Rise Time and Bandwidth of a System or Oscilloscope

10–90 % rise time from bandwidth, the rise time a scope and probe will display for a signal edge, and the bandwidth needed for a given error.

Method: Rise time–bandwidth relation and quadrature addition

Input parameters

Unit system: SI

Parameter	Value	Unit
Instrument (scope and probe) bandwidth	200.00	MHz
True rise time of the signal	3.0000	ns
Rise time–bandwidth constant (0.35 single pole, up to 0.45 sharp roll-off)	0.35000	
Allowed rise-time measurement error	3.0000	%

Calculated results

Parameter	Value	Unit
Instrument rise time k/BW	1.7500	ns
Displayed rise time √(t_sig² + t_inst²)	3.4731	ns
Rise-time error	15.770	%
Bandwidth for the allowed error	472.76	MHz
Knee frequency of the edge 0.5/t_r	166.67	MHz

Notes for this case

• t_r = 0.35/BW for a single-pole (Gaussian-like) response; cascaded Gaussian stages add in quadrature. Scopes with steeper roll-off have k ≈ 0.4–0.45.

Formula and method

$$t_r = \frac{k}{BW}\ (k \approx 0.35), \quad t_{r,meas} = \sqrt{t_{r,sig}^2 + t_{r,inst}^2}, \quad f_{knee} = \frac{0.5}{t_r}$$

Variables

BW	Instrument (scope and probe) bandwidth	1/s
$t_{r,sig}$	True rise time of the signal	s
k	Rise time–bandwidth constant (0.35 single pole, up to 0.45 sharp roll-off)	-
ε	Allowed rise-time measurement error	-
$t_{r,inst}$	Instrument rise time k/BW	s
$t_{r,meas}$	Displayed rise time √(t_sig² + t_inst²)	s
ε_{meas}	Rise-time error	-
BW_{needed}	Bandwidth for the allowed error	1/s
f_{knee}	Knee frequency of the edge 0.5/t_r	1/s

Method and standards

Bandwidth–rise-time relations.

Assumptions and limits

- Gaussian-like responses adding in quadrature.

References

Rise time–bandwidth relation and quadrature addition

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/electronics/rise-time-bandwidth

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.