Slew rate and bandwidth

TI Precision Labs – Current sense amplifiers

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Slew rate and bandwidth

- In the **electrical characteristics** table:

FREQUENCY RESPONSE				
BW	Bandwidth	A1 versions, C_{OUT} = 500 pF	550	kHz
		A2 versions, C_{OUT} = 500 pF	440	
		A3 versions, C_{OUT} = 500 pF	400	
SR	Slew rate		4	V/µs

- In the **typical characteristics** curves:

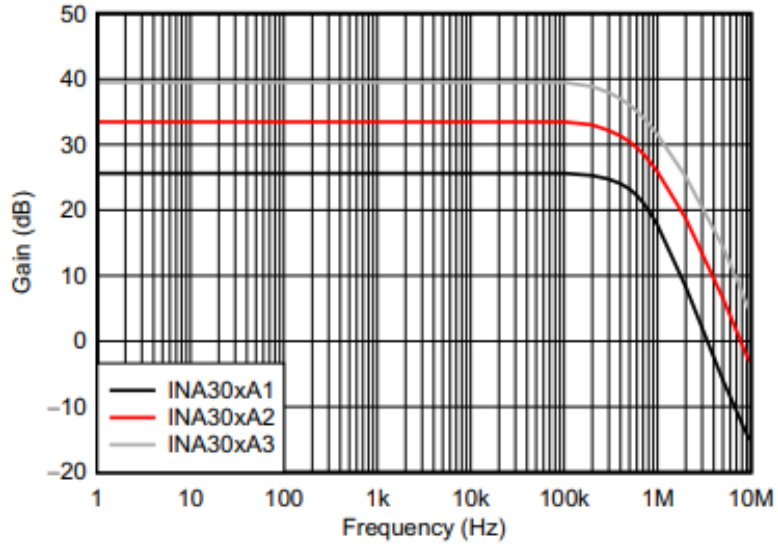


Figure 14. Gain vs Frequency

Bandwidth

- In the **electrical characteristics** table:

BW	Bandwidth	A2 versions, C_{OUT} = 500 pF	440	kHz
		A3 versions, C_{OUT} = 500 pF	400	

- In the **typical characteristics** curves:

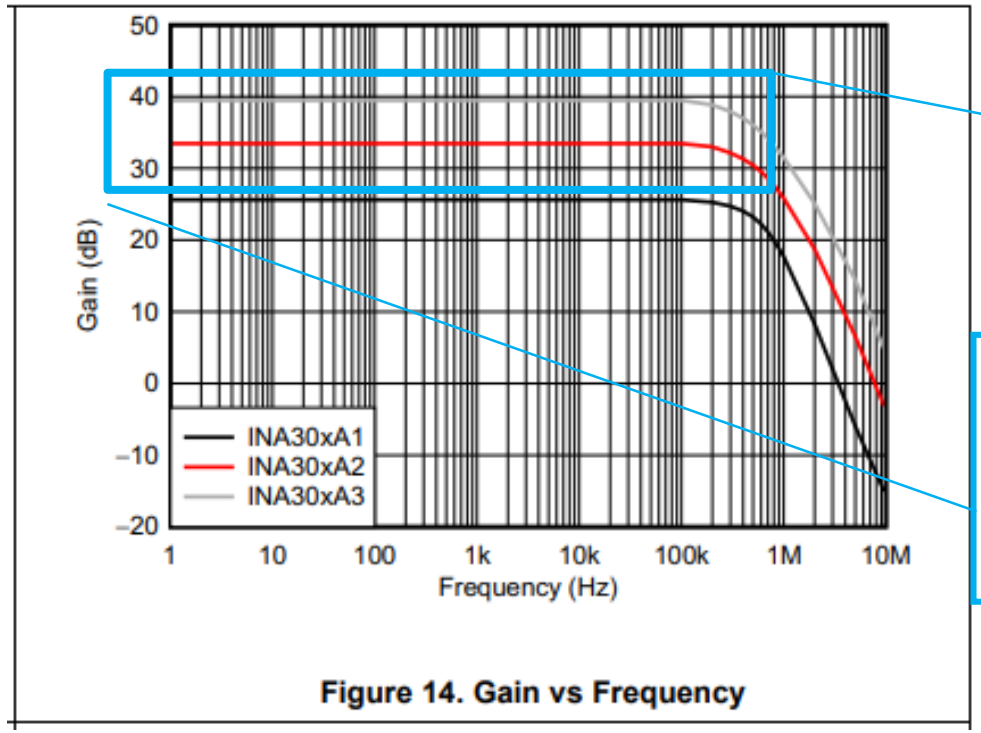
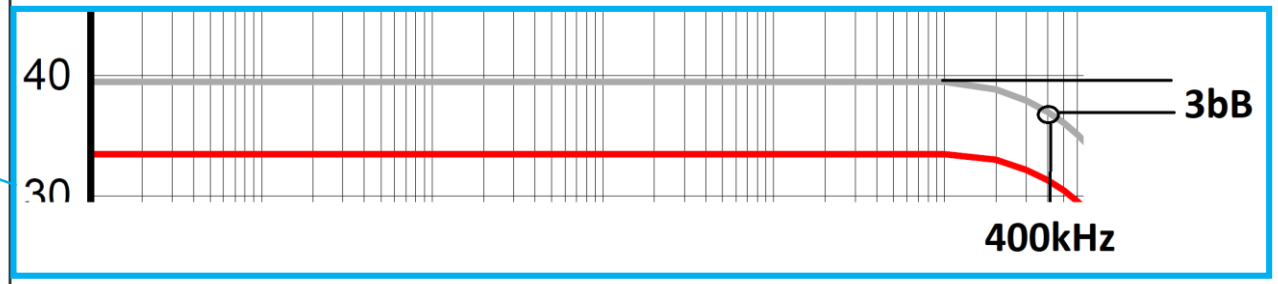
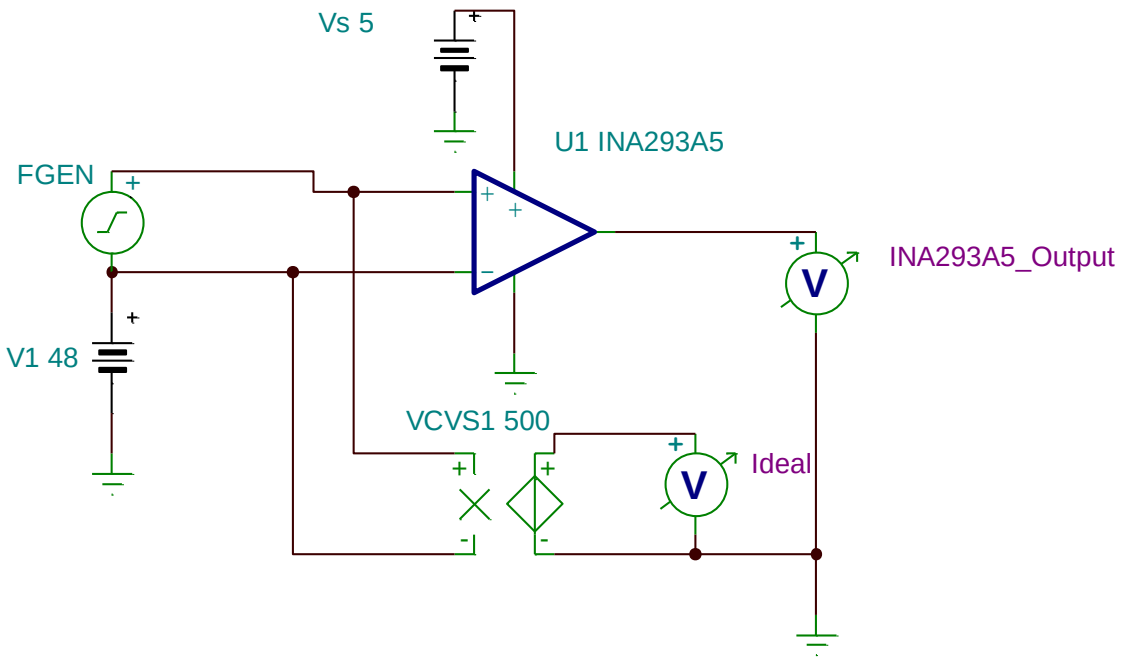
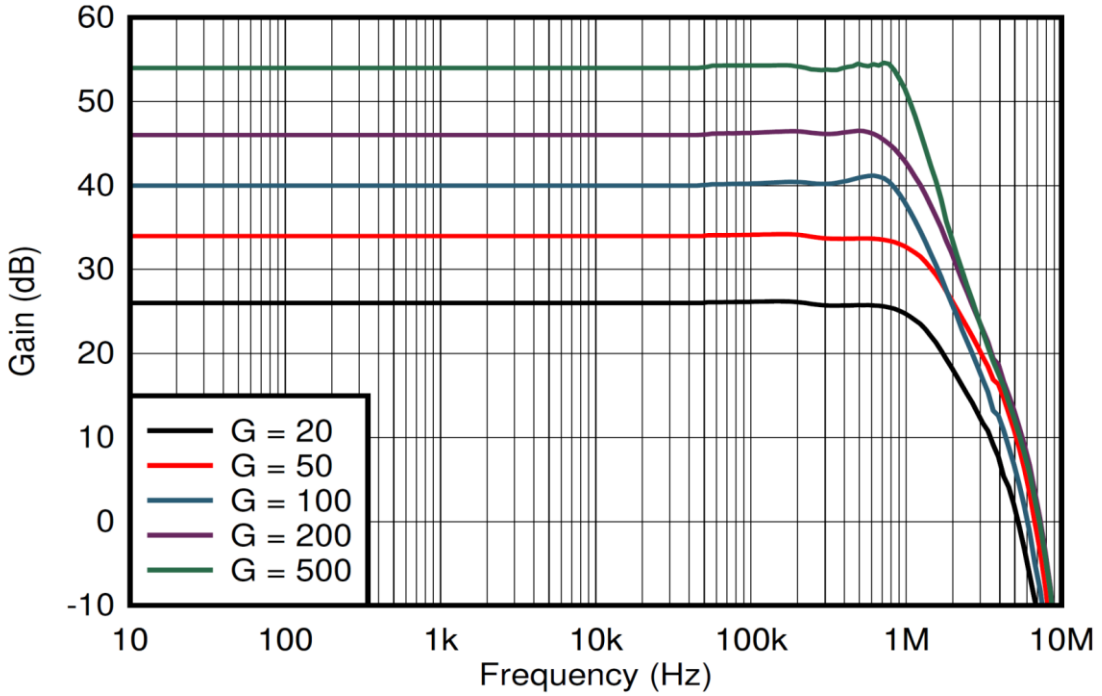


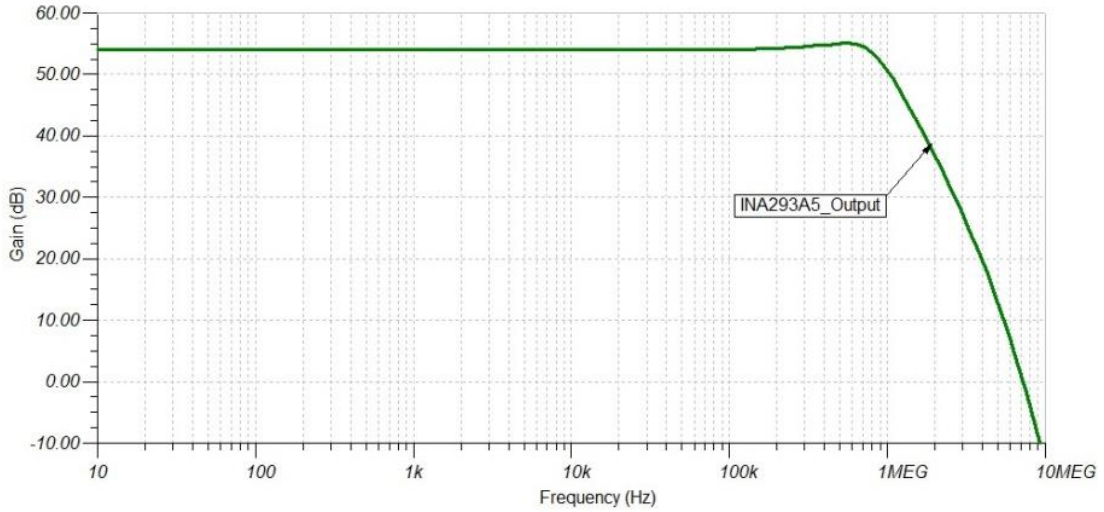
Figure 14. Gain vs Frequency



Bandwidth simulation



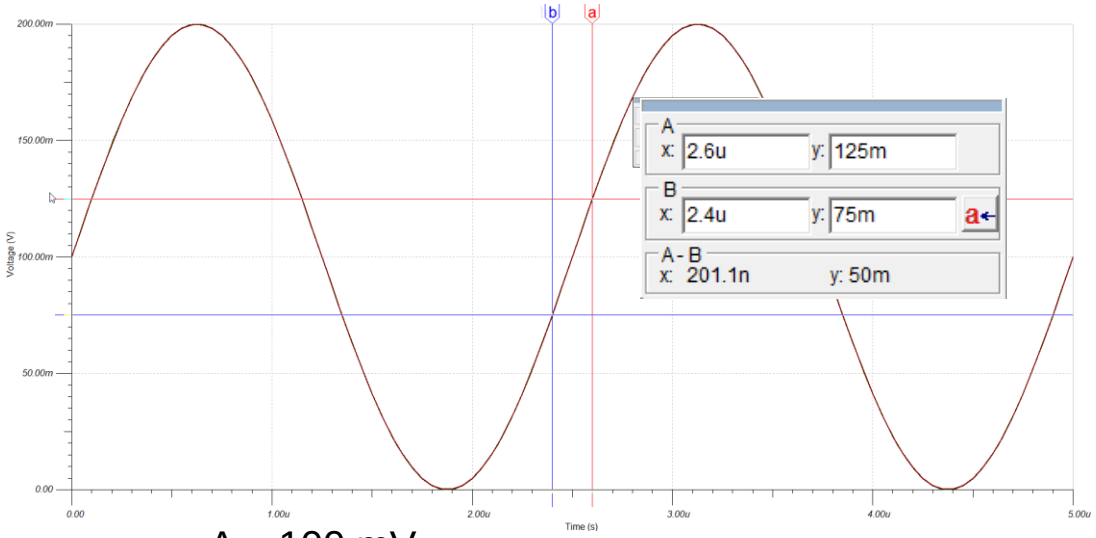




Bandwidth small signal vs. large signal

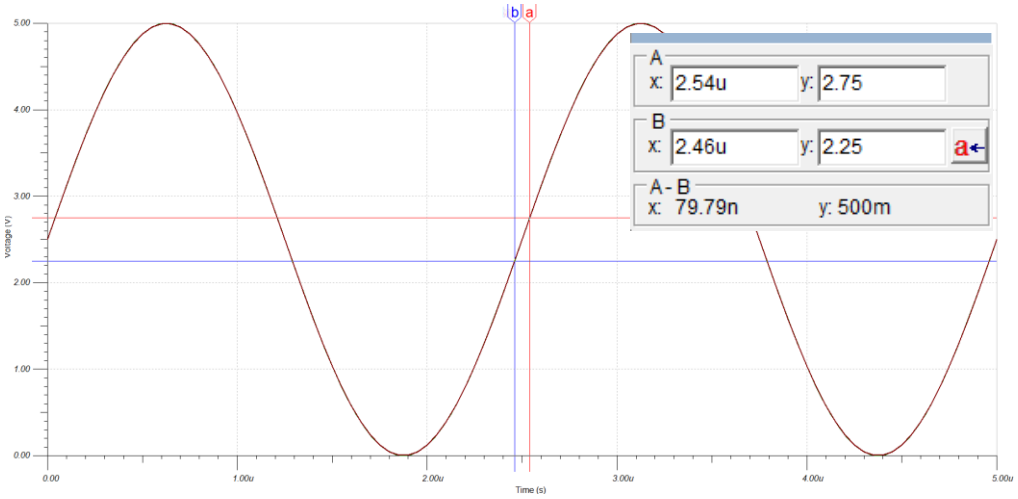
$$\text{Max Slew Rate of a sine wave} = 2\pi \cdot F \cdot A$$

F= Frequency
A = Amplitude of sine wave



A = 100 mV
F = 400 kHz
Max slew rate ≈ 0.25 V/µs

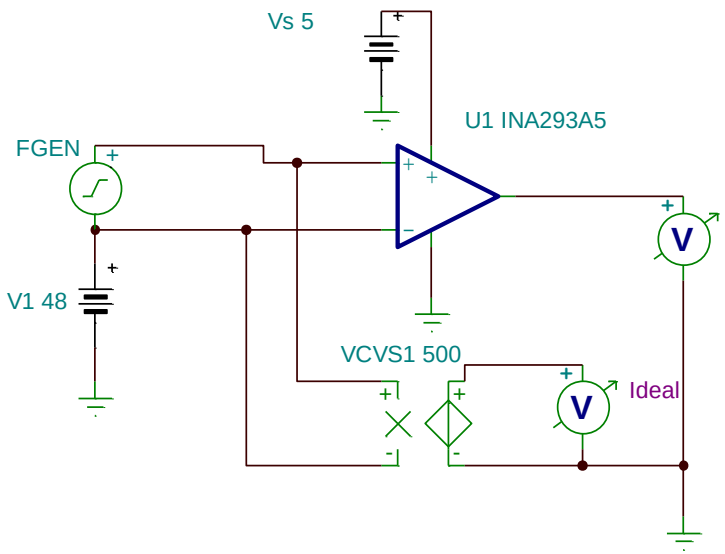
Graphical estimation ≈
0.05 V/200 ns →0.25 V/µS



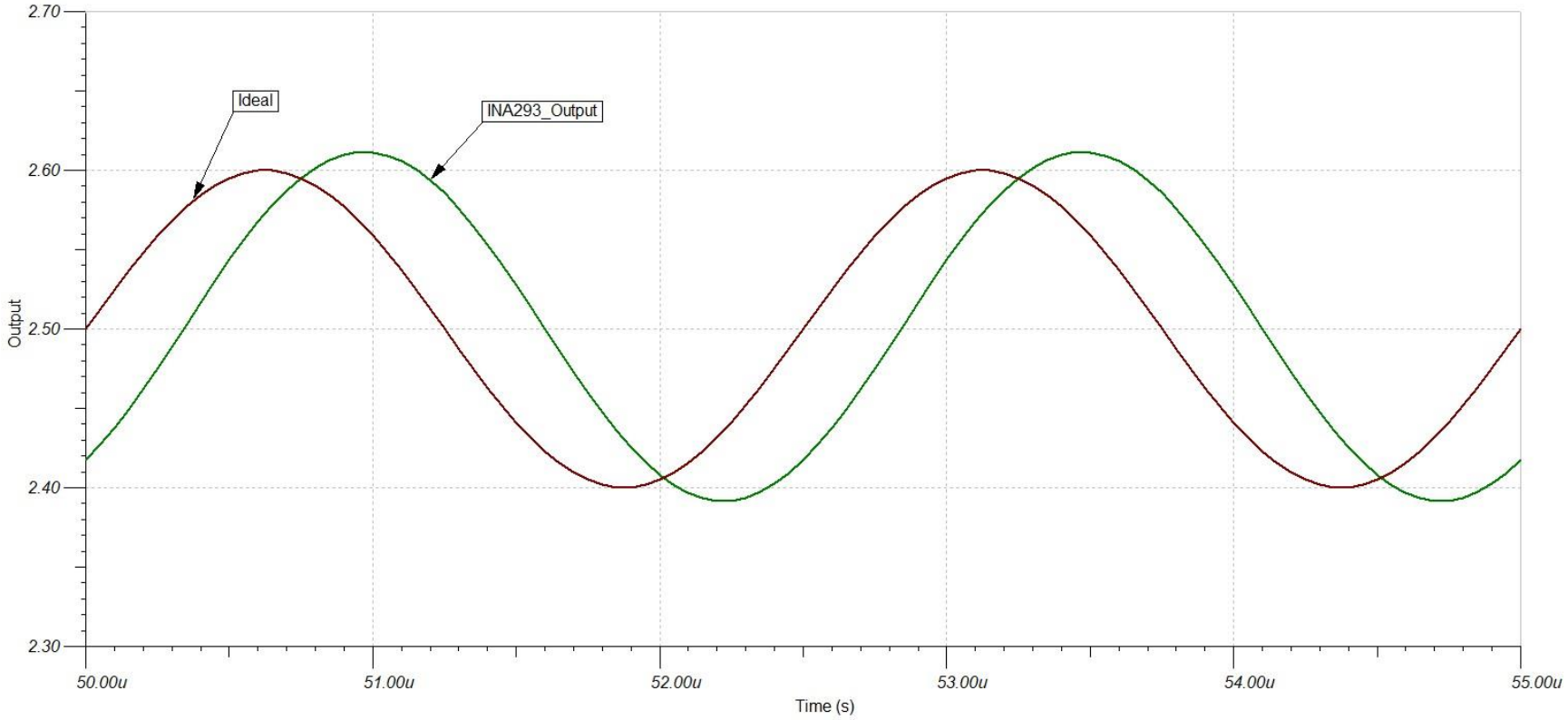
A = 2.5 V
F = 400 kHz
Max slew rate ≈ 6.28 V/µs

Graphical estimation ≈
0.5 V/80 ns →6.25 V/µS

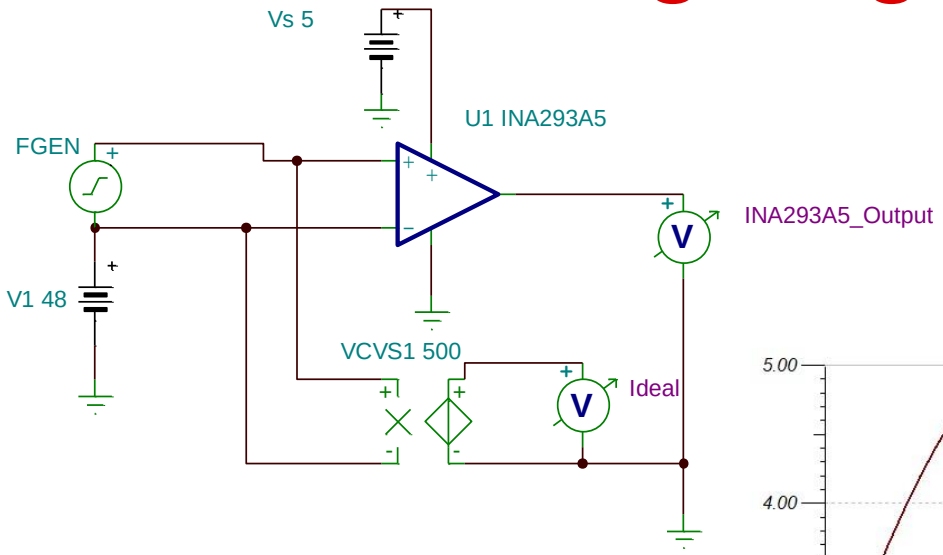
Bandwidth small signal transient simulation



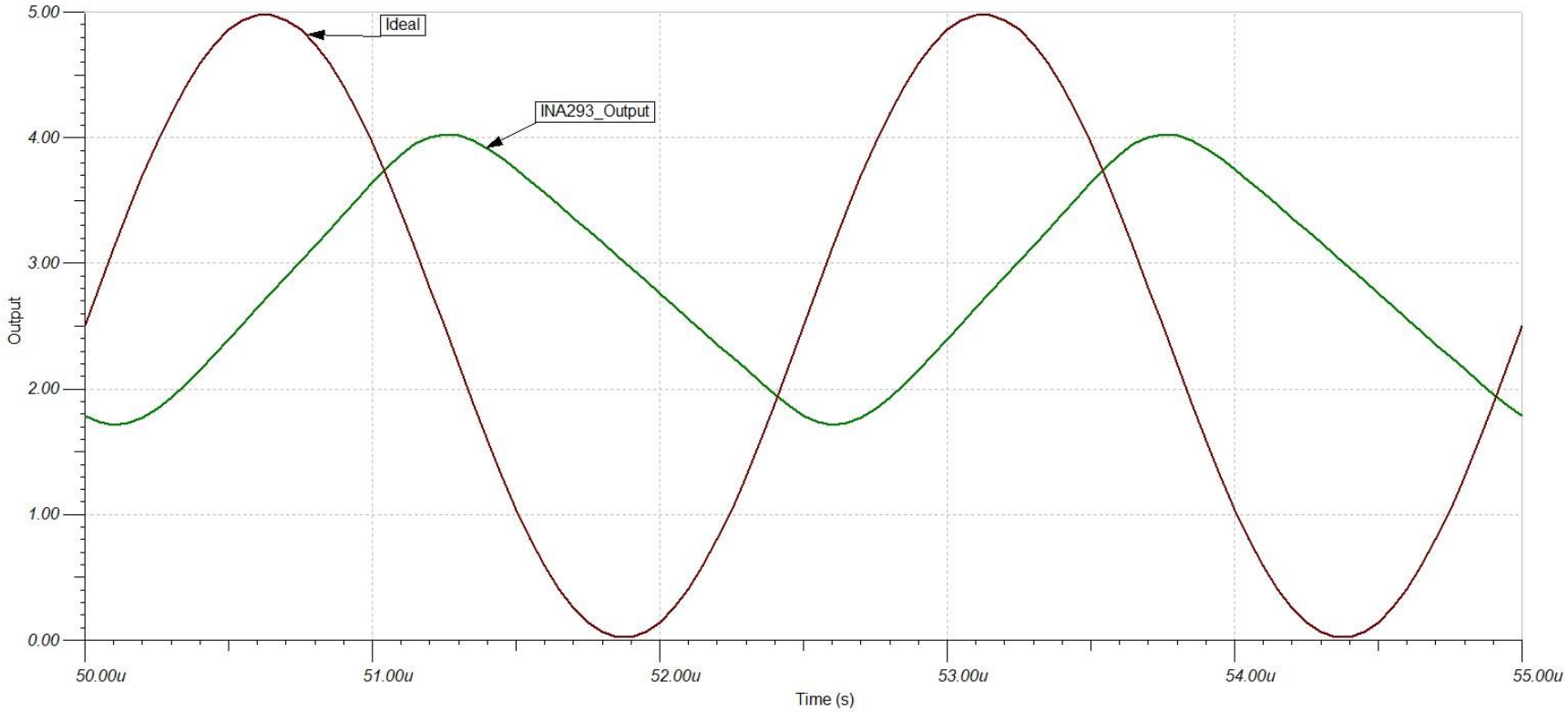
Input
Sinewave
200 µV amplitude
400 kHz



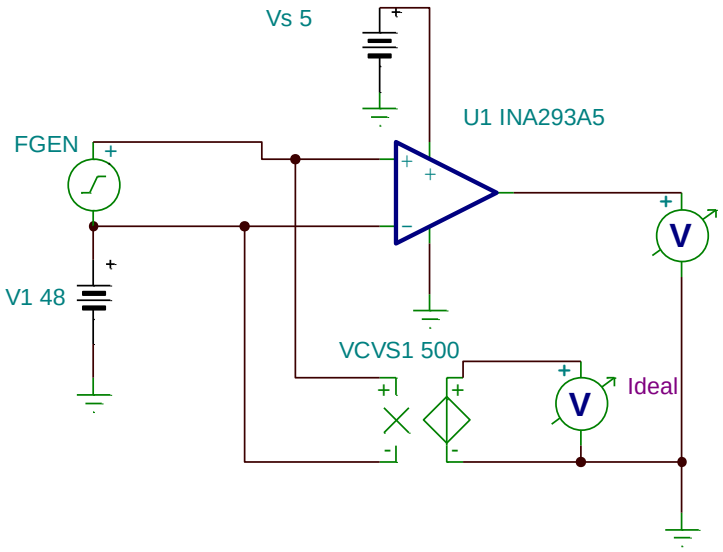
Bandwidth large signal transient simulation

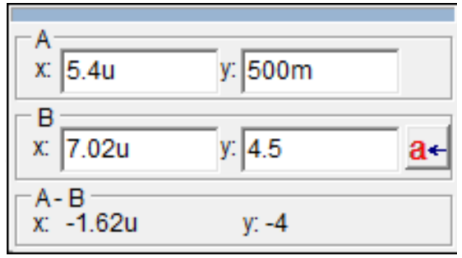


Input
Sinewave
~5 mV amplitude
400 kHz



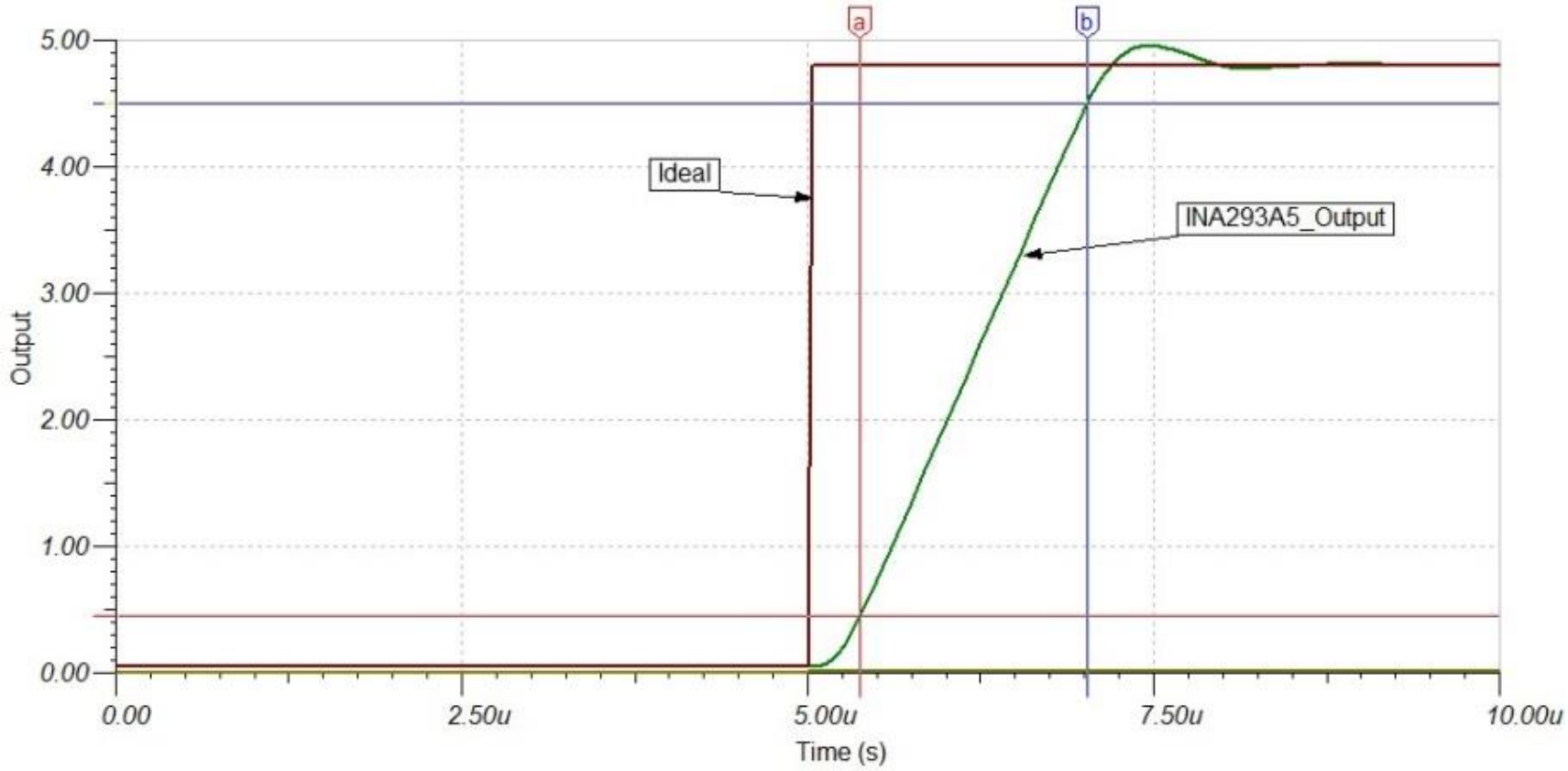
Slew rate





Input
Step
0.1 mV to 9.5 mV

Slew rate from simulation
4 V/1.62 µs→ 2.47 V/µs



Slew rate notes

- Slew rate measured in linear range of current sense amplifiers (CSA)
- Slew rate is not defined in non-linear range
- A device with a 0-V input could be considered having a negative input due to VOS for a unidirectional CSA
- Coming out of saturation requires time. Below is an example statement from the INA293:

8.2.2.1 Overload Recovery With Negative V_{SENSE}

The INA293 is a unidirectional current sense amplifier that is meant to operate with a positive differential input voltage (V_{SENSE}). If negative V_{SENSE} is applied, the device is placed in an overload condition and requires time to recover once V_{SENSE} returns positive. The required overload recovery time increases with more negative V_{SENSE}.

Normally modeled behavior

- Linear range of the device
- Small signal AC bandwidth
- Slew rate in linear range

Typical non-modeled behavior

- Outside of normal operating conditions.
- Overload recovery (non-linear)

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