Georgia Institute of Technology

Introduction to Electronics

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An introduction to linear electric components and a study of circuits containing such devices.

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Differentiators and Integrators

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Introduce Integrating and Differentiating Op Amp Circuits

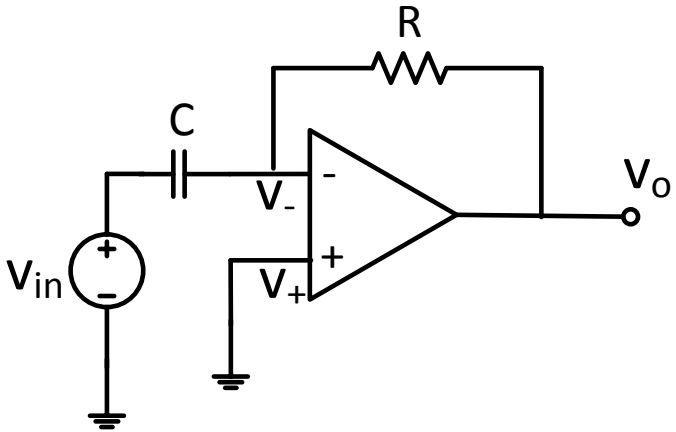
Previous Lesson

- Basic Op Amp Amplifier Configurations

Lesson Objectives

- Introduce Differentiators and Integrators
- Demonstrate the performance of both circuits on an oscilloscope

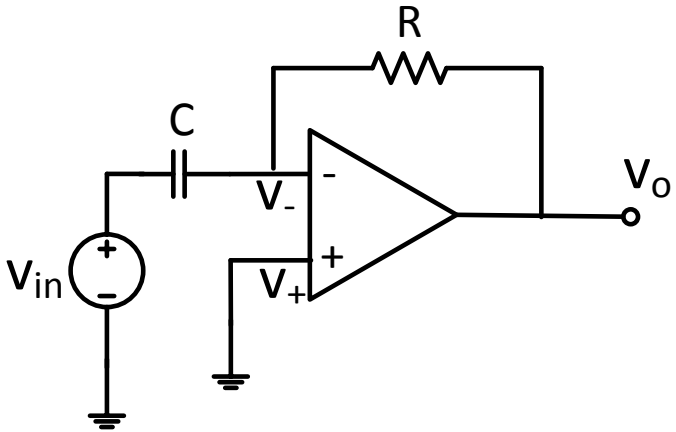
Differentiator Circuit



$$i = C\frac{dV_c}{dt}V_c$$

$$V_o = -RC\frac{dV_{in}}{dt}$$

Differentiator Circuit

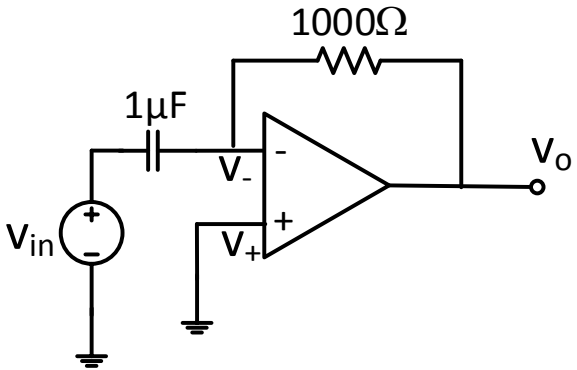


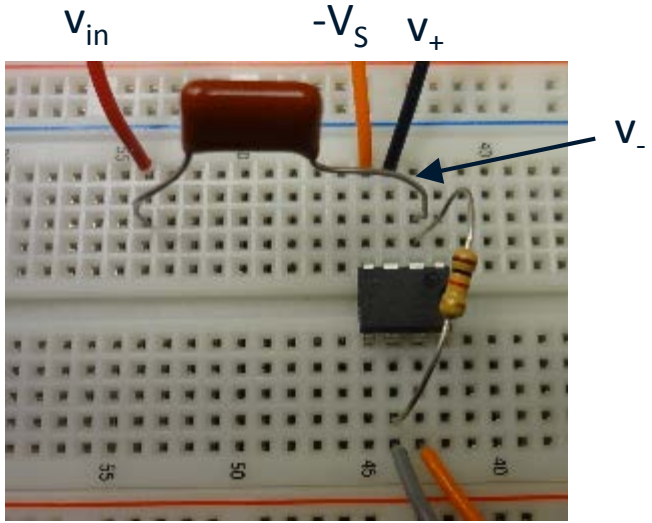
$$V_o = -RC\frac{dV_{in}}{dt}$$

Derivation:

1. KVL: $V_{in} = V_c + Ri + V_o$
2. $V_{in} = V_c$
3. $V_o = -Ri = -RC(dV_{in} / dt)$

Differentiator Example





V-

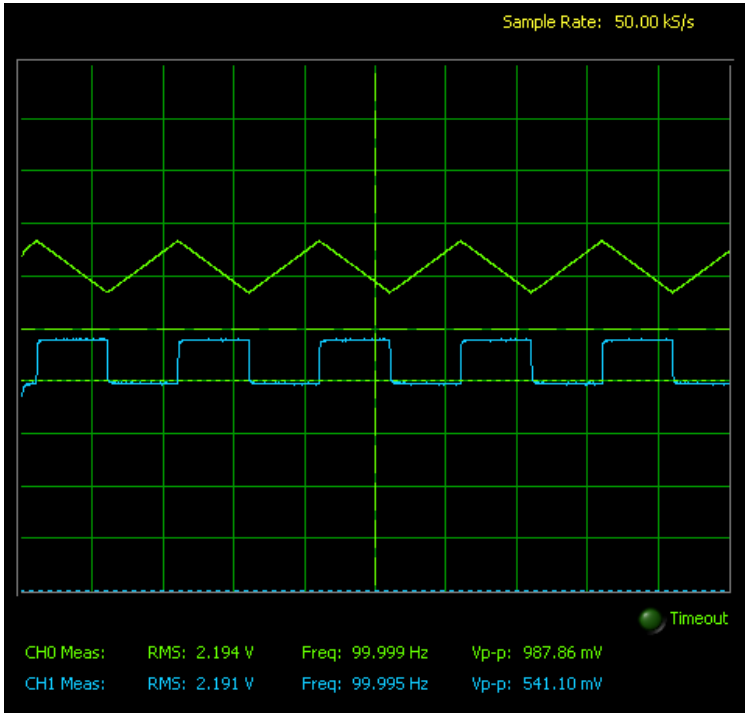
V+

$-V_S$ = -15v

$+V_S$= 15v

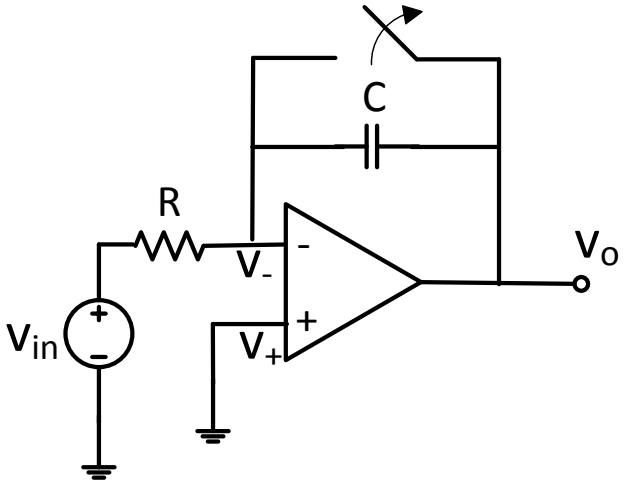
Vo

Results



$$V_o = -RC\frac{dV_{in}}{dt}$$

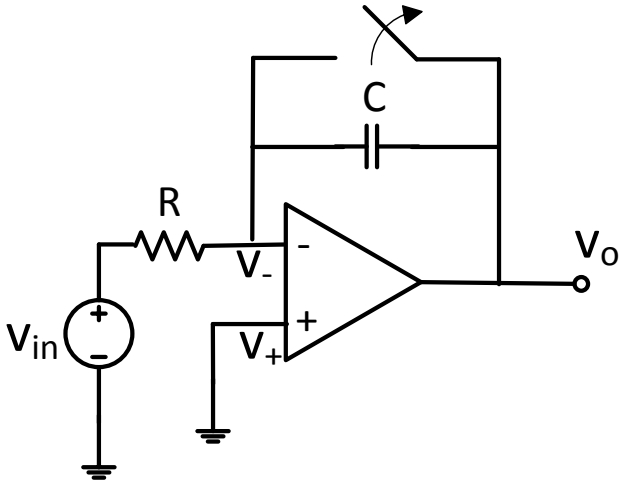
Integrator Circuit



$$i = C\frac{dV_c}{dt}V_c \qquad V_c = \frac{1}{C}\int_0^t i\,dt$$

$$V_o = \frac{-1}{RC}\int_0^t V_{in}\,dt$$

Integrator Circuit



$$V_o = \frac{-1}{RC}\int_0^t V_{in}\,dt$$

$$i = C\frac{dV_c}{dt}V_c \qquad V_c = \frac{1}{C}\int_0^t i\,dt$$

Derivation:

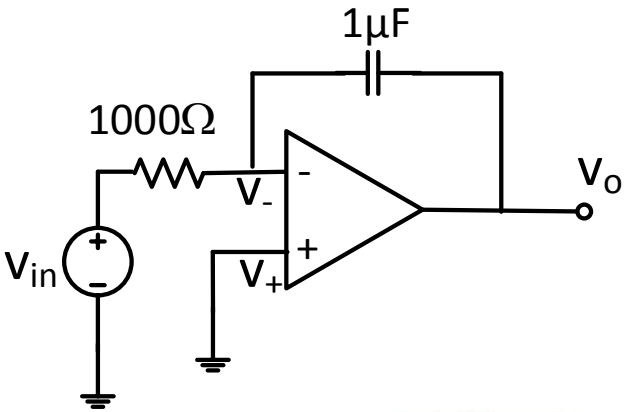
For t<0: $V_{in} = iR$ and $V_o = 0$

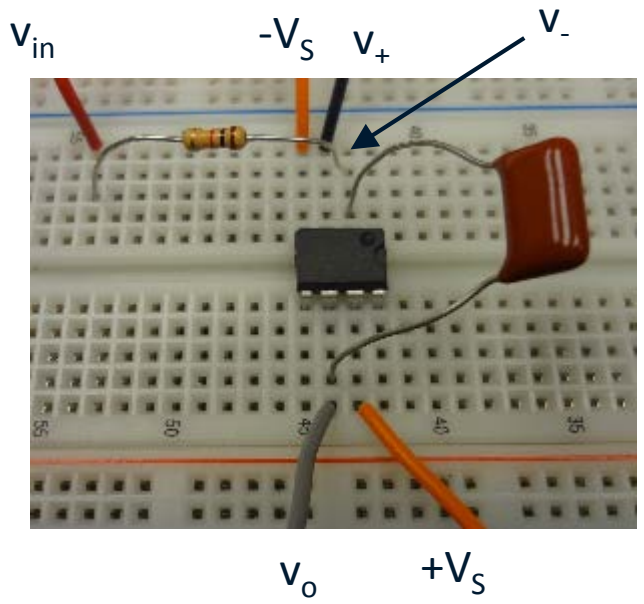
For t>0: $V_{in} = iR$ $\quad i = V_{in}/R$

$V_{in} = iR + V_c + V_o$

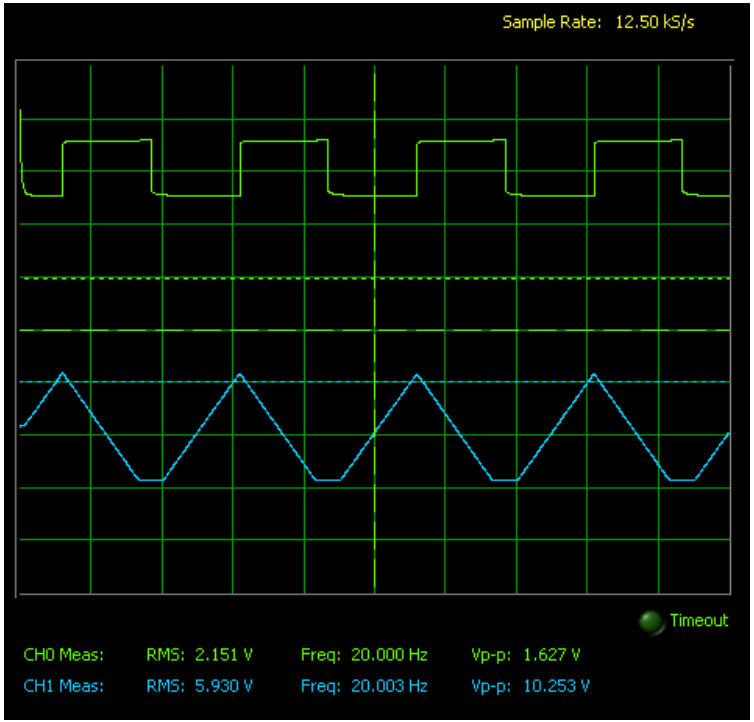
$V_o = -V_c = -1/C \int_0^t V_{in}/R\,dt$

Integrator Example





Results



$$V_o = \frac{-1}{RC}\int_0^t V_{in}\,dt$$

Summary

- Differentiator and Integrator Op Amp circuits examined

Next Lesson

- Active Filters