Slew Rate 1

Exercises

TI Precision Labs – Op Amps
1. Draw the output waveform for the circuit below and the excerpt from the data sheet. Confirm this result with simulation.

### Frequency Response

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBW</td>
<td>2 MHz</td>
</tr>
<tr>
<td>SR</td>
<td>0.8 V/µs</td>
</tr>
<tr>
<td>t&lt;sub&gt;S&lt;/sub&gt;</td>
<td>0.1%</td>
</tr>
<tr>
<td>t&lt;sub&gt;SR&lt;/sub&gt;</td>
<td>0.01%</td>
</tr>
<tr>
<td>t&lt;sub&gt;OR&lt;/sub&gt;</td>
<td>20 µs</td>
</tr>
<tr>
<td>THD+N</td>
<td>0.0001%</td>
</tr>
</tbody>
</table>

### Data Sheet Excerpt

- **Vin**
  - -15.00
  - -10.00
  - -5.00
  - 0.00
  - 5.00
  - 10.00
  - 15.00

- **VCC, VEE**
  - 18

- **RF, RI**
  - 10k

- **Vout**
  - Draw Output Here

- **VOS**
  - Draw Output Here
2. Why does the output waveform below have two different slopes?
3. Will the circuit below have an issue with slew induced distortion? What is the maximum 400kHz input signal that can be applied before significant slew induced distortion? What is the bandwidth limit?

Vin
5Vpk,
400kHz
Sinusoidal
Wave
Slew Rate 1

Solutions

TI Precision Labs – Op Amps
1. Draw the output waveform for the circuit below and the excerpt from the data sheet. The amplifier is inverting and will start to slew in the opposite direction to the applied signal. It will take 20µs to fully transition the 20V step. Confirm this result with simulation. Simulation result matches this

\[ \tau_r = \frac{V_{PP}}{SR} = \frac{(20V)}{0.8 \frac{V}{\mu s}} = 25\mu s \]

Simulated Output

Draw Output

Rise Time = 25µs
2. Why does the output waveform below have two different slopes? This amplifier has slew boost. The output rise time reduces as the signal approaches its final value.

LARGE-SIGNAL STEP RESPONSE

Normal slew as output approaches final value

Slew Boost

Time (1μs/div)

2V/div

G = +1
R_L = 604Ω
C_L = 100pF

[Diagram of an amplifier circuit with labels for OPA209, RL, and CL]
3. Will the circuit below have an issue with slew induced distortion? **No,** the OPA192 can support up to 636kHz sinusoidal waveform 5Vpk. What is the maximum 400kHz input signal that can be applied before significant slew induced distortion? **7.96Vpk** What is the bandwidth limit? **5MHz**

\[
\frac{f_{\text{max}}}{2\pi \cdot V_P} = \frac{20 \frac{V}{\mu S}}{2 \pi \cdot (5V)} = 636kHz
\]

\[
V_P = \frac{SR}{2\pi \cdot f_{\text{max}}} = \frac{20 \frac{V}{\mu S}}{2 \pi \cdot (400kHz)} = 7.96Vpk
\]

\[
\text{BW} = \frac{\text{GBW}}{R_f + 1} = \frac{10MHz}{2} = 5MHz
\]