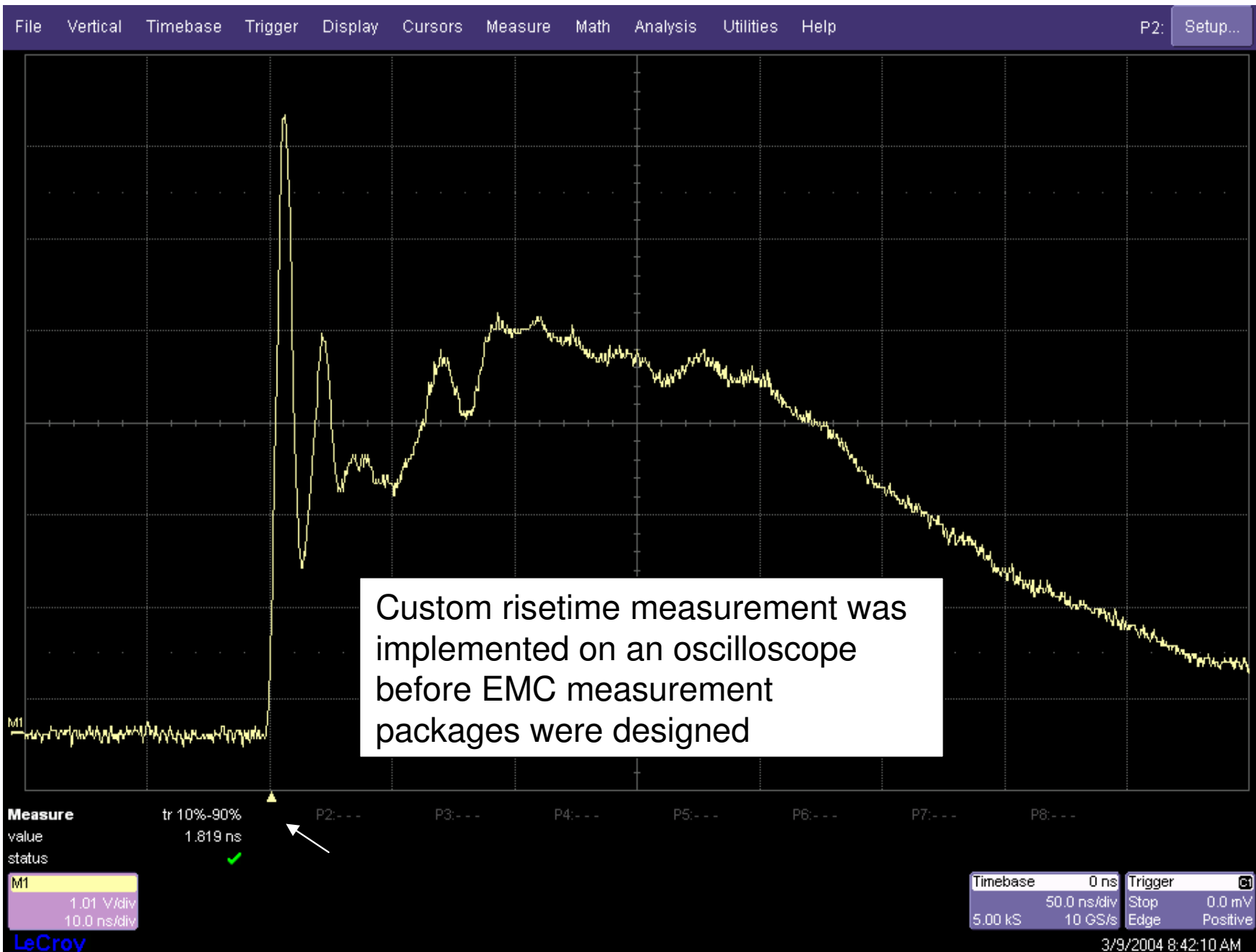
??? Undefined function or variable 'x'.

Error in ==> C:\MATLAB6pl\work\TimeDecayHalfLife.m
On line 7 ==> x = x + 5
  
```

Load Code Save Code Close

LeCroy 7/25/2002 3:14:28 AM

EMC Risetime Custom Definition



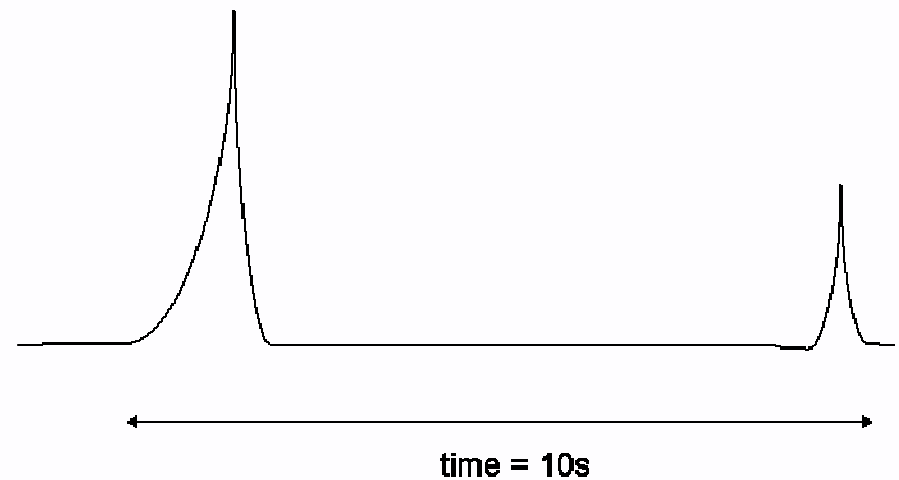
Summary

- EMC/ESD test specifications require verification of rise times, fall times, pulse widths and pulse shapes
- Standard oscilloscope pulse parameter measurements are based on IEEE pulse definitions
- EMC engineers use different pulse definitions which oscilloscopes are not designed to use
- Non-standard measurement setups are required to perform accurate pulse parameter measurements of electrostatic discharge, electrical fast transients, and surges.
- Selecting the correct measurement threshold can make a significant difference in the measurement accuracy of these signals.

Reference Slides

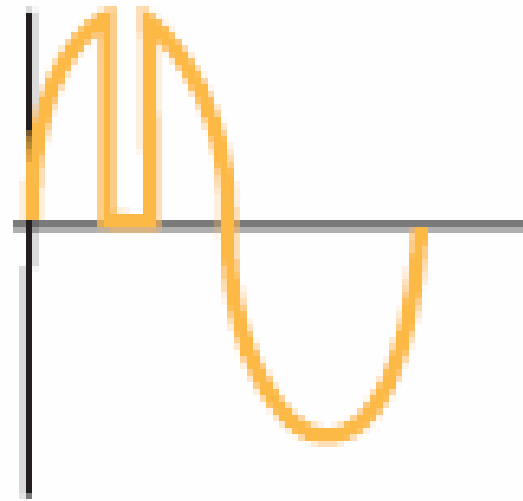
Transient Testing (Automotive)

- Pulse Characteristics
 - Capacitive load dump
 - Inductive kickback/spike (back EMF from motor turn off)
- Measurement Needs
 - Capture Time – longer the better:
 - Relay bounce (μs to ms)
 - Transient time
 - μs (motor)
 - ns (FET switch)
 - Measure 50-100 MHz transient
 - 10s capture = 2Mpts at 100 MHz Sample Rate



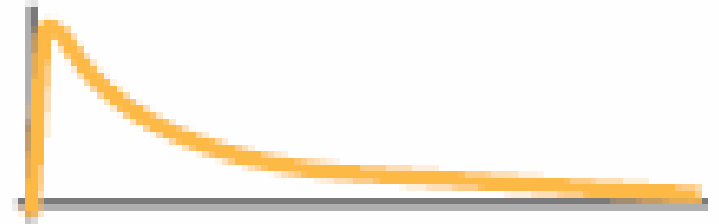
Dropout and Interrupt Testing

- Monitor AC or DC voltage line with oscilloscope during EMC testing
- Verify that dropout or interrupt occurred, and that device under test was unaffected

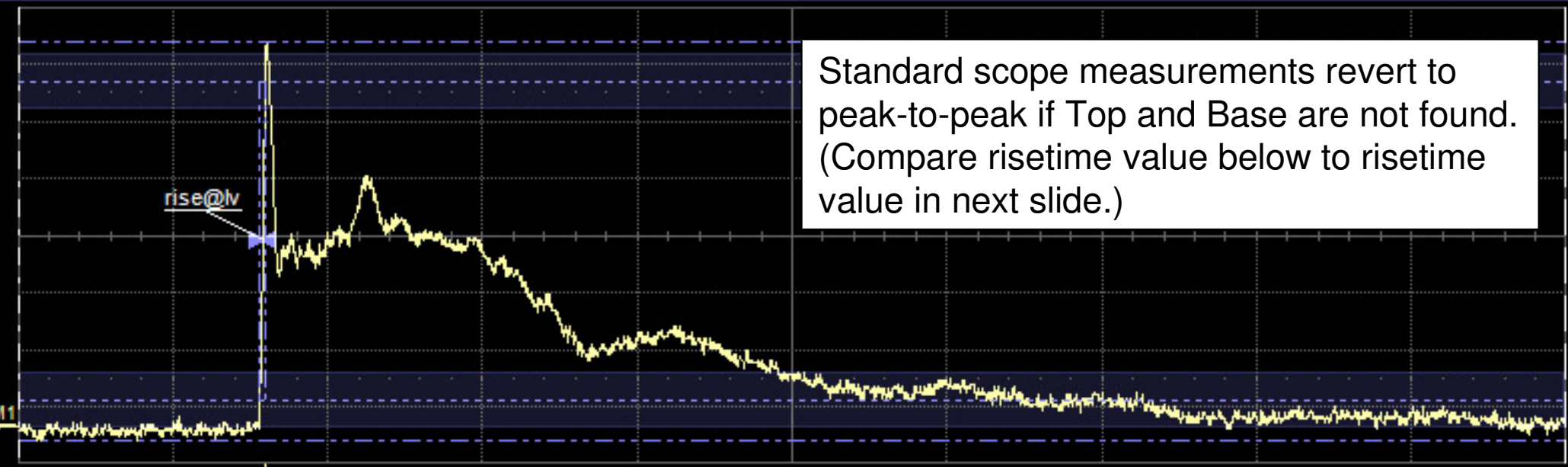


Surge Testing

- Pulse Characteristics
 - T_{rise} = typically 1.2 to 10 μs
 - T_{fall} = typically 20 to 10,000 μs
- Measurement Needs
 - Capture a Single Pulse
 - Measure one pulse, verify rise and fall time



Standard scope measurements revert to peak-to-peak if Top and Base are not found. (Compare risetime value below to risetime value in next slide.)



Measure value status P1:rise@lv(M1) 896 ps

M1 50 V/div 25.0 ns/div

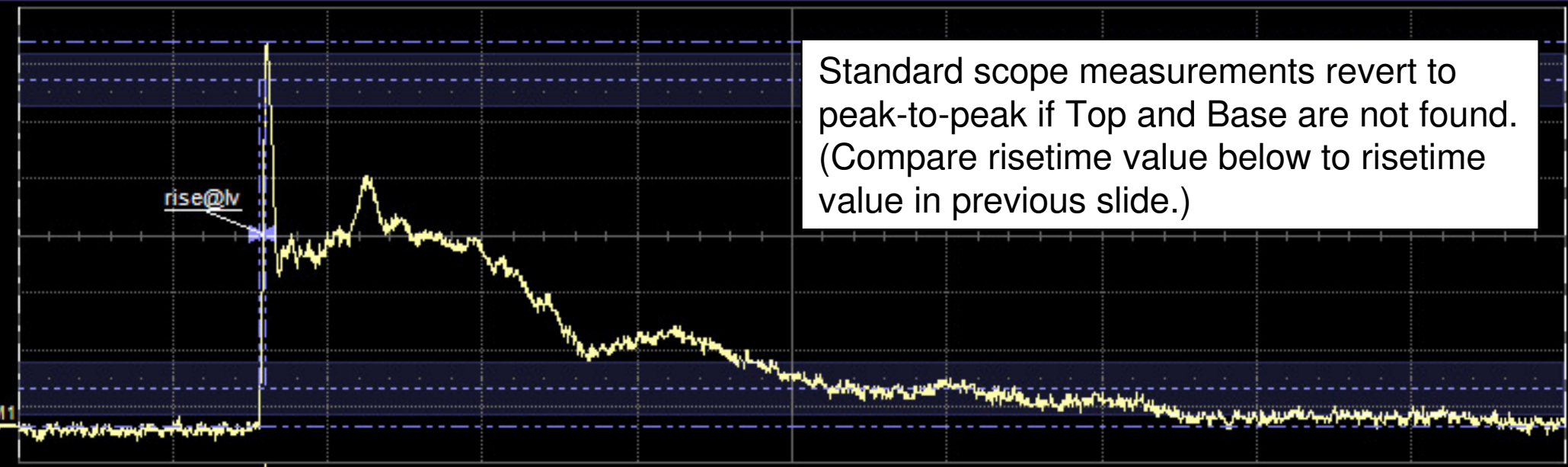
Timebase 0 ns 50.0 ns/div 5.00 kS 10 GS/s Trigger C1 Stop 0.0 mV Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

Configuration panel for Measure P1: Rise@level. Includes options for 'On', 'Type', 'Source1 M1', 'Summary rise@lv(M1)', and 'Always On'.

Configuration panel for 'Rise at level' measurement. Includes 'Slew Rate' settings, 'Levels are Percent 90 %', and buttons for 'Set Levels to 10% and 90%', 'Set Levels to 20% and 80%', and 'Low percent 10 %'.

Standard scope measurements revert to peak-to-peak if Top and Base are not found. (Compare risetime value below to risetime value in previous slide.)



Measure value status
P1:rise@lv(M1)
854 ps ✓

M1
50 V/div
25.0 ns/div

Timebase 0 ns
50.0 ns/div
5.00 kS
10 GS/s
Trigger C1
Stop 0.0 mV
Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type

- measure on waveforms
- math on parameters
- advanced web edit

Source1 M1

Measure Rise@level

Summary
rise@lv(M1)

Actions for P1

- Histogram
- Trend
- Track

Help

- Markers
- Always On
- Detailed

Rise at level Gate Accept Close

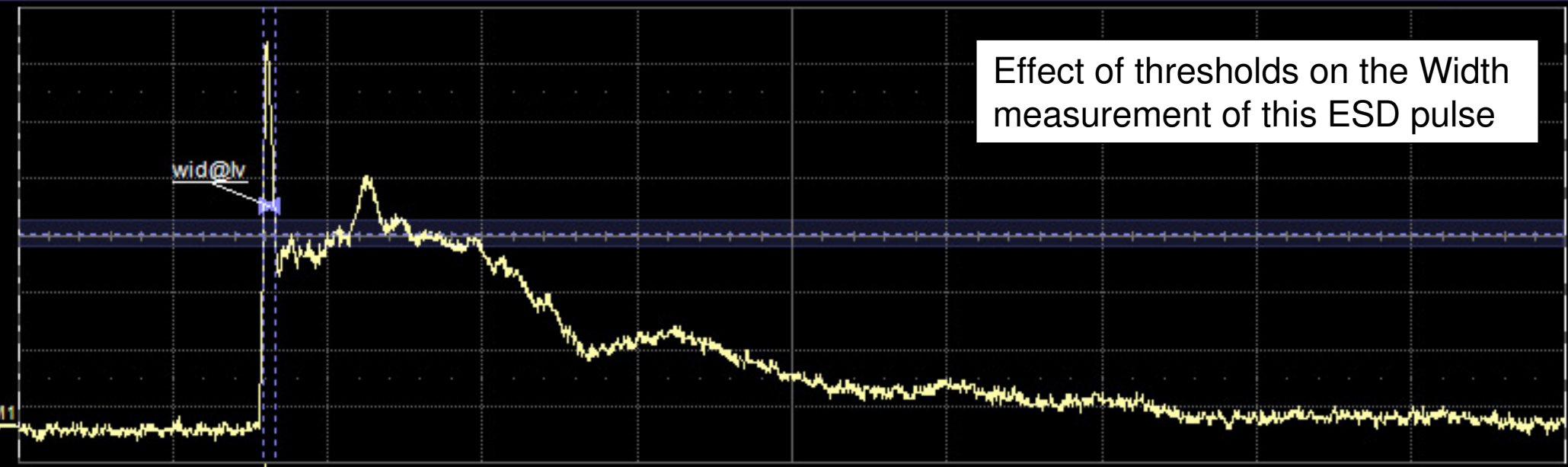
MAX GND

Slew Rate for % or absolute levels of rising or falling edges.

Levels are % 0-Max High percent 90 %

Set Levels to 10% and 90% Set Levels to 20% and 80% Low percent 10 %

Effect of thresholds on the Width measurement of this ESD pulse



Measure value status

P1:wid@lv(M1)
13.246 ns ✓

M1

50 V/div
25.0 ns/div

Timebase 0 ns
50.0 ns/div
5.00 kS

Trigger C1
Stop 0.0 mV
Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type

measure on waveforms

math on parameters

advanced web edit

Source1 M1

Measure Width@level

Summary wid@lv(M1)

Actions for P1

Histogram Trend Track

Help

Markers Detailed Always On

Width at Level Gate Accept Close

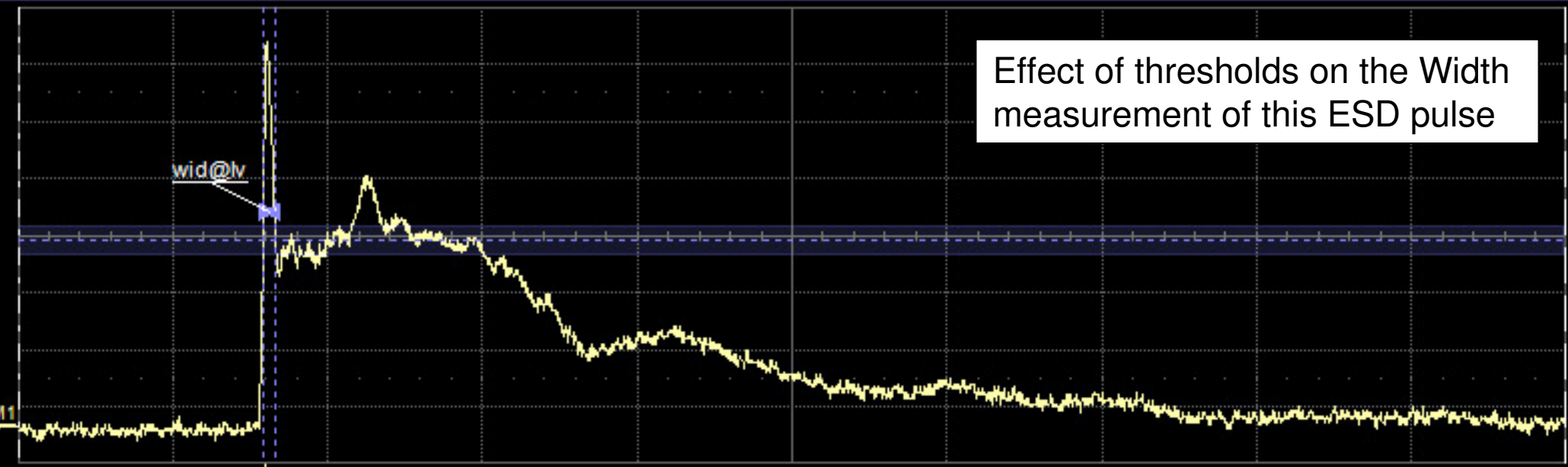
Time between two transitions of opposite slope at a specified level. (Slope specified for 1st transition)

Level is % 0-Max Percent level 50 % Find level

Slope Pos

Hyst. Type Divisions Hysteresis 500 mdiv

Effect of thresholds on the Width measurement of this ESD pulse



Measure value status

P1:wid@lv(M1)
23.084 ns ✓

M1

50 V/div
25.0 ns/div

Timebase 0 ns
50.0 ns/div
5.00 kS

Trigger C1
Stop 0.0 mV
Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type

measure on waveforms

math on parameters

advanced web edit

Source1 M1

Measure Width@level

Summary wid@lv(M1)

Actions for P1

Histogram Trend Track

Help

Markers Always On

Detailed

Width at Level Gate Accept Close

Time between two transitions of opposite slope at a specified level. (Slope specified for 1st transition)

Level is Percent level Find level

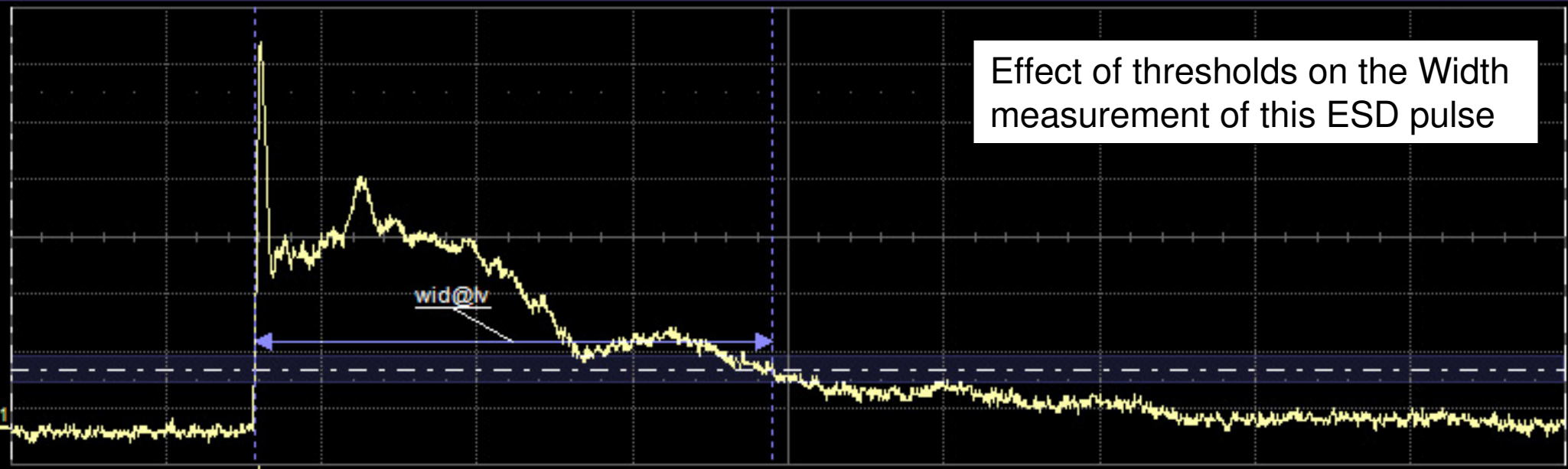
Percent 50 %

Slope Pos

Hyst. Type Hysteresis

Divisions 500 mdiv

Effect of thresholds on the Width measurement of this ESD pulse



Measure	P1:wid@lv(M1)	P2:---	P3:---	P4:---	P5:---	P6:---	P7:---	P8:---
value	83.106 ns							
status	✓							

M1
50 V/div
25.0 ns/div

Timebase	0 ns	Trigger	C1
	50.0 ns/div	Stop	0.0 mV
5.00 kS	10 GS/s	Edge	Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type: **measure on waveforms**

Source1: M1

Measure: Width@level

Summary: wid@lv(M1)

Actions for P1: Histogram, Trend, Track

Help: Markers, Always On (checked), Detailed

Width at Level Gate Accept Close

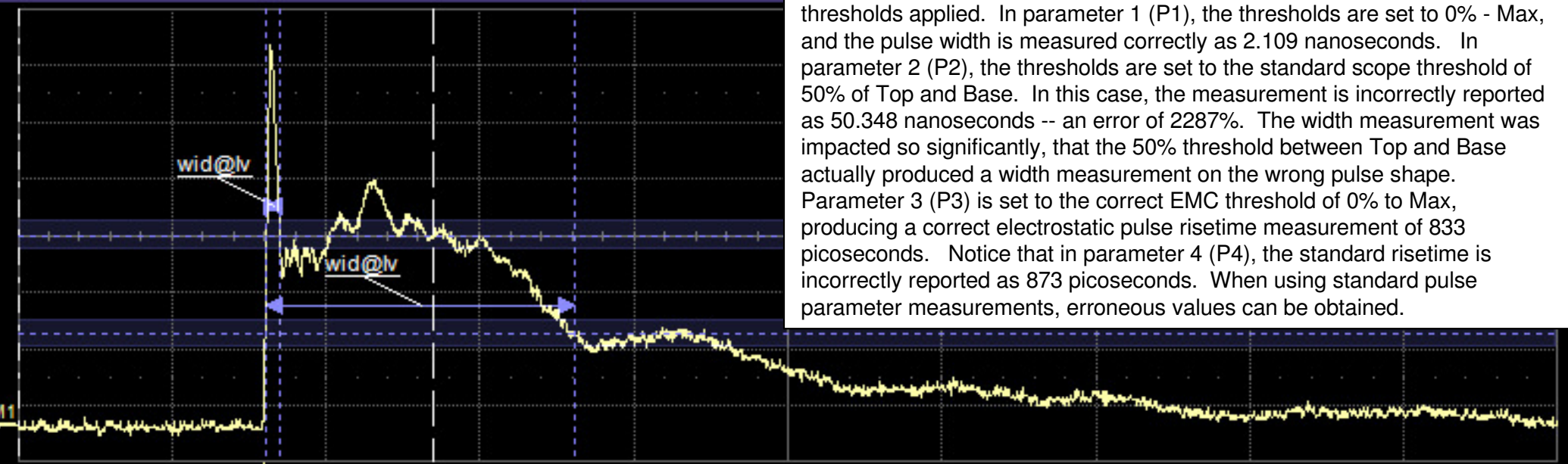
Time between two transitions of opposite slope at a specified level. (Slope specified for 1st transition)

Level is: Absolute level 52.2 V Find level

Slope: Pos

Hyst. Type: Divisions Hysteresis: 500 mdiv

The pulse width and risetime are measured, both with and without EMC thresholds applied. In parameter 1 (P1), the thresholds are set to 0% - Max, and the pulse width is measured correctly as 2.109 nanoseconds. In parameter 2 (P2), the thresholds are set to the standard scope threshold of 50% of Top and Base. In this case, the measurement is incorrectly reported as 50.348 nanoseconds -- an error of 2287%. The width measurement was impacted so significantly, that the 50% threshold between Top and Base actually produced a width measurement on the wrong pulse shape. Parameter 3 (P3) is set to the correct EMC threshold of 0% to Max, producing a correct electrostatic pulse risetime measurement of 833 picoseconds. Notice that in parameter 4 (P4), the standard risetime is incorrectly reported as 873 picoseconds. When using standard pulse parameter measurements, erroneous values can be obtained.



Measure value status	P1:wid@lv(M1) 2.109 ns ✓	P2:wid@lv(M1) 50.348 ns ✓	P3:rise@lv(M1) 833 ps ✓	P4:rise@lv(M1) 873 ps ✗	P5:---	P6:---	P7:---	P8:---
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M1
50 V/div
25.0 ns/div

Timebase -4.54 μs
1.00 μs/div
200 kS

Trigger C1
Stop 1.440 V
Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type
measure on waveforms
math on parameters
advanced web edit

Source1 M1 Measure Width@level

Summary
wid@lv(M1)

Actions for P1
Histogram Trend Track

Help
Markers Always On
Detailed

Width at Level Gate Accept Close

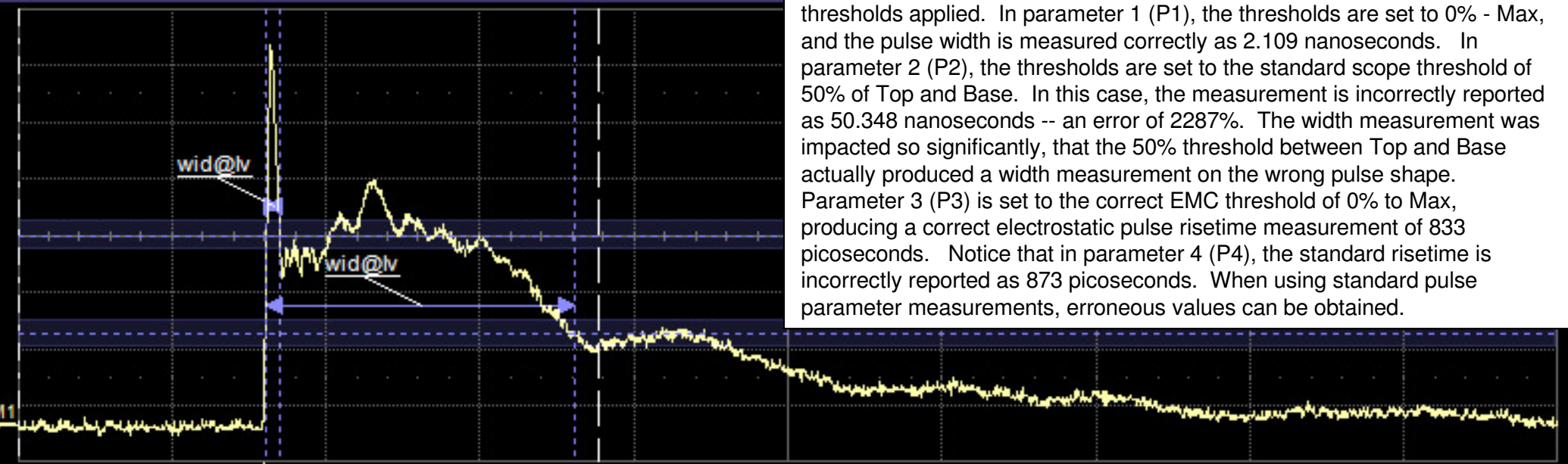
Time between two transitions of opposite slope at a specified level. (Slope specified for 1st transition)

Level is % 0-Max Percent level 50 % Find level

Slope Pos

Hyst. Type Divisions Hysteresis 500 mdiv

The pulse width and risetime are measured, both with and without EMC thresholds applied. In parameter 1 (P1), the thresholds are set to 0% - Max, and the pulse width is measured correctly as 2.109 nanoseconds. In parameter 2 (P2), the thresholds are set to the standard scope threshold of 50% of Top and Base. In this case, the measurement is incorrectly reported as 50.348 nanoseconds -- an error of 2287%. The width measurement was impacted so significantly, that the 50% threshold between Top and Base actually produced a width measurement on the wrong pulse shape. Parameter 3 (P3) is set to the correct EMC threshold of 0% to Max, producing a correct electrostatic pulse risetime measurement of 833 picoseconds. Notice that in parameter 4 (P4), the standard risetime is incorrectly reported as 873 picoseconds. When using standard pulse parameter measurements, erroneous values can be obtained.



Measure value status	P1:wid@lv(M1) 2.109 ns ✓	P2:wid@lv(M1) 50.348 ns ✓	P3:rise@lv(M1) 833 ps ✓	P4:rise@lv(M1) 873 ps ✗	P5:---	P6:---	P7:---	P8:---
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M1
50 V/div
25.0 ns/div

Timebase -4.54 μs
1.00 μs/div
200 kS
Trigger C1
Stop 1.440 V
Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type
measure on waveforms
math on parameters
advanced web edit

Source1 M1 Measure Width@level

Summary wid@lv(M1)

Actions for P2
Histogram Trend Track

Help
Markers Always On
Detailed

Width at Level Gate Accept Close

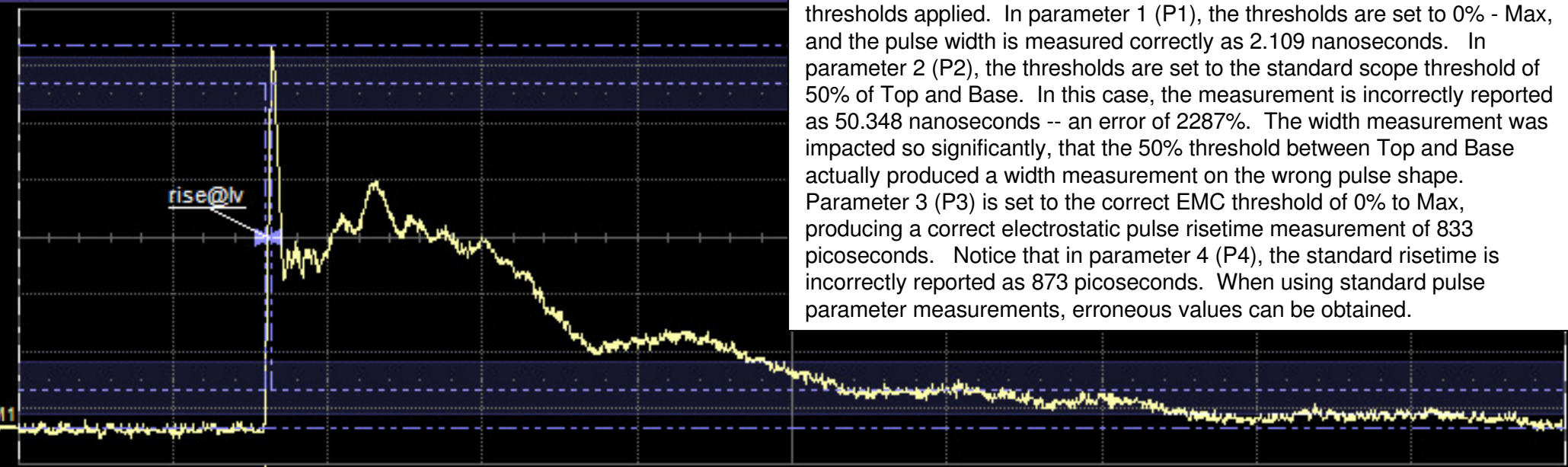
Time between two transitions of opposite slope at a specified level. (Slope specified for 1st transition)

Level is Percent
Percent 50 % Find level

Slope Pos

Hyst. Type Divisions Hysteresis 500 mdiv

The pulse width and risetime are measured, both with and without EMC thresholds applied. In parameter 1 (P1), the thresholds are set to 0% - Max, and the pulse width is measured correctly as 2.109 nanoseconds. In parameter 2 (P2), the thresholds are set to the standard scope threshold of 50% of Top and Base. In this case, the measurement is incorrectly reported as 50.348 nanoseconds -- an error of 2287%. The width measurement was impacted so significantly, that the 50% threshold between Top and Base actually produced a width measurement on the wrong pulse shape. Parameter 3 (P3) is set to the correct EMC threshold of 0% to Max, producing a correct electrostatic pulse risetime measurement of 833 picoseconds. Notice that in parameter 4 (P4), the standard risetime is incorrectly reported as 873 picoseconds. When using standard pulse parameter measurements, erroneous values can be obtained.



Measure value	P1:wid@lv(M1)	P2:wid@lv(M1)	P3:rise@lv(M1)	P4:rise@lv(M1)	P5:---	P6:---	P7:---	P8:---
status	2.109 ns	50.348 ns	833 ps	873 ps				

M1
50 V/div
25.0 ns/div

Timebase -4.54 μ s
1.00 μ s/div
200 kS
Trigger C1
Stop 1.440 V
Edge Positive

Measure P1 P2 P3 P4 P5 P6 P7 P8

On

Type

Source1 M1 Measure Rise@level

Summary rise@lv(M1)

Actions for P3

Histogram Trend Track

Help Markers Always On Detailed

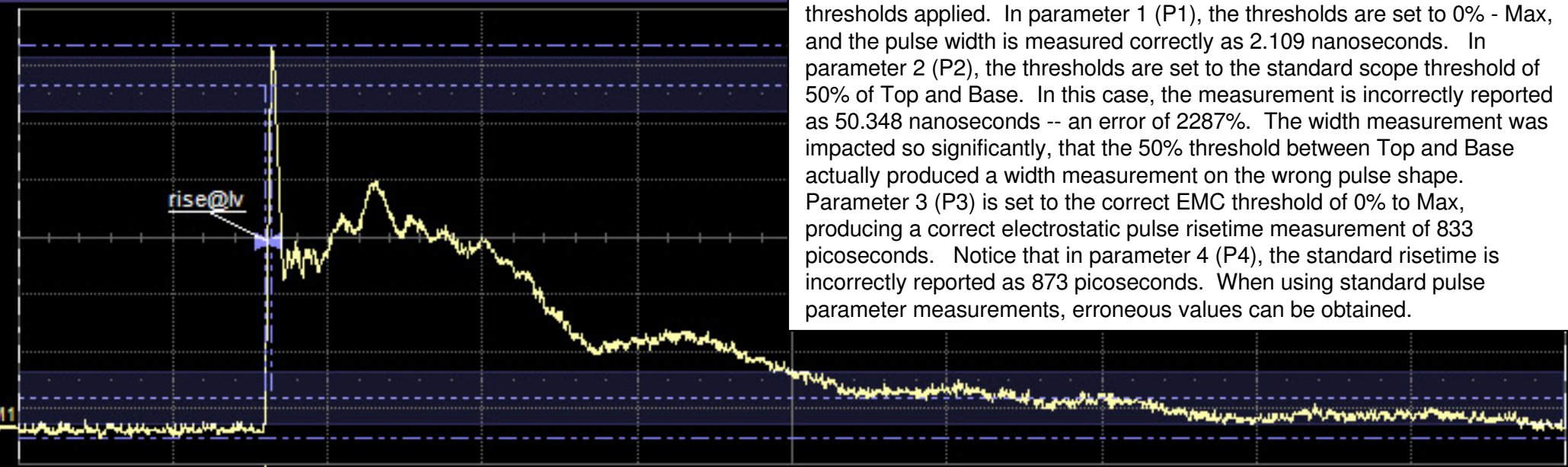
Rise at level Gate Accept Close

Transition time for % or absolute levels of all rising edges

Levels are % 0-Max High percent 90 %

Set Levels to 10% and 90% Set Levels to 20% and 80% Low percent 10 %

The pulse width and risetime are measured, both with and without EMC thresholds applied. In parameter 1 (P1), the thresholds are set to 0% - Max, and the pulse width is measured correctly as 2.109 nanoseconds. In parameter 2 (P2), the thresholds are set to the standard scope threshold of 50% of Top and Base. In this case, the measurement is incorrectly reported as 50.348 nanoseconds -- an error of 2287%. The width measurement was impacted so significantly, that the 50% threshold between Top and Base actually produced a width measurement on the wrong pulse shape. Parameter 3 (P3) is set to the correct EMC threshold of 0% to Max, producing a correct electrostatic pulse risetime measurement of 833 picoseconds. Notice that in parameter 4 (P4), the standard risetime is incorrectly reported as 873 picoseconds. When using standard pulse parameter measurements, erroneous values can be obtained.



Measure value	P1:wid@lv(M1)	P2:wid@lv(M1)	P3:rise@lv(M1)	P4:rise@lv(M1)	P5:---	P6:---	P7:---	P8:---
status	2.109 ns	50.348 ns	833 ps	873 ps				

M1
50 V/div
25.0 ns/div

Timebase -4.54 μ s
1.00 μ s/div
200 kS
Trigger C1
Stop 1.440 V
Edge Positive

- Measure
- P1
- P2
- P3
- P4
- P5
- P6
- P7
- P8

On

Type: measure on waveforms, math on parameters, advanced web edit

Source1: M1

Measure: Rise@level

Summary: rise@lv(M1)

Actions for P4: Histogram, Trend, Track

Help: Markers, Always On, Detailed

Rise at level Gate Accept Close

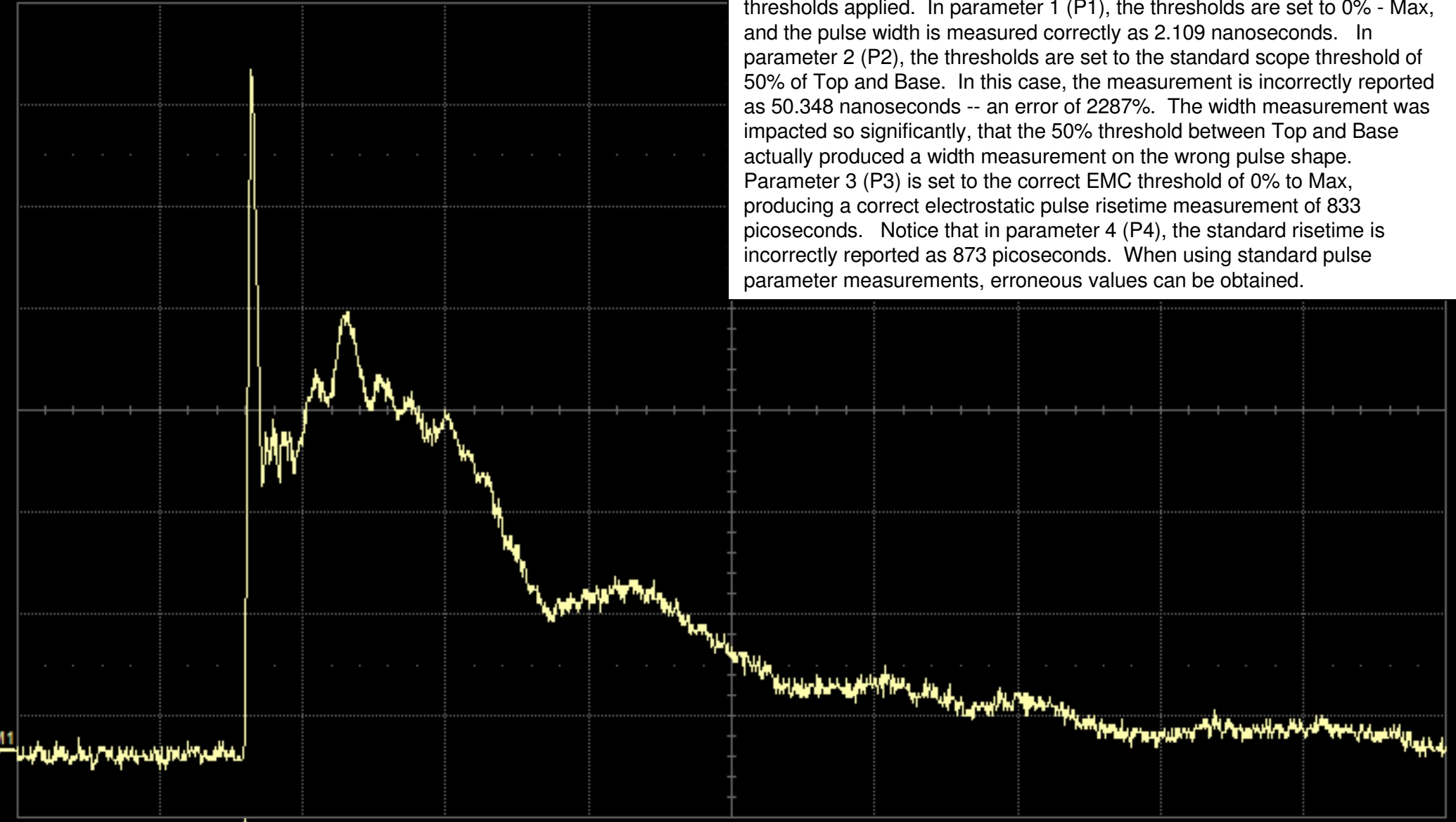
Transition time for % or absolute levels of all rising edges

Levels are Percent High percent 90%

Set Levels to 10% and 90% Set Levels to 20% and 80% Low percent 10%

P4 Status: Not a pulse.

The pulse width and risetime are measured, both with and without EMC thresholds applied. In parameter 1 (P1), the thresholds are set to 0% - Max, and the pulse width is measured correctly as 2.109 nanoseconds. In parameter 2 (P2), the thresholds are set to the standard scope threshold of 50% of Top and Base. In this case, the measurement is incorrectly reported as 50.348 nanoseconds -- an error of 2287%. The width measurement was impacted so significantly, that the 50% threshold between Top and Base actually produced a width measurement on the wrong pulse shape. Parameter 3 (P3) is set to the correct EMC threshold of 0% to Max, producing a correct electrostatic pulse risetime measurement of 833 picoseconds. Notice that in parameter 4 (P4), the standard risetime is incorrectly reported as 873 picoseconds. When using standard pulse parameter measurements, erroneous values can be obtained.



Measure	P1:wid@lv(M1)	P2:wid@lv(M1)	P3:rise@lv(M1)	P4:rise@lv(M1)	P5:---	P6:---	P7:---	P8:---
value	2.109 ns	50.348 ns	833 ps	873 ps				
status	✓	✓	✓	✗				

M1
50 V/div
25.0 ns/div

Timebase	-4.54 μ s	Trigger	C1
	1.00 μ s/div	Stop	1.440 V
200 kS	20 GS/s	Edge	Positive