

FAQs about Risetime Filters from Picosecond Pulse Labs (PSPL)

1. What makes PSPL risetime filters unique?

Risetime filters are very useful for slowing the edges of pulses and digital signals. They are sometimes called Transition Time Converters, (TTCs). PSPL risetime filters are absorptive. They produce a smooth quasi-gaussian transition and absorb much of the out-of-band energy. Most low pass and risetime filters filter by reflection, which can cause distortion in the signal. PSPL filters are bi-directional. Either port may be used as the input.

2. What is the difference between a Risetime Filter and a Low Pass Filter?

PSPL risetime filters and low pass filters share identical designs and construction methods. A low pass filters may be used as a risetime filter and vice versa. With Model 5915 and 5925 custom-tuned filters, a risetime filter is tuned on a sampling oscilloscope in the time domain while a low pass filter is tuned using a network analyzer. The -3dB bandwidth (BW) and the risetime (T_r) are related by the following equation when the edge transition is gaussian.

$$BW(-3\text{dB frequency}) * T_r(10\% - 90\%) = 0.35$$

This equation is a useful guide, but it may not be exact. For Model 5915 or 5925 filters, PSPL recommends that you specify the risetime when a specific risetime is needed or the -3dB frequency for a low pass filter.

Models 5933 and 5935 filters use thin-film-on-ceramic technology. They are not tuned because each one is designed for a specific -3dB frequency. These filters are ordered using the -3dB frequency. The table in Question 3 shows the measured risetimes for each of these filters.

3. What risetimes are available?

PSPL filters are available with risetimes between 12 ps and 10 ns. Please refer to the specification sheets for Models 5915, 5925, 5933, and 5935 for the characteristics of each product. The following tables list the risetime filters that are available from PSPL. Models 5915 and 5925 are hand-built and hand-tuned. Using these two models, PSPL can manufacture a custom filter with any risetime (10%–90%) between 24ps and 10ns.

Model	Minimum Risetime	Maximum Risetime	Connectors
5915	35 ps	10 ns	SMA
5925	24 ps	50 ps	SMA

Models 5933 and 5935 use thin-film-on-ceramic technology. Each filter is designed for specific -3dB frequency. A new risetime or -3dB frequency requires a custom design, mask, and thin-film production cycle. The table shows the measured risetimes for the low pass filters that are in production at this time.

Model	Frequency	Risetime	Connectors
5933	7.46 GHz	44 ps	SMA, 2.92, 2.4mm
5933	8.00 GHz	47 ps	SMA, 2.92, 2.4mm
5935	10.0 GHz	33 ps	2.92, 2.4mm
5935	12.5 GHz	27 ps	2.92, 2.4mm
5935	15.0 GHz	23 ps	2.92, 2.4mm
5935	17.5 GHz	19 ps	2.92, 2.4mm
5935	20.0 GHz	17 ps	2.92, 2.4mm
5935	22.5GHz	16 ps	2.92, 2.4mm
5935	25.0 GHz	14 ps	2.92, 2.4mm
5935	28.0 GHz	12 ps	2.92, 2.4mm

4. What is the difference between a 10% to 90% risetime and a 20% to 80% risetime?

PSPL specifies the 10% to 90% risetime for its filters. Sometimes systems or test procedures express risetimes as 20% to 80%. A PSPL risetime filter can be described with either method by using the following relationship.

$$Tr(10\% - 90\%) = \frac{Tr(20\% - 80\%)}{0.66}, \text{ where Tr is the risetime.}$$

As a consequence, the 20%-80% risetime for a filter will be about 2/3 of its 10% to 90% risetime.

6. How do I choose a risetime filter that slows the edge of a signal to a specific risetime?

The total risetime of a series of components will be slower than the risetime of any one component. The root sum of squares equation predicts the total risetime.

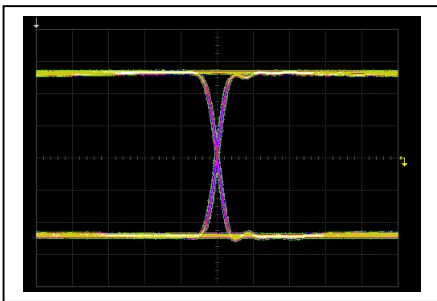
$$Tr(total) = \sqrt{Tr_1^2 + Tr_2^2 + \dots + Tr_n^2}, \text{ where Tr is the risetime.}$$

We can use this calculation to determine the filter that is needed to produce a specific edge speed. Consider the case where a pattern generator has a risetime of 25 ps and we wish to slow that risetime to 70 ps so that it will be typical of a 4X Fibre Channel signal. Adding a 65 ps risetime filter to that pattern generator will produce the desired output with 70 ps risetime.

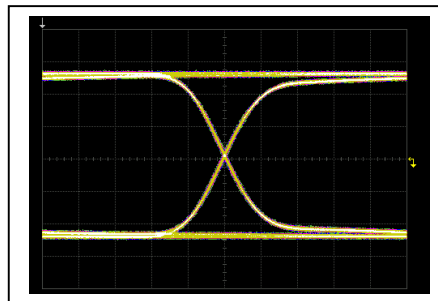
$$Tr(RisetimeFilter) = \sqrt{Tr(total)^2 - Tr(PG)^2}$$

$$Tr(RisetimeFilter) = \sqrt{70ps^2 - 25ps^2}, \quad Tr(RisetimeFilter) = 65ps$$

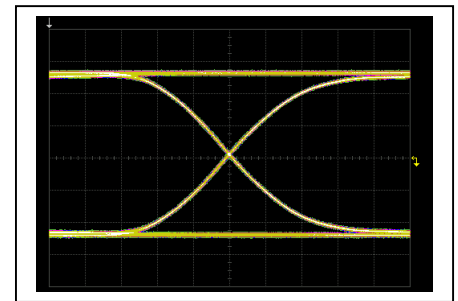
The following eye diagrams show examples of adding a PSPL risetime filter to a source with a fast edge. The signal source is a pattern generator with a 25 ps risetime. Plots show the result when a 100 ps or 200 ps risetime filter is added. The time scale is 50 ps/div in all cases.



Pattern Generator Output
Tr = 25 ps, Bit Rate = 2.0 G-b/s



Signal after passing through a
100 ps risetime filter.

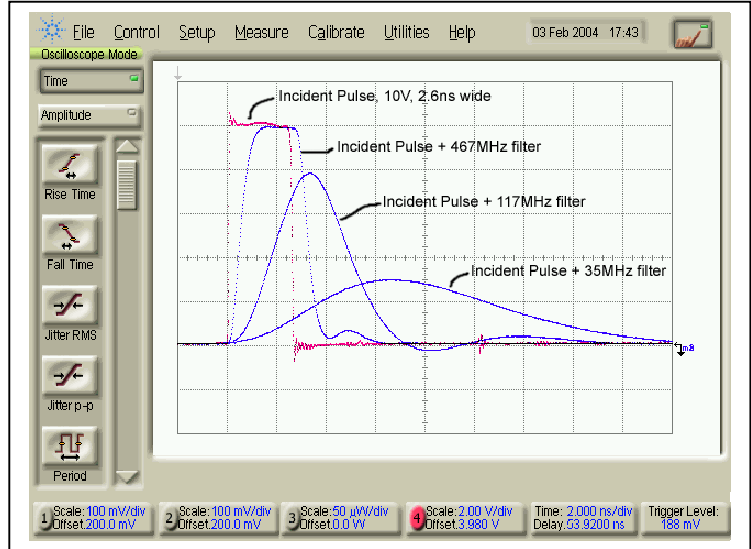


Signal after passing through a
200 ps risetime filter.

7. How do risetime filters affect narrow pulses and impulses?

A risetime filter can be used to slow the edge speed of a pulse or to increase the duration of an impulse. Adding a risetime filter to a rectangular pulse can transform it into a gaussian-like impulse by reducing the higher frequencies that are carried in the fast edges.

The oscilloscope plot at the right shows the effect of adding low pass/risetime filters to a narrow, fast pulse. A Model 10,050A pulse generator provided the incident pulse, which had 10 V amplitude, 45 ps risetime, and 2.6 ns duration. It is shown in red on the plot. The blue traces show the results of adding three different PSPL filters. Notice that the pulse amplitude decreases as the duration increases. The following table lists the equivalent risetime for each of these low pass filters.



-3dB Frequency	Equivalent Risetime (10%-90%)
467 MHz	750 ps
117 MHz	3.0 ns
35 MHz	10.0 ns